

# Master Specification Part ST-SC-C1

## Pre-Tensioned Concrete

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## ST-SC-C1 Pre-Tensioned Concrete

### 1 General

- a) This Master Specification Part specifies the requirements for the production of pre-tensioned prestressed concrete, including:
  - i) the documentation requirements, as set out in section 2;
  - ii) the materials requirements, as set out in section 3;
  - iii) the tensioning equipment requirements, as set out in section 4;
  - iv) the safety requirements, as set out in section 5;
  - v) the tensioning of tendons requirements, as set out in section 6;
  - vi) the Hold Point and Witness Point requirements, as set out in section 7; and
  - vii) the verification requirements and records, as set out in section 8.
- b) The production of pre-tensioned prestressed concrete must comply with:
  - i) the Reference Documents, including:
    - A. AS 1314 Prestressing anchorages;
    - B. AS 1319 Safety signs for the occupational environment;
    - C. AS 1349 Bourdon tube pressure and vacuum gauges;
    - D. AS 4672.1 Steel prestressing materials, Part 1: General requirements;
    - E. AS 4672.2 Steel prestressing materials, Part 2: Testing requirements;
    - F. AS 5100.5 Bridge design, Part 5: Concrete;
    - G. AS/NZS ISO 9001 Quality management systems - Requirements;
    - H. Worksafe Victoria: "Construction and Erection of Bridge Beams" (available from <https://www.worksafe.vic.gov.au/>); and
  - ii) all applicable Laws, including:
    - A. *Work Health and Safety Act (SA) 2012*; and
    - B. *Work Health and Safety Regulations (SA) 2012*.
- c) Prestressed concrete members must be manufactured under a quality system certified to AS/NZS ISO 9001 Quality management systems - Requirements.
- d) All testing and certification required under this Master Specification Part must be carried out by a NATA accredited laboratory.

### 2 Documentation

#### 2.1 Construction Documentation

In addition to the requirements of PC-CN3 "Construction Management", the Construction Documentation must include the following documents, procedures, and instructions:

- a) the procedures or safety plans to ensure the safety of all persons during production of pre-tensioned prestressed concrete, including details of no-go zones and protective barriers to prevent injury in the event of equipment failure, including the requirements of section 5a);

- b) for precast bridge beams, details of how the requirements of the Worksafe Victoria: “Construction and Erection of Bridge Beams” will be addressed;
- c) details of the experience of the personnel supervising activities;
- d) in relation to tensioning of tendons, details of:
  - i) the proposed tensioning equipment to be used and proof of its ability to carry out the work;
  - ii) the calibration of equipment;
  - iii) the recording of data;
  - iv) the stressing sequence;
  - v) the method of determination of the initial force;
  - vi) the checking for slippage and friction loss;
  - vii) the handling and storage of tendons both in the coiled and made up states; and
  - viii) the safety precautions during tensioning;
- e) in relation to fabrication and placing of tendons, details of:
  - i) the method of ensuring traceability of tendons;
  - ii) the method of placing;
  - iii) the layout of tendons at anchorages;
  - iv) the method of deflection tendons, if appropriate; and
  - v) the protection against corrosion;
- f) in relation to method of tensioning tendons, details of:
  - i) the sequence of tensioning (for deflected strands);
  - ii) the calculation of forces at anchorages and at member mid points; and
  - iii) the method of deflecting tendons, if appropriate; and
- g) in relation to method of transfer or prestress, details of:
  - i) the release of tendons at end of stressing bed, including sequence of release; and
  - ii) the release of tendons between members.

## 2.2 Quality Management Records

In addition to the requirements of PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable), the Quality Management Records must include:

- a) the evidence relating to the tendons required in section 3.1a) and 3.1b);
- b) the evidence relating to wedge draw-in required in section 6.4c); and
- c) the verification records required by Table ST-SC-C1 8-1.

## 3 Materials

### 3.1 Tendons

- a) The manufacturer / processor of the tendons must hold a valid certificate of approval issued by the Australasian Certification Authority for Reinforcing and Structural Steels (ACRS), which

must be provided as part of the Quality Management Records (refer to: <https://www.acrs.net.au/>).

