

PART S24**PRE-TENSIONED CONCRETE****CONTENTS**

1. GENERAL
2. QUALITY REQUIREMENTS
3. MATERIALS
4. TENSIONING EQUIPMENT
5. SAFETY
6. TENSIONING OF TENDONS
7. HOLD POINTS
8. VERIFICATION REQUIREMENTS AND RECORDS

1. GENERAL

- .1 This Part specifies the requirements for the production of pre-tensioned prestressed concrete.
- .2 Unless specified otherwise, the definitions in AS5100: Bridge Design Part 5: Concrete apply to this Part.
- .3 The following documents are referenced in this Part:
 - AS 1349: Bourdon Tube Pressure and Vacuum Gauges
 - AS 4672.1: Steel Prestressing Materials – General Requirements
 - AS 4672.2: Steel Prestressing Materials – Testing Requirements
 - AS 5100: Bridge Design.Worksafe Victoria: "Construction and Erection of Bridge Beams", available from <http://www.worksafe.vic.gov.au>

2. QUALITY REQUIREMENTS

- .1 Prestressed concrete members must be manufactured under a quality system certified to AS 9001.
- .2 All testing and certification required under this Part must be carried out by a NATA accredited laboratory.
- .3 The Contractor must 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 must be submitted at least 28 days prior to the commencement of tensioning.
- .4 Provision of the procedures listed in this Clause shall constitute a **HOLD POINT**.

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 tensioning activities.

Tensioning Of Tendons

- (a) Details of proposed tensioning equipment to be used and proof of its ability to carry out the work.
- (b) Calibration of equipment.

- (c) Recording of data.
- (d) Stressing sequence.
- (e) Method of determination of the initial force.
- (f) Checking for slippage and friction loss.
- (g) Handling and storage of tendons both in the coiled and made up states.
- (h) Safety precautions during tensioning.

Pretensioning - Associated Works

- (a) Fabrication and placing of tendons:
 - i) ensuring traceability of tendons
 - ii) method of placing
 - iii) layout of tendons at anchorages
 - iv) method of deflecting tendons, if appropriate
 - v) protection against corrosion.
- (b) Method of tensioning tendons:
 - i) sequence of tensioning (for deflected strands)
 - ii) calculation of forces at anchorages and at member mid points
 - iii) estimated friction losses.
- (c) Method of transfer of prestress.
 - i) release of tendons at end of stressing bed, including sequence of release
 - ii) release of tendons between members.

3. MATERIALS

Tendons

- .1 The manufacturer / processor of the tendons must hold a valid certificate of approval issued by the Australian Certification Authority for Reinforcing Steel (ACRS). Refer to <http://www.acrs.net.au>
- .2 The Contractor must provide:
 - (a) details of the composition of the tendons;
 - (b) test results in accordance 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 1.4 m long, from each coil.
- .3 Provision of the ACRS certification, details of tendon composition, evidence of compliance with AS 4672.2 and load extension graphs shall constitute a **HOLD POINT**.
- .4 Welding is not permitted on or near tendons. Heat must 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 75 mm of where the tendon will be gripped by the anchorage or jacks is not be permitted.

Traceability

- .5 Wire, strand, bars and anchorages must be labelled in accordance with the requirements of AS 4672 or AS 1314. Individual lengths of wire, strand or 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 must not be used.
- .6 Anchorages must be traceable from the place of manufacture to their final location by a unique identification number.

Handling, Storage and Fabrication of Materials

- .7 Materials must 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.
- .8 Tendons must 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

- .1 Dynamometers and each set of equipment comprising, pump, jack and pressure gauges must 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.
- .2 Pressure gauges must:
 - (a) be concentric scale type gauges complying with AS 1349;
 - (b) not be less than a nominal size of 150 mm;
 - (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.
- .3 The measuring equipment used must permit tendon force and elongation to be determined to an accuracy of $\pm 2\%$.

5. SAFETY

- .1 The Contractor's Safety Plan and / or procedures must identify and manage the hazards to site personnel, other persons who might be affected by the stressing operation and nearby property and must 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*.
- .2 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.
- .3 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 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 jacking equipment should the jack lose its grip on the tendons or should the tendon fail.

6. TENSIONING OF TENDONS

General

- .1 The Contractor must 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.
- .2 Provision of the above notices shall constitute a **HOLD POINT**.
- .3 Tensioning must be performed only by personnel experienced in this type of work and in accordance with the Quality Plan. Concrete must 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

- .4 The 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.

Placing of Tendons

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

Tensioning Force Required

- .6 The required force shown on the drawings must be achieved at the middle of the member immediately after all tendons have been anchored to the ends of the stressing bed.
- .7 The jacking force applied must allow for any anticipated slip at the anchorage devices, wedge draw-in, friction losses and temperature changes.
- .8 Unless specified otherwise, 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.

Tensioning Procedure

- .9 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.
- .10 After application of the initial force, 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.
- .11 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

Tendon Failure

- .12 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 as non-conforming and a **HOLD POINT** shall apply.

Transfer of Prestress

- .13 Prior to the transfer of prestress, a **HOLD POINT** shall apply.
- .14 The prestressing force must 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 must not be applied until the temperature of the concrete has cooled to ambient air temperature.
- .15 Prior to transfer of the force to the member(s), all tendons must be checked for slip at the reference marks and any tendons showing any increase in slip must be deemed to be non-conforming. The tendons must be marked at each end of every member prior to transfer to allow measurement of the pull-in to the concrete. Tendons must be released gradually in such a manner as to minimise the shock of transfer of stress to the member(s). Under no circumstances must tendons be severed while under tension.
- .16 Unless otherwise shown on the Drawings, 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.

Permissible Pull-in of Tendons

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

Method of Tensioning

- .18 If the stressing sequence is not shown on the Drawings, the release of pretensioned tendons must be done in such a sequence that produces a minimum of eccentric force in the member.
- .19 Only under exceptional circumstances and only with prior approval must 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.
- .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

- .21 Flame cutting of strands at unit ends is not permitted. Unless shown otherwise on the 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-molding of beams. A liberal coating of high build non-sagging epoxy paste must then be applied over the ends of the tendons and abraded concrete, unless shown otherwise on the Drawings.

Data to be Recorded

- .22 The following data, where applicable, must be recorded and submitted as soon as practicable:
 - (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.

7. HOLD POINTS

- .1 The following is a summary of Hold Points referenced in this Part:

CLAUSE REF.	HOLD POINT	RESPONSE TIME
2	Submission of procedures	7 days
3..3	Supply of tendons	14 days
6..1	Notification of Tensioning	1 day
6..12	Failure of a tendon	Refer Clause 6.7
6..13	Prior to transfer of prestress	2 hours
6.17	Excessive tendon pull-in	Refer Clause 6.9
6.20	Unacceptable elongation correlation during stressing	Refer Clause 6.10

8. VERIFICATION REQUIREMENTS AND RECORDS

- .1 In addition to the records provided with the Hold Points, the Contractor must supply the following records:

CLAUSE REF.	SUBJECT	RECORD TO BE PROVIDED
6..22	Tensioning	Records specified in Clause 6.22