

## 12 BRIDGE UTILITY

### 12.1 Bridge Expansion Joints

This work shall consist of the supply and installation of expansion joints in bridge decks and RC frames.

#### 12.1.1 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 placing any order for the joints.

The Contractor shall submit a certificate by the manufacturer to the Engineer for approval before furnishing the joints.

#### 12.1.2 Expansion Joint

Joint seal rubber expansion joints shall be for expansion size as shown on drawings.

Rubber expansion joints shall be for expansion amounts.

Sealant joints shall be for fixed joints.

#### 12.1.3 Epoxy Mortar Joints

The material used shall be of the following composition and specification:

Silica sand No.3 (grain diameter 1.68-1.19 mm)	:	4.00 kg
Silica sand No. 4 (grain diameter 0.42- 0.105 mm)	:	2.50 kg
Silica powder	:	1.00 kg
Epoxy binder	:	1.00 kg
Specific Gravity	:	2.20 ± 0.10
Bending strength JIS R5201	:	≥ 50 kg/cm <sup>2</sup>
Compressive strength JIS R5201	:	≥ 150 kg/cm <sup>2</sup>
Compression Young's modulus JIS R520	:	(0.5-2.0) x 10000kg/cm <sup>2</sup>

#### 12.1.4 Silica Sand Joints

Material used shall be clean and dry, grading shall be even for each size and shall contain a minimum 85% of SiO<sub>2</sub>.

#### 12.1.5 Epoxy binder Joints

The material used shall be of the following specification:

Specific Gravity JIS K7112	:	1.08 ± 0.10
Tensile strength JIS K6301	:	≥ 50 kg/cm <sup>2</sup>
Elongation JIS K6301	:	≥ 100%

#### 12.1.6 Fibre Reinforced Plastic Joints

The material used shall be of the following specification:

Tensile strength	:	$\geq 270 \text{ kg/mm}^2$
Tensile Young's modulus	:	22000 - 24500 $\text{kg/mm}^2$
Mass	:	$0.396 \pm 0.016 \text{ g/m}$

#### 12.1.7 Joint Seal Rubber Joints

The material used shall be of the following specification:

Tensile strength JIS K630	:	$\geq 120 \text{ kg/cm}^2$
Elongation JIS K630	:	$\geq 300\%$
Hardness JIS K6301	:	$50 \pm 5 \text{ Hs}$
Compressive permanent strain JIS K6301 (at 70°C, 22 hours)	:	$\leq 35\%$
Tearing strength JIS K6301, type-B	:	$\geq 30 \text{ kg/cm}^2$

#### 12.1.8 Bonding Agent for Joint Seal Rubber Joints

The material used shall be of the following specification:

Specific gravity JIS K6911	:	$1.20 \pm 0.10$
Viscosity JIS K6838	:	pasty condition
Peel Adhesive strength JIS K6854 (180 Degree peel adhesive strength between resin mortar and vulcanized rubber)	:	$\geq 3 \text{ kg/cm}^2$
Tensile strength JIS K6301	:	$\geq 200\%$
Elongation JIS K6301	:	$\geq 200\%$

#### 12.1.9 Joint Rubber Joint

The material used shall be of the following specification:

Tensile strength JIS K6301	:	$150 \text{ kg/cm}^2$
Elongation JIS K6301	:	$\geq 300\%$
Hardness JIS K6301	:	$55 \pm 5 \text{ Hs}$
Tearing strength JIS K6301	:	$\geq 30 \text{ kg/cm}^2$
Compressive permanent strain JIS K6301 (at 70°C, 22 hours)	:	$\leq 25\%$

#### 12.1.10 Epoxy Concrete Joints

The mixture of epoxy concrete shall include epoxy resin and silica sand.

The mixture shall be of the following specification:

Specific gravity (at 20°C, 7 days)	:	$2.25 \pm 0.10$
Bonding strength JIS A1106 (at 20°C, 7 days)	:	$\geq 170 \text{ kg/cm}^2$
Compressive strength JIS A1108 (at 20°C, 7 days)	:	$\geq 500 \text{ kg/cm}^2$
Compressive Young's modulus JIS A1108 (at 20°C, 7 days)	:	$\geq 1.0 \times 10^5 \text{ kg/cm}^2$

## 12.2 Sealant Material

Sealant material shall be a 2 part polysulphide material in accordance with JIS K6301.

Elongation = 500%  
Tensile strength: = 8 kg/cm<sup>2</sup>

### 12.2.1 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. The 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 shall not be permitted. Jointing of adjacent pieces shall be in accordance with the manufacturer's instructions.

## 12.3 Installation Generally

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.

Immediately prior to installation, the joint system shall be inspected by the Engineer for proper alignment and complete bond between the neoprene sealer and the steel sections and proper stud placement and effectiveness.

