Main Roads
Technical Standard

MRTS73

Manufacture of Prestressed Concrete Members and Stressing Units

June 09

Queensland Government

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June 09

Table of Contents

Page

Manufacture of Prestressed Concrete Members and Stressing Units

1 INTRODUCTION

This Technical Standard applies to the manufacture of precast, prestressed, pre-tensioned concrete deck units, kerb units, girders (including T girders) and piles, and alloy steel transverse post-tensioning units.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRTS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Technical Standard forms part of the Main Roads Specifications and Technical Standards Manual.

The requirements for the manufacture of prestressed concrete members and stressing units include the use of suppliers and products for the items listed in Table 1 that are registered by Transport and Main Roads.

Table 1 – Items Requiring Use of Registered Suppliers and Approved Products

Clauses	Category of Work
6.3	Prestressed concrete member supplier.
9.2.1	Prestressing strands.
9.3	Fabricated cast in items
13	Surface tolerant epoxy compound.

For information regarding registered suppliers and products for the above items refer to –

Department of Transport and Main Roads
Concrete Technology
GPO Box 1412
Brisbane Qld 4001

2 DEFINITION OF TERMS

The terms used in this Technical Standard shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Standards*.

3 REFERENCED DOCUMENTS

Table 3 lists documents referenced in this Technical Standard.

Table 3 – Referenced Documents

Reference	Title
AS/NZS ISO 9001	Quality management systems – Requirements
AS 1366.3	Rigid cellular plastics sheets for thermal insulation – Rigid cellular polystyrene – Moulded (RC/PS – M)
AS/NZS 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 2193	Calibration and classification of force-measuring systems

4 STANDARD TEST METHODS

The Standard test methods used in this Technical Standard shall be as specified in MRTS70 *Concrete*.

5 QUALITY SYSTEM REQUIREMENTS

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Standards*.

The Hold Points, Witness Points and Milestones applicable to this Technical Standard are summarised in Table 5.1

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6.3	1. Approval of new procedure. 2. Approval to manufacture a new member type.		Details of materials, equipment and processes.
6.5	3. Approval of proposed supplier.	The first cast of each member type.	
7.1		Measurement of dimensions.	
7.4.8	4. Approval of alternative dimensions void or tub lengths.		
8.2.1	5. Restraint system for void formers.		

5.2 Conformance Requirements

The conformance requirements which apply to lots of work covered by this Technical Standard are summarised in Table 5.2.

Table 5.2 – Conformance Requirements

Clause	Conformance Requirement
7	Tolerances
10.4	Stressing records
MRTS70	*Concrete*

5.3 Testing Frequency

The minimum testing frequency for work covered by this Technical Standard is each unit manufactured.

6 CONDITIONS FOR MANUFACTURE OF PRESTRESSED CONCRETE MEMBERS

6.1 Standard

All prestressed members shall be manufactured in accordance with the details shown in the Drawings and in accordance with this Technical Standard.

6.2 Design Life

The design life of all prestressed concrete members manufactured under this Technical Standard is 100 years.

6.3 Manufacture

Prestressed concrete members shall be manufactured only by a registered supplier (refer Clause 1). To be eligible for registration as a registered supplier a supplier shall –

a) operate a quality system certified to a minimum of AS/NZS ISO 9001;

b) establish procedures for manufacture of prestressed concrete members; and

c) have an inspection and test plan including Hold Points acceptable to the department for manufacturing prestressed concrete members which demonstrates compliance with this Technical Standard (the inspection and test plan shall address supply of materials).

Registration as a registered supplier of prestressed concrete members shall be reviewed at intervals varying from 6 months to 3 years depending on registration level, or earlier if unsatisfactory performance is reported.

Where a new prestressing process is being established, the supplier shall submit the procedure for manufacture of prestressed concrete members to the department giving details of materials, equipment and processes not less than 28 days prior to establishment of the plant. Milestone

Manufacture shall not occur until approval of the new procedure has been obtained from the department. Hold Point 1

No significant changes to the method of manufacture shall be permitted without the approval of the department. A minimum of 14 days notice shall be given to the department of any proposed change.

