

5.0 INCIDENTAL CONCRETE WORKS

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Note : Concrete curb and Medians are described in Section
of Safety Facilities

5.1 Pipe Culverts

5.1.1 Description

1. This work shall consist of supplying and installing concrete and steel pipe culverts, including excavation, bedding and backfilling.

5.1.2 Materials

Precast Reinforced Concrete Pipe

2. Reinforced concrete pipe shall meet the requirements of relevant sections of this Specification. Where this does not cover the pipe size or strength required, pipes shall comply with BS 5911.
3. Manufactured pipe shall, if required by the Engineer, be tested for structural strength, crushing strength and absorption. The manufacturer's specification and certificate shall be submitted for prior approval before pipes are delivered to the site.
4. Pipes that fail to meet the strength requirements may, with the approval of the Engineer, be incorporated in the Works provided the following requirements are met.
 - (i) The strength does not fall below 80% of that specified.
 - (ii) The pipes are clearly marked and stored separately from pipes which fully comply with strength requirements.
 - (iii) The pipes are bedded in Class 18 concrete.
5. If under-strength pipes are installed with pipes fully complying with the strength requirements, the whole run shall be Classified as under-strength.

Reinforced Concrete Arch Pipe

6. Reinforced concrete arch pipe shall comply with AASHTO M 206M. Unless otherwise specified Class A-IV shall be used for spans of 1300 mm or less, and Class A-III for larger spans.

Corrugated Steel Circular Pipe and Pipe Arches

7. Corrugated steel culvert pipe shall comply with the requirements of AASHTO M36M and be zinc coated.
8. A certificate of Guarantee from an approved pipe fabricator shall be submitted by the Contractor for each shipment of pipe delivered to the Site. The Certificate shall show the quantities of material and state that the listed materials conform to the specified requirements.
9. The Engineer may test any material for compliance with the Specification at any time and reject any material which does not meet the requirements even though it has received prior approval based on a Certificate of Guarantee.

Bituminous Coated Corrugated Steel Circular Pipe and Pipe Arches

10. Bituminous coated corrugated steel circular pipe and pipe arches shall comply with AASHTO M 190, and with sub-Clauses 51.7 to 51.9.

Polymer Coated Steel Circular Pipe and Pipe Arches

11. Polymer coated metal pipe and pipe arches shall comply with AASHTO M 246M and with sub-Clauses 51.7 to 51.9.

5.1.3 Construction Requirements

Excavation, Bedding and Backfilling

12. Excavation, bedding and backfilling of pipe culverts shall conform to the requirements of Clause of Earth Work and as shown on the Drawings.

Pipe Laying

13. No pipe culvert shall be placed until the formation has been approved by the Engineer. Pipes shall be laid accurately to line and level and shall have a uniform bearing at each joint and along the entire length of pipe. Pipe laying shall begin at the downstream end and progress upstream.

14. Manufactured pipe shall be handled and assembled in accordance with the manufacturer's instructions.

Precast Concrete Pipe and Pipe Arches

15. Pipes shall be laid with hub, bell or groove ends upstream.
16. Where lift holes have been used, they shall be filled with an approved cement sand mortar to provide a watertight section. Mortar shall be finished flush on the inside of the pipe.
17. Pipe joints shall be sealed with flexible watertight elastomeric or rubber gaskets, approved bituminous sealers or plastic sealants. Bituminous or plastic sealants shall be applied at the time the pipe is being laid. Sealants shall be installed in accordance with the sealant manufacturer's instructions so that the joint is completely filled.
18. When a concrete pipe has a gap greater than 10mm between sections when laid together, the joint inner surface shall be filled with oakum and a bituminous or plastic sealant. The extended gap between barrel and bell is not required to be filled. Oakum shall be closely twisted hemp or jute of suitable diameter to fill the annular space when caulked and in one piece of sufficient length to pass around the pipe and lap at the top.
19. Multiple pipe culverts, unless otherwise shown on the Drawings, shall be laid with one-half diameter of pipe or a minimum of 300 mm whichever is greater, between the pipes.

Corrugated Metal Pipe and Pipe Arches

20. Metal pipe shall be laid with outside laps of circumferential joints pointing upstream and with longitudinal laps along the sides. If pipe sections are jointed on the Site, the ends shall be butted as closely as corrugations will permit and shall be joined with a firmly bolted coupling band of the same material as the pipe. Camber shall be built into the pipe structure to compensate for settlement from fill loads.
21. Multiple culverts, unless shown otherwise on the Drawings, shall be laid with one-half diameter of pipe or a minimum of 300 mm whichever is the greater, between pipes.
22. Damage to bituminous or epoxy resin coatings may be repaired on site by application of a repair material of a brand and type approved by the Engineer. Pipes having any localized deformations in excess of 5% of the nominal pipe diameter or dents in excess

of 13 mm depth will be rejected. Pipes rejected because of these defects may be used if satisfactorily repaired and approved by the Engineer.

Cast-in-Situ Concrete Pipe and Pipe Arches

23. Cast-in-Situ pipes shall be constructed in accordance with the Drawings, or in a manner proposed by the Contractor and approved by the Engineer.
24. When the contractor elects to construct the pipe in a trench with no external vertical forms, 40 mm of additional concrete cover to the reinforcement steel shall be provided.
25. Longitudinal construction joints will only be permitted as shown on the Drawings. Transverse construction joints will be permitted provided prior approval is obtained from the Engineer.
26. Forms for cast-in-place pipe shall be approved prior to their use. Inside pipe forms shall be suitably unyielding during placement of concrete. Interior arch forms may be removed after 72 hours if approved by the Engineer. The Contractor shall take precautions when removing forms to protect the culvert from damage. Backfilling shall not commence until tests indicate the concrete has attained a strength of 50% of the Class requirement.

5.1.4 Method of Measurement

27. The approved work shall be measured by the linear metre of laid pipe of the various types, Classes and sizes. For pipe culverts without headwalls, measurement shall be taken from end to end along the centerline of the pipe. For pipes connected to structures, measurement shall be taken between the inside faces of parapet or wall along the centerline of the pipe.
28. The measured length of corrugated metal pipe shall include the length of bends (elbows) installed.
29. Headwalls, wing walls and aprons that are part of a pipe culvert installation shall not be measured separately.
30. No measurement or payment will be made for connection to drainage structures, bedding, jointing, backfilling and additional reinforcing steel cover which are considered incidental to the items 'Pipe Culvert or Arch', except for excavation in rock.

31. Measurement for excavation in rock will be made in accordance with Clause of Excavation and Backfilling for Structures.

5.1.5 Basis of Payment

32. The quantity of completed and accepted work, measured as provided for above, will be paid for at the unit rate per linear metre for 'Pipe Culvert and Arch' in the Bill of Quantities, for the various types, Classes and sizes of pipes, which rate shall include the cost of supplying and placing of pipe, materials, labour, equipment, tools and all other items necessary for proper completion of the work.

5.1.6 Items in the Bill of Quantities

Item No. 5.1 Reinforced concrete pipe culvert (diameter 1800)

5.2 Reinforced Concrete Box Culverts

5.2.1 Description

1. This work shall consist of constructing reinforced concrete box culverts, in situ or precast, in open excavation on a prepared foundation, and backfilling the excavation.
2. This work shall consist of excavation, backfilling, casting, erection, insulation and electrical installations as shown on the Drawings.
3. It includes constructing headwalls, wing walls and aprons for box culverts.

5.2.2 Materials

4. Cement, aggregate, water, concrete, reinforcing steel and forms shall be as specified in Clauses of Concrete Works.
5. Excavation and backfill shall be as specified in Section 200.
6. Road pavement layers shall be in accordance with previous relevant Clauses.
7. Drainage of the underpass and waterproofing shall be in accordance with previous relevant Clauses.
8. Ducts shall be as specified in previous relevant Clauses.

5.2.3 Construction Requirements

9. Box Culverts shall be constructed in sections with expansion joints located at intervals not exceeding 12m along the length of the culvert. Expansion joints shall also be installed between culvert ends and the wingwalls and apron slabs.
10. Culverts located in road embankments shall be constructed in excavation opened in the completed earthworks as described in Clause of Excavation and Backfilling for Structures. Culverts located below existing ground level shall be constructed in excavation carried out in accordance with Clause of Excavation and Backfilling for Structures.
11. Backfilling with approved granular material shall be carried out in layers in accordance with Clause of Excavation and Backfilling for Structures.

12. Box culverts, headwalls, wing walls and aprons shall be to the lines and levels shown on the Drawings. Unless otherwise shown culverts shall have a constant fall of 1:100 (H:V) along their centerline.
13. Concrete placing, forms, finishing, curing and jointing shall be carried out in accordance with Clauses of Concrete works.
14. Tucks and seals for waterproofing shall be provided at points of discontinuity such as edges, expansion joints and rainwater drains. Sharp internal and external edges shall be chamfered as shown in the drawings. The waterproofing membrane shall be protected from damage during the execution of the work.
15. Waterproofing plaster shall be used at the locations shown on the Drawings. Waterproofing admixture shall be approved by the Engineer and used at a rate specified by the manufacturer.
20. The tolerances for surfaces shall be as follows, when checked with a 3m straight edge.

Horizontal	3 mm
Vertical	6 mm.
30. Drain installation shall be carried out according to the requirements of section of Drainage.
32. Electrical work shall be carried out in accordance with Section of Electrical work.

5.2.4 Method of Measurement

16. The quantities of the various pay items which constitute the completed culvert shall be measured by linear meters for payment according to the dimensions shown on the Drawings.
15. Where the Contractor uses precast units, any extra material necessary shall not be measured.

5.2.5 Basis of Payment

35. The amount of completed and accepted work, measured as provided for above, will be paid for at the unit rate' in the Bill of Quantities, which rate shall be full compensation for supplying materials, transporting and placing, for labour, equipment, tools and other items necessary for the proper completion of the work.

5.2.6 Pay Items

Item No. 5.2.1 Box Culvert 2.7m x 3.4m (meters)

Item No. 5.2.2 Box Culvert 2.7m x 6.5m (meters)

Item No. 5.2.3 Box Culvert 2.7m x 7.0m (meters)

5.3 Small Bridge

5.3.1 Description

1. This work shall consist of constructing reinforced concrete bridge, in situ or precast.
2. This work shall consist of excavation, backfilling, casting, foundation, abutment, girders, slabs, pavement and electrical installations as shown on the Drawings.

5.3.2 Materials

3. Concrete materials shall be as specified in previous relevant Clauses.
4. Excavation and backfill shall be as specified in Section of Structural Excavation and backfill.
5. Road pavement layers shall be in accordance with previous relevant Clauses.
6. Ducts shall be as specified in previous relevant Clauses.

Pavement

7. Pavement shall be as specified in the Section of Pavement.

5.3.3 Construction Requirements

8. Structural concrete shall be poured, cast and finished in accordance with previous relevant *Clauses* and as shown on the Drawings.

5.3.4 Method of Measurement

9. The quantities shall be measured by square meters for payment according to the inner dimensions of the bridge as shown on the Drawings.
10. Where the Contractor uses precast units, any extra material necessary shall not be measured.

5.3.5 Basis of Payment

11. The amount of completed and accepted work measured, as provided for above, will be paid for at the unit rates in the Bill of Quantities, which rates shall include for all

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supplying, and placing materials, for forming, curing, finishing concrete and for labour, equipment, tools, and other items necessary for the proper completion of the work.

5.3.6 Pay Items

Item No. 5.3.1 Small Bridge (square meters)

5.4 Storm Sewers

5.4.1 Description

1. This work shall consist of the installation of pipes for the removal of surface water from carriageways, including bedding and connections.

5.4.2 Materials

Concrete

2. Concrete shall conform to Clauses of Concrete Mixtures and Concrete works.
3. Concrete pipes shall comply to the requirements of Clause of Excavation and Backfilling for Structures.

Asbestos-Cement Pipes

4. Asbestos-cement pipes, and fittings shall be made from Sulphate Resistant Portland cement. They shall be given a double coat, internally and externally, of bitumen emulsion or coal tar epoxy at the place of manufacture. The pipes shall be supplied with approved flexible joints.

UPVC Pipe

5. Pipes of synthetic material shall be unplasticised polyvinylchloride (UPVC) to the requirements of Class 2 or 3 of ASTM D3033, or to BS 4460 or BS 5481.

Joints for Concrete Beds and Pipe Surrounds

6. Flexible joints in concrete beds and surrounds to pipes shall be formed with compressible fibrous board, or similar approved material, 20 mm thick.

Bitumen Emulsion

7. Bitumen emulsion shall be to BS 434 and shall contain not less than 53% of prime bitumen.

5.4.3 Construction Requirements

Excavation, Bedding and Backfilling

8. Excavation, bedding and backfill shall be in accordance with Clause of Excavation and Backfilling for Structures.

Pipe Laying

9. Pipes shall be handled by approved lifting tackle. Unloading by rolling down planks or any other form of inclined ramp will not be allowed.
10. The inside of pipes shall be carefully brushed out and examined for soundness before laying. Pipes shall be laid starting at the outlet end so that the spigot end points in the direction of flow. The permissible tolerance shall be 6 mm in level and 25 mm in line between manholes or other connection points.

Jointing of Pipes

11. Asbestos-cement and concrete pipes shall have watertight joints sealed with approved rubber rings or flexible gaskets. Joints shall have a gap formed between the end of the spigot and the base of the bell of not less than 6 mm and not greater than 20 mm.
12. The inside of the joint shall be finished smooth and wiped clean. The mortar on the outside shall, after its initial set, be protected from the sun. Plastic joint compound may be used in lieu of Portland cement mortar, in which case it shall be prepared in accordance with the manufacturer's recommendations.
13. Synthetic or rubber joint rings shall be stored until needed in a cool place away from direct sunlight.
14. Properly fitted temporary wooden stoppers shall be used to close the ends of uncompleted pipe lines. The stoppers shall only be removed when pipes are being laid and jointed.

Cleaning and Inspecting of Storm Sewer Pipes

15. After backfilling and completion of connections to manholes, etc., but before the trench surfaces are permanently reinstated, the interior of the sewers shall be cleaned ready for inspection by the Engineer.

