

## **11 BRIDGE BEARING**

### **11.1 Bridge Bearings**

This Specification section provides requirements and procedures for the supply and installation of bridge bearing pads required as indicated on the Drawings, as or as directed by the Engineer.

### **11.2 Elastomeric Bearings Generally**

Elastomeric bearing types are different on the main bridge from those on the approach bridges. The main bridge bearings shall have a dispersion function for horizontal reaction, and shall have durability for long term life as well as bridge life without maintenance.

Elastomeric bearings shall consist of laminated elastomeric pads or assemblies of laminated elastomeric pads as indicated on the Drawings and as specified herein.

Variation in thickness of an individual elastomer lamination shall not exceed 3 mm within the width or length of a bearing pad and the variation in thickness of all elastomer laminations within a bearing pad shall be such that each metal or fabric lamination will not vary by more than 3 mm from a plane parallel to the top or bottom surface of the bearing pad.

The total out to out thickness of a bearing pad shall not be less than the thickness indicated on the Drawings nor more than 6 mm greater than that thickness. Variation of total thickness within an individual bearing pad shall not exceed 3 mm.

The length and width of a bearing pad shall not vary more than 3 mm from the dimensions indicated on the Drawings.

The bond between the elastomer and the steel laminate shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and the steel.

#### **11.2.1 Elastomeric Bearings Materials**

All materials used in the manufacture of the bearing assemblies shall be new and unused with no reclaimed material incorporated into the finished assembly. All bonding of components shall be done under heat and pressure during the vulcanizing process. The bond shall be continuous throughout the plan area with no air spaces greater than 0.25 mm within the bonding material. The bearing assemblies shall be furnished as complete units from one manufacturing source.

The materials for the elastomeric bearings and assemblies shall comply with the following requirements:

#### **11.2.2 Elastomeric Materials for Bearings**

The elastomeric materials of the compounds shall be 100% virgin polychloroprene synthetic rubber meeting the requirements of Table No.1. The properties of the elastomeric compounds shall be determined from test specimens complying with

ASTM D3182 through D3190 inclusive and D3192. A variation of  $\pm 10\%$  in tensile strength and ultimate elongation under "physical properties" will be permitted when test specimens are cut from the finished product.

### 11.2.3 Internal Steel Laminates for Bearings

The internal steel laminates for the laminated elastomeric bearing pads shall be rolled carbon steel sheets complying with ASTM A 570 or AASHTO N183 (ASTM A36).

### 11.2.4 Laminated Elastomeric Bearing Pads

Laminated elastomeric bearing pads shall be individually molded to the required size. Corners and edges may be rounded with a radius at the corners not exceeding 9 mm and a radius at the edges not exceeding 6 mm. All edges of the steel laminations shall be covered with not less than 4 mm and not more than 6 mm of elastomer. The characteristics of the elastomeric bearing pads shall be within the following listed tolerances:

| ASTM Standard                               | Physical Properties  | Value                      |
|---|--|----------------------------|
| D2240                                       | Hardness, ASTM D2240   | 60 $\pm$ 5                 |
| D412  | Tensile strength, min.kg/cm <sup>2</sup> Ultimate elongation, min. %   | 175<br>425                 |
| D573, 70 HR.<br>03100°C                     | Heat Resistance<br>Change in durometer hardness, max.points<br>Change in tensile strength, max.%<br>Change in ultimate elongation, max. %  | + 15<br>- 15<br>- 40       |
| D395<br>Method B                            | Compressive Set<br>22 hours 03100 °C max. %  | 35                         |
|   | Ozone  |                            |
| D1149                                       | 100 pphm ozone in air by volume, 20% strain, 37.7°C t 1C,100 hours mounting Procedure D 518, Procedure A   | No Cracks                  |
| D429, A<br>D429, B                          | Adhesion to Steel<br>Bond made during vulcanization<br>Bond Strength (per square cm)<br>Peel Strength (per cm of width)  | 80% R(Z1)<br>2.8kg<br>7 kg |
| D429, B                                     | Adhesion to TFE Bond made during vulcanization<br>Peel Strength  |                            |
| Low Temperature<br>Test-Durometer<br>Change | Bearing or sample to be exposed for 96 hrs.@-28 °C, $\pm 2$ °C. (The specimen shall have a24 hr. conditioning period at roomtemperature prior to low temperatureexposure). The durometer test shall bemade at-28 °C on an unbuffed surface.Durometer hardness increase, Max. ASTMD2240, 30 second reading. Durometer to beplaced in freezer with test specimen | + 15(Z2)                   |
| D746  | Brittleness temp, 3 min., at -40 °C  | No cracks                  |

