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AUSTROADS TECHNICAL SPECIFICATION ATS 5326
Pretensioned Concrete Members

Austroads

Contents

1. Scope

1.1 Austroads Technical Specification ATS 5326 sets out the requirements for the supply of pretensioned precast concrete members ('Pretensioned Members'), such as piles, girders and bridge planks / deck units.

1.2 The Contractor must ensure that the Manufacturer of the Pretensioned Members complies with this Specification and the Drawings. The Contractor may be the same entity as the Manufacturer.

2. Referenced Documents

2.1 The following documents are referenced in this Specification:

Australian / New Zealand Standards

AS 1319	Safety signs for the occupational environment
AS 1366.3	Rigid cellular polystyrene – Moulded
AS 2193	Calibration and classification of force measuring systems
AS 3850.3	Prefabricated concrete elements, Part 3: Civil construction
AS 5100.5	Bridge Design Part 5: Concrete
AS 4672.1	Steel prestressing materials – General Requirements
AS/NZS 4672.2	Steel prestressing materials – Testing Requirements
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS ISO 9001	Quality management systems – Requirements
AS ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

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ATS 5310	Steel for the Reinforcement of Concrete
ATS 5315	Supply of Special Class Concrete
ATS 5320	Placement of Concrete
ATS 5325	Precast Concrete Members
ATS 5340	Cementitious Patch Repair of Concrete
ATS 5410	Structural Steelwork – Fabrication and Erection
ATS 5430	Fabrication of Stainless Steel Components
ATS 5850	Handling, Storage, Transportation and Erection of Structural Members

3. Definitions

3.1 In addition to the definitions set out in AS 4672.1 and AS 5100.5, the following definitions apply to this Specification:

Manufacturer: The entity responsible for the manufacture of the Pretensioned Members in accordance with this Specification.

Principal's Registration Scheme: A scheme for the prequalification, registration or approval of products, manufacturers, suppliers and/or Professional Engineers in operation in the jurisdiction where the Pretensioned Members are to be installed.

Professional Engineer: A person who:

a) has at least 5 years of relevant experience in the design or manufacture (as appropriate) of Pretensioned Members;

b) is registered on any scheme of registration of engineers prescribed by legislation in the applicable jurisdiction;

c) is appropriately registered or prequalified if the Principal has implemented an applicable registration or prequalification scheme; and

d) satisfies at least one of the following requirements:

   i) is a Chartered Professional Engineer; or

   ii) holds a 4-year civil engineering degree from a university that is accredited under the Washington Accord and is registered in a relevant area of practice on the National Engineering Register (in Australia) or the Register of Chartered Professional Engineers (in New Zealand).

Required Jacking Force: The force required at the jack, which includes allowances for losses due to friction, slip at anchorages, shortening of the stressing bed, pull-in on transfer of prestress and any other causes, to achieve the Specified Tendon Force.

Specified Tendon Force: The average force that is specified on the Drawings (or other Contract documents) to remain in the tendons immediately after the release of the tensioning jacks and before concreting, within the length of any Pretension Member.

Type of Pretensioned Member: Refer to clause 11.2.

4. Quality System Requirements

4.1 The Contractor must prepare and implement a Quality Plan that includes the documentation in Table 4.1.

Table 4.1: Quality Plan

Clause	Description of document
4.2	Name of the manufacturer, place of manufacture and evidence of AS/NZS ISO 9001 certification.
5.1	Details of the training and experience of the supervisor, other key personnel and the professional Engineer.
6.1	Certification from a Professional Engineer that the Pretensioned Members comply with Clause 6.1 (where applicable).
7.1	Details of the prestressing materials.
8.6	Details of void formers (where applicable).
9.1	Details of the proposed tensioning equipment.
9.8	Certification of the stressing bed from a Professional Engineer (If applicable – not required if previously submitted to the Principal or a Principal's Registration Scheme applies to stressing beds).
11.1	Details, procedures, instructions and/or plans for stressing operations.
12.1	Cross references (as appropriate) to procedures and other quality documentation for the supply, placement, finishing and curing of concrete as specified in ATS 5315, ATS 5320 and ATS 5325.
13.1	Procedures / Inspection and Test Plans for the transfer of prestress.
14.1	Procedure / Inspection and Test Plan for measuring and verifying the dimensions of each member, including details of the method of measuring the hog of pretensioned planks and girders.