### 12.3.1 Placing of Epoxy Mortar

Placing of epoxy mortar for joint types 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.

### 12.3.2 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.

### 12.3.3 Time of installation

Setting of expansion joints shall be done after pavement works on the bridge are finished.

## 12.4 Bridge Railings

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 this Specification and as directed by the Engineer.

Materials shall conform to the requirements of:

- JIS G 3101 Rolled Steel for General Structures
- JIS G 3452 Carbon Steel Pipes for Ordinary Piping
- JIS G 3444 Carbon Steel Tubes for General Structural Purposes
- JIS G 3466 Carbon Steel Square Pipes for General Structural Purposes
- JIS G 3532 Low Carbon Steel Wires
- JIS G 3552 Chainlink Wire Netting
- JIS H 4040 Aluminium and Aluminium Alloy Rods, Bars, Wires
- JIS G 4303 Stainless Steel Bars

Mortar and grout shall conform to the provisions of this Specification.

All steel railing, chainlink fencing, and fittings shall be galvanised unless otherwise specified, in accordance with the requirements of Clause 9.22 of this Specification. All aluminium alloy shall be coated in accordance with the Specifications of JIS H8601. Galvanised areas damaged by welding or other site works shall be cleaned and given 3 coats of an approved zinc based paint, to the satisfaction of the Engineer.

Where painting is required, it shall be in accordance with the requirements of Clause 9.24 of this Specification.

#### 12.4.1 Construction of Bridge Railings

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.

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.

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 must be pinned at each post. Where welding of component parts is permitted, the details must be in accordance with the Drawings or as approved by the Engineer.

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.

The Contractor shall furnish for the approval of the Engineer working drawings for the particular type of railing and fence to be installed.

The steel barriers shall be inspected for proper alignment by the Engineer prior to the placement of the dry pack mortar.

#### 12.5 Drain Pipe

##### 12.5.1 Materials

Drain pipe material shall conform to the requirements of JIS K6741 (Unplasticized Polyvinyl Chloride Pipes: UPVC). Deck drain material shall conform to the requirements of JIS G5101 (Carbon Steel Castings), JIS G5501 (Grey Iron Castings), and JIS G3101 (Rolled Steel for General structures: SS41). All metal deck drain material including support rackets shall be galvanised.

Pull box material shall conform to the requirements of JIS G3101 (Rolled Steel for General Structures: SS41) and shall be galvanised.

## 12.5.2 Construction

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.

Drain pipes shall be fixed as indicated on the Drawings or as directed by the Engineer.

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.

The type and the material of name plate shall conform to the requirements as directed by the Engineer.

## 12.6 Measurement and Payment

### (1) Bridge Railing

The measurement and payment for shall be made in linear metres. The rates shall include for complying with the Clause 16.1 of the Preamble.

### (2) Expansion Joint

The measurement and payment for expansion joint shall be made in linear metres. The rates for expansion joint shall include for complying the Clause 16.2 of the Preamble.

### (3) Drain for Bridge

The measurement and payment for drain for bridge shall be made in linear metres, and the rate shall include full compensation for furnishing and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the work.

### (4) Lighting Protection System

The measurement and payment for lighting protection system shall be by set. The rate shall include supply of all material, labour, equipment, tools and other incidentals to complete the work.

### (5) Navigation Aids

The measurement and payment for navigation aids shall be by set. The rate shall include supply of safe water light (white), port hand light (red), starboard hand light (green), anchor bolt, control box and monitoring base system and incidentals necessary to complete the work.

## **13 ELECTRICAL SERVICE**

### **13.1 Scope of Work**

This work shall consist of furnishing and installing all materials and equipment necessary to complete in place, highway lighting, and other electrical systems, and the modification of such existing systems when so specified, all in accordance with the Drawings, this Specification, or as instructed by the Engineer.

The location, controllers, poles and appurtenances shown on the Drawings are approximate and the exact location will be established by the Engineer in the field.

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:

- Preparation and submission of Shop Drawings
- Submission of detailed Material Supply Lists
- All work associated with the removal of sections of the existing systems and the incorporation of the remaining sections in the permanent works.
- Site measurements of ambient brightness of natural daylight at tunnel sections to assist the Engineer in his review of the lighting details shown on the Tendering Drawings.
- All other electrical equipment and services needed to complete a usable and operable facility in accordance with the pertinent electric codes and local regulations for Electrical Installation.

### **13.2 Quality Assurance**

For the actual 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.

In acceptance or rejection of the installed electrical system, no allowance shall be made for lack of skill on the part of installers.

All work shall comply with the Drawings and this Specification, in addition to complying with the codes regulations and requirements of the relevant Vietnamese Authorities.

