REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS AND HOUSING
DIRECTORATE GENERAL OF HIGHWAYS

GENERAL SPECIFICATIONS

FOR FREEWAYS AND TOLL ROADS

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DIVISION 1 GENERAL

S1.01 Abbreviations

In addition to the definitions stated in the General Conditions of Contract, the following abbreviations are used in the General Specifications and Bill of Quantities and they shall be interpreted as follows:

C.B.R	-	California bearing ratio
cm	-	Centimeter(s)
Cov.Pl.	-	Cover plate
cu.m or m3	-	Cubic meter(s)
Dia. or Ø	-	Diameter
Diaph.	-	Diaphragm
Drg. or Dwg	-	Drawing
Ea	-	Each
Guss.	-	Gusset
Hp	-	Horsepower(s)
Kg	-	Kilogram(s)
L.M. or m	-	Linear meter(s)
lt	-	Liter(s)
Max.	-	Maximum
Min.	-	Minimum
mm.	-	Millimeter(s)
No.	-	Number
P.C.	-	Prestressed Concrete
R.C.	-	Reinforced Concrete
Rp.	-	Rupiah(s) of the Republic of Indonesia
Sht.	-	Sheet
Spl.	-	Splice
sq. cm or cm^2	-	Square centimeter(s)
sq. m or m^2	-	Square meter(s)
T or ton	-	Metric tonne
W or Wt	-	Weight

S1.02 Materials

S1.02 (1) Unless otherwise specifically provided in this Contract, all items incorporated in the completed work, such as plant, materials and other Clauses, are to be new and the most suitable grade for the purpose intended. Unless otherwise specifically provided in this Contract, reference to any plant, material, article, or patented process, by trade name, make, or catalogue number, shall be considered as establishing a standard or quality and shall not be construed as limiting competition, and the Contractor may, at his option, use any plant, material, goods, or process which, in evaluation of the Engineer, is equal to that named. Unless otherwise specified or instructed, all proprietary materials shall be used in accordance with the Manufacturer's instructions.

S1.02 (2) The Contractor, before placing any order for materials or manufactured goods o be incorporated in the Permanent Works, shall submit for approval a complete description of such items, the names of firms from whom the Contractor to obtain them, and a list of such of the items that proposes the firms should supply. The Contractor shall submit samples and certificates for approval of the Engineer.

S1.02 (3) The Contractor shall make all arrangements for locating, selecting and processing natural materials in accordance with these Specifications and shall submit for approval full information regarding the proposed location of the material source at least 30 days in advance of commencement of working the material. The Engineer's approval of a source does not imply that all the material in that source is approved. Locations of material sources that may be used and identified and specified in Drawings are the information only. The Contractor shall determine for himself the amount of equipment and work required to produce a material meeting the Specifications. It shall be understood that it is not feasible to ascertain from samples the exact limits for an entire deposit and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable

S1.02 (4) In the case of bituminous materials, cement and other manufactured material the manufacturer's test certificates are required to be submitted to the Engineer for his initial approval. The Engineer shall give his approval in writing to the Contractor for ordering. All materials that are delivered to the site shall be tested as specified under the supervision of or as directed by the Engineer.

S1.02 (5) If the quality of the material delivered to site does not conform to the quality previously inspected or tested, the offending material shall be rejected, and shall be removed from the site within 48 hours unless agreed otherwise with the Engineer.

S1.03 Storage of Materials

S1.03 (1) Materials shall be stored so as to ensure preservation of their specified quality and fitness for the work. They shall be placed on a hard, clean surface and, when required, they shall be placed under cover. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without written permission of the owner and lessee and payment to them, if necessary.

S1.03 (2) The stockpile site shall be prepared by clearing and leveling as directed by the Engineer.

S1.03 (3) The center of all aggregate stockpile areas shall be raised and sloped to the sides as required so as to provide proper drainage of excess moisture. The material shall be stored in such manner as to prevent segregation and coning and to ensure proper gradation and moisture content. Coarse aggregate storage piles shall be lifted up and removed in layers not exceeding one meter. The height of such stockpiles shall be limited to five meters.

S1.03 (4) Site means the places where the Permanent Works are to be executed including storage and working areas and to which Plant and Materials are to be delivered, and any other places as may be specified in the Contract as forming part of the Site.

S1.04 Royalties

The Contractor shall be responsible for all compensation and royalties due in respect of quarried materials. No separate payment will be made for the compensation of royalties, but all such costs shall be included in the applicable unit price and total of the Bill of Quantities.

S1.05 Right-of-Way

The right-of-way is the land to be acquired for and devoted to the Road. The right-of-way widths shown on the Drawings are approximate only, the effective width to be established by the Engineer.

S1.06 Working Area and Maintenance of Adjacent Roads and Bridges

The Contractor shall make all arrangements, inclusive of payment, if necessary, for the use of any land required for working areas outside the right-of-way, and the Employer will not accept any liability in connection with the use of such land. Any exceptions to this will be given in the Special Specifications or at the time of Bidding.

Existing public roads and bridges adjacent to the project which are use by the Contractor in the course of his transport and haulage operations in performing the Works, including existing bridges strengthened by the Contractor, temporary bridges constructed by the Contractor and quarry access roads subjected to additional heavy loading as a result of the Contractor's activities, shall be fully maintained by the Contractor at his own expense throughout the duration of the Works and shall be left in a condition of serviceability, quality and amenity such is no worse than before the Contractor's operations were commenced. Temporary bridges constructed by Contractor shall not be removed by the Contractor at the completion of the Works.

Any incident and/or negligence due to the failing of implementation of the maintenance of adjacent roads and bridges as specified in this Clause S1.06, the deduction of payment shall be applied as described in Clause S1.41 of these Specifications.

S1.07 Site for Detours, Equipment, and Other Uses

The Contractor shall select, arrange for, and if necessary pay for the use of sites for detours, for all central mixing equipments for concrete and bituminous materials, for the storage of equipment, for his own office buildings, housing, or other uses necessary for the execution of the Work.

Before any land belonging to the Government or to a private land-owner is used for any purposes in connection with the execution of the Work, the Engineer's approval shall be obtained.

If any utility for water, electricity, drainage, etc., passing through the temporary site will be affected by the Works, the Contractor at his own expense, shall provide a satisfactory alternative in full working order to the satisfaction of the owner of the utility and the Engineer, before the cutting or removal of the existing utility.

On completion of the Contract, or earlier if so directed by the Engineer, all Equipment and any other encumbrances shall be removed, the site properly cleaned, all damage made good, and, if necessary, the land-owner paid for the use of the land.

S1.08 Living Quarters, Sheds, and Stores

The Contractor shall supply, equip and maintain for the Contract period all his own living accommodation, sheds and stores necessary for the execution of the Work, and shall make his own arrangements, subject to the approval of the Engineers, with the owner of any land required and, if necessary, pay for its use.

The furnishing and maintenance of living quarters, sheds, and stores shall be paid for as provided in Clause S1.20 "Mobilization". Such payment covers the utilization but not the ownership of the living quarters, sheds, and stores which will remain the property of the Contractor at the completion of the Contract.

S1.09 Offices and Field Facilities

S1.09 (1) The Contractor shall provide and maintain for the duration of the Contract, all their own accommodations, barracks and stores required for the execution of the Works, and shall carry out his own arrangement with the owner of the land to be occupied, to the satisfaction of the Engineer, and if necessary, to pay for the land use.

S1.09 (2) The supply, equipping and maintenance of items described in this Clause shall be paid for as provided in Clause S1.20 "Mobilization". Such payment covers the utilization but not the ownership of the offices and fields facilities which will remain the property of the Contractor at the completion of the Contract.

S1.10 Laboratory

The Contractor shall supply, equip and maintain for the duration of the Contract, an approved fixed or mobile laboratory with facilities, furniture, equipment, personnel, apparatus, and installations for the quality control and workmanship testing as required in this Contract. Generally, Contractor shall be responsible to carry out all instructions and coordination of the Quality Control Manager under the supervision of the Engineer.

The laboratory shall be equipped with all the necessary apparatus and materials for the performance of all the standard tests required by the Specifications.

Group 1.
Testing, in opinion of the Engineer, not routine testing which able to be carried out in the approved external accredited laboratories.

Group 2.

All other apparatus and materials necessary for tests required under this Contract shall be supplied by the Contractor and installed in the laboratory. Not later than 30 days after the Commencement Date, the Contractor shall submit for the Engineer's approval, a list of all equipment to be procured and details of suppliers.

All equipment used for testing shall be of standard type and approved by the Engineer and properly housed by the Contractor. An adequate supply of water and electric power shall be provided at all times.

Indonesian National Standard (SNI) shall be used for the procedure of testing and requirements of Works. In all cases, the Contractor may use the relevant or equivalent SNIs specified in these Specifications. The contractor shall use the recent edition of SNIs or other relevant standards as the replacements or directed of the Engineer.

Every designation of AASHTO Test and Material in these Specifications refers to "AASHTO Specifications for Highways Material and Methods of Sampling and Testing" and shall refer to the latest revision of the Specification at the time of project bidding, except where otherwise nominated.

In any case where material or workmanship is specified by one of the above tests, and alternative test methods are allowed, the method used to determine compliance with this Specification will be at the absolute discretion of the Engineer. The Engineer's decision will be final and claims on the basis of the Engineer's selection of a particular allowable test method will be rejected.

Other than the laboratory prescribed in this Clause, a field laboratory shall be provided by the Contractor with an area not less than 108 square meters at the location designated by the Engineer in order that the Engineer can monitor the material used for bituminous pavements and operations of bituminous mixing Equipments, as provided in DIVISION 9 of these Specifications.

The furnishing and maintenance of laboratories including staffing, water, electric facilities, equipment, apparatus and materials and all other expenses shall be provided on a rental basis and will be paid for as provided in Clause S1.20. However, the Engineer may, during the Time for Completion, order the Contractor to add laboratory equipment as necessary without any change to the lump sum price for Mobilization. Such payment covers the utilization but not the ownership of the equipment, apparatus and installation of the laboratory building which will remain the property of the Contractor at the completion of the Contract.

S1.11 Setting-Out and Staking

S1.11 (1) The Contractor shall set construction stakes establishing lines and grades in accordance with the Drawings and shall secure the approval of the Engineer before commencing with the work of construction. The Engineer will, if he deems it necessary, revise the line and grade and require the Contractor to adjust

the stakes accordingly. The Contractor shall give the Engineer not less than forty-eight hours notice of his intention to stake out or establish levels for any part of the work in order that arrangements may be made for checking. The Contractor shall measure the staking out and the Engineer will check the measurement. The approved measurement will be the basis of payments.

S1.11 (2) The Contractor shall, as a requirement of the Contract and without extra charge, furnish for the exclusive use of the Engineer all necessary instruments, appliances, surveyor personnel and labor, and any material that the Engineer may require for checking the setting out or for any other relevant work to be done. Such survey personnel and equipment shall include but not necessarily be limited to:

(a) 2 Surveyors

6 Surveyors' laborers

(b) Survey equipments:

3 sets of Surveying Equipment as listed below or equal approved by the Engineer:

- Receiver GPS (Global Positioning System) L1/L2
- GPS L1/L2 RTK (Real Time Kinematic) Receiver
- Electronic total station which can read a minimum of one (1) second, accuracy ≤ five (5) second, produced after year of two years before Contract signed, and has calibration certificate that is still effective when used.
- Auto / Digital Level
- Aluminum Tripod (Flat Head)
- Program Card, including software and data cable
- Min 1 MB SRAM
- Card reader/Writer Model Card
- Single prism set
- Pole Tripod Type PPS
- Telescopic Prism Pole with nivo
- Three (4) sets walky-talky
- 2 steel measuring tapes 50m long;
- 2 steel measuring rods (4m);
- Survey stakes as required; and
- Miscellaneous tools and consumables as required in surveying

Such survey equipment will be utilized by the Engineer and will be repaired or replaced by the Contractor as required by the Engineer, however the equipment will remain the property of the Contractor at the completion of the Contract.

The Contractor shall at his own expense make any additional surveys and measurements that are required for the construction of the work such as slope stakes, temporary grade stakes, and bridge and culvert layout, offset line, etc. The Contractor shall be responsible for the accuracy of all surveys or measurements made by his employees.

Any marks made by the Engineer or the Contractor shall be carefully preserved and, if disturbed or destroyed, shall be immediately replaced by the Contractor at

his own expense and to the satisfaction of the Engineer. No work shall be carried out in any section until the necessary setting out in that section has been approved by the Engineer.

S1.11.(3) The Contractor shall stake out in accordance with the Drawings prior to the commencement of any work. Measurement of the cross section shall be within an interval of 25 meter or less in accordance with the filed requirement.

After clearing and grubbing, the Contractor shall re-measure the cross section to obtain the recent field condition

S1.11 (4) The Contractor shall submit to the Engineer one set of hard copies, together with soft copies, of the cross-sections as required by Clause S4.02. The Engineer will endorse one copy with his approval or his revision thereof, and return it to the Contractor.

The Contractor shall resubmit as above for approval any cross-sections that the Engineer may require to be revised.

The Contractor's cross-sections shall be drawn on standard format with scales and layout as approved by the Engineer. When they have been finally approved the Contractor shall give the soft copy and three printout to the Engineer.

The drawings of cross-sections shall have a title block and be of a size stipulated by the Engineer.

S1.11 (5) The cost of complying with this Clause shall be considered to be included in the Bid Prices for pay items under the Contract.

S1.12 Notice of Operations

S1.12 (1) The Contractor, when required by the Engineer, shall supply in writing full information regarding the locations in which the materials are being obtained and in which the work is being prepared.

S1.12 (2) No permanent work shall be undertaken without the Engineer's approval. Full and complete notice in writing shall be given to the Engineer sufficiently in advance of the time of the operation for him to be able to make such arrangements as he may deem necessary for its inspection.

S1.13 Occupational Health and Safety

S1.13 (1) General

Description

(a) This Clause involves the provisions of occupational health and safety management during construction for any person in the job site related to the hauling of raw materials, the use of heavy equipment, the production process and the environment around the job site.

(b) OHS management involves the preparation of means for preventing occupational accidents and protection of occupational health during construction as well as the preparation of competent personnel and the

OHS organization in accordance with the level of risk determined by the Engineer.

(c) Contractor shall comply with the provisions of OHS management specified in the Minister Regulation of Public Works and Housing No.21/PRT/M/2019 or Amendments (if any) regarding the Guidelines for the Occupational Safety and Health Management System (SMKK) for Construction in Public Works and Housing Sector, and the Guidelines of Implementation of OHS (K3) for Road and Bridge Construction No.004/BM/2006, and other related regulations.

(d) The contractor shall provide the OHS manual in the form of Pictures and Practical Instructions on each type of work which that easily understood by any worker in the Site.

(e) All facilities and other means provided by the Contractor under this Clause, however they will remain the property of the Contractor at the completion of the Contract.

S1.13 (2) Health and Safety Management System

(a) The Contractor shall prepare, implement, and maintain continuously the procedures for hazard identification, risk assessment and control in accordance with the Health and Safety Plan which approved by the Engineer as described in Clause S1.20 Mobilization.

(b) The Contractor shall provide the Occupational Health and Safety with OHS Plan for implementing the OHS in all stages of construction.

(c) The Contractor shall presentate the OHS Plan at the pre construction meeting for the approval and signed by the Engineer in accordance with Minister Regulation of Public Works and Housing No.21/PRT/M/2019 or Amendments (if any) concerning Guidelines of Health and Safety Management System in the Public Works Sector.

(d) The Contractor shall provide at least a Middle Expert of OHS (*Ahli Madya K3*) with experience of minimum 3 years or a Senior Expert of OHS (*Ahli Utama K3*), a Junior Expert of OHS (*Ahli Muda K3*) with experience of minimum 3 years or Middle Expert of OHS (*Ahli Madya K3*), an Officer of OHS (*Petugas K3*) for the package with high, middle and low potential risk, respectively. The risk level of OHS will be determined by the Employer Representative.

(e) Works with high level risk such as welding, confined space, lockout/ tagout, excavation, working at height, electrical work, shall require a specific permit, requested by the Contractor approved by the Engineer

(f) An Expert of OHS is a person who has a certificate of training and competence from the authorities with evidence of work experience in the OHS for construction for the Public Works and Housing. Officer of OHS is an officer in a Contractor's organization who has been trained the OHS for Construction for the Public Works and Housing. Application requirements of OHS Expert and OHS Officer shall refer to the Minister

Regulation of Public Works and Housing No.21/PRT/M/2019 or the Amendments (if any).

(g) The Contractor shall prepare an Advisory Committee of OHS (P2K3) if:

(i) manage the Works with employees more 100 persons or a contract amount of more than IDR.100,000,000,000 (one hundred billion rupiah) or in accordance with applicable regulations.

(ii) manage the Works with employees less than 100 persons, but uses the materials, processes and installations that has a high risk of explosion, fire, poisoning and radioactive radiation.

OHS Facilitator Committee (P2K3) is an assistant board in headquarter and job site which is the cooperation between employers (Contractor) and workers to develop mutual understanding and effective participation in the implementation of occupational health and safety. The team of P2K3 consists of Chairman, Secretary and Members. Secretary of P2K3 is the principle of the Contractor's organization.

(h) The Contractor shall provide at least each 3 month a routine report of P2K3's activities to the Local Manpower Office and a copy to be delivered to the Engineer.

(i) The Contractor shall carry out an internal audit of OHS for construction in the Public Works Sector.

(j) The Contractor together with the Engineer conduct a periodic inspection of OHS for Construction weekly and/or monthly basis.

(k) The Contractor shall immediately carry out the necessary corrective actions to the discrepancies found at the inspection of OHS for Construction. The inspection report shall be submitted by the Contractor to the Engineer.

(l) The Contractor shall carry out a review to OHS Plan for Construction (in the part which really needs to be reviewed) continuously during the implementation of construction work in progress.

S1.13 (3) <u>OHS for Field Offices and Facilities</u>

(a) <u>Washing Facilities</u>

The Contractor shall provide adequate washing facilities and in accordance with the work being carried out for all construction workers. Washing facilities including the provision of hot water and cleaning agents for the following conditions:

(i) If workers are at risk of exposure to contamination of skin caused by toxic substances, substances that cause infection and irritation or other sensitive substances.

(ii) If workers handle the skin material which difficultly washed with the cold water.

(iii) If workers have to clean their whole bodies.

(iv) If workers are exposed to excessive heat or cold conditions, or working in unusually wet conditions, causing the workers have to clean their whole body, then the Contractor shall provide a number of showers.

(v) For normal conditions, the Contractor shall provide the showers for bath at least one for every 15 peoples.

(b) Sanitation Facilities

(i) The Contractor shall provide adequate toilet both for man and woman for women who employed inside or around the working areas and the bins with enough capacity.

(ii) If the Contractor employs more than 30 workers, the minimum requirements are 1 toilet with 1 closet

(iii) If the Contractor employs women, toilet facilities shall be equipped with napkin disposal facilities.

(iv) Toilets of man and woman shall be separated with a full height wall. Toilets shall be easily accessible, have an enough lighting and ventilation, and protected from the weather. If the toilet is located outside, it shall be provided with a walking path and adequate lighting along the path. Toilets shall be made and placed in a such manner so that they are able to keep the privacy of people who use them and shall be made of a material which is easily cleaned.

(v) The Contractor may provide one toilet if the number of man and woman less than 10 peoples; toilet completely closed; have the key; available napkin disposal facilities; there are no urinals in the toilet.

(vi) In all cases, the toilet shall provide clean water with the fairly and smoothly discharge, plumbing system that separates water and sewage and disposal through drainage channels with a good sanitation.

(c) Water

The Contractor shall provide enough supply of drinking water for all workers with the following requirements:

(i) The drinking water shall be easily accessible by all employees and clearly labeled as drinking water.

(ii) Containers for drinking water shall conform to the applicable health standards.

(iii) If the water to be stored in a container, the container shall be clean; protected from any contamination and heat; shall be emptied and filled with the drinking water from the sources that conform to the health standards.

(d) First Aid Kit for Accident (P3K)

(i) First aid kit shall be available in all vehicles use construction activities and in the Site. First aid kit box shall consist of a standard content as specified in Regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia No. PER.15/MEN/VIII/2008 or the modifications (if any) for First Aid for Accident at the Job Site.

(ii) A first aid team which consists of the trained persons shall be ready in the Job Site and responsible to first aid for accidents.

(e) Accommodation for Foods and Clothes

(i) Sufficient accommodation for workers shall be provided by the Contractor such as a room for eating, rest, and protection from the weather.

(ii) The changing room shall have a clean floor, equipped with tables and chairs, and other furniture to ensure the availability of a meal break and protection from the weather.

(iii) The trash bins for food waste shall be provided separately from the trach bins of organic, non organic, and hazardous and toxic waste, they shall be periodically emptied and cleaned.

(iv) The changing room for workers and the locker of each worker for unused clothes during working hours shall be provided.

(f) Illumination

(i) Illumination shall be provided in throughout the job sites, including in the room, roads, access, stairs and alleys. All illumintion shall be able to be turned on when any person goes through or utilize.

(ii) Additional illumination shall be provided for the detailed work, dangerous processes, or when using the machine.

(iii) Sufficient emergency lighting shall also be provided

(g) Maintenance Facility

The Contractor shall ensure that the implementation of maintenance facilities to be provided in a clean and hygienic condition, and they able to be conveniently accessed by workers.

(h) Ventilation

(i) All job sites shall have a clean air flow.

(ii) In the working areas which are very dusty such a concrete cutting, the use of hazardous chemicals such as adhesives, and in other conditions, the Contractor shall provide a breathing protective equipment such as respirators and eye protective.

S1.13 (4) The Requirements for Working in High Places

(a) Working in high places shall be carried out by workers who have a knowledge, experience and resources required to complete the work safely.

(b) Safety to work in high places can use one or more of the following protections: guardrails, safety net, individual fall arrest system.

(c) Safety around the working areas:

(i) Guardrails in work areas shall be provided along the edge of working floor or open working areas in accordance with the Sub-clause S1.13 (4) (d) of this Specification.

(ii) If the work floor or working area is placed in public roads and if the hazard of struck down materials or others to the road users, then the working floor or working area shall be exempted for the access or the safety net shall be installed.

(d) Guardrails for Job Site

If the guardrails to be used around the building, or openings in the roof, floor, or lift void, then the guardrails shall conform following requirements:

(i) The height shall be 900 - 1100 mm from the working areas;

(ii) Having a mid-rail.

(iii) Having the toe board if the hazard of falling tools or materials from the roof or working places.

(e) Safety Net

(i) Workers who install the safety net shall be protected from fall hazards. It is recommended to use a special vehicle (mobile work platforms) when installing the safety net. However, if this mechanical moveable equipment is not available, the worker who installed the safety net shall be protected with safety harness which tied to the safety line or the scaffolding shall be used.

(ii) Safety net shall be installed as close as possible to the inner side of work area.

(iii) Safety net shall be installed with sufficient clearance from the surface of floor or existing ground so that if the workers fall on the net, they will not be touch to the surface of floor or existing ground.

f) Individual Fall Arrest System

(i) Individual fall arrest system including inertia reel system, safety harness and static line. Workers who use these tools shall be priorly trained.

(ii) Safety belt shall not be used for roofing work.

(iii) Workers who use the safety harness shall not allowed to work individually. Workers who fall and hanging on the safety harness shall be saved not more than 20 minutes after falling.

(iv) Care shall be taken to anchors point of static line, inertia reel, and/or safety net.

(g) Ladder

If the ladder to be used, then the Contractor shall:

(i) Select the type of ladder in accordance with the work to be carried out.

(ii) Arrange the training to use the ladders.

(iii) Tying the top and bottom of stairs to prevent accidents due to shifting of the ladder.

(iv) Place the ladder as close as possible to the job.

(vi) If the ladder is used to climb to upper working area, ensure that the ladder shall be at least 1m above the working area.

(h) Scaffolding

(i) Scaffolding with height of more than 5 m from the existing surface is able to be carried out by personnel who have competence as a scaffolder.

(ii) All scaffolding shall be inspected by a competent person before utilizing, at least each week during utilization, after the bad weather or other disorders that able to affect the stability, if the scaffold not used in the long term. The inspection shall be recorded, including the damage that rectified during inspection. The records shall be signed by the person who carry out the inspection.

(iii) The person who conduct the inspection shall ensure that:

- Sufficient access to the bedding floor of scaffolding.
- All components of pole to be placed on the strong foundation and equipped with a base plate. If necessary, use a wood base or other means to prevent pole shift and/or depression.
- Scaffolding which to be strongly tied to the building/structure so able to prevent the scaffolding collapse and keep the sufficient strong tying.
- If some tyings have been moved since the scaffolding installed, the additional tying or other means to replace shall be provided.
- Scaffolding has been braced sufficiently to ensure the stiffness and stability.
- Pole, rod, bracing, or strut is not yet moved.

- The work floor boards have been installed correctly, the board shall be clean of defects and have good order.
- The board of working floor shall be properly fastened to prevent the shifting.
- The guardrails and toe board is available on each side where a person can fall.
- If the scaffold is designed and built to bear the load of material, ensure that the load shall be evenly distributed.
- The barrier or warning ia available to prevent the use of the incomplete scaffolding.

S1.13 (5) Electrical

(a) Power Supply

Portable electric tools that able to be used in moist condition is just the tools that meet the following requirements:

(i) Having isolated supply from the grounding with voltage of inter-conductor no more than 230 volts.

(ii) Having a monitored earth circuit where the power supply to the equipment will automatically disconnect if a damage on the grounding occurred.

(iii) The tool has a double insulation.

(iv) Having a power supply connected to grounding such that the voltage to grounding shall not more than 55 volts AC; or

(v) Having a gauge of residual current.

(b) Temporary Supply Switchboard

The entire supply switchboards to be used at job sites shall become a main concern and shall be:

(i) If they placed outdoors, they shall be made in such a way so they are not be disturbed by the weather.

(ii) Equipped with doors and locks. Doors shall be designed and attached in such a way that it will not damage the flexible cable connected to panel and shall be able to protect the switch from mechanical damage. The door shall be marked: PLEASE ALWAYS CLOSED.

(iii) Having insulated slot at the bottom.

(iv) To be attached on permanent wall or structure designed for this.

(v) If attached, ensure that they are attached with bolts.

(c) Inspection Equipment

All electrical equipments and tools shall be inspected before use for the first time and thereafter at least every three months. All electrical

equipments and tools shall have the identification mark which inform the last inspection date and the date of next inspection.

(d) Safe Vertical Height from Overhead Power Lines

Cranes, excavators, drill rigs, or other mechanical plant, structure or scaffold shall not be less than 4 m below the overhead power lines without the written permission of the authority of power line. The safe vertical height from Overhead Power Lines shall conform to the Regulation of Minister of Energy and Mineral Resources (ESDM) No.2-2019 or the modifications (if any), as shown in Table 1.13.(5)-1

Table 1.13.(5)-1 Minimum Safe Vertical Height from Overhead Power Lines

Location	OVERHEAD POWER LINES					
	High Voltage (HV) *(SUTT)*		Extra High Voltage (EHV) (*SUTET*)		High Voltage Direct Current *(SUTTAS)*	
	66 kV (m)	150 kV (m)	275 kV (m)	500 kV (m)	250 kV(m)	500 kV (m)
1. Open field or area	7.5	8.5	10.5	12.5	7	12.5
2. Areas with specific circumstances, including:						
- Building, bridge	4.5	5	7	9	6	9
- Plantation, forest.	4.5	5	7	9	6	9
- Road/Highway/ Railway	8	9	11	15	10	15
- Public field	12.5	13.5	15	18	13	17
- Other Overhead High Voltage Lines, Overhead Low Volatage Lines (SUTR), Overhead Communication, Antenna and Cable Car	3	4	5	8.5	6	7
- Highest point of mast when tidal / highest position in the water traffic	3	4	6	8.5	6	10

S1.13 (6) Hazardous Material and Chemicals

(a) Personal Protective Equipment (PPE)

The contractor is responsible to provide the personal protective equipment for workers with the following requirements:

(i) All workers and other personnel involved shall be trained to use the personal protective equipment and shall understand the reason why to use.

(ii) If deemed not practical to protect the top of body and if the risk of injury caused by falling objects, then the contractor shall provide

the protective helmet and all personnel involved in the field shall use.

(iii) Eye protection shall be used if there is a possibility of eye damage due to welding work, or of flake material such as pieces of sawing wood, or fragments of concrete.

(iv) Shoes to be used shall be able to protect the feet of workers. Use the shoes with metal tip on the toes.

(v) Protective noise shall be used if the noise level is high.

(vi) Gloves will be required on some jobs.

(vii) Respiratory protection should be provided to workers exposed to hazardous material such as asbestos, chemical fumes and dust.

(b) Danger of Skin

(i) Each employee shall report if getting the skin problems, especially in the hands due to the use of hazardous materials.

(ii) Hands and eyes of workers shall be protected against contact with cement. Keep in contact with cement to a minimum. The use of protective creams can reduce the risk of skin damage.

(iii) Wherever possible, protective clothing shall be used during working. This clothing including long sleeves, gloves and protective shoes.

(iv) The Contractor shall provide facilities for washing the body and change clothes as specified in Sub-clause S1.13 (3).

(v) Respiratory protective equipment shall be used during concrete curing process where dust commence be formed.

(c) Use of Chemicals

(i) The Contractor shall have procedures that arrange the method for handling properly hazardous chemicals or substances, method for storage, method for waste disposal.

(ii) All chemicals shall be stored in their original containers in a safe place and well ventilated.

(iii) All workers shall be trained when dealing with chemicals or hazardous substances including emergency measures that need to be carried out in case of problems.

(iv) The Contractor which uses hazardous material for road and/or bridge work shall prepare a management document, including the collection, transportation, storage, use, and/or processing of such materials, and submitted to the Ministry of Environment and Forestry (LHK) or Regional Environmental Agency (BLHD)

(v) List of toxic and hazardous which can be used, prohibited, or limited use refer to Appendix I and II of Government Regulation No.101-2014 or the modifications (if any) about Management of Toxic and Hazardous Materials.

(d) Cutting and Welding with High Pressure Gas

(i) The contractor shall pay attention to potential hazards as follows:

- A fire due to leakage of fuel (propane, acetylene), usually the damage of hoses or hoses connection.
- The explosion of tube due to oxygen leakage from hoses or welding cutting torch.
- Sucking noxious fumes from welding operations.
- Fires of the flammable materials around the welding area.

(ii) Tube Handling

- The tube shall not be rolled in the existing ground or handled roughly. If possible, use the trolley and binding tube with chain.
- The tube shall not be placed free standing alone to prevent the collapse of tube.
- The tube shall be left alone for a while when positioned up before use
- The tube and manifold valves shall be closed when not used according to the procedures

(iii) Storage of Tube and Accessories

- All hoses and cutting accessories shall be removed when work is finished and stored away from the tubes.
- Tubes shall be stored in a position away from combustible materials and sources of ignition.
- Storage of empty cylinders shall separate from fully filled tubes.
- In storage, oxygen shall be separated from fuel gas and flammable materials and liquids at least 7 meters or have noncombustible barrier of five-foot-height.
- Fire extinguishers shall not be closer than 8 meters, but not more than 50 meters away from where the fuel gas is stored.
- The tube shall be kept away from heat sources

(iv) Equipment

- Only hoses that meets the standards that can be used. Hoses shall be inspected every day to check for potential damage.
- The hose shall be as short as possible. If the hose shall be connected due to damaged parts, hose coupler and hose clamps shall be used.
- If a leak occurs and can not be stopped, the tube shall be moved to a safe place with open air and immediately contact the supplier.

- Oxygen hoses shall have a different color with the hoses for fuel gas lines (oxygen - green; fuel - red).
- To ensure the flashback holder is mounted on the both regulator (oxygen and fuel line) or in the inlet torch line.

(v) Fire Extinguishers and Personal Protective Equipment

- Flammable materials shall be removed from the working area and sufficient fire extinguishers shall be provided by the Contractor.
- Workers shall use the eye protection and protective clothing to protect against fire, leather gloves, long-sleeved, helmets, and other protective equipment.

S1.13 (7) Use of Machinary Equipments

(a) General

The entire machinery equipments shall be equipped with the use and safety manuals with a copy which easily accessed by the operator or superintendent.

(b) Automatic or Portabel Nailer and Stapler

If the Contractor uses the automatic or portable nailer or stapler, the following safety requirements shall be met:

(i) This equipment shall not be directed to a person, even it has a safety device.

(ii) Trigger of nailer or stapler shall not be suppressed unless the tip of equipment is directed to a secure object surface.

(iii) Special attention shall be paid if nailing at the edge location of an object.

(iv) If the power of automatic nailer or stapler is pneumatic power, it is not allowed to use a harmful and flammable gases.

(v) The damaged equipment shall not be used.

(vi) The proper hearing and eye protection shall be used when using these equipments.

c) Portable Power Tools

(i) Chainsaws, concrete mixer, reinforcing steel cutting tools and other motorized tools shall always be equipped with a safety device.

(ii) The Contractor shall comply with the following safety requirements:

- Each operator shall be trained to use the tools mentioned above.
- To use only the proper tools and methods for each type of work carried out.

- Damaged tool or machine shall not be used.
- The sharpness of cutlery shall be maintained.
- The hearing and eye protection shall be used whe using these tools.
- The area around the tool or machine shall be clean.
- Extension wires shall be placed in such a way to avoid damage of tools and materials.
- Additional illumination shall be provided when using the tool or machine.

d) Hoist for Lifting Person and Material

(i) Hoist Lift for person and material shall be carried out by a proper person.

(ii) The operator shall be a trained and having a specific permission to operate the equipment.

(iii) Hoist lift shall be on a firm foundation and tied to the building or structure.

(iv) The access for operator and maintenance personnel shall be safe.

(v) Basket lift shall have a minimum height of 2 m, with fully sides and solid doors or covered by a weaving wire with minimum diameter of 3 mm and maximum aperture of 9 mm. Basket lift shall be covered with a roof, at least made of wooden planks or plywood with a minimum thickness of 18 mm.

(vi) Basket height shall be minimum of 2 m and have a secure key. The solid door shall have a transparent panel.

(vii) The distance from the existing ground to the basket floor shall not be more than 50 mm.

(viii) Basket lift shall have an electro-mechanical locking mechanism which can only be opened from the basket and can only be opened when the basket touches the existing ground and can prevent the lift move when the basket is being opened.

(ix) Lifting shall be controlled from the basket inside.

(x) All parts of metal shall be connected to the grounding system.

(xi) Lifesaver shall be available to stop the basket if it falls or moves too fast.

(xii) Description of manufacture, model and load capacity shall be attached in the basket.

(xiii) A mechanism for emergencies shall be available to exclude those who are stuck in the basket.

(xiv) An emergency alarm shall be provided in the basket.

(xv) If possible, a means of communication between the operator and the working personnel to be provided.

(e) Crane and Lifting Equipment

(i) It is not allowed to move or lift goods/material with a risk of physical disorder to the workers if they do not use the lift.

(ii) The moving or lifting of goods/material with a difference elevation of more than 5 m and weight more than 500 kg shall use crane, excavator or forklift.

(iii) Operation of lifting and transportation equipment shall be carried out by an operator of lifting and transportation who have OHS License and shall refer to the guidance book in accordance with their type and qualifications. The competency requirements of operator of lifting and transportation shall refer to Regulation of Minister of Manpower No.8 Year 2020 concerning the Lift and Transportation Equipment.

(iv) Operator assistants shall be trained to give the signals to the operator and tie the load properly and know the capacity of crane lifting.

(v) Loading, uploading and liftup with a lifting equipment shall be arranged with uniform codes that are truly understood.

(vi) If more than one worker working on lifting equipment, the operator shall work based on a signal from one appointed person only.

(vii) Prior to the implementation, the load has been determined by the operator that can be lifted.

(viii) Fiber rope shall be checked before use and during the use to lift the rope shall be checked as frequent as possible and at least once 3 months.

(ix) Steel ropes shall be checked at the time of first installation and every day by the operator and at least once a week by a qualified person for Lift and Transportation from the Manufacture.

(x) Steel ropes shall be prohibited to be used if they are broken, worn or rusty wires based on the standard of requirements

(xi) Crane shall stand on a firm foundation.

(xii) Requirements for the use and property of lifting equipment shall refer to Regulation of Minister of Manpower No.8 Year 2020 or amendments (if any) concerning Lift and Transportation Equipment, and other related regulations.

(xiii) All cranes shall be equipped with safety devices that can automatically give a clear warning sign, if the lifting capacity exceeds that permitted.

(xiv) Crane shall be inspected weekly and inspected thoroughly every 12 months by a qualified person. Inspection results shall be recorded.

(xv) The lifting gear shall be in good condition and has been thoroughly inspected.

(xvi) Control devices (levers, switches, etc.) shall be thoroughly inspected.

(xvii) Sufficient space shall be provided for the safe lifting.

(xviii) Any jib crane with a capacity of more than 1 ton shall have a safe load indicator that checked every week.

(xix) Hook shall be equipped with a latch.

S1.13 (8) Measurement and Payment

(a) Payments to be made for the Contractor shall include all costs for Occupational Health and Safety (K3) including all costs for Construction OHS Experts on the high and moderate risk project and Construction OHS Officer for small risk project.

(b) Occupational health and safety work shall be paid on a lump sum basis for the pay item listed below, which to be paid in installments on a monthly basis, proportionally based on the accepted progress of work. This amount shall be as full compensation for the supply of all materials, equipment, labour, methods and all other costs deemed necessary or usual to proper completion of the work prescribed in this Clause.

(c) Notwithstanding to the provisions of General and Special Conditions of the Contract, the Engineer who represent the Employer's Representative will notice to the Contractor if the Contractor deviate from the requirements of Clause S1.13 Occupational Health and Safety by the first and second warnings. If the second warning is not responded, then the Engineer who represent the Employer's Representative will suspend the Works in accordance with Minister Regulation of Public Works and Housing No.21/PRT/M/2019 or Amendments (if any) and for any event and/or omission due to non-implementation of the requirements of Clause S1.13, the deduction of payment will be applied as described in Clause S1.41 of these Specifications. All costs incurred due to the suspension shall be the responsibility of the Contractor.

Pay Item No. and Name		**Unit of Measurement**
1.13	Occupational Health and Safety	Lump Sum

S1.14 Temporary Road Works

S1.14 (1) The Contractor shall furnish, maintain, and remove on completion of the work for which they are required, all temporary roads and road works such as sleeper tracks and staging over roads, access and service roads, temporary crossings or bridges over streams or unstable ground, and shall make them suitable in every respect for carrying Constructional Equipment required for the work, for providing access for traffic for himself or others, or for any other purpose. Such temporary road works shall be constructed to the satisfaction of the Engineer, but

the Contractor shall nevertheless be responsible for any damage done to or caused by such temporary road works.

S1.14 (2) Before constructing temporary road works, the Contractor shall make all necessary arrangements, including payment if required, with the public authorities or landowners concerned, for the use of the land and he shall obtain the approval of the Engineer. Such approval will be dependent on the Engineer being satisfied with the Contractor's proposals for items such as signing, lighting and riding quality of the temporary road together with the proposed maintenance arrangements. Such approval will not, however, relieve the Contractor of his responsibilities under the Contract. Upon completion of the works the Contractor shall clean up and restore the land to the satisfaction of the Engineer.

S1.14 (3) The Contractor, when required by the Engineer, shall submit for the Engineer's approval drawings giving full details of temporary roads. Such details shall include alignment, profile, pavement construction, signing, lighting and the duration of the temporary road.

S1.14 (4) The Contractor shall make all arrangements necessary to permit the passage along the road section relating to this Contract of the Constructional Equipment, materials and employees belonging to other Contractors engaged in the construction of contiguous stretches of road. For this purpose the Contractor and the contractors concerned in the construction of the stretches contiguous to those through which they shall pass shall, when necessary and with at least 15 days' notice, request the Engineer for permission to pass and submit a schedule for such passage. After the Engineer has granted such permission and approved the schedule submitted, both the Contractors permitting the passage and those requesting it shall undertake to observe the schedule approved by the Engineer for the passage along the site without having any right to extra payment in consequence of the restrictions on passage or the necessary temporary suspension of works due to the aforesaid schedule.

S1.14 (5) Payment for Temporary Road Works will be as provided in Clause S1.19 "Traffic Management and Safety".

S1.15 Temporary Traffic Ramps

S1.15 (1) General

To provide access to the Works, the Contractor shall construct, maintain and demolish the completed temporary access roads, including the temporary bridges, to provide the installation, equipment and vehicles which required for the Works.

The temporary road and/or bridge shall be constructed and accepted by the Engineer. However, Contractor shall be responsible for any deterioration of the temporary work.

The design of temporary bridge shall be prepared by the Contractor and submitted to the Engineer for his approval. However, this approval shall not relieve the Contractor from his responsibility under the Contract.

In cases where it is necessary or required by the Engineer, the Contractor shall construct and maintain temporary traffic ramps, and furnish all the labour and materials required therefor.

S1.15 (2) Layout

The general layout, dimensions and construction requirements shall be as shown in the approved shop Drawings or as directed by the Engineer.

S1.15 (3) Payment

Payment for temporary traffic ramps will be as provided in Clause S1.19 "Traffic Management and Safety".

S1.16 Traffic Control

S1.16 (1) General

In order to facilitate traffic through or around the Works, or wherever ordered by the Engineer, the Contractor shall erect and maintain at prescribed points on the work and at the approaches to the work, traffic signs, lights, flares, barricades, rubber cones with traffic lamps and other facilities as indicated in the Drawings or required by the Engineer for the direction and control of traffic.

Where required, or where directed by the Engineer, the Contractor shall furnish and station competent flagmen whose sole duties shall consist of directing the movement of traffic through or around the work.

In addition to the requirements, the Contractor shall furnish and erect, within or in the vicinity of the project area, such warning and guide signs as may be ordered by the Engineer.

In order to minimize disruption to traffic flows the Contractor shall enclose the Site with temporary fence to provide a visual barrier between his work and adjacent traffic. The temporary fence shall be of 2.0 m height as indicated in the Drawings and the movement of men, materials and Equipment into and out of the barriered area shall be controlled by flagmen.

For high speed roads and toll roads, details not shown in the Drawings shall be in conformity with all the applicable standards, Specifications and regulations of the agencies concerned such as "*Petunjuk Teknis Pemeliharaan Jalan Tol dan Jalan Penghubung* (PTP)" under Peraturan Menteri Pekerjaan Umum, Nomor 02/PRT/M/2007.

It should be noted that the construction work will take place in one of the busiest traffic corridors in Indonesia and the Contractor should thoroughly acquaint himself with existing traffic conditions and understand the importance of maintaining traffic safety and the avoidance of excessive traffic delay.

The Contractor shall co-operate with the pertinent agencies regarding traffic control and all details will be subject to the Engineer's approval.

Temporary Traffic Control as Traffic Safety Superintendent, Labour and Flagman, Traffic Sign as described in Table 1.16-1

The contractor shall estimate the required quantity of each type of purposes by the methods of work and requirements of the Contract Documents. The quantity

on the list is the minimum requirement to be prepared by the Contractor. Types of purposes that do not exist in the list below does not relieve the Contractor to complete when needed.

All temporary traffic control devices shall be provided by the Contractor under this Clause, however, they will remain the property of the Contractor and shall be cleaned out from the Site at the completion of the Contract.

Table 1.16-1 Temporary Traffic Control

Code	Description	Unit	Quantity
L	Traffic Safety Superintendent	person	1
L	Labor and Flagman	person	12
M	Traffic Cone	Each	500
M	Traffic Sign	Each	96
M	Temporary Fence with banner H=2.0m	M	1,000
M	Warning Light included power supply	M	1,000
M	Movable Concrete Barrier (New Jersey Type)	M	200
M	Project Description Board during Construction	Each	6
M	Brochure	Each	10,000
M	Overhead Banner	Each	8
M	Rotary Lamp	Each	20
M	Red Flag	Each	36
M	Flashlight	Each	20
M	Handy Transceiver	Each	12
E.38	Flat Bed Truck with 2,9 Ton Crane Patrol and Installation	Hour	1,500

S1.16 (2) Vertical Clearance

In general, any temporary works placed over roads or diversions used by public traffic should maintain a vertical clearance of at least 5.1 meters. Where required by the Engineer the Contractor shall erect and maintain suitable approved check gates, fitted with warning signs indicating the vertical clearance. Clearance over railway tracks shall be as required by the railway authority.

S1.16 (3) Materials

Materials for traffic control devices shall conform to the requirements set forth below and/or as specified in the contract. Details not covered by the plans and specifications shall conform to the applicable provisions of the PTP.

(a) Retro-reflective Material

Unless otherwise specified in the contract, sign panels, barricades, cones, vertical panels, and flagman paddles shall have retro-reflective sheeting meeting the minimum requirements for retro-reflective material, Clauses S12.07 and S12.08 of the General Specifications.

(b) Sign Panels

Sign panels shall conform to Clauses S12.07 and S12.08 of the General Specifications and shall be orange with black legend unless otherwise specified in the contract or required in the PTP.

(c) Sign Posts

Sign posts shall be fabricated from untreated soft wood, metal, or other materials acceptable to the Engineer. Signs shall be capable of remaining in position during normal traffic flow and wind conditions.

(d) Barricades

Barricades shall be constructed of wood, metal, plastic or concrete, e.g. New Jersey type.

(e) Cones

Cones shall be a minimum of 75 cm in height with a broadened base and shall be capable of withstanding impact without damage to the cones or vehicles. All cones shall be orange/white colored and highly visible both in daylight and darkness. Cones shall be capable of remaining bright and in position during normal traffic flow and wind conditions in the area where they are used. Lamps for cones shall be in accordance with PTP.

(f) Temporary Fence

Temporary fence shall be fabricated in panels with painted steel framework, galvanized metal panels and cover by banner which shows the perspective of the project and green plant as approved by the Engineer. The panel face towards the traffic shall be painted.

(g) Vertical Panels

Vertical panels other than for temporary fence shall be constructed of wood, metal or plastic.

(h) Warning Lights (flashing or steady)

Warning lights shall be installed in accordance with the minimum requirements of the PTP.

(i) Flagmen and Pilot Car Operators

Flagmen and pilot car operators shall be physically and mentally qualified, trained in their duties, efficient, and courteous. Each flagman on duty shall be identified with appropriate and distinctive apparel, including orange retro-reflective vest and hat, and shall be equipped with a highly visible, retro-reflective "Stop/Slow" hand sign. Flags will not be permitted unless approved by the Engineer.

Pilot cars shall be identified with an appropriate informative sign mounted on the rear thereof and with a rotating amber beacon and shall be operated at proper speeds. Strobe light beacons will not be permitted.

S1.16 (4) Construction Requirements

(a) General

The Contractor shall keep the entire length of the project in such condition that traffic will be accommodated safely. Traffic control devices and services shall be provided and maintained both inside and outside the project limits as needed to facilitate traffic guidance.

The Contractor shall prepare and submit for approval by the Engineer, traffic control plans for handling traffic. Such plans shall be based on the Contractor's Method Statements for Traffic Management as required by the Instructions to Bidders, modified or revised as required by the Engineer, and shall comply with the requirements of these specifications.

Prior to the start of construction operations, the Contractor shall erect such signs, barricades, and other traffic control devices as may be required by the plans and specifications or directed by the Engineer. Traffic control devices shall be operated only when they are needed and only those devices that apply to conditions actually in existence shall be operable.

Temporary fence shall be placed to provide a visual barrier between the work area and adjacent traffic or buildings and at locations directed by the Engineer.

Any devices provided under this Clause that are lost, stolen, destroyed, or deemed unacceptable while their use is required on the project shall be replaced by the Contractor without additional compensation.

During nonworking hours and following completion of a particular construction operation, all warning signs, except those necessary for the safety of the public, shall be removed or entirely covered with either metal or plywood sheeting so that the sign panel will not be visible.

Retro-reflective sheeting on signs, barricades, and other devices shall be kept clean. Stretches, rips, and tears in the sheeting shall be promptly corrected by the Contractor. Retro-reflective sheeting shall have a maintained retro-reflection.\

Night time operations shall be illuminated by a lighting system approved by the Engineer. The lighting system shall be positioned and operated to preclude glare to the approaching traveling public. Incandescent lights will not be permitted.

(b) Removal of Existing Marking

All conflicting construction striping and other pavement markings shall be removed to the fullest extent possible by sand blasting or other approved method that does not materially damage the surface or texture of the pavement. The removal pattern shall be in an uneven shape that does not perpetuate the outline of the removed markings by using diagonal strokes and including some surrounding surface area. Damage to the surface shall be repaired at the Contractor's expense by methods acceptable to the Engineer. Accumulations of sand or other material that might constitute a traffic hazard shall be removed. Upon completion,

sandblasted areas on bituminous surfaces shall be lightly coated with a coal tar emulsion or approved equal.

(c) Traffic Safety Superintendent

The Contractor shall have a competent Traffic Safety Superintendent who shall be responsible for the Contractor's maintenance of traffic operations. The Traffic Safety Superintendent shall have previous experience in supervising traffic management and safety through highway construction work areas.

The Contractor's Traffic Safety Superintendent's duties shall include the following:

(i) Understand the requirements of the current PTP, the contract drawings and specifications and the approved traffic control plans.

(ii) Routinely inspect the condition and position of traffic control devices in use on the project and assure that they are in proper working order, clean, visible, and conform to the plans and specifications.

(iii) Review and anticipate appropriate traffic control device needs, advise the Engineer thereof, and assure the devices determined to be necessary for safe and efficient traffic movement are obtained and placed.

(iv) Coordinate maintenance of traffic operations with the Engineer.

(v) Review work areas, storage of equipment, and handling and storage of materials to traffic safety.

(vi) Hold Contractor's traffic safety meeting with the prime Contractor's and Subcontractor's superintendents and foremen prior to beginning construction, and periodic meetings thereafter as deemed necessary or as directed by the Engineer. The Engineer shall be provided the opportunity to attend these meetings.

(d) Limitation of Operations

The Contractor's operations shall be limited as follows for roadways open to public traffic:

(i) Construction operations shall not be performed during the hours of darkness unless authorized by the Engineer.

(ii) The Contractor's equipment shall be operated in the direction of traffic, where practical.

(iii) Private vehicles belonging to the Contractor's employees shall not be parked along the roadway but shall be parked in areas approved by Engineer or off the right-of-way.

(iv) The Contractor shall provide approved equipment for two-way radio communications between flagmen when they are not in plain view of each other and shall make such equipment available to the Engineer for use as may be necessary.

(v) Prior to switching traffic to a completed lane, the Contractor shall have the following:

- Adequate personnel and equipment to remove and set up all traffic control devices as approved by the Engineer.
- Acceptable two-way radio communication network other than citizen band units.
- Paving and related equipment removed off the travel lane.

(vi) The Contractor shall schedule operations to minimize potential traffic backups. The Engineer may suspend the performance of the work, either in whole or in part, should an inordinate traffic delay occur during a construction operation.

(vii) The Contractor shall obtain all the permits and/or approval required for his operation mentioned above from the Police and any other authorities concerned.

S1.16 (5) Basis of Payment

Payment for this Clause of traffic control will be as provided in General Specifications Clause S1.19 "Traffic Management and Safety" and shall be deemed full compensation for complying with the requirements of and performing the work presented in this Clause

S1.17 Number of Lanes for Traffic Control

The existing number of traffic lanes on roads at the project site shall be maintained at all times during the work and if diversions are provided these shall be of the same traffic capacity as the original road. Notwithstanding the above, the Engineer may give approval to reductions in traffic capacity if the Contractor can show that these will not cause excessive delay to traffic. If such approval is given, the Engineer may specify the hours during the day when the reduction in capacity may be applied and it should be anticipated that these hours may not include the peak period for the traffic movement under consideration.

The Contractor shall cooperate with the pertinent agencies regarding traffic control and all details will be subject to the Engineer's approval.

The cost of complying with this Clause shall be deemed to have been included in Pay Item 1.19 "Traffic Management and Safety".

S1.18 Extraordinary Traffic

The Contractor shall observe the requirements of General Conditions of Contract and is responsible for carrying out any necessary investigations and the obtaining of approvals, licenses, escorts and any other necessary facilities in order to enable extraordinary traffic to be moved on the roads in the project area.

Any expenses arising out of this requirement shall be deemed to have been included in the lump sum payment for "Traffic Management and Safety" described in Clause S1.19.

S1.19 Traffic Management and Safety

Contractors shall follow the requirements as specified in the Minister of Public Works Regulation No.2/PRT/M/2007 "*Petunjuk Teknis Pemeliharaan Jalan Tol dan Jalan Penghubung"* so that during the construction it is not dangerous and safe for road users and do not interfere the smooth of running traffic. Design and installation of temporary road marking markers shall refer to the Minister of Transportation Regulation No. PM 67 of 2018 or changes thereof (if any) regarding road markings

The Contractor shall keep open to traffic existing roads during the performance of the Works, provided that when approved by the Engineer the Contractor may bypass traffic over a detour. The Contractor shall at all times keep roads and footpaths, affected by his operations, in good condition, free from soil and material spillage, and shall carry out repair and reinstatement work, including asphalt pavement repair, as directed by the Engineer.

The Contractor shall take necessary care at all times during the execution of the works to ensure the existing convenience and safety of residents along and adjacent to the road, and any public highway or port facility that may be affected by the Works. Street lighting shall be relocated as necessary to maintain the same standard of lighting during the course of the works until new lighting facilities are brought into operation.

To protect works, ensure public safety and facilitate traffic flow into and around the working location, the Contractor shall install and maintain traffic signs, barriers and other facilities at each site, where the execution of the work affect road users/traffic. All barrier signs including reflective stripes or other instrument shall be visible in the dark. The Contractor shall also provide and place the officer to direct and control the traffic flow into and around the works, in the locations where the execution of the work will affect the traffic flow. When the road surface is not fully completed and to be opened to traffic, the Contractor shall provide pre marking and temporary traffic signs or other road furniture required to ensure the safety of the road user.

The Contractor shall prevent congestion and accidents during transport of material to set the speed and implement the approved operating schedule.

All temporary road works and traffic control installations provided by the Contractor on adjacent or feeder roads to the site of works shall at all times during the Time for Completion be maintained in a safe and serviceable condition to the requirements and satisfaction of the Engineer, to ensure the safety of other traffic and of the public using the road.

Payment to the Contractor under Pay Item 1.19 shall be deemed to include the cost to the Contractor of meeting his obligations under this Clause together with such other items as are expressly stated in the General or Special Specifications as for being included payment in this Clause. Such payment covers the utilization but not the ownership of any facilities and means to support the traffic management and safety which will remain the property of the Contractor at the completion of the Contract.

Any incident and/or negligence due to the failing of implementation of the requirements in this Clause S1.19, the deduction of payment shall be applied as described in Clause S1.41 of these Specifications.

Payment of this sum will be made in three instalments, as follows:

- 25% (twenty-five percent) with the first Monthly Certificate after the main equipments for traffic management and safety delivered on Site and approved by the Engineer;
- 50% (fifty percent) with the Monthly Certificates in instalments proportional to the progress of work executed; and
- 25% (twenty-five percent) with the Final Certificate after clearing and demobilizing complete.

Pay Item	**No. and Name**	**Unit of Measurement**
1.19	Traffic Management and Safety	Lump Sum

S1.20 Mobilization

S1.20 (1) When the Bill of Quantities contains an item for "Mobilization", the following are understood to be paid for:

(a) Transport of Construction Equipment, on the basis of the list of Construction Equipment submitted with the Bid, from the port of unloading in Indonesia to the sites where they are to be used on the road under Construction, and their installation;

(b) The construction of offices, housing, workshops, stores, etc.;

(c) The supply, installation and maintenance of vehicles, living quarters, offices, laboratories, workshops, stores, communications, facilities, etc.; and

(d) Such other items as are expressly stated in the General or Special Specifications as being included in "Mobilization".

S1.20 (2) The Contractor may, always subject to the authorization of the Engineer, at any time during the works, make any alterations, reductions and/or improvements to the Construction Equipment and installations.

Payment is also intended to cover the dismantling of the work site by the Contractor, with the removal of all the installations, Constructional Equipment and equipment, so that the site is restored to the state it was in before the installations, Equipment and equipment were placed there.

S1.20 (3) Within seven (7) days after the Noice to Proceed, the Contractor shall prepare, submit and obtain the Employer's approval of a Mobilization Programme. The mobilization shall be completed within a period of 90 days from the Commencement Date except for the completion of the office, laboratory and housing shall be completed within a period of 45 days from the Commencement Date.

If some plants or equipments or instruments to be requested by the Employer at the end of the works, these may be handed over against payment to be agreed by

the both parties. In that case, a reduction to the cost of demobilization shall be agreed by the both parties, and this reduction will govern on the date of hand over.

Mobilization of main equipments and personals could be carried out in stages based on the mobilization schedule approved by the Engineer. This staging mobilization shall be amended in the Addendum.

.**S1.20 (4)** Payments under this Clause will be made in four installments for each Pay Item as follows:

- 30% (thirty percent) on completion of the office, laboratory, housing and other facilities for the Contractor;
- 50% (fifty percent) on completion of mobilization and acceptance by the Engineer;
- 20% (twenty percent) on completion of demobilization and acceptance by the Engineer.

In the event that the Contractor does not complete mobilization in accordance with either of the two limits specified in Sub-clause S1.20 (3), the amount to be certified by the Engineer for payment will be the full percentage installments of the Lump Sum price for Mobilization less an amount of 1 (one percent) of the value of the installment for each day's delay in completion up to a maximum of 50 (fifty) days.

Pay Item No. and Name		**Unit of Measurement**
1.20	Mobilization	Lump Sum

S1.21 Half-Width Construction

S1.21 (1) Where, in the opinion of the Engineer, a detour is not feasible, construction on existing public roads shall be undertaken only over half of the full width of the roadway. The length of such half-width construction shall be kept as short as possible.

S1.21 (2) Where half-width construction is necessary, work on culverts commenced in the dry season shall be completed and the embankment adjacent to them shall be reinstated so that at least half the full width shall be available for use by the public throughout the next rainy season.

S1.21 (3) Where single-lane traffic becomes necessary over a particular length of the works or over the approaches thereto, the Contractor, in maintaining through traffic, shall provide a single lane at least three and a half meters wide on the roadway or embankment to be kept open to traffic.

The Contractor shall so conduct his operations as to offer the least possible obstruction, inconvenience, and delay to traffic and shall be responsible for the adequate control of the traffic using such lengths of single lane.

S1.22 Filling in Holes and Trenches

The Contractor, upon completion of any part of the work, shall immediately, at his own expense, fill up all holes and trenches, or carry out the work to them as required by the Engineer, that he may have dug or excavated and are no longer required for the project, and he shall clear away all rubbish and material that is no longer required for the execution of the work.

S1.23 Location and Protection of Utilities

The utility survey results given in the drawings or in any other documents are intended only for the reference and guidance.

Before commencing construction work the Contractor shall undertake a survey, e.g. by making test pits, to establish the detailed location of all utilities to be affected by the Works. Survey results shall be recorded in plan form to the satisfaction of the Engineer and surface pegs fixed on the site to indicate the location of all underground utilities. These pegs shall remain for the duration of the contract.

Where works of either a temporary or permanent nature are to be undertaken by the Contractor in the vicinity of utilities, the Contractor shall adopt appropriate construction methods, provide adequate protective devices and take precautionary measures, without additional payment, in order to avoid damage to the utilities. Any damage to utilities caused directly or indirectly by the Contractor's work will be considered the Contractor's responsibility.

When during construction, there is a plan for installing the new utilities, the Contractor shall report this plan to the Engineer and the Employer. The Employer will coordinate with the employer of utilities.

The requirements of this Clause shall be met without additional payment and all costs thereof shall be included in the various items of the Bill of Quantities under the Contract.

S1.24 Project Information Signs

The Contractor shall within the mobilization period erect project information signs at all major roads crossing or joining the project area and at the beginning and end of the contract. The size of the project information signs and the message thereon shall be determined by the Employer and the Engineer. Payment for information signs and their proper maintenance during the entire construction period shall be considered as included in the lump sum payment as provided in Clause S1.20 - Mobilization.

S1.25 Maintenance of Existing Drainage

The Contractor shall maintain the existing drainage entering, crossing or affecting the works.

This shall include where required by the Engineer the cleaning of all existing channels, ditches and pipes upstream and down-stream to an extent of 100 m beyond the construction limits and the right-of-way.

These requirements shall be met without additional payment and all costs thereof shall be included in the various items of the Bill of Quantities under the Contract. However, should the maintenance work necessitate, in the opinion of the Engineer, repair, remedial or reconstruction work to the existing drainage, except where such work is due to damage caused by the Contractor, the Engineer will instruct the extent of such work required and the Contractor will be entitled to payment in accordance with the Contract.

S1.26 Working In and Dealing With, Existing Water Flows

S1.26 (1) The Contractor shall take all necessary measures to remove water from the area of his work when, in the opinion of the Engineer, this is necessary for the protection of completed work or to allow satisfactory execution of work in progress.

S1.26 (2) If an excavation or riverbed dredging can be avoided for the execution of proper work, the Contractor, after the work is completed, shall backfill all such excavations up to the original surface or river bed with materials approved by the Engineer.

S1.26 (3) Where the stabilization of the embankment or other permanent work will obstruct unavoidably all or part of the existing waterways, the drains shall be removed to ensure that the flow is not blocked by work at normal flow heights.

S1.26 (4) The removal of the such waterways shall maintain the bed slope of the existing waterways and should be placed in such a way which not cause destructive scouring both on the work and on adjacent property

S1.26 (5) The Contractor shall make measurements and cross sections drawing of the waterways to be removed and provide detailed markings for the work required. The Engineer could revise the Contractor's proposal before a transfer work begins.

S1.26 (6) Except for the extra payment detailed in Division 5 of these Specifications (Structure Excavation), all costs resulting from the Contractor's compliance with (1) above will be deemed to be included in this Pay Item.

Such payment is understood to include for the following :

(a) All expenses involved in providing temporary dams, pumps, cofferdams, temporary realignment of the flow, or any other methods approved by the Engineer.

(b) All expenses resulting from the Contractor's observance of all rules and regulations of appropriate authorities regarding the interference or maintenance of flow in the appropriate canals, water courses, channels or pipes.

S1.26 (7) Payment from such lump sum will be considered to be full compensation for all expenses involved in the work and the Contractor's estimate will be assumed to

be based on a thorough study of the work involved and be deemed to cover the cost of working in any season of the year and for working in flow of both storm water and foul sewage.

S1.26 (8) Payment of the lump sum will be made in such instalments as the Engineer considers reasonable and will be based on the total amount of such work in the Contract.

Pay Item No. and Name		**Unit of Measurement**
1.26	Working in and Dealing with, Existing Water Flows	Lump Sum

S1.27 Contractors Responsibility for Work

Where the approval of the Engineer is required under these Specifications, such approval shall not relieve the Contractor of his duties or responsibilities under the Contract.

S1.28 Standards of Workmanship

All workmanship shall be the best of its particular kind, and shall be carried out to the satisfaction of the Engineer.

S1.29 Protection of Works from the Weather

The Contractor shall, at his own expense, carefully protect all work and materials from damage by the weather.

S1.30 Units of Measurement

All units of measurement used in these Specifications and in the priced Bill of Quantities are according to the standard metric measurement (or unit mks-meter, kilogram, second) except specified otherwise.

S1.31 Day Works

If, in the opinion of the Engineer, it is necessary or desirable to execute any additional or substituted work or furnish any Labour, services or materials regarded as being on a Day work basis after a written order of the Engineer, the Contractor shall therefore be paid for such work and supply according to the priced Bill of Quantities.

The measurements shall be taken jointly and recorded and agreed at the time such work is executed or such material furnished. The Contractors measurements will not otherwise be recognized by the Engineer.

The Engineer shall always have full access to the Contractors time records, and may check daily with the Contractors timekeeper, or otherwise, the time taken for executing any Day work, but the fact of his agreeing upon any time shall in no way bind the Engineer to value the work other than by measurement and

comparing unit costs of the same work done under this contract. Details for Day Work are given in Division 17.

S1.32 Templates and Straightedges

S1.32 (1) Sufficient metal templates shall be furnished by the Contractor and used by the Contractor or the Engineer to check the finished surface of the pavement structure. These templates shall be submitted to the Engineer for his approval. The templates used to control the work shall be maintained at all times in a condition to produce the correct cross-sectional profile and shall be checked at intervals and, if necessary, repaired or adjusted as directed by the Engineer.

S1.32 (2) The Contractor shall furnish sufficient straightedges, three meters long, to check the surface of the pavement.

S1.32 (3) The furnishing of templates and straightedges will not be paid for directly, but all costs shall be included in the Bid Prices for Pay Items under the Contract.

S 1.33 Orders to Foreman

Whenever the Contractor or his authorized representative is not present on any part of the work where the Engineer may decide to give orders or directions, such orders or directions shall be received and obeyed by the foreman or other person who is in charge of the particular work concerned. All foreman shall be proficient in Indonesia language, or the Contractor shall provide interpreters to the satisfaction of the Engineer as to their number and proficiency in Indonesia language.

S1.34 Work and Material included in the Contract Prices

S1.34 (1) The work to be performed and the material to be furnished under the various Clauses of these Specifications, or shown on the Drawings, or the supplementary or explanatory drawings, or ordered by the Engineer for all Labour, materials, Construction Plant, organization of work, profits, royalties, taxes, custody of completed works, payment to third parties for land or the use of land, or for damage to property, incidental work where herein specified for the proper completion of the Works; temporary drainage to protect the Works during construction, haulage, tools, explosives and material for blasting, placing of material where herein specified or where directed, sheeting, shoring, staging, centering and supports, usual for the proper performance of the work are not paid for separately.

S1.34 (2) In case where the basis of payment Clause or part of any Clause in these Specifications relating to any pay item requires that the Contract Price covers and be compensation for certain work or material essential to the item, this same work or material shall not be measured or paid for under any other item that may appear elsewhere in these Specifications.

S1.34 (3) The Contractor shall construct the Works to the details given in the Contract Drawings, and the directions of the Engineer under a predominantly unit price

system. Payment to the Contractor shall be made for the actual measured quantities of Contract Pay Items performed in accordance with the relevant Divisions of these Specifications concerning measurement and payment. Payment shall also be made on the basis of the measurement and payment provisions of the lump sums for Clause S1.13 Occupactional Health and Safety, Clause S.1.19 Management Tarffic and Safety, Clause S1.20 Mobilization, Clause 1.26 Working In and Dealing With, Existing Water Flows, Clause S1.39 Environmental Safeguard, Clause S1.40 Quality Management, and the part of Clause S16.01 Toll Office and Facilities as well as for Works instructed on Division 17 Day Works.

S1.35 Workshop

The Contractor shall have on the Site a suitable workshop, adequately equipped and provided with electric power, to allow for repairs on the equipment employed to carry out the Works. He shall also provide a warehouse for the equipment spare parts, mainly for the parts that frequently fail or are difficult to procure.

The workshop shall be managed by a chief foreman qualified for mechanical repairs, with an adequate labour force. The furnishing of the Workshop, including all equipment and facilities, shall be paid for as provided in Clause S1.19.

S1.36 Drawings

The Drawings of this project are issued and made part of these Specifications and the Contract Documents. It shall be anticipated that minor revisions of alignment location, section and details may be made during the work. The Contractor shall perform the work in accordance with the intent of the Drawings and Specifications and shall take no advantage of any error or omission in the Drawings or discrepancy between the Drawings and these Specifications. The Engineer will make such corrections and interpretations deemed necessary for the fulfillment of these Specifications and Drawings. Where dimensions on the Drawings are given or can be computed, scaled measurements shall not be used except when approved by the Engineer. Any deviation from the Drawings due to field conditions not anticipated will be determined by the Engineer and authorized in writing.

S1.37 Fire Prevention

The Contractor shall take adequate fire prevention measures during the carrying out of his operation ad in his camps, stores and workshop areas. He shall provide and maintain throughout the Contract period adequate firefighting equipment in all camps, offices, stores and workshop as provided for in Clause S1.20.

S1.38 Irrigation Works

The Contractor shall not interrupt or interfere with the flow of irrigation waters without making prior arrangements with and obtaining the agreement of the irrigation authorities. The Contractor shall allow in his program for the

construction of those works which might interfere with the flow of irrigation waters to be carried out at such times as will cause the least disturbance to irrigation operation.

S1.39 Environmental Safeguards

S.1.39 (1) General

(a) This Clause covers the provision of environmental countermeasures and actions that are needed to perform any civil works required under the Contract. In most cases the Clauses have been extracted from other Clauses of these Specifications and are included here to ensure awareness and compliance.

(b) The Contractor shall take all reasonable steps to protect the environment (both on and off the Site, access road, including base camp and other installations under the control of the Contractor) and to limit damage and disturbance to people and property resulting from pollution, noise and other results of his operations. The Contractor should also ensure that transportation, quarrying activities and all other activities are undertaken in an environmentally acceptable manner.

(c) As a means of minimizing environmental disturbance to all nearby communities all construction and transportation activities shall be confined to the hours of operation as defined in the Conditions of Contract, unless otherwise approved by the Engineer.

(d) Prior to implementation of the Contract commences, if excluded in the document category of Environmental Impact Assessment (EIA, Ind: AMDAL) or Environmental Management Effort / Environmental Monitoring Effort (Ind : UKL/UPL), Environmental Evaluation Document (Ind: DELH - *Dokumen Evaluasi Lingkungan Hidup)* atau Environmental Management Document (Ind: DPLH - *Dokumen Pengelolaan Lingkungan Hidup*), the Employer Representative will notice the Contractor the obligation to carry out environmental management in accordance with the provisions of these Specifications and to fulfill the provisions as regulated in the environmental regulations / legislation in the field of roads, local regulations and other relevant laws and regulations and based on the approval of the relevant environmental agencies.

(e) Before the commencement date, if the activities plan is included in the EIA or UKL-UPL or DELH or DPLH mandatory category, the Employer Representative shall notice in writing to the Contractor to comply with and implement the environmental management and monitoring plan stated in the Environmental Document, Decree of Environmental Feasibility (SKKLH – *Surat Keputusan Kelayakan Lingkungan Hidup*) and/or the available Environmental Permit (Izin Lingkungan). The Contractor shall prepare himself all Environmental Permit requirements related to his activities in all activity locations such as quarry, AMP (Asphalt Mixing Plant), CBP (Concrete Batching Plant) and base camp, as required, and attach a copy of the environmental permit in the Pre

Construction Meeting (PCM) and Implementation Report RKPPL. The form of RKPPL as shown in Attachment 1.39 to this Specification

(f) The Contractor shall prepare a Management and Monitoring Environmental Plan (RKPPL) based on Environmental Documents, Decree of Environmental Feasibility (SKKLH – *Surat Keputusan Kelayakan Lingkungan Hidup)* and/or Environmental Permit (*Izin Lingkungan*) that have been available during the Pre-Construction Meeting (PCM) to be discussed together with the Employer and Engineer. RKPPL form as in the Appendix 1.39 of this specification shall describe the initial field condition, the potential impact of work activities and the environmental management plan of any changes to the initial field condition.

(g) Based on the RKPPL, the Engineer shall monitor in accordance with the period specified in the Environmental Document, SKKLH, and/or Environmental Permit of any location of field activities, AMP or CBP location, quarry sites, and basecamp location including access roads related to the environmental management.

(h) The Contractor shall carry out the sampling in accordance with the provisions in the Environmental Document, SKKLH, and/or the Environmental Permit. If the sampling requirements are not regulated in the Environmental Document, SKKLH and/or the Environmental Permit, the Contractor shall carry out the sampling of water, ambient air, and noise and/or vibration.

(i) The point of sampling location shall represent the existence of activities around the location of activities, sampling can be taken 3 to 6 points for road and/or bridge work which are included in the activities required to have the Environmental Documents (AMDAL or UKL-UPL or DELH or DPLH), or determined by authorized environmental agencies. Sampling shall be taken at the time before construction, during construction, and after construction to be completed.

(j) The criteria for sampling locations shall follow the provisions specified in Environmental Documents, SKKLH, and/or Environmental Permits. The sampling points generally represent the existence of activities around the location of activities including settlements, public facilities (schools, health centres, markets, hospitals), water sources, surface water (rivers, lakes), which adjacent and/or crossing activities, quarries, cultivation activities (forest, rice fields, plantations etc.) and basecamp locations.

(k) By the instruction or the delegation of authorities from the Employer, the Engineer shall prepare the reports on the implementation of Environmental Management Plans (RKL) and Environmental Monitoring Plans (RPL) as specified in the Environmental Documents which at the level of AMDAL or DELH, or reporting on the implementation of Environmental Management Efforts (UKL) and Environmental Monitoring Efforts (UPL) as specified in the level of UKL-UPL or DPLH, and/or Environmental Feasibility Decree (SKKLH), and/or Environmental Permit to be addressed by the Employer to the environmental agency in accordance with the period specified in the

Environmental Document, Decree of Environmental Feasibility Decree (SKKLH) and/or Environmental Permit using the format determined by the environmental agencies in accordance with the Minister Decree of Environment No.45 of 2005 or the Amendments (if any) regarding to the Guidelines for Preparation of Implementation Report to the Environmental Management Plan (RKL) and the Environmental Monitoring Plan (RPL) or the amendments, and/or other relevant Laws and Regulations. Report on the Implementation of RKL-RPL or UKL-UPL can be obtained from the Contractor.

(l) The using equipment for road works which use materials that can cause the radiation and potentially reduce the quality of environment shall have a permit established by the authorized environmental agency.

S.1.39 (2) Environmental Management

(a) Impacts on Water Quality

(i) Before commencement of the work the Contractor shall ensure the quality of water (rivers, lakes, springs, underground water) or other water ways do not exceed the water quality standard or parameters listed in Environmental Documents, SKKLH, and/or Environmental Permits. If it has exceeded the environmental quality standard, the Contractor shall inform the society or relevant agencies, especially environmental agencies in the related area. Water quality standard requirements are shown in Table 1.39 (1) of Appendix 1.39 of these specifications with the following standard test methods and types of tests:

Standard Test Method	**Type of Tests**
SNI 06-6989.11-2004	*Pengujian pH Metode Elektrometik*
SNI 06-6989.14:2004	*Pengujian Oksigen Terlarut (DO) Metode Winkler*
SNI 06-6989.27:2005	*Pengujian Zat Padat Terlarut (TDS) Metode Gravimetrik*
SNI 06-6989.3:2004	*Pengujian Zat Padat Tersuspensi (TSS) Metode Gravimetrik*
SNI 6989.72:2009	*Pengujian Biological Oxygen Demand (BOD) Metode Inkubasi – Winkler*
SNI 6989.2:2009	*Pengujian Chemical Oxygen Demand (COD) Metode Spektrofotometrik*
SNI ISO 9308-1-2010	*Pengujian Coliform Metode Petrifilm*
SNI ISO 9308-1-2010	*Pengujian E.Coli Metode MPN*
SNI 6989.4:2009	*Pengujian Fe Metode Spektrofotometri Serapan Atom*
SNI 6989.5:2009	*Pengujian Mn Metode Spektrofo- tometri Serapan Atom*

Standard Test Method	Type of Tests
SNI 6989.6:2009	*Pengujian Cu Metode Spektrofotometri Serapan Atom*
SNI 6989.7:2009	*Pengujian Zn Metode Spektrofotometri Serapan Atom*
SNI 6989.8:2009	*Pengujian Pb Metode Spektrofoto- metri Serapan Atom*
SNI 6989.16:2009	*Pengujian Cd Metode Spektrofoto- metri Serapan Atom*
SNI 6989.18:2009	*Pengujian Ni Metode Spektrofotometri Serapan Atom*
SNI 6989.33:2009	*Pengujian Ag Metode Spektrofoto- metri Serapan Atom*
SNI 6989.68:2009	*Pengujian Co Metode Spektrofoto- metri Serapan Atom*
SNI 06-6989.23-2005	*Pengujian Temperatur (Suhu) Metode Termometrik*

(ii) The Contractor shall ensure that polluting effluent from all of the Contractor's activities shall not exceed the values stated in the prescribed applicable Laws.

(iii) Natural streams or channels within or adjacent to the works of this Contract shall not be disturbed without the approval of the Engineer.

(iv) If any excavation or dredging in the stream bed that is unavoidable for the proper execution of the works, the Contractor shall, after the works are constructed, backfill all such excavations to the original ground surface or stream bed with material approved by the Engineer.

(v) Material deposited within the stream area from foundation or other excavations, or from the placing of cofferdams, shall be removed completely following construction.

(vi) Waterways shall be relocated to ensure unrestricted flow past the works at all usual levels of flood, where embankment stabilization or other permanent works will unavoidably block, or partially block, any existing waterway.

(vii) All excavation shall be maintained free of water and the Contractor shall provide all necessary materials, equipment and labour for diverting waterways and the construction of temporary drains, cut off walls and cofferdams.

(viii) Excavation for borrow materials shall be prohibited or restricted where they might interfere with all drainage channels.

(ix) In the excavation of potentially mixed with surface water i.e. rain water, waste water, the other water which will pollute the surrounding road surface, the Contractor shall prepare an excavation method plan including disposal and sewer muddy water plan, and shall be approved by the Engineer prior to carrying out the excavation work.

(x) Any damaging liquid or solid contaminant, such as hydraulic or lubricating oils, dropped or spilled upon any portion of the site work and adjacent environment, base camp, or haul route shall be cleaned up immediately by the Contactor in order to avoid contamination of water and soil. The Engineer shall approve the completion of the clean up.

(xi) Washing of contractor's vehicles and equipment shall only be permitted in specially designated and equipped areas and shall not be permitted in any existing water courses.

(xii) The waste water from the washing material process shall be treated before discharging into the river or other sewer waste drain in accordance with the waste water management to meet water quality standard, if it cannot meet the standards required the specific water treatment shall be carried out.

(b) Impacts on Air Quality

(i) The Contractor shall ensure that emissions from all the Contractor's activities including transportation activities shall not exceed the values stated in the applicable Laws.

(ii) The asphalt mixing plant, concrete batching plant, stone crusher and any other static construction equipment shall be installed in area as distant as possible from housing and other sensitive areas (forest area, disaster-prone area, residential area, sustainable food agricultural land area (LP2B)), to ensure minimal disturbance and complaint from any member of the local community. The location shall be approved by the Engineer.

(iii) The Contractor shall have an Environmental License issued by the authorized officer for asphalt mixing plant (AMP) and concrete batching plant (CBP) before operated. The asphalt mixing plant (AMP) shall be provided with a complete dust collector, i.e. dry cyclone and wet cyclone or filter tube system to ensure no air pollution in the atmosphere. If either of these systems is damaged or not functioning the equipment shall not be operated. The stone crusher shall be ensured will not pollute the air.

(iv) Trucks shall be sealed, and all covers shall be securely fastened.

(v) The Contractor shall maintain at the work site adequate supplies of water for the moisture control during all placing and compacting operations, and shall also remove excess material from all existing roadways and the location shall not potentially cause dusty and these shall be approved by the Engineer.

(vi) The Contractor shall ensure that the exhaust emissions of equipment or vehicles used during the implementation of the work does not exceed the quality standards of vehicle exhaust emissions or the parameters listed in Environmental Documents, SKKLH, and/or Environmental Permits. The quality standards for vehicle exhaust emissions are shown in Table 1.39 (4) of Appendix 1.39 of these Specifications.

(vii) Before commencement of the work the Contractor shall ensure that the quality of air during construction does not exceed ambient air standards or parameters listed in Environmental Documents, SKKLH, and/or Environmental Permits. If it has exceeded the environmental quality standard, the Contractor shall inform the society or relevant agencies, especially environmental agencies in the related area. Air quality standard requirements are shown in Table 1.39 (3) of Appendix 1.39 of these specifications with the following standard test methods and types of tests:

Standard Test Method	**Type of Tests**
SNI 19-7117.5-2005	*Pengujian NOx Metode PDS*
SNI 19-7117.18:2009	*Pengujian Sulfurdioksida (SO_2) Metode Turbidimetrik*
SNI 19-7117.18:2009	*Pengujian Karbonmonoksida (CO) Metode NDIR*
SNI 7119.13:2009	*Pengujian Hidro Carbon (HC) – CH4 Metode Gas Chromatography – Flame Ionized Detector*
SNI 7119.15:2016	*Pengujian Particulate Matter 10 (PM10)*
SNI 19-7119.3-2005	*Pengujian Total Partikulat (TSP) – Debu Metode Gravimetri*
SNI 19-7119.4-2005	*Pengujian Timah Hitam (Pb) Metode SSA*

(c) Impacts on the Noise and Vibration

Before commencement of the work the Contractor shall ensure that the noise and vibration level during construction does not exceed noise and vibration standards or parameters listed in Environmental Documents, SKKLH, and/or Environmental Permits. If it has exceeded the environmental quality standard, the Contractor shall inform the society or relevant agencies, especially environmental agencies in the related area. The noise and vibration standard requirements are shown respectively in Table 1.39 (5), Table 1.39.(6) and Table 1.13.(7) of Appendix 1.39 of these specifications with the following standard test methods and types of tests:

Standard Test Method	**Type of Tests**
SNI 7231:2009	*Pengujian Emisi bising kendaraan bermotor secara statis*

(d) Impacts on Traffic, Adjoining Properties, and Utilities

(i) The provision given in Clause S1.19, regarding Traffic Management and Safety, shall apply.

(ii) Trenching or other excavation across the roadway shall be carried out using half width construction so that the road is maintained open to traffic at all times.

(iii) The Contractor shall be responsible for all the consequences of traffic and shall prohibit such traffic when necessary by the provision of a detour or by half width construction.

(iv) All the works shall be carried out with the least inconvenience to traffic and at least one traffic lane shall be kept open at all times.

(v) At all times during the performance of the Works, the Contractor shall ensure that the pavement, shoulders and adjacent areas within the right-of-way shall be maintained free of construction material, debris or other such loose objects that may obstruct or endanger the free and safe passage of traffic. The Works shall also be maintained free of any unauthorized parking or street trading activity except in areas designated for such purposes.

(vi) The Contractor shall be responsible for obtaining any existing information on the existence and location of existing underground utilities and for obtaining and paying when required for any necessary permits or other authorization for their diversion or temporary cessation.

(vii) The Contractor shall be responsible for the care and protection of any existing serviceable underground piping, cables, conduit, or other subsurface lines or structures that may be encountered and for repairing any damage caused to them by his operations.

(viii) All potholes in sealed pavements and holes in the finished Work made by density testing or otherwise shall be reinstated as soon as possible after damaged layers have been cut back, in order to avoid obstruction or hazards to traffic.

(ix) At all times during the time for completion the contractor shall maintain vehicular and pedestrian access to all houses, commercial, industrial and all other uses. Temporary accesses shall be provided where construction will close permanent access for any period of over 16 hours and all affected owners and community members shall be notified at least 24 hours in advance of any impact on accesses.

(e) Human Health and Safety

(i) Provisions given in Clause S1.13 shall govern

(ii) The Contractor shall: (i) comply with all applicable safety regulations*;* (ii) take care for the safety of all persons entitled to be on the Site and prepare the Occupational Health and Safety Management System (*SMK3*); and (iii) provide any Temporary

Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land. The preparation of the Occupational Health and Safety Management System Plan shall refer to the Government Regulation No.50-2012 concerning The Implementation of Occupational Safety and Health Management System or the modifications (if any).

(iii) The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel and shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents.

(iv) The Contractor shall at all times take necessary actions to protect the health and well being of the Contractor's Personnel employed on the Site by ensuring that all parts of the worksite are regularly kept clean and sanitary.

(v) All gears, pulleys, chains, sprockets, and other dangerous moving parts of Mixing Plants shall be thoroughly guarded and protected.

(vi) Adequate sanitary waste control facilities shall be provided for all project staff and workers and waste shall be collected regularly and disposed of in accordance with applicable laws.

(f) Impact on Flora and Fauna

(i) The cutting of trees shall be carried out only when absolutely necessary for widening either the carriageway or the shoulders or for the clear zone and will be specifically defined and agreed by all parties during the field investigation. Every tree felled should be replaced by two semi mature trees of the same or similar species. No new tree planting should take place within the clear zone. Tree planting shall be in accordance with Clause S.12.17 of the Specifications.

(ii) The Contractor shall limit the movement of his employees, the location of Base Camps, AMP etc and equipment within the sensitive environmental areas, such as the forest areas disaster-prone area, residential area, sustainable food agricultural land area (LP2B) and all other officially protected sensitive areas so as to minimize damage to natural vegetation and shall endeavor to avoid any damage to land. No Base Camp, AMP, CBP, equipment or vehicle parking or storage area will be allowed outside the ROW where the road passes through an officially protected sensitive area.

(g) Impacts on Soil

(i) The Contractor shall ensure that pollutant discharge from the Contractor's activities shall not exceed the values stated in the prescribed applicable Laws.

(ii) In order to avoid land sliding and erosion during excavation for borrow materials, the edge of a borrow pit shall be not closer than 2 meters from the toe of the embankment or 10 meters from the top of any cutting.

(h) Disposal of Waste

(i) The disposal of all solid and liquid waste from construction activities should only take place in accordance with Sub-clause S4.07 (2), and the requirements and permissions of responsible institution at Province or *Kabupaten/Kota*.

(ii) When any material is to be disposed of outside the Site, the Contractor shall obtain a written permit from the property owner on whose property the disposal is to made, which permit shall designate the disposal location and shall be submitted to the Engineer together with a request for approval to proceed.

(iii) When material is disposed of as provided above and the disposal location is visible from a highway, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.

(i) Hazardous and Toxic Waste (LB3).

(i) Management of hazardous and toxic waste (LB3) resulting from construction activities (eg used oil, used/contaminated B3, cloth rags, used lamps, used batteries, used/contaminated B3 residual packaging and so on) shall be in accordance with the provisions and permits related to waste management of LB3.

(ii) Hazardous and toxic waste which generated during construction activities shall be stored in Temporary Storage with specifications that meet that the licensing requirements related to applicable LB3 and issued by the authorized environmental agency

(j) Impact in Protected Sensitive Area.

The following provisions in sensitive areas shall govern:

(i) Especially for the implementation activities of roads and/or bridges which within the protected sensitive areas, the Engineer will coordinate with relevant relevant government agency in order to obtain the required information such as the existing presence, habitat, species and corridors of wildlife. When implementation, the core zone/ corridor of wildlife shall be avoided.

(ii) For all quarries and other sources of material (owned by the Contractor or other parties), the Contractor shall submit to the Engineer a plan of hauling route which explains the route travelled by hauling material from the sources of material.

(iii) The Contractor shall have an approval letter from the relevant government agency that the locations and activities of material sources and the route of hauling will not disturb the environment

and local community and accepted in accordance with applicable laws and regulations.

(iv) All borrow pits and quarries shall be licensed and have full legal authorization from the local government

(v) The extraction of any construction materials shall not be allowed in any National Park or other officially protected sensitive area

(vi) The contractor shall ensure that the Base Camp is operated in accordance with good environmental practice and that adverse environmental impacts are kept to an absolute minimum and in accordance with this section, and that the local community is not disturbed by any of the activities of the Base Camp.

(vii) In compliance with sustainable development practice, all timber materials for sheet piles, bearing piles, and mini timber piles, shall be purchased from a certified dealer (not from illegal logging). *Surat Keterangan Sahnya Hasil Hutan* (SKSHH, letter indicating source from legal forest production) operates a certificate of its legal nature be attached to the purchase document shall be submitted to the Engineer.

(viii) All part of the Site shall be reinstated to their original conditions prior to the commencement date of works.

S1.39 (3) Implementation of Required Environmental Documents

The Contractor shall comply to any recommendations that has been incorporated in the environment documents (Environmental Impact Analysis (AMDAL) or Environmental Management Efforts - Environment Monitoring Efforts (UKL-UPL) or Environmental Evaluation Document (DELH) or Environmental Management Document (DPLH)), Environmental Feasibility Decree (SKKLH) and/or Environmental Permit. The Employer shall make the Environmental Documents, Environmental Feasibility Decree, and/or Environmental Permit available to the Contractor and Engineer as an information or reference for the implementation of environmental safeguards. General overview of the potential impact on the environment as a result of road and bridge work activities that may occur at each stage of activities, shall be submitted by the Contractor to the Engineer if the potential impact is not specified in the Environmental Documents, Environmental Feasibility Decree (SKKLH) and/or Environmental Permit, and the Contractor shall carry out an impact reduction effort with the approval of the Engineer. The stage of activities shall include the following:

(a) Pre-Construction Stage

(i) Preliminary survey, impact on the perception and unrest of community.

(ii) The dissemination of activities planned, to be carried out in order to provide the information and collect the feedback from the community. The dissemination of activities planned activities has an impact to the perception and unrest of community.

(iii) Land acquisition shall involve the survey of land use, land area and estimated land price associated with the required compensation of the land acquisition.

b) Construction Stage

(i) Mobilization, the impact of traffic disruption, air pollution and deterioration of access road.

(ii) Construction which have an impact on the location of works, material source material (quarry) including the access roads and Base Camp.

At each of these locations, monitoring to the environmental impact related with activity locations either directly or indirectly shall be carried out, including the activity locations of the access road.

(c) Post-Construction Stage

(i) The operation of road will have an impact of dust pollution by traffic, congestion and traffic accidents as well as the changes of uncontrolled land use.

(ii) Maintenance of road, will have an impact of traffic disruption.

While hypothetical significant impacts classification in accordance with the disturbed environmental component groups as follows:

(a) Reduction of Environmental Quality includes:

(i) The change in land use;

(ii) The loss of flora and fauna;

(iii) Disruption of the flow of surface water;

(iv) Reduction of air quality;

(v) Increase of noise and vibration;

(vi) Disruption of aquatic biota;

(vii) Hazardous and toxic waste;

(viii) Declining water quality (rivers, lakes, springs, underground water);

(ix) Soil pollution.

(b) Disruption of Society includes:

(i) The loss of assets;

(ii) Disruption of traffic;

(iii) The loss of livelihood;

(iv) Attitudes and Negative Perception of Society;

(v) The emergence of public unrest;

(vi) Missing / disruption of public / social facilities;

(c) Disruption of Infrastructure includes:

(i) Disruption of utilities;

(ii) Disruption of accessibility;

(iii) Road damage.

S1.39 (4) Monthly Report

(1) Type of Reports

(a) The report consists of the internal report in the form of the Implementation Report of Management and Monitoring Environmental Plan (RKPPL) and external report in the form of the Implementation Report of the Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL) or Implementation Report of Environmental Management Efforts (UKL) and Environmental Monitoring Efforts (UPL).

(b) The implementation report of RKPPL shall be submitted by the Contractor to the Engineer

(c) Implementation Report of RKL-RPL as listed in the EIA or DELH document and Implementation Report of UKL-UPL as listed in UKL-UPL or DPLH document, SKKLH and/or Environmental Permits shall be submitted by the Contractor to the Employer through the Engineer and then addressed to the Environmental Authority.

(d) The internal report's method and forms are applied in accordance with those listed in these Specifications and the external report's method and form which addressed to environmental agencies shall follow the laws and regulations determined by the Environmental Authority in accordance with the Minister Decree of Environment of the Republic of Indonesia No.45 of 2005 or the Amendment (if any) regarding Guidelines for the Preparation of Implementation Report of Environmental Management Plan (RKL) and the Environmental Monitoring Plan (RPL) and/or other relevant laws and regulations.

(2) Submittal

Draft Environmental Management and Monitoring Plan (RKPPL) by the Contractor shall be submitted at the time of the Pre-Construction Meeting (PCM) and to be discussed and approved by the Employer and Engineer. Then the approved RKPPL will be used to carry out the monitoring on the progress and treatment required in environmental management for each month. Environmental Management and Monitoring Plan (RKPPL) form included in Appendix 1.39 of this Specifications.

In the preparation of RKPPL, the Contractor shall conform the following conditions:

(a) RKPPL shall be prepared in accordance with this specification and scope of works under the Contract.

(b) RKPPL shall be equipped with adequate supporting documentation and complete and substantially according to the activity location, potential

impact and treatment required to the environmental management as supporting data to certify the payment within the time specified in accordance with the relevant Clause of the General Conditions of Contract and this specification.

(c) A copy of RKPPL including the supporting data shall be submitted to the Employer and Engineer. It will be used as guidance for monitoring of environmental management in the implementation activities of each month

(d) The draft implementation report of RKL-RPL or UKL-UPL shall be submitted by the Contractor to the Engineer at least two (2) weeks before latest date of reporting as specified in the Environmental Feasibility Decree (SKKLH) and/or Environmental Permit for the approval from the Employer as the holder of Environmental Permit. Implementation report which approved by the Employer as the holder of Environmental Permit will be addressed to the Environmental Authority.

(3) Timing

(a) Internal report (RKPPL) shall be carried by monthly basis and the external report (implementation report of RKL-RPL or UKL-UPL) to the Environmental Authority shall be carried out every 6 months or in accordance with the period stated in the Environmental Document, SKKLH and/or Permit Environment.

(b) Each Monthly Report of the Environmental Management and Monitoring Plan (RKPPL) shall be dated on the last day of calendar month collectively as the backup data of Monthly Statement as stipulated in the General Conditions of Contract.

S1.39 (5) Method of Measurement

(a) Work that is measured for payment according to this pay item is the work carried out directly and instructed by the Engineer based on the recommendations listed in the Environmental Document, SKKLH and/or Environmental Permit, for sampling and testing of water quality, ambient air quality, noise and/or vibration as specified in Sub-clause S1.39.(2) of these Specifications.

(b) For planting trees will be paid separately in another Division of this Specification.

(c) The cost of work as instructed in Sub-clause S1.39.(3) (Implementation of Required Environmental Documents) and S1.39.(4) (Monthly Reports) shall be included in the unit rate of all pay items as specified in the Contract, where the price shall be full compensation for the furnishing all materials, labour, equipment and other costs required for environmental management.

(d) For the measurement of payment for tests of water quality of groundwater and surface water, ambient air quality, noise and/or vibration, all provisions of the quality standard shall be met (mandatory if the activities around the Site have not changed or the same as specified in the environmental document), if the results do not meet the requirements/

provisions on environmental quality standards, so the work shall not be paid for the tests required for the environmental safeguard.

(e) Sampling shall be carried out before construction, during construction, and after construction completed.

S1.39 (5) Basis for Payment

This work shall be paid for at the basis of the number of tests for the Pay Items listed below. which price and payment shall be full compensation for furnishing all materials, equipment, labour, methods, tests and other costs, including tools and reporting costs which is a recommendation of quality standard measurement for the environmental safeguards. During the construction period, the Engineer may instruct the Contractor to carry out environmental management in accordance with the provisions of the local government and the Laws. The tests are carried out before, during and after construction at the same location is considered as 3 times,

If the pay items are is not listed in the priced Bill of Quantities, then there is no separate payment will be made for the payment of environmental safeguard executed in accordance with this Division of these Specifications, the cost for this work shall be included in the Unit Rate of all other Pay Items included in the Contract, which prices shall be full compensation for furnishing all materials, labor, equipment, tools and other expenses necessary for environmental management.

If the Contractor fails to carry out the work of environmental safeguards, the Supervisory Consultant without freeing the Contractor of the responsibility, will be entitled to carry out such work as is deemed necessary and charge all the repair costs to the Contractor, in which the value of the fee will be deducted from any payment certificate paid or will be paid to the Contractor under the Contract. Service users will be responsible in setting the jobs that need to be repaired and prepare a cost estimate.

Any incident and/or negligence due to the failing of implementation of the requirements in this Clause S1.39, the deduction of payment shall be applied as described in Clause S1.41 of these Specifications.

Pay Item No.	**Description**	**Unit of Measurement**
1.39.(1a)	Test of pH	Each
1.39.(1b)	Test of Dissolved Oxygen (DO)	Each
1.39.(1c)	Test of Dissolved Solid (TDS)	Each
1.39.(1d)	Test of Suspended Solids (TSS)	Each
1.39.(1e)	Test of Biological Oxygen Demand (BOD)	Each
1.39.(1f)	Test of Chemical Oxygen Demand (COD)	Each
1.39.(1g)	Test of Coliform	Each
1.39.(1h)	Test of E.Coli	Each
1.39.(1i)	Destruction Testing of Cu, Pb, Cd, Ni, Fe, Zn, Ag, Co, Mn	Each

1.39.(1j)	Test of Temperature	Each
1.39.(1k)	Other Parameter Test of Water Quality….	Each
1.39.(2a)	Test of Environmental Vibration for Comfort and Health	Each
1.39.(2b)	Test of Vibration Level of Motored Vehicles	Each
1.39.(2c)	Other Test of Noise and /or Vibration …	Each
1.39.(3a)	Test of NOx	Each
1.39.(3b)	Test of Sulphur Dioxide (SO_2)	Each
1.39.(3c)	Test of Carbon Dioxide (CO_2)	Each
1.39.(3d)	Test of Hydro Carbon (HC) - CH_4	Each
1.39.(3e)	Test of Total Suspended Particulate (TSP) – Dust	Each
1.39.(3f)	Test of Lead (Pb)	Each
1.39.(3g)	Other Parameter Test of Air Emissions and Ambient …….	Each

S1.40 Quality Management

S1.40 (1) General

The Works shall be undertaken through a quality management process, utilizing Employer, Engineer, Contractor and third-party resources, as necessary.

The Employer accepts the following definitions associated with Quality Management:

- Quality Control (QC): The process of checking specific product or service results to determine if they comply with relevant quality standards, correct errors and substandard quality, and identifying ways to eliminate causes of unsatisfactory product or service performance. The process of inspection and approval/ rejection of product quality or performance of specific services is carried out by the Quality Control Manager (QCM) provided by the Contractor to internally control and ensure the quality of construction works which carried out by the representative of Contractor (General Superintendent/GS) in accordance with the provisions specified in the Specifications. The report of QC results from QCM to be submitted to the Contractor with a copy to the Engineer.
- Quality Assurance (QA): The process of evaluating standard procedures and work instructions for overall product or service, which are evaluated by Engineer, to ensure that the quality of works carried out by the Contractor are able to be accepted or rejected as a basis for payment approval of the works which conform to the contract requirements.

The quality management program has two key components as follows:

- Quality Control – the Contractor's responsibility

- Quality Assurance – the Engineer's responsibility under the Engineer's Quality Assurance Plan

Each component of the program shall address materials, processes, workmanship, products, and documentation which specified in Quality Control Plan (QCM). QCM is prepared and then presented by the Contractor when pre-construction meeting (PCM) which consists of:

1. Scope of works.
2. Organization Chart of the Contractor, including the task and responsibility
3. Detailed Construction Schedule per component of works.
4. Detailed Procedure of Construction
5. Detailed Standard Procedure of Job Instruction and Checklist
6. Form of Product
7. List of Superintendents

The Contractor shall provide unrestricted access to all Quality Control operations and documentation produced by or on behalf of the Contractor and shall allow the Engineer full access at any time.

The Engineer will review the Contractor's performance of the Work and determine the acceptability of the Work based on the Engineer's Quality Assurance results and, where deemed appropriate by the Engineer, supplemented by the Contractor's Quality Control results.

Work failing to meet the Conditions of the Contract shall be considered Unacceptable Work.

The Engineer may consider all Work from the last acceptable Quality Assurance testing as Unacceptable Work. The Contractor shall not be entitled to payment for Work that lacks the appropriate Quality Control documentation, verified by the QC Manager, as required by the Contract.

The Contractor shall implement a well-coordinated approach to all operations related to the Work and will organize its team and operations in keeping with the goal of doing things right the first time.

S1.40 (2) Quality Control Plan (QC Plan)

(a) QC Plan General Requirements

As a part of the Contractor's Quality Assurance required the General Conditions, the Contractor shall be responsible for all Quality Control during the performance of the Work. QC work includes monitoring, inspecting and testing the means, methods, materials, workmanship, processes and products of all aspects of the Work as necessary to ensure conformance with the Contract.

The Contractor shall prepare a Quality Control Plan (QC Plan) in accordance with the Contract provisions and shall submit the complete QC Plan to the Engineer a minimum of two weeks in advance of commencement of any element of Work covered by the plan.

The QC Plan shall be structured around the ISO 9001:2015 / SNI ISO 9001:2015 program (although ISO registration is not required), and clearly demonstrate the Contractor's understanding and commitment to ISO's seven principles of quality management:

- Customer focused
- Leadership
- Engagement of people
- Process approach
- Improvement
- Evidence-based decision making
- Relationship Management

The QC Plan shall also include sections detailing the Contractor's methodology associated with each of the relevant sections of ISO 9001:2015 / SNI ISO 9001:2015 as follows (No.1 to No.3 are not specified below):

4. Context of the Organization
4.1 Understanding the organization and its context
4.2 Understanding the needs and expectations of interested parties
4.3 Determining the scope of the quality management system
4.4 Quality management system and its processes
5. Leadership
5.1 Leadership and commitment
5.2 Policy
5.3 Organizational roles, responsibilities and authorities
6. Planning
6.1 Actions to address risks and opportunities
6.2 Quality objectives and planning to achieve them
6.3 Planning of changes
7. Support
7.1 Resources
7.2 Competence
7.3 Awareness
7.4 Communication
7.5 Documented information
8. Operation
8.1 Operational planning and control
8.2 Requirements for products and services
8.3 Design and development of products and services
8.4 Control of externally provided products and services
8.5 Production and service provision
8.6 Release of products and services
8.7 Control of nonconforming outputs
9. Performance Evaluation
9.1 Monitoring, measurement, analysis and evaluation
9.2 Internal audit
9.3 Management review

10. Improvement

10.1 General
10.2 Nonconformity and corrective action
10.3 Continual improvement

No Work shall be undertaken on any element of Work (including pay items and temporary Work, or submittals for review) for which there are QC Plan submission requirements until the Engineer has accepted the base portion of the QC Plan and the specific details for that element of Work.

The QC Plan shall cover the Work in its entirety, including without limitation all materials the Contractor and Subcontractors are supplying, and all items and phases of construction on the Project.

The Quality Assurance Plan (QA Plan) shall cover the whole of Work, including without limitation to all materials supplied by the Contractor and Sub-Contractor, and all types and stages of activities.

The plan may be operated wholly or in part by a qualified Subcontractor or an independent agency/organization. However, the plan's administration (including conformance with the plan and its modifications) and the quality of the Work remain the responsibility of the Contractor.

The Contractor's QC program and the Work shall be undertaken in accordance with the QC Plan and shall be well managed, with testing results representative of actual operations. Results will be reported accurately and in a timely manner.

The Contractor shall also ensure that all workers are familiar with the Quality Control Plans, its goals, and their role under it, as well as with the Contract specifications associated with the Work they are to undertake.

(b) <u>QC Plan Quality Control Staff and Equipment Submission Requirements</u>

In accordance with Clause S1.09 and S1.10 of these Specifications, and the General Conditions of Contract, the Contractor shall provide all resources and take all actions necessary to ensure:

(i) Provision of sufficient inspection or testing staff, with adequate equipment and technical support to perform all Quality Control functions in an accurate and timely manner.

(ii) That QC staff perform only inspections and tests for which they are qualified

(iii) All testing equipment is calibrated, properly maintained, and in good operating condition.

(iv) All testing and inspection is performed in accordance with appropriate standards of the Contract.

(v) Submission to the Engineer, within twenty-four (24) hours, of daily reports for all tests and inspections that indicate non-conformance of the material being tested.

(vi) Production, within forty-eight (48) hours, of daily reports for all tests and inspections that indicate conformance of the material being tested and the availability of back-up documentation to substantiate test results when required.

(vii) Organization, compilation and submission of all project QC documentation within 14 days of issuance of the Completion Certificate.

The Contractor shall designate one person as the Quality Control Manager (QC Manager) who shall be responsible for the implementation of the QC Plan. The QC Manager shall be a qualified Professional Engineer, Certified Engineering Technician, or Applied Science Technologist, or other person with knowledge, skills and abilities acceptable to the Engineer.

The QC Manager shall be at arms length from the productivity part of the Contractor's organization and specifically shall not be the Project Manager or the Project Superintendent.

The Engineer recognizes the Contractor's Project Manager and Superintendent as the personnel responsible for making the product meet the contractual requirements, but the QC Manager's duties include being responsible to measure conformance and to ensure that quality is not compromised by production pressures.

The QC Manager, or a designated replacement acceptable to the Engineer empowered and able to perform all of the QC Manager's relevant duties, shall remain on Site at all times the Contractor is performing Work which shall be tested or inspected in-process, and shall be readily accessible and able to return when off- Site.

The QC Plan will include the following information:

- the name of the QC Manager and qualifications establishing a proven capability to provide the specific services required for the Project;
- the name of QC testing agencies and their proven capability to provide the specific services required for the Project;
- a listing of QC staff (including names, qualifications and relevant experience) and their assigned roles and work scheduling in performing QC duties;
- a list of testing equipment to be used for the Work.

The QC Plan shall include an organizational chart showing details of the flow of information, holding points as listed in Sub-clause S1.40.(4) below, rectification of deficiencies and other relationships and responsibilities necessary to assure Project quality requirements are met.

The QC Plan should describe how the QC staff are allocated to Project requirements, the tasks assigned to each, and how their work will be coordinated.

Without limitation, the Contractor's QC Manager shall, with the output indicators and checklist as shown in Appendix 1.40:

- implement the Contractor's QC Plan;
- be responsible for measuring conformance with all aspects of the contract quality;
- stop work when materials, product, processes or submittals are deficient;
- develop inspection and testing plans for each element of Work;
- ensure all surveys, tests, technical audits, etc. shall use GPS instruments for their exact coordinates (latitude-longitude).
- develop acceptance/non-acceptance reports and quality control checklists for each element of Work in sufficient detail to gauge conformance with all significant contractual requirements;
- ensure the requirements for quality management (including an overview of how the QC Plan operates, the worker's role in it, contractual specifications for the Work, and work procedures) are known to, understood by, and adhered to by all workers on the Site;
- ensure that all QC checklists are signed-off by competent and responsible parties as close to the actual work as appropriate to the nature of the Work (e.g. by the actual worker or a foreman for most work; by a Professional Engineer for false work erection; etc.)
- review, sign, and be responsible for all reports (materials and testing results);
- consult with Engineer regarding materials and testing issues;
- receive notification by Engineer re deficiencies and ensure re-testing or rejection;
- provide weekly and monthly summary reports on testing and inspection results;
- initiate the non-conformance process when materials or product do not meet the required specifications and, inform the Engineer of such nonconformance;
- consult with the Contractor Representative and initiate corrective action on non-conformance;
- respond to each Non-Conformance Report (NCR) issued by the Engineer within the time specified in the NCR;
- schedule testing and inspection services in coordination with the Contractor's superintendent and foremen;
- monitor QC testing and inspection procedures including those of the Subcontractors;
- work directly with the Engineer on matters related to QC;
- ensure required approvals and permits from the Engineer and others are obtained as and when required;

- verify that all testing equipment is properly maintained and kept in good working order;
- keep an organized filing system to ensure that quality records are easily accessible so that auditors can obtain necessary information;
- review issued for construction drawings, calculations, and shop drawings and ensure that all concerned Contractor staff have current versions of documents applicable to their part of the Work;
- notify the Engineer of any changes in survey layout, location, line, grade, etc., for approval;
- notify the Contractor principles of any issues that compromise the integrity or function of the Quality Management System, and
- provide an auditable trail for survey computations to the Engineer.

(c) QC Plan Submission Requirements

(i) Full Submission

Unless otherwise specified in the Special Provisions, the Contractor's QC plan shall provide details of the means, methods, and frequencies of Quality Control measures for all elements of Work in the Contract

(ii) Partial Submission

On projects considered by the Engineer to be of low complexity and/or risk, and only where explicitly invoked by the Special Provisions, the Engineer will accept a partial QC Plan submission.

Notwithstanding any such reduced submission requirements, the Contractor remains responsible for QC for all aspects of the Work.

The Contractor's partial QC Plan submission to the Engineer is only required to address the details of the following types of Work:

- Traffic Management and Safety
- Survey/layout
- Materials incorporated into the Work (concrete barrier, culverts, filter cloth, etc.)
- Compaction (sub-grade, embankments, granular aggregates, culvert backfill, etc.)
- Aggregate gradation
- Plus any other elements identified in the Special Provisions as a submission requirement.

The Contractor shall initiate such other Quality Control procedures as are necessary for ensuring the production of a quality product and may include them in the Quality Control Plan submission.

(iii) For Both Full and Partial Submissions

The initial QC Plan shall be submitted to the Engineer a minimum of seven (7) days in advance of the Project Pre-construction Meeting (PCM) and shall provide details of all elements of Work anticipated to be undertaken within the Contractor's first thirty (30) days on Site.

Detailed submissions for the balance of the Work shall be received a minimum of fourteen (14) days prior to the anticipated first day of Work on each element covered by the submission.

The initial submission, as well as any subsequent submission or revision, shall be accompanied by the Contractor's QC checklist for Quality Management, verifying that the submission meets all relevant contractual requirements.

Improved procedures may be introduced after the start of work as necessary as amendments to the Quality Control Plan. All amendments require the written acceptance of the Engineer.

The type and frequency of QC tests shall be established by the Contractor and shall be in conformance with the requirements of the Contract, including the minimum frequencies specified in the Special Provisions and/or Standard Specifications (for those listed items applicable to the Work), and the current acceptable practice of the industry.

When materials or equipment are specified by the Specifications the Contractor shall obtain from suppliers or manufacturers independent test reports, or test certificates stating that the materials or equipment meet or exceed specified requirements. The Contractor shall provide back-up documentation of actual testing results upon request by the Engineer.

S1.40 (3) Quality Assurance Plan

The Engineer will prepare and implement a Quality Assurance Plan, based in part on the effectiveness and reliability of the Contractor's Quality Control Plan. The Engineer may also undertake random and systematic inspections of the Work and of the Contractor's QC documentation.

The purpose of the QA Plan and inspectional activities is to ensure that payment is made only for acceptable works in place and may be based on a limited amount of sampling and testing, in accordance with ASTM D3665-12(2017) or SNI 03-6868-2002.

The Engineer will monitor the Contractor's operations and the Quality Control program to assure that standards are being met and to assess what payments have been earned under the terms of the Contract.

Any instances of Unacceptable Work discovered will result in a Non-Conformance Report (NCR) being issued to the Contractor.

The QA program activities will not relieve the Contractor of Quality Control responsibilities under the terms of the Contract.

The frequency of QA inspection and testing will generally be approximately zero to ten percent (0 – 10%) of the frequencies undertaken by the Contractor in its QC Plan and will initially be set at a level commensurate with the Engineer's confidence in the anticipated effectiveness of the Contractor's QC program.

The Engineer may increase or decrease the frequency of QA inspection and testing during the course of the Work, based in part on the actual effectiveness of the Contractor's QC Plan.

S1.40 (4) Holding Points

The Contractor shall notify the Engineer, and the Engineer or his delegate shall inspect and approve the following work stages, but not limited, before covering up.

(a) Setting out

(b) Ground level

(c) Pile tests

(d) Bridge foundation excavation

(e) Steel reinforcement and formwork before concrete casting

(f) Acceptance of a concrete mix design to be used according to the type of concrete (normal concrete, SCC, mass concrete) and the structure.

(g) Erection of super structure and their bearing systems.

(h) Top of subgrade

(i) Top of compacted Base B

(j) Top of compacted Base A inclusive of proof rolling, impact hammer or another test nominated by the Engineer.

(k) Existing asphalt preparation for overlay

(l) Each asphalt layers

(m) Soil stabilization, drainage layer, lean concrete, and portland cement concrete pavement

(o) Pipe culverts, drainage structures

(p) Subgrade drains, bleeder drain and permeable fill

(q) Underground utilities

The Engineer may nominate other activities for which inspection is required and may also nominate any test which is to be provided before giving approval for covering up. For each of the above-mentioned stages and activities, the Engineer and Contractor shall agree the procedure, place and time for giving of notice to inspect. The contractor shall not be bound to delay work if the Engineer's or Engineer's Assistant is not present at the agreed time, provided notice has been correctly given, and provided all other applicable requirements have been met.

S1.40 (5) Tests on Completion

In accordance with the General Conditions of Contract, the Contractor shall submit as-built documents including as-built drawings and QC documentations before the date of Tests on Completion.

Tests on Completion shall include:

- An evaluation of all as-built documents which show that all completed works are comply with the work requirements and all Non-Conformance Reports (NCRs) are resolved.
- Submission of written Engineer's instructions and/or approval where the as-built documents depart from the work requirements.
- Checking on the overall performance of the final works completed showing compliance with the Employer's overall requirements or the intention of the design/drawings, e.g. dimensions, levels, functions such as pavement surface roughness, water flows, etc.
- Minimum random sampling for testing if required by the Engineer.

The Engineer will evaluate the Engineer's QA documentations supplemented with Contractor's Documents to ensure that all completed works comply with the work requirements and all Non-Conformance Reports (NCRs) are resolved.

Tests on Completion shall assure the readiness of the Works to be taken over by the Employer for public use.

S1.40 (6) Quality Audit

As a part of the overall project management, the Employer may have one or more auditors on the Project, supplementing the work of the Engineer Quality Assurance staff. When utilized, the auditor(s) will report to the Employer and provide a systematic and independent assessment of whether or not the materials and Project activities and related results comply with the Contract, the Contractor's Quality Control Plan, and the Engineer's Quality Assurance Plan. These auditors may be Employer employees or other persons appointed by the Employer which have not otherwise been involved with the Work.

The objective of Quality Auditing is to have an independent opinion on both Quality Control and Quality Assurance activities and be proactive in avoiding or reducing quality related issues by requiring the process of conformance verification to be systematic.

The auditor(s) will be allowed unrestricted access to the Site and all activities therein, to all testing and documentation of the work done by the Engineer, Contractor and their agents and suppliers.

S1.40 (7) Non-Conformance Reports (NCRs)

The Contractor shall and the Engineer may review the Work to determine conformance with the contractual requirements. Non-conformances found shall be dealt with as follows.

(a) Contractor's Internal NCR

Should the Contractor's QC reporting indicate that the Work is not in conformance, the QC Manager shall issue in internal Non-Conformance Report (NCR) to the Contractor, with a copy to the Engineer, including a response time.

The Contractor shall then respond to the QC Manager, with a copy to the Engineer, with respect to the NCR, within the specified time, with proposed resolutions and corrective actions. The Contractor and/or the QC Manager may consult with the Engineer on the resolutions but is not required to do so.

Payment for a Quality Management will not be affected by internal NCRs, as long as the issue is diligently pursued and resolved.

Payment for the Work itself may be withheld until the NCR issue is resolved.

(b) Engineer-Issued NCR

Should the Engineer's QA reporting indicate that the Work is not in conformance, the Engineer will issue to the Contractor a NCR, including a response time.

The Contractor shall then respond to that NCR, within the specified time, with proposed resolutions and corrective actions.

The Engineer will accept or reject the proposed resolution and corrective action proposal.

Assurance testing and inspection will be performed to determine if the corrective action has provided an acceptable product. Acceptance and rejection will continue until the Engineer determines that a quality product has been achieved.

A portion of the payment for a Quality Management may be withheld until the NCR issue is resolved or may be withheld permanently.

Payment for the Work itself may be withheld until the NCR issue is resolved.

(c) Opportunity for Improvement

Should the QA review indicate that the Work is not in conformance, but the variance is deemed minor by the Engineer, the Engineer may issue an Opportunity for Improvement (OFI) report.

The Contractor is encouraged to review the findings and undertake such modifications to the QC Plan and the work procedures as necessary to address the issue.

An OFI will not affect payment for Quality Management or for the Work itself.

S1.40 (8) Appeal

If the Contractor disputes the validity of a finding in an NCR, the Contractor may file an appeal with the Engineer. The Engineer and the Contractor Representative

will use all reasonable efforts to refine the area of dispute and to resolve the determination of conformance with the Contract.

If the Engineer and the Contractor Representative cannot come to a mutually agreeable resolution, the Work that is the subject of the Non-Conformance Report shall be re-evaluated by an independent third-party, selected by the Engineer in consultation with the Contractor, at a test frequency equivalent to twice that specified in the Contract or to such other frequency as may be mutually agreed between the Engineer and the Contractor.

If the appeal testing confirms the non-conformance determination, all appeal testing costs will be borne by the Contractor. If the appeal testing shows that the Work did in fact meet the requirements of the Contract, all appeal testing costs will be borne by the Engineer

S1.40 (9) Payment

The Lump Sum Price bid for Quality Management shall be full compensation for all costs of all personnel salaries and operational activities resulting from the Quality Management requirements set out in the Contract.

Payment will be made on a monthly basis prorated for the percentage of the total Work completed as determined by the Engineer, subject to the Contractor being totally compliant with the requirements of this Division and with its own Quality Control Plan

The Engineer shall reduce the total Lump Sum payable by the value of any quality management work required but not satisfactorily undertaken during the Time for Completion. The foregoing determinations will be made in the sole discretion of the Engineer. In addition, notwithstanding the provisions required in the Clause S1.41 of these Specifications the Engineer may deduct the amount from each Monthly Statement prepared, due to the failing to implementation of the Quality Management activities required in this Clause S.1.40 for the related month.