| ASTM Standard | Physical Properties   | Value  |
|---------------|---|--|
|               | Structural Steel. The internal steel laminates  | for the laminated elastomeric bearings shall be rolled mild steel sheets conforming to SAE 1020 or AASHTO M183 |
|               | Laminated elastomeric bearings shall be individually molded to the required size. Corners and edges may be rounded with a radius at the corners not exceeding 9 mm and radius at the edges not exceeding 6 mm. All edges of the steel laminations shall be covered with not less than 3 mm and not more than 6 mm of elastomer. The dimensions of the elastomeric bearings shall be within the following listed tolerances: |  |

#### Overall Vertical Rubber Dimension

|  |           |
|--|-----------|
| Average total rubber thickness 32 mm or less | -0, +3 mm |
| Average total rubber thickness over 32 mm    | -0, +6 mm |

#### Overall Horizontal Rubber Dimension

|               |           |
|---------------|-----------|
| 90 cm or less | -0, +3 mm |
|---------------|-----------|

Thickness of individual layers of elastomer (60 Durometer Only)  $\pm 20\%$

Variation from a plane parallel to the theoretical surface 1.5 mm per 300 mm, Tops 6 mm, Sides.

Edge cover of embedded metallic laminate 4 mm min, 6 mm max.

The rubber laminates shall be of uniform integral units, capable of being separated by mechanical means into separate, well-defined elastomeric layers. The ultimate breakdown limit of the elastomeric bearing under compressive loading shall be not less than 140 kgs/cm<sup>2</sup>. In addition to the requirements of Table No. 1, the stress-strain relationship of the finished elastomeric bearings at room temperature shall not exceed the following limitations.

|  |              |               |
|--|--------------|---------------|
| Compression Stress   | 35 kgs/sq.cm | 56 kgs./sq.cm |
| Strain (Percent of total thickness of all elastomer laminations) | 5%           | 7%            |

In addition, shear resistance of the bearing shall not exceed 2.1kg/cm for 60 durometer, Table No. 1 compounds at 25% strain of the total effective rubber thickness after an extended four-day ambient temperature of -28 °C.

The Contractor shall furnish to the Engineer a certification by the manufacturer that the elastomer, in the elastomeric bearing pads to be furnished conforms to all of the above requirements. The certification shall be supported by a certified copy of the results of tests performed by the manufacturer upon samples of the elastomer to be used in the pads.

### 11.3 Rubber Bearings with Dispersion Function

The rubber bearings on the main bridge shall have a function of force dispersion with a large deformation capacity. The basic components of the bearing shall consists of rubber material, a weatherproof rubber cover, internal laminates steel sheets, upper and lower steel plates with anchored connection rods, and guide device for shear deformation.

The rubber shall be a natural rubber derivative meeting the requirements in accordance with the following Standards for Malaysian Rubber:

| Description       | Unit   | Grade  |
|-------------------|--------|--------|
| Rubbish content   | %      | < 0.05 |
| Ash content       | %      | < 0.5  |
| Copper content    | p.p.m. | < 8    |
| Manganese content | p.p.m. | < 10   |
| Nitrogen content  | %      | < 0.7  |
| Volatile content  | %      | < 1.0  |

Bearing material shall meet the following requirements:

- Design Conditions:

|  |   |  |
|--|---|--|
| Capacity of bearing stress<br>(calculated by valid bearing area) | : | $f_{min}=80\text{kgf/cm}^2$ , $f'_{min}=15\text{kgf/cm}^2$ |
| Amplitude of a stress  | : | $50\text{kgf/cm}^2$  |
| Capacity of shear strain   | : | 70%, and 150%(seismic design)                              |
| Rotation angle   | : | 1/300 at end support, 1/600 at mid span support            |

