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SECTION TS 4. PRECAST CONCRETE

SECTION TS 4. PRECAST CONCRETE

4.1 GENERAL

This section of the technical specification covers the general and specific requirements of precast concrete. It shall apply wherever precast concrete is used in the Works, such as in pile, sheet piles, pipes, prestressed beams, and the like, as shown on the Drawings or specified in this and other technical specification clauses or where it is approved in writing by the Engineer in writing to be used as alternative form of construction.

Concrete in precast concrete units shall be in accordance with the requirements of Section TS 3 of this Specification.

Storage handling, transport from the site storage area and erection of the precast concrete members are covered in Section TS 8 of this Specification.

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

4.2 FORMWORK

4.2.1 General

Formwork shall comply with the requirements of Section TS 3 of this Specification except as modified below.

Prior to the commencement of manufacture of this units, the Contractor shall submit detailed plans and calculations of the proposed formwork. These plans shall include details of all formwork, formwork joints, sealing procedures, ties, size and spacing of framing and details of any propriety fittings or systems proposed to be used.

The dimensions of formwork shall make allowance for changes in dimensions due to shrinkage, elastic shortening and creep, so that the completed unit conforms with the tolerances specified.

Formwork shall be constructed so that movement of the unit resulting from the effects of shrinkage, steam curing and prestress is not restrained and so that the unit is not damaged by movement within the formwork, Special attention shall be given to projecting reinforcement and bolts and to the methods of fixing base plates and devices for holding down deflected tendons.

4.2.2 Formwork Materials

Forms shall generally be manufactured from steel only. However, the Engineer may consent to the use of plywood and timber formwork for non-repetitive non-prestressed units.

4.2.3 Forms

Where forms incorporate insertions for forming voids in the units, the formers and the method of securing them in position shall be subject to the consent of the Engineer. Void formers shall be securely restrained in position vertically against the action of placing concrete and subsequent flotation under vibration. The void

former shall likewise be laterally restrained against forces arising from differential pressure during placing of concrete.

4.3 STEEL REINFORCEMENT

The supply, bending, cutting and placing of reinforcement shall be in accordance with the requirements of Section TS 3 of this Specification except as modified below.

Reinforcement shall be supported at no more than 0.5 metre intervals transversely and 1.0 metre longitudinally or vertically unless otherwise consented to by the Engineer.

Unless shown otherwise on the Drawings the clear cover to bars shall be the greater of one and a half (11/2) times the diameter of the bar and 25 mm.

4.4 PROJECTING REINFORCEMENT

Where shown on the Drawings, steel reinforcement shall be left projecting for the purpose of bonding on subsequent work. Care shall be taken to avoid disturbing the bars during the specified period for curing of the concrete. Projecting reinforcement which has been damaged or dislodged or which is loose in the concrete will be cause for rejecting of the units.

4.5 BEARING PLATES

This clause is not applicable to this contract.

4.6 UNIFORMITY OF PROFILE-PRECAST BEAMS

Where a number of beams are to placed in one span, it is essential that the hog of these beams be as nearly uniform as practicable. Accordingly, the Contractor shall ensure that:

- The concrete in these beams is uniform in compensation, consistency, compaction and strength.
- The curing conditions are as uniform as practicable.
- The concrete in each beam is approximately the same age when tensioned.
- All the beams or segments for any one span are cast within as short a time as is reasonably practicable.

4.7 MARKING

The identification number, date of casting, the lifting positions and the word 'TOP' shall be marked on every unit.

Immediately after screeding, temporary identification shall be made on the top surface of the unit near an end. Final marking shall be made by indelible marking material, using letters approximately 75 mm high.

The ends of unsymmetrical members shall be clearly marked to indicate the manner in which they are to be oriented in the structure.

4.8 PREPARATION OF STORAGE AREA AND ACCESS TRACKS

The Contractor shall construct a storage area and access tracks in accordance with the requirements of this Clause.

The storage area shall be sufficient size to accommodate all units and allow for handling and manoeuvring of cranes and vehicles. The surfaces of storage areas and access tracks shall be paved to provide adequate drainage and ensure that surface water will not pond.

The width of access tracks shall not be less than 3.5 metres. Access tracks shall be widened on curves where required to accommodate trailing bogies for transport of long units.

Crossfall on access tracks shall not be greater than 1 in 30 unless consented to by the Engineer.

The alignment and grading of the access tracks shall be as shown on the Drawings or as consented to by the Engineer.

After completion of the works or at a time consented to by the Engineer, the Contractor shall reinstate the access track and storage area to the satisfaction of the Engineer.

4.9 DEFECTIVE CONCRETE

Concrete which is not placed and completed in accordance with this Specification, or does not meet the requirements of this Specification in regards to surface finishes, or which is, in the opinion of the Engineer, defective, shall be removed within the limits assigned by the Engineer and replaced in accordance with the requirements of Section TS 9, Concrete Repairs, of this Specification. Repairs to concrete shall not be carried without the consent of the Engineer.

If a unit is to be repaired the Contractor shall submit for consent details of the materials to be used and the method to be adopted in effecting the repair.

4.10 GENERAL STORAGE REQUIREMENTS

Where units are placed in storage side by side, the minimum lateral clearance between side faces of adjacent units shall be a nominal 50 mm unless otherwise directed by the Engineer.