### **13.3 Drawings and Documents**

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 working drawings shall be submitted in duplicate and within the periods stipulated below:

- Details of ducts and method of fixing street lighting panels and cable entry into buildings: Working drawings shall be submitted within two months of handing over the site to the Contractor.
- All other working drawings shall be submitted within a period of one month from the date of approval of the street lighting panels by the Engineer.
- Should however the Contractor be obliged to install electrical conduits prior to this period then he shall submit the relevant working drawings at least four weeks prior to the proposed date for commencement of the work.

The Contractor shall submit a programme indicating the dates on which concreting in different sections shall take place together with the submission of the working drawings.

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.

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.

#### 13.4 Standards and Regulations

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.

JIS	Japanese Industrial Standard
JEC	Japanese Electrical Committee
IEE	Institute of Electrical Engineers
ASA	American Standards Association
ASTM	American Society for Testing Materials
DIN	German Industry Standard
IEA	International Electrical Association
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)
UL	Underwriter's Laboratories, Inc.
IALA	International Association of Lighthouse Authorities
22TCN-208-92	Regulations on Navigation Signals Equipped for Domestic Waterways in Vietnam
JIS A 4201	The Protection of Structures Against Lightning (Japan)
CEGS-16670	Lighting Protection System, Department of Army (U.S.A)



TCVN-4756-89 Specification on Grounding for Electrical Equipment  
BS Specification for Sheet-Lighting Lanterns for use with Electric Lamps

The Contractor shall allow for any changes or modification of this Specification to ensure conformance with local regulations.

### 13.5 Lighting Units Generally

Lighting units as shown on the Drawings shall consist of lighting 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 2m in roadway direction and every 1.2 m across the roadway.

#### 13.5.1 Street Lighting Units (Pole Mounted)

Street lighting luminaires shall be 250W high pressure sodium vapor type having a light distribution complying with Semi Cut-off B.S 1788 and CP1004.

Street lighting luminaires shall be mounted at 11.5m from road surface, with 15deg of mounting angle, on a single/double armed street lighting column.

Street lighting luminaires shall incorporate a splash and dust-proof type sealing with gaskets between the housing and the front cover not less than IP55 for the lamp compartment and IP23 for the gear compartment. All exposed metal parts shall be made of non-corrosive materials. The luminaire shall be of the integral control gear type and shall consist of the following components:

- One piece die-cast aluminium body housing consist of lamp compartment and gear compartment. Gaskets shall be fitted to all joints between body housing and front cover.
- One-piece die-cast aluminium hinged front cover with optical prism structure (attached inside) temper glass bowl diffuser. The glass bowl shall comply with IEC impact test.
- Anodised aluminium sheet reflectors consist of one-piece top reflector and two pieces of side reflectors. All reflectance of reflectors shall be more than 80%
- Ballast for high-pressure sodium vapour lamp for operation on a 220V, 50Hz supply.
- Suitable igniter for lamp characteristics.
- Capacitor to improve power factor correction to 0.9 or more. The capacitor shall be dry and self-protecting type.
- Stainless steel shaft of hinge and one set of stainless steel toggle for locking the front cover.

The efficiency of the street lighting luminaire shall be 60% or more. The wind resistant intensity of luminaire shall be secured against wind speed 60m/s.

250W clear type of high pressure sodium lamp (elliptical/ tubular) shall be used to the street lighting luminair. The luminous flux of the lamp shall be more than 27,500 lm.

#### 13.5.2 Ballasts for High Pressure Sodium Lamp

Ballasts for high pressure sodium lamps shall be designed to properly operate the lamps of the wattage as designated in the Drawings. All ballasts shall be drip-proof, canned, 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.

#### 13.6 Interchange and Tollgate Lighting Unit (Floodlighting)

Flood lighting luminaires shall be 1000W mercury vapor type having a light distribution of middle angle type.

Flood lighting luminaires shall be mounted at 20m height from road surface with the most suitable aiming on high must.

Flood lighting luminaires shall incorporate a splash and dust-proof type sealing between the housing and the glass front cover. Not less than IP55. All exposed metal parts shall be made of non-corrosive materials or finishing. The luminaire shall be of the remote control gear type and shall consist of the following components.

Aluminum reflector with multi-layer transparent treatment to increase light reflection rate.

Tempered front clear glass.

Rear opening type of aluminum lamp holder cover with integrated lamp damage prevention fitting and three sets of toggles of stainless steel for locking the rear cover.

Dust filter to eliminate dust and dirt contained in the air.

Die-cast aluminum connection box for cable entry.

Galvanized steel mounting arm with horizontal / vertical angle graduation.

Transit level for aiming.

Remote type of control gear box with ballast for mercury vapor lamp and capacitor for operation on a 220V, 50Hz supply. The gear box shall be splash and dust-proof type.