Requirements of bearing material made from natural rubber:

| Item   | Unit                | Value                          | Remarks   |
|--|---------------------|--------------------------------|---|
| Static modulus of share elasticity                                 | Kgf/cm <sup>2</sup> | 13.5-L1.3                      | JISK 6301-13  |
| Hardness   |                     | 65±5                           | D2240, JISK 6301-5  |
| Ultimate Elongation, min.  | %                   | >500                           | D412, JISK 6301-3   |
| Tensile strength, min.   | Kgf/cm <sup>2</sup> | >150                           | D412, JISK 6301-3   |
| Heart Resistance for change in tensile strength at 25 % elongation | %                   | -10 to +30                     | D573, 70 hours at 70°C<br>JISK 6301-6,13  |
| Heat Resistance for change in ultimate elongation, max.            | %                   | > - 50                         | D573, 70 hours at 70°C<br>JISK 6301-6,13  |
| Compressive set  | %                   | < 25                           | D395, 22 hours at 70°C<br>JISK 6301-10  |
| Ozone Endurance<br>D1149   | -                   | No cracks by visual inspection | 50pphm ozone in air by volume, 20% strain, 40 °C ± 1 °C, 96 hours mounting<br>Procedure D518, Procedure A<br>JISK 6301-16 |
| Water Endurance  | %                   | < 10                           | 72 hours at 50°C, D471<br>JISK 6011-5   |
| Coldproof  | -                   | < - 30 °C                      | D746, JISK 6301-14  |
| Peel Strength  | Kgf/cm <sup>2</sup> | > 7                            | D429, JISK 6301-8   |
| Chemical proof etc.  |                     |                                | D471, D1460   |
| Bond strength between steel  |                     |                                | D413, D429  |

- Bearing rubber surface material shall be weatherproof and provide ozone protection of the bearing material and protect the bearing laminate steel from rust. The surface material shall provide such protection for the life of the bearings.

Internal laminate sheets, sole, bed, upper and lower plates and guide devices shall be high-strength low-alloy steel complying with AASHTO M270 grade 50 (ASTM A 709, grade 50) or an approved stainless steel.

- The Contractor shall provide test certifications supposing testing by two million repeated (2Hz) loads for compressive shear fatigue test.

The anchor bolts for sole and bed plates shall:

- be zinc coated in accordance with requirements of AISI 1035, or an approved equivalent,
- be threaded,
- have a diameter not less than 25 mm,
- have an embedded depth not be less than 10 times the bolt diameter and
- have a shear strength of not less than 80 Mpa.

### 11.3.1 Mechanical Bearings

Mechanical Bearings shall be pot type and will have an elastomeric rotational element. Movement bearings will normally have sliding surfaces of stainless steel

and polytetrafluorethylene and may also have been fitted with guide bars or keyways. The bearings will have been designed in accordance with the requirements of the 1989 and/any Edition of AASHTO "Standard Specifications for Highway Bridges" 1989 and subsequent Interim revisions.

The Contractor shall provide shop drawings and calculations demonstrating the compliance of all bearings with the schedule show on the drawings.

Bearings shall have surface protecting in accordance with requirements and procedures noted under this Specification.

#### **11.4 Packaging, Handling, And Storage Of Mechanical Bearings**

Prior to shipment from the point of manufacture, bearings shall be packaged in such a manner to ensure that during shipment and storage the bearings will be protected against damage form handling, weather, or any normal hazard.

Each completed bearing shall have its components clearly identified, be securely bolted, strapped or otherwise fastened to prevent any relative movement, and marked on its top as to location and orientation in each structure in the project in conformity with the plans.

Dismantling at the site shall not be done unless absolutely necessary for inspection or installation.

All bearing devices and components shall be stored at the work site in an area that provides protection form environmental and physical damage.

When installed, bearings shall be clean and free of all foreign substances.

#### **11.5 Galvanized Steel Dowels**

I beam and slab galvanized steel dowels shall be provided and installed in accordance with requirements and with accessories noted on the drawings.

Dowels shall be smooth plain billet-steel bars conforming to requirements of ASTM A615, 400 MPa and shall be zinc (hot-dip galvanized) in accordance with ASTM A123.

Dowels may be cast-insitu as shown on the drawings or drilled and grouted with an approved epoxy compound.