16. Sewers of 675 mm or more diameter will, where practicable, be inspected from the inside and the Contractor shall provide a suitable personnel trolley for this purpose.
17. Sewers less than 675 mm diameter and larger sewers which cannot be inspected from the inside shall have a mandrel (pig) formed from a cylinder to the approval of the Engineer, of diameter 25 mm smaller than the sewer and of length not less than the internal diameter of the sewer, passed through.
18. On completion the drains and sewer pipes shall be flushed from end to end with water and left clean and free from obstructions and debris.

Testing of Sewers

19. As soon as practicable after a length of pipe has been completed, it shall be subjected to an Air Test. The length shall be plugged and sealed and air pumped into the pipe until a pressure of 100 mm head of water is indicated. The section will not be considered satisfactory if the air pressure falls from 100 mm to 75 mm head of water in 5 minutes or less.
20. Sewers failing the air test shall be subject to a supplementary water test. The pipeline shall be filled with water in a manner approved by the Engineer to a level 1.25m above the highest point and not more than 6m above the lowest point of the section under test. After standing for 2 hours the water shall be topped up if necessary. The loss of water over a 60 minute period shall be measured by topping up at 10 minute intervals. The test will be considered satisfactory and the installation acceptable if the volume of water added does not exceed 1l/h/m, per metre of nominal diameter of the pipeline.

5.4.4 Method of Measurement

21. The approved work shall be measured by the linear metre of pipe, regardless of the depth to which it is laid, measured along its centerline between the inside wall faces of manhole, inlet, sump or gully connection.
22. No measurement shall be made for breaking into existing pipes and manholes and making good afterwards; this work shall be considered incidental to the laying of the storm sewer.
23. Measurement of excavation in rock will be made in accordance with Clause of Excavation and Backfilling for Structures.

5.4.5 Basis of Payment

24. The amount of completed and accepted work, measured as provided for above, will be paid for at the unit rate in the Bill of Quantities for 'Storm Sewer Pipe' of the various sizes and types, which rate shall include for all excavation, bedding, backfilling, testing including connections to existing networks, disposal of surplus materials, reinstatement of surfaces and for labour, equipment, tools and other items necessary for the proper completion of the work.

5.4.6 Items in the Bill of Quantities

Item No. 5.4 Storm sewer (type) (diameter) (Linear meters)

5.5 Catch Basins, Catch Pits, Manholes, Curb Inlets, Ditch Inlets and Outlets

5.5.1 Description

1. This work shall consist of supplying and installing chambers for gullies, catch basins, catch pits, manholes, curb inlets and ditch inlets and outlets.

5.5.2 Materials

2. Concrete shall conform to the requirements of Clauses of Concrete Mixtures and Concrete works, reinforcing steel to Clause of reinforcing Steel and structural steel to Clause of Steel Works.
3. *Class 24 concrete shall be used, with Sulphate Resisting Portland cement.*
4. Precast concrete chambers shall comply with BS 5911 Part 200.
5. Chamber covers, gratings and frames shall comply with BS 497. Two sets of lifting keys shall be supplied with each removable cover.
6. Precast concrete gullies shall comply with BS 5911 Part 2. Gully gratings and covers shall comply with BS 497.
7. Bricks and concrete blocks for masonry work shall comply with BS 3921. or ES 1289: and blue bricks to ES 41 : made from Aswan clay.
8. Mortar for masonry shall be mixed in the proportions 1:3 (cement: sand) by volume, or 1:1/2:4 (cement: lime: sand). The sand shall be well graded and the cement Sulphate Resisting.

Certification

9. The Contractor shall submit to the Engineer manufacturers' Certificates of Guarantee for steel, cast iron, cast steel and wrought iron parts, stating that the materials supplied meet the applicable specification and Standards. If instructed by the Engineer, examples shall be tested for compliance at an approved laboratory.

5.5.3 Construction Requirements

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10. Excavation and backfilling shall be carried out to the requirements of Clause of Earth Works.
11. The formwork for cast in place concrete chambers, and the placing, curing, and protection of the concrete shall conform to the requirements of Clause of Concrete works.

Placing Precast Concrete Items

12. Precast chambers and gullies shall be surrounded by a minimum thickness of 150 mm of Class 18 concrete.

Masonry Chambers

13. Where shown on the Drawings or if approved by the Engineer, brick or concrete block masonry shall be used for the walls of catch basins, manholes, or curb inlets.
14. Brick and blockwork shall be laid on a full bed of mortar. Whole bricks and blocks shall be used except where closers must be cut.
15. Corners shall be stepped back and not raised above the general wall level more than 900 mm. Courses shall be horizontal. Reinforcement in the masonry shall be fully embedded in the mortar joint.
16. If pointing is required, the joint shall be raked out to a depth of 12 mm after completion of the entire face.
17. Brick and blockwork shall be protected by impermeable sheeting or damp cloth for 3 days after completion of laying.
18. The nearest pipe line joint to any chamber or gully shall be not more than 500 mm from the inner wall face and shall not be restricted by concrete or masonry from the structure.

Ironwork

19. Manhole steps shall be built into chambers with an invert depth more than 900 mm below road level or adjacent ground level. The steps shall conform to BS 1247 and be built-in as specified in BS 5911 Part 200.
20. Frames for covers and gratings shall be set in mortar.

21. The upper surface of gully gratings shall be flat. Slots shall not be parallel to traffic flow unless the slots are less than 150 mm long or less than 20 mm wide.

Cleaning

22. Catch basins, catch pits, manholes, inlets and outlets shall be thoroughly cleaned on completion, and shall be free from dirt and debris at the time of final inspection.

5.5.4 Method of Measurement

23. The approved work shall be measured by the number of each type constructed and installed including the supply and installation of frames, grates, covers and steps.

5.5.5 Basis of Payment

24. The amount of completed and accepted Work, measured as provided for above, will be paid for at the unit rate of 'Manholes', 'Catch basins' 'Catch Pits', 'Curb Inlets', 'Ditch Inlets' and 'Ditch Outlets' in the Bill of Quantities, which rates shall *include for all* excavation, installation, fitting, backfilling, supplying materials, labour, equipment, forms, tools and other items necessary for the proper completion of the work.

5.5.6 Items in the Bill of Quantities

- Item no. 5.5.1 Catch basin (type)
- Item no. 5.5.2 Catch pit (type)
- Item no. 5.5.3 Manhole (type)
- Item no. 5.5.4 Curb inlet (type)
- Item no. 5.5.5 Curb outlet (type)

5.6 Drainage on Structures

5.6.1 Description

1. This work shall consist of supplying and installing gully and channel gratings and frames on bridge decks, subways and underpasses with the associated pipework. It includes the supply and placing of permeable drainage backing to structures.

5.6.2 Materials

Gully and Channel Gratings and Frames

2. Gully and channel gratings and frames shall conform to the requirements of BS 497 (Grade A). Integral hoppers shall be of the same grade and quality as the gully or channel grate and frame. Molded UPVC or GRP shall be to the approval of the Engineer who may require material and load testing.

Pipes

3. Pipes used in bridge decks shall be 100 mm internal diameter and to the Standards listed in Table 5.1.

Table 5.1: Drainage Pipe Standards for Bridge Decks

Pipe Material	Pipe Standard
Ductile Iron	BS 437
UPVC	BS 3506
GRP	BS 5480

4. Pipes for filter drains shall comply with the Standards listed in Table 5.2.

Table 5.2: Drainage Pipe Standards for Filter Drains

Pipe Material	Pipe Standard
UPVC	BS 4660 or 5481
Corrugated steel	AASHTO M36
Vitrified clay	BS 65
Concrete	BS 1194

Drainage Backing

5. Permeable backing to structures shall be precast porous concrete blocks to BS 6073: or equivalent standard. Part 1 (3.5) laid in stretcher bond with dry joints. The minimum thickness of backing shall be 225 mm.
6. Granular backfill to structures shall be well graded natural sand, gravel or crushed rock with a particle size distribution as given in Table 5.3.

Table 5.3: Drainage Backfill to Structures

AASHTO sieve size	% passing (by mass)
75 mm	100
37.5 mm	85 - 100
9.5 mm	45 - 100
4.75 mm	25 - 85
710 mm	8 - 45
75 mm	0 - 10

5.6.3 Construction Requirements

7. Drainage pipes cast into the concrete structure shall be firmly supported to prevent their displacement during the concreting operation. Pipes located within the cellular sections of a bridge deck where access after completion of the deck is limited, shall be installed, tested and approved by the Engineer before the deck construction is allowed to proceed to the stage where access to the pipes will not be possible.
8. Pipe joints in bridge decks shall be flexible and watertight. Seals and gaskets shall be appropriate for the pipe material used.
9. Joints between bridge deck waterproofing and drainage components shall be watertight and the sealants shall be compatible with the waterproofing system.
10. Granular drainage backfill shall be placed and compacted in accordance with Clause of Earth works.
11. Drainage pipes and connections in bridge decks shall be tested for water tightness on completion as approved by the Engineer.

5.6.4 Method of Measurement

12. The approved work shall be measured by the number of gratings and frames installed, the length of pipe laid, the area of permeable backing and the volume of granular backfill placed.
13. Hoppers integral with the drainage items shall not be separately measured.

5.6.5 Basis of Payment

14. The amount of completed and accepted work measured as provided for above, will be paid for at the unit rate for the various items of 'Drainage for Structures' in the Bill of Quantities, which rate shall include for all supplying, fabricating, connecting and testing, and for labour, materials, equipment, tools, and other items necessary for the completion of the Work.

5.6.6 Items in the Bill of Quantities

- Item no. 5.6.1 Gully grate and frame for Main Bridge
- Item no. 5.6.2 Gully grate and frame for Approach Bridge
- Item no. 5.6.3 Drainage pipe in structure for Main Bridge
- Item no. 5.6.4 Drainage pipe in structure for Approach Bridge

5.7 Service Ducts

5.7.1 Description

1. This work shall consist of supplying and laying pipe ducts including excavation and backfilling of trenches for ducts.

5.7.2 Materials

2. Unless otherwise shown on the Drawings, pipes for service ducts shall comply with the Standards listed in Table 5.4.

Table 5.4: Service Duct Standards

Pipe Material	Pipe Standard
Ductile Iron	BS 4772
UPVC	BS 4660 or 5481
GRP	BS 5480
Vitrified clay	BS 65
Asbestos cement	BS 3656

3. Duct bedding, surround and backfill shall be granular material as specified in Clause of Earth Works.
4. Concrete ducts where shown on the Drawings shall be in accordance with Clause of Concrete.

5.7.3 Construction Requirements

5. Pipes for service ducts shall have a smooth internal bore with no sharp edges at the ends and joints. Each duct less than 750 mm internal diameter shall be fitted with a stranded polypropylene draw rope of 5 kN breaking load, the ends of which shall be permanently fixed to concrete marker blocks. The ends of the ducts shall be sealed with a close-fitting removable stopper of wood, metal or plastic immediately after laying.

6. Pipes shall be laid so that each length is in full contact with the bedding, which shall be 200mm thick. Duct invert level shall not deviate more than ± 20 mm from the level shown on the Drawings.
7. Ducts need not be watertight, but shall be jointed so that no silt, grout, surround or concrete is able to enter. Pipes with push fit joints shall have a register to indicate that the pipe is fully jointed.
8. The routing of ducts shall be as indicated on the Drawings and shall present the minimum of difficulty in subsequently installing the services. If an obstruction is met, the re-routing shall be approved by the Engineer before re-starting the work.
9. Drawpits, if shown on the Drawings, shall be constructed in accordance with Clause of Catch Basins, Catch Pits, Manholes, Curb Inlets, Ditch Inlets and Outlets.
10. Indicator tape or mesh shall be installed, located 200mm below the final finished surface, above each run.
11. Completed duct runs shall be tested by pulling through a mandrel of diameter 90% of the inside duct diameter and 500 mm long. Ducts which do not allow the smooth drawing of the mandrel without binding shall be repaired or replaced as instructed by the Engineer.

5.7.4 Method of Measurement

12. The approved work shall be measured by the linear metre of duct or group of ducts installed. The amount shall be the length along the axis of the duct from end to end, including curves. Drawpit's shall be measured according to Clause of Catch Basins, Catch Pits, Manholes, Curb Inlets, Ditch Inlets and Outlets.
13. Excavation in rock will be measured as provided for in Clause of Excavation and Backfilling for Structures.

5.7.5 Basis of Payment

14. The amount of completed and accepted work measured as provided for above will be paid at the unit rate for 'Service Duct' in the Bill of Quantities which rate shall include for all excavation, backfilling, supplying, constructing and laying ducts, marking and

testing, and for materials, labour, equipment, tools and other items necessary for the completion of the work.

5.7.6 Items in the Bill of Quantities

Item no. 5.7 Service duct (linear meters)

5.8 Side Ditches

5.8.1 Description

1. This item shall consist of concrete side ditches constructed in accordance with these specifications at the specified locations in accordance with the dimensions, lines, and grades as shown on the plans.

5.8.2 Materials

2. Concrete. Plain and reinforced concrete shall meet the requirements of Clause of Concrete works.
3. Joints. Joint filler materials and premolded joint material shall conform to Clause of Concrete works.

5.8.3 Construction Methods

4. **Preparing Subgrade.** Excavation shall be made to the required width and depth, and the subgrade upon which the item is to be built shall be compacted to a firm uniform grade. All soft and unsuitable material shall be removed and replaced with suitable approved material. When required, a layer of approved granular material, compacted to the thickness indicated on the plans, shall be placed to form a subbase. The underlying course shall be checked and accepted by the Engineer before placing and spreading operations are started.
5. **Placing concrete.** The forms for and the mixing, placing, finishing, and curing of concrete shall conform to the requirements of Clause of Concrete works and shall be in accordance with the following requirements.

The concrete shall be tamped and leveled until it is consolidated and the surface of the concrete shall be floated smooth and the edges radiused as shown on the Drawings. Before the concrete is given the final finishing, the surface shall be tested with a 3m straightedge, and any irregularities of more than 6 mm in 3 m shall be eliminated.