HOLD POINT 1.	
Process Held	Commencement of the manufacture of Pretensioned Members.
Submission Details	The Quality Plan must be provided at least 15 working days prior to the commencement of the manufacture of Pretensioned Members.

4.2 Pretensioned Members must be manufactured under a Quality Management System that is certified as complying with AS/NZS ISO 9001 by an organisation that is accredited by the Joint Accreditation System of Australia New Zealand (JAS-ANZ) or a member of the International Accreditation Forum.

4.3 If not previously provided as part of the Contractor's program of work, a casting program must be submitted with the Quality Plan.

4.4 If the Pretensioned Member is to be placed in a jurisdiction where a Principal's Registration Scheme for companies manufacturing Pretensioned Members is in place, the Manufacturer must be registered or approved under that scheme to the appropriate level and/or category.

5. Personnel

5.1 The Quality Plan must include the names, qualifications and experience of the supervisor, other key personnel and the Professional Engineer.

5.2 Prestressing operations must be carried out only under the direction of an experienced and competent supervisor and all personnel operating the stressing equipment must have been properly trained in the use of the equipment.

6. Design

6.1 In addition to any other design standards / requirements specified in the Contract documents, the Contractor must ensure that the Pretensioned Member is designed in accordance with the design standards specified in Table 6.1. The Quality Plan must include certification from a Professional Engineer that the Pretensioned Members comply with this Clause 6.1.

Table 6.1: Applicable design standard

Design stages	Applicable design standard for the specified design life [1]
In-service design [2] (provides for the performance of the element as part of the permanent structure)	AS 5100.5.
Erection design (provides for the element to resist all construction loads, temporary surcharge loads as applicable, handling forces, including impact, arising from stripping, storage, transport, lifting, temporary bracing and propping)	AS 3850.3

1. *Unless specified otherwise in the Contract documents.*
2. *Unless the Principal has supplied the design of the Pretensioned Member.*

6.2 The design documents include design calculations/drawings showing the profile dimensions of the element, prestressing steel and reinforcement details, grade of concrete, cover to steel, exposure classification and calculated mass.

7. Materials

General

7.1 The Quality Plan must include:

a) details of the steel prestressing materials and the supplier;

b) evidence of ACRS certification;

c) certification or other evidence that the prestressing materials are registered / approved products (where applicable); and

d) procedures for the handling, storage and identification of materials.

7.2 The manufacturer of the steel prestressing materials must hold a valid certificate of approval issued by the Australasian Certification Authority for Reinforcing and Structural Steel (ACRS). Refer to http://www.acrs.net.au.

7.3 Where a Principal's Registration Scheme is in place for the supply of materials used in the manufacture of Pretensioned Members, the materials must comply with that scheme for Pretensioned Members installed in that jurisdiction.

7.4 All sampling and testing specified in this Contract must be performed by a laboratory that:

a) is accredited for the test method to meet the requirements of AS ISO/IEC 17025; and

b) complies with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025.

7.5 The laboratory's accreditation body must be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA) for testing laboratories. The National Association of Testing Authorities (NATA) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

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

Steel Prestressing Materials

7.7 Steel prestressing materials must comply with AS 4672.1 and be tested in accordance with AS/NZS 4672.2.

7.8 The nominal strength must not be less than that specified on the Drawings.

7.9 Steel wires and strands must be relaxation class Relax 2.

7.10 Strand must be supplied in coils large enough to be self-straightening. Kinked or damaged strand must not be used in Pretensioned Members.

7.11 If additional relaxation loss testing is specified in the Contract documents, the maximum projected relaxation loss of the strand at 10,000 days is 5.0% when stressed to 80% of the characteristic minimum breaking force specified in AS 4672.1.

7.12 Unless specified otherwise in the Contract documents, prior to each coil of strand being incorporated into the Works, the following information must be submitted to the Principal for each coil:

a) documentation listing the Lot numbers from which each coil is taken;

b) certification of compliance with AS 4672.1; and

c) test certificates showing the following test results:

i) breaking load;

ii) yield strength and elongation;

iii) load-elongation curve;

iv) cast analysis of the steel;

v) cross-sectional area of tendon;

vi) 1000-hour isothermal relaxation test of the strand supplied or of a strand that is representative of the strand Lot to be used. A strand is considered representative if it is obtained from the same production run as the strand that has been supplied.