Inspection or testing by the Engineer will be at the Engineer's cost. However, re-inspection or retesting by the Engineer for repaired deficient details shall be at the Contractor's cost.

Work that is deemed unacceptable will not be eligible for payment from the applicable Item for that Work.

The Completion Certificate will not be issued if there are any unresolved Non-Conformance Reports.

Pay Item No. and Name		**Unit of Measurement**
1.40	Quality Management	Lump Sum

S1.41 Deduction of Monthly Payment due to the Incident and/or Omission

The meaning of incident in this Specification is an unplanned/unwanted /uncontrolled/ unexpected event which able to cause any kind of loss.

The meaning of omission in this Specification is a mistake, carelessness, negligence to carry out the works in accordance with the requirements.

Notwithstanding the provisions of the Contract Conditions, the Engineer will impose the sanctions by deduction of one (1) of the Contract Price or a maximum of Rp.500,000,000 (five hundred million rupiahs) whichever is lesser, if any incident and/or omission occurs as the result of no action with the following activities: S1.06 Working Area and Maintenance of Adjacent Roads and Bridges; S1.13 Occupational Health and Safety; S1.19 Traffic Management and Safety; S1.39 Environmental Safeguards; S1.40 Quality Management; which cause the losses.

ATTACHMENT 1.10

LIST OF LABORATORY EQUIPMENT FOR SOILS, BITUMINOUS AND CONCRETE TESTING

Items and quantities given in this list are given as a general guide only as to the minimum testing equipment required for the project. The absence of any required testing equipment from this list will in no way absolve the Contractor of his responsibility to carry out fully all testing work in accordance with the Specifications or as directed by the Engineer.

ITEM	Quantities
1. SOIL TESTING	
1.1 Compaction Test:	
Standard Proctor mould	1
Standard Proctor hammer	1
Modified compaction mould	1
Modified compaction hammer	1
Straight edge	1
Sample ejector	1
Mixing spoon	1
Mixing trowel	1
Spatula	1
Mixing Pan	1
Aluminium pan 25 cm diameter	1
Wash bottle	1
Moisture cans	36
1.2 Laboratory CBR:	
Mechanical loading press	1
6000 lbs capacity Proving ring	1
CBR moulds	6
Spacer disk	1
Swell plate surcharge plate	3
Tripod attachment	3
Swell dial indicator	3
Surcharge weight	6
Slotted surcharge weight	6
Steel cutting edge	1

ITEM	Quantities
1.3 Specific Gravity:	
Pycnometer bottles of 100 cc capacity	3
Porcelain mortar and pestle	1
Hot plate, 1000 watts, 220 volts 50 cycle	1
1.4 Atterberg Limits:	
Standard liquid limit device	1
ASTM grooving tool	1
Evaporating dish	3
Flexible spatula	2
100 cm graduated cylinder	2
Casagrande grooving tool	1
Plastic limit glass plate	1
1.5 Grain Size Analysis:	
Hydrometer jars	3
Mechanical stirrer, electric powered 220 V 50 cycle	1
Dispersion cups with baffles	2
Hydrometer, scale 0 - 60 gr	1
Set brass sieves, 8 inches diameter, 75 mm, 50, 38, 25, 19, 12.5, 9.5, No. 4, 10, 30, 60, 100 including cover and pan	2
No. 200 brass sieves	4
Wet washing sieve	1
50 ml. graduated cylinder	1
Sieve brushes for fine sieve	2
Sieve brushes for coarse sieves	2
1.6 Abrasion Test :	
Los Angeles Machine	1
Oven	6
1.7 Field Density Test, Sand Cone Method:	
Sand cone	1
Replacement jug	1
Field density plate	1
Spoon	1
Steel chisel, 1 inch	1
Rubber mallet	1
Sand scoop	1
1 gallon field cans	6
1.8 Moisture Content:	
Speedy, moisture tester, 26 grams capacity	1
Cans “Speedy” reagent	6

	ITEM	Quantities
2.	**BITUMINOUS TESTING**	
2.1	**Marshall Asphalt Test:**	
	Stability compression machine 220 volt 50 cycles complete with 6000 lbs proving ring	1
	Stability compaction mould 4”	4
	Stability compaction mould 6” (if AC-Base to be used)	4
	Mechanical compaction hammer for 4” mould	1
	Mechanical compaction hammer for 6” mould (if AC-Base to be used)	1
	Mould holder for 4” mould	1
	Mould holder for 6” mould (if AC-Base to be used)	1
	Stability mould 4”	1
	Stability mould 6” (if AC-Base to be used)	1
	Dial flow indicator	1
	Pedestal	1
	Water bath 220 V 50 cycle	1
	Sample extractor	1
	Stainless steel mixing bowls	2
2.2	**Extraction Test, Centrifuge Method :**	
	Centrifuge extraction, 1500 gram capacity, 220 V 50 cycle	1
	Boxes filter paper rings (100 - box)	10
	Extractor bowl	1
	Bowl cover	1
	Bowl nut	1
2.3	**Extraction Test, Reflux Method:**	
	Reflux extractor set, 1000 gram capacity	1
	Boxes filter paper (50 - box)	1
2.4	**Specific Gravity of Coarse Aggregates:**	
	Density Basket	1
	Sample Splitter 1”	1
	Sample Splitter 1/2”	1
2.5	**Specific Gravity of Fine Aggregates :**	
	Cone	1
	Tamper	1
	Pycnometer	1
	Thermometer (Glass), 0 - 150 ^{0} C	3
	Desiccator	1

ITEM	Quantities
2.6 Mix Air Voids Content, (Accurate Method):	
200 cc Conical Flask with neck large enough to admit 25 mm aggregate, with airtight ground glass stoppers	2
Vacuum pump (+ special oil)	1
Rubber tubing	1
Warm air fan	1
2.7 Core Drilling:	
Core drill machine, 7 HP, 4 cycle	1
9" extension shaft	1
18" strap wrench	1
Diamond bit 4" diameter (resettable)	2
Expanding adaptor	1
2.8 Metal Thermometer:	
0 - 100 ^{0} Metal Thermometer	1
0 - 250 ^{0} Metal Thermometer	1
0- 500 ^{0} Portable Infrared Thermometer	1
2.9 Accessories and Tools:	
Heavy duty balance complete with set of weights, scoop and counterweight	1
Triple beam scale complete with set of weights	1
Generator, 10 kVA	1
Double wall oven, 1600 W 240 volt 50 cycle	2
Plastic funnels	3
Sodium hexametaphosphate	1 lb.
Pairs asbestos gloves	2
Laboratory tongs	2
2.10 Penetrometer :	
Penetration Apparatus	1
Penetration Needle	2
Sample Container diameter 55 mm, internal depth 35 mm	6
Water Batch min.10 liters, 25 + 0.1°C	1
Transfer Dish, min. 350 ml	1
Timing Device, accurate to within 0.1 s for 60 s interval	1
Thermometer, maximum scale error of 0.1 °C	1
Flakiness	1
Elongation Test	1

2.11 Softening Point :

Ring	2
Pouring Plate	1
Ball	2
Ball Center Guide	2
Bath (a glass vessel)	1
Ring Holder and Assembly	1

2.12 Refusal Density Compactor of BS 598 Part 104 (1989) : 1 set

3. CONCRETE TESTING

Slump Cone with other supporting sets	31
Base Plate of a Stiff Non-Absorbing Material min. 700 mm^2	1
Trowel	1
Scoop	1
Ruler	1
Stop Watch	1
Cylinder moulds diameter 15 cm and height 30 cm	30
Cylinder crushing machine (provisional)	1
Tamping bar (40 cm long, weighing 2 kg and tamping section having size of 25 mm x 25 mm)	1
pH meter	1
Ultrasonic Pulse Velocity	1

4. OTHERS

Handheld GPS with decimeter precision	4

All laboratory measuring instruments shall be calibrated by an independent institution approved by the Engineer and shall govern at least 12 and the Contractor shall provide this backup data at the request of the Engineer.

APPENDIX 1.39:

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (RKPPL)

The systematic of Environmental Management and Monitoring Plan (RKPPL) are as follows:

(1) The front cover contains the title of EMMP (RKPPL) for the project and location of Works.

(2) Validation Sheet containing the parties involved in environmental management of this activity which includes, made by the Contractor, checked by Engineer and approved by the Employer representative as the initiator.

(3) Chapter I Introduction: The objectives of EMMP, project location, project data, technical activities data, and organization chart of Contractor.

(4) Chapter II Initial Environmental Baseline: contains the environmental baseline at the location where the activities are described in a table on each typical of road section and accompanied with the photos of existing condition.

(5) Chapter III: Environmental Management Work Plan: contains the environmental management plan for each activity on road section including the potential impacts.

(6) Chapter IV: Environmental Monitoring Work Plan: contains the monitoring plan for environmental management to be carried out.

(7) Attachments which involve:
   (a) Environmental Permit
   (b) Map of Base Camp and Quarry.
   (c) Permits related to the quarry, concrete batching plant, AMP and/or Stone Crusher.

Form of EMMP (RKPPL) Documents involve:

- Cover of EMMP (RKPPL)
- Validation Sheet of EMMP (RKPPL)
- Project Data

1	Project Name	:
2	Project Location	:
3	Project Length	:
4	Budget Sources	:
5	Employer	:
6	Project Manager	:
7	Engineer	:
8	Contractor	:
9	Contractor’s Address	:
10	Contract Number	:
11	Contract Signing Date	:
12	Accepted Contract Amount	:
13	Time for Completion	:
14	Commencement Date	:
15	Defect Notification Period	:

- Technical Data
  Sample of Technical Data

Table A.1- Technical Data

No	Description	Unit	Value
1	Length	km	
2	Right of Way	m	
3	Carriageway Width	m	
4	Shoulder Width	m	
5	Pavement		
	Flexible Pavement		
	a. AC-WC	cm	
	b. AC-BC	cm	
	c. AC-Base	cm	
	d. Aggregate Base Class A	cm	
	e. Aggregate Base Class B	cm	
	f. Selected Embankment	cm	
	Rigid Pavement		
	a. Rigid pavement	cm	
	b. Lean concrete	cm	
	c. Drainage layer	cm	
6	Shoulder Thickness	cm	

- Table of Initial Environmental Baseline:
  Sample of Initial Environmental Baseline

Left Side		CL	Right Side	
Photos	**Initial Baseline**	**STA**	**Initial Baseline**	**Photos**
(1)	**(2)**	**(3)**	**(4)**	**(5)**

APPENDIX 1.39 : TABLE OF EVIRONMENTAL MANAGEMENT PLAN (RKKL)

Sample of Table of Environmental Management Plan

LEFT SIDE				ROAD	RIGHT SIDE			
Environmental Impact	Activities that have an Impact	Environmental Management	Initial Baseline	STA	Initial Baseline	Environmental Management	Activities that have an Impact	Environmental Impact
1	2	3	4	5	6	7	8	9

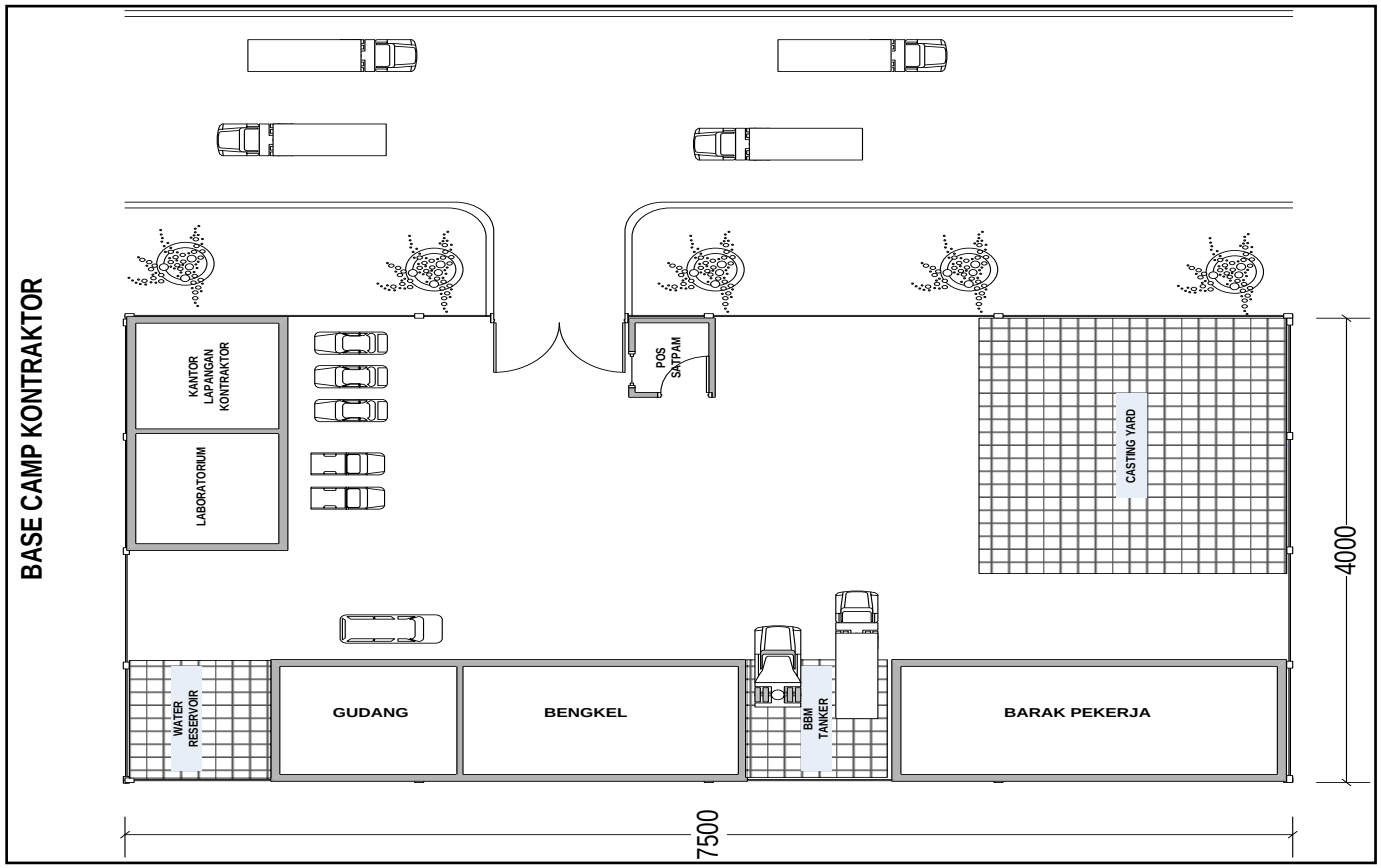
APPENDIX 1.39 : TABLE OF EVIRONMENTAL MONITORING PLAN (RPKL)

Sample of Table of Environmental Monitoring Plan

LEFT SIDE				ROAD	RIGHT SIDE			
Environmental Impact	Activities that have an Impact	Environmental Management	Initial Baseline	STA	Initial Baseline	Environmental Management	Activities that have an Impact	Environmental Impact
1	2	3	4	5	6	7	8	9

APPENDIX 1.39 : SAMPLE OF BASECAMP MAP

Sample of Basecamp Map



APPENDIX 1.39: REPORTING MATRIX OF THE IMPLEMENTATION OF MANAGEMENT AND MONITORING PLAN

- Sample of Reporting Matrix of the Implementation of EMMP

Location (Sta – Sta)	Activities Progress (Sources of Impact)	Environmental Impact	Results of the Implementation of Environmental Management	Results of the Implementation of Environmental Monitoring	Evaluation and Conclusion	Documentations
1	2	3	4	5	6	7

Table 1.39 (1) Classes of Water Quality

PARAMETER	UNIT	CLASS				REMARK
		I	II	III	IV	
PHYSICS						
Temperature	ºC	Deviation 3	Deviation 3	Deviation 3	Deviation 5	Deviation of temperature from the nature state
Dissolved Residue	mg/ L	1000	1000	1000	2000	
Suspended Residue	mg/L	50	50	400	400	For conventional drinking water treatment, the residue is suspended ≤ 5000 mg/L
ANORGANIC CHEMICAL						
pH		6-9	6-9	6-9	5-9	If naturally out of that range, then it is determined based on natural conditions
BOD	mg/L	2	3	6	12	
COD	mg/L	10	25	50	100	
DO	mg/L	6	4	3	0	Minimum Threshold Value
Cadmium	mg/L	0.01	0.01	0.01	0.01	
Copper	mg/L	0.02	0.02	0.02	0.2	For conventional drinking water treatment, Cu ≤ 1 mg/L
Iron	mg/L	0.3	(-)	(-)	(-)	For conventional drinking water treatment, Fe ≤ 5 mg/L
Lead	mg/L	0.03	0.03	0.03	1	For conventional drinking water treatment, Pb ≤ 0,1 mg/L
Mangan	mg/L	0.1	(-)	(-)	(-)	
Zinc	mg/L	0.05	0.05	0.05	2	For conventional drinking water treatment, Zn ≤ 5mg/L
MICROBIOLOGY						
Fecal coliform	total/100ml	100	1,000	2,000	2,000	For conventional drinking water treatment, fecal coliform ≤ 2,000 total/100 ml dan total coliform ≤ 10,000 total/100 ml
Total coliform	total/100ml	1,000	5,000	10,000	10,000	

Source : Government Regulation of the Republic of Indonesia No.82-2001 concerning Management Water Quality and Control of Water Contamination.

Remark : * Following the modification to the Government Regulations, and/or other relevant laws and regulations.

Note:

mg = milligram
ml = milliliter
L = liter

The values above are the maximum limits, except for pH and DO.
For pH is within a range which shall not be less or more than the value listed.
DO value is the minimum limit

Table 1.39 (2) Standard of Domestic Wastewater

Parameter	Unit	Allowable Maximum Content
pH		6-9
BOD	mg/L	30
COD	mg/L	100
TSS	mg/L	30
Oil & Fat	mg/L	5
Ammonia	mg/L	10
Total coliform	total/100mL	3000
Debit	L/person. Day	100

Source : Regulation of Minister of Environment and Forestry of the Republik Indonesia No.68-2016 concerning the Standard of Domestic Wastewater.

Remark : * Following the modification to the Regulation of Minister of Environment and Forestry and/or other relevant laws and regulations.

Table 1.39 (3) Standard of National Ambient Air Quality

No	Parameter	Time of Measurement	Raw Materials	Analysis Method	Equipment
1.	SO_2 (Sulphur Dioxide)	1 hour 24 hours 1 year	900 ug/Nm^3 365 ug/Nm^3 60 ug/Nm^3	Pararosanilin	Spectrophotometer
2.	CO (Carbon Monoxide)	1 hour 24 hours 1 year	30.000 ug/Nm^3 10.000 ug/Nm^3	NDIR	NDIR Analyzer
3.	NO_2 (Nitrogen Dioxide)	1 hour 24 hours 1 year	400 ug/Nm^3 150 ug/Nm^3 100 ug/Nm^3	Saltzman	Spectrophotometer
4.	O_3 (Oxidant)	1 hour 1 year	235 ug/Nm^3 50 ug/Nm^3	Chemiluminescent	Spectrophotometer
5.	HC (Hydrocarbon)	3 hours	160 ug/Nm^3	Flame Ionization	Gas Chromatography
6.	PM_{10} (Particle < 10 um)	24 hours	150 ug/Nm^3	Gravimetric	Hi – Vol Sampler
	PM_{25} *) (Particle < 2.5 um)	24 hours 1 year	65 ug/Nm^3 15 ug/Nm^3	Gravimetric Gravimetric	Hi – Vol Sampler Hi – Vol Sampler
7.	TSP (Dust)	24 hours 1 year	230 ug/Nm^3 90 ug/Nm^3	Gravimetric	Hi – Vol Sampler
8.	Pb (Lead)	24 hours 1 year	2 ug/Nm^3 1 ug/Nm^3	Gravimetric Ignition Extractive	Hi – Vol Sampler AAS
9.	Dust fall	30 days	10 Ton/Km^2/month (Residence) 20 Ton/km^2/month (Industry)	Gravimetric	Cannister

No	Parameter	Time of Measurement	Raw Materials	Analysis Method	Equipment
10.	Total Fluorides (as F)	24 hours 90 days	3 ug/Nm^3 0,5 ug/Nm^3	Specific Ion Electrode	Impinger or Continuous Analyzer
11.	Fluor Index	30 days	40 ug/Nm^3 from limed filter paper	Colorimetric	Lime Filter Paper
12.	Chlorine & Chlorine Dioxide	24 hours	150 ug/Nm^3	Specific Ion Electrode	Impinger or Continuous Analyzer
13.	Sulphur Index	30 days	1 mg SO_3/100 cm^3 from Lead Peroxide	Colorimetric	Lead Peroxide Candle

Source : Government Regulation of the Republic of Indonesia No.41-1999 concerning the Control of Air Contamination (Attachment I).

Remark : * Following the modification to the Government Regulations, and/or other relevant laws and regulations.

Note : - *) PM25 shall govern since 2002

- Nomor 10 to 13 shall govern for region/area of Basic Chemical Industry,
  Example: Petro Chemical Industry or Sulfuric Acid Manufacturing Industry

Table 1.39 (4) Standard of Old Motorized Vehicle Exhaust Emission

A. MOTORIZED VEHICLES CATEGORY OF L						
No.	**Category**	**Year of Made**	**Parameter**			**Testing Method**
			CO (%)	**HC (ppm)**		
1.	2 stroke motorcycle	< 2010	4.5	12,000		Idle
2.	4 stroke motorcycle	< 2010	5.5	2,400		Idle
3.	Motorcycle (2 and 4 stroke	≥ 2010	4.5	2,000		Idle
B. MOTORIZED VEHICLES CATEGORY OF M, N, AND O						
No.	**Category**	**Year of Made**	**CO (%)**	**HC (ppm)**	**Opasity (% HSU) ***	**Testing Method**
1.	Enginee running of spark plug (gasoline)	< 2007	4.5	1,200		Idle
		≥ 2007	1.5	200		
2.	Enginee running of ignition compression (diesel)					Free accele-ration
	- GVW ≤ 3.5 ton	< 2010			70	
		≥ 2010			40	
	- GVW > 3.5 ton	< 2010			70	
		≥ 2010			50	

Note:
For motorized vehicle of spark plug with category of M, N, and O (for wheels or more):
- < 2007: shall govern upto 31 Dec 2006
- ≥ 2007: shall govern since 1 Jan 2007

For motorized vehicle with category of L (motorcycles) and motorized vehicle of ignition compression M, N, and O (four wheels or more):
- < 2010: shall govern up to 31 Dec 2009
- ≥ 2010: shall govern since 1 Jan 2010

* : or equivalent % bosch

Source : Regulation of Minister of Environment and Forestry of the Republic of Indonesia No.5-2006 concerning the Standard of Old Motorized Vehicle Exhaust Emission.

Remark : * Following the modification to the Regulation of Minister of Environment and Forestry and/or other relevant laws and regulations.

Note : The CO and HC content are measured under free acceleration conditions (idling), the thickness of exhaust fumes is measured at free acceleration conditions

Table 1.39 (5) Standard of Noise Rate

For Health Region/Area	Noise Rate db.(A)
a. For Region	
1. Housing and Settlements	55
2. Trade and Services	70
3. Offices and Warehousing	65
4. Green Open Space	50
5. Industry	70
6. Government and Public Facilities	60
7. Recreation	70
8. Specific	
- Airport - Railway Station - Port - Cultural Heritage	 60 70
b. Activities Environment	55
1. Hospital or the similar	55
2. School or the similar	55
3. Worship Place or the similar	

Source : Minister Decree of Environment of the Republic of Indonesia No.48-1996 concerning the Standard of Noise Rate

Remark : * Following the modification to the Minister Decree of Environment and/or other relevant laws and regulations.

Table 1.39 (6) Effects of Vibration Levels on Comfort and Health

No	Frequency HZ	Vibration Rate Value, in micron (10^{-6} meter)			
		Not Disturb	Disturb	Not Comfort	Painful
1	4	<100	100 – 500	> 500 – 1000	> 1000
2	5	<80	80 – 350	> 350 – 1000	> 1000
3	6.3	<70	70 – 275	> 275 – 1000	> 1000
4	8	<50	50 – 160	> 160 – 500	> 500
5	10	<37	37 – 120	> 120 – 300	> 300
6	12.5	<32	32 – 90	> 90 – 220	> 220
7	16	<25	25 – 60	> 60 – 120	> 120
8	20	<20	20 – 40	> 40 – 85	> 85
9	25	<17	17 – 30	> 30 – 50	> 50
10	31.5	<12	12 – 20	> 20 – 30	> 30
11	40	<9	9 – 15	> 15 – 20	> 20
12	50	<8	8 – 12	> 12 – 15	> 15
13	63	<6	6 – 9	> 9 – 12	> 12

Source : Minister Decree of Environment of the Republic of Indonesia No.Kep.49/MENLH/XI/1996 concerning the Standard of Vibration Rate

Remark : * Following the modification to the Minister Decree of Environment and/or other relevant laws and regulations.

Conversion:

Acceleration = $(2\pi f)^2$ x deviation

Speed = $2\pi f$ x deviation

$\pi = 3.14$

Table 1.39 (7) Standard of Vibration Rate Based on the Impact Damage

Vibration		Frequency	Limits of Peak Movement (mm/second)			
Parameter	**Unit**	**(Hz)**	**Category A**	**Category B**	**Category C**	**Category D**
Vibration Speed	mm/second	4	< 2	2 - 27	> 27 - 140	> 140
		5	< 7.5	< 7.5 - 25	> 24 - 130	> 130
Frequency	Hz	6.3	<7	<7 – 21	>21 – 110	>110
		8	<6	<6 – 19	>19 – 100	>100
		10	<5.2	<5.2 – 16	>16 – 90	>90
		12.5	<4.8	<4.8 – 15	>15 – 80	>80
		16	<4	<4 – 14	>14 – 70	>70
		20	<3.8	<3.8 – 12	>12 – 67	>67
		25	<3.2	<3.2 – 10	>10 – 60	>60
		31.5	<3	<3 – 9	>9 – 53	>53
		40	<2	<2 – 8	>8 – 50	>50
		50	<1	<1 – 7	7 – 42	>42

Source : Minister Decree of Environment of the Republic of Indonesia No.Kep.49/ MENLH/XI/1996 concerning the Standard of Vibration Rate

Remark : * Following the modification to the Minister Decree of Environment and/or other relevant laws and regulations.

Note:

Category A : Not cause the damage.

Category B : Possible cracking system (cracking/removal of plastering on the load bearing wall in special cases)

Category C : Possible damage to load bearing wall as the structure components.

Category D : Damage on load bearing wall

APPENDIX 1.40:

DUTY OF QUALITY CONTROL MANAGER (QCM) AND THE OUTPUT INDICATOR

DUTY OF QUALITY CONTROL MANAGER (QCM)	OUTPUT INDICATOR	HAVE IMPLEMENTED THIS DUTY? (IF ALREADY, GIVE A COPY OF OUTPUT SAMPLE) IF NOT YET, PLEASE EXPLAIN WHY?
1. Implement the Contractor's QC Plan;	• Report on the implementation of the Quality Control Plan.	
2. Be responsible for measuring conformance with all aspects of the contract quality;	• Quality Record • NCR	
3. Stop work when materials, product, processes or submittals are deficient;	• NCR	
4. Develop inspection and testing plans for each element of Work;	• Inspection & Testing Schedule.	
5. Ensure all surveys, tests, technical audits, etc shall use GPS instruments for their exact coordinates (latitude-longitude);	• Position Reference System. • Integrity and Continuity Data.	
6. Develop acceptance/non-acceptance reports and quality control checklists for each element of Work in sufficient detail to gauge conformance with all significant contractual requirements;	• Acceptance/Rejection Report. • Check List of the Quality Control.	
7. Ensure the requirements for quality management (including an overview of how the QC Plan operates, the worker's role in it, contractual specifications for the Work, and work procedures) are known to, understood by, and adhered to by all workers on the Site;	• Staffs Training • Manuals, Procedures, Work Instructions.	
8. Ensure that all QC checklists are signed-off by competent and responsible parties as close to the actual work as appropriate to the nature of the Work (e.g. by the actual worker or a foreman for most work; by a Professional Engineer for false work erection; etc.;	• Check List Documentation.	
9. Review, sign, and be responsible for all reports (materials and testing results);	• Documentation of Material and Work Testing Report.	

DUTY OF QUALITY CONTROL MANAGER (QCM)	OUTPUT INDICATOR	HAVE IMPLEMENTED THIS DUTY? (IF ALREADY, GIVE A COPY OF OUTPUT SAMPLE) IF NOT YET, PLEASE EXPLAIN WHY?
10. Consult with field inspectors regarding materials and testing issues;	• Minutes	
11. Receive notification by inspectors re deficiencies and ensure re-testing or rejection;	• Documentation of Reportings and Instruction's Action.	
12. Provide weekly and monthly summary reports on testing and inspection results;	• Weekly/Monthly Report on Inspection and Testing Results	
13. Initiate the non-conformance process when materials or product do not meet the required specifications and, inform the Engineer of such nonconformance;	• Documentation of the Action Plans, Actions, Monitoring and Evaluation of Actions for each NCR • Reporting to the Employer.	
14. Consult with the Contractor Representative and initiate corrective action on non-conformance;	• Minutes	
15. Respond to each Non-Conformance Report (NCR) issued by the Engineer within the time specified in the NCR;	• Documentation of the Action Plans, Actions, Monitoring and Evaluation of Actions for each NCR.	
16. Schedule testing and inspection services in coordination with the Contractor's superintendent and foremen;	• Inspection & Testing Schedule.	
17. Monitor QC testing and inspection procedures including those of the Subcontractors;	• Inspection & testing monitoring records.	
18. Work directly with the Engineer on matters related to QC;	• Minutes	
19. Ensure required approvals and permits from the Engineer and others are obtained as and when required;	• Approval Documentation	
20. Verify that all testing equipment is properly maintained and kept in good working order;	• List of Testing Equipment Conformity Status	

DUTY OF QUALITY CONTROL MANAGER (QCM)	OUTPUT INDICATOR	HAVE IMPLEMENTED THIS DUTY? (IF ALREADY, GIVE A COPY OF OUTPUT SAMPLE) IF NOT YET, PLEASE EXPLAIN WHY?
21. Keep an organized filing system to ensure that quality records are easily accessible so that auditors can obtain necessary information;	• Filing System	
22. Review issued for construction drawings, calculations, and shop drawings and ensure that all concerned Contractor staff have current versions of documents applicable to their part of the Work;	• Availability of the Latest Shop Drawings that have been checked	
23. Notify the Engineer of any changes in survey layout, location, line, grade, etc., for approval;	• Report	
24. Notify the company principles of any issues that compromise the integrity or function of the Quality Management System, and	• Report	
25. Provide an auditable trail for survey computations to the Engineer.	• Filing System	

DIVISION 2 SITE CLEARING

S2.01 Site Clearing

S2.01 (1) Description

The Clearing and grubbing shall consist of clearing of all trees less than 15 cm in diameter, downed timber, snags, bush, other vegetation, rubbish, and all other objectionable material, and shall include grubbing stumps, roots, and disposing of all spoil material resulting from the clearing and grubbing in accordance with these Specifications or as directed by the Engineer. It shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the Works except where otherwise provided for in these Specifications or ordered by the Engineer.

Selected tree removal shall consist of the removal of all trees shown on the Drawings or designated by the Engineer measuring 15 cm or more in diameter at a point measured one meter above the ground surface. The work shall consist of not only the removal and disposal to the satisfaction of the Engineer of the individual tree but the stump and roots as well.

This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

S2.01 (2) Construction Requirements

(a) General

The Engineer will establish the limits of work and designate all trees, shrubs, plants and other things to remain. The Contractor shall preserve all items designated to remain.

(b) Clearing and Grubbing and Tree Removal

All surface objects and all trees, down timber, rotten wood, stumps, roots, snags, brush, other vegetation, rubbish, and other protruding obstructions, not designated to remain, shall be cleared and/or grubbed, including disposal as required.

In areas under roadway embankments, from which top soil or unsuitable materials are to be removed or which are designated to be compacted, all stumps and roots shall be thoroughly removed.

In roadway cut areas, all stumps and roots shall be thoroughly removed.

Clearing and grubbing of pits, channel changes, and ditches will be required only to the depth necessitated by the excavation within those areas.

Voids left after removal of roots shall be filled with suitable compacted material in accordance with Clause S.4.06.

(c) Topsoil Stripping

In areas under roadway embankments or where designated by the Engineer, the Contractor shall remove the topsoil and dispose of it as directed by the Engineer.

In general, the removal of topsoil shall include only the removal of soil which is fertile enough to encourage or sustain a growth of vegetation with maximum of 30 cm.

Removal of topsoil over any designated area shall be executed to the depth as directed by the Engineer, and the topsoil shall be kept separate from other excavated material.

When the topsoil will be used for dressing of the slopes of the embankment or other areas as directed by the Engineer or as indicated on the Drawings, the work of topsoil stripping will be deemed to include stockpiling the topsoil when necessary and removing therefrom and the placing and spreading of the topsoil in areas designated by the Engineer. After spreading, the topsoil shall be raked to form a smooth surface free from weeds, roots, sods and large stones.

(d) Protection of Areas Designated to Remain

In areas designated by the Engineer, the Contractor will be responsible for the protection and routine maintenance of existing shrubs, trees and grassed areas. On completion of the Works these areas will be returned to the Employer in the same condition as before and any damage due directly or indirectly to the Contractor's operations shall be made good at his own expense.

S2.01 (3) Disposal of Cleared Material

The Contractor shall have the right to use unsaleable timber (or saleable timber when permission is granted in writing by the appropriate Government agency or authority) for his own purposes in connection with the Contract always provided that he has ascertained and complied with the requirements of the appropriate Government agency or authority.

Saleable timber shall be neatly stored in an approved accessible place within or near the right-of-way as directed and shall be trimmed and stacked in accordance with the requirements of the appropriate Government agency.

All other timber, except timber to be used, and all brush, stumps, roots, logs, and other refuse from the clearing and grubbing operation shall be disposed of at locations provided by the Contractor.

The roadway and adjacent areas shall be left with a neat and finished appearance. No accumulation of debris shall remain on or adjacent to the right-of-way.

S2.01 (4) Method of Measurement

Clearing and grubbing, topsoil stripping and protection of designated areas, will together be considered as Site Clearing, and will be paid for by the square meter.

Tree cutting and protection to the selected tree to be considered as Removal of Existing Tree and shall be paid for by each. Tree removal and protection of trees designated to remain in place will be considered as Removal of Existing Trees more than 15 cm in diameter at a point measured one meter above the ground surface and will be paid for by number. The work of Site Clearing and Tree Removal for disposal sites, material sites, imported borrow pit sites, haul roads and all temporary construction shall not be paid for when such sites are outside the areas designated for clearing and grubbing and the Contractor is permitted to exercise his own option as to whether he elects to use such disposal sites or borrow pit sites.

S2.01 (5) Basis of Payment

The work measured as provided above shall be paid for as undermentioned. The payment shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals necessary to do the work and for doing all the Site Clearance and Tree Removal in the designated areas as specified in these Specifications and as directed by the Engineer including if necessary, removal and disposal of the resulting material.

Pay Item No. and Name		**Unit of Measurement**
2.01 (1)	Site Clearing	Square Meter
2.01 (2)	Removal of Existing Tree dia. >15 – 30 cm	Each
2.01 (3)	Removal of Existing Tree dia. >30 – 50 cm	Each
2.01 (4)	Removal of Existing Tree dia. >50 – 75 cm	Each
2.01 (5)	Removal of Existing Tree dia. >75 cm	Each

DIVISION 3 DEMOLITION

S3.01 Demolition

S3.01 (1) Description

This work shall consist of the removal, wholly or in part and satisfactory disposal of blocks of masonry of an individual size greater than 1 cubic meter, of all buildings, hedges, fences, structures, curbs, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the Contract Documents. It shall also consist of the salvaging of designated materials and backfilling the resulting trenches, holes and pits.

In general, when the materials are not required by the Employer and they shall be removed by the Contractor as instructed by the Engineer, such materials should be disposed of at the disposal area itself, in accordance with the provisions of Clause S4.07 of Specifications.

S3.01 (2) Work Requirements

(a) General

The Contractor shall perform the above work, within and adjacent to the roadway, on the right-of-way, as shown on the Drawings or as directed by the Engineer. The Engineer may instruct that materials recovered from demolition shall remain the property of the Employer unless specifically provided otherwise in the Contract Documents. All designated saleable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places on the project as directed by the Engineer. Basements or cavities left by structure removal shall be filled with acceptable material to the level of the surrounding ground and, if within the prism of construction, shall be compacted in accordance with Clause S4.06.

Performance of these works under the Contract shall include salvage of materials removed, their custody, preservation, storage on the right-of-way or any other places as may be designated by the Engineer or the Employer, or disposal as provided herein.

(b) Removal of Bridges, Culverts, and other Structures

Bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, the substructures of existing water structures shall be removed down to the natural stream bottom and those parts outside of a stream shall be removed to the extent necessary to avoid influence on new works.

Where portions of the existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Where only a section of the existing structure is to be demolished, the Contractor shall execute this work in such a way as to avoid damage to the section designated to remain. All details of the Contractor's proposed working method shall be submitted to the Engineer for approval.

Steel bridges and wood bridges, when specified by the Engineer to be salvaged, shall be carefully dismantled without damage. Steel components shall be match marked, unless such match marking is waived by the Engineer. All salvaged material shall be stored as requested by the Engineer.

Unless waived in writing by the Engineer, all concrete removed that is of suitable size for riprap and not needed for such use on the Project, shall be stockpiled at locations designated by the Engineer, for use by the Employer.

(c) Removal of Curbs

Existing curbs designated for removal, including their bases, shall be broken into pieces and shall be removed and stockpiled at designated locations on the site for use of the Employer, or shall be otherwise disposed of as directed by the Engineer.

Removal of existing curbs shall be undertaken in such a manner as to avoid damage to existing pavements and curbs which are designated to remain.

(d) Removal of Traffic Signs

When directed, traffic signs including steel frames shall be carefully dismantled, removed and stored where directed by the Engineer.

Concrete foundations shall be broken into pieces removed and stockpiled at designated locations on the site for use of the Employer or shall be otherwise disposed of as directed by the Engineer.

(e) Removal of Guardrail

Guardrail including block piece shall be carefully dismantled and the condition of material shall be remained as before. Bolts and nuts shall be opened with a key to remain intact. If the bolt or nut has been in the welding, welding former shall be chiseled or grinded in order not to damage the guardrail or other parts. Demolition of the welding pieces on the guardrail, block piece or post is not permitted unless the bolt or nut if the existing was welded.

(f) Demolition of Housing

House including all fence and yard shall be demolished until level to the surrounding ground level. Demolition includes foundations shall be accompanied by refill and recompaction with soil. Certain parts of the house that shall be carefully demolished to maintain its integrity in accordance with the direction of the Engineer.

.. **S3.01 (3)** Method of Measurement

The quantities to be paid for according to these Specifications or as directed by the Engineer, shall be cubic meter or square meter or linear meter depending upon the nature of structure and obstructions demolished acceptably within the limits as directed by the Engineer. Demolition of housing will be measured for payment in square meter per story.

Demolition required for the Permanent Works will be measured for payment, while demolition for haul roads, borrow areas and all the Temporary Works will not be measured for payment.

S3.01 (4) Basis of Payment

The work measured as provided above shall be paid as undermentioned. The payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals necessary to do the work and for doing all the demolition in the designated locations or areas as specified in these Specifications, including backfilling if necessary. The unit price for any work under this Clause will be deemed to include any precautions or special working methods necessary to avoid damage to abutting material designated to remain. Any such damage shall be rectified by the Contractor at his own expense. All work shall be as directed by the Engineer including the removal and disposal of all the resulting material.

Pay Item	**No. and Name**	**Unit of Measurement**
3.01 (1a)	Demolition of Stone Masonry or Brick	Cubic Meter
3.01 (1b)	Demolition of Structural Concrete	Cubic Meter
3.01 (1c)	Demolition of Prestressed Concrete	Cubic Meter
3.01 (2)	Demolition of Curb	Linear Meter
3.01 (3)	Demolition of Traffic Sign	Each
3.01 (4)	Demolition of Guardrail/Railing/Chain Link	Linear Meter
3.01 (5)	Demolition of Housing	Square Meter

DIVISION 4 ROAD EARTHWORK AND GEOSYNTHETICS WORK

S4.01 Scope

Road earthwork shall consist of all necessary work for the excavation and placing or disposal of earth or rock or other material from or to the roadway or adjacent thereto, for construction of waterways, ditches, laybys and bridge approaches, for the removal of unsuitable material, the removal of landslides, all in accordance with the lines, grades, cross-sections shown on the Drawings or as established by the Engineer. Structure excavation shall not be included in Division 4, but in Division 5 "Structure Excavation".

S4.02 General

S4.02 (1) Soil Information

Any information of the properties of the soil that may be shown on the Drawings or obtained by the Contractor as a result of discussion with the Engineer shall alone not be considered as a sufficient basis for the Contractor's Bid Prices.

The Contractor is responsible for his interpretation of information supplied by the Employer and shall visit the Site and possible Borrow Pits. Prior to start the earthwork, the Contractor shall ascertain the nature of the soil, its quantity, locations, and suitability to meet the specified requirements.

S4.02 (2) Classes of the Work

This work will be divided into the following classes, which are hereinafter described in detail under separate headings:

(a) Common Excavation; Soft Rock Excavation, Rock Excavation; Excavation on Existing Granular Pavement and Excavation on Existing Cement Concrete Pavement;

(b) Borrow Material;

(c) Formation of Embankment and Areas of Fill;

(d) Waste;

(e) Areas of Special Fill;

(f) Granular Backfill;

(g) Permeable Backfill.

(h) Vertical Sand Drain and Horizontal Sand Drain.

(i) Geotextiles

(j) Prefabricated Vertical Drain (PVD)

(k) Geotechnical Instruments

All road earthworks shall be carried out in accordance with the Specifications for the classes as named above, and the specifications for other work items involved,

and in conformity with the lines, grades, sections and dimensions, shown on the Drawings or required by the Engineer.

S4.02 (3) Horizontal and Vertical Alignment

The Engineer will supply the Contractor with the locations of the Points of Intersection of Tangents and Grade lines. The Drawings will indicate the properties of horizontal and vertical curves, together with the rates of super elevation where required. The Contractor shall prepare cross-sections based upon the above properties, secure the Engineer's approval of his cross-sections and stake out before proceeding with construction. If, in the opinion of the Engineer, any modification of the line or grade is advisable, either before or after stake-out, the Engineer will issue detailed instructions to the Contractor for such modifications and the Contractor shall revise the stake-out for further approval. These requirements shall be met without additional payment and all costs thereof shall be included in the Bid Prices for pay items under the Contract.

Horizontal alignment tolerances for road earthwork shall not exceed 20 mm tolerance.

S4.02 (4) Quantities

The quantities of the various classes of excavation and embankment includes the unlined ditches, to be measured for payment under the Contract will be based on the lines shown on the approved profiles and cross-sections or as instructed by the Engineer. The Engineer may decide the angle of the slope of cut and fill or the formation of benches in the slopes as the work proceeds on the basis of his evaluation of the soil characteristics.

The cross-sections will form the basis of the earthwork's calculations, but they will be supplemented by such site measurements as are necessary to accurately determine the quantity for each pay item. The actual lines of the cut and fill as made shall be duly measured and recorded by the Contractor. The Engineer will check these records and will approve the measurements, if correct, as a basis of payment. Excavation and fill in excess of the approved cross-section will not be paid for.

Suitable excavated material surplus to the requirements of Division 5 (Structure Excavation) of these Specifications, shall be considered as available for incorporation in fill areas, and should be stockpiled if not required at the time of excavation.

Excess excavation shall be back-filled, as directed by the Engineer, with sub-base or other suitable material without extra payment.

S4.02 (5) Method of Measurement

The quantities of earthwork to be paid for shall be the number of cubic meters of material measured and computed by calculations incorporating the average end-area method, except where the error may exceed plus or minus five percent as compared with the prismoidal formula, in which case the Engineer will authorize the use of the more accurate method. However, the Contractor shall request such authority before he submits his quantities for approval. Quantities measured on

the average end-area basis, once they have been submitted and approved, shall not be subject to review for the purpose of applying a more accurate method.

S4.02 (6) Removal of Existing Obstructions

The Bid Prices for the classes of excavation shall include the cost of removal of all material, regardless of its nature, encountered within the approved limits for excavation, including the removal and disposal, as required by the Engineer, of sections of existing brick, stone, concrete or masonry, and rock boulders encountered during earthwork.

Only boulders or bricks of masonry of individual size greater than 1 cubic meter, will be paid for under the respective pay item from Division 3 of these specifications.

S4.02 (7) Removal or Diversion of Water

Removal or Diversion of Water will be paid for in accordance with Clause S1.26 of these Specifications and no additional payment will be made for this work under this Division 4.

The Contractor shall provide necessary facilities for dewatering, and for draining or diverting water-courses when necessary for the execution and protection of the work or where required by the Engineer.

The Contractor shall provide such temporary or permanent drainage outlet ditches as may be necessary to affect proper drainage before rain is to be expected. Payment will only be made for the permanent work.

S4.02 (8) Use and Disposal of Excavated Material

All surplus suitable material excavated within the limit and scope of the project shall, unless provision is expressly made to the contrary in these Specifications, be used in the most effective manner for the formation of the embankment. Any material surplus to these requirements, or any material declared in writing by the Engineer to be unsuitable, shall be disposed of by the Contractor outside the right-of-way or as directed by the Engineer in accordance with the provisions of these Specifications, and shall be considered as Waste, which shall be subject to the provisions of Clause S4.07.

S4.02 (9) Ditches

The Contractor shall construct channels, side and interception ditches, inlet and outlet ditches as shown on the Drawings or where ordered by the Engineer, whether for temporary or permanent drainage. In order to keep water away from the embankment, sub grade, sub-base, and/or base during construction, the Contractor shall at all times ensure adequate drainage is operative before work is begun on the embankment and pavement structure. He shall clean and trim all such drainage ditches from time to time so that there may be a free flow of water throughout the whole Time for Completion and Defect Notification Period.

Damage to the work due to soaking water caused by inadequate drainage shall be repaired at the Contractor's expense. Ditches shall first be trimmed short of the approved cross-sections, and final trimming, including the repair of any damage

that may have been done during the construction work, shall be carried out after the completion of the construction work and shall be a condition for final approval and acceptance.

Irrigation of areas on which earthworks are to be executed shall have been halted at least two months in advance of the construction. All surface water shall be drained off and temporary and permanent ditches constructed in good time to allow the area to dry out.

S4.02 (10) Relocation of Stream Channels

Where indicated on the Drawings or where required by the Engineer, the Contractor shall take cross-sections of existing stream channels and, in collaboration with the Engineer, mark them with details of the excavation required for the relocation of the stream channel. The Contractor shall also take levels to allow the profile levels of box culverts and their extensions to be accurately fixed by the Engineer. Work shall not proceed without approval of the marked cross-sections by the Engineer. The work of stream-channel excavation shall be considered as Common Excavation and paid for at the Contract unit prices for this item, subject to the provisions of Clause S4.03.

S4.02 (11) Loose Earth or Rock, Landslides, Benches, Flattening of Slopes

Loose earth or loose rock shall be removed from slopes when required by the Engineer. The Engineer may also order the removal of material resulting from landslides, the construction of benches in or above the cut slopes, or, where in his opinion the slope, after cutting, shows signs of instability, the flattening of the slope.

Performance of this work under the contract is not payable directly but shall be considered as a subsidiary obligation of the Contractor covered under the unit rate for Common Excavation or Borrow Material.

S4.02 (12) Filling Existing Watercourses

Where watercourses have to be diverted from sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and carefully filled with suitable materials deposited and compacted as specified in Clause S4.06.

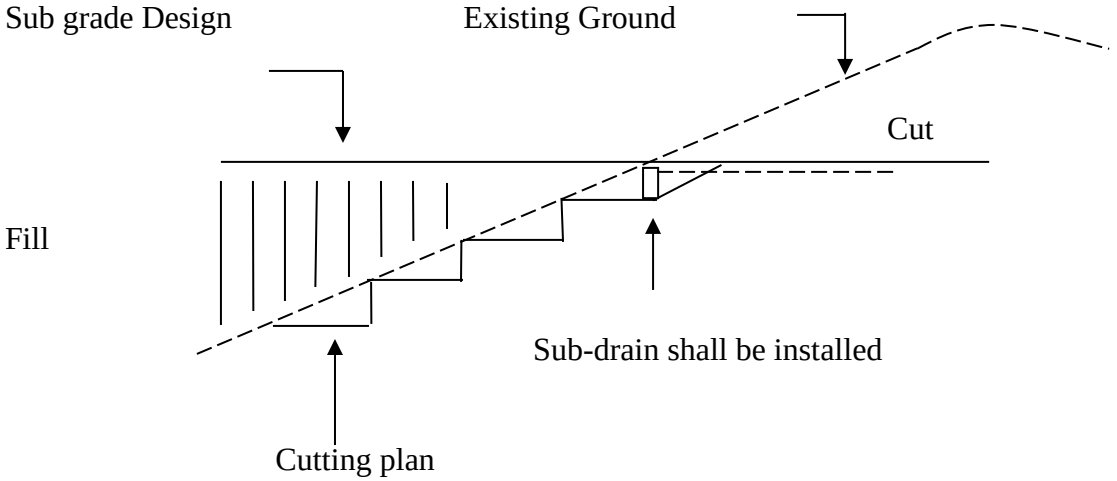
S4.02 (13) Cut and Fill at Sliding Areas

Excavation at the sliding area, in addition to follow the procedures specified in the General Specifications, the material shall be removed or dumped outside the landslide area. The excavation material shall be directly put into the truck and placed in a location approved by the Engineer.

Embankment material shall be immediately placed in the location of the road, and stock piling on the road is not allowed to be carried out. This material shall be immediately leveled in accordance with loose thickness allowed for compaction.

S4.02 (14) Embankment in Transition Area between Cut and Fill

The transition area between cut and fill on the longitudinal direction shall be benched and sub-drain shall be installed as shown in the Drawing. Benching should be entered into the cutting area to ensure that all unstable existing ground material can be removed from the sub grade area. Benching (for landslides) the top layer shall be tilted parallel to the original existing slope to provide a gradual transition between the fill and the existing ground soil



S4.02 (15) Dimensional Tolerances

(a) Excavation

(i) Finished grades lines and formations after excavation shall not vary from those specified by more than 2 centimeters at any point.

(ii) Finished excavation slope surfaces shall not vary from the specified profile line by more than 10 centimeters for non-rock and 20 centimeters for rock where excessive rock cut is unavoidable.

(iii) Finished excavated soil or rock surfaces which are exposed to surface run-off water shall be sufficiently smooth and uniform and have sufficient slope to ensure the free drainage of the surface with no pounding.

(b) Fill

(i) The finished levels and grades after compaction shall be not more than 1 centimeter higher nor 2 centimeter lower than those specified or approved.

(ii) All exposed finished fill surfaces shall be sufficiently smooth and uniform and have sufficient slope to ensure the free run-off of surface water.

(iii) Finished embankment slope surfaces shall not vary from the specified profile line by more than 10 centimeters.

S4.02 (16) Weather Limitation

Fill shall not be placed, spread or compacted while rain is falling, and no compaction shall be carried out after rain or otherwise when the moisture content of the material falls outside the range specified in Sub-clause S4.06.(3).(e). All uncompacted fill surfaces shall be scarified and compacted sufficiently to maintaince the moisture content and shall be covered with plastic or tarpauline sheets at the end of daily working time as well as the rain will fall.

S4.03 Common Excavation, Soft Rock Excavation, Excavation of Existing Granular Pavement, Excavation of Existing Cement Concrete Pavement

S4.03 (1) Description

Common Excavation shall consist of all excavation within the limits of the right-of-way which is not classified as soft rock excavation, rock excavation, structure excavation, borrow excavation, excavation on existing asphalt pavement, granular pavement excavation, and concrete pavement excavation, the removal, handling and proper utilization or disposal of all excavated materials and shaping of excavation and preparation of exposed surface of excavation for the entire length of the roadway and approaches, in accordance with these Specifications and the lines, levels, grades, dimensions and cross-sections shown on the Drawings and as required by the Engineer.

Soft Rock Excavation shall include excavations on conglomerate or soft/ weathered rock which have a uniaxial compressive strength of 0.6 – 12.5 MPa in accordance with ASTM D7012-14e1 or SNI 2825:2008.

Excavation of existing Granular Pavement includes excavations on existing granular pavements and disposal of unused granular pavement as shown in the Drawings or as directed by the Engineer.

Excavation of existing Cement Concrete Pavement includes excavation on existing cement concrete pavement and disposal of unused cement concrete pavement as shown in the Drawings or as directed by the Engineer.

S4.03 (2) Applicable Provisions

The applicable provisions of Clause S4.02 shall be read into and become part of this Clause S4.03 "Common Excavation".

S4.03 (3) Execution of the works

Excavation shall be carried out according to the grade, line, and elevation specified in the Drawings or as directed by the Engineer and shall involve the disposal of all materials in any kind that were found, including soil, stone, brick, concrete, masonry and old pavement materials, which do not used for permanent works.

S4.03 (4) Use of Excavated Material

Suitable material excavated under this Clause shall be incorporated in the permanent works in accordance with Clause S4.06, or excavated material shall,

if directed by the Engineer, be considered as Waste and dealt with in accordance with Clause S4.07.

S4.03 (5) Removal and Disposal of Unsuitable Material

When so directed in writing by the Engineer, the Contractor shall remove material unsuitable for use in the embankment and shall dispose of it as provided in Clause S4.07.

Where the excavation reveals a combination of suitable and unsuitable materials the Contractor shall unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable materials.

When unsuitable material below sub-grade level in cut or below embankment foundation level is ordered to be removed, the soil left in place after the removal of the unsuitable material shall be compacted, to a depth of 20 cm, to a density of 100 percent of the maximum dry density determined according to AASHTO T99-15 or SNI 1742:2008. Payment for such compaction shall be included in the unit rate for Common Excavation.

S4.03 (6) Method of Measurement

The quantity to be paid for shall be the number of cubic meters of material acceptably excavated as hereinbefore prescribed. The material shall be measured in the original position in the natural ground after Site Clearing (Division 2) and Demolition (Division 3).

The volume of material excavated for temporary diversion roads constructed by the Contractor that fall outside the width affected by the excavation of the road will not be measured for direct payment, since this work is covered by the price tendered for the provisions of Clause S.1.19 " Traffic Management and Safety".

The measurement shall include the unavoidable over breakage due to slides when not attributable to carelessness of the Contractor.

S4.03 (7) Basis of Payment

When the Engineer orders the use of material obtained from Common Excavation for the execution of other works (such as stone masonry or aggregates for pavement or concrete) the Common Excavation shall not be paid for separately but shall be considered as a subsidiary obligation of the Contractor covered under the unit rates paid for the other works in which the material is employed.

The quantity of Common Excavation measured as specified above shall be paid for at the Contract unit price per cubic meter listed in the Bill of Quantities. The price and payment shall be full compensation for all work involved in performing excavation including excavating, removal, haulage, placing and compaction or satisfactory disposal of roadway excavation, for shaping and completion of all surfaces and for furnishing all labor, materials, tools, equipment and incidentals to complete the work as shown on the Drawings and as specified in these Specifications and as directed by the Engineer.

Pay Item	No. and Name	Unit of Measurement
4.03 (1)	Common Excavation for Embankment	Cubic Meter
4.03 (2)	Common Excavation for Filling Material in Median	Cubic Meter
4.03 (3)	Common Excavation as Waste Material	Cubic Meter
4.03 (4)	Soft Rock Excavation for Embankment	Cubic Meter
4.03 (5)	Soft Rock Excavation as Waste Material	Cubic Meter
4.03 (6)	Excavation on Existing Granular Pavement	Cubic Meter
4.03 (7)	Excavation on Existing Cement Concrete Pavement	Cubic Meter

S4.04 Rock Excavation

S4.04 (1) Description

Rock excavation shall consist of the excavation of boulders which have an uniaxial compressive strength of more than 12.5 MPa in accordance with ASTM D7012-14e1 or SNI 2825:2008 with l cubic meter in volume or greater and all rock or other hard material which, in the opinion of the Engineer, it is not practical to excavate without drilling and blasting. It is not including material which, in the opinion of Engineer, can be loosened by a single tine hydraulic ripper drawn by a tractor unit with a minimum weight of 15 tons and a net horsepower rating of 180 HP

S4.04 (2) Applicable Provisions

The applicable provisions of Clause S4.02 shall be read into and become part of this Clause.

S4.04 (3) Explosives

(a) The Contractor shall provide suitable buildings or warehouses in appropriate positions for the storage of explosives, which shall be stored in the manner and quantity approved of by the Engineer. Such storage places shall be accessible only to authorized personnel. They shall be properly marked, and all doors or accesses there to shall be provided with secure locks and all necessary means of preventing access by unauthorized persons.

(b) The Contractor shall be responsible for the prevention of any unauthorized issue or improper use of any explosives. The handling of explosives shall be entrusted only to experienced and responsible men, shall be to the satisfaction of the Engineer, and in conformity with the statutory regulations.

(c) All drilling and blasting shall be done in such a manner as to bring the excavation as close as possible to the required grade lines, and to disturb as little as possible the material to be left in place. Blasting by means of drill holes, tunnels or any other similar methods shall be performed at the

entire risk and responsibility of the Contractor, who shall have no claim to payment for any extra work occasioned by breakage outside the approved or revised cross sections.

(c) The greatest care shall be taken by the Contractor during all blasting operations to ensure that no injury be done to persons or damage to property or the finished work. Shots shall be properly loaded and capped, and only appropriate charges shall be used in each hole. A register of all explosives used, showing locations and amounts, shall be kept by the Contractor for checking by the Engineer.

(e) Where directed by the Engineer, the Contractor shall provide heavy mesh blasting mats for protection of persons, property and the Works during the excavation. If found necessary, blasting shall be restricted to times prescribed by the Engineer.

(f) The Engineer may prohibit blasting and order the rock to be excavated by other means, if, in his opinion, it would be dangerous to persons or adjacent structures, or is being carried out in a reckless manner. If traffic on the road has to be interrupted, the Contractor shall obtain approval of his schedule for such interruption from the proper authorities and shall satisfy the Engineer that he has obtained it.

S4.04 (4) Subgrade Level in Rock Cut

Rock cut for the roadway shall be excavated to the sub grade levels shown on the drawings and provided in Sub-clause S4.02 (3) and S7.01 (2).

S4.04 (5) Method of Measurement

The quantities to be paid for shall be the number of cubic meters of material acceptably excavated as herein before prescribed. The material shall be measured in the original position in the existing ground after the operation of clearing and grubbing, demolition and common excavation and excavation profile plan.

S4.04 (6) Basis of Payment

Rock Excavation, including work defined as Rock Excavation in Clause S4.04 and elsewhere in these Specifications, shall be paid for separately only in the following cases:

- when the material resulting from the Rock Excavation is declared in writing by the Engineer to be unsuitable for use for embankment in the project;
- when the material resulting from the Rock Excavation is surplus to the amount required for the construction of embankment, provided, however, it is not material rendered surplus by reason of the Contractors having opened borrow pits solely for his own convenience as provided in Sub-clause S4.05 (4).
- where the Engineer orders the use of material obtained from Rock Excavation for the execution of other works (such as stone masonry or aggregates for pavement or concrete) the Rock Excavation shall not be

paid for separately but shall be considered as a subsidiary obligation of the Contractor covered under the Contract Price paid for the other works in which the material is employed.

The quantities, determined as provided above, whatever the haulage distance of the excavated material shall be paid for at the Contract Price per unit of measurement for the Pay Item listed below, which price and payment shall be full compensation for all the costs indicated in Sub-clause S1.34 (1), and all other costs necessary or usual for the proper completion of the work prescribed in this Clause.

Pay Item No. and Name		**Unit of Measurement**
4.04	Rock Excavation	Cubic Meter

S4.05 Borrow Material

S4.05 (1) Description

This work shall consist of the clearing and stripping of borrow pits, the excavating and hauling spreading and compacting of materials obtained from approved sources for constructing embankment, subgrade and other parts of the work as required by the Contract or by the Engineer.

S4.05 (2) Applicable Provisions

The applicable provisions of Clause S4.02 shall be read into and become part of this Clause.

S4.05 (3) Materials

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Materials shall be free from detrimental quantities of organic material such as leaves, grass, roots and sewage.

Common Borrow Materials will also be selected preferentially to exclude the use of highly plastic clay soils, classified as A-7 by AASHTO specification M145-91(2012) or SNI 03-6797-2002 or as CH on the Unified or Casagrande Soil Classification System. Where the use of highly plastic soils cannot reasonably be avoided, such material shall be used only in the bottom portion of embankments or in backfill not required to possess good bearing or shear strength, but not in the subgrade unless it is possible to obtain the minimum design CBR value required when compacted as specified in Sub-clause S7.01.(2).(c). Highly expansive soils having an Activity Value greater than 1.25, or a degree of expansion classified by AASHTO T258-81(2013) or SNI 03-6795-2002 as “Very High” or “Extra High”, shall not be used as embankment fill material. The Activity Value shall be measured as the ratio Plasticity Index (AASHTO T90-15 or SNI 1966:2008) / Percent Clay Sizes (AASHTO T89-13 or SNI 1967:2008).

Selected Borrow Material to be used in locations or for purposes where these materials have been specified or otherwise approved in writing by the Engineer, it shall consist of soil or rock material, when tested in accordance with AASHTO

T193-13 or SNI 1744:2012 have a CBR value of at least 10% (ten percent) after four days soaking when compacted to 100% of the maximum dry density as determined according to AASHTO T99-15 or SNI 1742:2008.

S4.05 (4) Use of Borrow Pits

Borrow material shall be obtained from approved private sources. Permission to open borrow pits, including advice as to suitability, shall first be obtained in writing from the Engineer. Nevertheless, the total amount of surplus material from excavation under Divisions 4 and 5 of these Specifications, after deduction of the material declared unsuitable by the Engineer, shall be considered to be available for use in the embankment, and any borrow material resulting from the Contractor having used pit borrow in place of surplus material shall not be measured for payment under these Specifications.

The distance of borrow pits from the work site shall not be grounds for extra payment or revision of the Contract Price.

Where suitable material for embankments is available adjacent to the embankment the Engineer may order the excavation of drainage channels wider and deeper than normally required in which case such excavation will be measured and included in cross-sections as Common Excavation.

S4.05 (5) Placing and Compaction

Suitable borrow material shall be incorporated in the permanent works in accordance with the requirements of Clause S4.06.

S4.05 (6) Payment to Others

The consent of the landowner and tenant for the digging and taking of material for borrow shall be secured by the Contractor, who shall, if required, pay for such concession. The pit shall be left in a condition acceptable to the owner and to the Engineer.

Any fees payable for permission to cut or haul the borrow material shall be at the Contractor's expense and shall be deemed to be included in the unit price for this pay item.

S4.05 (7) Method of Measurement

The quantity of borrow material to be measured and paid for shall be the balance of the earthworks remaining after applying to the volume of embankment the quantity of all suitable material excavated within the site. The volume of embankment to be measured will be the net volume, after Site Clearing, of required and accepted embankment, actually constructed and completed to the lines, grades, and cross-sections shown on the Drawings and as directed by the Engineer. To calculate the balance of the earthworks it shall be assumed that the shrinkage factor for all suitable material excavated within the site is 0.90. This factor is fixed for all such material and claims on the basis of a variation to this factor will be rejected. No allowance will be made for shrinkage in the borrow material between cutting at the borrow pit and incorporation in the permanent work.

If the borrow material to be constructed where significant consolidation of the original ground is anticipated, the borrow material will be measured for payment by the installation of settlement plates and rods which shall be placed and surveyed jointly by the Engineer and Contractor. The borrow material quantities may then be determined on the basis of ground levels after settlement finished. If documented settlement records have not been properly maintained, measurement shall be based on original ground levels before settlement.

S4.05 (8) Basis of Payment

This work measured as provided above shall be paid for at the unit rate listed below, which price and payment shall be full compensation for the cost of searching for and finding borrow pits, for acquiring the right to occupy the sites and extract materials, for the cost of any negotiation right of access, for the cost of establishing and maintaining access, for any fees, licenses, or royalties in connection with borrow pits, for clearing grubbing sloping draining and cleaning up of pits, for furnishing excavating hauling placing and compacting material from borrow pits and for providing all labor, equipment, tools and incidentals necessary to the works.

Pay Item No. and Name		**Unit of Measurement**
4.05 (1)	Common Borrow Material	Cubic Meter
4.05 (2)	Selected Borrow Material	Cubic Meter

S4.06 Formation of Embankment and Areas of Fill

S4.06 (1) Description

This work shall consist of the construction of embankment and backfill not specified elsewhere by furnishing, placing, compacting and shaping suitable material of acceptable quality obtained from approved sources in accordance with these Specifications, and to the lines, levels, grades, dimensions and cross-sections shown on the Drawings and as required by the Engineer.

S4.06 (2) Sources and Use of Material

Material for embankment shall consist of suitable material approved by the Engineer, excavated under any other Clause of this Specification. Borrow material, however, shall only be used under the provisions of Sub-clause S4.05.(5). Surplus or suitable material shall be disposed of as provided in Sub-clause S4.02.(8) and Clause S4.07.

S4.06 (3) Construction

(a) Compaction of Foundation of Embankment

When ordered by the Engineer, the Contractor shall excavate turf, decayed vegetable matter, or other unsuitable matter to such depth as the Engineer may require. This work shall be considered as Site Clearing or Common Excavation and paid for as provided in Clause S2.01 or S4.03.

Before beginning the construction of Embankment, the Contractor shall fill all holes, etc. within all the areas which have been cleared and grubbed, and such areas shall be suitably leveled at the level resulting after the removal of the topsoil. Fill material shall be approved by the Engineer. This work shall not be paid for directly, but shall be considered a subsidiary obligation of the Contractor covered by the Contract price for item 2.01.

Before the construction of the embankment is begun, the Engineer may order the compaction of the cleared surface or that resulting after removal of the topsoil, in which case the density after compaction shall conform to the requirements of Sub-clause S4.06 (3) (d).

(b) Placing and Compaction

(i) Material for embankment, obtained and approved as provided above, shall be placed in horizontal layers of uniform thickness over a width determined by the Engineer and in conformity with the lines, grades, sections, and dimensions shown on the Drawings. The layer of loose material other than rock shall be not more than 20 cm thick, unless the compacting equipment used is capable of compacting a depth greater than 20 cm to a uniform density through the full depth which is acceptable to the Engineer, in which case the Contractor may place and compact the material other than rock, in layers of thickness approved by the Engineer. After adjustment of the moisture content to that required obtaining maximum density, the loose material shall be compacted to the required density.

(ii) If the material deposited as fill subsequently reaches a condition such that it cannot be compacted in accordance with the requirements of the Contract, the Contractor shall at his own expense either:

(1) make good by removing the material either to tip or elsewhere until it is in a suitable physical condition for re-use and replace it with suitable material; or

(2) make good the material by mechanical or chemical means; or

(3) cease work in the material until its physical condition is again such that it can be compacted as described in the Contract.

(iii) Where embankments are located on hillsides, or where new fill is to be compacted against existing embankments or where fill is constructed on half width at a time, the original slope of the hillside, of the old or of the first half width fill, shall be cut into a distance sufficient to accommodate the width of the compacting equipment as the new fill is placed in horizontal layers, and this material cut shall be incorporated and compacted with the new fill.

In the measurement of the work no allowance will be made for the volumes of material cut from the hillside or from the old or from the first half width fill to accommodate the compacting equipment, but will be calculated only on the net volume of fill placed against the original hillside, the old embankment or the first half width fill.

(iv) To avoid interference with the construction of bridge abutments, wing walls and box culverts, the Contractor shall, at points to be determined by the Engineer, suspend work on embankment forming the approaches to any such structure until such time as the construction of the latter is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of suspension of work shall be included in the Contract unit price for "Common Excavation", and "Borrow Material".

(v) Material for embankment at points inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 10 cm thick and thoroughly compacted by the use of mechanical hammers.

(vi) In carrying embankments up to or over culverts and where required in the Contract up to or over bridges, the Contractor shall bring the embankments up equally on both sides. If conditions require placing backfill or embankment appreciably higher on one side than on the opposite side, the additional material on the higher side shall not be placed until permission shall have been given by the Engineer and preferably not until the structure has been in place 14 days, and tests made by the laboratory under the supervision of the Engineer establish that the structure has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor.

Where special materials for filling adjacent to structures are described in the Contract, filling may proceed over widths less than the full width of the embankment and in steps not exceeding the depth of one layer above the adjoining area of fill.

In rock fill embankments the materials shall be carefully packed for such distance from the structure as is described in the Contract.

Special care shall be taken to prevent any wedging action against the structure and all slopes bounding or within the areas to be filled shall be benched or serrated to prevent wedge action. The placing of embankment and the benching of slopes shall continue in such a manner that at all times there shall be a horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to be backfilled against except in so far as undisturbed material intrudes upon the areas.

(vii) on certain embankment lengths surcharge material will be required to induce settlement/consolidation to the existing grade level being

overlaid with embankment. This may be common fill and / or concrete blocks and / or any acceptable alternative proposal made by the Contractor and will be dependent on the site conditions at the time of fill operations and as agreed with and / or directed by the Engineer.

(c) Compaction Trials

Before starting the formation of the embankment, the Contractor shall construct trial lengths for compacting as directed by the Engineer. The soils used in the trials shall be those encountered along the roadway and the compacting equipment shall be the same equipment that the Contractor will use for the main work accepted by the Engineer.

The object of these trials will be to determine the optimum moisture content and the relationship between the number of passes of compacting equipment and density obtained for the soil types under trial. No separate payment will be made for this work, which will be regarded as a subsidiary obligation of the Contractor covered under the other Clauses of this Specification.

(d) Required Density

The required densities to which embankment layers shall be compacted are as follows:

(i) Layers more than 30 cm below subgrade level shall be compacted to 95 percent of the maximum dry density determined according to AASHTO T99-15 or SNI 1742:2008. For all soils, except rock fill materials, containing more than 10 percent oversize material retained on a 19.0 mm (¾ inch) sieve, the maximum dry density thus obtained shall be adjusted for such oversize material as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer.

(ii) Layers 30 cm or less below subgrade level shall be compacted to 100 percent of the maximum dry density determined according to AASHTO T99-15 or SNI 1742:2008.

(e) Moisture Content

Embankment material that does not contain sufficient moisture to obtain the required compaction shall be given additional moisture by means of approved sprinklers and mixing. Material containing more than the amount of moisture necessary to obtain the required compaction may not, without approval of the Engineer, be incorporated in the embankment until it has been sufficiently dried out. The drying of wet material may be expedited only by methods approved by the Engineer.

The compaction of the embankment shall be carried out at the optimum moisture content. In forming the embankment, the Contractor shall take steps to ensure that the work can be drained free of rain-water, and he shall make due allowance in the height and width of the work for swelling or shrinkage.

(f) Rock Fill

No rock fill shall be placed until after the Contractor has discussed his proposals for the work of cut and fill with the Engineer and secured the latter's approval. In order to provide a suitable grade level, material for covering the rock fill shall be reserved from the excavation of cut.

Should such material be available and not be so reserved by the Contractor, so that borrow material has to be used for forming the grade level, such borrow shall be supplied and placed without extra payment to the Contractor.

Rock fill shall be placed in loose layers not to exceed 60 cm in thickness and compacted as herein provided. The top of this fill shall be not less than 20 cm below the required finished subgrade, and the interstices shall be thoroughly filled with clean small spalls, shale, gravel or similar approved material and thoroughly compacted to the satisfaction of the Engineer.

Rock in fill shall be considered as rock only when the earth or other finer material, when uniformly distributed throughout the mass, is considerably less than sufficient to fill the voids so that the rock particles shall be in intimate contact and not separated by earth or similar materials. Otherwise, the fill material shall be handled and considered as earth fill to be placed and compacted as specified in Clause S4.06.

Where rock is to be incorporated in fill or portions of fill, composed largely of earth friable material, the rock shall be reduced to a maximum size not exceeding 75 percent of the thickness of the layer being placed. A sufficient cover of earth over rock fill shall be used to produce a uniform grade level.

(g) Mixed Material in Fill

When materials of widely divergent characteristics, such as clay and chalk or sand, drawn from different sources, are to be used in the embankment, they shall be deposited in alternate layers over the full width of the embankment to depth approved by the Engineer.

When material used for fill is of variable quality, the Contractor shall schedule and execute his works so that the material designated as better quality by the Engineer, is used in the upper layers of the fill.

Rock, clay or other material shall be broken up, and no accumulation of lumps or boulders at the toe of the embankment will be permitted.

(h) Leveling of Existing Embankment

Before fill is placed and compacted on an existing roadway, the existing embankment and/or pavement may be leveled by cutting, rooting, or scarifying with approved mechanical means to a level to be determined by the Engineer. The earth, old asphalt, or other material obtained as a result of this operation will be declared by the Engineer to be either suitable or unsuitable for use in the embankment. In the first case it shall be used in the adjacent embankment as directed by the Engineer, subject

to the provisions in Clause S4.03 "Common Excavation". In the second case the material shall be disposed of as provided in Clause S4.07 "Waste".

(i) Finishing Roadbed

(i) Final Grade Level - When an embankment requires the addition of material to a depth of not more than 30 cm to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified and re-compacted before the additional material is placed.

The final grade level, to the profile indicated and adjusted for super elevation where required, shall conform to the provisions of Sub-clause S4.02 (3) of these Specifications, and to the tolerances given in the Special Specifications. Prior to adding any material to raise the level of any low spots, the existing surface shall be scarified.

(ii) Slopes - Side slopes shall be neatly trimmed to the lines and slopes shown on the Drawings as directed by the Engineer, and finished work shall be left in a neat and acceptable condition. In order to achieve uniform slope density with the entire embankment, when carrying out compaction layers the Contractor exceeds the width of the embankment width which at the end of compaction the outer edge is neatly cut according to the requested slope line. Thickness and lack of slope not justified resulting from the patching of the slope.

(iii) Stability - The Contractor shall be responsible for the stability of all embankments and shall replace any portions that have been damaged or displaced due, in the opinion of the Engineer, to carelessness or neglect on the part of the Contractor, or to such natural causes as storms. The Contractor will not be responsible for damage caused by unavoidable movements of the natural ground upon which the embankment is made. During construction the roadway shall be kept shaped to drain at all times. When unsuitable material has been placed in the embankment by the Contractor, he shall remove it and replace it using suitable material, and without extra payment there for.

S4.06 (4) Method of Measurement

The performance of the work above shall be covered by the Contract Prices of the appropriate pay items under which the fill material is obtained and the work of this Clause S4.06 shall not be measured for direct payment.

S4.06 (5) Basis of Payment

Performance of this work under the Contract is not payable directly but shall be considered as a subsidiary obligation of the Contractor covered under the Contract Prices for performance of work under Clause S4.03 "Common Excavation",

Clause S4.05 “Borrow Material", Division 5 of these Specifications and Division 6 of these Specifications.

S4.06 (6) With regards to surcharge material and/or concrete block surcharge and/or whatever acceptable proposal from the Contractor with regards to method of surcharge in S4.06 (3).(b), it shall be deemed to be included in the earthwork rates, covering for removal as well as initial placing with all that details.

S4.07 Waste

S4.07 (1) Description

This item shall consist of excavating, ripping, loading, hauling and spreading in waste areas, soil material designated as waste.

S4.07 (2) Waste Material

Material shall be known as "Waste" in the following cases:

(a) When the material resulting from the excavation made for the construction of the road is declared in writing by the Engineer to be unsuitable for use in the embankment or other work.

Normally, highly organic clays and silts, peat, soil containing large amounts of roots, grass and other vegetable matter, domestic or industrial waste, are to be unsuitable. Materials that are soft or unsuitable merely because they are too wet or dry are not to be classified as unsuitable unless otherwise directed by the Engineer.

(b) When the material resulting from the excavation made for the construction of the road is surplus to the amount required for the construction of the embankment, provided, however, it is not material rendered surplus by reason of the Contractor having opened borrow pits solely for his own convenience as provided in Clause S4.04 of these Specifications.

The material proposed for wasting shall not be wasted until approved or directed in writing by the Engineer after guided by the Employer. If the material is not wasted, then the Employer shall provide the storage locations.

S4.07 (3) Work Requirements

Unsuitable material shall be excavated below sub grade level in cut and below embankment foundation level to the depth shown on the Drawings or directed by the Engineer. Where unsuitable material is excavated below the normal sub grade level or below embankment foundation or for benching under embankments, the excavation shall be back filled with material and in a manner that conforms to Clause S4.06.

Waste shall be removed and disposed of in waste areas provided by the Contractor in such manner as to present a neat appearance and not to obstruct drainage to any highway nor to cause injury to highway works or property. If it becomes necessary for the Contractor to locate or relocate any waste areas, they shall be approved by the Engineer prior to spreading any waste.

Waste areas shall be left in a smooth, neat and drainable condition, as directed by the Engineer, and all waste material shall be placed in such manner that adjacent property will not be damaged or endangered.

Soil slopes shall not be steeper than 2:1, unless otherwise directed by the Engineer.

Performance of this work shall not be paid for under this Clause but shall be considered as a subsidiary obligation of the Contractor covered under the unit rates of the appropriate pay item for excavation.

S4.08 Areas of Special Fill

S4.08 (1) Description

The work under this item shall consist of supplying and placing free-draining granular material under water in swampy areas or filling in areas where there are deep beds of unsuitable material and full depth removal is not possible.

The Backfill for reinforced earth wall construction will also satisfy this Clause of the Specification, but in addition, the backfill material will satisfy the requirements of the specialist contractor and be subject to the approval of the Engineer. The backfill material shall not comprise pit-run river gravel, unless screened and crushed to give a 20 mm maximum size. A granular, crushed rock-based course material, or well graded natural gravelly sand, or similar material, is recommended.

Swampy areas are understood to be those areas where the embankment is to be constructed across low ground permanently or seasonally under a level of water or subject to the action of water that, in the opinion of the Engineer, given the topography of the area, cannot be drained and dried out with the methods envisaged in these Specifications.

S4.08 (2) Applicable Provisions

The applicable provisions of Clauses S4.02 and S4.06 shall be read into and become part of this Clause.

S4.08 (3) Construction

Before carrying out the work described in this Clause, all work under Sub-clauses S2.01 (2) (b), S4.02 (12) and S4.03 (4), shall be completed to the satisfaction of the Engineer.

The filling shall be executed to a height not less than 50 cm above existing ground level or not less than 50 cm above the water level at that time, with material coming from common excavation, borrow material or free-draining material as specified below.

Free draining material:

Free draining material, on swampy area, and for situations where spreading in saturated or flood conditions cannot be avoided, shall be rock, sand or gravel or other clean grained material with a maximum Plasticity Index of 6% (six percent).

The material used shall be approved beforehand by the Engineer.

The selected material shall be placed in conformity with the elevation and cross-sections shown on the Drawings or ordered by the Engineer, and in any case in such a way that:

(a) After compaction and proof rolling, it is not less than 50 cm above the water level at that time; and/or

(b) A support grade is formed for the construction, if required, of an embankment in accordance with Clause S4.06, up to the elevation of the sub grade.

For this purpose, the selected material shall be placed according to the profiles shown on the Drawings or ordered by the Engineer, with suitable equipment and if necessary by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers. Material placed outside the profiles indicated will be not measured for payment.

Compaction shall begin on the material in accordance with the Engineer's instructions and shall be executed with suitable equipment. Losses of elevation due to settling of the embankment shall be compensated, either by laying the loose material up to elevations higher than those indicated, or by adding other material during compaction.

Compaction shall continue until the Engineer has ascertained that settlement of the top grade has ceased and that it no longer shows deformation under rollers or site equipment.

On completion of the work as described in this Clause, filling shall continue in accordance with Clause S4.06.

S4.08 (4) Method of Measurement

The material placed and compacted under this Clause will be calculated in cubic meters measured in the trucks before unloading. For each truckload of material supplied at the place of loading, the Contractor shall deliver to the Engineer or his representative present at the unloading a numbered note, duly signed by both parties, showing the registration number of the truck and the volume of the material transported in it then be determined on the basis of aggregated quantity of material supplied, as measured and recorded by the Engineer, after the material has been leveled in the truck body according to a horizontal plane parallel to the edges of the sides of the truck.

Each day details of each note with the registration number of the truck and the load transported shall be entered in a special register kept by the Engineer. The material supplied will be measured after it has been leveled in the truck body according to a horizontal plane parallel to the edges of the sides of the truck; no other method of measurement will be allowed.

S4.08 (5) Basis of Payment

The quantities, determined as provided above, shall be paid for at the Contract unit price for the pay items as listed below. The prices and payment shall be full

compensation for all costs including furnishing, hauling, placing and for all materials, labor, tools, equipment and incidentals necessary to complete the works as described in this Clause.

Pay Item No. and Name		Unit of Measurement
4.08	Free-Draining Material	Cubic Meter

S4.09 Granular Backfill

S4.09 (1) Description

This item shall consist of furnishing, placing and compacting granular backfill adjacent to structures. The area in which this material is to be placed is the "Influence Zone" of certain structures and this will be shown on the Drawings.

S4.09 (2) Material

The material shall be well graded crushed or uncrushed gravel, stone, rock fill or natural sand or a well-mixed combination of any of these. Grading requirements for the material are as follows:

Maximum size	:	10 cm
Passing 4.75 mm sieve	:	25% to 90%
Passing 0.075 mm sieve	:	0% to 10%
Plasticity Index	:	10 max.

S4.09 (3) Construction

The granular backfill shall be placed in layers not exceeding 15 cm and compacted to a density of 95% of the maximum dry density determined according to AASHTO T180-15 or SNI 1743:2008.

S4.09 (4) Method of Measurement

The quantity of granular backfill to be measured and paid for will be the number of cubic meters of suitable material supplied and compacted to the Engineer's satisfaction and in accordance with this Specification. This material is required to be placed when filling within the influence zone of certain structures and any material placed outside the specified zone will not be measured for payment.

Any existing material within the influence zone which is removed because of the Contractor's method of working shall be replaced by granular backfill at the Contractor's expense. Where excavation within the influence zone is instructed under any Clause of these Specifications, then the backfilling will be carried out with granular backfill and the work will be measured for payment under this Clause.

S4.09 (5) Basis of Payment

The accepted quantities of granular backfill, measured as provided above, will be paid for at the Contract unit price for the pay item as below. The price and

payment will be full compensation for the work described in this Clause, including furnishing, hauling, placing and compacting the material.

Pay Item No. and Name		Unit of Measurement
4.09	Granular Backfill	Cubic Meter

S4.10 Permeable Backfill

S4.10 (1) Description

This work shall consist of supplying and installing selected backfill material adjacent to structures in accordance with these Specifications and in locations as shown on the Drawings or instructed by the Engineer.

S4.10 (2) Material

Material shall be hard, clean, crushed rock or gravel complying with the following grading.

Sieve Size	% Passing by Weight
63 mm	100
37.5 mm	85 - 100
19 mm	0 - 20
9.5 mm	0 - 5

S4.10 (3) Construction

The method of construction will be at the discretion of the Contractor, but details shall be submitted for the Engineer's approval before commencement of the work. All details of the permeable backfill shall be as shown on the Drawings and the degree of compaction shall be as instructed by the Engineer.

S4.10 (4) Method of Measurement

Unless this material is specified as included in another pay item, the quantity of permeable backfill to be measured and paid for will be the number of cubic meters of suitable material supplied, placed and compacted in accordance with the details shown on the Drawings. Any material placed beyond the dimensions shown on the Drawings will not be measured for payment.

S4.10 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract price per unit of measurement for the item listed below, which price and payment will be full compensation for furnishing and placing all materials, and for all labor, equipment and other incidentals necessary to complete the work in accordance with the Drawings, Specifications and as directed by the Engineer.

Pay Item No. and Name		Unit of Measurement
4.10	Permeable Backfill	Cubic Meter

S4.11 Vertical and Horizontal Sand Drains

S4.11 (1) Description

This work shall consist of the installation of a system of vertical and horizontal sand drains in areas of soft ground as shown on the Drawings or directed by the Engineer. The work shall be carried out in close conformity with the requirements which will be established by the Engineer after the carrying out of the necessary subsoil investigations by the Contractor.

The work will include installation of vertical sand piles at the spacing and to the depth required, and placing of a sand blanket over the area intended to be drained.

S4.11 (2) Materials

Sand to be used for the sand drains shall be coarse sand of high permeability and shall conform to the following requirements:

ASTM Standard Sieve (mm)	Percentage Passing by Weight
25.0	100
9.5	90 - 100
4.75	70 - 100
2.00	35 - 90
0.850	12 - 70
0.425	4 - 40
0.180	2 - 8
0.075	0 - 3

All materials shall be free from lumps of dirt, organic matter or any other deleterious matter.

S4.11 (3) Construction

Unless otherwise approved by the Engineer, the method of construction shall be as given below:

Sand Drains will be installed by driving a pipe with a closed valve at its lower end, using pile-driving equipment. When it has penetrated to the required depth, the inside of the pipe is filled with dry coarse sand and the valve at the bottom of the pipe opened. The upper end of the pipe is closed, and compressed air applied inside of the pipe to raise the pipe out of the ground, simultaneously expelling the sand out of the bottom of the pipe. On completion of all vertical sand drains to the spacing instructed by the Engineer, a horizontal layer of suitable coarse sand shall be spread over the area to the depth instructed by the Engineer.

Surface settlement plates shall be installed on a 10 cm thick level sand base in such a way that the top of the base plate is horizontal. Before placing any embankment material, the Engineer will inspect the completed installation and take initial elevations on the top of the base plate and the top of the pipe. A 30 cm thick layer of sand shall be placed on the settlement plate base to eliminate

bedding errors. As embankment construction advances the pipes shall be extended as shown on the Drawings.

The work shall also include the installation and maintenance of other settlement monitoring and measuring devices as required by the Engineer.

During settlement of sand drains an additional 1 m width of sand 1 m deep may be instructed by the Engineer to be placed at the toe of the sand embankment to be later removed after settlement is complete.

S4.11 (4) Method of Measurement

Vertical sand drains will be measured by the linear meter for the diameter as given in the Pay Item Name.

The quantity of horizontal sand drain will be measured by cubic meters as one pay item, irrespective of the depth of sand instructed by the Engineer.

The work of installing and maintaining the settlement monitoring devices will not be measured directly for payment but will be deemed to be included in the Contract unit price for the vertical sand drains.

Any work on boring, sampling and testing will be measured and paid for under Clause S10.08 of these General Specifications but any special laboratory testing required will be the Contractors responsibility and any additional costs will be deemed to be included in the Contract unit price for the vertical sand drains.

S4.11 (5) Basis of Payment

The quantities, determined as provided above, shall be paid for at the Contract unit price per linear or cubic meter for the pay items as listed below. The prices and payment shall be full compensation for all costs including hauling materials, placing sand piles and sand blanket, and for all materials labor, tools, equipment and incidentals necessary to complete the works as described in this Clause.

Pay Item No. and Name		**Unit of Measurement**
4.11(1)	Vertical Sand Drains (40 cm diameter)	Linear Meter
4.11(2)	Horizontal Sand Drain	Cubic Meter

S4.12 Geotextile Sheet

S4.12 (1) General

(a) Description

(i) This specification is the specification of the geotextile filter material for subsurface drainage, separator, and stabilizer.

(ii) This specification sets forth a set of physical, mechanical and endurance properties then shall be met. or exceeded.

(iii) These specifications are intended to ensure the quality and performance of the geotextile is good for use on applications as specified in Sub-clause S4.12 (1) (a) (i).

(iv) This specification is based on geotextile survivability from installation stresses

(b) Terms and Definitions

(i) Minimum Average Roll Value (MARV):

A manufacturing quality control tool used to allow manufacturers to establish published values such that the user/purchaser will have a 97.7 percent confidence that the property in question will meet published values. For normally distributed data. MARV is calculated as the typical value minus two standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

(ii) Minimum value

The lowest sample value from documented manufacturing quality control test results for a defined population from one test method associated with one specific property

(iii) Maximum Value

The highest sample value from documented manufacturing quality control test results for a defined population from one lest method associated with one specific property.

(iv) Permittivity

Volumetric flow rate of water per unit area per unit cross section of pressure on laminar flow conditions, in the direction normal (perpendicular) to the plane of the geotextile.

(v) The size of pores Geotextile (Apparent Opening Size, AOS)

A trait that gives an indication of approximate largest particle that would effectively pass through the geotextile.

(vi) Ultraviolet Stability

Ultraviolet Stability is a measure of tensile strength reduction (in percentage) against exposure to ultraviolet light. The percentage

decrease in tensile strength were obtained by comparing the tensile strength of five test samples after being exposed by ultraviolet light over a certain period in the xenon-arc device of tensile test samples are not exposed to ultraviolet light.

S4.12 (2) Material

(a) Physical Requirements

Fiber (fiber) is used to create geotextiles and rope (thread) which is used to connect the geotextile by stitching, should consist of a long chain synthetic polymer composed of at least 95% by weight of polyolefin or polyesters. Fiber and the rope should be formed into a stable network such that the filament (fiber basis), or strands of fiber (yarn) to maintain stability relative to other dimensions, including Selvage (the edge of a sheet of woven geotextile parallel to the longitudinal direction geotextile).

Geotextiles used for subsurface drainage, separation, stabilization, and permanent erosion control Applications shall conform to the physical requirements as specified in Table 4.12.(1).

All property values, with the exception of apparent opening size (AOS), in these specifications represent minimum average roll values (MARV) in the weakest principal direction (i.e. average test results of any roll in a lot sampled for conformance or quality assurance testing shall meet or exceed the minimum values provided herein). Values for AOS represent maximum average roll values.

(b) Geotextile Requirements

(i) General

(1) Table 4.12 (1) gives the properties of strength for the three classes of geotextiles. Geotextile shall conform to the values listed in Table 4.12.(1), Table 4.12.(2), Table 4.12.(3), Table 4.12.(4) or Table 4.12.(5) in accordance with their use.

(2) All the values in Table 4.12.(1) shows the value Scrolls Average Minimum (Minimum Average Roll Value, Marv) in the main direction of the weakest. Geotextile properties required for each class depends on the elongation of geotextiles. If required the connection seam (sewn seams), then the strong connection that is determined based on ASTM D4632/D4632M-15a or SNI 4417:2017 shall be equal to or more than 90% strong grab (grab strength) are required.

Table 4.12 (1) Geotextile Strength Requirement

			Classification of Geotextile (1, 2)					
Characteristic	**Test Method**	**Unit**	**Class 1**		**Class 2**		**Class 3**	
			Elongation < 50%(3)	**Elongation > 50%(3)**	**Elongation < 50%(3)**	**Elongation > 50%(3)**	**Elongation < 50%(3)**	**Elongation > 50%(3)**
Grab Strength	ASTM D4632 (SNI 4417:2017)	N	1400	900	1100	700	800	500
Sewn Seam Strength(4)	SNI 4417:2017 (ASTM D4632)	N	1260	810	990	630	720	450
Tear Strength	ASTM D4533 (SNI 08-4644-1998)	N	500	350	400(5)	250	300	180
Puncture Strength	ASTM D6241	N	2750	1925	2200	1375	1650	990
Permittivity	ASTM D4491 (SNI 08-6511-2001)	$detik^{-1}$	Minimum property value for Permittivity. AOS and UV stability are based on geotextile application. Refer to Table 4.12.(2) for subsurface drainage, Table 4.12.(3) and Table 4.12.(4) for separation, and Table 4.12.(5) for stabilization,					
Apparent Opening Size, AOS (3, 4)	ASTM D4751 (SNI 08-4418-1997)	mm						
Ultraviolet Stability (retained strength)	ASTM D4355	%	50 % after 500 hours of exposure					

NOTE :
(1) Required geotextile class is designated in Tables 4.12.(2), 4.12.(3), 4.12.(4) or 4.12.(5) for the indicated application. The severity of installation conditions for the application generally dictates the required geotextile class. Class 1 is specified for more severe or harsh installation conditions where there is a greater potential for geotextile damage, and Classes 2 and 3 are specified for less severe conditions.
(2) All numeric values represent MARV in the weaker principal direction.
(3) As measured in accordance with ASTM D4632.
(4) When sewn seams are required. Refer to Appendix for overlap seam requirements.
(5) The required MARV tear strength for woven monofilament geotextiles is 250 N.

(ii) Geotextile for sub-surface drainage.

(1) Description: This specification can be used for the geotextile in the soil to drain water into the subsurface drainage systems and holding local land transfer without the occurrence of blockage in the long term. The primary function of geotextiles in the subsurface drainage system is as a filter or filters. The property of the geotextile filter is a function of gradation, plasticity and local soil hydraulic conditions.

(2) Geotextile shall meet the requirements listed in based on the Table 4.12 (2). Footage woven geotextile (woven slit film geotextiles) should not be used for subsurface drainage. All the values in Table 4.12 (2) except for size pores Geotextile (Apparent Opening Size, AOS), showing Scrolls Value Average Minimum in the main direction of

the weakest. Value Size Pores Geotextile (Apparent Opening Size, AOS) shows the average value of maximum coil.

(3) The values in Table 4.12.(2) is the default values (default), which provides power to survive geotextiles under various conditions. Note (b) of on Table 4.12.(2) provides a reduction of the minimum character requirements when the available information regarding the power to survive geotextiles.

Table 4.12 (2) Surface Drainage Geotextile requirements

Characteristic	**Test Method**	**Unit**	**Requirements, percent in situ soil passing 0,075 mm(1)**		
			< 15	**15 - 50**	**> 50**
Class Geotextile			Class 2 from Table 4.12.(1)(2)		
Permittivity (3, 4)	ASTM D 4491 (SNI 08-6511-2001)	$detik^{-1}$	0.5	0.2	0.1
(Apparent Opening Size, AOS) (3, 4)	ASTM D 4751 (SNI 08-4418-1997)	mm	0.43 (maximum avg rolls value)	0.25 (maximum avg rolls value)	0.22(5) (maximum avg rolls value)
Ultraviolet Stability (Retained strength)	ASTM D 4355	%	50% after 500 hours exposure		

NOTE :
(1) Based on grain size analysis *of in situ* soil in accordance with AASHTO T88 and SNI 03-3423-1994.
(2) Default geotextile selection is Class 2.
(3) These default filtration property values are based on the predominant particle sizes of in situ soil.
(4) Site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered unstable or highly erodible soils such as non-cohesive silts: gap graded soils: alternating sand/silt laminated soils; dispersive clays: and/or rock flour.
(5) For cohesive soils with a plasticity index greater than seven, geotextile maximum average roll value for apparent opening size is 0.30 mm.

(iii) <u>Geotextile Separator</u>

(1) Description of this specification is applicable to the use of a geotextile to prevent mixing of a subgrade soil and an aggregate cover material (subbase, base, select embankment, etc.). This specification may also apply to situations other than beneath pavements where separation of two dissimilar materials is required, but where water seepage through the geotextile is not a critical function.

(2) The separation application is-appropriate for pavement structures constructed over soils with a California Bearing Ratio equal to or greater than 3 (CBR > 3) (shear strength greater than approximately 90 KPa). It is appropriate for unsaturated subgrade soils. The primary function of a geotextile in this application is separation.

(3) Geotextile Requirements The geotextile shall meet the requirements of Table 4.12.(3). All numeric values in Table 3 except AOS represent MARV in the weakest

principal direction. Values for AOS represent maximum average roll values.

Table 4.12 (3) Separation Geotextile Property Requirements

Characteristic	Test Method	Unit	Requirement
Geotextile Class	See Table 4.12.(4)		
Permittivity	ASTM D 4491 (SNI 08-6511-2001)	sec^{-1}	$0.02^{(1)}$
Apparent Opening Size, AOS	ASTM D 4751 (SNI 08-4418-1997)	mm	0.60 (maximum avg. rolls value)
Ultraviolet Stability	ASTM D 4355	%	50 % after 500 hours of exposure
(Retained strength)			
NOTE : (1) Default value Permittivity of the geotextile should be greater than of the soil grain size ($\psi_g > \psi_s$).			

Table 4.12 (4) Required Degree of Survivability

	(Low Ground Pressure equipment) < 25 KPa (3.6 psi)	(Medium Ground Pressure equipment) 25 KPa - 50 KPa (3.6 psi -7.3 psi)	(High Ground Pressure equipment) > 50 KPa (> 7.3 psi)
Sub grade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Sub grade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 450 mm (18 in.) in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed and left in place. Stumps should be cut to project not more than ±150 mm (±6 in.) above subgrade. Geotextile may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the geotextile and cover material over them will distort the finished road surface	High (Class 1)	Very High (Class 1+)	Not recommended

NOTE :

Recommendations are for 150 to 300 mm (6 to 12 in.) initial lift thickness. For other initial lift thicknesses:

- 300 to 450 mm (12 to 18 in.): reduce survivability requirement one level,
- 450 to 600 mm (18 10 24 in.): reduce survivability requirement two levels
- 600 mm (24 in.): reduce survivability requirement three levels.

For special construction techniques such as pre-cutting increase the geotextile survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of the soft subgrade.

(iv) Geotextile Stabilization

(1) Description: This specification can be used for the application of geotextile in wet conditions and saturated with water that serves as a separator and a double filter or filters. In some cases, the geotextile can also serve as reinforcement. The function of geotextile for stabilization according to pavement structure erected on the land with the California Bearing Ratio between 1 and 3 (1 <CBR<3) or the shear strength between 30 KPa and 90 KPa.

(2) Application of geotextile for stabilization according to the basic water- saturated soil due to high ground water or due to the rainy season in a long time. These specifications are not suitable for embankment reinforcement where the state of stress can lead to a global collapse of subgrade foundation. Strengthening the embankment is planning a special problem for a location.

(3) Geotextiles for stabilization shall meet the conditions set out in Table 4.12.(3). All the values in Table 4.12.(3), except for size pores Geotextile (Apparent Opening Size, AOS), showing Scrolls Value Average Minimum in the main direction of the weakest. Value Size Pores Geotextile shows Scrolls Average Value Maximum.

(4) The values in Table 4.12.(5) is the default values (default), which provides power to survive geotextiles under various conditions. Note (a) of Table 4.12.(5) provides a reduction of the minimum character requirements when the available information regarding the power to survive geotextiles. Engineers can also create different requirements to those contained in Table 4.12.(5) based on the technical planning and experience.

Table 4.12 (5) Stabilization Geotextile Property Requirements

Characteristic	Test Method	Unit	Requirement
Class Geotextile			Class 1 from Table 4.12.(1)[(1)]
Permittivity	ASTM D 4491	sec^{-1}	0.05[(2)]
	(SNI 08-6511-2001)		
Apparent Opening Size, AOS	ASTM D 4751 (SNI 08-4418-1997)	mm	0.43 (maximum average rolled value)
Ultraviolet Stability (Retained strength)	ASTM D 4355	%	50 % after 500 hour of exposure

NOTE :
(1) Default geotextile selection is Class 1.
(2) Default value. Permittivity of the geotextile should be greater than that of the soil grain size ($\psi_g > \psi_s$).

The property values in Table 4.12.(5) represent default values that provide for sufficient geotextile survivability under most construction conditions.

S4.12 (3) Construction

(a) General

Atmospheric exposure of geotextiles to the elements following lav down shall be a maximum of 14 days to minimize damage potential.

(b) Seaming

(i) If a sewn seam is to be used for the seaming of the geotextile, the thread used shall consist of high strength polypropylene, or polyester. Nylon thread shall not he used. For erosion control applications, the thread shall also be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

(ii) For seams that are sewn in the field, the contractor shall provide at least a two-meter length of sewn seam for sampling by the engineer before the geotextile is installed. For seams that are sewn in the factory, the engineer shall obtain samples of the factory seams at random from any roll of geotextile that is used on the project:

(1) For seams that are field sewn, the seams sewn for sampling shall he sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided.

(2) The contractor shall submit the seam assembly description along with the sample of the seam. The description shall include the seam type, stitch type, sewing thread, and stitch density

(c) Subsurface Drainage

(i) Trench excavation shall be done in accordance with details of the project plans. In all instances excavation shall be done in such a way so as to prevent large voids from occurring in the sides and bottom of the trench. The graded surface shall be smooth and free of debris.

(ii) In the placement of the geotextile for drainage applications, the geotextile shall be placed loosely with no wrinkles or folds, and with no void spaces between the geotextile and the ground surface. Successive sheets of geotextiles shall be overlapped a minimum of 300 mm. with the upstream sheet overlapping the downstream sheet.

(1) In trenches equal to or greater than 300 mm in width, after placing the drainage aggregate the geotextile shall be folded over the top of the backfill material in a manner to produce a minimum overlap of 300 mm. In trenches less than 300 mm, but greater than 100 mm wide, the overlap shall be equal to the width of the trench. Where the trench

is less than 100 mm the geotextile overlap shall be sewn or otherwise bonded. All seams shall be subject to the approval of the engineer.

(2) Should the geotextile be damaged during installation or drainage aggregate placement, a geotextile patch shall be placed over the damaged area a extending beyond the damaged area a distance of 300 mm, or the specified seam overlap, whichever is greater.

(iii) Placement of drainage aggregate should proceed immediately following placement of the geotextile. The geotextile should be covered with a minimum of 300 mm of loosely placed aggregate prior to compaction. If a perforated collector pipe is to be installed in the trench, a bedding layer of drainage aggregate should be placed below the pipe, with the remainder of the aggregate placed to the minimum required construction depth.

(iv) The aggregate should be compacted with vibratory equipment to a minimum of 95 percent Standard Density, unless the trench is required for structural support. If higher compaction effort is required, a Class 1 geotextile as per Table 4.12.(1) in these Specification.

(d) Separator and Stabilization

(i) The installation site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation.

(ii) Soft spots and unsuitable areas will he identified during site preparation or subsequent proof rolling. These areas shall be excavated and backfilled with select material and compacted using normal procedures.

(iii) The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geotextile rolls shall be overlapped, sewn or joined as required in the plans. Overlaps shall be in the direction as shown on the plans. See Table 4.12.(6) for overlap requirements.

Table 4.12.(6) Overlap Requirement

Soil CBR	**Minimum Overlap**
> 3	300 - 450 mm
1 - 3	0.6 - 1 m
0.5 - 1	1 m or sewn
Less than 0.5	sewn
All roll ends	1 m or sewn

(iv) On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

(v) Prior to covering, the geotextile shall be inspected to ensure that the geotextile has not been damaged (i.e., holes, tears, rips) during installation. The inspection shall be done by the Engineer or the Engineer's designated representative. It is recommended that the designated representative be a certified inspector. Damaged geotextiles as identified by the Engineer shall be repaired immediately. Cover the damaged area with a geotextile patch that extends an amount equal to the required overlap beyond the damaged area.

(vi) The sub base shall be placed by end dumping onto the geotextile from the edge of the geotextile over previously placed subbase aggregate. Construction vehicles shall not be allowed directly on the geotextile. The sub base shall be placed such that at least the minimum specified lift thickness shall be between the geotextile and equipment tires or tracks at all times. Turning of vehicles shall not be permitted on the first lift above the geotextile.

(vii) Any ruts occurring during construction shall the Contractor filled with additional sub base material, and compacted to the specified density.

(viii) If placement of the backfill material causes damage to the geotextile the damaged area shall be repaired as previously described in Sub-clause 4.12 (3) (c). The placement procedures shall then be modified to eliminate further damage from taking place (i.e. increase initial lift thickness, decrease equipment loads, etc.). In stabilization applications, the use of vibratory compaction equipment is not recommended with the initial lift of subbase material, as it may cause damage to the geotextile

S4.12 (4) Quality Control

(a) Certification

(i) The Contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, and style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile.

(ii) The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification Documentation describing the quality control program shall be made available upon request.

(iii) The manufacturer s certificate shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the manufacturer s quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

(iv) Either mislabeling or misrepresentation of 'materials shall be reason to reject those geotextile products.

(b) Sampling, Testing and Acceptance

(i) Geotextiles shall be subject to sampling and testing to verily conformance with this specification. Sampling shall be in accordance with the most current ASTM D4354-12 in the chapter entitled "Procedure for Sampling for Purchaser's Specification Conformance Testing" or refer to the ISO 9868-1990 or SNI 08-4419-1997, using the section tilled. Procedure for Sampling for Purchaser s Specification Conformance Testing. In the absence of purchaser s testing, verification may be based on manufacturer s certifications as a result of testing by the manufacturer of quality assurance samples obtained using the procedure for Sampling for Manufacturer s Quality Assurance (MQA) Testing. A lot size shall be considered to be the shipment quantity of the given product, or a truck load of the given product, whichever is smaller.

(ii) Testing shall be performed in accordance with the methods referenced in this specification for indicated application. The number of specimens to test per sample is specified by each test method. Geotextile product acceptance shall be based on ASTM D4759-11(2018) "Practice for determining the specification conformance of Geo-synthetics" Product acceptance is determined by comparing the average test results of all specimens within a given sample.

(c) Shipment and Storage

(i) Geotextiles labeling, shipment, and storage shall follow ASTM D4873/D4873M-17. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Bach shipping document shall include a notation certifying that the material is in accordance with the manufacturer s certificate.

(ii) Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

(iii) During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 71°C. and any other environmental condition that may damage the physical property values of the geotextile.

S4.12 (5) Method and Measurement

(a) The geotextile shall be measured by the number of square metres computed from the payment lines shown on the plans or from payment lines established in writing by the Engineer. This Excludes seam overlaps, but shall include geotextile used in crest and toe of slope treatments.

(i) Slope preparation, excavation and backfill, bedding, and cover material are separate pay items.

S4.12 (6) Basic of Payment

The quantities, determined as provided above, shall be paid for at the Contract unit price per square meter for the pay items as listed below. The prices and payment shall be full compensation for all costs including hauling materials, horizontal sand blanket, and geotextile separator, placing temporary dike if directed, and for all materials, labor, tools, equipment and incidentals necessary to complete the works as described in this Clause.

Pay Item No. and Name		**Unit of Measurement**
4.12 (1)	Geotextile for Subsurface Drainage (Class 2)	Square Meter
4.12 (2)	Geotextile for Separator (Class 1)	Square Meter
4.12 (3)	Geotextile for Separator (Class 2)	Square Meter
4.12 (4)	Geotextile for Separator (Class 3)	Square Meter
4.12 (5)	Geotextile for Stabilization (Class 1)	Square Meter

S.4.13 Prefabricated Vertical Drain (PVD)

S.4.13 (1) Desciption

This work consists of the installation of *Prefabrication Vertical Drains (PVD)* in accordance with the details shown in the Drawings and with the requirements of these Specifications. The drains shall consist of a band-shaped plastic core enclosed in a suitable jacket material or other shape or configuration approved by the Engineer. They shall be spaced and arranged as shown in the Drawings or as otherwise directed by the Engineer.

S.4.13 (2) Material

(a) General

(i) The PVD shall be manufactured of new materials and shall consist of a core enclosed in or integrated with a jacket. The jacket shall allow free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage.

(ii) The drain shall be band-shaped with an aspect ratio (width devided by thickness) not exceeding 50.

(b) Jacket

(i) The jacket shall be a synthetic non-woven geotextile, capable of resisting all bending, punching and tensile forces imposed during installation and during the design life of the drain.

(ii) The jacket material shall not be subject to localized damage (e.g., punching through the filter bys sand/gravel particles).

(iii) The jacket material shall be sufficiently rigid to withstand lateral earth pressures due to embedment and surcharges so that the vertical flow capacity through the core will not be adversely affected. The jacket material shall be sufficiently flexible to bend smoothly during installation and induced consolidation settlement without damage. Jacket material shall not undergo cracking and peeling during installation of the drain

(iv) The jacket material shall meet the following requirements:

Table 4.13.1 Jacket Material Requirement

Properties	Test Method	Requirement
Grab strength	SNI 4417:2017 (ASTM D4632)	min. 356 N
Puncture Strength	SNI 8058:2014 (ASTM D4833)	min. 220 N
Bursting strength	ASTM D 3786	min. 896 KPa
Tear Strength	SNI 08-4644-1998 (ASTM D4533)	min. 111 N
Apparent Opening Size, O_{95}	SNI 08-4418-1997 (ASTM D 4751)	As shown in Drawing
Permittivity	SNI 08-6511-2001 (ASTM D 4491)	As shown in Drawing

Note:

(1) All values in Table 4.13.1, except Apparent Opening Size (AOS), indicate the minimum average roll value in the weakest major direction. The Geotextile Pore Size Value shows the maximum average roll value.

(2) Jacket material shall be tested in saturated and dry conditions, taken from the lowest value

(c) Core

The core shall be a black three-dimensional polyester filament core structure fabrication to promote drainage along the axis of the vertical drain.

(d) Assembled Drain

(i) The assembled drain shall be resistant against wet rot, mildew, bacterial action, insects, salts in solution in the groundwater, acids, alkalis, solvents, and any other significant ingredients in the site groundwater.

(ii) One single type of assembled drain shall be used on the project unless otherwise specified or approved by the Engineer.

(iii) PVD materials shall be labeled or tagged in such a manner that the information for sample identification and other quality control purposes can be read from the label. As a minimum, each roll shall be identified by the manufacturer as to lot or control numbers, individual roll number, date of manufacture, manufacturer and product identification of the jacket and core.

(iv) During shipment and storage, the drain shall be wrapped in heavy paper, burlap or similar heavy-duty protective covering. The drains shall be protected from sunlight, mud, dirt, dust, debris and other detrimental substances during shipping and on-site storage.

(v) All material which is damage during shipment, unloading, storage, or handling and/or which does not meet the minimum requirements of the drain material shall be rejected by the Engineer. No payment of any kind shall be made for rejected material.

(vi) PVD shall have a minimum equivalent diameter of 2 inches using the following definition of equivalent diameter:

$d_w = (a+b)/2$,

where:

d_w = diameter of a circular drain equivalent to the band shaped drain

a = width of the band shaped drain

b = thickness of the band shaped drain

S.4.13 (3) Quality Control and Testing

(a) The actual vertical drain to be used shall be at the option of the contractor subject to the approval of the Engineer.

(b) The Contractor shall indicate the proposed source of the materials prior to delivery to site as specified in Sub-clause S1.02 (4). The contractor shall also submit samples and Manufacturer's certificates to verify the physical, mechanical and hydraulic properties of the drain to be used for Engineer's approval.

(c) Prior to installation and at the discretion of the Engineer, individual test sample shall be cut from at least one roll selected at random to represent each batch or every 100,000 meters, whichever is lesser. Individual sample shall be no less than 3 meters in length and shall be full width. Samples submitted for tests shall indicate the linear meters of drain and manufacturer's identifications represented by the sample.

(d) Should any individual sample selected at random fail to meet the specification, then that roll shall be rejected and two additional samples shall be taken at random from two other rolls representing the same batch on 100,000 meters. If either of these two additional samples fail to comply

with the specification, then the entire batch of vertical drains represented by the samples shall be rejected.

Table 4.13.2: Properties of Prefabricated Vertical Drain

Properties	Requirements	Test Method
Composite		
Weight Width Thickness	70 gr/m 100 MM 5.0 mm	ASTM D5261 ASTM D5199
Tensile Strength	2.8 kN	ASTM D4595
Elongation at 2.0 kN	20 %	ASTM D4595
Strength at 10 % elongation	1.3 kN	ASTM D4594
Discharge Capacity - Straight (240 kPa) - Kinked (240 kPa) - Buckled	 180×10^{-6} m^3/sec 120×10^{-6} m^3/sec 80×10^{-6} m^3/sec	 ASTM D4716 ASTM D4716 ASTM D4716
Filter		
Tensile Strength	11 kN/m	ASTM D4595
Core compressive strength	800 kPa	ASTM D1621
Grab strength (MD	310 N	ASTM D4632
Trapezoid tear	70 N	ASTM D4533
Puncture resistance	80 N	ASTM D4833
Elongation at break	20 %	ASTM D4595
Apparent Opening Size - A.O.S. (O_{95})	< 90μm	ASTM D4751
Permittivity	0.75 s^{-1}	ASTM D4491
Permeability (Kv)	18×10^{-4} m/s	ASTM D4491

S.4.13 (4) Construction

(a) General

(i) PVD drains shall be installed with approved modern equipment of a type which will cause a minimum of disturbance of the sub-soil during the installation operation and maintain the mandrel in a vertical position.

(ii) Drains shall be installed using a mandrel or sleeve which shall be inserted (i.e., pushed or vibrated) into the soil. The mandrel or sleeve shall protect the drain material from tears, cuts, and abrasion during installation, and shall be retracted after each drain is installed.

(iii) The mandrel or sleeve shall be provided with an anchor plate or similar arrangement at the bottom to prevent the soil from entering the bottom of the mandrel during the installation of the drain and to anchor the drain tip at the required depth at the time of mandrel withdrawal. The dimensions of the anchor shall conform as closely

as possible to the dimensions of the mandrel so as to minimize soil disturbance. The Engineer shall determine the acceptability of the anchorage system and produce.

(b) Installation Procedures

(i) Two weeks prior to the beginning of trial installation, the Contractor shall submit full details on the materials, equipment, sequence and method proposed for PVD Drain installation to the Engineer for review and approval. Approval by the Engineer of installation sequence and methods shall not relieve the Contractor of its responsibility to install drains in accordance with the plans and specifications.

(ii) Prior to the installation of production PVD drains, the Contractor shall demonstrate that its equipment, methods, and materials produce a satisfactory.

Installation in accordance with these specifications. For this the Contractor will be required to install 5 trial totaling approximately 50 linear meters at locations designated by the Engineer.

(iii) Approval by the Engineer of the method or equipment used to install the trial drains shall not constitute, necessarily, acceptance of the method for the remainder of the project. If, at any time, the Engineer considers that the method of installation does not produce satisfactory pv drains, the Contractor shall alter his method and/or equipment as necessary to comply with these specifications.

(c) Installation

(i) PVD shall be located, numbered and staked out by the Contractor using a baseline and benchmark as shown in the Drawings. The Contractor shall take all reasonable precautions to preserve the stakes and is responsible for any necessary re-staking. The as-installed location of the PVD shall not vary by more than 150 mm from the plan locations designated on the drawings.

(ii) PVD that are more than 150 mm from design plan location or are damaged or improperly installed, will be rejected and abandoned in place.

(iii) PVD shall be installed from the working surface to the depth shown on the drawings, or to such depth as directed by the Engineer. The Engineer may vary the depths, spacing, or the number of drains to be installed, and may revise the plan limits for this work as necessary.

(iv) During PVD installation, the Contractor shall provide the Engineer with suitable means of determining the depth of the advancing drain at any given time and the length (to nearest 50 mm) quantity of pv drain installed at each location.

(v) Equipment for installing PVD shall be plumbed prior to installing each drain and shall not deviate from the vertical more than 50 mm in 3 meters during installation of any drain.

(vi) PVD shall be installed using a continuous push using static weight or vibration.

(vii) Installation techniques requiring driving will not be permitted. Jetting techniques will be permitted only after receiving written approval from the Engineer.

(viii) The installation shall be performed, without any damage to the drain during advancement or retraction of the mandrel. In no case will alternate raising or lowering of the mandrel during advancement be permitted. Raising of the mandrel will only be permitted after completion of a drain installation.

(ix) The completed PVD shall be cut off neatly 300 mm above the working grade, or as otherwise specified on the contract drawings.

(x) The Contractor shall observe precautions necessary for protection of any field instrumentation devices. The Contractor shall replace, at his own expenses, any instrumentation equipment that has been damaged or become unreliable as a result of his operations prior to continuing with drain installation or order construction activities.

(d) Preaugering/Obstructions

(i) The Contractor shall be responsible for penetrating any overlying material as necessary to install the drains.

(ii) Where obstruction is encountered below the working surface which cannot be penetrated by the drain installation equipment, the Contractor shall complete the drain from the elevation of the working surface to the obstruction and notify the Engineer prior to installing any more drains. At the direction of the Engineer and under his review, the Contractor shall attempt to install anew drain within 600 mm horizontally from the obstructed drain. A maximum of two attempts shall be made as directed by the Engineer. If the drain still cannot be installed to the design tip elevation, the drain location shall be abandoned and the installation equipment shall be moved to the next location, or other action shall be taken as directed by the Engineer.

(iii) If permitted by the Engineer, the Contractor may use augering, spudding, or other methods to loosen the soil and clear obstructions, providing the augering does not penetrate more than 600 mm into the underlaying compressible soil.

(iv) Where obstructions are encountered, the following procedure shall be implemented in the listed sequence:

(1) The Contractor shall immediately notify the Engineer prior to completing the drain and prior to installing any other drains.

(2) The Contractor shall attempt to install drains adjacent to the obstructed location. Based upon the results of these installations and at the direction of the Engineer and under his review, the Contractor shall:

- attempt to install an offset drain within 600 mm horizontally of the obstructed drain, or
- implement obstruction clearance procedures and install the drain at the design location.