The concrete shall be placed with dummy-grooved joints not to exceed 7.5 m apart, except where shorter lengths are necessary for closures, but no section shall be less than 120 cm long.

Expansion joints as indicated on the Drawings shall be constructed to replace a dummy groove at spacing of approximately 30 m. When the ditch is placed next to concrete pavement, expansion joints shall match the expansion joints in the pavement. When a ditch abuts a pavement or other structure, an expansion joint shall be placed between them.

Forms shall not be removed within 24 hours after the concrete has been placed. Minor defects shall be repaired with mortar containing 1 part cement and 2 parts fine aggregate.

The operations of depositing, compacting, and finishing the item shall be conducted so as to build a satisfactory structure. If any section of concrete is found to be porous, other than minor defects which may be plastered, or is otherwise defective, it shall be removed and replaced by the Contractor at his expense and to the satisfaction of the Engineer.

6. **Backfilling.** After the concrete has hardened, any spaces adjacent to the structure shall be refilled to the required elevation with material as specified and compacted by mechanical equipment to at least 90% of the maximum density as determined by ASTM D698. The in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2167.
7. **Clearing and Restoration of Site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. The Contractor shall restore all disturbed areas to their original condition.

After all work is completed, the Contractor shall remove all tools and equipment, leaving the entire site free, clear and in good condition.

5.8.4 Method of Measurement

8. Side Ditches shall be measured by the linear meter in accordance with the dimensions shown on the plans or ordered by the Engineer.

5.8.5 Basis of Payment

9. The accepted quantities of side ditches will be paid for at the contract unit price per linear meter complete in place.

5.8.6 Items in the bill of Quantities

Item no. 5.8 Side ditch - per linear meter

6.0 STRUCTURAL STEEL WORK

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6.1 Fabricated Steel Structures

6.1.1 Description

Materials, Workmanship, Inspection and Testing, Handling, Transport and Erection, Supply, Measurement and Weighing of Structural Steelworks shall comply with the specification Clauses of BS 5400 : Part 6 all as amended by Clause 6.1.3.

Although the strength of the steel in the Drawings are described by JIS, the Contractor is allowed to use the equivalent specification Clauses of BS 5400 with the prior approval of the Engineer if the strength of the steel is equivalent .

Whatever erection method is proposed, the Contractor shall provide, for the prior approval of the Engineer, a detailed statement of his proposed methods for assembly, movement, and erection of bridge units. The statement shall include, but not be limited to:

- programme for assembly of the superstructure units
- details of the proposed assembly methods
- layout and details of the assembly yard and its equipment
- methods for fabricating, including temporary supports (or bracing) to steelworks, etc.
- methods and equipment for storage of bridge girders
- methods for movement, load-out, and transport of bridge girders to erection position
- methods and equipment for lifting of girders into position
- methods for temporary support of girders prior to lowering onto permanent bearings
- details of temporary connections required to provide and maintain accurate alignment at field splices prior to completion of permanent joint
- methods for paving on steel deck

To ensure consistent high quality, the Contractor shall employ only qualified engineers and personnel experienced in the techniques of steel bridge construction to superintend these works. The works manager and his deputy shall be registered members of a recognized professional body or institution and be qualified to university degree level.

The Contractor shall submit to the Engineer full details of the experience and qualifications of the personnel he proposes to superintend these works together with descriptions of their duties, down to foreman level.

Supervisory staff down to foreman level shall be able to communicate clearly with their local counterparts and operatives. The Contractor shall provide special practical training to his local staff prior to manufacture of units for the permanent works. This training shall be deemed part of the Contractor's obligations under the contract and included in his price for the works.

Expatriate operatives employed for steelworks assembly or erection shall be experienced in the construction of steel bridge works.

6.1.2 Surface preparation and Protection Against Corrosion

The surface preparation and corrosion protection of structural steelworks shall comply with the Technical Specification for Painting.

6.1.3 Amendments and Additions to BS 5400 : Part 6:

Contents

Insert in the contents page:-

"3.4.4. Stainless steel bolts, nuts and washers".

"5.2.3 Testing of bolts, nuts and washers including HSFG".

Delete from the contents page:-

"7.1 Computed weights".

"7.2 Weighbridge weights".

Page 1

Insert additional table title as follows:-

"2A preliminary tightening of HSFG nuts".

Page 2

Clause 3.1.1: Delete heading and text of Clause and insert the following:

"Structural steels shall comply with the requirements of BS EN 10 025,

and BS EN 10155 for weathering steels. Unless otherwise specified, the ladle analysis for each grade of steel shall be supplied. Where specified by the Engineer the maximum carbon equivalent values for each grade of steel shall not exceed the specified values.

Clause 3.1.2 and Table 1

Clause 3.1.2 Delete references to BS 4360 and replace by BS EN 10 025.

Table 1. Delete table.

Clause 3.1.4.1, lines 5, 8 and 14

Delete "C of DD21", insert "L1 of BS 5996".

Clause 3.1.4.1, line 10. Delete "DD21", insert "BS 5996".

Clause 3.1.4.2, line 3. Delete "DD21", insert "BS 5996".

Clause 3.1.5 Delete text of Clause and insert:

"Steel supplied to BS EN 10 025 shall be specifically marked in accordance with Option 14 of BS EN 10 025.

Clause 3.1.6 Delete "BS 4360" and insert: "BS EN 10 025"

Clause 3.1.7 Delete "BS 4360" and insert: "BS EN 10 025"

Clause 3.3 Delete "BS 4360" and insert: "BS EN 10 025"

Page 3

Clause 3.4.4. Insert additional Clause 3.4.4 as follows:-

"3.4.4 Stainless steel bolts, nuts and washers.

Stainless steel bolts and nuts shall comply with steel Grade A4 and property class 80 to BS 6105 and washers with steel Grade 316 S 31 or 316 S 33 in the softened condition, to BS 1449 : Part 2. Dimensions and tolerances shall comply with:

BS 3692 for bolts and nuts.

BS 4320 Form C for flat washers.

BS 3410 for taper washers."

Clause 3.5 Delete "BS 4360" and insert: "BS EN 10 025"

Clause 3.6 Delete "or grade 43, 50 or 55 of BS 4360 as appropriate" and insert: ", grades Fe 430 or Fe 510 of BS EN 10 025"

Clause 4.2.1. Line 2, delete "4.4.2", insert "4.2.2".

Clause 4.3.3. Paragraph 2 line 1, delete the words

"where specified by the Engineer"

Clause 4.3.3. In (f), delete "grade 43" and insert: "grade Fe 430".

Page 4

Clause 4.4.5. After paragraph 1, insert additional paragraphs and table as follows:-

"Where bolts and nuts in compliance with BS 4395 : Part 1 are tightened by the 'part turn' method, the value of bedding torque for the preliminary tightening shall be as in table 2A.

Where bolts or washers with load indicating devices are described in the Contract or approved by the Engineer, the range of final average gap for each batch (as defined in BS 4395) shall be established by testing a minimum of three bolt, nut and washer assemblies in a bolt load meter, and agreed by the Engineer. The bolts shall be tightened in two stages, and in a sequence and pattern as agreed with the Engineer' the range of the average gap after initial tightening shall be as agreed by the Engineer. On final tightening of each bolt and nut, the average gap under the bolt head or washer shall be within the agreed final range.

Table 2A : Preliminary Tightening of Nuts

Nominal dia of bolt (mm)	Bedding Torque $\pm 10\%$ (Nm)
16	80
20	160
22	210
24	270
27	340
30	460

Bolts shall be tightened to a pattern, generally by working from the centre of a group of bolts to the outside. This procedure shall be followed both for the preliminary and final tightening. As layers are drawn together during the application of the preliminary bedding torque, the first bolts tightened and then all subsequent bolts in a group shall be checked and further tightened as necessary until the specified bedding torque is achieved."

Clause 4.4.6. Paragraph 1, delete the second sentence (lines 3-5)

Clause 4.7.1. Paragraph 2, line 4, delete "Clause 23 of BS 5135 1974" and insert "BS 5135".

Clause 4.7.1 Paragraph 5, line 4

Delete "BS 4360" and insert "BS EN 10 025".

Page 5

Clause 4.7.1 After paragraph 6, insert additional paragraphs as follows:-

"Unless otherwise described in the Contract, all butt welds shall be complete penetration welds between prepared fusion faces.

In the fabrication of built-up assemblies, all butt welds in each component part shall be completed, whenever possible, before the final assembly.

Temporary welded attachments shall not be used on otherwise unwelded members, unless agreed by the Engineer."

Clause 4.7.2 After paragraph 2, insert additional paragraphs as follows:-

"Unless otherwise described in the Contract, all butt welds shall be complete penetration welds between prepared fusion faces.

In the fabrication of built-up assemblies, all butt welds in each component part shall be completed, whenever possible, before the final assembly.

Temporary welded attachments shall not be used on otherwise unwelded members, unless agreed by the Engineer."

Clause 4.7.3 After paragraph 3, insert additional paragraphs as follows:-

"For welding trials, where galvanizing or other metal coating of the material is to be applied to a part which is to be subsequently welded in the shop or on site, the same coating shall be applied to the sample material before the procedure trials are made.

For flame cutting, trials on materials 20 mm thick shall be deemed to cover all material up to and including 20 mm thick; trials on material 40 mm thick shall be deemed to cover all material over 20 mm thick up to and including 40 mm thick; material over 40 mm thick shall be tested for every thickness increment of 10 mm.

The Contractor may omit these trials if he can supply fully documented and tested procedures for the same material and thickness to the satisfaction of the Engineer".

Clause 4.8 Delete "BS 4360" and replace by "BS EN 10 025".

Clause 4.16. Delete "BS 4360" and replace by "BS EN 10 025".

Page 6

Clause 5.2.1 Delete "BS 4360" and replace by "BS EN 10 025".

Clause 5.2.2 Line 2, delete "'DD21'", insert "BS 5996".

Clause 5.2.3 Insert additional Clause 5.2.3 as follows:-

"5.2.3 Testing of bolts, nuts and washers including HSFG.

The frequency of sampling and testing of high strength friction grip bolts, nuts and washers shall be in compliance with the appropriate part of BS 4395.

The frequency of sampling and testing of structural steel and stainless steel, bolts, nuts and washers shall be as defined in BS 4395 : Part 2."

Clause 5.4.1.2 Paragraph (a)(1), lines 1 to 3

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Delete lines and insert the following:

"For regions with an applied principal tensile stress at the ultimate limit state (ignoring geometric stress concentrations) greater than 100N/mm^2 the energy absorption requirement shall be:

18J or

$$(\sigma_y/355) \times (t/2) \text{ J when } \sigma_y \leq 355\text{N/mm}^2$$

$$(\sigma_y/355)^2 \times (t/2) \text{ J when } \sigma_y > 355\text{N/mm}^2$$

whichever is the greater, at"

paragraph (a)(2), lines 1 to 4 Delete lines and insert the following:

"For regions with an applied principal tensile stress at the ultimate limit state (ignoring geometric stress concentrations) less than or equal to 100N/mm^2 the energy absorption requirement shall be:

18J or

$$(\sigma_y/355) \times (t/4) \text{ J when } \sigma_y \leq 355\text{N/mm}^2$$

$$(\sigma_y/355)^2 \times (t/4) \text{ J when } \sigma_y > 355\text{N/mm}^2$$

whichever is the greater, at the minimum"

paragraph (a)(3), last two lines Delete lines and insert the following:

"... for the weld metal, may be taken as the lesser of the values calculated in accordance with (1) and (2) or 27J when testing is to be at -20°C ."

Table 3 Delete "grades 40, 43 and 50 of BS 4360" and insert:

"grades Fe 360, Fe 430 and Fe 510 of BS EN 10 025"

Page 7

Clause 5.5.1 After Paragraph 1, in the final paragraph of Sub-clause 5.5.1.2(c) delete the words

"where specified by" and substitute "unless otherwise agreed with".

Clause 5.5.2 Delete the first and second paragraphs and insert the following:-

"Non destructive testing of welding for structural steels. The non-destructive testing of the following welds shall be carried out using methods agreed with the Engineer.

(a) Transverse butt welds in all flanges (and additionally transverse butt welds

in those portions of webs which will experience longitudinal tensile stresses) shall be subject to 100% testing. The method of testing shall be either by ultrasonics or radiography and the acceptance level shall be to BS 5135 table 18 quality category A.

- (b) All full penetration tee and cruciform butt welds shall be subjected to 100% testing by both ultrasonics and magnetic particle inspection. Adjacent plate material shall be tested for lamellar defects both before and after welding. The acceptance level shall be to BS 5135 table 18 quality category A.
- (c) All transverse butt welds in foundation piles shall be subjected to 100% testing. The method of testing shall be either ultrasonics or radiography and the acceptance standard shall generally be BS 5135 table 18 quality category A. For field welds made as part of the pile installation, quality category B will however be acceptable.
- (d) All longitudinal butt welds in tension flanges and in foundation piles shall be subjected to 10% random testing. The method of testing shall be either by ultrasonics or radiography and the acceptance level shall be to BS 5135 table 18 quality category B.
- (e) All other transverse and longitudinal butt welds shall be subjected to 5% random testing. The method of testing shall be either by ultrasonic or radiography and the acceptance level shall be to BS 5135 table 18 quality category B.
- (f) Intersections between longitudinal and transverse butt welds shall be subject to 100% radiography for 150 mm either side of the transverse weld centerline unless otherwise agreed with the Engineer.
- (g) All fillet welds connecting bearing diaphragms to webs, flanges and stiffeners shall be subjected to 100% testing. The method of testing shall be by magnetic particle inspection and the acceptance level shall be to BS 5135 table 19 category A.
- (h) All other fillet welds shall be subjected to testing by random 5% magnetic particle inspection. The acceptance level shall be to BS 5135 table 19 quality category C.

In the second paragraph, delete "(b) and (c)" and replace by "(d), (e), and (h)"

In the third paragraph, first sentence, delete "grider" and substitute "girder"

Add an additional paragraph as follows:

"Ultrasonic testing shall be carried out in accordance with BS 3923 Part 1, using operators qualified to United Kingdom CSWIP (Certification Scheme for

Weldment Inspection) ultrasonic practitioner standard 3.9 or an equivalent national scheme. A random sample of 1% of the welding inspected ultrasonically by each operator shall be verified by check radiography."