Where lifting frames are used in handling units, the minimum lateral clearance shall be the overall width of the frame plus 100 mm unless otherwise directed by the Engineer.

Where are stored in the vicinity of trees, the units shall be protected from damage caused by staining from foliage.

Units shall not be stored in areas subject to flooding, within 10 m of existing or proposed overhead power or telephone lines, or over service conduits, drainage pipes or uncompacted fill without the consent of the Engineer.

Concrete foundations used for storage shall be removed from the storage area by the Contractor after the units have been erected.

4.10.1 Storage and Temporary Supports for Precast Beams

Temporary supports for beams shall be concrete unless otherwise specified or consented to by the Engineer.

The Contractor shall submit details of the proposed system of temporary supports for the consent of the Engineer. This information shall be submitted not less than 4 weeks prior to the proposed delivery of the units.

The width of temporary supports shall not be less than 100 mm for units under 7 tonnes in weight and not less than 200 mm for units 7 tonnes and over.

The length of the temporary support shall not less than the height of the unit, or the width of the bottom flange plus 600 mm, whichever is the greater, and the unit shall not be placed within 300 mm of the end of the support.

Temporary supports shall be clear of the sole plate.

The maximum ground bearing pressure for designing supports shall not exceed 500 kPa (50 t/m^2).

All beams shall be laterally supported. The lateral bracing shall be designed for 10% of the dead load of the beam at the mid height of the beam.

The ground or space between supports of a unit shall be carefully cleared and levelled to prevent the unit from being supported at intermediate points.

A minimum clearance of not less than 100 mm shall be provided between soffit of units and the ground. This amount shall be increased in instances where greater clearance is required for handling operations involving lifting frames.

4.10.2 Storage and Temporary Supports for Piles and Slabs

All units shall be supported on bearers clear of the ground. The bearers shall be either steel, concrete or merchant grade hardwood. The bearing pressures on supports and/or ground shall be as shown on the Drawings or as consented to by the Engineer. The safe bearing pressure on ground shall not exceed 500 kPa (50 t/m^2) where units are stacked. The bearing pressures of units on timber shall not exceed 2.0 MPa (200 t/m^2).

Each layer of stacked units shall be separated by seasoned hardwood timber bearers of at least 100 mm wide and not more than 75 mm thick and not less than 30 mm thick. The bearing stresses on these timbers shall not allowable stresses.

Units maybe stored in separate stacks of identical units up to a maximum height of 2 m or 2 units high, whichever is the greater, subject to the consent of the Engineer.

Each layer of units shall be separated by timber bearers in line vertically with the underlying supports.

Piles may be stacked to a maximum of six layers, if consented to by the Engineer. The minimum bearing width for the piles in each instance shall not be less than 200 mm.

4.11 HANDLING

Units shall be carefully handled at all times and shall not be subject to shock and impact loads. They shall be lifted at the positions, and in a manner required by the Drawings and Specification or as consented to by the Engineer. Where the method of handling is not specified the Contractor shall submit, for the consent of the Engineer, details of his proposals for handling the units.

Unless otherwise specified, units such as beams and structural slabs shall be lifted and supported with the top surface uppermost at all times. Beams shall be stored and handled with webs vertical at all times.

Stiffening frames, where required, shall be attached as shown on the Drawings during lifting and handling.

Where shown on the Drawings the Contractor shall provide lifting frames for lifting of the units. Except during the initial lift from the casting bed, units shall be lifted and moved with the lifting frame. When the units are first lifted off the

casting bed they shall only be raised vertically and sufficiently to permit attachment of the lifting frame.

The position and mode of attachment of slings or other tackle for guiding and controlling the movement of the units during lifting and transport shall be subject to the consent of the Engineer. Special care shall be taken to protect the units from damage due to slings or other tackle.

The angle subtended by the slings and the longitudinal axis of the unit shall be not less than 60 degrees. A single sling lifting will not be permitted.

Guide ropes shall be attached to each end of units for the purpose of hand guiding the units when being lifted. The guide ropes shall have a nominal capacity of 10 kiloNewtons (1 tonne).

Temporary supports during handling operations shall comply with the relevant provision of this Specification unless otherwise to by the Engineer.

All handling, transport and erection operations shall be performed in the presence of the Engineer's Representative.

4.12 TRANSPORTING

Units shall not be transported to the temporary storage or the Site less than 7 days after casting nor until concrete test samples representing the concrete in the units have reached a strength of not less than the specified 28 days strength.

No unit shall be removed from the casting yard prior to a release note having been issued by the Engineer.

During transporting units shall be handled and supported as specified in Clause 4.11 above.

Units shall be securely fixed to the transporter by means of wire ropes or steel chains of adequate size at each end. They shall pass over the top flange and shall be fitted with suitable tensioners. Provision shall be made to protect the units from damage caused bay these lashings. Adequate restraints shall be provided against lateral deflection.

4.13 DAMAGE TO UNITS

In the event of any unit sustaining damage such as cracking, spalling or deformation of projecting reinforcement or bolts, the unit shall be set aside until it has been inspected by the Engineer, who will decide whether it shall be rejected, tested or repaired.

If a unit is to be repaired, the Contractor shall submit for consent 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, Concrete Repairs, of this Specification. Repairs to damaged units and the replacement of rejected units shall be at the expense of the Contractor.