Obstruction clearance procedures shall be used only as directed by the Engineer.

(e) Splicing

(i) Splicing of prefabricated vertical drain material shall be done by stapling in a workmanlike manner and so as to insure structural and hydraulic continuity of the drain.

(ii) A maximum of 1 splice per drain installed will be permitted, without specific permission from the Engineer.

(iii) The jacket and core shall be overlapped a minimum of 150 mm at any splice.

S.4.13 (5) Method of Measurement

(a) Vertical drains shall be measured by the linear meter. The length of PVD to be paid for shall be the distance the installation mandrel tip penetrates below the working grade plus the required cut off length above the working grade. Payment will not be made for drains which are not anchored to the required depth.

(b) PVD placed in excess of the length designated on the contract drawings shall not be paid for unless the additional length was authorized by the Engineer in writing prior to or during the drain installation.

S.4.13 (6) Basis of Payment

The quantities, measured as provided above, shall be paid for at the Contract price per linear meter, which price and payment shall be full compensation for furnishing and installing all materials including all supervision, equipment, crew, survey stake out of drain locations, other equipment and materials as necessary to properly execute the work.

Pay Item No. and Name		**Unit of Measurement**
4.13	Prefabricated Vertical Drain (PVD)	Linear Meter

S4.14 Geotechnical Instrumentation

S4.14 (1) General

(a) Description

(i) This specification is intended to explain and control the requirements for using Instrumentation on embankment work on soft soil, slope stabilization, Prefabricated Vertical Drain (PVD) work and Preloading Systems

(ii) The scope of work of this specification includes: the supply, installation, monitoring and analysis of data which shall comply with the regulations and standards stated in this Specification

(iii) The instrumentation referred to in this specification includes instruments to monitor vertical settlement, horizontal movements, and pore pressures which shall be installed and adjusted as shown in Drawing.

(iv) These specifications are intended to ensure good quality and performance

(b) Reference Standard

Standar Nasional Indonesia (SNI)

SNI 3404:2008	:	*Tata cara pemasangan inklinometer dan pemantauan pergerakan horisontal tanah*
SNI 03-3431-1994	:	*Tata cara pemantauan gerakan horizontal batuan dan bangunan dengan alat inklinometer*
SNI 03-3442-1994	:	*Tata cara pengukuran tekanan air pori tanah dengan pisometer pipa terbuka Casagrande*
SNI 03-3443-1994	:	*Tata cara pemantauan tekanan air pori dengan pisometer pipa terbuka casagrande*
SNI 03-3452-1994	:	*Tata cara pemasangan pisometer pneumatik*
SNI 03-3453-1994	:	*Tata cara pemantauan tekanan air pori dengan alat pisometer penumatik*
SNI 3454:2008	:	*Tata cara pemasangan instrumen magnetis dan pemantauan pergerakan vertikal tanah.*
SNI 6461:2012	:	*Tata cara pemasangan dan pembacaan pisometer kawat vibrasi*
Pt T-08-2002-B	:	*Panduan geoteknik 1 : Proses pembentukan dan sifat-sifat dasar tanah lunak*
Pt T-09-2002-B	:	*Panduan geoteknik 2 : Penyelidikan tanah lunak desain dan pekerjaan lapangan*
Pt M-01-2002-B	:	*Panduan geoteknik 3 : Pengujian tanah lunak pengujian laboratorium*
Pt T-10-2002-B	:	*Panduan geoteknik 4 : Desain dan konstruksi*

ASTM

ASTM D6230-13	:	Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers

ASTM D6598-19 : Standard Guide for Installing and Operating Settlement Platforms for Monitoring Vertical Deformations

(c) Terms and Definition

(i) Settlement Plate, Settlement Probe, Settlement Sensor

Instruments used to measure vertical settlement of embankment or existing ground.

(ii) Piezometer

Instruments used to measure water pore pressure. Water pore pressure can indicate instability in embankment and evaluate the progress of the consolidation process.

(iii) Inclinometer

Instruments used to measure horizontal movement and monitor the stability of the embankment.

S4.14 (2) Material

(a) Physical Instrument Requirements

(i) The instrument for monitoring the vertical settlement used shall comply with the requirements set forth in ASTM D6598-19.

(ii) (Instruments to monitor horizontal movements used shall be in accordance with the requirements SNI 3404: 2008.

(iii) Instruments to measure pore pressures used shall comply with the requirements in SNI 03-3442-1994 or SNI 03-3453-1994 or SNI 6461:2012.

(b) Instrumentation Requirements

(i) The instrument to be installed shall be instrumentation which has been approved by the Engineer

(ii) All requirements for types and models of instruments used shall obtain approval from the Engineer

(iii) All instruments shall be able to function in accordance with the requirements specified in these Specifications.

S4.14 (3) Implementation

(a) Installation

Installation of instrumentation shall follow:

(i) All instruments shall be installed in accordance with the Drawings before loading or embankment started.

(ii) Schedule, description of the layout plan shall be prepared and implemented appropriately according to Drawings and records shall be made if there are deviations from the original plan.

(iii) The inclinometer should be planted to hard soil.

(iv) All instruments shall be marked with serial numbers.

(v) During the installation, a record shall be made and when completed, the installation note shall be made into a report, which will be the definite factual information about the instrumentation.

(b) Protection

During the installation and implementation of the embankment, all instruments installed shall be protected against vehicle traffic and heavy equipment. After completion of installation and backfilling, the instrument shall be protected with a protective device which is not easily damaged or stolen, to ensure that all instruments are not damaged and work well.

Special safety precautions shall be taken for instruments that are mounted until they are protruding on the ground surface that can be damaged by construction activities. Inclinometer casings and settlement probes require a barrier to protect it and shall be clearly marked or painted to warn construction equipment operators.

To avoid theft and vandalism, all terminals shall be buried and made not stand out because the protective box that is striking invites damage.

All vertical pipes shall be given a lid/cover to prevent the entry of dirt into the pipe.

(c) Embankment record

Embankments are carried out in layer by layer 20 cm thick. The initial speed is 60 cm / week. Progress of the embankment shall be recorded ie the start date of the embankment and the finish date for each layer. Embankment is controlled by the instrument. The Contractor's consultant who evaluates the results of the monitoring will determine whether the speed of embankment above needs to be reduced or may be accelerated.

Since the embankment is not possible to settle uniformly, recording the thickness of the overlay layer is not sufficient to determine the height of the embankment that has been carried out. Each time the plate is measured, the height of the measurement point above the embankment shall also be recorded.

(d) Settlement Plate

The height of the base plate and the end of the rod should be recorded as a preliminary reading. The initial height of the tip of the stem shall be revised when the rod is extended. Decreasing plate readings are carried out at the completion of each pile layer or taken weekly or every 3 days if necessary.

A settlement plate shall be installed before the embankment is carried out and so that the plates do not move when they are buried, the bottom plates shall be leveled with sand. The most common problem is in areas of flooding or paddy fields where a very soft layer of mud covers the surface of the soil which will swell out from under the plate and give the appearance of an early decline.

Data shall be plotted and reviewed as soon as it is obtained. If the values change quickly, the frequency of readings shall be increased. If the values are not consistent with the previous set of readings, the measurement shall be repeated.

(e) Embankment Measurement

(i) Marking Surface Settlement

A settlement marker is the simplest and cheapest instrument for measuring a decline. These markers consist of wooden, steel or concrete pegs placed on the finished embankment surface.

Measurements with this technique only measure the total settlement in embankment after completion of construction, including the settlement in the lower layer and the embankment itself. Settlement is measured by measuring the height of a fixed-point peg which is a reference datum.

(ii) Settlement Plate

A settlement plate consists of a rod welded on a 60 cm x 60 cm square steel plate placed at the bottom of the embankment. Settlement is measured by measuring the height of a fixed point peg which is the datum reference.

(iii) Measuring Water Pore Pressure

Pore pressures can provide an indication of instability in the embankment and are also important for evaluating the progress of consolidation. The type of piezometer selected shall meet the following requirements:

- Shall be able to accurately record pore pressures in the soil
- The piezometer shall cause minimal disturbance to the original soil
- Piezometers shall react quickly to changes in pore pressure conditions
- The piezometer shall be strong, reliable and stable for long periods of time
- A piezometer can be recorded continuously or alternately if required

S4.14 (4) Method of Measurement

The measurement basis is determined based on the functioning of each instrumentation which has been installed according to Drawing. Each instrumentation shall be able to function as: an instrument for monitoring changes in pore water values, settlement vertically and monitoring horizontal movements for the stability of the embankment.

S4.14 (5) Basis of Payment

The instrument used to complete this work, as described in the Clause above shall be measured and paid for each point for instruments for monitoring pore pressure, vertical settlement and horizontal movement. This unit price and payment is full compensation for the rental price of monitoring instruments, consumables, installation work, labor supply, monitoring services, data collection and analysis, and reporting.

Payments will be made in two stages:

(a) 50% when instruments and consumables are installed;

(b) 50% when monitoring reports are received and approved by the Engineer.

Pay Item No. and Name		**Unit of Measurement**
4.14 (1)	Water Pore Pressure Monitoring	Each
4.14 (2)	Vertical Settlement Monitoring	Each
4.14 (3)	Horizontal Moving Monitoring	Each

DIVISION 5 STRUCTURE EXCAVATION

S5.01 Structure Excavation

S5.01 (1) Definition

Structure Excavation shall consist of excavation in earth, within the limits of the work as specified herein or as shown on the Drawings, that is made for structures. Any excavation which can be defined under any other Clause of this Specification shall not be considered to be Structure Excavation.

Structure Excavation shall be limited to excavation for the foundation of bridges or concrete retaining walls, box culverts, wing walls and other structures, unless otherwise noted in these Specifications. It shall include backfilling with suitable material accepted by the Engineer; incorporating surplus material in the fill areas as described in Clause S4.06; all necessary of sheeting, shoring, preparation of working area or cofferdam and the demolition, disposing of waste material, and all necessary materials and equipment for keeping the excavation free of surface run-off and groundwater. Removal of free-surface water shall not be paid for under this Clause but will be considered to be covered by Clause S1.26 of these Specifications.

S5.01 (2) Classification

Structure Excavation shall be classified for measurement and payment as :

(a) structure excavation in earth;

(b) structure excavation executed at a depth greater than 20 cm below the constant level to which the groundwater naturally rises in a foundation pit;

(c) blinding stone for structure foundation.

S5.01 (3) Groundwater

(a) Whenever groundwater is encountered during structure excavation, the Contractor shall take such measures as are described in Sub-clause S5.01.(3).(c), to ensure that the excavation and footing are kept free of water.

(b) When the excavation is taking place in or directly adjacent to free-surface water, this will not be considered as groundwater and will be deemed to be covered by the Contractor's obligations under Clause S1.26 of these Specifications and therefore not measured for additional payment under this Division 5. The decision as to whether water is free-surface water or groundwater will be at the absolute discretion of the Engineer. Where water can be kept out of the excavation by the use of a non-closed cofferdam, the water will generally not be considered to be groundwater.

(c) Suitable and practically watertight cofferdams shall be used wherever water bearing strata are encountered above the elevation of the bottom of the excavation. Upon request, the Contractor shall submit drawings

showing his proposed method of cofferdam construction to the Engineer for his approval.

Cofferdams or cribs for foundation construction shall, in general, be carried out well below the bottoms of the footings and shall be well braced and as nearly water-tight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

When conditions are encountered which, as determined by the Engineer, render it impractical to dewater the foundation before placing the footing, the Engineer may require the construction of a concrete foundation seal of such dimensions as he may consider necessary, and such seal shall be placed as shown on the Drawings or as directed by the Engineer. The foundation shall then be dewatered and the footing placed. When weighted cribs are employed and the weight is utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorages such as dowels or keys shall be provided to transfer the entire weight of the crib to the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level as directed.

Cofferdams shall be constructed so as to protect concrete against damage from sudden rising of the water and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs, without the approval of the Engineer.

Any pumping that may be permitted from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. Any pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall be done from a suitable pump located outside the concrete forms. Pumping to dewater shall not be commenced until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdam or cribs, with all sheeting and bracing involved therewith, shall be removed by the Contractor after the completion of the substructure. Removal shall be effected in such a manner as not to disturb or damage any finished work.

(d) Preservation of Channel

Unless otherwise permitted, no excavation shall be made outside of caissons, cribs, cofferdams, or sheet piling and the natural stream bed adjacent to the structure shall not be disturbed without the approval of the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs, or cofferdams are sunk in place, the Contractor shall, after the foundation base is in place, backfill all such excavations to the original ground surface or stream bed with material satisfactory to the Engineer. Material deposited within the stream area from foundation or

other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction.

S5.01 (4) Excavation

Prior to starting excavation operations in any area, the Contractor shall:

(a) take steps on his own initiative to regulate the natural drainage of the water flowing on the surface of the ground, to prevent flooding of excavations.

(b) ensure that all necessary Site Clearance and Demolition in that area has been performed in accordance with these Specifications.

(c) notify the Engineer sufficiently in advance of the beginning of any excavation so that cross-sectional elevations and measurements can be taken of the undisturbed ground. The existing ground adjacent to the structures shall not be disturbed without the permission of the Engineer.

Trenches or foundation pits for structures or structure footings shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown. The sides of trenches or pits shall be adequately supported, as approved by the Engineer, at all times. The elevations of the bottoms of footings as shown on the Drawings shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.

Boulders, logs, and any other unsuitable material encountered in excavation shall be removed from the site and shall not be used for backfilling purposes.

After each excavation is completed, the Contractor shall notify the Engineer to that effect, and no footing or bedding material shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface, either level, stepped or serrated as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed.

When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to be placed. When the foundation material is soft or mucky or otherwise unsuitable, in the opinion of the Engineer, the Contractor shall remove the unsuitable material and replace it with granular backfill, as specified in Clause S4.08. This foundation fill shall be placed and properly compacted in 15 cm layers up to the foundation elevation at the density required by the Engineer.

If, in the opinion of the Engineer, the foundation material is unsuitable solely because of the Contractor's failure to fulfill his obligations under Clause S1.26 or S5.01 (3), then the Contractor shall either:

(a) carry out at his own expense the removal and replacement described above; or

(b) suspend works in that excavation until such time as the foundation material becomes suitable.

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven and any placing of blinding stone shall be done after the piles are driven. However if for any reason it is impossible to drive the piles after excavation, piles shall be driven from the natural ground level, as directed by the Engineer. Surplus length of piles in this case will not be measured for payment.

After both the driving and the excavation are completed, all loose and displaced material shall be removed, leaving a smooth, solid bed to receive the footing.

All excavated material, so far as suitable, shall be utilized as backfill or embankment, or shall be removed from the site if surplus to requirements.

Where a box culvert is to be located in embankment the Engineer may instruct that the excavation shall be performed after the embankment has been constructed to the proposed subgrade level and compacted sufficiently.

Necessary support shall be constructed so as to protect the current structure which will be above or side of the excavation. Excavation under railway shall include support with suitable foundation for the railway as shown in the drawings to secure the current railway transportation. All details of excavation under railway shall be approved by the Engineer before commencement of the work.

Structure excavation shall be made so that any adverse effect on the existing or adjacent roads or facilities shall be avoided or kept at minimum by use of sheet-piling and/or or other suitable measures.

S5.01 (5) Blinding Stone

Blinding stone for use as a foundation for structures shall be provided as shown on the Drawings or instructed by the Engineer.

The main component of the blinding stone shall be approved cobble-stone or crushed rock, of the maximum size compatible with the thickness of blinding stone as shown on the Drawings. The minimum height of any stone as placed shall be 7 cm. Stone shall be closely packed by hand placing, to the dimensions shown on the Drawings, and then thoroughly rammed by mechanical rammer. Smaller stone pieces of minimum size 3 mm shall then be placed between the larger stones and the upper surface brought up to the finished level shown on the Drawings or instructed by the Engineer. The complete surface shall then be thoroughly compacted to the satisfaction of the Engineer using a mechanical rammer or vibrating roller.

The Contractor may propose an alternative to the above process, based on the use of graded, crushed stone of maximum size less than 5 cm. The Engineer's acceptance of this alternative and the maximum thickness to be laid in one layer will be dependent on the proposed compacting plant and its suitability for the restricted working area available.

S5.01 (6) Backfill and Embankments for Structure

On completion of the structure, excavated areas if not to be backfilled in accordance with Clause S4.09 or S4.10, shall be backfilled with approved material to the level of the finished ground surface. Unless otherwise approved by the Engineer, all backfill shall be carried out in accordance with the requirements of Clause S4.06 of these Specifications.

All material surplus to the requirement of this Clause shall be utilized for the formation of areas of fill or shall, if instructed by the Engineer, be considered as waste and treated in accordance with Clause S4.07.

S5.01 (7) Method of Measurement

Structure Excavation and Blinding Stone will not be measured for payment under any item in which the Basis of Payment states that such work is included in the pay item.

Additional payment for structure excavation underwater will not be made unless the Engineer is satisfied that the water is groundwater. Payment for dealing with free-surface water will be in accordance with Clause S1.26 of these Specifications.

The quantity of structure excavation to be paid for shall be the number of cubic meters of material measured in its original position and shall be computed as follows.

The volume of earth or rock to be measured for structure excavation shall consist of a prismoidal bounded by the following planes:

(a) upper plane; the horizontal plane reproducing the perimeter of the base of the structural member and passing through the lowest point of the natural ground or excavated ground along the perimeter; above which plane excavation shall be considered as common excavation and shall be measured and paid for accordingly;

(b) lower plane; the horizontal plane at the base of the foundation; which will be taken as the lower surface of the structural concrete, leveling concrete or blinding stone as shown on the Drawings or instructed by the Engineer;

(c) the vertical planes coinciding with the perimeter of the base of the structural member. Any additional width of excavation necessary for the installation of blinding stone or class E leveling concrete or structural concrete exceeding area of lower plane or method of construction which requires a larger space will not be measured for payment and the cost of this excavation will be deemed to be included in the unit price for the measured quantity as described above.

Except as described previously in Sub-clause S5.01.(4) of these Specifications measurement for structure excavation shall not include material removal below the footing grade and beyond the specified limits of the excavation to compensate for anticipated swell or as a result of effective swell during pile driving or additional material resulting from slides, slips, cave-ins, silting or filling whether due to the action of the elements or to the operations by the Contractor.

Where the Engineer orders the excavation after the embankment has been placed, this extra excavation in the embankment will be measured for payment as structure excavation as otherwise provided in these Specifications.

Structure excavation under railway shall include all temporary works such as support for the existing railway and temporary bridges, rails, and etc. as shown in the drawings to secure current transportation with suitable foundation. It also includes all the monitoring works of the existing railway to prevent the accident and failure of railway network.

The volume of structure excavation where groundwater is present will be measured for additional payment, only where the excavation is executed to a depth greater than 20 cm below the constant level to which the water rises in the foundation pit.

The volume of Blinding Stone measured for payment will be the number of cubic meters of stone completed in accordance with these Specifications and calculated using the dimensions shown on the drawings or instructed by the Engineer.

S5.01 (8) Basis of Payment

The quantities, determined as provided above shall be paid for at the Contract Price per unit of measurement, respectively, for each of the particular pay items listed below that is shown in the Bill of Quantities, which prices and payment shall be full compensation for all costs necessary or usual for the proper completion of the work described in this Division 5.

Pay Item No. and Name		**Unit of Measurement**
5.01 (1)	Structure Excavation >0 – 2 meter depth	Cubic Meter
5.01 (2)	Structure Excavation >2 – 4 meter depth	Cubic Meter
5.01 (3)	Structure Excavation >4 – 6 meter depth	Cubic Meter
5.01 (4)	Addition to the prices of Items Nos.5.01 (1) through 5.01 (3) for Structure Excavation where water is present	Cubic Meter
5.01 (5)	Addition to the prices of Items Nos.5.01 (1) through 5.01 (3) for Excavation in Rock	Cubic Meter
5.01 (6)	Blinding Stone	Cubic Meter

DIVISION 6 DRAINAGE

S6.01 Scope

This work shall consist of the construction of drainage pipes, culverts, U-ditches, and other drainage facilities in accordance with these Specifications and the specifications for other work items involved, all in conformity with the lines, grades and dimensions instructed by the Engineer.

The applicable provisions of Clause S1.26 shall be read into and become part of this Clause. The cost of working in or dealing with all ground water encountered in executing the work of this Division will be deemed to be included in the unit price for the pay item being installed or constructed.

The Engineer reserves the right to inspect and test all precast concrete items before their delivery to the site and at any time prior to and during laying.

S6.02 General

The types and characteristics of the drainage pipes and other drainage structures shown on the Drawings and their estimated total quantities entered in the Bill of Quantities are not to be taken as final. To assist the Engineer in his review of the contract drawings, the Contractor will undertake a survey of the site to determine the location, pipe or channel size, invert level and estimated discharge of all storm water or foul sewer flows entering the Site. On the basis of the results of this survey the final types, lines, characteristics and quantities will be decided by the Engineer, who will inform the Contractor of them in writing in due time in relation to the approved schedule of work submitted by the Contractor. Responsibility for accurately locating all existing flows will rest with the Contractor and the cost of this survey will be deemed to be included in the various pay items of this Division.

S6.03 Sequence of Work

The Contractor shall provide the construction schedule of drainage works such that the discharge of runoff from rain or other sources, both during and after construction, is properly provided for. To avoid damage to works in course of construction the Contractor shall provide adequate means of protection, including all necessary temporary outlet ditches, dams, or diversion channels. Culverts or other drainage works for the discharge of runoff water either during or after construction shall not be built until adequate facilities for the inflow and outflow of the water have been completed, and they shall be kept clear of all obstructions that might impede the flow of water. All culverts, ditches and other drainage works shall be fully operative before work is begun on the construction of subgrade, sub-base or shoulders. These requirements shall be met without additional payment and all costs thereof shall be included in Pay Item 1.26.

S6.04 Box Culverts and Pumping/Dewatering

S6.04 (1) Box Culverts

Box culverts and associated wing walls will be measured and paid for on the basis of individual pay items described elsewhere in these Specifications. The relevant provisions of Clauses S6.01, S6.02 and S6.03 will be deemed to be applicable to all work on box culverts, except that groundwater encountered during structure excavation for box culverts will be measured and paid for under Pay Item 5.01 (4).

The work shall consist of reinforced concrete box culverts furnished and installed in accordance with the relevant Clauses of this Specification in conformity with the lines, levels, grades and dimensions shown on the Drawings or instructed by the Engineer.

S6.04 (2) Pumping/dewatering

The submersible pumps to be used should be suitable for clear and waste water and sewage-type waste with sludge containing solids and fibrous material. The pumps should be with automatic coupling system for below-ground level wet installation. The pumps should also be suitable for horizontal or vertical dry installation. The permanent seals and temperature monitoring and early warning system are also required to indicate whenever inspection is required, ensuring longer durability along with low service costs and maintenance requirements.

The Contractor shall propose for the Engineer’s approval all the details including the above for such pumping/dewatering arrangement prior to the start of the related activities for approval of the Engineer.

The cost associated with the above operation shall be deemed to be included, unless otherwise provided elsewhere in the Contract, in the unit rates/prices provided for the other pay items included in the Bill of Quantities.

S6.05 Drainage Pipes

S6.05 (1) Description

The work shall consist of reinforced concrete drainage pipes furnished and installed in accordance with these Specifications and in conformity with the lines, levels and other details decided by the Engineer as a result of the Contractor's survey mentioned in Clause S6.02. The relevant requirements of Clauses S6.02, and S6.03 shall be read into and considered part of this Clause.

S6.05 (2) Material

All concrete and reinforcement shall comply with the relevant requirements of Division 10 of these Specifications. Pipe details shall be as shown on the Drawings and the Contractor shall submit for the Engineer's approval, full details of his proposed arrangements for the manufacture, curing and handling of reinforced concrete pipes. Formwork used in the manufacture shall be steel and of rigid construction.

S6.05 (3) Construction

(a) Excavation

Prior to starting excavation, the Contractor shall take all necessary measures to keep the excavation free from free-surface water or surface water run-off.

In areas of fill, filling shall be completed to a depth of one pipe diameter above the top of the pipe, before excavation begins. All excavation shall be carried out so as to minimize damage to existing surfaces.

The sides of pits and trenches shall be adequately supported at all times. Except where otherwise described in the Contract, they shall not be battered. The supports shall be left in pits or trenches only where described in the Contract. Excavated material not required for backfilling shall be dealt with in accordance with Division 4 of these Specifications.

Soft soil in the bottom of drainage excavation shall be removed and the resulting void immediately backfilled with Granular Backfill to Clause S4.09. When the Engineer instructs this additional treatment, it will be paid for under the relevant Clauses of this Specification. Where the Engineer considers that soft spots are due to the contractor's failure to fulfill his obligations under any Clause of these Specifications then the Contractor shall, at his own expense, undertake the additional excavation and replacement with Granular Backfill to the satisfaction of the Engineer. Any suitable material below the level of the concrete pipe bed which is removed unnecessarily shall be replaced at the Contractor's expense with Granular Backfill in accordance with Clause S4.09 of these Specifications.

(b) Bedding, Laying and Surrounding of Pipes

All pipes shall be laid, using cradles if necessary, to the true line and level as directed by the Engineer. Joints shall be sealed with cement mortar of 1 PC: 2 sand, except where otherwise specified, so that water will not leak. The inside of the joint shall be wiped and finished smooth and the outside shall be protected for two days or as otherwise directed by the Engineer to prevent cracking.

If the joint between the pipe culverts is equipped with a rubber or other seal as shown in the Drawings, the seal prepared by the manufacturer shall be installed between the bell and spigot, and accepted by the Engineer. All seals shall be circular or profile and in accordance with ASTM C443-12(2017). Bitumen type seal shall not be used.

After the Engineer has checked and approved the pipes and joints, the Contractor will complete the concrete bedding and encasing or surrounding as instructed by the Engineer. Concrete shall be thoroughly compacted below and around the pipe to the dimensions shown on the Drawings, but special care should be taken to avoid dislodging the pipes or damaging the joints.

(c) Backfilling and Reinstatement

Backfilling shall not commence until in the opinion of the Engineer, the concrete has achieved sufficient strength. Backfilling shall be carried out in accordance with the requirements of Clause S4.06, except that the maximum thickness of loose material shall not exceed 15 cm. Where insufficient suitable material is available from any particular pipe excavation, surplus material from any other excavation shall be used. On completion of backfilling, the area excavated shall be reinstated to its original condition, but the Engineer may waive or modify this requirement if the area is to be overlaid or reconstructed under other Clauses of this Contract.

S6.05 (4) Method of Measurement

The quantity of reinforced concrete drainage pipe to be paid for, shall be the number of linear meters measured along the center-line of the pipe, between the inside faces of the headwalls, catch-basins or manholes, as installed in accordance with these Specifications and the Engineer's instructions.

Pipes will be measured and paid for according to the pipe diameter and the method of bedding or surrounding. Type A pipe will have concrete bed and surrounding, and Type B pipe will have full concrete encased. All details shall be as shown on the drawings.

S6.05 (5) Basis of Payment

Drainage pipes, measured as provided above shall be paid for at the Contract unit price per linear meter for the particular pipe size and bedding type as specified below. The price and payment will be full compensation for furnishing, hauling and installing the pipe including cradles if necessary, jointing, concrete foundation or surround, reinforcement, excavation to any depth and backfilling, maintaining the excavation free of groundwater, breaking in to any existing manholes or channels to form a connection, and for all labor, tools, equipment and incidentals necessary to complete the work as described in this Specification.

If the Engineer instructs that the area of excavation should be completely or partially reinstated, this will be measured and paid for under the other Clauses of this Specification. Any extra costs resulting from working on small areas will be deemed to be included in the other Pay Items.

Pay Item No. and Name		**Unit of Measurement**
6.05 (1)	Unreinforced Concrete Pipe ∅ 40 cm	Linear Meter
6.05 (2)	RC Spun Pipe Type A ∅ 40 cm	Linear Meter
6.05 (3)	RC Spun Pipe Type B ∅ 40 cm	Linear Meter
6.05 (4)	RC Spun Pipe Type A ∅ 60 cm	Linear Meter
6.05 (5)	RC Spun Pipe Type B ∅ 60 cm	Linear Meter
6.05 (6)	RC Spun Pipe Type A ∅ 80 cm	Linear Meter
6.05 (7)	RC Spun Pipe Type B ∅ 80 cm	Linear Meter

6.05 (8)	RC Spun Pipe Type A ∅ 100 cm	Linear Meter
6.05 (9)	RC Spun Pipe Type B ∅ 100 cm	Linear Meter
6.05 (10)	RC Spun Pipe Type A ∅ 120 cm	Linear Meter
6.05 (11)	RC Spun Pipe Type B ∅ 120 cm	Linear Meter
6.05 (12)	RC Spun Pipe Type A ∅ 150 cm	Linear Meter
6.05 (13)	RC Spun Pipe Type B ∅ 150 cm	Linear Meter
6.05 (14)	RC Spun Pipe Type A ∅ 200 cm	Linear Meter
6.05 (15)	RC Spun Pipe Type B ∅ 200 cm	Linear Meter
6.05 (16)	RC Spun Pipe Type A 2 ∅ 40 cm	Linear Meter
6.05 (17)	RC Spun Pipe Type B 2 ∅ 40 cm	Linear Meter
6.05 (18)	RC Spun Pipe Type A 2 ∅ 60 cm	Linear Meter
6.05 (19)	RC Spun Pipe Type B 2 ∅ 60 cm	Linear Meter
6.05 (20)	RC Spun Pipe Type A 2 ∅ 80 cm	Linear Meter
6.05 (21)	RC Spun Pipe Type B 2 ∅ 80 cm	Linear Meter
6.05 (22)	RC Spun Pipe Type A 2 ∅ 100 cm	Linear Meter
6.05 (23)	RC Spun Pipe Type B 2 ∅ 100 cm	Linear Meter
6.05 (24)	RC Spun Pipe Type A 2 ∅ 120 cm	Linear Meter
6.05 (25)	RC Spun Pipe Type B 2 ∅ 120 cm	Linear Meter
6.05 (26)	RC Spun Pipe Type A 2 ∅ 150 cm	Linear Meter
6.05 (27)	RC Spun Pipe Type B 2 ∅ 150 cm	Linear Meter
6.05 (28)	RC Spun Pipe Type A 2 ∅ 200 cm	Linear Meter
6.05 (29)	RC Spun Pipe Type B 2 ∅ 200 cm	Linear Meter

6.06 U-Ditch, Concrete Ditch, Inlets, Outlet, Headwalls and Joint Boxes, etc.

S6.06 General

S6.06 (1) Description

This item shall consist of all work in connection with the construction of ditches, inlets, pipe headwalls and joint boxes along the shoulders, footpaths and where shown on the Drawings or where instructed by the Engineer.

All work shall be precast and done in accordance with these Specifications and in conformity with the lines, levels, grades and dimensions shown on the Drawings or as directed by the Engineer. The applicable provisions of Clauses S6.01, S6.02 and S6.03 shall be read into and become part of this Clause.

S6.06 (2) Materials

Materials shall be as shown on the Drawings and shall comply with the relevant Clauses of this Specification. Information about units which require reinforcement will be shown on the drawings.

Grating steel materials shall conform to the requirements of JIS G3101: Rolled Steel for General Structures - SS400 or ASTM A36/A36M-14 or SNI 6764:2016 and shall be galvanized unless otherwise specified, in accordance with the requirements of Clause S12.18 of these Specifications.

S6.06 (3) Construction

(a) Excavation

Excavation shall be performed in accordance with the requirements of Division 5, "Structure Excavation" of these Specifications and the relevant requirements of Clause S6.05.

(b) Foundation

The foundation shall be prepared in accordance with Sub-clause S5.01 (5). When Class E concrete is shown on the Drawings or instructed by the Engineer, this shall be in accordance with Clause S10.01 of these Specifications.

(c) Layout

All work on U-ditches or concrete ditches, inlets, pipe headwalls and joint boxes shall be carefully set out and constructed with due recognition being taken of the fact that the upper surfaces shall be incorporated exactly into curbs, footpaths, etc. The Engineer may reject any item of work under this Clause when the upper surfaces do not meet the tolerances for curb and footpath given elsewhere in these Specifications.

Bottom surface of ditches shall be smoothly and neatly finished. Where the Engineer considers that any ditch, inlet or catch basin is likely to carry foul sewage, he may instruct that the 150 mm sand trap as shown on the Drawings be deleted and replaced by benching formed in Class D concrete. All details regarding the shape of benching and method of construction shall be in accordance with the Engineer's instructions. Unless otherwise specified, joints of precast blocks shall be carefully constructed using cement mortar of 1-part cement and 2 part sand so as to prevent leakage. Hook of U-ditches or concrete ditches along steep slopes shall be constructed so as to effectively resist sliding, by excavating soil to the shape of the hook and placing the concrete without disturbing the surrounding soil.

Cast-in-place concrete for waterways, drainage ditches, joint boxes, manholes, pipe headwalls, inlet and outlet of waterways, shall be constructed according to the requirements of Clause S10.01 and S10.02 of these Specifications. These structures shall be exactly as shown on the Drawings and as directed by the Engineer. The top portions of catch basins or inlets on which covers are to be placed shall be set exactly, and carefully and smoothly finished.

To ensure uniformity in the horizontal and vertical alignment of the curb, the Engineer may instruct that work on the upper sections of inlets, catch basins and U-ditches or concrete ditches be deferred and carried out immediately before or during work on the adjacent curb. Any additional expense incurred in complying with this instruction will be deemed to be already included in the unit price for this work.

(d) Backfill and Reinstatement

Backfill shall be performed in accordance with the requirements of Clause S5.01 of these Specifications. Backfill shall be carefully made so as to obtain a bearing capacity equal to the adjacent subgrade. In compacting subbase or base course in contact with drainage structures, rammers or small compactors shall be used and care taken to prevent damage to the adjacent structures. Backfill shall be carefully constructed so as to prevent erosion by overflow of drain water or rain.

On completion of backfilling, the area excavated shall be reinstated to its original condition, but the Engineer may waive or modify this requirement if the area is to be overlaid or reconstructed under other Clauses of this Contract.

S6.06 (4) Method of Measurement

The quantities of ditches, catch basins, inlets, pipe headwalls and joint boxes completed and accepted in accordance with the Drawings, these Specifications and as directed by the Engineer, will be measured as follows:

(a) The quantities of each type of ditch to be paid for will be the number of linear meters measured along the centerline of the completed ditch. The length will be measured to the outside face of any inlet or catch basin. In locations where P.C. piles are shown on the Drawings under any U-ditch or concrete ditch type the measurement and payment will be made under the appropriate pay item in Division 10.

(b) The quantities of catch basins, manholes, inlet or outlet of waterway, pipe headwalls and joint boxes to be paid for, will be the respective number for each structure furnished and installed, complete in place and accepted in accordance with the Drawings and the Engineer's instructions. The measurement for the pipe headwalls will be deemed to include the mortared rubble apron as detailed on the Drawings and no additional measurement will be made for this apron.

(c) The measurement for ditches, inlets and catch basins will be independent of the depth and the unit price will be deemed to cover any depth within the range shown on the Drawings. Where U-ditches are formed with vertical walls of different heights, the combined height of walls will be compared with the combined height of walls on standard U-ditches as shown on the Drawings, when determining the compliance with this method of measurement. No additional measurement will be made for joints between inlets or catch basins and ditches or drainage pipes. Any additional expense involved in forming joints or junctions between

individual pay items, will be deemed to be included in the cost of the pay items.

(d) Excavations for U-ditches or concrete ditches from the lowest elevation of the surface of shoulder shall not be measured separately for payment.

(e) Very thin fill of non-compressible material shall not be paid separately and shall be included in the Unit Price for the main work

S6.06 (5) Basis of Payment

U-ditches or concrete ditches, inlets, catch basins, pipe headwalls and joint boxes measured as provided above shall be paid at the Contract unit price for each pay item as described below. The price and payment will be full compensation for all the work in accordance with the Drawings, these Specifications and the instructions of the Engineer and shall include for excavation, foundation construction and backfill. No separate payments will be made for steel or concrete covers, step irons, jointing, benching or any such similar work which is shown in the Drawings or described in these Specifications.

If the Engineer instructs that the area of excavation should be partially or completely reinstated, this will be measured and paid for under the other Clauses of the Specifications. Any extra costs resulting from working on small areas will be deemed to be included in the other pay items.

Pay Item No. and Name		**Unit of Measurement**
6.06 (1)	Precast U-Ditch, DS-3	Linear Meter
6.06 (1)	Precast U-Ditch, DS-3A	Linear Meter
6.06 (2)	Precast U-Ditch, DS-3B	Linear Meter
6.06 (3)	Precast U-Ditch, DS-3B	Linear Meter
6.06 (4)	Precast U-Ditch, DS-3C	Linear Meter
6.06 (5)	Concrete Ditch, DS-7	Linear Meter
6.06 (6)	Concrete Ditch, DS-8	Linear Meter
6.06 (7)	Catch basin, DC-1	Each
6.06 (8)	Catch basin, DC-2	Each
6.06 (9)	Catch basin, DC-3	Each
6.06 (10)	Catch basin, DC-4	Each
6.06 (11)	Catch basin, DC-5	Each
6.06 (12)	Catch basin, DC-6	Each
6.06 (13)	Catch basin, DC-7	Each
6.06 (14)	Catch basin, DC-8	Each
6.06 (15)	Inlet Drain, Type DI-1	Each
6.06 (16)	Inlet Drain, Type DI-2	Each
6.06 (17)	Inlet Drain, Type DI-3	Each

6.06 (18)	Inlet Drain, Type DI-4	Each
6.06 (19)	Inlet Drain, Type DI-5	Each
6.06 (20)	Outlet Drain, Type DO-1	Each
6.06 (21)	Outlet Drain, Type DO-2	Each
6.06 (22)	Outlet Drain, Type DO-3	Each
6.06 (23)	Outlet Drain, Type DO-4	each
6.06 (24)	Outlet Drain, Type DO-5	Each

S6.07 Porous Drainage

S6.07 (1) General

(a) Description

(i) This work shall consist of winning, hauling, placing and compacting porous drainage materials required for the bedding of concrete drains or pipes or for subsurface drainage purposes or to prevent the washout or scour of soil fines by groundwater seepage. The work also includes the supply and placing of porous pipes (drain type) and soil filter fabrics where these materials are called for.

(ii) These materials are to be used against the rear faces of abutments, wing walls retaining walls, rip rap and gabion walls, and in the construction of pavement subsurface drains, concrete lined drains, culverts, sand blankets and chimney drain, for stabilization works, weep hole pockets, slope toe filters and other similar works, in accordance with these Specifications or as directed by the Engineer.

(b) Dimensional Tolerances

(i) Finished profiles for porous drainage granular fill shall not vary from the specified or approved profiles by more than 2 cm.

(ii) Finished levels and grades for pipe and concrete drain bedding material shall not vary from those specified or approved by more than 1 cm.

(iii) Dimensional tolerances for the shape, diameter, and length and wall thickness of porous pipes shall be as specified in AASHTO 178M/M178-17. The maximum gap between the ends of butt jointed porous pipes when laid shall be 5 mm.

(iv) The minimum fall in drains constructed using porous pipe, shall be 1: 1000.

(v) Foundation surfaces for porous drainage used in drainage blankets shall be smooth and regular with a uniform fall that will prevent ponding. The minimum grade for such surfaces shall be 1 : 200.

(c) Submittals

(i) At least 21 days prior to the proposed date of placing any materials, representative samples shall be submitted to the Engineer.

(ii) In the case of porous drainage or filter material, at least one 50 kg sample of each material proposed to be used shall be submitted together with 5 kg samples of the materials that will be upstream and downstream of water seeping through the porous drainage. The results of wash grading tests (AASHTO T11-05(2013) or SNI ASTM C117:2012) shall also be supplied for each sample submitted.

(iii) Samples of porous pipe or filter mesh proposed to be used shall be submitted together with the manufacturer's specifications and proof-test data.

(iv) The Contractor shall notify the Engineer in writing when the placing is complete and before the work is concealed by any other material or work. The notification of completion shall be accompanied by the results of density tests as specified in Sub-clause S6.07.(3).(a).(iii) and by survey records verifying that the dimensional tolerances given in Sub-clause S6.07.(1).(b) are met.

(d) Work Scheduling

(i) Clean granular porous drainage material shall be placed only immediately prior to the placing of the overlaying materials.

(ii) Granular Porous Drainage material in vertical slot drains in new embankment shall be placed in horizontal layers at the same time as the other embankment fill layers are laid.

S6.07 (2) Materials

(a) Porous Drainage or Filter Material

(i) Granular porous drainage or filter material shall be hard, durable and clean. It shall be free from organic material, clay balls and other deleterious substances, laterite or concretionary materials shall not be used.

(ii) The required particle grading of the material will depend on its intended function in the works and on the characteristics in the materials that will be upstream and downstream of water seeping through it, and also on the materials available. The grading required in each case will be as directed by the Engineer, whose assessment shall include ensuring that "Piping" (washing-out of fines) cannot occur from the upstream material into the porous backfill or from the porous backfill into the downstream material, in accordance with the following criteria :

(1) $$\frac{D_{15}\ (\text{filter})}{D_{85}\ (\text{soil})} < 5$$

(2) $$4 < \frac{D_{15}\text{ (filter)}}{D_{15}\text{ (soil)}} < 20$$

(3) $$\frac{D_{50}\text{ (filter)}}{D_{50}\text{ (soil)}} < 25$$

where D_{15}, D_{50} and D_{85} are the particle sizes from the grading curve at 15 %, 50 % and 85 %, respectively, finer by weight. The term "filter" refers to the coarser protecting material; the term "soil" refers to the finer material being protected from piping.

(iii) Porous backfill and filter materials shall carry seepage water without piping from embankment clay to 30 cm diameter rip rap which generally to be protected by a gravel, the gravel by a sand and the sand by a fine silty sand or plastic filter mesh.

(iv) In the case where there is no granular material downstream of the porous drainage material but rather weep holes or pipe perforations, selection and approval of the porous drainage material shall be based on the following criteria:

(1) D_{85} (backfill) > 0.2 x D (hole)

and

(2) D_{50} (backfill) > 0.04 x D (hole)

where D_{85} and D_{50} are as defined in this Sub-clause in (b) above and D (hole) is the inside diameter of the weep hole or pipe perforation.

(v) Any sized porous drainage may be safely used downstream of a plastic filter mesh. For example, in the case of pavement subsurface drains, the porous backfill may be coarse uniform cobbles if the trench sides are protected with the suitable plastic filter mesh, but generally shall be a fine sand, if there is no plastic filter mesh. Under no circumstances shall coconut palm fiber *(Ind: ijuk*) be used as a substitute for a specified plastic mesh.

(b) <u>Bedding Material for Pipes and Concrete Drains</u>

Granular material for use as bedding material shall be sand, sandy gravel or crushed rock and shall conform to the following requirements.

(i)	Maximum Particle Size (AASHTO T88-13 or SNI 3423:2008)	:	20 mm or less, but at least twice the maximum clear gap in any open jointed pipe
(ii)	Passing No. 200 Sieve (AASHTO T11-05(2013) or SNI ASTM C117:2012)	:	15% maximum
(iii)	Plasticity Index	:	6 maximum

(iv) Liquid Limit (AASHTO T89-13 or SNI 1967:2008) : 25 maximum

The material shall be well graded rather than uniform.

(c) Plastic Filter Mesh

Plastic filter mesh shall be a propriety woven synthetic geotextile fabric approved by the Engineer. Selection of the mesh opening size (MOS) for filter fabric shall be based on the particle size distribution curve for the soil upstream of the filter fabric in accordance with whichever is the smaller of:

(i) D_{85} (backfill) > 5 x D_{85} (soil)

and

(ii) D_{50} (backfill) > 25 x D_{50} (soil)

where, D_{85} and D_{50} are as defined in Sub-clause 6.07 (2).(a).(ii) above.

(d) Porous Pipes and Weep Hole Pipes

(i) Porous pipes for subsurface drainage shall be porous concrete or perforated PVC or corrugated perforated polyethylene drain type of approximately 100 mm inside diameter and comply with AASHTO M176M/M176-17, AASHTO M278-15 and ASTM F758-14(2019), and AASHTO M252-09(2012) respectively or other specification approved by the Engineer.

(ii) Pipes to be placed through concrete or mortared walls or linings as weep holes shall be 50 mm inside diameter and shall be of any material approved by the Engineer which is strong enough to resist being deformed during construction and setting of the mortar or concrete.

(e) Mortar

Mortar used for locking pipe joints shall be Cement Mortar in accordance with Clause S12.04 of these Specifications.

S6.07 (3) Placing Porous Drainage Material

(a) Placing Porous Drainage Material for Filter

(i) Before Porous Backfill shall be placed on any area, all unsuitable too soft or too hard material shall have been replaced in accordance with Sub-clause S4.03.(4) and S4.03.(1) of these Specifications.

(ii) Placing of Porous Backfill around pipes or drains or behind structures shall be performed systematically and as soon as possible following placing of the pipes or structure. A minimum period of 14 days before backfilling, however, should be allowed following the mortaring of pipe joints or the placing of structures.

(iii) The Porous Backfill shall be thoroughly compacted in layers not exceeding 15 cm compacted thickness to a density in excess of 95 % of the maximum dry density determined according to AASHTO T99-15 or SNI 1742:2008. Any approved method of compaction may be used which achieves the required density.

(iv) The adequacy of compaction shall be monitored by density tests in accordance with AASHTO T176-08(2013) or SNI 03-4428-1997, and if the tests show insufficient density has been obtained the Contractor shall apply additional compaction or otherwise remedy the work as directed by the Engineer. The frequency and position of testing shall be as directed by the Engineer

(v) Thin drainage blankets (less than 20 cm thick) of Porous Backfill which are to be covered with earth fill shall be only nominally compacted before the first layer of earth fill is placed on top. The earth fill layer shall then be heavily compact until the underlying layer of Porous Backfill has attained the specified density.

(vi) Until it is covered by other materials, Porous Drainage material shall be careful protected from disturbance by traffic or feet. Temporary wooden planks shall be laid over sand blankets to allow the passage of workmen and the first layer of over the porous material shall be carefully spread by hand methods to avoid co-mingling of the two materials,

(vii) Care shall be taken to ensure minimum contamination of the Porous Backfill material with the adjacent soil or fill, and where, in the opinion of the Engineer this is occurring, or is likely to occur, a form shall be used to separate the two materials during placing. The form shall be 3 mm thick steel sheet or similar and shall be gradually lifted as the backfilling work proceeds. The form shall be completely removed from the completed fill.

(b) Placing Bedding Material

(i) Trenches or foundation pits for pipe culverts, concrete drains, subsurface drains or other works requiring a bedding layer shall be excavated in accordance with Division 4 of these Specifications and a firm bed of uniform compaction prepared to the required grade less the required thickness of bedding material.

(ii) The thickness of the bedding for pipes shall be not less than 10 % of the diameter of the pipe nor less than 50 mm for any works,

(iii) Pipe bedding shall be shaped (using a semi-circular template of the same diameter as outside diameter of the pipe) to fit the underside of the pipe, so that it provides uniform support. When bell and spigot pipe is used, recesses shall also be dug to accommodate the bells.

(c) Placing Plastic Filter Mesh

Plastic filter mesh shall be installed in accordance with the procedures recommended by the manufacturer and as directed by the Engineer.

(d) Placing Porous Pipes

(i) Beds for porous pipes shall be prepared as above but using Porous Backfill as specified in Sub-clause S6.07.(2).(a) rather than Bedding Material as specified in Sub-clause S6.07.(2).(b)

(ii) The porous pipes shall be placed on the prepared bed and carefully positioned with respect to both alignment and grade. The pipes shall be butt jointed with a 1 to 5 mm gap left between pipes. The joints shall be wrapped with an approved filter fabric which will allow passage of water but not the porous backfill material. The upper half of each joint shall be further protected with a strip of tarred paper or similar non-perishable sheeting material. Each joint shall be locked in place, but not sealed, using a small amount of cement mortar on either side.

(iii) After the pipes have been laid, inspected and approved, porous backfill material shall be placed and compacted as specified in Sub-clause S6.07.(2).(a) above.

(e) Construction of Weep holes

(i) Where weep holes are required to be formed through a wall or other construction without the permanent incorporation in the works of a pipe or other forms the method of forming the weep holes shall be subject to the approval of the Engineer.

(ii) All non-durable forms shall be removed on completion of the structure

(iii) Weep holes shall be formed horizontally unless otherwise directed by the Engineer.

(iv) Pipes that are to be encased in concrete as weep holes, or as forms for weep holes, shall be held or braced rigidly during the concrete placement.

(v) Unless otherwise specified or directed by the Engineer, weep holes shall be spaced horizontally and vertically at intervals no greater than 2 meters and 1 meter respectively.

(vi) Where filter pockets are required to be formed at the back of weep holes the filter material shall extend into the bedding or backfill for a distance of at least 30 centimeters from the end of the hole in all directions, unless otherwise specified or directed by the Engineer.

S6.07 (4) Method of Measurement

(a) Measurement of Porous Drainage Material or Filter Material

(i) Fill shall only be classified and measured as Porous Backfill or Filter Material when used in locations or for purposes where Porous Backfill or Bedding or Filter Material of Filter Pockets or Drainage Blanket have been specified or otherwise approved in writing by the Engineer, and when the material has been accepted

by the Engineer as being suitable as Porous Drainage in terms of the relevant provisions of this Clause.

(ii) The quantity of Porous Backfill to be measured for payment shall be the number of cubic meter of the compacted material required to fill the specified or approved lines. Any material placed in excess of the approved theoretical volume shall be regarded as either Common Fill or Selected Fill, as directed by the Engineer, and shall not be measured under this Division irrespective of its material qualities.

(iii) All approved porous backfill used and accepted on the Contract, and which qualifies for measurement as above, shall be measured and paid for under this Clause.

(b) Measurement of Plastic Filter Mesh

The quantity of Plastic Filter Mesh to be measured for payment shall be the number of square meters of approved fabric actually installed in the works and accepted in place and to be paid Pay Item 4.12.(1) Geotextile for Subsurface Drainage (Class 2).

(c) Measurement of Porous Pipes

The quantity of Porous Pipe to be measured for payment shall be the number of linear meters of approved pipe actually installed in the works and accepted in place. No deduction in the measured length will be made for the gaps at the pipe joints.

(d) Weep Holes, Tarred Paper and Cement Mortar

Pipe used for forming weep holes, tarred paper or other sheeting used to wrap pipes and cement mortar used to seal joints between the pipe will not be measured for payment, the cost of these materials being deemed to be included in the bid price for Subsurface Drainage Works.

(e) Excavation for Porous Drainage Material, Filter Material

Except for Rock Excavation, no separate measurement for payment will be made for excavation for filling work, the cost of this work being deemed incidental to carry out the Porous Backfill or Filter Material and included in the prices bid for the various construction materials used.

(f) Excavation for Subsurface Drainage Works

The quantity of excavation for Subsurface Drainage Works shall be measured for payment in accordance with Division 4, Road Earthwork.

S6.07 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract Unit Price for the Pay Items listed below and included in the Bill of Quantities, which prices and payment shall be full compensation for all labor, material, equipment and incidentals required to complete satisfactorily the work prescribed in this Clause.

Pay Item No. and Name		**Unit of Measurement**
6.07.(1)	Porous Drainage or Filter Material	Cubic Meter

6.07 (2a)	Perforated Pipe for Subsurface Drainage Works, Dia.4 inch	Linear Meter
6.07 (2b)	Perforated Pipe for Subsurface Drainage Works, Dia.5 inch	Linear Meter
6.07 (2c)	Perforated Pipe for Subsurface Drainage Works, Dia.6 inch	Linear Meter
6.07 (2d)	Perforated Pipe for Subsurface Drainage Works, Dia.8 inch	Linear Meter

DIVISION 7 SUBGRADE

S7.01 Subgrade Preparation

S7.01 (1) Description

The subgrade shall be that part of the work which is prepared for the sub-base or, if there is no sub-base, the base of the pavement. It shall extend to the full width of the roadbed including the shoulders and spot widening or such limited areas as shown on the Drawings or as instructed by the Engineer.

For the purpose of payment, no differentiation is made between sub grade in cut or fills areas.

Work on subgrade preparation shall only be carried out immediately prior to laying the sub-base.

S7.01 (2) Construction

(a) Templates and Straightedges

The Contractor shall provide and use straightedges to check the accuracy of the work and to ensure adherence to the requirements of these Specifications.

When a 3 meter straightedge is laid on the surface parallel to and perpendicular to the center line, variation of compacted the surface sub grade from the lower edge of the straightedge shall not exceed 12 mm over 3 m.

(b) Prior Works

Culverts, drain pipes and any other minor structures below the subgrade level, including fully compacted backfill shall be completed before work is begun on the subgrade. Ditches, drains, outlets for drainage, and headwalls for culverts shall be in such operative condition as to ensure prompt and effective drainage and to avoid damage to the subgrade by surface water.

Any subgrade areas failing to meet the planned elevation due to settlement or any other cause, or which have become damaged since completion of earthwork, shall be removed, material replaced or added, recompacted and finished to the specified lines, grades and cross-sections as directed by the Engineer.

No work shall be started on the preparation of the subgrade before the prior works herein described have been approved by the Engineer.

(c) Degree of Compaction

All material down to a depth of 30 centimeters below the subgrade level shall be compacted to at least 100 percent of the maximum dry density as determined according to AASHTO T99-15 or SNI 1742:2008 within moisture content of - 3% to +1% of the optimum moisture content in laboratory testing.

(d) Subgrade in Earth Cut

When the subgrade is in earth cut it shall be formed to the correct transverse and longitudinal profiles as provided in Sub-clause S4.02 (3) but at a grade level higher than the final grade in order to allow for the effect of compaction. The soil shall be compacted with approved rollers and prior to compaction the moisture content shall be adjusted by watering with approved sprinkler trucks or by drying out, as may be required, in order that the degree of compaction specified in Sub-clause S7.01.(2).(c) may be attained.

If the natural characteristics of the soil are such that it is impossible to obtain the minimum of 6% CBR when compacted as specified in Sub-clause S7.01.(2).(c), the Engineer will specify remedial works with additional capping layer of Selected Borrow Material as shown in Table 7.01.(1) or instruct its removal.

Table 7.01.(1) Capping Layer of Subgrade Improvement

<table>
<tr><td rowspan="3">CBR of existing ground after compaction</td><td colspan="3">Flexible Pavement</td><td>Rigid Pavement</td></tr>
<tr><td colspan="4">Design Lane Traffic with Design Life of 40 years (millions CESA of exponent 5)</td></tr>
<tr><td>< 2</td><td>2 - 4</td><td>> 4</td><td rowspan="2">Soil Stabilization for Subgrade Improvement</td></tr>
<tr><td colspan="3">Minimum Thickness of Capping Layer (cm)</td></tr>
<tr><td>≥ 6</td><td colspan="3">Not required</td><td rowspan="5">15 cm of Soil Stabilization + 15 cm of Capping Layer</td></tr>
<tr><td>5</td><td>-</td><td>-</td><td>10</td></tr>
<tr><td>4</td><td>10</td><td>15</td><td>20</td></tr>
<tr><td>3</td><td>15</td><td>20</td><td>30</td></tr>
<tr><td>2.5</td><td>17.5</td><td>25</td><td>35</td></tr>
</table>

(e) Subgrade on Embankment

When the subgrade is to be formed on embankment, the material to be placed more than one layer in the upper part of the embankment down to a depth of 30 centimeters below the grade level shall meet the compaction requirements of Sub-clause S7.01.(2).(c). Rollers of approved size and type, accepted by the Engineer, shall be used for compaction, and the moisture content shall be properly adjusted in order to obtain the dry density specified in Sub-clause S7.01.(2).(c). Care shall be taken to use suitable material for the subgrade. If unsuitable material is placed, it shall be removed and replaced with suitable material by the Contractor without additional payment. The minimum CBR on embankment shall be 6%.

The Contractor shall be directed by the Engineer in all the phases of the subgrade preparation and he shall repeat any part of the work if necessary to attain the specified degree of compaction.

(f) Protection of Completed Work

Any part of the subgrade that has been completed shall be protected against drying out and cracking and any damage resulting from default of the Contractor shall be repaired as directed by the Engineer without additional payment.

(g) Traffic and Repairs

The Contractor shall be responsible for all the consequences of traffic being admitted to the subgrade, and he may prohibit such traffic if he has provided a detour or is operating half-width construction. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repair. The Contractor shall arrange for subgrade preparation and sub-base or base placing to follow each other closely.

The subgrade, when prepared too soon in relation to the laying of the sub-base, is liable to deteriorate, and in such case the Contractor shall repair, re-roll, or compact the subgrade as may be necessary to restore it to the state specified herein, without additional payment.

(h) Tolerances

(i) Final elevation after compaction shall not be more than 1 cm or less than 2 cm as required or approved

(ii) The entire final surface shall be fine and flat and shall have proper slope to ensure free flow of water surface.

S7.01 (3) Method of Measurement

The quantities to be paid for shall be the number of square meters of subgrade in cut or in fill, prepared as hereinbefore prescribed, tested and accepted. The area to be measured for payment will be limited to the sub-grade below sub-base or under the lean concrete on rigid pavement in areas of new pavement construction. Areas to be sodded or laid with interlocking concrete paving will not be measured for payment under this Division.

S7.01 (4) Basis of Payment

The quantities, determined as provided in Sub-clause S7.01.(3) shall be paid for at the pay item listed below. This payment shall be full compensation for furnishing all labor, equipment and material necessary to complete the work including scarifying, reworking, wetting or drying, compacting, proof rolling, shaping and finishing, maintenance and other incidental items of work prescribed in this Division.

Pay Item No. and Name		**Unit of Measurement**
7.01	Subgrade Preparation	Square Meter

DIVISION 8 AGGREGATE BASE AND CEMENT TREATED BASE

S8.01 Aggregate Base

S8.01 (1) General

(a) Description

This work shall consist of supplying and placing of untreated crushed stone materials between the subgrade and the concrete slab or bituminous base course, in accordance with these Specifications and in conformity with the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer.

(b) Dimensional Tolerances

(i) Dimensional tolerances for the prepared sub-grade and sub-base shall be in accordance with Sub-clauses S7.01 (2) (h) and S8.01 (3) (e) respectively.

(ii) The average thickness of Cement Treated Base shall not less than 1 cm of the design thickness as shown in the Drawings.

(iii) The finished surface of Cement Treated Base shall conform reasonably closely to the design grade and shall be not less than one centimeter below the design level at any point.

(iv) The finished surface of Cement Treated Base shall deviate by no more than 2 cm from a 3-meter-long straight edge placed on the surface parallel to the road center line or from a template placed transversely.

(v) The Contractor should note that poor surface shape of Cement Treated Base will lead to greater asphalt quantities being required in the overlay to meet the specified asphalt surface smoothness tolerances. Since Hot Asphalt Mixtures are paid for on the basis of design nominal dimensions rather than by weight, such additional asphalt quantities will represent a loss to the Contractor. The smoothest possible finish to the Cement Treated Base will therefore give the Contractor the best economic solution and also produce the best road.

S8.01 (2) Materials

(a) Material Sources

Aggregate Base and Drainage Layer material shall be selected from an source approved by the Engineer and stored in accordance with Clause S.1.03 “Storage of Materials” of these Specifications.

(b) Aggregate Base and Drainage Layer

The three different qualities in this Clause are specified as Aggregate Base Class A, Aggregate Base Class B and Drainage Layer. Generally, Aggregate Base Class A is base course quality for use in the layers

immediately below a bituminous surfacing, Aggregate Base Class B is for sub-base layers, and Drainage Layer is immediately below the wet lean concrete of rigid pavement.

(c) Coarse Aggregate Fraction

The coarse aggregate retained on the 4.75 mm sieve shall consist of hard, durable particles or fragments of rock and gravel. Material which breaks up when alternately wetted and dried shall not be used.

(d) Fine Aggregate Fraction

Fine aggregate passing the 4.75 mm sieve shall consist of natural or crushed sand and fine mineral particles.

(e) Required Material Properties

All Aggregate Base and Drainage Layer shall be free from organic matter and lumps of clay or other deleterious matter and after compaction shall conform to the grading requirements given in Table 8.01 (a) (using wet sieve testing) and to the properties given in Table 8.01 (b).

Table 8.01 (a) Aggregate Base and Drainage Layer Grading

Sieve Size		**Percent Passing by Weight**		
ASTM	(mm)	Class A	Class B	Drainage Layer
2”	50		100	
1 ½”	37.5	100	88 - 95	100
1”	25.0	79 – 85	70 - 85	71 - 87
¾”	19.0			58 - 74
½”	12.5			44 - 60
⅜”	9.50	44 – 58	30 - 65	34 - 50
No.4	4.75	29 – 44	25 - 55	19 - 31
No.8	2.36			8 - 16
No.10	2.0	17 – 30	15 – 40	
No.16	1.18			0 - 4
No.40	0.425	7 – 17	8 - 20	
No.200	0.075	2 – 8	2 - 8	

Table 8.01 (b) Aggregate Base and Drainage Layer Properties

PROPERTIES	**CLASS A**	**CLASS B**	**Drainage Layer**
Abrasion of Coarse Aggregate (AASHTO T96-15 or SNI 1742:2008)	0 - 40 %	0 - 40 %	0 - 40 %
Angularity, retained ⅜” (AASHTO T335-09(2013) or SNI 7619:2012)	95/90[1)]	55/50[2)]	80/75[3)]
Liquid Limit (AASHTO T89-13 or SNI 03-1967-1990)	0 - 25	0 - 35	

PROPERTIES	CLASS A	CLASS B	Drainage Layer
Plasticity Index (AASHTO T90-15 or SNI 1966:2008)	0 - 6	4 - 10	
Product Plasticity Index times Percentage Passing # 200	Max. 25	-	
Soft Fragments (AASHTO T112-00(2012) or SNI 4141:2015)	0 - 5 %	0 - 5 %	0 - 5 %
CBR at a density of 100 % of the maximum dry density after 4 days soaking (AASHTO T180-15 Method D or SNI 1743:2008)	min.90%	min.60%	
Ratio percent passing sieve No.200 and No.40	max.2/3	max.2/3	
Uniformity Coefficient : $C_u = D_{60}/D_{10}$			> 3.5

Note:

1) 95/90 denotes that 95% coarse aggregate has one or more fractured faces and 90% coarse aggregate has two or more fractured faces.
2) 55/50 denotes that 55% coarse aggregate has one or more fractured faces and 50% coarse aggregate has two or more fractured faces.
3) 80/75 denotes that 80% coarse aggregate has one or more fractured faces and 75% coarse aggregate has two or more fractured faces

(f) Blending of Aggregate Base and Drainage Layer Material

Blending of materials to meet the specified requirements shall be carried out in an approved crushing or blending plant, using suitable calibrated mechanical feeders providing a continuous flow of mix components in the correct proportions. Under no circumstances shall site mixing be used.

S8.01 (3) Construction

(a) Preparation of Sub-grade

(i) Where Aggregate Base is to be placed on an existing pavement or shoulder, all defects in the existing pavement or shoulder shall be rectified in accordance with Division 7 of this Specifications.

(ii) The area being prepared for laying the Aggregate Base and Drainage Layer Material shall be completed and the approval of the Engineer obtained for at least 100 m ahead of the placing of the base at all times. For short repair sections less than 100 meters in length, the entire area of formation shall be prepared and approved before placement of the base.

(iii) Where Aggregate Base is to be placed directly on an intact existing asphalt surfaced pavement, which in the opinion of the Engineer still in a good condition, scratching on the asphalt surface pavement will be needed to obtain better friction resistance.

(b) Spreading

(i) Aggregate Base and Drainage Layer shall be delivered to the road bed as a uniform mix and shall be spread at a moisture content within the range specified in Sub-clause 8.01.(3).(c). The moisture in the material shall be uniformly distributed throughout.

(ii) Each layer shall be spread in one operation at a uniform rate which will produce the required compacted thickness within the specified tolerances. Where more than one layer is to be placed the layers are to be as nearly equal in thickness as possible.

(iii) Aggregate Base and Drainage Layer shall be spread and shaped by any approved method which does not cause segregation of the fine and coarse aggregate particles. Segregated material shall be corrected or removed and replaced with graded material..

(iv) Aggregate Base shall be spread at least with an aggregate spreader. Specifically, Aggregate Base Class A shall be spread with paver to obtain a uniform thickness and evenness, and prevention of segregation.

(iv) The minimum dense layer thickness for any construction layer shall be twice the aggregate base maximum particle size. The maximum loose layer thickness shall not exceed 20 cm, except use special equipment approved by Engineer.

(v) Thickness Tolerances of compacted Base Course shall not exceed 10% and shall not less than 5% of design thickness accordance with Drawings

(vi) Aggregate Base shall not be placed, spread or compacted while rain is falling, and no compaction shall be carried out immediately after rain or otherwise when the moisture content of the material falls outside the range specified in Sub-clause S8.01. (3). (c)) (iii).

(vii) When a 3-meter straightedge is laid on the surface parallel to and perpendicular to the center line, variation of the surface aggregate base and drainage layer course from the lower edge of the straightedge shall not exceed 8 mm over 3 m.

(c) Compaction

(i) Immediately following final mixing and shaping, each layer shall be thoroughly compacted with suitable and adequate compaction equipment approved by the Engineer to a density of at least 100 % of the maximum modified dry density as determined by AASHTO T180-15, Method D or SNI 1743:2008. Compaction of the Drainage Layer shall be carried out about six passing with a vibratory roller of 10 tons or as instructed by the Engineer.

(ii) The Engineer may direct that pneumatic tired rollers be used for the final surface compaction, if static steel wheeled rollers are considered likely to cause excessive breakdown or degradation of the aggregate base.

(iii) Compaction shall be carried out only when the moisture content of the material is within the range of 3% less than optimum moisture content to 1% more than optimum moisture content, where the optimum moisture content is defined by the maximum modified dry density determined by AASHTO T180-15, Method D or SNI 1743:2008.

(iv) Rolling operations shall begin along the edges and progress gradually towards the center, in a longitudinal direction. On super-elevated sections rolling shall begin at the low side and progress towards the high side. The rolling operation shall continue until all roller marks are eliminated and the layer is uniformly compacted.

(v) Material along curbs, walls, and at other places not accessible to the roller shall be compacted using approved mechanical tampers or compactors.

(d) Testing

(i) The amount of supporting test data required for initial approval of the quality of the material will be as directed by the Engineer but will include all the tests specified in Sub-clause 8.01.(2)(e) on at least three representative samples from the proposed material source, selected to represent the range of material quality likely to be obtained from the source.

(ii) Following approval of the quality of a proposed Aggregate Base and Drainage Layer material, the full range of material quality tests performed will be repeated subsequently, at the discretion of the Engineer, in the event of observed changes in the material or in its source or to its method of production.

(iii) A program of routine material quality control testing will be carried out to control variability of the material being brought on site. The extent of the testing shall be directed by the Engineer but for every 1000 cubic meters of material produced the testing shall include no less than five (5) plasticity index tests, five (5) particle grading tests, and one (1) maximum dry density determined using AASHTO T180-15, Method D or SNI 1743:2008. CBR tests shall be carried out from time to time as directed by the Engineer.

(iv) The density and moisture content of the compacted aggregate base material shall be routinely determined using AASHTO T191-14 or SNI 2828:2011 and/or Light Weight Deflectometer (LWD) determined using ASTM E2583-07(2015) or Pd 03-2016-B which equipped with a relationship between deflection and density, if approved by the Engineer. The test shall be made to the full depth of the layer at locations directed by the Engineer, but not more than 200 m apart.

(e) Dimension and Elevation Tolerance

(i) Final surface layer Aggregate Base and Drainage Layer shall comply with Table 8.01.(c) with the following tolerances:

Table 8.01.(c) Surface Level Tolerances relative to Design Level

Aggregate Base Material and Drainage Layer	Surface Level Tolerances relative to Design Level
Aggregate Base Class B used as Sub-base (Top Surface of Sub-base only)	+ 0 cm - 2 cm
Aggregate Base Class A Surfaces for Prime Coat or Surface Treatment (Pavement or Shoulder)	+ 1 cm - 1 cm
Drainage Layer	+ 1.5 cm - 1.5 cm

Note:
Aggregate Base Class A, B and Drainage Layer are defined in Sub-clause S8.01 (2) (b).

(ii) The surfaces of all construction Aggregate Base layers shall not have any irregularities which can hold moisture and the camber of all such surfaces shall comply with that shown on the Drawings.

(iii) The minimum total thickness of Aggregate Base shall not be less than the required thickness less one centimeter.

(iv) The minimum total thickness of Aggregate Base Class A or Drainage Layer shall not be less than the required thickness less one centimeter.

(v) For Aggregate Base Class A surfaces for priming or surface treatment, when all loose material is removed by hard brooming, the maximum permitted deviation in surface smoothness shall be one centimeter from a straight edge 3 m long, laid parallel or transverse to the road center line.

S8.01 (4) Method of Measurement

The quantities to be paid for shall be the number of cubic meters of aggregate base course and drainage layer, as laid according to the Drawings or as instructed by the Engineer, compacted, tested and accepted by the Engineer. The quantity to be paid for will be based on the nominal dimensions and shape shown on the plans and the actual length measured along the centerline of survey. During the performance of the work, the thickness of each course shall be accurately controlled to attain the required thickness after compaction.

S8.01 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price per cubic meter for aggregate base and drainage layer as listed below. The payment shall be full compensation for furnishing all materials, hauling, placing, compacting, sprinkling, proof rolling, finishing and shaping, and for all labor, equipment tools and other incidentals necessary to complete the work as specified herein.

Pay Item No. and Name		**Unit of Measurement**
8.01 (1)	Aggregate Base Class A	Cubic Meter
8.01 (2)	Aggregate Base Class B	Cubic Meter

8.01 (3)	Drainage Layer	Cubic Meter

S8.02 Cement Treated Base

S8.02 (1) Description

This work shall consist of providing a cement treated base course on a previously prepared surface including the supplying, mixing, hauling, spreading, shaping, compacting, curing and finishing of the material, all in accordance with the requirements of these Specifications and in conformity with the dimensions and typical cross sections shown on the Drawings and to the lines and grades established by the Engineer.

S8.02 (2) Materials

(a) Portland Cement

The cement to be used for Cement Treated Base shall be Ordinary Portland Cement Type I complying with the requirements of AASHTO M85-15 or SNI 15-2049-2004 or PPC (Portland Pozzolan Cement) complying with the requirements of ASTM C595/C595M-18 or SNI 0302: 2014 is able to be used if permitted in writing by the Engineer.

The Engineer may call for quality tests on each consignment of cement on arrival on site, and also at any time after it has been stored on site prior to use, to ascertain if the cement has deteriorated in any manner during transit or storage. No cement will be allowed to be used until it has been accepted by the Engineer.

All cement to be used in the Works shall be stored on site in accordance with the provisions of Clause S10.01.(1).(e) of these Specifications, and shall be inventoried on arrival under supervision of the Engineer. The inventory records shall be signed in confirmation of their correctness by both the Contractor and the Engineer. The amount of cement placed in the Preliminary Field Trials or in the Works shall also be recorded in detail and no cement shall be placed except when the Engineer or his representative is on site to supervise and record the laying. Both the Contractor and the Engineer will sign the daily record showing the amount of cement actually placed in the Works.

(b) Water

The requirements of Sub-clause S10.01.(2).(d) shall govern

(c) Aggregate

The aggregate material shall be Aggregate Base Class A in accordance with the provisions of Sub-clause S8.02.(2) of these Specifications.

S8.03 (3) Mixes

(a) General Composition of the Mixture

The Cement Treated Base mixture shall be comprised of approved aggregate, cement and moisture. The cement content to be used shall be

fixed by the Engineer on the basis of laboratory test data and Preliminary Field Trials.

(b) Laboratory Mix Design

The contractor shall carry out the mix design to determine:

(i) The unconfined compressive strength.

(ii) The minimum cement content.

(iii) The optimum moisture content, and

(iv) The maximum dry density.

(c) Characteristic of the Cement Treated Base

Determination of Laboratory density shall be determined in accordance AASHTO T180-15 or SNI 1743: 2008 method D by substituting the particle of aggregate above 19 mm (¾"). Furthermore, the proportion of aggregates, water and cement for compressive strength testing is based on the test results of mixture with maximum dry density and optimum moisture content.

The strength of the mixture is based on the compressive strength at 7 days of cylinder specimens with diameter of 150 mm and height of 300 mm height at 7 days, 45 – 55 kg/cm^2.

Cylinder specimens using materials prepared in accordance with AASHTO T180-15 or SNI 1743: 2008 method D, to be compacted in 5 layers, each layer to be compacted with 145 blows (see the note below) with a hammer weight of 4.5 kg and falling height of 45 cm. Furthermore, the compressive strength test of cylindrical specimens shall be in accordance with ASTM C873/C873M-15 or SNI 1974: 2011.

Note:

(1) Compaction of 145 blows in each layer based on the calculation of the volume ratio of cylinder (diameter of 15 cm and height of 30 cm) and the mold (diameter of 152 mm and height of 116 mm) multiplied by 56 blows.

(2) Estimate of cement content of Cement Treated Base is 3-5%. The required cement content shall be determined based on the results of the job mix design.

(3) During the implementation of Cement treated Base, a minimum of 4 cylinder specimens shall be provided for testing.

S8.02 (4) Construction

(a) Surface Preparation

Aggregate Base Class B as sub-base preparation work shall be carried out in accordance with this Clause and the provisions of Clause S8.01 of these Specifications to the grades, lines and dimensions shown on the Drawings or directed by the Engineer.

On completion of compaction and before commencing the next operation, the surface of the sub-base shall comply with the surface to tolerances specified in Sub-clause S8.01.(3).(e) of the Specifications.

Prior to laying each section of Cement Treated Base, the prepared compacted sub-base shall be cleaned of all dust and other deleterious

materials by air jesting or other approved means, and shall be moistened if necessary, as directed by the Engineer.

(b) Spreading of Cement

The cement shall be uniformly spread at a controlled mass by area rate (kg/m^2) across the pavement. The rate of spreading shall be such as to provide the specified cement content in the compacted material. The spreader shall be equipped with gates to allow variable widths of cements to be deposited onto the pavement surface. The spreader hopper shall be equipped with load cells or other means to permit accurate measurement of cement usage. Unless otherwise approved by the Engineer the cement shall be spread in two passes over each point on the pavement.

The contractor shall record the area of spread, tonnage of cement used for each cement distribution run, and shall take tray samples at least once per day in the presence of the Engineer.

The construction tolerance for the cement spread rate shall not exceed 10% of the Design Mix value.

Once the cement has been spread, the only traffic that may travel over the area to be mixed, shall be construction plant employed for the work.

Cement shall not be spread when the wind speed exceeds 25 km/hour, if rain is imminent or if the cement is likely to be affected by surface water flows. Cement shall not be spread unless the mixer is ready to work. All cement that has been spread shall be incorporated into the pavement as soon as possible after spreading and not later than the same day as it is spread. Mixed material that is left overnight without compaction shall be removed or shall be reworked to the satisfaction of the Engineer and fresh cement shall be added sufficient to achieve a UCS for 7 days of 45 - 55 kg/cm^2 in accordance with AASHTO T22-14 or SNI 1974:2011.

(c) Mixing

The total specified quantity of cement required for the full depth of the treatment shall be uniformly spread over the surface to be treated prior to the mixing process, or incorporated in the pavement by an approved controlled mechanical feed in one operation in a manner satisfactory to the Engineer. No equipment except that used in spreading and mixing will be allowed to pass over the freshly spread cement until mixing operations are complete.

Water shall be added during the mixing process by means of a controlled pressure feed distributor located inside the mixing chamber. The moisture content shall be uniformly distributed through the pavement material and shall be within the range approved by the Engineer to ensure that full compaction can be achieved.

The mixing equipment shall be so operated that the mixed depth of CTB shall be to the full design depth of the stabilized layer. Mixing shall be by a self-propelled rotary mixer or reclaimer/mixer having a mixing width of not less than 1.8 meters and a mixing depth of at least 300 mm. Mixing

by other equipment including graders, profilers, rotary hoes and other agricultural type implements shall not be approved.

Two passes of the mixer shall be provided to obtain an even mixture of the cement throughout the pavement depth.

Mixing shall proceed in lanes working generally from the low to the high side of the pavement, with sufficient overlap to ensure uniformity and without intervening lanes of unmixed material. The stabilized layer shall be 0.5 meters wider than the pavement seal on each side of the pavement

(d) Moisture Content

The moisture content of the material immediately after mixing shall be 80% to 110% of the moisture content specified by the Engineer and not greater than the optimum moisture content. If no value has been specified by the Engineer, the moisture content shall be 70% to 100% of the laboratory optimum.

(e) Compaction

Compaction of the material in the pavement shall commence and shall complete within 30 minutes and 60 minutes of the cement first coming in contact with the soil respectively.

The compaction achieved, as determined by tests of the insitu material, shall not be less than 98% of the maximum dry density.

Compaction shall be by a vibratory sheep foot roller having a minimum static mass as shown below and a preferred pad height of at least 125mm.

Dense Thickness of CTB (cm)	Static Weight of Vibratory Sheep Foot Roller Minimum (ton)
≤ 20	13
25	19
30	25

(f) Curing

The mixed CTB shall be protected from moisture loss for a period of 4 days or until a further pavement layer is applied. Curing may be attained by:

(i) keeping the pavement continuously damp by means of water spray

(ii) tack coat application in accordance with Clause S9.05 Specifications of within 24 hours of the finishing operations

S8.02 (5) Field Quality Control and Testing

(a) General

The Contractor shall provide a site laboratory and all necessary equipment to carry out compaction control testing. Testing procedures and frequency for Mix Design and quality control inclusive cement addition, shape, depth, moisture content, surface tolerances and other shall be included in the contractors Quality Plan.

(b) Spread Rate

The cement spread rate shall be verified at least twice per day, or as directed or approved by the Engineer.

(c) Depth

The depth of mixture shall be verified by measuring the depth of "cutting" adjacent to an existing pavement material in at least two locations within the lot and measured to the nearest 5 mm. The construction tolerance for the mixed and compacted depth shall be ± 20 mm.

(d) Density

The density of mixture shall be verified by testing in at least two locations per day in accordance with AASHTO T191-14 or SNI 2828:2011 (by the sand cone method). For layers deeper than 200 mm there shall be two tests for each location comprising the top 200 mm and the bottom 150 mm.

(e) Other Tests

There shall be at least two Unconfined Compressive Strength (UCS) and moisture content tests per day. There shall be no separate payment for tests.

(f) Acceptance/Rejection Criteria

Where the cement addition, compaction, shape or mixture depth does not meet the specified requirements, at the discreation of the Engineer, this work may be accepted without any payment, accepted by strengthening with overlay, or the Contractor shall rework of the affected area.

S8.02 (6) Method of Measurement

The quantity of CTB to be measured for payment shall be the number of cubic meters of required work completed and accepted work based on the specified plan dimensions and the accepted average thickness. The average thickness (higher or lower than design thickness as shown in the Drawings) shall not be less than the design thickness.

S8.01.(7) Basis of Payment

The quantities of cement treated base, determined as provided above, shall be paid for at the Contract Price per unit of measurement, for the Pay Items shown below and in the Bill of Quantities. The rates shall include for all materials, labour, plant, tools, testing and other work incidental to satisfactory completion of the work.

Pay Item No. and Name		**Unit of Measurement**
8.02	Cement Treated Base	Cubic Meter

DIVISION 9 PAVEMENTS

S9.01 Bituminous Pavements - General

S9.01 (1) Description

The work described in this clause covers the treatment and repair of existing bituminous pavements together with the supplying and laying of new construction to form the completed pavements as shown on the Drawings and as instructed by the Engineer.

The extent and treatment of existing pavement to be incorporated in the new works will be instructed by the Engineer following a survey of cross-sections prepared by the Contractor. The Contractor shall cooperate in the survey and will be required to prepare additional cross-sections or levels to supplement those used in the earthworks calculations and provide experienced staff to assist the Engineer in his work.

S9.01 (2) Equipment

Unless specified elsewhere or approved by the Engineer, equipment used in the work for bituminous pavements shall comply with the following specifications.

(a) Bitumen Distributor

The distributor shall be self-powered and have pneumatic tires of such width and number that the load produced on the road surface shall not exceed 100 kilograms per centimeter of tire width. It shall be so designed, equipped, maintained, and operated that bituminous materials at even heat may be applied uniformly on variable width of surface up to 5 meters at readily determined and controlled rates of from 0.2 to 9.0 liter per square meter with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.1 liter per square meter.

Distributor equipment shall include an instrument for measuring the speed of travel accurately at low speeds, the rate of flow of asphaltic material through nozzles, the temperature of the contents of the tank, and the pressure. These instruments shall be so located that the operator can easily read them whilst operating the distributor.

The distributor shall be equipped with a separate power unit for the pump, and full circulation spray bars which shall be adjustable laterally and vertically. The spray bars on the distributor shall be controlled by a man riding at the rear of the distributor in such a position that the operation of all sprays is in his full view. The distributor shall incorporate one or more hand operated lances, but these shall only be used in areas inaccessible to the main spray bars.

(b) Bitumen Heater

This shall be of the oil jacket type or else incorporate an automatic agitator to prevent local overheating of the material. The heater should incorporate a thermometer.

(c) Bituminous Mixing Plant (Asphalt Mixing Plant)

The Bituminous Mixing Plant shall:

(i) has a valid operation certificate from Ministry of Public Work and Housing, and calibration certificate from - Metrology Office for the asphalt, aggregate and filler scales, which appointed by the Engineer. If the opinion of the Engineer, Asphalt Mixing Plant or scales are in bad condition, the Asphalt Mixing Plant or scales shall be recalibrated even the certificate is not yet expire;

(ii) be a batch mix plant and shall have a capacity sufficient to supply the finisher on the road continuously when spreading the asphaltic mix at normal speed and required thickness;

(iii) be so designed, coordinated and operated as to produce a mixture within the job mix formula (JMF) tolerances;

(iv) be installed in an area approved by the Engineer which is sufficiently far from residential areas to minimize disturbance and complaints from local people;

(v) be provided with a dust collector, comprising dry cyclone and wet cyclone system or bag house to ensure that emissions remain below required levels. If one of these systems is damaged or not functioning, the mixing plant shall not be operated;

(vi) have a minimum single pug mill capacity of 800 kg (as origin manufacture) and equipped with the weighing computerized system;

(vii) if used for the manufacture of modified asphalt mixes shall be equipped with automated thermostatic temperature controls capable of maintaining a mix temperature of 175ºC. If used the gas fuel heater (dryer) shall be equipped with a temperature control device (regulator) to maintain temperature constantly;

(viii) if used for the manufacture of AC-Base, have not fewer than five cold feed bins and for other bituminous mix use minimum four cold bins;

(ix) be of a well proven design, equipped with all necessary features;

(x) fuel used to heat the aggregate and asphalt shall be high speed diesel oil with maximum specific gravity of 860 kg/m^3 or kerosene or LNG (*Liquefied Natural Gas*) or coal gas. The coal used in the gasification process shall be min.5.500 K.Cal/kg;

(xi) aggregate supplied from hot bin or dryer shall not contain of soot and or not burned oil residual; and

(xii) the overall operating system shall be computerized, starting from the cold bin, hot bin control, mixing time, mixing weighing up to production control and digital recording of each quantity of each material until hot mix is produced.

(d) Bituminous Storage Tank

Tanks for storage of bituminous binder shall be equipped for heating the binder under effective and positive control at all times to a temperature within the range specified. The heating shall be accomplished by steam coils, electricity, or other means such that no flame shall come in contact with the heating tank. Each tank shall be fitted with a thermometer located so that the tank temperature can be easily read. A valve shall be positioned in the outlet pipe from each tank for sampling.

The circulating system for the bituminous binder shall be of adequate size to ensure proper and continuous circulation during the entire operating period. Suitable means shall be provided, either by steam jackets or other insulation, for maintaining the specified temperature of the bituminous binder throughout the circulation system.

The total storage of the tanks shall be not less than the quantity required for two days production. At least two equal capacity tanks shall be provided. The tanks shall be so connected to the circulatory system that each tank can be separately isolated without interference to the circulation of bituminous binder to the mixer.

(e) Hot Bin Screen:

Hot bin screen sizes shall be provided in accordance with that are appropriate for the asphalt mixtures required for the project. (Refer to Table 9.07(3))

(f) Control of Mixing Time:

The plant shall be equipped with a positive means to govern the time of mixing. Once agreed, this shall not be change without the Engineer's written approval.

(g) Weighing Bridge and Weighing House:

A weighing bridge and weighing house shall be provided for the weighing of trucks loaded with material ready for delivery to Site. The scales shall comply with the requirements for Plant Scales described above.

(h) Filler Storage and Handling:

A filler silo or weatherproof filler storage shed and elevator, and weigh batch filler delivery system shall be provided

(i) Safety Requirements:

(i) Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations. Accessibility to the top of truck bodies shall be provided by means of a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. To facilitate handling scale calibration equipment, sampling equipment, etc, a hoist or pulley system shall be provided to raise or lower the equipment from the ground to platform or vice versa. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and

protected.

(ii) Ample and unobstructed passage shall be maintained at all times in and around the truck loading space. This space shall be kept free from drippings from the mixing platform.

(j) Hauling Equipment

(i) Trucks for hauling bituminous mixture shall have tight, clean and smooth metal beds that have been sprayed with a minimum amount of soapy water, or lime solution to prevent the mixture from adhering to the beds. Use of diesel fuel or other petroleum products for this purpose shall not be allowed. Each load shall be covered with canvas or other suitable material of adequate size as to protect the mixture from the weather and the oxidation process. The truck rear body overhang sand tail gate shall be so arranged that the whole of the asphalt mixture can be discharged to the asphalt paver hopper without interfering with the smooth operation of the asphalt paver and while the truck remains engaged with the asphalt finisher. Trucks fitted with oversize bodies shall not be permitted. Overloading of asphalt trucks shall not be permitted.

(ii) Any truck causing excessive segregation of material, or that shows oil leaks in detrimental amounts, that causes undue delays, or that the Engineer's deems to be unsatisfactory shall, upon direction of the Engineer, be removed from the work until such defects have been corrected.

(iii) The mixture shall be delivered on the road at the specified temperature, truck beds shall be insulated, and all covers shall be securely fastened.

(iv) There shall be sufficient trucks hauling asphalt and they shall be so organized as to ensure that the pavers can operate continuously, at the approved speed.

(v) Paving on any section of the works shall not begin until there are at least three trucks waiting to unload into the pavers. The paver operating speed is low enough that the number of trucks in use for haulage of asphalt, on each day, can keep the pavers moving continuously. If this is impossible to achieve, the Engineer shall only allow the pavers to restart, after a stoppage, when there are at least three asphalt trucks waiting to unload. This is normal good practice and no delays to paving caused by the Contractor's failure to maintain an adequate supply of mix material to the pavers shall be accepted as a cause for any claim for extra payment or time.

(k) Spreading Finishing Equipment

(i) The equipment for spreading and finishing shall be approved mechanical, self-powered pavers, capable of spreading and finishing the mixture true to the line, grade, and cross section required.

(ii) The pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. They shall be equipped with quick and efficient steering devices and shall have reverse as well as forward gears. The hoppers shall have wings that can be folded in at the end of each truck load of asphalt to prevent retention of cooled material.

(iii) The pavers shall be equipped with electronic and/or mechanical level control devices such as leveling beams, line and joint matching shoes and cross fall devices, when necessary to maintain the trueness of grade and to form the edges of the pavement to true lines without the use of stationary side forms. A spirit level cross fall device shall be mandatory. Other level control device requirements may be nominated in the Instructions to Bidders for each contract.

(iv) Pavers shall be equipped with a screed, of either the tamping or vibrating type, and devices for heating the screed to the temperature required for the laying of the mixture without pulling or marring.

(v) The term "screed" refers to the standard floating mechanism connected by side arms, to pivot points mounted on the paver tractor unit forward of the rear wheels and designed to produce a level, even, smooth textured surface without tearing, shoving or gouging.

(vi) If, during construction, it is found that the spreading and finishing equipment in operation leaves tracks, indented areas, segregation or other objectionable irregularities that cannot satisfactorily corrected by modification to the operating procedures, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.

(l) Compacting Equipment

(i) With each paver, at least two tandem steel wheeled rollers and one pneumatic tired roller shall be required. At least one additional pneumatic tired roller shall be provided for each 40 ton per hour of production capacity or part thereof exceeding 40 ton per hour. All rollers shall be self-propelled.

(ii) Pneumatic tired rollers shall be of an approved type having not less than nine wheels with smooth tread compaction tires of equal size and construction capable of operating at an inflation pressure of 6 - 6.5 kg per square centimeter (85 - 90 pounds per square inch) with the same ply of tires. Wheels shall be equally spaced along both axle lines and arranged so that tires on one axle line track midway between those on the other axle with an overlap. Each tire shall be kept inflated to the specified operating pressure such that the pressure difference between any two tires shall not exceed 0.35 kg per square centimeter (5 pounds per square inch). Means shall

be provided for checking and adjusting the tire pressures on the job at all times. For each size and type of tire used the Contractor shall supply to the Engineer charts or tabulations showing the relationship between wheel load, inflation pressure, tire contact pressure, width and area. Each roller shall be equipped with means of adjusting its total weight by ballasting so that the load per wheel width can be varied from 300 - 600 kilograms per 0.1 meter. In operation the tire inflation pressure and the wheel load shall be adjusted, as required by the Engineer, to meet the requirements of each particular application. In general, the compaction of any course with a pneumatic tired roller shall be accomplished with contact pressures as high as the material will support.

(iii) Self-propelled steel wheeled rollers may be of two types:

(a) Tandem static rollers

(b) Twin drum vibratory rollers

(iv) Static rollers shall have a minimum static weight of not less than 8 tons. Twin drum vibratory rollers shall have a static weight of not less than 6 tons. The rollers shall be free of flat areas, dents, openings or projections which will mar the surface of the pavement.

(v) In the laying trial, for approval of the Job Mix Formula (JMF), the Contractor will have demonstrated to the Engineer's satisfaction the combination of roller types he shall use to compact each mixture satisfactory. He shall continue to keep available and use the approved combination of rollers for each mixture. No alteration shall be allowed unless the Contractor proves to the Engineer that the new combination of rollers he proposes to use is at least as effective as that already approved.

(m) <u>Other Equipment's</u>

All necessary field equipment shall be provided including but not limited to:

- Petrol driven vibrating plate.
- Vibratory Roller, 600 Kg.
- Straight edge 4 meters
- Thermometer (dial type) 300 °C (minimum three units).
- Compressor and jack hammers
- Water pass mounted on 4 meters straight edge and adjustable to read 3% or other cross falls and super-elevations of 0% - 6%,
- Diamond or fiber power saw
- Rotary broom
- Calibrated asphalt depth gauge
- Tire pressure gauge

S9.01 (3) General Requirement

Unless specified elsewhere or approved by the Engineer, all work utilizing new bituminous material shall comply with the following for the purposes of construction and measurement.

(a) Weather

Bituminous material shall not be laid in rain or in foggy weather and the surface being covered shall be clean and dry. Bituminous plant mix shall not be placed when weather conditions prevent the proper handling or finishing of the material.

(b) Protection of Existing Work

Constructional plant used on pavements under construction shall be suitable in relation to the material, condition and thickness of the courses it traverses so that damage is not caused to the sub-grade or the pavement courses already constructed. Bituminous material shall be kept clean and uncontaminated for so long as it remains uncovered by succeeding layers or surface treatment. The only traffic permitted access to bituminous material shall be that engaged in laying and compacting the next course.

At his own risk, the Contractor may allow traffic to use the AC Binder Course or AC Base Course but this will be subject to the Engineer's approval and he may require the Contractor at his own expense, to seal or otherwise protect the binder course. Should any bituminous material become contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Engineer and if this proves impractical, he shall remove and replace the layer at his own expense.

Before undertaking any bituminous spraying, the surfaces of structures, curbs, trees, etc., adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred.

(c) Layers of Bituminous Courses

A bituminous pavement shall be laid so that the compacted thickness of each layer does not exceed 2.5 times the minimum nominal thickness as required in Sub-clause S9.07.(3).(h). Where any course of material exceeds this thickness, it shall be laid in 2 or more layers of equal thickness.

(d) Measurement

When payment is made by weight for any pay item this will be calculated by using load delivery tickets for material incorporated in the permanent works in accordance with the Drawings and these Specifications. The weight of bituminous material shall be evidenced by machine stamped load delivery tickets which shall identify the hauling unit (truck) for which it was issued, together with the time of issue. The accuracy of the scales shall be checked before the start of the works and in every subsequent month the actual date of checking is to be chosen randomly.

For purpose of checking, each truck will bear an identification number painted on the sides of the truck, of such size as to be easily read by the Engineer's representatives or checkers.

Payment will only be made for material incorporated in the permanent works in accordance with the detailed drawings and the Engineer's instructions. The Contractor should schedule and carry out his work in such a way as to eliminate waste. The Engineer will deduct from the certified weight-tickets for any material laid outside the dimensions shown on the drawings or otherwise wasted due to the Contractor's method of working.

(e) Overlay

When the contract covers for the overlay of existing pavement, any regulating or levelling required shall be carried out using the material determined in the Drawing or instructed by Engineer. All remedial works to the pavement shall be executed before commencement of overlay operations.

(f) Finished Work Samples

Plant-Mix: The Contractor shall cut full depth samples as directed, from the finished course, for testing by the Engineer. Samples shall be neatly cut by a saw, core drill, or other approved equipment.

Each sample shall be one slab of at least 15 cm by 15 cm, or a number of cores, each with a minimum 10 cm diameter totaling at least 230 cubic cm. At least one, but not more than three samples shall be taken for each full day's operations. The Contractor shall supply and finish new material to backfill voids left by sampling. Extra samples will be taken whenever a substantial change has been approved and made in the job-mix formula, or when the Engineer directs that more samples be taken.

Bituminous Spray: To check the rate of bituminous material actually applied, sheets of building paper 50 cm by 50 cm previously weighed shall be laid on the surface to be treated and weighed again after application of the coat. The Contractor will supply the material for this check and will re-spray the areas from which the paper is lifted.

Based on the results of the above checks and subsequent laboratory analysis, the Engineer may instruct the removal and replacement at the Contractor's expense, of any material which does not fully comply with these Specifications. The Engineer may also instruct an additional coat of material or removal of excess material and/or may reduce the quantity of material approved for payment.

S9.02 Scarify Pavement

S9.02 (1) Description

This work shall consist of the removal of the upper layer or layers of an existing asphalt pavement with or without cold milling machine where this is necessary to allow resurfacing or to allow formation of a joint between existing and new work.

Scarifying necessary solely because of the Contractor's method of working will not be measured for payment.

S9.02 (2) Construction

The work shall be done by machine or by hand in such a manner that the area scarified does not exceed that instructed by the Engineer. Any damage to asphalt or curb designated by the Engineer to remain will be made good to the Engineer's satisfaction at the Contractor's own expense. All material removed shall be stockpiled on the site for use of the Employer, or otherwise disposed of as directed by the Engineer.

S9.02 (3) Method of Measurement

The quantity measured for payment will be the number of square meters of existing asphalt scarified in accordance with the Engineer's instructions. Where the Engineer orders the removal of more than one layer in separate operations, each layer removed will be measured and paid for separately. Where the Engineer instructs that the full depth of existing asphalt shall be removed, the work shall conform to the requirements of Clause S9.02 of these Specifications for removal, measurement and payment.

S9.02 (4) Basis of Payment

The work measured as provided above shall be paid for at the Contract price per unit of measurement for the pay item below. The Contract unit price will be full compensation for furnishing all labor, tools, equipment and incidentals necessary to do the work as directed by the Engineer, including removal and disposal of all the resulting material.

Pay Item No. and Name		**Unit of Measurement**
9.02 (1)	Scarify existing Asphalt Pavement with Cold Milling Machine	Square Meter
9.02 (2)	Scarify existing Asphalt Pavement without Cold Milling Machine	Square Meter

S9.03 Patching of Existing Pavements

S9.03 (1) Description

This work will consist of removal and replacement of damaged existing pavement in localized areas. The Engineer will designate the areas of pavement to be so treated and all work shall be carried out as specified below and will be paid for on the basis of the number of square meters so treated.

S9.03 (2) Material

All material and work furnished under this pay item shall comply with the requirements of the following Clauses and all compaction equipment may be varied to suit the size of the area being treated:

- Subgrade preparation : Clause S7.01
- Aggregate base : Clause S8.01
- Scarify existing asphalt pavement : Clause S9.02
- Prime : Clause S9.04
- Tack coat : Clause S9.05
- Asphalt concrete : Clause S9.07
- Asphalt cement : Clause S9.07

S9.03 (3) Construction

The area to be treated shall be marked on the surface, and the existing pavement and sub-grade removed to a depth of 50 cm. Pavement to remain shall be cut to form a vertical face and the edges of the excavation shall be straight and in neat lines. After preparation of the subgrade in accordance with Sub-clause S7.01.(2).(d), 30 cm of the aggregate base as used for new construction shall be laid in accordance with Clause S8.01. The aggregate base shall then be primed in accordance with Clause S9.04 and 20 cm of asphalt concrete base course laid in 2 equal layers, in accordance with Clause S9.07. Bituminous material in the existing pavement which will about with the new base course shall be tack coated in accordance with Clause S9.05 or else lightly brushed with hot asphalt cement. The finished level of the patched area shall be carefully formed to leave a smooth surface level with the adjacent existing pavement.

S9.03 (4) Method of Measurement

The quantities to be paid for under this Clause will be the number of square meters of existing pavement removed and replaced in accordance with this specification and the Engineer's instructions. The maximum area of a single patch treated under this Clause will be 40 square meters. When any single area exceeds this quantity, it will be dealt with on the basis of the other individual pay items in this specification for the purpose of measurement and payment.

Any pavement damaged by the Contractor's work under other Clauses of the Specification shall be replaced in accordance with the requirements of this Clause but will not be measured for payment and replacement will be at the Contractor's own expense.

S9.03 (5) Basis of Payment

The accepted quantity of pavement replaced as determined above, will be paid for at the Contract price per square meter, for the pay item as shown below. Such price and payment will be considered as full compensation for the work of this Clause, including any special working methods due to the restricted area being repaired.

Pay Item No. and Name		**Unit of Measurement**
9.03	Patching of Existing Pavements	Square Meter

S9.04 Bituminous Prime Coat

S9.04 (1) Description

This work shall consist of furnishing and applying bituminous material to a previously prepared unbound base surface in accordance with these Specifications and to the width shown on the typical cross sections or instructed by the Engineer.

S9.04 (2) Material

(a) Bituminous Material

Bituminous material shall be of type and grade called for in the Drawings and shall conform to the requirements of the specifications listed below.

Medium-curing cut back asphalt	:	AASHTO M82-75(2012) or SNI 4799:2008
Medium setting emulsion asphalt	:	AASHTO M140-13 or SNI 6832: 2011 and or M208-01(2013) or SNI 4798:2011
Slow setting emulsion asphalt	:	AASHTO M140-13 or SNI 6832: 2011 and or M208-01(2013) or SNI 4798:2011

The grade (with temperatures of application in degrees C shall be MC-30 (40°C ± 10°C).

(b) Blotter Material

Blotter material shall be approved clean, dry sand or stone screenings free from any cohesive material. It shall contain no organic matter.

S9.04 (3) Construction

(a) Weather Limitations

Prime coat shall be applied only with the approval of the Engineer who will specify the grade to be used. The surface to be treated shall be dry or slightly damp. Spraying prime coat shall not be applied when strong winds or rain.

(b) Equipment

The equipment shall meet the requirements of Sub-clause S9.01 (2).

(c) Preparation of Surface

Immediately before applying the bituminous material all loose dirt and other objectionable material shall be removed from the surface with a power broom and/or blower as required. If the Engineer so orders, the surface shall be lightly bladed and rolled immediately prior to the application of bituminous material, in which case brooming or blowing will not be required. When so ordered by the Engineer a light application of water shall be made just before the application of bituminous material. The area to be treated shall be approved by the Engineer prior to application.

(d) Application of Bituminous Material

Bituminous material shall be applied to the width of the section to be primed by means of a bitumen distributor in a uniform, continuous spread. The rate of application will usually be in the range of 0.4 to 1.3 kg/sq.m. and the Engineer will determine the rate and material grade to be used for each material being covered. Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified amount. Excess bituminous material shall be sponged from the surface. Skipped areas or deficiencies shall be corrected. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of.

(e) Application of Blotter Material

In order to minimize possible damage by rain before the surface has completely dried, the Engineer may instruct that blotter material should be spread to cover any wet bituminous material. Blotter material shall be spread so that no wheels or tracks will travel on uncovered wet bituminous material.

(f) General

The relevant requirements of Clause S9.01 shall be read into and considered part of this Clause.

S9.04 (4) Method of Measurement

The quantity of prime coat to be paid for shall be the number of kilograms of bituminous material, laid in accordance with this Specification and the Engineer's instructions.

S9.04 (5) Basis of Payment

The accepted quantities of prime coat, determined as provided above, will be paid for at the Contract price per kilogram for bituminous material which price and payment will be full compensation for the work of this Clause.

Blotter material will not be payable directly but shall be considered as a subsidiary obligation of the Contractor covered under the Contract price for this Clause.

Pay Item No. and Name	**Unit of Measurement**
9.04 Bituminous Prime Coat	Kilogram

S9.05 Bituminous Tack Coat

S9.05 (1) Description

This work shall consist of preparing and treating an existing bituminous or bound surface with bituminous material in accordance with these Specifications and in conformity with the details shown on the Drawings or instructed by the Engineer.

S9.05 (2) Materials

Bituminous material shall conform to the requirements of the specification listed below.

Rapid-curing cut back asphalt	:	AASHTO M81-92(2012) or SNI 4800: 2011
Rapid-setting emulsion asphalt	:	AASHTO M140-13 or SNI 6832: 2011 and or M208-01(2013) or SNI 4798:2011

The grade (with temperatures of application in degrees C) shall be RC-250 (70 ± 10 degrees).

S9.05 (3) Construction

(a) Equipment

The equipment shall meet the requirements of Sub-clause S9.01 (2).

(b) Preparation of Surface to be treated

The existing surface shall be patched and cleaned and shall be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. Unstable, corrugated or damaged areas shall be removed and replaced or repaired as instructed by the Engineer. The edges of existing pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials. The area to be treated shall be cleaned by a power broom and/or blower and approved by the Engineer.

(c) Application of Bituminous Material

The bituminous material shall be uniformly applied with a pressure distributor within the 1 hours preceding placement of the covering course. The Engineer will specify the rate of the application which will usually be in the range of 0.15 to 0.5 kg/sq.m.

Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified amount. Excess bituminous material shall be sponged from the surface. Skipped areas or deficiencies shall be corrected.

The surface shall be allowed to dry until it is in a proper condition of tackiness to receive the covering course. Tack coat shall be applied only in advance of covering course placement as is necessary to obtain this proper condition of tackiness. Until the covering course is placed, the Contractor shall protect the tack coat from damage.

(d) General

The relevant requirements of Clause S9.01 shall be read into and considered part of this Clause.

S9.05 (4) Method of Measurement

The quantity of tack coat to be paid for shall be the number of kilograms of bituminous material, laid in accordance with this Specification and the Engineer's instructions.

S9.05 (5) Basis of Payment

The accepted quantities of tack coat, determined as provided above, will be paid for at the Contract unit price per kilogram for bituminous material complete in place, which price and payment will be full compensation for the work of this Clause.

Pay Item No. and Name		Unit of Measurement
9.05	Bituminous Tack Coat	Kilogram

S9.06 Seal Coat

S9.06 (1) Description

This work shall consist of an application of bituminous material with an application of cover coat material in accordance with these Specifications in conformity with the lines shown on the Drawings or established by the Engineer.

S9.06 (2) Materials

(a) Bituminous Material

Bituminous material shall conform to the requirements of the following specification.

Rapid-curing cut back asphalt : AASHTO M81-92(2012) or SNI 4800:2011

Rapid-setting emulsion asphalt : AASHTO M140-13 or SNI 6832: 2011 and or M208-01(2013) or SNI 4798:2011

The grade of cut back asphalt shall be RC-250 with application temperature of 70 ± 10℃ or that directed by the Engineer.

(b) Cover Coat Material

Cover coat material shall be crushed stone, or crushed gravel and shall meet the requirements for surface course material in Sub-clause S9.07.(2).(b). When crushed gravel is used, not less than 50 percent by weight of the particles retained on the No. 4 sieve shall have at least one fractured face. Aggregates shall meet the gradation requirements of the following table.

Sieve Designation (mm)	Percentage Passing by Weight
9.5	100
4.75	85 - 100
2.36	0 - 40
0.075	0 – 5

(c) The approximate amounts of materials per square meter for seal coats shall be as follows:

Bituminous material (residue) ..... 0.87 – 1.00 lt. per sq.m.

Cover aggregate..... 7.8 – 8.6 kg per sq.m.

The exact spread rates will be instructed by the Engineer.

S9.06 (3) Construction

(a) Weather Limitations

Seal coat shall be applied only when the surface to be treated is dry or slightly damp, when the temperature of the road surface is 21 degrees Celsius or more.

(b) Equipment

The equipment shall meet the requirements of Sub-clause S9.01 (2).

(c) Preparation of Surface

Seal coating operations shall not be started until the surface is thoroughly compacted by Pneumatic Tired Roller. Bituminous material shall not be spread until the surface has been cleaned as required, and the section to be sealed has been approved by Engineer.

(d) Applying Bituminous Material

Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified. The quantity of bituminous material to be used per square meter shall be as directed. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from 0.2 to 0.5 liter per square meter of surface may be required. A strip of building paper, at least 100 cm in width and with a length equal to that of the spray bar of the distributor plus 30 cm, shall be used at the beginning of each spread. If the cut-off is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junction of spreads shall be carefully made to assure a smooth riding surface. The length of bituminous material shall not be in excess of that which approved spreading equipment can immediately cover with approved material.

The spread of bituminous material shall not be more than 15 cm wider than the width covered by the cover coat material from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, or otherwise impair retention of the cover coat.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials on the surface of the travelled way.

(e) Application of Cover Coat Material

Immediately following the application of the bituminous material, cover coat for seal shall be spread in quantities as designated. Spreading shall be accomplished in such a manner that the tires of the approved aggregate spreader at no time contact the uncovered and newly applied bituminous material.

If directed, the cover coat material shall be moistened with water to eliminate or reduce the dust coating of the aggregate. Moistening shall be done the day before the use of the aggregate.

Immediately after the cover coat material is spread, any deficient areas shall be covered by additional material. Initial rolling shall begin immediately behind the spreader and shall consist of one complete coverage with a power roller. Pneumatic tired roller shall begin immediately after completion of the initial rolling and shall be completed the same day the bituminous material and cover coat materials are applied.

After the application of the cover coat material, the surface shall be lightly broomed or otherwise maintained as directed for a period of 4 days or as directed. Maintenance of the surface shall include the distribution of cover coat material over the surface to absorb any free bituminous material and to cover any area deficient in cover coat material. The maintenance shall be conducted so as not to displace embedded material. Excess material shall be swept from the entire surface by means of rotary brooms. The surface shall be swept at the time determined by the Engineer. The Contractor shall furnish a pilot car and driver to conduct traffic over completed seal coat at a maximum speed of 10 kilometers per hour for the first 24 hours after cover aggregate is applied, if so directed by the Engineer.

S9.06 (4) Method of Measurement

Seal coat will be measured by the square meter. No measurement or payment will be made of areas "sealed" outside the limits shown on the plans or ordered by the Engineer. No measurement or payment will be made for material used in excess of those specified by the Engineer nor shall they form the basis of a claim for additional payment.

S9.06 (5) Basis of Payment

The accepted quantities of seal coat determined as provided above, will be paid for at the Contract price per square meter which price and payment will be full compensation for the work of this Clause and for any specified spread rates within the ranges given in Sub-clause S9.06 (1).

Pay Item No. and Name		Unit of Measurement
9.06	Seal Coat	Square Meter

S9.07 Asphalt Concrete

S9.07 (1) Description

(a) This work shall consist of aggregate, filler added, anti-stripping agent and bituminous material mixed in a central plant and spread and compacted on a prepared surface in accordance with these Specifications and in close conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings or established by the Engineer

(b) Type of hot bituminous mixture shall be as determined on this Clause or as directed by Engineer. Asphalt mixtures to be used for pavement works are Asphalt Concrete Base (AC-Base), Asphalt Concrete Binder Course (AC-BC) and Asphalt Concrete Wearing Course (AC-WC)

(c) The relevant sections of Sub-clause S9.01 (2) and S9.01 (3) shall be read into and considered as part of this Clause.

S9.07 (2) Material

(a) Composition of Mixtures

The bituminous material shall be composed of a mixture of aggregate, filler added, asphalt cement and anti-stripping agent and/or modifier. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting composite blend meets the job-mix formula and the following index of retained strength as determined in accordance with SNI 06-2489-1991 (AASHTO T245-15) for AC-WC and AC-BC and RSNI M-06-2004 (ASTM D5581-07a(2013)) for AC-Base.

In calculating the void characteristics of the mixture the Contractor shall allow for the asphalt absorbed by the aggregate and use the effective specific gravity of aggregate and the maximum specific gravity of the loose paving mixture (SNI 03-6893-2002 or AASHTO T209-12).

Some fractions of aggregate and filler added for the asphalt mixture shall be batched and mixed with a proper proportion to obtain the grading required in Table 9.07 (1).

The properties of asphalt mixture are specified in Table 9.07 (2).

Table 9.07 (1) Aggregate Grading Requirements

Sieve Designation (mm)	Percentage Passing by Weight		
	AC-Base	AC-BC	AC-WC
37.5	100	-	-
25.0	90 - 100	100	-
19.0	76 - 90	90 - 100	100
12.5	60 - 78	75 - 90	90 - 100
9.5	52 - 71	66 - 82	77 - 90
4.75	35 - 54	46 - 64	53 - 69
2.36	23 - 41	30 - 49	33 - 53
1.18	13 - 30	18 - 38	21 - 40
0.600	10 - 22	12 - 28	14 - 30
0.300	6 - 15	7 - 20	9 - 22
0.150	4 - 10	5 - 13	6 - 15
0.075	3 - 7	4 - 8	4 - 9

Table 9.07 (2) Hot Asphaltic Mixture Property Requirements

Mix Property		**AC-WC**	**AC-BC**	**AC-Base**
Number of blows per Face		75		112[(1)]
Ratio particle passing #200 – effective bitumen content	Min	1.0		
	Max	1.4		
VIM (%)[(3)]	Min	3.0		
	Max	5.0		
VMA (%)	Min	15	14	13
Void Filled with Bitumen (VFB) %	Min	65		
Marshall Stability (kg)	Min	1000		2250[(1)]
	Max	-		-
Marshall Flow (mm)	Min	2.0		3.0[(1)]
	Max	4.0		6.0[(1)]
Retained Marshall Stability after 24 hours soaking, 60°C (%)[(4)]	Min	90		
Voids in Mix at Refusal Density (%)[(2)]	Min	2		

Note:

(1) Marshall Modification see Appendix 9.07.A.

(2) A vibratory hammer is preferred for Refusal Density compaction. The number of blows per face shall be 600 for diameter 6 inches and 400 for diameter 4 inches.

(3) The Effective specific gravity of aggregate shall be calculated from the Maximum Specific Gravity of Mix (Gmm test) SNI 03-6893-2002 or AASHTO T209-12.

(4) The Engineer may require or approve AASHTO T283-14 as an alternative test without freeze thaw conditioning of -18 ± 3ºC.

Before stockpiling aggregate, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix to

be used with the proposed materials. The formula submitted shall propose definite single values for:

- The percentage of aggregate passing each specified sieve
- The percentage of bituminous material to be added, on the total aggregate basis
- The temperature of the mixture leaving the mixer
- The temperature of the mixture delivered on the road
- The grade of bituminous material

Values shall be proposed within the limits specified for the particular type of bituminous concrete called for. The Engineer will determine a job-mix formula with single values for the above-mentioned and so notify the Contractor in writing.

The mixture furnished by the Contractor shall conform to this job-mix formula, within the following range of tolerances and within the grading ranges of Table 9.07 (2).

Aggregate equal to the 2.36 mm and larger sieve ..... ± 5 percent

Aggregate passing the 2.36 mm and retained the 0.150 mm sieve ..... ± 3 percent

Aggregate passing the 0.150 mm and retained the 0.075 mm sieve ..... ± 2 percent

Aggregate passing the 0.075 mm sieve..... .± 1 percent

Bituminous material ..... ± 0.3 percent

Temperature leaving the mixer ..... ± 10 degrees C

When unsatisfactory results make it necessary, the Engineer may ask a new job-mix formula and so notify the Contractor in writing. Should a change in sources of material be proposed, a new job-mix formula will be established before the new material is used.

The plant mixed material will be tested after blending or mixing at the plant or prior to final incorporation in the work.

The limits set by the Job Mix Formula and the Job Mix Tolerances represent boundaries will guide the Contractor to product the mixtures within the limits of job grading. The Engineer may accept job grading beyond the permissible tolerance provided that the asphaltic mixture meets all the requirements required in Table 9.07.(2).

(b) Coarse Aggregate

The coarse aggregate (retained on the 4.75 mm sieve) shall consist of clean tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable material.

The percentage of wear when tested according to AASHTO T96-02(2015) or SNI 2417:2008 not more than 30 for 500 revolutions and 6 for 100 revolutions.

The sodium sulfate soundness loss shall not exceed 12 percent and the magnesium sulfate soundness loss shall not exceed 18 percent. All to be tested according to AASHTO T104-99(2011) or SNI 3407:2008.

The coating and stripping tested according to AASHTO T182-84(2002) or SNI 2439:2011 is not less than 95%.

When crushed gravel is used, coarse aggregate angularity is defined as the percent by weight of aggregate larger than 4.75 mm with one or more fractured faces, tested according to AASHTO T335-09(2013) or SNI 7619:2012, at least 95/90 (means 95% of coarse aggregate has one fractured face or more and 90% of coarse aggregate has two or more fractured face).

The flat and elongated particles tested according to ASTM D4791-10 or RSNI T-01-2005 (caliper ratio 1:5) or SNI 8287:2016 is not more than 10%.

The mineral particle passing No.200 sieve tested according to AASHTO T11-05(2013) or SNI ASTMC117:2012 is not more than 1%.

Coarse aggregate fraction shall consist crushed stone or crushed gravel and shall be provided in the nominal single size. Individual coarse aggregate fractions shall be stockpiled separately and shall be fed into the mixing plant using separate cold bin feeds with the following nominal sizes:

Table 9.07 (3) Coarse Aggregate Cold Feed Stockpile Nominal Sizes

Mix Type	Minimum coarse aggregate cold feed nominal sizes required (mm)			
	5 - 10	10 - 14	14 - 22	22 - 30
AC-WC	yes	yes		
AC-BC	yes	yes	yes	
AC-Base	yes	yes	yes	yes

(c) Fine Aggregate

Fine aggregate, from each source, shall consist of natural sand or crushed stone screening and consists of materials passing 4.75 mm size (No.4).

Each source and type of fine aggregate shall be stock-piled separately.

Natural sand used in asphaltic concrete mixtures shall not exceed 15% of total mix by weight.

The fine aggregate shall be composed of clean, tough particles, free from clay, or other objectionable material. Stone screenings shall be produced from stone meeting the quality requirements of Sub-clause S9.07.(2).

To obtain a fine aggregate that meets the above requirements:

(i) raw materials for fine aggregate mechanically washed prior to the stone-crusher.

(ii) scalping screen to be installed with the following process:

- The fine fraction obtained from the primary crusher shall not be directly used.
- Aggregate obtained from the primary crusher shall be split with a vibro-scalping screen installed between the primary and secondary crusher.
- Material retained on vibro scalping screen shall be crushed by the secondary crusher, screening results after crushing will be used as fine aggregate.
- Material passing vibro scalping screen shall be used as a component material for Aggregate Base

If the fine aggregate portion of the discharge from the primary crusher does not satisfy the Standard Sand Value (sand equivalent) of not less than 50%, it shall be discarded prior to secondary crushing and shall not be used in any asphaltic mixture.

Crushed and natural fine aggregates shall be stockpiled separately and shall be fed into the mixing plant using separate cold bin feeds.

Aggregate angularity to be tested in accordance with ASTM C1252-17 or SNI 03-6877-2002 shall not less than 45%.

Clay Lump and Friable Particles to be tested in accordance with SNI 03-4141-1996 (AASHTO T112-00), shall not more than 1%

Mineral particles finer than No.200 to be tested in accordance with SNI ASTM C117:2012 (AASHTO T11-05) shall not more than 10%.