Page 8

Clause 5.9 Delete text and insert the following:-

"At each works where fabrication is carried out, the steelwork for the first span fabricated or other such length as agreed with the Engineer shall be temporarily erected at the works to the approval of the Engineer".

Page 9

Clause 6.3.1 Delete text and insert the following:-

"Appropriate allowances shall be made for deformation due to permanent loads and the process and sequence of fabrication, erection and construction, so that the completed structure conforms to the lines and levels described on the approved Working Drawings. The Contractor shall submit his detailed proposals for controlling alignment and ensuring proper fit-up of splices. This shall include allowances for differential weld shrinkage affects and differential temperature effects between shaded and unshaded parts of the steelwork."

Clause 6.3.2 Add an additional 2 paragraphs as follows:

"To ensure accurate alignment of the structural steelwork at the field splices, the abutting ends of each erection unit shall be matched at the assembly stage either by:

(a) Physical matching of the girder ends during assembly.

or

(b) Comparative survey of the girder ends followed by adjustment of the steelworks as found necessary.

In either case, appropriate allowance shall be made for the effects of deflection of the steelworks from the surveyed assembly stage to the erection condition.

Before commencing erection of the superstructure units at any pier, the Contractor shall make an accurate field survey of the actual locations of the bridge bearings.

Any discrepancies from the specified tolerances in bearing location, orientation, and elevation shall be rectified by adjustments to the bearings or to the superstructure before erection of the superstructure units."

Insert new Clause 6.3.5:

"6.3.5 Temporary Welded Attachments. The position of any temporary welded

attachments required for handling or erection purposes shall be subject to the approval of the Engineer. Unless otherwise agreed with the Engineer, such attachments shall be removed and the surface made good as specified in BS 5135 Clause 16.2."

Clause 7.1. Delete Clause

Clause 7.2. Delete Clause

Page 11

Clause 3.1.4 In the third sentence delete "DD21" and insert "BS 5996".

Clause 3.9 Line 1, delete "BS 970 : Part 4" and insert "BS 970".

Add to the end of the sentence "or equivalent in later editions of BS."

Page 12

Clause 5.5.2 In the last sentence, delete the words "should be indicated" and insert "shall be as directed".

Page 15

Table 5, column 3, Member Component 4. Delete 'G = O', insert "G = D".

6.1.4 Drawings

1. The Contractor shall prepare detailed drawings of all parts of the permanent steel structure, and shall submit copies of each in accordance with the requirements of the Contract for approval. These drawings shall be based upon his erection sequence and methods which have been consented to by the Engineer in accordance with the requirements of the Contract. He shall submit further amended copies as required, until approval is obtained. No part of the steelworks fabrication shall be put in hand until the relevant drawings have been approved.
2. All relevant requirements for fixings, openings, accesses or other provisions in steelworks shall be approved in advance And included on the steelworks fabrication details.
3. On approval, the Contractor shall supply copies of each approved Drawing to the Engineer, and shall maintain two complete sets of such Drawings on Site throughout the period of steelworks erection.

4. Among the Drawings prepared by the Contractor and supplied to the Engineer shall be:-
 - (a) a full and clear set of marking plans and all necessary erection and Temporary Works Drawings prepared in accordance with the Clause 4.23(2); and
 - (b) a full set of protective coating sketches or procedure sheets prepared in accordance with the Technical Specifications.
5. Notwithstanding any approval, given or implied, the Contractor shall be entirely responsible for the accuracy of his Drawings and for the fabrication thereto.
6. On completion, the Contractor shall supply to the Engineer for record purposes, six 35 mm first-generation transparencies of each Drawing, mounted on aperture cards, filmed in accordance with BS 4210. The Drawing number shall be displayed on the card.

6.1.5 Materials

1. Structural steels shall comply with the requirements of BS EN 10 025, including the Options of Clause 11 of that Standard where specified, and other amplifications and amendments as specified in this Clause.
2. Where structural steels comply with requirements of Technical Specifications other than BS EN 10 025 the performance requirements, as listed in Table 1 of BS 5400 : Part 6, of these steels shall comply with those of Clause 4.04(1).
3. Steel of minimum tensile strength 410N/mm^2 shall be either Grade S 275 JO for material of up to and including 100 mm in thickness for sections and 150 mm in thickness for all other products, or Grade S 275 JO for ancillary components, where specified on the Drawings.
4. Steel of minimum tensile strength 490N/mm^2 shall be either Grade S 355 JO for material up to and including 100 mm in thickness for sections and 150 mm in thickness for all other products or, with prior approval, Grade S 355 J2G3 or S 355 K2G3; where the latter result in lower welding costs.
5. Grade S 275 JO and S 355 JO steels up to and including 100 mm in thickness, shall be supplied to Maximum Carbon Equivalent Values in accordance with Option 5 of Clause 11 of BS EN 10 025.

6. Where provided in accordance with Clause 4.04(4), plates and wide flats up to and including 40 mm thickness in Grade S 355 J2G3 or S 355 K2G3 steel shall be supplied with a Maximum Carbon Equivalent Value in accordance with Option 5 of Clause 11 of BS EN 10 025.
7. Clause 5.1 of BS EN 10 025 shall be amplified as follows for "Thickness Tolerance":-
 - (a) plates shall be supplied to an all-over thickness tolerance in accordance with S EN 10 029; and
 - (b) wide flats shall be supplied to an all-over thickness tolerance in accordance with EURONORM 91.
8. Clause 7.4.3 and Option 10 of Clause 11 of BS EN 10 025 shall be amplified as follows for "Through Thickness Testing":-
 - (a) where specified on the Drawings, plates and wide flats shall be through thickness tested in accordance with BS EN 10164;
 - (b) unless otherwise specified, such steel shall be tested to Acceptance Class Z35; and
 - (c) such steel shall be specially marked, in accordance with Clause 4.04 (13)(c).
9. Clause 7.6.2 of BS EN 10 025 shall be amplified as follows for "Surface Finish":-
 - (a) Hot-rolled plates and wide flats:-
 - (i) repair by grinding shall not reduce the local thickness after grinding to below the minimum rolling tolerance; and
 - (ii) repair by welding shall not be carried out.
 - (b) Sections (other than hollow sections) flats and round and square bars:-
 - (i) repair by grinding shall not reduce the local thickness after grinding by over 3 mm nor over 4% of the minimum thickness; and
 - (ii) repair by welding shall not be carried out without the prior consent of the Engineer.
10. Clause 8.1 and 8.10 and Options 12 and 13 of Clause 11 of BS EN 10 025 shall be amplified as follows for "Inspection by the Engineer":-

The Engineer shall be afforded the opportunity to inspect visually all material to select the test samples and to witness the tests, and shall be provided with duplicate

copies of the manufacturer's certificates covering specific testing of the ordered products, providing full details of chemical composition, mechanical properties and other required tests.

11. Clause 8.5.2 of BS EN 10 025 shall be amended as follows for "Product Analysis":-
Product analysis shall be undertaken on the basis of one test per cast, recording the elements contained in the carbon equivalent formula of Clause 7.3.3.1 - Option 15 of BS EN 10 025.

12. Clause 8.9 of BS EN 10 025 shall be amplified as follows for "Ultrasonic Testing":-
 - (a) all plates and wide flats shall be supplied ultrasonically tested to grade LCI of BS 5996;
 - (b) edges of plates and wide flats to be joined by corner welds made on the surface of such plates shall be ultrasonically tested to grade ES of BS 5996, at the place of manufacture;
 - (c) flanges and web plates to be welded on the surface at tee and cruciform joints shall be ultrasonically tested on a band of width four times the plate thickness each side of the attachment, to grade LC 3 of BS 5996, at the place of manufacture;
 - (d) plates and wide flats to be through thickness tested in accordance with sub-clause (8) above shall be supplied ultrasonically tested to grade LC 3 of BS 5996, in accordance with BS EN 10164;
 - (e) the Engineer shall be afforded the opportunity to witness all ultrasonic testing;
 - (f) the Contractor shall undertake all due inspection to ensure that steel containing laminations and other defects are not incorporated into the Works; and
 - (g) where the use of blast cleaning as a preparation for the corrosion protection system, exposes surface defects missed through inadequate prior inspection, these shall be rectified in accordance with the Technical Specification, or the material shall be replaced at the Contractor's expense.

13. Clause 9 and Option 16 of Clause 11 of BS EN 10 025 shall be amplified as follows for "Marking":-
 - (a) each plate, wide flat, section (other than hollow sections and flat) shall be marked with a continuous paint line not less than 12.5 mm wide throughout

- its length. This requirement shall also be applicable to any material supplied in bundles;
- (b) for Grade S275, the color shall be red and for Grade S335, blue;
 - (c) plates and wide flats supplied through thickness tested in accordance with Clause 4.04(8) shall be marked with a second continuous line of the same color, parallel to and approximately 50 mm from, the line provided in accordance with (a) above; and
 - (d) additionally, the Contractor shall maintain a system of identification, other than hard-stamping, for the material used in fabrication, in order that all material in completed components can be traced to its origin.
14. Steel plate for the deck trough stiffeners shall be of a quality suitable for cold bending to the radius shown upon the Drawings without the development of splits or tears.
15. Cleaning and Prime Painting of factory Pre-Assembled components
Factory assembled components, whether performed in factories abroad or in Egypt, shall be dry blast-cleaned to BS 4232, first Quality Finish standard, as shown in Table 6.1 .

Table 6.1 Quality of Surface Finish of Steel

Quality	Typical Application
First Quality Finish	For treating steelwork where extremely clean surfaces can be expected to prolong the life of chemical-resistant paint systems in exacting conditions.
Second Quality Finish	The minimum requirement for chemically resistant paint systems such as epoxide and vinyl resin paints ; also required from conventional paint systems used under fairly corrosive conditions.
Third Quality Finish	For steel that is to be painted with conventional paints for exposure to mildly corrosive atmospheric conditions.

The blast profile, unless otherwise specified shall be 1.5 to 2.5 mils as measured by ASTM D 4417, Method C, within 8 hours after cleaning, prior to the deposition of any detectable moisture, contaminants, or corrosion, all ferrous surfaces blast cleaned to BS 4232, first Quality Finish standard shall be cleaned of dust and

abrasive particles by brush, vacuum cleaner, and / or blown down with clean , dry compressed air and given the first coat of paint. Upon written request by the Contractor , the Engineer may authorize mill or shop cleaning of assembled or partially assembled bridge components specified to receive one of the paint systems specified in section of Paint. The shop coating shall be maintained in good condition by cleaning and touching up of areas damaged during the shipping or stored period. If pinpoint or general rusting appears, surface shall be reblasted and repaired at no added cost to the Employer. Prior to the field application of subsequent paint coats, soiled areas of the shop coat shall be thoroughly cleaned and all welds or other unpainted or damaged areas shall be cleaned and coated in a manner equivalent to adjacent areas.

6.1.6 Construction Requirements

6. Fabrication of metal for structures shall be in accordance with the shop drawings submitted by the Contractor for prior approval by the Engineer. Three copies of each shop drawing prepared by the Contractor shall be submitted and further copies of corrected or amended drawings shall be submitted if required before final approval is given. These drawings shall conform to the general Drawings and Technical Specification. Shop drawings shall include marking details.
7. The tolerances given in sub-Clause 6.1.25 shall be achieved on erection of the members. Tolerances shall form a guide for accuracy of manufacture. The Contractor shall also provide for the tolerances necessary to permit parts in an assembly to fit accurately in accordance with the Drawings.
8. The Contractor shall satisfy himself that the steelworks design provides for built-in ducts, signs and control equipment. The dimensions of equipment designed by specialist suppliers shall also be taken into account.

Inspection Procedure

9. In lieu of mill inspection, the Contractor shall supply the Engineer with 3 certified copies of the mill orders showing heat numbers of the individual members, together with 3 certified copies of mill heat test reports showing the properties of each heat number.

10. When received at the fabrication shop, each member shall bear the heat number in legible form for identification by the shop inspector. Acceptance of the material shall be based on approval of the mill heat test reports by the Engineer.
11. When the fabrication shop is located outside Egypt, the Contractor shall notify the Engineer at least 2 weeks in advance of beginning fabrication work to allow for inspection. The Contractor shall provide facilities for inspection of material and workmanship, and give free access to the workshop.
12. Acceptance of a material or finished member by the Engineer shall not preclude subsequent rejection in the structure. Rejected materials shall be replaced promptly and rejected workmanship shall be made good, at no additional expense to the Employer.

Welding

13. Radiographic inspection of welds shall be carried out in accordance with the Standard Technical Specifications for Welded Highway and Railway Bridges of the AWS or a similar approved standard such as BS or JIS. Additional welds to be inspected radiographically will be shown on the Drawings.
14. The Contractor shall employ an approved body or firm qualified in the inspection of welds, unless the factory has not authorized by the standard of ISO 9002. The Engineer shall review radiographs and other nondestructive or destructive test results before giving approval.
15. The presence of any of the following defects will result in rejection of the weld:
 - (i) Cracks, regardless of length or location.
 - (ii) Overlaps, lack of penetration or incomplete fusion.
 - (iii) Inclusions of slag, porosity and other deleterious materials less than 1.5 mm in size, unless well dispersed.
 - (iv) Inclusions outside the size limits given in Table 6.2
 - (v) Any line of inclusions in a length of 12T that have an aggregate length greater than T.

Table 6.2: Weld defect limits.

Welded plate thickness (T) (mm)	Maximum allowable defect dimension (mm)
19 or less	6.5
19-57	T/3
greater than 57	19

16. Defects shall be removed by mechanical means or by oxygen grooving, after which the joints shall be re-welded.
17. Box members, including rolled hollow sections, shall be completely sealed with weld metal as shown on the Drawings except where specific openings are required. No subsequent drilling of holes, either before or after erection, will be allowed for fixing of signs or other purposes. Holes in other members will not be permitted unless approved by the Engineer.
18. Ends of members shall be provided with an end plate at least 6 mm thick, sealed all round with weld metal. Where duct tubes pass through a box member they shall be fully sealed to it with weld metal.
19. For the members to be painted, the type, quality and number of coats of shop paint and site paint shall be applied as shown on the Drawings and shall conform to the requirements of Clause of Paint.