4.14 ACCEPTANCE

Consent or comment given by the Engineer to any drawings, work or methods will be tentative only and will not relieve the Contractor of the responsibility for producing units in accordance with this Specification.

Any unit which is cracked, honeycombed or otherwise defective to an extent which, in the opinion of the Engineer renders it unfit for its intended purpose, will be rejected.

For units made at locations remote from the site, the Engineer will arrange to supervise and inspect the processes involved in the manufacture of the units only, with limited attention to the checking of dimensions of the forms and the finished units. On delivery to the Site, the units will be inspected by the Engineer who will advise the Contractor if the units are acceptable for incorporation into the Works.

Acceptance will only be made following Completion of the Works in accordance with the General Conditions of Contract.

4.15 MEASUREMENT AND PAYMENT

Measurement will be made of the number of precast units completed, in place, in accordance with Section TS 4 and other relevant sections of the technical specification, in place and approved by the Engineer.

Payment shall be made in accordance with the rates entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

In addition to the above items of inclusion in the rates, the rates for precast prestressed beams and diaphragms shall be deemed to include, but not be limited to compliance with the following sections of the technical specification:

Section TS 3 Concrete Work

Section TS 4 Precast Concrete

Section TS 5 Prestressed Concrete

Section TS 7 Post-tensioned Concrete

Section TS 8 Handling and Erection of Precast Concrete

Section TS 9 Concrete Repairs

Section TS 10 Falsework and Scaffolding

Subject to the provisions of the Contract, for the purposes of interim payments, 50 % of the unit rate for precast units may be made following their casting and being deemed acceptable by the Engineer. The remaining 50% shall be made following placement and approval by the Engineer in their final locations.

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

Pay Item No.	Description	Unit of Measurement
E.3.1	Precast Prestressed Concrete Beam including Reinforcing Bar, Tension Reinforcing and Erection (Concrete Type A2, PC Cable)	No.
E.3.2	Precast Prestressed Concrete Diaphragm including Tensioning and Erection (Concrete Type A2, PC Cable)	No.
E.1.12	Precast Concrete Blocks and their Installation (Cross-shaped Block with Anchor Bars, 2 t / piece)	No.

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SECTION TS 5. PRESTRESSED CONCRETE

SECTION TS 5. PRESTRESSED CONCRETE

5.1 GENERAL

This section of the Technical Specification covers the general and specific requirements of precast prestressed concrete. It shall apply wherever precast prestressed concrete is used in the works, such as piles and precast prestressed beams, 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 supply and tensioning of tendons for both post-tensioned and pre-tensioned units.

Concrete for prestressed concrete is covered by Section TS 3 of this Specification.

Tensioning shall not be commenced until the Engineer has consented to the Contractor's proposed method of prestressing.

Concrete shall not drilled or any portion cut or chipped away or otherwise disturbed after prestressing without the express consent of the Engineer.

Only under exceptional circumstances and with the consent of the Engineer shall the maximum jacking force exceed 80 percent of the rated capacity of the jacking equipment used, or 75 percent of the specified minimum breaking load of the tendon whichever is the lesser.

All materials necessary for the prestressing shall be supplied by the Contractor unless shown on the Drawings or in the Special Specifications.

This section shall apply whether or not prestressed concrete units are manufactured directly by the Contractor or by a specialist, reputable manufacturer approved by the Engineer

5.2 TENDONS

5.2.1 Materials

Prestressing tendons shall be as shown on the Drawings and shall comply with the requirements of:

AASHTO M 203	Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete (ASTM A 416)
AASHTO M 204	Uncoated Stress-Relieved Wire for Prestressed Concrete (ASTM A 421)
AASHTO M 275	Uncoated High Strength Steel Bar for Prestressed Concrete (ASTM A 722).

The material selected for use in the tendons shall have an ultimate tensile of not less than 167 percent of the specified forces shown on the Drawings after losses.

5.2.2 Manufacture

Fabrication of tendons shall not commence without the written consent of the Engineer.

Tendons shall be made to the required length plus an allowance, where applicable, at each end for stressing operations.

No welding will be permitted on or near tendons nor shall any heat be applied to tendons. Any tendons which have been affected by welding, weld spatter or heat will be rejected.

Spicing of strands or wires forming a tendon will not be permitted. Tendon couplings shall only be used where shown on the Drawings and the type shall be subject to the consent of the Engineer.

Flame cutting of wire or strand within 75 mm of where the tendon will be gripped by the anchorage or jacks will not be permitted.

A durable metal label on which shall be stamped the length of the tendon and the coil number of the wire or strand used shall be tied to each tendon.

5.2.3 Testing

A copy of the manufacturer's test certificates and load-extension graphs covering each coil to be used shall be supplied to the Engineer. If test certificates relating to the material cannot be supplied the Contractor shall arrange for testing of samples in accordance with the Standards in Clause 5. 2.1.above.

This testing shall be at the Contractor's expense.

If the test certificates are satisfactory further testing of tendons will not be required provided that a satisfactory correlation is obtained during the initial stressing stages.

Should the correlation between jacking force and extension be unacceptable to the Engineer, then testing of the tendon will be required prior to the commencement or continuation of the tensioning operation. In such cases, three samples, each 1.4 m long shall be tested at a laboratory approved by the Engineer at the Contractor's expense. The samples will be tested for the breaking load, modulus of elasticity, and percentage elongation at rupture on a 600 mm gauge length.