(d) Filler

Mineral filler, when required, shall consist of limestone dust, Portland cement, hydrated lime, dolomite dust, cement kiln dust, fly ash type C or F, or other non-plastic mineral matter from sources approved by the Engineer. Mineral filler shall be dry, free flowing, free from lumps and other objectionable material and when tested by means of laboratory sieve, shall meet the following gradation requirements:

Table 9.07 (4) Filler Grading Requirements

Sieve Designation (mm)	Percentage Passing by Weight
0.600	100
0.300	95 - 100
0.075	75 - 100

Added filler shall be in the form of cement, limestone dust, hydrated lime, dolomite dust, cement kiln dust or fly ash from sources approved by the Engineer. It shall be free from all objectionable material. When the Job Mix requires more than 3% added filler, the add filler shall be limestone

dust.

Added filler, shall be in the range of 1% to 2% of the total weight of aggregate for portland cement and in the range of 1% to 3% of the total weight of the aggregate for the others.

(e) Bituminous Binder for Asphaltic Mixtures

The following bituminous binders may be used in accordance with the relevant Table 9.07(5): 60 pen bituminous binder. Sampling of the bituminous binder shall be in accordance with AASHTO R66-16 or SNI 03-6399-2000. Penetration and softening point test shall be carried out on delivery.

The manufactures or suppliers of bituminous binder shall ensure the following:

- International quality certificate (ISO 9002)
- Bituminous binder quality security system during shipment to the location of asphalt mixing plant, and a proven reliability.
- Continuity of bituminous binder supply during construction
- A uniform of bituminous binder quality.

Table 9.07 (5) Bituminous Binder Requirements

Properties	Unit	Min	Max	Standards
1. Penetration at 25°C, 100g, 5 second	0.1 mm	60	70	AASHTO T49-15 or SNI 2456:2011
2. Softening Point	°C	50	-	AASHTO T53-09(2013) or SNI 2434:2011
3. Kinematic Viscosity 135°C	Pa's	300	-	ASTM D2170-10
4. Ductility at 25°C, 5cm/min	cm	100	-	AASHTO T51-09(2013) or SNI 2432:2011
5. Flashing Point	°C	232	-	AASHTO T48-06(2015) or SNI 2433:2011
6. Solubility in Trichloroethylene	%	9.0	-	AASHTO T44-14
7. Specific Gravity	kg/m3	1.0	-	AASHTO T228-09(2013) or SNI 2441:2011
8. Paraffin Content	%	-	2.0	DIN 52015(1980-12) or SNI-03-3639-2002
Residue Test after TFOT or RTFOT				
9. Loss of weight	%	-	0.8	AASHTO T179-05(2015) or SNI 06-2440-1991
10. Penetration at 25°C, 100g, 5 second	%	54	-	AASHTO T49-15 or SNI 2456:2011
11. Ductility at 25°C, 5cm/min	Pa's	100	-	AASHTO T51-09(2013) or SNI 2432:2011

Bitumen samples when required from mix samples shall be extracted in accordance with SNI 03-3640-1994 (double cone method) or AASHTO T164-14 Method A (centrifuge method) or AASHTO T164-14 (ignition

oven method). If the centrifuge method is used, after concentration of extracted bitumen solvent solution approximately 200 ml the contained mineral particles shall be removed in a centrifuge. This removal shall be considered satisfactory when the ash content (by ignition) of the bitumen is not greater than 1% by weight. If bitumen is required for the further tests it shall be recovered from the solution in accordance with AASHTO R59-11(2015) or SNI 4797:2015.

Bitumen shall be tested on delivery and before discharge to the AMP storage tanks for penetration at 25°C (AASHTO T49-15 or SNI 2456:2011) and Softening Point (AASHTO T53-09(2013) or SNI 2434:2011). No bitumen shall be used in the works until tested and approved.

(f) Anti Stripping Agents

When the retained Marshall Stability is less than 90%, an anti-stripping agent shall be added to the bituminous binder in liquid form with dozing pump during wet mixing in pug mill in accordance with the manufacturer's instructions. The quantity of anti-stripping agent shall be in range of 0.2 – 0.4% of bitumen weight as directed or approved by Engineer. The anti-stripping agent shall conform to Table 9.07.(6) and compatibility with the asphalt specified in Table 9.07.(7).

Table 9.07.(6) Requirements of Anti Stripping Agent Containing Amine

No.	Description	Standard	Requirements
1	Flash Point (Cleveland Open Cup), °C	SNI 2433:2011	min.180
2	Viscosity, at 25ºC (Saybolt Furol), sec.	SNI 03-6721-2002	>200
3	Specific Gravity, at 25ºC,	SNI 2441:2011	0,92 – 1,06
4	Acid Value, mL KOH/g	SNI 04-7182-2006	< 10
5	Total amine value, mL HCl/g	ASTM D2073-07	150 - 350

Table 9.07.(7)–Compatibility of Anti Stripping Agent to Bitumen

No.	Description	Standard	Requirements
1	Boiling Water Test, %(1)	ASTM D3625 (2005)	min.80(3)
2	Storage Stability of Bitumen and Anti Stripping Agent, ºC	SNI 2434:2011	max.2.2(2)
3	Heat Stability. Conditioning 72 hours, % asphalt coating surface	ASTM D3625-96 Modification	min.703)
4	Homogeneity, % |Bbottom – Btop| (4)	ASTM D3625/ D3625M-12	< 103)

Note:

(1) Modification of the testing procedure for the preparation of test specimens include the size and type of aggregate, asphalt content and temperature of mixing between the asphalt, aggregate and anti-stripping agent.

(2) Differences of Softening Point (ISO 2434: 2011).

(3) The requirements apply to the testing using silica aggregates.

(4) Difference value of the boiling test of asphalt samples taken at the top and bottom

(g) Job Mix Formula

Asphalt Mixing Plant and Laying Trial to allow the Design Mix Formula (DMF) to be approved as the Job Mix Formula (JMF).

Following approval of the Design Mix Formula by the Engineer, the Contractor shall place a trial section of at least 50 tones using the proposed production, placing and compaction equipment procedures. The Contractor shall demonstrate that: each paver is capable of laying the material at the specified thickness without segregation, tearing, etc and the combination of rollers he proposes to use is capable of achieving the required density in the time that will be available for compaction during normal production laying.

Samples of the mix shall be taken to the laboratory and used for production of Marshall samples and for compaction to refusal density. The results of these tests shall be compared with Table 9.07 (2) depend on the which type of mixture selected. If the trial fails to conform to the specification in any respect all necessary adjustment shall be made and the trial repeated. The Engineer will not approve the design mix formula as the Job Mix Formula until a satisfactory trial has been placed and approved.

No asphalt shall be placed in the permanent works until there is an approved Job Mix Formula (JMF). Once approved, the JMF shall be fixed, unless and until the Engineer approves a replacement JMF. The quality of the mix shall be controlled, in term of the Job Mix Tolerance, as specified in Sub-clause S9.07 (2) (a).

Twelve Marshall samples shall be made using material each laying trial. They shall be taken from the asphalt mixing plant or from trucks at the mixing plant, and transported to the laboratory in a well-insulated box. Marshall samples shall be made with temperature of 155 ± 1°C (viscosity of 0.2 P.a.s) and compacted with temperature of 145 ± 1°C (viscosity of 0.4 P.a.s). The average bulk density (Gmb) of the samples from the successful laying trial shall become the Job Standard Density (JSD), against which the compaction of asphalt placed in the work shall be judged.

S9.07 (3) Construction

(a) Equipment

The mixing plant and all equipment used for hauling and laying the bituminous mixture shall comply with the requirements of Clause S9.01 (2). The Contractor shall provide suitable means for keeping all small tools clean and free from accumulation of bituminous material. He shall provide and have ready for use at all times enough tarpaulins or covers, as may be directed by the Engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may have been dumped, or spread but not compacted.

(b) Preparation of Bituminous Material

The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times. The maximum temperature of asphalt cement delivered to the mixer shall not be more than 5 degrees Celsius above the temperature as specified in (c) hereof for aggregate. Asphalt cement shall not be used while it is foaming nor shall it be heated above 175 degrees Celsius at any time.

(c) Preparation of Aggregates

The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate. Immediately after heating and drying, the aggregates shall be screened into three or more fractions as specified and conveyed into separate compartments ready for batching and mixing with bituminous material. When asphalt cement is used, the temperature of the aggregates as introduced into the mixer, including the tolerance permitted by the job-mix formula, shall not exceed that at which the asphalt cement has a Say bolt Furol viscosity of 100 seconds, determined by AASHTO T72-10(2019) or SNI 7729:2011. It shall not be lower than is required to obtain complete coating and uniform distribution of the aggregate particles and to provide a mixture of satisfactory workability.

(d) Mixing

The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material and anti-stripping agent shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

After the required amounts of aggregate, bituminous material and anti-stripping agent have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured. Mixing time shall be determined by using the procedure in accordance with AASHTO T195-11(2015) (generally the dry and wet mix are approximately 10 and 35 seconds or more, respectively). Total mixing time will be determined by the Engineer for each plant and for each type of aggregate used.

For plant mix bituminous pavement, the mixture shall be produced as closely as practicable to the lowest temperature that will produce a workable mix within the specified temperature range.

(e) Transporting, Spreading and Finishing

The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Sub-clause S9.01 (2). No loads shall be sent out so late in the day as to prevent completion of the

spreading and compaction of the mixture during daylight hours unless with the Engineers approval and satisfactory illumination is provided. Each vehicle shall be weighed after each loading at the mixer and a record shall be kept of the gross weight, tare, net weight, and time of day of each load operation. The mixture temperature shall be unloaded to asphalt paver with the minimum 130^{o}C and while the break down rolling minimum 125^{o}C.

The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practical.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 15 cm; however, the joint in the top layer shall be at the center line of the pavement if the roadway comprises two lanes in width, or at lane lines if the roadway is more than 2 lanes in width, unless otherwise directed.

On areas where irregularities or unavoidable obstacles make the use of mechanical spread and finishing equipment impracticable, the mixture shall be spread out, and raked by hand tools until the specified thickness.

If the continuity of concrete asphalt mixture production can be maintained and is considered practical, the paver shall be used in a row (lined up) to lay out the surface course on adjacent lanes.

The Contractor shall carry out such tests as are necessary to determine the uncompacted thickness of mixture to be laid for compaction to conform to the required finished depths. The uncompacted material immediately behind the paver shall then be measured at frequent intervals and adjustments made to ensure conformity with the nominal thickness.

(f) Compaction

After the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The specific gravity of the consolidated mixture, as determined by AASHTO T166-13 or SNI 03-6757-2002 shall be not less than 98 percent of the Job Standard Density (JSD) as defined in Sub-clause S9.07 (3) (k).

The Contractor shall be deemed to have complied with his obligation to thoroughly compact the asphalt mixture if the density of the compacted layer is equal to or greater than the value given in Table 9.07 (8). If the ratio of the minimum and maximum densities determined in the first set of cores representing any individual area being measured for payment is greater than 1.08, the cores shall be discarded and a new set shall be taken.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable

condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

Table 9.07 (8) Density Requirements

Specified Density (% of JSD)	Number of Tests per Sample	Minimum Mean Density (% of JSD)	Minimum Value of Each Single Test (% of JSD)
98	3 - 4	98.1	95
	5	98.3	94.9
	> 6	98.5	94.8

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

The compaction shall be three step operations as:

1. Break Down Rolling
2. Intermediate Rolling
3. Finishing Rolling

Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the road center line, each trip overlapping one-half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line.

Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver. Rolling shall be continued until all roller marks are eliminated and at least the minimum density indicated above has been attained. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Along forms, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Any mixture that becomes loose and broke, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced. No traffic shall be permitted on the final course in less than 12 hours after completion unless authorized by the Engineer.

(g) Joint, Trimming Edges and Clean-up

Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Where pavers are not used in echelon to place the wearing course in adjacent lanes and where the edges of the previously laid wearing course are, in the opinion of the Engineer, in such condition that the quality of the completed joint will be affected, longitudinal joints shall be trimmed to a vertical face and to a neat line.

The exposed edges of the completed mat shall be cut off true to the required lines. Material trimmed from the edges and any other discarded or rejected bituminous mixture shall be removed from the roadway and disposed of by the Contractor as instructed by the Engineer. When directed by the Engineer, a brush coat of bituminous material shall be used on contact surfaces of joints just before additional mixture is placed against the previously rolled material.

(h) Layer Thicknesses and Surface Tolerance

The variation of the surface from the testing edge of a straightedge between any two contacts with the surface shall not exceed the allowable tolerances. For base course and binder course, the test for conformity shall be made immediately after initial rolling and variation shall be corrected by removing or adding materials as may be necessary. Rolling shall then be continued as specified. Removal or addition of material to the surface course will not be permitted after rolling has commenced. Work on surface course shall be carefully controlled to ensure that material as laid will conform to the allowable tolerance.

The thickness of each asphalt layer shall be monitored by pavement cores taken by the Contractor under the supervision of the Engineer. The spacing and location of the cores shall be as directed by the Engineer but there shall be at least two cores taken transversely per traffic lane per cross-section investigated. The longitudinal spacing of cross sections investigated shall be no greater than 100 m per lane and shall be at least 2 cores taken randomly in any cross section

The "actual thickness" of Asphaltic Mixture placed over any given section of the works, defined as the average thickness of all cores (either more or less than the thicknesses as shown in the Drawings) taken in that section, shall be conform to the tolerance given below:

- Asphaltic Concrete - Wearing Course : - 3.0 mm

- Asphaltic Concrete - Binder Course : - 4.0 mm
- Asphaltic Concrete - Base : - 5.0 mm

Section is the length of an overlay for one day of AMP production.

The actual thickness of the non levelling asphaltic layer, shall be close to the thickness of the design as practical as shown in Drawings. The Engineer may, in his opinion, may to approve and accept the actual thickness of the first layer less than the thickness shown in the Drawings due to shaping correction.

When the asphalt mixture overlaid more than one layer and the first actual thickness layer does not conform to the thickness shown in the Drawings, this thickness shall be corrected by the adjustment thickness of the next layer. The total thickness of the asphalt mixture shall not be less than the total design thickness of each type asphalt mixture as shown in the Drawings minus 5 mm. When the adjustment thickness of the last subsequent layer (surface layer) in a sub-section does not conform to the above-mentioned requirements, this sub-section shall be removed or re-overlaid with the following minimum nominal thickness:

- Asphalt Concrete - Base = 7.5 cm
- Asphalt Concrete - Binder Course = 6.0 cm
- Asphalt Concrete - Wearing Course = 4.0 cm

When tested with a 3 m straight edge laid at right angles to the road center line the surface shall not deviate from the bottom of the straight edge by more than 5 mm for AC-WC and AC-BC nor 10 mm for AC-Base. At any transverse section the difference in level between any two pints shall not vary from their difference in level computed from the cross section shown on the Drawings by more than 5 mm

(i) Overlay and Regulating

Where the contract requires the overlay of an existing pavement this shall be carried out strictly in accordance with the Engineer's instructions. The Engineer may instruct that a layer of the pavement be laid over a partial width or to a restricted length if this is necessary to facilitate the regulation of levels.

(j) Frequency of Tests

Quality Control of bituminous mixture and acceptance sampling and testing shall be carried out in accordance with the Table 9.07 (8) and the Engineer's instructions.

Table 9.07.(8) Mixture Quality Control Sampling

TEST	**SAMPLING FREQUANCY ONE SAMPLE PER :**
Asphalt:	
▪ Asphalt in drums	3√ number of drum
▪ Asphalt in bulk	Each tank

TEST	SAMPLING FREQUANCY ONE SAMPLE PER :
Aggregate:	
▪ Los Angeles Abrasion	5,000 m^3
▪ Aggregate grading when adding to stockpiles	1,000 m^3
▪ Aggregate grading from hot bins	250 m^3 (min.2 samples per day)
▪ Sand Equivalent of Natural Sand	250 m3
Mixtures:	
▪ Temperature at the mixing plant and on delivery to site	Hour
▪ Grading and bituminous binder content	200 tons (min.1 sample per day)
▪ Marshall density, stability, flow, quotient at 75 blows and voids at refusal density	200 tons (min.1 sample per day)
▪ Voids in Mix at refusal density	3,000 tons
▪ Marshall mix design	Every change in aggregate or design
Constructed layers:	
▪ 100 mm diameter for up to 25 mm max. size or for greater than 25 mm max. size use 150 mm diameter cores for compaction and layer thickness	2 specimens for each 100 m length per lane.
Construction tolerances:	
▪ Surface levels, for the cross section of each carriageway	At least 3 transverse points measured at least every 12.5 meter along the length of the road

S9.07 (4) Method of Measurement

Plant mix bituminous material will be measured by the ton as described in Sub-clause S9.01.(3).(d).

The quantity of base course, binder and surfacing to be paid for will be the weight of the completed plant-mix bituminous material less the quantity of asphalt cement and anti-stripping agent, which will be paid for separately. No adjustment in contract unit price will be made for variation in quantity due to differences in the specific gravity of material actually used. The quantity of asphalt cement to be paid for will be based on the delivery weight of bituminous treated aggregate using the actual percentage of blended bituminous (as verified by tests) in the mixture.The quantity of anti-stripping agent to be paid will be based on the record of any material used, and approved by the Engineer.

S9.07 (5) Basis of Payment

The accepted quantities of all materials determined as provided above, will be paid for at the Contract unit price per ton for asphalt concrete base, asphalt concrete binder course, asphalt concrete wearing course and asphalt cement, and per kg for anti-stripping agent, completed in place and accepted, which price and payment will be full compensation for the work of this Clause including any extra costs due to regulating or over-laying existing pavements.

Pay Item No. and Name		Unit of Measurement
9.07 (1)	Asphalt Concrete - Base	ton
9.07 (2)	Asphalt Concrete - Binder Course	ton
9.07 (3)	Asphalt Concrete - Wearing Course	ton
9.07 (4)	Asphalt Cement Pen 60/70	ton
9.07 (5)	Anti Stripping Agent	kg

S9.08 Cement Concrete Pavement

S9.08 (1) Description

This work shall consist of constructing a Portland cement concrete pavement, constructed in accordance with the thickness and typical cross sections shown on the Drawings or as instructed by the Engineer.

S9.08 (2) Applicable Provisions

The applicable provisions of Clauses S10.01 and S10.02 shall be read into and become part of this Clause S9.08 "Concrete Pavement".

S9.08 (3) Materials

(a) Pavement Quality Concrete (P.Q.C.)

The constituent materials for P.Q.C. shall comply with Clause S10.01 of the General Specifications except that Coarse Aggregate shall be crushed stone.

(b) Reinforcing Steel and Dowel Bar

Reinforcing steel and dowel bar shall be in accordance with Clause S10.02 of these Specifications and such further details as are shown on the Drawings.

(c) Joint Filler

Poured filler for joints shall conform to the requirements of ASTM D6690-15 or SNI 03-4814-1998

Preformed fillers for joints shall conform to the requirements of AASHTO M33-99(2012), AASHTO M153-06(2011) or SNI 03-4432-1997, AASHTO M213-01(2015) or SNI 03-4815-1998, and ASTM D2628-91(2016), as specified on the Drawings or by the Engineer and shall be punched to admit dowels where called for on the Drawings. The filler for each joint shall be furnished in a single piece for the depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape, by stapling or other positive fastening satisfactory to the Engineer.

(d) Slip Sheet Membrane

Membrane for waterproof underlay below the slab shall be polythene sheeting 125 microns thick or as instructed by the Engineer. When an overlap of underlay materials is necessary this shall be at least 300 mm.

(e) Curing Materials

Curing materials shall conform to the following requirements as specified or other materials satisfactory to the Engineer:

Liquid Membrane - Forming Compounds for Curing Concrete - Type 2 white pigmented	ASTM C309-19 or SNI ASTM C309:2012

(f) Concrete

(i) Components of the Mix

The approval of mix proportions shall be made on the basis of trial mixes developed by the Contractor in accordance with Clause S10.01 of these Specifications.

The cement content per cubic meter of solid concrete shall not less than the content of trial mix approved. The using of very high cement content shall be undesirable and the Contractor shall provide the mix design with the most economical proportion that meets all the requirements.

The coarse and fine aggregate shall be as specified in Clause S10.01 of the General Specifications. In determining the coarse aggregate/fine aggregate ratio the fine aggregate proportion shall be kept to a minimum. However, at least 40% aggregate (by weight) in the concrete mix shall be the fine aggregate which defined as aggregate passing 4.75 mm sieve. The combined aggregate shall not contain the particle finer than 0.075 mm more than 2% except the Pozolan material. Once the appropriate total grading has been determined and approved, it shall be varied only with the permission of the Engineer.

The Contractor is allowed a choice of coarse aggregate up to a maximum size of 40 mm providing that suitable workability for the plant being used can be achieved and the surface regularity required maintained. The Engineer at his discretion, may order a change in the size of the Contractor's choice of coarse aggregate.

Fly ash may be used by maximum of 25% of the portland cement weight for the Ordinary Portland Cement (OPC) Type I or III only and may not be used for Pozolan Portland Cement (PPC)

The use of plasticizers or water reducing agents shall not be permitted except with the written permission of the Engineer. Accelerating admixtures and those containing calcium chloride shall not be used.

Chemical additives shall be in accordance with AASHTO M194M/M194-13 or SNI 03-2495-1991. Additional materials

containing calcium chloride, calcium format, and try ethanolamine shall not be used.
The following conditions shall be met:

(1) For the combination of two or more additives, the compatibility of additives shall be specified in the manufacture's certificate.

(2) For the mixture with fly ash of less than 50 kg/m^3, the contribution of total alkali (expressed as Na_2O equivalent) of all additives used in the mixture shall not more than 0.20 kg/m^3.

Super plasticizer/high range water reducer can be used on the written approval of the Engineer.

(ii) Concrete Strength

The minimum trial mix and site working (production control) flexural strength shall not be less than 4.7 MPa and 4.5 MPa respectively at 28 days when tested by the third point method in accordance with AASHTO T97-14 or SNI 4431:2011. Especially, Fast Track Cement Concrete Pavement 8 or 24 hours shall be obtained according to their ages and shall not be less than the requirements as above mentioned in 8 or 24 hours.

The minimum compressive strength value for production may be amended based on a comparison of flexural and compressive strengths achieved for a series of not less than 16, 8 compressive and 8 flexural strength tests of the approved mix design. Amendment of the minimum Compressive Strength values above mentioned shall be subject to the instruction or approval of the Engineer.

(iii) Sampling of Concrete

Concrete will be sampled each 50 cubic meters for slip form and 30 cubic meter for fixed form, two pairs of beam test specimens shall be printed for flexural testing of non-fast track cement concrete pavement, the first pair for 7 days and the other pair at 28 days, and a pair only for fast track cement concrete pavement, both for 8 hours and 24 hours.

If the site working flexural strength less than 90% of minimum requirement as specified in Sub-clause S9.08.(3).(f).(ii), sampling of minimum 4 cores shall be carried out for the compressive strength test. If the compressive strength results meet the compressive strength of the same concrete mixtures which used for flexural strength test, the concrete will be accepted for the payment.

(iv) Consistence for PCC Pavement

Consistence of the concrete shall be determined by measuring the slump in accordance with AASHTO T119-13 or SNI 1972:2008.

The Contractor shall nominate a slump for each concrete mix within the ranges:

- 20 – 50 mm for concrete to be slipform
- 50 – 75 mm for concrete to be placed manually (fixed-form)

The ratio of free water to cement for surface dry of aggregate shall be determined based on the requirements to obtain the strength and durability of concrete. The free cement water ratio shall be listed in the document of concrete mix design approved by the Engineer.

The tolerance permitted relative to the Contractor's nominated slump for any concrete mix shall be +/- 13 mm. Care shall be taken to ensure that a consistent method of test is adopted to minimizes random variations in the test result.

(v) Uniformity of Concrete Mix

Concrete mixture properties shall conform to the following table:

Concrete Uniformity Parameters

Test	**Requirement, Expressed as Maximum Permissible Difference in Results of Tests of Samples Taken from Two Locations in the Concrete Batch**
Weight per cubic meter calculated to an air free basis (kg/m^3)	16
Air content, volume % of concrete	1
Slump (mm)	25
Coarse Aggregate Content, portion by weight of each sample retained on No.4 (4.75 mm) sieve, %	6
Unit Weight of air free mortar (not less than 3 cylinders will be molded and tested from each of the samples) based on average for all comparative samples tested, %	1.6
Average compressive strength at 7 days for each sample, based on average strength of all comparative test specimens, %	7.5

(vi) Cement Concrete Pavement for Early Traffic Opening

(1) Portland Cement

Ordinary Portland Cement (OPC) Type I generally to be used for all cement concrete pavement.

Ordinary Portland Cement (OPC) Type III to be used for cement concrete pavement which to be opened for traffic of 8 hours after casting and shall be strictly under control by an Expert. Due to the low durability consideration, the

fast track cement concrete pavement of 8 hours to be recommended only for reinstatement of the damaged section.

(2) Admixture

The admixture may be used fast track cement concrete pavement are Water Reducer Retarder (Type D). Accelerator (Type C) may be used for fast track cement concrete pavement of 8 hours and shall be strictly under control by an Expert. Due to the low durability consideration, the using of accelerator for fast track cement concrete pavement of 8 hours is recommended only for reinstatement of the damaged section. If urgent required, the using of Super-Plasticizer Type F to reduce the water/ cement ratio is permitted

S9.08 (4) Equipment

(a) General

Equipment shall conform to the requirements of Sub-clause S10.01.(3) of these Specifications. The capacity of the concrete batching plant shall be able to achieve the requirement of the slipform concrete paver so that the device keeps on moving without any stopping as a consequence of delay with the supply of fresh concrete. A dump truck can be used to deliver mixed concrete with low slump.

(b) Slipform Concrete Paver.

The slipform concrete paver machine shall be designed as a unit that has functions of spreading, leveling, compacting and smoothening, and shall also be capable of being directed and adjusted to the required elevation as it moves forward.

The type of machine shall be a slipform paver type with minimum width of 4.0 m and shall have 4 (four) crawler tracks, complete with steering sensors, level control sensors in the front and at the back on both sides, and slope sensors where all sensors are computerized controlled and automatically operated.

This equipment shall be generally equipped by:

- Auger that can uniformly `spread out and distribute the concrete mixture into full width of paving slab.
- A Screed that can control and adjust the concrete filling into the mold.
- Vibrator with sufficient capacity to guarantee all uniform compaction and consolidation of the concrete mixture and placement into width of mold. The vibrator shall have an operation frequency ranging from 160 – 200 Hertz and shall be flexible in order to be able to work even if it touches the reinforcement.

- The mold (slipform pan / finishing pan) pavement forming shall be designed by high quality steel and the form shall be guaranteed so that the formed concrete will not be dragged along and will produce the compact concrete.
- Super smoother / float pan finisher – smooth finishing, leveling the final pavement surface and move oscillating move.
- Tie bar inserter inserts tie bar automatically into longitudinal joints in a certain space.

The equipment can be equipped by dowel inserter to insert dowel automatically into concrete pavement which is in processing of spreading and compacting to the required space interval and parallel to machine movement.

(c) If the pavement location is narrow or irregular and it is impossible for slipform concrete paver to operate, after approval of Engineer the following equipment can be used:

(i) Spreading and Finishing Machines

Spreading machines shall be designed so as to reduce to the minimum segregation of the mixed concrete. Finishing machines shall be equipped with at least two oscillating type transverse screeds or other comparable means of striking off concrete as required by Sub-clause S9.08.(6).

(ii) Vibrators

Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute (58 Hz) and the frequency of the internal type shall not be less than 5,000 impulses per minute (83 Hz) for tube vibrators and not less than 7,000 impulses per minute (117 Hz) for spud vibrators.

When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute (58 Hz).

(c) Concrete Saw

When saw joints are elected or specified, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times

during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of these equipments shall be on the job both before and continuously during concrete placement.

(e) Forms

Straight side forms shall be made of metal having a thickness of not less than 5 mm and shall be furnished in sections not less than 3.0 m in length. Forms shall have a depth at least equal to the prescribed edge thickness of the pavement without horizontal joint, and a base width equal to not less than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 30.0 m radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than ⅔ the height of the form. Forms with battered top surfaces, and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. The top face of the form shall not vary from a true plane more than 3 mm in 3.0 m and the upstanding leg shall not vary more than 6 mm. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.

S9.08 (5) Joints

Joints shall be constructed of the type and dimensions, and at the locations required by the Drawings. All joints shall be protected from the intrusion of injurious foreign material until sealed.

(a) Longitudinal Joints

Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material or enclosed in tubes or sleeves except for future extension joint. When shown on the Drawings and when adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars, except those made of rail steel, may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed or in lieu of bent tie bars, approved two-piece connectors may be used.

Longitudinal formed joints shall consist of a groove extending downward from, and normal to, the surface of the pavement. These joints shall be affected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the Drawings and while the concrete is in a plastic state. The groove shall be filled with either a premoulded strip or poured material as required.

The longitudinal center joint shall be installed so that its ends are in contact with the transverse joints, if any.

Longitudinal sawn joints shall be cut by means of approved concrete saws to the depth, width and line shown on the Drawings. Suitable guidelines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the Drawings. The longitudinal joint shall be sawn before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawn area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

Longitudinal permanent insert type joints shall be formed by placing a continuous strip of plastic material which will not react adversely with the chemical constituents of the concrete. The insert strip shall be of sufficient width to form a weakened plane to the depth required by the Drawings. Weakened plane type joints shall not be sawn. The insert strip thickness shall not be less than 0.5 mm and shall be inserted with a mechanical device that places the material in a continuous strip. Splices will be permitted provided they are effective in maintaining the continuity of the insert strip. The top edge of the insert strip shall be positioned below the finished surface as shown in the Drawings.

The insert strip shall not be deformed from a vertical position during installation or in subsequent finishing operations performed on the concrete. The alignment of the finished joint shall be uniformly parallel with the centerline of the pavement and shall be free from excessive local irregularities in alignment. The mechanical installation device shall vibrate the concrete during the insertion of the strip in such a manner as to cause the disturbed concrete to return evenly along the edges of the strip without segregation or developing voids.

(b) Transverse Expansion Joints

The expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than 5 mm in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

(c) Transverse Contraction Joints

Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the Drawings, shall include load transfer assemblies.

(i) Transverse strip contraction joints - These joints shall be formed by installing a parting strip to be left in place as shown on the Drawings.

(ii) Formed grooves - These grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place at least until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

(iii) Sawn contraction joints - These joints shall be created by sawing grooves in the surface of the pavement of the width, depth, and at the spacing and lines shown on the Drawings, with an approved concrete saw. After each joint is sawn, the saw cut and adjacent concrete surface shall be thoroughly cleaned.

Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, and generally not less than 4 hours but in no case more than 10 hours after the final compaction of the concrete. All joints shall be sawn before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above. In general, all joints should be sawn in sequence.

(iv) Transverse formed contraction joints - These joints shall comply with the requirements of sub-clause (a) above for the longitudinal formed joint.

(v) Transverse construction joints - Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 1.8 m of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 1.8 m long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

(d) Load Transfer Devices

Dowels, when used, shall be held in position parallel to the surface and center line of the slab by a metal device that is left in the pavement.

Dowel ends shall be carefully sawn to provide a smooth regular surface. The portion of each dowel lubricated as shown on the Drawings shall be thoroughly coated with approved bituminous material or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. A dowel cap or sleeve approved by the Engineer shall be furnished for dowel bar used with the expansion joints as shown in the Drawings. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be water-tight.

In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

Prior to placing concrete, the alignment tolerance of individual dowels at any locations as measured in the dowel assembly will be ± 2 mm for two thirds of dowels within a joint, ± 4 mm for one third, and ± 2 mm for the adjacent horizontal or vertical dowels. During pouring the concrete, the position of dowels shall be ensured no any movement.

(e) Sealing Joints

Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.

The sealing material shall be applied to each joint opening to conform to the details shown on the Drawings or as directed by the Engineer.

If a sealing material of preformed filler type (elastomeric compression joint sealant) is used, a hot air blower compressor shall be used, to asssist the acceleration process of developing preformed filler when the location is wet (after rain). The length of preformed filler shall be at least 4 (four) meters per-roll, and the joint of preformed filler shall be really tight, in order to ensure no gap available.

Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted.

S9.08 (6) Construction without Slipform

(a) General

The construction without slipform work shall be carried out only in areas where the slipform paver cannot be used due to irregular pavement forms.

Before commencing work on the concrete slab, all work on the sub-base, ducts, and adjacent curb shall be completed to the satisfaction of the Engineer.

Except for areas falling within the scope of and laid in accordance with Sub-clause S9.08.(6).(f) all concrete shall be distributed uniformly, compacted and finished by machines.

(b) Form Setting

Forms shall be set sufficiently in advance of the point where concrete is being placed to permit the performance and approval of all operations required within and adjacent to the form lines. Forms shall be staked into place with no less than 3 pins for each 3.0 m section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 5 mm at any point. Forms shall be so set that they will withstand without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and coated with a form release agent or oiled prior to the placing of concrete.

The alignment and grade elevation of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

(c) Placing Concrete

The concrete shall be spread with a thickness such that a removal or rework is avoided Unless truck mixers, truck agitators, or non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained at least 90% of the strength specified for 28 days concrete. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 3 days.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies,

by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

(d) Placement of Reinforcement

Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the Drawings. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be firmly positioned in advance of concrete placement or it may be placed at the depth shown on the Drawings in the plastic concrete, after spreading, by mechanical or vibratory means.

At joints between mats of steel fabric reinforcement the first wire of one mat shall lie within the complete mesh of the previous mat and the overlap shall be not less than 450 mm.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair bond of the steel with the concrete.

(e) Machine Finishing

The concrete shall be distributed or spread as soon as placed and shall be struck off, vibrated and screed up by an approved finishing machine. The machine shall pass each area of pavement as many times and at such intervals as necessary to give the proper consolidation and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other vibration tending to affect the precision finish.

During the first pass of the finishing machine a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

(f) Hand Finishing

Where slabs are so small or irregular, or with the permission of the Engineer when the Site is so restricted or limited as to make the use of the

methods specified in sub-clause (e) impracticable, concrete shall be evenly distributed and spread by hand without pre-compaction or segregation.

Concrete to be compacted by a vibrating beam shall be struck off at such a level that the surface level after all entrapped air has been removed by compaction is above that of the side forms. The concrete shall be compacted by a steel or steel-shod hardwood compacting beam not less than 75 mm wide, 225 mm deep with an energy input of not less than 250 W per meter width of slab, the beam being lifted and moved forward by increments not exceeding the beam width. Alternatively, a vibrating twin beam compactor of equivalent power may be used. When compacting layers of concrete exceeding 200 mm in depth, or when directed by the Engineer sufficient additional internal vibration shall be provided over the whole width of the slab to produce full compaction. After every 1.5 m length of slab has been compacted the vibrating beam shall be taken back 1.5 m and then drawn slowly forward whilst vibrating over the compacted surface to provide a smooth finish.

The surface shall then be regulated by at least two passes of a scraping straight-edge with blade length not less than 1.8 m. If the surface is torn extensively by the straight-edge, owing to irregularities in the surface, a further pass of the vibrating beam shall be made, followed by a further pass of the scraping straight-edge.

When laying reinforced concrete two-layer construction shall be used. The first layer shall be spread, struck off and compacted to a level so that the reinforcement when placed shall have the required depth of cover. Immediately after placing the reinforcement the top layer of concrete shall be laid and finished.

(g) Floating

After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a float, using one of the following methods as specified or permitted.

(i) Hand method - A hand-operated longitudinal float not less than 3.5 m in length and 150 mm in width, properly stiffened to prevent flexibility and warping shall be used. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centre line, and passing gradually from one side of the pavement to the other. Movement ahead along the center line of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or fluid material shall be wasted over the side forms on each pass.

(ii) Mechanical method - The mechanical float shall be of a design approved by the Engineer and shall be in good working condition. The float shall be accurately adjusted to the required crown and

coordinated with the adjustments of the transverse finishing machine.

As an alternative to the mechanical float above, the Contractor may use a machine composed of a cutting and smoothing float or floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms.

If necessary, following one of the preceding methods of floating, long-handled floats having blades not less than 1.5 m in length and 150 mm in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and residue shall be removed from the surface of the pavement by a straightedge 3.0 m or more in length. Successive drags shall be lapped one-half the length of the blade.

(h) Surface Correction

After the floating has been completed and the excess water removed, but while the concrete is still plastic, depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Surface corrections shall continue until the entire surface is found to be free from observable departures and the slab conforms to the required grade and cross section.

The variation of the surface from the testing edge of a straightedge between any two contacts with the surface shall not exceed the allowable tolerance specified in Sub-clause S9.08 (6) (l).

(i) Edging

As soon as the concrete has been struck off and consolidated, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius which unless shown otherwise on the Drawings shall be 12 mm.

(j) Surface Finish

After the completion of joints and edging and before the application of curing compound the surface of the concrete pavement shall be brushed in a direction aspect of the center line of the pavement.

A brushed finish shall be formed with a wire broom not less than 450 mm wide. The broom shall have two rows of tufts made from 100mm long 32-gauge wire with 20mm between the centers of each tuft. The two rows of

tufts shall be offset in a zigzag arrangement maintaining the 25 mm center to center spacing with the second row of tufts offset by 12.5 mm from the first row. Each tuft shall have 14 wires which shall be replaced if the shortest wire length wears down to less than 90mm in length. Average texture depth shall not be less than 3 mm. Manual or mechanical grooving tool, which has a rake rods of 3 mm thick and distance between 15 to 20 mm, approved by the Engineer.

(k) Level Survey

Within 24 hours of placing, the Contractor shall survey the surface levels for conformity of the layer surface and thickness.

The level at any point on top of the layer for Lean Concrete Sub-base shall not vary by more than 10 mm below or 10 mm above the design level (-10 mm, +10 mm)

(l) Surface Test

As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 3.0 m straight edge. Areas showing high spots of more than 3 mm but not exceeding 12.5 mm in 3.0 m shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 3 mm when tested with a 3.0 m straight-edge. Where the departure from correct cross section exceeds 12.5 mm, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be neither less than 3.0 m in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 3.0 m in length, shall also be removed and replaced.

The surface roughness of completed cement concrete pavement shall conform to the requirement of Minister Regulation of Public Works No.16/PRT/M/2014 or the addendum (if any) when to be tested with the NAASRA-meter in accordance with SNI 03-3426-1994.

(m) Curing

The exposed surfaces of concrete pavement shall be cured immediately after the surface finish brushing by treating with an approved curing compound which shall be mechanically sprayed on to the surface at a rate of 0.22 - 0.27 liter/m2, or at a rate recommended by the manufacturer, using a fine spray. For the sides of slip-formed slab or where the side forms are removed and for small areas where a mechanical distributor cannot be used, the compound shall be sprayed by hand lance at the rate of 0.27 - 0.36 liter/m2 or at a rate recommended by the manufacturer. Any groove over a joint shall be protected from the entry of curing compound.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one

of the methods specified in Sub-clause S10.01.(4).(g). Failure to provide sufficient cover or lack of water to adequately take care of both curing and other requirements shall be cause for immediate suspension of concreting operations.

(n) Removal of Forms

Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least 12 hours. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as required in (l) above.

Minor areas of honeycomb shall be cleaned, wetted, and neatly patched with stiff mortar in the proportions of 1-part cement to 2 parts fine aggregate. Patching shall not be carried out until the honeycomb areas have been inspected and method of patching approved by the Engineer.

Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 2.5 m in length nor less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 3.0 m in length shall also be removed and replaced.

S9.08 (7) Construction with Slipform

(a) Setting of string line

A string line that serves as the main guide for line and grade shall be set along the pavement production plan. The string line shall be set at the proper position (elevation and coordinate) to provide the final thickness, line and grade of pavement and shall be set with a measuring instrument.

(b) Bedding of track

Track - working path for the crawler track shall be prepared along the production plan and with a flat, tough and stable surface to support the crawler track. The crawler track shall not be depression in order to ensure the track moves forward stably.

(c) Continuity

A slipform paver shall be operated continuously without stopping. This paver will be operated when the fresh concrete supplied to the Site is enough to ensure that the paver will operate continuously without stopping due to shortage or delay supply.

Continuity of spreading - compaction shall be strictly maintained continuously without stopping. Discontinuation of spreading - compaction shall be stopped if the paver suddenly has a technical trouble such as breaking down or the production completed according to the production plan on that day.

The requirements of Sub-clause S9.08 (6) (a), (j), (k), (l) shall govern for apply the using of slipform paver.

S9.08 (8) Trial Lengths

The Contractor shall demonstrate the plant, equipment and method of construction by laying an initial trial length not less than 30 m long at a location provided by the Contractor outside the permanent works. Subsequent trial lengths may be instructed by the Engineer if any aspect of the initial trial proves unsatisfactory.

Following approval by the Engineer of the initial trial a comprehensive trial length at least 150 m and not more than 300 m long shall be carried out within the permanent works. This comprehensive trial shall demonstrate all aspects of the work and shall include each type of joint to be used in the Works.

The Contractor shall submit to the Engineer at least one month prior to the date proposed for the initial trial length, a detailed description of the plant, equipment and method of construction. No development of the plant shall be permitted either during this trial length or when pavement concrete is being laid in the permanent works.

The Contractor shall not continue with the laying of pavement quality concrete in the permanent works until approval to a comprehensive trial has been given or permission has been given by the Engineer to proceed with another comprehensive trial.

For the comprehensive trial to be acceptable, the length of pavement shall conform, without remedial works, to the Specification.

If the comprehensive trial length does not conform to the Specification the Contractor shall construct another trial length. Trial lengths which do not conform to the Specification shall be removed unless the Engineer permits otherwise.

Trial length outside the permanent works may not be required where the amount of concrete pavement work is limited, such as at Toll Plaza areas only. Determination of non-requirement of the trial length will be solely decided by the Engineer.

S9.08 (9) Protection of Pavement

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc.

Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement replaced, as directed by the Engineer.

S9.08 (10) Opening to Traffic

The Engineer will decide when the pavement shall be opened to traffic. The pavement will not be opened to traffic until test specimens molded and cured in accordance with SNI 4810:2013 or AASHTO T23-14 have attained not less than 90% of the minimum flexural strength at 28 days given in Table 10-1-1 of the Specifications when tested by the third point method. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the

concrete was placed. Prior to opening to traffic, the pavement shall be cleaned, and joint sealing completed.

S9.08 (11) Tolerance in Pavement Thickness

Actual concrete pavement thickness will normally be determined by the difference in values from the level surveys carried out before and after the rigid pavement is placed. In the event of any area of concrete thickness discrepancy being revealed by the two-level surveys, the Engineer may request that cores be drilled to determine the actual concrete thickness in these areas. In the event that coring is required, the thickness of the pavement in these areas will be determined by average caliper measurement of cores tested in accordance with AASHTO T 148-15(2019) or SNI 03-6969-2003.

In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 5 mm will be considered as the specified thickness plus 5 mm,

Areas found deficient in thickness by more than 12.5 mm shall be evaluated by the Engineer, and if in his determination the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the Drawings.

S9.08 (12) Method of Measurement

The quantity to be paid for under this item will be the number of square meters of concrete pavement completed and accepted as measured complete in place in the permanent works. The width for measurement will be the width of the pavement shown on the typical cross section of the plans, additional areas such as ramps and toll plazas where called for, or as otherwise directed in writing by the Engineer. The length will be measured by the Engineer. The length will be measured along the center line of each roadway.

Joints and reinforcing steel required for the work of this Clause will not be measured for separate payment.

The initial trial length placed outside the permanent works shall not be measured for payment.

S9.08 (13) Basis of Payment

(a) General

The accepted quantities of concrete pavement determined as provided above will be paid for at the contract unit price per square meter which price and payment will be full compensation for furnishing and placing all materials, including, but not limited to, class P concrete, reinforcing steel, forms, dowels, tie bars and joint materials, carrying out trial lengths, taking cores for price adjustment, and all other material, labor, equipment and incidentals necessary to complete the work as shown on the Drawings.

However, for any pavement found deficient in thickness by more than 5 mm, but not more than 12.5 mm, only the reduced price stipulated below will be paid.

No additional payment over the unit contract bid price will be made for any pavement which has an average thickness in excess of that shown on the Drawings.

(b) Price Adjustments

Where the average thickness of pavement is deficient in thickness by more than 5 mm, but not more than 12.5 mm, payment will be made at an adjusted price as specified in the following table :

CONCRETE PAVEMENT DEFICIENCY

Deficiency in Thickness Determined by Cores	**Proportional Part of Contract Price Allowed**
0 to 5 mm	100 percent
6 to 8 mm	80 percent
9 to 10 mm	72 percent
11 to 12.5 mm	68 percent

When the thickness of pavement is deficient by more than 12.5 mm and the determination of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.

In the event that strength compliance of the concrete pavement is not achieved, but all other aspects comply with that specified, the Engineer may, at his direction accept the concrete pavement, providing the average value of the 4 (four) consecutive results of tests shall not be less than 90% of the specified minimum site working strength, subject to the following price adjustment:

Flexural strength of concrete at 28 days between 90 and 100% of the minimum flexural strength required will be acceptable with a 4% deduction in unit rate for Cement Concrete Pavement for every 0.1 MPa or part thereof.

If the average of the four test results is less than 90%, it shall be demolished and replaced

Pay Item No. and Name		**Unit of Measurement**
9.08 (1a)	Concrete Pavement	Cubic Meter
9.08 (1b)	Concrete Pavement, Fast Track 8 hours	Cubic Meter
9.08 (1c)	Concrete Pavement, Fast Track 24 hours	Cubic Meter
9.08 (2a)	Concrete Pavement, Double Wire Mesh	Cubic Meter
9.08 (2b)	Concrete Pavement, Double Wire Mesh Fast Track 8 hours	Cubic Meter

9.08 (2c)	Concrete Pavement, Double Wire Mesh Fast Track 24 hours	Cubic Meter
9.08 (3a)	Concrete Pavement, Single Wire Mesh	Cubic Meter
9.08 (3b)	Concrete Pavement, Single Wire Mesh Fast Track 8 hours	Cubic Meter
9.08 (3c)	Concrete Pavement, Single Wire Mesh Fast Track 24 hours	Cubic Meter

S9.09 Wet Lean Concrete

S9.09 (1) Description

The work shall consist of furnishing all labor, equipment, supplies and materials, and of performing all operations in connection with construction of levelling course and pavement widening works with wet lean concrete including underlying course preparation, importing and preparation of aggregates, batching, mixing, transporting, placing, consolidating, finishing, curing, maintenance and other incidental operations pertaining to the construction. All work shall be done in strict accordance with the plans and drawings, specifications, and as directed by the Engineer.

S9.09 (2) Underlying Course

Where wet lean concrete is specified for leveling course, prior to construction the underlying course shall be cleaned of dirt, mud, loose stone or other foreign matter and inspected by the Engineer to ensure compaction, finish and surface smoothness. Any areas failing to comply with the applicable specification requirements shall be removed, repaired or reconstructed as directed by the Engineer. No direct payment will be made for this removal, repair, or reconstruction provided that the Contractor is held responsible therefor.

S9.09 (3) Sand Bedding

Where wet lean concrete is specified for pavement widening work, the lean concrete shall be laid on a prepared leveled bed comprising 4 cm of natural sand except other specified in the Drawings. Any natural sand with the bulk of its mass being retained on a No.200 mesh sieve and its mortar fraction being non-plastic may be used. The sand at suitable moisture content shall be spread on the prepared approved sub-grade and leveled. The leveled bed shall be compacted with the largest roller that can be utilized in the excavation to refusal. Prior to placing wet lean concrete the sand bed shall be dampened with water.

S9.09 (4) Materials

The aggregates, cement and water shall conform to the requirements of Sub-clause S10.01 (2) of these Specifications. The maximum aggregate size, subject to the Engineer's approval, shall be selected by the Contractor with regard to the specific application of wet lean concrete.

S9.09 (5) Mix Proportions

The ratio mass of cement to aggregate in the saturated surface dry condition shall be sufficient to achieve the crushing strength requirements of this Clause, and to provide a satisfactory consistency of mixing.

S9.09 (6) Formwork

Wet lean concrete for leveling course shall be placed between cut-off screeding forms of steel or timber set true to grade and elevation.

S9.09 (7) Joints

Longitudinal joints shall be offset by at least 20 cm from the longitudinal joint of the concrete pavement to be superimposed.

Transverse construction joints shall be formed at the end of each day's work and shall form a true transverse vertical surface.

S9.09 (8) Mixing, Transportation, Laying and Consolidation

Wet lean concrete shall be mixed, transported, placed, spread and compacted in accordance with the requirements of Sub-clauses S10.01 (3) and S10.01 (4).

S9.09 (9) Finishing

After consolidation and screeding to the correct plane and elevation the wet lean concrete shall be floated to a smooth finish the surface being free from depressions or projections and areas of open texture. The surface shall then be regulated by at least two passes of a scraping straightedge with a blade not less than 1.8 m.

S9.09 (10) Curing

Wet lean concrete shall immediately on completion of finishing be cured for a period of not less than 7 days. Curing of the surface shall be achieved by one of the following methods:

(a) Covering until the next pavement layer is laid with impermeable plastic sheeting, adequately secured from being blown off the surface and with the joints overlapped at least 300 mm and set to prohibit egress of moisture.

(b) The entire surface sprayed uniformly with white pigmented curing compound.

(c) Continual mist spraying covering the entire surface and maintaining a permanently moist condition for the full duration of the curing period. Intermittent wet curing will not be accepted.

S9.09 (11) Testing for Strength

Compressive strength test cylinders, 15 cm diameter by 30 cm high shall be prepared from the wet lean concrete delivered to site.

One cylinder shall be prepared representing each 50 linear meter of wet lean concrete being laid and not less than three (3) cylinders shall be prepared from each day's work.

S9.09 (12) Crushing Strength Requirements

The average crushing strength at 28 days of each group of specimens representing each day's work of 80 – 110 kg/cm^2.

If the average crushing strength of more than one group of any five consecutive groups falls below 80 kg/cm2, the cement content shall be increased to such a value as may be approved by the Engineer, until it can be shown by the results that satisfactory material can be achieved with different mix proportions.

S9.09 (13) Cause for Rejection

Provided the crushing strength requirements are followed, low crushing strength values will not be cause for rejection.

All loose, segregated or otherwise defective areas, along with areas not complying with the surface smoothness requirements, which cannot be corrected by grinding, shall be delimited by the Engineer. The material shall be broken out to the full thickness of layer, removed and replaced with freshly mixed material complying to the Specification. Surface patching will not be permitted.

S9.09 (14) Surface Smoothness

Wet lean concrete shall be shaped and finished to the lines, grades, and cross sections as shown on the plans and drawings. The finished surface shall not deviate more than 1 cm from the planned elevation.

Lean Concrete Sub-base shall have a cross-fall equal to the design cross-fall with tolerance of ± 0.3 %.

S9.09 (15) Maintenance

Neither equipment nor traffic, including construction vehicles, will be allowed on the finished surface during the initial 7 day's curing period.

After the curing period such equipment and vehicles required for the continuation of works will be permitted to traffic on the wet lean concrete.

Wet lean concrete shall be maintained in a proper condition prior to placing the next pavement layer. Any damage from any cause whatsoever shall be repaired by replacement of the area in question at the expense of the Contractor.

S9.09 (16) Method of Measurement

Wet lean concrete for leveling course to be paid for will be the number of square meters of leveling course, completed and accepted in accordance with the plans, drawings, and specifications and as directed by the Engineer.

Sand bedding will not be measured separately.

In computing all quantities, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No pay allowance shall be made for any increased cement content or for variations in layer thickness where minimum thickness is specified.

S9.09 (17) Basis of Payment

The accepted quantities of wet lean concrete and sand bedding, determined as provided above, will be paid for at the Contract unit price for the item shown below. This payment shall be full compensation for furnishing all labor, equipment and materials necessary to complete the work, including underlying course preparation, sand bedding, mixing, preparation, transporting, laying, consolidation, finishing, curing, maintenance and all other incidental items of work in accordance with the plans, drawings, specifications, and as directed by the Engineer.

Pay Item No. and Name	**Unit of Measurement**
9.09 Wet Lean Concrete (t = 10 cm)	Square Meter

APPENDIX 9.07.A

Marshall Modification for Large Aggregate (> 1" &< 2")

Modification Marshall Procedure (ASTM D5581-07a(2013) or RSNI M-06-2004) is basically the same as the original method (AASHTO T245-15 or SNI 06-2489-1991) except for these differences that are due to the larger specimen size that used:

(1) The hammer weights 10.206 kg and has a 14.94 cm flat tamping face. Only a mechanically operated device is used for the same 45.7 cm drop height.
(2) The specimen has a 15.24 cm diameter by 9.52 cm height.
(3) The batch weights are typically 4 kg.
(4) The equipment for compacting and testing (mold and breaking heads) are proportionately larger than normal Marshall to accommodate the larger specimens.
(5) The mix is placed in the mold in two approximately equal increments, with spading performed after each increment to avoid the honey combing.
(6) The number of blows needed for the larger specimen is 1.5 times (75 or 112 blows) for AC-Base than required of the smaller specimen (50 or 75 blows) for AC-WC or AC-BC to obtain equivalent compaction.
(7) The design criteria should be modified as well. The minimum stability should be 2.25 time and the range of the flow values should 1.5 times from the normal size specimen.
(8) Similar to the normal procedure, these values should be used to convert the measured stability values to an equivalent values for a specimen with a 9.52 cm thickness, if the actual thickness varies:

Approximate Height (mm)	Specimen Volume (cm3)	Correlation Ratio
88.9	1608 - 1626	1.12
90.5	1637 - 1665	1.09
92.1	1666 - 1694	1.06
93.7	1695 - 1723	1.03
95.2	1724 - 1752	1.00
96.8	1753 - 1781	0.97
98.4	1782 - 1810	0.95
100.0	1811 - 1839	0.92
101.6	1840 - 1868	0.90

Note :
Important to note that to determine the void in mix at refusal density, it is recommended to use vibratory hammer than Marshall hammer. Crushing aggregate to be smaller fragments may be avoided in the mix.

DIVISION 10 CONCRETE STRUCTURES

S10.01 Concrete and High Performance Concrete

S10.01 (1) Description

(a) Scope

This work shall consist of the general items pertaining to the required class or classes of concrete: reinforced and unreinforced concrete; self compacting concrete (SCC); mass concrete; prestressed concrete; precast concrete; and concrete for composite steel structures, constructed in accordance with these Specifications and the lines, levels, grades and dimensions shown on the Drawings, and as required by the Engineer.

Cement concrete shall consist of a mixture of portland cement or equivalent hydraulic cement, water, coarse and fine aggregates, with or without additives forming solid mass

High-performance concrete is the concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. The performance requirements involve the placement and compaction without segregation, early strength, toughness, volume stability, service life such as self compacting concrete (SCC).

Mass concrete is any volume of concrete with the smallest dimensions equal to or greater than one meter or the structural components with a smallest dimension of less than one meter, but it has a potential to produce a peak temperature exceeding the permitted limits. These specific dimensions will require that measures be taken to cope with the generation of heat from hydration of the cement and attendant volume change to minimize cracking. The one characteristic that distinguishes mass concrete from other concrete work is thermal behavior.

This work shall also include the preparing working areas for casting concrete, furnishing the curing, working floors and maintaining foundation such as pumping or other measures to keep the foundation dry.

(b) Concrete Classes and their Use

The use of each class of concrete shall be as follows unless otherwise shown on the Drawings or directed by the Engineer:

Strength Class	Use of Each Class of Concrete
AA (fc’ 50 MPa)	- Segmental precast prestressed concrete U-girders
	- Segmental prestressed concrete U-girders
	- Preccast/Segmental prestressed concrete I-girders
	- Prestressed concrete spun piles
A - 1 (fc’ 40 MPa)	- Precast prestressed concrete box girders
	- Precast prestressed concrete I-girders

	- Precast prestressed concrete U-girders
	- Prestressed concrete box girders
	- Precast prestressed concrete hollow slab units
A - 2 (fc’ 35 MPa)	- Prestressed concrete cantilevered pier heads and columns
	- Prestressed concrete portal pier
	- Prestressed concrete hollow slabs
	- Precast Cross Beams
B - 1 (fc’ 30 MPa)	- Reinforced concrete slab bridges
	- Reinforced concrete deck slabs
	- Diaphragms of prestressed concrete I- girder and U-girderbridges
	- Reinforced concrete hollow slab
	- Concrete barriers
	- Pipe culverts
	- Reinforced concrete for pier columns and heads
	- Stairs and pier for pedestrian bridges
	- Reinforced Concrete Piled slabs
	- Curb (reinforcing and plain)
B - 2 (fc’ 30 MPa)	- Cast-in-place reinforced concrete piles
	- Reinforced concrete piles
C (fc’ 20 MPa)	- Wall piers
	- Abutments, footing of piers, retaining walls
	- Approach slabs
	- Stairs on embankment and foundations of street lighting poles
	- Box culverts (including wing walls)
	- RC frames and encasement of pipe culverts
	- Planting boxes
	- Precast plates for slabs
	- Stairs of pedestrian bridge
	- Piers of pedestrian bridge
	- U-ditches or concrete ditches
D (fc’ 15 MPa)	- Gravity type retaining walls
	- Concrete footpaths

- Head walls, cradles of pipe culverts

E (fc' 10 MPa) - Leveling concrete, backfill concrete in masonry structures, and as specified on the Drawings

P (fs 4.5 MPa) - Cement Concrete Pavement.

(c) Tolerances

(i) Dimensional Tolerances:

▪ Overall length up to 6 m	± 5 mm
▪ Overall length over 6 m	± 15 mm
▪ Length of beams, deck slabs, columns walls, or between abutments	- 0 and +10 mm

(ii) Shape Tolerances:

▪ Square (difference in diagonal lengths)	10 mm
▪ Straightness or Bow (deviation from intended line) for lengths up to 3 m	12 mm
▪ Straightness or Bow for lengths 3 m to 6 m	15 mm
▪ Straightness or Bow for lengths greater than 6 m	20 mm

(iii) Position Tolerances (from reference point):

▪ Plan position of precast columns	± 10 mm
▪ Plan position of horizontal surfaces	± 10 mm
▪ Plan position of vertical surfaces	± 10 mm

(iv) Vertical Alignment Tolerance:

▪ Plumb alignment for columns and walls	± 10 mm

(v) Level/Elevations Tolerances:

▪ Top of blinding concrete under foundations	± 10 mm
▪ Top of blinding concrete under approach slabs	± 10 mm
▪ Top of columns, abutments and transverse beams	± 10 mm

(vi) Horizontal Alignments Tolerance:

- 10 mm in 4 m horizontal length

(vii) Tolerances for Concrete cover over Reinforcing Steel:

▪ Concrete cover up to 3 cm.	- 0 and + 5 mm
▪ Concrete cover of >3 cm - 5 cm	- 0 and + 10 mm
▪ Concrete cover of >5 cm - 10 cm	± 10 mm

(d) Submittals

(i) The Contractor shall submit samples of all materials he intends to use together with test data confirming that all material properties as specified in Sub-clause S10.01 (2) of these Specifications are met.

(ii) The Contractor shall submit a mix design for each concrete class to be used before the start of concrete placement, complete with the test results of materials and concrete trial mix in the laboratory based on the compressive strength results generally within ages of 7 and 28 days, and an additional age of 56 days for mass concrete unless otherwise specified for other ages by the Engineer.

(iii) Especially for Mass Concrete

Before commencement of the mass concrete work, the Contractor shall submit a temperature control plan together with the design calculation for the approval of the Engineer. The design is in the form of concrete mix design, method and duration of curing with the following equipments:

(1) Thermal Control with Insulation Walls

When the insulation walls are used to maintain temperature differences, the material used shall have a heat holding level of 2 - 4 hour-foot^2/BTU.

1 BTU (BTU: British Thermal Unit) is defined as the amount of heat rquired to raise the temperature for one pound (about 454 grams) of water by 1-degree Fahrenheit. 143 BTU is required to melt 1 pound of ice.

(2) Temperature Sensor Tool

The temperature sensor used is a thermistor type or the others. The sensor shall be able to show temperatures in the range of 10 - 95°C or within the required range with a reading accuracy of 0.5°C. Temperature sensor tool shall be calibrated.

(iii) The Contractor shall submit the detailed drawings for all scaffolds to be used and shall obtain approval from the Engineer before any scaffolding installment commenced.

(iv) The Contractor shall notify the Engineer in writing at least 24 hours prior to the starting date plan of mixing or placement of any concrete classes, as required under Sub-clause S10.01 (4) below.

(e) Storage and Protection of Cement

For storage of cement the Contractor shall provide a weatherproof shed that is airtight and has a raised wooden floor which is covered with polyethylene sheeting. At all times stacks of cement bags shall be kept covered with an envelope of polyethylene sheeting.

Bulk cement shall be stored in a silo made from steel or concrete and shall be avoided from the possibility of mixing with the other material. If the cement has been stored for more than 2 (two) months, then before it is used shall be checked first that the cement is still comply with Specification

(f) Job Conditions

The Contractor shall maintain the temperature of all materials, particularly the coarse aggregate, at the lowest possible levels and shall maintain the temperature of the concrete below 30 ºC at the time of placement. In extreme conditions, where placement is forced at temperatures above 30 °C, the method of conducting placement work shall refer to ACI 305.1-14 Hot Weather Concreting. In addition, the Contractor shall not place any concrete when:

(i) The rate of evaporation exceeds 1.0 kg/m^2/hour, as determined by the chart below.

(ii) The relative humidity of the air is less than 40 %.

(iii) Directed not to do so by the Engineer, during periods of rain or when the air is dust laden or otherwise polluted.

Rate of Evaporation of Water from Concrete

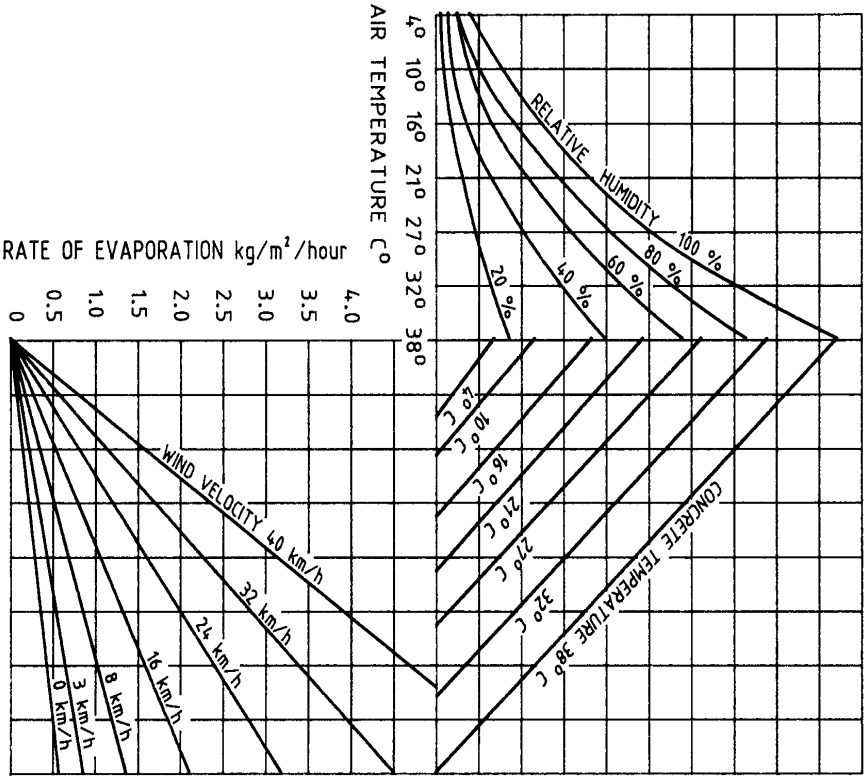


Figure 10-1-1 Nomogram to Determinate the Average Water Evaporation Rate

Note:

The estimated temperature of concrete is determined by the following empirical formula:

Concrete temperature = 0.1 PC temperature + 0.3 water temperature + 0.6 aggregate temperature (coarse and fine).

(g) Rectification of Unsatisfactory Concrete Work

(i) Rectification of concrete work which does not meet the tolerance criteria specified in Sub-clause S10.01.(1).(c), or which does not have a satisfactory surface finish, or which does not meet the mix property requirements specified in Sub-clause S10.01.(3).(a), shall be as directed by the Engineer and may include:

(1) Changes in the mix proportions for the remainder of the work.

(2) Additional curing on those portions of the structure represented by the test specimens which failed.

(3) Strengthening or complete removal and replacement of those portions of the work which he deems to be unsatisfactory.

(ii) In the event of a dispute regarding the quality of the concrete work or any doubt regarding the adequacy of the available test data, the Engineer may direct the Contractor to carry out additional testing to ensure that a fair judgement of the work quality can be made. Such additional testing shall be at the Contractor's own expense.

(iii) Rectification of cracked or displaced concrete work due to negligence of the Contractor is the responsibility of the Contractor and shall be carried out at his own expense. The Contractor shall not be responsible for the damages caused by natural disasters which is not able be avoided, provided that the damaged work has been completed and accepted and declared by the Engineer in writing.

(iv) Rectification of concrete works which do not meet the requirements as specified in Sub-clauses S10.01.(5).(c).(ix) and S10.01.(5).(c).(x) may include the demolition and replacing all concrete.

(h) Supply of Ready Mix Concrete

Concrete supplied as Ready Mix by an outside supplier shall comply with the requirements of ASTM C94/C94M-09 – Standard Specification for Ready Mix Concrete. Unless otherwise noted in the bid documents the "purchaser" described within ASTM C94/C94M-09 shall be the Contractor. The General Conditions of Contract and the requirements of Clause S10.01 of the Specifications take precedence over ASTM C94/C94M-09. The contractor shall not thereby be relieved of any of his duties under the Contract

S10.01 (2) Materials

(a) General

All materials to be furnished and used that are not covered in this Clause shall conform to the requirements stipulated in other applicable Clauses.

(b) Cement

(i) The cement used for Concrete Work shall be Portland cement conforming to SNI 2049:2015 (AASHTO M85-15) type I, II, III, IV and V.

(ii) Unless otherwise permitted by the Engineer, the product of only one mill of any one brand type of Portland Cement shall be used on the project. If this is permitted, the Kontraktor shall re-submit the concrete mix design according to the type and mill of cement used.

(c) Additives

The Contractor shall submit samples of any additives. The Contractor requests to use to the Engineer at least 28 days prior to the date of commencement of construction of the particular structure or portion of structure on which he intends to use such admixtures. The use of any kind of additives for any purpose shall be based on the laboratory test results where the results shall be in accordance with the requirements and approved by the Engineer.

Additives to be used to improve the performance of concrete can be chemical, mineral or waste products in the form of pozzolan powder as a filler in the concrete mix.

i) Chemical

Admixtures in the form of chemicals added to concrete in an amount not more than 5% by weight of cement during the mixing process or during the additional mixing in concrete. The admixture shall conform to the requirements specified in ASTM C494/ C494M-17 or SNI 03-2495-1991. Admixtures shall not contain chlorides, nitrates, sulphates or sulphides.

For the purpose of performance improvement of the fresh concrete, the admixture can be used for the purposes of : improving the workability of concrete mix without adding water; reducing the water used in the concrete mix without reducing workability; acceleration ofthe cement hydration binding or concrete hardening; deceleration of the cement hydration binding or concrete hardening; improving the workability of concrete pumping; deceleration of the slump loss; reducing theshrinkage of concrete or providing a little expansion for concrete; reducing the possibility of bleeding; reducing the possibility of segregation.

For the purpose of performance improvement after the concrete hardening, the admixture can be used for the purposes of: increasing the strength of concrete (indirectly); increasing the

strength of the young concrete; reducing or slowing the hydration heat in concrete hardening process, especially for concrete with high early strength; improving the workability of concrete casting in the water or in the sea; improving the long-term durability of concrete; improving water-tightness of concrete (reducing the permeability of concrete); controlling the expansion of concrete due to alkali-aggregate reaction; increase of the bonding between new and old concrete; improving the adhesion between concrete and reinforcing steel; increase of the concrete resistance to abrasion and impact.

Viscocity Modifying Admixture (VMA) may be used to reduce the segregation and sensitivity of the mixture to variations in other components, especially water content, usually used for self-compacting concrete (SCC) when the powder content as described in Sub-clause S10.01.(2).(h) in the mixture is not enough.

ii) Mineral

The additives in the form of mineral or waste material can be in the form of fly ash class F or pozzolan which conforms to ASTM C618-17a or SNI 2460:2014, slag cement or ground granulated blast furnace slag which conforms to ASTM C989/C989M-18 or SNI 6385:2016, micro silica or silica fume.

(d) Water

Water used in mixing, curing, or other designated applications shall be clean and free from harmful matter such as oil, salt, acid, alkali, sugar, or organic materials. Water shall be tested in accordance with and shall meet the requirements of ASTM C1602/C1602M-12 or SNI 7974:2016. Water known to be of potable quality may be used without being tested. When the proposed water quality is doubtful and the testing as above mentioned could not be carried out, comparison testing shall be carried out by using the cement mortar with the proposed water and with the distillated or drinking water. The proposed water could be used when the compressive strength at 7 days and 28 days of cement mortar with the proposed water is at least 90 % of cement mortar with the distillated or drinking water at the same curing period.

(e) Aggregate Grading Requirements

(i) The coarse and fine aggregate gradations shall conform to the requirements given in Table 10-1-1 Aggregate Grading Requirements. Aggregates do not conform to these grading requirements shall not necessarily be rejected if the Contractor can demonstrate that the concrete mixture conforms to the mix property requirements specified in Sub-clauses S10.01.(1).(d) and S10.01.(3).(a) of the Specifications.

Table 10-1-1 Aggregate Grading Requirements

Sieve Size		Percent by Weight Passing for Aggregates					
ASTM	(mm)	Fine *	Coarse				
2”	50.8	-	100	-	-	-	-
1½”	38.1	-	95 - 100	100	-	-	-
1”	25.4	-	-	95 - 100	100	-	-
¾”	19	-	35 - 70	-	90 - 100	100	-
½”	12.7	-	-	25 - 60	-	90 - 100	100
3/8”	9.5	100	10 - 30	-	20 - 55	40 - 70	90 - 100
No.4	4.75	95 - 100	0 - 5	0 -10	0 - 10	0 - 15	20 - 55
No.8	2.36	80 - 100	-	0 - 5	0 - 5	0 - 5	5 - 30
No.16	1.18	50 - 85	-	-	-	-	0 - 10
No.50	0.300	10 - 30	-	-	-	-	0 - 5
No.100	0.150	2 - 10	-	-	-	-	-

(*) : not conform to the gradation of fine aggregate in SNI 03-2834-2000

(ii) The coarse aggregate shall be selected so that the maximum particle size is no greater than three quarters the minimum clear space between reinforcing bars or between the bars and the form work or between any other restrictions in the space that the concrete shall occupy in the work.

(f) Aggregate Properties

(i) Aggregates for concrete shall consist of clean, hard, durable particles obtained by crushing rock or boulders, or by the screening and washing (if necessary) of natural river gravel and sand.

(ii) The aggregates shall conform with the other property specifications given in Table 10-1-2 – Property of Aggregates when sampled and tested in accordance with the provisions of the relevant SNI and/or AASHTO procedures.

Table 10-1-2 Properties of Aggregates

Property	**Test Method**	**Maximum Permissible Limits**	
		Fine Aggregate	**Coarse Aggregate**
Los Angeles Abrasion loss 500 revolutions	AASHTO T96-02(2015) or SNI 2417:2008	-	40 %
Sodium or Magnesium Sulphate Soundness loss after 5 cycles	AASHTO T104-99(2011) or SNI 3407:2008	10 % for Sodium Sulphate	12 % for Sodium Sulphate
		15 % for Magne-sium Sulfate	18 % for Magne-sium Sulfate
Percent of Clay Lumps and Friable Particles	AASHTO T112-00(2012) or SNI 4141:2015	3 %	2 %

Property	Test Method	Maximum Permissible Limits	
		Fine Aggregate	**Coarse Aggregate**
Material Passing No.200 sieve	AASHTO T11-05(2013) or SNI ASTM C117: 2012	5% for general condition, 3% for surface abrasion	1 %
Organic Impuritiies	AASHTO T21-15 or SNI 2816:2014	Organic Plate No.3	-

(g) Rubble Stone for Cyclopean Concrete

Stone for cyclopean concrete shall be of approved quality, sound and durable, and free from segregation, cracks, or imperfections tending to destroy its resistance to the weather. It shall be sharp angled, free from dirt, oil or any other injurious material which may prevent the proper adhesion of the mortar. The size of rubble stone to be used for cyclopean cocrete is not more than 250 mm.

(h) Powder

Powder is the particles passing sieve No.120 (0.125 mm) that required to prevent the segregation of self-compacting concrete (SCC) mixture, may derived from Portland cement, aggregates and mineral additives that have particles passing sieve No.230 (0.063 mm) of more than 70%.

(i) Storage of Materials

(i) Storage of cement - Cement may be shipped from prestrested and approved bins at the mill. Cement shall be stored in a damp-proof warehouse with a floor raised at least 30 cm from the ground so as to permit easy access for inspection and for use in the delivered order. Bagged cement shall not be piled more than 13 sacks high. Cement which has become damp, lumpy or otherwise not in proper condition shall not be used. Cement stored by the Contractor for a period longer than 60 (sixty) days shall require the Engineer's approval before being used on the work. Subject to the Engineer's approval of their use, cement of different brands, types, or from different mills shall be stored separately. The use of cement reclaimed from discarded or used bags will not be permitted.

(ii) Storage of aggregate - Fine and coarse aggregates shall be stored separately to prevent contamination by foreign material. Aggregate shall be stored in such a manner as to keep the moisture content as uniform as possible and shall be handled in such a manner as to prevent segregation. Aggregate shall be stored so as to protect it from the direct rays of the sun. Aggregate from different sources of supply shall not be stored in the same place without permission from the Engineer.

(j) Adhesive

(i) Introduction

Epoxy resin adhesive shall be used for the jointing of precast concrete blocks.

(ii) Quality Standards

The quality standards are shown in the following Table 10-1-3.

Table 10-1-3 Requirements of Epoxy Resin Adhesive

Item		Unit	Quality Standards	Testing Conditions	Curing Conditions
UNHARDENED ADHESIVE	External Appearance		No foreign matters recognized as to be harmful shall be mixed in. No separation of materials shall be observed.		
	Specific Gravity		1.2 - 1.6	at room temperature	
	Viscosity	cp	1 x 104 - 5 x 104	at standard working temperature	
	Pot life	hr	2, or more	at standard working temperature	
	Minimum Thickness of Slack	mm	0.3, or more	at standard working temperature	
HARDENED ADHESIVE	Tensile Strength	kg/cm^2	125, or more	7 days(age) at room temperature	at room temperature
	Compressive Strength	kg/cm^2	700, or more	7 days(age) at room temperature	at room temperature
	Adhesive Strength	kg/cm^2	60, or more	7 days(age) at room temperature	at room temperature

Note :

1/ "Room temperature" refers to the Class-2, Standard Temperature Condition specified in JIS Z8703-1983 (Standard Condition of Testing Location) i.e. 20 degrees Celsius + 2 degrees Celsius.

2/ "Standard Working Temperature" refers to 3 categories (summer type, spring-and-autumn type and winter type) according to working temperatures and are respectively 30 degrees Celsius + 2 degrees Celsius, 20 degrees Celsius + 2 degrees Celsius and 10 degrees Celsius + 2 degrees Celsius.

3/ "Pot life" refer to 70% of the time from mixing to the start of gelation.

4/ "Minimum slack thickness" refers to the minimum thickness of the adhesive layer formed by the application of the adhesive to a perpendicular surface to a thickness of approximately 1 mm and measured after the adhesive has slackened downward.

5/ The adhesive strength shall be obtained from a shearing test.

S10.01 (3) Mixing and Batching

(a) Mix Property Requirements

(i) All concrete used in the works shall conform to the workability (expressed in slump), strength (expressed in compressive

strength), and durability (expressed with resistance to weather, abrasion, impermeability and chemistry) as required. For Self Compacting Concrete (SCC), the assessment of workability shall be carried out through a slump flow test, unless determined for other ages by the Engineer. Unless otherwise specified, the mixed design shall have a design standard deviation (Sr) in accordance with Tables 4.3 and 4.4 of ACI 214R-11 shown in Table 10-1-4 and Table 10-1-5, for concrete quality control during general implementation and trial mix in the laboratory

Table 10-1-4 Standard Deviation Overall

Concrete Class	General Implementation	Trial Mix in Laboratory
≤ 35 MPa	2.8 – 4.8 (MPa)	1.4 – 2.4 (MPa)
> 35 MPa	7% – 14 % *fc'*	3.5% - 7% *fc'*

Note:

* : overall involve within batch and batch to batch)

Table 10-1-5 Standard Deviation within Batch

Concrete Class	General Implementation	Trial Mix in Laboratory
≤ 35 MPa	3 - 6 (MPa)	2 - 5 (MPa)
> 35 MPa	3% - 6% *fc'*	2% - 5% *fc'*

(ii) For other classes of concrete work, the mechanical properties of concrete in addition to compressive strength are also signifiantly known. The Contractor shall submit the data to the Engineer.

(iii) Prior to concrete placement, the Contractor shall provide a trial mix using the proportion of design mix and materials (with or without additives) proposed, under supervision of the Engineer, using the same type of batch plant and equipment used for the works (and taking into account travel the time etc.). For new concrete, the concrete mixture shall conform to the workability requirement (slump value). The 7-day concrete compressive strength test of trial mix shall meet a minimum strength of 90% of the average compressive strength decided for 7-day mix design and meet the standard deviation requirements according to Table 10-1-4 and 10-1-5. Where the 7-day concrete test results of trial mix does not conform to the strength required, the Contractor shall make a mix adjustment and try to find the cause of discrepancy, by providing an advice of proper concrete experts, then re-mix design shall be carried out up to the requirements of compressive strength have been obtained. When the standard deviation of concrete trial mix conforms to Table 10-1-4 and 10-1-5 and approved by the Engineer, then the Contractor may carry out concrete mixing in accordance with the approved mix design as a result of trial mix.

(iv) If the concrete compressive strength test of 28 days and an additional test of 56 days for mass concrete does not meet the requirements, the prompt action shall be taken following the

provisions as specified in Sub-clause S10.01.(5).(c).(ix) and Sub-clause S10.01.(5).(c).(x).

(b) Mix Adjustments

(i) Adjustment for Variation in Workability

If it is found impossible to obtain concrete of the desired placeability and workability with the proportions originally designated by the Engineer, the Contractor may carry out such changes in aggregate weights as are necessary, provided that in no case shall the cement content originally and water/cement ratio originally designated be changed. Remixing concrete of fresh concrete by adding water content or other means is not permitted.

Additives used to improve the workability shall be permitted only if approved by the Engineer.

Slump flow (the mean diameter of the spread of fresh concrete using a inverted conventional slump cone) according to ASTM C1611/C1611M-14 with a range in Table 10-1-6 below:

Table 10-1-6 Slump Flow Requirements

Description	Slump Flow (mm) T_{500} = 2 - 7 seconds
Concrete without Reinforcement or with Light Reinforcement (such as bored pile)	550 – 650
Concrete with tightly spaced reinforcement (concrete in general such as columns)	650 – 750
Concrete with complicated shapes or difficult casting (maximum nominal aggregate size of 9.5 mm)	750 - 850

Note:

T500 is the time (in seconds) taken for SCC to spread 500 mm in the flow test.

Acceptance requirements of the SCC test results for various testing tools or methods are shown in Table 10-1-7 below:

Table 10-1-7 Acceptance Requirements of Test Results for SCC

Method	Unit	Valus of Acceptance Range	
		Minimum	Maximum
Slump flow	mm	550	850
T_{500} slump flow	second	2	7
J-ring	mm	0	10
V-funnel	second	8	12
V-funnel at T 5 minutes	second	0	+3
L-box	(h/h1)	0.8	1.0
U-box	(h2/hj)	0	30
Fill box	%	90	100

(ii) Adjustment for Strength

If the concrete at an earlier age before 28 days produces a compressive strength below the target strength, the Contractor shall not be permitted to further cast the concrete until the cause of low strength is certainly known and until the proper actions have been taken to ensure that the concrete production will meet the requirements specified in these Specifications.

If the concrete does not come up to the specified strength, as the approval of Engineer the cement content may be increased provided that it does not exceed the maximum cement content limit due to heat hydration considerations (AASHTO LRFD Bridge Construction Specification 8.4.3 Maximum Cementitious 593 kilograms/m3 for High Performance Concrete). The other alternative may be carried out by using the plasticizer to improve the workability of concrete mix without adding water content.

(iii) Adjustment for New Materials

No change in the source or character of the materials shall be made without due notice to the Engineer and no new materials shall be used until the Engineer has accepted such materials and has designated new proportions based on tests or trial mixes as provided herein. Should the changes due to the new materials require an increase in the amount of cement, no additional payment shall be made to the Contractor for the cost of such additional cement.

(iv) Adjustment for Admixtures

If the admixtures need to be added and originally mix design without admixtures, then the implementation shall be carried out in accordance with Sub-clause S10.01.(2).(c).(i) and the approval from the Engineer required.

(c) Proportions and Batch Weights

(i) For concrete class fc' > 20 MPa, all components of concrete materials shall be measured by weight. For concrete class fc' < 20 MPa, measurement to be allowed by volume according to ACI 304R-00 or SNI 03-3976-1995. When cement used in bag, the quantity of batching shall be such that the quantity of cement used is equivalent to rounded number of cement bag. The aggregate shall be measured by weight separately. The weight of batch shall not exceed the capacity of mixer.

(ii) Batching of aggregate and water shall be carried out on the basis of saturated surface dry aggregate. The surface dry saturated aggregate may be carried out by spraying the aggregate stockpile to be used with water at least 12 (twelve) hours before batching. If the aggregate is not in a saturated surface dry condition, then the batching correction of water and aggregate shall be carried out using the data of aggregate water absorption for water and the

moisture content of aggregate in field. If batching volume, the bulking factor of fine aggregate shall be taken into account as shown in Figure 10-1-2.

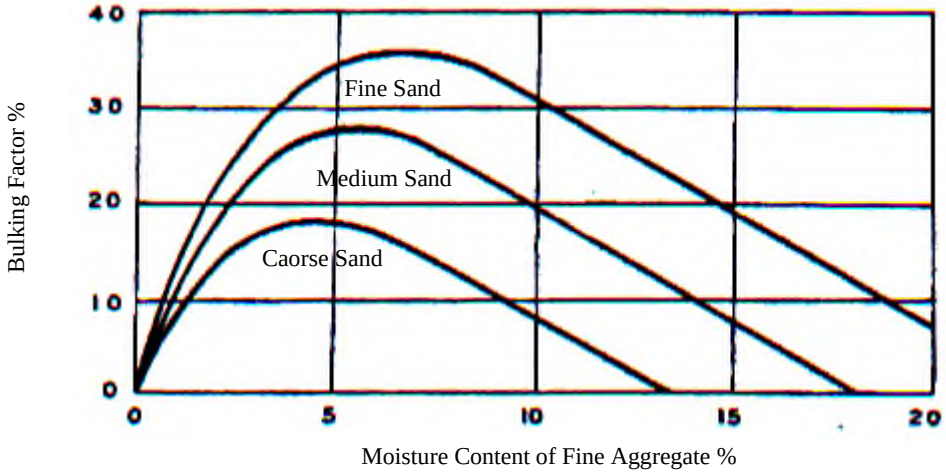


Figure 10-1-2 Bulking Factor of Fine Aggregate

Note :

Estimated Fineness Modulus (FM), according to SNI 03-1749-1990:

1. Coarse Sand = 2.9 – 3.2
2. Medium Sand = 2.6 – 2.9
3. Fine Sand = 2.2 – 2.6

(iii) If temperature control uses granular ice cube or aggregate watering as part of the cooling system, the water contribution shall be taken into account in the correction of water dosing.

(d) Mixing

(i) General

Concrete shall be mixed at the construction site, at a central mixing plant, in a truck mixer, or by a combination of central plant and truck mixing. Hand mixing may be used when approved by the Engineer. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

(ii) Mixing at Site of Concrete Construction

Concrete shall be mixed in a batch mixer of the type and capacity approved by the Engineer. The mixing time for machines of ¾ cubic metre capacity or less shall be longer than 1.5 minutes after all the materials have been introduced into the mixer, for larger machines the time shall be increased 15 seconds for each additional 0.5 cubic metre in size, but in no case shall the mixing time exceed three times the mixing time prescribed above. Charging of water into the mixer shall begin before the cement and aggregates enter the drum. During mixing, the drum shall be operated at speeds specified by manufacturers. Pick-up blades in

the drum of the mixer which are worn down 2 cm or more at any part shall be replaced.

The volume of a batch shall not exceed the manufacturer's rated capacity of the mixer without written permission of the Engineer. No mixer whose rated capacity is less than a one-bag batch shall be used.

Concrete shall be mixed only in such quantities as are required for immediate use, and concrete which is not of the required consistency at the time of placement shall not be used.

Re-tempering of concrete will not be permitted. Entire content of the mixer shall be removed from the drum before materials for the next batch are placed therein. Upon cessation of mixing for a considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete materials placed in the mixer shall contain sufficient sand, cement and water to coat the inside surface of the drum without diminishing the required content of the mix.

(iii) Central Plant Mixing

When mixed at a central plant, the mixer and methods used shall be in accordance with the requirements of Sub-clause S10.01.(3).(c). Mixed concrete shall be transported from the central mixing plant to the site of work in agitator or non-agitator trucks approved by the Engineer.

Unless otherwise permitted in writing by the Engineer, agitator trucks shall be equipped with water-tight, revolving drum, and shall be capable of transporting and discharging concrete without segregation. The agitation speed of the drum shall be between 2 and 6 revolutions per minute. The volume of mixed concrete permitted in the drum shall not exceed the manufacturer's rating nor exceed 70% of the gross volume of the drum. Upon approval of the Engineer, truck mixers may be used in lieu of agitator trucks for transportation of central plant mixed concrete. Gross volume of agitator bodies, expressed in cubic metre, shall be as determined by the mixer manufacturer. The interval between introduction of water into mixer drum and final discharge time shall be as determined by the Engineer. During this interval the mixture shall be agitated continuously.

Bodies of non-agitator trucks shall be smooth and water-tight. Covers shall be provided when needed for protection against rainfall. The non-agitator trucks shall deliver concrete to the work site in a thoroughly mixed and uniform mass. Uniformity shall be deemed satisfactory if samples from the one-quarter and three-quarter points of the load do not differ more than 2.5 cm in slump. Placing of concrete shall be completed within 30 minutes after introduction of mixing water into the cement and aggregates or if admixture is used at a time to be determined by the Engineer.

(iv) Truck Mixing

Concrete may be mixed in truck mixers of approved design. Truck mixing shall be in accordance with the following provisions. The truck mixer shall be either a closed, water-tight, revolving drum or an open-top revolving-blade or paddle type. It shall combine all ingredients into a thoroughly mixed and uniform mass, and shall discharge the concrete with satisfactory uniformity. A maximum difference of 2.5 cm between slumps of samples from the one-quarter and three-quarter points of the discharge load shall be deemed satisfactory.

Mixing speed for revolving drum type mixers shall not be less than 4 revolutions per minute of the drum nor greater than a speed resulting in a peripheral velocity of the drum of 1 metre per second. For the open-top type mixer, mixing speed shall be between 4 and 16 revolutions per minute of the mixing blades or paddles. Agitation speed for both the revolving-drum and revolving blade type mixers shall be between 2 and 6 revolutions per minute of the drum or mixing blades or paddles.

The capacities of truck mixer shall be in accordance with the manufacturer's ratings except that they shall not exceed the limitation herein. Standard for normal rated capacity, expressed as percentage of the gross volume of the drum, shall not be more than 50% for truck mixing and 70% for agitating.

The concrete shall be delivered to the site of the work and discharge shall be completed within 45 minutes after the introduction of the mixing water into cement and aggregates or if admixture is used at a time to be determined by the Engineer.

When the concrete is mixed in a truck mixer, the mixing operation shall begin within 30 minutes after the cement has been mixed with the aggregates. Except when intended for use exclusively as agitators, truck mixers shall be provided with a water measuring device which will measure accurately the quantity of water for each batch. The delivered amount of water shall be within plus or minus 1% of the indicated amount when the tank, if mounted on the truck mixer, is satisfactorily and practically level.

(v) Hand Mixing

Hand mixing will not be permitted, except in case of emergency, without written permission from the Engineer. For non-structural concrete ($f_c' \leq 15$ MPa), when permitted, it shall be performed only on water-tight mixing platforms made of metal, etc. Concrete shall be turned and returned on the platform at least six times and until all particles of the coarse aggregate are covered thoroughly with mortar and the mixture is uniform.

S10.01 (4) Construction

(a) General

The Contractor shall maintain an adequate number of trained and experienced superintendents and foremen at the site to supervise and control the work. All construction, other than the concrete, shall conform to the requirements prescribed in other clauses for the several items of work entering the complete structure.

(b) Foundation

Preparation of foundations shall conform to the details as shown on the Drawings in accordance with the requirements of Clause S5.01. The elevations of the bottoms of footings as shown on the Drawings are approximate only and the Engineer may order further excavation as necessary to obtain satisfactory foundations.

Foundations to be prepared with concrete leveling class E or on rock shall be excavated with a tolerance of 0 - 5 cm. Any excessive exvacation shall be filled with material of the upper layer, and not to be filled with excavated materials.

Pile foundations shall be constructed in accordance with the provisions set out in the other relevant Clauses and as shown on the Drawings.

(c) Falsework

Falsework shall be built on foundations of sufficient strength to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings shall be supported by ample falsework piling provided at the Contractor's expense.

Before constructing falsework the Contractor shall submit detailed drawings and, if required, design calculations of proposed falsework for approval by the Engineer, but such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

In falsework, deflection factor shall be considered in accordance with the Shop Drawings prepared by the Contractor and approved by the Engineer.

(d) Formwork

Before concrete is placed the Engineer shall inspect all formwork and falsework and no concrete shall be placed until the Engineer has inspected and approved such formwork and falsework. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

Internal formwork for hollow slab shall be made of plywood, thin metal plate or other materials. These materials shall have strength sufficient to resist the pressure of fresh concrete and the buoyancy.

Type and structure of joint and cover for the cylindrical form shall be tight to prevent any leakage of concrete and shall be approved by the Engineer. Nominal diameter of cylindrical forms shall be the outer diameter, or the

outer diameter of projecting portion in case of thin metal plate having projection. The height of the projection shall be less than 10 mm.

Internal forms shall be fixed in the correct position such that they will not displace or deform during placing concrete. U-shape bolts shall be used to fix the internal forms and the method of supporting and fixing the internal forms shall be approved by the Engineer. Care shall be taken to ensure that U-shape bolts and other items can resist the buoyancy of the formwork.

In formwork, deflection factor shall be considered in accordance with the Shop Drawings prepared by the Contractor and approved by the Engineer.

Shapes, types, material and strengthening type in the fabrication of false work and formwork as described above, are subject to that positions, vertically and the dimensions of the type of concrete works not exceed the allowable tolerance than as specified in Sub-clause S10.01.(1).(c).

(e) Reinforcement

The Engineer shall inspect and approve all reinforcement in place in accordance with the requirements of Clause S10.02, before concrete is placed. An experienced steel fixer shall be present while all concrete is placed to ensure that no reinforcement becomes displaced during placing and if it does to reposition reinforcement before placing continues.

(f) Placing Concrete

(i) General - All concrete shall be placed within the time specified in Sub-clause S10.01 (3) (f). Concrete shall be placed in such a manner as to avoid segregation and the displacement of reinforcing bars and shall be spread in horizontal layers where practicable. Concrete shall be placed where necessary inside forms by hand shovels and in no instance shall vibrators be so manipulated to transport concrete inside formwork. Care shall be taken to prevent mortar from spattering forms and reinforcing steel and from drying ahead of the final covering with concrete. When spattering has occurred the forms and steel shall be cleaned with wire brushes or scrapers before concrete is placed around steel or in forms which have been spattered.

Troughs, pipes, or short chutes used as aids in placing concrete shall be positioned in such a manner that segregation of the concrete will not occur. All chutes, troughs, and pipes shall be kept clean and free from coating of hardened concrete or mortar.

Concrete shall not be dropped freely over a vertical distance of more than 1.5 meters.

Concrete shall be placed continuously throughout each section of the structure or between indicated joints if shown on the Drawings or as directed by the Engineer.

If in an emergency it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer

may direct and the resulting joint shall be deemed a construction joint, and treated as specified herein below.

(ii) Concrete columns - Concrete in columns or bents shall be placed in one continuous operation unless shown on the Drawings or permitted by the Engineer.

(iii) Concrete slab and girder spans - Slabs and girders having spans of 10 meters or less shall be placed in one continuous operation unless otherwise stated on the Drawings. Concrete preferably shall be deposited by beginning at the centre of the span working from the centre toward the ends.

Concrete in slab spans shall be placed in one continuous operation and in one layer for each span, unless otherwise stated on the Drawings.

Concrete in girders spanning more than 10 meters may be placed in two operations, the first operation being the placing of concrete in the girder stems to the bottom of the slab haunches or the bottom of the slab whichever is applicable. A period of at least 24 hours shall elapse between the completion of placing concrete in the girder and the commencement of placing concrete in slab.

The construction procedure for the concrete deck slab on steel box girders shall be so arranged as to eliminate excessive stress in new or recently placed concrete.

Immediately before placing concrete, the top surface of the previously placed concrete shall be hammered with a sharp hand tool until the aggregate is exposed and cleaned. The Contractor shall check all falsework for shrinkage and settlement, and shall tighten all wedges to ensure minimum deflection of all formwork.

(iv) Walls, piers, etc. - Where walls, piers, columns, struts, posts and other such structural members allow horizontal construction joints, concrete shall not be placed on top of other concrete which has not been allowed to set for 12 hours or more.

Work shall not be discontinued within 45 centimeters of the top of any face, unless provision has been made for a coping less than 45 centimeters thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of the coping.

(v) Culverts - The slabs of box culverts shall be placed for their full depth in one mass or layer and allowed to set not less than 12 hours before any additional work is done on them.

Before concrete is placed in sidewalls, bottom slabs shall be cleaned of all shavings, sticks, sawdust and other extraneous material.

The Contractor shall submit to the Engineer for approval his proposals for pouring culvert walls before commencing culvert construction. Concrete shall not be placed in layers more than

one meter high relative to the concrete already placed. Deposition shall proceed in a systematic manner.

(vi) Depositing concrete underwater - Concrete shall not be deposited in water except with the approval of the Engineer and with his immediate supervision, and by the method described in this paragraph.

To prevent segregation, the concrete shall be carefully placed in a compact mass in its final position by means of a tremie tube or pipe, or a closed bottom-dump bucket, or by other means, and shall not be disturbed after being deposited. Special care shall be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces.

Concrete seals shall be placed in one continuous operation. When a tremie tube or pipe is used, it shall consist of a tube or pipe not less than 25 centimeters in diameter, constructed in sections having flanged couplings fitted with gaskets.

The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the concrete and permit its being lowered rapidly when necessary to choke off or retard the flow.

The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie shall contain sufficient concrete to prevent any water entry.

When concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than 1.20 cubic meters and shall be equipped with loose-fitting top covers. The bottom door shall open freely downward and outward when tripped. The bucket shall be completely filled and be lowered gradually and carefully until it rests on the surface upon which the concrete is to be deposited. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Dewatering shall proceed only when the concrete seal is considered strong enough to withstand any pressures to be exerted upon it. This time will be decided by the Engineer. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, jetting, chipping or other means which will not unduly injure the seal.

(vii) Construction joints - Construction joints shall be located where shown on the Drawings or permitted or instructed by the Engineer. Construction joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear.

At horizontal construction joints, details shall be as approved by the Engineer. Before placing fresh concrete, the surfaces of construction joints shall be sandblasted or washed and scrubbed with a wire brush to expose clean aggregate, drenched with water until saturated, and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place. Concrete in substructures shall be placed in such a manner that all horizontal construction joints will be truly horizontal.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through panelled wing walls or other large surfaces which are to have an architectural finish.

Necessary dowel, load-transfer devices, and bonding devices shall be placed as shown on the Drawings or directed by the Engineer.

(viii) Expansion joints - Expansion joints shall be asphaltic joint filler, 20 mm thick, and shall be located and formed as required on the Drawings. Asphaltic joint filler shall be measured and paid for as provided at Pay Item 10.01 (21).

Cut-off plate for water stops used for the expansion joints shall be flexible PVC to SNI 06-0162-1987 and SNI 06-0178-1987 or according to ASTM D2665-14 with basic materials made of virgin PVC compounds that meet the 12454 class according to ASTM D1784-11 and shall be placed in accordance with the Drawings.

The water stops shall be held firmly in place to prevent displacement during concreting. If after placing concrete water stops are materially out of position or shape, the surrounding concrete shall be removed, the water stop reset, and the concrete replaced, all at the Contractor's expense.

Water stop shall be furnished full length for each straight portion of the joint, without field splices. Water stop shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion. All field splices shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations to form continuous watertight joints.

Water stop shall be measured and paid for as provided at Pay Item 10.01 (20).

(ix) Open joints - Open joints shall be constructed where shown on the Drawings by insertion and subsequent removal of a wooden strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the Drawings.

(x) Steel joints - The plates, or other structural shapes shall be accurately shaped at the shop to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of the specifications covering those items. When called for on the Drawings or in the Specifications, the material shall be galvanized in lieu of painting. Care shall be taken to ensure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the Drawings at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

(xi) Anchor bolts - All necessary anchor bolts in piers or abutments shall be accurately set in holes formed while the concrete is being placed. Holes may be formed by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices, and withdrawing them after the concrete has partially set. Holes so formed shall be at least 10 cm in diameter. Bolts shall be set accurately and fixed with grout completely filling the holes. The grout shall be non-shrink mortar of a type approved by the Engineer.

Anchor bolts used in connection with expansion shoes, rollers, and rockers shall be located with due regard to the temperature at the time of erection. Care shall be taken that full and free movement of the superstructure at the moveable bearings is not restricted by improper setting or adjustment of bearings or anchor bolt and nuts.

(xii) Shoes and bearing plates - Bridge seat bearing areas shall preferably be finished high and ground to level required. Shoes and bearing plates shall be set as provided in Clause S10.11.

(xiii) Drainage holes and weep holes - Drainage holes and weep holes shall be constructed in the manner and at the locations indicated on the Drawings or required by the Engineer. Ports or vents for equalizing hydrostatic pressure shall be placed below low water.

Forms for weep holes through concrete shall be PVC pipe. Exposed surfaces of weep drain pipe shall be flush with the concrete.

(xiv) Pipe, conduits, and ducts - Pipes, conduits, and ducts that are to be encased in concrete shall be installed by the Contractor before the concrete is placed. Unless otherwise indicated, pipe embedded in concrete shall be standard, light weight, non-corrosive pipes. Pipes shall be held or braced rigidly during concrete placement in order to prevent their displacement.

(xv) Piers and abutments - No superstructure load shall be placed upon finished bents, piers, or abutments until the Engineer so directs, but the minimum time allowed for the hardening of concrete in the

substructure before any load of the superstructure is placed thereon shall be 7 days when normal Portland cement is used.

(g) Control Temperature of Mass Concrete

(i) Control of Material Composition

Control of material composition to produce the maximum concrete temperature required shall be proven by the measuring the temperature of test object (mock up) with a minimum size in accordance with the structural elements to be carried out.

(ii) Mechanical Cooling System

If the Contractor chooses to use a mechanical cooling system, it shall be planned according to the temperature control plan with the following requirements:

- The mechanical cooling system shall be located inside of concrete elements and when the concrete has reached the required age, the joint in surface to the cooling pipe shall be discharged to a depth of 10 cm from the surface.
- Formwork shall be planned so that the opening does not interfere the monitoring of cooling system and temperature.
- The cooling pipes shall not break or sag during concrete casting and shall be guaranteed to be protected from movement. Broken cooling pipes shall be replaced immediately.
- Mechanical cooling systems shall be tested at 30 psi for 30 minutes to ensure no leak before concrete casting.
- Cooling circulation shall be carried out when casting commences, and after the cooling process completes the cooling pipe shall be immediately grouted with a grouting mixture without shrinkage in accordance with ASTM C1107-17 for 0.0 percent shrinkage and ASTM C-827-16 for 0.0 - 4.0 percent change. Grouting shall be carried out in accordance with the manufacturer's recommendations.
- After opening the joint in surface to the cooling pipe, the hole shall be patched with mortar.

(iii) Temperature Monitoring and Recording System

Temperature monitoring and recording systems shall consist of temperature sensors which connected to a data collection system and it is able to print, save and download data to a computer. The temperature sensor shall be placed so that the maximum temperature difference of concrete can be observed. At least, the concrete temperature shall be observed at the hottest location based on the computation or at the center of mass, and minimum 2 outer walls or at a depth of 50 mm from the outer surface and approved by the Engineer.

(iv) Temperature Readings

Temperature readings shall be automatically recorded every hour or faster. A set of backup sensors shall be installed closed to the main sensor. Backup sensors shall be able to be recorded, but recording is not necessary if the main sensor is working properly. The temperature reading can be stopped if the difference temperature between the concrete with the average daily air temperature is less than the allowable temperature difference for three consecutive days and there is no casting mass concrete of adjacent to this concrete. Data shall be printed and submitted to the Engineer every day.

(v) Sensor Protection

The method of compacting mass concrete shall be able to protect the temperature monitoring and reading system. The cable of temperature sensor which installed in the concrete shall be protected from any movement. The length of cable shall be as short as possible. The edges of the temperature sensor shall not be in contact with the formwork or reinforcement.

(vi) Tool Failure

If the tool for temperature monitoring and recording system is damage during the implementation of mass concrete, the Contractor shall immediately carry out the repairs in accordance with the Temperature Control Plan. Failure to meet temperature monitoring requirements will cause the rejection of concrete work.

(vii) Allowable Temperature (includes the acceptance criteria)

Mass concrete works shall meet the following acceptance criteria and temperature requirements:

- The maximum allowable temperature is 71°C;
- The allowable temperature difference is not more than 21°C, unless it can be proven by an analysis that the concrete structure is able to accommodate temperature differences greater than 21°C.

(viii) Failure to Meet Temperature Requirements

If the Contractor fails to meet the maximum temperature requirements as required in Sub-clause S10.01 (6) (h) of these Specifications, the related concrete element shall be rejected. Rejected concrete shall be removed at the expense of the Contractor. The Contractor shall modify the Temperature Control Plan and planning computation to resolve the problem and submit the revised Temperature Control Plan.

(ix) Grace Period

The Contractor will be given of the 15 days to review the revised Temperature Control Plan. Concrete casting shall not be carried out before the Engineer approves the revised Temperature Control

Plan. There is no additional or extra for any rejection of structural elements or correction of Temperature Control Plan.

(h) Consolidation

(i) Concrete shall be consolidated with approved internal or external mechanical vibrators. When required, and when approved by the Engineer, vibrating shall be supplemented by hand rod with suitable tools to assure proper and adequate consolidation. Vibrators shall not be used to transport concrete from point to point inside the forms.

(ii) Care shall be taken during consolidation to ensure that all corners and spaces between and around reinforcing bars are properly filled without displacement of the reinforcing cage and that all voids and air bubbles are filled with concrete.

(iii) Vibration shall be limited to the time necessary to produce satisfactory consolidation without causing segregation of aggregates.

(iv) External mechanical vibrators shall be capable of producing at least 5000 cycles per minute with an effective weight of 0.25 kg, and able to be located on the form work so as to produce even vibrations.

(v) Internal mechanical vibrators shall be of the pulsating type and shall be capable of producing at least 5000 cycles per minute when used in concrete that has a slump of 2.5 cm or less, with vibrated radius area shall not be less than 45 cm.

(vi) Each internal vibrator shall be inserted into the wet concrete vertically so that it penetrates to the bottom of the freshly placed concrete and provides consolidation throughout the full depth of the section. The vibrator shall then be withdrawn slowly and inserted again at an adjacent position no more then 45 cm away. Vibrators shall not remain for more than 30 seconds in one location, shall not be used to move concrete to adjacent locations and shall not be allowed to touch the reinforcing.

(vii) The minimum number of internal mechanical vibrators shall be as shown on the following Table 10-1-8.

Table 10-1-8 Minimum Number of Internal Mechanical Vibrator

Concreting Speed (m^3/hour)	Vibrator Number
4	2
8	3
12	4
16	5
20	6

(viii) A more detailed requirement of vibrator head diameter (mm), recommended frequency (Hz), average amplitude (mm), vibrating

radius (mm), casting speed (m3/hour/ vibrator) and the guidance of implementation can be adopted from Table 5.1 ACI Committee Report : Guide for Consolidation of Concrete 309R-05 ACI Manual of Concrete Practice - 2006 Part.2.

(i) Curing Concrete

Immediately after forms have been removed and finishing completed, all concrete shall be cured by one of the following methods. The Engineer will specify the concrete surface which may be cured by either method.

(i) Water method - The entire exposed surfaces other than slabs shall be protected from the sun and the whole structure shall be covered with wet burlap, cotton mats, or other suitable fabric for a period of at least seven days. These materials shall be kept thoroughly wet for the entire curing period. Curbs, walls, and other surfaces requiring a rubbed finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible. All concrete slabs shall be covered as soon as possible with sand, earth or other suitable material and kept thoroughly wet for at least seven days. This covering material shall not be cleared from the surface of the concrete slabs for a period of twenty one days.

If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent them from shrinking.

(ii) Membrane - forming curing compound - All surfaces shall be given the required surface finish prior to application of the curing compound. During the finishing period, the concrete shall be protected by the water method of curing.

Membrane curing compound shall be applied after the removal of forms, or after the disappearance of surface water. It shall be sprayed on the concrete surface in one or more coats at the rate instructed by the manufacturer.

Should the membrane seal be broken or damaged before the expiration of the curing period, the damaged area shall be immediately repaired by the application of additional membrane material.

The Contractor's proposals for the use of liquid membrane curing compound and the locations shall be subject to the approval of the Engineer.

Curing of mass concrete is carried out by taking into account the initial setting time of cement. Immediately after initial setting time passed, the curing of casting mass concrete shall be carried out by spraying the curing compounds to retain heat that conforms to ASTM C309:2012 or SNI ASTM C309: 2012. Curing membrane which has a function as a cover shall have a heat resistance rate of 0.5 hour-foot^2/BTU.

First curing of mass concrete using a curing coumpounds to be carried out after the initial setting time passed. The other curings may be carried out after application of the curing compounds complete. The difference temperature between the air and the concrete surface temperature shall not more than 11°C.

(j) Steam Curing

(i) Steam curing may be used to get high early strength. Additive material shall not be permitted unless otherwise approved by the Engineer.

(ii) Steam curing shall be applied continuously until the concrete reaches 70 % of its 28-day design strength. Steam curing shall follow the requirements below:

- Steam pressure shall not exceed atmospheric pressure
- The temperature shall not exceed 38 °C within 2 hours after concreting, and may gradually increase to 65 °C, with a maximum rate of increase of 14 °C/hour.
- The temperature difference between two locations on the steamer shall not exceed 5.5 °C.
- The rate of temperature decrease during the cooling down period shall not exceed 11 °C/hour.
- The concrete temperature at the time of removal from the steamer shall not differ by more than 11 °C from the air temperature.
- During steam curing, the steamer shall always be in a saturated condition.
- After finishing steam curing, each part of the structure shall be kept wet for 4 days.

(iii) The Contractor shall ensure that the equipment is in good working condition and the temperature in the steamer can be adjusted in accordance with the above requirements and variations in the weather.

(iv) The steam pipe shall be located, and the beam protected such that steam will not be directly sprayed on the concrete, as this may cause temperature differences between adjacent concrete parts.

(k) Removal of Formwork and Falsework

(i) Time of removal - Formwork and falsework shall not be removed without the approval of the Engineer. The Engineer's approval shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the same time as the forms and in no case shall any portion of the wood forms be left in the concrete.

Falsework removal for continuous or cantilevered structures shall be as directed by the Engineer or shall be such that the structure is gradually subjected to its working stress.

When the time for removal of forms and supports is determined based on concrete strength tests, such removal shall not begin until the concrete has attained the percentage of the specified design strength shown in the table below.

If field operations are not controlled by compressive strength tests, the time shown below for removal of forms and supports shall be used as a minimum:

Table 10-1-9 Minimum Days for Removal of Forms and Supports

	Standard Concrete	Early Strength Concrete	Percentage Design Strength
Centering under girders, beams, frames or arches	14 days	7 days	80%
Floor slabs	14 days	7 days	70%
Walls	1 day	12 hours	-
Columns	2 days	1 day	-
Side of beams and all other vertical surfaces	1 day	12 hours	-

In continuous structures, falsework shall not be released in any span until the first and second adjoining spans on each side have reached the strength specified herein or in the special provisions. When cast-in-place post tensioned bridges are constructed, falsework shall remain in place until all post tensioning has been accomplished.

Falsework under all spans of continuous structures shall be completely released before concrete is placed in railings and bridge parapets.

Forms and falsework shall not be released from under concrete without first determining if the concrete has gained adequate strength without regard to the time element. In the absence of strength determinations, the forms and falsework are to remain in place until removal is permitted by the Engineer.

The forms for footings constructed within cofferdams or cribs may be left in place when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the finished structure. All other forms shall be removed whether above or below the ground line or water level.

All formwork shall be removed from the cells of concrete box girders within which utilities are required, and all formwork except that necessary to support the deck slab shall be removed from the remaining cells of the box girder.

To facilitate finishing, forms used on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed at least 12 but not more than 48 hours later depending upon weather conditions.

In order to determine the condition of concrete in columns, forms to columns shall always be removed before releasing supports from beneath beams and girders.

Falsework supporting the deck of rigid frame structures shall not be removed until fill has been placed behind the vertical legs.

(ii) Patching - Immediately following removal of the forms all projecting wires or metal devices that have been used for holding the forms in place shall be removed or cut back at least 2.5 cm beneath the surface of the concrete. Fins or runs of mortar and all irregularities caused by form joints shall be removed. Small holes, depressions, and voids that show on the concrete shall be filled with cement mortar mixed in the same proportions as that used in the body of the work, except without coarse aggregate.

The surface of this mortar shall be floated with a wooden float before initial set takes place. It shall be uniform in colour with the surrounding concrete and neat and workmanlike in appearance.

(iii) Cause for rejection - Excessive honeycombing shall be sufficient cause for rejection of portions of the structure containing this honeycombing. The Contractor, on receipt of written orders from the Engineer, shall remove and rebuild such portions of the structure at his own expense.

(l) Finishing Concrete

All concrete surfaces exposed in the completed work shall comply with the requirements of (iii) Ordinary finish except where otherwise shown or specified.

(i) Concrete decks - Immediately after placing concrete, concrete decks shall be struck off with templates to provide proper transverse sections and shall be hand finished smooth to the concrete levels. Finish shall be slightly but uniformly roughened by brooming. The finished surface shall not vary more than 10 millimeters from a 4 meter straightedge placed parallel to the centreline of the roadway and 10 millimeters from a transverse template cut to the true cross section of the roadway.

(ii) Curb and footpath surface - Exposed faces of curbs and footpath shall be finished true to lines and grades. The curb surface shall be wood floated to a smooth but non-slippery finish. Footpath surfaces shall be slightly but uniformly roughened by brooming across the direction of travel. Flatteness of surfaces as measured using a 3 meter straightedge laid on the top or face of the curb or

on the surface of gutters shall not vary more than 3 mm from the edge of the straightedge, except at grade changes or curves

(iii) Ordinary finish - An ordinary finish is defined as the finish left on a surface after the removal of the forms when all holes left by form ties have been filled, and any minor surface defects have been repaired. The surface shall be true and even, free from depressions or projections and of reasonably uniform colour.

Repaired surfaces, the appearance of which is not satisfactory, shall be "rubbed" as specified in Item (iv) Rubbed finish.

The concrete in bridge seats, caps, and tops of walls shall be struck off with a straightedge and floated to true grade. Unless shown on the Drawings the use of mortar topping for concrete surfaces will not be permitted.

(iv) Rubbed finish - After the removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in patching to set thoroughly. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as those used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour.

After the final rubbing has been completed and the surface has dried, it shall be rubbed with burlap to remove loose particles and laitance. The final surface shall be free from all unsound patches, paste, powder and objectionable marks.

On the concrete surface either the exposed surface or the covered surface that flatteness tolerances allowed are as follows:

(1) Flatteness of covered vertical surfaces:

- Tolerance for offset at form joint ..… 3 mm
- Tolerance on flatness ……. 5 mm over 2 m

(2) Flatteness of exposed vertical surfaces :

- Tolerance for joint offset …..…… 0 mm
- Tolerance on flatteness …..……. 5 mm over 2 m

(v) Backfill and road fills - All spaces which have been excavated and the volumes of which are not occupied by the concrete structure

shall be backfilled and compacted with acceptable material in accordance with the provisions of Division 5 of these Specifications.

If there is likelihood of water accumulating behind any wall, the backfill shall not be placed until after the retaining, diaphragm, or spandrel walls are 28 days old. No fill shall be placed over arches and slabs until the concrete is 28 days old or until test specimens indicate the concrete has attained the required 28-day strength.

(vi) Loadings - Traffic or heavy construction equipment shall not be allowed on reinforced concrete structures until 28 days have elapsed from the last placing of concrete except as noted below. If it is proposed to use the structure at an earlier date, extra test specimens shall be cast. The structure may be used when tests of these specimens show that the concrete has attained its specified 28-day strength.

(m) Adhesive

(i) Construction Method

(1) Smoothing Treatment of Jointing Surface

The block surface to which adhesive is to be applied shall be wire brushed till smooth, removing any sheath ends that may be projecting beyond the jointing surface.

(2) Dust Removal and Degreasing

After treating the jointing surface to a smooth and flat surface, dust and dirt shall be removed using compressed air or other means. If any form of releasing agent or grease has been deposited, the surface shall be degreased using an organic solvent.

(3) Drying of Bond Surface

After separating the form from the PC block, the surface shall be covered with a sheet cover, etc., as protection against rainwater, in order to maintain the bonded blocks in a dried condition. If bonding work shall be performed when the PC blocks to be bonded are in a wet condition, forced drying by means of a torch lamp, gas burner, etc., shall be performed.

(ii) Application of Adhesive

(1) Mixing and Stirring

On completion of surface treatment, the base agent and hardener shall be mixed according to the specified mix proportion and thoroughly stirred.

(2) Application Method

The adhesive is to be applied thoroughly to both bonding surfaces using a rubber, or metallic spatula. The optimum

coat thickness for each concrete surface is about 1 mm and the adhesive should ooze out beyond the joints when the blocks are jointed and prestressing is introduced.

(3) Jointing

The air temperature during block jointing should preferably be in the range from 5 - 35 degrees celsius and work should proceed so that the first prestressing should be completed at least within the adhesive's pot life time. Since with the introduction of prestressing, the adhesive will ooze out beyond the joints, and at the same time, will be pushed inside the sheath, it is advisable to leave an uncoated area of 10 - 20 mm around the sheath.

Satisfactory results can be obtained also by covering the sheath holes by means of gum tape, etc.

(4) Curing

For at least 24 hours after bonding, the jointed section should be protected against rainwater or excessive impact.

(n) Cyclopean Concrete

Cyclopean concrete shall consist of Class fc' 15 MPa containing large embedded stones. The stones shall be carefully placed and shall not be dropped into place. They shall be cast to avoid damage to the forms or to the partially set adjacent masonry. Stones shall be washed and saturated with water before placing. Total volume of stone shall not be greater than 1/3 of total volume of cyclopean concrete.

For retaining walls or piers greater than 60 cm thickness, stone having a maximum size of 25 cm may be used. Each stone shall be surrounded by at least 15 cm of concrete and no stone shall be closer than 30 cm to any top surface nor closer than 15 cm to any coping

(o) Cleaning Up

Upon completion of structure and before final acceptance, the Contractor shall remove all falsework, falsework piling, etc., down to 1.0 meter below the finished ground line. Excavated, or useless materials, rubbish, etc. shall be removed from the site and the site shall be left in a neat and presentable condition satisfactory to the Engineer.

(p) Storage of precast concrete units.

Precast concrete unit shall be stored or stacked on site after removal from forms so that no distortion or bending of the units shall occur. Where units are stacked on the ground, the surface of the ground shall be level and be of such hard material that no softening of the soil, or settlement of the stack, will occur when the ground becomes wet. Two timber bearers (of minimum section 50 mm by 100 mm) will be placed on the ground and be firmly seated and made level and parallel before any precast units are placed on them. Timber pallets may be used instead of the two bearers with the approval of the Engineer.

Care will be taken to avoid any damage to the precast concrete units during handling and storage. Any units which are damaged shall be rejected and removed from the site of works.

S10.01 (5) Field Quality Control

(a) Accepted Materials

The accepted materials (water, cement, aggregates and additives required) shall be checked by the Engineer by examining written evidence indicating that the materials conform to the requirements of Sub-clause S10.01 (2).

