TABLE OF CONTENTS

SECTION TS 6. PRETENSIONED PRESTRESSED CONCRETE

SECTION TS 6. PRETENSIONED PRESTRESSED CONCRETE

6.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of precast pretensioned prestressed concrete. It shall apply wherever precast pretensioned prestressed concrete is used in the works, such as piles, as shown on the Drawings or specified in this and other Technical Specification clauses or where it is approved in writing by the Engineer to be used as an alternative form of construction.

This Section covers the pretensioning of prestressed concrete members which are subsequently incorporated in a structure. The requirements of Section TS 5, Prestressed Concrete, of this Specification relating to prestressing shall be followed.

Concrete for pretensioned prestressed members shall be in accordance with the requirements of sections TS 3 and TS 4 of the technical specification.

This section shall apply whether or not Pretensioned Prestressed Concrete units are manufactured directly by the Contractor or a specialist reputable manufacturer approved by the Engineer. Where Pretensioned Prestressed Concrete units are obtained from an approved specialist manufacturer the Engineer may, at his sole discretion, waive the need for the Contractor to submit detailed manufacturing plans and calculations.

6.2 STRESSING BED

The abutments and bed for the tensioning of tendons shall be designed to withstand the total tensioning force shown on the Drawings.

The bed shall be constructed to withstand the concentrated loads resulting from the application of the prestress and support the total dead load.

A notice shall be displayed adjacent to the stressing bed showing the maximum tensioning force allowed, the upper limit of the force and the Standards used in the design of the bed. Calculations shall be made available when requested by the Engineer.

6.3 ANCHORAGES

The anchorages, consisting of barrel and wedges or any other devices, shall be as shown on the Drawings and such as to prevent slip occurring during the casting or curing operations.

6.4 PLACING OF TENDONS

The tendons shall be located accurately in the positions shown on the Drawings and suitable devices shall be provided to ensure that the correct positioning of the tendons is maintained during casting.

When tendons are being placed, particular care shall be taken to ensure that the tendons do not come into contact with the oiled surface of the forms or other deleterious substances. Any deleterious material which might collect on the tendons shall be removed by cleaning with a suitable solvent or by other suitable methods.

6.5 COVER

Unless shown otherwise on the Drawings, the cover of concrete to the surface of any tendon for a unit which will be situated in air shall not be less than twice the diameter of the tendon or 25 mm, whichever is the greater. The above minimum cover shall be increased by 13 mm for units which will be situated in earth or water or over salt water, and by 25 mm for units which will be in salt water.

6.6 TENSIONING FORCE

Unless otherwise stated on the Drawings, the force required is the force remaining in the tendons at the middle of each unit immediately after all tendons have been anchored to the abutments of the stressing bed and are in their final deflected position. The allowable variation of this force from its required value shall be 5 percent. The jacking force applied shall allow for any anticipated slip at the anchorage devices, wedge draw-in, and friction losses.

The method of tensioning tendons including the arrangement and layout of each line, calculation of forces at anchorages and all deflection points, and estimated friction losses, shall be submitted to the Engineer for his consent before manufacture of members commences.

The Contractor shall carry out trial stressing operations to establish the frictional resistance offered by the hold-downs and also to confirm that the stated wedge draw-in is consistent with the type of jack and operator technique proposed.

Tendons shall be deflected, where shown on the Drawings, with devices strong enough to hold the tendons firmly in their positions, especially during concreting and vibrating operations. Unless otherwise directed by the Engineer hold-downs shall be located longitudinally within 200 mm and vertically within 5 mm of the locations shown on the Drawings.

Hold-downs shall be designed such that the deflector in contact with the strand shall have a diameter of not less than the tendon diameter or 15 mm whichever is the greater. The deflector shall be constructed from material no harder than AASHTO M 183 (ASTM A 36) grade the steel.

The Contractor shall submit calculations showing that the hold-downs have been designed and constructed to withstand concentrated loads resulting from the application of the tensioning force.

The method of tensioning shall ensure that the required force is produced in all tendons at the middle of all units, especially where more than one tendon or one unit is tensioned in the one operation.

The tensioning force shall be measured in accordance with the requirements of Section TS 5 of this Specification.

Concrete shall not be cast later than 12 hours after tensioning. Should this time be exceeded, the Contractor shall check that the required tendon force has been maintained. Should re-stressing be required, tendon extensions shall be maintained by the use of shims and without disturbing the bedded wedges.

6.7 DEBONDING

Where ducting of pretensioned tendons is required to prevent bond over a specified length, it shall consist of plastic tubing or other material consented to by the Engineer of a quality, diameter and thickness such that bond shall be effectively prevented. This ducting shall be fastened to the tendon in such a manner that the cement mortar cannot enter. The Engineer may order that the pull-in of the tendon be measured during the transfer of prestress.

6.8 TENSIONING PROCEDURE

The tensioning operation shall performed only by personnel trained and experienced in this type of work.

The tensioning force shall be applied and released at a uniform rate.

In order to remove slack and no lift tendons off the bed floor an initial force consented to by the Engineer shall be applied to the tendons. Allowance shall be made for this force in calculating the required elongation.

Tendons shall be marked for measurement of elongation after the initial force has been applied. When required by the Engineer tendons shall be marked at both the jacking end and dead end of the stressing bed and at coupler (if used) so that slip and draw-in may be measured.

Should slip occur in any one of a group of tendons tensioned together, the tensioning of the whole group shall be relaxed, the tendons re-set, and the whole group tensioned again. Alternatively, if not more than two tendons have slipped the tensioning of the group may be completed with such tendons being subsequently tensioned.

The pressing force shall be transferred from the tensioning jack to the abutment of the stressing bed immediately the required force (or elongation) has been reached in the tendons, and the pressure in the jack shall be relaxed before any other operation is commenced.

Where deflected strands have been specified the Engineer may direct that elongation or strain gauge measurements be taken at various positions along the tendon to determine the force in the tendon at those positions.

6.9 TENDON FAILURE

Should any tendon for any unit fail before the concrete has been placed the tendon shall be replaced.

Should any tendon for any unit fail after the concrete has been placed the unit may be rejected by the Engineer.

6.10 TRANSFER OF PRESTRESS

Transfer of prestress shall not proceed until the Engineer has consented to the proposed method. Tendons and deflecting devices shall be released in such a pre-determined order that unacceptable tensile stresses are not induced in the concrete.

The prestressing tendons shall not be released before the concrete has reached the minimum strength required for transfer for the prestressing force as stated on the Drawings.

Prior to transfer of the force to the units, all tendons shall be tested for tightness and any loose tendons shall be reported to the Engineer who will decided whether the units affected shall be rejected.

All tendons shall be marked at each ends of every unit to allow measurement of the pull-in to the concrete.