Where such testing is required the tendons represented by the test samples shall not be stressed until results acceptable to the Engineer have been obtained.

5.2.4 Handling and Storage

High tensile steel wire and strand shall be supplied in coils of sufficiently large diameter such that they shall retain their physical properties and shall be straight as they unwind from the coil. Wire or strand of any type that is damaged, kinked, or bent shall not be used.

Tendons shall be free from loose, oil, grease, tar, paint, mud or any other deleterious substance. A slight film of rust shall not be regarded as harmful but the steel shall not be pitted by rust. If cleaning is required, the tendons shall not be brought to a polished condition.

Material for tendons, whether made up or not, shall be stored under a waterproof shelter, supported above ground level and shall be protected from damage or deterioration.

5.3 SAFETY PRECAUTIONS

Care shall be taken during tensioning to ensure the safety of all persons in the vicinity.

Jacks shall be secured in such a manner that they will be held in position should they lose their grip on the tendons.

No person shall be allowed so stand behind the jacks or close to the line of the tendons while tensioning is in progress.

The operations of the jacks and the measurement of the elongation and associated operations shall be carried out in such a manner and from such a position that the safety of all concerned is ensured.

A safety barrier shall be provided, at both ends of the stressing bed or unit, to prevent any tendon which might become loose from recoiling unchecked.

When pretensioning, ligatures enclosing the tendons shall be used, or alternatively, timber planks or rolls of hessian shall be laid across the tendons to restrain lateral or vertical movement of tendons which may break under stress.

During actual tensioning operations suitable warning signs shall be displayed at both ends of tensioning bed or member.

5.4 EQUIPMENT

All tensioning equipment shall be subject to the consent of the Engineer prior to use. Hydraulic pumps shall be power-driven unless otherwise consented to by the Engineer.

The power unit shall be adjusted so that the rate of extension of the tendon is within the limits recommended by the equipment manufacturer and as consented to by the Engineer.

Dynamometers, and each set of equipment comprising pump, jack pressure gauge and mater gauge shall be calibrated by a registered immediately prior to use and then at intervals not exceeding 3 months and the true force determined from the calibration curve.

Pressure gauges shall be concentric scale type complying with the requirements of AS 1349 'Bourdon tube pressure and vacuum gauges', which requires gauges to be accurate to within one percent of their full capacity. They shall be so selected that when the tendon is stressed to 75 percent of its breaking load the gauge is reading between 50 percent and 90 percent of its full capacity. Suitable safety devices shall be fitted to protect pressure gauges against sudden release of pressure.

Provision shall be made for the attachment of a master gauge to be used as a check whenever requested by the Engineer.

The measuring equipment used shall permit tendon force and elongation to be determined within an accuracy of ± 1 mm or 2 percent, whichever is the lesser.

The equipment used shall prevent unwinding of the strand during tensioning.

5.5 MEASUREMENT OF TENSIONING FORCE

The tensioning force applied to any tendon shall be determined by direct measurement of the force and checked by measurement of the elongation of the tendon.

The secant modulus determined from test samples or test certificates shall be used when interpreting the measurement of elongation.

Should the secant modulus of batches of tendons differ by more than 3 percent, the required elongation shall be adjusted accordingly.

The average force in the tendon calculated from elongation measurements will, in general, differ from the force measured at the jack due to friction losses inside the duct and at the anchorage. Where not shown on the Drawings, the Engineer will

specify the required values for the elongation and for the force in the tendon at the jack. Allowance shall be made for any anticipated draw-in at the member and for anticipated losses due to stressing of subsequent tendons.

If, on completion of tensioning each tendon to the required force, the check measurement of elongation differs from its required value by more than 5 percent the Engineer may direct that some or all of the following steps by taken:

- Re-calibration of equipment.
- Testing of tendon material to check secant modulus.
- Tendons released and re-stressed. (Secant modulus applicable to second stressing to be adopted).
- Lubrication of tendons to reduce friction losses. Only water soluble oils shall be used in ducted system and these shall be washed out before grouting.
- Where only one jack was used previously, the tendon to be tensioned from both ends using two jacks.
- Other methods as directed by the Engineer.

The cost of any of the above steps shall be borne by the Contractor

5.6 DATA TO BE RECORDED

The following data, where applicable, shall be recorded by the Contractor:

- Identification number of each dynamometer, gauge, pump and jack.
- Identification particulars of tendons.
- Initial forces (or pressure) when tendons are marked for measurement of elongation.
- Final forces (or pressures) and elongation obtained on completion of tensioning.
- Elongations remaining after release of jacks.
- Elongations obtaining at intervals during tensioning, together with corresponding forces (or pressures), as required by the Engineer.

Fully completed forms shall be forward to the Engineer no later than four days after stressing.

5.7 INITIAL PRESTRESS

Consideration will be given to the application of an initial partial prestress at an earlier date to overcome handling or shrinkage problems, or to permit early removal of falsework. Details of proposals shall be submitted to the Engineer for his consent.

5.8 MEASUREMENT AND PAYMENT

Measurement and Payment for 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 rates entered in the Bill of Quantities for works which incorporate the requirements of Prestressed Concrete. These shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

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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's 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.