If the quantity materials required are sufficient by continuous shipment, then as the engineer direction, for aggregate coarse and fine aggregate the Contractor shall carry out a periodic testing during construction with a maximum interval of 1000 m^3 for gradation and a maximum of 5000 m^3 for abrasion test, and for the cement with maximum interval of 300 ton each for delivery. But if in the opinion of the Engineer there is an indication of quality change or the nature of material used, the Contractor shall promptly carry out the additional tests before the material to be used.

(b) Testing for Workability

One slump test or more as directed by the Engineer, shall be carried out on every batch of concrete produced, and the test shall not be deemed to have been carried out unless witnessed by the Engineer or his representative.

If the concrete mixture does not conform to the proposed workability, it shall not be used for the work, unless in some cases, the Engineer approves their limited use and the quality of concrete remains maintained. Workability and textures shall be such that the concrete may be placed for the work without forming hollow spaces or gaps or retention of air or water bubbles, and when the formwork to be removed the surface results shall be flat, smooth and dense.

(c) Compressive Strength Testing

(i) The Contractor shall obtain a number of compressive strength test results from the concrete works carried out. Each result is the average of a pair compressive strength of the specimens in one set specimens (1 set = 3 test specimens), the different of a pair results shall not more than 5% for each age, for each compressive strength required and for each type of structural component placed separately for each day placement.

(ii) For the purpose of concrete compressive tests, the Contractor shall provide a cylindrical specimen with a diameter of 150 mm and a height of 300 mm and shall be cured in accordance with AASHTO T23-14 or SNI 4810:2013. The test specimen shall be prepared and taken together from the concrete to be placed, and then cured in accordance with the curing in the laboratory.

(iii) For the purposes of concrete quality evaluation as the basis of payment, the concrete compressive strength test results in accordance with the age specified in the Contract shall be evaluated. Test results at ages other than those specified in the Contract may only be used for purposes other than the purpose of concrete quality evaluation as the basis for payment. The ratio values used for this purpose shall be adjusted to the development chart of compressive strength as a function of time.

(iv) For mixing manually, concrete work with the amount of each class of ≤ 60 m^3, one test shall be provided for maximum of each 5 m^3 with minimum one test per day. In all cases, the number of tests shall not be less than four for each age. If the concrete work reaches > 60 m^3, then maximum of each 10 m^3 for the subsequent concrete after the amount of 60 m^3 is achieved at least one test.

(v) For placement of ready mixed production, concrete work with the amount of each class of ≤ 60 m^3, one test shall be provided randomly for maximum of each 15 m^3 of concrete at random, with a minimum one test per day. In all cases, the number of tests shall not be less than four for each age. If the concrete work reaches > 60 m^3, then for maximum of each 20 m3 of subsequent concrete after the amount of 60 m^3 is achieved at least one test.

(vi) All concrete used in the work shall conform to the compressive strength as specified in Sub-clause S10.01.(1).(b) of these Specifications.

(vii) <u>The characteristic strength shall be calculated by the equation:</u>

$$fcc = fc'm - K.S$$

$$fcm = \frac{\sum_{i=1}^{n} fc'i}{n}$$ is means compressive strength

$$S = \sqrt{\frac{\sum_{i=1}^{n} (fc'i - fc'm)^2}{n-1}}$$ is standard deviation

where:

n = number tests

fcc = characteristic strength

fc'm = average test strength

fc'i = result of the test on the specimen

K = 1.645 for the reliability of 95%.

S = standard deviation

Note:

The parameters of fck, fc'm and fc'i to be used for cylindrical specimens with a diameter of 150 mm and a height of 300 mm.

(viii) Strength Requirements

The concrete class and the quality of the construction deemed acceptable, if they fulfilled by the following conditions:

(1) No more than 5% of minimum 30 test specimens values consecutive results less than fc'.

(2) If after the placement is complete for each concrete class, the minimum number of specimens shall be collected, then the consecutive results of the specimen shall fulfill the $fcc > fc'm$

(3) If the test specimens collected is less than the prescribed minimum number (30 samples), the standard deviation (S) value shall be increased by the modification factor given in Table 10-1-10.

Table 10-1-10 Modified Factor of Standard Deviation

Number Test	**Modified Factor**
< 15	Refer Table 10-1-11 or 10-1-12
15	1.16
20	1.08
25	1.03
>30	1.00
Interpolation for intermediate number of tests. Modified standard deviation to be used to determine required average strength, fc'r, from Table 10-1-11	

If the number of specimens less than 15 and the field compressive strength test records are available, the required average compressive strength fc'r used as the basis for selection of concrete proportions shall be determined using a standard deviation calculated in accordance with Table 10-1-11, then the standard deviation of Specimens will be computed in accordance with the formula specified in Sub-clause S10.01.(5).(c).(vii).

The detailed calculation of standard deviation is shown in Sub-clause 4.2.3 of SNI 6880:2016

Table 10-1-11 Required Average Compressive Strength for the number of specimens less than 15 and the field compressive strength test records are available.

Specified compressive strength (MPa)	Required average compressive strength (MPa)
$fc' \leq 35$	Use the larger value, computed from the formula (10-1) and (10-2) $fcr' = fc' + 1.34\ S$ (10-1) $fcr' = fc' + 2.3\ S - 3.5$ (10-2)
$fc' > 35$	Use the larger value, computed from the formula (10-1) and (10-3) $fcr' = fc' + 1.34\ S$ (10-1) $fcr' = 0.90\ fc' + 2.33\ S$ (10-3)

When a concrete production facility does not have field strength test records for calculation of standard deviation meeting requirements of the above mentioned, required average strength fc'r shall be determined from Table 10-1-12 and documentation of average strength shall be in accordance with requirements of Sub-clause S10.01.(c).(viii).(4).

Table 10-1-12 Required Average Compressive Strength when data are not available to establish a standard deviation

Specified compressive strength (MPa)	Required average compressive strength (MPa)
$fc' < 21$ MPa	$fcr' = fc' + 7$
21 MPa $\leq fc' \leq 35$ MPa	$fcr' = fc' + 8{,}3$
$fc' > 35$ MPa	$fcr' = 1{,}1\ fc' + 5$

(4) For the number of test specimens less than the minimum as described in Table 10-1-11 and do not meet the fc'r requirements as described in Table 10-1-12 so if it is not able to be carried out based on statistical mathematic method, no more than one result of average of four consecutive specimens, *fcm,4*, less than 1.15 fc'. Individual test result shall not be less than 0.85 fc'.

(ix) If the calculation result of compressive strength indicates that the bearing capacity of structure is less than the required, then if the concrete placement has not been completed, the concrete placement shall be stopped immediately and a core drilling test shall be carried out on the doubtful area based on the standard test guidance. When the core drilling test to be carried out, at least 3 (three) test specimens shall be taken in the locations which do not harm to the structure and upon approval of the Engineer. None of the concrete core test objects has a strength of less than 0.75fc'. If the average compressive strength of the concrete core test is not less than 0.85fc', then the remaining part of construction is able to be considered acceptable and the work to be suspend is able be continued. In this case, the difference strength for the certain

concrete age when testing and the concrete strength required shall be taken into account and this correction required to determine the compressive strength of the related concrete placement.

If the test using core specimens is not possible, then an UPV (ultra pulse velocity) test in accordance with ASTM C597-16 may be used and approved by the Engineer. The correction factor for the UPV results follows the manual of the manufacturer

(x) If the test results as specified in Sub-clause S10.01 (5).(c).(ix) do not conform to the requirements, the Contractor shall carried out the direct loading test with full expertise. If from this test obtained a deflection values and/or strain less than the allowable on the service loading, then the remaining construction part is able be considered acceptable. But if the test results do not conform to the required value, then the remaining construction part is able to be maintained only and this suspension work is able to be continued after one or both following actions being fulfilled without prejudice to its function:

- make changes to the original plan so that the load effect of on the construction may be reduced;
- carry out the strengthening to the construction part in a responsible manner;

If both actions are not able to be carried out, then with an instruction from the Engineer, the Contractor shall demolish the unacceptable concrete and immediately remove this demolition material from the site.

S10.01 (6) Method of Measurement

Concrete shall be measured by the number of cubic meters of the several classes complete in place and accepted. In computing quantities, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer but the measurement shall not include any concrete used for the construction of temporary works. No deduction from the measured quantity shall be made for the volume occupied by pipes less than 20 cm in diameter nor for reinforcing steel, anchors, conduits, weep holes or piling except that deductions will be made for the volume of structural steel, including steel piling, encased in concrete. The measurement shall not include any concrete used in the construction of cofferdams or falsework, or the volume of forms or falsework.

No pay allowance shall be made for any increased cement content, for any admixtures, nor for any finishing of any description of concrete or concrete floor. Any class B concrete permitted to be constructed where class C or D concrete was specified shall be measured for payment as class C and D concrete, respectively. Any class C concrete permitted to be constructed where class D concrete was specified shall be measured for payment as class D concrete.

Precast plate for deck slab shall not be measured for payment but will be considered to be included in the unit price of reinforced concrete deck slab otherwise shown in the Drawings

Concrete used for the Pay Items in Division 6, 12 and 13 (except foundation for high mast lighting pole) and for the Pay Items 10.03, 10.04, 10.05, 10.07, 10.09 and 10.10, of these Specifications will not be measured separately for payment under this Clause S10.01.

The quantities of reinforcing steel and other Contract items which are included in the completed and accepted structure shall be measured for payment as described for the separate items involved.

S10.01 (7) Basis of Payment

The work measured as provided above for the class or classes of concrete specified, shall be paid for at the Contract unit price per cubic meter for concrete as detailed below. The payment shall be full compensation for furnishing and placing all materials, including all labour, tools, equipment, formwork, falsework (scaffolding and supporting), including piling of formwork for beams and slabs; for mixing, placing, finishing and curing the concrete, etc., and all incidental work thereto including the provision and construction of drainage falls and systems and weepholes. The supply, fixing and finishing of expansion joints and reinforcing steel shall be paid for separately and is not included in the payment for concrete.

Pay Item No. and Name		**Unit of Measurement**
10.01(1)	Structural Concrete Class A-1 (PC Box Girders)	Cubic Meter
10.01(2)	Structural Concrete Class A-2-1 (PC T-Girders)	Cubic Meter
10.01(3)	Structural Concrete Class A-2-2 (PC Pier Heads of Y-Type Piers)	Cubic Meter
10.01(3a)	Structural Concrete Class A-2-3 (PC Pier Heads of T-Type Piers)	Cubic Meter
10.01(3b)	Structural Concrete Class A-2-4 (PC Pier Heads of Portal Piers)	Cubic Meter
10.01(3c)	Structural Concrete Class A-2-5 (PC Pier Heads)	Cubic Meter
10.01(3d)	Structural Mass Concrete Class A-2	Cubic Meter
10.01(4a)	Structural Concrete Class B-1-1a (RC Deck Slabs of PCU/PCI-Girders)	Cubic Meter
10.01(4b)	Structural Concrete Class B-1-1b (RC Deck Slabs of Steel Box Girders)	Cubic Meter
10.01(5)	Structural Concrete Class B-1-2 (Diaphragms of PCU/PCIGirders)	Cubic Meter

10.01(5a)	Structural Concrete Class B-1-3a (RC Pier Heads)	Cubic Meter
10.01(5b)	Structural Concrete Class B-1-3b (RC Pier Heads as Pile Slab)	Cubic Meter
10.01(5c)	Structural Mass Concrete Class B-1	Cubic Meter
10.01(5d)	Self Compacted Concrete Class B-1	Cubic Meter
10.01(6)	Filling Concrete Class B of PC-Void	Cubic Meter
10.01(7a)	Structural Concrete Class B-1-4a (RC Columns of Wall-Type Piers)	Cubic Meter
10.01(7b)	Structural Concrete Class B-1-4b (RC Columns of Y-Type Piers)	Cubic Meter
10.01(7c)	Structural Concrete Class B-1-4c (RC Columns of T-Type Piers)	Cubic Meter
10.01(7d)	Structural Concrete Class B-1-4d (RC Columns of Portal Piers)	Cubic Meter
10.01(7e)	Structural Concrete Class B-1-4e (RC Columns of Piers of Ramps)	Cubic Meter
10.01(7f)	Structural Concrete Class B-1-4f (RC Columns of Piers)	Cubic Meter
10.01(8)	Structural Concrete Class B-1-5 (RC Piled Slabs)	Cubic Meter
10.01(9)	Structural Concrete Class B-1 (Concrete Barriers)	Cubic Meter
10.01(10)	Structural Concrete Class C-1 (Abutments, Pier Footings, Retaining Walls, Approach Slabs, Planting Box)	Cubic Meter
10.01(11)	Structural Concrete Class C-2 (Box Culverts and Box Underpass)	Cubic Meter
10.01(12)	Structural Concrete Class C-3 (Curbs)	Cubic Meter
10.01(13)	Structural Concrete Class C-4 (Precast Plates for Slabs)	Cubic Meter
10.01(13a)	Structural Mass Concrete Class C	Cubic Meter
10.01(13b)	Self Compacted Concrete Class C	Cubic Meter
10.01(14)	Structural Concrete Class D	Cubic Meter
10.01(15)	Structural Concrete Class E	Cubic Meter
10.01(16)	Cut Off Plate for Water Stop	Linear Meter

10.02 Reinforcing Steel Bars

S10.02 (1) Description

This work shall consist of furnishing, fabricating, and placing reinforcing steel bars of the type and size provided in accordance with these Specifications and in reasonably close conformity with the Drawings or as directed by the Engineer.

S10.02 (2) Materials

(a) Reinforcing Steel

(i) Reinforcing steel shall be plain or deformed billet steel bars in accordance with the Drawings and conforms to Table 10-2-1 below:

Table 10-2-1 Yield Stress of Reinforcing Steel

Reinforcing Steel Grade	**Tensile Test**			
	Yeild Strength (YS)		**Tensile Strength (TS)**	**Elongation in 200 mm Min.**
	MPa		**MPa**	**%**
BjTP 280	Min.280	Max.405	Min.350	11 (d ≤ 10 mm)
				12 (d ≥ 12 mm)
BjTS 280	Min.280	Max.405	Min.350	11 (d ≤ 10 mm)
				12 (d ≥ 13 mm)
BjTS 420A	Min.420	Max.545	Min.525	9 (d ≤ 19 mm)
				8 (22 ≤ d ≤ 25 mm)
				7 (d ≥ 29 mm)
BjTS 420B	Min.420	Max.545	Min.525	14 (d ≤ 19 mm)
				12 (22 ≤ d ≤ 36 mm)
				10 (d > 36 mm)
BjTS 520	Min.520	Max.645	Min.650	7 (d ≤ 25 mm)
				6 (d ≥ 29 mm)
BjTS 550	Min.550	Max.675	Min.687,5	7 (d ≤ 25 mm)
				6 (d ≥ 29 mm)
BjTS 700	Min.700	Max.825	Min.805	7 (d ≤ 25 mm)
				6 (d ≥ 29 mm)

Catatan:

d : nominal diameter of reinforcing steel

BjTP : Reinforcing Steel Plain Bars (*Baja Tulangan Polos*)

BjTS : Reinforcing Steel Deformed Bars (*Baja Tulangan Sirip*)

(ii) Welded wire mesh reinforcement shall be in accordance with AASHTO M55M/M55-09(2013) or SNI 03-6862-2002.

Reinforcing bars shall be kept off the ground and stored within a building or provided with suitable cover. The deformed bars be delivered and

maintained straight or bent in a shape as shown in Drawings. They shall not be bent and then straightened or bent twice at the same point of deformed bar.

(b) Support for Reinforcement

Supports for reinforcement shall be formed from lightweight wire bar or precuts concrete blocks of Class fc' 20 MPa concrete as specified in Clause S10.01 of these Specifications, unless otherwise directed by the Engineer. Wood, bricks, stone or other materials shall not be used as supports.

(c) Ties for Reinforcement

Tie wire for fastening reinforcement shall be annealed steel wire conforming to AASHTO M32M/M32-09(2013) or SNI 03-07-6401-2000.

S10.02 (3) Construction

(a) Fabrication

(i) Reinforcing bars shall be accurately formed to the shapes and dimensions indicated in the design, and shall be fabricated in a manner that will not injure the material. When bending failed, reinforcement bars shall not be repeated bending without the approval of the Engineer.

(ii) Unless otherwise permitted, all reinforcing bars requiring bending shall be bent cold. When reinforcing bars are bent by heating, the entire operation shall be approved by the Engineer. Should the Engineer approve the application of heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

(iii) Reinforcing bars that cannot be straightened by means of fabrication shall not be used. Bars partially embedded in concrete shall not be bent except as shown on the Drawings or otherwise permitted.

(iv) Qualified men shall be employed for cutting and bending, and proper appliances shall be provided for such work.

(v) If it is necessary for the Engineer to ascertain the quality of reinforcing bars, the Contractor shall test reinforcing bars, at his own expense, by means as directed by the Engineer.

(b) Placing

(i) Reinforcing bars before being positioned shall be cleaned and free from rust, dirt, mud and loose scale and from paint, oil, or any other foreign substance that destroys or reduces the bond.

(ii) Reinforcing bars shall be accurately placed in proper position so that they will be firmly held during placing concrete. Reinforcing bars for erecting shall be used when needed.

(iii) Bars shall be tied at all intersections by using annealed iron wire 0.9 mm or larger diameter or suitable clips.

(iv) Distances from the forms shall be maintained correctly by means of metal hangers, mortar blocks, metal supports, or other supports approved by the Engineer.

(v) Reinforcing bars shall be inspected by the Engineer after placing. When a long time has elapsed after placing reinforcing bars, they shall be cleaned and inspected again by the Engineer before placing concrete.

(c) Splicing

(i) When it is necessary to splice reinforcing bar at points other than shown on the designs, positions and methods of splicing shall be determined based on strength calculations approved by the Engineer.

(ii) In lapped splices, the bars shall be lapped the required length and wired together at several points by using annealed iron wire larger than 0.9 mm.

(iii) Exposed reinforcing bars intended for bonding with future extensions shall be effectively protected from injury and corrosion.

(iv) Welding of reinforcing steel shall be done only if detailed on the Drawings or if authorized by the Engineer in writing.

(v) Substitution of different size bars shall be permitted only upon the specific authorization of the Engineer. If steel is substituted, it shall be of a size equivalent to the design size or larger.

(d) Tolerances

(i) The tolerance for the fabrication shall be as specified in ACI 315-99 or SNI 03-6816-2002.

(ii) Reinforing Steel shall be installed so that the concrete cover which covers the outside of the reinforcing steel are as follows:

Table 10-2-2 Concrete Cover for Formwork and Normal Consolidation

Environment Classification	Nominal thickness of concrete covering (mm) for the concrete with strength, fc', not less than				
	20 MPa	25 MPa	30 MPa	35 MPa	40 MPa
A	35	30	25	25	25
B1	(65)	45	40	35	25
B2	-	(75)	55	45	35
C	-	-	(90)	70	60

Note:
The brackets indicate the concrete covering for the environment beyond the corridor boundary if it should be used.

Table 10-2-3 Concrete Cover for Formwork and Intensive Compaction

Environment Classification	Nominal thickness of concrete covering (mm) for the concrete with strength, fc', not less than				
	20 MPa	25 MPa	30 MPa	35 MPa	40 MPa
A	25	25	25	25	25
B1	(50)	35	30	25	25
B2	-	(60)	45	35	25
C	-	-	(65)	50	40

Note:

The brackets indicate the concrete covering for the environment beyond the corridor boundary if it should be used.

Table 10-2-4 Concrete Cover for Components produced by Twisting

Environment Classification	Compressive Strength fc' (MPa)	Concrete Cover (mm)
A, B1	35	20
B2	40 50	25 20
C	40	35

(iii) The following requirement to be applied to structures and components of reinforced concrete and prestressed concrete with a design life of 50 years or more. This requirement to be applied due to the classifications and environmental conditions which affect to structural concrete as follows:

Table 10-2-5 Environmental Classification

Surface and Environmental Conditions	**Environmental Classification**
1. Structural components directly contact to the soil:	
a. Component parts protected by a moisture-resistant or waterproof coating	A
b. Other component parts under ground with non-aggressive soil.	A
c. Component parts under ground with aggressive soil (permeable soil with pH <4, or with ground water containing sulfate ions > 1gr liter)	U
2. The structural components in a closed room inside the building, except for need due to the implementation in a short time.	A
3. Structural components above ground level in an opened environment:	
a. Areas in the inland (> 50 km from the coastal line) where the environment is:	
(i) non industrial area and within a cool climate	A
(ii)	
(iii) non industrial area but within tropical climate	B1
(iv) industrial area within any climate	B1
b. Area near the beach (1 km to 50 km from the coastline), any climate)	B1

Surface and Environmental Conditions	Environmental Classification
c. Coastal area (<1 km from the coastline but not in the tidal area), any climate	B2
4. Structural components in water	
a. Fresh water	B1
b. Sea water	
(i) permanently submerged	B2
(ii) within the tidal area	C
c. Water flow	U
5. Structural components in other environments which unprotected and excluded in the categories mentioned above	U

Note :

Specifically for the environmental classification of "U", the quality and characteristics of concrete shall be specifically determined so as to ensure the long-term durability of structural components in a special unprotected environment.

iv) Limits of the allowable tolerance of distance between concrete cover to installation the reinforcement steel is :

- Concrete cover for superstructures … 0 mm, + 5 mm
- Concrete cover for other structure….. ±10 mm
- Space of reinforcement steel …… ±10 mm

S10.02 (4) Method of Measurement

The quantity of reinforcing steel bar to be paid for shall be the weight (kg) of reinforcing bar erected as shown on the Drawings or ordered by the Engineer in writing. The weight calculated will be based upon the following tables:

Table 10-2-6 Unit Weights of Plain Round Bars

Bar Size (dia. mm)	6	9
Weight per linear meter in kg	0.222	0.499

Table 10-2-7 Unit Weights of Deformed Bars

Bar Size (dia. mm)	D10	D13	D16	D19	D22	D25	D29	D32
Weight per linear meter in kg	0.617	1.04	1.58	2.23	2.98	3.85	5.19	6.31

The lengths to be taken in calculating the weight for the purpose of payment shall be shown on the Drawings or ordered in writing by the Engineer.

No measurement or payment will be made for splices added by the Contractor for his convenience or for splices which are not shown on the Drawings and are not approved by the Engineer.

Clips, ties or other material used for positioning and fastening the reinforcing bars in place shall not be measured for payment. Reinforcing steel bars used for the pay items in Divisions 6, 12 and 13 (except foundation for high mast lighting pole) and for the Pay Items 10.03, 10.04, 10.05, 10.07, 10.10, 10.11 and 10.12 of these Specifications, shall not be measured for payment in this Clause S10.02.

S10.02 (5) Basis of Payment

The accepted quantities of reinforcing steel bar determined as provided above shall be paid for at the Contract price per kilogram, completed in place.

This payment shall be full compensation for furnishing all labour, equipment, and materials, necessary for fabricating, bending, assembling, erecting and if necessary gas pressure welding reinforcing bar, for unloading at the specific location, storing and handling of reinforcing steel bar.

Payment Item No. and Name		Unit of Measurement
10.02 (1)	Reinforcing Steel Plain Bars BjTP 280	kilogram
10.02 (2)	Reinforcing Steel Deformed Bars BjTS 280	kilogram
10.02 (3)	Reinforcing Steel Deformed Bars BjTS 420A	kilogram
10.02 (4)	Reinforcing Steel Deformed Bars BjTS 420B	kilogram
10.02 (5)	Reinforcing Steel Deformed Bars BjTS 520	kilogram
10.02 (6)	Reinforcing Steel Deformed Bars BjTS 550	kilogram
10.02 (7)	Reinforcing Steel Deformed Bars BjTS 700	kilogram
10.02 (8)	Welded Wire Mesh	kilogram

S10.03 Prestressed Concrete

S10.03 (1) Description

(a) General

This work shall consist of prestressed concrete structures and the prestressed concrete portions of composite structures, constructed in close conformity with the lines, grades, design, and dimensions shown on the Drawings, or established by the Engineer and in accordance with this and other specification items involved.

The work shall include the furnishing and installing of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies and grout used for pressure grouting ducts.

This work also consists of the assembling, joining and stressing of precast segments on Site. The units shall be manufactured in accordance with the requirements of this Clause of these Specifications

It shall include the manufacture, transportation, and storage of beams, slabs, and other structural members of precast concrete prestressed by either pretensioning or post-tensioning methods. It shall also include the installation of all precast prestressed members.

For cast-in-place prestressed concrete, the term "member" as used in this clause shall be considered to mean the concrete which is to be prestressed.

(b) Definitions

Post-tensioning is defined as any method of prestressing concrete in which the tensioned reinforcement is tensioned after the concrete is placed.

Pretensioning is defined as any method of prestressing concrete in which the tensioned reinforcement is tensioned before the concrete is placed. Prestressing reinforcement is defined as any reinforcement to which prestress is applied by post-tensioning or pretensioning.

(c) Tolerances

(i) Beams and Planks

(1) Dimension Tolerance

The overall length of any unit from the centre to centre of bearings shall not vary by more than 0.06% from the specified length, with a maximum variation of 15 mm. The centre to centre spacing of holes for transverse reinforcement, bars or cables shall not vary by more than 6 mm from the specified position as measured from the transverse centre line of the unit.

(2) Shape Tolerances

- Overall widths up to 600 mm ± 3 mm
- Overall widths greater than 600 mm ± 5 mm
- Overall depth ± 5 mm

(3) Void Location

- Vertically measured from soffit ± 10 mm
- Transversely measured from longitudinal centre line of the unit ± 5 mm

(4) Out of Square

Transverse cross-section: The adjacent faces shall not be out of square by more than the larger of 5 mm per metre or 4 mm overall.

Longitudinal cross-section: The slope of the end face shall not deviate from that specified by more than :

- On overall length of face : 5 mm up to 400 mm
- For dimensions greater : 15 mm per metre to a maximum than 400 mm of 12 mm overall

(5) Hog or Sag

The hog or sag values of similar units to be used in the same span shall lie within a maximum overall range of 20 mm for the same conditions of age, curing etc.

(6) Bow

Longitudinal centre lines shall not deviate in the transverse direction from a straight line joining the centre points of the ends of the member by 6 mm or 0.06 % of the specified length, whichever is the larger.

(7) Twist

The angular rotation of any cross-section relative to an end cross-section shall not exceed 5 mm per metre for the edge being checked.

(8) Tendons

- Tendon exit holes in formwork ± 2 mm
- Cover to tendon ± 5 mm

(ii) Piles

(1) Dimension Tolerances

- Cross-sectional dimensions ± 6 mm
- Total length ± 25 mm
- Deviation from straight line per metre length 1 mm
- Head out of square (in width of head) 2 mm
- Clear cover to reinforcement (including tendons) + 5 mm, - 3 mm
- Tendon exit holes in formwork and plates ± 2 mm
- Tendons generally ± 1.5 mm

(2) Shoes and Prefabricated Splice Joints

Shoes and joints, when spices are permitted, shall be firmly bonded to the pile, centrally and in line with the pile axis.

(3) Cast length

Unless otherwise shown on the Drawings, piles shall be cast in single lengths, without splices.

S10.03 (2) Materials

(a) General

All materials to be furnished and used which are not covered in this clause shall conform to the requirements stipulated in other applicable clauses.

(b) Reinforcement - General

(i) Non prestressing reinforcement shall conform either to Clause S10.02 or, where prestressing quality is called for on the Drawings it shall conform to the requirements for prestressing steel.

(ii) Prestressing steel shall be high tensile strength steel wire, high tensile strength steel strand or high tensile strength steel bar.

(c) Prestressing Steel

(i) Prestressing strand shall consist of seven wire high tensile strength, stress relieved, low relaxation strand in continuous lengths without splices or couplings, conforming to AASHTO M203M/M203-12 or SNI 1154-2016 with the class of strands and minimum tensile strength as specified shown in Table 10-3-1, and the diameter tolerance as shown in Table 10-3-2 and the mechanical properties as shown in Table 10-3-3.

(ii) Wire for prestressing shall consist of high tensile wire in continuous lengths without splices or couplings and shall conform to AASHTO M204M/M204-14 or SNI 1155:2016

(iii) High tensile steel bar shall be stress relieved and shall conform to the requirements of AASHTO M275M/M275-19 or ASTM A722/A722M-15.

.Table 10-3-1 Class of Stranded Wire and Minimum Tensile Strength

CLASS	SYMBOL	RELAXATION
A	KBjP-P7 NA	Normal Relaxation
B	KBjP-P7 NB	
A	KBjP-P7 RA	Low Relaxation
B	KBjP-P7 RB	

Catatan :
1. KBjP-P7 N: seven seamless stranded wire steel for normal relaxation prestressed concrete construction
2. KBjP-P7 R: seven seamless stranded wire steel for low relaxation prestressed concrete construction
3. Class A: minimum tensile strength of 1725 MPa
4. Class B: minimum tensile strength of 1860 MPa

Table 10-3-2 Demension and Diamater Tolerance

Symbol	Nominal Diameter of Strand	Nominal Diamater Tolerance of Strand	Nominal area of cross section[1]	Nominal Weight[1]	Difference of core wire diamater and outer wire
	(mm)	(mm)	(mm^2)	(g/m)	(mm)
KBjP-P7 N A KBjP-P7 R A	6.4	± 0.40	23	182	0.025
	7.9		37	294	0.038
	9.5		52	405	0.051
	11.1		69.7	548	0.064
	12.7		92.9	730	0.076
	15.2		139	1090	0.102

Symbol	Nominal Diameter of Strand	Nominal Diamater Tolerance of Strand	Nominal area of cross section[1]	Nominal Weight[1]	Difference of core wire diamater and outer wire
	(mm)	(mm)	(mm^2)	(g/m)	(mm)
	9.53		55	430	0.051
KBjP-P7 N B KBjP-P7 R B	11.1	+ 0.65 - 0.15	74.2	580	0.064
	12.7		987	780	0.076
	13.2		108	840	0.076
	14.3		124	970	0.089
	15.2		140	1100	0.102
	15.7		150	1200	0.102
	17.8		190	1500	0.114
	6.4		23	182	0.025

Note:
[1]: as reference

Tabel 10-3-3 Mechanical Properties of Stranded Wire

Symbol	Nominal Diameter (mm)	Elongation Load min. (kN)	Tensile load min. (kN)	Elongation minimum (%)	Relaxation		
					Wire load (kN)	Maximum (%)	Duration (Hour)
		1	2	3	4		
KBjP-P7 NA	6.4	34	40	3.5	70% tensile strength load	8.0	1000 with tempe-rature of 18 - 22°C
	7.9	54.7	64.5				
	9.5	75.6	89				
	11.1	102.3	120				
	12.7	136.2	160				
	15.2	204.2	240				
KBjP-P7 NB	9.53	87	102				
	11.1	117.2	138				
	12.7	156.1	184				
	13.2	170.1	200				
	14.3	195.5	230				
	15.24	221.5	261				
	15.7	237.4	279				
	17.8	300.2	353				
KBjP-P7 RA	6.4	36	40		70% tensile strength load	2.5	
	7.9	58.1	6.,5				
	9.5	80.1	89				
	11.1	10.1	120				
	12.7	14.1	160				
	15.2	21.2	240				
KBjP-P7 RB	9.53	92.1	102		80% tensile	3.5	
	11.1	124,1	138				

Symbol	Nominal Diameter (mm)	Elongation Load min. (kN)	Tensile load min. (kN)	Elongation minimum (%)	Relaxation		
					Wire load (kN)	Maximum (%)	Duration (Hour)
		1	2	3	4		
	12.7	165.3	184		strength load		
	13.2	180.1	200				
	14.3	207	230				
	15.24	234.6	261				
	15.7	251,4	279				
	17.8	318	353				

Note :

1. Elongation Load

   Measured at elongation of 1%. The value shall not be less than 85% breaking load for normal relaxation and 90% for low relaxation. The initial loading of test shall commence at 10% of the tensile load.

2. Tensile Load

   Tensile load values are determined in Table 10-3-3 above.

3. Elongation

   Elongation is measured using a calibrated extensiometer. Minimum total elongation shall be 3.5% with a gauge length for the sample not less than 600 mm

4. Relaxation

   Normal relaxation with an initial load of 70% of tensile load not more than 8.0%. Low relaxation with an initial load of 70% of tensile load not more than 2.5% and an initial load of 80% of tensile load not more than 3.5%

   To determine the relaxation of 1000 hours calculated by computerized extrapolation, minimum of 200 hours period may be carried out if the extrapolation results are equivalent to the results of 1000 m relaxation test.

(iv) Testing - The testing of prestressing reinforcement shall be in accordance with the requirements of the AASHTO Specifications for the type of system intended to be used.

PC cable and bar shall be used as follows:

Notation	Nominal Diameter (mm)	Utilization*
PC Wire SWPR 1 (Type C)	7	PC Pile
PC Wire SWPR 1 (Type B)	8	Diaphragm for PC Box Girder
PC 7-Wire Strand SWPR 7A (Type D)	T 12.4	PC Core Slab
PC 7-Wire Strand SWPR 7B (Type A)	T 12.7	PC I-Girder, PC U-Girder and PC Hollow Slab
PC 19-Wire Strand SWPR 19 (Type E)	T 19.3	Diaphragm for PC I-Girder
PC Bar SBPR 80/95	23	Diaphragm for PC Box Girder
PC 7-Wire Strand SWPR 7B (Type F)	T 12.7	Diaphragm for PC I-Girder

Note:

* The exact use shall be in accordance with the Drawings.

(d) Anchorages

All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

All anchorage devices for post-tensioning shall be capable of holding the prestressing steel at a load producing a stress of not less than 95 percent of the guaranteed minimum tensile strength of the prestressing steel.

(e) Ducts

All ducts shall be metallic and shall be mortar-tight. Ducts shall be strong enough to maintain their shape under working stresses, and where grouting is specified, air and grout holes shall be provided with pipes or other devices so that the injection of grout will completely fill all void spaces within the entire length of the duct.

(f) Grout

Grout shall consist of Portland cement, water, and an expansive admixture plus retarder as approved by the Engineer. Water shall be potable. No admixtures containing chlorides or nitrates shall be used.

The Contractor shall submit the proportion of mixing for approval of the Engineer.

Water shall be first added to the mixer followed by cement and admixture. The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. Retempering of grout will not be permitted. Grout shall be continuously agitated until it is pumped.

(g) Concrete

Concrete shall conform to the requirements of Class A-1, A-2 or Class AA concrete of Clause S10.01 of this Specification and to the requirements specified below unless otherwise stated in the Drawings.

The Contractor shall develop his own mix designs which shall be submitted to the Engineer for approval.

The maximum size of aggregate for use in the manufacture of prestressed concrete shall be 2 centimeters.

S10.03 (3) Construction

(a) General

The Contractor shall provide a Technician skilled in the use of the system of prestressing to be used, who shall supervise the work and give the Engineer such assistance as the Engineer may consider necessary.

The Contractor shall provide all equipment necessary for the construction and the prestressing. Prestressing shall be done with approved jacking equipment. If hydraulic jacks are used they shall be equipped with accurately reading pressure gauges. The combination of jack and gauge shall be calibrated and a graph or table showing the calibration shall be furnished to the Engineer. Should other types of jacks be used, calibrated

proving rings or other devices shall be furnished so that the jacking forces may be accurately known.

All of the applicable requirements of Sub-clause S10.01.(4) "Construction" shall be complied with, except as may be modified in this Sub-clause. Prestressed concrete shall be formed, stressed, placed, cured, and protected at shops, manufacturing plants, and locations approved by the Engineer, where the fabrication of such members may be properly inspected and controlled.

The position/ lay out of the tendons in the Prestressed Concrete either the vertical or horizontal direction allowable tolerance ± 6 mm

(b) Plan of Operation

The Contractor shall, if required, prepare, check and submit to the Engineer complete detailed Working Drawings or Schedules showing:

(i) Contractor's alternative designs if the submission of alternatives is approved;

(ii) Contractor's details of proposed manufacture and construction;

(iii) Sequence of operations proposed; and

(iv) Dimensions and complete descriptions of all devices, joints, bearings, and anchorages not specified or detailed in the Contract Documents.

Concrete shall not be cast prior to the Engineer's approval of the Contractor's Drawings, if any, of concrete mixtures, of formwork, of method of application of prestressing forces, of methods of placing, of curing, of protecting, of handling and of erecting members. Any alternative to the design in the Contract Documents shall be subject to the Engineer's approval before manufacture or construction.

The Contractor shall inform the Engineer not less than 3 days in advance of the probable date of commencement of manufacture and the dates when tensioning of steel, casting of units and transfer of stress will be undertaken for the first time.

(c) Placing Steel

All steel units shall be accurately placed in the position shown on the Drawings and rigidly held during placing and setting of the concrete. Distance from the forms shall be maintained by stays, blocks, ties, hangers, or other approved support. Blocks for holding units from contact with the forms shall be precast mortar blocks of approved shape and dimensions. Layers of units shall be separated by mortar blocks or other equally suitable devices. Wooden blocks shall not be used.

(d) Pretensioning Method

The prestressing elements shall be accurately held in position and stressed by jacks. Stressing shall be applied to produce the stresses required in the wires or strands immediately after the anchorage as shown on the Drawings or as directed by the Engineer. Suitable allowances shall be

made for friction in the jacks and for slip and yield in the grips or anchorages.

A record shall be kept of the jacking forces and the elongations produced thereby and the minimum age in hours of the concrete in the line at the time the tendons were released.

Several units may be cast in one continuous line and stressed at one time, in which case sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to the concrete, nor shall end anchors be released, until the concrete has attained a compressive strength not less than 85% of the specified 28-day strength as shown by standard specimens made and cured identically with the members. The elements shall be cut or released in such an order that eccentricity of prestress will be a minimum.

(e) Curing

Steam curing process may be used as an alternative to water curing. The casting bed for any unit cured with steam shall be completely enclosed to prevent steam escaping and exclude outside atmosphere. Two to four hours after placing concrete and after the concrete has undergone initial set, the first application of steam shall be made. If retarding admixtures have been used, the delay before application of the steam shall be increased to four to six hours. Water curing methods shall be used from the time the concrete is placed until steam is first applied.

The steam shall be at 100% relative humidity to prevent loss of moisture and to provide moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During the application of the steam, the ambient air temperature shall increase at a rate not to exceed 22 degrees celsius per hour until the maximum temperature is reached and shall be held until the concrete has reached the desired strength. In discontinuing the steam application, the ambient air temperature shall not decrease at a rate to exceed 22 degrees celsius per hour until a temperature has been reached 10 degrees celsius above the temperature of the air to which the concrete will be exposed. The maximum curing temperature shall be from 60 degrees celsius to 67 degrees celsius.

If the Contractor elects to cure by any other special method, the method and details shall be subject to the approval of the Engineer.

Except as specified or otherwise approved, curing shall comply with the requirements in Clause S10.01.

(f) Post-tensioning Method

Tensioning of the prestressing reinforcement shall not be commenced until tests on concrete cylinders, manufactured of the same concrete of the particular member to be prestressed has attained compressive strength indicated in the Drawings or directed by the Engineer.

After all concrete has attained the required strength, the prestressing reinforcement shall be stressed by means of jacks to the desired tension and the stress transferred to the end anchorage.

Cast in place concrete shall not be post-tensioned until at least 10 days after the last concrete has been placed in the member to be post-tensioned and until the compressive strength of said placed concrete has reached the strength specified for the concrete at the time of stressing.

All side and inside forms for girders shall be removed before post-tensioning. The falsework under the bottom slab supporting the superstructure shall not be released until a minimum of 48 hours have elapsed neither after grouting of the post-tension tendons nor until all other conditions of the specifications have been met. The supporting falsework shall be constructed in such a manner that the superstructure will be free to lift off the falsework and shorten during post-tensioning.

The tensioning process shall be so conducted that the tension being applied and the elongation of the prestressing elements may be measured at all times.

A record shall be kept of gauge pressures and elongation at all times and submitted to the Engineer for his approval.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least 50 mm inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tenioning, the recesses shall be filled with concrete, and finished as shown in the Drawings.

(g) Bonding Steel

Post-tensioned steel shall be bonded to the concrete. All prestressing steel to be bonded to the concrete shall be free of dirt, loose rust, grease or other deleterious substances.

Prestressing steel shall be bonded to the concrete by filling the void space between the duct and the tendon with grout. All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

All grout shall pass through a screen with 1.20 mm maximum clear openings prior to being introduced into the grout pump.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves, caps, or other devices capable of withstanding the pumping pressure. Valves and caps shall not be removed or opened until the grout has set.

(h) Handling, Transport and Storage

Precast prestressed concrete shall not be moved from the casting position until the concrete has attained a compressive strength of 85% of the specified 28-day strength, nor transported until it has developed a strength of 90% of the specified 28-day strength.

Extreme care shall be exercised in handling and moving precast prestressed concrete members. Precast girders and slabs shall be transported in an upright position, shock shall be avoided and the points of support and directions of the reactions with respect to the member shall be approximately the same during transporting and storage as when the member is in its final position. If the Contractor deems it expedient to transport or store precast prestressed units in other than this position, it shall be done at his own risk after notifying the Engineer of his intention to do so. Any unit considered by the Engineer to have become substandard shall be rejected and replaced at the Contractor's expense by an acceptable unit.

(i) Marking of Precast Prestressed Members

Each precast prestressed member is to be uniquely and permanently marked so as to show its type, date of casting and reinforcement.

(j) Testing of Precast Prestressed Members

When directed by the Engineer one or more beams shall be subjected to a loading test. The Contractor shall obtain the prior approval of the Engineer to the detailed arrangements for the testing. A beam which is to undergo testing shall be supported at its design points of bearing and the upward deflection due to the prestressing force measured relative to a line joining these points. Equal loads shall then be applied at the third points in ten equal increments, the total being sustained for 5 minutes. The beam shall then be unloaded.

The midspan deflection relative to the reference line shall be measured for each increment of load. The load deflection curve plotted from these values shall show no appreciable variation from a straight line. The Drawings shall show, or the Engineer shall direct, the loads to be applied and the corresponding deflections which shall not be exceeded.

Any beam which fails to satisfy the Engineer under the prescribed test shall be rejected and all other beams cast in the same line as the rejected beam shall also be rejected unless tested at the Contractor's expense and found satisfactory.

The Contractor shall supply to the Engineer record sheets of the tests showing date of test, the loads, deflections, and load deflection curves, calculated values of "E" and the strength of the concrete at release as indicated by the relevant cube or cylinder test results.

The tests are to be carried out on units selected by and in the presence of the Engineer after he has agreed to the method of testing and form of records. The cost of such tests and records shall be included in the unit prices.

(k) Post Tensioned Segmental Construction

(i) Assembly of Precast Segments

Handling of precast units for segmental construction during placing operations shall be in accordance with the requirements of Sub-clause S10.03 (3) (h).

The Contractor shall submit details of the falsework design and the method of erection and assembly to the Engineer for his approval at least four weeks prior to the proposed date for commencing assembly of the segments.

Segments shall be assembled on falsework or on bearers at ground level. The Contractor shall design the supporting system to carry all the loads that may be applied to it, and shall incorporate provision for adjusting the position of each segment during assembly.

The unit shall be assembled with minimum misalignment of ducts and outside surfaces and shall be within the tolerances given in Sub-clause S10.01.(1).(c).

(ii) Joint Concrete

Concrete for joints and associated diaphragms or other infill concrete involved in the assembly of segments for post-tensioned construction shall comply with the requirements of Clause S10.01 of this Specification except where modified below.

Unless otherwise approved by the Engineer the effective maximum size shall be 10 mm.

Joint concrete shall be subject to the same strength requirements prior to stressing as given in Sub-clause S10.03 (2) (g) of this Specification.

Concrete materials shall be carefully selected and proportioned to produce joint concrete of the specified strength and of a similar colour to that of the segments. If requested by the Engineer, the Contractor shall supply cured samples of the proposed joint concrete for colour comparison.

Joint concrete between segments shall be placed in forms which shall conform to the shape, lines and dimensions required in the finished work. Forms shall be rigid, watertight, and braced and tied together so that they will maintain position and shape during placing of concrete. The fit of the forms against the segments shall be such that a completely watertight joint, flush with adjacent surfaces is obtained. Forms shall be such that a Class 2 surface finish (the "default" for any architectural finish where the concrete is left exposed) in accordance with AS 3610.1:2018 can be produced.

Where necessary, temporary openings shall be provided in the formwork to enable the adequate placing and compaction of concrete especially around and underneath ducting and anchorages.

The joints between segments shall be completely filled with compacted concrete of a strength as shown on the Drawings. Surfaces against which concrete is to be placed shall be scabbed to a dense hard surface. Just prior to placing concrete, these surfaces shall be cleaned to remove all dirt and other foreign matter.

Joint concrete shall be placed in the presence of the Engineer and any joint concrete placed during his absence or not placed to his satisfaction shall be broken out by the Contractor and made good at no extra cost to the Employer.

Care shall be taken during placing and compaction of concrete to avoid damage to the ducting. Vibrators shall not come into direct contact with the ducting. If the ducting is damaged during concreting the whole or a portion of the concrete cast may be rejected by the Engineer.

After placing the concrete, the top surface of the joint shall be screeded flush with the tops of the adjacent segments and covered to prevent premature drying. Joint concrete shall be cured by one or more of the methods specified in Sub-clause S10.03 (3) (e) of this Specification for a minimum period of 7 days.

(iii) Concreting of Anchorage Recesses

Concreting of anchorage recesses of the post tensioned segmental member shall be carried out as shown on the Drawings and in accordance with the requirements of these Specifications.

(iv) Damage to Units

In the event of any unit, which has been manufactured or accepted by the Contractor, sustaining damage such as cracking, spalling or deformation of projecting reinforcement, the unit shall be set aside until it has been inspected by the Engineer, who will decide whether it shall be rejected and removed from the site of the works, or repaired by the Contractor.

The cost of such repairs, or the removal of rejected units, and all costs of replacing these units at the site of the works shall be borne by the Contractor.

(l) Erection of Prestressed Units

(i) Acceptance of Units

If units are manufactured off site the Contractor shall check these for quality and condition upon taking delivery and shall immediately report in writing to the Engineer any defect or deficiency. The Contractor is responsible for all damage to the units occurring after he accepts delivery thereof.

(ii) Seating for Units

(1) Unit placed on Neoprene Pads or Elastomeric Bearings.

Where the units are to be placed on neoprene pads or elastomeric bearings the pads shall be located as shown on the Drawings and shall be retained in position by gluing to the concrete bearing surface with an approved contact adhesive, in order to prevent dislodgment of the pads during unit placing.

(2) Units Bedded on Mortar.

Where the Drawings show that the units are to be bedded on cement mortar, a mortar seating strip shall be prepared on the substructure immediately before erection of the prestressed units. The mortar shall be made of a 1 : 3 mixture of Portland cement and fine sand plus an approved bonding agent; mixed to give widths shown on the Drawings and approximately 10 mm thick, and shall provide an even seating strip is laid the prestressed units shall be seated on the prepared substructure in the position indicated on the Drawings. Any excess mortar shall be struck off.

(iii) Positioning Units

All holding down bolts and holes for transverse reinforcement, etc. shall be carefully aligned during placement of the units. Bars shall be placed through holes for transverse reinforcement as erection proceeds, in order to ensure the correct alignment of the holes.

S10.03 (4) Method of Measurement

The quantity of prestressed concrete I-girders and U-girders to be measured for payment shall be the actual number of precast prestressed concrete structural members, furnished, erected in place, completed and accepted. Each member shall include the concrete, reinforcement and prestressing steel, and other such material contained within or attached to the beam or slab unit.

Prestressed cast-in-place concrete members will be paid for on the basis of the number of cubic meters of concrete, the weight (kg) of reinforcing steel and the weight (kg) of prestressing steel, respectively. For concrete reference is made to Clause S10.01 and for reinforcing steel reference is made to Clause S10.02.

Prestressing steel used in Pay Item of these Specifications will not be measured separately for payment in this Clause S10.03.

Concrete plates to be measured for payment are paid shall be the number of square meters in accordance with the Drawings.

S10.03 (5) Basis of Payment

The work measured as provided above, shall be paid for at the Contract unit price for any item listed below which appears in the Bid Schedule. The prices and payment shall be full compensation for furnishing and placing all materials

including all labour, tools, equipment and incidentals necessary to complete the work prescribed in this Clause. The payment of PC cable shall include the work of tensioning, grouting, anchorages and ducts. The unit price for I-girders and U-girders will be deemed to include all concrete, reinforcement, PC cable, hauling and erection.

Pay Item No. and Name		**Unit of Measurement**
10.03(1a)	PC-U Girder Nominal Span of 35.5m, H= 1.95m (Type RB), furnished	Each
10.03(1b)	PC-U Girder Nominal Span of 35.5m, H= 1.95m (Type RB), erected	Each
10.03(2a)	PC-U Girder Nominal Span of 31.3m, H= 1.95m (Type RC), furmished	Each
10.03(2b)	PC-U Girder Nominal Span of 31.3m, H= 1.95m (Type RC), erected	Each
10.03(3a)	PC-U Girder Nominal Span of 26.5m, H= 1.95m (Type RD), furnished	Each
10.03(3b)	PC-U Girder Nominal Span of 26.5m, H= 1.95m (Type RD), erected	Each
10.03(4a)	PC-U Girder Nominal Span of 18.5m, H= 1.85m (Type A), furnished	Each
10.03(4b)	PC-U Girder Nominal Span of 18.5m, H= 1.85m (Type A), erected	Each
10.03(5a)	PC-U Girder Nominal Span of 23m, H= 1.85m (Type B), furnished	Each
10.03(5b)	PC-U Girder Nominal Span of 23m, H= 1.85m (Type B), erected	Each
10.03(6a)	PC-U Girder Nominal Span of 26m, H= 1.85m (Type C), furnished	Each
10.03(6b)	PC-U Girder Nominal Span of 26m, H= 1.85m (Type C), erected	Each
10.03(7a)	PC-U Girder Nominal Span of 28.5m, H= 1.85m (Type D), furnished	Each
10.03(7b)	PC-U Girder Nominal Span of 28.5m, H= 1.85m (Type D), erected	Each
10.03(8a)	PC-U Girder Nominal Span of 31m, H= 1.85m (Type E), furnished	Each
10.03(8b)	PC-U Girder Nominal Span of 31m, H= 1.85m (Type E), erected	Each
10.03(9a)	PC-U Girder Nominal Span of 31m, H= 1.85m (Type F), furnished	Each

10.03(9b)	PC-U Girder Nominal Span of 31m, H= 1.85m (Type F), erected	Each
10.03(10a)	PC-U Girder Nominal Span of 33m, H= 1.85m (Type G), furnished	Each
10.03(10b)	PC-U Girder Nominal Span of 33m, H= 1.85m (Type G), erected	Each
10.03(11a1)	PC-Void Slab Nominal Span of 16m, H= 0.85m, furnished	Each
10.03(11a2)	PC-Void Slab Nominal Span of 16m, H= 0.85m, erected	Each
10.03(11b1)	PC-Void Slab Nominal Span of 12.28m, H= 0.74m, furnished	Each
10.03(11b2)	PC-Void Slab Nominal Span of 12.28m, H= 0.74m, erected	Each
10.03(12a1)	PC-I Girder Nominal Span of 11.50m to 13.00m, H= 0.90m, furnished	Each
10.03(12a2)	PC-I Girder Nominal Span of 11.50m to 13.00m, H= 0.90m, erected	Each
10.03(12b1)	PC-I Girder Nominal Span of 13.10m to 14.50m, H= 0.90m, furnished	Each
10.03(12b2)	PC-I Girder Nominal Span of 13.10m to 14.50m, H= 0.90m, erected	Each
10.03(12c1)	PC-I Girder Nominal Span of 14.60m to 16.00m, H= 0.90m, furnished	Each
10.03(12c2)	PC-I Girder Nominal Span of 14.60m to 16.00m, H= 0.90m, erected	Each
10.03(12d1)	PC-I Girder Nominal Span of 15.10m to 17.00m, H= 1.25m, furnished	Each
10.03(12d2)	PC-I Girder Nominal Span of 15.10m to 17.00m, H= 1.25m, erected	Each
10.03(13a1)	PC-I Girder Nominal Span of 12.0m to 14.0m, H= 1.40m, furnished	Each
10.03(13a2)	PC-I Girder Nominal Span of 12.0m to 14.0m, H= 1.40m, erected	Each
10.03(13b1)	PC-I Girder Nominal Span of 14.10m to 15.00m,H= 1.40m, furnished	Each
10.03(13b2)	PC-I Girder Nominal Span of 14.10m to 15.00m, H= 1.40m, erected	Each
10.03(13c1)	PC-I Girder Nominal Span of 15.10m to 17.0m, H= 1.40m, furnished	Each

10.03(13c2)	PC-I Girder Nominal Span of 15.10m to 17.0m, H= 1.40m, erected	Each
10.03(13d1)	PC-I Girder Nominal Span of 25.00m to 27.0m, H= 1.40m, furnished	Each
10.03(13d2)	PC-I Girder Nominal Span of 25.00m to 27.0m, H= 1.40m, erected	Each
10.03(14a)	PC-I Girder Nominal Span of 25.0m to 27.00m,H= 1.60m, furnished	Each
10.03(14b)	PC-I Girder Nominal Span of 25.0m to 27.00m, H= 1.60m, erected	Each
10.03(15a)	PC-I Girder Nominal Span of 30.0m to 32.00m,H= 1.70m, furnished	Each
10.03(15b)	PC-I Girder Nominal Span of 30.0m to 32.00m, H= 1.70m, erected	Each
10.03(16a1)	PC-I Girder Nominal Span of 20.0m to 22.0m, H=2.10m, furnished	Each
10.03(16a2)	PC-I Girder Nominal Span of 20.0m to 22.0m, H= 2.10m, erected	Each
10.03(16b1)	PC-I Girder Nominal Span of 39.0m to 41.0m, H=2.10m, furnished	Each
10.03(16b2)	PC-I Girder Nominal Span of 39.0m to 41.0m, H= 2.10m, erected	Each
10.03(16c1)	PC-I Girder Nominal Span of 49.0m to 51.0m, H=2.30m, furnished	Each
10.03(16c2)	PC-I Girder Nominal Span of 49.0m to 51.0m, H= 2.30m, erected	Each
10.03(17)	Prestressing Steel Type A (SWPR7B, T12.7)	Kilogram
10.03(18)	Prestressing Steel Type B (SWPR7B, T15.2)	Kilogram

S10.04 Precast Concrete Beam

S10.04 (1) Description

This work shall consist of precast reinforced concrete beams, furnished and placed in accordance with these Specifications and in conformity with the requirements on the Drawings or elsewhere in the Contract Documents.

The work shall include the manufacture, transportation, storage and installation of precast beams.

S10.04 (2) Materials

(a) General

All materials to be furnished and used which are not covered in this clause shall conform to the requirements stipulated in other applicable clauses.

(b) Concrete

Concrete shall conform to the requirements of Class A-2 concrete of Clause S10.01 of these Specifications unless otherwise stated in the Drawings.

(c) Reinforcement

Reinforcement shall be in accordance with the provisions set out in Clause S10.02 of these Specifications.

(d) Formwork

Forms for precast beams shall conform to the general requirements for concrete formwork as described in Clause S10.01 of these Specifications.

S10.04 (3) Construction

(a) General

Construction shall comply with the applicable requirements of Sub-clause S10.01(4) of these Specifications.

(b) Plan of Operation

The Contractor shall, if required, prepare, check and submit to the Engineer complete detailed Working Drawings or Schedules showing:

(i) Contractor's alternative designs if the submission of alternatives is approved;

(ii) Contractor's details of proposed manufacture and construction; and

(iii) Sequence of operations proposed.

Concrete shall not be cast prior to the Engineer's approval of the Contractor's Drawings, if any, of concrete mixtures, of formwork, of methods of placing, of curing, of protecting, of handling and of erecting members. Any alternative to the design in the Contract Documents shall be subject to the Engineer's approval before manufacture or construction.

(c) Placing Reinforcement

All steel reinforcement shall be accurately placed in the position shown on the Drawings and rigidly held during placing and setting of the concrete. Distance from the forms shall be maintained by stays, blocks, ties, hangers, or other approved support. Blocks for holding units from contact with the forms shall be precast mortar blocks of approved shape and dimensions.

(d) Casting

The beams shall be cast in a horizontal position. Special care shall be taken to place the concrete so as to produce a beam free from any air pockets, honeycomb or other defect. Concrete shall be placed continuously and shall be compacted by vibrating or by other means satisfactory to the Engineer.

(e) Handling, Transport and Storage

Precast reinforced concrete beams shall not be moved from the casting position until the concrete has attained a compressive strength of 85% of the specified 28-day strength, nor transported until it has developed strength of 90% of the specified 28-day strength.

Extreme care shall be exercised in handling and moving precast concrete beams. Precast beams shall be transported in an upright position, shock shall be avoided and the points of support and directions of the reactions with respect to the member shall be approximately the same during transporting and storage as when the member is in its final position. If the Contractor deems it expedient to transport or store precast beam unit in other than this position, it shall be done at his own risk after notifying the Engineer of his intention to do so. Any unit considered by the Engineer to have become substrandard shall be rejected and replaced at the Contractor's expense by an acceptable unit.

(f) Marking of Precast Beams

Each precast beam unit is to be uniquely and permanently marked including its date of casting.

S10.04 (4) Method of Measurements

The quantity of reinforced concrete beams to be measured for payment shall be the actual number of precast concrete beams, installed in place, completed and accepted. Each beam shall include the concrete, reinforcement steel, and other such material contained within or attached to the beam unit.

S10.04 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for each type of precast reinforced concrete beam listed below.

The price and payment shall be full compensation for furnishing and placing all materials including concrete and reinforcement, for casting and for hauling, storage and erection of the beams including all labour, tools, equipment and incidentals necessary to complete the work as shown on the drawings and prescribed in this Clause.

S10.05 Pretensioned Concrete Piling and Precast Reinforced Concrete Piling

S10.05 (1) Description

This work shall consist of pretensioned spun concrete piling and pretensioned precast concrete piling as well as precast reinforced concrete piling, furnished and

driven in accordance with these Specifications and in reasonably close conformity with the requirements on the Drawings or elsewhere in the Contract Documents.

S10.05 (2) Materials

(a) General

Pretensioned concrete piles shall be constructed in accordance with the details shown on the Drawings and to the requirements of ACI 318-14. Pretensioned spun concrete piles shall also comply with the requirement of JIS A5335-1987 Type A and Type B, pretensioned spun concrete piles.

The applicable provisions of Clause S10.01 and S10.03 shall be read into and become part of this Clause.

(b) Concrete

Pretensioned concrete piles and precast reinforced concrete piles shall be Class AA and Class B2 respectively, in accordance with the provisions of Clause S10.01 of these Specifications.

(c) Reinforcement

Reinforcement shall comply with the provisions of Clause S10.02 of these Specifications and shall be positioned as shown on the Drawings.

(d) Prestressing Steel

High tensile steel prestressing wire shall conform to the requirements of AASHTO M203M/M203-12 or SNI 1154-2016.

(e) Certificate

Prior to furnishing pretensioned concrete and precast reinforced concrete piles the Contractor shall submit to the Engineer for approval a certificate by the manufacturer certifying that the piles comply with the specification requirements.

S10.05 (3) Construction

(a) Preparation for Driving

(i) Caps - The heads of all concrete piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design having a suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block. No pile head will be held so firmly that the slightrotation of the pile normally occurring while the pile is being driven will be prevented.

(ii) Joints - Joints of pretensioned concrete and precast reinforced concrete piles shall be carefully constructed in accordance with the Drawings or the instruction of the Engineer. Welding shall be made in accordance with the requirements specified in JIS A7201:2009 (Standard Practice for Execution of Spun Concrete Piles).

All welded joints shall be protected with an anti corrosion paint. The anti corrosion paint and thickness required shall conform to ISO 12944-6:2018 or SNI ISO 12944-6-2012 and SE Menteri PUPR No.26/SE/M/2015 Pedoman Perlindungan Komponen Baja Jembatan dengan Cara Pengecatan.

(iii) Pile shoes - Shoe bases shall consist of steel plate as shown on the Drawings.

(b) Handling, Pitching and Driving

(i) General - When raising or transporting piles the Contractor shall provide slings and other equipment necessary to prevent any appreciable bending of the pile.

The main setting out for the piles is to be completed prior to commencement of driving. Secondary or individual pile setting out is to be completed and agreed not less than 8 hours prior to commencing work on the piles concerned. All main setting out points, lines and stations are to be maintained safe and undisturbed until the work is complete.

Piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings or fixed by the Engineer. Piles deflected from the vertical or proper line shall, where ordered by the Engineer, be withdrawn and repitched until the proper line is obtained.

No forcible method of correction of the position or line of any pile will be permitted. Any pile damaged by reason of improper driving or driven out of its proper location or driven below the elevation fixed by the Drawings or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer for the pile in question :

- The pile shall be withdrawn and replaced by a new and if necessary longer pile. Any holes from which piles are withdrawn shall be packed with approved non-plastic material before redriving takes place; or
- A second pile shall be driven adjacent to the defective pile.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven again.

(ii) Batter piles - Batter piles shall be driven accurately to the batter shown on the Drawings. The pile frame employed for the driving of the batter piles shall have leads capable of adjustment to the required angle. When piles have to be driven below the level of the bottom of the leads, extension leads shall be provided except where the use of a follower is specifically permitted by the Engineer.

(iii) Driving equipment - Before any piling work is commenced the Contractor shall submit to the Engineer full details of the pile

driving equipment and the method of carrying out the work he intends to use. All piles shall be provided with caps for driving as specified in Item (a) (i) above. For special types of piling, driving head mandrels, or other devices in accordance with these requirements shall be provided so that piles may be driven without damage.

Piles shall be driven with steam, air or diesel hammers, a combination of hammers with water jets or gravity hammers. When diesel hammers are used, they shall be calibrated by a load test if necessary.

The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain, under working conditions, the pressure in the manner specified by the manufacturer. The boiler or tank shall be equipped with an accurate pressure gauge, and another gauge shall be supplied at the hammer intake.

When gravity hammers are used for driving concrete piles, the drop of the hammer shall not exceed 2.5 meters and the hammer shall have a weight of not less than half the weight of the pile. The fall shall be regulated so as to prevent injury to the pile.

(iv) Driving - Piles shall be supported in line and position with leads while being driven. Pile drive leads shall be constructed so as to afford freedom of movement of the hammer, and they shall be held firmly in position to ensure rigid lateral support to the pile during driving. Except where piles are driven through water, the leads shall be of sufficient length to make the use of a follower unnecessary and shall be so designed as to permit the proper placing of batter piles. If the condition at the site requires the necessity of a follower, the Contractor shall not use it without approval of the Engineer.

When water jets are considered by the Engineer to be necessary, the number of jets and the nozzle volume and pressure shall be sufficient to erode freely the material adjacent to the piling. The plant shall have at all times a pressure of at least seven (7) kilogrammes per square centimeter at two (2) centimeter jet nozzles. Before the required penetration is reached, the jets shall be shut off and the piles driven by hammer to final penetration.

A detailed accurate record of the driving of all piles shall be kept by the Engineer and the Contractor shall give every assistance to the Engineer to help him keep this record which will include the following: pile numbers, positions, types, sizes, actual lengths, dates driven, lengths in footings, penetration under final blows of the hammer, striking energy of the hammer, lengths extended, length cut off, and final pay lengths.

No piles shall be driven near freshly placed concrete.

(v) Bearing values - Piles shall be driven to a bearing value of not less than that shown on the Drawings. The Engineer will specify the penetration and the Contractor shall drive the piles to the penetration specified, but if the Engineer is not satisfied that the desired bearing value has been attained the Contractor shall carry on driving until such desired bearing value is attained.

(vi) Cut off and extension - Piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the Drawings.

The extended length of a pile shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section as the pile itself or as shown on the Drawings. After piles have been lengthened driving shall not be resumed until the approval of the Engineer has been given.

Unless otherwise specified, pile cut-off length shall become the property of the Contractor and shall be disposed of beyond Government property limits and outside the limit of view from the roadway to the satisfaction of the Engineer.

(vii) Connection with footing - All piles shall be connected to footings as shown on the Drawings or directed by the Engineer.

(c) Test Piles

The Engineer may order the execution of test piles as he may consider necessary to ascertain the type of the foundation or the length of pile for the project. The Contractor shall furnish and execute test piling at the locations designated by the Engineer.

The lengths of the piles shown on the Drawings are based on information obtained from previous site investigations. However, piles of different lengths may be required and as ordered by the Engineer.

Before pile lengths are finally settled, the Contractor shall construct to the lengths shown on the Drawings such test piles as may be found necessary and these piles shall be driven in the positions specified by the Engineer who shall be notified in advance of the driving. The Contractor shall furnish the Engineer daily with a detailed record of the driving of test piles throughout the full depth of driving.

After attaining the approved set, driving shall be continued until the Engineer directs that it shall cease. Driving of test piles beyond the point at which the approved set is obtained will be called for to demonstrate that driving resistance continues to increase. The Contractor shall then furnish the remainder of the piles in the structure. In determining the lengths of piles the Contractor shall base his list on the lengths assumed to remain in the completed structure.

Test piles shall be used as foundation piles, only on the written agreement of the Engineer.

The Contractor at his own expense may increase the lengths to provide for fresh heading and or such lengths as may be necessary to suit his method of operation.

(d) Test Loading

The static and dynamic load tests shall be made by the methods approved by the Engineer. The Contractor shall submit to the Engineer for approval detailed drawings of the loading apparatus he intends to use.

(i) Static Load Test

The apparatus of static load tests shall be so constructed as to allow the various increments of the load to be placed gradually without causing vibration to the test piles.

If the approved method requires the use of tension (anchor) piles, such tension piles shall be of the same type and diameter as the permanent piles and shall be executed in the location of permanent piles. Pipe and shell piles whose walls are not of adequate strength to sustain the test loading when empty shall have the required reinforcement and concrete placed before loading. Loads for the load tests shall not be applied until the concrete has attained a minimum compressive strength of 95 percent of the design 28 day compressive strength. If he so elects, the Contractor may use high early strength cement, type III, in the concrete of the load test piles and the tension piles.

Suitable approved apparatus for determining accurately the load on the piles and the settlement of the piles under each increment of load shall be supplied by the Contractor.

The apparatus shall have a working capacity of three times the design load shown on the Drawings for the pile being tested. Reference points for measuring pile settlement shall be sufficiently removed from the test pile to preclude all possibility of disturbance. All pile load settlement shall be measured by adequate devices, such as gauges, and shall be checked by means of an Engineer's level.

Increments of deflection shall be read just after each load increment is applied and at 15 minute intervals thereafter. The safe allowable load shall be considered as 50% of the load which, after 48 hours of continuous application, has caused not more than 6.5 mm of permanent settlement, measured at the top of the pile. The test load shall be twice the design load shown on the Drawings.

The first increment of load to be applied to the test pile shall be the pile design load. The load on the pile shall be increased to twice the design load by applying additional loads in three equal increments. A minimum period of 2 hours shall intervene between the application of each increment, except that no increment shall be added until a settlement of less than 0.12 mm is observed in a 15 minute interval under the previously applied increment. If there

is a question as to whether the test pile will support the test load, the load increments shall be reduced by 50 percent, at the direction of the Engineer, in order that a more closely controlled failure curve may be plotted. The full test load shall remain on the test pile not less than 48 hours. The full test load shall then be removed and the permanent settlement read. When requested by the Engineer, loading shall then continue beyond the double design load in 10 ton increments until the pile fails or the capacity of the loading apparatus is reached, whichever is the lesser. The pile may be considered to have failed when the total settlement under load exceeds 2.5 cm or the permanent settlement exceeds 6.5 mm.

After the completion of loading tests, the load used shall be removed and the piles, including tension piles, shall be utilized in the structure if found by the Engineer to be satisfactory for such use. Test piles not loaded shall be utilized similarly. If any pile, after serving its purpose as a test or tension pile, is found unsatisfactory for utilization in the structure, it shall be removed if so ordered by the Engineer or shall be cut off below the ground line or footings, whichever is applicable.

(ii) Dynamic Load Test

Dynamic Load Test shall be in accordance with ASTM D4945-17 Standard Test Method for High-Strain Dynamic Testing of Pile. The dynamic load test covers the procedure for testing vertical or batter piles individually to determine the force and velocity response of the pile to an impact force applied axially by pile driving hammer to the top of pile. This is applicable to deep foundation piles.

This method is used to provide data on strain or force and acceleration, velocity or displacement of a pile under impact force. The data will be used to estimate the bearing capacity, pile integrity, as well as hammer performance, pile stresses, and soil dynamic characteristics.

The apparatus for applying impact force is pile driving hammer or similar device which is capable of generating a net measurable pile penetration, or an estimated mobilized static resistance in the bearing stratum.

The apparatus for obtaining dynamic measurement shall consist of force or strain transducers and velocity or displacement transducers. The first transducers shall be capable of independently measuring strain and acceleration versus time at a specific location along the pile axis during the impact event. The second transducers shall be placed at equal radial distances on the diametrically opposite side of the pile to where the first transducers were placed. Both of the transducers shall be placed securely so that they do not slip. Velocity data shall be obtained with the second transducers or accelerometers provided the signal can be processed by integration in the apparatus for reducing data.

The accelerometers shall have a minimum of two accelerometers with a resonant frequency above 7500 Hz.

The signals from the transducers during the impact event shall be transmitted to the apparatus for recording, reducing and displaying data to allow determination of the force and velocity versus time. It may be desirable to also determine the acceleration and displacement of the pile head, and the energy transfer to the pile. This apparatus shall include an oscilloscope or oscillograph for displaying the force and velocity traces, a tape recorder or equivalent for obtaining a record for future analysis, and a means to reduce data. The apparatus shall have the capability of making internal calibration check of strain, acceleration, and time scales. No error shall exceed 2% of the maximum signal expected.

The number and location of the piles to be submitted to static or dynamic load testing shall be decided by the Engineer. This number, for piles over 600 mm in diameter, shall be not less than one and not more than three for each bridge. For piles up to and including 600 mm in diameter it shall be not less than one for every 30 piles.

(iii) Reporting

A report shall be prepared by the Contractor on each load test. This report shall include the following documents:

- Plan of the foundation;
- Stratification of the soil;
- Calibrating curve of the gauges;
- Drawing of the jack diameter of the piston;
- Graph of the test, having for abscissa the loads (tons) and for ordinates the settlements in fractions of mm;
- Tables showing, as a function of the times (date and hour), the readings of the gauge in atmospheres, the loads in tons, the settlements and average of the settlement.

When the safe bearing capacity of any pile is found by test to be less than the design load, longer piles or additional piles shall be installed as directed by the Engineer.

(e) Dynamic Formula for Estimating Pile Capacity

The pile load capacity of driven piles may be estimated using the following dynamic formula (Hiley). The Contractor may propose another formula for the Engineer's approval.

$$P_u = \frac{e_f W H}{S + (C_1 + C_2 + C_3)/2} \times \frac{W + n^2 W_p}{W + P}$$

Where :

P_u : ultimate load capacity (ton)
P_a : permissible load capacity (ton)
e_f : hammer efficiency
e_f = 1.00 for diesel hammer
e_f = 0.75 for drop hammer actuated by rope and friction winch
W : weight of hammer or ram (ton)
W_p : weight of pile (ton)
n : coefficient of restitution
n = 0.25 for concrete pile
H : drop of hammer (m)
H = 2H' for diesel hammer (H' : drop of ram)
S : pile penetration for last blow, or "set" (m)
C_1 : temporary compression allowance for pile head and cap (m)
C_2 : temporary compression allowance for elastic deformation of pile shaft (m)
C_3 : temporary compression allowance for quake of ground (m)
N : safety factor

Value of $C_1 + C_2 + C_3$ shall be measured during driving.

S10.05 (4) Method of Measurement

(a) Piles Furnished

The unit of measurement for payment for furnishing pretensioned concrete and precast reinforced concrete piles shall be the linear meters, measured from the toe of pile to the cut off of pile, in compliance with the Engineer's instructions and the material requirements of these Specifications and stockpiled in good condition at the site of the work by the Contractor, and accepted by the Engineer. No allowance will be made for the length of piles furnished by the Contractor to replace piles previously accepted by the Engineer that are subsequently lost or those that are damaged prior to completion of the Contract while in stockpile, or during handling or driving, and are ordered by the Engineer to be removed from the site of the work or disposed of otherwise. No payment for the lengths cut off or the undriven of furnished piles.

(b) Piles Driven

The quantities of driven pretensioned concrete and precast reinforced concrete piles to be paid for shall be the number of linear meters of piles actually driven and accepted. The pay lengths of the satisfactorily driven piles shall be measured from the tip to the cut-off or the piles totally penetrated in groundor from the toe of pile to the ground level for the piles partly penetrated in ground. Lengths cut-off will not be measured for payment.

(c) Piles Executed in Water Stream

Measurement for additional payment for piles constructed under water shall be calculated by linear metre. No additional payment will be made if the depth of water is less than 50 cm. The additional payment will be

based on the linear metre measurement of the depth of water, based on the elevation difference between the river bed and normal water level for each individual pile.

(d) Test Piles

The quantities of test piles as provided in Sub-clause S10.05 (3) (c) to be paid for shall be the linear meters of test piles completed and accepted, whether they are executed inside or outside the foundation.

S10.05 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price per linear meter for the particular pay items listed below. The rate shall constitute full compensation for all materials including prestressing, reinforcement and shoes, equipment, hardware, furnishing, jointing, driving, jetting, welding (extending), painting, testing, coupling, cutting-off, concrete filling for spun piles, reinforcement for connection with footing and all related tools, rigs, cranes, boilers, hammers, jets, labour and other incidental equipment and work.

Pile connection with footing, including reinforcement bars and including concrete filling for spun piles, will not be measured separately and is deemed to be included in the cost of pile driving.

Payment for test piles, completed and accepted, shall be made as the linear meter of test piles for furnishing and driving a test pile of the size specified. When test piles are incorporated in the foundation connection with footing is included and no additional payment shall be made for the pile so utilized other than as for test pile.

No payment shall be made for unauthorized, defective, unsound or unsatisfactorily driven piles or for any costs incurred by the Contractor for such piles.

Pay Item No. and Name		**Unit of Measurement**
10.05 (1)	Pretensioned Spun Concrete Pile, Furnished, D = 80cm	Linear Meter
10.05 (2)	Pretensioned Spun Concrete Pile, Driven, D = 80cm	Linear Meter
10.05 (3)	Pretensioned Spun Concrete Pile Test Furnished and Driven, D = 80cm	Linear Meter
10.05 (4)	Pretensioned Spun Concrete Pile, Furnished, D = 60cm	Linear Meter
10.05 (5)	Pretensioned Spun Concrete Pile, Driven, D = 60cm	Linear Meter
10.05 (6)	Pretensioned Spun Concrete Pile Test Furnished and Driven, D = 60cm	Linear Meter
10.05 (7)	Pretensioned Spun Concrete Pile, Furnished, D = 50cm	Linear Meter

10.05 (8)	Pretensioned Spun Concrete Pile, Driven, D = 50cm	Linear Meter
10.05 (9)	Pretensioned Spun Concrete Test Pile, Furnished and Driven, D = 50cm	Linear Meter
10.05 (10)	Additional Price to Prices No.10.05.(2), No.10.05.(5) and No.10.05.(8) when the Pile is executed in the Water Stream,	Linear Meter
10.05 (11)	Static Loading Test for Pretensioned Spun Concrete Pile D = 50 - 60cm	Each
10.05 (12)	Static Loading Test for Pretensioned Spun Concrete Pile D = 80cm	Each
10.05 (13)	Dynamic Loading Test for Pretensioned Spun Concrete Pile D = 50 - 60cm	Each
10.05 (14)	Dynamic Loading Test for Pretensioned Spun Concrete Pile D = 80cm	Each
10.05 (15)	Precast Reinforced Concrete Pile 30cm x 30cm, furnished	Each
10.05 (16)	Precast Reinforced Concrete Pile 30cm x 30cm, driven	Each
10.05 (17)	Precast Reinforced Concrete Pile 20cm x 20cm, furnished	Each
10.05 (18)	Precast Reinforced Concrete Pile 20cm x 20cm, driven	Each

S10.06 Steel Piling

S10.06 (1) Description

This work shall consist of steel piling for structure foundations furnished and driven in accordance with these Specifications and in reasonably close conformity with the Drawings at the penetration or depth ordered by the Engineer. When the Engineer judges that pile foundation is not necessary, based on the result of Test Drilling specified in Clause S10.08 or the result of Test Piling, Contractor shall change the footing design as directed by the Engineer.

When the steel pipe pile to be used and to be filled with concrete, the concrete shall be selft compacted concrete (SCC) with minimum strength of fc '30 MPa and filled up to a minimum depth of 8 meters under existing ground or as shown in the Drawings. The sand to be filled into the steel pipe pile shall be clean and does not contain the corrosive materials such as sea sand.

S10.06 (2) Materials

Steel pile shall be shop-fabricated and shall have the type, weight, quality and dimensions specified ASTM A500/A500M - 18 (Steel Pipe Grade B), or as shown on the Drawings.

Prior to furnishing steel piles the Contractor shall submit to the Engineer for approval a certificate by the manufacturer certifying that the piles comply with the specification requirements.

S10.06 (3) Construction

(a) Preparation for Driving

(i) Caps - The heads of all steel piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design having a suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block. No pile head will be held so firmly that the slight rotation of the pile normally occurring while the pile is being driven will be prevented.

(ii) Joints of steel pile - Joints of steel pile shall be carefully constructed in accordance with the Drawings, or the instruction of the Engineer. When joints which are not specified on the Drawings are to be constructed, the Contractor shall obtain the approval of the Engineer and employ electric arc welding throughout the butt joint. Welding shall be made in accordance with requirements specified in JIS A7201:2009 (Standard Practice for Execution of Spun Concrete Piles).

(iii) Pile shoes - Shoe bases where used shall consist of steel plate as shown on the Drawings.

(iv) Protection Against Corrosion - Where there is a possibility of corrosion of steel piles, the lengths or sections liable to corrosion shall be protected by painting with an approved protective coating and/or shall be installed with a thicker metal section when the rate of corrosion can be reasonably accurately estimated. Generally, all exposed lengths of steel pile, and any lengths installed in disturbed ground above the minimum water table shall be protected against corrosion.

If the steel piles to be located in watery areas (rivers), these piles shall be protected with an anti corrosion paint at least 1.5 meters above the highest flood water level and 0.5 meters below the lowest water level, and if the steel piles to be located in the tidal area, these piles shall be protected with an anti corrosion paint at least 1.5 meters above the highest tidel level and 0.5 meters below the lowest tidel level. The anti corrosion paint and thickness required shall conform to ISO 12944-6:2018 or SNI ISO 12944-6-2012 and SE Menteri PUPR No.26/SE/M/2015 Pedoman Perlindungan Komponen Baja Jembatan dengan Cara Pengecatan.

(b) Handling, Pitching and Driving

(i) General - When raising or transporting steel pipe piles the Contractor shall provide slings and other equipment necessary to prevent any appreciable bending of the pile. No steel pile shall be lifted otherwise than by slinging from the lifting holes, the

positions of which shall be as directed or approved by the Engineer.

The main setting out for the piles is to be completed prior to commencement of driving. Secondary or individual pile setting out is to be completed and agreed not less than 8 hours prior to commencing work on the piles concerned. All main setting out points, lines and stations are to be maintained safe and undisturbed until the work is complete.

Piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings or fixed by the Engineer. Piles deflected from the vertical or proper line shall, where ordered by the Engineer, be withdrawn and repitched until the proper line is obtained.

No forcible method of correction of the position or line of any pile will be permitted. Any pile damaged by reason of improper driving or driven out of its proper location or driven below the elevation fixed by the Drawings or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer for the pile in question :

- The pile shall be withdrawn and redriven or replaced by a new pile as decided by the Engineer. Any holes from which piles are withdrawn shall be packed with approved non-plastic material before redriving takes place; or
- A second pile shall be driven adjacent to the defective pile.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven again.

(ii) Battered piles - Battered piles shall be driven accurately to the batter shown on the Drawings. The pile frame employed for the driving of the batter piles shall have leads capable of adjustment to the required angle. When piles have to be driven below the level of the bottom of the leads, extension leads shall be provided except where the use of a follower is specifically permitted by the Engineer.

(iii) Driving equipment - Before any piling work is commenced the Contractor shall submit to the Engineer full details of the pile driving equipment and the method of carrying out the work he intends to use. All piles shall be provided with caps for driving as specified in Item (a) (i) above. For special types of piling, driving head mandrels, or other devices in accordance with these requirements shall be provided so that piles may be driven without damage.

Shoes shall be provided as shown on the Drawings. Piles shall be driven with steam, air or diesel hammers, a combination of hammers with water jets or gravity hammers. When diesel

hammers are used, they shall be calibrated by a load test if necessary.

The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain, under working conditions, the pressure in the manner specified by the manufacturer. The boiler or tank shall be equipped with an accurate pressure gauge, and another gauge shall be supplied at the hammer intake.

(iv) Driving - Piles shall be supported in line and position with leads while being driven. Pile drive leads shall be constructed so as to afford freedom of movement of the hammer, and they shall be held firmly in position to ensure rigid lateral support to the pile during driving. Except where piles are driven through water, the leads shall be of sufficient length to make the use of a follower unnecessary, and shall be so designed as to permit the proper placing of batter piles. If the condition at the site requires the necessity of a follower, the Contractor shall not use it without approval of the Engineer.

When water jets are considered by the Engineer to be necessary, the number of jets and the nozzle volume and pressure shall be sufficient to erode freely the material adjacent to the piling. The plant shall have at all times a pressure of at least 7 kilogrammes per square centimeter at two (2) centimeter jet nozzles. Before the required penetration is reached, the jets shall be shut off and the piles driven by hammer to final penetration.

A detailed accurate record of the driving of all piles shall be kept by the Engineer and the Contractor shall give every assistance to the Engineer to help him keep this record which will include the following: pile numbers, positions, types, sizes, actual lengths, dates driven, lengths in footings, penetration under final blows of the hammer, striking energy of the hammer, lengths extended, lengths cut off, and final pay lengths.

No pile shall be driven near freshly placed concrete.

(v) Bearing values - Piles shall be driven to a bearing value of not less than that shown on the Drawings. The Engineer will specify the penetration and the Contractor shall drive the piles to the penetration specified, but if the Engineer is not satisfied that the desired bearing value has been attained the Contractor shall carry on driving until such desired bearing value is attained.

(vi) Cut off and extension - Steel pipe piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the Drawings.

The extended length of a pile shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section as the pile itself or as shown on the Drawings. After piles have

been lengthened driving shall not be resumed until the approval of the Engineer has been given.

If so required and directed by the Engineer pile cut-off lengths, of 1.0 meter or more, shall be utilized as extension piles or otherwise. The preparation of such cut-off pile lengths shall be undertaken by the Contractor without additional payment or claim.

In compliance with this Clause all pile cut-off lengths shall be salvaged and safely stored and protected by the Contractor. On completion of the Works any unused pile cut-off lengths will become the property of the Contractor and shall be disposed of beyond Government property limits and outside the limit of view from the roadway to the satisfaction of the Engineer.

(vii) Connection with footing - All piles shall be connected to footings using reinforcing bars and steel plate, as shown on the Drawing or directed by the Engineer.

(c) Test Piles

The Engineer may order the execution of test piles as he may consider necessary to ascertain the type of the foundation or the length of pile for the project. The Contractor shall furnish and execute test piling at the locations designated by the Engineer.

The lengths of the piles shown on the Drawings are based on information obtained from previous site investigations. However, piles of different lengths may be required and as ordered by the Engineer.

Before pile lengths are finally settled, the Contractor shall construct to the lengths shown on the Drawings such test piles as may be found necessary and these piles shall be driven in the positions specified by the Engineer who shall be notified in advance of the driving. The Contractor shall furnish the Engineer daily with a detailed record of the driving of test piles throughout the full depth of driving.

After attaining the approved set, driving shall be continued until the Engineer directs that it shall cease. Driving of test piles beyond the point at which the approved set is obtained will be called for to demonstrate that driving resistance continues to increase. The Contractor shall then furnish the remainder of the piles in the structure. In determining the lengths of piles the Contractor shall base his list on the lengths assumed to remain in the completed structure.

Test piles shall be used as foundation piles, only on the written agreement of the Engineer.

The Contractor at his own expense may increase the lengths to provide for fresh heading and or such lengths as may be necessary to suit his method of operation.

S10.06 (4) Method of Measurement

(a) Piles Furnished

The unit of measurement for payment for furnishing steel piles shall be the weight (tonne), measured from the toe of pile to the under-side of pile cap, including plates, jointing steel and cap reinforcement, furnished in compliance with the material requirements of these Specifications and as directed by the Engineer. No payment for the lengths cut off or the undriven of furnished piles.

(b) Piles Driven

The quantities of driven steel piles to be paid for shall be the number of linear meters of piles actually driven and accepted. The length of individual piles shall be measured from the toe of pile to the under-side of pile cap for the piles totally penetrated in ground, or from the toe of pile to the ground level for the piles partly penetrated in ground.

(c) Test Piles

Test piles will be measured and paid for in accordance with (a) and (b) above, and the quantities given in the Bid Schedule will be based on the assumption that test piles can subsequently be incorporated into the permanent works.

S10.06 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract price per unit of measurement for the pay items listed below. The payment shall include full compensation for furnishing and driving the piles including materials for completion of the pile and for all labor, tools, equipment, hauling, handling, jetting, jointing, cutting and all other incidental works connected therewith.

Pay Item No. and Name		**Unit of Measurement**
10.06 (1)	Steel Pile, Furnished., D = 50cm	Tonne
10.06 (2)	Steel Pile, Driven, D = 50cm	Linear Meter
10.06 (3)	Steel Pile, Furnished. D = 60cm	Tonne
10.06 (4)	Steel Pile, Driven, D = 60cm	Linear Meter
10.06 (5)	Steel Pile, Furnished. D = 80cm	Tonne
10.06 (6)	Steel Pile, Driven, D = 80cm	Linear Meter
10.06 (7)	Additional Price to Prices No.10.06 (2), No.10.06.(4) and No.10.06 (6) and when the Pile is executed in the Water Stream	Linear Meter

S10.07 Cast-in-place Concrete Piling

S10.07 (1) Description

The work shall consist of cast-in-place concrete piles constructed by the reverse circulation drill method in accordance with these Specifications and with the requirements shown on the Drawings. Loading test is also included and required to determine beraring capacity of bored pile foundation.

S10.07 (2) Materials

Cast-in-place concrete piles shall be constructed, in accordance with the details shown on the Drawings, of concrete Class B-2 Self Compacted Concrete (SCC), mixed and placed in accordance with the provisions of Clause S10.01 of these Specifications.

Reinforcement shall comply with the provisions of Clause S10.02 of these Specifications.

S10.07 (3) Construction

(a) Drilled holes

All holes for concrete piles cast in drilled holes shall be drilled to the tips of piles. The length of piles shall be instructed by the Engineer. The drilling machine shall be such that the hole can be maintained exactly vertical during drilling operations.

Completed piles and existing structures very close to the drilling area shall be protected from the influence of piling and the Contractor's proposals for this shall be submitted to, and approved by, the Engineer before the start of piling.

Drilled holes shall be protected from collapse by a water surcharge, by providing a steel casing (i.e. stand casing pipe). The stand casing pipe shall be rigid and project at least 50 cm above ground level.

The water level of the inside of the drilled hole shall be always kept approximately 2 m higher than the natural ground water level. Water supplied from a municipal water supply system or a river is allowed for this purpose.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed by air lift or suction pump before placing concrete.

(b) Bentonite

The bentonite material shall be sourced from approved international brands or from equivalent material such as polymer, which shall be considered if there is influence of salt water from the seaside.

The bentonite shall be mixed in high turbulence mixers and pumped into storage silos or clean bentonite tank/pool built on site.

Slurry shall be pumped through 4" diameter steel pipes from and to the excavation.

Used bentonite will be passed through descending sieves and stored for re-used.

Unsuitable bentonite slurry shall be stored separately and transported off site in slurry tankers and dumped in an approved area.

A mud testing laboratory shall be provided on site and shall contain the following apparatus and result of test shall be approved by the Engineer:

- 1 baroid filter press (free water test);
- 1 mud balance (density test);
- 1 marsh cone (viscosity test);
- 1 sand screen set (sand content test);
- Apparatus for measuring pH.

(c) Soil Disposal

Soil waste from the drilled hole which is dumped beside the rig during drilling workshall be transported away from the site immediately to prevent obstructing the drillingprogress. The spoil shall be loaded into dump trucks with an excavator or loader andshall be carried to stockpile area inside the site and then transported out of project siteto an approved waste disposal area

(d) Reinforcement

Reinforcement shall be positioned as shown on the Drawings. The connecting portions of main bars with hoops shall generally be welded by arc fillet welding.

During the placing of the reinforcement in the hole, the verticality and position of the reinforcement shall be carefully controlled to prevent collapse of the drilled hole or damage to the walls.

(e) Casting

Concrete shall be placed in one continuous operation from tip to cut-off elevation by tremie tubes and shall be carried out in such a manner as to avoid segregation. The tip of the tremie shall generally be 2 m lower than the fresh concrete surface.

The Contractor at his own expense shall initially cast an additional length of pile above the finished level of the top of the pile and subsequently remove any defective concrete to ensure satisfactory bonding of the pile head to the footing structure.

(f) Reporting

The Contractor shall furnish the Engineer daily with a detailed record of the construction of piles.

(g) Static Loading Test Piles

The Engineer may instruct the load testing of cast-in-place concrete piles. Details of the loading test are given in the Special Specification.

The Engineer may instruct the load testing of cast-in-place concrete piles. Details of the loading test are given in as directed by the Engineer and in accordance with the requirements of maximum loading which is 150 % of service load.

(h) Dynamic Loading Testing Pile

For the Dynamic loading test a proper weight of hammer shall requiredmakingsufficient energy to mobilize the soil element around the pile. As the method of testing, the minimal proper hammer weight shall be minimum 1 % of the expected ultimate bearing capacity. The standard test method shall be accordance with the requirement of ASTM D4945-17 “Standard Test Method for High-Strain Dynamic Testing of Piles”.

(i) Non-destructive checking

The Contractor may be requested to check all drilled holes by ultrasonic measurement before installation of reinforcement, and the details of such checking shall be approved by the Engineer.

(i) Measurement Monitor of Drilling Hole

The Contractor shall check all drilled holes by ultrasonic measurement before installation of the reinforcement bar, and the details of such method shall be approved by the Engineer. The monitor shall be check for the vertical drilling holes and the direct recording shall be in four directions (X-X' and Y-Y'). This work shall include in pay item 10.07 (1) and (2).

(ii) Pile Integrity Testing (PIT)

The Contractor shall test all concrete piles by Pile Integrity Testing (PIT) after casting of concrete, which is a non-destructive integrity test method for foundation piles. It is a “Low Strain” Method (since it requires the impact of only a small hand-held hammer). The evaluation of PIT records is conducted either according to the pulseecho (or Sonic Echo – a time domain analysis) or the transient response (frequency domain analysis) procedure. The standard test method shall be accordance with the requirement of ASTM D5882-16 “Standard Test Method for Low -Strain Integrity Testing of Piles”, and shall include in pay item 10.07 (1) and (2).

(iii) Ultrasonic Measurement monitor of concrete pile

The Contractor may be requested to monitor concrete piles used installed pipe in the pile by ultrasonic measurement monitor after casting of concrete, and the result of such monitoring shall be approved by the Engineer and may instruct the location of the testing of cast-in-place concrete piles. The hole of pile for the

ultrasonic equipment installation shall pour the suitable material after result of the ultrasonic test record.

Specification of ultrasonic measurement monitor shall be approved the Engineer and shall pay item 10.07 (4).

S10.07 (4) Method of Measurement

(a) Cast-in-place Concrete Piles

The quantity of cast-in-place concrete piles to be paid for will be the actual number of linear meters of piles cast and left in place in the completed and accepted work.

Measurement will be made from the point of the tip of the pile to the bottom of the footing. Portions of piles cast deeper than required through over-drilling procedures will not be measured for payment.

(b) Static Loading Test Piles

The quantities of static loading test piles to be paid for will be the actual number of piles installed and tested as instructed by the Engineer Measurement of test piles will

(c) Dynamic Loading Test Piles

The quantities of dynamic loading test piles to be paid for will be the actual number of tested as instructed by the Engineer. The pile installation will be excluded in this pay item.

(d) Ultrasonic Measurement Monitor of Concrete Pile

The quantities of ultrasonic measurement monitor of concrete pile to be paid for will be the actual number of tested as instructed by the Engineer. The pile installation will be excluded in this pay item.

S10.07 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract price per unit of measurement for the pay items listed below.

The payment for cast-in-place pile shall be full compensation for construction of the piles including protection of existing piles and structures, all materials for completion of the pile and for all labour, tools, equipment, hauling, handling, jetting, jointing, cutting and all other incidental works connected therewith.

Payment for each test pile shall be full compensation for all labour, equipment, material, including temporary piles, required to install the test pile and carry out the loading test in a manner as approved by the Engineer. When test piles are incorporated in the foundation no additional payment shall be made for the pile so utilized other than as for test pile.

Pay Item No. and Name	**Unit of Measurement**
10.07 (1) Cast-in-Place RC Pile D=80cm with Ultrasonic Monitoring	Linear Meter

10.07 (1a)	Cast-in-Place RC Pile D=100cm with Ultrasonic Monitoring	Linear Meter
10.07 (2)	Cast-in-Place RC Pile D=80cm including Static Loading Test	Linear Meter
10.07 (2a)	Cast-in-Place RC Pile D=100cm including Static Loading Test	Linear Meter
10.07 (3)	Dynamic Loading Test for Cast-in-Place RC Pile D=80cm	Each
10.07 (3a)	Dynamic Loading Test for Cast-in-Place RC Pile D=100cm	Each
10.07 (4)	Ultrasonic Measurement Monitor for Cast-in-Place RC Pile D=80cm	Each
10.07 (4a)	Ultrasonic Measurement Monitor for Cast-in-Place RC Pile D=100cm	Each
10.07 (5)	Cast-in-Place RC Pile D=120cm, with Ultrasonic Monitoring	Linear Meter
10.07 (6)	Cast-in-Place RC Pile D=120cm, including Static LoadingTest	Linear Meter
10.07 (7)	Dynamic Loading Test for Cast-in-Place RC Pile D=120cm	Each
10.07 (8)	Ultrasonic Measurement Monitor for Cast-in-Place RC Pile D=120cm	Each
10.07 (9)	Additional Price to Prices No.10.07.(1), No.10.07.(1a), No.10.07.(2), No.10.07.(2a), No.10.07.(5) and No.10.07.(6) when the Pile is executed in the Water Stream	Linear Meter

S10.08 Test Drilling

S10.08 (1) Description

This work shall consist of test drilling for the investigation of sites on which any structure foundation is to be provided.

S10.08 (2) Test Bores

(a) General

When testing is required the Contractor shall take several test bores at each structure site to get the exact soil profile or as otherwise directed by the Engineer. Where rock is outcropping on the surface the Engineer may dispense with test bores.

(b) Depth of Bores

The test bores shall be taken down to the bearing stratum and into it sufficiently to prove its continuity. Generally, this will be five meters.

When bearing stratum has not been reached within 50 meters of the surface, the test bore may be stopped after the approval of the Engineer.

(c) Method of Boring

The Contractor may use rotary wash drilling. Basement rock shall be continuously core drilled.

(d) Tests Required on All Holes

Standard penetration tests shall be taken at two (2) meter intervals or at each change of strata whichever is lesser. The static ground water level shall be recorded for each hole. In rock core drilling the full core shall be recovered and stored in core boxes for inspection by the Engineer.

(e) Logging of the Bores

If so requested by the Engineer, the Contractor shall supply on the working day following completion of the bore the following information:

(i) Structure name

(ii) Bore position and code number

(iii) Reduced level of top of the bore

(iv) Date and time of boring

(v) Diameter of bore

(vi) Type of plant used

(vii) Depth to which bore was cased

(viii) Depth to base of each stratum from the surface

(ix) Description of strata

(x) Depth and results of tests

(xi) Static water level

(xii) Remarks

All descriptions and classifications of soils shall be in accordance with "Procedures for Testing Soils, ASTM".

(f) Further Tests that may be Required

The Engineer may call for more elaborate testing than described above at any structure site if he finds that the information is not adequate.

When instructed by the Engineer, undisturbed core samples shall be taken in cohesive soil strata.

The sampling cylinder is to be sealed and used for transport of the core from site to testing laboratory. All laboratory testing will be the responsibility of the Contractor.

S10.08 (3) Method of Measurement

The test drilling will be measured for payment purposes as lengths of hole drilled no matter what materials are encountered.

S10.08 (4) Basis of Payment

Payment will be made on the quantities as measured above and at the rates shown in the Bid Schedule. The payment shall include full compensation for all drilling, casing, if necessary, penetration test and split-barrel sampling, recording and presenting the results and storing the samples until their disposal is approved by the Engineer.

Pay Item No. and Name		**Unit of Measurement**
10.08	Test Drilling	Linear Meter

S10.09 Bridge Railing and Chainlink Fence and Stair Handrail

S10.09 (1) Description

This work shall consist of furnishing, fabricating and erecting steel pipe railings, aluminium railings and chainlink fences for bridges, RC frames and incidental structures, all as indicated on the Drawings and required by these Specifications and as directed by the Engineer.

S10.09 (2) Materials

(a) Materials shall conform to the requirements of :

JIS G 3101 (ASTM A36/A36M-19)	: Rolled Steel for General Structures
JIS G 3452 (ASTM A53/A53M-18)	: Carbon Steel Pipes for Ordinary Piping
JIS G 3444 (ASTM A500/A500M-18)	: Carbon Steel Tubes for General structural Purposes
JIS G 3466	: Carbon Steel Square Pipes for General Structural Purposes
JIS G 3532 (ASTM A82/A82M-07)	: Low Carbon Steel Wires
JIS G 3552 (ASTM A392-11a(2017))	: Chainlink Wire Netting
JIS H 4040	: Aluminium and Aluminium Alloy Rods, Bars, Wires
JIS G 4303	: Stainless Steel Bars

(b) Mortar and grout shall conform to the provisions of Clause S12.04 of these Specifications.

(c) All steel railing, chainlink fencing, and fittings shall be galvanised unless otherwise specified, in accordance with the requirements of Clause S12.18 of these Specifications. All aluminium alloy shall be coated in accordance with the Specifications of JIS H8601:1999. Galvanised areas damaged by welding or other site works shall be cleaned and given 3 coats of approved zinc based paint, to the satisfaction of the Engineer.

(d) Where painting is required, it shall be in accordance with the requirements of Clause S12.18 of these Specifications.

S10.09 (3) Construction

(a) Pipe railings, fittings and incidental parts shall be carefully handled and stored on blocking, racks or platforms so as not to be in contact with the ground and shall be protected from corrosion. Materials shall be kept free from dirt, oil, grease and other foreign matter. Surfaces to be painted shall be carefully protected both in the shop and in the field. Threads shall be carefully protected from damage.

(b) Railings and fences shall be carefully constructed true to line and grade as shown on the Drawings, and no construction shall be commenced before the inspection and approval by the Engineer and before all centres, supports, and falsework or staging of bridge superstructure have been removed.

(c) The component parts of pipe railings shall be connected with threaded screws unless otherwise specified on the Drawings. Fitting for railings on slopes shall be levelled to fit the required grades. Screw thread fittings shall be coated with red lead and oil, and the threads shall engage for a minimum length of 2 centimeters. Expansion shall be provided by omitting threads on one side of fittings at designated posts. Where the rails are continuous through two or more posts threads may be omitted between the rails and the fitting, but the rail shall be pinned at each post. Where welding of component parts is permitted, the details shall be in accordance with the Drawings or as approved by the Engineer.

(d) The Contractor shall provide for the erection of pipe railing by suitable fabrication in the shop. Where railing is fitted between concrete posts, provision shall be made to allow the installation of same.

Railing and fence shall be fabricated and erected as indicated on the Drawings, and rails shall be parallel to the grade of the road. Posts shall be set truly vertical unless otherwise instructed by the Engineer.

All exposed surfaces shall be thoroughly cleaned in an approved manner as a final operation under this project.

(e) The Contractor shall furnish for the approval of the Engineer working drawings for the particular type of railing and fence to be installed.

S10.09 (4) Method of Measurement

The quantities of metal railing and chainlink fence to be paid for shall be the number of linear meters of railings or chain-link fence satisfactorily completed and accepted in accordance with the Drawings, these Specifications, and as directed by the Engineer.

S10.09 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price per linear meter of railings and chainlink fence. The price and payment shall be full compensation for furnishing all railings, chainlink wire netting, posts and fittings including delivery, erection and finishing, and for all labour, equipment, tools and incidentals necessary for the completion of the work.

Pay Item No. and Name		Unit of Measurement
10.09 (1)	Bridge Railing	linear meter
10.09 (2)	Stair Handrail H = 1.5m	linear meter
10.09 (3)	Chainlink Fence, H = 2.6m	linear meter

S10.10 Bridge Expansion Joints

S10.10 (1) Description

This work shall consist of furnishing, fabricating and erecting expansion joint at slab, deck slab concrete of bridge and RC bridge, wihich made of metal or elastomer or asphaltic type and each of filler and sealer for structure connection either longitudinalor traversal as indicated on the Drawings and required by these Specifications and as directed by the Engineer.

S10.10 (2) Submittals

A sample of any expansion joint material that the Contractor proposes to use in the work, together with a statement as to its source and test data giving its properties shall be submitted to the Engineer and approved by him before furnishing the joints.

Before furnishing the joints the Contractor shall submit to the Engineer for approval a certificate by the manufacturer certifying that the joints comply with the specification requirements.

S10.10 (3) Expansion Joint Types

(a) Surface Rubber joint with Load - supporting Type (Type A)

Surface Rubber joint with Load-supporting type (Type A) shall be for movable joints (30mm) for short span concrete bridges (PC-U, PC-I, Hollow slab, etc).

(b) Adhesive Sealant Joint (Type B)

Adhesive Sealant type joints (Type B) shall be for fixed joints (20mm) for short span concrete bridges (PC-U, PC-I, Hollow slab, etc) and Piled slab.

(c) Steel Finger Joint (Type C)

Steel Finger Joint (Type C) shall be for expansion joint of steel box girders. The expansion amount of each type shall be 60mm in Type C-1, 175mm in Type C-2 and 220mm in type C-3.

(d) Rubberized Bitumen Binder Joint (Type D)

Rubberized Bitumen Binder Joint (Type D) shall be a combination of rubberized bitumen binder and a selected aggregate constructed in-situ by a hot process. Type D-1 shall be 40 cm wide and type D-2 shall be 30 cm wide.

(e) Longitudinal Expansion Joint (Type E)

Longitudinal Expansion Joint shall be capability of adapting itself to deflection differences of vertical movements between the left-and right-side joints as well as displacement in the axial direction of widening bridge.

(f) Strip Seal Joint (Type F)

Strip Seal Expansion Joint covers the material requirements for preformed elastomeric strip seals and the corresponding steel locking edge rail used in expansion joint sealing. The structural steel locking edge rail shall be anchored into the structure as shown di the Drawings.

S.10.10.4 Materials

Materials for the various types of joints shall comply with the following requirements under each sub-heading. This specification shall be some reference of the material grade for the Engineer's approval, thus the contractor may be submit equivalent materials as same grade and quality of the expansion joint.

(a) Surface Rubber Joint with Load-supporting Type (Type A)

The rubber material used shall be of the following specification:

Tensile strength JIS K 6301	$\geq$ 15 N/mm^2
Elongation JIS K 6301	$\geq$ 300%
Hardness JIS K 6301	55 ± 5 Hs
Tearing strength JIS K 6301	$\geq$ 3 N/mm^2
Compressive permanent strain JIS K 6301 (at 70˚C, 22 hours)	< 25%

The material of the support block used shall be of the following specification:

Rolled Steel for General structure	SS400 steel Plate (JIS G3101)

(b) Adhesive Sealant Type Joints (Type B)

Sealant material shall be a two polysulphide material in accordance with JIS K 6301.

Elongation	500%
Tensile strength	≥ 8 kg/cm2

(c) Steel Finger Joint (Type C)

The steel finger expansion joint shall be designed to accommodate the movements given on the Drawings.

Steel plates for finger plates or saw tooth plates shall comply with ASTM A1011/A1011M-18 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

Anchor bolts, nuts and washers shall conform to the requirements of ASTM F3125/F3125M-19.

Anchorage to deck joints shall conform to ASTM A668/A668M-19a. The following additional requirements shall apply to the design of anchors:

(i) Bolts shall have a minimum diameter of 16 mm.

(ii) Bars used as anchorage must form a loop of sufficient size to permit anchoring into the concrete with the contribution of the transverse and other reinforcement.

(iii) Any welding of anchorage bars shall develop the full strength of the bar and accommodate an infinite number of fatigue cycles.

(iv) Stud welded shear connectors used as anchors shall be at least 16 mm diameter and minimum of 150 mm in length and welded only by resistance welding using a welding gun. Welded steel stud shear connectors shall not be used with aluminium joints.

(v) Anchors are to be designed to allow easy replacement of the joint, and

(vi) Chemical anchors are not permitted as joint anchors. However, chemical anchor inserts with sufficient anchor length are permitted to use for joint rehabilitation works.

(d) Rubberized Bitumen Binder Joint (Type D)

Material shall comply with the following specification requirements or shall be in accordance with the specifications of manufacturer recommended and approved by the Engineer.

Binder (Polymer modified bituminous materials)

Type of Test	**Standard**	**Physical Properties**
Softening Point, min.	AASHTO T53-09(2013) or SNI 2434:2011	88°C
Tensile Adhesion, min.	ASTM D5329-16	700%

Type of Test	Standard	Physical Properties
Ductility at 25°C, min.	AASHTO T51-09(2013) or SNI 2432:2011	400mm
Penetration at 25°C, max.	ASTM D5329-16	7.5 mm
Flow at 60°C, 5 hours	ASTM D5329-16	3.0 mm
Resiliency at 25°C, min. – max.	ASTM D5329-16	40 - 70%
Asphalt Compatibility	ASTM D5329-16	pass
Recommended Installation Temperature		193°C
Maximum Heating Temperature		204°C
Bond, 50% extension, 25mm, 3 cycles	ASTM D5329-16	-22°C
Flexbility	ASTM D5329-16	-28°C

Aggregate

The aggregate shall consist of material that clean, hard, durable and free of organic impurities and other unwanted impurities and meets the conditions specified below and has a uniform gradation in a single nominal size of 14, 20 and 28 mm or may be mixed between these three sizes.

Properties	Standard	Requirement
Agregate loss with Los Angeles machine	AASHTO T96-02(2015) or SNI 2417:2008	Max.25%
Soundness of aggregate to sodium sulfate or magnesium sulfate	AASHTO T104-99(2011) or SNI 3407:2008	Max.12% - Sodium
		Max.18% - Magnesium

(e) Longitudinal Expansion Joint (Type E)

The material of the rubber used shall be of the following requirements:

Tensile strength JIS K 6301	≥ 15 N/mm2
Elongation JIS K 6301	≥ 300%
Hardness JIS K 6301	55 ± 5 Hs
Tearing strength JIS K 6301	≥ 30 kN/m
Compressive permanent strain JIS K 6301 (at 70˚C, 22 hours)	< 25%

The material of support block used shall be of the following requirement:

Rolled Steel for General Structure	SS400 steel Plate (JIS G3101)

(f) Strip Seal Expansion Joint (Type F)

The strip seal expansion joint consists of the following:

Elastomeric Seal

Physical Properties for Preformed Elastomeric Strip Seals shall meet the rquirements below:

Properties	Test Method	Requirement
Tensile strength, min psi (MPa)	ASTM D412-16	2000 (13.8)
Elongation at break, min %	ASTM D412-16	250
Hardness, Type A durometer, points	ASTM D2240-15e1 (modified)[1]	60 ± 5
Oven aging, 70 h at 212°F (100°C)	ASTM D573-04(2019)	
- Tensile strength, loss, max %		20
- Elongation, loss max %		20
- Hardness, Type A durometer, points change		0 to +10
Oil swell, IRM 903	ASTM D471-16a	
- 70 h at 212°F (100°C) weight change, max %		45
Ozone resistance	ASTM D1149-18[2]	
- 20 % strain, 300 pphm in air, 70 h at 104°F (40°C)		No cracks
Low temperature stiffening	ASTM D2240-15e1	
- 7 days at +14°F (±10°C)		
Hardness, Type A durometer, point change		0 to +15
Compression set, 70 h at 212°F (100°C), max %	ASTM D395-18 Method B	35

Note:

1. The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more plies than speci®ed in either of the modi®ed test procedures be used. Such specimen modi®cation shall be agreed upon by the purchaser and producer or supplier prior to testing. The hardness test shall be made with the durometer in a durometer stand as recommended in Test Method D2240.
2. Test in accordance with Method A of D518-99 (withdrawn 2008) and ozone concentration is expressed in pphm. Such specimen preparation should be agreed upon by the purchaser and producer or supplier prior to testing

Structural Steel

The structural steel locking edge rail shall conform to the requirements of ASTM D558/ D558M-19, ASTM A36/A36M-19 or SNI 6764:2016, and ASTM A572/ A572M-18.

Adhesive Lubricant

The adhesive-lubricant shall conform to the requirements of ASTM D4070-15.

S10.10 (5) Construction

(a) Storage and Preparation

Expansion joint material delivered to the bridge site shall be stored under cover on platforms above the surface of the ground.

It shall be protected at all times from damage, and when placed it shall be free from dirt, oil, grease or other foreign substance. Premoulded material shall be used in as large pieces as possible. The material shall be cut to a clean, true edge with a sharp tool. Rough or ragged edges will not be permitted. Jointing of adjacent pieces shall be in accordance with the manufacturer's instructions.

(b) Installation of Rubber Type Joints

(i) General - Expansion joints shall be shaped to the section, and of a type of material as shown on the Drawings or approved by the Engineer. The size of the gap shall be compatible with the mean bridge temperature at the time of installation. This temperature shall be determined in accordance with arrangements agreed with the Engineer.

The position of all bolts cast into concrete and all holes shall be accurately determined from templates. The mixing, application and curing of all proprietary materials shall comply with the manufacturer's requirements.

All joints shall be constructed according to physical details shown on the Drawings or as directed by the Engineer, and strictly in accordance with the manufacturer's recommendations.

(ii) Placing of epoxy mortar - Placing of epoxy mortar for joint type A and B shall be executed in 2 (two) stages. Bottom-layer mortar shall be placed after a primer (epoxy binder) has been applied to the slab surface and side section of the pavement and the mortar compacted by means of a vibrator machine to a thickness of 2.0 cm from the pavement level. The top-layer of mortar shall be placed after embedding the Fibre Reinforced Plastic. The top layer shall be compacted with a vibrator to level with the surface pavement. Rough finishing shall be carried out with a wooden trowel and final finishing with a metallic trowel.

(iii) Prevention of damage - During the placing and hardening of concrete or mortar under expansion joint components, relative movement shall be prevented between them and the supports to which they are being fixed.

When one half of the joint is being set, the other half shall be completely free from longitudinal restraint. In particular where strongbacks or templates are used to locate the two sides of a joint they shall not be fixed simultaneously to both sides. Screw threads shall be kept clean and free from rust.

Ramps shall be provided and maintained to protect all expansion joints from vehicular loading. Vehicles shall cross the joints only by means of the ramps until the Engineer permits their removal.

(iv) Time of installation - Setting of expansion joints shall be done after pavement works on the bridge are finished.

(c) Installation of Rubberized Bitumen Binder Type Joints

Installation shall be carried out complying with the following requirements, or strictly in accordance with the manufacturer's instructions.

(i) Time of Installation - Installation of expansion joints shall be carried out after pavement works on the structure are finished.

(ii) Marking out - The joint shall be marked out to the width shown in the Drawings or such other width as directed by the Engineer.

(iii) Excavation - The asphalt shall be cut full depth and broken out carefully by hand or plane to the structure slab ensuring that the slab concrete is not damaged.

(iv) Cleaning - The entire joint shall be thoroughly cleaned and dried using a hot compressed air lance immediately prior to filling. All loose debris shall be removed from the expansion gap.

(v) Caulking - The expansion gap shall be caulked with a tarred hemp in such a way as to allow 25 mm of binder in the expansion gap between the top of the arris and the finished level of the caulking yarn.

(vi) Tanking - The joint shall be coated with a layer of hot binder immediately after caulking and cleaning.

(vii) Plating - The joint gap shall be covered with an aluminium strip according to the width and the condition of the gap.

(viii) Material Preparation

- Aggregate - The aggregate shall be dried, cleaned and heated in a drum mixer by means of hot compressed air. The aggregate shall be heated to a temperature of ± 150 degrees Celsius and all visible signs of dust shall be removed.
- Binder - The binder shall be heated by means of a sealant pre-heater to a temperature of 170 - 190 degrees Celsius.

(ix) Material Installation - Layers of hot stone not less than 20 and not more than 40 mm thick shall be placed in the trench and immediately flooded with hot binder. Each layer shall be raked to ensure that the stone is fully coated and voids filled. This process shall stop approximately 25 mm from the top of the excavation for application of the final surface layer.

(x) Surface Layer - Hot pre-mixed prepared material shall be transferred to the joint and spread to a slight overfill.

(xi) Compaction - The material shall be compacted as soon as possible after filling using a vibrator plate or roller which shall be pre-wetted. At least 3 passes shall be carried out to bring the joint to the existing road surface.

(xii) Screeding/Finishing Work - The surface of the joint and the surrounding road shall be dried and cleaned with a hot compressed air lance prior to the final screeding. Immediately thereafter a single hot binder layer shall be applied to fill all surface voids.

S10.10 (6) Method of Measurement

The quantities to be paid for shall be the actual number of linear meters of expansion joints completed in place in accordance with the Drawings.

Sealant and back up form of foamed polystyrene or similar material used in adjacent curbs and parapet walls will not be measured separately for payment.

S10.10 (7) Basis of Payment

The quantities, measured as specified above, shall be paid for at the Contract price per unit of measurement, respectively, for each of the particular pay items listed below, which price and payment shall constitute full compensation for all cutting and excavation of pavement, formation of construction joint with existing concrete and for all labour and equipment, furnishing of materials including epoxy concrete, epoxy mortar, fibre reinforced plastic, reinforcement, concrete, binder and aggregate, fabricating, transporting, painting, setting expansion joints, and for other incidentals. Payment for expansion joints will be deemed to include the cost of sealant used in adjacent works and parapets.

Pay Item No. and Name		**Unit of Measurement**
10.10 (1)	Expansion Joint Type A (Surface Rubber Joint with Load - supporting Type)	Linear Meter
10.10 (2)	Expansion Joint Type B (Adhesive Sealant Joint)	Linear Meter
10.10 (3)	Expansion Joint Type C-1 (Steel Finger 60 mm)	Linear Meter
10.10 (3a)	Expansion Joint Type C-1 (Steel Finger 20 mm)	Linear Meter
10.10 (3b)	Expansion Joint Type C-1 (Steel Finger 50 mm)	Linear Meter
10.10 (4)	Expansion Joint Type C-2 (Steel Finger Joint 175 mm)	Linear Meter
10.10 (5)	Expansion Joint Type C-3 (Steel Finger Joint 220 mm)	Linear Meter
10.10 (6a)	Expansion Joint Type D-1 (Rubberized Bitumen Binder Type 40 cm)	Linear Meter

10.10 (6b)	Expansion Joint Type D-2 (Rubberized Bitumen Binder Type 30 cm)	Linear Meter
10.10 (6c)	Expansion Joint Type D-3 (Rubberized Bitumen Binder Type 50 cm)	Linear Meter
10.10 (6d)	Expansion Joint Type D-4 (Rubberized Bitumen Binder Type 15 cm)	Linear Meter
10.10 (7)	Expansion Joint Type E (Longitudinal Expansion Joint)	Linear Meter
10.10 (8)	Expansion Joint Type F (Strip Seal Joint)	Linear Meter

S10.11 Bridge Bearings

S10.11 (1) Description

This work shall consist of furnishing and installing bearing shoes and bearing pads for bridge superstructure, piled slab and extended pile structure and rubber sheet for RC frame and approach slab.

S10.11 (2) Materials

(a) Bearing Shoes

Material for bearing shoes of general type shall conform to the following:

JIS G 3101 : Rolled Steel for General Structure SS 400

JIS G 5101 : Carbon Steel Castings - SC 450

JIS G 5102 : High Strength Brass Castings-HBsC3

The Contractor shall have the Engineer's approval prior to furnishing bearing shoes.

(b) Bearing Pads

Elastomeric bearing pads shall conform to AASHTO M251-06(2011).

Bearing pads shall consist of alternative laminations of elastomer and metal bonded together, and shall conform to the following design requirements:

Durometer Hardness : 53

Bearing stress : 5.0 – 10.0 N/mm2

Shearing Modulus : 0.69 N/mm2

Bulk Modulus : 2000 N/mm2

The elastomer portion of the elastomeric compound will be a 100 percent virgin chloroprene meeting the requirements of Column B of Table 10-11-1, which shall be referred to unless in conflict with AASHTO M251-06(2011).