If dowels are drilled and grouted:

- holes shall provide at least 10 mm in diameter grater than the largest diameter of the dowel;
- holes shall be thoroughly cleaned with compressed air and water prior to grouting of dowels so as to remove all loose or extraneous materials;
- epoxy grout shall be ASTM C881 Type IV, or approved equivalent.

## 11.6 Bearing Installation

The bearings will have been clearly marked with their longitudinal and transverse axes, their type number and their intended locations in the Works.

Unless otherwise approved by the Engineer bearing beds shall be of non-shrink grout conforming to ASTM C 1107, Grade A. Proposals for the thickness and type of bearing plinths and beds shall be submitted by the Contractor and approved by the Engineer's in advance of bearing installation.

The Contractor shall submit to the Engineer for approval a detailed statement with respect to the methods for installation of Elastomeric Bearings. Once the Engineer has approved these methods, they shall not be changed without prior approval by the Engineer.

Bearings shall not be dismantled. Any transit bolts, straps or other temporary fixing shall not be removed until the bearing is fixed in its final position and the structure immediately above the bearing is in place. Care shall be taken to ensure that all transit bolts straps or other temporary fixings are finally removed.

All bearings shall be set horizontal in both directions and shall be positioned so that the Inscribed longitudinal axis is parallel to the structure axis at the point of support, unless otherwise noted in the Drawings.

Any devices such as steel packs used to hold bearings level whilst being fixed, must be removed finally, so that the bearings seats only on its mortar bedding.

Where precast beams and segments are placed on elastomeric bearings, immediately prior to the placing of each beam and segment the top of the bearing shall be coated with a sufficient thickness of approved mortar to take up any irregularities between the surface of the beams and segment and the bearings.

Bearings shall be positioned within the following tolerances:

- Alignment, maximum departure from required vertical or horizontal plane.

Entire assembly 1:400

Lower part of bearing 1:1000 relative to upper

- Plan Position

Laterally 3mm

Longitudinally 6mm

- Center/ Center Spacing 3mm

## 11.7 Testing of Bearings Generally

The testing of selected bearings shall be arranged with the Engineer prior to their inclusion in the Works. The testing shall be done at an independent testing facility approved by the Engineer.

#### 11.7.1 Vertical Proof Load Test of Complete Mechanical Bearing

The vertical proof load shall be 1.5 times the maximum vertical load specified in the bearing schedule. The proof load shall be maintained for a minimum period of 3 minutes.

#### 11.7.2 Horizontal Vertical Proof Load Test of Complete Mechanical Bearing

Bearings, which are required to resist lateral forces, shall be further tested to 1.5 times the lateral load stated on the Drawings while loaded in compression to the minimum vertical load shown on the drawings. The load shall be maintained for three minutes.

#### 11.7.3 Rotation Test of Complete Mechanical Bearing

The bearing shall be tested in rotation to the value for rotation shown on the drawings while being loaded in compression to the maximum vertical load shown on the drawings. Bearings, which are required to resist lateral forces, shall also have the specified lateral load stated on the drawings applied during this test.

The direction of application of the lateral load and the axis of rotation shall be compatible with the in service loads and rotational requirements. The lateral load shall be applied using a calibrated sliding surface to minimize any frictional restraint. Stainless steel interface shall be lubricated prior to the test. The test loads shall be maintained for three minutes.

#### 11.7.4 Long - Duration Compression Tests on Elastomeric Bearings

Selected bearings shall be loaded in compression to 1.5 times its maximum design load for a minimum period of 15 hours. If, during the test, the load falls below 1.3 times the maximum design load, the test duration shall be increased by the period of time for which the load is below this limit. The bearing shall be examined visually at the end of the test while it is still under load. If the bulging pattern suggests laminate parallelism or a layer thickness that is outside the specified tolerances, or poor laminate bond, the bearing shall be rejected. If there are three or more separate surface cracks that are greater than 0.08 in. (2mm) wide and 0.08 in. (2mm) deep, the bearing shall be rejected.