Traceability

7.13 Steel prestressing materials must be identified in accordance with the requirements of AS 4672.1. Individual lengths of strand must be traceable from the point of manufacture to their final location by a unique identification number. Each coil must be clearly identified by the use of a durable label to enable matching with the appropriate test certificates and load-extension graphs. Any strand that is not clearly identified must not be used in the Works.

Storage and Surface Condition

7.14 Until their incorporation into the works, strand must not come into contact with the ground and be protected from damage, including mechanical damage and contamination with harmful substances. Water must not collect or pond in the strand coil or packaging.

7.15 Strand must:

a) not show any evidence of damage, kinks or bends;

b) not be heavily corroded or visibly pitted (slight surface rusting is acceptable provided that no pitting is visible); and

c) be kept free from loose rust, oil, grease, tar, paint, soil or any other harmful substances.

7.16 If strand becomes contaminated with any substance, it must be cleaned with suitable equipment and appropriate detergents and/or clean water until all of the contaminant and any detergent have been removed.

7.17 Any loose rust must be removed by mechanical or manual methods that do not cause damage to the strand or which impair the bond between the strand and the concrete.

7.18 Any strand that remains contaminated or that has suffered damage or impairment during cleaning is non-conforming and must not be used in the Works.

Other Materials

7.19 Reinforcing steel must comply with ATS 5310. Concrete must comply with ATS 5315.

7.20 Lifting devices, such as anchors and ferrules, must comply with AS 3850.1. Fabricated cast in items, such as top attachment plates and splice assemblies, must be fabricated in accordance with ATS 5410.

7.21 Cast in items must be registered / approved if a Principal's Registration Scheme which applies to the Works is in place.

7.22 Where sheathing of strand is required to prevent bond over a specified length, it must consist of smooth PVC or polyethylene, of a quality, diameter and thickness such that bond must be effectively prevented. The external diameter of the sheath must not exceed the tendon diameter plus 3 mm.

8. Formwork

General

8.1 Formwork must be manufactured from metal and must be substantial enough so that it does not deflect beyond the tolerance limits during casting. Where rigid forms and intense vibration is specified, external form vibrators must be used, except where super-workable concrete is used.

8.2 Chamfers, and other corner treatments, must be straight and true to shape and line. Any cores for forming transverse holes in the finished work or any other forming devices that would restrict longitudinal strains in the member must be loosened so that concrete shrinkage and thermal movements are not restrained.

8.3 Where a transverse or vertical hole is shown in the concrete on the Drawings, the formwork or void former must be removed after casting. Unless shown otherwise on the Drawings, permanent hole formers must not be used.

8.4 Formwork must be kept clean of adhering slurry so that cast surfaces are smooth. Water, excess form oil, dirt, tie wires, sawdust and other foreign matter must be removed from the formwork prior to casting.

8.5 Seals must be fitted to prevent loss of cement paste through joints in the formwork.

Void Formers

8.6 The Quality Plan must include details of the void formers, including the material used in their manufacture.

8.7 The void formers must be sufficiently robust to prevent the void former being damaged or deformed during the concrete pour. If a hollow void former is used, the ends must be sealed to stop the entry of water and grout into the void. Non-circular voids must be manufactured from cellular polystyrene Grade S to AS 1366.3 or from steel.

8.8 The void formers must be positively restrained so that the applicable tolerance limits are achieved. Damage to voids must not occur during casting operations. Void formers must not be secured to tendons or reinforcement. Systems that require or rely on floatation of the void for the void to achieve its final position are not permitted.

8.9 Where a Principal's Registration Scheme is in place for void formers, the formers must be approved under that system.

8.10 Precautions must be taken to prevent the occurrence of cracks over the voids.

8.11 Removable void formers for girders must be removed carefully in a manner that does not damage or crack the girder. Methods such as the use of air pressure to release void formers or cold water or other fluid to cool the void former are not permitted.

Fillets

8.12 Internal corners and external edges of all prestressed elements must be finished with curved or straight fillets appropriate to the application.

9. Equipment

Tensioning Equipment

9.1 The Quality Plan must include details of the proposed tensioning equipment and evidence of its capacity to undertake the work.

9.2 Each set of equipment comprising, pump, jack and pressure gauges must be calibrated as a single unit in accordance with AS 2193 by an approved testing facility accredited by NATA immediately prior to first use and must meet the readability, repeatability and mean error requirements of Class B for the range of forces used in the pretensioning. The calibration or test certificates must be endorsed in accordance with the AS ISO/IEC 17025 accreditation for the calibration laboratory.