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SECTION TS 7. POST-TENSIONED PRESTRESSED CONCRETE

7.1 GENERAL

7.1.1 Scope

This section of the Technical Specification covers the general and specific requirements of post-tensioned precast concrete. It shall apply wherever post-tensioned precast concrete is used in the works, such as precast prestressed concrete beams and prestressed precast concrete diaphragms, 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 reinforced concrete either cast-in-place or precast which is subsequently prestressed by post-tensioning.

Concrete shall be in accordance with the requirements of Section TS 3 and 4 of this Specification except as modified below.

Stressing shall be in accordance with the requirements of Section TS 5 of this Specification except as modified below.

This section shall apply whether or not post-tensioned precast concrete members are manufactured assembled and joined directly by the Contractor or a specialist, reputable manufacturer approved by the Engineer. Where post-tensioned precast concrete members 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.

7.1.2 Prestressing System

If the Contractor proposes to use a prestressing system different from that shown on the Drawings or if the prestressing is not specified he shall submit, with his Bid, full details including amended Drawings where the proposed system necessitates any change of details from those shown.

This description shall include type, composition and number of tendons, type of ducting, anchorage devices and any other relevant information.

Within four weeks of the date of acceptance of the Bid and prior to the commencement of manufacture if concrete members for post-tensioning the Contractor shall submit to the Engineer, for his consent, full details of the prestressing system. These details shall include diagrams and descriptions as required and Drawings showing any proposed alterations to the Contract Drawings which are necessary for the prestressing system.

The cost of any variation from the details shown on the Drawings, resulting from the proposed system, shall be borne by the Contractor.

Minor amendments to the shape of the members shown on the Drawings will be considered but the general arrangement, depth, spacing and outward appearance of the members shall remain unaltered.

The alternative system shall not be used unless the Engineer gives written consent to the Contractor.

7.2 DUCTING

7.2.1 Supply

The Contractor shall supply the ducting for the units plus any allowance required for joints.

Ducting shall be strong enough to withstand the placing and compaction of the concrete without suffering damage or deformation. Ducting and any joints shall be mortar tight.

Internal and external diameters of ducting shall be within the limits specified on the Drawings. When the limits are not specified, details shall be submitted for the Engineer's consent prior to commencing work.

Steel ducting shall be galvanised or lead coated and all details shall be subject to the consent of the Engineer. In submitting details, the Contractor shall also state the manufacturer's values for the friction coefficients.

Enlarged portions of the ducting at couplings or anchorages shall be of sufficient diameter and length to accommodate the extension of the tendons.

Grout holes or vents shall be provided at the anchorages, at high and low points in the tendon profile and other suitable points. The number and location of these points shall be specified by the Engineer but shall be no more than 30 mm apart along the ducting. Grout holes and vents shall be at least 10 mm in diameter and each shall be fitted with a plug valve or similar device capable of withstanding a pressure of 1.0 MPa (10 kg/cm^2) without loss of water, grout or air.

7.2.2 Placing

Ducting shall be securely fixed at points sufficiently close together but not greater than 600 mm centres to maintain a smooth tendon profile throughout the length of the tendon within a tolerance of ± 3 mm of the position shown on the Drawings. It shall be fixed by methods which will not damage or deform the ducting.

At high or low points in the tendon profile, the position of the ducting shall be adjusted to allow for the relative displacement of the tendon in the ducting, and to ensure that the tendon profile is within the specified tolerances.

Displacement of the ducting with respect to the tendon profile shall be to the satisfaction of the Engineer.

The minimum straight length of ducting at anchorages and at coupling points required by the post-tensioning system shall conform with the manufacturer's recommendations.

Ducting in which the permanent tendon will not be in place during concreting shall have temporary tendons, mandrels or other methods consented to by the Engineer inserted to stiffen the ducting during placing and compaction of concrete. The contractor shall ensure that the position and shape on the ducting is maintained.

Any temporary openings in the ducting shall be satisfactorily plugged and all joints between ducting and any other part of the prestressing system shall be effectively sealed to prevent the entry of mortar, dust, water or other deleterious matter.

Ducting shall neatly fitted at joints without internal projections or reductions of diameter.

Unless otherwise shown on the Drawings, the minimum cover of concrete to the outside surface of any ducting shall be 50 mm for beam soffits and 40 mm elsewhere.

Unless otherwise shown on the Drawings, the minimum clear space between individual ducting shall be 40 mm.

Ducting shall be cleaned out within one half hour of completion of each concreting operation by blowing oil-free compressed air through the length of ducting.

Enlarged portions of the ducting at couplings or anchorages shall be of sufficient length to provide for the extension of tendons.

7.3 ANCHORAGES

7.3.1 Supply

Anchorages shall comply with the requirements of AS 1314 'Prestressing Anchorages' or equivalent and shall be subject to the consent of the Engineer.

Each anchorage device shall be capable of transmitting a force not less than the ultimate strength of the corresponding tendon without over-stressing the concrete.

No damaged anchorages shall be used. Steel parts shall be protected from corrosion at all times. Threaded parts shall be protected by greased wrappings and tapped holes shall be protected by suitable plugs until used. The anchorage components shall be kept free from mortar and loose rust and any other deleterious coating.

Spiral and other reinforcement required as a part of the anchorages of the prestressing system shall be incorporated in the works in accordance with sizes and dimensions required. Details of this reinforcement shall be submitted to the Engineer for his consent.

