

Structures

Master Specification

ST-SC-C1 Pre-Tensioned Concrete

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ST-SC-C1 Pre-Tensioned Concrete

1 General

- 1.1 This Part specifies the requirements for the production of pre-tensioned prestressed concrete.
- 1.2 The definitions in AS5100: Bridge Design Part 5: Concrete apply to this part.
- 1.3 Unless specified otherwise, all design and / or documentation must comply with the most recent revisions (including published amendments) of the following design standards and / or specifications:
 - a) AS 1314 Prestressed Anchorages.
 - b) AS 1349 Bourdon Tube Pressure and Vacuum Gauges.
 - c) AS 4672.1 Steel prestressing materials – General Requirements.
 - d) AS 4672.2 Steel prestressing materials – Testing Requirements.
 - e) AS 5100 Bridge Design.
 - f) Work Health and Safety Act (SA) 2012.
 - g) Work health and Safety Regulations (SA) 2012.
 - h) Worksafe Victoria: “Construction and Erection of Bridge Beams”, available from <https://www.worksafe.vic.gov.au/>.
 - i) Australian Certification Authority for Reinforcing Steel (ACRS), available from <https://www.acrs.net.au/>.

2 Quality Requirements

- 2.1 Prestressed concrete members shall be manufactured under a quality system certified to AS 9001.
- 2.2 All testing and certification required under this Part shall be carried out by a NATA accredited laboratory.
- 2.3 The Contractor shall prepare and implement a Quality Plan that at a minimum includes the documents, procedures and / or instructions listed in this Clause. If not provided beforehand, the procedures shall be submitted at least 28 days prior to the commencement of tensioning.
- 2.4 Provisions of the procedures listed in this Clause shall constitute a **Hold Point**. These procedures are:

Safety:

- a) Procedures / Safety Plan to ensure the safety of all persons during production, including details of no-go zones and protective barriers to prevent injury in the event of equipment failure;
- b) for precast bridge beams, full details of how the requirements of Section 4 “Manufacture” of the Worksafe Victoria publication: “Construction and Erection of Bridge Beams” will be addressed;

Personnel

- c) details of experience of personnel supervising activities;

Tensioning of Tendons

- d) details of proposed tensioning equipment to be used and proof of its ability to carry out the work;
- e) calibration of equipment;
- f) recording of data;
- g) stressing sequence;

- h) method of determination of the initial force;
- i) checking for slippage and friction loss;
- j) handling and storage of tendons both in the coiled and made up states;
- k) safety precautions during tensioning;

Pre-Tensioning – Associated Works

Fabrication and Placing of Tendons:

- l) ensuring traceability of tendons;
- m) method of placing;
- n) layout of tendons at anchorages;
- o) method of deflection tendons, if appropriate;
- p) protection against corrosion;

Method of Tensioning Tendons:

- q) sequence of tensioning (for deflected strands);
- r) calculation of forces at anchorages and at member mid points;
- s) method of deflecting tendons, if appropriate;

Method of Transfer or Prestress:

- t) release of tendons at end of stressing bed, including sequence of release; and
- u) release of tendons between members.

3 Materials

Tendons

- 3.1 The manufacturer / processor of the tendons shall hold a valid certificate of approval issued by the Australian Certification Authority for Reinforcing Steel (ACRS). Refer to <https://www.acrs.net.au/>.
- 3.2 The Contractor shall provide:
 - a) details of the composition of the tendons;
 - b) test results in accordance with AS 4672.2 demonstrating compliance with AS 4672.1; and
 - c) load-extension graphs covering each coil to be used, taken from 3 representative samples, each 1.4m long, from each coil.
- 3.3 Provisions of the ACRS verification, details of tendon composition, evidence of compliance with AS 4672.2 and load extension graphs shall constitute a **Hold Point**.
- 3.4 Welding is not permitted on or near tendons. Heat shall not be applied to tendons. Tendons which have been affected by welding, weld splatter and / or heat will be considered as non-conforming. Flame cutting of wire or tendon within 75mm of where the tendon will be gripped by the anchorage or jacks is not permitted.

Traceability

- 3.5 Wire, strand, bars and anchorages shall be labelled in accordance with the requirements of AS 4672 or AS 1314. Individual lengths of wire, strand or bar shall be traceable from the point of manufacture of coils or lots to their final location by a unique identification number. Each Coil shall be clearly identified by use of a durable metal label to enable matching with the appropriate test certificates and load-extension graphs. Wire or strand not clearly identified shall not be used.

