DEPARTMENT *of* INFRASTRUCTURE, ENERGY *and* RESOURCES, TASMANIA

BRIDGEWORKS SPECIFICATION

B12 - PRESTRESSED CONCRETE BEAMS OCTOBER 2006

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B12.1 SCOPE

This specification covers the supply of all materials, the manufacture, handling, storage at works and/or on site, delivery to site and erection of precast prestressed or post-tensioned beams onto their bearings.

B12.2 OBJECTIVE

To ensure that prestressed and post-tensioned precast concrete beams are manufactured and installed to provide a durable concrete structure with the required load carrying capacity.

B12.3 REFERENCES

The following Australian and British Standards apply:

A.S. 1012 Methods of testing concrete

A.S. 1310 Steel wire for tendons in prestressed concrete

A.S. 1311 Steel tendons for prestressed concrete - Wire stress relieved steel strand for tendons in prestressed concrete

A.S. 1313 Steel tendons for prestressed concrete. Cold worked high tensile alloy steel strand bars for prestressed concrete

A.S. 1349 Bourdon tube pressure & vacuum gauges

A.S. 1379 Specification and supply of concrete

A.S. 1391 Methods for tensile testing of metals

A.S. 1554 Structural steel welding Part 3 Reinforcing steel

A.S. 1554 Structural steel welding Part 6 Stainless steel for structural purposes

A.S. 1720 Timber structures code

A.S. 2082 Visually Stress graded Hardwood for Structural Purposes

A.S. 2271 Plywood and Block Board for External Use

A.S. 2701 Methods of Sampling & Testing Mortar for Masonry Construction

A.S. 3600 Concrete Structures

A.S. 3610 Formwork for Concrete

A.S. 4671 Steel Reinforcing Materials

B.S. EN 10088-1 Stainless steels. Part 1 List of stainless steels

B.S. 6744 Austenitic stainless steel bars for the reinforcement and use in concrete

Specifications

- B10 Supply of Concrete.
- B11 Reinforced, Prestressed and Mass Concrete
- B14 Precast Concrete Units
- B25 Bridge Fence and Miscellaneous Steelwork

B12.4 MANUFACTURE

B12.4.1 General

Concrete shall comply with Specification B10. Manufacture shall comply with the requirements of Specifications B11 and B14.

B12.4.2 Reinforcement

Reinforcement supply and placement shall be in accordance with Specification B11.

Full strength butt welds for ligatures in the end blocks of girders shall be formed using the flash butt welding method described in AS 1554 Part 3.

B12.4.3 Tendons

(i) Material

- Tendons used for longitudinal stressing shall consist of uncoated, stress relieved, low relaxation 7-wire strand complying with AS 1311. Copies of the Manufacturer's test certificates for the tendons shall be submitted to the Superintendent. All coils of tendons shall be capable of being identified with the test certificates.
- The material selected for use in the tendons shall have an ultimate tensile strength not less than the value specified on the Drawings and shall not be galvanised.
- The tendons shall be supplied in coils of a sufficiently large diameter so that they are straight as they unwind from the coils. Kinked or damaged tendons will not be permitted.

(ii) Testing

Physical testing of tendons will not be required provided that a satisfactory correlation is obtained between the jacking force and extension during the stressing operation. However, if such correlation is not obtained, or if the tendon exhibits any peculiarities as referred to in AS 1311 usage of such tendons shall cease until physical tests have been made at a NATA registered laboratory. Two samples each 1.4 metres long from the coil in question shall be taken and tested for ultimate tensile strength, 0.1% proof stress, 0.2% proof stress, secant modulus of elasticity or stressing load and percentage elongation at rupture on a 600 mm gauge length. These samples shall not be taken from within 1.5 metre of the end of the coil.

(iii) Fabrication

- No tendon containing splices shall be used.
- No welding shall be permitted on or near tendons, nor shall any heat be applied to tendons. Any tendons which have been affected by welding, weld spatter and/or heat, or otherwise damaged shall be rejected and shall be replaced by the Contractor at its expense.
- 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.

(iv) Storage and Cleaning

- Coils of tendons shall be protected from the weather, chlorides, urea and other aggressive substances, and shall not be placed in direct contact with the ground.
- All lubricant used in the drawing of the tendon shall be thoroughly removed by a suitable degreasing agent. No rust shall be permitted on the tendons.

B12.4.4 Sheathing

Sheathing shall be of a type suitable for the prestressing system to be used and shall be strong enough to withstand the placing and compaction of the concrete without suffering damage or deformation.

- The sheathing and all splices shall be mortar tight.
- Sheathing shall be stored off the ground and protected from the weather at all times.
- The Manufacturer's test values for the friction coefficients of the proposed sheathing shall be confirmed by the Contractor.