7.3.2 Placing

Each anchorage device shall be set square to the line of action of the corresponding prestressing tendon and shall be positioned securely to prevent movement during concreting.

Where not specified on the Drawings the Contractor shall submit details of the proposed anchorages recesses to the Engineer for his consent. Recesses shall be designed in accordance with the recommendations of the manufacturer supplying the post-tensioning system, especially with regard to such details as:

- the cover requirements to the end of anchored tendons:
- the minimum recess dimensions, including the clearance between the edge of the anchor plate and the recess wall (or at the edge of the concrete), the required side slopes of the recess, and the provision of access behind the anchorage to allow the assembly, installation and operation of the jack.

The placing and securing of the anchorage shall be subject to the consent of the Engineer.

The anchorage devices shall be cleaned to the satisfaction of the Engineer prior to the placing of concrete. Any mortar or concrete which adheres to bearing or wedging surfaces shall be removed immediately.

7.3.3 Swaging and Button-Heading

Swaging of strand and button-heading of wire shall be carried out only by methods consented to by the Engineer and the swages/button-heads shall develop not less than 95 percent of the specified minimum breaking load of the stand of wire. Prior to the commencement of stressing work, three sample lengths with treated ends shall be tested at an approved testing laboratory in the presence of the Engineer. Stressing shall not commence until satisfactory test results are available.

7.4 FALSEWORK

Falsework shall conform to the requirements of Section TS 10, Falsework and Scaffolding. In addition allowance shall be made for elastic shortening and deflection of the members following prestressing. Where deflections are in a downward direction, provision shall be made for lowering the falsework in stages to avoid overstressing the member or falsework.

7.5 CONCRETING

Care shall be taken during placing and compaction of concrete to avoid damage to ducting. If the ducting is damaged during concreting the whole or portion of the concrete cast may be rejected by the Engineer. Particular care shall be taken during placing and compacting concrete around anchorages to ensure that no part of the anchorages or reinforcement is moved from its correct position or line.

When the permanent tendons are inserted in the ducting before all concreting has been completed, inclusive of concrete infills and joints, the tendons shall be moved backwards and forwards approximately 300 mm after the concrete has hardened in order to ensure that the tendons are free to move during tensioning operations. If the tendons cannot be moved due to obstructions in the ducting, tensioning operations shall not be undertaken until the tendons are freed and can move.

Where a permanent tendon is not used a wooden or steel dolly shall be drawn through the ducting to check for obstructions prior to reeving tendons. Any obstructions which may impede the passage or movement of the tendons in the ducting shall be removed to the satisfaction of the Engineer.

7.6 TENDONS

7.6.1 Fabrication

Fabrication of tendons shall comply with the requirements of Clause 5.2 of this Specification.

7.6.2 Placing

Where possible tendons shall not be placed until immediately prior to stressing. Tendons shall be handled with care, and shall be pulled through the ducting in such a manner as to avoid damage or contamination, to either the tendon or the ducting. Any tendons damaged or contaminated shall be cleaned or replaced.

Where directed by the Engineer the tendons shall be pulled back and forth for about 300 mm to ensure that the tendons are free.

Any steel which is pitted by rust will be rejected.

When installing tendons, care shall be taken to ensure that each strand maintains its relative position with respect to all other strands throughout the length of the tendon.

Tendons which are installed in members prior to placing and curing of concrete, shall be continuously protected against corrosion, until grouted. The corrosion protector shall have no deleterious effect on the tendons or concrete or on the bond strength of steel to concrete.

When steam curing is used, tendons shall not be installed until the steam curing is complete.

Tendons which are installed in the ducts after completion of concrete curing and where stressing and grouting are completed within 10 calendar days will not be rejected on the basis of rust which may form in that time.

Tendons installed after completion of concrete curing but not grouted within 10 calendar days shall be subject to all the requirements of this Section pertaining to corrosion protection and rejection due to rust.

7.7 REQUIRED STRENGTH AND AGE OF CONCRETE FOR STRESSING

7.7.1 Strength and Age

The prestressing force shall not be applied to a member until it has attained the compressive strength as shown on the Drawings, nor shall it be applied at an earlier age than 14 days after casting, when normal curing methods are used, or two days after casting when steam cured, provided that in the latter case the temperature of the member has returned to normal.

Consideration will given to the application of partial prestress at an earlier date to overcome handling or shrinkage problems, or to permit early removal of falsework. Details of proposals shall be submitted to the Engineer for his consent.

7.7.2 Post tensioning Before 28 Days

Sampling and testing of concrete shall be carried out in accordance with Clause 3.3.7 of this Specification.

The Engineer will give consent to post tensioning before 28 days based on the results of tests carried out in accordance with Clause 3.3.7.

7.8 TENSIONING FORCE REQUIRED

Unless otherwise shown on the Drawings the Engineer will supply the following assumed coefficients :

- Friction wobble co-efficient per metre of prestressing steel.
- Friction curvature co-efficient.
- Friction loss in anchorage.
- Draw-in.

Where the above coefficients vary for the prestressing system adopted, any changes to the specified tensioning force shall require the consent of the Engineer.

The final force in each tendon, as measured, shall be within three percent of the values required.

7.9 STRESSING PROCEDURE

7.9.1 General

All stressing operations shall take place in the presence of the Engineer or his Representative.