When a bed is set up to manufacture a new member type, no concrete shall be placed in the members until the formwork, reinforcement and stressing materials have been approved by the department. Manufacture shall not occur until approval has been granted by the department. Hold Point 2

6.4 Registration Status

Information regarding registered status can be obtained from Transport and Main Roads. Refer to Clause 1.

6.5 Manufacture of Members

At least 14 days before manufacture is due to commence, the Contractor shall submit to the Administrator the identity and address of the proposed supplier and a copy of the program for manufacture of members. Hold Point 3 The supplier shall advise the Administrator when the first cast of each member type is to occur. Witness Point

6.6 Acceptance

The acceptability of members shall be determined by inspection by the Administrator and by the results of tests herein specified. Members may be rejected should they fail to meet any of the requirements of the Contract.

7 TOLERANCES

7.1 General

Precast members shall comply with the tolerances specified in Clauses 7.2 to 7.4 inclusive. The tolerances specified herein shall be applied to the completed work.

The supplier shall make allowance for creep and shrinkage effects taking into account effects nominated in the design and actual properties. The length and hog of the first cast units for a structure shall be measured. Adjustments shall be made to the manufacturing process to ensure that all subsequent units are within tolerances.

Tolerance in relation to length and hog for final acceptance of members shall apply at 28 days from the date of manufacture. The determination of compliance of members in relation to dimensional tolerances shall be based on dimensions measured by the supplier during a period 21 to 35 days from the date of manufacture.

The measurement of dimensions for acceptance of product shall be a Witness Point.

7.2 Piles

7.2.1 Dimensional Tolerance

Piles shall be manufactured to the following dimensional tolerances –

a) Cross-sectional dimensions ± 5 mm;

b) Total length ± 50 mm;

c) Deviation from a straight line –

- Less than 10 m long 10 mm;
- 10 m to 20 m long 1 mm/m; and
- greater than 20 m long 20 mm,

d) Head out of square 2 mm in width of head;

e) Deviation of head from a straight edge 2 mm;

f) Clear cover to reinforcement and tendons ± 5 mm;

g) Tendon exit holes in formwork end plates ± 2 mm; and

h) Tendon location along pile ± 5 mm.

7.2.2 Shoe Location

The approved shoe shall be firmly bonded to the pile, within ± 10 mm of centreline and in line with the pile axis.

7.2.3 Pile Head

The head form shall be flat across any diameter to within 1 mm and shall be secured in the formwork so that its maximum out-of-squareness is 2 mm in the width of the head. The method of fixing the head form shall be fully detailed in the construction procedure.

Measurements of out-of-squareness shall be made with a square of 1 m length placed along the corner folds of the steel forms.

7.3 Deck Units and Kerb Units

7.3.1 Cross-Section

At any cross-section, dimensions shall be accurate to within ± 5 mm.

7.3.2 Length

The overall length of any unit and the length from centre to centre of the bearings at each end shall not vary by more than 0.06% from the specified length with a maximum variation of 20 mm. Centre-to-centre spacing of holes for transverse stressing bars shall not vary by more than 10 mm from the specified position as measured from the transverse centreline of the unit. The vertical position and diameter of holes for transverse stressing bars, and other holes and cast in fittings shall not vary by more than 5 mm from the specified dimensions.

7.3.3 Location of Tendons and Reinforcing Steel

The following tolerances shall apply to the location of tendons and steel reinforcing –

a) Tendon pattern plates ± 2 mm;

b) Cover to tendons and reinforcement (includes cover to internal voids) ± 5 mm; and

c) Vertical / horizontal position of the tendon location at any point in unit ± 5 mm.

7.3.4 Void Location

Voids shall be located within –

a) ± 10 mm vertically measured from the soffit;

b) ± 5 mm transversely measured from the longitudinal centreline of the unit; and

c) + 5 mm or - 20 mm longitudinally where a positive dimension is the void or void position being longer than specified and a negative dimension is the void or void position being shorter than specified.