#### 11.7.5 Shear Modulus Tests on Material from Elastomeric Bearings

The shear modulus of the material in the finished bearing shall be evaluated by testing a specimen cut from it using the apparatus and procedure described in Annex A of ASTM D 4014, or, at the discretion of the Engineer, a comparable nondestructive stiffness test may be conducted on a pair of finished bearings. The shear modulus shall fall within 15 percent of the specified value or within the range for its hardness given in Article 14.3 of Division I if no shear modulus is specified. If the test is conducted on finished bearings, the material shear modulus shall be computed from the measured shear stiffness of the bearings, taking due account of the influence on shear stiffness of bearing geometry and compressive load.



## **11.8 Rejection of Bearings**

Any bearing which, as a results of the testing specified, exhibits any signs of failure such as:

- splitting or permanent deformation of the elastomer;
- tearing, cracking or permanent deformation of the PTFE sliding surface;
- cracking or permanent deformation of the sealing ring or other part of the bearing;
- abrasive marks indicating abnormal contact between the metal surfaces of the bearing plates or piston, and the pot;

shall be rejected and replaced.

Bearings damaged during transport, installation or subsequent construction operations shall also be liable for rejection and replacement.

## **11.9 Measurement and Payment**

- (1) The measurement and payment for bearing pad with Accessories shall be by number. The rates for bearing pad shall be made in accordance with the Clause 15 of the Preamble.

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

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

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

#### **13.24 Material and Installation for Lightning Rod**

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

#### **13.25 Material and Installation for Lightning Conductor**

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

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

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

##### **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. Centerlized control of obstruction lighting where isolated and relatively remote obstructions exist and manual controls must be established. In these instances, the lights may be served from a local supply and controlled by light sensitive photoelectric cells, or by astronomic-dial time clocks. When such controls are used, an auxiliary-locked manual control, accessible from the outside, shall be installed. The light sensitive control device shall be adjusted so that the lights shall be turned on when the illumination on a vertical surface facing north is about 35 foot-candles and turned off at a north sky light illumination level of about 58 foot-candles.

### **13.31 Temporary Navigation Marker Buoys**

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

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

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

#### **13.31.1 Manufacture of Temporary Navigation Marker Buoys**

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

#### **13.31.2 Temporary Navigation Marker Buoy Body**

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

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

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

### 13.31.3 Temporary Navigation Marker Buoy Lighting Equipment

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

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

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

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

### 13.31.4 Power Source for Temporary Buoy Lighting Equipment

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

### 13.31.5 Accessories for Temporary Buoy Lighting Equipment

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

To be recognized easier by vessel's radar, all buoys must be completed with Aluminum made radar reflector which must have a minimum effective reflective area 8.5m<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.

## **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 proposed manufacture and construction;
- Sequence of operations proposed; and
- Production schedule in relation to Construction Schedule and Contract Period.

The Contractor shall not cast concrete prior to the Engineer's approval of the Contractor's Drawings and Schedules, the concrete mixture, formwork, sequence of operations, method of placing, curing, protecting, handling and erecting members. Any alternative to the design in the Contract Documents, shall be subject to the Engineer's approval before manufacture or construction.

After all stipulated necessary approvals have been given the Contractor shall inform the Engineer, not less than three working days in advance, of the probable date of commencement of manufacture.

Forms shall be erected, set, braced and supported in a manner satisfactory to the Engineer with the inverted base of the form truly level both longitudinally and transversely.

All reinforcing steel shall be accurately placed in the position shown on the Drawings and rigidly held during placing and setting of concrete. Distances from the forms shall be maintained by stay blocks, ties, hangers, or other approved support. The use of precast mortar blocks for holding units from contact with the forms is deprecated, and approval for their use shall only be given if their design and dimensions are such that the contact area with the forms is minimal. The use of wooden blocks is prohibited.

Immediately after placing concrete the upper exposed surface shall be struck off true to the forms and hand finished using wooden floats. On completion of floating all units cast shall be checked by means of a straight edge to ensure that no high spots exist.

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

#### **17.13 Storage of Concrete Barrier Units**

Units shall not be moved until the concrete has attained at least 70% of the specified minimum compressive strength. Units shall be stored clear of the ground. Stacking of units shall be permitted providing it is limited to double stacking but no concrete to concrete contact shall be permitted.

#### **17.14 Erection of Concrete Barrier Units**

Units shall be double slung from a gantry or crane of adequate capacity to facilitate ease of handling and correct positioning. Lifting devices shall not damage or mark the concrete barrier.

