

13.12 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 IP10 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 2.55 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.

13.12.1 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°C.

Cable colors shall comply with JIS 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 (NYYY)" 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 armouring 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.

All cables to be used shall be certified as tested, and approved by the Engineer before installation.

13.13 Grounding

Conduit, steel poles and cabinets shall be made mechanically and electrical, 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 mm² 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 mm² 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.

Details of all grounding points shall be submitted to the Engineer for approval.

13.14 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 moulds. The material used shall be compatible with the insulation specified in the Contract Drawings or this Specification. 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.

13.15 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 Conduit Pipe.

Exterior and interior surfaces of all steel conduit 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.

13.16 Cable Trays

All details regarding requirements, material and installation of cable trays shall be as shown on the Drawings.

13.17 Civil Works for Electrical Installation Generally

Installation of duct, construction of manholes, and excavation for cable or duct track, shall be in accordance with other clauses in this Specification and in accordance with the drawings except where obstructions prevent this. In such cases the Contractor shall construct effective alternative foundations to the satisfaction of the Engineer.

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 this Specification. 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.

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. A rubbed surface finish shall be applied to exposed surfaces of concrete.

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.

Forms shall not be removed until at least 3 days after pouring of concrete and piles shall not be erected until the concrete has reached its 28 days strength.

13.17.1 Conduit

The size of conduit used shall be as shown on the Drawings. Conduits smaller than 25mm 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 shall 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 shall butt or come together for the full circumference thereof. Slip joints or running threads shall 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 shall 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 preformed.

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 pullwire 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.

13.17.2 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.

13.17.3 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 shall 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.

13.17.4 Service

Service points are located within or close to the Site, normally, but not necessarily always, at the 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 shall 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, but not the electrical energy consumption, shall be charged to the Contractor.

13.17.5 Field Test

Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer.

- Test for continuity of each circuit.
- Test for grounds in each circuit.
- 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 must be approved by the Engineer. Such approval must be in writing, following written application by the Contractor.
- 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.

13.18 Painting of Electrical Components

All painting required shall be in conformance with applicable portions of this Specification.

If the enclosure of any electrical equipment (less signal heads) located above ground does not have an exterior surface of either aluminium 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.

Galvanised steel or aluminium lighting poles and lighting lanterns shall not be painted.

13.19 Erection of Lighting Poles

Lighting poles shall be handled at all times in such a manner that they shall not be damaged. Any parts that are damaged shall be repaired or replaced to the satisfaction of the Engineer.

Lighting poles shall be erected on concrete foundations and plumbed by the use of adjusting nuts. The use of shims for plumbing or raking will not be permitted.

13.20 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.

13.21 "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.

13.22 Guarantees

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.

13.23 Lightning Protection

This section gives requirements and procedures applicable for the furnishing and installing all materials, and equipment necessary to complete in lightning rods, with arresting system in accordance with the drawings.

All lightning rods and arresting systems, including materials and accessories shall be in accordance with the following, which are incorporated as an integral part of this Specification:

- "Guide Specification for Lightning Protection System for Buildings and Other Structures, Section 16670, Department of Army U.S", and
- "JIS A 4201, The protection of Structures Against Lightning", or as directed by the Engineer.

The location of each facilities and appurtenances shown on the Drawings are approximate and the Contractor shall propose the exact location to the Engineer for approval.

13.24 Material and Installation for Lightning Rod

Lightning rods shall consist of metallic body made of aluminium alloy used for receiving a lightning stroke directly and be connected to earth electrode by lightning conductors.

13.25 Material and Installation for Lightning Conductor

The lightning conductor that connects the lightning receiving parts with earth electrodes, to pass the lightning current shall be annealed copper stranded wire of \downarrow 8~ 10mm or aluminium solid wires, stranded wires, strip or tubes which conform to requirements.

The down conductor shall be copper of 8 ~ 10mm dia and be protected in the reinforced concrete pier.

The combined value of earthing resistance of foundation of the object to be protected and that of earth electrode shall be not more than 5 Ω .

13.25.1 Material and Installation for Lightning Conduit and Earth Electrode

All conduit embedded in concrete shall be steel material.

Conduit to be installed under the ground shall be zinc-coated steel by a hot-dip galvanizing process. The zinc coating shall be on the interior and exterior of the conduit and shall be uniformly and properly applied.

The earth electrode shall be a copper plate of 5mm tick, 1.0m x 1.0m with a 1.5m length of annealed copper stranded wire 15 nun in diameter.

13.26 Permanent Navigation Light System on Bridge

This section cover general specification related to navigation aids consisting of Permanent Bridge Light System for the main channel and sub channel.

The buoyage system of the navigation aids shall be in accordance with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System A.