7.3.5 Out of Square

On any transverse cross-section, the adjacent faces shall not be out of square by more than 5 mm per metre or 5 mm overall, whichever is the greater.

On any longitudinal cross-section the slope of the end face shall not deviate from that specified by more than 15 mm per metre, to a maximum of 12 mm overall.

7.3.6 Hog

The hog values of similar units of the same age, which are to be used in the same span, shall lie within a maximum range of 20 mm for units up to 20 m long and of 25 mm for units over 20 m long. The design hog shall be shown in the Drawings. Any unit with a measured hog greater than the design hog plus 50% or less than the design hog minus 50% shall be rejected. Nonconformance

7.3.7 Bow

At any section, the longitudinal centreline shall not deviate in the transverse direction from a straight line joining the centre points of the ends of the unit (bow) by more than the following –

a) for units up to 15 m long 10 mm;

b) for units over 15 m up to 20 m long 12 mm; and

c) for units over 20 m long 17 mm.

Notwithstanding these tolerances, the dimensions and side bow of deck units shall be such that each unit shall fit between two parallel vertical planes spaced 610 mm apart for units to 20 m and between two parallel vertical planes spaced 615 mm apart for units longer than 20 m.

7.3.8 Twist

With one end cross-section taken as a reference, the rotation of any cross-section shall not exceed 5 mm per metre for the edge being checked.

7.4 Girders

7.4.1 Cross-Section

7.4.1.1 All Girders

At any cross-section, dimensions shall be accurate to within ± 5 mm.

7.4.1.2 T Girders Only

The tolerance described in this clause shall take precedence over all other geometric requirements.

At any location along the length of a girder, the dimension from the theoretical centreline of the girder to the outer extreme of the top flange (including lateral bowing of the girder resulting from stressing) shall lie within a ± 5 mm tolerance of the corresponding dimension shown in the Drawings. The theoretical centreline is defined as a line which joins the centre point at each end of the girder.

7.4.2 Length

The overall length of any girder and the length from centre to centre of the bearings at each end shall not vary by more than 0.06% from the specified length, with a maximum variation of 20 mm. The location and diameter of any transverse or vertical holes and cast in fittings shall not vary by more than 5 mm from the specified dimensions.

7.4.3 Location of Tendons and Reinforcing Steel

The following tolerances shall apply to the location of tendons and steel reinforcing –

a) Tendon pattern plates ± 2 mm;

b) Cover to tendons and reinforcement ± 5 mm; and

c) Vertical / horizontal position of the tendon location along girder ± 5 mm.

7.4.4 Out of Square

On any transverse cross-section the adjacent faces shall not be out of square by more than 5 mm per metre or 5 mm overall, whichever is the greater.

On any longitudinal cross-section the slope of the end face shall not deviate from that specified by more than 15 mm per metre, to a maximum of 12 mm overall.

7.4.5 Hog

The hog values of similar units and girders of the same age, which are to be used in the same span, shall lie within a maximum range of 20 mm for spans up to and including 20 metres and 25 mm for spans exceeding 20 metres.

The design hog shall be as shown in the Drawings. Any unit or girder with a measured hog greater than the design hog plus 50% or less than the design hog minus 50% shall be rejected. Nonconformance

7.4.6 Bow

At any section, the longitudinal centreline shall not deviate in the transverse direction from a straight line joining the centre points of the ends of the girder (bow) by more than 20 mm.

7.4.7 Twist

With one end cross-section taken as a reference, the rotation of any cross-section shall not exceed 5 mm per metre for the edge being checked.

7.4.8 Tolerances for Voids or Tub Location

Voids or tubs in T girders are to be positioned such that the following tolerances apply –

a) Cover to tendons and reinforcement as per Clause 7.4.3;

b) Overall thickness of cross section as per Clause 7.4.1.1; and

c) Lengths of voids or tubs shall be positioned such that the final dimensions are within ± 10 mm of the specified dimensions. Approval of alternative dimensions, void or tub lengths shall be obtained before casting commences. Hold Point 4

8 FORMWORK (INCLUDING VOIDS)

8.1 Formwork

Formwork shall be manufactured from metal and shall be substantial enough so that it does not deflect beyond the tolerance limits during casting.

Chamfers shall be straight and true to shape and line.

Cores for forming transverse holes in the finished work or other forming devices which would restrict longitudinal strains in the member shall be loosened so that concrete shrinkage and/or thermal movements are not restrained.

Where a transverse or vertical hole is shown in the concrete on the drawing, the formwork or void former shall be removed after casting. Permanent hole formers are not accepted, unless shown on the drawing.

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

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

8.2 Voids

8.2.1 General

The void formers shall be restrained so that the applicable tolerance limits of either Clause 7.3 are achieved. No damage to voids shall occur during casting operations. Void formers shall not be secured to the designed product tendons.

The restraint systems for void formers shall be approved by the Administrator prior to placing the concrete. Hold Point 5

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

8.2.2 Circular Voids

Circular voids shall be manufactured from material approved by the Administrator. The ends shall be sealed to stop the entry of water and grout into the void.

8.2.3 Non-Circular Voids

Non-circular voids shall be manufactured from cellular polystyrene Grade SL to AS 1366.3.

9 STEEL REINFORCING AND CAST IN ITEMS

9.1 Normal Steel Reinforcing

Steel reinforcing shall comply with the requirements of MRTS71 *Reinforcing Steel*.

9.2 Stressing Tendons and Units

9.2.1 Longitudinal Prestressing Tendons

Tendons used for longitudinal stressing shall comply with AS/NZS 4672.1, AS/NZS 4672.2-7 wire ordinary-12.7-1870-Relax 2 and AS/NZS 4672.2-7 wire ordinary-15.2-1750-Relax 2, except that the maximum projected relaxation loss at 10,000 days shall be 5.0% when stressed to 80% of minimum Ultimate Tensile Strength specified in AS/NZS 4672.1.

Strand shall be a registered product. (Refer to Clause 1).

9.2.2 Transverse Stressing Units

A transverse prestressing unit shall consist of a stressing bar complete with necessary nuts, washers, anchor plates and couplers where shown in the Drawings.

Stressing bars shall be plain 29 mm nominal diameter, to AS/NZS 4672.1 and AS/NZS 4672.2-bar-29-1030-P. Bars shall have a coarse thread.

Anchor plates shall be hot dip galvanised to AS/NZS 4680.

All components shall be supplied by the supplier of the stressing bar.

9.2.3 Test Certificates for Tendons and Stressing Bars

Copies of supplier's test certificates for the tendons and stressing bars shall be made available by the prestressed concrete member supplier on request.

All coils of tendons shall be capable of being identified with the test certificates. Tendons in members shall be able to be traced to the coil used and the relevant test certificate.

9.2.4 Testing of Tendons and Stressing Bars

In general, physical testing of tendons shall not be required while satisfactory correlation is obtained between the jacking force and extension during the stressing operation. If such correlation is not obtained, or if the tendon exhibits any peculiarities, as referred to in AS/NZS 4672.1 and AS/NZS 4672.2, as relevant, the use of such tendons shall cease until physical tests have been carried out at a laboratory registered by NATA.

The samples shall be tested for –

a) ultimate tensile strength;

b) 0.1% proof stress;

c) 0.2% proof stress;

d) secant modulus of elasticity at stressing load; and

e) percentage elongation at rupture on a 600 mm gauge length.

The cost of testing shall be borne by the Contractor.

9.2.5 Storage and Cleaning

Stressing units and coils of prestressing tendon shall be stored away from the weather and shall not be placed in direct contact with the ground.

Any lubricant used in the manufacture of the tendon shall be thoroughly removed by a suitable degreasing agent. All loose rust shall be removed from the tendon before use.

Badly rusted or pitted steel shall not be used.

A very light film of rust is not considered detrimental providing that the steel is not visibly pitted.

Any foreign matter adhering to the tendon after stressing shall be removed before placement of concrete. The cleanliness of the tendon shall be such that bond with the concrete is not impaired.

9.2.6 Straightening

Tendons shall be supplied in coils large enough to be self straightening. Kinked or damaged tendons shall not be used in prestressed concrete members.

9.3 Cast in Items

Cast in items, including ferrules, formwork anchors, bearing attachment plates, pile shoes and pile splices shall be either –

a) Fabricated by an approved fabricator in accordance with MRTS78; or

b) Proprietary items as specified in the Drawings, supplied by an approved supplier, or approved equivalent.

9.4 Lifting Points

9.4.1 Piles

Lifting Points shall be as shown on Standard Prestressed Concrete Pile Drawings.

9.4.2 Decks and Girders

Lifting points shall be strand loops as shown on the drawings. Two separate loops shall be provided on each end of the product. The designer shall be responsible for certification of the strand lifting loops as part of the design. The minimum factor of safety for the design of the loops shall be 5. A rigging diagram shall be shown on the drawing.

10 STRESSING

10.1 General

Prestressing operations shall be carried out only under the direction of an experienced and competent supervisor and all personnel operating the stressing equipment shall have been properly trained in its use. In addition to the normal precautions against accidents which shall be taken at all times for the whole of the works, special precautions shall be taken when working with or near tendons which have been tensioned or are in the process of being tensioned.

The supplier shall have an independent RPEQ certification for each stressing bed and stressing system stating the safe capacities and eccentricities for the system.

10.2 Debonding of Tendons

Where sheathing of pre-tensioned tendons is required to prevent bond over a specified length, it shall consist of plastic tubing or other material, of a quality, diameter and thickness such that bond shall be effectively prevented. This sheathing shall be fastened to the tendon in such a manner that the efficiency of the bond-break shall not be impaired by the entry of cement mortar, and such that it shall not move along the strand during placement of concrete.

10.3 Tensioning Equipment

All equipment used for verification of pre-tensioning and testing shall be calibrated in accordance with AS 2193. Maximum period between calibrations shall be as given in Clause 3.8 of AS 2193 with the maximum interval between calibrations being 1 year.

10.4 Stressing Records

The following information relating to the prestressing operation shall be recorded –

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

b) identification particulars of the tendons;

c) required overall elongation;

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

e) force (or pressure) at the time tendons 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.

Stressing records shall be supplied to the Administrator within 7 days after transfer.

10.5 Stressing Procedures

10.5.1 General

The pre-tensioning force at stressing stated in the Drawings, is defined as the average force remaining in the tendons, within the length of any member, immediately after release of the tensioning jacks and before concreting. The maximum variation in force between tendons shall be 5% of the jacking force.

The actual tensioning force applied shall allow for any anticipated movement of the anchorage devices, friction through forms and, in the case of deflected strands, friction losses at deflection points.

The method of tensioning shall ensure that the required force is applied to all tendons.

Prior to establishing a datum mark on each tendon for the purpose of measuring elongation, a known initial tension of from 15% to 30% of the jacking force shall be applied to each tendon to lift it off the bed floor and to equalise sag effects. The measurement of elongation shall commence from this mark.

The true extension shall be considered to be the sum of the measured extension and the calculated value of the extension obtained by application of the initial tension minus the amount of pull-in at anchorages and anchorage movements (if any).

A uniform load shall be maintained throughout the entire length of all tendons and locked off as close as possible to design load.

The jacking force applied shall not differ by more than 5% of actual/calculated elongation at total design loads.

Under no circumstances shall the force applied to a tendon exceed 85% of the minimum breaking load specified in AS/NZS 4672.1 and AS/NZS 4672.2.

Elongation is to be calculated using secant modulus of the stress/strain curve taken from the test certificate supplied with every coil of strand.

10.5.2 Deflected Tendons

The stressing operation shall be carried out in such a manner as to ensure that the tendons are uniformly stressed and that the holding devices are secure.

If friction losses are such that the specified tendon force cannot be attained by stressing from one end only, it shall be necessary to stress the tendons from both ends. Furthermore, the Administrator may request that elongation measurements or strain gauge measurements be taken at various positions along the tendon to determine the force in the tendon at those positions.

The supplier shall provide a load cell and supply all necessary labour for measuring tension in deflected tendons should it be considered necessary by the Administrator.

After transfer of prestress, devices for deflecting tendons shall be removed to a depth of at least 20 mm. The recess shall be thoroughly cleaned of grease, oil or other foreign matter and completely filled to form a dense

waterproof patch. The colour of the infill material shall match that of the parent concrete where such patches are visible in the completed structure. The patches shall be neatly finished flush with the surface of the unit.

10.5.3 Measurement of Tension in Tendons

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

The prestressing force shall be determined by measuring both the elongation of the tendon and the final jacking force and shall meet the requirements of Clause 10.5.1.

Elongation shall be calculated on the basis of the secant modulus of the material being used.

After completion of stressing, a lift off test on the tendons in the product shall be conducted to verify the tension in the tendon. This test shall be conducted at the opposite end of the bed to the main stressing operation.

When the force in a multi wire stressing operation is not measured during stressing, the frequency shall be one tendon per cast per strand coil.

When the force is measured during the multi wire stressing operation –

a) one test for one tendon for the first cast of a product per strand coil; and

b) one test for one tendon for each new strand coil introduced into the process thereafter.

11 CONCRETE

11.1 General

The manufacture, placement and surface finish of concrete shall be carried out in accordance with MRTS70 *Concrete* and Clauses 11.2 and 11.4.

Quality system requirements for setting up and manufacture of members shall be as stated in this Technical Standard.

The placing of concrete shall be a mandatory hold point in the supplier's Quality Management system and can be enforced as a witness or hold point by the Administrator if required.

11.2 Placement

Placement of concrete shall be a Hold Point in the suppliers Quality System.

11.2.1 Strand Debonding

Concrete placement techniques shall ensure that the debonding material remains against the end of the form. The pour shall start at least 1 m from the end of the unit then proceed back to the end of the form. Only when this is complete shall the pour proceed along the member.

11.2.2 Voids

Concrete over voids shall be placed in two stages. The concrete shall be first placed and vibrated such that the top of the void is visible. In the second stage the concrete shall be placed up to the full depth of the unit.

A minimum of two internal vibrators are to be used simultaneously, one each side of the void.

11.3 Curing

All piles, girders, deck units and kerb units shall be steam cured in accordance with MRTS70 *Concrete*.

In addition to meeting these requirements the supplier must ensure the production and curing cycles are consistent from day to day to achieve compliance with either Clause 7.3.6 or 7.4.5

11.4 Prevention of Cracking

As per the requirements of MRTS70 "the supplier shall plan and control the placing, compacting, curing and finishing operations to prevent cracking".

12 TRANSFER OF PRESTRESS

12.1 Strength of Concrete at Transfer

Transfer of prestress shall not be carried out until the concrete has attained the specified transfer strength as proved by appropriate test cylinders, manufactured and cured for this purpose.

12.2 Preliminary Check

Prior to transfer of the prestressing force from the abutments of the casting bed to the members, tendons shall be examined for tightness and the presence of any loose tendons shall be reported to the Administrator. Members with loose tendons may be rejected by the Administrator. Nonconformance

12.3 Transfer Procedure

The prestress shall be transferred to the members in such a manner that the tendons are released gradually and simultaneously.

Large differences of tension between the tendons shall be avoided. No shock release of stress is to occur during de-tensioning operations. De-tensioning equipment used shall have adequate capacity to completely release all tendons in one operation. Flame release of tendons is not permitted.

If the tension is released from one end only or if there are several moulds in line, provision shall be made for the members to slide, allowing a transfer of the force all along the tensioned line.

Where there are several moulds in line, cutting strand between members shall proceed after de-tensioning and shall proceed in sequence from the de-tensioned end.

If shock release of stress occurs due to any cause, members adjacent to the shock-released strand may be rejected by the Administrator. Nonconformance

12.4 Precautions for Delayed Transfer

If de-tensioning is delayed beyond 24 hours, cooling and shrinkage of the member shall increase the stress in the free tendon and can cause sudden failure.

If de-tensioning is delayed beyond 24 hours after casting, precautions shall be taken to limit stresses in free strand to a maximum of 85% of minimum breaking load by covering the member and keeping it warm, insulating forms, or partial de-tensioning based on rational engineering calculations.

13 TRIMMING ENDS OF TENDONS

After the transfer of prestress, tendons shall be trimmed flush with the end of the member by power grinders. De-bonded tendons shall be sealed prior to painting. Except for piles, the ends of the tendons and the area immediately adjacent to the tendons shall then be painted with a registered surface tolerant epoxy compound (refer Clause 1) to provide a film thickness at least 0.3 mm dry or 0.6 mm wet. Generally a minimum of two coats shall be applied. Ends of tendons for piles need not be painted.

14 SURFACE PREPARATION FOR CROSS GIRDERS

Where shown in the Drawings, the surface of girders at the interface area with any cross girders to be constructed after erection shall be roughened by scabbling, sand blasting, or use of a surface retarder.

15 MARKING, HANDLING AND STORAGE

15.1 Marking

15.1.1 Prestressed Concrete Piles

Each pile shall have the date of casting, pile mass, supplier's name and length clearly and permanently marked thereon. Length marks shall be placed at 0.25 m intervals commencing at 3 m from the toe of the pile and extending to the head of the pile. Length marks shall be permanently numbered at 1 m intervals with figures 75 mm high, showing the length.

15.1.2 Prestressed Concrete Deck and Kerb Unit and Girders

Each deck and kerb unit and girder shall have the date of casting, unit mass, supplier's name, identification number and type clearly and permanently marked on vertical faces of both ends. In addition, each deck and kerb unit shall have the identification number and casting date scratched in the top surface immediately after casting.

15.2 Supplier's Labels

If the supplier desires to attach advertising labels to the members on dispatch from the storage yard, these shall be fastened in such a way that removal of the labels at the delivery point is simple.

If these labels are firmly glued to the members and removal is difficult, the supplier shall be responsible for their removal, or alternatively shall pay for the cost of removal.

15.3 Handling, Transport and Storage

15.3.1 General

The method of handling and storage shall be such as to avoid the danger of fracture by impact, undue bending, twisting and whipping.

Prestressed concrete members shall be moved only while fully suspended. In no case shall they be moved by dragging across the terrain.

All Quality Assurance checks shall be performed and repairs carried out prior to placing units in a stack where access to individual units cannot be gained.

No prestressed member shall be transported from a supplier's yard until a minimum of 7 days has elapsed from the date of casting.

15.3.2 Prestressed Concrete Piles

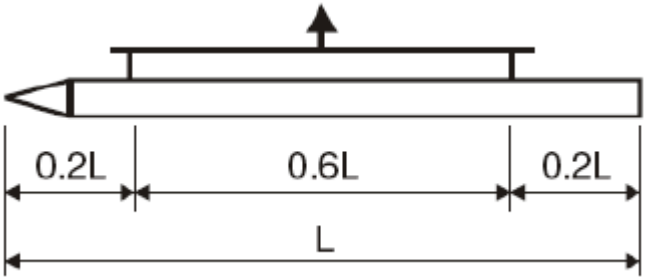
Piles shall not be lifted or handled until fully stressed.

In general, piles shall be lifted by means of a suitable bridle or sling attached to the pile at points specified below. Other methods of lifting proposed by the supplier shall be subject to the approval of the Administrator before use.

Piles shall be protected at all times so as to avoid chipping or spalling of the edges by the handling slings, support timbers or any other cause.

Piles shall be handled, transported and stored using a two-point support system located at the points indicated in Figure 13.3.2.