The sequence of stressing shall be as shown on the Drawings or as consented to by the Engineer. To minimise uneven of forces and to avoid tensile cracking the stressing sequence shall ensure that the forces applied are kept as symmetrical as possible about the centroid of the tendons.

No members shall be left partly stressed without the consent of the Engineer unless the Drawings require the member to be stressed in stages.

If ducts will not be grouted within 14 days of the commencement of stressing, the ducts shall be sealed to protect tendons from corrosion.

Tendons ducts shall be cleaned out by blowing oil-free compressed air through them, and anchorages shall be thoroughly cleaned prior to commencement of tensioning. The protruding ends of tendons shall be cleaned of any coating, such as rust, mortar, oil or mud, which would lessen the grip of wedges or of anchorage devices. Tendons shall be checked before tensioning to ensure that they are free to move inside the duct.

The jacks shall be set accurately in the line of the tendons.

The force which is applied initially to take up the slack of the tendon shall be sufficient to seat the jack firmly but shall not exceed the amount normally associated with the particular method of prestressing. After taking up the slack, the tendon shall where possible be accurately marked at both ends and elongations or draw-in measured from these markings. When requested by the Engineer readings of force and elongation shall be taken at stages during the tensioning of a tendon and plotted to determine the zero error in measuring elongation. Allowance for this shall be made by the Contractor if required by the Engineer. Where tendons consist of a number of individual components each component shall be marked so that any slip may be observed.

Where one or more components or tendons of a group stressed together slips during stressing operations the Engineer may permit a compensating increase in the elongation of the remaining tendons of the group provided that the jacking force does not exceed 85 percent of the minimum ultimate tensile strength of the remaining tendons.

In the case of a tendon breaking or slipping after tensioning, so that the allowable tolerances above are exceeded, the tendon shall be released, replaced if necessary, and restressed. Under no circumstances shall the maximum jacking force exceed the rated capacity of the jacking equipment used, or 85 percent of the specified minimum ultimate strength of the tendon, whichever is the lesser.

7.9.2 Tensioning with Two Jacks

a. Tensioning from Both Ends Simultaneously

In general, the prestressing operation shall be carried out by jacks at each end operating simultaneously. Every endeavour shall be made to keep almost identical forces at each jack throughout the tensioning operation which shall continue until the required force in the jacks is reached or until the sum of the elongations equals the total elongation required.

b. Tensioning Initially from One End

This procedure shall be used to determine friction losses when requested by the Engineer. Jacks shall be connected at both ends of each tendon. One jack shall be extended by at least 25 mm prior to connecting the second jack. The slack in the tendon shall be taken up, and the tendon stressed initially from the jack which was not extended (leading jack). The non-stressing jack (trailing jack) shall be set so that the force transmitted to this end may be recorded. Stressing from one end shall continue until the elongation is approximately 75 percent of the total the trailing jack end. Stressing shall then continue by working the trailing jack only, until both jacks are registering the same force. Both jacks shall then be worked, keeping forces equal, until tensioning is completed.

7.9.3 Tensioning with One Jack

Where shown on the Drawings or where consented to by the Engineer the tendons may be tensioned by means of one jack only. Tendons shall be marked for measurement of elongation at both the jacking end and the anchored end where possible, and allowance shall be made for any draw-in of the tendon at the anchored end. Where tendons are coupled together allowance shall be made for any draw-in movement at the coupling.

Friction losses shall be measured, by methods acceptable to the Engineer, if required.

7.10 GROUTING

7.10.1 General

Precautions against injury to workmen similar to those during tensioning shall be observed as far as applicable during grouting.

Unless otherwise consented to by the Engineer, tendons shall be grouted within 48 hours after completion of stressing. (Note also the requirements of Section TS 7.6.2).

The Contractor shall submit his proposals for grouting to the Engineer for his consent. The grouting shall be carried out in such a manner that the ducts are completely filled with a dense and uniform grout.

Before grouting, prestressing anchorages shall be sealed to prevent loss of grout. If it is necessary to cut the tendons to enable the ducts to be grouted, this shall be delayed as long as practicable up to the time grouting.

Grouting shall not be carried out when the temperature of the grout is more than 35 degrees Celsius.

7.10.2 Grout

a. Materials

Grout shall consist of cement and water but may, with the consent of the Engineer, contain an additive to increase workability and reduce shrinkage and bleeding. It shall comply with the requirements of Clause 3.1.2.3 of this Specification. Cement shall conform to the requirements of AASHTO M 85 (ASTM C 150) 'Portland Cement', shall be free from calcium chloride and shall be less than one month old. Additives shall be free from any product liable to damage the steel or the grout itself, such as chlorides, nitrates and sulphides.

The total dissolved salts contained in the water shall not exceed 1000 ppm and dissolved chlorides shall not exceed 330 ppm.

The water-cement ratio should be as low as possible consistent with adequate workability but shall not exceed 0.50 without the consent of the Engineer.

b. Properties

The minimum compressive strength of a 75 mm test tube shall be 30 MPa (300 kg/cm^2) at 28 days.

The bleeding of the grout shall not exceed 2 percent of the volume three hours after mixing and a maximum of 4 percent of the volume at any time. In addition, the separated water must be reabsorbed after 24 hours.

Bleeding shall be measured in a metal or glass cylinder with an internal diameter of approximately 100 mm and with a height of grout approximately 100 mm and with a height of grout approximately 100 mm. During the test the cylinder shall be covered to prevent evaporation.