The procedure of release shall be continuous, and shall be performed in the shortest practicable time without interruption. The prestress shall be transferred to the units in such a manner the tendons are released gradually and, preferably simultaneously. Under no circumstances shall tendons to be cut while tension.

The Contractor shall submit to the Engineer details of his proposed method to transfer of progress consent will give to proceed with the work. Subject to the consent of the Engineer, tendons may be released by applying heat, in which case the following conditions shall apply:

- The Contractor shall submit to the Engineer details of his method of transfer of prestress including the lengths of free tendons between units, the lengths of free tendons at both ends of the bed, the location where the heat will be applied, the order of severance of tendons and of release of devices for deflecting tendons, the method of applying heat and the equipment he propose to use.
- The heat shall be applied over a length of tendon and for a period of time sufficient to ensure that the tendon so treated is entirely relaxed before severing. Concrete shall not be heated excessively, and heat shall not be applied directly to any part of any tendon within 100 mm of the concrete surface of the units.
- The Engineer or his representative shall be present on every occasion of releasing tendons by heat. After the prestress has been transferred to the units, the tendons between the units shall be severed working along the fine from the point of release.

On completion of the transfer of prestress the projecting lengths of tendon shall be cut off flush with the end surface of the unit by means of mechanical cutter. Every effort shall be made to avoid damage to the concrete.

6.11 PERMISSIBLE PULL-IN OF TENDONS

The maximum pull-in of any tendon shall not exceed 6 mm, at any end, unless specified otherwise on the Drawings.

Tendon pull-in shall be measured and the tensioning force adjusted to allow for this effect.

Units with a pull-in excess of the value specified may be rejected.

6.12 SOLE PLATES AND BEARING RETAINERS

This clause is not applicable to this contract.

6.13 PROTECTION OF ENDS

The exposed ends of the tendons and the correct surfaces of the ends of the units shall be wire brushed clean of all rust, loose mortar, grease and dirt.

The exposed ends of the tendons and the concrete surface within 50 mm of the tendons shall be then abraded to provide a clean sound surface. Unless otherwise directed by the Engineer an epoxy tar paint suitably formulated to give a dry film thickness of 0.15 mm per coat, shall then be immediately applied over the ends of the tendons.

A second coat of paint shall be applied prior to the drying out of the first coat.

After completion of the unit the tendon holddowns shall be protected from corrosion by patching the tapped hole in accordance with the requirements of Section TS 3 of this Specification. Patching shall be finished flush with the soffit of the unit.

6.14 PAYMENT

Measurement and Payment for Pretensioned Prestressed Concrete will not be made exclusively and all costs incurred by the Contractor in complying with the requirement of this clause shall be deemed to be included in the lump sums or rates entered in the priced Bill of Quantities for works which incorporate the requirements of Pretensioned Prestressed Concrete. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

Pretensioned precast concrete members will be paid for in accordance with payment clauses elsewhere in this Technical Specification and no separate payment will be made for the furnishing of prestressing materials or the prestressing of precast members.

SECTION TS 7. Deleted

TABLE OF CONTENTS

SECTION TS 8. HANDLING AND ERECTION OF PRECAST CONCRETE UNITS

SECTION TS 8. HANDLING AND ERECTION OF PRECAST CONCRETE UNITS

8.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of handling and erection of precast concrete units. It shall apply wherever handling and erection of precast concrete units is required within the works, such as pipes and Precast Prestressed Beams (except piles), or specified in this and other Technical Specification clauses.

The section covers the handling, transport from the site storage area and erection of precast concrete units previously manufactured and placed in temporary site storage area in accordance with the requirements of Section TS 4 of this Specification.

The supply and replacement of concrete is covered in Section TS 3 of this Specification.

The design, erection and removal of falsework is covered in Section TS 10 of this Specification.

The Contractor shall be responsible for the care of the units while in the storage area and for the maintenance of supports, storage areas, access tracks and drains.

8.2 HANDLING

Handling of precast concrete units shall be in accordance with the requirements of Section TS 4 of this Specification except as modified below.

8.3 SECURING DEVICES, ANCHOR POINTS AND BEARING

The Contractor shall ensure that lashings of chain or wire rope, bearings, lateral bracing and other fittings will not cause spalling or damage to units at contact surfaces.

A minimum of two anchor points per side at each support shall be provided. Bearings or supports shall have low compressive deflection and shall provide adequate frictional restraint to movement of the units. They shall allow for longitudinal rotation of the unit in transport and have adequate width and bearing capacity.

8.4 TRANSPORT OF PRECAST CONCRETE UNITS

Transport of precast concrete units shall be in accordance with the requirements of Section TS 4 of this Specification except as modified below.

During transport of beam units from the storage area to the bridge, the Contractor shall provide end bracing and, if necessary, top flange bracing as consented to by the Engineer or as shown on the Drawings.

For units which are support on a prime mover and a steerable bogie, the prime mover turntable shall have a low coefficient of friction to prevent damage to units. Where the turntable and springing of prime mover does not provide satisfactory rotation requirements, special bearings may be required to support beams during transport.

Beams shall not be handled when wind velocities exceed 30 km/hr. No beam shall be transported from the storage to the bridge and erected if has a bow in excess of 1 in 400 of the length. The bow shall be measured when the beam is on the transporter and before delivery is begun. A beam with a bow greater than 1 in 400 of the length may have approved devices fitted to reduce the bow to an amount acceptable to the Engineer. The bow of each beam shall be continuously observed during the journey by means of a string line or other approved equipment. Should the bow at any time exceed 75 mm the transporter shall be stopped and steps taken to ensure the safety of the unit before the journey is continued.

8.5 TRANSPORTER TIME RESTRICTIONS

The Contractor shall satisfy himself as to conditions of permits that will apply, and make due allowance in his Bid for transport time restrictions.

8.6 WEATHER AND ACCESS CONDITIONS

When in the opinion of the Engineer, conditions at the bridge site, in storage areas or access roadways are considered to be unsafe for satisfactory transport of units, delivery or handling of units shall be postponed until such times that weather conditions and access are considered by the Engineer to be satisfactory. The Contractor will not be entitled to claim for any financial loss due to adverse weather conditions which prevent the units being delivered to the specified point of delivery.

8.7 DAMAGE TO UNITS

If any unit which has been approved in accordance with the provisions of Section TS 4 of this Specification sustains damage such as cracking, spalling or deformation of projecting reinforcement, the unit shall be set aside it has been inspected by the Engineer.

The Engineer will decide the units is to be rejected and removed form the site, or repaired by the Contractor.

If a unit is to be repaired, the Contractor shall submit for approval details of the materials to be used and method to be adopted in effecting the repair. Repairs shall be carried out in accordance with the requirements of Section TS 9 of this Specification. Repairs to damaged units or the removal from site and replacement of rejected units shall be at the expense of the Contractor.