Cement grout bedding shall be spread to the thickness shown on the Drawings. The spreading of grout shall not be made far in advance of barrier placing as the grout shall still be plastic at the time of placing the barrier unit. Grout squeezed out from under the barrier shall be removed.

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

#### **17.15 Measurement and Payment**

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

## 18 LANDSCAPING WORK

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

The Contractor shall give attention to the preparatory measures required before planting is carried out, such as levels of soil, slope of ground, and topsoil requirements including turning over and levelling the soil.

All work such as planting of shrubs, trees, and the cultivation of vegetation to cover the bare soil, shall be executed in accordance with specifications and current standards for such work.

### 18.1 Preparation for Landscaping Work

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

To prevent any standing water occurring a slope of 0.30/00 (three thousandths) shall be made in the direction of flow indicated by the Engineer.

All top soil for the areas of cultivation shall consist of a soil mixture of 5 cm humus and 10 cm existing soil.

These layers shall be executed after the ground to be filled is clear of debris resulting from the construction works and clear of other growths or weeds.

The use of weed killers for destroying weeds etc. shall not be permitted.

The preparation of the soil forms the final stage in the soil workings. At this stage the condition and compactness of the soil shall be good, there being no further changes occurring to the heights and contours desired.

### 18.2 Provision of Plants

Before the plants are finally planted in position on the site they shall first be put in a location to be indicated by the Engineer. Permission to execute the planting on site shall be given by the Engineer to the Contractor before planting is commenced.

The plants shall comply with the following requirement:

- Height of trees shall be between 2.0 m and 3.0 m.
- Height of shrubs shall be not less than 60 cm.

When dispatching trees to the site the trees shall be tied to support posts or similar in order that the trees are not damaged, similarly the leaves may be trimmed to reduce evaporation.

Plants shall be free of disease, infestation and shall have good healthy branches.



### 18.3 Planting

Execution of the landscaping can be commenced:

- When all the construction and civil works are completed.
- When the Contractor has received permission in writing, from the Engineer.

Holes to be planted shall be enriched with a mixture of soil and fertilizers, and shall be cleared of debris and stones. Each plant shall be held somewhat above the bottom of the hole to receive it, then soil added gradually to the hole and around the roots, tamping the soil to the required compaction. After the roots of the plant have spread, its trunk shall be slowly pulled out to ascertain that the surrounding soil is compact enough to support its roots, and so promote healthy growth.

In promoting cultivation, care of the topsoil around the plants, similar to potted plants, requires that the top soil is cleaned up around the planted area.

### 18.4 Trees and Shrubs

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

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

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

To protect soil fertility and plant growth the Contractor shall complete the tree planting not more than 1 week after the holes for the trees have been dug, in order to avoid acid condition of the soil.

The mixture of soil for filling in holes for planting shall consist of red soil and stable manure or of a quality similar to compost (compost is soil containing vegetation that has already undergone a process of decomposition).

The mixture of soil for filling shall be comparable to:

- |                           |     |
|---------------------------|-----|
| - soil for planting (pH7) | 75% |
| - stable manure           | 25% |

The soil mixture shall be free of stones greater than 4 cm in size. This mixture shall be put into the holes evenly to a depth of 15 cm, with another 5 cm around the tree roots.

Sufficient watering shall be carried out at every stage of planting. To avoid the possibility of water flowing away to another level when watering, the height of the top soil around trees and shrubs shall be made 4 cm lower than the surrounding level as shown on drawings.

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

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

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

During and after the work of planting and other works the Contractor shall continue to clean up all refuse or debris caused by landscaping activities over the pavements and/or the drains and channels for the duration of the Period of Warranty. The Contractor shall transport the remaining materials left over and other rubbish away from the site as early as possible when the landscaping activities are completed.

### **18.5 Nursing Completed Landscaping**

Any weeds which grow after the landscaping work is completed shall be pulled up and removed. The use of chemical weed killer is not permitted.

The prevention of disease or infestation shall be dealt with by twice weekly applications of Basudin 60 or Dithane M45.

Watering shall be carried out twice daily, mornings and afternoons, until the completion of the maintenance period.