B12.4.5 Bond Release Material

Where indicated on the Drawings, bond release tape, or other approved material, shall be wrapped around tendons and shall be continued through the end forms for at least 25mm.

B12.4.6 Anchorage Devices

Anchorage devices shall comply with AS 1314 Prestressing Anchorages.

They shall be capable of withstanding a force not less than 95 percent of the ultimate tensile strength of the tendon without damage or excessive draw-in or deformation. Spiral and other reinforcement specified by the manufacturer as being required as part of the anchorage devices shall be incorporated in the works in accordance with the sizes and dimensions recommended by the manufacturer for the prestressing system to be used.

Damaged or used anchorage components shall not be permitted.

Components shall be handled and stored so that mechanical damage and detrimental corrosion are prevented. They shall be kept free from chlorides, urea, dirt, mortar, loose rust, tar, paint, oil or any other deleterious matter.

B12.4.7 Miscellaneous

Lifting eyes shall be in accordance with Specification B25.

B12.5 PLACING OF POST-TENSIONING COMPONENTS

B12.5.1 Sheathing

Sheathing shall be securely fixed throughout its length, by methods that will hold it in position and resist movement due to flotation, concrete placement or vibration and do not damage or deform it. Joints between the sheathing and any other part of the prestressing system shall be effectively sealed to prevent entry of mortar, dust, water or other deleterious matter.

B12.5.2 Tendons

Tendons shall be handled with care, and be pulled through the sheathing in such a manner as to avoid damage or contamination to either the tendon or sheathing.

Any damaged or contaminated tendons shall be replaced at the Contractor's expense.

B12.5.3 Anchorages

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

The anchorage devices shall be cleaned prior to the placing of concrete.

B12.5.4 Grout Holes

Grout holes shall be provided at both ends of the ducts and shall be at least 10 mm diameter. The ends of the grouting holes shall be equipped with a plug, valve or similar device capable of withstanding a grout pressure of 700 kPa without loss of water or air. Additional vents with plug valves shall be provided at high and / or low points of the duct to bleed air or water and to ensure the duct is completely filled after grouting.

B12.6 TOLERANCES

Beams shall conform to the following dimensional tolerances:

a) Variations in cross section

(1) Dimensions up to 200 mm -0 to +4 mm

(2) 200 mm and above -0 to +7 mm

b) Variation in length -7 to +7 mm

or -0.06% to +0.06% of length of beam whichever is the greater

c) Twist - 0.5 deg. per length of beam

d) Straightness of edges and flatness of surfaces $\frac{\text{Length}}{1000}$

e)	Maximum Vertical hogs (at stress transfer)		Length / 300
f)	Maximum variation in hog between beams		20 mm
g)	Maximum deviation in the horizontal plane (bow)		-7 to +7 mm
	or 0.06% to +0.06% of length of beam whichever is the greater		
h)	Warp		
	1)	Up to 5 m diagonal	7 mm
	2)	Over 5 m diagonal	10 mm
i)	Accuracy of corners		
	1) up to 2m		4 mm
	2) over 2 m and up to 4 m		5 mm
	3) over 4 m		7 mm
j)	Spacing and position of tendons		-1.5 to +1.5 mm
k)	Bearing seating		
	Maximum deviation from design plane		1mm

B12.7 PRECAUTIONS AFTER TENDON INSTALLATION AND CONCRETING

The Contractor shall ensure that ducts are clear of obstructions and allow free movement of the tendons.

The Contractor shall prevent damage to the ducts caused by any water freezing in the ducts prior to grouting.

B12.8 TENSIONING OPERATIONS

B12.8.1 General

Stressing shall not be carried out without 24 hours prior notice being given to the Superintendent. The stressing operation shall be performed under the supervision of a competent person provided by the Contractor.

No tendons shall be stressed if they are at a temperature of 0^{o}C or below. In addition, the air temperature must be 5^{o}C or above.

B12.8.2 Equipment

All tensioning equipment shall be calibrated as a complete unit by a NATA registered laboratory at least annually in order to give a correlation between the force applied to the tendon and the reading indicated by the pressure gauge.

Pressure gauges shall comply with the requirements of A.S. 1349 for industrial gauges. NATA endorsed test certificates showing such compliance shall be kept in the site office of the Contractor.

B12.8.3 Tensioning Force Required

At least 1 week prior to stressing the Contractor shall provide detailed calculations of extensions corresponding to the required tension force at the anchorage, as shown on the Drawings, to the Superintendent.

These calculations shall be based on the secant modulus determined from the test certificates or test samples and the expected jack and anchorage friction.

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

Under no circumstances shall the maximum jacking force exceed the rated capacity of the jacking equipment used or 85% of the specified minimum ultimate tensile strength of the tendon, whichever is the lesser.

True extension of the tendon shall be considered to be the sum of the measured extension and the zero corrected value of the extension obtained by application of the initial tension minus the amount of pull-in at anchorages and anchorage movements (if any).

Whenever the actual extension and the calculated extension differ by more than 5% the Superintendent shall be advised.

B12.8.4 Stressing Procedure

(i) General

- The stressing operation shall be performed in accordance with best practice applicable to the particular system approved.
- The sequence of stressing shall be as shown on the Drawings.
- No structural member shall be left partly stressed unless the Drawings require the member to be stressed in stages.
- After taking up the slack, the tendon shall be accurately marked at both ends and elongations or draw-in measured from these markings.
- 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, a compensating increase in the elongation of the remaining tendons of the group will be permitted 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 tolerance specified above is exceeded, the tendon shall be released, replaced and re-stressed.

(ii) Tensioning with one jack

- Unless otherwise stated on the Drawings, 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, and allowance shall be made for any draw-in of the tendon at the anchored end.

(iii) Stressing Records

The Contractor shall keep records of the stressing operation as follows:

(a) Identification number of dynamometers, gauge, pump and jack.

(b) Identification particulars of tendons.

(c) Initial forces (or pressures) when tendons are marked for measurement of elongation.

(d) Final forces (or pressures) and elongation obtained on completion of tensioning.

(e) Elongation remaining after anchoring.

(f) Elongation obtained at intervals during tensioning, together with corresponding forces (or pressures).

(g) Measured beam hog at transfer of prestress.

(h) Beam identification and date of casting and stressing

Copies of the stressing records of all tendons for a particular beam shall be forwarded to the Superintendent within 24 hours after transfer of prestress.

B12.9 GROUTING

B12.9.1 General

Tendons shall be grouted as soon as practicable, but not more than 48 hours after fully stressing the tendons.

B12.9.2 Preparation of the Ducts before Grouting

Prestressing anchorages shall be sealed to prevent loss of grout.

The duct shall be water tested for blockages and shall be capable of sustaining a pressure of at least 700 kPa without leakage. Any leaks shall be plugged.

All surplus water shall be removed from the ducts prior to grouting.

B12.9.3 Materials

Grout for filling prestressing sheathing shall consist of normal Portland cement, water and an additive to reduce shrinkage and bleeding.

The maximum water-cement ratio shall be 0.40 by mass.

B12.9.4 Properties

The minimum compressive strength of 75 mm test cubes made of grout shall be 30 MPa at 28 days - 2 cubes to be taken from each day's grout material. Test cubes shall be made and cured in accordance with AS 2701.4.

The bleeding of the grout shall not exceed 2% of the volume 3 hours after mixing and shall not exceed 4% of the volume at any time.

All separated water shall be absorbed within 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 of approximately 100 mm. During the test the container shall be covered to prevent evaporation. At least one bleeding test shall be carried out for each day's grouting.

B12.9.5 Mixing and Pumping Equipment

Grout shall be mixed until a uniform colloidal consistency is produced. Mixing by hand, or by a tumbling action, will not be permitted.

Grout shall be mixed and pumped into place not more than 1 hour after the addition of cement to the mix.

Pumps shall be capable of continuous operation with little pressure variation, and shall have a system for recirculating the grout whilst actual grouting is not in progress. Pumps shall be fitted with a pressure gauge and shall be capable of delivery at pressures up to 1000 kPa. The use of compressed air will not be permitted.

All equipment, especially piping, shall be maintained in a clean condition.

B12.9.6 Grouting

Grouting shall not be carried out while the air temperature is below 5 deg. C, or while the shade temperature exceeds 32 deg. C. A continuous, steady flow of grout shall be maintained until the duct is completely filled and pure grout issues from all vents and all entrapped air has been expelled.

The vents shall be progressively closed as required to ensure the complete filling of the duct. The grout pressure shall then be held at 700 kPa for ten minutes. During this period bleed water shall be bled from the crest vents at five minutes and just prior to the end of the period. After this ten minute period the inlet vent shall be closed in such a way as to hold the pressure in the duct at 700 kPa. If any leaks occur such that the pressure over the length of the duct cannot be maintained at 700 kPa, the grouting shall be stopped, the duct flushed clean with water and the leakage plugged before continuing with grouting.

The quantity of materials shall be such as to enable the completion of grouting of whole duct(s) (allowing 10% wastage) without interruption.

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

All duct openings shall be inspected two or three days after grouting and topped up if necessary.

In the event of difficulties occurring due to a blockage which prevents a duct from being completely filled with grout the grouting shall be stopped, the duct flushed clean with water and the blockage removed before continuing with grouting.

B12.9.7 Transfer of Prestress

(i) Post Tensioned Beams

After the grout has hardened sufficiently any vents or grouting tubes which extend to the surface of the concrete shall be cut off 25 mm below the concrete surface and the recess plugged with an approved concrete repair mortar.

Tendons shall not be cut until 5 days after grouting. The tendons shall be cut back to give a minimum of 25 mm cover on post tensioned beams.

Concreting of recesses at the ends of the beams, where required, shall be carried out in accordance with Specification B11.

Where there is no diaphragm to be constructed immediately adjacent to the ends of beams the recesses may be concreted before erection. Before concreting, the recesses shall be roughened lightly by abrasive blasting and a "wet to dry" epoxy shall be applied to the whole of the end faces of the beams in accordance with the manufacturer's instructions.

Where a diaphragm is to be constructed immediately adjacent to the ends of beams the concreting of the ends of the beams shall be carried out with the relevant diaphragm. In this case, the ends of the beams shall be roughened lightly by abrasive blasting the concrete face prior to erection of the beams.

(ii) Prestressed Beams

Transfer of prestress shall not be carried out until the concrete has attained the specified transfer strength as proved by standard test cylinders, manufactured and cured for this purpose.

The transfer shall be carried out by jacks, detensioning screws or by other approved mechanical means. Flame releasing shall not be allowed. Shock releases shall NOT be permitted; if tendons should fail suddenly, the Superintendent may order load testing of any beams so affected. Special care shall be taken to ensure that the force in any tendon never exceeds 85 percent of the specified ultimate tensile strength of the tendon.

After the transfer of prestress, severed tendons shall be trimmed flush with the end of the beams using abrasive disc grinders without damaging the concrete.

After trimming, the ends of the tendons and the area immediately adjacent to the tendons shall be painted with an epoxy compound to provide a film thickness at least 0.3 mm dry or 0.6 mm wet. A minimum of two coats shall be applied.

B12.10 MARKING, HANDLING AND DELIVERY

B12.10.1 Marking of Beams

Beams shall be identified as specified in B14.

The final marking shall be made by indelible marking material using letters approximately 75 mm high.

B12.10.2 Lifting, Handling and Stacking of Beams

Beams shall be lifted, handled and stacked in compliance with Specification B14.

No superimposed load shall be placed on a beam

B12.10.3 Delivery of Beams

Prior to delivery to the site for erection the Contractor shall verify that each beam exhibits satisfactory workmanship and finish, and complies with this Specification.

B12.11 ERECTION OF BEAMS

The Contractor shall submit detailed proposals for the erection of the beams in their permanent position to the Superintendent at least two weeks before commencing this operation.

Beams shall not be erected in their permanent position unless they have attained the required 28 day compressive strength and have been cured for the specified period.

Beams shall not be erected on their bearings if any gap is evident between the bearing pad and the bearing base. Bearing pad mortar shall be cured as specified prior to the placement of bearings and beams.

B12.12 PAYMENT

The rate in the Bill of Quantities for the manufacture of post-tensioned beams shall allow for providing all labour, materials, tools, equipment and any other work incidental to the supply and storage of the beams on the site including formwork, handling and placing tendons, sheathing, anchorages, reinforcement, lifting eyes, stressing and grouting, etc. For the purposes of payment under this item, the precasting yard shall be considered as an area of the site.

The rate in the Bill of Quantities for the manufacture of prestressed beams shall include full payment for providing all labour, materials, tools, equipment and any other work incidental to the supply and delivery of the beams to the storage area. Payment for this item shall include formwork, handling and placing tendons, bond release tape, reinforcement, lifting hooks, stressing, prestress transfer and all other items covered by the Specification. For the purpose of payment under this item the precasting yard shall be considered as an area of the site.

The rate in the Bill of Quantities for the erection of beams shall include full payment for providing all labour, materials, tools, equipment and any other work incidental to removing the beams from storage and placing them in their final position on the bearings.

All materials, tools and equipment supplied by the Contractor which do not form part of the completed works shall remain the property of the Contractor unless specified otherwise.

B12.13 HOLDPOINTS

The following Holdpoints have been identified in this Specification.

- Damage to tendons (B12.5.2)
- Prior to stressing operations. (B12.8.1,3)
- Stressing extensions or forces exceed the specified tolerance. (B12.8.3)
- Incomplete Grouting or pressure loss of a duct (B12.9.6)
- Shock loading during tendon release (B12.9.7)
- Prior to erection of beams. (B12.11)

B12.14 INFORMATION TO BE INCLUDED IN CONTRACT MANAGEMENT PLAN

The following information to be included in the Contract Management Plan has been identified in this Specification:

- Manufacturer's test certificates for tendons (B12.4.4)

- Manufacturers friction data for sheathing (B12.4.5)
- Name of competent person to supervise stressing operation (B12.8.1)
- Test documentation for stressing equipment (B12.8.2)
- Stressing record pro-forma (B12.8.4)