8.8 ERECTION OF PRECAST CONCRETE UNITS

8.8.1 General

At least four weeks prior to the proposed date of erection precast concrete units the Contractor shall submit to the Engineer for his consent details of his transport and erection methods and the equipment proposed to be used for these operations.

The Contractor shall not commence transport and erection of any concrete units until the Engineer's consent has been received to the methods proposed.

Precast units shall not normally be placed in position less than 14 days after casting supporting structures. Where an earlier placing the time is requested

by the Contractor, two additional concrete test specimens shall be prepared when casting the supporting structure, cured and tested. The average compressive strength of the two specimens shall be not less than the specified Characteristics Minimum Compressive Strength at 28 days and the compressive strength of either specimen shall be not less than 90% of the specified Characteristic Minimum Compressive Strength at 28 days for the supporting structure as shown on the Drawings. Where fixed bearings are specified beams shall not be placed until at least 4 days after fixing the dowels.

Erection operations shall be carried out using only experienced crane operators and cranes which are of a capacity sufficient for the proposed lifting operations.

Where directed by the Engineer the Contractor shall carry out a load test to demonstrate that the crane proposed to be used is stable against overturning when operating at the required radius with a load equal to that of the concrete unit to be lifted.

The crane will be deemed to have passed the test if all outriggers remain firm on the ground when the load is positioned one metre in excess of the proposed maximum working radius.

8.8.2 Erection of Precast Concrete Beams

Concrete beams shall be erected as shown on the Drawings.

Care shall be taken that concrete units scupper openings or with one end constructed differently from the other correctly positioned in the structure.

Beams shall be placed so that anchor dowels at fixed bearings are bearings engaged in the holes provided in the sole plates of beams.

Except as indicated below, beams to be supported on bearings shall be placed only when the temperature of the concrete is less than 30 degrees, as determined by the Engineer. Subject to the Engineer's approval, beams may be placed in position when the temperature is outside the above limit, provided the bearings are pre-test to compensate for the difference between the length of the beam at 27 degrees Celsius and the actual length at temperature occurring during erection.

Similar pre-setting of the bearings may be required to compensate for shortening of the concrete beams due to creep, elastic movement, or other causes, if this requirement is shown on the Drawings or called for in the Special Specifications.

The bearing seatings on the substructure shall be specially prepared to the correct form, dimensions levels and/or slope so that the bearings when lowered into position make full and even contact over their full bearing area, both against the beams and against the contact surface of the substructure, without causing any uneven compression of the bearing.

Where pre-setting of the bearing is required to compensate of the concrete beams due to variations in temperature or other causes, the specially prepared surface shall make allowance for this distortion.

When beams are being placed in position, they shall be braced independently against overturning, before being released by the crane or other lifting device.

Concrete shall not be placed in the deck until all tests of the bridge beams have been completed satisfactorily, and the beams have been accepted by the Engineer.

When bridge beams are in place within one span, permanent formwork (if used) shall be placed close together on a thin bed of cement mortar.

Unless otherwise consented to by the Engineer, formwork shall be supported by the bridge beams, except that the formwork for the end cross girders may be supported by the substructure.

8.9 MEASUREMENT AND PAYMENT

Measurement and Payment for Handling and Erection of Precast Concrete Units will not be made exclusively and all costs incurred by the Contractor in complying with the requirement of this clause shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities for works which incorporate the requirements of Handling and Erection of Precast Concrete Units. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs and, in particular, shall be deemed to include, but not be limited to, the following:

1) equipment and work involved in the loading onto transport, handling, placing and fixing the units in position and no separate payment will be made for any of these.

TABLE OF CONTENTS

SECTION TS 9. CONCRETE REPAIRS

SECTION TS 9. CONCRETE REPAIRS

9.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of concrete repairs. It shall apply wherever concrete repairs are required within the Works or specified in this and other Technical Specification clauses.

This section covers the repairs of concrete as shown on the Drawings or ordered by the Engineer. The supply and placing of concrete and reinforcement and the supply and use of epoxy resins are covered in Sections TS 3 and 12 respectively of this Specification excepted as modified below.

9.2 IDENTIFICATION OF DEFECTS

The defects to be repaired shall be as shown on the Drawings or as directed by the Engineer. The extent of the areas to be repaired shall be subject to the decision of the Engineer who may direct that additional concrete be removed to allow assessment of the defect to be made. In addition the Engineer may direct that the defect be exposed or further exposed prior to giving consent to the method of repair.

9.3 REPLACEMENT OF CONCRETE

9.3.1 Removal of Concrete

Where shown on the Drawings or ordered by the Engineer areas where concrete is to be replaced shall have the existing concrete to the limits assigned by the Engineer.

The Contractor shall submit details of the proposed of removal of the concrete to the Engineer for his consent prior to commencement of any removal operations.

Where concrete is to be removed from a load bearing structure the Contractor shall submit for the consent of the Engineer details of his proposed method of support of the structure.

The area to be removed shall be marked with saw cuts 20 mm deep, cut on straight lines. Corners shall be rounded to obtain good contact between the existing concrete and the new material. Edges shall be undercut to eliminate feather edges and to provide a keyed joint. Where the extent of the area to be removed is not known beforehand the Engineer may consent to the use of a jackhammer to mark the edge. The type and weight of hammer and the type of pint on the tool to be used shall be subject to the consent of the Engineer.

The Contractor shall ensure that the reinforcement is not damaged during the concrete removal process. Any reinforcement damaged by the Contractor shall be repaired at the Contractor's expense in a manner as directed by the Engineer.

After removal of concrete the area shall be flushed with high pressure water or other approved method to remove loose materials and dust. Air blowing may be used if the compressor is lifted with a functioning oil trap.

9.3.2 Reinforcement

Where more than the perimeter of a reinforcement bar is exposed concrete shall be removed to a minimum of one and one half bar diameters beyond the bar. Loose scaly rust on the reinforcement shall be removed. Tightly adhering mortar, if sound, may be left on the steel.

Where the Engineer so directs the surface of the reinforcement shall be prepared to Class SA 2 ½ in accordance with AS 1627 "Metal Finishing – Preparation and Pre-treatment of Surfaces" or equivalent standard. This shall be carried out using water blasting.

Where replacement of reinforcement is required due to corrosion or other causes new bars may be added by splicing onto the walked bars, by welding new bars to the existing with full strength welds or by additional bars into holes drilled into concrete. The Engineer shall direct which method, if any, of the above is to be adopted.

Coating of reinforcement shall only be carried out if ordered by the Engineer.

9.3.3 Concrete

Prior to replacement of concrete the existing concrete surface shall be treated as directed by the Engineer. This treatment may consist of saturating the existing concrete and/or coating the existing concrete with a bonding agent.

The concrete may be replaced with either a Portland cement concrete or an epoxy concrete as directed by the Engineer.