- b) The Contractor must provide as part of the Quality Management Records:
  - i) details of the composition of the tendons;
  - ii) test results in accordance with AS 4672.2 Steel prestressing materials, Part 2: Testing requirements demonstrating compliance with AS 4672.1 Steel prestressing materials, Part 1: General requirements; and
  - iii) load-extension graphs covering each coil to be used, taken from 3 representative samples, each 1.4 m long, from each coil.
- c) Evidence of compliance with sections 3.1a) and 3.1b) will constitute a **Hold Point**. Installation of the relevant tendons must not commence until this Hold Point has been released.
- d) Welding is not permitted on or near tendons.
- e) Heat must not be applied to tendons.
- f) Flame cutting of wire or tendon within 75 mm of where the tendon will be gripped by the anchorage or jacks is not permitted.
- g) Tendons which have been affected by welding, weld splatter or heat will be considered a Non-Conformance and the associated Hold Point set out in PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable) will apply.

### 3.2 Traceability

- a) Wire, strand, bars, and anchorages must be labelled in accordance with the requirements of AS 4672 Steel prestressing materials, or AS 1314 Prestressing anchorages (as applicable).
- b) Individual lengths of wire, strand, and bar must be traceable from the point of manufacture of coils or lots to their final location by a unique identification number. Each coil must 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 in accordance with this section 3.2b) must not be used.
- c) Anchorages must be traceable from the place of manufacture to their final location by a unique identification number.

### 3.3 Handling, storage and fabrication of materials

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

## 4 Tensioning equipment

- a) Dynamometers and each set of equipment comprising, pump, jack and pressure gauges must be calibrated by a NATA accredited 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.
- b) Pressure gauges must:

- i) be concentric scale types gauges complying with AS 1349 Bourdon tube pressure and vacuum gauges;
  - ii) not be less than a nominal size of 150 mm;
  - iii) read between 50% and 80% of their full capacity when the tendon is stressed to 75% of its breaking load; and
  - iv) be fitted with safety devices to protect pressure gauges against sudden release of pressure.
- c) The measuring equipment used must permit tendon force and elongation to be determined to an accuracy of  $\pm 2\%$ .

## 5 Safety

- a) The Contractor's safety plans or procedures, included as part of the Construction Documentation, must:
- i) identify and manage the hazards:
    - A. to site personnel;
    - B. other persons who might be affected by the stressing operation; and
    - C. nearby property; and
  - ii) 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*.
- b) The Contractor must 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.
- c) Jacking and other site personnel must 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 Safety signs for the occupational environment, must be displayed at both ends of the member being tensioned. The stressing jack must 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

### 6.1 General

- a) The Contractor must provide at least:
- i) 14 days' notice of the day that tensioning will commence, which will constitute a **Witness Point**; and
  - ii) 24 hours' notice of the time that tensioning of each member will commence, which will constitute a **Hold Point**. Tensioning of tendons for the relevant member must not commence until this Hold Point has been released.
- b) Tensioning must be performed only by personnel experienced in the tensioning of tendons. Concrete must not be drilled, or any portion cut or chipped away or otherwise disturbed after prestressing.

## 6.2 Stressing bed and anchorages

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

## 6.3 Placing of tendons

Suitable devices must be provided to ensure that the correct positioning of the tendons is maintained during casting, with tolerances in accordance with AS 5100.5 Bridge design, Part 5: Concrete. During placement of tendons, care must be taken to prevent tendon surface contamination with foreign substances.

## 6.4 Tensioning force required

- a) The required force shown on the Design Drawings must be achieved immediately after all tendons have been anchored to the ends of the stressing bed.
- b) The jacking force applied must allow for any anticipated slip at the anchorage devices, wedge draw-in, friction losses and temperature changes.
- c) The Contractor must 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. Evidence that the stated wedge draw-in is consistent with the type of jack and operator technique proposed must be provided as part of the Quality Management Records and must be no more than 12 months old.

## 6.5 Tensioning procedure

- a) In order to remove slack and to lift tendons off the bed floor, an initial force must be applied to the tendons. The force which is applied initially to take up the slack of the tendon must be sufficient to seat the jack firmly but must not exceed the amount normally associated with the particular method of prestressing.
- b) After application of the initial force required in section 6.5a), the tendon must 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.
- c) The tensioning force applied to any tendon must 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.

## 6.6 Tendon failure

Should any tendon fail before the concrete has been placed the tendon must be replaced. Should any tendon in any member fail after the concrete has been placed, the member must be considered a Non-Conformance, and the associated Hold Point set out in PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable) will apply.

## 6.7 Transfer of prestress

- a) Prior to the transfer of prestress, a **Hold Point** will apply. The transfer of prestress must not commence until the Hold Point has been released.
- b) The prestressing force must not be applied to the members until all the concrete in the members has attained the required compressive strengths required by the Design Documentation. If the members have been steam cured, the prestressing force must not be applied until the temperature of the concrete has cooled to ambient air temperature.
- c) Prior to transfer of the force to the members, all tendons must be checked for slip at the reference marks and any tendons showing any increase in slip will be deemed to be a Non-Conformance, and the associated Hold Point set out in PC-QA1 "Quality Management



Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable) will apply.

- d) The tendons must be marked at each end of every member prior to transfer to allow measurement of the pull-in to the concrete.
- e) Tendons must be released gradually in such a manner as to minimise the shock of transfer of stress to the members.
- f) Tendons must not be severed while under tension.
- g) On completion of the transfer of prestress, the projecting lengths of tendons must 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 must not be used.

## 6.8 Permissible pull-in of tendons

The maximum pull-in at transfer of any tendon must not exceed 3 mm at any end. If the pull-in exceeds this amount, the cause of excessive pull-in must be reported and investigated. Excessive pull-in will be considered a Non-Conformance and the associated Hold Point set out in PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable) will apply.

## 6.9 Method of tensioning

- a) Only under exceptional circumstances and only with prior approval can the maximum jacking force exceed:
  - i) 80% of the rated capacity of the jacking equipment used;
  - ii) 85% of the specified minimum ultimate strength of the tendon; or
  - iii) 75% of the minimum ultimate strength of the bar,with such request constituting a **Hold Point**. The maximum jacking forces must not be exceeded until the Hold Point has been released.
- b) If, during tensioning, the check measurement of any individual strand elongation differs from its required value by +10% or -5%, this will be considered a Non-Conformance and the associated Hold Point set out in PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable) will apply. If the average measured extension of a group of tendons anchored at the same anchorage differs by more than  $\pm 7\%$ , this will be considered a Non-Conformance and the associated Hold Point set out in PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable) will apply.

## 6.10 Cutting of tendons

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

## 6.11 Data to be recorded

The following data, where applicable, must be recorded and submitted as soon as practicable as part of the Quality Management Records:

- a) identification number of each dynamometer, gauge, pump, and jack;
- b) identification particulars of tendons;
- c) initial forces / pressures and elongations;

- d) final forces / pressures and elongations;
- e) elongations obtained at all stages during tensioning, together with corresponding forces / pressures;
- f) elongations and forces / pressures when resetting of jacks is required;
- g) draw-in at both ends of tendons (where applicable);
- h) draw-in of auxiliary wedges at the rear of the jack (where applicable);
- i) hog of individual members, measured to the nearest 1.0 mm at the mid-length point of the member, immediately after transfer of prestress; and
- j) axial shortening of the member immediately after transfer of prestress.

## 7 Hold Points and Witness Points

- a) Table ST-SC-C1 7-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.
- b) Table ST-SC-C1 7-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

**Table ST-SC-C1 7-1 Hold Points**

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
3.1c)	Evidence relating to the tendons	Documentation	10 Business Days review
6.1a)ii)	Notification of tensioning of each member	Construction quality	24 hours notification
6.7a)	Prior to transfer of prestress	Construction quality	2 hours notification
6.9a)	Proposal to use excessive jacking force	Documentation	5 Business Days review

**Table ST-SC-C1 7-2 Witness Points**

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
6.1a)i)	Notification of tensioning	Construction quality	14 days notification

## 8 Verification requirements and records

The Contractor must supply written verification as part of the Quality Management Records that the requirements listed in Table ST-SC-C1 8-1 have been complied with.

**Table ST-SC-C1 8-1 Verification records**

Section reference	Subject	Record to be provided
6.11	Tensioning data records	Records specified in section 6.11