- 3.6 Anchorages shall be traceable from the place of manufacture to their final location by a unique identification number.

Handling, Storage and Fabrication of Materials

- 3.7 Materials shall be stored and handled in such a manner so that they are not damaged, contaminated or their physical properties altered. This includes:
- a) storage under a waterproof shelter;
 - b) being supported above ground level; and
 - c) kept free of all foreign matter on the surface.
- 3.8 Tendons shall be free of surface pitting, kinks and other damage. Ducts shall not be damaged or kinked. Anchorage steel components including threads shall be protected from corrosion by greased wrappings or plugs until required for use.

4 Tensioning Equipment

- 4.1 Dynamometers and each set of equipment comprising, pump, jack and pressure gauges shall be calibrated by an approved laboratory immediately prior to first use and then at intervals not exceeding 6 months and the true force at the jack determined from the calibration curve.
- 4.2 Pressure gauges shall:
- a) be concentric scale types gauges complying with AS 1349;
 - b) not be less than a nominal size of 150mm;
 - c) read between 50% and 80% of its full capacity when the tendon is stressed to 75% of its breaking load; and
 - d) be fitted with safety devices to protect pressure gauges against sudden release of pressure.
- 4.3 The measuring equipment used shall permit tendon force and elongation to be determined to an accuracy of $\pm 2\%$.

5 Safety

- 5.1 The Contractor's Safety Plan and / or procedures shall identify and manage the hazards to site personnel, other persons who might be affected by the stressing operation and nearby property and shall take the highest standard of care to ensure the safety of all affected persons and property in accordance with the provisions of the Work Health and Safety Act (SA) 2012 and the Work Health and Safety Regulations (SA) 2012.
- 5.2 The Contractor shall establish no-go zones with warning signs and substantial barricades in order to provide a protective barrier for site personnel, other persons and property and to prevent the entry of unauthorised persons into the hazard zone around and behind the jacking equipment.
- 5.3 Jacking and other site personnel shall not be permitted to stand behind the jack or close to the line of the tendons while stressing is in progress. During stressing operations, warning signs that conform to AS 1319 shall be displayed at both ends of the member being tensioned. The stressing jack shall be adequately supported and restrained in order to ensure that it cannot cause injury to personnel operating the jack equipment should the jack lose its grip on the tendons or should the tendon fail.

6 Tensioning of Tendons

General

- 6.1 The Contractor shall provide at least:
- a) 14 days' notice of the day that tensioning will commence; and
 - b) 24 hours' notice of the time that tensioning of each member will commence.

- 6.2 Provision of the above notices shall constitute a **Hold Point**.
- 6.3 Tensioning shall be performed only by personnel experienced in this type of work and in accordance with the Quality Plan. Concrete shall not be drilled or any portion cut or chipped away or otherwise disturbed after prestressing, unless prior approval has been obtained.

Stressing Bed and Anchorages

- 6.4 The bed shall be constructed such that it will withstand the concentrated loads resulting from the application of the prestress without settlement, deflection or distortion. The anchorages shall prevent slip occurring before transfer of prestress to the members.

Placing of Tendons

- 6.5 Suitable devices shall be provided to ensure that the correct positioning of the tendons is maintained during casting. During placement, care shall be taken to prevent tendon surface contamination with foreign substances.

Tensioning Force Required

- 6.6 The required force shown on the drawings shall be achieved at the middle of the member immediately after all tendons have been anchored to the ends of the stressing bed.
- 6.7 The jacking force applied shall allow for any anticipated slip at the anchorage devices, wedge draw-in, friction losses and temperature changes.
- 6.8 Unless specified otherwise, the Contractor shall carry out trial stressing operations to establish the frictional resistance and also to confirm that the stated wedge draw-in is consistent with the type of jack and operator technique proposed.

Tensioning Procedure

- 6.9 In order to remove slack and to lift tendons off the bed floor, an initial force shall be applied to 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.
- 6.10 After application of the initial force, the tendon shall be accurately reference marked at both the jacking end and the dead end of the stressing bed, and at couplers if used, and elongations, slip and draw-in measured from these reference marks.
- 6.11 The tensioning force applied to any tendon shall be measured by direct reading of the pressure gauges and checked by comparison of the measured elongation with the elongation calculated from the load-extension graphs.

Tendon Failure

- 6.12 Should any tendon fail before the concrete has been placed the tendon shall be replaced. Should any tendon in any member fail after the concrete has been placed the member shall be considered as nonconforming and a **Hold Point** shall apply.

Transfer of Prestress

- 6.13 Prior to the transfer of prestress, a **Hold Point** shall apply.
- 6.14 The prestressing force shall not be applied to the member(s) until all the concrete in the member(s) has attained the required compressive strengths shown on the Drawings. If the member(s) has been steam cured, the prestressing force shall not be applied until the temperature of the concrete has cooled to ambient air temperature.
- 6.15 Prior to transfer of the force to the member(s), all tendons shall be checked for slip at the reference marks and any tendons showing any increase in slip shall be deemed to be non-conforming. The tendons shall be marked at each end of every member prior to transfer to allow measurement of the pull-in to the concrete. Tendons shall be released gradually in such a manner as to minimise the

shock of transfer of stress to the member(s). Under no circumstances shall tendons be severed while under tension.

- 6.16 Unless otherwise shown on the Drawings, on completion of the transfer of prestress the projecting lengths of tendons shall be cut off with a high speed abrasive disc or wheel so as to be flush with the end surface of the member. Flame cutting shall not be used.

Permissible Pull-in of Tendons

- 6.17 The maximum pull-in at transfer of any tendon shall not exceed 3 mm at any end. Pull-in exceeding this amount shall constitute a **Hold Point**. The cause of excessive pull-in shall be reported and investigated. Excessive pull-in may be considered as non-conforming.

Method of Tensioning

- 6.18 If the stressing sequence is not shown on the Drawings, the release of pre-tensioned tendons shall be done in such a sequence that produces a minimum of eccentric force in the member.
- 6.19 Only under exceptional circumstances and only with prior approval shall the maximum jacking force exceed 80% of the rated capacity of the jacking equipment used, or 85% of the specified minimum ultimate strength of the tendon or 75% of the minimum ultimate strength of the bar.
- 6.20 If, during tensioning, the check measurement of any individual strand elongation differs from its required value by +10% or -5%, a **Hold Point** shall apply. If the average measured extension of a group of tendons anchored at the same anchorage differs by more than $\pm 7\%$, a **Hold Point** shall apply.

Cutting of Tendons

- 6.21 Flame cutting of strands at unit ends is not permitted. Unless shown otherwise on the drawings, strands shall be friction cut, flush with the concrete surface. The exposed ends of the tendons and the concrete surface within 50 mm of the tendons shall be abraded to provide a clean sound surface. Strand cutting and coating shall be undertaken no earlier than 3 days after de-moulding of beams. A liberal coating of high build non-sagging epoxy paste shall then be applied over the ends of the tendons and abraded concrete, unless shown otherwise on the Drawings.

Data to be Recorded

- 6.22 The following data, where applicable, shall be recorded and submitted as soon as practicable:
- identification number of each dynamometer, gauge, pump and jack;
 - identification particulars of tendons;
 - initial forces / pressures and elongations;
 - final forces / pressures and elongations;
 - elongations obtained at all stages during tensioning, together with corresponding forces / pressures;
 - elongations and forces / pressures when resetting of jacks is required;
 - draw-in at both ends of tendons (where applicable);
 - draw-in of auxiliary wedges at the rear of the jack (where applicable); and
 - hog of individual members, measured to the nearest 1.0 mm at the mid-length point of the member, immediately after transfer of prestress.

7 Hold Points

- 7.1 The following is a summary of hold Points referenced in this Part:

| Document Ref. | Hold Point | Response Time |
|---------------|--------------------------|---------------|
| 2.4 | Submission of Procedures | 7 days |

| Document Ref. | Hold Point | Response Time |
|---------------|--|--|
| 3.3 | Supply of Tendons | 14 days |
| 6.2 | Notification of Tensioning | 1 day |
| 6.12 | Failure of a Tendon | Refer Clause 6.12 "Tendon Failure" |
| 6.13 | Prior to transfer of prestress | 2 hours |
| 6.17 | Excessive tendon pull-in | Refer Clause 6.17 "Permissible Pull-In of Tendons" |
| 6.20 | Unacceptable elongation correlation during stressing | Refer Clause 6.20 "Method of Tensioning" |

8 Verification Requirements and Records

- 8.1 The Contractor shall supply written verification that the following requirements have been compiled with and supply the verification with the lot package.

Table ST-SC-C1 8-1 Verification Records

| Document Ref. | Subject | Record to be Provided |
|---------------|------------|--|
| 6.22 | Tensioning | Records specified in Clause 6.22 "Data to be Recorded" |