Replacement of concrete, including formwork, placing and curing shall be in accordance with the requirements of Section TS 3 and TS 12 of this Specification except as modified below.

Details of the mix design for concrete intended for use in repair work to be carried out in accordance with this Section shall be submitted to the Engineer at least six (6) weeks before concrete work is to commence.

The mix shall have a minimum cement content of 410 kg/cm^3 and a maximum water cement ratio of 0.40. Where directed by the Engineer a mixture of 65 % Portland cement and 35 % silica fume shall be used for the cement. The maximum aggregate size shall be 10 mm.

No concrete shall be placed until the excavated area has been inspected by the Engineer and his consent obtained in writing.

9.4 REPAIRS TO CONCRETE

9.4.1 Non-Injection Repair

This clause covers the repairs of cracks which are wider than 0.1 mm and which are clean or are capable of being cleaned.

Where shown on the Drawings or ordered by the Engineer repairs shall be carried out by "V" ing the crack to a width of 5 mm at the surface.

Where the cracks are in horizontal surfaces and are to be filled with epoxy by gravity flow the top surface shall be chipped or sawn to form a small trough to provide an inlet for the pouring of epoxy into the crack.

Cracks wider than 6 mm at the surface shall be filled with an epoxy concrete which contains a mineral filler. The Contractor shall submit details of his proposed method of repair for the consent of the Engineer.

Any lines or spills of epoxy shall be immediately removed and the repair finished to an even surface.

Where pouring of epoxy cannot be used an approved epoxy adhesive putty or drypack cement mortar shall be placed into crack and finished to a smooth even surface.

9.4.2 Structural Crack Repairs by Epoxy Injection

Where epoxy injection repairs are shown on the Drawings or ordered by the Engineer the Contractor shall submit to the Engineer for his consent details of an epoxy resin suitable for crack injection.

The crack shall be "V"ed to a width of 25 mm at the surface. The surface shall be then be cleaned free from dirt and broken concrete and any area oil or grease shall be cleaned with solvent. Hole10 mm in diameter shall be drilled to intersect the crack 50 mm below the surface with spacings as shown below.

a. Where the crack does not extend the full depth of the member holes shall be spaced at the desired depth penetration. For cracks less than 0.15 mm wide the maximum spacing shall be 150 mm.

b. Where the crack extends the full of the member the holes shall be spaced as shown:

   (i) For members 0.3 m or less in thickness holes shall be drilled in the crack on one side only and spaced at the thickness of the member.

   (ii) For members greater than 0.3 m thick and less than 0.6 m thick holes shall be drilled on all available sides and spaced at the thickness of the member.

   (iii) For members greater than 0.6 m thick holes shall be drilled generally as in (ii) above but subject to the direction of the Engineer.

The Engineer may direct that intermediate holes be drilled to monitor the flow of injected epoxy.

Nipple stems shall be bonded in each hole and the winded crack filled with an approved epoxy putty. If the crack extends through the member back sealing shall be done to prevent run out. After the epoxy putty has hardened, the heads of all nipples shall be removed except for the nipple at the lowest point.

The resin shall be pumped into the nipple until the epoxy appears at the adjacent stem. After a nipple to the adjacent stem the pumping shall

continue through this nipple until the epoxy resin appears at the next stem. This procedure shall be repeated until all the nipples have been injected. On vertical or sloping members the first nipple to be injected shall always be the lowest and the injection shall progress upwards.

Final cleaning of the concrete surface shall be carried out after the grout is seven days old. The injection valves and the hardened sealing compound shall be removed from the surface of the concrete.

9.4.3 Repair of Spalled Concrete

The repair of spalled concrete as shown on the Drawings or ordered by the Engineer shall be carried out in accordance with the requirements of the various clauses of this Section of the Specification as appropriate.

9.5 MEASUREMENT AND PAYMENT

Measurement and Payment for Concrete Repairs will not be made exclusively and all costs incurred by the Contractor in complying with the requirement of this clause shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities for works which may need to incorporate the requirements of Concrete Repairs. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs and, in particular, shall be deemed to include, but not be limited to, the following:

1) Removal and replacement of concrete, surface preparation, cleaning existing reinforcement, supply and placement of new reinforcement, coating of reinforcement (if ordered) and supply, resurfacing aggregate exposed concrete and repair of spalled concrete, placement and curing of new concrete.

2) crack surface preparation, supply and placement of epoxy to be injected into cracks, drilling of holes for injection valves and supply and placement of injection valves

3) surface preparation, supply and application of sprayed concrete and curing of finished concrete.

TABLE OF CONTENTS

SECTION TS 10. FALSEWORK AND SCAFFOLDING

SECTION TS 10. FALSEWORK AND SCAFFOLDING

10.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of falsework and scaffolding. It shall apply wherever falsework and scaffolding is required within the Works, such as for construction of bridges, pumping stations, gate works, buildings and the like, or specified in this and other Technical Specification.

This section covers design, erection and removal of falsework used to support steel or concrete during erection.

Supply and placement of concrete shall be in accordance with the requirements of Section TS 3 of this Specification.

Falsework is defined as the structural system required to support the permanent structural components, material, plant, equipment and personnel required in the construction of the works.

The structural system comprises foundations and all structural members supporting the formwork, or supporting permanent structural components.

10.2 FALSEWORK PROPOSALS

All erection gear, falsework, props, access ways, scaffolding, platforms, railings, erection and dismantling procedures and the like shall comply with the relevant requirements of any local scaffolding regulations.

If required by the Engineer details drawings and design calculations shall be submitted for consent at least four (4) weeks prior to commencement of falsework manufacture. Submission of falsework proposals and subsequent consent by the Engineer shall in no way affect the responsibility of the Contractor for the proper design and construction of the falsework system.

The submitted computations and drawings shall have been certified by an engineer experienced in structural design.

10.3 DESIGN

Falsework shall be of sufficient strength to carry all applied loads, including erection loads, vibration effects, and load concentrations produced by prestressing operations, wind and water loads, including flood debris and drift where applicable. Falsework for prestressed concrete shall be of a design which shall permit the application of prestress without damage to the completed structure. The design shall allow removal of the falsework without damage to the finished work.

Falsework shall be designed to withstand all forces resulting from the loads as specified in this Clause or, in the case of falsework used to support concrete works, from the loads specified in ACI 347 'Recommended Practice for Concrete Formwork' and the Indonesian Loading Code (PMI 1970 - N.I. 18), whichever produces the most significant effect, and any additional loads that may be imposed on the falsework during construction. The design shall take into account the magnitude, direction and duration of these forces individually and collectively.

The design loads (other than those in ACI 347 or PMI 1970 - N.I. 18) shall be --

1. Dead load - this shall include the weight of form, falsework, wet concrete, reinforcement, steel sections and any other material. The density of wet concrete, including reinforcement shall be taken as 2700 kilograms per cubic metre. The density of steel shall be taken as 7850 kilograms per cubic metre.