Applications of fertilizers, commencing 2 weeks after planting, are to be made twice monthly using "NPK" fertilizers for all trees and shrubs.

For any and all omissions by the Contractor during the period of nursing which causes damage or death to the plant life, the Contractor shall be required to replace the dead plants as quickly as possible, at the latest 3 days after the request for replacement is issued.

### **18.6 Interlocking Concrete Paving**

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

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

### **18.7 Materials**

#### **- Bedding Material**

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

- Concrete

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

- Mortar

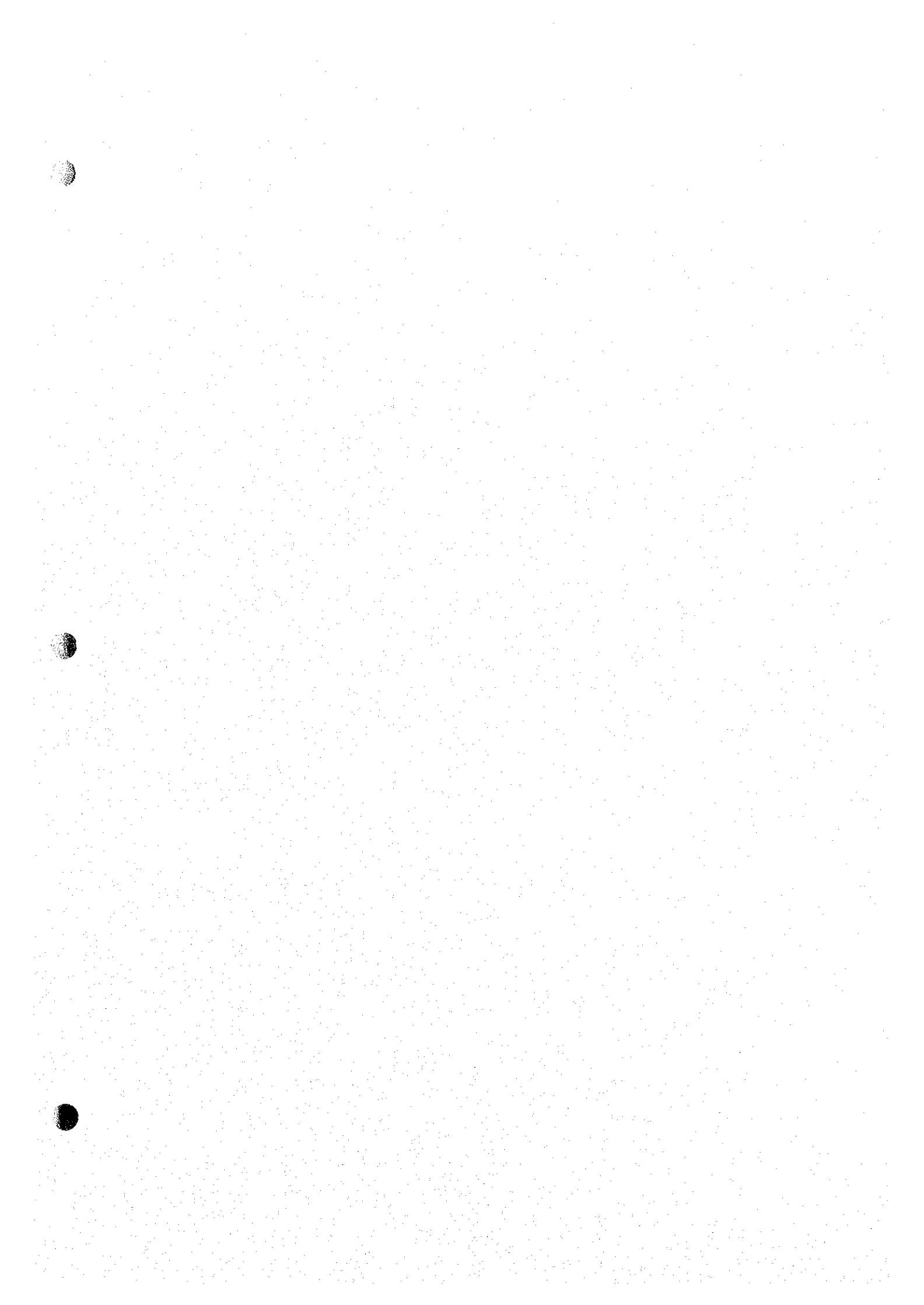
Mortar, if required, shall be in accordance with the provision of specification section in Stone Masonry