9.3 Calibration certificates must not be more than six months old for bourdon tube pressure gauges, or more than one year old for digital pressure gauges.

9.4 Unless digital display gauges are used, the gauges must be concentric scale type gauges with a nominal size not less than 150 mm and will allow visual reading to the nearest 0.5 MPa or 5 bar. The maximum jacking force must correspond to a pressure between 50% and 90% of the hydraulic gauge capacity.

9.5 The measuring equipment used must be capable of measuring tendon force and elongation to achieve the accuracy specified in Clause 11.12.

9.6 The equipment must prevent unwinding of the strand during tensioning and have a rated capacity exceeding the applied stressing forces.

Stressing Beds

9.7 The stressing bed must have the capacity to safely accommodate the forces that will occur during the manufacture of the Pretensioned Members.

9.8 Unless certification of the stressing bed has been previously submitted to the Principal or a Principal's Registration Scheme applies to stressing beds, the Quality Plan must include certification from a Professional Engineer stating the safe capacities and eccentricities of each stressing bed and stressing system.

10. Stressing Calculations

10.1 Prior to stress being applied to the strand, the Required Jacking Force, corresponding gauge pressure and the extension corresponding to the Specified Tendon Force must be calculated. The calculation must:

a) be based on:

i) the measured length of the tendon between the tendon anchorages at the end blocks,

ii) actual cross sectional area of the strand;

iii) the calibration report(s) for the jack/gauge combination(s), and

iv) the secant modulus of elasticity determined from the sample tested in accordance with Clause 7; and

b) 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.

10.2 If modulus of elasticity of batches of the tendons differs by more than 3%, the required elongation must be adjusted accordingly.

10.3 Unless specified otherwise in the Contract documents, the Contractor must submit to the Principal the calculations and certification from a Professional Engineer that the calculations comply with the requirements of this Specification.

11. Stressing Operations

General

11.1 The Quality Plan must include details, procedures and Inspection and Test Plans (ITP) which address the following:

a) calibration of equipment;

b) stressing operations, including the stressing sequence;

c) verifying that the mould has been inspected prior to each concrete pour;

d) recording data, including a standard record sheet for recording all of the stressing information required by this Specification;

e) applying the initial tension to lift the tendon off the bed floor;

f) checking for slippage;

g) transfer of prestress, including sequence of release; and

h) the dimensions and cross section of the Pretensioned Members that it proposes to include in each Type of Pretensioned Member.

11.2 'Type of Pretensioned Member' refers to Pretensioned Members which:

a) have been defined as such in the Quality Plan, subject to the Principal's approval;

b) are of a same cross section;

c) have the same number of strands with identical prestressing requirements; and

d) are manufactured in the same prestressing bed or in a long-line prestressing bed at the same time and under the same conditions using the same stressing procedures and equipment.

11.3 The Contractor must submit the certification required by this Specification to the Principal prior to stressing the first unit of each Type of Pretensioned Member.

HOLD POINT 2.	
Process Held	Commencement of the production of each Type of Pretensioned Member.
Submission Details	At least 2 working days prior to stressing the first unit of each Type of Pretensioned Member, the following must be submitted to the Principal: a) test certificates for the steel prestressing materials (refer Clause 7.12). b) calculations and certification that the calculations comply with this Specification (refer Clause 10.3) c) notification of the date and time that stressing of the Pretensioned Members will commence.

Placing Tendons

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

11.5 Sheathing for debonding must be fastened to the tendon in such a manner that the efficiency of the bond break is not impaired by the entry of cement mortar and the sheath does not move along the tendon during placement of concrete. Grease or rigid electrical conduit must not be used as sheathing.

11.6 Tendons must 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 must 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 must be replaced.

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

11.8 Tendons must not be affected by welding or exposed to heat or splatter from welding or other sources.

Stressing of Tendons

11.9 The Contractor must:

a) apply the initial tension specified in the Quality Plan to each tendon to lift it off the bed floor and to equalise sag effects;

b) establish a datum mark on each tendon and use this mark for the purpose of measuring elongation during subsequent tensioning;

c) record the initial tension applied to each tendon together with the corresponding elongation;

d) at the completion of the initial stressing, check the first tendon for losses due to bed shortening during stressing;

e) if losses have occurred, re-stress all tendons to ensure equal forces in all tendons;

f) where multi-strand jacks are used, after the initial tensioning, evenly tension all tendons simultaneously using hydraulic jacks acting on a moveable stressing head; and

g) transfer the prestressing forces from the hydraulic jacks to the stressing bed end blocks immediately after the required tendon elongation and the Required Jacking Force have been reached.