2. Superimposed load -- this shall include the weight of workmen, plant, equipment and runways, stacked material and an impact allowance equal to 25 per cent of the all up weight of any mechanically operated plant.

   In no case shall the superimposed load be less than 2 kPa (0.02 kg/cm^2) (plus the weight of stacked material) on the plant area of the finished concrete or a single isolated load of 2.5 kiloNewtons applied at any point of the structure, whichever is the more severe.

3. Wind load - this shall be 2.4 kPa (0.024 kg/cm^2) minimum acting on the exposed area of falsework, formwork and any object supported by the falsework or formwork.

4. Other loads – these shall include any special conditions likely to occur during construction, the effects of prestressing, construction stages and removal of falsework. Reference shall be made to the relevant section on Bridge Loads I the Bina Marga Bridge Design Code.

5. Horizontal loading – this shall include wind loading, horizontal surge loading equal to 25 percent of the all up weight of any mechanically operated plant and loading occurring during construction.

In no case shall the design value of the horizontal load acting and any direction be less than 1.5 kiloNewtons per metre applied at the edge of deck or 3 per cent of the total dead load, whichever is the greater.

Unless specified otherwise, the design of all falsework members and connections shall comply with AASHTO HB-14 'Standard specifications for highway Bridges' and ACI 347.

Falsework members supporting concrete shall be design to limit deflections to prevent cracking of previously cast sections due to subsequent casts. Deflections of beams and dimensional changes in other members and connections shall be limited to ensure that the erected steel members or finished concrete (as appropriate) is within the specified tolerances for line level.

The Contractor shall make allowance for the deflections and foundations settlements due to loading prestressing (if any) during the progress of the work, to ensure that the completed work shall conform in respect of all levels and dimensions shown on the Drawings or specified elsewhere

The falsework shall be such as to produce the least practicable obstruction in the waterway area or vehicular or other access. Clearances in the falsework shown on the Drawings or specified shall be provided.

The computations submitted to the Engineer shall state all design assumptions and shall include a detailed analysis of the forces, stresses, stability, deflections and other dimensional changes due to loading in all members of the falsework.

The drawings shall be fully detailed including all member sizes and materials, dimensions, levels, erection procedures and other relevant details including bracing, connections and foundations.

10.4 ERECTION AND USE

10.4.1 General

Falsework shall be erected on firm and secure footings and, in the case of bridges over streams, shall be safe from scour.

Materials shall be sound and sufficiently durable for the purpose intended. Particular consideration shall be given to protection of timber against marine organism in brackish or tidal waters.

10.4.2 Provision for Adjustment

The falsework shall have provisions for making adjustment to level. where the falsework is of tubular construction, screw jacks shall be provided at both top and bottom of the standards.

For other types of falsework construction, provision for a similar form of adjustment shall be made.

10.4.3 Provision for Longitudinal and Lateral Movements

The structural members of the falsework shall be designed for loads which may result from longitudinal or lateral movements caused by thermal or shrinkage effects. Alternatively, provisions shall be incorporated in the falsework to permit these movements.

10.4.4 Bracing

Adequate bracing shall be provided longitudinal and transversely to ensure that the falsework is stable and that significant horizontal movements resulting from the applied loads are limited. Additional bracing shall be provided after erection of the falsework if, in the opinion of the Engineer, the falsework is not sufficiently rigid.

10.4.5 Foundations

The foundations of the falsework shall be designed to prevent excessive settlement, including relative settlement between adjacent supports, and rotation of supports.

Individual footings and groups footings shall be designed also to satisfy stability criteria.

Where the foundation material can become saturated with water, the foundation material can become saturated with water, allowance shall be made for possible reduction in bearing capacity, consequent changes in stability, and increased settlement or heave of foundation. Bearing surfaces of footings shall be horizontal.

Footings shall not be founded directly on filled ground without the consent of the Engineer. Refer also to Clause 10.4.6 below.

Foundation material such as soil, filling, or other materials which are soft and compressible, or which may be subject to erosion by water, shall be removed as required to expose a suitable foundation.

Where such materials have been removed, the excavation may be backfilled to the required level by compacted stabilised crushed rock or equivalent containing not less than three (3) percent cement, to the satisfaction of the Engineer. No such excavation shall be backfilled without the prior examination and the consent of the Engineer.

Footings supported directly on the ground near surface level shall comprise concrete bases, timber and bed logs, or other types of materials approved by the Engineer. Where Contractor proposes to use timber bed logs, they shall comprise sound timber of dimensions not less than 200 mm wide and 100 mm deep.

Timber bed logs, which in the opinion of the Engineer do not satisfy these requirements, shall be removed from the site immediately. Unless approved otherwise, each bed log shall be bedded for its full length on net freshly placed concrete of thickness not less than 150 mm.

The concrete used for footings or under bed logs shall be Class K220 (220 kg/cm^2) or stronger.

Base plates for the falsework standard shall be located to ensure uniform bearing pressure under each footing. Where timber bed logs are used base plates shall be placed not less than 600 mm from the ends centrally within the width of bed logs. Comprise driven piles, bored cast-in-place concrete piles or other suitable type of foundation.

10.4.6 Test Loading

The Contractor shall allow for the falsework, or the foundations of falsework to the best loaded if so required by the Engineer. The test load shall be applied for a period of 48 hours and shall be equivalent to the design load.

The deflection and settlement under test shall not exceed 1/300 of the span of the member being supported. Testing shall be at the Contractor's expense.

10.4.7 Drainage

The Contractor shall provide adequate for stormwater to prevent scour of falsework foundations. Prior to commencement of erection of the falsework, the ground surface under the falsework shall be shaped, and if necessary filled to bring the site to a suitable level, to prevent ponding of water in the vicinity of the falsework footings. Foundations on batters shall be protected against scour directing drainage away from the falsework.

All drainage trenches, pipes and diversion channels shall at all times be maintained to the satisfaction of the Engineer. Where roadside drainage channels pass through the site, the Contractor will be responsible for maintenance of this drainage.

10.4.8 Settlement of Falsework

If falsework settles during construction to and extent which in the Engineer's opinion appreciably alters levels of the supported materials those shown on

the Drawings, the Engineer may stop the work and require removal of the supported materials and a through remodelling of the falsework. This work shall be carried out at the Contractor's expense.

10.5 REMOVAL OF FALSEWORK

As soon as practicable all falsework, including fill and other material placed to facilitate construction shall be removed and ground levels as existing prior to the commencement of the work by the Contractor shall be restored, unless shown on the Drawings or as directed by the Engineer.

The Contractor shall submit details of the method he proposes to use to release falsework two weeks prior to commencing this operation.