Laminates shall be rolled mild steel sheets embedded by a minimum of 3.2 mm of elastomer.

Prior to furnishing bearing pads the Contractor shall submit, together with samples, to the Engineer for approval a certificate by the manufacturer certifying that the bearing pads comply with the specification requirements.

Randomly selected samples of up to 5 units shall be taken out of every 100 units and tested to confirm compliance with the specification requirements.

Table 10-11-1 Elastomer Properties

ASTM Standard	Physical Properties	Natural Rubber			Synthetic Rubber (Neoprene)		
		50 duro	60 duro	70 duro	50 duro	60 duro	70 duro
D2240	Hardness	50 ± 5	60 ± 5	70 ± 5	50 ± 5	60 ± 5	70 ± 5
D412	Tensile strength, min. MPa	15.5	15.5	15.5	15.5	15.5	15.5
	Ultimate elongation, min. %	450	400	300	400	350	300
	Heat Resistance						
D573	Change in durometer hardness, max. points	± 10	± 10	± 10	± 15	± 15	± 15
70 hr. @158°F (69.9°C)	Change in tensile strength, max. %	- 25	- 25	- 25	- 15	- 15	- 15
	Change in ultimate elongation, max. %	- 25	- 25	- 25	- 40	- 40	- 40
	Compression Set						
D395, Method B	22 hours @ 158°F (69.9°C), max. %	25	25	25	35	35	35
	Ozone						
D1149	25(col.A)/100(col.B) pphm ozone in air by volume, 20% strain 100°F ± 2°F (37.7°C ± 1°C), 48 hours mounting procedure D518. Procedure A	No Cracks	No Cracks	No Cracks	No Cracks	No Cracks	No Cracks
	Adhesion						
D429, Method E	Bond made during vulcanization, lbs. per inch (kg/m)	40 (714)	40 (714)	40 (714)	40 (714)	40 (714)	40 (714)
	Low Temperature Test						
D746 Procedure B	Brittleness at - 40°F (-40°C)	No Failure	No Failure	No Failure	No Failure	No Failure	No Failure

(c) Rubber Sheet

Material for rubber sheet shall be chloroprene or styrene-butadine synthetic rubber and shall conform to the following:

ASTM D2240	:	Durometer Hardness	40 points ± 5
ASTM D412	:	Tensile Strength (min.)	1450 psi
	:	Ultimate Elongation (min.)	400%

Prior to furnishing rubber sheet the Contractor shall submit to the Engineer for approval a certificate by the manufacturer certifying that the rubber sheet complies with the specification requirements.

(d) Anchor Bar

Anchor bar shall be made from steel JIS G3101 Grade SS400 or equivalent

S10.11 (3) Construction

(a) Bearing Shoes

(i) Bearing shoes shall be accurately set in the specified position. The shoes shall be set before construction of superstructure members unless otherwise approved by the Engineer. This setting work shall be carefully done with non-shrink mortar so that the bottom of bearing shoes will adhere tightly to the top of the pier or abutment.

(ii) Placing anchor bolts - Reference is made to Sub-clause S10.01 (4) (f) (xi).

(b) Bearing Pads

The bearing pads shall be installed in the appropriate setting as directed by the Engineer or shown on the Drawings.

When they are set on thin beds of cement mortar, the mortar shall be cured and allowed to develop sufficient strength before the beams are erected.

The bearing pads shall be maintained in their correct position during the placing of the beams. After the beam has been completed, each bearing and the area around it shall be left clean.

(c) Rubber Sheet

The rubber sheet shall be set at the Mesnager hinge (concrete hinge) of continuous slab bridges at the end of RC frames and at the approach slabs as shown on the Drawings or directed by the Engineer.

S10.11 (4) Method of Measurement

(a) Bearing Shoes

The quantities of bearing shoes shall be measured by the number of each type completed in place and accepted.

The classification of bearing shoes shall be as follows:

Type	Design Load (P)
Type A;	125 ton (Movable Bearing)
Type B;	150 ton (Movable Bearing)
Type C;	175 ton (Movable Bearing)
Type D;	275 ton (Movable Bearing)
Type E;	450 ton (Movable Bearing)
Type F;	450 ton (Fixed Bearing)
Type G;	162 ton (Movable Bearing)
Type H;	175 ton (Fixed Bearing)

Type I;	200 ton (Movable Bearing)
Type J;	300 ton (Movable Bearing)
Type K;	300 ton (Fixed Bearing)
Type L;	350 ton (Fixed Bearing)

(b) Rubber Sheet

The quantities of rubber sheet shall be measured by the number or linear meters completed in place and accepted.

(c) Bearing Pads

The quantities of bearing pads shall be measured by the number of each type completed in place in accordance with the Drawings.

The classification of bearing pads shall be as follows:

Type	Design Load	Allowable Shear Deformation
Type A;	60 tons	20 mm
Type B;	70 tons	20 mm
Type C;	70 tons	22 mm
Type D;	85 tons	22 mm
Type E;	110 tons	22 mm
Type F;	70 tons	25 mm
Type G;	95 tons	25 mm
Type H;	110 tons	25 mm
Type I;	150 tons	25 mm
Type J;	125 tons	29 mm
Type K-1;	35 tons	15 mm
Type K-2;	35 tons	15 mm

(d) Anchor Bar

The quantities of anchor bar shall be measured for payment based on the weight of the anchor bar excluding the accessories, payment for wich is included with the anchor bar.

S10.11 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price respectively. The payment shall consist of full compensation for furnishing, fabricating, transporting, painting, random sample testing and placing all materials including all labour, tools, equipment, and incidentals necessary to complete the work prescribed. Details of necessary accessories are shown on the Drawings, and includes anchor bar and cap, and reinforcement, etc.

Pay Item No. and Name		**Unit of Measurement**
10.11(1)	Elastomeric Bearing Pad 460 x 550 x 75 (Mov.)	Each
10.11(2)	Elastomeric Bearing Pad 450 x 520 x 75 (Mov.)	Each
10.11(3)	Elastomeric Bearing Pad 420 x 500 x 75 (Mov.)	Each

10.11(4a)	Elastomeric Bearing Pad 400 x 450 x 75 (Mov.)	Each
10.11(4b)	Elastomeric Bearing Pad 450 x 450 x 76 (Mov.)	Each
10.11(5a)	Elastomeric Bearing Pad 450 x 450 x 76 (Fix)	Each
10.11(5b)	Elastomeric Bearing Pad 460 x 550 x 49 (Fix)	Each
10.11(6)	Elastomeric Bearing Pad 450 x 520 x 49 (Fix)	Each
10.11(7)	Elastomeric Bearing Pad 420 x 500 x 49 (Fix)	Each
10.11(8)	Elastomeric Bearing Pad 400 x 450 x 49 (Fix)	Each
10.11(8a)	Elastomeric Bearing Pad 300 x 350 x 39 (Mov.) (for RCI-Girder)	Each
10.11(8b)	Elastomeric Bearing Pad 300 x 350 x 26 (Fix) (for RCI-Girder)	Each
10.11(9)	Elastomeric Bearing Pad 450 x 550 x 83 (Mov.)	Each
10.11(10a)	Elastomeric Bearing Pad 600 x 600 x 83 (Mov.)	Each
10.11(10b)	Elastomeric Bearing Pad 600 x 600 x 83 (Fix.)	Each
10.11(11)	Elastomeric Bearing Pad 400 x 450 x 83 (Mov.)	Each
10.11(12)	Elastomeric Bearing Pad 700 x 750 x 48 (Fix)	Each
10.11(13)	Elastomeric Bearing Pad 850 x 850 x 52 (Fix)	Each
10.11(14)	Elastomeric Bearing Pad 650 x 650 x 52 (Fix)	Each
10.11(15)	Elastomeric Bearing Pad 300 x 350 x 36 (Mov.)	Each
10.11(16)	Elastomeric Bearing Pad 350 x 400 x 40 (Mov.)	Each
10.11(17)	Elastomeric Bearing Pad 450 x 500 x 60 (Mov.)	Each
10.11(18)	Elastomeric Bearing Pad 300 x 350 x 36 (Fix.)	Each

10.11(19)	Elastomeric Bearing Pad 350 x 400 x 40 (Fix.)	Each
10.11(20)	Elastomeric Bearing Pad 450 x 500 x 60 (Fix.)	Each
10.11(21)	Elastomeric Bearing Pad 350 x 400 x 52 (Mov.)	Each
10.11(22)	Elastomeric Bearing Pad 350 x 400 x 52 (Fix.)	Each
10.11(22a)	Elastomeric Bearing Pad 450 x 400 x 52 (Mov.)	Each
10.11(22b)	Elastomeric Bearing Pad 450 x 400 x 52 (Fix.)	Each
10.11(23)	Elastomeric Bearing Pad for PC Void 100 x 500 x 29 (Fix)	Each
10.11(24)	Elastomeric Bearing Pad for PC Void 100 x 500 x 38(Move)	Each
10.11(25)	Rubber Bearing Sheet 200 x 200 x 20	Each
10.11(26a)	Rubber Bearing Sheet 200x20	Linear Meter
10.11(26b)	Rubber Bearing Sheet 250x25	Linear Meter
10.11(27)	Anchor Bar with Accessories	Kg
10.11(28)	Elastomeric Bearing Shoe for Steel Girder 7,400kN (Fix)	Each
10.11(29)	Elastomeric Bearing Shoe for Steel Girder 8,800kN (Fix)	Each
10.11(30)	Elastomeric Bearing Shoe for Steel Girder 7,200kN (Fix)	Each
10.11(31)	Elastomeric Bearing Shoe for Steel Girder 8,200kN (Fix)	Each
10.11(32)	Elastomeric Bearing Shoe for Steel Girder 4,200kN (Move)	Each
10.11(33)	Elastomeric Bearing Shoe for Steel Girder 4,200kN (Fix)	Each
10.11(34)	Elastomeric Bearing Shoe for Steel Girder 4,000kN (Move)	Each
10.11(35)	Elastomeric Bearing Shoe for Steel Girder 4,000kN (Fix)	Each
10.11(36)	Elastomeric Bearing Shoe for Steel Girder 3,800kN (Move)	Each
10.11(37)	Elastomeric Bearing Shoe for Steel Girder 3,800kN (Fix)	Each

10.11(38)	Elastomeric Bearing Shoe for Steel Girder 3,400kN (Fix)	Each
10.11(39)	Elastomeric Bearing Shoe for Steel Girder 1,800kN (Mov.)	Each
10.11(40)	Elastomeric Bearing Shoe for Steel Girder 2,000kN (Move)	Each
10.11(41)	Elastomeric Bearing Shoe for Steel Girder 1,800kN (Fix)	Each
10.11(42)	Elastomeric Bearing Shoe for Steel Girder 4,700kN (Fix)	Each
10.11(43)	Elastomeric Bearing Shoe for Steel Girder 4,700kN (Mov.)	Each
10.11(44)	Pot Bearing ,1900/220/80 kN	Each

S10.12 Other Incidental Bridge Facilities

S10.12 (1) Description

This work shall consist of the furnishing and installation of drainage facilities and pull boxes for bridges, RC frames and other incidental bridge facilities. All work shall be done in strict accordance with the Drawings and these Specifications and as directed by the Engineer.

S10.12 (2) Material

(a) Drain pipe material shall conform to the requirements of SNI 06-0162-1987 and SNI 06-0178-1987 or comply to ASTM D2665-14 with basic material of virgin PVC compounds which conform to Class 12454 as specified in ASTM D1784-11. Deck drain material shall conform to the requirements of JIS G 5101 (Carbon Steel Castings), JIS G 5501 (Grey Iron Castings), and JIS G 3101 (Rolled Steel for General Structures: SS41). Cast metal deck drain material shall be painted three coats tar epoxy resin paint, each coat thickness 80 µm, and support brackets and other accessories shall be galvanised, all in accordance with Clause S12.18 of these Specifications.

(b) Pull box material shall conform to the requirements of JIS G 3101 (Rolled Steel for General Structures: SS41) and shall be galvanised in accordance with Clause S12.18 of these Specifications.

S10.12 (3) Construction

(a) Drainage Facilities

(i) Drain pipes, catch basin and deck drains that are to be encased in concrete shall be installed by the Contractor as indicated on the Drawings.

(ii) Drain pipes shall be fixed as indicated on the Drawings or as directed by the Engineer.

(b) Pull Box

Pull boxes and conduit for lighting in bridge parapets shall be installed as indicated on the Drawings, or directed by the Engineer, before the concrete is placed. After concrete hardens it shall be checked that pull boxes can open freely.

(c) Name Plate

The type and the material of name plate shall conform to the requirements as directed by the Engineer.

S10.12 (4) Method of Measurement

The quantities of drain pipe to be paid for will be the number of linear meters measured along the central lines of pipe runs and no extra measurement will be made for bends or junction pieces.

The quantities of deck drain to be paid for shall be measured by the number of each type, completed in place and accepted.

The quantities of name plate to be paid for shall be by the number of each furnished, installed and accepted as directed by the Engineer.

Pull boxes and conduits for electrical work will be measured and paid for under Division 13 of these Specifications.

S10.12 (5) Basis of Payment

The quantities, measured as specified above, will be paid for at the Contract unit price per linear meter of drain pipes and per number of deck drains and name plates.

Drain pipe shall be 20 cm and 15 cm diameter. Payment for drain pipe and deck drain will be deemed to include for all fittings and supports necessary to install the drains in accordance with the details shown on the Drawings.

The prices and payment for the above items shall be considered full compensation for labour, tools and equipment, furnishing of materials, fabricating, transporting, and setting of each item and all other incidental works connected therewith.

Pay Item No. and Name		**Unit of Measurement**
10.12(1)	Drain Pipe D=20cm with Fitting and Supports	Linear Meter
10.12(2)	Drain Pipe D=15cm with Fitting and Supports	Linear Meter
10.12(3)	Deck Drain Type 1 with Accessories	Each
10.12(4)	Deck Drain Type 2 with Accessories	Each

S10.13 Prestressed Concrete Corrugated Sheet Pile

S10.13 (1) Description

This work shall consist of Prestressed Concrete Corrugated Sheet Pile furnished and driven in accordance with this Specifications and in reasonably close conformity to the Drawings.

S10.13 (2) Material

(a) General

Prestressed concrete corrugated sheet piles shall be constructed in accordance with the details shown on the Drawings and to the requirements of JIS A 5326, Prestressed Concrete Sheet Pile.

The applicable provisions of Clause S10.03 shall be read into and become part of this Clause.

(b) Concrete

Concrete shall comply with the provisions of Clause S10.01 of these Specifications and as shown in the Drawings.

(c) Reinforcement

Reinforcement shall comply with the provisions of Clause S10.02 of these Specifications and shall be positioned as shown on the Drawings.

(d) Prestressing Steel

High tensile steel prestressing wire shall conform to the requirements of JIS G 3536 Class SWPR 1 135/155.

(e) Certificate

The Contractor shall submit a certificated by the manufacturer to the Engineer for approval prior to furnishing pretensioned corrugated concrete sheet pile.

(f) Tie Rod

Reinforcement bar which conforms the requirements of SNI 2052:2017 or AASHTO M31M/M31-19, minimum grade BjTS 420a, D32 shall be used as Tie Rods.

Coating - Tie rods shall be coated by epoxy zinc rich anti-corrosion primer which conforms the requirements of BS4652 – specification for metallic zinc-rich priming paint or BS5493 – Code of practice for protective coating of iron and steel structures against corrosion.

S10.13 (3) Construction

(a) Preparation for Driving (in case of Water jet type)

(i) The Contractor shall install guide frame for PC Sheet Piles.The usual method of guide frame installation is to provide two horizontal runs of steel section secured at adequate convenient intervals. The structure of guide frame shall be of adequate proportion to ensure that PC Sheet Piles are rigidly support during

driving.

(ii) Connect the top of jetting pipe (which is installed inside the PC Sheet Pile) with the delivery hoses of water jet, insure that pipes & nozzle in good condition.

(iii) The PC Sheet Piles (which has been connected to the water jet cutter) is lifted and slotted in it's position. Hold the pile tip at about 25 cm above driving ditch/ground. Then secure the pile by using lever block.

(iv) Start water jet cutter machine, check the water pressure at certain level.

(v) Connect vibro hammer on the upper part of the PC Sheet Pile, check grip pressure, activate vibro then drive.Check vertically and longitudinal alignment during driving by lead or theodolite.

(vi) Driving will be terminated when the top of the PC Sheet Pile reaches the design level. (the water jet cutter shall be stopped at 0.5~1m before reaching final level of the PC Sheet Pile).

(vii) Release the vibro hammer and disconnect the delivery hoses of water jet cutter from the jetting pipes in the PC Sheet Pile, Start all over again.

(b) Handling, Pitching and Driving

(i) General – When raising or transporting sheet piles the Contractor shall provide slings and other equipment necessary to prevent any appreciable bending of the pile.

The main setting out for the piles is to be completed prior to commencement of driving. Secondary or individual pile setting out is to be completed and agreed not less than 8 hours prior to commencing work on the pile concerned. All main setting out points, lines and stations are to be maintained safe and undisturbed until the work is complete.

Sheet piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings or fixed by the Enginner. Sheet piles deflected from vertical or proper line shall, where ordered by the Engineer, be withdrawn and repatched until the proper line is obtained.

No forcible method of correction of the position or line of any pile will be permitted. Any pile damaged by reason of improper driving or driven out of its proper location or driven below the elevation fixed by the Drawing or by the Engineer, shall be corrected at the contractor's expense by one of the following methods approved by the Engineer for the pile in question:

(c) Water Supply

(i) PC Corrugated Sheet Pile shall drive using water jet to open soil beneath pile tip and to avoid friction against PC Sheet Pile, so that PC Sheet Pile not compacting the soil and penetration will be

easier.

(ii) In hard soil, water jet will break out particle or soften soil to let PC Sheet Pile hammered the layer.

(iii) Mud and fine particle will flow out from PC Sheet Pile side due to vibration (pumping action of vibro hammer). Water consumption at about 20 ~ 30 m^3/day according to soil condition.

(iv) To accommodate mud, fine particle and waste-water, driving ditch shall be constructed accordingly.

(v) Mud and waste-water may not higher than guide frame.

(vi) Water pressure (low/high) 70~150 Kg/cm2.

(vii) The Contractor may not cut off the sheet piles less than that shown on the Drawings. The Engineer will specify the soil condition and the Contractor shall drive the all length of sheet piles.

(d) Tie Rod

Tie rods shall be coated by the epoxy zinc rich anti-corrosion primer. The coating material shall be applied to the tie rods in sufficient thickness without pin holes or other defects. If any doubt exists about having achieved an unbroken coating, a second application should be made as soon as possible the first coating is fully dry. Forced ventilation in confined areas shall be provided during application and curing.

S10.13 (4) Method of Measurement

(a) Sheet Piles Furnished

The unit of measurement for payment for furnishing pretensioned concrete sheet piles shall be the linear metres, furnished in compliance with the Engineer's instructions and the material requirements of these specification and stockpiled in good condition at the site of the work by the Contractor, and accepted by the Engineer. No allowance will be made for the length of sheet pile furnished by the Contractor to replace pile previously accepted by the Engineer that are subsequently lost or those that are damaged prior to completion of the Contract while in the stockpile, or during handling or driving, and are ordered by the Engineer to be removed from the site of the work or disposed of otherwise.

All Sheet Pile surface that will be exposed to the air shall be covered by the Aluminium Composite Panel. The details shall be approved by the Engineer before orders are given to the suppliers or manufacturers.

In areas with tie rods, Sheet Piles shall be manufactured with anchor holes to tie up the sheet piles with the tie rods. The details are shown in the drawings.

Capping beam concrete and reinforcements will be measured and paid for under the other pay items in this specification.

(b) Piles Driven

The quantities of driven pretensioned concrete sheet piles to be paid for

shall be the number of linear metres of piles actually driven and accepted. The pay lengths of the satisfactorily driven piles shall be measured from the tip to the ground surface. Total length of sheet pile will not be measured for payment.

S10.13 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price per linear metre for the particular pay items listed below. The rate shall constitute full compensation for all materials including prestressing, reinforcement and high pressure pipes, water jet equipments, hardware, furnishing, driving, guide beam, support frames, jetting, welding and all related tools, rigs, cranes, bolts, hammers, jets, labour and other incidental equipment and work

Tie rods are measured and shall be paid for at the contract unit price per kg for the particular pay items listed below. The rate shall constitute full compensation for all materials including epoxy zinc rich anti corrosion primer, materials to tie the tie rods up to the sheet pile that is shown on the drawings, covering mortal of tie rods ends, and any other necessary materials in the relevant drawings, necessary equipments, labours, and works until the requested setting is fully completed.

No payment shall be made for unauthorized, defective, unsound or unsatisfactorily driven piles or for any costs incurred by the Contractor for such piles.

Pay Item No. and Name		**Unit of Measurement**
10.13 (1)	Prestressed Concrete Corrugated Sheet Pile W 325A, furnished	Linear Meter
10.13 (2)	Prestressed Concrete Corrugated Sheet pile W 325A, driven	Linear Meter

DIVISION 11 STRUCTURAL STEEL WORK

S11.01 Bridge Steel Work

S11.01 (1) General

(a) Description

This work consists of steel structures and the steel portions of composite structures, constructed in close conformity to the lines, grades and dimensions shown on the Drawings or established by the Engineer. It shall cover completely new construction and the widening and repair of existing structures. The work shall include the furnishing, fabricating, erecting, galvanizing or painting of structural metal as required in these Specifications or as shown on the Drawings. Structural metals shall include structural steel, rivets, welding, special and alloy steels, metallic electrodes and steel forgings and castings. This work shall also include any incidental metal construction not otherwise provided for, all in accordance with these Specifications and with the Drawings.

(b) Reference Standards

Standar Nasional Indonesia (SNI) :

SNI ASTM A325:2012	: *Spesifikasi baut baja hasil perlakuan panas dengan kuat tarik minimum 830 MPa* (ASTM A325M-04, IDT).
SNI 07-0722-1989	: *Baja canai panas untuk konstruksi umum*
SNI 07-3015-1992	: *Baja canai panas untuk konstruksi dengan pengelasan*.
SNI 6764:2016	: *Spesifikasi baja karbon struktural* (ASTM A36/A36M-12, IDT).
SNI 8458:2017	: *Metode uji pengencangan baut mutu tinggi*.
SE No.14/SE/M/2015	: *Pedoman Pemasangan Baut Jembatan*.

AASHTO:

AASHTO M111M/M111-15	: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
AASHTO M169-15	: Steel Bars, Carbon, Cold Finished, Standard Quality
AASHTO M270M/M270-15	: Carbon and High-strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges.

ASTM:

ASTM A307-14e1	: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

ASTM F3125/F3125M-15a : Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

American Welding Society (AWS):

AWS D1.1/D1.1M:2015 : Structural Welding Code – Steel
AWS D1.5M/D1.5:2015 : Bridge Welding Code.

If not otherwise indicated on the Drawings, the fabrication and erection of the steel superstructure shall conform to the requirements of AASHTO's Standard Specifications for Highway Bridges and AWS D1.1/D1.1M: 2015, Structural Welding Code, and Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-14 (2014), Division 550, Section 555, PP 436 - 452.

In case of conflict between the above referenced specifications and this Specification, this Specification shall govern.

(c) Testing and Inspection

(i) Inspection Authority

The Employer has the right to appoint an Inspection Authority to inspect, examine and test materials, workmanship and performance of any part of the works at the manufacturer's works or the site of fabrication. The Inspection Authority will be selected by the Employer but all fees and expenses for this work will be paid by the Contractor and will be deemed to be included in the unit prices for this work. Should the Employer decide to waive his right to appoint an Inspection Authority this will be notified at the time of bidding.

The Inspection Authority shall take instructions from the Engineer and his representatives and shall submit monthly reports to the Engineer. The Inspection Authority will certify that all works up to the stage of fabrication shop painting after trial assemblage, have been carried out in accordance with these specifications and the approved shop Drawings. Certain authority of the Engineer will be delegated to the Inspection Authority, for the purpose of quality control and testing. The limits of this Authority will be notified to the Contractor in writing when the Inspection Authority is appointed.

The Inspection Authority's certificates shall not relieve the Contractor of any of his obligations under the contract.

(ii) Inspection by the Contractor

Irrespective of the appointment of an Inspection Authority, the Contractor shall himself inspect or have inspected all materials, shop work and field work to determine that the requirements of the

Drawings and Specifications are met and that the Works are carried out in a first-class and workmanlike manner.

The Contractor shall provide the necessary assistants, labor, materials, electricity, fuel, stores, apparatus and instruments and any other materials required to ensure that all testing and inspection by the Engineer or the Inspection Authority can be carried out efficiently.

(d) Submittals

(i) Overall Schedule

Before any technical submittals are made, the Contractor shall submit his proposed schedule for all shop drawing submissions, materials submissions, and fabrication processes. In this schedule, the Contractor shall allow the Engineer 4 weeks from receipt of any submittal or resubmittal, for his review.

(ii) Approval of the Engineer

The Contractor shall not proceed with any purchase or fabrication of materials until the relevant shop drawings have been approved by the Engineer.

(iii) Materials

Prior to the use of any materials, the Contractor shall submit for the Engineer's approval, 2 copies of the Manufacture's certificates for:

- bolts, nuts, washers, and filler for welding.
- mill test certificates for structural steel. These shall include the names and locations of steel mills, analysis of chemical and physical properties, and shall be properly correlated to the various grades of structural steel to be used in the project.

(iv) Welding Plan

The Contractor shall not proceed with any welding until the Engineer has approved his Welding Plan which shall include the following.

- All information on welding procedures, equipment, additives and preheating during the welding operations.
- Details of non-destructive testing methods to be used for specific typical joints.
- Precautions with regard to welding shrinkage.
- Possible treatment of completed welds by grinding with indication of grinding direction, etc.
- Procedures and program of welding sequence (for each component and for welding components together). After approval of this submittal, welding procedures and sequences shall be followed without deviation.

The Engineer will require confirmation as to the suitability of the details contained in the welding plan, by tests as prescribed in the AWS "Standard Qualification Procedure".

(v) Painting Plan

The Contractor shall in ample time before the commencement of the surface treatment, prepare and submit for approval a detailed program relating to the execution of the works, in the workshop, at the site, etc., as well as the methods used, and a time schedule for the individual treatments. The program shall be subject to approval by the Engineer.

(vi) Erection Plan

Prior to the start of Fabrication, the Contractor shall submit for the Engineer's approval a full description of his proposed erection method including:

- sequence of erection
- use of temporary or permanent stanchions, beams and bracing
- connection details
- erection camber diagrams to show the vertical position of the structure at each stage of the erection process
- design calculation to cover the various stages in the erection process
- type of equipment to be used during erection.

The Engineer's approval of the above details will not relieve the Contractor of his contractual obligations or of his responsibility for providing proper methods, equipment, workmanship and safety precautions.

(vii) Painting Certification

The Contractor shall submit to the Engineer, 2 copies of certification stating that requirements pertaining to preprint cleaning and painting of steel have been performed in accordance with the specifications.

(viii) Connection Records

The Contractor shall maintain records of shop welding procedures, welders employed with date of qualification and identification symbol. Records shall also be maintained of all bolts tested and the corresponding torque values if torque control is used. These records shall be freely available for the use of the Inspection Authority and shall be submitted to the Engineer on completion of all shop fabrication work.

(ix) As-built Drawings

Within 4 weeks of completion of the related works, the Contractor shall submit 1 softcopy and 2 prints of the as-built drawings.

These drawings shall include details of actual camber achieved, details of temporary bracings left in the works, etc.

(e) Matters to be considered by the Contractor

In this preparation of shop drawings and in all his fabrication works the Contractor shall give careful consideration to the following:

(i) the need for trial assemblage at the fabrication shop

(ii) problems on the weight and size of elements for transportation between fabrication yard and the construction site

(iii) temperature variation between the fabrication yard and the site temperature of 28 degrees Centigrade, assumed for the purposes of the Drawing

(iv) the need for certain dimensions of structural steel work to be verified by measurement at site

(v) the prohibition of the use of site welding except for fixtures.

(f) Storage and Protection of Materials

Steel work, at both the fabrication yard and at site, shall be stacked on blocks, racks or platforms so as not to be in contact with the ground and in a manner approved by the Engineer. When steelwork is stacked several levels high, supports for all levels shall be in line. Materials shall be protected from corrosion and other damage and shall be kept free of dirt, oil, greases and other foreign matter. Surfaces to be painted shall be carefully protected both at the fabrication shop and in the field. Threads to fixings shall be protected from damage.

S11.01 (2) Material and Workmanship

(a) Materials

(i) Structural Steel

Unless otherwise shown on the Drawings structural carbon steel for riveted, bolted or welded construction shall conform to the requirements of SNI 6764:2016 or ASTM A36/A36M-14. Structural steel shall have a minimum strength as specified in Table 11.01 (1).

Table 11.01 (1) Minimum Strength Requirements of Structural Steel

Grade		**Yield Stress**	**Tensile Strength**
		Minimum (MPa)	
Grade 250		250	400
Grade 345		345	450
Grade 485		485	585
Grade 690	Plate Thickness ≤ 63.5 mm	690	760
	Plate Thickness > 63.5 mm	620	690

The quality of steel, and other relevant data shall be clearly marked on units to allow identification during fabrication and erection.

(ii) Bolts, Nuts and Washers

(1) Standard Bolts and nuts shall conform to the requirements of ASTM A307-14e1 Mild Steel Bolts and Nuts (Grade A), having hexagonal heads and nuts.

(2) High Strength Friction Grip Bolts, Nuts and Washers

High Strength Bolts, nuts and washers shall be fabricated from heat treated carbon steel conforming to ASTM F3125 /F3125M-15a with a minimum yield stress of 92 ksi (634 MPa) and 130 ksi (896 MPa) for the Type A320 and A490 respectively and A490 and a minimum elongation of 14 %.

High strength bolts to be used shall meet the following conditions:

(a) Mechanical properties are in accordance with above mentioned requirements.

(b) The diameter of bolt, the contact area of bolt head, and nut or the replacement shall be greater than the nominal size specified in the applicable provisions. Other sizes may be different.

(c) The method of tensile test and the inspection procedure for the joint means may differ from the applicable provisions above as long as the minimum proof load required at the joint conform to the provisions of Table 11.01 (2) and the tensile procedure can be checked.

Table 11.01 (2) Proof Load Provisions for Critical Slip Joint Types

Nominal Size (mm) and Thread-Pitch (mm)	Minimum Proof Load for Bolts Tested Full Size (kN)	
	Type A325	Type A490
M12 x 1.75	50.6	70
M16 x 2.0	94.2	130
M20 x 2.5	147	203
M22 x 2.5	182	251
M24 x 3.0	212	293
M27 x 3,0	275	381
M30 x 3.5	337	466
M36 x 4.0	490	678

Note:

M12 x 1.75 is a bolt with a diameter of 12 mm (including thread) and pitch is a movement of 1 rotation of 360° bolt of 1.75 mm.

The other quality standard of bolts may be used if the manufacturer can provide data of proof load and the minimum tensile strength.

The torque wrench against the minimum tensile load of the bolt using a gauge shall be calibrated.

The use of torque wrench method shall be carried out carefully and needs more detailed attentions. Calibration of torque wrench in the Site shall be carried out every day or:

- When a lot of components (bolt, nut and washer) is replaced;
- When a lot of components (bolt, nut and washer) is re-lubricated;
- When there are significant differences on the surface of bolts, thread, nuts or washers;
- When replacement the torque wrench or the main component of torque wrench to be changed (lubricated).

Bolt tightening may be carried using the bridge erection guidelines.

(3) Bolts and nuts shall be marked for identification in accordance with ASTM F3125/F3125M-15a. Sizes of bolts shall be as indicated on the Drawings.

(iii) Welded Shear Connector Studs

Welded shear connector studs shall conform to the requirements of AASHTO M169-15 Cold Finished Carbon Steel Bars and Shafting, and be cold drawn bar, grade 1015, 1018 or 1020, either semi-killed or fully killed.

(iv) Welding Consumables:

Welding consumables used in the metal-arc welding of grades of steel complying with the requirements of SNI 03-6764-2002 or ASTM A36/A36M-14 shall conform to Structural Welding code AWS D1.1-81/D1.1M:2015.

If the base metal is not included in the group of ASTM steel covered by Table 4.1.1 of AWS D1.1~~-81~~/D1.1M:2015, then the properties of the welding metal used for filler material shall correspond to the properties of the base metal used for the parts to be welded. The Contractor shall in this respect submit his proposal for the Engineer's approval.

All materials to be used for welding shall be of a recognized manufacture, and the Contractor shall when requested by the

Engineer furnish manufacturer's certification that the electrodes and other products used for welding meet the requirement of the specifications.

(v) Materials used in painting of steel structures shall be as shown on the Drawings or specified elsewhere and shall conform to the requirements of the following specifications.

JIS K 5400 Testing Methods for Organic Coatings
JIS K 5421 Boiled Oil and Boiled Linseed Oil
JIS K 5516 Ready Mixed Paint
JIS K 5492 Aluminum Paint
JIS K 5621 Anticorrosive Paint for General Use
JIS K 5622 Red-Lead Anticorrosive Paint
JIS K 5623 Lead Suboxide Anticorrosive Paint (Class 1)
JIS K 5624 Basic Lead Chromate Anticorrosive Paint (Class 1)
JIS K 5625 Lead Cyanamide Anticorrosive Paint (Class 1)
JIS K 5626 Zinc Dust Anticorrosive Paint
JIS K 5627 Zinc Chromate Anticorrosive Paint
JIS K 5628 Red-Lead Zinc Chromate Anticorrosive Paint
JIS K 5633 Etching Primer (Class 2)
JIS K 5664 Tar-Epoxy Resin Paint

Where paints are specified that do not comply with any of the above specifications, they shall be supplied only by recognized manufacturers, and samples and technical data shall be submitted to the Engineer for his approval. In any paint system (viz. primer, undercoats, intermediate coat and finishing coats) each coat of paint shall be compatible with the other, and to ensure this, all paint shall be obtained from the same approved manufacturer with a guarantee of compatibility.

(b) Workmanship

Except as otherwise denoted herein or on the drawings, all work shall be executed in accordance with the relevant clauses of the specification given in Sub-clause S11.01 (1) (b).

The Contractor shall be responsible for any damage caused to other components of the structure including the substructures, by his operations for the duration of this Contract. In particular, the Contractor shall take all necessary precautions to minimize concrete splash onto completed steel work or rust staining of concrete due to erected steel-work. He shall clean and/or repair all stains and other damage to completed work, before acceptance.

(c) Tolerances

The Contractor shall, through appropriate planning and continuous measurements in the workshop and at the erection site, ensure that the tolerances given shall be strictly observed. The Engineer will require any specific working procedure changed in case such procedure appears not to afford sufficient security against exceeding the tolerances. The

dimensional tolerance limits shall be in accordance with AWS D1.1/D1.1M:2015 with the following additional requirements:

(i) Hole Diameter

(1) Hole in main member : + 1.2 mm, - 0.4 mm

(2) Hole in secondary member : + 1.8 mm, - 0.4 mm

(b) Hole Alignment

(1) Main member, shop positioned : ± 0.4 mm

(2) Secondary member, field positioned : ± 0.6 mm

(c) Girders

Camber - deviation from specified camber ± 0.2 mm per metre length beam or ± 6 mm vehicle is less.

Lateral deviation from straight line between centers of bearings 0.1 mm per meter length of beam to a maximum of 3 mm.

Lateral deviation between center line of web and center line of flange in built up girders 3 mm maximum.

Combined warpage and tilt of flange of welded beams or girders shall be determined by measuring the offset at toe of flange from a line normal to the plane of the web through the intersection center line of web with the outside surface of the flange plate. This offset shall not exceed 1/200 of total width of flange or 3 mm whichever is greater.

Out of flatness or seats or bases:

(1) To be set on grout : 3.0 mm, max.

(2) To be set on steel, hard masonry, or lead : - 0.25 mm, max.

The maximum deviation from specified depth for welded beam and girders, measured at the web center line, shall be as follows:

(1) For depths up to 900 mm : ± 3 mm

(2) For depths over 900 mm to inclusive 1.8 meters : ± 5 mm

(3) For depths over 1.80 m : - 5 mm, + 8 mm

(d) Struts

Maximum deviation form straightness, including that of individual flanges in either direction: length/1000 or 3 mm whichever is the greater.

(e) Machined Surfaces

Machined bearing surfaces shall be machined within a deviation of 0.25 mm for surfaces that can be inscribed within a square of side 0.5 m.

The Contractor is fully responsible for the calculation and provision of the necessary camber in the preassembled elements to obtain the correct levels in the completed bridge, duly considering the applied erection procedure and the sequence in the installation of the various dead load components.

The roadway load levels given on the Drawings - or defined by the given inclination and curvature - are the required roadway load levels to top of asphalt surfacing in bridge axis of the completed bridge, when loaded only with the dead loads of the installed and completed structure. In fixing the geometry of the superstructure, the Contractor shall make compensation for the difference between workshop temperature and the temperature of the bridge in normal position (28^0 Celsius).

S11.01 (3) Construction

(a) Fabrication

(i) Templates and Measurements

The Contractor shall supply all templates, jigs and other appliances necessary to ensure the accuracy of the work.

(ii) Straightening

Before any work is done on them, all plates shall be checked for flatness and all bars and sections checked for straightness and freedom from twist. Any corrective action shall be taken so that when assembled, adjacent surfaces shall be in close contact throughout. The methods adopted for the work above shall be such as not to damage, mark or impair the strength of the material.

(iii) Cutting

Marking shall be performed accurately and elaborately using full size rules and templates. Prior to marking, the dimensions and grade of materials shall be checked.

Through-going plates in the box girder including longitudinal rib shall be so oriented that the direction of rolling shall follow the longitudinal direction of the bridge. For built-up sections the direction of rolling of the individual components shall follow the axis of the section.

Cutting shall be done automatically. Hand cutting may be used exceptionally, in connection with the erection, if approved by the Engineer. In such cases the joint edges shall receive a finishing treatment, with planning and grinding tools.

Cutting by shearing machine may be used for plates not exceeding 10 mm in thickness provided that the plate edge be fully enclosed in a weld.

Oxygen cutting may be used provided a smooth and regular surface free from cracks and notches is secured and provided that

the roughness of oxygen cut-surfaces shall be no greater than 50S according to JIS B 0601 by the use of a mechanical guide.

All cut plate edges that will not be welded shall be ground to planeness and all edges of plates and sections that will not be welded shall be rounded to the appropriate radius for painting.

(iv) Holing

Holes for bolts shall be drilled. Punching of holes shall not be permitted. If not otherwise indicated on the drawings, the diameter of bolt holes shall be 2.5 mm larger than the nominal diameter of bolts. All holes for field connection of girder, except stringer and bracket, shall be sub drilled 1.5 mm smaller and during shop assembly reamed 2.5 mm larger than the nominal diameter of the bolts.

(v) Bending

Bending of plate may be machined by cold processes, provided that the bending inner radius is at least 15 times the thickness of the plate.

(vi) Welding (Execution)

All welding shall be planned and executed using the most suitable materials and working methods for the particular purpose. Site welding will only be permitted for fixtures and details of any fixture welding proposed by the Contractor shall be clearly identified on the shop drawings and referred to in the accompanying submittal letter.

Welding requirements shall in all respects conform to the following sections of AWS D1.1/D1.1M:2015: Section 2, Design of Welded Connections; Section 3, Workmanship; Section 4, Technique; Section 5, Qualification; Section 6, Inspection; and Section 9, Design of New Bridges.

All welding shall be executed by skilled, experienced welders holding valid welder examination qualifications based on the qualification tests specified in part C of Section 5 of AWS D1.1/D1.1M:2015 or similar internationally recognized qualification tests. A welder shall be qualified for each process used.

Prior to commencement of any welding, the joint shall be carefully freed from rust, scale, slag, and burrs. Where two welds for structural reasons have to cross each other, the former has to be ground flush. Where a flush surface is required, the excess weld metal shall be ground.

During the assembly work, the components shall be held in position and supported in such a manner that no unfavorable inherent stresses or deformation shall develop. Drilling of holes

for temporary assembly for welding purposes shall not be accepted.

Minimum preheating and interphases temperature shall comply with the welding procedure in question and shall be approved by the Engineer.

(vii) Welding (Tolerances)

The members to be connected by welding shall be so prepared that they fit exactly together, without being forced into position.

The tolerances concerning gap between parts to be welded, eccentricity and departure from theoretical alignment, dimensions of the cross section of groove welded joints, etc. shall conform to Section 3.3, Assembly, of AWS D1.1/D1.1M:2015, except that the gap between parts to be joined by fillet welds shall not exceed 1 mm for fillet welds connecting flange to web in box girder and 5 mm for all other fillet welds. Tolerances of weld profiles shall correspond to section 3.6 of AWS D1.1/D1.1M:2015.

(viii) Welding Procedure Qualification Tests

The Contractor shall perform test welds of the layers type of welding to be applied in the structure, according to a program to be agreed upon with the Engineer. The quality of the test welds shall be approved by the Engineer prior to execution of the welding work in question. The test welding shall be made from working positions corresponding to the actual working positions during construction.

(ix) Welding Inspection

The Contractor shall prepare a detailed program for control of welds in consultation with the Engineer and the established program shall not be deviated from without the Engineer's consent.

The Contractor's control program shall assure satisfactory inspection in the workshops to fulfill the stipulations laid down in Section 9.25 of AWS D1.1/D1.1M:2015. The Contractor's control shall be performed at his own expense and shall correspond to the following schedule:

(1) Preparation for Welding

- Visual inspection of edge preparation
- Visual inspection of surface conditions for cracks, gaps and other items that may cause any defect of welding.

(2) Visual Inspection before and after Welding

- All welds shall be visually inspected in accordance with Section 9.25.1 of AWS D1.1/D1.1M:2015.

(3) Non-destructive Testing of Welds

- Welds that are subject to radiographic or magnetic particle testing in addition to visual inspection, shall be unacceptable if the radiographic or magnetic particle testing show any of the types of discontinuities given in AWS D1.1/D1.1M:2015, Section 9.25.2.
- Welds that are subject to ultrasonic testing, in addition to visual inspection, are acceptable if they meet the requirements of table 9.25.3 in AWS D1.1-81/D1.1M: 2015. Welds that are subject to liquid penetration testing, in addition to visual inspection, shall be evaluated on the basis of the requirements for visual inspection.

4) Scope of Non-destructive Testing of Weld

- Fillet welds shall be tested by the most suitable of either the magnetic particle test or the liquid penetration.
- Groove welds shall be tested by the most suitable of either the radiographic test or the ultrasonic test.
- The method of non-destructive testing for a specific weld shall be elaborated in consultation with the Engineer.

The minimum extent of the testing (control) shall be as follows:

Box girder plate

Transverse butt weld in top and bottom flange plate:

Welds subject to tensile stress And reversal stress	= 100%
Weld subject to compressive stress	= 25%
Transverse butt weld in web plate	= 50%

(The major part of the control to be performed in the tension zone)

Longitudinal fillet weld:

Top and bottom flange to web	= 25%
Longitudinal rib to top and bottom flange	= 10%
Horizontal stiffener to web	= 10%

Diaphragm

All end weld	= 25%
Fillet weld	= 10%

Other

Other welds not mentioned above	= 10%

The above figures are the minimum extent of testing and the Engineer may require additional tests if these are considered necessary to ensure compliance with the specifications.

(x) Stud Welding

After the studs have been welded to the beams a visual inspection shall be made and each stud shall be given a light blow with a hammer. Any stud which does not have a complete end weld, which does not emit a ringing sound when given a light blow with a hammer, which has been repaired by welding, or which has less than normal height due to welding, shall be forged with a hammer and bent 15 degrees from the correct axis of installation, and in the case of a defective or repaired weld, the stud shall be bent 15 degrees in the direction that will place that defective portion of the weld in the greatest tension. Studs that crack either in the weld or in the shank shall be replaced.

The Contractor is obliged to show the exact extent of the control on the shop drawings to be approved by the Engineer. Two sets of reports describing the inspection and comprising all the results have to be handed over to the Engineer concurrently with the execution of the inspection. The Contractor shall execute, at his own expense, the repair of unsatisfactory welds, and the repaired welds shall be tested anew on the Contractor's account.

(xi) Bolted Connection

Contact surfaces in bolted joints shall not be painted. When assembled in the field, the rust on joint surfaces, including those adjacent to bolt head, nut and washer, shall be removed by wire brushing. The separation between fraying surfaces of bolted connections shall be not greater than 1 mm. If the separation is between 1 mm and 3 mm, the surface shall be tapered to eliminate the separation. Over 3 mm separation shall be filled with filler plate as required.

Each bolt shall be tightened to provide, when all bolts in the joint are tight, the minimum bolt tension shown in the following Table 11.01 (2).

High strength bolts shall not be reused. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered reuse.

All high strength bolts shall be tightened by properly calibrated wrenches and their setting shall be such as to induce a bolt tension 10% in excess of the above value. These wrenches shall be calibrated at least once each working day by tightening in a device of the diameter of each bolt to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used the torque indication corresponding to the calibrating tension shall be noted and used in the installation

of all bolts of the tested lot. The nut shall be turned in the tightening direction when torque is measured. "Turn of the nut" method may be used for A490 bolts if the Engineer is satisfied that climatic conditions make the torque control method unsuitable.

For A325 bolts tightening may be by "Turn of the nut" method. When this method is used there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight shall be defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

Nut Rotation from Snug-Tight Condition

Disposition of outer faces of bolted parts		
Both faces normal to bolt axis, or one face normal to axis and other face sloped [1)]		Both faces sloped from normal to bolt axis
Bolt length not exceeding 8 x diameter or 20 cm	Bolt length exceeding 8 x diameter or 20 cm	For all lengths of bolts
1/2 turn	2/3 turn	3/4 turn

Note:

1) slope 1: 20 maximums

(xii) Trial Assemblage

The Contractor shall to the extent necessary carry out trial assemblage in his regular workshop and/or in the site workshop depending on the fabrication and erection procedure adopted.

Trial assemblage shall be understood as placing of prefabricated elements together to control the fit. The Contractor shall submit his proposal for trial assemblage for the approval of the Engineer. The trial assemblage shall verify that the individual elements have the shape to fit exactly into adjoining elements. Also, the trial assemblage shall verify that the camber aimed at, or prescribed, actually exists, and that the geometry is generally correct.

The Contractor shall perform measurement of the structural members, and the results shall be recorded and submitted to the Engineer. The Contractor shall inform the Engineer that the trial assemblage of major components have been completed and measured, and the structure shall not be dismantled until the trial assemblage has been approved by the Engineer.

(b) Surface Treatment of Steel

(i) General

This specification covers the complete surface treatment of all steel parts, including surface preparation, priming and final protective coatings. Surface treatment of structural steel work

shall be considered in six classes as shown on the drawings and as described below :

System I : Generally, all external steel work which will be exposed to the atmospheric conditions.

System II : Concealed surfaces not liable to wetting or exposure to the atmosphere.

System III : Generally, all steel work to be encased, or in contact, with concrete.

System IV : Internal surfaces including box girders.

System V : Bolted joint.

System VI : Particular areas which are difficult to repaint during maintenance works.

(ii) Surface Preparation

Before the application of any paint, the surfaces to be treated shall be thoroughly cleaned and freed from all scale, loose paint, rust and other deleterious matters. Oil and grease shall be removed from the surface by washing with solvents or with a detergent solution before any blast cleaning operation. If any traces of oil or grease remain after blasting, they shall be removed by solvent cleaning and the area blasted back.

All welding areas shall be given special attention for removal of weld flux slag, weld metal splatter, weld head oxides, weld flux fumes, slivers and other foreign objects before blasting. If deemed necessary by the Engineer acid washing and subsequent washing with clean water shall be used.

Any rough welding seams have to be ground and shall be inspected and approved by the Engineer before application of the coatings.

All structural steel which will be painted shall be cleaned by blast cleaning in accordance with SSPC-SP 10 Near-White Blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are light stains in the form of spots or stripes. Finally, the surface is cleaned with a vacuum cleaner or clean, dry compressed air.

The blast cleaning shall produce a surface roughness complying with the one specified by the paint manufacturer for the primer concerned. If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be recleaned by the Contractor at his expense.

(iii) Painting Materials

All materials shall comply with the requirements of Sub-clause S11.01 (2) (a) (v). The colors of all paint coats will be as instructed by the Engineer.

(iv) Painting

The execution of the painting works shall be carried out in the most perfect and workmanship manner by experienced labor to the satisfaction of the Engineer. Furthermore, the application of the paints shall be carried out in accordance with the manufacturer's recommendations.

Planning and execution of the painting work shall be in conformity with the supplier's specifications in respect to minimum and maximum intervals between the application of the individual coats.

If a coating material requires the addition of a curing agent, the pot life under application conditions shall be clearly stated on the container label, and this pot life shall not be exceeded. When the pot life limit is reached, the spray equipment shall be emptied, remaining material discarded, the equipment cleaned and new material prepared.

Each coat shall be applied uniformly over the entire surface. Skips, runs, sags and drips shall be avoided. When these occur, they shall be brushed out immediately or the material shall be removed and the surface recoated. Each coat shall be allowed to dry for the time specified by the manufacturer or as directed by the Engineer before application of any succeeding coat.

The surface shall be completely dry, and its temperature should be at least 5 degrees Celsius above the dew point. Paint should only be applied in suitable weather conditions and any fresh paint damaged by weather shall be repaired or replaced at the Contractor's expense. Measure shall be taken to prevent dust or other extraneous matter from adhering to wet paint.

Brushes, when used, shall have sufficient body and length of bristle to spread the paint in a uniform film. Paint shall be evenly spread and thoroughly brushed out. On all surfaces which are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers, bottle brushes, or by any other means approved by the Engineer. Rollers, when used, shall be of a type which do not leave a stippled texture in the paint film.

A water trap acceptable to the Engineer shall be furnished and installed on all equipment used in spray painting. Mechanical mixers shall be used to mix paint. Prior to applying, the paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together and shall be kept thoroughly mixed during its application. The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge. The thickness of each application shall be limited to that specified in the Paint Systems.

(v) Film Thickness

The specified film thicknesses for coating materials shall be strictly observed and shall be checked with appropriate film thickness gauges furnished by the Contractor. The Contractor shall calibrate the gauges for the thickness range to be checked.

Calibration shall generally be carried out on a ground and polished steel plate of a quality corresponding to the structural steel to be coated.

The dry film thickness shown on the painting systems are the minimum according to the specification SSPC-PA2, Measurement of Dry Paint Thickness with Magnetic Gauges.

When dry film thickness is less than specified, additional coats shall be applied as required at no additional cost to the Employer. Particular attention shall be paid to the film thickness on edges, welding, etc.

(vi) Protection of Paintwork

The Contractor shall provide protective measures as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations. Paint or paint stains which result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated by the Contractor at his expense. All painted surfaces that in the opinion of the Engineer are marred or damaged in any way, shall be repaired by the Contractor, at his expense, with materials and to a condition equal to that of the coating specified herein. The Contractor's proposal for retreatment of areas damaged by flame cutting and welding operations should be clearly stated in the detailed painting plan submitted in accordance with Sub-clause S11.01 (1) (d) (v).

Upon completion of al painting operations and of any other work that would cause dust, grease, or other foreign materials to be deposited upon the painted surfaces, the painted surfaces shall be thoroughly cleaned. At the time of opening structures to public traffic, the painting shall be completed, and the surfaces shall be undamaged and clean.

(vii) Types of Surface Treatment

The treatment of the various areas of structural steel shall be in accordance with Sub-clause S11.01 (3) (b) one of the six treatment systems (I to VI) as shown on the attached table. The application of each system of surface treatment within the structure shall be as shown on the Drawings.

The attached table is prepared on the assumption that the painting sequence is as follows:

Mill shop - shot blasting and etching primer

Fabrication shop	-	painting to be after satisfactory completion of trial assemblage.
Site	-	painting to be after final erection.

Where the Contractor requests permission to deviate from the above sequence, this shall be clearly stated in the detailed painting plan submitted in accordance with Sub-clause S11.01 (1) (d) (v).

The areas for HSFG bolts shall be protected by masking at the time of the fabrication shop undercoats. Immediately prior to final erection, any rust in the joint area shall be removed by power wire brushing to a standard equivalent to SSPC-SP 3.

(c) Transport Handling and Storage

Before shop assembling is dismantled, all adjacent sections shall be marked with paint or grooved. The Contractor shall submit to the Engineer drawings of the finished structure showing all part and match marks.

The methods of transporting and handing shall be subject to the approval of the Engineer. Special care shall be taken in the packing, methods of supporting, lifting during handling and transporting of structural steel work which is shop assembled before delivery, to ensure protection from damage.

Immediately following delivery to the site, the Contractor shall check the material and bring immediately to the notice of the Engineer or his representative any damage or defects therein. He shall also report in writing to the Engineer any such damage or defects, and give his proposals for the rectification or replacement or damaged sections.

Material to be stored shall be placed on skids above the ground and shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members shall be supported on skids placed near enough together to prevent injury from deflection.

Any structural steel materials (whether painted or unpainted) shipped to the site by sea transport, and positioned on board in such a way as to come into contact with salt water spray, shall be thoroughly washed with clean fresh water, using pressure hoses and stiff bristle brushes, prior to erection or application of finish coats of paint.

(d) Field Erection

The position of field splices as shown on the Drawings is for information only and the Contractor is free to propose alternative procedures providing, they comply with all the relevant requirements of these specifications. The preparation of the calculations and detailed design to support the proposed alternative shall be at the Contractor's responsibility and cost.

The Contractor will provide setting drawings, templates, and directions for the installation of anchor bolts or other items to be embedded in concrete.

During erection, the parts shall be accurately assembled as shown on the approved Shop Drawings and any match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Splices and field connections shall have one half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before bolting with high-strength bolts. Fitting-up bolts shall be of the same nominal diameter as the high-strength bolts, and cylindrical erection pins shall be 1 mm larger.

The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in his presence. The Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

The straightening of plates, angles, other shapes and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by the careful planned and supervised application of a limited amount of localized heat, each application subject to the approval of the Engineer.

S11.01 (4) Method of Measurement

The quantity of structural steel measured for payment shall be the number of kilograms complete in place and accepted in the works. For computing the nominal weight of rolled or cast steel, the material shall be assumed to have a density of 7,850 kilograms per cubic meter. The weights of other metals shall be as indicated on the Drawings or as approved by the Engineer. In particular, there will be no separate measurement or payment for trial assemblage, transportation and shop or field painting.

The computed weight of material shall be the nominal weight of finished steelwork comprising plates, rolled section, shear connectors, stiffeners, cleats, packs, splices plates, and all fittings, without allowance for rolling margin and other permissible deviations from standard weights or nominal dimensions, and excluding the weights of welds, fillets, bolts, nuts, washers, rived heads and protective coatings. No deduction shall be made for notches, bolt holes and rivet holes etc which are less than 0.03 square metres in area.

Reinforced concrete for the deck slab, expansion joints, bridge bearings, bridge railings, deck drains, electrical works and traffic signs will be measured and paid for under the other pay items in this specification.

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S11.01 (5) Basis of Payment

The quantities of structural steelwork determined as provided above, shall be paid for at the price per unit of measurement for the Pay Item listed below and shown in the Bill of Quantities. Such price and payment shall be deemed full compensation for supplying, fabricating and erecting the materials, including all labor, equipment, tools, testing and other incidentals necessary or usual for the satisfactory completion of the work prescribed in this Clause.

Pay Item No. and Name		**Unit of Measurement**
11.01 (1)	Continuous Steel Box Girders, furnished	ton
11.01 (2)	Continuous Steel Box Girders, erection	ton
11.01 (3)	Simple Steel Box Girders, furnished	ton
11.01 (4)	Simple Steel Box Girders, erection	ton
11.01 (5)	Continuous Steel Box Girders with Steel Deck, furnished	ton
11.01 (6)	Continuous Steel Box Girders with Steel Deck, erection	ton

DIVISION 12 MISCELLANEOUS

S12.01 Sodding

S12.01 (1) Description

This work shall consist of furnishing grass sods as required and planting them to give a healthy, stable covering of grass which will maintain its growth in any weather and prevent erosion of the material in which it is planted.

S12.01 (2) Material

(a) The species of grass may be Polytrias amaura (*rumput embun*). It shall be rapid spreading, free of disease and noxious weeds and shall be deep rooted. The Contractor shall notify the Engineer not less than 3 days before cutting of sods begins. The source of sods will be approved by the Engineer before cutting and delivery to the Project.

Sods shall be planted with their root system substantially undamaged and cut into blocks with moist earth in which they have grown. Sods shall be laid within 5 days of cutting. Sod blocks shall be hauled and stored in such manner that they will be protected from direct sun rays, provided with air circulation, and prevented against drying.

(b) The species of Vetiver Grass System used for slope stabilization and retaining the surface water erosion is species of Vetiveria zizanioides or otherwise known as vetiver grass, hereinafter called Vetiver System (VS). VS has a stiff, long and narrow leaf with width of no more than 8mm, grow upright with height of 1.5 m to 2.5 m after 2 years old, formed big clumps, smooth surface leaf, slender edge, pointed, meeting, and erect along the flower stalk. It has a longitudinal root which able to be more than 2m length at 1 year old.

(c) Fertilizer shall be approved mixtures of plant nutrients.

S12.01 (3) Construction

(a) Non Vertiver Grass System

Grass sodding shall not take place until tree planting in the area has been completed.

Surfaces on which sod blocks are to be placed shall be scarified and shaped after removing debris, gravel and weeds. All stones of more than 3 cm diameter shall be removed. The surface below the sods shall be made up as necessary with good quality topsoil so as to ensure that the sod and topsoil together form a finished thickness of not less than 20 cm consisting of 5 cm humus and 15 cm existing soil as shown on the Drawings. Every square meter of soil shall be implanted with lime or other approved materials approximately 3 gram to a depth of 20 cm and a final layer of topsoil 10 cm thick placed on top. The purpose of the lime is to neutralize any existing sour condition of the soil. The Contractor shall be responsible for ensuring a healthy growth in sodded areas and necessary fertilizer used

before or after sodding will be at the Contractor's own expense. Urea or NPK fertilizer shall be used.

Sod blocks shall be placed so as to cover 50% of the surface by forming sod strips at the interval of 30 cm (this will be called "Strip Sodding"), or to cover entire surfaces (which shall be called "Solid Sodding"), as noted in the Drawings or directed by the Engineer. In strip sodding joints shall be staggered to form a broken bond. Joints between adjacent sod blocks shall not exceed 0.5 cm. Sod blocks shall be placed in smooth finish and compacted by a roller of 100 kg weight or by tamper plate. Sand shall be spread over the grass sods already laid and into the joints and the whole area shall be watered twice daily until the grass has taken firm root.

Sufficient bamboo stakes shall be used to prevent the sod blocks slipping when sodding is provided on slopes.

For at least six months after completion of sodding, the Contractor shall maintain watering and other incidental operations. Sodded areas will be subject to special checks, 2 and 12 months after they have been laid. Any areas in which sods are not maintaining a healthy growth shall be refurnished and resodded by the Contractor at his own expense.

The Contractor will be responsible for cutting and keeping clean any sodded areas until completion of the Defect Notification Period.

(b) Vertiver Grass System

(i) Preparation

- Fine grade all areas to be sodded to a uniform surface and loosen the surface materials.
- Make up the surface with top soil so that the sod and top soil form a finished thickness of 15 cm.
- After surface preparation, spread fertilizer uniformly over all surfaces which are to be sodded, at a rate of 4 kg per 100 square meters. Incorporate fertilizer into such surfaces by raking, dishing or harrowing. Apply fertilizer not more than 48 hours before the grass is to be placed.
- Sods shall be cut with their root system substantially intact and taken when the earth is moist or has been artificially watered. Sods should be stacked on pallets in layers together with as much moisture as possible, protected from sun and wind and watered every 4 hours. They should be laid within 2 days of cutting.

(ii) Application

- Prepare the points of the planting hole location by marking with wooden stick/rod of 50 cm which is designed with a distance of not more than 2 m.
- If in the opinion of the Engineer, the slope to be stabilized is a critical or steep slope of more than 1: 1.5, then slip No.2 above mentioned able to be planted first on the ground in a polybag,

then placed lined up on the critical soil until the slip age of 1.5 - 2 months. Then the polybag to be removed before the slip to be planted at the right time/ time of planting.

- Procedure of removing the polybags shall be in accordance with VS Planting Guidance.
- Diameter of polybags shall be approximately 10 cm with a height of approximately 15cm, then filled in sequential sandy soil up to one-third of the volume, the fertilizer approximately 20 grams, and filled the again with soil up to full.

(iii) Watering

- At least 3 months after VS has been planted, the surface ground shall be watered at regular intervals in accordance with current weather conditions or as directed by the Engineer. The amount of water sprayed shall be such as that the surface ground which just planted with VS will not erode, drift or otherwise damage. Water sprinkling shall be approximately 5-10 liters/m2/day in the afternoon every day until the first 2 weeks after planting. Then it shall be sprayed every 2 days for the second 2 weeks. Finally sprayed 2 times a week until the age of 3 months of planting. All with water needs of approximately 5-10 liters/m2/day. In the dry season, due to the type of sandy soil, and the steep of slope, the water needs shall be increased by up to 10 liters/m2/day or more in accordance with the instructions of the Engineer.
- The land shall be cleaned out from weed plants, shrubs, weeds. Cleaning should be used Atrazine herbicide or the like as a precaution, and do not use glyphosate as it may interfere with the survival of VS.
- Water sprinkling on slip into polybags is recommended less than slip that is planted freely as directed by the Engineer in order to maintain the stability of slope/critical slopes.

(iv) Maintenance

- After 3 months VS able to grow without routine watering except trimming to maintain a height of about 30 cm from the existing ground surface at least once a month.

S12.01 (4) Method of Measurement

The quantities of sodding to be paid for shall be the number of square meters of treated surface measured on the slope including unsodded areas between strip sods, completed and accepted in accordance with the Drawings, Specifications and as directed by the Engineer.

S12.01 (5) Basis of Payment

The quantities, determined as provided above, shall be paid for at the Contract price per unit of measurement for the pay items listed below, which price and

payment shall be full compensation for furnishing all materials, labor, equipment, tools including preparation of surface, sodding, protection and maintenance, and other incidentals to complete the work in accordance with the Drawings and Specifications, and as directed by the Engineer.

Pay Item No. and Name		Unit of Measurement
12.01 (1)	Solid Sodding	Square Meter
12.01 (2)	Strip Sodding	Square Meter
12.01 (3)	Vetiver Grass System	Square Meter

S12.02 Stone Masonry for Retaining Walls

S12.02 (1) Description

This work shall consist of stone masonry in retaining walls for both cut and embankment sections, in minor structures, and in other places where called for on the Drawings or ordered in writing by the Engineer. The stone masonry shall be constructed on the prepared foundation bed in accordance with these Specifications and the specifications for other work items involved and in conformity with lines, grades, sections, and dimensions shown on the Drawings or required by the Engineer.

S12.02 (2) Material

(a) Stone

The stone shall be sound, have sufficient strength, no seams, shall be of good quality, and shall be resistant to weathering. Quality of stone shall be approved by the Engineer prior to use. The stone shall be of the strength specified on the Drawings, and shall be flat, wedge or convex shaped. The base surface shall be not less than 1/16 of the front surface, and the shorter length of the base surface shall be more than 1/10 of the longer length. The standard number of stones per square meter shall be 14. However, if directed by the Engineer the number may differ from that specified.

(b) Mortar

Mortar shall be in accordance with Clause S12.04 "Cement Mortar".

(c) Concrete

Class D concrete for footings and class E for backing shall be in accordance with the requirements of Division 10 of these Specifications.

(d) Filter Backfill

Permeable backfill shall be in accordance with Clause S4.10 of these Specifications.

S12.02 (3) Construction

(a) Excavation

Excavation shall be in strict accordance with the cross-sections, grades and lines shown on the Drawings after staking has been inspected and approved by the Engineer. When the excavation method and dimensions are not specified, the method shall be selected by the Contractor and approved by the Engineer. Excavation and backfill shall be made in accordance with the requirements of Division 5 of these Specifications.

(b) Foundation

Prior to placing the foundation, the soil shall be thoroughly compacted by mechanical or hand ramming. Blinding stone foundation in accordance with Sub-clause S5.01 (5) shall then be placed and compacted as shown on the Drawings. A footing of Class E concrete shall then be formed to the dimensions shown on the Drawings.

(c) Backfill and Backing Concrete

Permeable backfill shall be provided as shown in the Drawings, Specifications or as directed by the Engineer. Class E concrete shall be placed and compacted on the permeable backfill material with consideration being given to the need to provide expansion joints and weep holes as directed elsewhere in this clause. Backfill material and Class E concrete shall be provided in advance of the stonework only to such height as can be adequately compacted.

(d) Placing

Placing of stone masonry shall not begin until the finishing stakes set according to the design have been inspected and approved by the Engineer. Stones shall be washed with water before placing. A mortar bed shall be spread on the sides of adjacent stones before the next stone is laid. The thickness of the mortar shall be the minimum necessary to ensure that there is no direct contact between stones. Stones shall be thoroughly hammered into place and any stone whose face is deviating more than 20 mm from the true face or more than 30 mm from the face of the adjacent stone, shall immediately be made good by lifting and relaying. Face joints between stones shall be flush-pointed as work proceeds.

(e) Weep holes

Walls of stone masonry shall be provided with weep holes. Unless otherwise shown on the Drawings or directed by the Engineer, the weep holes shall be spaced not more than 2 meters center to center and shall be 50 mm in diameter.

(f) Coping

Coping shall be as shown on the Drawings. Where copings are not determined, the upper surfaces of masonry shall be mortared and finished smooth by wooden float.

(g) Joints

Expansion joints shall be formed at a maximum spacing of 20 meters. Joints shall be 30 mm in width and shall extend through the complete wall including the footing and backing concrete. Stones used for joint forming shall be selected so as to form a clean vertical joint of the dimensions specified above.

(h) Finishing

Appearance of stone masonry should be outer carving in between two stone surfaces, and no additional payment for this work and already included in the Pay Item 12.02.(1).

(i) Curing

In hot or dry weather, the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

S12.02 (4) Method of Measurement

The quantities to be paid for shall be the number of square meters for Type A and B of stone masonry laid in accordance with this Specification, and cubic meters for Type C. In computing the quantity for payment, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No deductions shall be made for weep holes, drain pipes, or other openings of less than 0.10 square meters in area and no increase will be allowed for the concrete footing. Any coping provided shall be included in the measurement as though it were stone masonry.

Stone masonry type A shall be used in embankment sections and type B in cut sections, and type C as directed by the Engineer.

S12.02 (5) Basis of Payment

The quantities determined as provided above, shall be paid for at the contract price per unit of measurement for the pay items as listed below.

All excavation and backfilling for these pay items will be deemed to be covered by and paid for under the work described in Division 5 of these Specifications. Any extra expense due to excavation, or due to provision of foundations or of special backfill will be considered to be included in the unit price for these pay items.

The contract unit price shall be full compensation for furnishing and placing all materials including concrete footing and coping and all other necessary work as specified for the proper completion of all the work as described in this Clause.

Pay Item No. and Name	**Unit of Measurement**
12.02 (1) Stone Masonry Type A	Square Meter
12.02 (2) Stone Masonry Type B	Square Meter
12.02 (3) Stone Masonry Type C	Cubic Meter

S12.03 Slope Protection

S12.03(1) Description

This work shall consist of dry-stone riprap and concrete blocks for slope protection furnished and constructed in accordance with these Specifications and in conformity with the lines, grades and dimensions shown on the Drawings or required by the Engineer. The concrete block slope protection shall be installed at bridge abutments.

S12.03 (2) Materials

Stone for riprap shall consist of field stone or unhewn quarry stone as nearly rectangular in section as is practical. The stone shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended. Adobe blocks shall not be used for riprap work.

Stone pieces for protecting slopes shall range in weight from a minimum of 2 kg to a maximum of 20 kg with not less than 60 percent of the stones weighing more than 12 kg.

Grout for grouted rip rap shall be mortar with compressive strength at least 5 MPa as specified in Clause S12.04 of these Specifications

Concrete blocks shall be solid plain rectangular blocks. Representative sample blocks shall be submitted to the Engineer for approval before orders are given to the suppliers or manufacturers.

S12.03 (3) Construction

(a) Preparation

Slope surface on which slope protection is to be placed shall be compacted and properly smoothed after removing all vegetation.

Placing slope protection shall not begin until the finishing stakes are set according to the Drawings and have been inspected and approved by the Engineer.

(b) Placing

(i) Riprap Slope Protection

Stone placed below the water line shall be distributed and compacted so that the thickness of riprap is not less than that specified. Stone placed above the water line shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with ends in contact. Smaller stones shall be first laid on the slope and larger stones shall be used as surface cover. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be chinked with spalls firmly rammed into place.

Unless otherwise provided, riprap shall be at least 60 cm in thickness, measured perpendicular to the slope. The surface of riprap placed above the water line shall not vary from the theoretical surface by more than 8 cm at any point.

(ii) Grouted Rip Rap Slope Protection

Stones shall be thoroughly clean and saturated with water before being placed. Grout material shall be applied to the previously placed stone against which a new stone is to be placed. Stones shall be firmly bedded into the slope and tamped into close contact with adjacent stones to form the required thickness of rip rap.

The interstices between stones may be partly filled with spills or small stones after which all remaining voids shall be solidly filled with concrete and neatly pointed to within not more than 10 millimeters of the surface of the stones.

Weep holes shall be constructed as directed by the Engineer.

The work shall be kept shaded and damp for not less than 3 days after completion

(iii) Concrete Block Slope Protection

The concrete blocks shall be placed on a bed of Class E concrete and sand. The blocks shall be thoroughly tamped into the sand to produce an even surface. Joints between blocks shall be filled with mortar. The finished surface shall be such that it will not exceed more than 6 mm from the testing edge between any two contacts of a 3-meter straight edge applied anywhere on the paved area. Blocks shall be neatly cut as necessary to completely fill the area to be covered.

In hot or dry weather, the paved area shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

S12.03 (4) Method of Measurement

The quantities to be paid for shall be the number of square meters of dry riprap or grouted riprap or concrete blocks measured in place and incorporated in the completed work in accordance with the Contract. In computing the quantity for payment of slope protection the height shall be measured along the slope surface and no measurement will be made for the toe key to dry riprap or grouted riprap. In computing the quantity for concrete block slope protection no measurement will be made for the concrete edge key or the concrete and blinding stone footing. Only accepted work will be measured for payment and the computation of the quantity thereof will be based on the area within the limiting dimensions designed on the Drawings or ordered by the Engineer.

S12.03 (5) Basis of Payment

The quantities, determined as provided above, shall be paid for at the Contract price per unit of measurement for the items listed below, which price and payment

shall be full compensation for furnishing and placing all materials, labor, equipment, tools including preparation of slope bed, foundations and other incidentals to complete the work in accordance with the Drawings and Specifications, and as directed by the Engineer.

Pay Item No. and Name		Unit of Measurement
12.03 (1)	Dry Riprap Slope Protection	Square Meter
12.03 (2)	Grouted Riprap	Square Meter
12.03 (3)	Concrete Block Slope Protection	Square Meter

S12.04 Cement Mortar

S12.04 (1) Description

(a) General

This work shall consist of preparing and furnishing mortar in accordance with these Specifications, for masonry and for any other incidental work.

(b) Composition

Unless otherwise instructed by the Engineer, masonry mortar shall be composed of one part Portland cement and five parts fine aggregate by volume to which hydrated lime may be added in an amount equal to 10 percent of the cement by weight.

S12.04 (2) Materials

(a) Cement shall conform to the requirements of AASHTO M85-15 or SNI 2049:2015.

(b) Fine aggregate shall conform to the requirements of SNI 03-6820-2002 or AASHTO M45-15.

(c) Hydrated lime shall meet the requirements for residue, popping and pitting, and water retention shown for Type N Lime in ASTM C207-18.

(d) Water shall conform to the requirements of Sub-clause S10.01.(2).(d) of these Specifications

Unless directed otherwise by the Engineer, masonry mortar shall have a compressive strength of at least 5 MPa at 28 days. Hydrated lime may be added in an amount equal to 10 percent of the cement by weight

S12.04 (3) Construction

(a) All the materials except water shall be mixed in an approved mortar mixer until the mixture assumes a uniform color, after which water shall be added and the mixing continued. Mortar shall be mixed only in those quantities required for immediate use. Mortar that is not used within 45 minutes after water has been added shall be discarded in an approved manner.

(b) Surface shall be cleaned of any clay, or materials other unused and fully saturated before the mortar used.

(c) When used finishing surface, the mortar thickness minimum 15 mm and surface should be clean and shall be leveled up to get a smooth and flat surface.

S12.04 (4) Method of Measurement

Cement mortar shall not be measured for direct payment.

S12.04 (5) Basis of Payment

Performance of this work shall not be paid for separately but shall be a subsidiary obligation of the Contractor for which full payment is made in the payment of Contract prices for the work items in which it is called for or required.

S12.05 Mortared Rubble

S12.05 (1) Description

This work shall consist of open ditches lined with mortared rubble furnished and constructed in accordance with these Specifications and in conformity with lines, grades, and dimensions shown on the Drawings or required by the Engineer.

S12.05 (2) Materials

(a) Stone shall consist of field stone or rough unhewn quarry stone, as nearly rectangular in section as is practical. The stone shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended.

Quality and dimensions of stone shall be approved by the Engineer prior to use. Unless otherwise provided by the Drawings or Specifications, all stone shall be more than 0.008 cu. m in volume.

(b) Mortar shall conform to the requirements of Clause S12.04.

S12.05 (3) Construction

Earthworks shall be completed, and the foundation tamped prior to placing the class E foundation concrete. Stone shall be securely placed by hand, and voids shall be avoided. The face surfaces of all stones shall form a smooth regular surface conforming to the shape of the ditch. No stone surface shall extend more than one and a half centimeter above or below the general level of the ditch.

All voids between stones shall be filled and flushed with mortar but the face surface of the stone shall be left exposed. Mortar shall be placed from bottom to top and the surface swept with a stiff broom. The surface shall be cured as specified in Division 10 for a period of at least three days.

Copings shall be as shown on the Drawings. Where copings are not called for the upper surface of the mortared rubble shall be mortared and finished smooth by wooden float.

S12.05 (4) Method of Measurement

The quantities to be paid for shall be the number of linear meters of open ditches lined with mortared rubble or cubic meters of inlet and outlet with mortared rubble measured, as indicated on the Drawings, completed and accepted. In computing the length for payment the dimensions used will be those determined by the payment lines or payment areas shown on the Drawings or ordered by the Engineer. Any coping provided shall be included in the measurement as though it were mortared rubble. Where the Engineer instructs special joint or edge details of a thickness greater than the standard shown on the Drawings, this will be measured by volume and converted to an equivalent length of the standard thickness for the purpose of payment. Excavations for mortared rubble ditches from the lowest elevation of the surface of shoulder shall not be measured separately for payment.

S12.05 (5) Basis of Payment

The quantities, determined as provided above, shall be paid for at the Contract price per unit of measurement for the pay item listed below, which price and payment shall be full compensation for furnishing all labor, equipment and materials necessary for the proper completion of the work prescribed in this clause.

Pay Item No. and Name		**Unit of Measurement**
12.05 (1)	Mortared Rubble DS-2	Linear Meter
12.05 (2)	Mortared Rubble DS-4	Linear Meter
12.05 (3)	Mortared Rubble DS-5	Linear Meter
12.05 (4)	Mortared Rubble DS-5 with Subdrain	Linear Meter
12.05 (5)	Mortared Rubble D-6	Linear Meter
12.05 (6)	Mortared Rubble DV-10	Linear Meter
12.05 (7)	Mortared Rubble for Inlet and Outlet	Cubic Meter

12.06 Guardrail and Fence

S12.06 (1) Description

This work shall consist of furnishing and installing the specified type of railing at locations indicated on the Drawings or as directed by the Engineer. The work shall include all required posts, rails, fixtures and fastenings, beams and attachments as well as aligning, fabricating, erecting and painting of guardrail or fence, if required, and all the process necessary to complete the work as described in the Drawings and this Specification.

S12.06 (2) Materials

(a) Materials shall conform to the relevant requirements of :

JIS G 3101/ (ASTM A36/A36M-19):
Rolled Steel for General Structures

JIS G 3452/ (ASTM A53/A53M-18):
Carbon Steel Pipes for Ordinary Piping

JIS G 3444/ (ASTM A500/A500M-18):
Carbon Steel Tubes for General Structures Purposes

JIS G 3466/ (ASTM A511/A511M - 16):
Carbon Steel Square Pipes for General Structures Purposes

JIS G 3532/ (ASTM A82/A82M-07) :
Low Carbon Steel Wires

JIS G 3552/ (ASTM A392-11a(2017)):
Chain-link Wire Netting

Corrugated sheet steel beams for vehicle guardrail shall conform to AASHTO M180-18 Class A, Type 1.

(b) All steel railing and fittings shall be galvanized unless otherwise specified, in accordance with the requirements of Clause S12.18 of these Specifications. Where painting is required it shall also be in accordance with the requirements of Clause S12.18.

(c) All other materials shall be in accordance with the relevant clauses of this Specification or as specified on the Drawings.

S12.06 (3) Construction

General

(a) Pipe, railing, fittings and incidental parts shall be carefully handled and stored on blocking, racks or platforms so as not to be in contact with the ground and shall be protected from corrosion. Materials shall be kept free from dirt, oil, grease and other foreign matter. Threads shall be carefully protected from damage.

(b) Guardrail shall be constructed to the lines and grades, and in the exact positions shown on the Drawings or as directed by the Engineer.

(c) Steel shall not be heated or welded in the field unless with the prior written approval of the Engineer. Field operation of drilling holes or cutting steel shall be carefully conducted so as to prevent damage to steel.

(d) Posts shall be firmly set after digging holes by means of auger or post driving machine or other equipment approved by the Engineer. When handwork is required, care shall be exercised not to damage existing pavement. When posts are to be set in concrete or masonry, all details of preformed openings and the method of fixing the post therein shall be as shown on the Drawings.

Post holes in soil shall be backfilled using material approved by the Engineer or concrete according to the details on the Drawings. Backfill material shall be thoroughly compacted to the same degree of compaction as the adjacent soil. The surface surrounding the fixed pole shall be reinstated to its original condition to the satisfaction of the Engineer.

(e) The component parts of pipe railings shall be connected with threaded screws unless otherwise specified on the Drawings. Fitting of railings on slopes shall be leveled to fit the required grades. Screw thread fittings shall be coated with red lead and oil.

Expansion shall be provided by omitting screws on one side of fittings at designated posts. Where the rails are continuous through two or more posts screws may be omitted between the rails and the fitting.

Barbed wire and chain-link netting shall be securely fixed to steel posts with suitable metal fittings including steel connecting plates at joints of steel angles, at corners and at ends of fence bolted as required, materials and workmanship to be approved by the Engineer.

Gates shall be supplied and fixed all in accordance with the drawings including hinges, locks, bolts and keepers and other ironmongery required, materials and workmanship to be approved by the Engineer.

Barbed wire shall be securely fixed to steel posts with suitable metal fittings, materials and workmanship to be approved by the Engineer.

S12.06 (4) Method of Measurement

The quantities to be paid for shall be the number of linear meters of each type of guardrail or fence, completed and accepted in accordance with the Drawings, Specifications, and as directed by the Engineer. Vehicle Guardrail Type C will be use on Diverging nose, for protection pier of bridge and approach of bridge and unit of completed measurement to be paid for shall be the number of linear meters.

S12.06 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for each type of guardrail or fence as designated below. The price and payment shall be full compensation for furnishing and installing all materials, including labor, equipment, tools and all incidentals necessary to complete the work as shown on the Drawings and described in this Specification.

Pay Item No. and Name		**Unit of Measurement**
12.06 (1)	Vehicle Guardrail Type A	Linear Meter
12.06 (2)	Vehicle Guardrail Type B	Linear Meter
12.06 (3)	Vehicle Guardrail Type C	Linear Meter
12.06 (4)	Separator Fence (Concrete Panel) Type-A	Linear Meter
12.06 (5)	Separator Fence (Spine Wire) Type-B	Linear Meter
12.06 (6)	Fence Gate Type-A	Each
12.06 (7)	Fence Gate Type-B	Each
12.06 (8)	Moveable Fence Type-A	Each
12.06 (9)	Moveable Fence Type-B	Each

12.06 (10) BRC Fence	Linear Meter
12.06 (11) Guard Rail End Section	Each
12.06 (12) Chain-link Fence	Linear Meter

S12.07 Traffic Signs (Warning and Regulatory Signs)

S12.07 (1) Description

This work shall consist of furnishing, fabricating, hauling, and establishing the specified types of traffic signs at locations indicated on the Drawings or as directed by the Engineer and as required by the Ministry of Transportation Regulation No. PM -13/2014 or the modifications (if any)

S12.07 (2) Materials

(a) Materials shall conform to the requirements noted in the Drawings.

Steel and aluminum materials shall be of durable quality and shall be approved by the Engineer.

Material for poles shall comply with the requirements of ASTM A53/A53M-12.

Nut, Bolts, U-Bolt, washer, clamps and others to be used for tightening sign boards shall be steel bolts, fully galvanized, and free from deformation and bending and shall conform to the requirement of AASHTO M232M/M232-19.

(b) Aluminum plates shall be degreased, etched, neutralized and processed prior to use as traffic sign boards, and shall conform to the requirement of ASTM B209-14 or AASHTO M290-96(2013), with the minimum thickness 2 mm.

Reflective sheeting shall conform to the requirements of AASHTO M268-15(2019) or ASTM D4956-17 and the color shall be as shown on the Drawings and shall include a precoated adhesive on the back capable of forming a durable bond, by vacuum or roller method, to aluminum plates.

(c) Steel plate type for traffic sign is steel for general structure as requirements of ASTM A36/A36M-19 or SNI 6764:2016 and galvanized as per the requirements AASHTO M111M/M111-19 or JIS H 8641.

(d) Steel poles for traffic signs shall either be processed for rust prevention by phosphatic membrane or zinc galvanizing, or if approved by the Engineer, by means of a rust prevention painting process. Rust prevention paint and galvanizing shall conform to Clause S12.18 of these Specifications and all details of materials and painting shall be approved in advance by the Engineer.

(e) The quality of the concrete to be used for the foundation as shown in Drawing and shall comply with the provisions of Division 10 of this Specification.

S12.07 (3) Construction

(a) The type and location of traffic signs shall conform to the Drawings and the instructions of the Engineer. Traffic sign locations shall be established in the presence of the Engineer.

(b) Poles shall be set on a foundation as shown on the Drawings after digging holes by means of auger or other equipment approved by the Engineer. When handwork is required, care shall be exercised not to damage existing pavement.

(c) Poles shall be supported as necessary until the concrete has achieved sufficient strength and the hole shall then be backfilled and thoroughly compacted with suitable material to the satisfaction of the Engineer. The adjacent surface shall be restored to its original condition as directed by the Engineer.

(d) When traffic signs are to be installed on an existing road extreme care shall be exercised to prevent obstruction of traffic. Any damaged portion shall be repaired to its original condition immediately after installation.

(e) Traffic signs shall be carefully handled so as not to cause damage, and the Contractor shall repair or replace signs at his own expense in the event of damage.

S12.07 (4) Method of Measurement

The quantities to be paid for shall be the actual number of permanent traffic sign poles furnished, placed and accepted in accordance with the Drawings, and as directed by the Engineer.

S12.07 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for each type of traffic sign pole listed below.

The prices and payment shall be full compensation for furnishing and placing all materials including sign or signs as necessary, for all materials, for foundations, for all excavation, backfill and reinstatement, including labour, equipment, tools and incidentals necessary to complete the work as shown on the Drawings or described herein.

Pay Item No. and Name		**Unit of Measurement**
12.07 (1)	Regulatory and warning signs type A-1	Each
12.07 (2)	Regulatory and warning signs type A-2	Each
12.07 (3)	Regulatory and warning signs type B-1	Each
12.07 (4)	Regulatory and warning signs type B-2	Each
12.07 (5)	Regulatory and warning signs type C-1	Each
12.07 (6)	Regulatory and warning signs type C-2	Each
12.07 (7)	Regulatory and warning signs type D	Each

12.07 (7a) Regulatory and warning signs type D-2 Each

S12.08 Traffic Guide and Prohibition Signs (Traffic Guide Signs)

S12.08 (1) Description

This work shall consist of furnishing, fabricating, hauling and installing the specified types of traffic guide signs at locations indicated on the Drawings or as directed by the Engineer and as required by the Ministry of Transportation Regulation No. PM 13/2014 or the modifications (if any).

S12.08 (2) Materials

(a) Unless otherwise noted in these Specifications, all materials shall conform to the requirements given on the Drawings.

(b) The specification for steel and aluminums products and for reflective sheeting as given in Clause S12.07 of these Specifications shall also be applied to traffic guide signs.

All materials for this work shall be approved by the Engineer before orders are given to the suppliers or manufacturers.

S12.08 (3) Construction

(a) The type, location and placement of signs shall be in accordance with Drawing or instructed by the Engineer. Setting and fixing the location shall be supervised by the Engineer.

(b) All details given in Clause S12.07 regarding the fabrication and installation of signs and poles shall also be applied to traffic guide signs. Foundation details shall be as shown on the Drawings.

(c) Guide signs and light units shall be carefully handled so as to avoid damage, and the Contractor shall repair or replace these at his own expense in the event of any damage.

S12.08 (4) Method of Measurement

The quantities to be paid for shall be the actual number of permanent traffic sign poles furnished, placed and accepted in accordance with the Drawings, and as directed by the Engineer.

S12.08 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for each type of traffic guide sign as listed below.

The prices and payment shall be full compensation for furnishing and placing all materials including signs lettered in accordance with the Engineer's instructions, pole(s), jointing, for all sundry materials, for foundations, for all excavation, backfill and reinstatement, including labor, equipment, tools and incidentals necessary to complete the work.

Pay Item No. and Name	Unit of Measurement
12.08 (1) Guide Sign Type A-1	Each
12.08 (2) Guide Sign Type A-2	Each
12.08 (3) Guide Sign Type A-3	Each
12.08 (4) Guide Sign Type A-4	Each
12.08 (5) Guide Sign Type A-5	Each
12.08 (6) Guide Sign Type A-6	Each
12.08 (7) Guide Sign Type A-7	Each
12.08 (8) Guide Sign Type B-1	Each
12.08 (9) Guide Sign Type B-2	Each
12.08 (10) Guide Sign Type C-1	Each
12.08 (11) Guide Sign Type C-2	Each
12.08 (12) Guide Sign Type D-1	Each
12.08 (13) Guide Sign Type D-2	Each

S12.09 Road Markings

S12.09 (1) Description

This work shall consist of furnishing and applying Type A, Type B and Rumble Strip painted road markings on the finished paved area in accordance with these Specifications, at the locations and of the dimensions shown on the Drawings, or as directed by the Engineer.

S12.09 (2) Materials

(a) Type A material shall be white and yellow thermoplastic material (solid form) incorporating glass beads and conforming with AASHTO M249-12(2016) or SNI 06-4826-1998.

(b) Type B material shall be white and yellow ready-mixed traffic paint conforming with AASHTO M248-91(2012) or SNI 06-4825-1998.

(c) Glass beads applied to the surface of both Class A and Class B and Rumble Strip material shall conform to AASHTO M247-13 or SNI 15-4839-1998 (Type 2).

S12.09 (3) Construction

(a) Existing lines and markings to be removed will be designated by the Engineer and shall be removed by grit-blasting or other approved method causing minimum damage to the road surface.

(b) The surface area to be marked shall be clean, dry and free from loose particles. Setting out and location of all markings shall be approved by the Engineer before work begins. Except where approved by the

Engineer, all markings shall be laid by self-propelled machines equipped with cut-off valves and nozzles capable of forming clean and sharp edged lines and markings, of the specified thickness.

(c) Type A material shall be laid by screed to the dimensions shown on the Drawings and agreed by the Engineer. The finished thickness of the material shall be at least 3 mm exclusive of the glass beads described in (e) below. Preparation and application of the material shall be in accordance with the manufacturer's instructions or as agreed by the Engineer. On concrete surfaces the Contractor shall first apply a tack coat of a type compatible with the thermoplastic material.

(d) Type B material shall be laid by spray type machine equipped with a mechanical agitator. Each nozzle shall be equipped with suitable guidelines consisting of metallic shrouds or air blasts, and with a satisfactory cut-off valve capable of applying broken or skip lines automatically. Spread rate shall be not less than 40 liters/ 100 m^2. In areas where machine laying is impossible, the Engineer may give approval to brush application.

(e) Glass beads shall be applied to the surface of Class A and Class B markings immediately after they have been laid. Unless otherwise approved by the Engineer, all glass beads shall be applied by pressure or spray application at a rate not less than 450 gm/m^2.

(f) All road markings shall be protected from traffic as instructed by the Engineer. All markings shall present a clean cut, uniform and workmanlike appearance and the surface shall be free from streaks and cracks. All markings which do not have a uniform satisfactory appearance by day and night shall be corrected by the Contractor at his own expense.

(g) The thickness of the rumble strip shall be 12.5 mm ± 0.5 mm with some applications of thermoplastic material.

S12.09 (4) Method of Measurement

The quantities of road marking and rumble strip to be paid for will be the number of square meters of the relevant material applied to the surface, completed and accepted in accordance with the Drawings, these Specifications, and as directed by the Engineer. For the purposes of measurement each type of material for road marking will be divided into two categories as follows:

General Application - Centre lines, edge lines, lane markings and other work which is basically parallel to the centerline of carriageway or ramp.

Special Application - Arrows, pedestrian markings, striping and other work which is transverse or sharply angled to the direction of traffic flow.

S12.09 (5) Basis of Payment

The quantities, measured as provided above, will be paid for at the Contract unit price per square meter of traffic marking and Rumble Strip for each category of work as listed below.

The price and payment shall constitute full compensation for furnishing all materials, labor and equipment and for fulfilling all the work as described in this clause.

Pay Item No. and Name		Unit of Measurement
12.09 (1)	Road Marking Type A (General Application)	Square Meter
12.09 (2)	Road Marking Type A (Special Application)	Square Meter
12.09 (3)	Road Marking Type B (General Application)	Square Meter
12.09 (4)	Rumble Strip	Square Meter

S12.10 Delineators

S12.10 (1) Description

This work shall consist of furnishing and installing the specified type of delineators at the locations indicated on the Drawings or as directed by the Engineer.

The work shall include all required posts, fixtures, fastenings and attachments as well as aligning and installing, and all the process necessary to complete the work.

S12.10 (2) Materials

The manufacturer and model type of all delineators shall be approved by the Engineer before any order is placed for their supply as specified in Sub-clause S1.02.(4) of these Specifications. All details of delineators shall conform to the relevant JIS or AASHTO standards.

Delineator Type A : Reflective disc fixed to steel post placed in the ground.

Delineator Type B : Reflective disc on guardrail post or bridge railing.

Delineator Type C : Reflective road stud fixed to the face of the curb.

S12.10 (3) Construction

Delineators shall be exactly installed in accordance with the Drawings and the instructions given by the Engineer. All metal parts of delineators shall be fully galvanized. Reflector color shall be as directed by the Engineer.

S12.10 (4) Method of Measurement

The quantities to be paid for shall be the actual number of delineators furnished, installed and accepted in accordance with the Drawings, and as directed by the Engineer.

S12.10 (5) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for each type of delineator as listed below. The prices and payment shall be full compensation for furnishing and installing delineators, including labor, equipment, tools and all incidentals necessary to complete the work.

Pay Item No. and Name		Unit of Measurement
12.10 (1)	Delineator Type A	Each
12.10 (2)	Delineator Type B	Each
12.10 (3)	Delineator Type C	Each

S12.11 Dwarf Stone Walls

S12.11 (1) Description

This work shall consist of stone masonry in small retaining walls where shown on the Drawings or instructed by the Engineer. The walls shall be constructed on the prepared foundation as shown on the Drawings. There shall be only one pay item for this work although the Drawings may detail different types for the purposes of construction.

S12.11 (2) Materials

Materials shall be in accordance with sub-clause S12.02 (2), except that backfill to Clause S4.09 will not be required.

S12.11 (3) Construction

Excavation shall be in accordance with the cross-sections, grades and lines shown on the Drawings after staking has been inspected and approved by the Engineer. Excavation and backfill shall be made in accordance with the requirements of Division 5 of these Specifications.

The foundation shall be as shown on the Drawings. All other details of construction shall comply with the relevant Sub-clauses of paragraphs (d) to (h) of Sub-clause S12.02 (3).

S12.11 (4) Method of Measurement

The quantities to be paid for shall be the number of square meters of stone masonry laid in accordance with this Specification. In computing the quantity for payment, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No deductions shall be made for weep holes, drain pipe, or other openings of less than 0.10 square meter in area, and no increase will be allowed for the concrete or stone foundation. Coping will be included in the measurement as though it were stone.

S12.11 (5) Basis of Payment

The quantities determined as provided above, shall be paid for at the Contract prices per unit of measurement for the pay item listed below.

All excavation and backfilling for this pay item will be deemed to be covered by and paid for under the work described in Division 5 of these Specifications. Any extra expense due to excavation or due to provision of the foundation will be deemed to be included in the unit price for this pay item. The Contract unit price will be full compensation for furnishing and placing all materials including foundation and coping and all other necessary works as specified for the proper completion of all the work described in this Clause.

Pay Item No. and Name		**Unit of Measurement**
12.11	Dwarf Stone Walls	Square Meter

S12.12 Concrete Curb

S12.12 (1) Description

This work shall consist of the construction of concrete curb of the various shapes and at the locations as shown on the Drawings or instructed by the Engineer.

S12.12 (2) Materials

Curbs may be cast-in-place or precast. The concrete for reinforced or precast curbs shall be Class B, for non- reinforced cast-in-place curbs Class B, and any base or foundation shall be of concrete Class E or blinding stone as shown on the Drawings. All concrete shall meet the requirements of Clause S10.01 of the Specifications.

Preformed expansion joint fillers for curb joints shall consist of a bituminous mastic composition, formed and encased between two layers of bituminous felt, all in conformity with AASHTO M33-99(2012).

S12.12 (3) Construction Requirements

The construction requirements shall conform to Clause S10.01 for concrete structures. Maximum joint spacing shall be 10 m. Before placing the exposed section of the curb all lines and levels shall be checked by the Engineer. Any junction between the concrete base and the Class B concrete shall be prepared and treated as a construction joint in accordance with Clause S10.01 of these Specifications.

When at driveway entrance crossings or for other reasons, a transition section of curb is indicated on the Drawings or ordered by the Engineer, the Contractor shall furnish concrete curbs with the required modification.

Precast curbs shall be cast in mortar-tight metal molds sufficiently rigid to prevent any deformation of the curb. The precast curbs shall be removed from the molds as soon as practicable and shall be kept damp for a period of at least 7 days. During this period, they shall be protected from the sun and wind. Any curbs that show cracking or soft or damaged corners or surfaces shall be rejected.

Curbs shall be carefully handled, transported and off-loaded so as to avoid damage. Any curbs which become chipped, marred or cracked before or during placing shall be rejected.

Bedding and joint mortar for precast curbs shall comply with the requirements of Clause S12.04.

Precast curb units shall not be more than 80 cm long. Special units shall be cast for radii of less than 5.0 m.

Curb construction shall be properly carried out. The tops and faces of all curbs are measured with a straight-edge to check the 6 mm in 3 meter tolerance. All curb that does not meet the straight-edge requirement is removed and replaced.

On completion of curb the Contractor shall backfill and tidy up the work to the satisfaction of the Engineer.

The precast curbs shall be painted to surface of concrete based on local government specification. The contractor shall submit specification of painting material to the Engineer

S12.12 (4) Method of Measurement

Concrete curb of the types as shown on the Drawings will be measured by the linear meter along the face of the curb.

No additional allowance will be made for curbs constructed on curves. No deduction in length will be made for drainage structures installed in the curb section, but payment for these structures will be deemed to be full compensation for finishing the structures to the same standard and tolerance as the adjacent curb and for providing expansion joints between the units and the adjacent curbs.

Reinforced concrete curbs provided as an integral part of non- drainage structures will not be measured for payment under this clause but will be dealt with under Division 10 of these Specifications.

S12.12 (5) Basis of Payment

The accepted quantities of concrete curbs determined as provided above, will be paid for at the contract unit price per linear meter of curbing completed in place. This price and payment shall be full compensation for the work on the types of curb as shown in the Drawings, including excavation in any material, provision of base of foundation, expansion joint material, bedding, jointing of precast curbs, backfill and disposal of all surplus material, and all other materials, labor or equipment necessary to complete the work.

Pay Item No. and Name	**Unit of Measurement**
12.12 (1) Concrete Curb Type A	Linear Meter
12.12 (2) Concrete Curb Type B	Linear Meter
12.12 (3) Concrete Curb Type C	Linear Meter
12.12 (4) Concrete Curb Type D	Linear Meter

S12.13 Interlocking Concrete Paving

S12.13 (1) Description

This work shall consist of the furnishing and laying of interlocking concrete blocks to the lines, grades and locations shown on the Drawings or instructed by the Engineer.

S12.13 (2) Materials

(a) Aggregate for Production of Inter-block

(i) Coarse aggregate shall have an abrasion loss less than 30% for thickness of 8 and 10 cm and 40% for thickness of 6 cm the when tested with the Los Angeles Abrasion Method.

(ii) The silt content of the sand shall be less than 3% passing a 0.075 mm sieve opening.

(iii) The mix design of the concrete mixture for inter-block shall contain 30 - 40% of coarse aggregate (5 - 10 mm).

(b) Production of Inter-block

(i) Batching Plant

The inter-blocks shall be produced in a plant equipped with a batching plant where raw materials can be batched by weight and the moisture content of the mix can be controlled automatically.

(ii) Quality Control

The plant shall have its own laboratory to control the quality of the products of each shift, including but not limited to the following:

- Compressive test
- Abrasion resistance

(c) Inter-block

The shape, thickness, strength, quality, etc. shall conform to the following specifications:

(i) Shape

General shapes of inter-block shall be submitted to the Engineer for approval before orders are given to the suppliers or manufacturers.

(ii) Thickness

The following minimum thickness shall apply: 6 cm for sidewalk for pedestrian; 8 cm for medium/heavy traffic of passenger car, pick- up, bus and truck; 10 cm for super heavy traffic including crane, loader, etc.

(iii) Dimension Tolerances

Dimension tolerances shall be 2 mm for length and width, and 3 mm for thickness.

(iv) Compressive Strength

When tested in accordance with ASTM C140-12, the compressive strength average shall be not less than 490 kg/cm^2 and the crushing strength of any individual block shall be not less than 400 kg/cm^2. The inter-block for sidewalk shall have a minimum compressive strength of 250 kg/cm^2.

(v) Abrasion Resistance

Inter-block shall be durable and resistant to climate and wear, when tested in accordance with Procedure C of ASTM C770-19 shall have a minimum abrasion index of 1.5 for thickness of 8 and 10 cm and 1,2 for thickness of 6 cm, or in accordance with SNI 03-0028-1987 shall have an abrasion resistance of average 0.90 mm/minutes and minimum 0.103 mm/minutes for thickness of 8 and 10 cm and average 0.130 mm/minutes and minimum 0.149 for thickness of 6 cm.

(v) Sampling for Test

Randomly selected samples of 5 units for a compression test and 5 units for an abrasion test shall be taken out of every 10,000 units or out of every delivery lot, whichever is the least.

(d) Sand Bedding

The sand for inter-block bedding shall be concrete sand, which shall be clean, dry and of moisture content approximately 4 - 8%.

(e) Filler Sand

Filler sand shall be finer than 1.18 mm (passing No.16) and shall contain approximately 10% silt material.

S12.13 (3) Construction Requirements

(a) Base Course

(i) The base course shall be strong and stable, with a minimum CBR value of 90%.

(ii) The base course surface shall be crowned in the middle, and shall have a cross fall of 2 - 2.50% or as shown in the Drawings.

(iii) The base course surface shall be firm to avoid bedding sand from entering the space between inter-blocks.

(b) Spreading of Sand Bedding

(i) Bedding sand shall be dry, spread loose 20% thicker than compacted design thickness shown on drawings.

(ii) Using a straightedge, bedding sand shall be leveled to follow the designed road surface. Before and after being leveled, bedding sand shall not be compacted. Where previously prepared bedding is compacted unintentionally, that portion shall be made loose and leveled again.

(c) Placing of Inter-block

(i) Inter-block shall be placed above the leveled bedding sand.

(ii) Placing of inter-block shall start from the edge of the curbs following the design pattern.

(iii) The space between inter-blocks shall be 2 - 4 mm to accommodate insertion of filler sand, shall be straight and controlled by string lines and straightedges.

(iv) Damaged inter-block shall be rejected and shall not be placed.

(d) Compaction

(i) After one day placement is completed, inter-block shall be compacted with a vibrating plate compactor of specification as follows :

- Plate area 0.35 - 0.50 sq.m
- Centrifugal force 16 - 20 KN
- Frequency 75 - 100 Hz
- No. of passes 3 - 4 passes

(ii) Compaction shall be carefully carried out near curbs to avoid disturbing or damaging the curbs.

(iii) Inter-block damaged by this initial compaction shall be replaced by new blocks.

(iv) After initial compaction is completed, filler sand shall then be spread and swept to fill the spaces between inter-blocks.

(v) Final compaction using the same vibrating plate compactor shall comprise 3 - 4 passes.

(vi) Inter-block for heavy traffic shall also be compacted by a tire roller (TR) of 10 - 14 tons capacity for 8 - 10 passes, following compaction by vibrating plate compactor.

(e) Maintenance

For several weeks or as directed by the Engineer after the inter-block road is opened to traffic, maintenance is required by refilling the spaces between inter-blocks with filler sand. Ideally, refilling sand shall be continued before interlocking of inter-block takes place.

S12.13 (4) Method of Measurement

Interlocking paving will be measured by the square meter of paved area complete in place and accepted.

S12.13 (5) Basis of Payment

The quantities determined as provided above will be paid for at the contract price per unit of measurement, which price and payment will be full compensation for ground preparation, supply of inter-block, the sand bedding, the installation,

tamping or vibrating of the paving, and for all other incidentals necessary to complete the work as shown on the Drawings.

Pay Item No. and Name		Unit of Measurement
12.13	Interlocking Concrete Paving	Square Meter

S12.14 Staircases

S12.14 (1) Description

This work shall consist of constructing reinforced concrete staircases on the roadway embankment in accordance with the details shown on the Drawings or as instructed by the Engineer.

S12.14 (2) Applicable Provisions

The applicable provisions of Clauses S5.01, S10.01 and S10.02 shall be read into and become part of this Clause S12.14.

S12.14 (3) Materials

(a) Concrete

Concrete shall conform to the requirements of Clause S10.01 of these Specifications. Reinforced concrete stairs shall be Class C concrete. Leveling concrete shall be Class E concrete.

(b) Reinforcing Steel

Reinforcing steel shall be in accordance with Clause S10.02 of these Specifications.

(c) Blinding Stone

Blinding stone shall be in accordance with sub-clause S5.01 (5) of these Specifications.

S12.14 (4) Construction

Construction shall be in accordance with the requirements of sub-clause S10.01 (4) of these Specifications. Slope surface on which staircases are to be constructed shall be excavated to the required levels, compacted and properly smoothed.

Construction of the staircase shall not begin until survey stakes are set according to the Drawings and have been inspected and approved by the Engineer.

S12.14 (5) Method of Measurement

The quantity to be paid for shall be the number of linear meters of staircase measured in place. The length to be measured shall be the length of landings and the length of stairway measured up the slope.

S12.14 (6) Basis of Payment

The quantity, determined as provided above, shall be paid at the Contract price per unit of measurement for the item listed below, which price and payment shall be full compensation for furnishing and placing all materials, labor, equipment, tools including preparation of slope bed, blinding stone, leveling concrete and other incidentals to complete the work in accordance with the Drawings and Specifications, and as directed by the Engineer.

Pay Item No. and Name		Unit of Measurement
12.14	Staircase	Linear Meter

S12.15 Concrete Barrier

S12.15 (1) Description

This work shall consist of concrete barrier, constructed and erected in close conformity with the dimensions, lines, grades design shown on the Drawings or established by the Engineer in accordance with this and other specification items involved. It shall include the manufacture, transportation, and storage of precast concrete units and railing members.

S12.15 (2) Materials

(a) General

All materials to be furnished and used which are not covered in this clause shall conform to the requirements stipulated in other applicable Clauses.

(b) Reinforcement

Reinforcement steel bars shall conform to Clause S10.02 of the General Specifications.

(c) Concrete

Concrete shall conform to the requirements of Class B-1 concrete as in Clause S10.01 of the General Specifications and to the requirements specified below unless otherwise stated in the Drawings. The Contractor shall develop his own mix designs in compliance with Clause S10.01 of the General Specifications.

(d) Grout

Grout shall consist of Portland cement, potable water and retarder admixture approved by the Engineer. No admixture containing chlorides or nitrates shall be used. The Contractor shall submit the proportions of mixing for approval of the Engineer.

The grout shall be mixed by mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. Water shall be first added to the mixer followed by cement and admixture.

(e) Railing

Railing shall conform to the requirements of Clause S10.09 of the General Specifications and as shown on the Drawings.

(f) Expansion Joint Filler

Expansion joint filler shall conform to the requirement of AASHTO M33-99(2012).

S12.15 (3) Equipment and Tools

Equipment and tools necessary for handling materials and performing the work shall be satisfactory to the Engineer as to design, capacity, mechanical condition and shall be at the site of the work before work is started.

If any equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved, or other satisfactory equipment substituted or added at the direction of the Engineer.

(a) Concrete Batching Plant and Equipment

Concrete batching plant and equipment, concrete mixers, vibrators, tools and transportation shall conform to Clause S10.01 of the General Specifications.

(b) Forms

Forms shall be made of metal conforming to the shape, lines and dimensions of the members shown on the Drawings and be in accordance with the requirements of Clause S10.01 of the General Specifications.

The number of forms to be provided by the Contractor shall be adequate for the casting schedule which shall be submitted by the Contractor for the Engineer's agreement and approval. In the event that the rate of casting cannot maintain the approved schedule output, the Contractor shall provide additional forms, in such numbers as may be directed by the Engineer. Forms that deteriorate from reuse shall be replaced by the Contractor with new forms if so directed by the Engineer. Unless otherwise approved by the Engineer the form shall be so designed that the concrete barrier is cast in an inverted position.

S12.15 (4) Construction

(a) Pre-casting

Concrete barrier shall be constructed using precast members manufactured in a casting yard of sufficient size, provided by the Contractor. The Contractor shall provide a casting yard superintendent having the necessary technical expertise and experience to supervise the work on a full time basis.

The Contractor shall prepare, check and submit to the Engineer complete Shop Drawings and Schedules, showing:

(i) Details of the various precast units to be manufactured;

(ii) Contractor's alternative designs if the submission of alternatives is approved;
(iii) Details of forms;
(iv) Contractors details of proposed manufacture and construction;
(v) Sequence of operations proposed; and
(vi) Production schedule in relation to Construction Schedule and Time for Completion.

The Contractor shall not cast concrete prior to the Engineer's approval of the Contractor's Drawings and Schedules, the concrete mixture, formwork, sequence of operations, and method of placing, curing, protecting, handling and erecting members. Any alternative to the design in the Contract Documents shall be subject to the Engineer's approval before manufacture or construction.

After all stipulated necessary approvals have been given the Contractor shall inform the Engineer, not less than 3 (three) working days in advance, of the probable date of commencement of manufacture.

(b) Form Setting

Forms shall be erected, set, braced and supported in a manner satisfactory to the Engineer with the inverted base of the form truly level both longitudinally and transversely.

(c) Placing Steel

All reinforcing steel shall be accurately placed in the position shown on the Drawings and rigidly held during placing and setting of concrete. Distances from the forms shall be maintained by stay blocks, ties, hangers, or other approved support. The use of precast mortar blocks for holding units from contact with the forms is deprecated, and approval for their use will only be given if their design and dimensions are such that the contact area with the forms is minimal. The use of wooden blocks is prohibited.

(d) Placing Concrete

Concrete shall be placed in accordance with the requirements of Clause S10.01 of the General Specifications.

(e) Finishing Concrete

Immediately after placing concrete the upper exposed surface shall be struck off true to the forms and hand finished using wooden floats. On completion of floating all units cast shall be checked by means of a straight edge to ensure that no high spots exist.

(f) Curing Concrete

Curing shall commence immediately on finishing operations and shall comply with the requirement of Clause S10.01 and/or Clause S10.03 of the General Specifications. Water curing shall be continuous for at least 7 days.

(g) Form Removal

Forms shall not be removed until at least 24 hours after finishing of the concrete.

(h) Surface Finish

Immediately after form removal, unless otherwise approved by the Engineer, the units cast shall be given a Rubbed finish in accordance with Clause S10.01 of the General Specifications.

(i) Storage of Units

Units shall not be moved until the concrete has attained at least 70% of the specified minimum compressive strength. Units shall be stored clear of the ground. Stacking of units shall be permitted providing it is limited to double stacking but no concrete to concrete contact shall be permitted.

S12.15 (5) Erecting

(a) Equipment

Units shall be double slung from a gantry or crane of adequate capacity to facilitate ease of handling and correct positioning. Lifting devices shall not damage or mark the concrete barrier.

(b) Bedding

Cement grout bedding shall be spread to the thickness shown on the Drawings. The spreading of grout shall not be made far in advance of barrier placing as the grout shall still be plastic at the time of placing the barrier unit. Grout squeezed out from under the barrier shall be removed.

(c) Alignment

The barrier shall be erected to the correct alignment following and providing the correct smooth curvature.

(d) Railing

Railing shall be installed and constructed in accordance with Clause S10.09 of the General Specifications.

S12.15 (6) Method of Measurement

The quantity of concrete barrier to be measured for payment shall be the actual number of linear meters of precast concrete members and metal railing installed in place, completed and adopted. Special units of non-standard dimensions shall be measured in the length.

Transition blocks, lean concrete foundation and infill concrete foundation and infill concrete between the barrier and curb shall not be measured for payment the work being considered a subsidiary obligation of the Contractor under this Clause.

S12.15 (7) Basis of Payment

The work measured as provided above shall be paid for at the Contract unit price for the items listed below which appear in the Bid Schedule. The prices and

payment shall be full compensation for furnishing and placing all materials including all tools, equipment and incidentals necessary to complete the work prescribed in this Clause.

Pay Item No. and Name	Unit of Measurement
12.15 (1) Concrete Barrier Type A	Linear Meter
12.15 (2) Concrete Barrier Type B	Linear Meter
12.15 (3) Concrete Barrier and Planter Box	Cubic Meter

S12.16 Bus Stop Shelter

S12.16 (1) Description

This work shall consist of furnishing and installing bus stop shelters at locations shown on the Drawings or instructed by the Engineer.

S12.16 (2) Materials

All materials shall be as shown on the Drawings or equivalent as approved by the Engineer. Shop drawings and details of materials sources shall be approved by the Engineer before procurement of materials.

All materials for the electrical work shall be approved by the Engineer before orders are given to the suppliers or manufacturers.

S12.16 (3) Construction

All details of construction shall be in accordance with the approved shop drawings and the relevant clauses of the Specifications.

S12.16 (4) Method of Measurement

The quantities to be paid for will be the actual number of Bus Stop Shelters furnished and installed in accordance with the Drawings and the Engineer's instructions.

S12.16 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price for each Bus Stop Shelter. The prices and payment will be full compensation for furnishing and installing the Bus Stop Shelter, including labor, equipment, materials and all incidentals necessary to complete the work as shown on the Drawings.

Pay Item No. and Name		Unit of Measurement
12.16	Bus Stop Shelter	Each

S12.17 Landscaping Works

S12.17 (1) Description

This work shall consist of the provision and planting of trees and shrubs and their cultivation according to the specifications and their positioning as detailed on the Drawings and the furnishing or constructing of concrete, brick or block planting boxes at the locations shown on the Drawings or as instructed by the Engineer.

The Contractor shall give attention to the preparatory measures required before planting is carried out, such as levels of soil; slope of ground; and topsoil requirements including turning over and leveling the soil.

S12.17 (2) References

All work such as planting of shrubs, trees, and the cultivation of vegetation to cover the bare soil, shall be executed in accordance with specifications and current standards for such work. The Contractor shall acquaint himself with the regulations and requirements of the local government authority, *Dinas Pertamanan*, and shall carry out the work accordingly.

S12.17 (3) Materials

Plants used shall consist of trees and shrubs/bushes as detailed on the Drawings.

Supports and protection for trees shall be of wood/bamboo. Binding or ties shall be made of natural raffia. Fertilizer shall be as detailed in these specifications.

Concrete for planting boxes shall be in accordance with the requirements of Division 10 of these General Specifications.

Bricks and blocks shall be of local product best quality approved by the Engineer. The bricks/blocks shall have clean surfaces, sharp edges, uniform in dimensions and without cracks.

S12.17 (4) Preparation

After the soil is cleaned of debris from the construction works the topsoil shall be prepared for planting.

To prevent any standing water occurring a slope of 0.3 ‰ (three thousandths) shall be made in the direction of flow indicated by the Engineer.

All top soil for the areas of cultivation shall consist of a soil mixture of 5 cm humus and 10 cm existing soil.

These layers shall be executed after the ground to be prepared is clear of debris resulting from the construction works and clear of other growths or weeds.

The use of weed killers for destroying weeds etc. shall not be permitted.

The preparation of the soil forms the final stage in the soil workings. At this stage the condition and compactness of the soil shall be good, there being no further changes occurring to the heights and contours desired.

S12.17 (5) Provision of Plants

Before the plants are finally planted in position on the site they shall first be put in a location to be indicated by the Engineer. Permission to execute the planting on site will be given by the Engineer to the Contractor before planting is commenced.

The plants shall comply with the following requirements:

- Height of trees shall be between 2.0 m and 3.0 m.
- Height of shrubs shall be not less than 60 cm.
- When dispatching trees to the site the trees shall be tied to support posts or similar in order that the trees are not damaged, similarly the leaves may be trimmed to reduce evaporation.
- Plants shall be free of disease, infestation and shall have good healthy branches.

S12.17 (6) Planting

Execution of the landscaping can be commenced:

- When all the construction and civil works in the area are completed.
- When the Contractor has received permission in writing from the Engineer.

Holes to be planted shall be enriched with a mixture of soil and fertilizers, and shall be cleared of debris and stones. Each plant shall be held somewhat above the bottom of the hole to receive it, then soil added gradually to the hole and around the roots, tamping the soil to the required compaction. After the roots of the plant have spread, its trunk shall be slowly pulled out to ascertain that the surrounding soil is compact enough to support its roots, and so promote healthy growth.

In promoting cultivation, care of the topsoil around the plants requires that the top soil is cleaned up around the planted area.

S12.17 (7) Trees and Shrubs

Trees and shrubs shall be planted before grass sodding is placed but after the ground has been leveled and prepared.

(a) Locations of trees shall first be ascertained, with reference to staking out posts, in accordance with the specifications or detail drawings and as approved by the Engineer.

(b) Planting shall be in accordance with details in the drawings.

(c) Holes dug for planting shall be as follows:

- for trees : 80 x 80 cm to a depth of 80 cm
- for shrubs : 60 x 60 cm to a depth of 40 cm

(d) To protect soil fertility and plant growth the Contractor shall complete the tree planting not more than 1 week after the holes for the trees have been dug, in order to avoid acid condition of the soil.

(e) The mixture of soil for filling in holes for planting shall consist of red soil and stable manure or of a quality similar to compost (compost is soil containing vegetation that has already undergone a process of decomposition).

The mixture of soil for filling shall be comparable to:

- soil for planting (pH7) 75%
- stable manure 25%

(f) The soil mixture shall be free of stones greater than 4 cm in size. This mixture shall be put into the holes evenly to a depth of 15 cm, with another 5 cm around the tree roots.

(g) Sufficient watering shall be carried out at every stage of planting. To avoid the possibility of water flowing away to another level when watering, the height of the top soil around trees and shrubs shall be made 4 cm lower than the surrounding level.

(h) Each tree shall be protected by support posts. Such support posts (wooden or bamboo) shall be given a coating of creosote or its equivalent so that they do not quickly decay. Posts shall be 1.8 m in length of which 60 cm shall be buried in the soil.

(i) Trees shall be watered until they are growing healthily up to the end of the Defect Notification Period, the watering to be carried out in the mornings between 6 AM to 10 AM and in the afternoons from 3 PM until completed.

S12.17 (8) Planting Boxes

Type 1 planting boxes shall be pre-cast concrete comprising a group of 4 cylindrical containers as shown on the Drawings.