11.10 The maximum permissible variation in force between tendons is 2% of the jacking force.

11.11 The force applied to a strand must not exceed 80% of the minimum breaking load specified in AS 4672.1 under any circumstances. The maximum jacking load must be determined taking into consideration the accuracy of measuring equipment.

Measurement of Tension in Tendons

11.12 The method of measuring the prestressing force must always be such that the final accuracy of measurement is within ± 2%.

11.13 The jacking force must be determined by reading from a multi-strand stressing jacks or by way of lift off test (i.e. a test to determine the force in a tendon after stressing is complete which is independent of the main multi-strand stressing system).

11.14 If a lift off test is carried out, the test must be conducted at the opposite end of the bed to the main stressing operation and no earlier than six hours before the concrete is poured in the member. When the force in a multi-strand stressing operation is not measured during stressing, the frequency of lift off testing must be one strand per cast per strand coil.

Non-Correlation Between Actual and Required Jacking Force

11.15 If the difference between the actual force and Required Jacking Force (or actual and required elongations) exceeds 3%, stressing must be suspended and a Hold Point will apply. The proposed remedial action may include revised calculations and any or all of the following:

a) re-calibration of tensioning equipment;

b) testing of tendon material to check the modulus of elasticity; or

c) release of the tendons and restressed (with the adoption of a modulus of elasticity applicable to the second stressing).

HOLD POINT 3. (Where Applicable)	
Process Held	Stressing operations in the event that there is Non-Correlation Between Actual and Required Jacking Force (or actual and required elongations)
Submission Details	The proposed remedial steps must be submitted to the Principal at least one working day before commencement of the remedial action.

11.16 A lift off test on the two tendons in the member which are the furthest from the centreline is required if a non-correlation is found between the actual and required jacking forces (or actual and required elongations).

Action if Concreting is Delayed

11.17 If placing of concrete does not commence within 24 hours of completion of tensioning of the tendons, the jacking equipment must be re-established and the force in each of the tendons checked.

11.18 If the measured force in any of the tendons is less than the required tendon force, the tendon stressing procedure must be repeated. Placing of concrete may commence on completion of checking of tendon forces and re-tensioning (if required). Tendons must not remain fully stressed for longer than 36 hours before the concrete is poured.

Stressing Records

11.19 The following information relating to the prestressing operation must be recorded and included in the Conformance Report (refer Clause 16):

a) identification numbers of load cells, gauges, pumps and jacks;

b) identification particulars of the strands including traceability to the strand coil number and test results for the strands;

c) required overall elongation;

d) calculated jacking force after allowing for all appropriate losses;

e) force (or pressure) at the time strands are marked initially for measurement of elongation;

f) final force applied if load cell is used, alternatively final pump or jack pressure;

g) draw in losses, bed movement (if any), other losses;

h) elongation remaining immediately after anchoring; and

i) records of lift off test values.

12. Concrete Placement

Placement

12.1 Details, procedures and other quality documentation for the supply, placement, finishing and curing of concrete are specified in ATS 5315, ATS 5320 and ATS 5325. In addition, this documentation must include procedures / Inspection and Test Plans to check the mould prior to the placement of concrete in each Pretensioned Member to verify that it complies with this Specification.

WITNESS POINT 1.	
Process	Commencement of concrete placement in first unit of each Type of Pretensioned Member.
Notification Period	At least 1 working day (not less than 24 hours) before the commencement of concrete placement.

12.2 The concrete placement techniques must ensure that the debonding material remains against the end of the form. The pour must start at least 1 m from the end of the unit, proceed back to the end of the form and this part of the pour must be complete before proceeding along the remainder member.

12.3 Voided units must be poured in layers of 600 mm or half the unit depth. A minimum of two internal vibrators are to be used simultaneously, one on each side of the void in conjunction with the external vibrators.

12.4 Lifting anchors must be fixed securely in place before placement and compaction of concrete. Where the lifting anchor has a recess, the cover must be maintained to the recess.

12.5 If a tendon fails after the concrete has been placed, the member must be rejected.

Finish

12.6 Unless specified otherwise on the Drawings, the finish of concrete surfaces must comply with ATS 5320 and Table 12.6.