No falsework shall be released until the Engineer gives his written consent.

Provision shall be made to permit an even and gradual release of the falsework. Where shown on the Drawings the Contractor shall provide for the release of defined sections of the falsework.

For bridgework over navigable waters removal of the falsework shall include complete withdrawal of falsework piles and footings. After falsework has been dismantled, temporary piles shall be cut back to a depth of 300 mm below ground level.

Under the proposed road pavement the piles shall be cut back 1 metre below finished surface level. All temporary footings shall be removed and excavations associated with the falsework shall be backfilled in accordance with the requirements of Section TS 2 of this Specification.

10.6 PAYMENT

Measurement and Payment for Falsework and Scaffolding will not be made exclusively and all costs incurred by the Contractor in complying with the requirement of this clause shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities for works which incorporate the requirements of Falsework and Scaffolding. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

TABLE OF CONTENTS

SECTION TS 11. CONCRETE PIPES AND CULVERTS

SECTION TS 11. CONCRETE PIPES AND CULVERTS

11.1 GENERAL

This section covers the supply, handling and construction of reinforced concrete pipes.

11.2 MATERIALS

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

The supply and placement of concrete is covered in Section TS 3 of this Specification.

11.3 HANDLING, TRANSPORT AND STORAGE

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

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

11.4 DAMAGE TO UNITS

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

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

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

11.5 TOLERANCES

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

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

11.6 DIVERSION AND CARE OF WATER

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

11.7 EXCAVATION

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

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

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

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

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

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

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

11.8 BEDDING

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

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

Bedding shall be compacted to the satisfaction of the Engineer.

11.9 TESTING OF BEDDING AND BACKFILLING MATERIALS

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

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

11.10 CAST-IN-PLACE CONCRETE

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

11.11 PLACING PIPE CULVERTS

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

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

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

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

11.12 BACKFILLING

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

The material used, and the requirements for placing and compacting the fill, shall be in accordance with the requirements of Section TS 2 of this Specification.

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

11.13 CONSTRUCTION LOADING ON CULVERTS

11.13.1 General

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

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

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

11.13.2 Axle Loads up to and Including 10 Tonne

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

11.13.3 Axle Loads Greater than 10 Tonne

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

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

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

Cover over Pipe for Axles greater than 10 t

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

Strutting of concrete pipes will not be permitted.

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

11.14 MEASUREMENT AND PAYMENT

Precast Concrete Pipe

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

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

Earthworks and Other Concrete Works

Earthworks and other concrete works associated with the construction of the precast concrete pipe shall be measured and paid in according to the provisions of their respective sections elsewhere in this Specification.

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

Description	Unit of Measurement
Precast Concrete Pipe, Dia 800 mm	m

TABLE OF CONTENTS

SECTION TS 12. EPOXY RESINS

SECTION TS 12. EPOXY RESINS

12.1 SCOPE

This Specification covers the supply and application of epoxy resins as coatings, adhesives and structural systems in the construction, maintenance and repair of concrete structures.

12.2 GENERAL

The Contractor shall employ, or seek the advice of, personnel experienced in the use and application of epoxy materials in the construction of the works, and shall provide the Engineer with evidence of such experience before of commenced.

Epoxy resins may be modified by the use of flexibilisers, plasticisers, dilutants, filters, and pigments, subject to the consent of the Engineer. The choice of the proper system for a given application shall be based on the modulus of elasticity, creep characteristic, rate of heat development, and quantity of head developed during curing. The Contractor shall seek the manufacturer's guidance as to the most suitable system for the required application and shall abide by the manufacturer's recommendations as to properties of the materials to be used.

Adverse environmental conditions will severely affect the performance of the epoxy resin, and the Contractor shall schedule his work to coincide with suitable environmental, conditions or provide a favourable artificial environment at his expense.

The Contractor shall be solely responsible for the performance of the epoxy resin and its compliance with the requirements of this Specification and the Drawings.

12.3 MATERIAL

12.3.1 General

Epoxy Resins shall, unless otherwise shown on the Drawings or consented to by the Engineer, comply with the requirements of ASTM C 881 Type 1, 2 or 3 as appropriate.

The epoxy resin used for a particular job shall have properties suited for the job application as recommended by the manufacturer.

12.3.2 Definitions

For the purpose of this Specification the following definitions will apply :

Adhesive	An adhesive is a substance capable of holding solid materials together by surface attachment.
Epoxy Resin	A resinous polymer containing more than one epoxide group per molecule and which is capable of being converted to a useful thermoset form

	by reaction with a second component called a hardener. The converted materials are also referred to as epoxy resin.
Hardener	Chemicals resinous in form capable of reacting with epoxy groups in epoxy resins to produce a cross-linked polymer. They usually contain amine or amide groups.
Flexibilisers and Plasticisers	These are usually long chain liquid compounds added to the epoxy resin. Some react during curing to impact a degree of resilience and toughness to a normally rather rigid system. Other are non-reactive and are commonly described as plasticisers.
Fillers, extenders Pigments	These are finely divided, non-reactive inert materials added to epoxy and resins to modify certain properties such as consistency density, and colour.
Aggregates	Stable, non-reactive minerals of specified size grading, which have adequate hardness and strength. Aggregates and sands used for Portland cement concrete are usually satisfactory, but must be dust free and oven dry.

12.3.3 Physical Requirements

The epoxy resin shall not react chemically with the environment in which it is placed and shall remain stable. The curing period of the epoxy shall be such as to allowed adequate time to complete the required operations at the maximum operation temperature.

12.3.4 Sampling and Testing

Epoxy resins shall generally comply with the requirements of AASHTO M 235 'Epoxy Resin Adhesive' and/or ASTM C 881 as applicable.

At least eight weeks prior using and epoxy resin, and on request at any time during the Contract period, the Contractor shall make available an amount of epoxy material sufficient to carry out tests as determined by the Engineer. No epoxy materials shall be used until the results of the tests on samples are known and/or the Engineer gives his consent to proceed.

The Engineer may, at his discretion, arrange to take samples from each separate batch of the delivered epoxy resin. These samples shall be submitted to such test as are deemed to be necessary by the Engineer to prove their conformity with the manufacturer's advance samples and with the details given in the manufacturer's product data sheets.

12.3.5 Information to be Provided by the Contractor

- mixing directions for the base/hardener components of the system
- surface preparation needed or other conditions for use
- minimum and maximum application temperature in degrees Celsius
- curing conditions including maximum and minimum curing temperature in degrees Celsius and curing time
- percentage by mass of volatile material in the mixed resin system
- modulus of elasticity of the cured epoxy resin
- viscosity
- batch number and date of manufacture
- pot or working time for various air temperature between 5 degrees Celsius and 30 degrees Celsius
- safety precautions
- storage temperature of epoxy resin
- shelf life

12.3.6 Rejection and Replacement

If, in the opinion of the Engineer, the samples taken from the epoxy resin delivered to the work are of inferior quality to the advance samples, the Engineer may reject all material delivered to the work which, in this opinion, is represented by the samples. Rejected material shall be replaced by the Contractor at his own cost, or the Engineer may cancel the order for further supplies for the epoxy resin.