Type 2 planting boxes shall be brick or block as shown on the Drawings. Exposed brickwork/block work shall be of best quality, true to line, with even joints.

Palm fiber and broken bricks to promote drainage, and soil for planting in the boxes shall be as shown on the Drawings.

S12.17 (9) Cleaning Up

During and after the work of planting and other works the Contractor shall continue to clean up all refuse or debris caused by landscaping activities over the pavements and/or the drains and channels for the duration of the Period of Warranty. The Contractor shall transport the remaining materials left over and other rubbish away from the site as early as possible when the landscaping activities are completed.

S12.17 (10) Nursing

Any weeds which grow after the landscaping work is completed shall be pulled up and removed. The use of chemical weed killer is not permitted.

The prevention of disease or infestation is to be dealt with by twice weekly applications of Curacron 500 EC and/or Bazola 80 WP or the equivalent product

Watering shall be carried out twice daily, mornings and afternoons until growth is fully established and thereafter to maintain healthy growth until the completion of the Defect Notification Period.

Applications of fertilizers, commencing 2 weeks after planting, are to be made twice monthly using "NPK" fertilizers for all trees and shrubs.

For any and all omissions by the Contractor during the period of nursing which causes damage or death to the plant life, the Contractor will be required to replace the dead plants as quickly as possible, at the latest 3 days after the request for replacement is issued.

S12.17 (11) Method of Measurement

The quantities to be paid for shall be the number of trees and plants satisfactorily planted and nurtured in accordance with the Drawings, these Specifications and the Engineer's instructions.

Payment will be made for each type of planting box furnished and placed or constructed and accepted in accordance with the Drawings, and as directed by the Engineer.

S12.17 (12) Basis of Payment

The work measured as provided above will be paid for at the Contract Unit Prices for each type of tree, shrub and planting box listed below.

The prices and payment shall be full compensation for complying with local government authority requirements, for furnishing, planting and nurturing the trees and shrubs, and for furnishing and placing all materials, for foundations, for all excavation, backfill and reinstatement for planting boxes, and all labour, material, tools, equipment and incidentals necessary to complete the work

Pay Item No. and Name	**Unit of Measurement**
12.17 (1) Shrub-Planting for Plantation Box Type 1	Each
12.17 (2) Shrub-Planting for Plantation Box Type 2	Each
12.17 (3) Nyamplung (Calophylum Inophyllum)	Each
12.17 (4) Ketapang (Terminallia Cattapa)	Each
12.17 (5) Bungur (Largerslroemia Indica)	Each
12.17 (6) Bintaro (Cerbera Oddlam)	Each
12.17 (7) Waru Laut (Hibiscus Tillaceus)	Each
12.17 (8) Mahoni (Swietania Mahagoni)	Each
12.17 (9) Akasia Daun Lebar	Each
12.17 (10) Biola Cantik	Each
12.17 (11) Butterfly	Each
12.17 (12) Dadap Merah (Erythrina Oristagal)	Each
12.17 (13) Kelapa Sawit (Elais Guineensis)	Each

12.17 (14)	Trembesi (Samanea Saman)	Each
12.17 (15)	Jati Mas (Tectona grandis)	Each
12.17 (16)	Anggrek Tanah (Spathoglottis plicata BI)	Each
12.17 (17)	Api Kuning (Peltophorum pterocarpum)	Each
12.17 (18)	Bakung Air Mancur (Hymenocallis littoralis)	Each
12.17 (19)	Bogenvil (Bougainvillea hybrida)	Each
12.17 (20)	Flamboyan (Delonix regia)	Each
12.17 (21)	Hujan Mas (Casia glauca)	Each
12.17 (22)	Iris (Neomarica longofolia)	Each
12.17 (23)	Jambu Air (Syzigium aquae)	Each
12.17 (24)	Jatropa (Jatropha pandurifolia)	Each
12.17 (25)	Kaca Piring (Gardenia augusta)	Each
12.17 (26)	Kamboja Kuning (Plumeria acuminata)	Each
12.17 (27)	Kamboja Merah (Plumeria rubra)	Each
12.17 (28)	Kana (Canna hybrida)	Each
12.17 (29)	Karet Munding Belang (Ficus elastica variegata)	Each
12.17 (30)	Kecrutan (Spathodea campanulata)	Each
12.17 (31)	Kembang Merak (Caesalpinia pulcherrima)	Each
12.17 (32)	Kembang Sepatu (Hibiscus rosa sinesis)	Each
12.17 (33)	Mangga (Mangifera indica)	Each
12.17 (34)	Oleander (Nerrium oleander)	Each
12.17 (35)	Pagoda (Plumeria pudica)	Each
12.17 (36)	Palem Bambu (Chamaedorea seifrizii)	Each
12.17 (37)	Palem Putri (Veitchia merilli)	Each
12.17 (38)	Palem Weregu (Rhapis excelsa)	Each
12.17 (39)	Pangkas Kuning (Duranta sp)	Each
12.17 (40)	Pucuk Merah (Syzigium oleana)	Each
12.17 (41)	Rambutan (Nephelium lappaceum)	Each
12.17 (42)	Sukun (Artocarpus altilis)	Each
12.17 (43)	Tabebuya Pink (Tabebuia rosea)	Each
12.17 (44)	Wali Songo (Schefflera sp)	Each
12.17 (45)	Plant's Pot	Each

S12.18 Surface Treatment of Steel

S12.18 (1) General

This specification covers the surface treatment of all steel parts, including surface preparation and galvanizing or painting in accordance with the specifications and drawings or as required by the Engineer.

S12.18 (2) Materials

(a) Materials used for painting steel shall be as shown on the Drawings or specified elsewhere and shall conform to the requirements of the following specifications:

JIS K 5400 Testing Methods for Organic Coatings
JIS K 5421 Boiled Oil and Boiled Linseed Oil
JIS K 5516 Ready Mixed Paint
JIS K 5492 Aluminum Paint
JIS K 5621 Anticorrosive Paint for General Use
JIS K 5622 Red-Lead Anticorrosive Paint
JIS K 5623 Lead Sub oxide Anticorrosive Paint (Class 1)
JIS K 5624 Basic Lead Chromate Anticorrosive Paint (Class 1)
JIS K 5625 Lead Cyanamid Anticorrosive Paint (Class 1)
JIS K 5626 Zinc Dust Anticorrosive Paint
JIS K 5627 Zinc Chromate Anticorrosive Paint
JIS K 5628 Red-Lead Zinc Chromate Anticorrosive Paint
JIS K 5633 Etching Primer (Class 2)
JIS K 5664 Tar-Epoxy Resin Paint

Where paints are specified that do not comply with any of the above specifications, they shall be supplied only by recognized manufacturers, and samples and technical data shall be submitted to the Engineer for his approval. In any paint system (viz. primer, undercoats, intermediate coat and finishing coats) each coat of paint shall be compatible with the other, and to ensure this, all paint shall be obtained from the same approved manufacturer with a guarantee of compatibility.

(b) Galvanizing shall in general conform to the requirements of AASHTO M111M/M111-19 or JIS H 8641 class 3-55C and JIS H 0401. Material thinner than 3.2 mm may be galvanized before fabrication in conformance with the requirements of ASTM A525-93. Galvanizing of iron and steel hardware and nuts and bolts shall conform to the specifications of AASHTO M232M/M232-19 or equal.

S12.18 (3) Work Requirements

(a) Surface Preparation

Before the application of any paint or galvanizing, the surface to be treated shall be thoroughly cleaned and freed from all scale, rust and other deleterious matters. Oil and grease shall be removed from the surface by washing with solvents or with a detergent solution before any blast

cleaning operation. If any traces of oil or grease remain after blasting, they shall be removed by solvent cleaning and the area reblasted.

If cleaned surfaces rust or are contaminated with foreign material before painting or galvanizing is accomplished, they shall be reclined.

All welding areas shall be given special attention for removal of weld flux slag, weld metal splatter, weld head oxides, weld flux fumes, slivers and other foreign objects. Any rough welding seams are to be ground smooth.

(b) Painting

The execution of the painting works shall be carried out in a neat and workmanlike manner by experienced labor to the satisfaction of the Engineer. Furthermore, the application of the paints shall be carried out in accordance with the manufacturer's recommendations.

Planning and execution of the painting work shall be in conformity with the manufacturer's specifications in respect to minimum and maximum intervals between the applications of the individual coats.

If a coating material requires the addition of a curing agent, the pot life under application conditions shall be clearly stated on the container label, and this pot life shall not be exceeded. When the pot life limit is reached, spray equipment shall be emptied, remaining material discarded, the equipment cleaned and new material prepared.

Each coat shall be applied uniformly over the entire surface. Skips, runs, sags and drips shall be avoided. When these occur, they shall be brushed out immediately or the material shall be allowed to dry for the time specified by the manufacturer or as directed by the Engineer before application of any succeeding coat.

The surface shall be completely dry, and its temperature shall be at least 5 degrees C above the dew point. Paint shall only be applied in suitable weather conditions and any fresh paint damaged by weather shall be repaired or replaced at the Contractor's expense. Measures shall be taken to prevent dust or other extraneous matter from adhering to wet paint.

Brushes, when used, shall have sufficient body and length of bristle to spread the paint in a uniform film. Paint shall be evenly spread and thoroughly brushed out. On all surfaces which are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers, bottle brushes, or by any other means approved by the Engineer. Rollers, when used, shall be of a type which does not leave a stippled texture in the paint film.

A water trap acceptable to the Engineer shall be furnished and installed on all equipment used in spray painting. Prior to applying, the paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together, and shall be kept thoroughly mixed during its application.

The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge. The thickness of each application shall be as specified.

When dry film thickness is less than that specified, additional coats shall be applied as required at no additional cost to the Employer. Particular attention shall be paid to the film thickness on edges, welding, etc.

Number of coats, type of paint and dry film thickness of the paint shall be as follows unless otherwise specified or noted on the Drawings.

Number of Coats	Type of Paint	Minimum Film Thickness per Coat (micron)
Two	Lead Suboxide (JIS K 5623) or Basic Lead Chromate (JIS K 5624) or Lead Cyanamide (JIS K 5625)	35
One	Phenol M10 (or equivalent)	45
One	Chlorinated Rubber Intermediate Coat	35
One	Chlorinated Rubber Top Coat	30

Succeeding applications of paint shall be of such shade as to contrast with the paint being covered. Paint color shall be approved by the Engineer prior to commencing the work.

(c) Protection of Paintwork

The Contractor shall provide protective measures as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations. Paint or paint stains which result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated by the Contractor at his expense. All painted surfaces that in the opinion of the Engineer are marred or damaged in any way, shall be repaired by the Contractor, at his expense, with materials and to a condition equal to that of the coating specified herein.

(d) Galvanizing

Except for pre-galvanized standard pipe, galvanizing of material 3.2 mm thick or thicker shall be performed after fabrication into the largest practical sections.

All welded areas shall be thoroughly cleaned prior to galvanizing to remove all slag or other material that would interfere with the adherence of the zinc. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.

Galvanizing surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with three applications of zinc anticorrosive paint as approved by the Engineer.

S12.18 (4) Method of Measurement

Painting and galvanizing will not be measured for direct payment.

S12.18 (5) Basis of Payment

Performance of this work shall not be paid for separately, but shall be a subsidiary obligation of the Contractor for which full payment is made in the payment of Contract prices for the work items in which it is called for or required.

S12.19 Guide Post, Kilometers Post and ROW Post

S12.19 (1) Description

This work shall consist of the supply and installation of guide post type, ROW post and kilometer post markers specific to the location in the Drawing or by the Engineer.

This work shall consist furnish of the pole, the reflector board, adjustment, manufacture and installation of foundation and all the processes needed to complete the work.

S12.19 (2) Material

(a) Guide post pole conform of the steel pipe or steel profiles according with of Clause S12.07.

Reflector boards consist of aluminum plate with a minimum thickness 2 mm and coated with reflective sheeting type of "high intensity grade" in accordance with of Clause S12.07 and S12.08. The size of the reflector board conforms to the requirements in the Drawings.

Color of reflector board shall conform to the requirements noted in the Drawings as red, white or yellow.

(b) ROW post shall conform of square reinforced concrete according with of requirements noted in the Drawings. Concrete shall be concrete Class D according with Clause S10.01 and Reinforcing steel bars used type BJTP 280

(c) Kilometer post pole conform of the steel pipe and panel material shall be fulfill of the Clause S12.07.

S12.19 (3) Construction

Reflector boards installed on the pole post with bolts or rivets and carried out as fabrication. Pole of guidepost planted directly on a concrete foundation with the size according to Drawing. A foundation excavated hole shall be backfill and

compacted so that the density of at least equal to the density of the surrounding soil

The distance of between guidepost shall be in accordance with the Drawing or as required by the Engineer.

The number and location of the ROW Post as instructed by the Engineer. All poles shall be set precisely at the location and height required and, in this way, to ensure the poles is maintained in place with strong, especially during setting time of each concrete

Distance of placement kilometers post shall be in accordance with the Drawing or instruction by Engineer.

S12.19 (4) Method of Measurement

The number will be paid as number of guide post, ROW post and kilometer post for furnishing and placing and accepted accordance with Drawing and required by Engineer.

S12.19 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price for each type of work listed below. The prices and payment shall be full compensation for furnishing and placing guide post, ROW Post, Kilometer Post including labor, equipment, tools and incidentals necessary to complete the work.

Pay Item No. and Name		**Unit of Measurement**
12.19 (1)	Guide Post, Type A	Each
12.19 (2)	Guide Post, Type B	Each
12.19 (2a)	Guide Post, Type C	Each
12.19 (3)	ROW Post, Type A	Each
12.19 (4)	ROW Post, Type B	Each
12.19 (5)	Kilometer Post	Each

S12.20 ROW Fence

S12.20 (1) Description

This work shall consist of furnishing and installing all the material of fence, lane preparation for these fences will be done at locations accordance with the Drawings.

S12.20 (2) Material

ROW fence consist pre-cast concrete panel fence, barbed wire and BRC. Material to be use as below:

- Foundation : Concrete Class C for ROW Fence type 1.
- Foundation : Concrete Class D for ROW Fence type 2 and type 3

- Column : Precast Concrete Class C with reinforced accordance Drawing (type 1, 2).
- Panel/Concrete plate : Precast Concrete class C with reinforced accordance Drawing (type 1).
- Iron Elbow : L-40-40 (ROW type 1)
- Barbed Wire
- BRC fence

Other provisions that have not been defined in this specification shall refer to the Drawings.

S12.20 (3) Construction

(a) Preparation of the fence that made should be done carefully, with a true measure of the street and to the building in accordance with Drawing.

(b) Prior to the implementation of this work, the Contractor is required to make Shop Drawing to get the approval of the Engineer.

(c) Mistakenness that may occur later after the fence is already installed and the Contractor cannot be proved to have the approval of the Engineer will be the responsibility of the Contractor.

(d) The execution of this fence, one way or another in accordance with Clause iron work and concrete work section of this specification.

(e) Welding work and painting shall be in accordance with the related Clauses in this specification.

S12.20 (4) Method of Measurement

The quantity to be measured for payment shall be the actual number of linear meters of ROW fence (concrete panel) and ROW fence (barbed wire) installed in place, completed and approved by Engineer. For quantity for payment, length of fence already included of foundation, concrete panel, concrete column barbed wire and iron elbow that approved by Engineer.

S12.20 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price for each type of work listed below. The prices and payment shall be full compensation for make of foundation, column, concrete panel, barbed wire and including labor, equipment, tools and incidentals necessary to complete the work in this Clause.

Pay Item No. and Name		**Unit of Measurement**
12.20 (1)	ROW fence, Type 1 (Concrete Panel)	Linear Meter
12.20 (2)	ROW fence, Type 2 (Barbed Wire)	Linear Meter
12.20 (3)	ROW Fence, Type 3 (BRC)	Linear Meter

S12.21 Escape Lanes

S12.21 (1) Description

This work shall consist of furnishing all the material for escape lane, preparation will be done at locations accordance with the Drawings.

S12.21 (2) Material

All material and work done in these pay item shall be in accordance with the Clauses in this Specification.

- Sub grade preparation (Subgrade) - Clause S7.01
- Aggregate base course (Subbase) - Clause S8.01
- Prime Coat - Clause S9.04
- Asphalt Concrete Base - Clause S9.07
- Sand - Clause S9.09 (3)
- Concrete Class C - Clause S10.01
- Stone Masonry - Clause S12.02
- Bumper

Other provisions that have not been defined in this specification shall refer to the Drawings.

S12.21 (3) Construction

(a) Preparation of the Escape Lane should be done carefully, with a true measure of the street and to the building in accordance with Drawing.

(b) Prior to the implementation of this work, the Contractor is required to make Shop Drawing to get the approval of the Engineer.

(c) Mistakenness that may occur later after the fence is already installed and the Contractor cannot be proved to have the approval of the Engineer will be the responsibility of the Contractor.

S12.21 (4) Basis of Payment

Material, labor and equipment necessary to complete this work in this Clause shall be paid with lump sum payment for escape lane where the amount will be regarded as full payment for the construction, equipment and also includes purposes incidental to complete the work as specified in the Drawings and in this specification, as well as instructions by Engineer.

Pay Item No. and Name		Unit of Measurement
12.21	Escape Lane	Lump Sum

S12.22 Shotcrete

S12.22 (1) General

(a) Description

This work shall consist of providing all the materials and labuor required for placing shotcrete as a slope protection, installing drainage material, connecting pipe, weep holes, and horizontal drains (if required), opened drain, and reinforcing steel as shown in the Drawings.

Shotcrete may be applied one or more layers to surfaces using a dry or wet mix method. The wet mix concrete method consists of portland cement and aggregate premixed with water before the pump pushes the mixture though the hose. Additional compressed air is added at the nozzle to increase the velocity of the mixture.

This work includes the stripping and cleaning on old surface of hardened shotcrete in the joint before placing the new shotcrete.

If the mixing is wet method, all materials shall be thoroughly mixed, flowed into the nozzle and pushed at high pressure to the surface which prepared in advance. In the mixing is dry method, cement and aggregate are mixed and then put into a silo, then pushed together with water into the nozzle with a high pressure.

(b) Submittal

Prior to commencement the Work, the Contractor shall provide the Engineer with the following:

(i) Experience of the NOZZLEMAN as the nozzle operator.

(ii) Method for placing the shotcrete and arrangements to maintain the stable slope and thickness proposed.

(iii) Mix Design of shotcrete which includes:

- Type of Portland Cement
- Source and gradation of aggregates
- Manufacture and references of the proposed admixture
- Compressice strength results of 3 and 28 days

(iv) Strip drain material data

(v) Reinforcing steel data

The Engineer will accept or reject this submittal within 10 days after receiving the proposal. Before the approval to be given, the Contractor shall not allow to deliver the material the the site and to commence the work. Suspension of work may be carried out by the Engineer if the qualification of personnel proposed does not meet the requirements and the Contractor shall fully responsible for any additional costs as a result of the disqualification without any additional of Time for Completion.

(c) Work Conditions

No shotcrete work shall be carried out during rain or when rain appears imminent or during high winds. The fresh surface shall be protected from rainy water, it is necessary to prepare a surface cover in case of rain. An eroded shotcrete surface by the rainy water shall be domolised and replaced with a new shotcrete.

(d) Tolerances

Shotcrete shall be carried out the the following tolerances:

(i) The wire mesh and reinforcement in horizontal possition of ± 10 mm.

(ii) Nail to nail of reinforcing steel of not more than 25 mm.

(iii) The overlapping of reinforcement of not less than 25 mm.

(iv) The thickness design of not less than 10 mm.

S12.22 (2) Material

All materials to be used for shotcrete shall conform to the following requirements:

Description	Standard	Requirements
Bearing Plate and Nuts	ASTM A563M-07(2013)	Grade B, hexagonal, shape in accordance with the tapered ring or bearing in order to obtain the uniform supporting.
Curing Compound	SNI ASTM C309:2012 (ASTM C309-12)	Type 1D or Type 2
Fly Ash	SNI 2460:2014 (ASTM C618-17a)	Type F or C, the portland cement can be substitued up to 35 percent by weight of the cement content
Geo-composite Drainage for Drain Strip	AASHTO M288-17	Class 3, permittivity min. 0.2 per second; AOS max. 0.25 mm
Aggregate Drainage	AASHTO M43-05(2018)	Table 1; No.67 (Nominal Size 19.0mm – 4.75mm) Material passing 0.075mm of not more than 2 percent.
PVC Connector and Drainpipe	ASTM D1785-15e1	Schedule 40 PVC, solid and perforated wall, cell classification 12454-B or 12354-C, wall thickness SDR 35, with solvent weld joints or elastomeric gasket
Fittings	ASTM D3034-14a	cell classification 12454- 12454-B or C guardian SDR35 thickness, with an elastomeric gasket or solvent weld joints

Geo-composite Drain Strip shall conform to the following requirements:

Physical Properties	Standard	Unit of Measure	Typical Value
FABRIC			
Material [1]		PP	
Water Flow Rate	ASTM D4491/D4491M - 17	gpm/ft^2	165

Physical Properties	Standard	Unit of Measure	Typical Value
		Lpm/m^2	6,724
Grab Tensile Strength	SNI 4417:2017 (ASTM D4632/D4632M-15a)	lbs	100
		N	445
Puncture Resistance	ASTM D4833/D4833M-07(2013)e1	lbs	65
		N	289
Apparent Opening Size	SNI 08-4418-1997 (ASTM D4751-16)	sieve	70
		mm	0.21
Grab Elongation	SNI 4417:2017 (ASTM D4632/D4632M-15a)	%	65
UV Resistance	ASTM D4355/D4355M-14(2018)	% / 500 Hrs	70
CORE			
Material [1]		HIPS	
Thickness	ASTM D1777-96(2019)	in	0.44
		mm	11.0
Compressive Strength	ASTM D1621-16	psf	15,000
		kPa	718
Flow Rate [2]	ASTM D4716/D4716M-14	gpm/ft	17
		Lpm/m	211
1- PP = Polypropylene; HIPS = High Impact Polystyrene 2 - In-plane flow rate measured at 3,600 psf (172 kPa) compressive load and a hydraulic gradient of 1.0.			

The shotcrete shall confirm to the requirements of ACI 506.2-13(R2018) "Specification for Shotcrete", except as otherwised stated in this specification.

(a) Aggregates

Aggregate used for shotcrete shall conform to the strength and durability requirements. There are two types of aggregates are used, namely:

(i) Ordinary aggregate, with the following gradation:

Sieve Size	Percentage Passing by Weight		
	Gradation 1	Gradation 2	Gradation 3
¾" (19.0 mm)	—	—	100
½" (12.5 mm)	—	100	85-95
⅜" (9.50 mm)	100	90-100	70-90
No. 4 (4.75 mm)	95-100	70-85	50-70
No. 8 (2.36 mm)	80-100	50-70	35-55
No. 16 (1.18 mm)	50-85	35-55	20-45
No.30 (0.60 mm)	25-60	20-35	10-30
No. 50 (0.30 mm)	10-30	8-20	5-17
No. 100 (0.15 mm)	2-10	2-10	2-10

Gradation 1 to be used for fine graded shotcrete, gradation 2 and 3 to be used for coarse graded shotcrete.

(ii) Lightweight aggregate, as specified in the AASHTO M195-11(2019).

(b) Reinforcing Steel

Reinforcement is required when the shotcrete has a function as structure to support the loading. Reinforcement to be used in form of welded wire mesh or reinforcing bar, either plain or deformed. For the proper implementation, reinforcing steel shall have a diameter of 10 - 16 mm and the galvanized wire mesh shall have a size of 5 mm X 150 mm X 150 mm.

Materials to be used shall be delivered, stored, and handled properly to avoid contamination, segregation, corrosion, or damage. Liquid material shall be stored properly to avoid the evaporation.

All geocomposite materials shall be rolled up and wrapped and stored in such a way that protect them from mud, dirt, dust, soil and cement. The coverage shall not be opened until the geo-composite will be installed. This material shall not be directly exposed to ultraviolet light during storage. Each roll of geocomposit in shipment shall be labeled as an identification of production.

S12.22 (3) Mixing

(a) Mix Design

Contractor shall not commence the shotcrete work without Engineer's written approval of the mix design and method of construction.

(i) Proportions of Mixture and the Using of Admixture

The mixture shall be proportioned such as that the material can be flowed using a pump provided for this work, with a bonding material (portland cement) at least 390 kg/m^3 and water-cement ratio of less than 0.45. Admixture shall not be used without a prior approval from the Engineer. Admixture to be added into the mixture with the stirring speed as recommended by the manufacturer. Accelerators (if used) shall be compatible with the portland cement used, not corrosive to steel, and other negative impacts such as cracks and excessive shrinkage. The content of chloride ions is allowed of maximum 0.10% when tested in accordance with AASHTO T260-97(2016).

(ii) Air Content

Air content is required for wet mixture. Air content in the mixture shall be in the range of 7 - 10% when tested in accordance with AASHTO T152-19. Air content limitation is not required for the dry mix.

(iii) Strength and Durability Requirements

The compressive strength of shotcrete for 3 days shall have a minimum strength of 14 MPa and for 28 days 28 MPa. Average

compressive strength of a set of 3 specimens (cores) taken from the preconstruction panel test or from the shotcrete wall shall be equal to or more than 85% of the compressive strength required, with each test specimen is not less than 75% of the compressive strength required in accordance with ACI 506.2-13(R2018). Boiled absorption of shotcrete for 7 days shall not exceed 8.0% in accordance with ASTM C642-13 "Standard Test Methodfor Density, Absorption and voids in hardened concrete".

(b) Mixing of Shotcrete

Aggregate and cement shall be mixed with a ratio of weight or volume as specified in AASHTO M241M/M241:2013(R2017) "Standard Specification for concrete Made by Volumetrie Batching and Continuous Mixing". Mixing equipment shall be able to mix throroughly with the proper amount to maintain the continuous supply of materials. When the ready-mix concrete to be used for shotcrete, it shall be in accordance with AASHTO M157-13(2017). Shotcrete concrete shall be made, delivered, to be placed within 90 minutes. The use of admixture may extend the placement of more than 90 minutes, but it shall be approved by the Engineer.

Shotcrete materials produced by a manufacture may be provided for mixing in the site. The materials shall be in accordance with the section of this specification. Placement time of shotcrete shall be in accordance with the recommendations of the manufacturer.

S12.22 (4) Construction

(a) Surface Preparation

The slope surface or area for the shotcrete shall be cleaned out from loose material, mud, splashes of cement, or other materials which is able to cause bonding of shotcrete loose. To prevent of the spraying the edges and adjacent shall be protected. During excavation and cleaning the surface, it shall be avoided of soil loose, cracks, or damage. Surface of loose and damaged soil shall be cleaned out to a depth which sufficient to provide the shotcrete foundation. Material which causes the shotcrete apart when spraying shall be cleaned out. To turn the flow of water when detected to protect the shotcrete from the damage by the flow.

(b) Drainage Preparation on Slope

Installing and protecting all drainage components as shown in the Drawings or requested by the Engineer in situ are required to match with the Drawings or as requested by the Engineer in situ to accomodate the field conditions. Drainage network shall include the drain strip made of nonwoven geotextile, PVC pipe for the weep holes as shown in the Drawings or the approved by the Engineer in accordance with the field conditions. All components shall be installed before the shotcrete placed.

When the sub-drainage networks are found during excavation and is not shown in the Drawings, they shall be treated and discharged separately, and not combined with new drainage network and they shall be carried

out before placing any shotcrete. The costs expended for such work are taken into account as an additional cost.

Strip drain shall be installed in the middle of two nail points as shown in the Drawings. The strip drain shall have a minimum thickness of 100 mm and a minimum width of 300 mm with geocomposite component on the ground. Strip drain shall be placed and maintained in such a way that the shotcrete does not enter into the strip drain. Strip drain to be made continously, when the joint to be used, the strip drain shall have a minimum overlapping of 30 cm in order to prevent interruption of water flow.

PVC pipe shall be in accordance with the Drawings to drain out the water from strip drain. A special connector from manufacturer shall be used between two strips drain to the pipe or a direct wrapped connection to prevent intrusion of shotcrete shall be applied. This connection shall be carried out by making a hole with the larger diamater than the pipe of strip drains behind the plastic part and does not penetrate the geotextile. The end of pipe shall be wrapped with the geotextile to prevent the migration of fine particles into the pipeline. The end of pipe which connected to the strip drain shall be protected and wrapped to prevent the shotcrete enter in this section. Wheepholes made of PVC pipe shall be installed in accordance with the Drawings to drain the water out from the wall. At the end of pipe shall be closed temporarily during the placement of shotcrete in order to prevent the clogged.

(c) Installation of Wire Mesh

Wire mesh with dimension of 5 mm X 150 mm X 150 mm is the reinforcement of shotcrete, installed with spikes which planted on sloping ground with a concrete decking under the reinforcement so that it does not contact with the surface of soil. At least The quality of concrete decking at least equal to concrete shotcrete. With the contribution of wire mesh, it is expected that the shotcrete is a stronger cover of slope and reduce or eliminate the possibility of cracks.

(d) Shotcrete Surface

(i) Shotcrete Thickness Setting

For the unloading shotcrete or structures with limited load, the thickness is 75 mm both interior and exterior. The thickness of the shotcrete shall be ensured to meet the minimum requirements as shown in the Drawings by using the tools such as string, thickness regulator sticks or other tools that can be accepted by the Engineer. The tools shall be installed perpendicular to the plane so that the minimum thickness can be achieved and the alignment of the shotcrete surface in accordance with the Drawings. The maximum distance tool shall be equal to the distance between the nails. When the string used as a tool it shall be ensured that the string are securely attached, straight, and placed in such manner to allow re-tightening. The string shall be removed after completion placing of shotcrete

(ii) Placing or Spraying of Shotcrete

Shotcrete placementshall be carried out from the bottom up to prevent excessive rebound. The nozzle shall be pointed repeatly at a distance of 60-100 cm in order to obtain the thickness design and keep to perpendicular to the working plane so that the rebound effect to be minimized and the maximum density obtained. Reinforcement shall be ensured to be clean and shotcrete to be placed behind the reinforcement in order to prevent the occurance of voids or empty sandbag. Use the spray pipe to clean out the rebound and excessive placing of shotcrete. The hardened rebound and excessive shotcrete shall be cleaned out before the placement of next shotcrete, cleaning shall be carried out by using the proper manner. When the shotcrete to be used to fill part of the drill holes that are close to the surface, pointing the nozzle into the hole until fully charged.

When the pattern of shotcrete vertically or horizontally for the strengthening section shows obviuosly the lack of shotcrete covering or improper nozzle ponting, the shotcrete work shall be suspended, and the Contractor shall investigate thoroughly before continuing the work. Shotcrete placement procedure shal be improved by adjusting the nozzle distance and the direction of spraying to ensure the proper thickness of shotcrete cover on the reinforcing steel, and to ensure the proper water content of the mixtire or the other things. Adjustment of the water content in wet mixing shall be approved by the Engineer.

The spraying pipe used for cleaning the rebound shall have the clean, dry pressurized air flow, free from any lubricated oil in order to obtain proper speed and continuous operation of the equipment. Shotcrete equipment shall be able to tenasport the mixture accurately, uniformly and continuously through a transport hose. The thickness of shotcrete placing, nozzle pointing, air pressure, and speed of shotcrete placing shall be controlled to prevent uneven shotcrete, piling or excessive wet, which makes shotcrete flow down.

(e) Surface Rectification

The rectification of shotcrete surface which not tidy but meet the strength requirement shall be carried out with the following:

(i) brushing the surface with a steel brush for cleaning of loose material, rebound, excessive spray or shiny surface before the shotcrete hardening.

(ii) If the shotcrete has hardened, the surface preparation shall be post-poned for at least 24 hours, then the surface shall be prepared with sand blast or pressurized water spraying to remove all loose materials, rebound, excessive hardened spray or a shiny surface, or any other material that may cause a weak bonding with the new concrete.

(f) Defect of Shotcrete

Engineer may decide to accept or reject the work of shotcrete. The shotcrete which does not conform to the specifications shall be rejected, either at the time of construction, test results, or after completion of work. Defects on the shotcrete surface shall be rectified immediately after the placement of shotcrete. All parts of shotcrete which are segregation, honeycombe or empty sandbag shall be cleaned out. Shotcrete which has been placed and does not meet the requirement of the compressive strength will be recfified as the direction of the Engineer. Rectifiaction that possibly carried out is the placement of additional shotcrete, or demolition and replacing of new shotcrete with costs fully borne by the Contractor.

(g) Joints

Shotcrete joint shall be quite rough, clean and hard with a taper shape. Prior to placing a new shotcrete, the joint shall be cleaned and moistened. If shotcrete is used to cover the space above the top of the nail holes, then the jointing shall pay attention to the things above.

(h) Curing

Shotcrete has been placed sahll be kept moist for at least 7 days after placing with a method to ensure the shotcrete surface in wet conditions. Curing commenced 1 hour after shotcrete placing, but if the air temperature is over 27°Celsius, the curing shall be commenced immediately after shtcrete placing.

Proper curing shall be carrie out with the following requirements:

(i) Curing with water. The supply of water shall be arranged so that the shotcrete surface always be in wet condition and the surface shall be kept in such manner that no erosion by water flow. Irregular wetting where the shotcrete is in wet and dry condition during the curing period shall not be allowed.

(ii) Curing with membrane. Curing compound shall not be applied on the surface which will be overlaid with a new shotcrete unless the surface is cleaned out using the sand blast. Curing compound membrane shall be sprayed on the surface as soon as the initial hardening of shotcrete with the rate of not more than 2.5 liters/m2

S12.22 (5) Quality Control

The manufacture of pre-construction panel test and cores sampling on the constructed walls, both shall be carried out. Implementation of the panel test and core sampling shall be carried out by experienced personnel and supervised by the Engineer. Contractor shall provide equipment, materials, and personnel required to obtain the cores to be tested, panel test box, and curing required in situ. Shotcrete compressive strength for 28 days shall be a basis of final acceptance.

Shotcrete material supply shall not be carried out prior to the initial approval of the mix design and nozzlemen, and shotcerete work will be commenced when the

required compressive strength has been achieved. Shotcrete work may be suspended if the test result does not meet the compressive strength required. Contractor shall carrie out this procedure. The entire costs required to obtain the compressive strength required shall be borne by the Contractor.

Pre-construction Panel Test. Each nozzleman who has no certification shall carry out at least two pre-construction panel test for each mixture to be used and any spraying position that will be found in this work. Preconstruction panel test shall be carried out before commencing the work using the same tools, materials, mix proportions, and the procedure to be used in the work.

The workers involved in this work shall have an experience to carry out this work, especially the Nozzleman and his assistants as the key workers in the shotcrete operation. Nozzleman who has a skill certificate in the shotcrete or equivalent is preferred, therefore they can produce a dense shotcrete and meet the requirements of compressive strength. The manufacture of pre-construction panel test and taking core samples by core drilling shall be carried out in accordance ACI 506.2-13(R2018) and AASHTO T24M/T24-15 or "Test Method for Obtaining and Testing Cores drilled and sawed Beams of Concrete".

Initial qualification of nozzleman shall be carried out with the skill certification owned and conduct pre-construction panel testing. Testing shall be carried out using the same tools, materials, mix proportions, and the procedure to be used during construction. Initial qualification of Nozzleman is based on visual inspection of the density of shotcrete, structure space, and requirements of compressive strength for 3 days and 28 days from the core of preconstruction panel test taken. Loading of preconstruction panel test and core-making shall be conducted in accordance with ACI 506.2-13(R2018) and AASHTO T24M/T24-15, unless otherwise specified. Nozzleman without certificate may be permitted to do the work if based on the compressive strength results of the pre-construction panel test for 3 days meet the requirements, the continued for compressive strength results for 28 days meet the requirements and the work is satisfactory peformanced.

Preconstruction panel test shall be made with a minimum size of 750 mm x 750 mm and thickness of 100 mm. Spraying shall be carried out with a slope of 45° to release the rebound. A preconstruction panel test shall include the reinforcing steel as shown in the Drawings. Drill test shall be carried out from this panel test which show the reinforcing steel in accordance with ACI 506.2 which equal to the drill test of grade 2 or better. Other preconstruction panel test shall be prepared without reinforcing steel, then the core shall be taken to test the absorption and compressive strength.

Production Panel Test. Preparation of panel test at least once, nine (9) drill holes with diameter of 75 mm were taken from the shotcrete wall for each area of 500 m2. Preparation of panel test shall be carried out simultaneously with the work in progress by the time as determined by the Engineer. Production panel test to be prepared shall have a minimum thickness of 100 mm and dimensions of 450 mm x 450 mm.

Sampling, Curing and Testing. Immediately after spraying the mixture, the panel test shall be kept moist by covering or wrap it with a sheet of material that meets the requirements in SNI ASTM C309:2012 or ASTM C309-12 "Liquid

Membrane forming Compound for Curing Concrete" until it has been brought into the laboratory or testing sample has been carried out. Panel test shall not be immersed into the water. Panel test also shall not be interrupted during the first 24 hours after the spraying mix. Samples shall be provided in 3 drill with a diameter of 75 mm from each pre-construction panel test with installed reinforcement for the purpose of determining the grade. For the purpose's absorption and compressive strength, preconstruction panel test without reinforcement shall be provided in 9 Specimens with a diameter of 75 mm. Contractor may choose to carry out the core drill testing in situ or brought to another place for that purpose. Drill test shall be taken at a distance of 150 mm from the outer edge of the panel test. For compressive strength testing, the core drill results shall be cut at both ends in order to obtain the specimen with a height of 75 mm. The both ends of core drill to be tested for absorption shall not be cut. If the Contractor chooses to take the drill results from the panel test taken from the walls of shotcrete in situ, then location will be determined by the Engineer. Each specimen shall be marked properly in order to distinguish between the specimen taken from preconstruction or during construction. If the specimen is taken during the construction, the test specimen shall be marked on the part of wall that represented. Immeditaely the drill results to be wrapped with wet material or other material that meets the requirements of SNI ASTM C309:2012 (ASTM C309-12) and then put them in a sealed plastic bag. Within 48 hours, the drill results shall be immediately delivered to the designated laboratory. The compressive strength and absorption test will be conducted by the Engineer. During transportation up to testing, the specimen shall be placed in a moisty room. When the height of the test specimen is less than twice of diameter, a correction factor from AASHTO T24M/T24-15 shall be applied to obtain the compressive strength results of specimens. The compressive strength of 3 specimens shall be tested for 3 days, and three other specimens for 28 days in accordance with AASHTO T24M/T24-15. The absorption of the next 3 specimens again shall be tested for 7 days in accordance with ASTM C642-13.

The hole of drill test in the wall shall be filled with the unexpanded mortar after the hole has been cleaned out. This hole shall not be filled by using shotcrete material.

S12.22 (6) Method of Measurement

Shotcrete shall be calculated from the surface area in square meter for the shotcrete with the related thickness has been completed and accepted. The net area is calculated from the outside plain surface as shown in the Drawings. Addtional measurement and payment shall be not made for the additional shotcrete required to cover the cavity caused by the incorrect excavation, excessive or unplanned excavation, or workmanship which is not accordance with a allowable tolerance. The payment shall include shotcrete, admixture, reinforcing steel, wire mesh, panel test, and sampling, testing and reporting in accordance with the design and this Specification. The quantity to be measured shall be the area as shown in the Drawings or as approved by the Engineer.

S12.22 (7) Basis of Payment

The quantity of work to be measured as above mentioned will be paid according to the contract price per square meter with the acceptable thickness. The payment to be made shall include the supply of all equipments, materials, labour, and tools to complete the work in accordance with the design and specification, including the other work to obtain the alignment and thickness design of shotcrete. All materials shall include strip drains, pipe for weep holes, catch basin, geotextiles, and all accessories for the completion of the work will not be paid separately.

Pay Item No. and Name		Unit of Measurement
12.22	Shotcrete	Square Meter

S12.23 Bridge Deck Loading Test

S12.23 (1) General

(a) Description

Bridge deck load testing is carried out with the following purposes:

(1) To know the level of bridge safety.

(2) To determine the level of structure safety to the service load.

(3) To determine the initial condition of bridge using based on the stiffness of bridge which obtained from the natural frequency value of the bridge.

(b) Reference Standards

Standar Nasional Indonesia (SNI):

SNI 1725:2016 : *Pembebanan untuk Jembatan*
RSNI T-12-2004 : *Perencanaan Struktur Beton untuk Jembatan*
RSNI T-03-2005 : *Perencanaan Struktur Baja untuk Jembatan*

(c) Submittals

(i) Technical Preparation

Some matters that need to be carried out in the technical preparation, such as:

(1) Collecting drawings and design documents.

(2) Communication (discussion) with the designer which bridge to be tested as well as superintendent to obtain the information regarding the condition of design and bridge construction in order to predict easier the bridge's behavior.

(3) Implementing the examination on Drawings and design documents regarding structural analysis and bridge modeling.

Prior to commencement the test on site, it is required to exanimate the bridge design, including the Drawings and design data as well as the As Built Drawings and post construction data. Based on these two documents, a view will be able to obtained regarding the condition of bridge when designed and constructed, therefore the current condition of the bridge will can able to be predicted based on the desk study result, whether there is any change from design to construction stage.

(ii) Administrative Preparation

Administrative preparation includes the completion of correspondence and approval of testing location. This approval process involves Toll Road Regulatory Agency (BPJT), Local Public Works Office, Local Transport Office, and Local Police. The types of correspondence that need to be prepared are:

(1) Permit for Implementation of Testing

Permit for testing this is given an appendix as of a technical proposal for testing plan. Permit for Implementation of Testing is addressed to:

(a) Toll Road Regulatory Agency (BPJT)

(b) The National Road Construction Agency.

(c) Provincial Public Works Office for Provincial Road.

(d) Region/Municipal Public Works for Region/ Municipal Road.

(2) Request of Engagement for Implementation of Testing

(a) Police for Toll and National Road.

(b) Provincial Transportation Office and Regional Police for Provincial Road.

(c) Region/Municipal Transportation Office and Resort Police for Region/Municipal Road.

When these permits have been approved, then bridge deck load testing will be carried out.

S12.23 (2) Equipment

Any tool to be used shall be ensured that it shall be in a good condition and has been calibrated and ready for use.

(a) Main Equipment

(i) Visual Test Equipment

Main equipment to be required on visual test implementation except the inspection form, the detailed bridge condition to be determined based on the type bridge, steel or concrete structure bridge, such as:

(1) Steel Structure Bridge:

(a) Crack Detection Microscoupe/Crack Meter

(b) Torgue Wrench

(c) Total Station

(d) Waterpass

(2) Concrete Structure Bridge:

(a) UPV (Ultrasonic Pulse Velocity)

(b) Hammer Test

(c) Crack Detection Microscoupe/Crack Meter

(d) Total Station

(e) Waterpass

(ii) Static Load Testing Equipment

Main Equipment required for the implementation of static load testing are:

(1) Strain Gauge

Strain gauge has it's characteristic for steel and concrete structure, therefore, for static load testing for steel bridge, steel strain gauge shall be used, while for concrete structure, concrete strain gauge shall be used.

(2) Logger Static data

(3) Switch Box (if required)

(4) Total Station

(5) Testing Truck

(iii) Dynamic Load Testing Equipment

Main equipment required for implementation of dynamic load testing are:

(1) Blastmate or 3 dimension Accelerometer

(2) Logger Dynamic Data

(3) Switch Box (if required)

(4) Testing Beam

(5) Testing Truck

(b) Supporting Tools for Implementation of Testing

Supporting tools for implementation of testing, such as:

(i) Climbing tools (to install sensor, etc)

(ii) Cloth Uniform

(iii) Safety Hat

(iv) Handy Talky

(v) Spray Paint

(vi) Hammer + Nail (as required)

(vii) Thin Plastik (rain protection)

(viii) Double Tape

(ix) Scissor

(x) Digital Camera

(xi) Handycam

(xii) Walking Measure

(c) Occupational Safety Tools

Occupational safety tools required and shall be prepared to prevent unexpected event during preparation and implementation of load testing. Some of the safety tools required are as follows:

(i) Safety hat, for protecting the head from falling or bumping of hard material during preparation and implementation of load testing.

(ii) Safety shoes, preventing the slip due to slippery or protecting the leg from hard material falling or others.

(iii) Gloves, required for doing the works related with hard material, such as opening or fastening bolt or others.

(iv) Safety Belt, protecting the body from falling hazard, particularly when the installation of sensor tool

(v) Full body harness, for working at height more than 1.24 meter, useful to protect the body from falling hazard, particularly when the installation of sensor tool.

S12.23 (3) Execution

(a) Requirements for Bridge Deck Load Testing

For Bridge deck load testing, some issues need to be paid attention, include:

(i) Testing shall provide information about the condition of stress and deformation of the main part of bridge structure.

(ii) Testing shall reflect load capacity of structure

Capacity is a synthetic index of physical mechanics of structure, including strength, stiffness, stability, response, dynamic and others. Of course, this will be different for the different structural system. Therefore, based on the basis of previous structural analysis, proper method shall be adopted on testing to evaluate structural load capacity.

(iii) Testing load shall not impact on structural damage

The purpose of bridge deck load testing is to determine the actual load capacity of bridge and ensure it is safe for traffic load. Therefore, the testing shall not impact to destruction or damage to the bridge structure. The testing shall not impact to the new cracking, peeled concrete or other damages, maximum deflection to be controlled within the allowable range, and stress/strain on the cross section not exceed the allowable limit

(b) Testing Documents

(i) Working Paper

To support the implementation of testing, some working paper which consists of the following:

(1) Design Documents

Design documents consist of: As Built Drawings; Specifications; and Structure Analysis.

(2) Technical Criterion Data

Technical Criterion of Bridge, shall include:

Table 12.23.(1) Technical Criterion of Bridge

Description	Unit	Technical Criterion/ Index
Number of Lanes		
Traffic Load		
Design of Traffic Speed	km/hour	
Design Period Reference	tahun	
Bridge Deck Width	m	
Vehicle Lane Width	m	
Motorcycle Lane Width	m	
Longitudinal Grade of Deck	m	
Cross Section Slope of Deck	%	
Vertical Curve Radius	%	
Design of Water Speed	m	
Design of Wind Speed	m/detik	
Earthquake Resistance	m/detik	
Design of Water Surface Level	m	

(3) Material Data

Component data of the main material used for the bridge construction.

(ii) Testing Form

As a reference on testing implementation on site, some forms required to be used as a tool to record testing result as well as to provide a view regarding the testing procedure and the results. Testing form used can be taken from BMS. Forms to be that used are as follows:

(1) Inspection Form of Detailed Bridge Condition (Visual)

Inspection Form of Detailed Bridge Condition (Visual) consists of:

(a) Bridge identity includes: number; name and location of bridge

(b) Date of inspection and identity of inspector

(c) Element required to be tested

(d) Types of action required to be carried out

(e) Documentation photo of the bridge

(f) List of damaged elements

(g) Evaluation of the elements

(h) Notes and Drawings

(2) Testing Form of Static Loading

Testing Form of Static Loading consists of:

(a) Bridge identity includes: number; name and location of bridge

(b) Date of inspection and identity of inspector.

(c) Information of total and location of load used applied (as table and drawing)

(d) Information of the total and location of sensor used (as table and drawing)

(e) Record of the deflection observation

(3) Testing Form of Dynamic Loading

Testing Form of Dynamic Loading consists of:

(a) Bridge identity includes: number, name and location of bridge

(b) Date of inspection and identity of inspector.

(c) Sketch of position for vibration recording tool

(d) Record issues that shall be noted during implementation of testing

(iii) Testing Proposal

Testing proposal consists of the following:

(1) The purpose and objective of testing

(2) Metode used

(3) Procedure of testing

(4) Human resources and equipment requirement

(5) Analysis of modelling result

(6) Expected result

(c) Field Testing

(i) Visual Inspection

Visual inspection requires a trained expert who able to detect abnormal issues which may occur on the structure and able to differentiate types of damage and their causes. For example, the expert shall be able to differentiate types of crack that may occur on concrete structure.

Procedure to be carried out on visual inspection:

(1) Inspect the general condition of bridge

Detail inspection by recording the damages or the main deviation on elements of bridge structures.

(2) Check the crack with the UPV and crack measuring tools for concrete bridge.

Crack inspection is required to determine accurate and complete data regarding current crack condition therefore a conclusion can be determined regarding how far the current crack can influence the structure as well as to understand or indicate the cause of crack.

Tool that can be used to examine the depth of crack is PUNDIT (Portable Unit Non Destructive Indicator Tester) or Ultrasonic Pulse Velocity (UPV) and for the width of crack can be examined using crack meter with an additional magnifying glass to measure occurred crack. To differentiate types of crack as well as their causes, an intensive investigation regarding the crack pattern is required. Based on the investigation, early prediction regarding the cause of crack can be obtained.

From the testing using UPV and crack measuring tool, the data of depth, length and width of the crack can be determined, as well as the presence of void or honeycomb on the concrete. Elements of bridge that are examined (possibility of cracks) are the structural parts and made of concrete, such as abutment, pier, girder deck plate of the bridge.

(3) Cary out a more accurate regarding the concrete compressive strength.

Based on the visual inspection, the result can be put in a proposal of load testing which include the determination of total load and model testing where all damages (if any) on bridge have been considered.

(ii) Static Load Testing

(1) Criterion of load that can be applied on structure:

(a) Total of static load applied shall be calculated in such manner in order to not cause the damage to the structural element of bridge. In some cases, the maximum of load that can be applied shall not exceed 50% of Uniformly Distributed Load (UDL).

(b) Total of load shall be distributed to some load points, therefore this loading can represent the actual traffic load.

(c) Load shall be applied in stages, starting from the loading position which gives a minimum effect.

(d) Load shall be applied symmetrical.

(e) From the first loading stage to the next loading stage shall have a sufficient duration for structure to response the applied load. This can be observed from whether the bridge still provides an additional deflection or not.

(2) Testing Procedures:

(a) Preparation:

(1) Planning Preparation (in office)

Calculation of total load and truck configuration to be used:

Total of load that will be used depends on the load planning that will be implemented, by keeping the principle that the testing shall be a non-destructive test, therefore the determination of total load used is as much as possible but it shall not impact to the bridge and still provide the required data.

(2) Planning Preparation (in situ)

(a) After initial planning and site investigation, arrange testing items if required.

(b) Mark loading position on the bridge

deck in accordance with the testing points and reference marks predetermined

(c) Sensor Installation

Strain Gauge shall be is placed on the point that will have highest stress. The location is adjusted with the modelling result that has been carried out by a bridge expert.

(d) Set the tool: logger static data and switch box if the total of sensor exceed the capacity of logger data.

(e) Check the sensor condition and tool whether ready to be used and no disruption

(f) Connect the instrument and the tool, check whether each system has worked after electrified

(g) Put the Total Station on the location that can cover all cross section of the bridge.

(h) Preparation of Testing Truck

Truck that will be used as a load on the testing shall be prepared previously in accordance with the total of load planned and the availability on the testing location.

Truck that will be used shall be recorded for the configuration and total load, therefore the weighting shall be carried out prior to testing

Scale used to determine the truck loading has to be calibrated in order to obtain the accurate load

(i) Check the Fasten Bolt

For the steel bridge testing, ensure all bolts are installed with good and fastened condition in accordance with the fastened torque

(j) Determine loading time in accordance with site condition and weather

(b) Testing Implementation

Loading dan Un-loading Test

(i) Ensuring that all equipment in good condition, particularly the strain gauge.

(ii) Record initial condition by pushing the button of logger static data, therefore the initial sensor data will be read.

(iii) Reading the total station for all observed location (TS-0) when the truck just arrived, and when the truck totally stopped.

(iv) Placing the truck on the mid of span according to the initial plan by staging up to the entire trucks are placed on the bridge and all data are read in each stage.

(v) Loading scheme:

Loading shall be carried out by staging to observe behavior of bridge when tested and post tested. Static loading scheme is as follows:

(1) Loading :

- Stage 1 no truck
- Stage 2, trucks used are 4 which are located on left and right edge of the bridge span respectively
- Continuing each stage until the truck reach the mid of span or maximum load planned
- The deflection of each stage shall be recorded and shall be coordinated to a Structure Expert to obtain the next instruction.

(2) Un-loading :

- Unloading Stage 1, trucks occupy half span of bridge
- Unloading Stage 2, trucks used are eliminated by 2 and all trucks in front move backward for (10 + length of truck) m.
- Repeating until all trucks on bridge have been moved.

During testing, structure displacement as well as the strain of structural elements in the critical locations shall be measured using variety of techniques and measurement tools.

Generally, displacement can be considered a measure of structural stiffness, while strain is a measure of material structural capacity.

Structural displacement due to static loading can be measured on horizontal and vertical direction, however vertical direction is generally specified as deflection of structural element, measured in each case, using dial gauge (strain gauge), calibrated Linear Variable Differential Transformer (LVDT), evenness measurement or other measuring methods.

Measured results of displacement, majority are deflection, are compared to the calculated results according to standard loading, design load and correspond to vehicle used for testing

(iii) Dynamic Load Testing

Dynamic load on a road bridge can be carried out using the following loading:

- a normal traffic,
- vehicle or test machine,
- sudden release of displacement by producing a load related to structure,
- producing sinusoidal excitation wave,
- energy input tool,
- braking of vehicle or a machine on the bridge,
- impact produced by a vehicle that go through a standard bar (on road case).

Bridge vibration inspection is carried out to know whether the bridge vibration behavior still meet the criterion of bridge behavior or not. Vibration criterion on the bridge includes stiffness criteria, service capacity criteria, load capacity criteria, and damping criteria. Vibration testing is carried out by using moving

load or heavy traffic load. The measurement of bridge vibration is carried out by using vibrocorder that produces a vibration record on a film paper with a sensor of transducer that located on mid span.

This testing provides information regarding some dynamic characteristics that generally selected from the bridge. During the dynamic testing, the following parameter indicates dynamic behavior of a bridge that generally measured.:

- natural frequency,
- mode shape,
- damping factor.

In general, the method of dynamic load testing using vibration recording sensor tool is as follows:

- Prepare sensor to obtain vibration on horizontal direction (in this case, Wireless Structural Testing System (STS-WiFi) to be used),
- Place sensor on the top of the pier/base of bridge,
- Place vibration recording device the safe location and free from distraction,
- Calibrate vibration recording device to obtain a good record.
- Pass the vehicle (testing truck) on a wooden beam with particular dimension (according to plan)
- Record the vibration.

(iv) Management and Safety Testing

During all processes of testing implementation, testing personnel shall take a control of site condition to manage the loading. This will impact to good testing, other than safety to personnel, tools and supplies, and the bridge. There are some components shall be paid attention, as below:

(1) Load Control

Loading area and internal force per each part shall be gradually increased from the lower level to higher level, step by step to comply with the load testing specified. Unloading shall be ready to be carried out for any time.

(2) Location of the Measurement Point

Measurement points shall be measured and calculated during all load test processes. All data shall be has collected and analyzed to determine the testing status any time. If the actual measurement value is so far below the calculated value, then the loading shall be stopped

temporarily to search the reason why, then to determine when the testing to be continued.

(3) Observation on Loading Process

A person shall be assigned to observe structural weak points to examine if there is any cracking, damage, abnormal voice, abnormal vibration, etc, on the load testing. If an abnormality occure, then it shall be reported immediately to take a relevant measurement and action.

(4) Criteria to stop the Loading

Loading shall be stopped if the following conditions occure:

- The stress on measurement point achieves or exceeds the control value that calculated using elastic theory according to design standard.
- Displacement/deflection of measurement point exceeds the allowable limit.
- The deflection distribution which actually measured on the girder throughout the bridge is really different with the calculated value, or the deformation which actually measured is so far above the calculated value.
- Other damages that will impact to the load capacity or the service level of bridge.

To ensure security as well as easiness of testing implementation, and to prevent the accident, then the following requirements shall be strictly implemented on the testing, such as:

- To establish the awareness regarding safety, increase vigilance and avoid the accident occupational.
- Key point of construction shall be arranged with protection and lighting facilities, testing staffs shall wear helmet and safety belt.
- During testing, take care the safety and water protection for equipment and tools.
- Testing staffs shall understand the site instructions.
- Unauthorized persons are prohibited to enter testing area.

To prevent the damage on the data recording in situ, some matters need to be ensured, such as:

- Ensure that when testing is commenced, consent from local government has been obtained with allowable time for testing as planned.
- Ensure that the time for testing implementation on site is accordance with the plan which has been agreed in order

that all preparations can be ripened by all parties who involve in the testing implementation

- Prepare all equipment and tools are ready to withstand to all kinds of weather, such as hot weather or rain. Provide cover if the equipment does not withstand to weather by maintaining the performace to keep it running well.

S12.23 (4) Method of Measurement

The Bridge Deck Load Testing shall be measured by the number of testing carried out, completed as well as the report accepted.

S12.23 (5) Basis of Payment

Quantity of Bridge Deck Load Testing will be determined as provided above, shall be paid for at the Unit Price for the Pay Item and using the unit of measurement shown below and in the Bill of Quantities.

Pay Item No. and Name		**Unit of Measurement**
12.23	Bridge Deck Load Testing	Each

DIVISION 13 LIGHTINGS, TRAFFIC SIGNALS AND ELECTRICAL WORKS

S13.01 Lighting, Traffic Signals and Electrical Works

S13.01 (1) General

(a) This work shall consist of furnishing and installing all materials and equipment necessary to complete in place traffic signals, highway lighting, and other electrical systems, and the modification of such existing systems when so specified, all in accordance with the Drawings, these Specifications, or as instructed by the Engineer. Unless otherwise noted, civil engineering works necessary for the work of this Clause S13.01 shall be executed and paid for under Clause S13.02 of this Specification.

(b) The location of signals, controllers, poles and appurtenances shown on the Drawings are approximate and the exact location will be established by the Engineer in the field.

(c) The electrical works for Guide Signs shall be executed in accordance with this Clause and Clause S13.02. Payment under this Clause for Guide Sign cables will terminate at the junction board in the hand hole of the pole.

S13.01 (2) Scope of Work

The scope of work shall cover the supply, delivery to site, erection, test and commissioning of all material and equipment in connection with the Electrical Installation to the extent described and shown on the Drawings and includes but is not necessarily limited to :

(a) Preparation and submission of Shop Drawings

(b) Submission of detailed Material Supply Lists

(c) All work associated with the removal of sections of the existing systems and the incorporation of the remaining sections in the permanent works.

(d) Site measurements of ambient brightness of natural daylight at tunnel or underpass sections to assist the Engineer in his review of the lighting details shown on the Drawings.

(e) All other electrical equipment and services needed to complete operation facilities in accordance with the pertinent electric codes and local regulations for Electrical Installation, included all permits required from Electrical Authority to operate properly.

S13.01 (3) Quality Assurance

(a) For fabrication, installation, and testing of the work described in this Clause, the Contractor shall use only thoroughly trained and experienced personnel who are completely familiar with the requirements for this work and with the installation recommendations of the manufacturers of the specified items.

(i) In acceptance or rejection of the installed electrical system, no allowance will be made for lack of skill on the part of installers.

(ii) Installers shall hold the relevant valid certificates complying with PLN and local Regulations.

(b) All work shall comply with the Drawings and this Specification, in addition to complying with the following codes and regulations:

(i) Requirements of the local unit of PLN exploitation and local government agencies;

(ii) PUIL, SPLN and Local Electricity authority standards.

S13.01 (4) Drawings and Documents

(a) The Contractor shall refer to all relevant drawings to ascertain for himself the location and routes of all other utility services so as to maintain adequate clearance between electrical and other services. The supplied Drawings are to indicate generally the arrangement of the work. The Contractor is therefore required to provide working drawings showing the exact routes of all underground or overhead cables and ducts, the exact run of all conduits and trunking, the location of manholes, draw-in and junction boxes, the number and size of wires in each conduit or trunking, the final connection arrangements at street lighting panels, the detail of ducts and the method of fixing street lighting panels for the approval of the Engineer before commencing any portion of the Works. All such shopdrawings shall be submitted in duplicate and within the periods stipulated below:

(i) Details of ducts and method of fixing street lighting panels and cable entry into buildings: Shop drawings shall be submitted within two months of handing over the site to the Contractor.

(ii) All other shop drawings shall be submitted within a period of one month from the date of approval of the street lighting panels by the Engineer.

(iii) Should however the Contractor be obliged to install electrical conduits prior to this period then he shall submit the relevant shop drawings at least four weeks prior to the proposed date for commencement of the work.

(iv) The Contractor shall submit a program indicating the dates on which concreting in different sections will take place, together with the submission of the shop drawings.

(b) On completion of testing, the Contractor shall make "as built" drawings of plans and circuit diagrams, which clearly indicate any modifications which have been made to the original design drawings.

(c) Upon completion of the work, and as a condition of its acceptance, the Contractor shall supply to the Engineer three copies of a Manual for the maintenance and operation of all electrical installations and a parts list sufficient for the ordering of parts.

S13.01 (5) Standards and Regulations

(a) The work covered by this Contract shall be carried out in accordance with the regulations issued by the local Electricity Authority and with the applicable standards and codes of any of the following:

ASA : American Standards Association
ASTM : American Society for Testing Materials
CIE : Commission Internationale de l'Elclairege (International Commission of Illumination)
DIN : German Industry Standard (Deutsche Industrie Normen)
EN : European Standards
IEC : International Electrotechnical Commission
IEE : Institute of Electrical Engineers
IEA : International Electrical Association
JEC : Japanese Electrical Committee
JIS : Japanese Industrial Standard
LMK : *Lembaga Masalah Kelistrikan*
NEC : National Electrical Code (U.S.A)
NECA : National Electrical Contractors "Standard of Installation" (U.S.A)
NEMA : National Electrical Manufacturers Association (U.S.A)
PLN : Indonesia Government Electric Company
PUIL : *Peraturan Umum Instalasi Listrik*
SPLN : *Standar Perusahaan Listrik Negara*
UL : Underwriters Laboratories, Inc.

(b) Before commencing the works, the Contractor shall carefully examine his works at all of the Regulations issued by the local Electricity Authority and selected materials and method of installation shall be in accordance with these Regulations.

S13.01 (6) Lighting Units

A. For non-LED

(a) General

Lighting units as shown on the Drawings shall consist of lighting lanterns (lanterns), lamps, electrical control ballasts (ballasts), and mounting accessories.

The Contractor shall submit for approval, detailed street lighting panel diagrams for each type of lantern he proposes to install. Furthermore, calculations shall be submitted showing the horizontal illuminance in lux

at roadway level and the luminance distribution in candela per sq.m for every 2 m in roadway direction and every 1.2 m across the roadway.

(b) Street Lighting Units (Pole Mounted)

Lamps for expressway lighting system shall be 250 watts high-pressure sodium type and for the arterial roads lamps shall be 250 watts high pressure sodium type.

All lanterns shall be of the type shown on the Drawings or equivalent as approved by the Engineer.

(c) Lighting Units for Under Bridges or Inside Tunnels

Lighting units fixed to the ceiling/wall under Bridges or inside Tunnels (Box Culverts) shall have 150 watts low-pressure sodium type lamps.

The layout of tunnel lighting units shown on the Drawings is based on the estimated ambient brightness of natural daylight at the tunnel entrance. On completion of the box culvert and substantial pavement works, the Contractor shall undertake site measurements to check the actual ambient brightness. Based on these results, the Engineer may revise the layout of lighting units as shown on the Drawings.

Lanterns shall be surface mounted type with symmetrical light distribution and of the type shown on the Drawings or equivalent as approved by the Engineer.

(d) High Mast Lighting Units

The lanterns shall be floodlight type and shall be mounted on a high mast carrying 1000 watts mercury or high pressure sodium lamps. The lantern shall comprise three main parts; a low-pressure die-cast aluminum housing; a toughened front glass, attached to the housing by two hinges and four clips of stainless steel; and a hot dip galvanized mounting bracket. The lantern shall be fitted with an asymmetrical optical system of special design, made of high purity aluminum which has been chemically polished and anodized.

The lantern shall incorporate a splash and dustproof type sealing between the housing and the glass front cover. All exposed metal parts shall be made of non-corrosive materials. In its basic mounting position with the glass front cover in an absolute horizontal position the flood-light shall keep all distributed light below the horizontal plane, providing a cut-off light distribution with perfect glare limitation in accordance with C.I.E. recommendations. (C.I.E.: Commission International de l' Eclairage).

(e) Toll Plaza Lighting Units (Pole Mounted)

The lanterns shall be horizontal burning type with semi-cut-off light distribution and shall be of the type shown on the Drawings or equivalent as approved by the Engineer. Lamps shall be high-pressure mercury type.

(f) Ballasts for Low Pressure Sodium Lamp

Ballasts for low pressure sodium lamps shall be designated to properly operate the lamps of the wattage as designated in the Drawings.

Ballasts shall have the electrical characteristics of the high power factor type with voltage ratings as noted on the Drawings. The ballasts shall be remotely mounted and shall be set on the junction board located in the handhole of the lighting pole.

Each ballast shall have a name plate permanently attached to the case, listing all electrical data.

(g) Ballasts for High Pressure Sodium Lamp

Ballasts for high pressure sodium lamps shall be designated to properly operate the lamps of the wattage as designated in the Drawings. All ballasts shall be drip-proof, canned, and polyester-filled and shall be equipped with terminal blocks for the electrical connections. Instructions for making the electrical connection shall be printed clearly on the can of the ballast.

The power factor of a lamp combination shall have a higher value than 0.85 and shall be achieved by connecting parallel capacitors with sufficient capacitance across the mains. The capacitors used for the purpose shall be suitable to operate at a normal voltage of at least 220 V 50 Hz.

(h) Ballasts for High-Pressure Mercury Lamp

Ballasts for high-pressure mercury lamps shall be designated to properly operate the lamps of the wattage as detailed in the Drawings. All ballasts shall be drip-proof nylon encapsulated orthocyclically wound, units of low power loss and rugged mechanical and electrical construction. The ballasts shall be equipped with terminal blocks for electrical connections.

Instructions of the electrical connection shall have a name plate permanently attached to the case listing all electrical data.

(i) The Lanterns for Public Street Lighting

(i) General

(1) Luminaire is a tool that distribute, filter or change the transmitted light from the lamp, consisting of all the parts needed to support, install and protect the lamp, including electrical circuit in it to be connected to the mains.

(2) Luminaire and its components are made of corrosion-resistant material and vibration and are made of materials of high pressure die cast aluminum and shall be evidenced by a brochure or catalog from the factory.

(ii) Classification

Classification luminaire shall be meet the criteria for protection against dust, solid objects, humidity and water on the luminaire (IP) and the coefficient of utilization of at least 60%.

(1) Lantern / optical Minimum: IP 65

(2) The minimum gear control room: IP 43

(iii) The Lantern and cover

(1) In the lantern there is a light bulb, fitting, reflector and cover are equipped with silicon gasket from a tropical climate resistant and securely fastened in position.

(2) The locking clamp lamp cover shall be opened easily without using tools.

(3) Lamp cover made of borosilicate or tempered glass.

(4) Electrical components chamber cover is made of high pressure die cast aluminum.

(iv) Optic Reflector

(1) The reflector is made of anodized aluminum or all-glass with high purity and can give the effect of light reflection, resulting in a minimum luminaire light efficiency of 60%.

(2) In the optical space should be no air circulation and reflectors shall meet the room lights (full reflector)

B. FOR LED (Light-Emitting Diode)

(a) LED Standard

Standard to be used as follows:

- EN61347-1 : General standard and safety.
- EN62384 : DC/AC supply, electronic control gear module LED
- EN61347-2-13 : DC/AC condition supply, electronic control gear module LED

Standard test LED

- IEC 60598-2-3: Certification Body Test (CB Test)
- IEC 3130125: Electro Magnetic Compatibility (EMC Test)

(b) Certification

Prior to request to Engineer, Contractor shall perform the following certificates:

- Certificate LM80 (Lumen Depreciation Test) of LED used
- Certificate type IEC 60598
- Certificate of Vibration Test
- Certificate of Electro Magnetic Compatibility (EMC Test)
- Certificate of Salt spray test
- Certificate of ISO from the Manufacture.
- Certificate of Laboratory of Test.

(c) Lantern

- The lantern shall be made from the full die cast Aluminum.
- For optimal heat dissipation strength and ease of operation, the driver and LED module shall be in the same lantern set (complete set)
- The LED module chamber glass cover shall be made of tempered glass of silicon material which guarantees a minimum protection index of IP66.

(d) Optic

The following optical requirements shall be met:

- Luminaires for 120 watt LEDs shall have a minimum light flux output (13000 Lumen +/- 5%) with maximum power consumption (120 Watt +/- 5%), and an 80 watt LED luminaire shall have a minimum light flux output (Lumen 8000 + / - 5%) with maximum power consumption (80 Watt +/- 5%).
- For the optimum efficiency of LED light spread the lens used shall have multi-layer technology in order the light distribution can still be maintained in the event of a failure on one of the LED chips on the module.
- The lens and LED module board shall have the following characteristics: ultraviolet protection in order the lens does not change color and the LED module board is bright white to obtain high reflectance.

(e) Protection index and impact resistance index

To guarantee durability and performance, the following requirements shall be met:

- For street lighting: Luminaires shall have a minimum protection index of IP66 and an Impact Resistance Index IK08
- For under bridge lighting or in tunnels: Luminaires shall have an IP 65 Protection Indicator and IK07 Impact Resistance Index.
- Installation of silicone gaskets shall be without using adhesive chemicals.

(f) Heat release technology

To ensure perfect heat release and maintain optimal luminaire system durability, the following requirements shall be met:

- The lantern shall have a special design which allows perfect meeting between the back of the LED module board and the inside surface of the lantern.
- The LED module board is installed in the lantern by using a high conductance material and it is not permitted to use silicone glue as an adhesive LED module board.

(g) Driver LED

The following requirement of LED driver shall be met:

- The LED driver used in the luminaire shall have a working voltage of 220V-240VAC, 50Hz with a minimum efficiency of 0.9.
- The LED driver shall have a dimming feature for energy savings, where the dimming system can also be used with a 1-10V DC system.
- The LED driver shall also have a feature to be programmed into staging dimming.

(h) Chip Modul LED

To guarantee the quality and performance of LEDs, the Luminaires proposed by the Contractor shall have LED chips from manufacturers which meet the standards and certifications mentioned above.

(i) Color Renderation (Ra), Color Temperature, Efficiency and Lumen efficacy

- LEDs on luminaires shall have a Color Render Index (Ra) of minimum CRI (70 +/- 10%)
- Color temperature 4000K-6500K
- Efficiency of LED lights ≥ 95% with Power Factor (PF): 0.9501
- Efficacy of LED lights ≥ 100 Lumen / Watt

(j) Protection against overvoltage

Luminaires shall have a protection system which is able to protect all electrical components from overvoltage, such as lightning strikes. The protection system on this luminaire consists of at least 2 stages of protection,

- Stage 1 for Driver LED protection.
- Stage 2 for LED module protection.
- Protection value: minimum 10kV.

(k) Installation

The following luminaire installation shall be met:

- Luminaires shall be able to accommodate horizontal mounting on the ornament handlebar (48 - 60) mm.
- Luminaires shall have a Certificate of Origin from the manufacturer.

(l) Upgrade / Module Change

The luminaire used shall have a design and system that allows upgrading / replacing LED modules without having to replace the luminaire.

(m) Maintenance

The LED module compartment and components shall be accessible by opening the luminaire glass without tools.

(n) Guarantee Period

The entire luminaire system shall have a minimum service life of 50,000 hours at an ambient temperature of 35o°C with a 3-year warranty period issued officially by the manufacturer

(o) Lighting Unit

The Road and Tunnel Lighting Unit are 120 watt and 70 watt respectively.

(p) Illumination

Illumination in accordance with SNI 7391: 2008: average E = 15 - 20 lux, uniformity = 0.14 - 0.20

S13.01 (7) Lighting Panels

(a) General

The lighting panels shall be included as feeders of the power source fed to the circuits of the street and tunnel lighting, traffic signals and the guide signs. The panels shall be as shown on the Drawings or equivalent as approved by the Engineer.

The panels shall be ventilated and shall be substantial, free-standing structures on a concrete foundation a minimum of 40 cm above ground level.

Panel house roofs shall be double pitched, the apex being central to the panel.

The panel and door shall be made from fully-finished steel sheet not less than 3.2 millimeters in thickness with the necessary steel frames. The welding for all outside joints shall be smooth finished. The panel shall have a bottom design that will permit tack welding to channels that shall be set on the raised concrete foundation as shown on the Drawings.

The panel shall be completely assembled and wired at the factory. Main and small wiring shall be easily accessible for maintenance and inspection, and small wiring shall be effectively isolated from the main wiring. The wiring diagram, engraved or etched on an aluminum plate, shall be permanently fixed to the inner door of the panel.

Each panel shall have one or more nameplates for identification. Nameplates shall be made of laminated plastic with white characters to show through a black top layer when cut or engraved.

The panel Type-SS shall be made for LVMDP (Low Voltage Main Distribution Panel). The panel Types MB1 and MB2 shall be made for Lighting Panel. Dimension and content of the panels are as shown on the drawings.

Panel housings shall be fitted with a PLN master lock.

(b) Components of Lighting Panels

All lighting panels shall be as shown on the Drawings. The components shall be designed for 3-phase 4-wire, 50 Hertz operation at 380/220 volts.

The components shall be in accordance with the following items:

(i) Circuit Breakers

The circuit breakers shall be molded case, air break type, rated for 600-volt A.C. service. The circuit breakers shall have 3-poles unless otherwise noted.

The circuit breakers shall provide inverse time tripping for overloads and instantaneous action and overload ten times the normal rating.

The circuit breakers shall be arc resisting contact type and be provided with trip-free lever handles and arc quenchers.

The circuit breakers' interrupting capacity shall be 16,000 amperes based on JIS C8370 standard duty cycles, except that breakers larger than 225 amperes shall have 25,000 amperes interrupting capacity, or as approved by the Engineer.

The breakers for the main power feeders shall be provided with auxiliary contact that will close when the breaker is closed and 380 volts shunt trip coil. They shall be wired to prevent either breaker being closed while the other is closed.

(ii) Control Equipment

Multiple lighting circuits shall be controlled by combination of timer switches and remote-control relay which shall be installed in the panel of lighting pole type A, B, C and D

(iii) Timer Switch/Photo Censor

Timer switch units shall have two control elements, one of which shall be for "on" control at evening/darkness and "off" at early morning/bright, and the other which shall be for reduced current control at midnight for saving energy, all as shown on the Drawings. Timer switch shall be operated on 220 volts, 50 Hz

Timer installation for basic lighting is 100 % on at 06.00 PM and 06,00 AM, while for lighting less than 100 % the dimming ballast/ electromagnet/ inductive ballast is to be used and can reduce power and electric consumption minimum 30 % which installed in the lantern, and setting of lamp lighting as follows:

(1) 100 % on at 06.00 PM -10.00PM with timer switch

(2) 100 % on (energy saved 30 %) at 10.00 PM-06.00 AM with dimming ballast

(3) 50% on (energy saved 80 %) at 02.00 AM-06.00 AM with combination of dimming ballast and timer switch system

(iv) Control Equipment for Tunnel Lighting

Additional control equipment for tunnel lighting panels comprises auto controller and photo sensor. The former is to be attached to the tunnel lighting panel and the latter is to be installed at the entrance of the tunnel.

The auto controller shall be a panel mounted type provided with a built-in timer switch, display lamps, power switch and change-over switches for automatic or manual control. Power source requirement shall be AC 1 phase 220 V + 10% 50 Hz and 40 VA at maximum.

Setting of timers for basic lighting shall be 100% turn on between 06:00 hours and 24:00 hours and 50% turn on between 24:00 hours and 06:00 hours.

The timer switch shall have an emergency driving device for 48 hours or more when the incoming power source fails.

The entrance zone lighting which shall be controlled by the photo sensor shall be arranged in two sets as follows:

- First set of entrance zone lights turns on at 5,000 lux of outside illuminance;
- First set of entrance zone lights turns off at 2,500 lux of outside illuminance;
- Second set of entrance zone lights turns on at 10,000 lux of outside illuminance;
- Second set of entrance zone lights turns off at 5,000 lux of outside illuminance.

The photo sensor shall consist of a light receiving window and cadmium sulphate detecting device and relay unit.

S13.01 (8) Poles and Masts

(a) Lighting Poles

Lighting poles shall be galvanized steel, in accordance with the details shown on the Drawings, as outlined herein and in accordance with the requirements of Clause S12.18 of these Specifications.

The height of lighting poles Type-A1 single arm shall be 13m and height of the lighting poles TypeB-1 double arms shall be 12m and stand on the median.

The Contractor may propose the use of spun prestressed concrete lighting poles as an alternative to the galvanized steel poles for the Engineer's approval construction drawings of the lighting poles, method of handling and transportation, erection and details how the poles are fixed in the ground. All relevant Clauses for steel lighting poles shall be applicable to spun prestressed concrete poles.

All materials shall be in natural color and shall not be painted or coated with any other material. All pole items and all hardware shall be galvanized steel. Scratches, marks, dents or other damages to poles and fittings will be cause for rejection. Any marks or stains resulting from wrapping materials shall be removed.

All poles and arms shall be individually spiral wrapped and, in addition, shall be packed for shipping in groups with suitable form fitting wood dunnage between all poles and completely around each group at a minimum of 4 locations, and held with suitable metal strapping. Arms shall be wrapped, packed and shipped to the job site with a minimum of reloading between points of origin and destination. Packing not in conformance with this provision shall be cause for rejection of poles and/or arms. All loading and unloading of poles and arms shall be under the supervision of the manufacturer and/or Contractor. All miscellaneous pole line hardware required to complete the project shall be standard material manufactured for pole line construction. All metal parts shall be hot dip galvanized. All poles supplied shall be of the anchor base type and shall have a cast steel anchor base fitted over the shaft and secured with two circumferential welds.

The hand hole and cover plate for the terminal connection shall be 2.0 meters above ground level. Identification plates shall be attached to each lighting pole.

(b) Lighting poles for Floodlight

All requirements accent lighting poles together with requirements for lighting poles for street lighting.

(c) High Masts

(i) The masts shall be made of steel folded in conical sections, automatically welded in one longitudinal seam. The sections shall be telescopic jointed or by means of bolts. If bolted joints are used, flanges shall not disturb the aesthetics of the silhouette of the mast and should preferably be positioned inside the mast. The steel parts of the mast shall be hot dip galvanized over their entire surface in accordance with the requirements of Clause S11.11 of these Specifications. After installation of the mast, all exposed anchor bolts and securing nuts on the foundation shall be given one coat of an approved bituminous paint. All scratches and other damage of the finish occurring during transport or installation works shall be thoroughly cleaned and touched up.

(ii) The masts shall be bolted on a reinforced concrete foundation by means of steel bolts and nuts of adequate diameter and quantity. The foundation shall be made of concrete and rolled steel bars in accordance with the applicable requirements of Division 10.

The Contractor shall submit for the Engineer's approval, construction drawings of the foundations and calculations showing that the foundation and the anchor bolts will not move. Anchor bolts shall conform to the specifications of JIS B1180 and

B 1181 or equal, and each shall be provided with 2 nuts and 2 washers. Anchor bolts, nuts and washers shall be galvanized over their entire surface in accordance with the requirements of Clause S12.18 of these Specifications.

(iii) The masts shall have a lockable access door at ground level.

(iv) The lamp accessories such as fuses, ballasts, ignitors and capacitors shall be mounted on a suitable frame and installed inside the mast at ground level. Provisions shall be made that no moisture, either from condensation or from entering rain water, will drip on the lamp accessories. Rising cables from the accessories to the lamps shall be bunched and fixed in the mast. Near the accessory frame inside the mast an earth terminal of at least M10 diameter shall be provided, directly welded to the mast. At the top of the mast a head frame shall be provided suitable to receive the lighting fittings in quantities and directions as shown on the drawings.

(v) The mast shall have a harmonious silhouette and the Contractor shall submit for approval, full information on the shape and detailed dimensions of the proposed masts.

(vi) Before manufacturing the masts, the Contractor shall provide calculations and obtain the Engineer's approval for detailed construction drawings of the mast. The calculations shall cover the complete structure, including head frame and lanterns, and shall show that:

- No parts of the assembly are submitted to stresses above acceptable limits;
- The deflection caused by dynamic forces does not exceed acceptable limits; and
- Calculation is in accordance with JIL-1001- 1962.

  (JIL: Japan Lighting Fixtures and Equipment Industry Association)

(vii) The height of masts shall be 30 meters.

(d) <u>Foundations</u>

Concrete for foundations for lighting poles and pedestals of cabinets shall be of class C or as shown on the Drawings. All details of concrete and reinforcement for foundations shall conform to the applicable requirements of Division 10.

For pole tower (high mast), the Contractor shall submit a picture of the foundation and its calculation, the Engineer for approval. Anchor bolts shall comply with JIS B1180 and B1181 or equivalent, and each shall be equipped with two nuts and two rings. Anchor bolts, nuts and rings shall be galvanized in accordance with the provisions of Clause S11.01 of this specification.

(e) Mobile Equipment for Floodlight Masts

(i) Mobile equipment shall consist of head frame assembly, mobile floodlight carriage, hoisting device, and electrical equipment.

(ii) Each mast will be provided with a mechanism which shall have three locks at the top of the structure capable of supporting a mobile floodlight suspension, etc., when the raising cables are slack. Head frame assemblies shall be fitted at the top of the mast, and one carriage for supporting a maximum of six floodlights shall be provided.

(iii) Each mast structure shall be complete with three hoisting cables, a six-conductor minimum 10 mm^2 electrical cable, circuit breaker box and hoist with removable common drive. The electrical cable shall be disconnected from the circuit breaker box and securely attached to the lowering cable when the floodlights are lowered. The electric cables shall be split within the flood-light carriage with a 5 ampere in-line fuse installed in each floodlight ballast supply line.

(iv) The head frame assembly shall be covered by a removable cover and the carriage ring shall be supplied in semi-circles to facilitate shipping, mounting or dismounting after the High Mast pole has been erected. The ring shall be supplied with means of supporting six floodlights equally spaced around the ring, and a plug to match the six pole socket outlet in the base shall be installed in the main power feeder for testing purposes when the ring is in the lower position.

(v) Guides shall be provided on the head frame sleeve, to ensure correct alignment of the carriage to the locking mechanism in the raised position. Rollers shall be provided on the inside of the carriage to aid in the final alignment of the carriage in the raising operation. The carriage shall be equipped with indicating flags to confirm that the carriage is in the fully locked position. This flag shall be clearly discernible from ground level.

The locking mechanisms shall be located at a maximum of 120 degrees to each other on the head frame assembly and shall be able to support the carriage, lanterns and ballast in the fully locked position. The hoisting cables shall not be under tension when the carriage is in the raised and locked position.

(vi) A winch shall be provided in the base of each mast shaft, for raising and lowering the carriage by means of flexible steel hoisting cables. The winch shall be of the worm and gear type, having a gear ratio that will allow easy raising and lowering and prevent the free fall of the carriage in the event of an accidental release of the winch handle. A winch handle shall be provided for hand operation of the winch in an emergency.

(vii) A hinged door cover shall be provided over the access opening in the mast shaft. The opening shall be of sufficient size to permit

the removal from the shaft of the equipment installed therein, for replacement or maintenance. The door shall be provided with facilities for padlocking. The access opening shall be suitably reinforced to ensure that there is no weakening of the structure in this area, also it shall be ensured that the reinforcing is such that it does not interfere with the operation or access to equipment required therein.

(viii) In addition to the cable hoist, the masts shall be provided with a grounding stud and nuts, and a code gauge epoxy-painted steel sheet metal box containing:

(1) One three-pole, 20 ampere molded case circuit breaker (interrupting capacity of 30,000 amperes at 460 volts) for the area lighting luminaires.

(2) One single-pole, 15 amperes as in the above for the security lighting luminaire.

(3) One single-pole, 15 ampere circuit breakers, as in the above, for the lowering device drive outlet.

(4) One six-pole matching plug and socket outlet for the six-conductor hanging cable.

(5) One neutral connecting strip to which the neutral circuit from the street lighting panels shown on the drawings and the mast socket outlets shall be connected.

One single phase socket 265-volt outlet compatible with the lowering device drive plug shall be connected to the circuit breaker in (iii) above.

The removable lowering and raising device drive motor (one only supplied) shall include a torque rated clutch with shaft connection for the lowering device drive. Mounting and bracing for the drive motor shall be provided. A water tight connection and control box shall be supplied with the drive motor which shall contain:

- One reversing motor starter with cable and plug to match the socket outlet in the circuit breaker box, plus a six meter length of control cable complete with a water tight reversing push button station. The latter will allow the operator to stand back out of the possible danger zone during the "raising" and "lowering" of the luminaire mounting ring.
- Before placing an order for the motor, the Contractor shall submit the characteristics of the motor to be used to the Engineer to obtain his approval.

S13.01 (9) Cable, Grounding, Splices and Conduit

(a) Wiring for Lighting

All cables to be used for roadway lighting shall be of the type and size shown on the Drawings. Cables shall be pulled into a pole through pipes prepared in the foundation of the pole and shall be connected to the terminals in the terminal box installed in the pole.

All poles shall include an approved miniature circuit breaker rated at IP-10 amperes, 240 volts, installed in the base of each pole and accessible through the handhole of the pole. The fuse shall protect both pole cables and electrical control ballasts.

Cables installed in the pole shall have two conductors of 2.5 mm as prescribed in "Cable and Wire" herein. Cables shall be adequately attached to the lantern so that lantern terminals shall be free from carrying their weights.

Roadway lighting cables shall be four (4) core through to the last pole.

(b) Cable and Wire

All cables shall be suitable for operation at the specified voltage in open, duct or conduit, under the condition of the maximum conductor operating temperature which at rated current shall be less than 70 degrees C.

Cable colors shall comply with Indonesian color code standards.

Cables shall be delivered to the Site on substantial non- returnable wooden drums, each bearing a securely fixed label stating gross weight, serial number, length of cable and other description.

Covers shall be provided around the periphery of the drum in order to protect the cable in transit and the inner cable end shall be adequately protected by a metal guard or other approved means. Both ends of the cable shall be sealed by a suitable method to prevent the entrance of moisture.

All cables inside of the lighting pole shall have two conductors per lantern. Cables shall be 600 volts, grade "Polyvinyl Chloride Insulated and Sheathed Cable (NYY)" or shall be of the type approved by the Engineer.

All cables for the roadway lighting system to be installed underground shall be PVC insulated, Galvanized Flat Steel wire armoring, and PVC sheeting type NYFGbY or equal approved by the Engineer. Conductors shall have a minimum cross-sectional area of 10 mm2 for use in underground installations. Cable type shall Indonesian National Standard (S01.01) and the type specified.

All cables to be used shall be tested and approved by *Lembaga Masalah Kelistrikan (LMK)* or PLN prior to the Engineer's approval.

The cable Type-1 shall be 4 cores by 2.5 mm2.

The cable Type-2 shall be 4 cores by 10 mm2.

The cable Type-3 shall be 4 cores by 16 mm2.

The cable Type-4 shall be 4 cores by 25 mm2.

The cable Type-5 shall be 4 cores by 70 mm2.

(c) Grounding

Conduit, steel poles and cabinets shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire of the same cross-sectional area for all systems.

Bonding jumpers shall be used in all non-metallic boxes. Metallic boxes shall employ hubs of double lock nuts and bushes. The bonding of all conduits, lighting poles and panels to form a continuous ground system shall be in accordance with applicable code standards. If directed by the Engineer each lighting pole shall be individually grounded.

Size of grounding wire shall be minimum 6 mm^2 Bare Copper Conductor (BCC) or as approved by the Engineer.

Ground rods shall be copper 10 dia. x 1,500 millimeter minimum, depth 1.2 meter below finished grade and thermo-welded or connected using connection hardware to the 6 mm^2 grounding wire.

The Contractor shall investigate each site and measure the grounding resistance of the sites. After taking the data, the Contractor shall obtain the Engineer's approval before installation.

The grounding resistance shall be 5 ohms or less, or as approved by the Engineer.

Types of cable grounding shall be as follows:

- Cable Type-6 shall be BCC 10 mm^2.
- Cable Type-7 shall be BCC 16 mm^2.
- Cable Type-8 shall be BCC 25 mm^2.

Details of all grounding points shall be submitted to the Engineer for approval.

(d) Electrical Splice Materials

Splices and taps shall be made with pressure type solderless connectors to securely joint the wires both mechanically and electrically.

An epoxy resin, cast type insulation shall be formed in clear plastic molds. The material used shall be compatible with the insulation specified in the Contract Drawings or these Specifications. Materials to be used for the work shall conform to the requirements of JIS C2804, C2805 and C2806, or shall have the quality approved by the Engineer.

Insulating tape when specified for use in splice formation shall conform to JIS C2336.

Unfused quick-disconnect connectors such as In-line connectors or Tee connectors shall be of quality approved by the Engineer.

(e) Conduit Pipe

Conduit to be installed below ground, above ground or on the surface of structures shall be steel. Cable pipes installed below ground are termed as ducts and are dealt with in Clause S13.02.

Exterior and interior surfaces of all steel conduits shall be uniformly and adequately zinc-coated by a hot-dip galvanizing process.

Conduit to be embedded in concrete shall be PVC in accordance with the requirements of JIS C8430 or ”AZ” type

(f) Cable Trays

All details regarding material and installation of cable trays shall be as shown on the Drawings.

(g) Pull Box

Material pull box shall comply with condition of JIS G3101. Pull box is installed in underpass, overpass or tunnel which requires lighting, and its function is as a place for connecting cable to the lighting pole.

S13.01.(10) Lightning Protection Systems

(a) General

This Clause includes the supply, testing and repair during the maintenance of a complete flashing lights system according to Specifications including obtaining the permission from the competent authority.

Scope of work:

(i) Supply and installation of the entire installation material according to the Drawing.

(ii) Supply and installation flashing lights Spitzen supporting pole.

(iii) Testing system

(b) Standardization

Standard and regulation applicable in this work, among others :

SNI	:	*Standard Nasional Indonesia*
PUIPP	:	*Peraturan Umum Instalasi Penangkal Petir*
PUIL	:	*Peraturan Umum Instalasi Listrik tahun 2000*
Others	:	Fabricator recommendation

(c) Material Requirements

Materials used in the lightning protection system shall be in good condition and in accordance with requirement of and approved by the Engineer.

List of material, catalogs and shop drawings shall be submitted to the Engineer prior to installation. Material or equipment that does not comply with these specifications will be rejected.

Lightning protection system used is: System Electrostatic non-radioactive

The components used are as follows:

(i) Head Electrodes (Spitzen):

Head of special electrodes for non-radioactive or electrostatic system that can create field ionization in the surrounding area (ionizer dissipation system).

(ii) Conductor:

That is vertical conductor (down conductor) which electrically connects between the head of protector and the grounding electrode.

This protector shall guarantee that it can safely transfer lightning energy from air terminal to the ground safely.

For electrostatic system, special types of lighting cable protection Bare Copper is applied

(iii) Grounding System:

Grounding terminal located in the control tanks are equipped with a grounding electrode. Control tanks required for periodic testing of soil resistance

(iv) Electrode Grounding:

Electrode Grounding, made of Copper Rod galvanized with a diameter of no less than 1inch and 6 meters length and should be put into the ground vertically and measuring a maximum of ~~3~~ 1 Ohm grounding resistant

(d) Work Requirements

The manner of installing lightning protection system shall comply with the instructions and manufacturer's specifications.

Lightning rod mounted on the roof of a building by means of bolts or clamps haunted. Installation shall be sufficiently strong to support the mechanical forces when lightning strike.

Conductor holder/clamp should be made of the same material with the conductor to prevent electrolysis if exposed to water.

Connections:

The required connectors should ensure good contact and are not easily separated. Connectors are as possible to reduce losses due to thin connection

Mechanical protector:

Down Conductor shall be protected against mechanical damage to the type of high impact PVC pipe.

(e) Testing and Commissioning

To determine whether or not a lightning protection system is installed, it shall be held to the installation and testing of the grounding system

Testing should be done:

(i) Grounding Resistant Test

Resistant value of earth is by using standard methods.

(ii) Continuity Test.

(f) Sample

The Contractor shall submit samples of materials to be used / installed, the minimum conductor and a grounding electrode requested in requirements.

All costs associated with the delivery and return of these examples is responsibility of the Contractor

(g) Checking

Lightning protection system shall be checked by the Engineer to ensure compliance with this Specification.

All parts of this plant shall be inspected by the Engineer before closed or covered. Any parts which are not in accordance with the terms of the Specification and Drawings shall be replaced immediately, without any additional charge to the Engineer.

(h) Permit Letter

(i) The Contractor shall have permit letter from PLN class C for installation this lightning protection.

(ii) The Contractor/Subcontractor shall be experienced in the installation of flashing lights, evidenced by providing a list of projects that have been undertaken.

(i) Material List

For all of the material to be used, the Contractor shall fill material list as: brand, type, and class complete with brochures/catalogs that are attached prior to commence the works and submitted to the Engineer. This table lists are preferred material for components in the form of goods production.

S13.01 (11) Traffic Control Light

Each unit traffic control light shall consist of complete electrical mechanism for controlling traffic operations, include:

a) Electrical Panel PLN

As a source of electrical power for the operation of the control panel lights traffic control and traffic lights. Electricity grid panel mounted on a concrete foundation, panels made of 3.2 mm thick steel plate and painted

anti-rust, details and dimensions of the foundation panel and electrical panel in accordance with the Drawings.

b) Control Panel for Traffic Light

Control Panel for traffic lights serves to regulate the operation of traffic lights automatically and equipped for manual operation (operated by the operator).

The control panel mounted on a concrete foundation, panels made of 3.2 mm steel plate and painted with anti-rust paint.

c) Traffic Light Pole

Traffic light poles octagonal shaped, made of thick steel plate with 3.2 mm protected with hot dip galvanized. Detail and dimension foundation traffic lights and traffic lights pole is referred to the Drawing, and or under instruction of the Engineer.

d) Traffic Control Light

Traffic control lights should be a halogen type, and the pedestrian light control shall be contained symbols/images "the man walks" or writing symbols in accordance with the Drawing. Pillar of light traffic control should be painted with colors as the requirement in Drawing. The type and capacity control unit (controller) details, the provision and installation of traffic lights should be in accordance with the regulation of Ministry of Transportation. and shall be in accordance with the instructions of the Engineer.

The relevant requirement for the installation of street lighting is also effective for the installation of traffic control lights.

Details of flashing light shall be in accordance with Drawing, Sample of materials to be used shall firstly be approved by the Engineer before ordering.

Flashing Light Specification:

No.	DESCRIPTION	REQUIREMENTS
1	Appearance	Warning Light Standing
2	Voltage	180 – 240 VAC
3	Light	Traffic Signal: 40/60/70 Watt (2 Aspect, LED 10 Watt/Aspect)
4	Lantern	Material from Box Aluminum
5	Lens	Yellow – Yellow: 2 Aspect diameter 20 cm

The traffic lights at the toll gate shall have the following requirements:

Type 1

No.	DESCRIPTION	REQUIREMENTS
1	Type	Outdoor super bright LED Cluster (Over head traffic light)
2	Appearance	Red (Cross) : 6000 cd/mm2; Blue Green (Arrow) : 7000 cd/mm2
3	Lighting age	50,000 hours
4	Cluster Arrangement	8 LED/Cluster, ABS housing (hood), Weather sealed
5	Voltage	180 240 VAC
6	Power	Red : 18 Watt, Blue Green : 15 Watt
7	Lantern	Material from Box Aluminum
8	Dimension	(50x50x15) cm
9	Weight	21 kg
10	Temperature	(10 – 55) ^{o}C

Type 2

No.	DESCRIPTION	REQUIREMENTS
1	Appearance	Traffic Light LLA (Upper Traffic Light)
2	Voltage	180 – 240 VAC
3	Lighting	Red : 60/75/100 Watt (LED 20 Watt); Green : 60/75/100 Watt (LED 20 Watt)
4	Lantern	Material from Box Aluminum
5	Lens	Red – Green : 2 Aspect diameter 30 cm

The traffic lights at the street shall have the following requirements:

No.	DESCRIPTION	REQUIREENTS
1	Standard	1. EN61347-1 : General Condition and Safety for Lighting type LED 2. PLN : Perusahaan Listrik Negara 3. PUIL : Peraturan Umum Instalasi Listrik 2000 04-2763-1992 : Standar Nasional Indonesia
2	Reference	1. Permenhub No.PM 82 tahun 2018
3	Certification	1. IEC 60598 : Practical Guide to Testing and Certification requirements for Luminaires 2. Vibration Test

No.	DESCRIPTION	REQUIREENTS
4	Voltage	180 – 240 V, 50 Hz
5	Grounding system	shall be grounded at minimum resistance 1 Ω
6	Lighting age	minimum 50,000 hours
7	Power	Red : 15 Watt Yellow :15 Watt Green : 15 Watt
8	Lantern	Material from Box Aluminum, minimum thickness 2 mm
9	Type	Outdoor Super Bright, IP minimum 65
10	Lens	Red, yellow, green: 3 aspect-diameter 20 cm, or Red, yellow, green: 3 aspect-diameter diameter 30 cm
11	Operational	Temperature: 5-700 ºC, Humidity : 0 – 95%

S13.01 (12) Modification of Existing Systems

(a) Removing

The Contractor shall remove existing materials such as lighting and lanterns, lighting panels, traffic signals, etc. which will obstruct the construction of the works, in accordance with the Drawings and these Specifications, and/or as established by the Engineer.

A removal manual shall be submitted for the Engineer's approval prior to carrying out the removing works.

On completion of removal works, all holes shall be filled, and the area left clean and tidy, all to the satisfaction of the Engineer.

All useless materials removed, such as lighting fittings and ballasts, poles, traffic signals, cables, conduits, etc. shall be dumped or carried to a store as specified by the Engineer on the Contractor's responsibility.

(b) Relocation

Part of the existing materials removed shall be relocated in accordance with the Drawings and/or as established by the Engineer.

All relocation shall be carried out by the same means of construction as additional furnished materials in the works as required in these Specifications.

Prior to re-fixing any lighting pole or control panel, accessible surfaces shall be rubbed or brushed clean of all rust, etc. and painted with 3 coats of zinc-based rust-preventing paint as specified by the Engineer.

If there are any dents or other damage to materials during the relocation, the material shall be replaced with the same kind, or repaired to the satisfaction of the Engineer.

S13.01 (13) Construction

(a) General

All workmanship shall be complete and in accordance with the latest accepted standards of the industry, as determined by the Engineer. Installation of duct, construction of manholes, and excavation for cable or duct track, shall be in accordance with Clause S13.02.

(b) Excavating and Backfilling

The excavation and backfilling required for the installation of foundations, poles and other appliances shall be performed in accordance with the requirements of Clause S13.02, but will not be measured for payment. The cost of such extra work will be deemed to be included in the unit price of the pay item being installed or removed.

(c) Foundations

Foundations shall be constructed of Portland cement concrete Class C, unless otherwise noted on the Drawings and all details shall meet the applicable requirements of Division 10 of the Specifications. The bottom of concrete foundations shall rest on firm ground.

Foundations shall be poured in one pour where practicable. The exposed portions shall be formed to present a neat appearance. The footing shown on the Drawings shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for under the applicable provision of Division 5 of these Specifications.

Forms shall be true to line and grade. Tops of footings for poles, except special foundations, shall be finished to ground line or sidewalk grade, unless otherwise noted on the Drawings or directed by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and to proper height and shall be held in place by means of a template until concrete sets.

Plumbing of poles shall be accomplished by adjusting leveling nuts. Shims or other similar devices for plumbing or raking will not be permitted.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has set at least 3 days.

A "rubbed surface finish" shall be applied to exposed surfaces of concrete in accordance with the requirements of Clause S10.01.

Where obstructions prevent construction of planned foundations, the Contractor shall construct an effective foundation, satisfactory to the Engineer.

(d) Conduit

Installation of conduit shall be performed in accordance with these Specifications and in reasonably close conformity with the locations as specified in the Drawings or as directed by the Engineer.

The size of conduit used shall be as shown on the Drawings. Conduits smaller than 25 mm electrical trade size shall not be used, unless otherwise specified. It shall be the option of the Contractor, at his own expense, to use larger size conduit if desired, and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads of all steel conduit shall be well painted with a good quality of lead or rust-preventative paint before couplings are made up. All steel couplings shall be screwed up until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run. Where coating on steel conduit has been damaged in handling or installing, such places shall be thoroughly painted with rust-preventative paint.

All conduit ends shall be threaded and capped with standard conduit couplings capped with conduit push pennies until wiring is started. When couplings and push pennies are removed the threaded ends shall be provided with approved conduit bushings. The use of any plugs, even though temporary, in lieu of the aforementioned conduit couplings and push pennies is expressly prohibited.

Conduit stubs from bases shall extend at least 15 cm from the face of foundations and at least 80 cm below the top of foundations.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, using an approved conduit bending tool employing correctly sized dies, without crimping or flattening, using the longest radius practicable. All PVC conduit bends shall be performed.

Conduit terminating in poles or pedestals shall extend approximately 15 cm above the foundation vertically and shall be sloped towards the handhole opening.

Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run, terminate 15 to 20 cm below the pull box lid and within 9 cm of the box wall nearest its entry location.

Suitable markers shall be set at the ends of conduits which are covered so that they may be easily located.

A galvanized pull wire shall be installed in all conduits which are to receive future conductors. At least 60 cm of pull wire shall be doubled back into the conduit at each termination.

Conduit of utility box shall cooperate to electric cables, telecom cables and water supply pipes located at grade beside of foot pass. This U-ditch with cover structure made by precast concrete product. The material shall be in accordance with Sub-clause S6.06 (2) of these Specifications

(e) Pull Boxes

Pull boxes shall be installed at the locations shown on the Drawings, and at such additional points as ordered by the Engineer. The Contractor may install, at his own expense, such additional boxes as may be desired to facilitate the work.

(f) Wire

Wiring shall conform to appropriate code requirements. Wiring within cabinets, manholes, etc. shall be neatly arranged and within cabinets shall be laced.

Powdered soapstone, talc, or lubricant shall be used in placing conductors in conduit.

Splicing in conductors will be permitted only at manholes, transformer leads, in pole bases, or at control equipment.

Sufficient signal light conductors shall be provided to perform the functional operation of the signal systems as shown. Spare conductors shall be provided when noted on the Drawings.

(g) Service

Service points are located within or close to the Site, normally, but not necessarily always, at the PLN sub-station transformer house nearest the project main lighting panel designated on the drawings.

Unless otherwise noted on the Drawings, each service point shall include a meter base installed in accordance with serving utility requirements, a three-wire service breaker of size noted on the Drawings, the necessary conduit risers and grounding assembly.

In general, all multiple lighting will be 220 volts, 50 Hz as noted on the Drawings.

The Contractor shall prepare all drawings required and all necessary documentation for the application for the service connection which shall be submitted to the Engineer. The Engineer shall then, upon request of the Contractor, make arrangements with the serving utility to complete the service connections.

The serving utility connection costs, and consumption of electrical energy to the date of completion, to be paid by the Contractor, payments are included in the unit price unless otherwise provided in the Contract

(h) Field Test

Prior to completion of the work, the Contractor shall cause the following tests to be made on all traffic signal and lighting circuits, in the presence of the Engineer.

(i) Test for continuity of each circuit.

(ii) Test for grounds in each circuit.

(iii) A megger test on each circuit between the conductor and ground with all switch boards, panel boards, fuse holders, switches, socket outlets and over current devices in place and all readings recorded. The Contractor shall furnish the Engineer with three copies of the test results identifying observed readings with their respective circuits. The insulation resistance between conductor and ground shall be not less than 8 megohms.

Any change in the above stated minimum readings shall be approved by the Engineer. Such approval shall be in writing, following written application by the Contractor.

(iv) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

(i) Painting

All painting required shall be in conformance with applicable portions of Clause S12.18 of these Specifications.

If the enclosure of any electrical equipment (less signal heads) located above ground does not have an exterior surface of either aluminum or galvanizing, then it shall be finished with two coats of an approved zinc based paint, plus such finishing coat as the Engineer may direct.

Controller cabinets shall be finished in accordance with the above requirements for electrical equipment.

Galvanized steel or aluminum lighting poles and lighting lanterns shall not be painted.

(j) Lighting Poles

Lighting poles shall be handled in loading, unloading and erecting in such a manner that they will not be damaged. Any parts that are damaged due to the Contractor's operations shall be repaired or replaced at the Contractor's expense, to the satisfaction of the Engineer.

Lighting poles shall not be erected on concrete foundations until foundations have set at least 72 hours, and shall be raked sufficiently to be plumb after all load has been placed, or as otherwise directed by the Engineer.

(k) Control Equipment

Where specifically detailed on the Drawings, for service locations where two or more lighting circuits are operated from one time switch control device, the relays, service breakers and any other necessary control equipment shall be grouped together and installed in a suitable rain-tight

enclosure of a sufficient size to accommodate all of the equipment installed therein.

Each electrical control ballast assembly shall be protected by moulded circuit breakers.

(l) Signal Controllers

All control cabinets and control equipment shall be factory wired ready for operation. Field work shall be limited to placing cabinets and equipment and connecting field wiring to field terminal strips.

(m) Signal Heads

All signal heads shall be installed as shown on the Drawings. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are covered.

(n) "As-Built" Drawings

Upon completion of the work, the Contractor shall submit "As-Built" or corrected drawings, or any data therefor as required by the Engineer, showing in detail all construction changes, especially location and depth of conduit and completed schematic circuit diagram.

The drawings shall be on sheets conforming to the standard contract Drawings. Corrected drawings shall be made on full sized sheets and not on reduced size prints.

(o) Guarantee

The Contractor shall furnish to the Employer any guarantee or warranty required as a normal trade practice in connection with the purchase of any materials or items used in the construction of the illumination or traffic signal system or systems included in this Contract.

S13.01 (14) Method of Measurement

The quantity of each item paid for under this Clause will be the number of linear meters or individual items as detailed below which are furnished and installed in accordance with this specification, the Drawings and the instructions of the Engineer.

Ducts, manholes and excavation for cable or ducts will be measured for payment under Clause S13.02 of these Specifications.

Cable within each pole or traffic signal will not be measured for payment but will be considered to be included in the unit price for the pay item being installed. Measurement of external cable will be taken to the junction board located within the handhole of the pole or to the first junction within the control panel.

Cables in the pole or lamp and connecting cables to the poles and panels as well as the connection to the power to PLN will not be measured and paid for but is considered to be in the Unit Price for pay item install work.

S13.01 (15) Basis of Payment

The quantity measured as provided above, shall be paid at the Contract unit price for each pay item as described below. The price and payment will be full compensation for all the work shown on the Drawings or described in these Specifications. The scope of work included in each pole item shall be as shown on the Drawings or as described in these Specifications.

The work of high mast lighting shall include furnishing, assembly and erection of the mast, mast head, lanterns, wiring, electrical control gear, base plate and anchor bolts for the mast. One removable lowering and raising device drive motor unit shall be furnished and payment shall be full compensation for furnishing the drive motor and all its mounting and control equipment. Detailed drawings for the pile foundation and pile cap will be supplied by the Engineer and this work will be measured and paid for under Division 10 of the Specifications.

The payment for tunnel lighting panel shall include furnishing and installing the remotely sited photo sensor.

The payment for bus stop shelters lighting shall include furnishing and installing the MCB box and all electrical items after this box.

The payment for cable shall be full compensation for the furnishing, laying or pulling, and jointing cable, but excavation, protection and backfilling will be paid for under Clause S13.02 of these Specification

Payment for installation, relocation or removal of any pole or panel shall be deemed to include any excavation, demolition, backfilling and all materials necessary for the provision of a base as shown on the Drawings or described in these Specifications.

The payment for utility box shall be full compensation for all the works, precast concrete U-ditch with cover, the furnishing, laying, for excavation, sand base, protections and backfilling. But installation of utilities will not include this pay item.

Pay Item No. and Name		**Unit of Measurement**
13.01	**STREET LIGHTING**	
13.01(1)	**Lighting (include *Grounding*), Cable and Auxiliary Materials**	
13.01(1).1	Street Lighting, Height 13 m, Type A (1 x 120 Watt), LED, Dimming System type	Each
13.01(1).1a	Street Lighting, Height 13 m, Type A (1 x 150 Watt), HPS, Dimming System type	Each
13.01(1).2	Street Lighting, Height 13 m, Type B (2 x 120 Watt), LED, Dimming System type	Each
13.01(1).2a	Street Lighting, Height 13 m, Type B (2 x 150 Watt), HPS, Dimming System type	Each
13.01(1).3	Street Lighting, Height 13 m, Type A (1 x 250 Watt), HPS, Dimming System type	Each

13.01(1).4	Street Lighting, Height 13 m, Type B (2 x 250 Watt), HPS, Dimming System type	Each
13.01(1).5	High Mast Pole Lighting, Height 20 m	Each
13.01(1).6	High Mast Pole Lighting, Height 30 m	Each
13.01(1).7	High Mast Pole Lighting, Height 35 m	Each
13.01(1).8	High Mast Pole Lighting, Height 40 m	Each
13.01(1).9	Under Bridge Lighting/Tunnel (1 x 150 Watt)	Each
13.01(1).9a	Under Bridge Lighting/Tunnel (1 x 120 Watt)	Each
13.01(1).9b	Under Bridge Lighting/Tunnel (1 x 80 Watt), LED	Each
13.01(1).10	Flood lighting, height 9 m	Each
13.01(1).11	Flood lighting, height 13 m	Each
13.01(1).12a	Flood lighting, height 14 m (3 x 250W)	Each
13.01(1).12b	Flood lighting, height 14 m (4 x 250W)	Each
13.01(1).13	Flashing Light	Each
13.01(1).14	Lightning Protector included Tower Lighting, Box Grounding and Grounding	Each
13.01(1).15	Cable NYFGBY 2C - 10 mm^2	Linear Meter
13.01(1).16	Cable NYFGBY 2C - 16 mm^2	Linear Meter
13.01(1).17	Cable NYFGBY 4C - 1 mm^2	Linear Meter
13.01(1).18	Cable NYFGBY 4C – 1.5 mm^2	Linear Meter
13.01(1).18a	Cable NYFGBY 4C – 4 mm^2	Linear Meter
13.01(1).18b	Cable NYFGBY 4C – 6 mm^2	Linear Meter
13.01(1).19	Cable NYFGBY 4C - 10 mm^2	Linear Meter
13.01(1).20	Cable NYFGBY 4C - 16 mm^2	Linear Meter
13.01(1).21	Cable NYFGBY 4C - 25 mm^2	Linear Meter
13.01(1).22	Cable NYFGBY 4C - 35 mm^2	Linear Meter
13.01(1).23	Cable NYFGBY 4C - 50 mm^2	Linear Meter
13.01(1).24	Cable NYFGBY 4C - 70 mm^2	Linear Meter
13.01(1).25	Cable NYFGBY 4C - 90 mm^2	Linear Meter
13.01(1).26	Cable NYFGBY 4C - 95 mm^2	Linear Meter
13.01(1).27	Cable NYFGBY 4C - 120 mm^2	Linear Meter
13.01(1).28	Cable NYFGBY 4C - 150 mm^2	Linear Meter
13.01(1).29	Cable NYFGBY 7C - 2.5 mm^2	Linear Meter
13.01(1).30	Cable NYY 3C - 2.5 mm^2	Linear Meter

13.01(1).31	Cable NYY 4C - 10 mm^2	Linear Meter
13.01(1).32	Cable NYY 4C - 16 mm^2	Linear Meter
13.01(1).33	Cable NYY 4C - 25 mm^2	Linear Meter
13.01(1).34	Cable NYY 4C - 35 mm^2	Linear Meter
13.01(1).35	Cable NYY 4C - 50 mm^2	Linear Meter
13.01(1).36	Cable NYY 4C - 70 mm^2	Linear Meter
13.01(1).37	Cable BC - 6 mm^2	Linear Meter
13.01(1).38	Cable BC - 10 mm^2	Linear Meter
13.01(1).39	Cable BC - 25 mm^2	Linear Meter
13.01(1).40	Cable BC - 35 mm^2	Linear Meter
13.01(1).41	Steel Conduit D = 100 mm	Linear Meter
13.01(1).42	Conduit PVC D = 50 mm	Linear Meter
13.01(1).43	Conduit PVC D = 100 mm	Linear Meter
13.01(1).44	Pull box, type A	Each
13.01(1).45	Pull box, type B	Each
13.01(1).46	Pull box, type C	Each
13.01(1).47	Pull box, type D	Each

13.01(2)	**Street Lighting Panel**	
13.01(2).1	Street Lighting Panel, included Box and foundation	Each
13.01(2).2	Street Lighting Panel 1, included Box and foundation	Each
13.01(2).3	Street Lighting Panel 2, included Box and foundation	Each
13.01(2).4	Street Lighting Panel 3, included Box and foundation	Each
13.01(2).5	Street Lighting Panel 4, included Box and foundation	Each
13.01(2).6	Street Lighting Panel for Toll Gate, included Box and foundation	Each
13.01(2).7	Street Lighting Panel 1A-01, included Box and foundation	Each
13.01(2).8	Street Lighting Panel 1A-03, included Box and foundation	Each
13.01(2).9	Street Lighting Panel 1A-04, included Box and foundation	Each

13.01(3)	**Power Supply from PLN**	
13.01(3).1	Box and foundation for PLN Panel Meter Box	Each
13.01(3).2	Cable NYFGBY 4C - 50 mm2	Linear Meter
13.01(3).3	Cable NYFGBY 4C - 70 mm2	Linear Meter
13.01(3).4	Cable NYFGBY 4C - 95 mm2	Linear Meter
13.01(4)	**Traffic Control Light**	
13.01(4).1	Panel Meter PLN (Foundation and Box Panel)	Each
13.01(4).2	Cable NYFGBY 4 x 10 mm2	Linear Meter
13.01(4).3	Control Panel included foundation and Panel Box	Each
13.01(4).4	Manhole for electric cable	Each
13.01(4).5	Galvanized pipe diameter 6 "(2 ways)	Linear Meter
13.01(4).6	Cable NYFGBY 3 x 10 mm2	Linear Meter
13.01(4).7	Cable BC 10 mm2	Linear Meter
13.01(4).8	Traffic Light type 1	Each
13.01(4).9	Traffic Light type 2	Each
13.01(4).10	Traffic Light type A	Each
13.01(4).11	Traffic Light type B	Each
13.01(4).12	Traffic Light type C	Each
13.01(4).13	Steel Pole for Traffic Light Protector	Each

S13.02 Civil Works for Electrical Items

S13.02 (1) Description

The work under this Clause will include ducts, manholes and the excavation necessary for the installation of the cable or duct as described in Clause S13.01.

S13.02 (2) Materials

All material shall conform to the details given on the Drawings. In the absence of any details on the Drawings, the work shall be carried out in accordance with the relevant Clauses of these Specifications and the instruction of the Engineer. The material for duct shall be as given for conduit in Clause S13.01.

S13.02 (3) Construction

(a) All details of manholes shall be in accordance with the Drawings and the relevant requirements of Division 6. Conduit or duct ends shall be fixed in the proper positions and held in place by means of templates until the concrete has set. A rubbed surface finish shall be applied to exposed concrete surfaces in accordance with Division 10 of these Specifications.

(b) Excavation for cable installation shall be of the width necessary for satisfactory laying of the cables and shall ensure that cables are at least 60 cm below finished level. The bottom of the cable track shall be level and free from stones or other sharp objects. The depth of the cable may be increased if this is necessary to avoid existing obstructions.

After cables have been laid, they shall be protected by concrete tile cable markers or protectors of a design approved by the local electricity authority.

(c) The location of ducts will be as shown on the Drawings or as instructed by the Engineer. Unless the Contractor elects at his own expense to install duct by jacking or drilling, all work on ducts shall be completed before work is started on the sub-base course. Full details of any ducts to be installed by jacking or drilling shall be submitted to the Engineer for his approval. Unless otherwise instructed, all ducts shall extend at least 60 cm beyond the edge of the pavement.

Suitable marker stakes shall be set at the ends of ducts which are buried so that they may be easily located. Existing underground ducts to be incorporated into a new system shall be blown out with compressed air and checked with a mandrel. A galvanized pull wire shall be installed in all ducts which are to receive future cables. At least 60 cm of pull wire shall be doubled back into the duct at each termination. All ducts shall be laid in straight lines only, with a minimum number of joints throughout the lengths of each duct run.

Where joints shall be provided the ends of all ducts shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling ducts. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads on all ducts shall be well painted with a good quality of lead or rust preventive paint before couplings are made up.

All ducts shall be checked with a mandrel after completion of each installation.

Unless otherwise approved by the Engineer ducts shall be laid to a depth of not less than 60 cm below the curb grade in the sidewalk and all other areas and to a depth of not less than 80 cm below the finished grade in road-crossing areas.