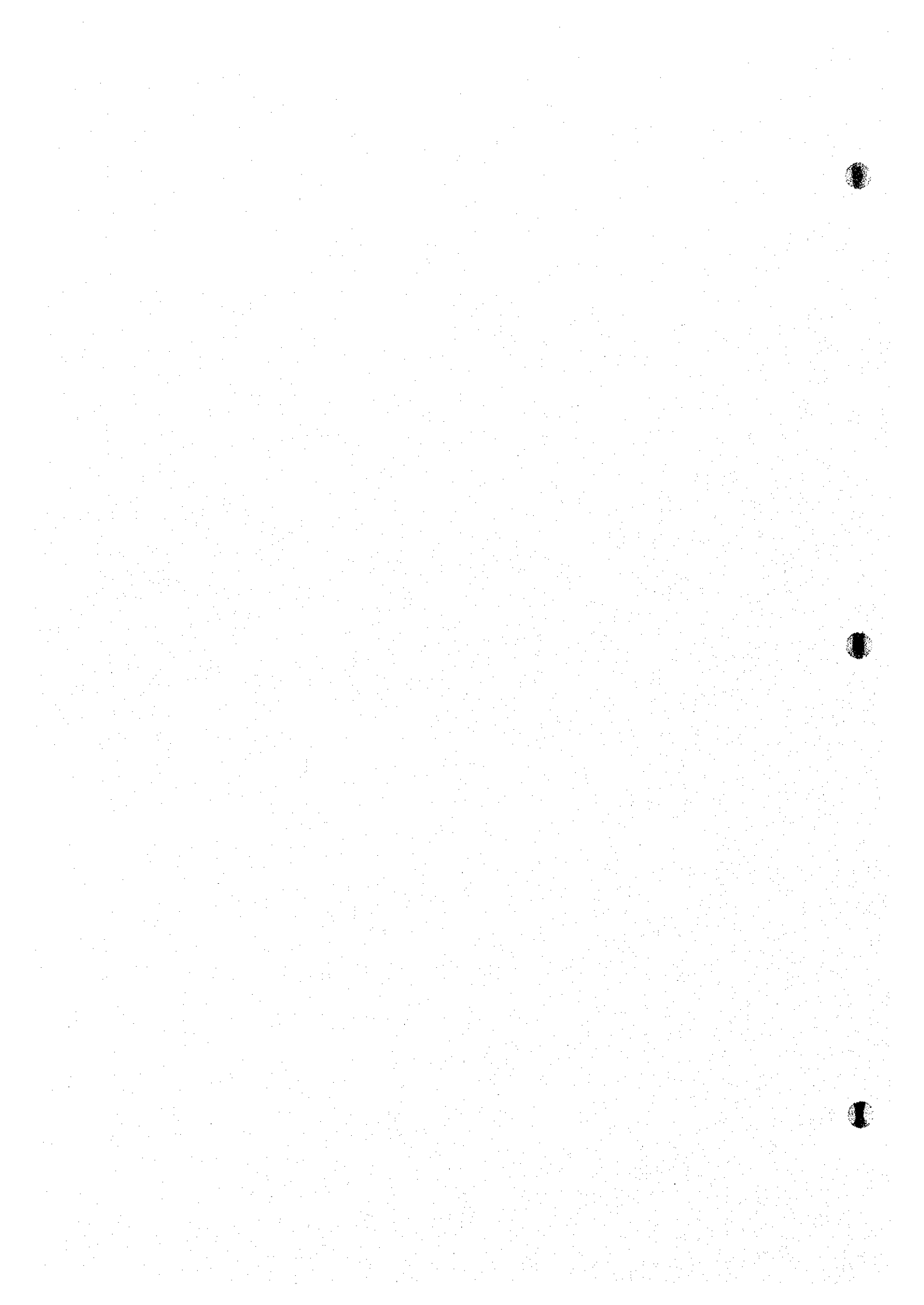
### **18.8 Construction Methods**

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

### **18.9 Measurement and payment**

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







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