Table 12.6: Finish for Pretensioned Members

Description	Finish
Formed surface:	As specified in ATS 5320
Top surface of planks / girders where a cast in place deck is to be applied: Any area that will interface with cross girders:	In accordance with the requirements for a construction joint specified in ATS 5320
Top surface of piles:	Steel float
Planks / units where an asphalt running surface is to be applied:	Coarse wood float or broom finish
An exposed top surface not listed above:	Steel float

12.7 Where an area is nominated to have a steel float finish on the Drawings, the Contractor may submit a proposal to the Principal to use an alternate finish, provided that the finish has an acceptable macro texture.

13. Transfer of Prestress

General

13.1 The Quality Plan must include procedures/Inspection and Test Plans for:

a) the transfer of prestress, including the sequence of release; and

b) treatment of the Pretensioned Member after the transfer of prestress

13.2 Transfer of prestress must not take place until the concrete has reached the transfer strength stated on the Drawings or elsewhere in the Contract documents and not before the steam covers have been removed.

13.3 Transfer of prestress must be gradual, continuous, avoid large differences in tension and must be performed in the shortest practicable time.

13.4 Transfer of prestress by cutting of tendons that are still under tension is not permitted. Any member which has been subject to a shock release of stress in the tendon is non-conforming.

13.5 The following applies unless specified otherwise in the Contract documents:

De-tensioning equipment must have adequate capacity to completely release all tendons in one operation. Flame release of tendons or strand by strand release by any other method is not permitted.

13.6 The following only applies if transfer of prestress by applying heat is permitted in the Contract documents and the Contractor proposes transfer prestress by this method:

a) the Quality Plan must include details of the method of transfer of prestress, 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; and

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

b) heat must 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;

c) care must be taken to prevent heat-damage to the concrete;

d) the heat must not be applied directly to any part of any tendon within 100 mm of the concrete surface of the units; and

e) gentle (slow) flame release may be used to provide a coordinated and synchronised release of tendons at each end of each member in a line.

13.7 Unless specified otherwise in the Contract documents, tendon pull-in must be recorded during the transfer of prestress. The maximum pull-in of any tendon must not exceed 6 mm. If pull in exceeds 6 mm, the degree of variation must be recorded and the cause must be investigated by the Contractor and the results must be submitted to the Principal.

Precautions for Delayed Transfer

13.8 If transfer of prestress is delayed beyond 24 hours after casting, precautions must be taken to limit stresses in the free tendon to a maximum of 80% of minimum breaking load by covering the Pretensioned Member and keeping it warm, insulating forms, or partial de-tensioning based on engineering calculations.

Production of Subsequent Members

13.9 Upon removal of the first Pretensioned Member from the mould (or multiple Pretensioned Members where a long line stressing bed is used), the dimensions of the member must be measured and recorded.

13.10 Unless specified otherwise in the Contract documents, the Contractor must submit to the Principal a diagram showing the actual dimensions achieved for the first member compared to the specified dimensions and tolerances, prior to any further members being cast in the mould. The diagram must be accompanied by a certificate stating that:

"The member dimensions, as anticipated at the age of 28 days, will be as shown on the Drawings and will be within the tolerances specified in Specification ATS 5326".

HOLD POINT 4.	
Process Held	Casting of any further members in that mould.
Submission Details	A certificate with supporting checklists verifying that the formwork will produce members conforming to the tolerances specified in Clause 14 must be submitted to the Principal at least one working day prior to the casting of the next member in that mould.

13.11 For members other than the first member from each mould, the Manufacturer must maintain records to verify that the specified tolerances for overall length, overall height and overall width at each end face have not been exceeded.

Treatment After Transfer of Prestress

13.12 Unless specified otherwise in the Contract documents or on the Drawings, on completion of the transfer of prestress, the projecting lengths of tendons must be cut-off flush with the end of the unit using a mechanical cutter. Cutting must not damage the concrete. If damage to the concrete surfaces around the tendon occurs during cutting, the Contractor must submit a proposal for its repair to the Principal.

13.13 Debonded tendons must be sealed with a cementitious repair grout prior to painting.

13.14 Exposed tendons in piles or those in the end face of a Pretensioned Member which is to be cast into concrete do not need to be treated. For other Pretensioned Members, the ends of the tendons and the area immediately adjacent to the tendons (at least 2.5 times the tendon diameter) must:

a) be wire-brushed to remove rust, loose mortar, grease, dirt and all other harmful material; and

b) then coated with an approved epoxy or epoxy mortar in accordance with the manufacturer's instructions.