7.10.3 Mixing and Pumping Equipment

Mixing and pumping equipment shall be subject to the consent of the Engineer. A separate mixer shall be provided when necessary to ensure a continuous supply of grout for long ducts. Grout shall be mixed in a high speed mechanical mixer, for at least 2 minutes, until a uniform colloidal consistency is produced. Mixing by hand, or by a tumbling action will not be permitted.

Pump hoppers shall be fitted with 1.18 mm sieve strainers.

Pumps shall be capable of continuous operation with pressure variation less than 5 percent, and shall have a system for recirculating the grout while actual grouting is not in progress. Pumps shall be fitted with a pressure gauge and shall be capable of delivery at pressure up to 1.0 MPa (10 kg/cm^2). The use of compressed air will not be permitted.

All piping to the grout pump shall have as few bends, valves and changes in diameter as possible.

All pipes and fittings shall have a minimum internal diameter of 20 mm.

7.10.4 Grouting

Just prior to grouting the ducts shall be flushed out with clean water until all loose particles are removed and clear water is discharged. The ducts shall then be water tested and shall be capable of sustaining a pressure of at least 0.5 MPa (5 kg/cm^2) without major leakage. Any leaks shall plugged to the satisfaction of the Engineer. Where water testing establishes that there is leakage between two adjacent ducts which cannot practically be rectified, the two ducts are to be grouted simultaneously with two grout pumps. Prior to grouting, all water shall be blown out of the ducts with compressed air.

Water shall be added to the mixer first, then the cement shall be added gradually, and the grout stirred continuously until pumped into the duct. Additives shall be added to the mix in accordance with the manufacturer's recommendations or as directed by the Engineer.

The methods of injecting grout should ensure that each duct is completely filled in one continuous operation. Grout shall be used within 30 minutes of mixing. Grouting shall be effected from either the lowest anchorage or the lowest vent of the duct as directed by the Engineer.

Grout shall be injected into each duct at a speed of between 2 and 6 metres per minute. A continuous, steady flow of grout shall be maintained until the duct is completely filed and the consistency of the grout flowing from the free end and

the vent openings is the same as that of the injected grout. The vents shall be progressively closed as required to ensure the complete filling of the duct. The grout pressure shall then be held at 0.7 MPa (7 kg/cm^2) for ten minutes.

During this period, bleed water shall be bled from the crest vents after five minutes and again at ten minutes. After this ten minutes period, the inlet vent shall be closed in such a way as to hold the pressure in the ducting at 0.7 MPa (7 kg/cm^2).

All vents and ends shall be kept closed until final setting of the grout has taken place.

If any leaks occur such that the pressure over the length of the duct cannot be maintained at 0.7 MPa (7 kg/cm^2) the grouting shall be stopped, the duct flushed clean with water and the leakage plugged before continuing with the grouting.

All equipment, especially piping, shall be thoroughly washed with clean water after each series of operations and more frequently if necessary. The intervals between washing shall not exceed three hours.

If a blockage occurs, pumping may be transferred without delay to the far end of the duct if there are sufficient vents to ensure that the duct will be filled with grout. Alternatively ducts may be flushed with clean water to clear the blockage.

The Contractor shall be endeavour to fully grout all ducts in one web during the course of one day. Where this cannot be achieved the ducts which have not been grouted shall be flushed with clean water then blown dry with oil-free compressed air.

The Contractor shall be responsible for the complete filling of the ducts with grout and shall record the amount of grout injected into each duct and submit the records to the Engineer within two days of the completion of grouting.

If several blockages occur the grout mix may be rejected and a new mix designed.

7.10.5 Precautions After Grouting

The filled ducts shall be protected to the satisfaction of the Engineer to ensure that they are not subjected to shock or vibration for one day.

Post-tensioned members shall not be moved and shall not have any external loads applied until seven days after grouting. All ducts openings shall be inspected two or three days after grouting and topped up if necessary.

7.11 CONCRETING OF ANCHORAGE RECESSES

Wires or strands shall not be cut or bent within 300 mm of the anchorages until seven days after grouting. The tendons shall be cut back to give a minimum of 30 mm cover after concreting of the recesses. Flame cutting within 50 mm of the anchorages will not be permitted. Flame cutting shall be done under the supervision of the Engineer and care taken to ensure that the flame does not play on the anchorages or on the tendon within 50 mm of the anchorage.

Prior to concreting, the interior surfaces of the anchorages recesses shall be scrabbled and coated with a wet-to-dry epoxy resin bonding agent as consented to by the Engineer.

Concrete, in accordance with the requirements of Section TS 3 of this Specification shall be cast in the recesses to shape shown on the Drawings.

7.12 PAYMENT

Measurement and Payment for Post-tensioned 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 rates and lump sums entered in the priced Bill of Quantities for works which incorporate the requirements of Post-tensioned Prestressed Concrete. 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) Supply, handling and placing of ducts, anchorages and tendons, the stressing and grouting of the prestressing system and concreting of anchorage recesses and no separate payment will be made for any of these.

Post-tensioned precast concrete members will be paid for in accordance with Clause 4.15 of this Technical Specification and no separate payment will be made for the furnishing of prestressing materials or the prestressing of precast members.

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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 installation of bearings is covered in Section TS 11 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 stringline 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.