Figure 15.3.2 – Pile Support System



The maximum length of pile which can be handled, transported or stored using this support system is shown in Table 15.3.2 for various strengths of concrete applicable at the time of handling.

Piles of length longer than those shown in Table 15.3.2 shall require additional support as directed by the Administrator.

Table 15.3.2 – Maximum Length of Pile Using Support System shown in Figure 15.3.2

Strength of Concrete at the Time of Handling (MPa)	Maximum Length of Pile Which Can Be Handled (m)		
	450 mm Pile	500 mm Pile	550 mm Pile
35	22	23	24
50	25	27	28

Note: A dynamic load of 50% of the static load has been used in determining the above limiting lengths.

Piles shall be stored clear of the ground on adequate timber supports, located as shown in Figure 15.3.2 and placed on firm ground which is not liable to subsidence, when wet or dry, under the weight of the piles. Where piles are stacked in layers, timber supports for each layer shall be placed directly above those of the preceding layer.

Where the length of piles requires the use of an articulated vehicle for transport, the piles shall be supported and rigidly attached to the vehicle at the specified lifting points.

Adequate protection shall be provided to prevent damage to the concrete by the restraints. The trailing jinker shall be connected to the prime-mover by a rigid pole which pivots at the leading end at the same point as the pile support.

Timber packers shall be used between the sides of individual piles to prevent contact between the piles during transport.

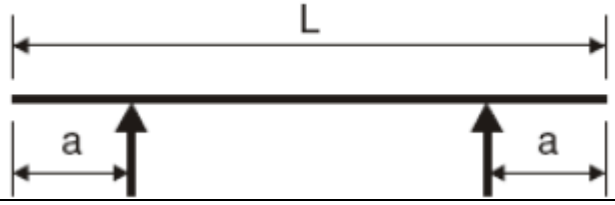
15.3.3 Prestressed Concrete Deck and Kerb Units and Girders

Prestressed concrete deck and kerb units and girders shall be held in such a position that the top surface is uppermost at all times during handling, transport and storage. All units shall be lifted by the lifting devices incorporated in the units. Webs of girders shall remain vertical with the top flange uppermost at all times.

Units and girders shall be stacked on two supports positioned one at each end, in the case of girders immediately under each lifting device, and, in the case of deck and kerb units, within the end distance shown in Table 15.3.3.

Units and girders shall not rest on any support at locations between the approved support points during handling, transport and storage.

Table 15.3.3 – Maximum Overhang Beyond Supports During Transport and Storage of Deck Units

Unit Type	Nominal Length † (L) (metres)	Maximum Overhang † (a) (metres)
596 mm wide deck units.	≤ 13	$L/8$
	14	1.3
	≥ 15 ≤ 16	1.2
	≥ 17	1.0
350 mm wide kerb units.	All lengths	$L/8$
		

† Measured along centreline of unit.

The support timbers shall be sufficiently large to store the units clear of the ground and to avoid subsidence under the supported weight when the ground is wet. The ground beneath the units shall be levelled so as to maintain the same clearance or greater as at the supports.

To avoid twisting of units, all stacking areas are to be an even plane from one end of the unit to the other. Where units are stacked in layers they shall be supported by timbers positioned directly above those below. Where practical, the units shall be stacked so that access for inspection of all units is possible at any time.

When loading or transporting girders, the Contractor shall provide means of restraining side whip.

15.3.4 Transverse Stressing Units

Transverse stressing bars shall be handled and stored in such a manner that no damage is incurred to them.

Threads on the ends of bars shall be covered and protected during handling and storage.

Transverse stressing units, consisting of stressing bars, nuts, washers, anchor plates and couplers, shall be stored in such a place that they shall not be subject to damage by welding, weld splatter, accidental heating by adjacent oxy-acetylene welding/cutting operations or by passage of stray electric currents. Stressing bars shall not be nicked during storage.

Transverse stressing units shall be supported well clear of the ground on timber supports protected from the weather and shall be protected from mud splatter and the corrosive effects of dust and chemicals.