Erection

20. The Contractor shall submit for approval details and drawings of proposed erection procedures, together with supporting calculations.
21. At all stages of erection the structure shall be stable.
22. Steelworks shall be precambered so that the specified geometry shown on the Drawings is achieved under full dead load conditions.
23. Handrails, frames grates and covers that are fabricated shall be located and fixed true to line and level and shall make full and even bearing on the underlying surface or support. Fabrications that are warped or otherwise damaged will be rejected

and shall be removed from the Site.

Tolerances

24. Steel members and structures shall conform to the tolerances given in BS 5400, Part 6 and in below Table 6.3.

Table 6.3: Tolerance Limits

Structural member	Divergence	Allowable limit (mm)	Measurement points, or spacing
Longitudinal stiffeners	Lateral departure from line	2	540 mm
Web and flange plates	Departure from flatness along line of stiffeners	2	Center to center of stiffeners
	Departure from flatness elsewhere (transversely)	3	Plate or web width
	Width under 400 mm over 400 mm (longitudinal)	3 5	Plate or web width
Completed erected structure	Line & level	±5	-
	Verticality	± 5	15m of height

6.1.7 Method of Measurement

26. Structural steel shall be measured by computed weight of the finished member comprising plates, rolled sections, shear connectors, stiffeners, cleats, packs, splice plates and fittings, without allowance for tolerances for permissible deviations from standard mass or nominal dimensions, and excluding the mass of welds, bolts, nuts, washers, rivets and protective coatings.
27. No deductions shall be made for notches, cope holes, bolt and rivet holes, and the like which are each less than 0.03m^2 measured in plan.
28. The computed mass of rolled and cast steel shall be determined from the dimensions shown on the Drawings, with the addition of 5% to the mass of castings for fillets and overrun assuming a mass of 7850 kg/m^3 .

29. The quantity of 'Structural Steel' to be paid for shall include any full-size members which are tested to destruction as ordered by the Engineer and which meet the requirements of the Technical Specification. Full-size members which fail to meet the requirements and members rejected as a result of tests will not be paid for.

6.1.8 Basis of Payment

30. The amount of completed and accepted structural steel, measured as provided for above, will be paid for at the unit rate per tone for the metal in the Bill of Quantities, which rate shall be full compensation for supplying, fabricating, casting, welding, delivering, erecting, radiographic inspection, painting and for materials, labour, equipment, tools and other items necessary for the proper completion of the work.
31. The payment shall be done for the following stages
- a) Materials on Site 50 % of rate of bill of quantities
 - b) Completion of Fabrication 50 % of rate of bill of quantities

6.1.9 Items in the Bill of Quantities

Item No. 6.1.1 Structural steel for main girder of Main Bridge

Item No. 6.1.2 Inspection Paths

Item No. 6.1.3 Ladder in Pylons

Item No. 6.1.4 Inspection Gondola

6.2 Stay Cable

6.2.1 General

1. This section covers the requirements for furnishing all equipment, materials, techniques and labour for providing and installing steel stay cables and accessories for the construction of the cable stayed bridge.
2. The work shall be performed in accordance with BS 5400, Part 7, 1978, Steel for materials and workmanship; concrete, reinforcement and prestressing.

6.2.2 MATERIALS

3. The following types of cable stay will be permitted.
 - An assembly of high strength seven wire steel strands, individually lubricated and galvanized and enclosed within a circular outer sheath of high density polyethylene.
4. Stressing tendon shall conform to the requirements of BS 5896:1980, Specification for high tensile steel wire strand for prestressing of concrete. Stressing tendons shall be clean and free of loose rust, scale and pitting.
5. The stranded wire shall be furnished on reels or in coils, with a strong tag showing the type, length, reel or lot number, with the date of manufacture. The Contractor's facilities shall be open for inspection by the Engineer at any time, and the Contractor may be required to furnish representative samples of the stressing tendon.
6. Materials shall be suitably wrapped, packaged or covered at the factory to prevent being affected by dirt, water and rust. Materials shall be protected against abrasion or damage during shipment and handling. Materials stored at the site shall be placed above ground on elevated covered platforms.
7. Anchorages shall be metal of proven corrosion resistance and compatible with the stressing tendon, capable of fully developing the minimum guaranteed ultimate strength of tendons without excessive slip of a type recommended by the

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Contractor and approved by the Engineer. The anchorages shall conform to the requirements of BS 4447 (1973), The performance of prestressing anchorages for post-tensioned construction. The efficiency of the anchorages shall be not less than 90%.

6.2.3 Seven wire strands by final assembly

6.2.3.1 General

Cable stays constructed as a group of seven wire strands by final assembly into a completed cable stay at site shall have individual strands complying with the requirements of BS 5896, except where amended or extended by this Technical Specification. Each strand shall be manufactured from galvanized wire. The completed strand group shall be enclosed within a circular outer polyethylene sheath.

6.2.3.2 Seven Wire Strands

Seven wire strands for cable stays shall comply with the requirements of BS 5896, except as amended or amplified below.

- (a) The finished wire diameter shall be not less than 5.0 mm. All wire shall be supplied smooth (designation E in Clause 14 (f) of Section 2 of BS 5896.
- (b) The nominal tensile strength of the wire shall be 1770N/mm^2 .
- (c) All wire shall be supplied straightened (designation P in Clause 14 (e)) and stress relieved to relaxation grade 2 (Clause 14(g)) of Section 2 of BS 5896.
- (d) Wire shall be galvanized in accordance with the requirements of BS 2763 1982, so as to give an average zinc coating of not less than 170g/m^2 .

6.2.3.3 Outer Sheathing for Cable Stays

The complete group of strands shall be enclosed within a circular outer sheath of polyethylene pipe as specified below:

- (a) Polyethylene sheathing of cable stays shall be of high density polyethylene pipe

in accordance with the requirements of ASTM F714 or a similar approved specification.

- (b) The polyethylene pipe shall meet the specific cell category requirements for PE 3408 material as defined in Table X1 of ASTM D3350.
- (c) The polyethylene material shall be resistant to the effects of weather and ultraviolet light. The material shall preferably be class C to ASTM D 3350 (black), but class E (colored with UV stabilizer) will be acceptable if comparable resistance to the effects of ultra violet light can be demonstrated. The color of the finished cable stays is an important factor with respect to both temperature effects and the appearance of the bridge, and the color of the completed stays shall be subject to the approval of the Engineer.
- (d) A consistent and uniform spacing between the load carrying strands and the outer sheath shall be ensured by spacer devices such as a helically wound spacer wire.
- (e) A flexible asphalt sealant based corrosion inhibitory compound shall be grouted to fill the voids between the outer sheath and strands.

6.2.3.4 End Anchorages

Details of the materials, structural arrangement, installation technique, tensioning and locking off, range of adjustment, vibration damping, weatherproofing, and testing requirements for the cable stay end anchorages shall be determined by the Contractor. Construction specification requirements in respect of these shall be provided by the Contractor and shall be subject to the approval of the Engineer.

The anchorage fitting of one end of each cable stay shall incorporate an external thread and nut, so as to provide a capability for adjustment of the complete cable stay.

The materials and systems used shall be appropriate for the durability and design life requirements in the Technical Specification.

6.2.3.5 Testing

Testing of Wire Materials

- (a) Mechanical test pieces shall be cut from each end of each coil of wire as supplied by the wire manufacturer to the strand maker.

- (b) Mechanical test procedures shall comply with BS 4545, and tensile tests shall be undertaken on machines maintained to grade B of BS 1610 part 2.
- (c) Galvanizing test pieces shall be cut from one end of every alternate coil as supplied. Testing for uniformity, thickness and adhesion of the zinc coating shall be in accordance with BS 443 1982.
- (d) The Engineer shall be afforded to select all test samples and witness all tests.
- (e) The cable stay supplier shall provide Manufacturer's certificates, in duplicate, for each cast of steel used in the manufacture of the wire. These certificates shall detail the chemical analysis and the results of all tests made on samples taken from wire made from that cast.

Testing of Cable Stay Samples

The tensile and fatigue strength of the proposed cable stays shall be demonstrated by testing as set out in 11 below.

11 Testing of Cable Stay Samples

The tensile and fatigue strength of the proposed cable stays shall be demonstrated by testing. The testing shall be carried out on specimens with all their load bearing fittings and corrosion protection systems in place. The specimen lengths shall be not less than 5 m and they shall be initially be bedded down by the application of 10 load cycles between 10 and 50% of the stay minimum breaking load.

At least three tensile and three fatigue tests shall be carried out on specimens representative of the cable size proposed for use in the permanent structure.

Each tensile test shall establish the load/extension relationship for the specimen both between the jaws of the test machine and also over a gauge length centered on the parallel part of the stay cable. Measurements and observations shall also be taken of any anchorage pullout. At least 50% of the tensile tests shall be continued to failure. The failure in such tests must occur in the central part of the specimen, and not at or near to the anchor fittings.

Fatigue testing shall be carried out to demonstrate that the stays have a minimum endurance at least equal to the proposal of the manufacturer.

During fatigue testing, not more than 2% of the total number of wires in the stay (rounded to the nearest whole number) may fail. No failure may occur in the strands within their anchor zone, and no failure may occur in any anchorage component.

Following completion of fatigue testing, the test specimen shall be tensile tested and shall develop a load equal to 95% of the specified minimum breaking load of the cable stay. At least 50% of these tests shall be continued to failure.

After testing, all tensile and fatigue specimens shall be examined to determine the nature of any failure or other damage. Where testing has not been continued to failure, the condition of wires, strands, and anchorage components shall be examined by sectioning these parts where necessary.

6.2.4 Installation

7. Stressing tendons and accessories shall be installed or placed as specified and as shown on contract and approved installation drawings, and in accordance with BS 4447.
 - (a) Stay cables shall be installed in accordance with an approved cable installation procedure prescribing the proposed methods of unreeling and handling, the pulling in and jacking loads required, and the nominal shim thickness or anchor nut position.
 - (b) Abrasion damage to the cable arising from rubbing contact with the bridge deck during installation shall be prevented by the use of rollers or similar equipment as necessary.
 - (c) At deck and tower anchorage positions, equipment shall be provided to support the cable during installation in a position tangential to its final profile, and control the cable bend radius within the limit specified in (d) below.
 - (d) The installation procedure shall be such as to:
 - (i) Prevent bending of stay cables to radius of 25 times their diameter or such larger radius as is necessary to prevent damage to the cable.
 - (ii) Support the sockets of the stay such that bending of the cable adjacent to the socket entry point is prevented

6.2.5 Accessories

8. Ducts shall be PE conduits, compatible with the stressing tendons, capable of fully developing the minimum guaranteed ultimate strength of tendons without excessive slip and approved by the Engineer.

6.2.6 Accuracy of Stress and Elongation Measurement

10. Stress Measurement

Hydraulic gauges, dynamometers, load cells or other devices for measuring stressing load shall have an accuracy of reading within two percent. Gauges are required to have been calibrated for the jacks for which they are used within a period not exceeding 12 months. Recalibration shall be performed at any time that a gauging system shows indication of erratic results in the opinion of the Engineer. Gauges shall indicate loads directly in kilograms or be accompanied by a chart which converts dial readings into kilograms.

11. Elongation Measurement

After the initial force has been applied to a tendon, reference points for measuring elongation due to additional tensioning forces shall be established. They shall be located according to the method of tensioning and type of equipment. The system used shall be capable of measuring the true elongation plus or minus 2 mm.

12. Prestressing Operation Records

The Contractor shall compile and submit complete records of the prestressing operations to the Engineer. These records shall show the manufacturer, identification and description of materials and equipment including prestressing tendons and jacking and load measuring equipment; location of prestressing tendons; initial design tensioning loads, final design tensioning loads and actual tensioning loads for tendons; dates tensioning loads applied; and theoretical and actual elongation for tendons.

6.2.7 Method of Measurement

13. Stay cables shall be measured by computed weight of the finished works comprising stressing strand, anchorages, couplers, sockets and forgings without allowance for tolerances for permissible deviations from standard mass or nominal dimensions.
14. The computed mass of stay cables shall be determined from the dimensions shown on the Drawings, with the addition of 5% of accessories or anchorages..

6.2.8 Basis of Payment

15. The amount of completed and accepted stay cables, measured as provided for above, will be paid for at the unit rate per tone for the items in the Bill of Quantities, which rate shall be full compensation for supplying, fabricating, grouting, erecting, inspection, adjusting, testing, labour, equipment, tools and other items necessary for the proper completion of the work.
16. The payment shall be done for the following stages
 - a) Materials on Site 50 % of rate of bill of quantities
 - b) Completion of Installation 50 % of rate of bill of quantities

6.2.7 Items in the Bill of Quantities

Item No. 6.2 Stay Cables (per tone)

6.3 FAIRING (WIND INDUCED OSCILLATION DAMPERS)

6.3.1. Description.

- 1 This work consists of supplying, installation, equipment and materials required for sheet metal fairings to reduce vortex induced oscillation of the cable-stayed bridge structure.

6.3.2. Materials.

- 2 Steel shall conform to the requirement of Clause 6.0.

6.3.3. Construction Requirements.

- 3 Install the fairing according to the manufacturer's instructions. Exercise care in the use of drift pins and pry bars to prevent damage to the structural plate and its coating. The fairings shall have proper fit-up.
- 4 Erection shall be conducted in corporate with deck girder.

6.3.4. Method of Measurement.

- 4 The approved work shall be measured by the linear metre installed.

6.3.6. Basis of Payment.

- 5 The accepted quantities, measured as provided above, will be not paid separately for the Fairings in the Bill of Quantities, which rate shall be included in the items of Structural Steel.