The work to be executed under this contract shall comprise design, fabrication and supply of sixteen (16) units of Bridge & Pier lights with remote monitoring system for permanent channel markers.

13.26.1 Manufacture of Permanent Navigation Light System on Bridge

The manufacturer must comply with ISO 9001 and must be an industrial member of IALA (International Association of Lighthouse Authorities). The tenderer must submit the supply record of Bridge Light system with remote monitoring system in Asia area.

13.26.2 Bridge Lighting Equipment

The lighting equipment shall be ZL-LS100M-W (Safe Water Mark), ZL-LS100M-R (Port Hand Marker) and ZL-LS100M-G (Starboard Mark) or proven equivalent LED lantern.

The Contractor shall submit supply record of LED lantern, which shows more than 1000 units supplied. The luminous range shall not be less than 4.4 NM for T=0.74 and 5.5 NM for T=0.85.

The light source shall be an LED (Light Emitting Diode) to reduce maintenance and increase reliability. The flasher shall be field adjustable microprocessor type.

The light character shall be fixed white color light as a safe water mark, fixed red color light for port hand mark and fixed green color light for starboard light according to IALA recommendation.

The Contractor shall submit supply record of Aluminium made swivel type Bridge light for more than 10 sets in Asia together with photographs of units more than 10 years old to prove the quality and durability.

All exposed metal parts shall be made by Aluminum alloy or Stainless steel to keep equipment good condition for longer. The body of the bridge light shall be made by aluminum alloy JIS standard A5052 for longer life with lighter weight for safety maintenance. The total length of bridge light shall be approximately 2900mm. The one end shall be equipped with LED lantern and the other end shall be equipped with counter weight for safety maintenance.

Main Pole must be fixed by swivelled flange and must be able to rotate for maintenance. The total weight including day mark and lantern shall be not less than 80 kg and not more than 100kg. The surface of bridge light body shall be painted by white color. The fixing method shall be by Stainless steel anchor bolts.

13.27 Bridge Daymark Equipment

The material shall be Aluminum alloy JIS A5052 and surface of Channel side shall be covered by 3M Scotch Film Diamond Grade to ensure easier recognition.

The safe water marker shall be 1.5m diameter circular shape with Red and White Vertical Stripe colour, the port hand marker shall be 1.0m square shape with red colour edged by white colour and the starboard hand marker shall be 1.4m triangular shape with green colour edged by white colour according to IALA recommendation.

13.28 Pier Lighting Equipment

The lightning equipment shall be ZL-LS100M-Y or proven equivalent LED lantern.

The Contractor shall submit supply record of LED lantern, which shows more than 1000 units supplied. The luminous range shall not be less than 4.5 NM for T=0.74 and 5.7 NM for T=0.85.

The light source shall be an LED (Light Emitting Diode) to reduce maintenance and increase reliability. The flasher shall be field adjustable microprocessor type.

The light character shall be fixed Yellow color light according to IALA recommendation.

All exposed metal parts shall be made by Aluminum alloy or Stainless steel made to keep equipment good condition for longer. Pier Light Body shall be made by aluminum alloy JIS standard A5052 for longer life. The total length of Pier light shall be approximately 1400mm. The total weight shall be not less than 10 kg and not more than 20kg. The surface of bridge light body shall be painted by white color. The fixing method shall be by Stainless steel anchor bolts.

13.29 Power Source for Bridge Lighting Equipment

Each Lantern for Bridge Light and Pier Lights shall be completed with DC/DC converters to convert supplied 24VDC to operational 12VDC.

13.29.1 Control Box for Bridge Lighting Equipment

Performance of the control box shall be as follows:

- To float charge storage battery
- To switch on/off automatically as daylight control
- To switch over automatically to storage battery in case of main power failure
- To prevent over-discharging of storage battery

The control box shall be made by Stainless Steel JIS G 4303 SUS304 and suitable for out door use. It shall comply with I.E.C. (International Electrical Code) IP-44.

Input Voltage shall be 240VAC single phase and output voltage shall be 24 VDC with 10A or bigger.

A back up battery 24V 80 AH for 6-hour operation shall be supplied to operate at an ambient temperature 20 degree, humidity 65% and 12 hrs operation per day. The operational light character shall be fixed and field adjustable FTM-12SP60 microprocessor flasher with sun-switch shall be provided. The sun-switch sensitivity shall be approximately 300 λ x.