12.3.7 Test Methods

The basic procedures of the epoxy resin shall be assessed in accordance with the following Test Methods which are attached as Appendix 'A' and are an integral part of this Specification.

- Preparation of Epoxy Concrete
- Making and curing Epoxy Concrete Test Specimens for determining Compressive Strength and Flexural Strength
- Inspection and capping of Epoxy Concrete Compressive Test Specimens
- Composite Cylinder test for Evaluation of Wet-to-dry concrete adhesive
- Tensile Bond Strength of Epoxy Concrete
- Compressive strength of Epoxy Concrete.

12.3.8 Properties Prior to Curing

a. Shelf Life

The two part epoxy components shall comply with all properties specified for a minimum period of 18 months after delivery. The expiry date of the shelf shall be marked on each container.

b. Work Time

Unless otherwise consented to by the Engineer, after blending of both component parts of a 4 litre mix at 30 degrees Celsius ± 2 degrees Celsius, the viscosity of the mixture shall remain within a workable range for at least 30 minutes.

c. Hardening Time

When mixed in the proportions recommended for a project, the compressive strength of epoxy resin mortar or concrete at 24 hours after mixing and curing at 30 degrees Celsius shall be not less than 75 percent of the strength developed in 7 days at 23 degrees Celsius ± 2 degrees Celsius.

12.3.9 Properties in the Cured State

Adhesion. When tested in accordance with Test Method No. 5 the strength of the composite cylinder shall be at least 90 percent of the control specimens at 14 days.

Compressive Strength. When tested in accordance with Test Method No. 7 the compressive strength shall be not less than 70 MPa (700 kg/cm^2) at 7 days.

12.3.10 Supply

The materials shall be packed in standard commercial containers so constructed as to protect the product from contamination. The quantities of resin and hardener packed in their separate containers shall be such that when the contents of the containers are mixed the epoxy materials shall be in their required reacting ratio.

12.3.11 Safety Precautions

All personnel shall be fully instructed in the potential hazards of the material, correct use of equipment, protective clothing washing procedures, washing materials and barrier creams.

Particular care shall be taken to prevent the material from coming into contact with the skin. Before using the epoxy compound, the manufacturer's technical data shall be read with particular reference to information on protective measures.

Personnel shall be informed that toxic fumes may be emitted from epoxy compounds and adequate provision shall be made for ventilation if conditions so dictate.

12.3.12 Storage

Component of epoxy resin shall be stored at a temperature recommended by the manufacturer. Components shall not be kept for more than 18 months and shall be checked before use for signs of crystallisation.

12.4 SURFACE PREPARATION

When removal of concrete is required the removal of dust, scale, oil, grease, dirt or any foreign matter shall be achieved by grinding, abrasive blasting, jackhammering, hand chipping, compressed air and water, or high pressure water jet. The use of hydrochloric acid may be consented to by the Engineer for selected applications.

The Contractor shall submit to the Engineer for his consent the proposed method of surface preparation. The method shall be in accordance with the relevant methods A to H inclusive of this Specification and with the consent of the Engineer. References shall also be made to AS 1627 'Metal Finishing-Preparation and pretreatment of surfaces'.

The Contractor shall be wholly responsible for adequate surface preparation prior to the application of epoxy resin.

12.4.1 Method 'A' Solvent Cleaning- Refer to AS 1627

This method shall be to remove oil, grease, wax, tar and other solvent soluble contaminants from the surface of non-porous materials. Large quantities of contamination shall be removed by hand or power tools prior to solvent cleaning.

Suitable solvents are Petroleum Solvents, Aromatic Solvents or Chlorinated Solvents except that petrol, Benzol or Carbon Tetrachloride shall not be used due to their flammable and toxic nature.

Surfaces may be cleaned by solvents using several techniques :

- immersion in the solvent
- spraying with the solvent
- swabbing with rags or cloths
- immersion in boiling solvent vapour
- trichloroethylene using suitable equipment

Except for the last method repeated cleaning using fresh solvent shall be done for a completely clean surface.

The use of this method alone is subject to the consent of the Engineer who will usually direct that it be used in conjunction with another of the methods below.

12.4.2 Method 'B' Abrasive Blast Cleaning

Abrasive blast cleaning shall be used to prepare steel surfaces to a Class 3 standard as specified in AS 1627. Degreasing of steel surfaces shall be undertaken before abrasive blast cleaning commences. The abrasive used shall be subject to the consent of the Engineer. Abrasive blast cleaning may also be used in galvanised steel, concrete, plastics and ceramics.

Before abrasive blasting a surface, heavy rust, weld spatter or major irregularities shall be removed by mechanical means. Heavy deposits of oil, grease, wax, tar shall be removed by solvent cleaning (Method A) before abrasive blasting.

After abrasive blasting the surface shall be cleaned of any traces of any blast products by clean brushing, blowing with clean dry air or vacuum cleaning. After cleaning, the surface shall be promptly coated with the adhesive before contamination can occur.

12.4.3 Method 'C' Ferric Chloride Etching

This method shall be used to prepare copper, grass and bronze surfaces. These metals are subject to rapid surface and shall be coated with adhesive immediately after preparation.

The surface shall first be degreased by solvent washing (see Method A).

Ferric chloride solution shall be made by mixing ferric chloride, distilled water and nitric acid.

The ferric chloride shall be dissolved in the water in a glass or glazed earthenware container and then the nitric acid added with stirring.

The surface to be etched shall be immersed in the bath at 25 degrees Celsius for 1 to 2 minutes, then washed thoroughly with clean water and finally rinsed with distilled water.

12.4.4 Method 'D' Chromic Acid Etching

This method shall be used to prepare aluminium surfaces which have a tightly adherent film of inert aluminium oxide.

The aluminium shall first be degreased by solvent washing (Method A), followed by chromic acid etching.

Glass or glazed earthenware containers shall be used to hold the chromic acid solution. Eye protection and protective clothing shall be worn at all times when using chromic acid.

The Chromic Acid solution shall be made by mixing water, sodium dichromate and sulphuric acid.

The sodium dichromate shall be dissolved in the water and then the sulphuric acid added slowly with stirring. Water shall not be added to sulphuric acid as violent reaction will result.

The surface to be etched shall be immersed in the solution heated to a temperature between 60 to 70 degrees Celsius for 10 to 15 minutes. The surface shall then be washed thoroughly with clean water and finally rinsed in distilled water. After cleaning, the surface shall be promptly coated with the adhesive contamination can occur.