6.4 Bridge Handrails

6.4.1 Description

1. This work shall consist of supplying, fabricating and fixing metal bridge posts and rails.

6.4.2 Materials

2. Steel shall conform to the requirements of Clause 6.0.
3. The anchorage system shall be as shown on the Drawings or of a type approved by the Engineer.

6.4.3 Construction Requirements

4. Fabrication and finishing of steelworks shall be in accordance with Clause 6.0. The rails and posts of the parapet shall be of closed section presenting no visible seam welds or exposed bolt heads. The shape and finish of the posts and rails and the protective treatment to be applied shall be as shown on the Drawings.
5. Post and Guardrail shall be galvanized. The coating weight per unit area of the surface shall be not less than 460 g/m^2 .
6. An arc shall not be struck on parts of the work other than the fusion faces to be welded.
7. If instructed by the Engineer, selected welds shall be tested by a nondestructive method. A weld or part of a weld shall not be repaired more than once.
8. After guardrails are put in place, they shall be securely held in their correct positions until connections and fastenings are complete and the post fixings have gained sufficient strength.

6.4.4 Method of Measurement

9. The approved work shall be measured by the linear metre installed.

6.4.5 Basis of Payment

10. The amount of completed and accepted work will be paid at the unit rate for 'Bridge guardrails' in the Bill of Quantities, which rate shall include for supplying all materials, fixing, fabricating, labour, equipment, tools, supplies and other items necessary for the completion of the work.

6.4.6 Items in the Bill of Quantities

Item No. 6.4.1 bridge guardrails (m)

6.5 BRIDGE LOAD TESTING

6.5.1 General

- 1 The bridge shall be load tested to verify the predicted deflections of deck induced in the structure under the critical design live load and natural vibration of deck. The theoretical predictions for dead loads plus critical live load shall be determined for reference purposes. The necessary location for testing are as follows :

	Central Section	West Bank section	East Bank Section
On Steel Bridge	1	-	-
On PSC Bridge	-	1	1

6.5.2 Loading

- 2 The bridge shall be loaded with the critical design traffic loading (intensity of about 25% or more) as ascertained from design. For the purpose of actual loading, equivalent truck loading inducing the same effects (deflections) shall be determined and used in the test.

6.5.3 Scope and procedure

- 3 The deck stresses and deflections at several points shall be measured under the truck loading.
- 4 The contractor shall submit for the Engineer's approval, a detailed method statement for the test showing loading to be used in the test, sections to be monitored, measurements to be taken and equipment to be used in the test.
- 5 Testing shall not be carried out until written approval has been given. Testing shall only be carried out under the full supervision of the Engineer.

6.5.4 Basis of Payment

- 6 The cost for the loading test shall be paid by the rate described in the Bill of Quantities, and the cost shall be included in all the relevant items of testing.

6.5.5 Pay Item

Item No. 6.5

Loading Test on Bridge (LS)

6.6 Paint for Steel works

6.6.1 Description

1. This work shall consist of preparation of surfaces and the application of paint to steel bridge surfaces in accordance with these specifications and applicable Drawings.

6.6.2 Materials

2. The coating system and paints to be applied shall consist of a system defined by Tables 6.4 and 6.5, as specified. BS Standard does not cover the specification for Paint 2 to Paint 7, and SSPC is specified which are widely referenced and accepted throughout the industry. The Contractor shall get approval from the Engineer about the materials prior to the work.

Table 6.4: Paints for Steel work

Reference No.	Paint type	Minimum dry film thickness (μm)
1	Inorganic Zinc primer BS 4652, Type 3	75
2	Epoxy intermediate coat SSPC-22 or equivalent	50
3	Vinyl wash primer USM DoD-P15328D or equivalent	8 *
4	Epoxy top coat SSPC-22 or equivalent	50
5	Vinyl top coat SSPC-Paint 9 or equivalent	50
6	Oil/Alkyd primer SSPC-Paint 25 or equivalent	50
7	Oil/Alkyd top coat SSPC-Paint 104 or equivalent	50

* Maximum dry film thickness 13 mm

Table 6.5: Paint Systems for Steel work

Coat	New Steel work	Maintenance painting	
	A	B	C
Primer	Paint 1	Paint 1	Paint 6
Intermediate	Paint 2	Paint 3	Paint 6
Top	Paint 4	Paint 5	Paint 7
Total system minimum dry film thickness (μm)	175	135	150

6.6.3 Construction Requirements

Blast Cleaning

3. Exposed surfaces of new structural steel, except galvanized surfaces, shall be cleaned by blast cleaning in accordance with SSPC-SP-10.
4. Abrasives used for blast cleaning shall be either clean dry sand, mineral grit, steel shot or steel grit with a suitable grading.
5. Blast cleaning shall leave surfaces with a dense and uniform anchor pattern 25-75 μm deep as measured with an approved surface profile comparator.
6. Surfaces shall be primed or treated the same day blast cleaning is done. If cleaned surfaces rust or are contaminated with foreign material before painting is completed, they shall be re-cleaned by blasting.

Steam Cleaning

7. Dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted or galvanized surfaces shall be removed by steam cleaning before other phases of cleaning. Paint which loses its bond with the preceding coat as a result of steam cleaning shall be removed to sound paint or metal surface.

8. A biodegradable detergent shall be added to the feed water of the steam generator or applied to the surface to be cleaned. Residue, detergent, and other foreign material on cleaned surfaces shall be removed by flushing with fresh water.
9. Steam cleaning shall be carried out not more than 2 weeks before painting or other phases of cleaning. Subsequent painting shall be carried out after the cleaned surfaces are thoroughly dry and not less than 24 hours after flushing.

Solvent Cleaning

10. Solvents shall be used to remove oil, grease, and other soluble contaminants in accordance with SSPC-SP1. Solvent cleaning shall be carried out prior to blast cleaning. If contamination remains after blasting, the area shall be recleaned with solvent.

Hand Cleaning

11. Hand or powered wire brushes, hand scraping tools, power grinders, or sandpaper shall be used to remove dirt, rust and mill scale, or paint which is not firmly bonded to the metal surfaces.

Application of Paint - General

12. The Contractor shall provide protection of pedestrian or vehicular traffic upon, underneath or near the work, and other parts of the structure against disfigurement by splashes.
13. Whether by hand or spray method, the coating of paint applied shall be smooth and spread uniformly so that no excess paint collects at any point.
14. Paint shall not be applied upon damp surfaces or when the humidity exceeds 85%. Painting in the open air shall not be done when the atmospheric temperature is less than 5 °C or above 40 °C or the surface has absorbed sufficient heat to cause the paint to blister, to produce a porous film or to cause separation of the vehicle and pigment.

15. Each application of paint shall be thoroughly cured and any skips, holidays, thin areas, or other deficiencies corrected before the succeeding application.
16. Paints shall be formulated ready for application and no thinning will be allowed unless agreed by the Engineer.
17. Brushes shall have sufficient body and length of bristle to spread the paint in a uniform film. Round, oval or flat brushes not wider than 115 mm shall be used. On surfaces that are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers, bottle brushes, or other means approved by the Engineer.
18. Rollers shall be of a type that does not leave a stippled texture in the paint film. They shall be used only on flat, even surfaces.
19. Paint may be applied with airless or conventional spray equipment. Traps or separators shall be installed in the airline to the spray pot to exclude oil and water from the air.
20. If the spray method produces excessive paint buildup, runs, sags, thin areas, skips or holidays, the Engineer may require modification of the spray method or prohibit its use.
21. Prior to application, paint shall be mixed by mechanical mixers a sufficient length of time to thoroughly blend the pigment and vehicle together. The paint shall be kept thoroughly mixed during application.
22. The dry film thickness of the paint will be measured with a calibrated magnetic film thickness gauge according to SSPC-PA 2. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.
23. Structures shall be blast cleaned and painted with the required thickness of primer and intermediate coats before erection. After erection and before applying subsequent coats, areas where paint has been damaged or has deteriorated, and exposed unpainted surfaces, shall be thoroughly cleaned and spot painted to the required thickness. Surfaces exposed to the atmosphere and which would be

inaccessible for painting after erection shall be painted with the full paint system prior to erection.

24. Two additional stripe coats of paint shall be given to welds, fasteners and external corners except those of rectangular hollow sections. The first stripe coat shall be applied before the intermediate coat, and the second before the top coat.
25. If necessary the required thickness of each coat shall be achieved by more than one application.
26. Surfaces of metal to be in contact when assembled shall be painted with the shop coats unless they form part of a connection using high strength friction grip bolts, in which case the primer applied to the parent material shall be taken 10 - 15 mm inside the perimeter of the joints. The outer surfaces and edges of site joint material may, at the option of the Contractor, also be given a coat of primer. The thickness of primer applied to the outside of site joint material before assembly of an HSFG bolted joint shall not exceed 20µm dry film thickness.
27. Surfaces that will have concrete cast against them shall be left unpainted. The treatment to surrounding areas shall extend into such surfaces by at least 25 mm.
28. At points of variation in the treatment, e.g. bolted connections, the additional shop coats on adjacent areas shall be successively stepped back a minimum of 50 mm each all round to permit adequate lapping and avoid an unsightly appearance of future site coats.
29. No succeeding coat shall be applied until the previous coat has dried through the full thickness of the paint film. After application of the final shop coat the paint shall be allowed to cure for at least 24 hours before exposure to external weather conditions.
30. The necessary precautions shall be taken to prevent dust and dirt from coming in contact with freshly painted or cleaned surfaces before more paint is applied.

Application of Vinyl Wash Primer

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31. Vinyl wash primer shall be applied within 12 hours of application of the succeeding coat of paint. It shall be applied by spraying to produce a uniform wet film on the surface.

Application of Zinc-Rich Primers

32. Zinc-rich primers shall be applied by spray methods, unless the area is inaccessible to spray application. Before spraying the primer shall be strained through a metal 30-60 mesh screen.
33. An agitating spray pot shall be used. The agitator shall reach to within 50 mm of the bottom of the spray pot and shall operate continuously during application. The atomization pressure shall be sufficient to produce a uniform coating. The hose from pot to nozzle shall not be more than 25m long, nor be used more than 5m above or below the pot.
34. Succeeding coats of inorganic zinc paints shall be applied not less than 30 minutes nor more than 24 hours after the previous coat.
35. If mud-cracking occurs it shall be blast cleaned back to soundly bonded paint, and recoated to the same thickness by the same application method.
36. Zinc rich primer shall be cured for at least 48 hours before the application of vinyl wash primer. If more than 21 days elapse or there is evidence of dust, dirt, salt, or other deleterious deposits on the inorganic zinc paint, the surface shall be hosed down with water and allowed to dry before the application of vinyl wash primer.

Painting Galvanized Surfaces

37. Galvanized surfaces to be painted shall be cleaned with mineral spirit solvent to remove any oil, grease, or other foreign materials. Vinyl wash primer shall then be applied, followed by the number of coats as shown on the Drawings.

6.6.4 Method of Measurement

38. The painting of new structures, miscellaneous metal fabrications and piling will

not be measured separately, but will be considered subsidiary to other items in the Bill of Quantities.

6.6.5 Basis of Payment

No separate payment.

7.0 INCIDENTAL BRIDGE WORKS

7.1	Bridge Bearings	1
7.2	Bridge Expansion Joints	14
7.3	Joint Seals and Fillers	18

7.1 BRIDGE BEARINGS

7.1.1 Construction

Unless otherwise described in the Contract bridge bearings shall be supplied and installed in compliance with:-

- (a) The Specification Clauses of BS 5400 Part 9, Section 9.2 including Appendix "A" and tables therein, all as amended by Clause 7.1.3, and
- (b) The requirements including any design requirements, contained in the Bridge Bearing Schedule shown on the approved Working Drawings.

7.1.2 Surface Preparation and Protection Against Corrosion

Except as stated herein, the surface preparation and corrosion protection of bearings shall comply with the relevant clauses in Section of Steel work.

The Contractor shall propose the corrosion protection system for components of bridge bearings, full details of which shall be submitted for the approval the Engineer.

The Warranties and Guarantees described in **Clause 11.12 of BS 5400** , **section 9.2** shall apply also to protective treatment for bridge bearing components.

7.1.3 Amendments and Additions to BS 5400 : Part 9 : Section 9.2

Page 2 Table 1
Against "steel Sections" delete "BS 1775" and insert "BS 6323"
Against "steel Sections" delete "316S16" and insert "316S31"
Clause 3.6.1
Paragraph 1, line 5, delete "grade A of BS 3784 : 1973"
and insert "grade A1 of BS 6564 : Part 2".

Page 6 Clause 6.1
Delete entire sub-clause and insert the following:-

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“Aluminium alloy components. Permanently exposed surfaces of aluminium alloy components shall be degreased and painted as described in the Contract. The surfaces of aluminium alloy components which will be in contact with concrete or mortars shall be treated before installation with two coats of alkali resistant bituminous paint complying with BS 3416 or similar paint approved by the Engineer.”

Clause 8.3.1

Add the following new final paragraph:-

“Bridge bearings shall be designed, detailed, and installed in a manner to facilitate inspection and replacement without disrupting traffic on the bridge.

Geometric and structural provisions shall be made to permit jacking the superstructure off the piers, and temporarily supporting it while a bearing is replaced.”

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Guidance Clauses

At the end of the first sentence add the following:-

“and shall be considered as mandatory”.

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Clauses 7.2 (b) (1)

Add the following new final paragraph:-

“The value of the partial material factor referred to in this clause shall be 1.00 for the serviceability limit state, and 1.10 for the ultimate limit state for all materials except for aluminium alloys in castings; in the latter case the partial material factor shall be 1.3”.

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Clauses 7.2 (b) (2) (i)

Quick production test. Para 3, line 9. Insert a comma and the following after “throughout”:-

“..., and all the tests shall be carried out on the same testing machine. Wherever possible the tests on a batch of bearings shall be completed within 24 hours and definitely not later than 72 hours”.

7.1.4 Bedding Mortar

7.1.4.1 General

Bedding mortar shall satisfy the following performance requirements:

- (a) It shall have a compressive strength not less than 60N/mm^2 when tested in accordance with Clauses of below :
- (b) The flow characteristics shall be such that the volume as described in the Contract is completely filled with a homogeneous material when placed within the range of ambient temperature between 10°C and 40°C or as otherwise described in the Contract.
- (c) The physical and chemical properties shall be compatible with those of all adjoining surfaces.

Bedding mortar shall at no time be subjected to a loading which will induce a compressive stress exceeding 15N/mm^2 or 0.25 of its compressive strength at the time of loading.

The compressive strength shall be confirmed by tests on mortar cubes stored under conditions that simulate the field conditions or by a method approved by the Engineer.

7.1.4.2 Materials

- (a) The maximum aggregate size in foldable bedding mortar shall not exceed one quarter of the minimum bedding thickness.
- (b) Proprietary materials shall be stored as follows:
 - (i) The materials shall be stored in a dry environment at a temperature of not less than 10°C .
 - (ii) The containers shall be damp proof, leak proof and readily emptied of their contents.
 - (iii) Containers shall be marked with the batch reference number, component identification, manufacturer's name, net weight and such warnings or precautions concerning the contents as are required.

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- (c) The material shall not be removed from the store for use in the Works until immediately prior to mixing.
- (d) Material shall not be used more than six months after the date of manufacture or any lesser period specified by the manufacturer or supplier.
- (e) The Contractor shall supply with each batch or part of a batch of the material delivered to the Site, certificates furnished by the supplier or manufacturer, unless not supplied by himself, stating the following:
 - (i) Manufacturer's name and address
 - (ii) Manufacturer's agent's name and address where applicable
 - (iii) Description of material and brand name
 - (iv) Batch reference number, size of batch, and number of containers in the delivery order
 - (v) Date of manufacture
 - (vi) The chloride ion content, expressed as a percentage by mass of the material
- (f) Calcium chloride or admixtures containing chloride salts shall not be used and the total chloride ion content shall not exceed 0.2% of the mass of cement.
- (g) Ordinary Portland Cement shall comply with BS 12.
- (h) Aggregate shall comply with Section 5 and be non-reactive with alkali in the mix.
- (i) If water for the Works is not available from a public Utility Undertaking supply, the Engineer's approval shall be obtained regarding the source of supply and manner of its use. When required by the Engineer the contractor shall arrange for tests of the water to be carried out in accordance with BS 3148. Water from the sea or tidal rivers shall not be used.

- (j) Resinous bedding mortars shall be based on thermosetting organic polymers consisting of stable fluid and/or solid components which on mixing react chemically to form a hardened solid mass. Products shall be formulated from epoxide, polyester, polyurethane or acrylic resin system or such other formulation as is approved by the Engineer.
- (k) Fillers or aggregates to be incorporated in accordance with the manufacturer's recommendations, to extend or modify the properties of the resinous composition, shall be pre-bagged, dry and factory proportioned. The addition of other fillers or aggregates shall not be permitted.

7.1.4.3 Site Mixing, Placing and Curing

- (a) Mixing placing and curing of proprietary bedding mortar shall be carried out in accordance with the manufacturer's written instructions together with the following:
 - (i) The material shall not be mixed or placed in the Works at ambient temperatures of less than 10°C. If for 24 hours before during or after placing, the ambient temperature falls below 10°C the Contractor shall maintain the temperature of the sub-strate and other adjoining surfaces at not less than 10°C for the duration of the curing period recommended by the manufacturer.
 - (ii) For cementitious mortars the water cement ratio shall not exceed 0.35. The water content shall be determined during the approval tests, and maintained with $\pm 2\%$ of the quantity approved by the Engineer in mortars placed in the Works.
 - (iii) At ambient temperatures of less than 10°C the temperature of the mixing water shall be not less than 20°C not more than 25°C.
- (b) For cementitious bedding mortars, the sub-strate shall be flushed clean two hours before placing and maintained wet until placing commences. Any free standing water on the surface of the sub-strate shall be removed before placing the mortar. The underside of the bearing shall be clean and free from loose rust and loose mill scale at the time of bedding.

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- (i) Immediately after casting the mortar shall be protected to prevent evaporation for at least three days.
 - (ii) The mortar shall be placed in its final position within 20 minutes of its discharge from the mixer.
- (c) For resinous bedding mortars, the sub-strate shall be removed before placing the mortar.
- (i) The mortar shall be placed in its final position within one hour, or lesser period specified by the manufacturer, from its time of discharge from the mixer.
 - (ii) Only full packs of mortar or sub-packs as presented by the supplier shall be mixed. On-site proportioning shall not be permitted.
- (d) When the mix proportions have been approved by the Engineer no variations shall be made in the manufacture, supply, mix proportions or method of mixing of the material without the consent of the Engineer.
- (e) No internal metal shims shall be allowed to remain in the hardened bedding mortar except where described in the Contract.

7.1.4.4 Laboratory Approval Tests

(a) General

Mortar shall not be used in the Works until it has been approved by the Engineer. The Contractor shall provide the Engineer with copies of the results of the following tests which shall be carried out at a laboratory approved by the Engineer.

The mortar for each flow test shall be batched in one load strictly according to the manufacturer's instructions.

(b) Flow Trough Test

- (i) The flow characteristics of the mortar shall be determined using the flow apparatus shown in Fig. 7.1.

- (ii) Tests shall be conducted at ambient temperatures of 10°C and 30°C.
 - (iii) For the test at 10°C the temperature of the flow trough and the mixer shall be 10°C, the temperature of the dry material 10°C, and the temperature of the water where required, 20°C.
 - (iv) For the test at 30°C the temperature of the flow trough, the mixer, the dry material and the water where required shall be 30°C.
 - (v) The funnel shall be fitted with a rubber bung and charged with 3 liters of mortar. On the release of the bung the mortar shall flow along the trough and the length of flow shall be measured. The mortar shall flow a minimum length of 450 mm without signs of segregation or bleeding, at both 10°C and 30°C.
 - (vi) If for cementitious mortars, the length of flow is insufficient, or signs of segregation or bleeding are evident then the water content only of the mortar may be adjusted up to a maximum of 0.35 and the procedure repeated. The mortar shall be rejected if further adjustments of the water content do not produce an acceptable result.
- (c) Flow Between Glass Plates
- (i) The flow characteristics of the mortar between glass plates shall be determined using the apparatus shown in Fig. 7.2.
 - (ii) Tests shall be conducted at ambient temperatures of 10°C and 30°C.
 - (iii) The temperature of the apparatus, dry material and water for each test shall comply Clauses 7.1.4.4.b.iii and iv.
 - (iv) The mortar shall be poured in one corner of the apparatus until the level of the mortar has reached at least 10 mm above the underside of the top plate.
 - (v) After 24 hours the top plate shall be removed and the exposed surface lightly brushed with a stiff bristle brush to remove any surface skin which may be covering voids. The bedding mortar formed shall be

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- free from significant voids, cracks and other defects, at both 10°C and 30°C.
- (vi) If for cementitious mortars, the test mortar is unsatisfactory then the water content of the mix may be adjusted up to a maximum of 0.35 and tests described in Clause 7.1.4.4.b and c repeated.
- (d) Flow tests between concrete and a rusty steel plate at 10°C ambient temperature.
- (i) The flow characteristics shall be assessed as in Clauses 7.1.4.4.c but with the top glass plate replaced by a rusty steel plate, and with the bottom glass plate replaced by a precast concrete slab, both complying with Clauses 7.1.4.3.b and c and having the same plan dimensions as the glass plates.
- (ii) The surface of the concrete slab shall be washed thoroughly with water and all traces of surface water removed.
- (iii) If for cementitious mortars a satisfactory flow is not achieved, the water content only, of the mix shall be adjusted and the tests described in Clause 7.1.4.4.b.c and d repeated. The mortar shall be rejected if further adjustments of the water content do not produce an acceptable result.
- (e) Compressive strength test for cementitious bedding mortars shall be carried out on six 100 mm cubes prepared, cast and cured at the temperatures given in Table 7.1.
- (i) The mortar used for strength tests and all subsequent testing shall have the same water content, as determined from the flow tests approved by the Engineer.
- (ii) The 100 mm cube molds shall comply with BS 1881 : Part 108. Test specimens shall be made by filling the molds carefully through a funnel to produce a void free mortar. There shall be no compaction. Specimens shall be damp cured for the first 24 hours, removed from the molds and then water cured. Curing shall comply with BS 1881 : Part 3.

- (iii) Testing shall comply with BS 1881 : Part 4.

Table 7.1 Cementitious Bedding Mortar Ambient Test Temperature of 20°C

Mixing water temperature	20°C
Mixer and mold temperature	20°C
Dry mortar material temperature	20°C
Curing temperature	20°C
Minimum 28 day compressive strength	60N/mm ²

- (f) Compressive strength tests for resinous bedding mortars shall comply with BS 6319: Part 2 and shall be carried out on six 40 mm cubes as shown in Table 7.2. The 40 mm cube molds shall comply with BS 6319 Part 1 and shall be carefully filled using a funnel to ensure void-free cubes. There shall be no compaction.

Table 7.2 Resinous Bedding Mortar Ambient Test Temperature of 20°C

Mixer and mold temperature	20°C	
Mortar material before mixing	20°C	
Curing temperature	20°C	
12 hour	Minimum Compressive Strength	30N/mm ²
24 hour	Minimum Compressive Strength	50N/mm ²
72 hour	Minimum Compressive Strength	60N/mm ²

- (g) Expansion Test

- (i) Short term expansion shall be determined by the method described in ASTM C827-82, Early volume change of cementitious mixtures. Results shall be determined from the mean of two tests.
- (ii) The expansion of cementitious bedding mortars at 24 hours shall be between 0.25% and 1.25%.
- (iii) The volume change of resinous bedding mortars at 24 hours shall be between -0.6% and +1.0%.

(h) Water Absorption Test

- (i) Absorption of water by cementitious bedding mortars shall be determined by the tests described in BS 3921. The specimens shall be prepared as follows:

Two sets of three cubes shall be made as described in Clause 7.1.4.4.e and cured at 20°C before removing from the molds at 24 hours. After removing from the mold the cubes shall be sealed in polythene bags and immersed in water at 20°C. After six days the cubes shall then be placed in an oven for a minimum of 48 hours at 110°C to dry. When cooled the dry weight of each cube shall be recorded.

One set of cubes shall be subjected to the 5 hour boiling test. The absorption shall be not greater than 8.0% measured as the mean of the three cubes.

One set of cubes shall be subjected to the 24 hour immersion in water at 20°C test. The absorption shall be not greater than 8.0% measured as the mean of the three cubes.

- (ii) Absorption of water by resinous bedding mortars shall be determined by the method described in ASTM C412. The absorption shall be not more than 0.4%.

(i) Initial Surface Absorption Test

- (i) The initial surface absorption of cementitious bedding mortars shall be determined as described in BS 1881 : Part 5.
- (ii) Tests shall be carried out on one set of three 100 mm cubes prepared as described in Clause 7.1.4.4.h.i.
- (iii) The average initial surface absorption of the three specimens shall not exceed the following:

0.30 ml(m² second) at 10 minutes

0.20 ml(m² second) at 30 minutes

0.13 ml(m² second) at 60 minutes

and the difference between the highest and lowest values for each time interval shall be not greater than 20% of the average.

- (j) Elastic stability tests for cementitious bedding mortars shall be carried out on one set of three cubes made as described in Clause 7.1.4.4.e at 20°C.
 - (i) Curing shall comply with BS 1881 : Part 3. After 28 days the cubes shall be placed in water at 20°C which is heated at a uniform rate to 45°C in 24 hours.
 - (ii) Upon attaining 45°C the cubes shall be loaded at a compressive stress of 30N/mm² maintained for 24 hours at 45° C and the strain measured.
 - (iii) The cubes shall then be unloaded for 24 hours and the cycle of loading and unloading repeated for 9 further cycles at 45°C ambient temperature and the strain measured.
 - (iv) The total compressive strain at the first loading shall not exceed 1%. The recovery of compressive strain on completion of the loading cycle shall be not less than 60%.

- (k) Elastic stability tests for resinous bedding mortars shall be carried out on one set of three 40 mm cubes complying with BS 6319 : Part 1.
 - (i) On removing the cubes from the molds after 24 hours they shall be heated at a uniform rate to 45°C in a further 24 hours.
 - (ii) Upon attaining 45°C the cubes shall be loaded at a compressive stress of 30N/mm² maintained for 24 hours at 45°C and the strain measured.
 - (iii) The cubes shall then be unloaded for 24 hours and the cycle of loading and unloading repeated for 9 further cycles at 45°C ambient temperature and the strain measured.
 - (iv) The total compressive strain at the first loading shall not exceed 1%. The recovery of compressive strain on completion of the loading cycles shall be not less than 60%.

(l) Calibration of Flow

(i) The flow of bedding mortars containing aggregates all passing a 2.36 mm sieve shall be determined by the Flow Cone Test method described in ASTM C939-81. The temperature of the dry materials, mixing water and mixer shall be 20°C. At least two tests having times of flow within $\pm 5\%$ of their average shall be made. The average time of efflux to the nearest 0.2 sec should be reported, with the test details to the Engineer.

(ii) The flow of bedding mortars containing aggregates retained on a 2.36 mm sieve shall be determined by the Cylinder Flow Test in the following manner.

A clean glass plate, 300 mm \times 300 mm is placed over a sheet of millimeter graph paper, on a horizontal, vibration-free surface.

An aluminium cylinder of 35 mm internal diameter and 50 mm long is placed vertically in the center of the glass plate and filled with mixed grout, without leakage.

The cylinder shall be raised slowly allowing the grout to flow. The flow, to the nearest mm, is the average of four equally spaced diameters of the spread grout, measured after the grout becomes stable.

The temperature of the dry materials, mixing water, mixer and test equipment shall be 20°C. The test shall be conducted within one minute of the mortar leaving the mixer.

7.1.4.5 Site Control Tests

(a) The tests listed below shall be carried out on a minimum of two samples taken from each batch of proprietary mortar material to be used in the Works.

(i) Expansion Test as detailed in Clause 7.1.4.4.g.

(ii) Calibration of Flow as detailed in Clause 7.1.4.4.1. The results of either the Flow Cone Test or the Cylinder Flow Test shall agree within $\pm 10\%$, with the values obtained in the Approval Tests.