13.15 If a surface tolerant epoxy compound is used to coat the tendon, each coat must provide a minimum film thickness at least 0.3 mm dry or 0.6 mm wet. If an epoxy mortar is used, it must be at between 3 mm and 10 mm thick.

13.16 If a Principal's Registration Scheme applies in the jurisdiction where the Pretensioned Member is to be installed, the epoxy compounds must be approved under that scheme.

13.17 On completion of the Pretensioned Member, any tapped holes for steel embedments must be patched in accordance with ATS 5340. Patching must be finished flush with the surface of the unit.

13.18 Where a Pretensioned Member is to interface with a structural member which is to be constructed after erection of the Pretensioned Member, the interface surface must be roughened by scabbling, sand blasting, or use of a surface retarder to achieve a construction joint finish. Any tendons to be cast into the concrete must be prepared as required on the Drawings.

13.19 All Pretensioned Members must be traceable from the completion of manufacture to their final location by a unique identification number.

14. Tolerances

14.1 The Quality Plan must include a procedure and/or Inspection and Test Plan which describes the method of measurement, frequency of measurement, timing of measurement and the method of ensuring that differential temperature effects will not be significant during measurement.

14.2 Unless shown otherwise on the Drawings, the dimensions of bridge girders, planks, piles and segments must conform to the tolerances in Table 14.2a) and Table 14.2 b). The dimensions are measured 28 days from the date of manufacture. The conformance of each Pretensioned Member is determined from the dimensions at 28 days from the date of manufacture. Refer to AS 5100.5 for the tolerance on the position of reinforcement and tendons.

Table 14.2 a): Tolerances for pre-tensioned girders / planks

Item	**Tolerance** (maximum permitted deviation of the actual dimension from the specified or calculated value)
1) Cross section	
Dimension of cross section: < 2 m	± 4 mm
Dimension of cross section: > 2 m	± 6 mm
Deviation between diagonal dimensions, corner to corner	
Planks:	± 7 mm
Girders:	< 0.02% x specified length with maximum of 5 mm
2) Squareness of ends	
On any transverse cross section, the deviation of adjacent faces from square:	< 5 mm per metre of the specified dimension with maximum of ± 5 mm
Deviation from a plane perpendicular to the longitudinal axis of a member, or from the specified end plane:	
Dimension: < 500 mm:	< 3 mm
Dimension: > 500 mm:	< 6 mm per metre with maximum of ± 12 mm
3) Length	
Overall length or length centre to centre of bearings (for beams and slabs):	< 0.06% x specified length with maximum of ± 20 mm
Centre to centre spacing of any holes for transverse rods:	± 5 mm
Dimension between ferrule group or other cast in items in the same Prestressed Member:	± 2 mm
4) Profile in a vertical plane at midspan (hog)	
Maximum range of hog values of similar Prestressed Members of the same age, which are to be used in the same span:	Prestressed Member length ≤ 20 m: 20 mm. Prestressed Member length > 20 m: 25 mm
Deviation from design hog for an individual plank / deck unit:	± 0.05% L
Deviation from design hog for an individual girder:	Greater of ±35% of the design value or ± 20 mm
The absolute value for hog for each Prestressed Member:	> 0

Item	**Tolerance** (maximum permitted deviation of the actual dimension from the specified or calculated value)
5) Profile in a horizontal plane at midspan (bow)	
Deviation from the required profile:	< 0.06% x length of the member with a maximum of 15 mm.
6) Twist	
Angular rotation of any cross section relative to an end cross section:	< 0.05% x specified length.
7) **End kick**	
The vertical alignment of the end of a Prestressed Members measured as an offset of the top of the end of the Prestressed Members versus the bottom of the end of the Prestressed Members:	± 5 mm of the specified value.
8) Surface deviation	
The distance of any point from a flat plane held against that surface:	< 3 mm in 2 m
9) Cored holes and cast in openings	
Location:	± 7 mm
Diameter or side dimensions:	± 4 mm
10) Voids and tubs	
Cross section - position/thickness	± 5 mm
End position and length of void/tub	± 10 mm