13.30 Control System

To ensure the safe and smooth operation of Navigational System for international channel, remote monitoring system must be supplied. The monitoring function must include following items:

- Lantern Failure
- Sun-switch Failure
- Main Power Failure
- Over-discharge of storage battery

To minimize lightning effects, the signal cable between each out station (each lantern) to monitoring base station shall be optical fiber cable. Centerlized control of obstruction lighting where isolated and relatively remote obstructions exist and manual controls must be established. In these instances, the lights may be served from a local supply and controlled by light sensitive photoelectric cells, or by astronomic-dial time clocks. When such controls are used, an auxiliary-locked manual control, accessible from the outside, shall be installed. The light sensitive control device shall be adjusted so that the lights shall be turned on when the illumination on a vertical surface facing north is about 35 foot-candles and turned off at a north sky light illumination level of about 58 foot-candles.

13.31 Temporary Navigation Marker Buoys

This section covers the general specification related to navigation aids consisting of temporary markers for the main channel and sub channel.

The buoyage system of the navigation aids shall be in accordance with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System A.

The work to be executed under this contract shall comprise design, fabrication and supply of eleven units of light buoys for temporary channel markers.

13.31.1 Manufacture of Temporary Navigation Marker Buoys

The buoy manufacturer must comply with ISO 9001 and must be an industrial member of IALA (International Association of Lighthouse Authorities). The tenderer must submit the supply record of proposed buoy and lantern.

13.31.2 Temporary Navigation Marker Buoy Body

The buoy shall be ZCB240D or proven equivalent model. The model must have a supply record more than 50 units in South East Asia.

The buoy shall be made of steel, SS41 or equivalent and the total weight shall not be more than 1,900kg and not less than 1,700kg for easy handling with good performance. The diameter of the float shall not be less than 2.4m and focal plane height shall not be less than 2.6m (without moorings). The total buoyancy shall not be less than 4.2kN.

The surface preparation for painting shall be sand blast SA 2.5. The expected life of paint life shall be 3 years. The paint colour must be yellow for working area markers (A to L) and red & white vertical stripe for the safe water marker (M).

13.31.3 Temporary Navigation Marker Buoy Lighting Equipment

The lighting equipment shall be ZL-LS100M-Y for yellow and ZL-LS100M-W for white or proven equivalent LED lantern.

The Contractor shall submit a supply record of LED lantern, which shows more than 1000 units supplied. The luminous range shall not be less than 4.0 NM for T=0.74 and 4.8 NM for T=0.85.

The light source shall be an LED (Light Emitting Diode) to reduce maintenance and increase reliability. The flasher shall be field adjustable microprocessor type.

The light Character shall be flashing every 4 seconds for item A to L. All of A to L buoys shall be synchronized for each group. Each group 1 to 4 is individually synchronized and from group 1 to 4, consequently each group shall be flashed to give easy identification of working area. The light character of Item M shall be ISO 4 seconds as a safe water mark.

13.31.4 Power Source for Temporary Buoy Lighting Equipment

Power source shall be Solar Power system. The Contractor shall submit the computerized solar power system size calculation. The Solar Module must be covered by tempered glass with stainless steel frame. The out put power shall be 17V with 26W. The storage battery must be fully sealed lead acid type of 12V 60Ah capacity. To avoid over charge, charging controller shall be used.

13.31.5 Accessories for Temporary Buoy Lighting Equipment

To ensure easier identification, Buoy of A to L must be complete with GPS synchronizer. All buoys must be completed with Aluminum alloy made top mark accordance with IALA recommendation.

To be recognized easier by vessel's radar, all buoys must be completed with Aluminum made radar reflector which must have a minimum effective reflective area 8.5m^2 or more. The aluminium radar reflector shall be electrically isolated from any steel.

All buoys must be completed with anode plates for 3 years operation.

13.32 Moorings for Temporary Navigation Marker Buoy

All buoys must be completed with mooring chain with accessories. The main chain is nominal diameter 28mm Grade U2 bitumatic surface solution long open link chain 25 to 75m length with 3 pcs of suitable shackles and swivel piece. The concrete sinker shall not be less than 6 ton.

The Contractor shall submit a mooring calculation.

13.33 Permanent Navigation Marker Buoys

This section covers the general specification related to navigation aids consisting of permanent markers for the main channel and sub channel.

The buoyage system of the navigation aids shall be in accordance with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System A.

The work to be executed under this contract shall comprise design, fabrication and supply of two units of light buoys for permanent channel markers.

13.33.1 Manufacture of Permanent Navigation Marker Buoys

The buoy manufacturer must comply with ISO 9001 and must be an industrial member of IALA (International Association of Lighthouse Authorities). The tenderer must submit the supply record of proposed buoy and lantern.

13.33.2 Permanent Navigation Marker Buoy Body

The buoy shall be ZCB350D or proven equivalent model. The model must have supply record of more than 20 units in South East Asia.

The buoy shall be made of steel, SS41 or equivalent and the total weight shall not be more than 4,900kg and not less than 4,700kg for easy handling with good performance. The diameter of the float shall not be less than 3.5m and focal plane height shall not be less than 3.5m (without moorings). The total buoyancy shall not be less than 100kN.

The surface preparation for painting shall be sand blast SA 2.5. The expected life of paint life shall be 5 years. The paint colour must be green for the starboard side marker and red & white vertical stripe for the safe water marker (M).

13.33.3 Permanent Navigation Marker Buoy Lighting Equipment

The lighting equipment shall be ZL-LS100M-G for green and ZL-LS100M-W for white or proven equivalent LED lantern.

The Contractor shall submit a supply record of LED lantern, which shows more than 1000 units supplied. The luminous range shall not be less than 4.6 NM for $T=0.74$ and 5.8 NM for $T=0.85$.

The light source shall be an LED (Light Emitting Diode) to reduce maintenance and increase reliability. The flasher shall be field adjustable microprocessor type.

The light character of the starboard side marker shall be flashing every 4 seconds. The light character of the safe water mark shall be ISO 4 seconds.

13.33.4 Power Source for Permanent Buoy Lighting Equipment

Power source shall be Solar Power system. The Contractor shall submit the computerized solar power system size calculation. The Solar Module must be covered by tempered glass with stainless steel frame. The out put power shall be 17V with 26W. The storage battery must be fully sealed lead acid type of 12V 80Ah capacity. To avoid over charge, charging controller shall be used.

13.33.5 Accessories for Permanent Buoy Lighting Equipment

All buoys must be completed with Aluminum alloy made top mark accordance with IALA recommendation.

To be recognized easier by vessel's radar, all buoys must be completed with Aluminum made radar reflector which must have a minimum effective reflective area 8.5m^2 or more. The aluminium radar reflector shall be electrically isolated from any steel.

All buoys must be completed with anode plates for 10 years operation.

13.33.6 Moorings for Permanent Navigation Marker Buoy

All buoys must be completed with mooring chain with accessories. The main chain is nominal diameter 42mm Grade U2 bitumatic surface solution long open link chain 25 to 35m length with 3 pcs of suitable shackles and swivel piece. The concrete sinker shall not be less than 6 ton.

The Contractor shall submit a mooring calculation.

13.34 Measurement and Payment

(1) Lighting Pole & Lighting Fixture

The measurement and payment shall be by number. The rates shall include for complying with the Clause 17.2 of the Preamble.

(2) Foundation for Lighting Pole

The measurement and payment shall be by set. Payment shall include full compensation for the supply of all materials, excavation, backfilling, labour, equipment and incidentals necessary to complete the work.

(3) Substation

The measurement and payment shall be by set. Payment shall include full compensation for the supply of all materials, labour equipment and incidentals necessary to install and fix the substations.

15 VEHICLE GUARDRAIL, PRECAST CONCRETE KM POSTS

15.1 Vehicle Guardrail

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, if required, and all the process- necessary to complete the work as described in the Drawings and this Specification.

15.2 Materials

Materials shall conform to the relevant requirements of:

- JIS G3101: Roiled Steel for General Structures
- JIS G3452: Carbon Steel Pipes for Ordinary Piping
- JIS G3444: Carbon Steel Tubes for General Structures Purposes
- JIS G3466: Carbon Steel Square Pipes for General Structures Purposes
- JIS G3532: Low Carbon Steel Wires
- JIS G3552: Chainlink Wire Netting

Corrugated sheet steel beams for vehicle guardrail shall conform to AASHTO M 180 - 74 Class A, Type 1.

All steel railing and fittings shall be galvanized unless otherwise specified, in accordance with the requirements of this Specification. Where painting is required it shall also be in accordance with the requirements of this specification.

All other materials shall be in accordance with the relevant clauses of this Specification or as specified on the Drawings.

15.3 Construction

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.

Guardrail shall be constructed to the lines and grades, and in the exact positions shown on the Drawings or as directed by the Engineer.

Steel shall not be heated or welded in the field unless with the prior written approval of the Engineer. Field operations of drilling holes or cutting steel shall be carefully conducted so as to prevent damage to steel.

Posts shall be firmly set 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. 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.

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 levelled 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.

15.4 Measurement and Payment

Road edge guide posts, timber or steel posts for guard precast concrete kilometer post installed, completed and accepted by the Engineer shall be measured for payment on a number basis.

Vehicle guard rail installed, completed and accepted by the Engineer shall be measured by length in metres from centre to centre of end posts.

The rates for vehicle guardrail and precast concrete KM posts shall include for complying with the Clause 19 of the Preamble.

16 TRAFFIC SIGNS

16.1 Traffic Signs (Warning and Regulatory)

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.

16.2 Materials

Materials shall conform to the requirements noted in the Drawings.

Steel and aluminium materials shall be of durable quality and shall be approved by the Engineer.

Material for poles shall comply with the requirements of JIS G3444.

Bolts to be used for tightening sign boards shall be steel bolts, fully galvanized, and free from deformation and bending. Each bolt shall be tightened with a galvanized nut and washer.

Aluminium plates shall be degreased, etched, neutralized and processed prior to use as traffic sign boards.

Reflective sheeting shall conform to the requirements of AASHTO.

M 268 and shall be of the colour specified by the Engineer or 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 aluminium plates.

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 9.21 ~ 9.27 of this Specification and all details of materials and painting shall be approved in advance by the Engineer.

16.3 Construction

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.

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.

Poles shall be supported as necessary until the concrete has achieved sufficient strength and the hole shall then be backfilled and thoroughly impacted with suitable material to the satisfaction of the Engineer. The adjacent surface shall be restored to its original condition as directed by the Engineer.

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.

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.

16.4 Traffic Guide Signs and Kilometre Posts

This work shall consist of furnishing, fabricating, hauling and installing the specified types of traffic guide signs and kilometre post at locations indicated on the Drawings or as directed by the Engineer and as required by the Ministry of Transportation.

16.5 Materials

Unless otherwise noted in this Specification, all materials shall conform to the requirements given on the drawings.

The specification for steel and aluminium products and for reflective sheeting as given elsewhere in this Specification 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.

16.6 Construction

The types and locations of all traffic guide signs shall be shown on the drawing or established by the Engineer before commencement of this work, When fixing the above, the Engineer will also instruct the lettering to be used on each sign.

All details given, 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.

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.

16.7 Measurement and Payment

(1) Traffic Sign

This work shall be measured as the actual number of traffic signs complete with places and posts erected and accepted, and shall be paid for at the scheduled rate for the item in the Bill of Quantities. The rate for traffic sign shall include for complying with the Clause 20 of the Preamble.

17 TRAFFIC CONTROL UTILITY

17.1 Road Marking

This work shall consist of furnishing and applying Type A and Type B painted road markings on the finished paved area in accordance with this Specification, at the locations and of the dimensions shown on the Drawings or as directed by the Engineer.

The markings Type A shall be used mainly for permanent works and Type B shall be used mainly for semi-permanent works at the boundaries between contract sections.

17.2 Materials for Road Marking

Type A material shall be white thermoplastic material incorporating glass beads and conforming with AASHTO M249 or equivalent.

Type B material shall be white ready-mixed traffic paint conforming with AASHTO M248 or equivalent.

Glass beads applied to the surface of both Type A and Type B material shall conform to AASHTO M247 (Type 2) or equivalent.

17.3 Construction of Road Marking

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.

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 marks 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.

Type A material shall be laid by spray or screed to the dimensions shown on the Drawings and agreed by the Engineer. The finished thickness of the material shall be a minimum 1.5mm for spray application and 3 mm for screed application, both exclusive of the glass beads described in 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.

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 litres/ 100 m². In areas where machine laying is impossible, the Engineer may give approval to brush application.

Glass beads shall be applied to the surface of Type A and Type B markings immediately after they have been laid. Unless otherwise a proved by the Engineer,

all glass beads shall be applied by pressure or spray application at a rate not less than 450 gm/m².

All road markings shall be protected from traffic as instructed by the Engineer. All markings shall present a clean cut, uniform and the surface shall be free from streaks and ricks. All markings which do not have a uniform satisfactory appearance by day and night shall be corrected by the Contractor at his own expense.

17.4 Delineators

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.

17.5 Materials for Delineators

The manufacturer and model type of all delineators shall be approved by the Engineer before any order is placed for their supply. All details of delineators shall conform to the relevant JIS or AASHTO standards.

17.6 Construction of Delineators

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 colour shall be as directed by the Engineer.

17.7 Concrete Curb

This work shall consist of the construction of concrete kerb of the various shapes and at the locations as shown on the Drawings or instructed by the Engineer.

Curbs may be cast-in-place or precast. The concrete for reinforced or precast kerbs shall be Class C, for non-reinforced cast-in-place kerbs Class D, 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 this Specification.

Preformed expansion joint fillers for kerb joints shall consist of a bituminous mastic composition, formed and encased between two layers of bituminous felt, all in conformity with AASHTO M33.

17.8 Construction Requirements for Curbs

The construction requirements shall conform to the clauses for concrete structures elsewhere in this Specification. Maximum joint spacing shall be 10 m. Before placing the exposed section of the kerb all lines and levels shall be checked by the Engineer. Any junction between the concrete base and the Class D concrete shall be prepared and treated as a construction joint in accordance with this Specification.

When at driveway entrance crossings or for other reasons, a transition section of kerb is indicated on the Drawings or ordered by the Engineer, the Contractor shall furnish concrete kerbs with the required modification.

Precast kerbs shall be cast in mortar tight metal moulds sufficiently rigid to prevent any deformation of the kerb. The precast kerbs shall be removed from the moulds 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 kerbs that show cracking or soft or damaged comers or surfaces shall be rejected.

Curbs shall be carefully handled, transported and off-loaded so as to avoid damage. Any kerbs which become chipped, marred or cracked before or during placing shall be rejected.

Bedding and joint mortar for precast kerbs shall comply with the requirements given elsewhere in this Specification.

Precast kerb units shall not be more than 80 cm long. Special units shall be cast for radii of less than 5.0 m.

On completion of kerb the Contractor shall backfill and tidy up the work to the satisfaction of the Engineer.

17.9 Concrete Barrier

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.

All materials to be furnished and used and all equipment and construction methods which are not covered in the following clauses shall conform to the requirements stipulated in other applicable Clauses.

17.10 Materials for Concrete Barrier

Concrete shall be Class B-1 concrete

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 proportion of mixing for approval of the Engineer.

The grout shall be mixed, by mechanical mixing equipment of a type that shall produce uniform and thoroughly mixed grout. Water shall be first added to the mixer followed by cement and admixture.

Expansion joint filler shall conform to the requirement of AASHTO M33.

17.11 Equipment and Tools for Concrete Barrier

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.

Forms shall be made of metal conforming to the shape, lines and dimensions of the members shown on the Drawings.

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.

17.12 Construction of Concrete Barrier

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 Working Drawings and Schedules, showing:

- Details of the various precast units to be manufactured;
- Contractor's alternative designs if the submission of alternatives is approved;
- Details of forms;
- Contractor's details of proposed manufacture and construction;
- Sequence of operations proposed; and
- Production schedule in relation to Construction Schedule and Contract Period.

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, 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 three working days in advance, of the probable date of commencement of manufacture.

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.

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 shall 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.

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.

Immediately after form removal, unless otherwise approved by the Engineer, the units cast shall be given a Rubbed finish in accordance with this Specification.

17.13 Storage of Concrete Barrier 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.

17.14 Erection of Concrete Barrier Units

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.

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.

The barrier shall be erected to the correct alignment following and providing the correct smooth curvature.

17.15 Measurement and Payment

Measurement and payment for traffic control utility shall be made in accordance with the Clause 21 (Traffic Control Utility) of the Preamble.

18 LANDSCAPING WORK

This work shall consist of the construction of interlocking concrete paving and planting, of trees and shrubs and their cultivation according to the specifications and their positioning as detailed on the Drawings.

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 levelling the soil.

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.

18.1 Preparation for Landscaping Work

After the soil is cleaned of debris from the construction works, the height of the topsoil shall be arranged as per the drawings.

To prevent any standing water occurring a slope of 0.30/00 (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 filled 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.

18.2 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 shall be given by the Engineer to the Contractor before planting is commenced.

The plants shall comply with the following requirement:

- 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.

18.3 Planting

Execution of the landscaping can be commenced:

- When all the construction and civil works 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, similar to potted plants, requires that the top soil is cleaned up around the planted area.

18.4 Trees and Shrubs

Trees and shrubs shall be planted before turf is placed but after the ground has been levelled and prepared.

Locations of trees shall first be ascertained, with reference to staking out posts, in accordance with specifications on detail drawings and as approved by the Engineer.

Holes dug for planting shall be in accordance with design drawings, for trees 80 x 80 cm to a depth of 80 cm and for shrubs 60 x 60 cm to a depth of 40 cm

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.

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% |

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.

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 as shown on drawings.

Each tree shall be protected by support posts as shown on the Drawings. Such support posts shall be given a coating of creosote or its equivalent so that they do not

quickly decay. Posts shall be wood/bamboo in accordance with detail drawings and 1.8 m in length of which 60 cm shall be buried in the soil. Binding or ties shall be made of natural raffia.

Trees shall be watered until they are growing healthily up to the end of the Period of Warranty, the watering to be carried out in the mornings between 6 AM to 10 AM and in the afternoons from 3 PM until completed.

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.

18.5 Nursing Completed Landscaping

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 shall be dealt with by twice weekly applications of Basudin 60 or Dithane M45.

Watering shall be carried out twice daily, mornings and afternoons, until the completion of the maintenance 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 shall be required to replace the dead plants as quickly as possible, at the latest 3 days after the request for replacement is issued.

18.6 Interlocking Concrete Paving

This Specification section describes requirements and procedures for constructing of concrete blocks on prepared beds in accordance with this Specification and in accordance with the lines, levels, grades, dimensions and types shown on the Drawings. If shown on the Drawings the work shall include the construction of bed courses.

This work shall also include concrete for median and island paving in accordance with the locations and details shown on the Drawings or as directed by the Engineer.

18.7 Materials

- Bedding Material

If bedding material is required by Drawings, unless otherwise specified, it shall be sand bedding in accordance with the provisions of this Specification section "Earth Work". The thickness of bedding material shall be in accordance with drawing requirements.

- Concrete

Concrete shall be of the class shown on the Drawings and shall be in accordance provision and requirements of Section of Specification "Concrete".

- Mortar

Mortar, if required, shall be in accordance with the provision of specification section in Stone Masonry

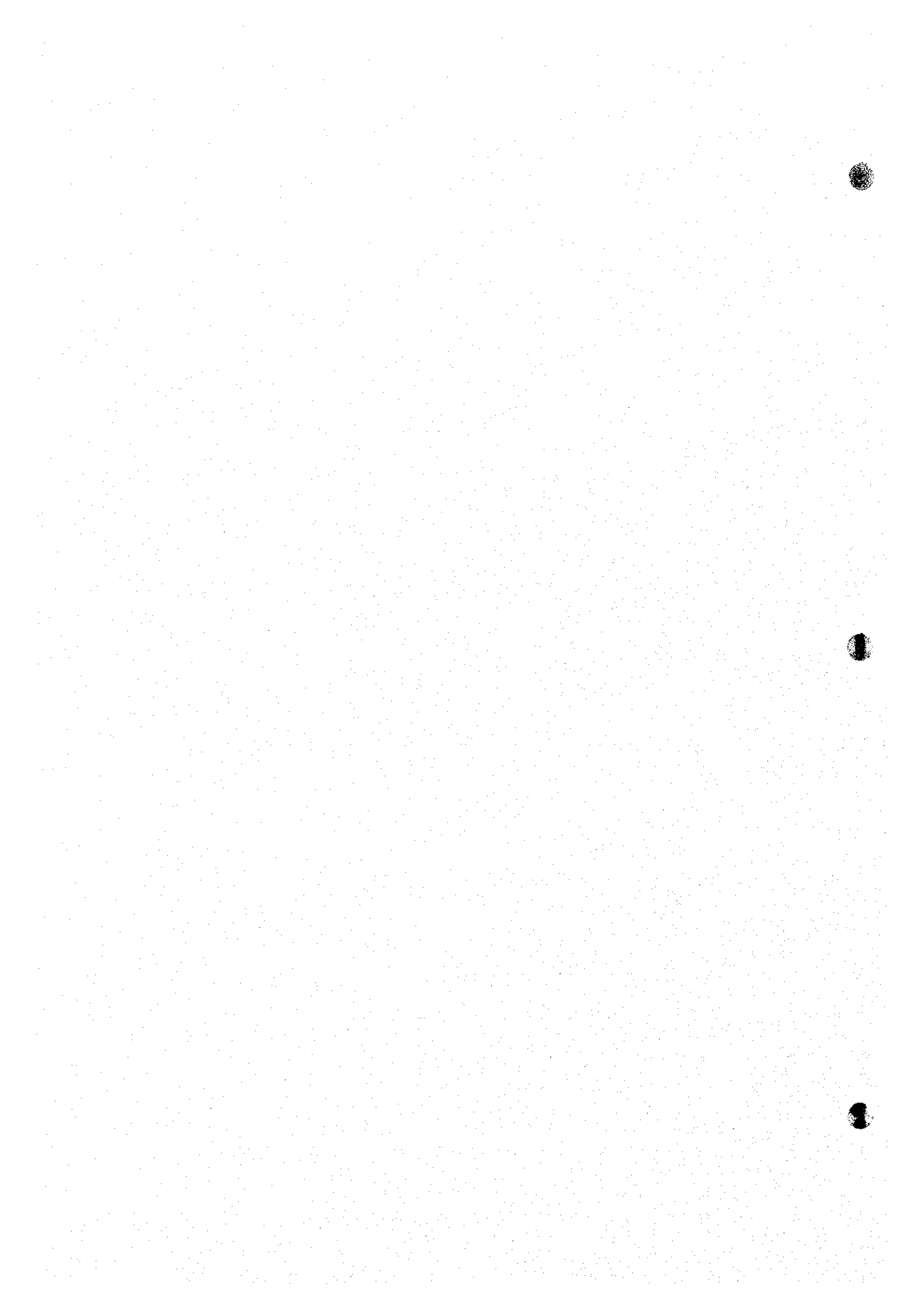
18.8 Construction Methods

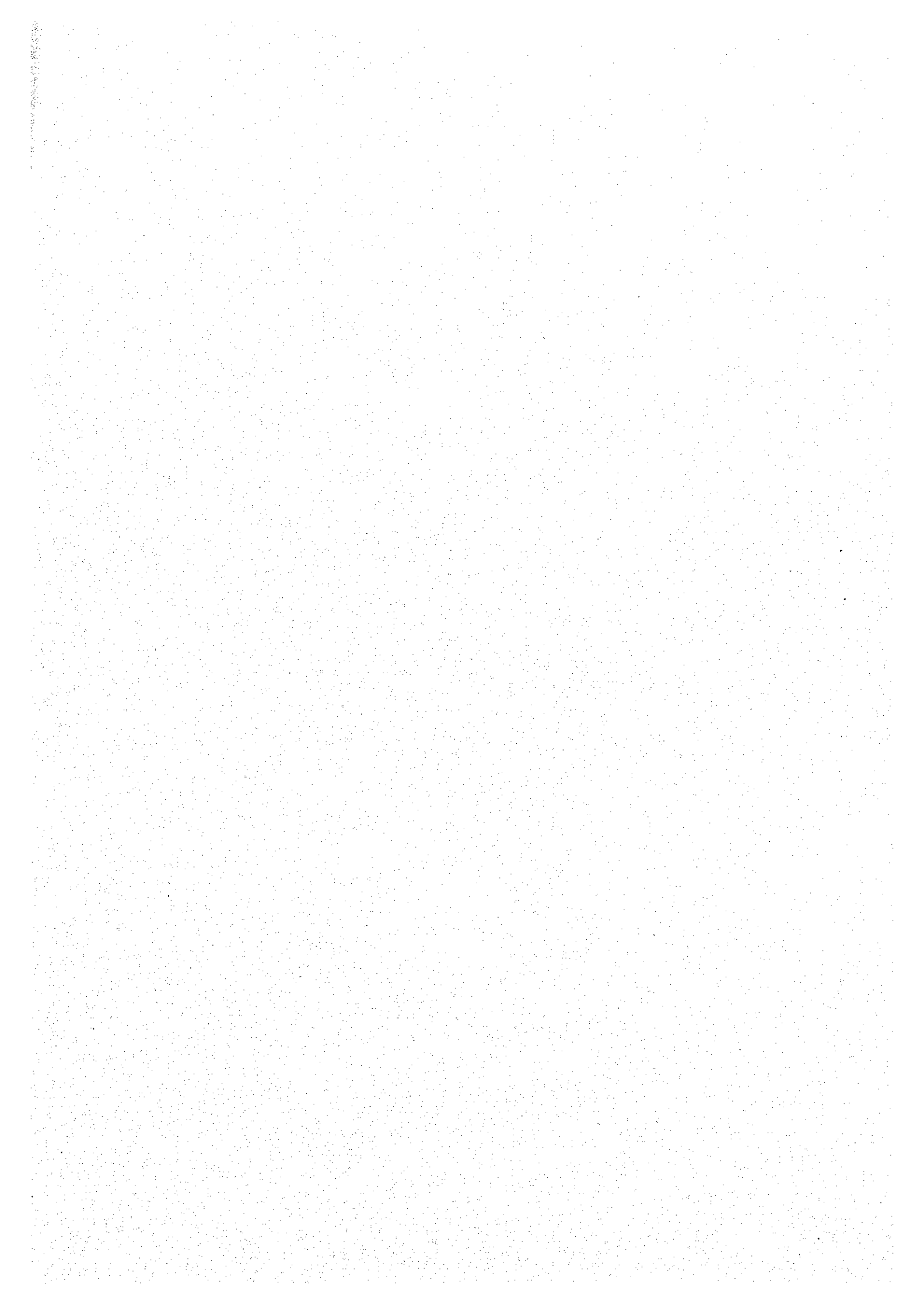
- Excavation shall be made to required depth, and the foundation shall be shaped to conform to the section shown on the Drawings and compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material.
- Concrete finish shall be as indicated on the drawings and in accordance with the provisions of Specification section 06100.
- If indicated on the Drawings, bed course material shall be placed and compacted to form a bed course of the required thickness.
- Concreting shall be in accordance with the requirements of Specification Section 06100. Preformed expansion joint filler, if required by drawings, shall be of the dimensions shown on the Drawings. It shall be set in the positions shown on the Drawings before the placing of concrete is started.
- The edges of the sidewalk and the transverse cuts shall be shaped with a suitable tool, so formed as to round the edges to a 1-centimeter radius.
- All work shall be correct to line, grade and level to within 3 millimeters.
- If shown on the Drawings, the Contractor shall construct the required sidewalk or island paving of individual precast concrete slabs or blocks of the size specified on the Drawings.

18.9 Measurement and payment

Measurement and payment for landscaping work shall be made in accordance with the Clause 22 (landscaping work) of the Preamble.







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