- (b) Compressive Strength. Two sets of three cubes from each load of mortar mixed for placing in the Works shall be tested for compressive strength as described in Clause 7.1.4.4. e or f. The compressive strengths shall be not less than stated in Tables 7.1.1 or 7.1.2.

7.1.4.6 Tolerances

The following tolerances shall apply to all temperatures referred to in this clause:

10°C	(-0°C + 1°C)
15°C	(-0°C + 2°C)
20°C	(-0°C + 2°C)
35°C	(-2°C + 2°C)
45°C	(-2°C + 2°C)
110°C	(-5°C + 5°C)

Intermediate values shall be determined by linear interpolation.

The tolerances applying to all linear dimensions, unless otherwise specified shall be $\pm 1\%$.

7.1.5 Method of Measurement

8. The approved work shall be by the number of bearings installed and measured.

7.1.6 Basis of Payment

9. The amount of completed and accepted work measured as provided for above shall be paid at the rate for 'Bridge Bearings' in the Bill of Quantities which rate shall be full compensation for supplying, installing, fixing and for materials, labour, equipment, tools and other items necessary for completion of the Work.

7.1.7 Items in the Bill of Quantities

- Item No. 7.1.1 Pendrum Bearing at Main Bridge end. (Numbers)
Item No. 7.1.2 Pendrum Bearing at Auxiliary Piers. (Numbers)
Item No. 7.1.3 Vertical Rubber Bearing at Pylon. (Numbers)
Item No. 7.1.4 Horizontal Bearing at PM 1 to PM 6. (Numbers)

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Item No. 7.1.5 Horizontal Bearing at Pylon. (Numbers)

Item No. 7.1.6 Bearing (free) for Approach Bridges. (Numbers)

Item No. 7.1.7 Bearing (fixed) for Approach Bridges. (Numbers)

7.2. BRIDGE EXPANSION JOINTS

7.2.1 General

All expansion joints shall be products which have a proven successful performance record. The Contractor shall submit for the approval of the Engineer full details of the proposed joint. This shall include lists of projects in which the proposed product has been incorporated in similar structures and climatic conditions. The Contractor shall submit substantiating information on previously installed joints of the same type supporting the durability and periods free of maintenance as claimed by the manufacturer.

The design of the joint system shall facilitate inspection and replacement.

7.2.2 Materials

Materials shall comply with the following or equivalent standards as agreed with the Engineer:

- (a) Structural Steel - BS 4360
- (b) Fixings to Bridge Structure - HSFG bolts to BS 4395
- (c) PTFE - As BS 5400 Section 9.1 Section 12 for Bridge Bearings
- (d) Elastomers - As BS 5400 Section 9.1 Section 12 for Bridge Bearings
- (e) Bedding and Transition Strip Mortars - As Clause 12.4

Exposed steel plate shall have a 2 mm non-skid surface coating in accordance with the manufacturer's recommendations, details of which shall be submitted to the Engineer.

7.2.3 Protection Against Corrosion

The protective treatment to steel components shall comply generally with the requirements of Specification Section of Paint except where stated otherwise herein.

The Contractor shall propose the corrosion protection system for components of expansion joints of which shall be submitted for the approval of the Engineer.

The Warranties and Guarantees described in Clause 11.12 shall apply also to protective treatment for steel expansion joint components.

7.2.4 Installation

Joints shall be installed as approved by the Engineer by the Shop Drawings and in accordance with the manufacturer's instructions and recommendations. The joint gap and presetting to suit ambient temperature shall be as described on the approved Working Drawings.

Joints shall be of uniform and shall be accurately set, finished and aligned flush with the finished carriageway level. The joint shall be included in the measurement of carriageway surface levels. This shall be set, finished and aligned to provide a smooth ride free from tyre slap and impact loading, all to the satisfaction of the Engineer.

7.2.5 Method of Measurement

11. The approved work shall be measured by **the linear metre** of joint calculated by the length from end to end, whether or not the joint changes in section. No separate measurement shall be made for special curb units, cover plates and transition strips.

7.2.6 Basis of Payment

12. The amount of completed and accepted work measured as provided for above shall be paid at the rate for 'Bridge Expansion Joints in the Bill of Quantities which rate shall be full compensation for supplying, installing, fixing and for materials, labour, equipment, tools and other items necessary for completion of the Work.

7.2.7 Items in the Bill of Quantities

- | | |
|----------------|--|
| Item No. 7.2.1 | Finger Joints at Main Bridge End (20.8 m) (lin. M) |
| Item No. 7.2.2 | Rubber Expansion Joint (8.6m on Piers) (lin. M) |
| Item No. 7.2.3 | Rubber Expansion Joint (8.6m on Abutment) (lin. M) |

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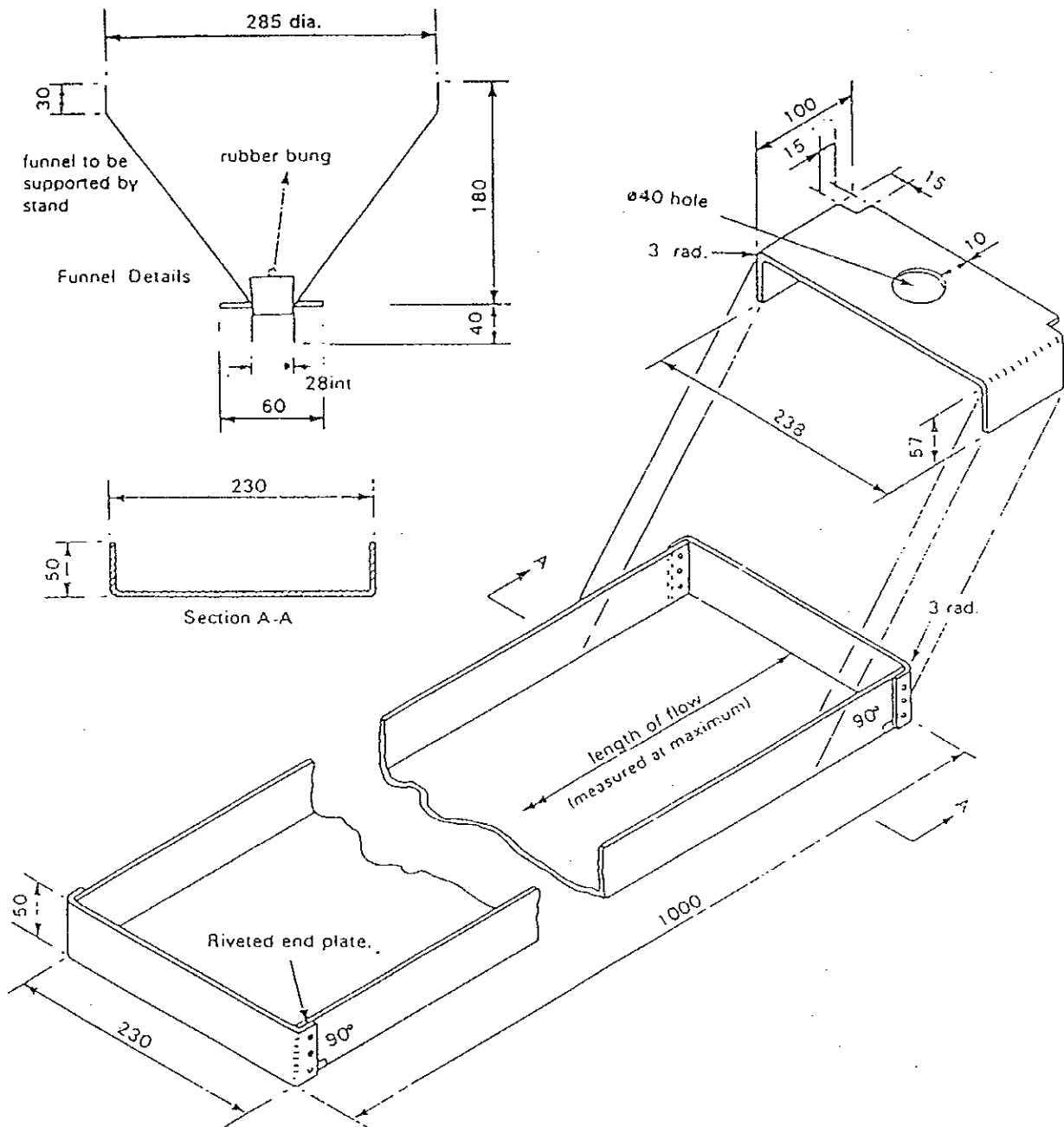


Fig 7.1 Flow Trough

NOTES:

- 1 Trough to be made of galvanised steel (14 gauge).
- 2 Trough to be horizontal while grout being poured.
- 3 Trough to be clean before start of test.
- 4 All dimensions in mm.

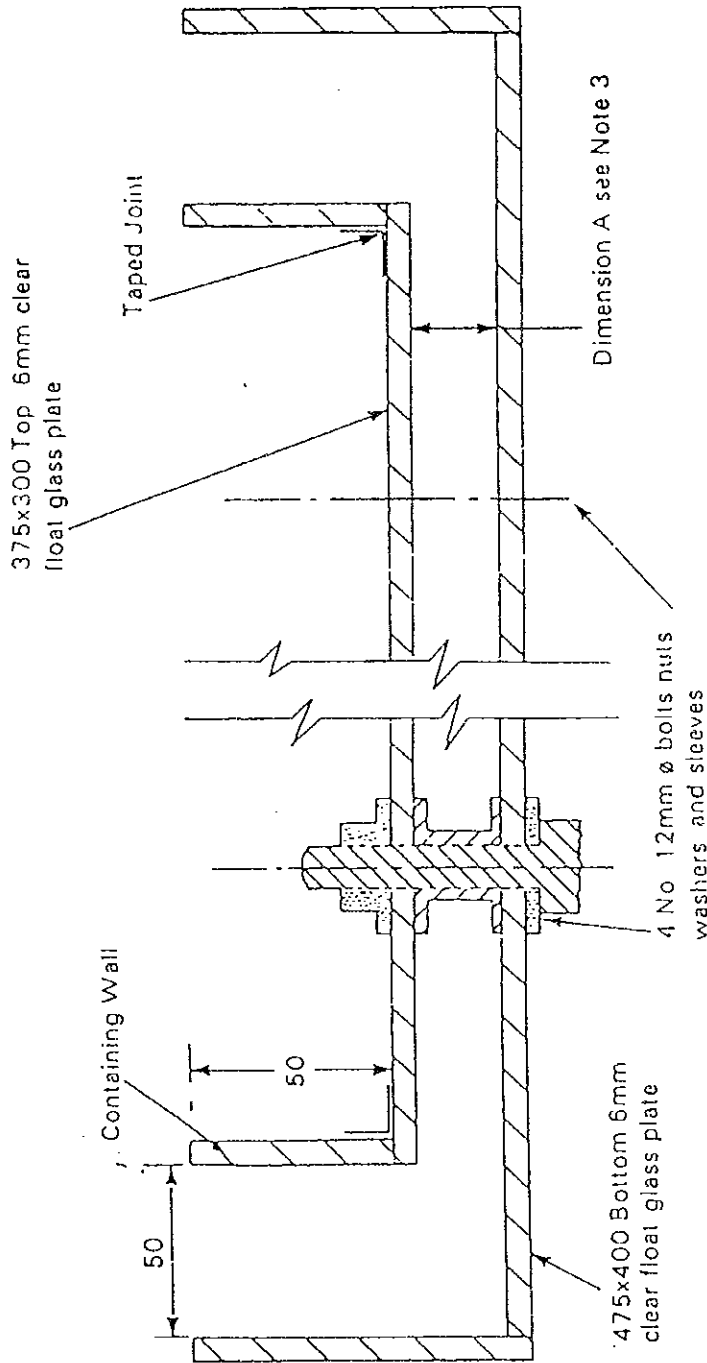


Fig 7.2 Flow Between Surfaces

NOTES:

- 1 This apparatus is to be used for the Test described in Clause 2601.4(iii).
- 2 Similar apparatus is to be used for the Test described in Clause 2601.4(iv) but with the top glass plate replaced by a rusty steel plate and the bottom glass plate replaced by a concrete slab.
- 3 Dimension A is 10 mm for grouts appropriate to plinth height 10-25 mm and 20 mm for grout appropriate to plinth height 20-50 mm.
- 4 Grout is to be mixed and poured using the Contractor's proposed site method until it reaches the underside of the top plate and has risen up the containing walls to a depth of at least 10 mm.
- 5 Plates are to be horizontal during pouring, and curing, and are not to be moved once pouring has commenced until dismantling.
- 6 All dimensions in mm.

7.3 Joint Seals and Fillers

7.3.1 Description

1. This work shall consist of supplying and installing seal and filler material for joints.

7.3.2 Materials

Sealants

2. Hot applied sealant shall comply with AASHTO M282 or a similar approved sealant.
3. Cold applied sealant shall be polysulphide based sealants complying with BS 5212. In addition to the manufacturer's certificate of compliance with BS 5212 a certificate shall be provided confirming that the 5 second reading on the Shore Hardness Scale A, as measured by a meter in accordance with BS 2719, is less than 20° for a cured sample 7 days after mixing. The difference between the Shore hardness measurement at 7 days and the measurement after the BS 5212 heat aging test shall not be more than 5°.
4. For joints in curbs and joints other than in pavements, gunning grades of 2-part polysulphide sealant complying with BS 4254 may be used.

Preformed Expansion Joint Filler

5. Preformed filler shall comply with AASHTO M213 or a similar approved specification.

Waterbars and Waterstops

6. Waterbars and Waterstops shall be approved type with eyelets.

7.3.3 Construction Requirements

7. Before installing seal and filler into the Permanent Works, the Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Guarantee for each type to be used. The certificate shall show compliance with the relevant

Standards. The Contractor shall, if instructed by the Engineer, have the joint materials tested at an approved testing laboratory.

7.3.4 Method of Measurement and Basis of Payment

8. Joint Sealing Compound and Joint Filler shall **not be separately measured** but shall be considered incidental to other items of work in the Bill of Quantities.