Table 14.2 b): Tolerances for pre-tensioned piles and segments for spliced piles

Item	Tolerance
1) Cross sectional dimensions	± 5 mm
2) Total length	± 50 mm
3) Deviation from a straight line:	
- less than 10 m long:	< 10 mm
- 10 m to 20 m long:	< 1 mm/m
- greater than 20 m long:	< 20 mm
4) Head out of square (1)	2 mm in width of head
5) Deviation of head from a straight edge	< 2 mm
6) Clear cover to reinforcement and strands	± 5 mm
7) Strand exit holes in formwork end plates:	± 2 mm
8) Strand location along pile:	± 5 mm
9) Splice joint locations (female):	± 2 mm
10) Splice joint locations (male):	± 5 mm.
11) Shoe location:	within ± 10 mm of centreline and in line with the pile axis
12) Flatness of pile head:	± 2 mm

1. *Measured with a square of 1 m length placed along the corner folds of the steel forms.*

14.3 Any other Pretensioned Member which is not covered in Table 14.2 must comply with the tolerances specified in ATS 5325.

15. Marking, Handling, Storing and Transportation

General

15.1 Pretensioned Members must be handled, lifted, stored and transported in accordance with ATS 5850.

Marking

15.2 On each Pretensioned Member, the following information must be clearly and permanently marked on a surface that is not on permanent display when erected:

a) date of manufacture;

b) unique identification number;

c) manufacturer's name or registered mark; and

d) maximum mass of the element.

15.3 Precast plank / deck and kerbs units must be permanently marked with the above information on both end vertical faces and in addition, have the identification number and casting date scratched in the top surface immediately after casting.

15.4 Unless specified otherwise, piles must be clearly and indelibly marked at 0.25 m intervals, commencing at 3 m from the toe of the pile and extending to the head of the pile for the purpose of monitoring the driving of the pile. Length marks must be permanently numbered at 1 m intervals with figures at least 75 mm high, showing the length of the pile from the toe.

15.5 Where necessary to identify the Pretensioned Member within the casting facility, a temporary marking may be used prior to the application of the permanent marking.

15.6 All Pretensioned Members must be traceable from the completion of manufacture to their final location by a unique identification number.

15.7 The manufacturer may attach temporary advertising labels or logos to the Pretensioned Members. However, any such labels or logos must be fastened in such a way that they can be easily removed without solvents. Paint must not be used for temporary labels or logos.

16. Inspection and Records

16.1 Prior to leaving the casting yard, the Contractor must ensure that each Pretensioned Member has been inspected for compliance with the requirements of this Specification.

16.2 Prior to a Pretensioned Member being incorporated in the Works, The Contractor must submit to the Principal a certificate for each Pretensioned Member stating that it conforms to this Specification.

16.3 The certificate must be accompanied a Conformance Report which includes the following at a minimum:

a) name of Manufacturer; and

b) confirmation that the Pretensioned Members have been manufactured under a quality system certified in accordance with Clause 4.2.

c) in addition to the requirements of ATS 5315, ATS 5320 and ATS 5325, for each Pretensioned Member:

i) individual unit unique identification number;

ii) lot register enabling traceability between records and each Pretensioned Member;

iii) stressing records (Clause 11.19);

iv) dimension accuracy checks (Clause 14.2); and

v) visual Inspection report (Clause 16.1).

HOLD POINT 5.	
Process Held	Incorporation of the Pretensioned Members into the Works.
Submission Details	The Certificate of Compliance and Conformance Report must be provided at least 24 hours prior to the Pretensioned Member being incorporated into the Works.

Annexure A: Summary of Hold Points, Witness Points and Records

The following is a summary of the Witness Points / Hold Points that apply to this Specification and the Records that the Contractor must submit to the Principal to demonstrate compliance with this Specification.

CLAUSE	HOLD POINT	WITNESS POINT	RECORD
4.3	1. Commencement of the manufacture of Pretensioned Members		Quality Plan
11.3	2. Commencement of the prestressing operations for each type of Pretensioned Member		Test certificates and certified stressing calculations
11.15	3. Stressing operations where there is non-correlation between the actual and required forces / elongations.		Proposed remedial action
12.1		1. Concrete placement in each Pretensioned Member.	
13.10	4. Casting of any further members in a mould.		Certificate of Compliance
16.2	5. Incorporation of the Pretensioned Members into the Works.		Certificate of Compliance and Conformance Report

Amendment Record

Amendment no.	Clauses amended	Action	Date
-	New specification	New	February 2025

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed