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SECTION TS 13. GABIONS AND MATTRESSES

SECTION TS 13. GABIONS AND MATTRESSES

13.1 GENERAL

This section of the Technical Specification covers the requirements for Gabions and Gabion Mattresses (also known as reno mattresses).

Gabions shall be flexible galvanised wire boxes of the size stated in the Drawings, fabricated of wire mesh of the type and size, and selvedged as specified as specified below. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabion plus 100 mm except in the case of reno mattresses where the diaphragms shall have a maximum spacing of 600mm.

13.2 MATERIAL REQUIREMENT

13.2.1 Gabion Wire Mesh Baskets

Wire

Wire used in the fabrication of gabions and in the wiring operations during construction shall conform to AASHTO M 279 (ASTM A 116) having a tensile strength of not less than 350 MPa (3500kg/cm^2). The minimum weight of zinc coating shall be 250 g/m^2.

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns around a mandrel of four times the diameter of the wire, it shall not crack to such an extent that any zinc can be removed by rubbing with the bare fingers.

Where shown in the Drawings or shown in the Bill of Quantities, wire, galvanised as specified above, shall be coated with PVC in accordance with the manufacturer's recommendations.

Manufacture

The mesh shall be hexagonal woven mesh wherein the joints are formed by twisting each pair of wires through three half turns. The diameter of the wire shall be as shown on the drawings but not less than 3 mm for body wire, 3.9 mm for perimeter wire and 2.4 mm for tying and connecting wire.

The undisturbed size of the mesh shall be as shown on the drawings but shall not be greater than 80 mm by 100 mm. The tightness of the twisted joints shall be such that a force of not less than 1.75 kN pulling on one wire is required to separate it from the other wire when each wire is prevented from turning and the wires and the applied force are in the same plane.

The wire mesh shall have elastic properties sufficient to permit elongation of the mesh equivalent to a minimum of 10% of the length of the section of mesh under test without reducing the gauge or tensile strength of individual wire strands to values less than those for a similar wire one gauge smaller in diameter.

All edges of the gabions, diaphragms and end-panels except as stated below shall be selvedged with a wire of which the diameter is 25% greater than that of the wire used to form the mesh. Where the selvedge is not woven integrally with the mesh but has to be fastened to the cut ends of the mesh, it shall be attached by binding the cut ends of the mesh, so that a force of not less that 8.5 kN applied in the same plane as the mesh, at a point on the selvedge of a mesh sample of length one (1) metre is required to separate it from the mesh.

The diaphragms and end-panels shall be selvedged on the top and vertical sides only. The end panels shall be attached by twisting the cut ends of the mesh at the bottom of the panel about the selvedge on the base of the gabions. Similarly, the diaphragms shall be attached by twisting the cut ends of the mesh to the twisted joins of the mesh of the gabions. In each case the force required to separate the panels from the base shall not be less than that required to break the mesh over the same length.

Sufficient binding and connecting wire shall be supplied with the gabions to perform all the wiring operations to be carried out in the construction of the gabion work as stated below. The diameter of the binding wire shall not be less than 2.20 mm.

Tolerances

A tolerance on the diameters of all wire of + or – 2.5 % shall be permitted. The length of the gabions is subject to a tolerance of + or – 3 % and the width of gabions to a tolerance of + or – 25 mm. All other gabion dimensions are subject to a tolerance of + or – 3% of the sizes shown on the Drawings.

13.2.2 Stone Fill

Stone fill material shall consist of hard, durable stone of minimum dimension 100 mm and maximum dimension of 250 mm.

13.2.3 Palm Fibre

Material shall be palm fibre comprising a dense matrix of interwoven fibrous material and shall approved for use by the Engineer prior to placement.

13.2.4 Geotextile Filter Cloth

Geotextile filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 gm/m^2 and shall comply with AASTHO M 288 'Geotextiles used for Subsurface Drainage Purposes'.

13.3 CONSTRUCTION

Gabions and Gabion Mattresses

Prior to constructing gabions the bed on which they are to be placed shall be cut to the lines and profiles as shown on the Drawings.

Where shown on the Drawings palm fibre filter material shall be placed on the prepared bed. Palm fibre shall be spread uniformly such that there are no gaps and shall have a minimum uncompressed thickness of fifty (50) mm. All palm fibre sealing shall be Approved by the Engineer before being covered with other materials.

Where shown on the Drawings geotextile cloth shall be placed on the prepared bed. Geotextile cloth shall be lapped by a minimum or 300 mm where joints are necessary and shall extend 300 mm beyond the outside the lines of gabions to constructed on top of the geotextile cloth.

The placement of the gabion boxes shall be carried out in an orderly manner so that a face of incomplete work is maintained.

At least two rows of empty boxes shall be wired together at the face of uncompleted work prior to filling the box closest to the completed work. Prior to filling any box, one end or side of the box shall be secured to completed works or to stakes driven into the ground at the corners or in any other approved manner

and the opposite end, side or corner shall be stretched with crow bars and secured to and bottom in a suitable manner.

Stone fill material shall be placed carefully in order to ensure that it is tightly packed with a minimum of voids. The boxes shall be filled to between 25 mm and 50 mm above their tops. The top layer of material shall consist of selected small stone not less than 100 mm minimum dimension.

Where shown on the Drawings soil filling, as describe in Clause 2.5.10 shall be place on top of the completed gabion mattresses and watered in such that soil fills the voids between the stone fill. The process shall be repeated until no further soil penetrates the voids and a uniform layer of soil remains on the surface of the gabions.

Gabion Cylinders

Prior to constructing cylindrical gabions the bed and batter slopes on which they are to be placed shall be cut to the lines and profiles as shown on the Drawings.

Wire mesh shall be laid out in place ensuring that the log piles, previously driven penetrate the wire mesh to ensure anchorage.

Stone filling shall be placed and the gabions assembled and completed in accordance with the manufacture's recommendations.

Soil filling, as describe in Clause 2.5.10 shall be place on top of the completed cylindrical gabions and watered in such that soil fills the voids between adjacent cylindrical gabions and the voids between the stone fill. The process shall be repeated until no further soil penetrates the voids and a uniform layer of soil remains on the surface of the cylindrical gabions.

13.4 MEASUREMENT AND PAYMENT

Gabion Mattresses

Measurement shall be made of the volume of gabion mattresses in place and accepted by the Engineer.

Payment shall be made at the rates entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

For pay item D.4.9 the rate shall also include the cost of providing and placing soil filling as shown in the Drawings and described in the Specification.

Gabion Cylinders

Measurement shall be made of the volume of gabion cylinders in place and accepted by the Engineer.

Payment shall be made at the rates entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

Payment for soil filling around the gabion cylinders shall be made in accordance with clause 2.7.3.2.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.2.11	Gabion Cylinder Dia 500 mm (Galvanised and coated with PVC)	m^3
D.2.13	Gabion Mattress t=500 mm (Galvanised)	m^3
D.4.9	Gabion Mattress (Galvanised) t=300 mm with Soil Covering	m^3
D.9.5	Placing Filter Cloth (Geotextile sheet)	m^2
D.9.6	Gabion Mattress t=500 mm (Galvanised)	m^3
D.9.7	Placing Palm Filter under Gabion Mattress	m^2
E.2.15	Gabion Mattress t=500 mm (Galvanised) on Riverbed	m^3
E.2.16	Placing Palm Fibre Filter under Gabion Mattress	m^2
E.2.17	Gabion cylinder Dia. 500 mm (Galvanised and Coated with PVC) on Side Slope	m^3
E.3.12	Gabion Mattress t=500 mm (Galvanised) on Riverbed	m^3
E.3.13	Placing Palm Fibre Filter under Gabion Mattress	m^2
E.3.14	Gabion cylinder Dia. 500 mm (Galvanised and coated with PVC) on Side Slope	m^3
F.3.11	Gabion cylinder Dia. 500 mm (Galvanised and coated with PVC)	m^3
G.2.17	Gabion Mattress t=500 mm (Galvanised)	m^3
F.3.13	Gabion Mattress t=500 mm (Galvanised)	m^3
G.2.18	Gabion Cylinder Dia 500 mm (Galvanised and coated with PVC)	m^3
H.3.9	Gabion Cylinder Dia 500 mm (Galvanised and PVC coated)	m^3
H.4.7	Gabion Cylinder Dia 500 mm (Galvanised and coated with PVC)	m^3
H.5.8	Gabion Cylinder Dia 500 mm (Galvanised and PVC coated)	m^3
H.5.11	Gabion Mattress t=500 mm (Galvanised) on Riverbed	m^3
H.6.11	Gabion Mattress t=500 mm (Galvanised) on Riverbed	m^3
I.2.10	Gabion Mattress, t = 500 mm (Galvanised)	m^3

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SECTION TS 14. WEEP HOLES

SECTION TS 14.WEEP HOLES

14.1 Scope

This section of the Technical Specification covers the general and specific requirements of Weep Holes. It shall apply wherever Weep Holes are used in the Works, such as in revetments, wall, wet stone masonry or other applications, as shown on the Drawings or specified in this and other Technical Specification clauses.

14.2 Material

Pipe:
Material for weep holes shall be 50 mm nominal diameter, black, Unplasticised Poly-Vinyl-Chloride (uPVC) conforming to the requirements of JIS K 6741. Pipe for weep holes shall be approved in writing by the Engineer before any purchase orders are placed.

Palm Fibre:
Palm fibre shall be fresh palm fibre to the Engineer's approval.

Filter Cloth
Filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 gm/m^2 and shall comply with AASTHO M 288 'Geotextiles used for Subsurface Drainage Purposes'.

14.3 Construction

Pipes for weep holes shall be cut to the required lengths as shown on the Drawings and the inner end shall be surrounded by a ball of palm fibre not less than 150 mm diameter wrapped in filter cloth. The filter cloth shall be tied firmly to the pipe with nylon twine so as to ensure that all water which will enter the pipes must pass trough the filter cloth and palm fibre filters.

Assembled units shall be placed in the work at the levels, positions and slopes shown on the Drawings taking care to ensure that filter constructed as described above remains intact and that the exposed ends on the face of the work are flush with the face of the structure through which the weep hole passes. Gravel backfill shall be carefully hand placed around inner ends of the filters ensuring that that the filter remains intact.

14.4 Measurement and Payment

Measurement will be made of the number of weep holes of the various lengths completed in accordance with the Drawings, the Specification and to the approval of the Engineer.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.2.10	Weep Hole, Dia 50 mm including Filter Cloth	No.
D.5.8	Weep Hole, Dia. 50 mm including Filter Cloth	No.
D.6.9	Weep Hole, Dia. 50 mm including Filter Cloth	No.

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SECTION TS 15. ROADS AND PAVEMENTS

SECTION TS 15.ROADS AND PAVEMENTS

15.1 GENERAL

This section covers the construction of gravel pavements and penetration macadam pavements and the preparation required prior to their construction.

15.2 PREPARATION OF SUBGRADE

15.2.1 General

This clause specifies the requirements of the preparation of the surface on which gravel pavements or penetration macadam pavements are to be constructed.

15.2.2 Testing and Preparation

Where sub-base is to be placed on a subgrade of natural material (i.e. not on embankment), the Contractor shall check and visually inspect the subgrade for soft spots which shall be removed and replaced with suitable approved, compacted granular material. The Contractor shall check the in-situ density of the subgrade to ensure that it complies with the acceptance criteria shown below.

The acceptance criteria for the subgrade shall be :

- No visible soft areas and;
- No discernible movement during rolling with a 6 to 8 ton roller and;
- Compaction 90% of the maximum dry density determined according to AASHTO T 99.

No measurement or additional payment shall be made for the testing and preparation of subgrade described herein and the cost of complying with this clause shall be deemed to be included in the rate for gravel pavement or penetration macadam pavement as applicable.

15.3 GRAVEL PAVEMENT

15.3.1 General

This clause specifies the requirements for the construction of gravel pavements to be constructed under the contract.

15.3.2 Materials

Gravel for use in gravel pavements shall consist of hard durable stone which will not break down or deteriorate in service and shall be clean and free from clay or other deleterious materials. Unless otherwise specified or directed, gravel shall be crushed stone with grading, by weight, determined in accordance with AASHTO test methods, conforming to the grading shown in the following table:

Sieve Size	Percentage Passing
2 inch	100
1½ inch	95-100
3/4 inch	50-100
1/2 inch	-
3/8 inch	15-55
No 4	0-25
No 8	0-5
No 200	0-3

The Contractor shall submit to the Engineer for approval, samples and grading analyses of proposed materials to be used in the construction of gravel pavements.

15.3.3 Construction

Preliminary Requirements

Prior to placing sub-base for any section of road the following activities must have been completed and approved by the Engineer:

the natural subgrade inspected and improved such that all of the acceptance criteria detailed in clause TS 15.2.2 are met.

the Upper 300 mm depth of embankment subgrade compacted in accordance with the requirements of clause TS 2.5.3

Spreading

Sub-base material shall be spread by a method Approved by the Engineer. It shall be placed and spread in uniform layers care being taken not to disturb the subgrade, kerbing or adjacent structures.

Compaction

Immediately following spreading the gravel shall be compacted by 4 to 6 passes of a 6 to 8 ton tandem roller, or other equipment Approved by the Engineer. Acceptance criteria shall be no visible movement of the compacted sub-base under the heavier wheel of the roller. Any areas showing movement shall be excavated and replaced with suitable material compacted in accordance with the requirements of that layer.

15.4 PENETRATION MACADAM BASE PAVEMENT

15.4.1 General

This clause refers to the penetration macadam pavement to be constructed under the contract.

15.4.2 Materials

The Contractor shall test all paving materials before their use in the construction. The Contractor shall furnish samples as well as the manufacturer's specifications for such tests. No material shall be delivered to the site or used in the construction before its adequacy has been ascertained and approved by the Engineer. During construction the Contractor shall furnish, as required by the Engineer, sample materials for further tests, and materials found to be unsatisfactory shall be hauled away from the site by and at the expense of the Contractor.

Prime coat material shall be medium-curing asphalt MC-70 conforming to the requirement of AASHTO M 82, ASTM D 2027 or JRA shall be used. MC-70 shall be heated in an open boiler at a temperature of 50 to 70°C and shall be placed at the rate of 0.8 to 1.6 litres per square meter as directed by the Engineer.

Asphalt cement shall be of 85 to 100 or 80 to 100 penetration grade and shall conform to the requirements of AASHTO M 20 and ASTM D 946 or JIS K 2207. Heating temperature shall be between 135°C and 195°C or as determined by the Engineer.

The aggregate shall be crushed gravel or rock classified into coarse aggregate, filler and chip, each having the following gradings:

Coarse Aggregate (either A or B)

Classification	Sieve Size and Percentage Passing by Weight						
	60mm (2-½")	50mm (2")	40mm (1-½")	25mm (1")	20mm (¾")	13mm (½")	5mm (No.4)
A	100	70-90	50-70	25-45	15-35	0-15	0-5
B		100	65-85	35-55	15-35	0-15	0-5

Intermediate Aggregate for Filler

Classification	Sieve Size and Percentage Passing by Weight					
	20mm (¾")	13mm (2")	9.5mm (• ")	5mm (No.4")	2.5mm (No.8)	1.2mm (No.16)
C	100	90-100	45-75	5-25	0-10	0-5

Fine Aggregate for Chip

Classification	Sieve Size and Percentage Passing by Weight				
	20mm (• ")	5mm (No.4)	2.5mm (No.8)	1.2mm (No.16")	0.3mm (No.50)
D	100	85-100	10-40	0-10	0-10

The aggregate shall be hard, dry, clean and free from organic impurities or other objectionable matter.

The proportion of excessively flat or elongated grains shall not be more than 10 percent, where an excessively flat grains is defined as one with thickness smaller than half the average thickness of grains of similar size and an excessively elongated grain is defined as one with its length larger than two times its breadth.

When subjected to the Los Angeles abrasion test, the rate of abrasion shall not be greater than 40 percent.

The stripping resistance of the aggregate, when mixed with asphalt cement, shall not be smaller than 95 percent.

Unless otherwise approved, the quantity of materials required for penetration macadam of 100 mm thick after compaction shall be as follows:

Coarse Aggregate	0.100 m^3/m^2
Asphalt Cement	4.6 l/m^2
Filler	0.030 m^3/m^2
Asphalt Cement	2.60 l/m^2
Chip	0.020 m^3/m^2
Asphalt Cement	2.00 l/m^2
Chip	0.010 m^3/m^2
Total Aggregates	0.16 m^3/m^2
Total Asphalt Cement	9.20 l/m^2

15.4.3 Construction

Construction work shall be performed by dividing the depth of base course into two layers each 100 mm thick and proceeding in the following order:

Clean and repair the prepared subgrade;

- Place prime coat of MC-70;
- Spread and compact coarse aggregate;
- Perform first spraying of asphalt cement;
- Spread and compact filler;
- Perform second spraying of asphalt cement;
- Spread and compact first layer of chip;
- Perform third spraying of asphalt cement;
- Spread and compact second layer of chip;
- Repeat process (iii) to (ix) for second layer of base course;
- Perform additional compaction.

Construction of penetration macadam base course shall be performed in fine weather when the ambient temperature is 15°C or higher and wind velocity is below 16 kilometres per hour. Work shall not be performed on a wet surface or with wet aggregate nor on a day with the probability of rain.

Before applying the prime coat the subgrade shall be prepared in accordance with clause TS 15-2 and then thoroughly cleaned with brooms to remove dust and loose material.

The bitumen for each layer shall be applied in the quantities specified in clause TS 14-2 Bitumen shall be heated to the required temperature and applied evenly by means of a distributor shall be adjusted to factory specifications, usually about 30 cm. The machine shall be checked for speed and accuracy of control devices prior to its use. At each end of the section upon which bitumen is to be applied, a sheet of heavy paper shall be placed to avoid uneven application of bitumen at the ends. After spraying is completed for the section, the paper shall be removed and burned without delay. Care shall be exercised so that from 20 to 30 litres of bitumen will remain in the tank shall be waster in places designated by the Engineer and covered with earth. If the spraying machine becomes clogged during the spraying operation, the application of bitumen shall be continued by means of hand tools. If the bitumen applied for any layer is insufficient in quantity, it may be supplemented in the application for the next layer. However, the

application shall not be reduced for any layer on account of over-application for the preceding layer. During the spraying operation, the Contractor shall use approved methods to prevent staining the structures or vegetation nearby. Any staining that does occur shall be immediately removed by and at the expense of the Contractor.

The aggregate for each layer shall be place evenly in the specified quantities to the lines and grades shown on the Drawings. The transportation and windrowing of material shall be such that the time lapse between bitumen application and aggregate placement shall be as specified in paragraph g. of this Subclause. The spread aggregate shall be graded by grader or broom and projecting rock fragments or excessively flat or elongated material shall be removed by hand. The removal by hand of unsuitable particles shall continue during compaction till all the aggregate has even grading on the compacted surface.

Compaction after aggregate spreading shall be performed first by one pass of a rubber tyred roller and then, after brooming, by a steel wheeled roller weighing 10 metric tons, repeating the process until the layer is sufficiently hard and compact as determined by the Engineer. Compaction shall begin from the edges of the layer. The roller shall travel in directions parallel to the road centre line in such a way that each roller track shall overlap with the immediately preceding and adjacent track by half the width of the track. Where roller compaction is impracticable, compaction shall be performed by mechanical tamper. The height of the compacted surface shall not deviate from the designed lines and grades by more than 10 mm. Any portion failing to meet this requirement shall be scarified and re-compacted by and at the expense of the Contractor. The travelling speed of the roller turns or sudden application of the brake shall not be made by the roller while performing compaction.

The brooming of the prime coat before spreading the coarse aggregate shall be performed 24 to 48 hours after the application of the prime coat and only after the prime cost has sufficiently dried. A limited amount of sand, as determined by the Engineer, may be sprinkled on the prime coat to make further work possible if it necessary to perform further work without waiting for the prime coat to dry sufficiently. Excess sand shall be removed by brooming prior to spreading of the coarse aggregate.

The filler shall be placed within 15 minutes after completion of the first spraying of asphalt cement. Similarly, placing of the first-layer chip and the second-layer chip shall follow within 15 minutes after the second and the third applications of asphalt cement, respectively.

Within 10 days after placing and compacting the second-layer of the base course, additional compaction shall be performed with a 10 tonne roller.

After completion of placing and compacting the second-layer of the base course the road shall be closed to traffic for at least 48 hours.

The size requirements of mechanical equipment for constructing penetration macadam pavements may be reduced, subject to the approval of the Engineer in the case of construction in confined spaces.

15.5 MEASUREMENT AND PAYMENT

15.5.1 Gravel Pavement

Measurement shall be made of the area of gravel pavement in place and accepted by the Engineer.

Payment shall be made at the rate entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer including, but not limited to, subgrade preparation as specified in clause .....

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
B.4.4	Gravel Pavement, 200 mm thick	m^2
H.7.3	Gravel Pavement, 200 mm thick	m^2

15.5.2 Penetration Macadam Pavement

Measurement shall be made of the area of penetration macadam pavement in place and accepted by the Engineer.

Payment shall be made at the rate entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer and shall include the cost of subgrade preparation, application of prime coat, testing, furnishing and transporting material, placing, brooming, grading, compacting and traffic control.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
H.7.4	Penetration Macadam Pavement, 200 mm thick	m^2
H.8.3	*Penetration* Macadam Pavement, 200 mm thick	m^2

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SECTION TS 16. LANDSCAPING

SECTION TS 16. LANDSCAPING

16.1 GENERAL

This section covers landscaping works in the riverside amenity area of the West Floodway.

16.2 SCOPE OF WORK

The work to be competed includes the following:

Planting of trees

Identification of trees to be relocated

Removal and replanting of selected trees

Maintenance of new trees and relocated trees

16.3 TREE PLANTING

16.3.1 Plant Requirements

Trees to be supplied, planted and maintained shall be as specified in the following table:

Species	Height including root ball (mm)	Minimum Length of Roots (mm)	Diameter of Trunk measured 1000 mm above ground level (mm)	Ideal Spacing Interval (m)
Angsana	2200	200	60	5
Glodogan	1700	150	15	4
Flamboyant	2200	200	80	5

Branches and leaves shall be in good healthy condition.

The root ball, comprising main roots, hair roots and surrounding soil shall be wrapped in a plastic or bamboo basket.

16.3.2 Method of Planting

16.3.2.1 Ground Preparation

When locations for trees to be planted has been fixed and approved by the Engineer ground preparation shall be carried out as follows:

- An area 800 mm by 800 mm by 600 mm deep shall be dug and the soil loosened and removed.
- All rocks and debris shall be removed.
- The loosened red soil shall be mixed with natural fertiliser in the ratio of 1:1.
- The excavation shall be half filled with the soil-fertiliser mix.
- Mix enough red soil with peat moss in the ratio of 2 parts soil to 1 part peat moss to form a 100 mm thick layer.
- The soil-peat moss mix shall be placed in the hole to form the 100 mm thick layers.

- Backfill the hole with the remaining red soil and tamp down.
- The prepared ground shall be left for a minimum of 10 days before tree planing.

16.3.2.2 Planting

Planting shall be done as described below:

A hole of sufficient size for the root ball shall be dug in the prepared ground.

The wrapping on the root ball shall be removed and the tree planted with backfilling made with the soil-peat moss mix. The soil level shall be the same as the surrounding finished ground surface.

Build a 100 mm high mound around the tree to form a watering saucer.

Stake the tree with 360 mm dia. bamboo stakes and fasten the tree to stakes with plastic rope a t a height of tow thirds of the trunk height.

16.3.2.3 Post-Planting Care

Refer to the clause specifying requirements for maintenance.

16.4 RELOCATION OF TREES

16.4.1 Trees to be Relocated

The following trees shall be selected by the contractor and a proposal for their relocation made to the Engineer for his approval:

Species

Trembesi, flamboyant, dadap and pines.

Other Requirements

Not taller than 3 metres and not shorter than 1.5 metres, have trunk diameters not greater than 200 mm and are in healthy condition.

16.4.2 Ground Preparation

Following selection and approval of the site for trees to be located the ground shall be prepared as follows:

Excavate a square hole of at least twice the width and on half of the depth of the root ball of the relocated tree to be planted in that location.

Remove rocks and debris from the excavated soil.

Mix clean excavated soil with peat moss in the ratio of 2 parts soil to 1 part peat moss and form a layer one-third of the depth of the hole with the mixture and tamp it down.

Water the hold and wait for water to soak in.

Repeat watering every day for 10 days.

16.4.3 Preparation of Trees for Relocation

Trees selected and approved for relocation shall be prepared as follows:

Cut off all long branches

Excavate a trench around the tree with a diameter of not less than half the diameter of the tree's canopy.

Cut off all roots where they are exposed in the trench.

Lift the tree taking care to include woven roots, hair roots and surrounding soil.

Cut the tap root at on third of its length.

Wrap the root ball together with the soil with hessian and transport the tree to the new site for replanting as soon as possible.

16.4.4 Replanting

Replanting shall be done as follows:

Remove the hessian wrapping from the root ball and carefully place the tree into the prepared hole.

Add soil mix comprising on part of the loose red soil from the excavation to on part natural fertiliser (pupuk kandang).

Fill the hole with the above mix until the soil level is the same as the surrounding finished ground level.

Build a 100 mm high mound around the tree to form a watering saucer.

Stake the tree with 360 mm dia. bamboo stakes and fasten the tree to stakes with plastic rope a t a height of tow thirds of the trunk height.

16.4.5 MAINTENANCE

The Contractor shall maintain all new and relocated trees up until the end of the defects liability period.

Maintenance shall include regular watering as required (twice a day during the dry season), weeding around the bases of trees, propping as required and trimming as directed by the Engineer.

Any tree which dies shall be replaced by the Contractor with a tree of the same species and of similar size at his cost.

16.5 MEASUREMENT AND PAYMENT

16.5.1 Tree Planting

Measurement shall be made of the number of trees planted and accepted by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour and equipment for completing the tree planting and maintaining the trees until the end of the defects liability period.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
H.9.1	Tree Planting (Angsana, Glodogan, Flamboyant)	No.

16.5.2 Relocation of Existing Trees

Measurement shall be made of the number of existing trees relocated and accepted by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour and equipment for completing the relocation of existing trees and maintaining the trees until the end of the defects liability period.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
H.9.2	Relocation of Existing Tree (rare species such as Trembesi, Flamboyant, Dadap and Pines)	No.

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SECTION TS 17. CONCRETE PIPES AND CULVERTS

SECTION TS 17. CONCRETE PIPES AND CULVERTS

17.1 GENERAL

This section covers the construction of reinforced concrete pipes for the culvert forming part of the drainage sluiceway WF 172 R + 15 m and concrete pipes for the water gauging station, both of which incorporate precast concrete pipes.

17.2 MATERIALS

Precast concrete pipes shall be supplied by the Contractor as shown on the Drawings in accordance with the requirements of AASHTO M 86M (ASTM C 14M) 'Concrete Sewer, Storm Drain Culvert Pipe' or AASHTO M 170M (ASTM C 76M) "Reinforced Concrete Culvert, Storm Drain and Sewer Pipe' as appropriate.

The supply and placement of concrete is covered in Section TS3 of this Specification.

17.3 HANDLING, TRANSPORT AND STORAGE

Handling, transport and storage of precast concrete pipe units shall be in accordance with the requirements of Section TS4, Precast Concrete, of this Specification.

Precast concrete drainage pipes shall be stored with the indicated "top" uppermost unless circularly reinforced.

17.4 DAMAGE TO UNITS

If any unit sustains damage such as cracking, spalling or deformation of projecting reinforcement, the unit shall be set aside until it has been inspected by the Engineer.

The Engineer will decide whether the unit is to be rejected and removed from the site, or repaired by the Contractor.

If a unit is to be repaired, the Contractor shall submit for approval details of the materials to be used and method to be adopted in effecting the repair. Repairs shall be carried out in accordance with the requirements of Section TS8, Concrete Repairs, of this Specification. Repairs to damaged units or the removal from the site and replacement of rejected units shall be at the expense of the Contractor.

17.5 TOLERANCES

Construction of the culvert shall be to the lines and levels shown on the Drawings or as specified by the Engineer within the tolerances shown below.

Invert level	-10 to + 10 mm
Grade	5 mm in 5 m (1 in 1000)
Plan position	50 mm

17.6 DIVERSION AND CARE OF WATER

The provisions of clause 1.13 of the General Specification shall apply to the work specified in this section.

17.7 EXCAVATION

Excavation for the culvert shall include all excavation necessary to provide the specified depth of bedding, and includes the removal and replacement of soft, unstable material or soil otherwise unsuitable as a foundation below the bedding.

Unless otherwise shown on the Drawings or consented to by the Engineer embankments shall be first constructed and compacted to a level not less than 300 mm above the top of the pipe for a distance not less than five times the diameter of the pipe on either side.

The excavation for the culvert shall be as shown on the Drawings. If not shown, the excavation shall be to the satisfaction of the Engineer and sufficient for placing and compacting the bedding material and placing and compacting the backfill material.

Excavated surfaces shall be supported as required to ensure the safety of workmen and traffic.

When shown on the Drawings or as directed by the Engineer, soft, unstable or otherwise unsuitable soil below the level of the underside of bedding shall be excavated to the level specified and replaced with 40 mm maximum size graded crushed rock or other approved stable material, spread in layers not exceeding 150 mm loose thickness and compacted to the satisfaction of the Engineer's Representative.

When soil below the level of the underside of bedding has, in the opinion of the Engineer been made soft, unstable or unsuitable as foundation by the Contractor's operations, the Engineer may direct that the Contractor excavate and replace the material at the Contractor's expense.

When the foundation is rock, all loose material and pockets of unsound material, mud or water shall be removed to expose the sound rock.

17.8 BEDDING

Bedding for the culvert shall comprise a compacted layer of graded crushed rock or other approved material, of not less than 150 mm compacted thickness, or as shown on the Drawings. None of the bedding material shall be retained on a 26.5 mm sieve and not more than 20% shall pass through a 0.075 mm sieve. The Contractor may, with the consent of the Engineer, construct bedding using Class K125 concrete in place of the above granular material.

Bedding shall not be placed without the prior consent of the Engineer.

Bedding shall be compacted to the satisfaction of the Engineer.

17.9 TESTING OF BEDDING AND BACKFILLING MATERIALS

Samples of the materials which then Contractor proposes to use for bedding and backfilling shall be delivered to the Engineer's laboratory for testing, at least three weeks prior to commencement of placing.

Samples for testing shall consist of at least 20 kilograms suitably packed to prevent loss of fines.

17.10 CAST-IN-PLACE CONCRETE

Where applicable, cast-in-place concrete shall be as shown on the Drawings and in accordance with the requirements of Section TS3 of this Specification. Steel reinforcement shall be supplied, handled and placed as shown on the Drawings and in accordance with the requirements of Section TS3 of this Specification.

17.11 PLACING PIPE CULVERTS

Pipe units shall be placed in position commencing at the downstream end of the culvert or run of concrete pipes, and then placing them progressively towards the upstream end. Each unit shall be in contact with the prepared bedding throughout its length. Units shall be firmly butted together with the mating ends fully engaged, and the inner surfaces flush and even.

Pipes with elliptical reinforcement shall be installed with the indicated "top" uppermost. The vertical axes of units, as marked by the manufacturer, shall be set within 5 degrees of vertical.

After placing the precast concrete pipe in position, further bedding material shall be rammed beneath the haunches of the pipes by hand or hand held mechanical tampers until the full width of the excavated trench, or the width shown on the Drawings, has been filled to a depth of 600 mm above the invert level.

Bedding shall be compacted to the satisfaction of the Engineer's Representative.

17.12 BACKFILLING

Backfilling shall be placed to the dimensions shown on the Drawings.

The material used, and the requirements for placing and compacting the fill, shall be in accordance with the requirements of Section TS2 of this Specification.

Filling above the precast concrete units shall only be compacted by hand operated equipment until the depth of filling over the units is 300 mm or more.

17.13 CONSTRUCTION LOADING ON CULVERTS

17.13.1 General

Where construction traffic is to pass over the culvert, the riding surface shall be constructed to a smooth profile and shall be finished using a grade to produce a surface free from ruts and bumps.

The Contractor shall construct the riding surface and shall maintain it for the period during which construction traffic passes over the culvert.

In the case of vibrating rollers the gross load, including static load and dynamic load, shall be taken as the axle load for determining required depth of cover over the culvert as set out below.

Axle Loads up to and Including 10 Tonne

Construction vehicles or plant, except for graders, with axle loads up to 10 t shall not pass over the culvert unless a cover of 400 mm minimum depth, including structural fill and approved pavement, is provided over the top of the culvert.

17.13.2 Axle Loads Greater than 10 Tonne

Construction vehicles or plant with axle loads in the range 10 t to 50 t shall not pass the culvert unless the depth of cover (including compacted fill and pavement) is in excess of the values specified in Table 15.1 below.

The following tabulation applies to pipes in the range of diameter 900 mm to 1800 mm and of length 2.4 m.

For pipes outside this range, the depth of cover shall be as specified by the Engineer.

Cover over Pipe for Axles greater than 10 t

Static Axle Load (tonnes)	Class of Pipe		
	X	Y	Z
10 – 25	1.1 metre	0.6 metre	0.6 metre
25 – 35	1.4 metre	0.9 metre	0.6 metre
35 – 50	Not permitted	1.1 metre	0.9 metre

Strutting of concrete pipes will not be permitted.

Construction vehicles or plant with axle loads greater than 50 t shall not be permitted to pass over the pipe culvert without prior approval of the Engineer.

17.14 MEASUREMENT AND PAYMENT

Concrete Pipes

Measurement will be made of the length of concrete pipes in place and approved by the Engineer.

Payment will be made at the rate entered in the priced Bill of Quantities for concrete pipes and shall include the entire cost of completing the work including material, labour, equipment, transportation, dewatering (where not paid as a separate payment item) and all incidental items necessary to complete the work in accordance with the Specifications and the instructions of the Engineer.

Earthworks and Other Concrete Works

Earthworks and other concrete works shall be measured and paid in according to the provisions of their respective sections elsewhere in this Specification

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
F.4.6	Furnishing and Placing RC Pipe, Dia 600 mm	m
I .2.7	Furnishing and Placing Concrete Pipe, Dia. 600 mm, L=10.2 m	m
I.2.8	Furnishing and Placing Concrete Pipe, Dia. 300 mm, L=6.6 m	m

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SECTION TS 18. MINOR METALWORK ITEMS

SECTION TS 18. MINOR METALWORK ITEMS

18.1 GENERAL

This section covers the minor metalwork items which are to be furnished under the contract and includes the following items:

-Steel Fencing

-Steel Handrails

-Steel Ladders

-Steel Maintenance Steps

18.2 DRAWINGS

The contractor shall prepare and submit shop Drawings and working drawing for all minor metalwork items in accordance with the procedures stated in clause 1.4.3 of the General Specification.

18.3 MATERIALS

18.3.1 General

All materials shall be of new stock, free of surface imperfections and shall conform to the applicable standards as specified hereunder.

18.3.2 Structural Steel Pipe

Structural Steel Pipe shall conform with the requirements of ASTM 120 or JIS G3444.

18.3.3 Round Bar

Round bar shall conform to the requirements for cold drawn steel wire as specified in clause 3.4, Steel Reinforcement.

18.4 FABRICATION

18.4.1 Welding

Welding shall be carried out in accordance with the requirements of the American Institute of Steel Construction (AISC) or approved equivalent and shall conform to the standard code of the American Welding Society or equivalent approved by the Engineer.

The Contractor shall submit, for approval, details of the experience and qualifications of proposed welders. The welders shall have sufficient experience and qualifications for welding work and hold certificates issued by "Balai Latihan Kerja, Departemen Tenaga Kerja (Employment Training Centre, Department of Labour)" or other training course approved by the Engineer.

All welds shall be visually inspected by the Engineer and shall be subject to his approval.

When so directed by the Engineer, welds shall be tested by radiographic tests specified in JIS 3104 or other testing method approved by the Engineer.

Field welding shall not normally be permitted. However, when expressly authorised by the Engineer it shall not be performed under adverse weather conditions of rain, temperature, moisture and wind unless the welding work is protected in a manner approved by the Engineer.

Welding electrodes shall conform to the requirements of JIS Z3211 to Z3212 or equivalent approved by the Engineer.

Welds disapproved by the Engineer shall be chipped out to sound metal, tested and repair-welded and subject to the Engineer's approval using a procedure approved by the Engineer prior to carrying out the repair.

18.4.2 Surface Protection

All minor metalwork shall be treated in accordance with the requirements of Section TS 20 of the Technical Specification using system 11.

All paint materials and colours shall be subject to the Engineer's approval.

18.5 CONSTRUCTION

Fabricated units shall be accurately installed in the locations as shown on the approved working Drawings.

Where blockouts in concrete or masonry structures have be made to accommodate the posts or anchorages of minor metalwork units, non-shrink grout shall be used to cast posts in place.

Field welding, cutting or drilling shall not be permitted.

18.6 MEASUREMENT AND PAYMENT

18.6.1 Steel Fence

Measurement shall be made of the length of steel fence installed and accepted.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour and equipment of completing the steel fencing in accordance with the Drawings and the Specification..

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
B.5.8	Steel Fence (with anti-corrosion painting), H = 1,110 mm	m
D.5.9	Steel Fence (with anti-corrosion painting), H = 1,110 mm	m
D.6.10	Steel Fence (with anti-corrosion painting), H = 1,110 mm	m

18.6.2 Handrails, Steps and Ladders

Measurement shall be made of the installed length, in metres, of steel tubing, bars or other steel sections comprising the item of handrail, step or ladder as the case may be. The mass of steel shall then be determined by multiplying measured lengths by the nominal mass per metre as shown in the relevant steel standard.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing the handrail in accordance with the Drawings and the Specification.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
I.2.12	Steel Maintenance Steps (with anti-corrosion painting)	kg
I.2.13	Steel Handrail (with anti-corrosion painting)	kg
I.2.14	Steel Ladder (with anti-corrosion painting)	kg

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SECTION TS 19. WATER LEVEL GAUGING STATION

SECTION TS 19.WATER LEVEL GAUGING STATION

19.1 GENERAL

This section covers the work required for the construction of the Water Level Gauging Station and the reinstallation of equipment from the old gauging station which is to be demolished as part of the work specified elsewhere.

19.2 SCHEDULE

The new gauging station shall be completed before the removal of equipment from and demolition of the existing gauging station.

19.3 CIVIL WORKS

Civil works for the construction of the well as listed in the Bill of Quantities as items I.1.1 to I.1.2 and I 2.1 to I.2.14 are specified elsewhere in this specification.

19.4 BUILDING WORKS FOR GAUGING HOUSE

19.4.1 General

The Gauging House refers to the concrete block and concrete building to be constructed on top of the reinforced concrete well.

19.4.2 Drawings

The Contractor shall prepare and submit shop Drawings and working drawing for all the construction of the Gauging House in accordance with the procedures stated in clause 1.4.4.3 of the General Specification.

19.4.3 Specifications for Building Works

All building works shall be in accordance with the specifications for building works included in Division D, Building Works, of this Specification.

19.5 BENCH MARK

A reinforced concrete bench mark shall be constructed in accordance with the Drawings as specified herein.

The base of the excavation shall be cleared of all loose material and the ground thoroughly tamped to ensure a firm base for subsequent concrete.

All concrete work shall be as specified in Section TS 3 of the Technical Specification.

The ground around the benchmark shall be levelled and tamped to ensure firm firm lateral support.

Following installation the contractor shall perform a closed loop levelling traverse to the nearest reliable bench mark as approved by the Engineer and establish the elevation of the bench mark. The number shall be recorded and advised in writing to the Engineer together with all survey data for the Engineer's review.

19.6 WATER LEVEL GAUGE

19.6.1 Scope of Work

The scope for work comprises the removal of the water level gauge and all associated equipment from the existing water level gauging station prior to its demolition, storage of such equipment, reinstallation of the equipment and re-commissioning the equipment in the new gauging station.

19.6.2 Removal of Equipment

The Contractor shall exercise due care and diligence when removing the existing equipment in order not to damage or otherwise adversely the equipment. Prior to removal of the equipment it shall be jointly inspected by the Contractor and the Engineer and any damage or malfunctioning shall be noted. Any such damage or malfunctioning shall not be the responsibility of the Contractor.

19.6.3 Storage

All equipment shall be cleaned then placed in protective wrapping or crates for temporary storage.

19.6.4 Reinstallation of Equipment

All equipment shall be reinstalled and re-commissioned to the satisfaction of the Engineer.

19.6.5 Responsibility for Equipment

The Contractor shall be responsible for the security and protection of the equipment at all times from the time that the Engineer notifies the Contractor in writing the existing gauging station may be demolished until the Completion Date.

19.7 MEASUREMENT AND PAYMENT

19.7.1 Gauging House

No measurement will be made of the components comprising the Gauging House

Payment shall be made at the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour and equipment of completing the gauging house in accordance with the Drawings and the Specification. Specifically included shall be reinforced columns, beams, slabs, hollow block walls, plastering, waterproof treatment of the roof slab and steel door.

19.7.2 Water Level Gauge

Payment shall be made at the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour and equipment required for the removal, storage, reinstallation and re-commissioning of the water level gauge equipment.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
I.2.15	Gauging House (including reinforced concrete, hollow concrete block, plastering, roofing, steel door)	L.S.
I.2.16	Installation of Water Level Gauge and Related Apparatus, and Calibration	L.S.
I.2.17	Setting Bench Mark	L.S

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SECTION TS 20. PROTECTIVE TREATMENTOF METALWORK

SECTION TS 20.PROTECTIVE TREATMENT OF METALWORK

20.1 GENERAL

20.1.1 Scope

This clause specifies the requirements for the protective treatment of metal surfaces for all metalwork to be furnished by the Contractor.

The items covered by this clause shall include, but not be limited to the following:

- metal components associated of slide gates and flap gates
- all handrails, ladders, safety rails etc.
- all metal machinery components including those supplied by specialised suppliers

20.1.2 Submission by Contractor

The Contractor shall prepare detailed painting procedures for the protective treatment of all metal items to be furnished by the Contractor under the Contract base on the minimum requirements described in this section of the Specification for the approval of the Engineer in accordance with clause 1.5.8 of the General Specification.

20.2 CLEANING AND PREPARATION

Cleaning and preparation of surfaces for painting shall be in accordance with the following and as required according to the painting system called for in clause 20.5 and specified in clause 20.8.

Surfaces to be painted shall be cleaned before the application of paint or surface treatment. All oil, grease, dirt, rust, loose mill scale, weld spatter, slag or flux deposit, oil weathered paint, and other foreign substances shall be removed. The removal of oil and grease shall be accomplished before mechanical cleaning is started. Clean cloths and cleaning fluids shall be used to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Cleaning and painting shall be so programmed that dust or spray from the cleaning process will not fall on wet, newly painted surfaces. Where required, imperfections and holes in surfaces and open joints between matching surfaces shall be filled or removed in an approved manner. Any required wash treatment shall be carried out in accordance with the paint manufacturer's instructions.

Extreme care shall be exercised when blast cleaning is applied on structures to prevent blasting materials from entering or damaging machined surfaces and other precision parts.

All cleaning, preparation and paint application shall be carried out after the parts are completely finished and checked in the shop assembly. The parts shall be disassembled to the extent necessary to enable cleaning and painting those surfaces which are inaccessible when assembled. After the finishing coats have been applied and the paint surface hardened, parts shall be reassembled as required for shipment. Those bolts and other connections which will not be removed in erection shall be coated with the shop primer and finishing.

All galvanised steel surfaces required to be painted shall be etched with a solution containing 4.5 percent of copper acetate applied twenty-four hours in advance of painting.

20.3 PAINT APPLICATION

Workmanship

All work shall be done in a workmanlike manner so that the finished surfaces will be free from runs, drops, ridges, waves, laps, pinholes, and unnecessary brush marks. All coats shall be applied in such manner as to produce an even film of uniform thickness completely coating all corners and crevices. All painting shall be done by thoroughly experienced and skilled workmen. Care shall be exercised during spraying to hold the nozzle sufficiently close to the surface being painted to avoid excessive evaporation of the volatile constituents, loss of material into the air, or the bridging of crevices and corners. All surface preparation and paint application in the shop and field shall be supervised by a supervisor, approved by the Engineer, from the paint manufacturer, provided by the Contractor. The supervisor shall certify that all preparations and applications are in accordance with this Specification and the paint manufacturer's recommendations and specifications.

Equipment

All paint shall be applied using airless spray equipment unless otherwise approved. Spray equipment shall be equipped with a mechanical agitator, a pressure gauge, and a pressure regulator. Nozzles shall be of the proper size as recommended by the paint manufacturer.

Paint Properties, Mixing and Thinning

(i) The Contractor shall submit the specification of each type of paint to be used in each system for the Works for the Engineer's approval prior to the executing any painting work.

(ii) Test certificates from the paint manufacturer shall be provided for each batch of each type of paint used in the Works.

(iii) All paint, when applied, shall provide a satisfactory film and a smooth even surface. Paint shall be thoroughly stirred, strained and kept at a uniform consistency during application. Paints may be thinned in accordance with the paint manufacturer's recommendations. Paint furnished for field touch-up work shall be delivered in containers which shall show the designated name, formula or specification number, colour, special directions, manufacturer, and date of manufacture.

Atmospheric Conditions

Paint shall be applied only to surfaces that are thoroughly dry and only under such combination of humidity and temperature of the atmosphere and surfaces to be painted as will cause evaporation rather that condensation. In no case shall any paint be applied to surfaces upon which there is moisture condensation. The temperature of the surface to be painted shall be at least 3°C above dew point. Painting shall not be carried out when the relative humidity of the surrounding air exceeds 85 percent.

Protection of Paint Surfaces

Where protection is provided for painted surfaces, such protection shall be kept in place until the paint film has properly dried. Items which have been painted shall not be handled, worked on, or otherwise disturbed until the paint coat is completely dry and hard.

Time Between Surface Preparation and Painting

Surfaces which have been cleaned, pre-treated, and/or otherwise prepared for painting shall be primed as soon as practicable after such preparation has been

completed prior to deterioration of the prepared surface in accordance with the paint manufacturer's recommendations.

Coating Progress

Where painting on any type of surfaces has been commenced for any portion of the Work, the complete painting operation shall be continuous and completed as soon as practicable and without delays.

20.4 COLOURS

The finish colour of all structures shall be as approved by the Engineer but the Contractor shall propose a colour scheme for the work and shall submit colour strips or paint samples. A colour strip shall be included with the approved colour schedule for each type of finish to be applied at the Site shop or site.

In cases where more than one coat of the same colour is not be applied, alternate coats shall be tinted to give contrast between coats.

20.5 PAINTING SCHEDULE FOR SYSTEMS APPLICATION

The following systems shall be applied to the items listed below. Where particular items are not listed they shall be treated in accordance with the system specified in the technical specification for that particular item or, where not specified, in accordance with the system appropriate to its location as shown in the tables in clause 16.8. or in accordance with the Engineer's directives.

Painting System 1

Gate guide frame

Gate leaves

Other ferrous metal subject to immersion in water

Painting System 10

Gate hoist

System 11

Handrails, steps, ladders, steel fencing

20.6 SURFACES NOT TO BE PAINTED

Wire ropes, gear teeth, interior of hydraulic piping, corrosion-resistant metal seals and other machined surfaces shall not be painted.

20.7 PAINT TESTING

All paint applications shall be tested in accordance with the following:

The dry film thickness of each shop primer coat and total thickness of all coats shall be measured by the Contractor and supervisor from the paint manufacturer in the presence of the Engineer.

The edges, corner and the areas within 5 mm distance from them, and the surface of castings and steels forgings shall be excluded unless the Engineer has reason to doubt the thickness of the application.

Two (2) portions shall be selected per 10 m² by the Engineer and more than four (4) arbitrary points shall be measured per portion.

An electronic thickness measuring gauge shall be used and shall be calibrated in accordance with an approved standard.

The mean value of each portion shall be more than the average thickness specified and the minimum thickness in all eight (8) or more points measured per 10 m² shall be more than the minimum thickness specified.

The details of testing shall be as approved by the Engineer following the submission of the Contractor's proposal.

20.8 PAINT SYSTEM

The appropriate paint system as specified in clause 16.5 and for which details of surface preparation and coating are specified hereunder shall be used. Where technical specifications for steel elements are not specified the coating system to be used shall be that for the location appropriate to its location.

Where the paint system is applied to a structure that is partly embedded in concrete, the surface preparation and paint system applied to the exposed material shall extend 100 mm beyond the edge of the concrete surround or embedment.

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
							Ave	Min
1	Ferrous Metal Continuous Immersion in Water	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			Primer Coat	Epoxy Zinc Rich Paint	1	3 days 6 months	20	15
			1st Coat	Coat Tar Epoxy Resin Paint	1	24 hours 7 days	280	200
			2nd Coat	Coat Tar Epoxy Resin Paint	1	-	280	200
		Field	Surface Preparation	Power Tool Cleaning (ISO 8501-1 Pt 3)		Note : Damaged areas and welded areas only		
			Touch-up Primer Coat	Epoxy Zinc Rich Paint	1	3 days 6 months	20	15
			Touch-up	Coal Tar Epoxy Resin Paint	2		280	200

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
							Ave	Min
2	Ferrous Metal Intermittent Immersion and Splash	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			Primer Coat	Epoxy Zinc Rich Paint	1	3 days 6 months	20	15
			1st Coat	Epoxy Resin Paint	1	24 hours 7 days	110	80
			2nd Coat	Epoxy Micaceous Iron Oxide Paint	1	24 hours 18 months	50	35
		Field	Surface Preparation	Power Tool Cleaning (ISO 8501-1 Pt 3)		Note : Damage areas and welded areas only		
			Touch-up Primer Coat	Epoxy Zinc Rich Paint	1	3 days 6 months	20	15
			Touch-up	Epoxy Resin Paint	2	24 hours 7 days	110	80
			3rd Coat	- ditto -	1	- ditto -	40	20
			4th Coat	- ditto -	1	-	40	20

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
							Ave	Min
3	Ferrous Metal Atmospheric Exposure	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			1st Coat	Lead Suboxide Anti-Corrosive Paint	1	24 hours 6 months	35	25
			2nd Coat	- ditto -	1	- ditto -	35	25
			3rd Coat	Phenol Micaceous Iron Oxide Paint	1	24 hours 18 months	50	35
		Field	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)		Note : Damage areas and welded areas only		
			Touch-up	Lead Suboxide Anti-Corrosive Paint	2	24 hours 6 months	35	25
			Touch-up	Phenol Micaceous Iron Anti-Corrosive Paint	1	24 hours 18 months	50	35
			4th Coat	Long Oil Alkyd Resin	1	24 hours 1 month	25	20
			5th Coat	- ditto -	1	-	25	20

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
							Ave	Min
4	Equipment for Temporary use	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			1st Coat	Zinc Chromate Primer	1	8 hours 6 months	35	25
			2nd Coat	- ditto -	1	-	35	25
		Field	Surface Preparation	Power Tool Cleaning (ISO 8501-1 Pt 3)		Note : Damaged areas and welded areas only		
			Touch-up	Zinc Chromate Primer	2	8 hours 6 months	35	25

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
5	Small Sized Steel Pipe (except Hydraulic Piping)	Shop	Surface Preparation	Solvent Wash (SSPC-SP1)			Ave	Min
			Coating	Hard-Drying Anti Corrosive Oil	1	Over 4 hours	50	-

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
6	Ferrous Metal Embedded in Soil	Shop	Surface Preparation	Blast Cleaning (SSPC-SP10)			Ave	Min
			1st Coat	Zinc Chromate Primer	1	8 hours 6 months	35	25
			2nd Coat	Zinc Chromate Primer	1	8 hours 6 months	35	25
			3rd Coat	Alkyd Resin Paint	1	5 hours 6 months	20	15
			4th Coat	Alkyd Resin Paint	1	-		

System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
7	Small Sized Steel Pipe (except Hydraulic Piping), Handrailing, steps, fence posts, etc	Shop	Surface Preparation Hot Dip Galvanising (Ref. Cl 16.9)	Hand Tool Cleaning (SSPC-SP2)				

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
8	Ferrous Metal Embedded in Concrete			Clean	Nil			

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
9	Ferrous Metal Embedded in Soil	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			1st Coat	Coal Tar Primer	1	24 hours 5 days		
			2nd Coat	Coal Tar Enamel		Note: 2nd+3rd Coat Simultaneous Application		3000
			3rd Coat	Glass Cloth				

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
10	Ferrous Metal in Sheltered Locations	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			Primer Coat	Epoxy Zinc Rich Paint	1	3 days 6 months	20	15
			2nd Coat	Chlorinated Rubber		As recommended by supplier	60	50
			3rd Coat	Chlorinated Rubber		As recommended by supplier	60	50

Paint System No.	Location	Site	Process	General Name	No. of Coats	Coating Interval (at 20°C)	Dry Film Thickness (micron/coat)	
11	Handrails, stairs, steps, etc	Shop	Surface Preparation	Commercial Blast Cleaning (ISO 8501-1 Sa 2 ½)				
			Primer Coat	Red Lead Primer	2	3 days 6 months	35	25
			2nd Coat	Oil Based Paint (Paint spec. and colour to Engineer's approval	1	As recommended by supplier	100	90
		Field	3rd Coat	Oil Based Paint (Paint spec. & colour to Engineer's approval	1	As recommended by supplier	100	90

20.9 GALVANISING

All galvanising specified on the Drawings shall be by the hot dip galvanising process in accordance with the requirements of AASHTO M 111 (ASTM A 1230 "Zinc (Hot Galvanised) Coatings", AASHTO M 232 (ASTM A 153) "Zinc Coating (Hot-Dip) on iron and Steel Hardware" and this Clause.

Surface Preparation

Steelwork shall be pre-cleaned in accordance with the requirements of AS 1627 Part 1 or equivalent standard followed by acid pickling in accordance with the requirements of A 1627 Part 5 or equivalent standard.

Surface contaminants and coatings which cannot be removed by the normal chemical cleaning process in the galvanizing operation shall be removed by abrasive blast cleaning or some other suitable method.

All weld spatter, slag, burrs, loose rust and mill scale and other foreign substances shall be removed by either sand or shot or grit-blasting to "Near-White metal" under "Sa 2 1/2" of Swedish Standard SIS 055900 or SSPC-SP10 of Steel Structures Painting Council Manual Volume 2 or ISO 8501-1 Sa 2 1/2.

Galvanizing

All articles to be galvanized shall be handled in such a manner as to avoid any mechanical damage and to minimise distortion.

Galvanising parameters such as galvanizing temperature, time of immersion and withdrawal speed shall be chosen to suit the requirements of the article being galvanised.

The composition of the zinc in the galvanising bath shall be not less than 98.0% zinc.

Coating Requirements

Thickness
The thickness of the galvanized coating shall conform with the table below:

Products	Minimum average coating on any individual tests area	
	Coating Mass Gram/sq.m	Equivalent Thickness Micron
Steel 5 mm thick and over	600	84
Steel under 5 mm thick but not less than 2 mm	450	63
Steel less than 2 mm thick	350	49
Centrifuged work	300	42

The thickness of the galvanized coatings of threaded fasteners shall conform with the table below:

Minimum Average		Minimum Individual	
Coating Mass Gram/sq. m	Equivalent Thickness Micron	Coating Mass Gram/sq.m	Equivalent Thickness Micron
375	52	300	42

Actual thicknesses shall be measured by an suitable thickness meter. Should any doubt arise, as to the quality of galvanizing, tests shall be carried out in accordance with AASHTO T 65 'Tests for Weight of Coating on Zinc-Coated (Galvanised) Iron or Steel Articles or ASTM E 376 'Measuring Coating Thickness by Magnetic Field or Eddy Current (Electromagnetic Test Methods).

Surface Finish

The galvanized coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from any defect that is detrimental to the stated and use of the coated article. On silicon killed steels, the coating may be dull grey, provided that the coating is sound and continuous.

The integrity of the coating shall be determined by visual inspection and coating thickness measurements.

Where slip factors are required to enable high strength friction grip bolting where shown, these shall be obtained after galvanizing by suitable mechanical treatment of the mating surfaces.

Where a paint finish is to be applied to the galvanized coating, all spikes shall be removed and all edges shall be free from lumps and runs.

Adhesion

The galvanized coating shall be sufficiently adherent to withstand normal handling during transport and erection. The Engineer may test the adhesion in accordance with AASHTO M 111 (ASTM A 123).

Passivation

Galvanised reinforcing bars and ferrules shall be passivated in a 2% sodium dichromate solution applied by the galvanizer.

Transport and Storage

Galvanised components shall, wherever possible, be transported and stored under dry, well ventilated conditions to prevent the formation of wet storage staining.

A chromate passivation treatment after galvanizing may be used to minimise the wet storage staining which may occur on articles unable to be stored in dry, well ventilated conditions.

Any wet storage staining shall be removed by the galvanizer if formed prior to leaving the galvanizer's plant. Provided that the coating thickness complies with the requirements of AASHTO M 111 (ASTM A 123), no further remedial action shall be required to the stained areas.

20.10 OTHER PROTECTIVE COATING SYSTEMS

Any other alternative systems proposed by the Contractor which are will result in superior protection to that specified herein shall be subject to the approval of the Engineer.