(d) All excavation for manholes, ducts and cable installation shall be carried out so as to minimize damage to existing surfaces. The Contractor will reinstate all surfaces on completion of backfilling to the original condition and in accordance with the Engineer's instruction. To facilitate reinstatement the outline of all areas to be removed in Portland cement concrete and asphalt concrete sidewalks and pavements shall be cut to a minimum depth of 5 cm with a saw, prior to removing the sidewalk and pavement material. Cut for remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true, and surfaces outside the removal area shall not be damaged.

The Engineer may waive or modify the above requirements for excavation and reinstatement when the excavation lies within an area to be overlaid or reconstructed under other Clauses of these Specifications.

All backfilling for manholes, ducts or cable tracks shall comply with the requirements of Sub-clause S6.05 (3) (c) of these Specifications.

S13.02 (4) Method of Measurement

The quantity of ducts to be paid for will be the number of linear meters of each size of ducts as shown on the approved drawings. Only ducts laid in accordance with the approved drawings and the Engineer's instructions and proven by mandrel will be measured for payment. The number of manholes paid for will be the number of each type of structure furnished and installed in accordance with this specification and the instructions of the Engineer. Any additional manholes installed because of the Contractor's method of working will not be measured for payment. The quantity of cable protectors or markers to be paid for will be the number of linear meters laid above cables in accordance with the approved Drawings and the Engineer's instructions.

The quantity of excavation measured for payment will be the number of linear meters of cable or duct track excavated in accordance with the approved Drawings and the instructions of the Engineer. The measurement of cable or duct track will be independent of the width or depth.

S13.02 (5) Basis of Payment

The quantities, determined as provided above shall be paid at the Contract price per unit of measurement for the pay items as listed below, which price and payment will be full compensation for all materials, labor, equipment and other incidentals necessary to complete the work in accordance with the Drawings, these Specifications and as instructed by the Engineer. In particular, the unit price for cable and duct excavation will cover all excavation and backfill through any material and to any depth and such reinstatement as the Engineer considers is necessary. Payment for duct will include furnishing and installing marker stakes at the ends of ducts which are buried.

Excavation for manholes will not be measured separately, but will be deemed to be included in the unit price for these items.

Pay Item No. and Name		**Unit of Measurement**
13.02 (1)	Protection of Cable or Duct Cable Track	Linear meter
13.02 (2)	Cable Tray	Linear meter
13.02 (3)	Excavation of Cable or Duct Cable Track	Linear meter
13.02 (4)	Horizontal Duct of Underground	Linear meter
13.02 (5)	Electrical Manhole, Type-A	Each
13.02 (6)	Electrical Manhole, Type-B	Each
13.02 (7)	Galvanized pipe Ø 6" (1 lane)	Linear meter
13.02 (8)	Galvanized pipe Ø 6" (2 lanes)	Linear meter

13.02 (9) Galvanized pipe Ø 4"	Linear meter
13.02 (10) Iron steel protection	Linear meter
13.02 (11) PVC pipe Ø 6"	Linear meter
13.02 (12) PVC pipe Ø 4"	Linear meter
13.02 (13) Utilities pipe, Type-1	Linear meter
13.02 (14) Utilities pipe, Type-2	Linear meter
13.02 (15) Utilities pipe, Type-3	Linear meter

S13.03 Drainage Pump

S13.03 (1) Description

This work shall consist of furnishing and installing control room of drainage pump at locations shown on the Drawings or instructed by the Engineer.

S13.03 (2) Materials

All materials shall be as shown on the Drawings or equivalent as approved by the Engineer. Working drawings and details of materials sources shall be approved by the Engineer before procurement of materials.

All materials for the electrical work shall be approved by the Engineer before orders are given to the suppliers or manufacturers.

The pump shall have the capacity to pump up 110 liter/s (0.11 m3/s) vertically from the reservoir under the road surface to catch basin on the level of frontage road.

S13.03 (3) Construction

All details of construction shall be in accordance with the approved working drawings and the relevant Clauses of the Specifications.

S13.03 (4) Method of Measurement

The quantities to be paid for will be the actual number of Drainage Pumps furnished and installed in accordance with the Drawings and the Engineer's instructions.

S13.03 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price for each Drainage Pump. The prices and payment will be full compensation for furnishing and installing the Drainage Pumps, including pipe from pump to catch basin above, supporting materials for pipes, foundation for the pump and all other material necessary for sufficient drainage system, labor, equipment, and all incidentals necessary to complete the work as shown on the Drawings.

Pay Item No. and Name	**Unit of Measurement**
13.03 Drainage Pump	Each

S13.04 Generator for Drainage Pump with Electric Panel

S13.04 (1) Description

This work shall consist of furnishing and installing control room of generator at locations shown on the Drawings or instructed by the Engineer.

S13.04 (2) Materials

All materials shall be as shown on the Drawings or equivalent as approved by the Engineer. Working drawings and details of materials sources shall be approved by the Engineer before procurement of materials.

All materials for the electrical work shall be approved by the Engineer before orders are given to the suppliers or manufacturers.

The Generator shall have the capacity of output rating: 55 KVA. It shall be soundproof type. The specification is as follows:

Output rating:	55 KVA
Voltage Rating	3 phases 220V / 380V, single voltage System
Frequency:	50 Hz
Power Factor:	0.8
Voltage Regulation	within ±1.0
Rotation:	1500 rpm
Insulation:	Class F
Fuel:	Diesel Fuel of equivalent (ASTM 2)

Generator Panel shall consist of followings. Voltmeter, Ampere meter, Frequency meter, Hour operating meter, DC Ampere meter, DC Voltmeter, Breaker.

Electric Panel shall follow the following specifications.

The main Circuit Breaker/CBs shall be of 150 Ampere rating electrically interlocked relays and shall be arranged with 3 positions as follows:

- Automatic mode
- Manual mode
- Trial mode

with the following indicators and pilot lamps :

OFF
Automatic mode
Manual mode
Trial mode
Supervision "ON"
Diesel running
Low oil pressure
Engine overheating

Main source CB on
Generator CB on
Start fails
Start
Manual start
Manual stop
Block
Reset
Test

The panel shall also be equipped with an emergency stop and horn automatically activated in case of emergency.

S13.04 (3) Construction

All details of construction shall be in accordance with the approved working drawings and the relevant Clauses of the Specifications.

S13.04 (4) Method of Measurement

The quantities to be paid for will be the actual number of control rooms furnished and installed in accordance with the Drawings and the Engineer's instructions.

S13.04 (5) Basis of Payment

The work measured as provided above will be paid for at the Contract unit price for each Generator with electric panel. The prices and payment will be full compensation for furnishing and installing the Generator including generator panel, electric panel, support and foundation, and all other material necessary for sufficient drainage system in emergency as well as normal condition, labor, equipment, and all incidentals necessary to complete the work as shown on the Drawings.

Pay Item No. and Name		**Unit of Measurement**
13.04	Generator for Drainage Pump	Each

DIVISION 14 TOLL PLAZAS

S14.01 Toll Plaza Works

S14.01 (1) General

This work consists of the construction of Toll Plazas and the furnishing and installation of Toll Plaza facilities, all in accordance with the Drawings, these Specifications, or as instructed by the Engineer.

S14.01 (2) Scope of Works

The scope of works can basically be divided into two parts, as follows :

(a) Construction of the Toll Plaza consisting of Toll Gate Island, Toll Gate Roofing, Foundation for Toll Gate Roofing, Generator House, Electrical Manhole and Septic Tank.

(b) Furnishing and installation of all materials and equipment to complete the Toll Plaza facilities such as Lighting Installation, Lightning Protection, Intercom, Alarm System, Public Address, CCTV, Traffic Lights, Fresh Air Supply, Guide Signs, Sanitary Work, Plumbing, Generator and AMF, Toll Booths, Flower Pots and Collection Furniture.

The above works shall be executed as described and shown on the Drawings and shall include but not necessarily be limited to :

(a) Preparation and submission of Shop Drawings;

(b) Submission of detailed Material Supply List; and

(c) All other electrical equipment and services shall be completed and operated in accordance with the pertinent electrical code and local regulations for Electrical Installations.

S14.01 (3) Quality Assurance

(a) For the construction of Toll Plaza as described in Sub-clause S14.01.(2).(a), the codes and regulations governing the execution of civil engineering works as referred to in the various Clauses of the General and Special Specifications shall be applied together with the relevant Clauses of this Division 14.

(b) For the Toll Facilities works as grouped in Sub-clause S14.01.(2).(b) refer to Sub-clauses S.13.01.(3).(a) and S.13.01.(3).(b) of these General Specifications together with the relevant Sub-clauses of this Division 14.

S14.01 (4) Drawings and Documents

(a) Since the supplied drawings are to indicate generally the arrangement of the work, the Contractor shall refer to all relevant drawings to ascertain for himself the location and routes of all other utility services so as to maintain adequate clearances between electrical and other services. The Contractor is therefore required to provide working drawings in duplicate

showing the exact routes of all underground or overhead cables and ducts, the exact run of all conduits and trunking, the location of manholes, draw-in and junction boxes, the number and size of wires in each conduit or trunking, the final connection arrangements at distribution boards, the detail of ducts and the method of fixing Main and Sub- main Distribution Boards for the portion of the Works. The contractor shall submit a programme indicating the dates on which concreting in different sections will take place, together with the submission of the working drawings.

(b) On completion of testing, the Contractor shall make "as- built" drawings of plans and circuit diagrams, which clearly indicate any modifications made to the original design.

(c) Upon completion of the work, and as a condition of its acceptance, the Contractor shall supply to the Engineer three copies of a Manual for the maintenance and operation of all electrical installations and a parts list sufficient for the ordering of parts.

S14.01 (5) Standards

(a) The works in Sub-clause S14.01 (2) (b) covered by this contract shall be carried out in accordance with the regulations issued by the local Electricity Authority and with the applicable standards and codes of any of the following :

AIEE	:	American Institute of Electrical Engineers
ASA	:	American Standards Association
ASTM	:	American Society for Testing Materials
DIN	:	German Industry Standards (*Deutsche Industrie Normen*)
IEA	:	International Electrical Association
JEA	:	Japanese Electrical Association
JIS	:	Japanese Industrial Standards
NEC	:	National Electrical Code (USA)
NECA	:	National Electrical Contractors "Standards of Installation" (USA)
NEMA	:	National Electrical Manufacturers Association (USA)
PLN	:	Indonesian Government Electrical Company
SII	:	Indonesia Industry Standard (*Standar Industri Indonesia*)
SNI	:	Indonesia National Standard (*Standar Nasional Indonesia*)
UL	:	Underwriters Laboratories, Inc.

(b) Before submitting his Bid, the Contractor must carefully examine all of the Regulations issued by the local electricity authority at his own expense and selected materials and method of installation shall be in accordance with these Regulations. The Contractor shall inform himself fully of the local authority regulations, DLLAJR, PLN, PDAM, PT. TELKOM, PT. PGN and appreciate all relevant rules and regulations before the submission of bids.

S14.01 (6) Materials

The materials required for the Construction of works referred to in Sub-clause S14.01 (2) (a) shall follow the relevant Sub-clauses referred to before.

For materials required for provision and installation of Toll facilities the following shall be fulfilled.

(a) Lighting Units

(i) Lighting units as shown on the Drawings shall consist of fixtures, lamps, ballasts, starters and mounting accessories.

Lamps of LED 100 watt daylight type shall be used. Fixtures placed outdoors on the ceiling of the Toll Plaza roof shall be of the recessed type.

(ii) Electrical Panels

Unless indicated otherwise in the Drawings, the panels shall be generally indoor type panels made of steel plate or special plastic material available in the market under well known brand names.

Sufficient space shall be provided to facilitate the easy maintenance and inspection of small wire sizes.

Panels shall be supplied with individual wiring diagram permanently affixed to the inner side of the panel door.

(iii) Panel Components

The components shall be designed for 3-phase, 4 wire, 50 Hz operation at 380/220 volts. The circuit breakers shall be moulded case, air break type, rated for 460 - volt AC service. The circuit breakers interrupting capacity shall be 15,000 amperes and based on JIS C8370 standard duty cycles, except that breakers larger than 225 amperes shall have 25,000 amperes interrupting capacity, or as approved by the Engineer.

(iv) Cable, Wire, Grounding and Electrical Splice Materials

All cable, wire, grounding and electrical splice materials shall comply with the requirements of Sub-clauses S.13.01.(9).(b), S.13.01.(9).(c) and S.13.01.(9).(d) of these General Specifications, and all requirements specified therein shall be applicable.

(v) In-line Connectors

A copper pin and copper receptacle each of at least 90% conductivity shall be crimped to the cable.

The receptacle shall establish constant pressure with the pin by the use of a copper beryllium sleeve spring and shall be equipped with a disposable mounting pin.

The pin shall be of at least half-hard material and the crimping portion shall be fully annealed while the rest of the pin is maintained in its original state of hardness.

The socket shall be fully annealed. Both the copper pin and socket shall have a centrally located recessed locking area adapted to be fitted and retained by the rubber housings. The pin and socket shall lock together so the connection will be maintained

when a minimum force of 10 kg tension pull is applied to the attached cables.

Plugs and socket housing shall each be made of water resisting, synthetic rubber capable of burial in the ground or of installation in sunlight. Each housing shall provide a water-seal around the cable, have an interior arrangement to suit and retain the copper pin or receptacle and shall have a water-seal between the two housings at the point of disconnection.

Each housing socket shall be provided with a through internal vent filled with a predetermined amount of silicon insulating compound which upon assembly of the housing to the conductor element, will force air through the vent rendering the entire interior of the connector body void free.

(vi) Tee Connectors

Each connector shall contain three terminal lugs, a bolt and stop nut. Each lug shall have a mounting hole for bolt and nut. Tap housings and a tee housings shall be made of water-resisting synthetic rubber capable of burial in the ground or installation in sunlight. The tap housing shall have a water-seal around the cable and between itself and the tee housing at the point of connection. The tee housing shall have a water-seal for the tap housing. Each kit shall be supplied with sufficient silicone compound to lubricate the rubber housing for easy assembly.

(vii) Conduit

Conduit installed below ground shall be steel. Exterior and interior surfaces of all steel conduit shall be uniformly and adequately zinc-coated by hot-dip galvanizing process.

Conduit embedded in concrete shall be PVC in accordance with the requirements of JIS C8430.

(b) Lightning Protection

Air-terminals shall be of conventional copper type as indicated in the Drawings.

BC conductors shall be fixed by a bracket at each 50 cm length and rubber sealants shall be applied to all holes to avoid leakage. The maximum ground resistance shall be less than or equal to 1(one) ohm.

(c) Alarm System

A control unit shall be placed at the road safety patrol room. A strobe light of yellow colour shall be fixed to the ceiling of the Toll Booth as indicated in the Drawings.

All Toll Booths shall be equipped with push buttons for quick and easy operation.

A siren shall be placed near the strobe light as shown on the Drawings.

(d) Public Address System

All Toll Booths shall be equipped with a microphone of condenser type with chime attached. The frequency response shall be 50 Hz to 20 KHz, output impedance 600 ohm and balance of uni-directional pickup pattern.

The speakers shall be of horn type of frequency response 280 Hz to 12,500 Hz and shall have an Output Sound Pressure as follows :

Input 1 watt, 1 meter	:	104 dB
Input 15 watt, 1 meter	:	116 dB

Input Rating 15 watt with impedance 8 ohm.

The Pre-Amplifier, separated from the Power Amplifier, shall have 1 input module for both microphone and chime having the following characteristics:

Power Output Mixer	:	0 dB / 600 ohm
Frequency Response	:	40 Hz to 16 KHz for 1 dB
Total Harmonic Distortion	:	Less than 0.5%
Indicator	:	LED
Power Output Amplifier	:	100 watt

Specification for the Power Amplifier shall be :

Power Output	:	100 watt
Total Harmonic Distortion	:	Less than 1% at 40 Hz to 16 KHz
Controls	:	1 Volume Control
		1 Power ON / OFF switch
		2 Priority inputs paralleled

Specifications for the Volume Control shall be :

Type	:	Auto Transformer
Power Rating	:	in accordance with the horn speaker
Attenuation/Step	:	3 dB / 6 dB
Total Attenuation	:	36 dB
Insertion Loss	:	0.6 dB

All wiring used in this system shall be NYAHY 2 x 1.5 mm2.

All equipment shall be grounded.

(e) CCTV

A camera equipped with a remote control lens and camera adjustment shall be placed at each Toll Booth located so that the CCTV operator can monitor the situation on the 21" UHDTV monitors placed in the road safety patrol room.

(f) Traffic Signals

As indicated in the Drawings, the location of the traffic control lights shall be 1 set overhead each lane entrance 30 cm diameter and 1 set on 20 cm diameter pole painted green. Each set shall consist of 2 LED lamps - 1 green and 1 red which shall be operated from the Toll Booth.

(g) Fresh Air Supply

Not required

h) Air Conditioning

Air conditioning shall be provided only for all personnel booths as follows:

(1) Toll Booth (Short Type)

Air conditioning for short type booth shall be installed as shown on the drawings.

For 4 booths, also utilized for 3 booths, the capacity shall be 15,000 BTU and for 2 booths the capacity shall be 9,000 BTU. Voltage shall be 220 V.

(2) Toll Booth (Long Type)

Air conditioning for long type booth shall be split unit type. Capacity of each unit shall be 8,000 BTU. Voltage shall be 220 V.

The air conditioning units shall be installed in the positions directed by the Engineer.

(i) Air Curtain

Air curtain shall be installed at all short type toll booths. The unit shall be installed above the operator's/personnel's window to provide an air curtain at the window and shall have the following characteristics:

Length	:	90 cm
Air Velocity	:	Dual speed control
		Hi = 9.0 m/s, Lo = 8.0 m/s
Voltage	:	220 V
Frequency	:	50 Hz
Weight	:	Not more than 15 kg

(j) Intercom System

The system shall comprise a key telephone unit with desk type telephone sets with branches as indicated in the Drawings. Armored cables shall be 0.8 mm^2 diameter of manufacture complying with SPLN. For conduits PVC type Az shall be used.

(k) Guide Signs

The relevant requirements of Clauses S12.07 and S12.08 shall be applicable for the guide signs.

(l) Sanitary Installation

Floor drains shall be stainless steel, 50 mm diameter and equipped with a siphon.

Water closets shall be of reputable manufacture equipped with the required fittings.

Excavation for and construction of septic tank shall comply with the code and regulations for civil engineering works.

(m) Plumbing

Piping for the plumbing system shall be PVC according to JIS K6742 type VIP.

The water pump shall be a jet pump type 250 watt single phase 220 volt, with the following characteristics :

Capacity	:	60 Lt. per minute
Section head	:	30 m
Pressure head	:	30 m
Total head	:	60 m

(n) Connection to Water Supply Authority PAM/PDAM

The plumbing system shall be connected to the main piped water supply of PAM/PDAM or from water tank storage if no PAM/PDAM available. The connection point will be determined by the Engineer.

The cost of the water connection will be as determined by the Public Water Authority and will be charged to the Contractor.

(o) Emergency Standby Generator

The emergency standby generator set shall be of the following specifications:

(i) Generator 100 KVA

(1) Diesel Engine

Rating	:	150 HP or as shown in the Drawings
Rpm	:	1500
Stroke	:	4

Water cooled, electrically started, skid mounted and equipped with vibration dampers.

(2) Fuel System

500 l daily tank on a steel structure 3 m high to enable fuel supply by gravity.

3000 l fuel tank on a concrete base, connected to the daily tank with transfer pump, electrical and manual type.

Fuel line connection through a set of filters, pre and fine filters, an injection pump and fine adjustment screw.

(3) Lubrication System

Lubrication oil pump

Filtered cooling radiator

Pressure gauge

Oil change pump (manual)

- Air Intake

  Filtered intake turbo charger system

- Exhaust System

  Insulated exhaust manifold with residential type silencer

- Cooling System

  Water cooling system equipped with circulator pump, radiator and fan

- Engine Monitor System

  The engine monitor system will protect the engine from:

  - low oil pressure
  - over speeding
  - coolant deficiency

  and shall be equipped with an emergency shut down button

- Manuals

  Manuals to be supplied are:

  - operation manual
  - repair manual
  - spare parts manual with a 2000 hours recommended spare part list

(4) Generator Set

Output rating	:	100 KVA continuous rating
Voltage rating	:	3 phase, 220 V / 380 V AC
Frequency	:	50 Hz
Rpm	:	1500
Power factor	:	0.8
Isolation	:	Class F

Standard : VDE IP-23

Voltage regulation shall be automatic and the generator shall be a brushless 3 phase synchronous type with damper windings.

(ii) Generator 30 KVA

(1) Diesel Engine

Rating : 55 HP

Rpm : 1500

Water cooled, electrically started with a 24-volt battery of 50 AH and equipped with a 500 Lt. fuel tank.

(2) The Generator Set

Output rating : 30 KVA

Voltage rating : 3 phase, 220 V / 380 V

Frequency : 50 Hz

Rotation : 1500 rpm

Power factor : 0.8

Isolation : F Class; IP - 23 (VDE)

The generator shall be brushless, three phase synchronous type with damper windings revolving field, self-excited, self-regulated.

(iii) Generator Panel

The generator panel shall be of free standing type made of 3.2 mm steel plate and steel frame, painted with an anti-rust layer as the first coat and heat treated grey color finished layer.

The panel shall contain the following:

- Voltmeter : Scale from 0 - 500 V

  Direct measurement, moving iron type, rectangular shape 100 mm x 100 mm, connected with a selector switch with suitable contacts for 3x phase to neutral, 3x phase to phase and an OFF position.

- Ampere meter : Scale 0 - 100 A

  One for each phase, moving iron type, rectangular shape 100 mm x 100 mm, operated with the aid of current transformers.

- Frequency meter : Vibration type with accuracy error less than 0.3%, rectangular shape 100 mm x 100 mm.

- Hour operating meter : Rectangular shape 50 mm x 50 mm.
- DC Ampere meter : Scale 0-50 A, moving iron type rectangular shape 100 mm x 100 mm.
- DC Voltmeter : Scale 0-50 V, moving coil type, rectangular shape 100 mm x 100 mm.

The main MCCB shall be a 3 pole 200 A breaker for the 100 KVA generator and 100 A for the 30 KVA generator.

The panel shall be placed on a foundation as shown on the Drawings.

(iv) Automatic Mains Failure (AMF) Panel

The main CBs shall be of 150 Ampere rating electrically interlocked relays and shall be arranged with 3 positions as follows:

- Automatic mode
- Manual mode
- Trial mode
  with the following indicators and pilot lamps:

  OFF
  Automatic mode
  Manual mode
  Trial mode
  Supervision "ON"
  Diesel running
  Low oil pressure
  Engine overheating
  Main source CB on
  Generator CB on
  Start fails
  Start
  Manual start
  Manual stop
  Block
  Reset
  Test

The panel shall also be equipped with an emergency stop and horn automatically activated in case of emergency.

The panel shall be of free standing type, made of 3.2 mm steel plate and steel frame, painted with an anti-rust layer as the first coat and heat treated grey colour finished layer.

(p) Fire Extinguishers

Multipurpose dry chemical type fire extinguishers shall be of the type for use against A, B or C types of fire with spray which is not injurious to operator, not of poisonous, unhealthy, corrosive or electrically conductive materials.

The extinguisher shall be of 4.5 kg weight, shall be placed upright and shall not be shaken before use. The active life of the extinguisher shall be not less than two years and shall have a range of 3.0 m.

(q) Steel Structure

The structure shall be of steel with plate conforming to JIS G 3101 or ASTM A36/A36M-14 or SNI 6764:2016 standards.

The welding electrodes shall be of steel electrode type Eutectic Rod Unimatic 6,000 (AC-DC) with tensile strength of 68,000 psi or equivalent.

Bolts and nuts shall conform to ASTM A36/A36M-14 for black bolts and F3125/F3125M-15a or SNI ASTM A325:2012 for HSB type.

(r) Wood

All wood used in the project structures shall be straight, old and dry and in accordance with SNI 7973:2013.

(s) Mosaic Tiles

The dimensions of the tiles shall be 10 cm x 20 cm originating from a local well known manufacturer. The colour and texture will be determined by the Engineer.

(t) Aluminum

Aluminum profiles shall comply with the following specification:

Anodize thickness	:	20 - 20 microns
Breaking limit	:	22 kg / mm^2
Elasticity limit	:	0.078 inch (without damaged)
		0.056 inch (with damaged)
Profile thickness	:	minimum 1.5 mm

Other accessories shall be aluminum.

All glass shall be 5 mm thick, with edge protected by vinyl gasket.

The specification for door keys is as follows:

Office : Kend or equivalent

Toilet : Alpha 6,000, p.11 WC or equivalent

Toll Booth : Cisa 44210 or equivalent

(u) Ceiling

Super deck type C thickness 0.3 mm or equivalent shall be used for the ceiling of the Toll Plaza roof.

(v) Roof and Fascia

Roof material shall be as follows:

- Office type LT 7 SWG 22
- Toll Booth Type L 7 SWG 22

The fascia material shall be Super deck type B (height of corrugation 15 mm) thickness 0.7 mm or equivalent of brown color.

S14.01 (7) Construction

(a) General

All workmanship shall be completed in accordance with the latest accepted standards of the industry as determined by the Engineer.

(b) Conduit

Installation of conduit shall be performed in accordance with these Specifications and in reasonably close conformity with the location as specified in the Drawings or as directed by the Engineer.

The size of conduit shall be as shown on the Drawings. Conduits smaller than 25 mm shall not be used, unless otherwise specified. It shall be the option of the Contractor, at his own expense, to use larger size conduit if desired and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

Ends of conduit shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that ends will butt or come together for the full circumference.

Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads on all-steel conduit shall be painted with good quality lead or rust-preventive paint before couplings are made up. All steel couplings shall be screwed up until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run. Where coating on conduit has been damaged in handling or installing, such places shall be thoroughly painted with rust-preventive paint.

All conduit ends shall be threaded and capped with standard conduit couplings capped with conduit push pennies until wiring is started. When couplings and push pennies are removed, the threaded ends shall be provided with approved conduit bushings. The use of any plugs, even temporary in lieu of the aforementioned conduit couplings and push pennies is expressly prohibited.

Conduit stubs from bases shall extend at least 15 cm from the face of foundations and at least 80 cm below the top of foundations.

Conduit bends, except factory bends, shall have a radius of not less than 6 times the inside diameter of the conduit. When factory bends are not

used, conduit shall be bent using an approved conduit bending tool employing correctly sized dies, without crimping or flattening, using the longest radius practicable.

Galvanized pull wire shall be installed in all conduits which are to receive future conductors. At least 60 cm of pull wire shall be doubled back into the conduit at each termination.

(c) Pull Boxes

Pull boxes shall be installed at the locations shown on the Drawings, and at such additional points as ordered by the Engineer. The Contractor may install, at its own expense, such additional boxes as may be desired to facilitate the work.

(d) Wire

Wiring shall conform to appropriate code requirements. Wiring within cabinets, manholes, etc. shall be neatly arranged and within cabinets shall be laced.

Powdered soapstone, talc, or lubricants shall be used in placing conductors in conduit.

Splicing in conductors will be permitted only at manholes, transformer leads, in pole bases, or at control equipment.

(e) Steel Profiles

Steel profiles shall be free of rust and backed up by the required quality certificates. All welding work shall be done by qualified welders and preferably by welders with qualifications as stipulated in JIS 2.3801.

All steel surfaces shall first be zinc-chromate primed twice before the final layers are applied.

Prior to painting, all surfaces shall be cleaned and sand blasted if required.

(f) Aluminum Works

Aluminum sheets shall be fixed by using screws, interlocking profile or rivets.

Aluminum frame in contact with cement or other materials, which might damage the anodizing shall first be protected by grease and wrapped in paper or caulking.

(g) Water Closets

Before installing water closets, a 3 cm thick oak wood base shall be placed and the water closet then screwed on by bronze screws.

(h) The Generator-Set Testing Procedure

After the generator-set has been completely installed, the following testing procedure shall be followed:

(i) Generator

With the use of an artificial loading device, the loading steps shall be :

No load	60 minutes
25% full load	15 minutes
50% full load	15 minutes
100% full load	60 minutes
110% full load	15 minutes

(ii) AMF (Automatic Mains Failure)

Having reached 25% generating load level the AMF shall be tested against:

(1) Functioning of the standing relays, such as automatic mode, manual start, etc.

(2) Interchange of power sources.

The testing procedure shall be repeated prior to first and final hand-over for 100% loading.

(i) Field Tests

Prior to completion of the work, the Contractor shall cause the following tests to be made on all traffic signals and lighting circuits, in the presence of the Engineer.

(i) Tests for continuity of each circuit.

(ii) Tests for grounds in each circuit.

(iii) A megger test on each circuit between the conductor and ground with all switch boards, panel boards, fuse holders, switches, receptacles and over current devices in place and all reading recorded. The Contractor shall furnish the Engineer with three copies of the test results identifying observed readings with their respective circuits. The insulation resistance between conductors and grounds shall be not less then 8 mega-ohms.

Any change in the above stated minimum reading shall be approved by the Engineer which approval shall be in writing, following written application by the Contractor.

(iv) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

(j) Painting

All painting required shall be in conformance with applicable portions of Clause S12.18 of these Specifications.

If the enclosure of any electrical equipment (less signal heads) located above ground does not have an exterior surface of either aluminum or

galvanizing, then it shall be finished with two coats of an approved zinc based paint, plus such finishing coat as the Engineer may direct.

Controller cabinets shall be finished in accordance with the above requirements for electrical equipment.

(k) Panels

All control cabinets and control equipment shall be factory wired ready for operation. Field work shall be limited to placing cabinets and equipment and connection of field wiring to field terminal strips.

(l) "As-Built" Drawings

Upon completion of the work, the Contractor shall submit "As-Built" or corrected drawings, or any data therefor as required by the Engineer, showing in detail all construction changes, especially location and depth of conduit and complete schematic circuit diagrams.

The drawings shall be on sheets conforming to the standard contract Drawings. Corrected drawings shall be made on full sized sheets and not on reduced size prints.

(m) Guarantee

The Contractor shall furnish the Employer with any guarantee or warranty required as a normal trade practice in connection with the purchase of any materials or items used in the construction of the illumination or traffic signal system or systems included in this Contract.

S14.01 (8) Method of Measurement

The quantity of each item paid for under this Clause will be the number of individual items as detailed below which are furnished and installed in accordance with this Specification, the Drawings and the instructions of the Engineer. Supply and installation of electrical cable and connection to existing or new generator system will not be measured separately and is deemed to be included in the item for electrical installation.

S14.01 (9) Basis of Payment

The quantity measured as provided above, shall be paid at the Contract unit price for each pay item as described below. The price and payment will be full compensation for all the work shown on the Drawings or described in these Specifications.

Pay Item No. and Name		**Unit of Measurement**
14.01 (1)	Toll Island Type. A (standard)	Each
14.01 (2)	Toll Island Type. B (standard with holes for stairs)	Each
14.01 (3)	Toll Island Type. C (for long booth type-security and chief toll collector booth)	Each

14.01 (4)	Toll Island Type. D (for long booth type-water closet booth)	Each
14.01 (5)	Toll Island Type. E (for reversible booth)	Each
14.01 (6)	Toll Island Type. F (for outer side of gate)	Each
14.02 (1)	Short Booth for Standard Type	Each
14.02 (1a)	Short Booth for Automatic Type (GTO)	Each
14.02 (2)	Long Booth for security and chief toll collector	Each
14.02 (3)	Long Booth with Water Closet	Each
14.03 (1)	Roof of the Toll Gate for 2 Islands	Each
14.03 (2)	Roof of the Toll Gate for 3 Islands	Each
14.03 (3)	Roof of the Toll Gate for 4 Islands	Each
14.03 (4)	Roof of the Toll Gate for 5 Islands	Each
14.03 (5)	Roof of the Toll Gate for 6 Islands	Each
14.03 (6)	Roof of the Toll Gate for 7 Islands	Each
14.03 (7)	Roof of the Toll Gate for 8 Islands	Each
14.03 (8)	Roof of the Toll Gate for 9 Islands	Each
14.04 (1)	Movable Generator Set 100 KVA (sound proof trailer)	Each
14.04 (2)	Movable Generator Set 50 KVA (sound proof trailer)	Each
14.04 (3)	Movable Generator Set 30 KVA (sound proof trailer)	Each

DIVISION 15 RELOCATION OF EXISTING UTILITIES AND SERVICES

S15.01 Relocation of Existing Utilities and Services

S15.01 (1) General

(a) This work consists of the relocation of existing underground service conduits, cables, lighting, electric power poles, telephone poles and traffic signal poles, together with all associated fittings, as necessary for the proper and smooth execution of the road works, as shown on the Drawings or as directed by the Engineer.

(b) The Provisional Sum which is included in this Clause is to cover the contingency allowance for possible price increases such as : (a) the work to be executed and, (b) plant, materials or services to be purchased by the Contractor, from a nominated Subcontractor as specified in Sub-clause 13.5 of the Conditions of Contract (if GCC of FIDIC applied) or Particular Conditions of Contract. The use of any Provisional Sum shall be subject to approval of the Engineer with the agreement from the Employer. Representative

S15.01 (2) Measurement and Payment

As indicated above, all costs associated with the Provisional Sum as specified in Sub-clause 13.5 of the Conditions of Contract (if GCC of FIDIC applied) or Particular Conditions of Contract will be paid under this Division.

Pay Item No. and Name		Unit of Measurement
15.01	Relocation of Existing Utilities	Provisional Sum

DIVISION 16 TOLL OFFICE AND FACILITIES

S16.01 General

Division 16 of these Specifications refers only to the area designated on the drawings as the Toll Office and Facilities area.

Unless specified to the contrary within this Division 16 the requirements of the General Specifications, the Special Specifications and any Addenda thereto shall apply.

S16.02 Site Works

S16.02 (1) Scope of Works

(a) General

The following scope of works as stated do not limit the extent of the works which are fully defined in the entire Specifications and Drawings but merely provide a preliminary overall description.

(b) Description of Works

The work to be executed consists of the following:

- Grading and preparation of existing ground or embankment as necessary under and around the Toll Office and Facilities Area
- Construction of Roads and Parking Lot
- Construction of Drainages around the Buildings
- Construction of Drainage Trenches, Culverts and Grates
- Excavation of Road-Side Drain
- Construction of Flower Boxes
- Landscaping i.e. planting, grass, flowers or shrubs, etc.
- Fence.

(c) Site Location

The site location is shown on the Drawings.

S16.02 (2) Site Clearing, Demolition, Excavation and Filling

(a) Specification Requirements

Site Clearing, Demolition, Excavation, Geotextile Sheet and Filling will be carried out in accordance with the requirements of Division 2 "Site Clearing", Division 3 "Demolition" and Division 4 "Road Earthwork" of these Specifications.

Excavation and Backfilling for structures, drainage, pipes, etc. shall be carried out in accordance with the requirements of Division 5 "Structure Excavation" of these Specifications.

(b) Method of Measurement

The quantities to be paid for shall be measured in accordance with the respective provisions of Division 2, Division 3 and Division 4 of these Specifications.

(c) Basis of Payment

The work measured as provided above shall be paid for in accordance with the provisions of Division 2, Division 3 and Division 4 of these Specifications.

Performance of excavation and backfilling for structures, drainage, pipes, etc. is not paid directly but shall be considered as a subsidiary obligation of the Contractor covered under the Pay Items in Sub-clause S16.03 (6) for performance of the respective works.

S16.02 (3) Masonry Works

(a) Cement

Cement for masonry works shall be of the same quality as the cement specified for concrete works, Sub-clause S16.02 (2).

(b) Sand

Sand for masonry works shall conform to the requirements of AASHTO M45-15 or SNI 03-6820-2002

(c) Water

Water used for masonry works shall be clean, free from harmful matters or impurities that will affect the bonding actions of the cement.

(d) Mortar Types

(i) Composition

The following mortar mixes shall be used as and where instructed on the drawings or in these specifications as follows : 1 part Portland Cement (1 PC): 5 parts sand (5 sand).

(ii) Mixing

Mortar shall be mixed in an approved mixer or by hand on a clean hard surface. Each batch shall be proportioned by volume, accurately measured and thoroughly mixed with the minimum amount of water to uniform consistency and workability.

Mortar shall not be mixed until needed. Any unused mortar mixed for a period of one (1) hour shall be discarded. Stiffened mortar shall not be re- tempered with water and shall be discarded.

(e) Stone Masonry

(i) Material

The stone shall be of the best quality locally available materials, sound, clean, free from cracks and other defects affecting the

quality. Either broken rock or river stone are acceptable. Maximum diameter size of stone is 15 cm.

(ii) Mortar

All stone masonry shall be executed with mortar type according to Sub-clause S16.02.(3).(d) and jointed with 1 PC : 5 sand.

(iii) Execution

The stone masonry structures shall be set out and built to the respective dimensions and heights required to comply with the drawings.

(iv) Protection

Stone masonry structures in the course of erection which are exposed to the weather shall be protected during periods of heavy rain by covering with suitable materials.

(v) Curing

The stone masonry shall be kept damp with water for a minimum period of 7 days after erection.

(v) Brick Masonry for Trenches/Gutters

The brick masonry shall be executed with mortar 1 PC : 5 sand, all joints shall be raked to 1/2 cm depth. All broken/damaged bricks shall not be used.

S16.02 (4) Roads and Car Parks

(a) General

The whole of the roadworks shall be constructed in accordance with the drawings. All road paving shall have a curb lining of curb Type A in accordance with Clause S12.12.

(b) Sub-grade

Description and construction of sub-grade preparation shall comply with the requirements of Clause S7.01 of these Specifications.

(c) Aggregate Base

Aggregate Base Class A Layer as required in Division 8 with a thickness of shown in Drawing, well compacted, placed at the top of the sub-grade as wide as the road (carriageway and shoulder), and all topsoil shall be completely removed from the sub-grade.

(d) Bituminous Pavement

(i) General

Bituminous pavement shall comply with the requirements of Clause S9.01 of these Specifications.

(ii) Bituminous Prime Coat

Bituminous prime coat description, material and construction shall comply with the requirements of Clause S9.04 of these Specifications.

(iii) Bituminous Layer

The asphalt layer consisting of AC-WC with a thickness of 4 cm and AC-BC with thickness of 6 cm, material and construction shall comply with the requirements of Clause S9.07 of these Specifications.

(e) Final Surface of Carriageway

The final surface of the carriageway shall be measured and comply with the requirement of Sub-clause S9.07.(3).(h) of these Specifications.

The surface shall be evenly textured and show no lean or flat areas and shall not have any low or flat spots where water will collect, and no surfacing work shall be executed in wet weather.

S16.02 (5) Drainage Trenches and Culverts

(a) Excavation for Road-Side Drains

Excavation for road-side drains shall be straight lines and to the correct depth and gradients as indicated on the drawings. The drain bottoms shall be of sufficient width to allow adequate working space.

Excavated material shall not be deposited within 50 cm of the edge of the trench and the side of the excavations shall be supported by planking and strutting if necessary, to ensure the proper and speedy execution of the work.

In case that the excavations as being made are deeper than necessary, they shall be filled to the proper level with an efficient means of effecting consolidation.

All excess soil from the excavation shall be removed from site as directed by the Engineer.

(b) Excavation for Culverts and Drainage Trenches

All preparatory works and excavations shall be executed in accordance with Sub-clause (a) of this Clause.

(c) Concrete Open Drains

Construction of concrete open drains shall be in accordance with the Specifications, dimensions and details shown in the Drawings. Such drains shall be formed of half round open concrete pipes set in concrete surround around buildings etc. and entirely in reinforced concrete construction where shown on the Drawings.

(d) Concrete Pipe Culverts

Excavation for the culverts shall be in trench, the width of which shall be at least 0.50 m greater than the outside diameter of the pipes. The concrete

pipe culverts shall be constructed to the specified dimensions, lines and levels, complete with beds, and where directed, suitable wing-walls, head walls, aprons and sump pits all as specified and as shown in the drawings.

Compacted sand beds shall be at least 0.10 m thick and 0.20 m. wider than the outside diameter of the pipes.

Brick masonry collars 10 cm thick (mortar 1 PC: 3 sand.) shall be made at each pipe joint.

Stone masonry wing-walls, head walls, aprons and sump pits in thickness according to the drawings shall be provided to the pipe culverts where directed. Where no head-wall is provided haunching or surrounds shall be terminated flush with the ends of the pipes. All stone masonry shall be made with mortar 1 PC: 3 sand.

Pipes shall be accurately laid along the center of the bed, properly butt-jointed and mortared to prevent ingress of grout or of backfill material. The steel grate in the sump pit shall be made according to the detailed drawings.

Backfill shall be evenly spread and thoroughly compacted in layers. No traffic over the concrete pipe culverts shall be permitted for at least 7 days after completion of all concrete pours.

(e) Brick Masonry Drainage Trenches/Gutters and Flower Boxes/Planters

The brick masonry trenches/boxes shall be constructed in accordance with Sub-clause S16.01 (3) (f) and the Drawings. Compacted sand beds shall be at least 0.10 m thick and 0.20 m wider than the outside dimensions of the bottom. Backfill shall be evenly spread and thoroughly compacted in layers.

(f) Reinforced Concrete Trenches

The concrete quality shall be Class C and the steel reinforcement Grade 40 or BJTP 280 (mild steel), and shall comply with the requirements for concrete works, Sub-clause S16.03 (2).

S16.02 (6) Landscaping

Landscaping work shall be carried out, measured and paid in accordance with Clause S12.17 of these Specifications.

S16.03 Building Work

S16.03 (1) Scope of Works

(a) General

The scope of works is as follows hereafter. Such descriptions do not limit the extent of the works which are fully defined in the total Specifications and Drawings but merely provide a preliminary overall description.

(b) Description of Work

The work to be executed consists of the construction of:

- Toll Office
- Staff Housing
- Security House
- Genset House
- Pump House
- Water Tower
- Ground Water Tank
- Covered Walkway

(c) Site Location

Site location is shown on the Drawings.

S16.03 (2) Concrete Works

(a) Material

Materials for concrete works shall meet the requirements of Division 10 and related ones.

(b) Final Surface of Concrete Cement

The final concrete surface for structural work as specified or shown in the Drawings will be achieved with the use of good quality references. The rough surface plastered will not be accepted.

(c) Anchors for Walling

At all vertical connections of concrete columns with walls, the Contractor shall provide 8 mm diameter rod steel bars, 40 cm long, bent at one end and cast into the concrete and the other end of 25 cm length for later connections with walls. The anchors shall be located at distances of 50 cm., 150 cm., 250 cm., etc. measured from the top of the reinforced concrete tie beam of the foundation or equivalent point.

(d) Sleeves, Openings and Blocks

The Contractor shall locate and install all sleeves, openings, hardwood nailing of fixing blocks, anchors etc. required for the crossing of pipes, fixing of frames or other joinery items, etc. Incorrectly placed devices shall be removed if so directed by the Engineer and other provisions shall be made to achieve the required purpose.

(e) Tolerances

(i) Tolerances for Rough Formed Concrete

The positions of members shall be accurate within 1 cm. but this tolerance shall not be cumulative. Sizes of members shall be accurate to within -0.3 and + 0.5 cm.

(ii) Tolerances for Fair Face Concrete

Tolerance for fair face concrete shall be 0.6 cm for position of members and within O and 0.3 cm for sizes of member. Moreover the displacement of shuttering boards at joints shall not be greater than 0.1 cm, and the displacement from straightness of the members shall be within 1/1000, but this tolerance shall not be cumulative.

(f) Concrete Cover to Steel

The requirements of concrete cover to reinforcing steel as specified in Clause S10.03 shall govern.

(g) Precast Concrete

The covers of manholes shall be made of precast concrete, reinforced with bars dia. 8 mm x 15 cm in both directions. The size and shape of these precast concrete covers are indicated in the Drawings.

(h) Lintels (Latel Beam)

Lintels (latel beam) over doors and similar openings up to a maximum clear span of 2 meters supporting brickwork and without any additional loading shall be constructed as follows:

- for hair brick walls 13 cm x 20 cm
- for one brick walls 22 cm x 25 cm

Lintels shall be in concrete (reinforced with 4 x 10 mm diameter mild steel bars (up to 1 meter span) and with 6 mm diameter mild steel for stirrups at 15 cm centers. Ends of lintels shall be built 20 cm into brickwork.

(i) Expansion Joints

Expansion joints shall be so constructed that any necessary movement may occur with the minimum resistance at joints. Reinforcement shall not extend across expansion joints and the break between the two sections shall be complete.

Premolded joint filler shall be of the thickness noted, shall conform to the requirements of AASHTO M33-99(2012), and shall be used within the expansion joints and construction joints as shown on the drawings.

S16.03 (3) Brick Wall and Stone Masonry Works

(a) Material

Material shall be as specified in Division 10 of these Specifications.

(b) Mortar Type:

- 1 part of PC: 3 parts of sand for masonry with waterproofed mortar.
- 1 part of PC: 5 parts of sand and 1 part of PC: 3 parts of sand for masonry with ordinary mortar.

(c) Bricks and Stone Masonry

(i) Bricks

Bricks to be used will be of local product best quality approved by the Engineer and have a thickness of 10 cm (Half Brick). The bricks shall have plane and clean surfaces, sharp edges, uniform in dimensions and without cracks.

(ii) Stone Masonry

Stone to be used will be of local product best quality, solid, clean, free of cracks and other defects that affect quality and approved by the Engineer. Either rock fragments or river rock will be accepted.

(d) Execution

Walling shall be set out and built to the respective dimensions, thicknesses and heights required to comply with the Drawings. No part of the work shall be carried up more than 1 meter above another at any one time, before filling the corners, intersections and wall ends with reinforcement and grout.

(e) Corners, Intersections and Wall Ends

In accordance with the recommendations and directions given by the manufacturer, all corners, intersections and wall ends shall be executed as intermediate columns. For this purpose the corners, intersections and wall ends shall be filled with 2 vertical steel bars diameter 10 mm and grout of 1 part PC to 2 parts of sand and 3 parts fine gravel.

(f) Intermediate Columns and Bond Beam

Larger wall surfaces shall be strengthened with intermediate columns and bond beam which divide the surface in bays of maximum 12 m^2. The intermediate columns shall be formed by filling the holes with 2 vertical steel bars diameter 10 mm and grout as specified for the intersections.

(g) Raking of Joint

All joints shall be raked at least 0.5 cm to provide a good bond for the plaster work.

S16.03 (4) Carpentry, Joinery and Hardware

(a) Timber

(i) Quality

All timber shall be of the best quality for the kind specified and shall be free from sap wood, shakes, large loose or dead knots, wavey edges, borers and other serious defects. All timber shall be kiln dried.

(ii) Moisture Content

The moisture content of the timber used for internal finish carpentry and joinery shall be less than 15%, and less than 20%

for timber used for structures. Said moisture contents are specified for the materials delivered to the site, and the moisture content shall be maintained until the building is finished.

(iii) Kinds of Timber

The following kinds of timber shall be used for the construction and items of work listed hereafter.

Kind of Timber	U s e
-*Kamper Samarinda* *ex Kalimantan* *Dryobalanops Aromatica* Grade A Durability Class II Strength Class II Unit Weight 0.75 min. as stated in PKKI	- Purlins - Rafters - Roof battens - Roof planks
-*Kamper Samarinda* Grade 5 Durability Class III Strength Class II Unit Weight, 0.75 min as stated in PKKI	- Unexposed ceiling hangers - Unexposed roof planks timber and all timber roof trusses - Wood fascias and ridge pieces of roof - Door and window frames - Door and window blades - Partition frames - Timber louvres - Exposed wood framing of ceiling - Wood slats ceiling - Wood base - All solid wood of furniture - Wood steps, wood railing - Wood framing of sun screens
-Teak (solid teakwood) natural finish quality.	- Timber beads/laths for: * fixing of glazing * lining of joints of wall panels * furniture

All timber shall be stored in a shaded place protected against rain and direct sunlight.

(iv) Testing

All kiln-dried timber for structural use shall be strictly inspected through:

(1) a visual check as directed by PKKI-1961 (Indonesia Timber Construction Code).

(2) the use of moisture content apparatus to measure the moisture degree of each piece of timber.

(3) the use of a machine stress reted timber MSR "Panter L12" (non destructive test) to measure the stiffness value.

(4) the use of a destructive test for verification of MSR Ratings.

(5) points (2), (3), and (4) as stated above shall be executed under the supervision of an approved timber laboratory.

Other timber shall be strictly inspected through points (1) and (2) as stated above.

(b) Dimensions

Unwrought timber shall be full to the dimensions stated except that occasional light variation in sawing is permissible. Wrought timber is to be planed, drilled or otherwise machined or worked at the correct sizes and as shown on the drawings. Only a maximum tolerance of 3 mm in size is allowed.

(c) Exposed Faces

All timber that is to be exposed on the finished surface or joinery work shall be wrought on the appropriate faces, to the satisfaction of the Engineer. All exposed faces of timber shall be planed and smoothed by fine sanding until a smooth surface is obtained.

(d) Knots

Surface for painting may contain sound or tight knots on one side if their average diameter does not exceed 4 cm and does not occupy more than half the width of the surfaces. In surfaces to be natural finished, only small, sound and tight knots will be accepted.

(e) Plywood

Plywood shall be manufactured by a firm which is a member of *"Assosiasi Panil Kayu Indonesia" (APKINDO)* and shall conform to the following:

- All plywood shall be Type I Standard Indonesia exterior grade with water resistant glue.
- Thickness of single layer of veneer shall not be less than 1.0 mm. The lamina shall be superimposed in layers with fibers crossing at right angles in successive layers. The number of layers shall be 3, 5, 7, etc.

- All exposed plywood with a natural finish shall have a face of decorative sliced veneer, preferably teak, but other suitable kinds of decorative timber will also be acceptable, as long as it is consistently used and approved by the Engineer.
- All exposed plywood for transparent finish shall be of equal and uniform color and grain; where grain character or color variations are noticeable, panels shall be selected and arranged on each wall for best match of adjacent panels.

(f) Shrinkage

The arrangement, jointing and fixing of all joinery shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work and shall not cause damage to contiguous materials.

(g) Fabrication

The Contractor shall perform all necessary mortising tenoning, grooving, matching, tonguing, housing, rebating and all other works necessary for correct jointing. He shall also provide all metal plates, screws, nails and other fixings that may be necessary for the proper construction of all framings, lining, etc. and for their support and fixing in the buildings.

(h) Partitions

(i) Material

Partitions made of timber shall be constructed in several rooms at floor plan level. Teak plywood shall be used for the panels.

(ii) Execution

The construction and dimensions shall be according to the drawings and accurately executed. The solid frame shall be framed together with tenon and mortise joints and half lap joints at the crossing in such a manner as to secure rigidity throughout the frame. The joints shall be secured with timber wedges and timber glue and not with timber pins. Frames adjoining concrete structural columns shall be fixed with galvanized screws and fisher or ramset of the specified diameter.

Teak overlay plywood panels shall be applied to the wood frames by adhesive. Panels will be firmly pressed into place and pressure of panel alignment will be maintained until adhesive has set.

(i) Doors, Windows, and Frames

(i) Doors

Flush doors shall be semi-solid cored and shall be covered on both sides with teakwood and formica and one face with glass. The doors shall be manufactured exactly to the dimensions and detailing given on the relevant drawings. Tenon and mortise joints shall be secured by using wedges and not timber pins.

(ii) Windows

Timber windows shall be framed together with fitting tenon and mortise joints secured with timber wedges and not with timber pins. Glazing rebates and beads shall be straight and true to form.

(iii) Frames

The solid frames shall be framed together with tenon and mortise joints in such a manner as to secure rigidity and soundness throughout the frame.

The frames shall be provided with timber as shown on the drawings. Frames adjoining concrete structure columns shall be fixed with timber wedges or ramset. All vertical surfaces adjoining walls or columns shall be provided with a mortar groove. The tenon and mortise joints shall be secured with timber wedges and not with timber pins.

(iv) Finish

The doors, windows and frames shall be truly square and flat. The surface exposed to view shall be true, smooth, free from machine marks and finished for varnishing. The surfaces coming into contact with mortar or masonry and all joints shall be painted two coats of red lead of best quality approved by the Engineer.

(v) Fitting and Hanging Doors and Windows

Each door and window shall be accurately fitted to each frame, with suitable allowance for finishing by painting and possible swelling and shrinking.

Hardware shall be fitted accurately at the positions shown on the drawings.

The clearance at the lock and hanging stiles at the top rail shall not exceed 2.5 mm. The clearance at the bottom shall not exceed 3 mm. All sharp edges shall be rounded.

(j) Protection of Joinery

Joinery shall not be brought on to the site until it is required for building-on or fixing-in. Material for joinery which is to be fabricated shall not be brought prematurely to the site, nor shall joinery works be assembled until the building has progressed sufficiently to receive such works. If stored, the materials and assembled units are to be protected from the weather.

Facilities are to be given to the Engineer to inspect all works in progress in shops and on site.

The Contractor shall further provide all temporary doors and closing-in of all openings necessary for the protection of the joinery works during progress. He shall provide and maintain any boxing or other temporary coverings required for the protection of dressed or finished joinery, projections, moldings, steps or the like that might be damaged during the progress of the work.

(k) Fixed-in Joinery

Where joinery works are to be fixed-in after the surrounding building frame is completed, the Contractor shall ensure that the necessary fixings are incorporated in the frame.

Vertical junctions between frames and buildings carcases shall be filled solid with mortar but a clearance shall be maintained at the head. Joinery shall not be fixed in position until carcasing of the floor, walls and ceilings is completed.

(l) Blocks and Grounds

All necessary blocks and grounds are to be provided and fixed for fitting water closets or other cisterns, also for towel rails, hooks, etc.

(m) Repairing Defective Work

All doors and windows shall operate freely, but not loosely, without sticking and with all hardware properly adjusted and functioning. Should any shrinkage or warping occur or any other defect appear in the joinery and carpentry work before the end of the defects liability period, such defective works shall be taken down and renewed to the Engineer's satisfaction and any work disturbed in consequence shall be made good at the Contractor's expense.

(n) Cleaning

All shavings cut ends and other timber waste are to be cleared out from all parts of the building from time to time and at completion of the works. All waste and rubbish shall be removed or destroyed.

(o) Builders Hardware

(i) General

Based on the hardware requirements indicated in the final hardware schedule, each item of hardware shall be furnished for use on doors, windows, and frames for proper installation and function. The Contractor shall submit a sample of each device to the Engineer before ordering.

(ii) Materials

- Hinges, pivots bolts, spring loaded bolts and casement adjusters shall be “Simonwerk”, “Schwarte”, "Henderson" or equal approved best quality.
- Weather stripping shall be "Super Seal Kleenex Ind. Ltd." or equal approved.
- Lock-cases shall be “Griff”. Nemef”, “Bostinco” or equal approved best quality.
- Cylinders, shall be “DOM”, “Griff” or equal approved best quality.

- Handles, back plates, door pulls, pull bars and push plates, escutcheons, panic exit devices shall be “Griff”, FSB” or equal approved best quality.
- Door closers, floor hinges and closers, door straps shall be “ESB”, “Geze” or equal approved.
- Finish shall match adjacent hardware.
- Sliding door devices shall be "Henderson", “Griff” or equal approved.
- The Contractor shall provide a key control system including labels, tags, card index, as recommended by the system manufacturer.

(iii) Installation

- Each hardware item shall be installed in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished, each item shall be completely installed and then removed and stored in a secure place during the finish application. After completion of the finishes, each item shall be reinstalled. Surface-mounted items shall not be installed until finishes have been completed on the substrate.
- Units shall be set level, plumb and true to line and location. The attachment substrate shall be adjusted and reinforced as necessary for proper installation and operation.
- Units which are not factory prepared for anchorage fasteners shall be drilled and countersunk.
- Threshold and floor covers shall be cut and fitted to profile of door frames, with mitered corners and hairline joints. Openings for spindles, bolts and similar items shall be cut smooth.
- Thresholds shall be screwed to substrate with stainless steel screws of the proper type for permanent anchorage.
- Each operating item of hardware shall be adjusted and checked to ensure proper operation or functioning of every unit.

(iv) Description of Hardware

For the purpose of establishing a basis of quality, the key system, door pulls, pull bars and push plates, escutcheons, panic exit devices specified in the Schedule of Hardware listed hereafter are based upon hardware as manufactured by “Bostinco”. The specifying of hardware by a manufacturer's name and type number shall not be considered as being proprietary but rather as establishing a basis for quality comparison only.

SCHEDULE OF HARDWARE (REFER TO DRAWINGS)
COLOR OF HARDWARE B.5 - DARK BRONZE

SET 1. DOUBLE DOOR WITH EXIT DEVICE

1 Lock case Type 1 without latch bolt
1 Cylinder Type 333 N (GMK)
1 Escutcheon Type II - B.5
4 Push/Pull Type 6670.34 - B.5
4 Screws for push/pull Type 6690 - 2299
2 Door closers Type TS 7310 - D
Aluminum Threshold
6 Hinges
2 Flush bolts
Weather striping at head and jambs.

SET 2. SINGLE DOOR WITH EXIT DEVICE

Weather striping at head and jambs
1 Lock case Type 1 without latch bolt
1 Cylinder Type 333 N (GMK)
1 Push/Pull Type 2141 - B.5
1 Door closer Type TS 7310 - D
3 Hinges

SET 3. TOILET DOOR

1 Lock case Type 1 WC
1 Handle & Backplate Type 1080/WC-B.5
3 Hinges

SET 4.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
3 Hinges
Weather striping

SET 5.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
6 Hinges
2 Flush bolts
Weather striping

SET 6. -

SET 7. -

SET 8.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
1 Door closer Type TS 7301-D
2 Hinges
Weather striping at head and jambs

SET 9.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
3 Hinges

SET 10.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
1 Door closer Type TS 7301-D
3 Hinges

SET 11. HARDWARE FOR STEEL DOOR

1 Lock case Type 1206/Zy/.g.W/65
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 7570/1-B.5
2 Hinges Type D 76

SET 12.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
6 Hinges
2 Flush bolts

SET 13.

1 Lock case Type 1
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5
1 Door closer Type TS 7301 - D
6 Hinges
2 Flush bolts

SET 14. HARDWARE FOR ACOUSTIC STEEL DOOR

1 Lock case Type 1206/Z
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 7570 01-B.5

4 Hinges Type D.76
1 Espagnolet Type 7-124
1 Set sound striping

SET 15. HARDWARE FOR ACOUSTIC STEEL DOOR

1 Lock case Type 1206/Zy/.g.W/65 mm
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 7570/1-B.5
4 Hinges Type D 76
1 Set sound striping

SET 16. HARDWARE FOR MAIN ENTRANCE DOOR WITH EXIT DEVICES

1 Lock case Type 1801 B
1 Cylinder Type 333 N (GMK)
4 Escutcheon Type II-B.5
4 Push/Pulls Type 6670. 380 B.5
4 Screws for Push/Pulls Type 6690-2299
2 Door Hinges/Closers Type BTS-75 including Pivot and Door Straps.
Aluminium Threshold

SET 17. HARDWARE FOR LIGHT TIGHT DOOR (DARKROOM)

1 Lock case Type 1206/Zy.g.W/65 mm
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 7570/1-B.5
1 set light lock striping

SET 18. HARDWARE FOR MAIN ENTRANCE DOOR OF AUDITORIUM WITH EXIT DEVICES

1 Lock case Type 1801 B
1 Cylinder Type 333 N (GMK)
4 Escutcheon Type II-B.5
4 Push/Pulls Type 6670. 38 B.5
4 Screws for Push/Pulls Type 6690-2299
2 Door Hinges/Closers Type BTS-75 including Pivot and Door Straps.
Aluminum Threshold

SET 19. HARDWARE FOR METAL DOORS OF UTILITY BUILDING

1 Lock case Type 1206/Zy.g.W/65 mm
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 7570 01-B.5
4 Hinges Type D.76
Aluminum Threshold

SET 20. HARDWARE FOR METAL SLIDING DOOR OF UTILITY BUILDING

1 Lock case Type 1801 H
1 Cylinder Type 333 N (GMK)
1 Handle & Backplate Type 1080/1-B.5

1 Set Henderson straight sliding single run (see detail drawings)
1 Set sound striping at head and jams.

SET 21. HARDWARE FOR WINDOW BLADES

- Spring loaded bolt
- Pivots
- Casement adjusters

S16.03 (5) Roofing and Roof Structure

(a) Cement Tile Roofing, Roof Insulation and Metal Flashing

(i) Material

Roof Tiles

Where indicated on the drawings provide and lay cement roof tiles for roofing. The roof tiles shall be pressed mechanically and shall be uniform in quality, dimensions, form, color and thickness. The roof tiles and ridge capping shall be best quality and approved by the Engineer, color will be decided by the Engineer.

The Contractor is particularly to note that the production capacity of the manufacturer may be limited, and early arrangement shall be made for product delivery to the Site - in accordance with the construction schedule.

Metal flashing

All metal flashing of roof shall be galvanized steel sheet nominal thickness 0.46 mm (BWG. 26).

(ii) Execution

Ribbed nails shall be used for the fixing of the roof battens and all roof battens shall be provided with weep-holes 0.5 x 2 cm each 50 cm to center and shall be tar coated on the bottom surface.

Two ply asphalt roofing felt shall be laid in between the roof battens and the wood planks with overlapping joints of 150 mm and waterproof package seals 2" wide to seal the joints. The asphalt roof felt shall be installed watertight and as shown on the detailed drawings.

(b) Concrete Roof and Gutters

The whole surface of concrete roof slabs and concrete fascia and all internal surfaces of concrete roof gutters shall be coated with a waterproofing material. For this purpose, "LANSTAR AQUAGARD" elastomeric coating or equal approved by the Engineer shall be used.

(c) Roof Structure

(i) Timber Roof Structure

Timber trusses shall be constructed as shown on the drawings, assembled on the ground in true rigid form ready for erection. All joints and connections shall be executed according to the details on the drawings and shall be fastened with black steel bolts of the specified diameter.

All jointing shall be executed in a workmanlike manner and tie bolts shall be carefully fixed in holes of a diameter of the bolt. Nuts shall be tightly screwed home. Trusses shall be fixed to the concrete tie beam either by means of steel plate/angle as specified on the drawings and where necessary wedged up or down to ensure tight and secure fixing or by means of metal brackets as shown on the detailed drawings of the trusses.

(ii) Purlins etc.

Purlins, rafters, wind braces, battens, plank, shall all be of the dimensions shown on the general and detailed drawings. Each member shall be securely fixed according to the detailed drawings.

(iii) Inspection of Roofing

Completed roof construction shall not be left unprotected longer than absolutely necessary. Before commencement of the fixing of the roof finish the roof, construction shall be inspected by the Engineer to ensure that the structure is not warped and that purlins and laths are straight and at the correct distance.

(iv) Finishing

The bars of the roof structure purlins and wood planks that are to be exposed shall be wrought and planed until a smooth surface is obtained and will be finished with a natural finishing. See Sub-clause S16.02 (8) Painting.

(v) Steel Roof Structure

The roof structure for the office shall be made of steel.

Steel work shall be executed in accordance with the information contained in the drawings, complete with support, means of fixings and connection. Materials used for steelwork shall meet the quality of ASTM A36-14 or SNI 6719:2015, ASTM A572/A572M-18 minimum yield strength 25 kg/mm2, tensile strength 40-52 kg/mm2, shall be obtained from recognized and approved suppliers, shall be free from excessive corrosion and the sections and sheets shall be not bent or otherwise deformed.

The exact sections, shapes, thicknesses, sizes, weight, and details of construction indicated in the Drawings shall be supplied, however, the Contractor, because of his stock or shop practices may suggest changes to the Engineer to be considered for approval.

(1) Connection

- Welding

  Welding shall be arc welding, executed with all possible care. The deposited weld metal shall be free from slag deposit and other faults impairing the strength and connection and when exposed shall be ground smooth. The surface of the welds shall have a uniform and consistent contour and regular appearance. Welds showing any signs of defects shall be cut and rewelded at the Contractor's expense.

- Bolts and nuts

  Bolts and nuts shall be of mild steel as required in Sub-clause S11.01.(2).(a).(ii).(1) of these Specifications. They shall be to the sizes indicated on the drawings.

(2) Protection

- Painting

  Mill scale and surface corrosion shall be removed until the surface has obtained a regular metallic appearance. Immediately after this treatment the steelwork shall be coated with two coats of 30 - 36 micron of metal primer chromate as specified in Sub-clause S16.02 (8).

  If these coats should be damaged during transport, stacking or erection they shall be repaired without delay.

(3) Finishing

The exposed steel roof structure shall be finished with gloss paint in accordance with the requirements of Sub-clause S16.02 (8).

S16.03 (6) Floor Finishing

(a) General

Tiles are to be laid as indicated on the Drawings and as described hereafter. Samples are to be submitted for each type for final review and approval of quality, color, pattern and texture.

(b) Finishing layer mortar for Floor

Finishing layer mortar for Floor are as follows: the mixing proportion shall be 1-part cement and 3 parts of fine aggregate. The thickness shall be determined by calculating the difference of the level of the floor finish and the reinforced concrete slab. Water shall be kept to a minimum but shall be sufficient to allow adequate compaction.

All cables, pipe work etc, shall be placed and inspected before commencing the screeds.

Mortar layer shall be laid in bays of monolithic construction not to exceed 30 m^2. Mortar layer shall be cured for 3 to 7 days and protected from wear or other damage until the laying of the floor finish.

No moisture sensitive floor finish shall be laid until a reliable moisture test shows that the screed is sufficiently dry to receive the covering.

Defective mortar layer shall be cut out and made good in such time as to allow a sufficient interval for drying out prior to the scheduled laying of the finished floor coverings.

The surface of the mortar layer shall be flat.

(c) Terrazzo Tile with Copper Joints

(i) Material

Materials for terrazzo flooring tile will be first class grade local product, approved by the Engineer. Minimum compressive strength of finished terrazzo tile shall be 40 kg/cm^2.

(ii) Execution

After the mortar layer are dried out (see sub Sub-clause (b) copper joints shall be laid following an equilateral triangle pattern as indicated on the drawings. The thickness of the joints shall be 2 mm. The joints shall be laid in a straight line.

The terrazzo tile shall be applied with a wood skimming float and traversed with a floating rule to a true and even surface. The average thickness of the tile shall be 2.5 cm.

Polishing of the surface shall be performed accurately by a polishing machine until a smooth and even surface is obtained to the satisfaction of the Engineer. Polishing shall be carried out at a minimum of 7 days after the tile work is finished.

The terrazzo tile work and polishing shall be executed by the manufacturer. Workmanship shall be of the best quality and performed only by skilled workmen. The Contractor shall be responsible for the appearance and quality of the finished work.

Terrazzo tile flooring that is not executed to the satisfaction of the Engineer shall be repaired as soon as possible.

(d) Exposed Concrete Floor

Exposed concrete floor refers to flooring with a cement mortar as the finishing layer on a concrete slab.

(i) Execution

Cement mortar as the finishing layer or exposed floor will be executed for :

- Pedestrian malls, etc.

Cement mortar shall be laid in bays or patterns as indicated in the drawings.

(e) Portland Cement Tile

(i) Material

Ribbed P.C. tile 20 x 20 cm with a minimum thickness of 2 cm shall be best quality local product approved by the Engineer.

(ii) Execution

Finishing mortar layer see sub Sub-clause (b).

After the mortar layer are dried out the tiles shall be laid in a bed of semi dry mortar. The thickness of mortar depends on the finished floor levels shown on the drawings.

Mortar for joints shall be a mixing of water and Portland cement. The joints shall be straight lines of even width.

Immediately after the laying of the tiles the floor shall be cleaned off with sawdust. The P.C. tiles shall be hand polished to obtain a good finish.

(f) Ceramics and Mosaics Tile

(i) Material

Ceramics and mosaics tile shall be best quality local product approved by the Engineer.

(ii) Execution

Screeds to receive finishers see sub Sub-clause (b).

After the mortar are dried out the tiles shall be laid in a bed of semi dry mortar. The thickness of mortar depends on the finished floor levels shown on the drawings.

Mortar for joints shall be a mixing of water and Portland cement. The joints shall be straight lines of even width.

Workmanship shall be of the best quality and performed only by skilled workmen. The Contractor shall be responsible for the appearance and quality of the finished work.

Ceramics and mosaics tile floating that is not executed to the satisfaction of the Engineer shall be repaired as soon as possible.

Dimensions for ceramics tile shall be 10 x 20 cm or as shown on the Drawings.

S16.03 (7) Wall Finish

(a) Plasterwork

(i) Materials

Portland cement, sand and water shall be in accordance with the requirements of Sub-clause S16.02 (2).

(ii) Mortar Composition

Mortar composition shall be 1 part of Portland cement to 5 parts of sand for concrete block masonry. For other surfaces the composition shall be 1-part PC to 4 parts of sand, and for waterproof mortar 1 part of PC to 2 parts of sand.

The mortar shall be mixed as described in Sub-clause S16.02 (3) and shall be thoroughly mixed dry before adding water.

(iii) Preparation of Surface

Adequate drying-out time shall be allowed for concrete block walls and concrete surface. All piping, conduits, etc, shall be previously set in the correct location.

Joints in concrete block walling shall be raked out as specified in Sub-clause S16.02 (3). Concrete surface shall be roughened by hacking or bush hammering and shall be free of grease or oil patches. Dirt and all lose materials shall be thoroughly brushed down with stiff brushes. Low spots and areas shall be dubbed out and sufficient time shall be allowed for the dubbing out to dry before the first plastering coat is applied. To prevent premature drying out of the plaster, prepared surface shall be soaked with water.

The underside of exposed concrete beams and floor slabs shall not be plastered.

(iv) Execution

The average thickness of plaster shall be 1.5 cm and minimum thickness 1 cm. A finish is to be obtained that is acceptable to the Engineer.

Mortar shall be formed to serve as guides to bring the work to an even surface. The plaster shall be applied with a wood skimming float and traversed with a floating rule to a true and even surface.

The plaster shall be kept damp for at least 7 days after its application. Moistening shall begin as soon as plaster has hardened sufficiently to avoid damage. The plaster shall be protected from uneven and excessive evaporation during hot, dry weather.

(b) Wall Tiling

(i) Preparation and Inspection

The Contractor shall not start wall tiling until all plumbing pipes, conduits, grounds, anchors, etc. have been installed and approved.

The Contractor shall inspect surfaces before tiling. If there are any defects or bad condition the Contractor shall repair these before commencing the tiling work.

(ii) Material

Tiles shall be white glazed ceramic tiles of best quality approved by the Engineer with a nominal dimensions of 11 cm x 11 cm or as shown in the Drawings. The tiles shall be uniform in dimension, colour, glaze and thickness. Tiles with defect surfaces shall not be used.

(iii) Mortar

- Mortar for bedding shall be 1 part of Portland cement to 3 parts of sand
- Mortar for joints shall be a mixing of white cement and water.

(iv) Cutting of Tiles

Cut edges of glazed ceramic tiles shall be smoothed with a carborundum stone.

(v) Execution

Before placing, the white glazed wall tiles shall be soaked in advance in clean water till they are damp, but not dripping wet.

The mortar for bedding shall be placed on a prepared plane surface which has been thoroughly cleaned and wetted. The tiling shall be true, straight and plumb, with joints in a straight line and of an even width of 3 mm.

(vi) Fixing of Wall Tiles with Adhesive

Wall tiles may be applied to a rendering coat by means of an approved adhesive on a cement base which has been levelled up and smoothed. The Contractor shall adhere strictly to all instructions given by the manufacturer of the adhesive.

The requirements for the tiling, the width and the pointing of the joints shall be as specified in the previous Sub-clause (v) "Execution".

(vii) Scope of Work

White glazed ceramic tiles shall be laid as lining of toilet walls, and as indicated on the drawings.

S16.03 (8) Glazing and Painting

(a) Glazing

(i) Materials

Glass used for the building shall be clear glass 6 mm thick best quality approved by the Engineer. A silicone rubber compound shall be used for back puttying of glazing to timber frames. Only compounds which are known (proven) to be fully compatible with surfaces contacted shall be used.

(ii) Execution

- Clean the timber framing members to receive glass immediately before glazing.
- The timber framing shall be primed and painted one coat before glazing.
- The Contractor shall be responsible for correct glass size for each opening within the tolerance and necessary dimensions established.
- Watertight and airtight installation of each piece of glass is required. Each piece of glass shall withstand normal temperature changes, wind loading, impact loading without failure of any kind.
- Glazing compound shall be used to ensure complete bond of sealant to glass and timber framing or beads.
- Timber beads shall be fixed with brass screws.
- Remove and replace glass which is broken, chipped cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- Wash and polish glass on both faces not more than 4 days prior to Employer's acceptance of the work.

(b) Painting

(i) Materials, General Requirements

All paint material and primers shall be obtained from approved suppliers.

For the purpose of establishing a basis of quality, the paints specified herein are based upon paints as manufactured by ICI. The specifying of paints by a manufacturer's name and series number shall not be construed as being proprietary but rather as establishing a basis for quality comparison only.

Paints to be used shall be as follows or equal

- ICI Vinyl Acrylic Emulsion A.921
- ICI Weather shield Exterior Wall Finish
- ICI Synthetic Super Gloss A. 365
- ICI Teak Oil A.101-110
- ICI Timber Glow Clear Finish A.291-Satin
- ICI Clear Varnish A.105-49010

Note: ICI = PT. ICI Indonesia or equal approved.

- Materials shall be delivered to the site in the manufacturer's sealed containers bearing the manufacturer's label identifying

type and grade of contents. No paint stored longer than the manufacturer's specified shelf life shall be used.

- Paint shall be mixed and applied in compliance with the manufacturer's directions. Paint shall be thoroughly stirred until the ingredients therein are completely intermixed and, if necessary shall be strained prior to being applied.
- Under no circumstances will the addition of driers or other materials be permitted, unless such additions are recommended or required by the manufacturer of the paint.
- White wash material shall be of "kapur pemutih/kapur sirih" of good quality (specified in N17) free from impure material. Three coats or more shall be applied until an even white wash finish is obtained to the satisfaction of the Engineer.

(ii) Materials, Specific Requirements

a. Transparent Finish (Pigmented)			Woodwork
a.1			
First Coat	:	1 Coat of wood primer	. Door, window & partition frames
Second Coat	:	2 Coats of varnish A.105-49010	. Exterior door & window blades . Timber louvres
a.2			
First Coat	:	1 Coat of wood primer	. Wood staircase wood handrailing
Second Coat	:	2 Coats of timber glow clear finish A.291-Satan	. Exposed wood framing of ceiling . Wood slats ceiling . Wood base . Exposed wood structures, trusses, purlins, etc. . Exposed roof planks . Furniture
a.3			
		3 Coats of Teak Oil	. Interior door blades, teak plywood

b. Gloss Finish			Surface Type
b.1			
First Coat	:	1 Coat of wood primer	. Wood Fascia
Second Coat	:	2 Coats of Synthetic Super Gloss A.365	

b.2			
First Coat	:	1 Coat of Q.D Metal Primer Chromate A/540-49020	. All exposed metal and steel work/ steel structures . All metal roof gutters
Second Coat	:	2 Coats of Synthetic Super Gloss A.365	
b.3		2 Coats Q.D. Metal Primer Chromate A.540-49020	. Galvanized steel plate . Flashing of roof & non exposed steel work

c. Emulsion Finish			Surface Type
c.1			
First Coat	:	1 Coat of alkali resisting primer	. All exterior walls, columns, beams etc.
Second Coat	:	2 Coats of ICI Weather shield	. All asbestos cement sunshades
c.2			
First Coat	:	1 Coat of alkali resisting primer	. All exterior walls columns, beams exposed concrete slabs/ceiling . Interior walls,
Second Coat	:	2 Coats of vinyl acrylic emulsion A.921	columns, beams, exposed concrete slabs/ceiling . Asbestos cement ceiling and soft-board ceiling

(iii) Preparation

(1) General

The contractor shall make areas available for painting when the work can be carried out without interference with other scheduled activities or damage from subsequent operations.

The Contractor shall begin painting only after obtaining clearance from the Engineer to work in a particular area. The Engineer will, if necessary, decide which trade shall have the priority to work in any area at any time.

Unless otherwise specifically recommended or required by the manufacturer's instructions for satisfactory use of special coating, the surface to be painted shall be dry when the work is performed. No paint or coating shall be applied over dust or other non-adhering matter nor over grease, oil or other matter which is incompatible with or may adversely affect the bond of the paint or coating to be applied. The general requirements of this paragraph shall apply to all surfaces including shop primed and factory painted items. All shop primed or painted items and all previously applied field coats shall be cleaned of any oil, grease or other incompatible matter by an appropriate surface preparation before applying the next coating.

(2) Preparation of Woodwork

- Alkaline cleaning as required to remove any grease, oil or wax. Remove alkali with water-soaked wipers and dry thoroughly.
- Smooth surface by fine sanding.
- Blunt sharp edges with grinder.
- Seal knots and pitch streaks with shellac.
- Fill holes, cracks, etc. with a latex base caulking compound and when hardened, sand smooth.

(3) Preparation of Steel Work

All surfaces to be painted shall be cleaned of all rust, scale, welding contaminants, grease, oil or other foreign matter by solvent cleaning and hand cleaning or power tool cleaning. All weld spatter and sharp edges and points shop primed steelwork shall be inspected. Heat damaged primer and unsatisfactory priming shall be removed, cleaned off, wire brushed, rubbed down and primed immediately as specified.

Strict precautions shall be taken to prevent introduction of rust, scale, dirt or other products of cleaning into working parts of adjacent machinery or equipment, adjacent processes or products or areas of paint.

Remove all oil, waste, oxides and other surface contaminants or coatings by scrubbing with Rustoleum surface-etch or equal approved, rinse clean with fresh water and dry thoroughly. Only quick drier metal primer chromate shall be used as primer.

(4) Preparation of Plaster Work

Plaster shall be allowed the maximum time possible for drying out. All defective plaster or cement rendering shall be cut out and made good to the satisfaction of the

Engineer. The manufacturer's recommendations regarding neutralizing the surface before treatment of the surface with alkali resisting primer coating shall be complied with.

(iv) Application

(1) Conditions for Painting

- No painting shall be done when windblown dust or debris may contaminate the work.
- Interior painting areas shall be isolated as required to prevent dust circulation. Temporary enclosures shall be provided by the Contractor where isolation cannot be affected by closing of existing doors.
- No solvent drying or catalyst curing coating shall be applied when the relative humidity is higher than 80%.
- No paint shall be applied to wet surface, unless so specified.

The Contractor shall examine the surface to be painted or coated and shall notify the Engineer of any detectable defects or unsatisfactory surface conditions not correctable by surface preparation. If in doubt regarding compatibility of previously painted surfaces with specified paints, the Contractor shall make a patch test before proceeding with field painting. Application of the first field coat of paint or coating shall be upon representation by the Contractor that the surface, including shop priming or painting, is suitable to receive his field painting.

Where portions or surfaces of structural steel will be inaccessible after installation of other materials, such portions or surfaces shall be painted before installation of such materials.

The manufacturer's recommendations for re-coat time for the conditions under which painting is performed shall be strictly followed.

All paint materials shall be used strictly in accordance with the manufacturer's instruction.

(v) Clean Up

Before final acceptance of the work, the Contractor shall remove all paint spots or stains caused by his work, from floors, walls, hardware, fixtures and similar items, leaving all surfaces in a clean and acceptable condition. All glass shall be cleaned of all paint and putty deposits.

S16.03 (9) Ceiling

(a) Panel Ceiling

(i) Material

Kamper class I (wood) shall be used for ceiling structure and the ceiling shall not be asbestos cement plate.

(ii) Construction and Execution

The panels 0.5 cm thick with wood framing 3 x 4 cm are to be supported by a wood frame 3 x 5 cm which is screwed to a frame 3 x 7 cm. The joining between the bars of the frame shall be executed with trimming joints. The underside of the hangers shall be planned to obtain a smooth surface.

(iii) Before fixing the ceiling, the Contractor shall inspect whether the underside of all hangers is plane and at a suitable height.

(iv) Finishing

The exposed parts of the wood frame on the corner shall be painted in accordance with Sub-clause S16.02 (8).

(v) Location

Panel ceilings shall be installed as indicated in the drawings.

S16.03 (10) Metal Railing

(a) Material

All parts of the railing, including posts are to be made of steel dia. 25 mm and 50 mm.

(b) Execution

For some parts of the balcony the railing shall be fitted to the steel framing along the building facade. The posts of the railing of the concrete staircase shall be fitted to the concrete straircase slab with four bolts.

(i) Connections

- Welding

  See Sub-clause S16.02 (5)

- Bolts and Nuts

  See Sub-clause S16.02 (5)

(ii) Finishing

The railing shall be painted in accordance with the requirements of Sub-clause S16.02 (8).

S16.03 (11) Rainwater Drain Pipe

(a) Material

All rainwater drain pipes or down pipes shall be P.V.C. diameter 15 cm (dia. 6"). Roof drains shall be cast iron.

(b) Execution

The drain pipes shall be constructed according to the detailed drawings.

S16.03 (12) Softboard Wall Finish

(a) Material

Softboard sheet 1.20 m x 2.40 m with a thickness of 1.2 cm best quality approved by the Engineer shall be used for the panels. Joints lath shall be teak (jati) 1.5 x 5 cm. The softboard panel shall be covered with fabric.

(b) Execution

Lathwork for fitting the softboard panels shall be made of *Kamper* (wood) 3 cm x 5 cm with a grid of 60 cm x 120 cm. The lathwork shall be fitted to the unplaster concrete block wall with screws and fisher 40 cm c.t.c. The softboard shall be fitted from the upper side of the wooden base to entrance door level (+ 3 m).

The upper side of the softboard wall finish shall be horizontal. The upper side shall be covered with a teak lath 1.5/2.5 cm x 6.5 cm (trapezium cross section). The softboard panels shall be nailed to the lath work at a distance of 40 cm c.t.c. with 1" nails. The vertical joints shall be covered with teak lath 1.5 cm x 5 cm. The horizontal joints shall not be covered.

The execution shall be carried out in accordance with the detail drawing. Above the softboard wall finish the concrete block wall shall be plastered.

(c) Finishing

The teak joint laths and upper side laths shall be finished with clear varnish in accordance with the requirements of Sub-clause S16.02 (8).

S16.03 (13) Soil Treatment and Termite Proofing

(a) Scope

The work shall include furnishing labor and material and performing all operations necessary in soil treatment in strict accordance with the specifications.

(b) Due to existing laws and regulations limiting the licensing of companies engaged in the practice of Termite Control and Prevention Operations and due to the necessity of using specialized knowledge, the license of the sub-contractor shall be submitted to the Engineer for approval.

(c) Application rates shall be determined by the use of a power sprayer, with calibrated flowmeter attachment to provide the required rate and uniformity of application. Any other method shall be approved by the Engineer.

(d) The chemical applied to soil areas to be treated shall be lambda cyhalothrin with concentration applied as the manufacturer's instruction.

(e) Prior to pouring of concrete floor slab for slabs on the ground and on fill, and prior to backfilling around the outside perimeter, along with interior foundation walls, and around critical areas soil treatment and termite proofing shall be applied as herein specified.

(i) Overall treatment shall be applied over the entire surface under the floor slab, entrance platforms, pedestrian malls, paved open terrace, steps and around outside perimeter of building 1.0 m wide, at a rate (liter per square meter) as the manufacturer's instruction. In critical areas such as around openings for utility pipes, conduit, ducts and floor drains, application shall be at rate (liter per square meter, generally 1,5 times of non critical areas) as the manufacturer's instruction.

(ii) Treatment shall be applied along both sides of foundation of columns and walls and shear walls at a rate (liter per square meter, generally equal with the above mentioned critical areas) as the manufacturer's instruction. Application shall be 1/3 of the emulsion applied near the level of the top of footings before backfilling; 1/3 after half of the backfill is placed; and then the remainder.

(f) The soil treatment and termite proofing operations shall be guaranteed by the sub-contractor for a period of five (5) years from the date of treatment as a condition for the final acceptance of the work. The Contractor shall hand over the pest control operator's certificate of warranty to the Engineer which guarantees among other items, the required concentration, rate and method of application complying in every aspect with the requirements contained herein. Any evidence of infestation within the guarantee period will require treatment without cost to the owner.

S16.04 Facilities Work

S16.04 (1) Plumbing and Fire Fighting Systems

(a) General

This clause covers furnishing and installing plumbing and fire fighting equipment and materials as specified herein and indicated in the drawings. The complete installation shall be inspected and tested and all work required to place the system in satisfactory operating condition shall be performed.

If the water supply from the PAM is inaccessible or the existing water supply does not have sufficient capacity, the Contractor shall assume that additonal water supply to be required and the Contractor shall provide the wells with the pumps required. The contractor shall discuss this case with the appropriate relevan agencies and include for all work that needed to provide a constant and sufficient water supply. For "adequate supply" with a normal discharge level of necessity shall be added to the discharge rate

of fire suppression pump for two hours. Supply and storage capacity shall be taken account as needed.

(b) Plumbing and Fire Fighting Installation Regulations

The plumbing and firefighting installation work shall be carried out in compliance with:

- *Pedoman Plumbing Indonesia* 1979
- National Fire Protection Association (NFPA)
- Fire Offices Committee (F.O.C)
- Regulation by other authorized authorities

The plumbing and firefighting installation work shall be performed by a sub-contractor registered and possessing a valid permit from PAM and experienced in installing similar systems. A list of installation references shall be submitted to the Engineer. The Contractor shall be responsible for all negotiations with the relevant institutions and for obtaining and paying all permits and fees.

(c) Scope of Work for Plumbing and Fire Fighting

The extent of work required under this clause covers furnishing, installation and testing of all equipment, materials and related items necessary to complete the plumbing and firefighting system and fulfill all requirements as indicated on the design drawings and described in this specification.

(i) Scope of plumbing works in general is as follows :

- Furnishing and installing Sanitary Fixtures
- Furnishing and installing Clean Water System
- Furnishing and installing Sanitation System e.g. sewage piping, waste water piping and vent piping, septic tank.
- Preparation and finishing of plumbing system.

(ii) Scope of fire fighting works in general is as follows:

- Furnishing and installing Fire Fighting Piping System including Pumps and Hydrant Boxes
- Furnishing and installing Siamese Connections
- Furnishing and installing Portable Fire Extinguishers

(iii) Detailed scope of plumbing works shall include but not be limited to the following items :

- Lavatory fixtures:
  * Water closets
  * Urinals
  * Wash basins
  * Sink basins

* Taps
* Floor drains
* Floor clean outs
* Mirrors
* Soap liquid dispensers

- Clean water system:
  * Furnishing and installing clean water system from the existing pipe line to underground water reservoir complete with all take-off points.
  * Furnishing and installing packaged booster pump system, clean water piping system complete with accessories from ground reservoir to all take-off points.
- Sanitation System:
  * Construction of a septic tank or furnishing and installing connection to the local exhaust system if available and permitted.
  * Furnishing and installing of waste water piping, sewage piping from lavatories, showers, WC, urinals, floor drains and kitchen sinks to septic tank. The septic tank system shall be separate for the sewage from the toilet and others in order to the biological reaction in the septic tank will be effective and not disturbed by soap or other impact.
  * Furnishing and installing vent piping for plumbing system to roof.
- Preparation and Finishing of Plumbing System:

  The preparation and finishing of plumbing system shall include:
  * Supply and installation of sleeves and openings on floor, beam and wall to provide holes for pipe work.
  * Supply and installation of pipe hangers and supports.
  * Soil excavation and backfill for buried piping installation
  * Leak test, flushing and cleaning.
  * Coating for all steel pipes and buried piping underground.
  * Painting for all steel piping which is above ground including steel support, hanger and all steel material.
  * Concrete blocks for piping as required.

(iv) Detailed scope of firefighting works shall include but not be limited to the following:

- Furnishing and installing electrical driven fire pump, electrical driven jockey pump and gasoline engine driven fire pump,

complete with pressure tanks, accessories, starter panels, power and control cables and all related items necessary.

- Furnishing and installing hydrant boxes and siamese connection.
- Furnishing and installing piping system for fire fighting systems.
- Furnishing and installing portable fire extinguishers.

(d) Standard of Materials

All materials shall be brand new and of good quality based on local standard as well as international standards ASA. Contractor shall be fully responsible regarding qualities of materials to be used. Before installing all materials the Engineer's approval shall be obtained.

(e) Substitution of Materials

(i) Material, equipment or fixtures which are not in accordance with the specifications may only be used after written approval from the Engineer. All costs due to testing these materials, equipment or fixtures shall be at the Contractor's expense.

(ii) If required, testing of materials, equipment or fixtures shall be carried out by institutes approved by the Engineer. These tests shall be carried out conforming to local standard procedures. If there are no standard procedures, the Engineer may determine the testing procedures to be used.

(iii) Each standard length of pipe fitting, fixture and equipment to be used shall have a clear manufacturer's mark on it. Materials without this mark shall be replaced.

(f) Material Specification

(i) Sanitary Fixtures

All sanitary fixtures shall be of "*K.I.A.* Ceramics Indonesia" or equal approved, color will be decided by the Engineer.

(1) W.C. western style shall be type *DUTA T.S*. or equal approved, supply valve, outlet seal & fixing screws.

(2) W.C. squatting type shall be type *RAPI E*. or equal approved, chromium plated angle valve, flush pipe and coupling, outlet seal and fixing screws.

(3) Urinals shall be type *PANDA* or equal approved.

Each urinal shall be provided with chromium plated flush valve, and fabricated perforated pipe spray nozzle, all in chromium.

(4) Washbasins shall be type *SUSAN* or equal approved

Each washbasin shall be provided with chromium plated tap, chromium plate waste fitting and "P" trap, back hangers, dynabolts fasteners etc.

(5) Taps shall be type *SINKTAP Y 100* or equal approved

(6) Floor drains shall be conventional type with grill and cover made of stainless steel or chromium plated brass.

(7) Floor clean-outs shall be made of stainless steel or chromium plated brass with cover and frame of same material.

(8) Paper roll holders shall be type *VIDI/BIMA* or equal approved and are required for each W.C.

(9) Placenta shall be type *SHINTA* or equal approved, required for each wash basin.

(ii) Sanitary System

(1) The following materials shall be used for sewage, waste water and vent piping systems:

- Pipes shall be PVC *Pralon* or *Rucika* brand class D or equal approved with glued joints.
- Pipe fittings shall be PVC injection molding fittings of the same brand as pipes.
- Bends in main pipes shall be long radius bends and for branches in the main pipe 45oY and 45o bends shall be used.
- Glue shall be in accordance with the PVC pipe manufacturer's recommendations.

(2) All pipes, fittings, valves, equipment and accessories shall be original products from the factory.

(iii) Fire Fighting System

(a) Fire hydrant pumping system shall consist of :

- One electric driven jockey pump *Fairbank Morse, Ingersol Rand* or approved equivalent c/w NUG motor, coupling, base plate etc.
- One electric driven fire pump *Fairbank Morse, Ingersol Rand* or approved equivalent c/w NUG motor, coupling, base plate etc. capacity 600 L/M, Head 50 m.
- One 500 lt pressure tank c/w pressure gauge & cock, hand hole, drain etc. on test pressure of 15 kg/cm2. Two pressure switches *FANAL type FG 10* or equal approved.
- One pump control panel PCP 1.

- One lot electrical wiring from PCP 1 to pumps and control.
- One 500 lt priming tank c/w all accessories.
- One gasoline fire pump *Fairbank Morse* or equal approved with gasoline driven Perkins or equal approved c/w all accessories.

(2) Indoor hydrant boxes type A shall mainly comprise as follows:

Metal casing complete with doors wall thickness 1.5 mm, hinges, handles, louvers, fixed type hose reel dia. 100 and hydrant valve diameter 12".

(3) Indoor hydrant type B shall mainly comprise as follows:

Metal casing complete with doors wall thickness 1.5 mm, hinges, handles, louvers, canvas hose diameter 1.5" length 200 feet, complete with nozzle, valve and rack, etc.

(4) Firefighting piping system shall be galvanized iron pipe ASTM A53/53M-18 Schedule 40 (welded type) and 300 lbs. screwed fittings for pipe size up to 2" and for larger than 2" black steel pipe BS 1387 medium class with welding fitting and shall be primed and painted minimum twice. Valves larger than 3" shall be Cast Iron Valve 150 psi flanged type.

(5) Portable fire extinguisher shall be type BCF, capacity 5 lbs. ABRO brand or equal approved.

(g) Joint Specification

(i) Galvanized Pipes and Fittings

(1) Joints between pipes and fittings shall be threaded.

(2) Length of thread on pipes shall be at least 3/4 the diameter of the pipe.

(3) All threaded joints shall use seal tape.

(4) For cutting pipes a suitable pipe cutter device shall be used.

(5) All ends of pipes shall be reamed.

(6) For piping system up to 2.5" after every valve a union shall be used, and for pipes larger than 3" flanges shall be used.

(7) In piping system, union or flanges shall be used at minimum every 60 m.

(8) All pipes shall be cleaned properly before installing.

(ii) P.V.C. Pipes and Fittings

(1) Pipes and fittings shall be joined by PVC glue as recommended by the PVC pipe manufacturer. Before

gluing the joint shall be cleaned properly with cleaning fluid.

(2) Joints between pipes and fittings shall be carried out properly using special pressing device. For cutting pipes a suitable cutting device shall be used to achieve straight ends of pipe after cutting.

(iii) Couplings

Coupling shall be used for the following joints:

- Joints between fire hoses.
- Joints between fire hose, nozzle and valve.

For all these joints "machine coupling" shall be used.

(iv) Gasket Joints

To achieve water tight joints gaskets shall be used for the following sanitary equipment joints:

- Between lavatory faucet and supply valve
- Between flush valve and urinal
- Between supply valve and closet floater
- For waste fittings and syphon

(h) Installation Specification

(i) All pipes shall be installed straight and parallel to walls and/or floor.

(ii) Bends of 90^{o} and 45^{o} shall be used.

(iii) Before pipes are installed supports shall be correctly installed.

(iv) Before installing, supports shall be painted with Zinc chromate primer.

(v) All installation works shall be correctly carried out.

(vi) All pipes shall be properly supported.

(vii) During installing, open pipe ends shall be covered with caps or plugs.

(viii) Pipes and fittings shall be free from stresses caused by improper fixing.

(ix) Before installing the Engineer's approval shall be obtained for all installation through, or connected to, building construction.

(x) The Contractor shall provide sleeves for all piping going through walls, floors, concrete slabs, etc.

(xi) Before being buried in the ground piping shall be painted with flintcote, minimum three coats.

(xii) Sewage piping shall have a 0.5 - 1% slope.

(xiii) Waste water piping shall have a 1 - 2% slope.

(xiv) PVC pipes buried in the ground shall be laid on a sand underlayer of 10 cm minimum thickness.

(xv) Septic tank construction shall be carried out by a Contractor experienced in such work.

(i) Sleeves and Supports

(i) General

(1) The subcontractor shall furnish all required sleeves and supports and is fully responsible for installing at the correct locations.

Installing sleeves and supports on building parts which will be poured with concrete shall be carried out by the Contractor.

(2) Piping shall not run through columns, column bases and beams without written approval from the Engineer.

(ii) Sleeves

(1) Sleeves for pipes passing through concrete shall be correctly placed before concrete is poured.

(2) Sleeves shall have an internal diameter at least 2" larger than the outside diameter of the pipe including insulation.

(3) Sleeves passing through walls etc, shall be of cast iron or steel pipe.

(4) Sleeves passing through waterproofed building parts shall be of "flashing sleeves" type.

(5) Contractor shall fill space between outside of pipe or insulation and inside of sleeves with gasket or "caulk" for waterproofing.

(iii) Supports

(1) All fixture and sanitary equipment shall be supported and fixed properly at the correct locations.

(2) All "inserts" in concrete slabs or walls shall be correctly fixed.

(3) Bolts passing through walls or floors shall be provided with a steel plate for holding the bolt on the other side of the wall or floor.

(4) All exposed bolts, nuts, screws and washers shall be chromium or nickel-plated type.

(j) Hangers

(i) All pipes shall be clamped and fastened with hangers, supports and fastenings of suitable size and strength.

(ii) Horizontal piping shall be supported on adjustable steel hangers at maximum spacing 3.0 m.

(iii) The Contractor shall submit to the Engineer samples of hangers and supports for approval. Perforated strip, wire, or the like will not be permitted to be used for hangers.

(iv) Hangers and supports shall be fastened to concrete construction by using "inserts" or "ramset" bolts before concrete is poured.

(v) Vertical pipes shall be clamped. Distance between clamps shall be less than the floor height.

(k) Underground Pipes

(i) Underground pipes shall be set to the correct depth and slope.

(ii) Piping shall be laid in trenches on a 10 cm underlayer of sand for stability.

(iii) Pipes for clean water and pipes for waste water or sewage shall not be laid in the same trench.

(iv) After installing piping in a trench and after checking by the Engineer the trench shall be cleaned and backfilled with sand or with an approved material.

(v) All underground piping shall be adequately supported to prevent sagging or breaking before and after back filling.

(l) Testing

(i) Testing of Cold-Water Pipes

After all piping is installed leakage test of the whole system shall be carried out to ensure satisfactory performance. The piping system will be tested uninterrupted for 2 hours, hydrostatic test pressure 10 kg/cm^2, maximum acceptable drop in pressure 5%.

The Contractor shall repair all leakages/damages without extra cost.

(ii) Fire Fighting Pipe Tests

After all pipes are installed leakage test of the whole system shall be carried out to ensure satisfactory performance. The piping system will be tested uninterrupted for 2 hours, hydrostatic test pressure 20 kg/cm^2, maximum acceptable drop in pressure 5%.

The Contractor shall repair all leakages/damages without extra cost.

(iii) Sanitation Pipe Tests

After all pipes are installed, leakage test of the whole system shall be carried out to ensure satisfactory performance. The piping system will be tested uninterrupted for 2 hours, hydrostatic test pressure 2 kg/cm^2, maximum acceptable drop in pressure 5%.

The Contractor shall repair all leakages/damages without extra cost.

(iv) Rinsing

After all tests for leakages are completed the whole piping system shall be rinsed by turning on the water distribution system and opening all the tap points with maximum pressure of 2 kg/cm^2.

(v) Distribution Test

After all tests for leakages and rinsing are completed the system shall be tested for distribution by turning on the whole system at once. This test shall be repeated for 6 days, each day 6 hours uninterrupted without causing any damage.

The Contractor shall repair all damages after these tests without extra cost.

(vi) Disinfection

(1) The contractor shall rinse and disinfect the whole water installation before handing it over to the Employer.

(2) Disinfection shall be carried out by chlorinating the piping system, with an approved method. Chlorine 500 p.p.m. (part per million).

(3) After 16 hours the whole piping system shall be rinsed with clean water diluted with chlorine solution to a maximum of 0.2 p.p.m.

(4) Within these 16 hours of disinfection process the taps shall be opened and closed several times.

S16.04 (2) Fire Fighting Alarm Installation

(a) General

This clause covers furnishing and installing fire alarm equipment and materials as specified herein and indicated in the Drawings. The completed installation shall be inspected and tested, and all work required to place the system in satisfactory operating condition shall be performed.

(b) Fire Alarm Installation Codes

The fire alarm system installation work shall be carried out in compliance with:

- FUIL Regulations
- National Fire Protection Association (N.F.P.A)
- Fire Office Committee (F.O.C.)
- Regulations by other authorized authorities

The fire alarm system installation work shall be performed by a Contractor experienced in installing similar systems. A list of installation references shall be submitted to the Engineer.

(c) Scope of the Fire Alarm System Installation

The Contractor shall furnish, install, test and submit in good condition and ready for use, materials and equipment for the Fire Alarm System in compliance with the technical regulations and drawings.

(d) Equipment

The Fire Alarm System is to warn of a fire at an early stage and to give a warning alarm, automatically, with a detector, or manually with a push button.

The Fire Alarm System network is designed to centralize the whole detector and manual push button network at a junction box in the corridor of each floor and from this junction box to the Control Panel.

This Control Panel will receive a signal automatically or manually and will give a visible signal and an audible signal.

Equipment for the system shall include but not be limited to the following:

- Thermal Detector: Fixed temperature detector, Rate of temperature rise detector
- Ionization Smoke Detector
- Optical Smoke Detector
- Alarm Horn (Bell)
- Control Panel

All the Fire Alarm equipment shall be approved by the Engineer and shall comply with the following requirements:

(i) Thermal Detector

The detector shall be a combination of "rate of rise" with a "temperature detector" and a "fixed" temperature detector".

Technical Specification:

- Frequency Test : Can be used repeatedly
- Operation Voltage : 20 V DC
- Quiescent Current : Less than 1000 u.A
- Alarm Current : Max: 100 mA

(ii) Ionization Smoke Detector

The detector shall fulfill the following requirements:

- Frequency Test : Can be used repeatedly
- Operation Voltage : 20 V DC
- Quiescent Current : Less than 100 mA.

Mounting plate and terminal base shall be the same as for the thermal detector.

(iii) Optical Smoke Detector

The detector used shall fulfill the following requirements:

- Frequency Test : Can be used repeatedly
- Operation Voltage : 20 V DC
- Alarm Current : Max 100 mA.
- Permissible Ambient temperature : -30ºC - + 60º C

(iv) Manual Push Button

Surface mounted with breakable glass.

(v) Alarm Horn

Surface mounted with the following technical requirements:

- Rust free construction
- Operating Voltage : 18 to 36 DC
- Current consumption : Max. 60mA
- Package Consumption : 2 VA
- Horn Sound Level : 95 dB

(vi) Control Panel

The Control Panel shall consist of a Power Module, Control Module, Zone Module and Delay Module. Control Panel shall have a door with framed glass.

(1) Power Module

The Power Module shall have the following facilities:

- An emergency power supply unit to stand in automatically when the electricity power of 220 V/50 Hz drops out.
- An electrical preventor (fuse, mini circuit breaker etc.).
- A sign lamp ON for the Main Power, internal voltage system (remote control/signaling), battery charge.
- Give signals when:
  * Main Power is ON
  * Fault in power supply

(2) Control Module

The Control Module shall have the following facilities:

- Lamp Sign for:
  * Horn off
  * Reset
  * Test

* Lamp Test
* Fault Signal General
* Signal for Alarm Condition
* Signal for "Zone Off"

- An output such as:
  * Visible/audible alarm
  * Visible/audible fault alarm
  * Signal Test (Visible)
  * Optical Signal "Zone Off"
- Facility to shut off all AC Package Units when fire breaks out, (cable control supplied/ installed by the Fire Alarm Contractor to AC Panels).

(vii) Conduit

- For conduits installed in concrete, steel ducts a minimum diameter 3/4" or as directed by the Engineer shall be used.
- For built up conduits, above ceiling, PVC pipes complete with accessories in compliance with *PUIL* regulations shall be used.

All cables for the Fire Alarm System shall use conduits.

(viii) C a b l e s

- Cables for Main Power Supply of each piece of equipment in the system shall be NYM 3 x 2.5 mm2.
- For circuit between detector and manual push button cable shall be NYA diameter 1.5 mm2.
- For Alarm Horn circuit cable shall be NYM 2.5 mm2.
- Cables shall be *Kabelmetal,* or *Kabelindo* or equal approved.

(e) Equipment Installation

(i) Location of detectors and other equipment will be determined by the Engineer.

(ii) Manual Push Button shall be installed at 1.5 m height from the floor.

(iii) Alarm Horn shall be installed approximately 0.5 m below ceiling level.

(iv) Approximately 0.6 m around the Detector shall be free from any obstacle.

S16.04 (3) Closed Circuit Television and Sound System

(a) General

This clause covers furnishing and installing closed circuit television equipment and paging system and materials as specified herein and indicated in the Drawing. The completed installations shall be inspected and tested, and all work required to place the systems in satisfactory operating condition shall be performed.

(b) Sound System Installation Regulations

The sound system installation work shall be carried out in compliance with:

- FUIL
- AVE
- Instructions issued by the equipment manufacturers
- Regulations by other authorized authorities

The sound system installation work shall be performed by a Contractor experienced in similar installation work. A list of installation references shall be submitted to the Engineer.

(c) Scope of the Closed-Circuit Television

The Contractor shall furnish install and submit in good condition and ready for use the following closed-circuit television installation.

(i) Supply and install cable from transmitter to each camera in the toll booth and every designated room.

(ii) Supply and install cable from transmitter to television monitors, lens control and pan & tilt control.

(d) Operation Conditions

All Closed-Circuit Television installation appliances shall operate in a good condition at an ambient temperature of 35^{o} C and a RH 70% or 35^{o} C and a RH 80%.

(e) Material and Installation Condition

(i) Closed Circuit Television Cables type RG-150 and RG-590 brand *Kabelmetal, Kabelindo* or equal approved shall be used.

(ii) All Closed-Circuit Television Installation cable shall use conduits except cables to be installed in floor ducts. For conduits installed in concrete, GIP pipes with a minimal diameter 3/4" shall be used or as prescribed by the Engineer. For conduits to be installed above ceiling, PVC pipes shall be used with accessories. For all cable joints, boxes with covers shall be used. Closed Circuit Television cable routes shall be separated from other cable systems.

(f) Installing System

(i) All wiring shall be grouped, cable or wiring shall be tied firmly, clamped as tied bundled of cable.

(ii) All cables shall be clearly marked and direction shown.

(iii) Contractor shall assign an expert to install and to supervise the installation/equipment and to assure good functioning of the installation.

(iv) Installing the Closed-Circuit Television and the testing shall be carried out in compliance with regulations and other authorities.

(g) Closed Circuit Television

(i) Camera with lenses 8 mm

(ii) Television monitor

(iii) Lens Control

(iv) Transmitter

The Closed-Circuit Television shall be Javelin or TOA or equal approved.

S16.04 (4) Air Conditioning Installation

(a) General

This clause covers furnishing and installing air conditioning equipment and material as specified herein or indicated in the drawings.

The completed installation shall be inspected and tested and all work required to place the system in satisfactory operating condition shall be performed.

(b) Air Conditioning Installation

The Air Conditioning installation work shall be carried out in compliance with the following regulations:

- FULL
- ASHRAE, ARI, NFPA
- ASTM. ASME
- SMACNA
- The regulations of relevant authorities.

The air conditioning installation work shall be performed by a sub-contractor experienced in similar installations. References shall be submitted to the Engineer.

(c) Air Conditioning Scheme

The Contractor shall prepare an air conditioning scheme, complete with calculations and drawings showing unit locations, to provide the room conditions in (d) below and submit to the Engineer for approval.

(d) Room Conditions

(i) Required room conditions are as follows:

Temperature	Relative Humidity
$74^{o} \pm 2^{o}$ F	50% + 5%

(ii) Noise level in occupied spaces caused by the air conditioning installation shall not exceed 150 NR-35.

(e) Scope of Work

Work includes furnishing of all labor, material and equipment and service necessary and required for the complete and proper installation of all air conditioning work to achieve the room conditions in (d) above.

S16.05 Measurement and Payment

S16.05 (1) Method of Measurement

The quantity of each pay item paid for under Division 16 will be the number of individual items as detailed below which are furnished and installed in accordance with this Specification, the Drawings and the instructions of the Engineer.

S16.05 (2) Basis of Payment

The work for "road, parking lot, drainage system, sanitary, fence and landscape for toll plaza and office", "electrical installation", and "plumbing and fire extinguishing system, as provided above shall be paid for on the basis of a lump sum respectively, and the other pay items shall be paid at the unit price for each pay item as described below. Such payment shall be full compensation for all the work shown on the Drawings or described in these Specifications and shall include excavation and backfilling for foundations, drainage, etc., preparation of subgrade for road and parking lot, and all other material necessary as well as labour, equipment, and all incidentals necessary to complete the work as shown on the Drawings.

Pay Item No. and Name			Unit of Measurement
16.01	**Toll Office and Facilities**		
16.01	(1)	Road, parking lot, drainage system, sanitary, fence and landscape for Toll Plaza and Office	Lump Sum
16.01	(2a)	Toll Gate Branch Office	Each
16.01	(2b)	Toll House	Each
16.01	(2c)	Toll Gate Office	Each
16.01	(2d)	Main Toll Gate Office	Each
16.01	(3a)	Guard and Security House	Each
16.01	(3b)	Highway Patrol Office	Each
16.01	(4)	Staff Housing, Type 54	Each
16.01	(5)	Mosque	Each
16.01	(6)	Pump House, Type A	Each
16.01	(7)	Generator Set House	Each

16.01 (8)	Water Tower and Supply Type A (8000 liter)	Each
16.01 (9)	Underground water Reservoir	Each
16.01 (9a)	Road Environment and Vehicle Parking	Each
16.01 (10)	Electrical Installation	Lump Sum
16.01 (11)	Plumbing and Fire Extinguishing System	Lump Sum
16.01 (12) .	Fire alarm system	Each
16.01 (13)	Air Condition	Each
16.01 (14)	Intercom System for Office Type A	Each

DIVISION 17 DAYWORK

S17.01 General

S17.01 (1) Description

This work shall consist of additional work items directed and/or approved by the Engineer that were not originally envisaged during design, or allowed for in the quantity schedule for Divisions 1 to 16 inclusive, but which have become apparent during construction as being necessary for the satisfactory execution and completion of the project. The operations carried out under Daywork may be of any kind whatsoever as directed or authorized by the Engineer, and may include additional drainage works, excavation, filling, stabilization, testing, demolition, restitution of existing pavement, construction of overlays, structures, utility protection or diversion or any other works.

S17.01 (2) Submittals

The Contractor shall, before ordering any materials which are not available in Contract, submit to the Engineer quotations for such material for his prior approval, and subsequent to ordering the material, shall furnish to the Engineer such receipts or other evidence as may be necessary to verify the amounts paid.

The Contractor shall submit at the end of each working day a written record of the hours for labor and plant and the quantities of all materials used on a Daywork basis and shall obtain the Engineer's signature on this record certifying his agreement with the items and quantities claimed.

The Contractor shall submit a Daywork Claim, in accordance with Sub-clause S17.03 (3) below.

S17.02 Materials and Equipment

S17.02 (1) Materials

All materials used on a Daywork basis shall meet the quality and performance provisions given in the relevant Divisions of these Specifications. For materials not specified in detail elsewhere in these Specifications, material quality shall be as directed or approved by the Engineer.

S17.02 (2) Equipment

All equipment used on a Daywork basis shall meet the provisions of the relevant Divisions of these Specifications and shall be approved for use by the Engineer before work is commenced.

S17.03 Execution of Daywork

S17.03 (1) Daywork Authorization

Daywork may be either requested in writing by the Contractor or instructed by the Engineer. In either case, the work shall not be commenced until the issue by the Engineer of a written Daywork Authorization, and if necessary, a signed Variation.

For work to be executed for which Daywork Unit Prices are already established in the priced Bill of Quantities, this authorization will describe scope and description of works required with attachments of drawings to define the details of the work, and shall designate the method of determining for setting the final price of the Work ordered.

For work to be executed for which new or additional Daywork Unit Prices have to prior approval, this authorization shall also be cross referenced to, and he accompanied by Addendum (variation) included the new or additional unit price which is approved.

The Engineer will sign and date the Daywork Authorization as authorization for the Contractor to proceed with the work.

S17.03 (2) Performance of Work Executed on a Daywork Basis

Daywork operations shall be carried out in accordance with the provisions of the relevant Divisions of these Specifications governing the placement and finishing of materials, the testing, quality and maintenance of the work and rectification of any unsatisfactory work. In the case of work required to be carried out on a Daywork basis which is not specified elsewhere in the Specifications, the work shall be performed as directed and approved by the Engineer.

S17.03 (3) Daywork Claims

Upon completion of each instruction for work executed on a Daywork basis, the Contractor shall prepare an itemized payment claim for the labor, plant and material costs incurred by him in carrying out the Daywork, and he shall include this Daywork Claim, together with all supporting data, in his next application for interim payment by Monthly Certificate. The supporting data for the Daywork Claim shall include all of the daily records approved by the Engineer plus any additional information requested by the Engineer such as:

- A copy of the Engineer's Daywork Authorization.
- A summary of the dates and times work was performed, and by whom.
- A summary of hours worked, for all labor.
- A summary of hours used for all Construction Plant.
- Where applicable, invoices and receipts for any materials, products or services used in the Works as directed by Addendum (Variation)

The Engineer will check and certify the Contractor's Daywork Claim as part of the application for Monthly Certificate Payment in accordance with the relevant Sub-clauses of the Conditions of Contract concerning certification and payment.

S17.04 Measurement and Payment

S17.04 (1) Measurement and Payment for Labor

Measurement of labor for payment under Daywork shall be made for the actual certified hours worked at the unit Prices for the various categories of labor entered in the Bill of Quantities, which price and payment shall constitute full compensation for the following costs:

The laborer's wages, taxes, bonuses, insurances, holiday pay, housing, welfare facilities, medical expenses, other entitled allowances and all other charges provided for in "Manpower Regulations in Indonesia: Guidance for Foreign Investors" (Labor Legislation Republic of Indonesia), published by the juridical Bureau, Ministry of Manpower.

- The use and maintenance of hand tools.
- The cost of transportation to and from the site of the work to be executed.
- All associated administration and accounting costs, supervision excluding foreman, and all other incidentals and overheads necessary to mobilize the labor at the site of the Works.
- Profit.

S17.04 (2) Measurement and Payment for Construction Plant

Measurement of plant for payment under Daywork, whether hired or owned by the Contractor, shall be made for the actual certified hours worked by the plant at the unit prices for the various categories of plant entered in the Bill of Quantities, which prices and payment shall constitute full compensation for the following costs:

- Drivers, operators and attendants, which shall include all the costs indicated in Sub-clause 17.04 (1) above for labor.
- Fuels and consumables.
- Overhauls, repairs and replacements.
- Idling and travelling time on site.
- Establishment charges, site and head office accounting costs and all other overheads.
- Cost of haulage to and from site.

S17.04 (3) Measurement for Materials

The quantity of Daywork to be measured for payment shall be the quantities of materials actually incorporated in the Daywork: as verified by suppliers' invoices and the approved daily work records.

S17.04 (4) Payment for Materials

For the materials which are not available in in the Contract and approved for use under Daywork, payment shall be made at the net price paid by the Contractor for the materials delivered to Site, as substantiated by suppliers' invoices, to which price shall be added an amount equal to 15 percent of the sum thereof. Such payment shall be deemed full compensation for the provision of materials, including the following Costs:

- Procurement and delivery to site.
- Receiving at site, unloading, checking, storage, testing, protection and general handling.
- Wastage.
- Administration and accounting charges and all other associated over-heads.
- Profit.

Payment of all materials incorporated into Daywork, shall be from the overall budget established for Dayworks under Division 17 of the Bill of Quantities or, at the discretion of the Engineer, shall be from any other Pay Item in Divisions 2 to 16 inclusive for which there is surplus budget. In either case a signed Variation shall be required before payment for materials used in Daywork can be certified.

Pay Item No. and Name		**Unit of Measurement**
17.01	Foreman	Hour
17.02	Skilled Labor	Hour
17.03	Labor	Hour
17.04	Concrete Class C	Cubic meter
17.05	Asphalt Cement	Ton
17.06	Kerosene	liter
17.07	Asphalt Concrete Binder Course	Ton
17.08	Asphalt Concrete Surface Course	Ton
17.09	Cement Concrete Pavement (Class P)	Cubic Meter
17.10	Steel Form Work	Square Meter
17.11	Curing Compound	liter
17.12	Joint Filler	Linear meter
17.13	Plywood Form Work	Square meter
17.14	Curing Mat	Square meter
17.15	Bulldozer 100-150 HP	Hour
17.16	Compressor 4000-6500 Lt/M	Hour
17.17	Concrete Mixer 0.3-0.6 M3	Hour
17.18	Crane 10-15 Ton	Hour

17.19	Dump Truck 10 Ton	Hour
17.20	Excavator 80-140 HP	Hour
17.21	Generator Set 125KVA	Hour
17.22	Wheel Loader 1.0-1.6 M3	Hour
17.23	Tandem Roller 6-8 Ton	Hour
17.24	Tire Roller 8-10 Ton	Hour
17.25	Vibratory Roller 5-8 Ton	Hour
17.26	Concrete Vibrator	Hour
17.27	Water Pump 70-100 mm	Hour
17.28	Tamper	Hour
17.29	Truck Crane 5 Ton	Hour
17.30	Welding Machine 300A	Hour
17.31	Truck Crane 22 Ton	Hour
17.32	Pick Hammer 7Kg	Hour
17.33	Concrete Breaker 20 Kg	Hour
17.34	Rammer 60-100 Kg	Hour
17.35	Agitator Truck 4.5 M3	Hour
17.36	Concrete Pump Truck 55-60 M3/Hr	Hour
17.37	Concrete Cutter 30 CM	Hour
17.38	Generator Set 45 KVA	Hour
17.39	Soil Compactor 100-110 Kg	Hour
17.40	Welding Machine Semi	Hour
17.41	Vibro Hammer 40 KW	Hour
17.42	Crawler Type Road Cutter W=2.1 M	Hour
17.43	Concrete Finisher 3.0-7.5m	Hour
17.44	Winch 1.8 Ton x 30m/min	Hour
17.45	Concrete Pump Truck 90-110 M3/Hr	Hour
17.46	Vibro Hammer 60 KW	Hour