SECTION 622 ‑ PRE‑TENSIONING OF CONCRETE UNITS‑‑

##This section cross-references Sections 610 and 620.

If any of the above sections are relevant, they should be included in the specification.

If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

622.01 GENERAL

This section specifies the requirements for the supply, placing and stressing of pre‑tensioning systems.

Cast‑in‑place concrete for pre‑tensioned construction shall comply with the requirements of Section 610 - Structural Concrete.

Precast concrete units for pre‑tensioned construction shall comply with the requirements of Section 620 - Precast Concrete Units.

622.02 SUPPLY OF TENDONS

(a) Materials

High‑tensile steel wires and strands for use in pre-tensioning and the testing of these materials shall comply with AS/NZS 4672 - Steel prestressing materials.

High‑tensile steel wires and strands for use in pre-tensioning shall be relaxation class Relax 2 and shall be tested for compliance with the requirements for relaxation class Relax 2 with an initial load of 80% of the specified minimum breaking force. Relaxation testing shall be at a frequency of at least one 1000 hour test per product per annum.

High tensile steel wires and strands shall be obtained from a supplier who holds appropriate product certification from the Australasian Certification Authority for Reinforcing Steels (ACRS).

High‑tensile steel wires or strands shall be supplied in coils of sufficiently large diameter to ensure that the wires or strands are straight when unwound from the coil.

The Contractor shall submit to the Superintendent at least seven days prior to the delivery of the coil or lot to its place of use, the following for the material in each coil of wire or strand:

 • test certificates for tensile testing

 • load-extension graphs

 • the manufacturer's certificate of compliance of the tendon material with AS/NZS 4672

 • a stress-relaxation test certificate for material taken from the same production facility and of the same type of material as that to be used in the works (Relaxation-test certificates for similar tendon product produced by the supplier within the past 12 months prior to the proposed use will be accepted). Additional relaxation testing of samples may be required by the Superintendent.

(b) Testing

Laboratories that perform tests required by this Section for compliance with AS/NZS 4672 shall meet the requirements of AS ISO/IEC 17025. All test reports shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (Test reports may be called test certificates.)

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website ([www.ilac.org](http://www.ilac.org)). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

The appropriate logo or further details of the ILAC (MRA) signatory shall be noted on the test document, and all reporting requirements of the test method and material standard shall be included. All test reports shall be in English alphanumeric characters.

(c) Sampling and Testing if Required Under Clause 622.06

 Where required under Clause 622.06(c) the Contractor shall arrange for the tendon material to be tested by a laboratory that meets the requirements of AS ISO/IEC 17025.

 Samples of wire or strand shall be taken by the Contractor at the site of the works or at the supplier’s fabrication shop, provided that the tendons fabricated from one coil or lot are bundles together and clearly identified with the coil or lot number.

 The Contractor shall arrange testing of test samples representative of each coil. These samples shall be taken not less than 1.5 metre from the end of any coil.

 For split coils, comprising two or more production runs of wire or strand, each production run shall be sampled and tested separately.

(d) Assembly of Tendons

 Splicing of strands or wires to form a tendon is not permitted.

 Welding is not permitted on or near tendons, nor shall any heat be applied to tendons. Tendons which have been affected by welding, weld splatter and/or heat shall be rejected.

 Flame-cutting of wire or strand within 75 mm of an anchorage or jack is not permitted.

(e) Storage and Surface Condition

 Coils of wire and strand and assembled tendons shall be stored above ground level and shall be protected from mechanical damage, contamination with harmful substances or other damage until their incorporation into the works.

 Wires and strands that show any evidence of damage, kinks or bends shall not be used.

 Wires and strands which are heavily corroded or visibly pitted will not be accepted.

 Slight surface rusting shall not be a reason for rejection provided that no pitting is visible.

 Wire and strand shall be kept free from loose rust, oil, grease, tar, paint, soil or any other harmful substances.

 If the wire or strand become contaminated with any substance, it shall be cleaned with suitable equipment and appropriate detergents and/or clean water until all of the contaminant and any detergent has been removed to the satisfaction of the Superintendent.

 Loose rust shall be removed by mechanical or manual methods that do not cause damage to the wire or strand or which impair the bond between the wire or strand and the concrete.

 Wire or strand that remains contaminated or that has suffered damage or impairment during cleaning will not be accepted.

622.03 TRACEABILITY OF MATERIALS

Wire strand shall be labelled in accordance with AS/NZS 4672.

Individual lengths of wire and strand shall be traceable from the point of manufacture of coils to their final location by a unique identification number.

Pre‑tensioned concrete units shall be traceable in accordance with the requirements of Section 620.

622.04 PLACING TENDONS

Tendons shall be placed in continuous lengths in the positions shown on the drawings and shall be held in the required position by end-blocks of sufficient strength and stiffness to safely maintain the required force in the tendons.

Tendons shall be debonded in the positions shown on the drawings by the use of close-fitting plastic tubing which shall be sealed to prevent grout leakage into the tube. Grease or other coatings shall not be used for debonding.