The luminaire shall be angle adjustable type having 180 degree in horizontal and 150 degree in vertical of adjustable angle.

1000W clear type of mercury vapor lamp shall be used to the flood lighting luminaire. The luminous flux of the lamp shall be more than 55,000 lm.

### **13.7 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.

### **13.8 Lighting Panels Generally**

The lighting panels shall be included as feeders of the power source fed to the circuits of the street and bridge lighting and the guide signs. The panels shall be as shown on the Drawings or equivalent as approved by the Engineer.

The components shall be designed for 3-phase 4-wire, 50 Hertz operation at 380-415/220-240 volts.

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 in conformity with the drawings or as approved by the Engineer.

The panel and door shall be made from fully-finished steel sheet not less than 2.3 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 shall 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 aluminium 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.

Panel housings shall be fitted with a substantial lock, master keyed if appropriate.

### 13.8.1 Circuit Breakers

The circuit breakers shall be moulded 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 shall 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.

### 13.8.2 Magnet Contactors

Magnet contactors shall be the moulded case type rated for 600V AC service. The magnet contactors shall be S poles and 100Amp capacity.

The magnet contactors shall be controlled by 220/240V and shall be capable of holding its contacts securely even if the control voltage drops by 85% if its rated value.

### 13.8.3 Control Equipment

The power switching to the multiple lighting circuits shall be achievable by each of:

- photoelectric devices,
- programmable timer, or
- manual operation

### 13.8.4 Timer Switch

Timer switch units shall have two control elements, one of which shall be for "on" control at evening and "off" at early morning, and the other which shall be for reduced current control at midnight for saving energy, all as shown on the Drawings.

Both "on" and "off" time setting shall be available for any of the 24 hours, and the minimum setting increment shall be one minute.

Timer switch shall be operated on 220/240 volts, 50 Hz. Timer switches installed in the street lighting panels shall have an emergency driving device for 48 hours or more when the incoming power source fails.

### 13.9 Aviation Obstruction Lighting

High intensity obstacle lights shall be installed to reduce hazards to aircraft by indicating the presence of the bridge towers. They shall be in accordance with the requirements of Annex 14 to the Convention on International Civil Aviation.

The work shall comprise the design, fabrication and supply of two systems of high intensity obstacle lights comprising 12 luminaires, 12 control panel units, 2 control equipment units and 2 photoelectric sensors.

The lighting shall comply with FX-7S-200K High Intensity Aviation Warning System and the following:

Single phase AC input rated 50 Hz, 220V  $\pm 10\%$  and a max input power of 700VA per lighting unit.

The lighting shall be designed to operate in an ambient temperature range from 100C to 450C and in wind velocities up to 260km/hr.

#### 13.9.1 Aviation Obstruction Lighting Performance

Aviation obstruction lighting shall meet the following performance requirements:

		High Intensity Obstruction Light FX-7S-200K		Remarks
Light axis luminous intensity	Daytime (H)	200,000cd		Change 3-Steps from higher intensity to lower
	Twilight (M)	20,000 cd $\pm 25\%$		
	Nighttime (L)	2 000 cd $\pm 25\%$		
Beam angle	Level	1200 or more	H-100,000cd M-8,000cd	
	Vertical	3-7°	L-1,500cd	
Flash number	40 times/m $\pm 5\%$			
Flash method	Synchronous			
Angle of elevation adjustment range	0 to +8°			

#### Environmental Conditions

Ambient Temperature +10~ +45°C

Wind Velocity 260km/h

### 13.10 Lighting Poles

Lighting poles shall be galvanised steel, in accordance with the details shown on the Drawings, as outlined herein and in accordance with the requirements of Clause 9.22 of this Specification.

All materials shall be in natural colour and shall not be painted or coated with any other material. All pole items shall be galvanised steel and all hardware shall be galvanised steel. Scratches, marks, dents or other damages to poles and fittings shall 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 hotdip galvanised. 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 1.0 meters above ground level. Identification plates shall be attached to each lighting pole.

Foundations 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 this Specification.

### **13.11 High Masts**

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 galvanised over their entire surface in accordance with the requirements of Clause 9.22 of this Specification. 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.

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 this Specification.

The Contractor shall submit for the Engineer's approval construction drawings of the foundations and calculations showing that the foundation and the anchor bolts shall not move. Anchor bolts shall conform to the specifications of JIS B1180 and B1181 or equal, and each shall be provided with 2 nuts and 2 washers. Anchor bolts, nuts and washers shall be galvanised over their entire surface in accordance with the requirements of this Specification.

The masts shall have a lockable access door at ground level.

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.

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.

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)

#### 13.11.1 Mobile Equipment for Floodlight Masts

Mobile equipment shall consist of head frame assembly, mobile floodlight carriage, hoisting device, and electrical equipment.

Each mast shall 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.

Each mast structure shall be complete with three hoisting cables, a six conductors minimum 10 mm<sup>2</sup> 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.

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.

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.

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 shall 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.

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 suitable 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.

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

- One three-pole, 20 ampere moulded case circuit breaker (interrupting capacity of 30,000 amperes at 460, volts) for the area lighting luminaires.
- One single-pole, 15 ampere as in the above for the security lighting luminaire.
- One single-pole, 15 ampere circuit breaker, as in the above, for the lowering device drive outlet.
- One six-pole matching plug and socket outlet for the six conductor hanging cable.
- 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 265-volt, single phase socket outlet compatible with the lowering device drive plug shall be connected to the circuit breaker.

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 metre length of control cable complete with a water tight reversing push button station. The latter shall 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.



### 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 (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 armouring and PVC sheeting type NYFGbY or equal approved by the Engineer. Conductors shall have a minimum cross-sectional area of 10 mm<sup>2</sup> 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 mm<sup>2</sup> 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<sup>2</sup> 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 lighting 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  $\Omega$ .

##### **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  $\lambda$  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. Centeralized 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<sup>2</sup> 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<sup>2</sup> 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.

## 14 TOLL PLAZA

### 14.1 Toll Plaza Generally

This work shall consist of the construction Portland cement concrete pavement, concrete barrier, drainage, the specifications for control office, work items including architectural, water-supply, electrical works, office facilities, toll booth and gate in accordance with these specifications and drawings, all in conformity with the lines, grade and dimensions instructed by the Engineer.

The Contractor shall submit all detailed design of toll booth, gate and office facilities to the Engineer for approval.

The type and characteristics of the booth, gate and office facilities shown on the Outline Drawings. To assist the Engineer in his review of the outline drawings, the Contractor will undertake a review design of the site to determine the location, elevation. On the bases of the results of this review the final types, lines, characteristics will be decided by the Engineer who will inform the Contractor of them in writing of the approved schedule of work submitted by the Contractor.

The details design of the architecture of management office and others storage building for reinforced concrete structure of foundation, toilet devices and finishing schedules of in accordance with the Technical Standard of Vietnam TCVN 4448-87, 5674-92, 4819-88 and others relative standard.

Electrical work shall be performed in accordance with the following regulations and codes, Electric installation criteria 11 TCN 18 to 21 - 84 and TCVN Vietnamese Standard.

### 14.2 Submission of Data and Shop Drawings for Toll Plaza Buildings

Detailed Shop drawings including design shall be submitted including

- Drawing and manufacture's recommendation toll booth of an architectural.
- Design and drawing for toll gate of steel structures.
- Design of water distribution plans including valves, valve boxes, fittings and elevated water tank.

The following electrical data shall be furnished by the Contractor to the Engineer and shall be included in the design documents.

- Catalogues of electrical component; transformer, lanterns, ballast, etc.
- Plans and circuit diagrams, ground road connection diagram.
- Photometric data
  - Utilisation Curve
  - Isocandela Diagram
  - Horizontal Iso Foot Candle Diagram
  - Polar Light Distribution Curve
- Details of columns, brackets, base plates

### **14.3 Materials and Construction of Toll Plaza Buildings**

The size and texture of building brick shall conform to the requirement of Vietnam Standard and construction shall comply with construction specification.

Electroliers shall be applied to the materials and equipment conforming to the applicable provisions of Vietnamese Standards.

### **14.4 Concrete Pavement for Toll Plaza**

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,

### **14.5 Material for Concrete Pavement**

Pavement Quality Concrete (P.Q.C.)

The constituent materials for P.Q.C. shall comply with the other requirements of this Specification except that coarse aggregate shall be crushed stone.

### **14.6 Joint Filler for Concrete Pavement**

Poured filler for joints shall conform to the requirements of AASHTO M 173.

Preformed fillers for joints shall conform to the requirements of AASHTO M 33, AASHTO M 153, AASHTO M 213, or AASHTO M 220, 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.

### **14.7 Slip Sheet Membrane for Concrete Pavement**

Membrane for waterproof underlay below the slab shall be polythene sheeting 125 microns thick or as specified by the Engineer. When an overlap of underlay materials is necessary this shall be at least 300 mm.

### **14.8 Curing Materials for Concrete Pavement**

Curing materials shall conform to the following requirements as specified or other materials satisfactory to the Engineer:

Liquid Membrane-Forming	AASHTO; M148
ComDounds for Curing	
Concrete - Type 2	
White pigmented	

#### **14.9 Concrete Mix for Concrete Pavement**

The approval of mix constituent proportions shall be made on the basis of trial mixes developed by the Contractor in accordance with this Specification.

The mass of cement incorporated in each cubic meter of fully compacted concrete shall not be less than 300 kg. The use of very high cement contents is unnecessary and the Contractor shall base his mix design on the leanest mix that meets all specified requirements.

In determining the coarse aggregate/fine aggregate ratio the fine aggregate proportion shall be kept to a minimum. 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. The ratio of free water to cement for surface dry aggregate shall be determined by strength requirement but shall in no case exceed 0.50 by mass.

The use of plasticisers 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.

#### **14.10 Concrete Strength for Concrete Pavement**

The minimum site working flexural strength shall not be less than 45 kg/cm<sup>2</sup> at 28 days when tested by the third point method in accordance with AASHTO T 97.

In respect of the minimum 7 days working strength this is provisionally specified as 80% of the minimum site working flexural strength. The Engineer may, at his discretion, at any time before or during concrete pavement operations, increase or decrease the minimum 7 days working strength.

The laboratory trial mix shall be so designed by the Contractor that the resultant flexural strength result shall show adequate working strength margin so that the probability of the working strength test values falling below the minimum specified site working flexural strength is reduced to a value not exceeding 1 %.

#### **14.11 Spreading and Finishing Machines for Concrete Pavement**

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.

#### **14.12 Vibrators for Concrete Pavement**

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).

#### **14.13 Concrete Saw for Concrete Pavement**

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 this equipment shall be on the job both before and continuously during concrete placement.

#### **14.14 Forms for Concrete Pavement**

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 in 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  $\frac{2}{3}$  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 formed sections together tightly, and for secure setting.

#### **14.15 Joints for Concrete Pavement**

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.

#### **14.16 Longitudinal Joints for Concrete Pavement**

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 effected 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 centre 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 centreline 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.

#### 14.16.1 Transverse Expansion Joints for Concrete Pavement

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 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.

#### 14.16.2 Transverse Contraction Joints for Concrete Pavement

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.

Transverse strip contraction joints shall be formed by installing a parting strip to be left in place as shown on the Drawings.

Formed 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.

Sawn contraction 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 ravelling and not more than 18 hours after 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.

Transverse formed contraction joints shall comply with the requirements of sub-clause (a) above for the longitudinal formed joint.

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 3.0 in 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 3.0 in long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

### 14.16.3 Load Transfer Devices in Joints for Concrete Pavement

Dowels, when used, shall be field in position parallel to the surface and centre 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 metal or PVC dowel cap or sleeve approved by the Engineer shall be furnished for each dowel bar used with the expansion joints.

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.

### 14.16.4 Sealing Joints in Concrete Pavement

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.

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.

## 14.17 Construction of Concrete Pavement Generally

Before commencing work on the concrete slab, all work on the sub-base, ducts, and adjacent kerb shall be completed to the satisfaction of the Engineer.

Except for small or irregular areas requiring hand finishing all concrete shall be distributed uniformly, compacted and finished by machines.

### 14.17.1 Form Setting for Concrete Pavement

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.

#### 14.17.2 Placing Concrete for Concrete Pavement

The concrete shall be deposited on the grade in such manner as to require as little rehandling as possible. 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 centred 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.

#### 14.17.3 Placement of Reinforcement for Concrete Pavement

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, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 330 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, millscale, and loose or thick rust which could impair bond of the steel with the concrete.

#### 14.17.4 Machine Finishing of Concrete for Concrete Pavement

The concrete shall be distributed or spread as soon as placed and shall be struck off, vibrated and screeded by an approved finishing machine. The machine shall go over 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 effect 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.

#### 14.17.5 Hand Finishing of Concrete for Concrete Pavement

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 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 even, 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.

#### 14.17.6 Floating of Concrete for Concrete Pavement

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.

For hand floating 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 centre 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.

For mechanical floating a 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.

#### 14.17.7 Surface Correction of Concrete for Concrete Pavement

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 the Special Specifications.

#### **14.18 Edging of Concrete for Concrete Pavement**

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.

#### **14.19 Surface Finish of Concrete for Concrete Pavement**

After the completion of joints and edging and before the application of in curing compound the surface of the concrete pavement shall be brushed in a direction aspect of the centre line of the pavement.

Brushed finish shall be formed with a wire broom not less than 450 mm wide, the tufts of the broom initially to be 100 mm long of 32 gauge tape wire. The broom shall contain two rows of tufts, at 20mm centres and tufts shall be at 10 mm centres; and offset to the centre of the gap minimum of 14 wires each. Brooms shall be replaced when shortest tufts wear down to 90 mm long. The average textured depth shall not be less than 0.75 mm.

#### **14.20 Surface Test of Concrete for Concrete Pavement**

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 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 not 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.

#### **14.21 Curing of Concrete for Concrete Pavement**

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 litre/m<sup>2</sup> 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 litre/m<sup>2</sup>. 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 Clause 8.33. 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.

#### **14.22 Removal of Forms for Concrete for Concrete for Concrete Pavement**

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 (1) 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.

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 3.0 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.

#### **14.23 Trial Lengths of Concrete for Concrete Pavement**

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 but 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 with the Specification the Contractor shall construct another trial length. Trial lengths which do not conform with 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. Determination of non requirement of the trial length will be solely decided by the Engineer.

#### **14.24 Protection of Concrete 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 cross overs, etc.

Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement replaced, as directed by the Engineer.

#### **14.25 Opening of Concrete Pavement 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 moulded and cured in accordance with AASHTO T23 have attained not less than 90% of the minimum flexural strength at 28 days 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.

#### **14.26 Tolerance in Concrete Pavement Thickness**

The thickness of the pavement will be determined by average calliper measurement of cores tested in accordance with AASHTO T148.

Areas found deficient in thickness by more than 25 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.

#### **14.27 Measurement and Payment**

##### **(1) Tool Collection Booths**

Measurement and payment shall be made in square metres payment shall include full compensation for the supply of concrete, rebar, tool booth and tool gate, labour, equipment and incidentals to install tool collection booths.

##### **(2) Concrete Pavement**

Measurement and payment for concrete pavement shall be made in square metres. The rates for concrete pavement shall include for complying with the Clause 18.2 of the Preamble.

## **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 m<sup>2</sup>. 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/m<sup>2</sup>.

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 propose 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

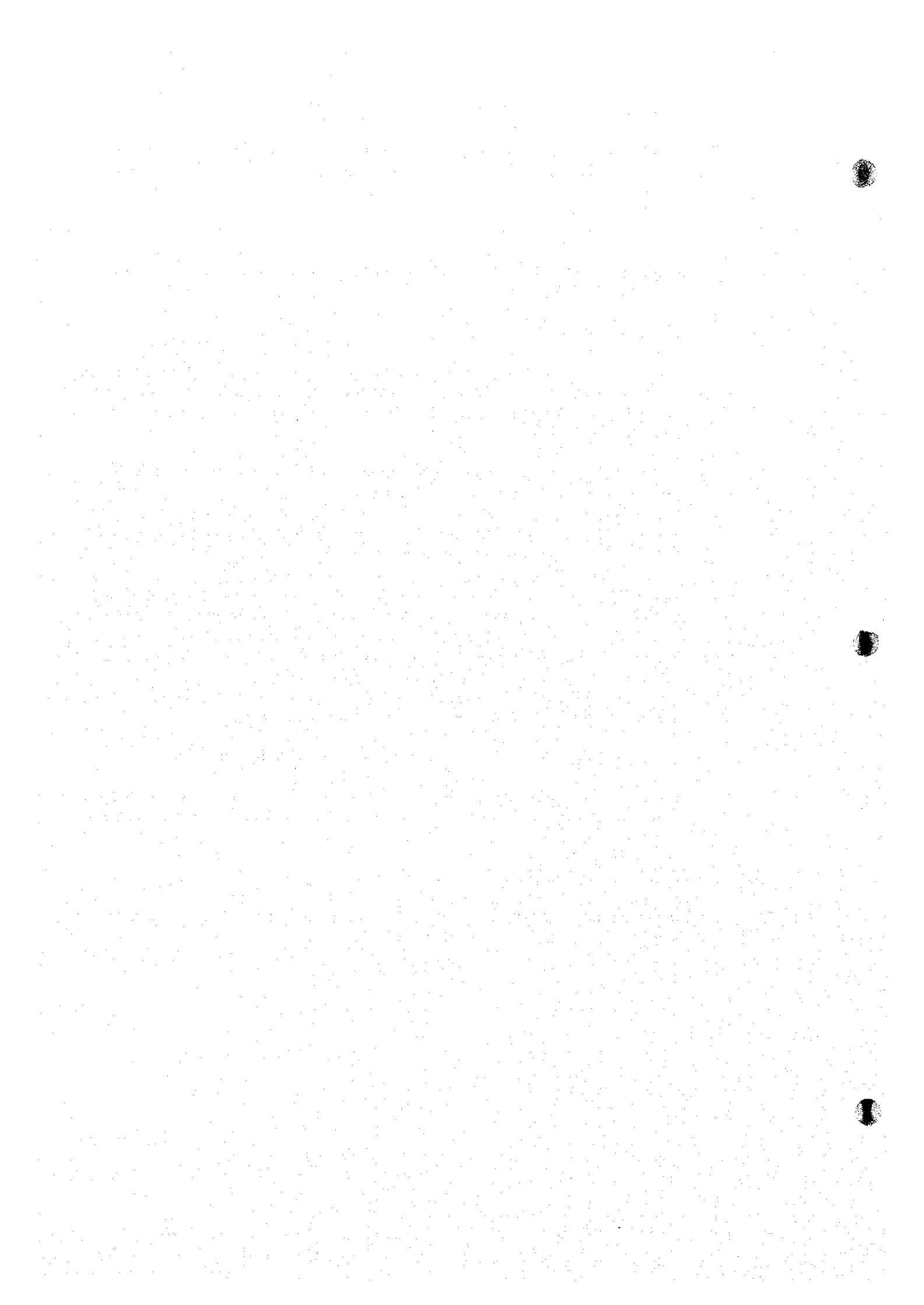
Mortar, if required, shall be in accordance with the provision of specification section in Stone Masonry

**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.

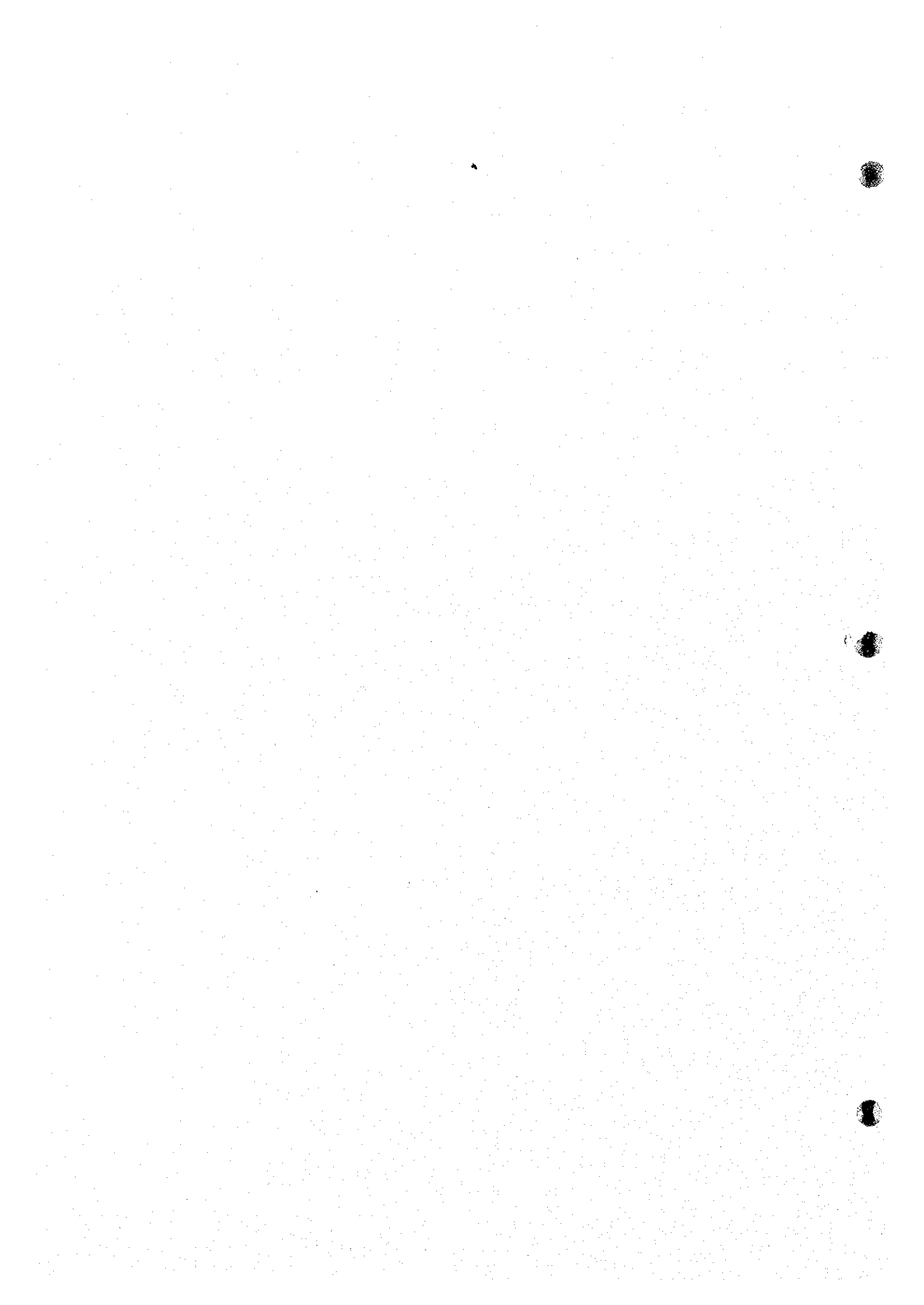
**18.9 Measurement and payment**

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











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