12.4.5 Method 'E' Hydrochloric Acid Cleaning

This method shall be used to clean sound concrete surfaces which have not been penetrated by contaminants.

If the concrete has been contaminated by oil, grease, paint, tar etc. other cleaning measures shall be adopted.

The hydrochloric acid solution of one part commercial hydrochloric acid to two parts of water by volume shall be made up in rubber, glass, glazed earthenware or plastic container. Suitable eye protection and protective clothing shall be worn when making of using this solution.

The acid shall be added to the water while constantly stirring.

The solution shall be applied to the surface of the concrete at the rate of 1 litre per square metre. When frothing ceases the surface shall be washed with water using a high pressure hose. If thorough hosing is not possible the surface shall be neutralised by washing with a weak solution of ammonia.

12.4.6 Method 'F' Preparation of Rubber Surfaces

This method shall be used to prepare rubber and neoprene surfaces.

Oil and bloom shall be removed from the surface with toluol to produce a uniform jet black appearance, then buffed with 80 grit emery paper or cloth to give a matt finish. All dust shall be removed and the adhesive applied in a uniform layer.

12.4.7 Method 'G' Preparation of Timber Surfaces

The surfaces to be joined shall be dry, sound and free from contamination by oil, grease, tars or old paint. Surface contamination and roughness shall be removed by planning and sanding. All dust shall removed.

12.4.8 Method 'H' Preparation of Bridge Decks

New bituminous road surfaces generally do not need preparation before mixing ceramic road markers. However, old surfaces which are uneven or contaminated with oil shall be prepared by one (or more) of the following methods :

• Grinding	A grinding wheel may be used to removed surface irregularities
• Burning	A burner may be used to remove oily residues
• Detergent	This mild but effective method may be used to remove
• Oily washing	Residues from bituminous surface. Neat detergent and a stiff bristle brush shall be used to clean the road surface then wash thoroughly with clean water.

12.5 MIXING

12.5.1 Mixing Equipment

All equipment and materials required for mixing of epoxy components shall be to the approval of the Engineer. All equipment shall be clean and free from harmful residue or foreign particles.

12.5.2 Mixing

Mixing shall be done in accordance with the manufacturer's directions.

The mixing of epoxy components shall in strict accordance with the manufacturer's instructions. Before any mixing is carried out, the correct proportions of components as recommended by the manufacturer shall be arranged into separate batches. All materials shall be conditioned to the temperature recommended by the manufacturer before mixing, usually 20 to 30 degrees Celsius. The base resin shall be stirred by a mixer for 10 seconds or until homogeneous prior to adding the hardener. The hardener shall then be added gradually to the base resin with constant mixing until the components are uniformly mixed.

Mixing shall be performed in a manner which will prevent frothing or air entrainment as this will considerably reduce the strength of the finished product. Mechanical mixing is preferable to hand mixing. The minimum time of mixing is five minutes.

The minimum time of mixing is five minutes.

Only small quantities (less than 1 litre) will be approved fir hand mixing.

When preparing epoxy mortars or epoxy concretes, aggregates shall be added after the epoxy components have been mixed thoroughly mixed prior to adding the next larger grade. Mixing shall then continue until a uniform mixture is produced.

All mixing shall occur as near as possible to the place of application. Mixing time shall not exceed five minutes. Part mixes will not be permitted.

12.6 METHODS OF APPLICATION

12.6.1 General

An epoxy resin shall not be applied over an epoxy application which has already hardened. No epoxy resin shall be applied until the consent of the Engineer has been obtained as to surface preparation and method of application.

12.6.2 Bonding

The epoxy resin shall be applied to the prepared surface by brush, roller, broom, squeegee, rubber gloves or spray equipment.

The epoxy resin shall be applied at a thickness to fill, with slight excess, the gap between substrate and the element to be bonded. Unless the date is available from the manufacturer the Contractor shall determine on the basis of trial joints an approximate applied rate of epoxy resin per square metre. The Contractor shall monitor the consumption of epoxy resin during the application to ascertain if significant variations occur which may indicate that either too much or too little epoxy is being applied.

Elements to be bonded shall be positioned within the contact time of the epoxy resin, as recommended by the manufacturer. If the movement of the element to be bonded is likely, the element shall be temporarily stressed or shored, within the contact time. The joint shall be checked to ensure uniform bearing and fit. Temporary fastenings or shores shall not be removed

without permission of the Engineer. The joint shall not be disturbed until the epoxy resin has set.

Around cable ducts a distance of 25 mm should be kept free of epoxy resin to minimise flow into the ducts.

The Contractor shall have an experienced supervisor on site at all times during jointing operations.

Where it becomes necessary to stop work on joint after the application of epoxy resin has commenced, the Contractor shall scrape off as much of the epoxy resin as possible before it sets. The remaining hardened epoxy resin shall be removed by abrasive blasting and surface prepared according to Clause 18.4

12.6.3 Repair of Damaged Concrete

Repair of Damaged concrete shall conform to the requirements of clause 16 of this Specification.

12.6.4 Date To Be Recorded

The Contractor shall keep records of all jointing operations which shall be made available to Engineer if required.

The information recorded shall include :

- Joint number
- date and time
- weather conditions
- shade temperature
- maximum temperature of mix
- time between adding components and initial application
- time between initial application and temporary stressing of elements to be bonded, or final application of surface coatings and fillers
- volume material used

12.6.5 Environmental Restrictions

The Contractor shall comply with the manufacture's recommendations as to environmental conditions under which the epoxy resin may be applied.

Epoxy resins shall not be applied when rains falling unless a non-moisture sensitive epoxy resin used. If rain falls on applied epoxy resin before the surfaces are brought together the application shall be stopped. If it become necessary to stop work on a joint the Contractor shall scrape off as much applied epoxy resin as possible before the material sets, and prepare the surface according to Clause 18.4 before re-applying epoxy resin.

12.6.6 Temperature

When the surface and atmospheric temperatures exceed 32 degrees Celsius difficulties may be experienced in mixing and application. Work shall scheduled when the temperature is generally lower, as in the early morning

hours, or the work area should be shaded from direct sunlight prior to, and during the application.

12.6.7 Clean-up

The Contractor shall protect surface beyond the limits of surface receiving the epoxy application from spillage. Any epoxy spilled or applied beyond the desired area of application shall be immediately removed, and the area affected shall be cleaned with material recommended by the manufacturer. The Contractor shall avoid contaminating the work area with the clean-up materials.

All tools and equipment should be cleaned immediately after completion of the application.

12.7 MEASUREMENT AND PAYMENT

Measurement and Payment for Epoxy Resins will not be made exclusively and all costs incurred by the Contractor in complying with the requirement of this clause shall be deemed to be included in the rates and lump sum prices entered in the priced Bill of Quantities for works which incorporate the requirements of Epoxy Resins. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.