Tendons shall not be allowed to come into contact with the oiled surface of the formwork. If a tendon is contaminated with oil or other harmful substance it shall be cleaned using an appropriate method in order to ensure that the bond between the tendon and the concrete is unimpaired. Tendons that cannot be cleaned shall be replaced.

Tendons shall not be welded or exposed to heat from welding or other sources.

Where deflected tendons are shown on the drawings, tendons shall be restrained with devices of sufficient strength to hold the tendons in their proper positions without displacement during the placing and compaction of concrete.

622.05 STRESSING PRECAUTIONS

Stressing of tendons, measurement of elongation and associated operations shall be conducted in a safe manner. The pre-cast concrete manufacturer shall comply with the requirement of the Work Health and Safety Act 2012 to provide a safe workplace.

The stressing jack shall 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.

No-one shall stand behind the jack or in a position where a broken tendon could cause injury when stressing is in progress.

Should a tendon break during stressing, adequate restraint shall be provided to prevent lateral or vertical movement of the broken tendon.

Robust barriers shall be provided in order to prevent a broken or loose tendon from recoiling into the working area.

Warning signs that conform to AS 1319 - Safety signs for the occupational environment - shall be displayed at both ends of the member being tensioned during stressing operations.

622.06 TENSIONING

(a) Equipment

 **The Contractor shall maintain current calibration certificates conforming to the requirements of AS 2193 Grade B for the jack and pressure gauges or other force measuring devices. Jacks and pressure gauges and other devices shall be used as a single unit, which shall be calibrated to AS 2193, at the appropriate force range. The calibration or test certificates shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for the calibration laboratory.**

 The power unit shall be adjusted so that the rate of extension of the tendon is within the specified limits. The measuring equipment shall permit measurement of the tendon force prior to lock-off to the degree of accuracy required by AS 2193 Grade B. The measuring equipment used shall permit elongation to be determined to an accuracy of ±2%. The equipment shall prevent unwinding of the strand during tensioning.

 The sag take-up force in the tendons shall be measured with equipment which complies with the repeatability and accuracy requirements of AS 2193 Grade B, at a scale mark at which the equipment has been calibrated. The readability requirements of AS 2193 Grade B shall be ignored for the purpose of establishing sag take-up. Sag take-up force shall not exceed 20% of the required tendon force, and shall be not less than 10% of the required tendon force or 10% of gauge capacity, whichever is the greater.

(b) Anchorages

 Anchorages shall be of a type that prevents the occurrence of slip during casting and curing operations.

(c) Tendon Force

 Before tensioning commences, the Contractor shall calculate the extension corresponding to the required tendon force shown on the drawings. The calculation shall be based on the measured length of the tendon between the tendon anchorages at the end blocks and the modulus of elasticity determined from the sample tested in accordance with Clause 622.02.

 The calculations shall include allowances for all losses including slip at anchorages, elastic shortening of the stressing bed, pull-in on transfer of prestress, friction losses and temperature changes.

 The calculations shall be reviewed by the designer of the pre-tensioned concrete units who shall certify that the calculations meet the requirements of the specification and the drawings. The Contractor shall provide a copy of the designer’s certification to the Superintendent.

 After all tendons have been anchored to the end-blocks (locked‑off), the force remaining in the tendons at mid-span of the unit shall be the required tendon force stated on the drawings.

 The allowable variation of the tendon force shall be ±2%.

 Under no circumstances shall the maximum tensioning force exceed the lesser of the rated capacity of the jacking equipment or 80% of the tensile strength of the tendon.

 The tensioning force required to achieve the design tendon force shall be determined from the calibration certificate and the actual elongation of the tendon corresponding to the tensioning force shall be recorded. Alternatively, the Superintendent may approve determination of the tensioning force by measurement of the elongation, provided that the limits of variation of the modulus of elasticity of the tendons are satisfactory. In this case, the jacking force shall be recorded.

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

 **Where the difference between the force determined from the calibration certificate and the tensioning force calculated from the elongation exceeds 4%, the Contractor shall nominate some or all of the following remedial steps subject to review by the Superintendent. The Contractor shall suspend stressing until the completion of the Superintendent’s review:**

 • re‑calibration of tensioning equipment

 • testing of tendon material to check the modulus of elasticity

 • that tendons be released and restressed (with the adoption of a modulus of elasticity applicable to the second stressing)

 • other steps as agreed by the Superintendent.

(d) Tensioning Procedure

 **The Contractor shall give the Superintendent seven days notice of stressing operations.**

***HP******All stressing operations shall take place in the presence of the Contractor’s Precast Concrete Surveillance Officer.***

 Tensioning operations shall be performed by suitably trained and experienced personnel.

 Where the sag take-up force is not measured, the slack shall be taken up by means of a pulling device pre‑set to the sag take-up force. An allowance (based on elongation measurements) shall be made for sag take-up force in calculating the tensioning force. Tendons shall be marked for measurement of elongation after this sag take-up force has been applied. In order that slip may be observed, each tendon shall be marked at both the jacking end and the dead end of the stressing bed prior to the commencement of tensioning.

 Should slip occur in any one of a group of tendons being tensioned together, provided that not more than two tendons have slipped, tensioning of the group including the slipped tendons may be completed. If more than two tendons have slipped, the whole of the group shall be relaxed, the tendons shall be re‑set and the whole group tensioned again.

 The prestressing force shall be transferred from the tensioning jack to the stressing-bed end-block immediately after the required tendon force prior to lock-off (or the required elongation) has been reached in the tendons. The hydraulic pressure in the jack shall then be relaxed before any other operation is commenced.

(e) Action if Concreting is Delayed

 If placing of concrete does not commence within 24 hours of completion of tensioning of the tendons, the Contractor shall re-establish the jacking equipment and check the force in each of the tendons. If the measured force in any of the tendons is less than the required tendon force, the tendon stressing procedure shall be repeated. Placing of concrete may commence on completion of checking of tendon forces and re-tensioning (if required).

622.07 FAILURE OF TENDONS

Should a tendon fail after the concrete has been placed, the unit shall be rejected.

622.08 TRANSFER OF PRESTRESS

**The Contractor shall submit details of the proposed method of transfer of prestress to the Superintendent for review not less than 14 days prior to the commencement of tensioning.**

(a) Procedure

 Transfer of prestress shall not take place:

 • until the concrete has reached the transfer strength stated on the drawings or in the specification; and

 • before the steam covers have been removed.

 Prior to transfer of the prestressing force to the units all tendons shall be:

 • tested for tightness; and

 • marked at each end of the unit to enable pull‑in of the tendons to be measured.

 Tendon pull-in shall be recorded and the record shall be supplied to the Superintendent on completion of the unit.

 Transfer shall be gradual, continuous and simultaneous from each end of the unit, and shall be performed in the shortest practicable time.

 Transfer by cutting of tendons that are still under tension is not permitted.

 If it is proposed to transfer prestress by applying heat, the Contractor shall submit details of the method of transfer of prestress to the Superintendent, including:

 (i) the lengths of free tendons between units and at both ends of the bed

 (ii) the locations where the heat will be applied

 (iii) the order of severance of tendons and of release of devices for deflecting tendons

 (iv) the method of applying heat and the proposed equipment.

 Heat shall be applied over a portion of the exposed tendon and for a period of time sufficient to ensure that the tendon is entirely relaxed before it is severed. Care shall be taken to prevent heat-damage to the concrete. Heat shall not be applied directly to any part of any tendon within 100 mm of the concrete surface of the units.

 Unless otherwise specified, on completion of the transfer of prestress the projecting lengths of tendons shall be cut-off flush with the end of the unit using a mechanical cutter. Care shall be taken to avoid damage to the concrete surface. Should damage to the concrete surfaces around the tendon anchorages occur during cutting, the Contractor shall submit proposals for its repair to the Superintendent.

(b) Pull-in of Tendons

 The maximum pull‑in of any tendon shall not exceed 6 mm. If pull‑in exceeds 6 mm, the degree of variation shall be recorded and the cause shall be investigated by the Contractor and the results shall be submitted to the Superintendent for review.

 If the unit does not meet strength and serviceability requirements of the design, it shall be rejected.

(c) Hog

 Hog shall be measured at mid-span of the unit immediately after transfer of prestress has been completed. The actual hog shall be compared to the anticipated hog and to the hogs of other units intended for the same structure. If the hog varies by more than ± 25% from the anticipated hog, the effects of this variation shall be investigated by the Contractor and the results shall be submitted to the Superintendent for review.

 If the unit does not meet strength and serviceability requirements of the design or if the geometrical variation between adjacent units is unacceptable, it shall be rejected. Unacceptable geometrical variation is defined as a difference in the levels of groups of units or between adjacent units that requires a change in grade-line to accommodate the variation allowing for the required thickness of asphalt surfacing.

622.09 DATA TO BE RECORDED

The following data shall be recorded:

• identification number of the unit

• identification number of each dynamometer, gauge, and jack

• calibration certificates for each dynamometer, gauge, and jack

• identification details for each tendon

• sag take-up force (or pressure) when tendons are marked for measurement of elongation

• elongation obtained at intervals during tensioning, together with corresponding force (or pressure gauge reading)

• tendon force (or pressure) and elongation obtained on completion of tensioning prior to lock‑off

• elongation after release of jack

• pull-in

• compressive strength of concrete at time of transfer of prestress

• steam curing charts

• measurement of hog following transfer of prestress.

Completed records shall be forwarded to the Superintendent prior to delivery of the pre-stressed units to the site.

622.10 PROTECTION OF EXPOSED ENDS OF TENDONS

If the end face of the unit and the tendons are to be cast into a diaphragm, the concrete surface surrounding the ends of the tendons and the tendons themselves shall be prepared as required on the drawings.

If the ends of tendons are to remain exposed, they shall be wire-brushed to remove rust, loose mortar, grease, dirt and all other harmful material and shall then be coated with a minimum 6 mm thickness of epoxy compound.

622.11 PROTECTION OF SURFACE-MOUNTED STEEL EMBEDMENTS

On completion of the unit, tapped holes for steel embedments such as tendon hold-downs shall be patched with a low-shrinkage mortar or epoxy mortar. Patching shall be finished flush with the surface of the unit.