Section 865—Manufacture of Prestressed Concrete Bridge Members

865.1 General Description

This section includes the following requirements for precast-prestressed concrete bridge members and piling:

- Manufacturing
- Inspecting
- Testing
- Marking
- Painting
- Rubbing as specified
- Plant handling
- Storing
- Shipping

The term “precast-prestressed concrete” is referred to as “prestressed concrete” in the rest of this Section.

865.1.01 Related References

A. Standard Specifications

Section 106–Control of Materials

Section 152–Field Laboratory Building

Section 500–Concrete Structures

Section 511–Reinforcement Steel

Section 514–Epoxy Coated Steel Reinforcement

Section 801–Fine Aggregates

Section 830–Portland Cement

Section 831–Admixtures

Section 853–Reinforcement and Tensioning Steel

Section 857–Bronze Bushings, Bearings, and Expansion Plates

Section 870–Paint

Section 885–Elastomeric Bearing Pads

Section 886–Epoxy Resin Adhesives

B. Referenced Documents

AASHTO M 55

AASHTO M 85

AASHTO M 221

AASHTO T 22

AASHTO T 27

ASTM A 123/A 123M)

ASTM A 153/A 153M)

ASTM A 185

ASTM A 416

ASTM A 497

AASHTO Specification for Highway Bridges

Laboratory SOP-3, Standard Operating Procedures for Precast/Prestressed Concrete

QPL 9

GDT 35

865.2 Materials

Use materials that meet the specifications as follows:

Material	Section
Concrete, Class AAA (except as noted)	500
Steel Bars for Reinforcement	853.2.01
Pretensioning Steel Wire Strand	853.2.02
Post-Tensioning Steel Wire	853.2.03
Post-Tensioning Steel Bars	853.2.04
Plain Steel Bars—Threaded Ends	853.2.05
Portland Cement	830.2.01
Fine Aggregate for Mortar	801.2.02
Aluminum Powder	835.2.01
Self-Lubricating Bronze Bearing and Expansion Plates and Bushings	857.2.03
Primer Coats	870
Elastomeric Pads	885.2.01
Epoxy Resin Adhesive	886
Microsilica (Silica Fume)	831.2.03

NOTE: Do not use accelerators (24-hour accelerated strength concrete) that contain chlorides in any prestressed concrete.

865.2.01 Prestressed Concrete Bridge Members

A. Requirements

1. Portland Cement

   Use Type I, Type II, or Type III cement that meets requirements of AASHTO M 85 for low alkali cement.

   a. Use Type II cement in concrete to cast pile for specific locations noted on the Plans.

2. Coarse Aggregate

   a. Use the size specified and approved for prestressed concrete products.

b. Do not use unconsolidated limerock coarse aggregate in prestressed concrete piling or in any structure that has direct contact with water.

3. Microsilica (Silica Fume)

The Department may approve silica fume as an additive to concrete. If approved, add the silica fume at a rate not to exceed 10 percent of the cement content.

4. Epoxy-coated Reinforcement Steel and Wire:

If top steel mat of the bridge deck is epoxy-coated, the shear steel in the prestressed concrete beams will be epoxy-coated in accordance with Section 514.

5. Welded Wire Fabric

Use welded wire fabric that meets the following requirements:

a. Use smooth wire fabric that meets the material requirements of AASHTO M 55 (ASTM A 185) and this Section.

b. Use deformed wire fabric that meets the requirements of AASHTO M 221 (ASTM A 497) and this Section.

6. Pretensioning Steel Wire Strand

Use strands that meet all the requirements of ASTM A 416, Grade 270.

7. Slump Limitation

Ensure the slump meets Subsection 500.1.03.A Table 1 – Concrete Mix Table , except when Type F high range water reducers (HRWR) are added. With HRWR, you may increase the slump value from 4 in to 6 in (100 mm to 150 mm) with a maximum slump value not to exceed 7 in (175 mm), provided the concrete mix does not segregate.

8. Facilities and Equipment Plans

Facilities are approved according to Laboratory SOP-3, Standard Operating Procedures for Precast/Prestressed Concrete. See QPL 9 for a list of approved facilities.

Submit a complete set of plans and an itemized equipment list of the prestressing facilities to the Engineer.

a. For established plants already approved by the Department, the Department will send a written notice about approval. The plant need not comply with the requirements concerning Plans and equipment listing.

b. The Department may withdraw the waiver at its discretion if the plant changes the facilities, equipment, production methods, types of products, or for any other reason.

B. Fabrication

1. General Plant Requirements

Furnish erection drawings to the Engineer that show the placement of superstructure units, especially when the units are not interchangeable with respect to transverse placement within a span or with respect to the reversal of ends within a span.

2. Manufacturing Facilities and Equipment

Ensure that the prestressed concrete bridge members are made at a plant that has as a minimum the facilities and equipment specified as follows:

a. Do not start manufacturing until the Engineer approves the facilities and equipment.

NOTE: Regardless of approval, the Contractor is responsible for the facilities' performance and obtaining additional equipment as needed.

b. Beds: Construct beds for casting prestressed concrete of concrete; these shall be level or on a grade acceptable to the Engineer.

c. Anchorages: Design and construct anchorages so they will not yield under 150 percent of the maximum design load.

d. Forms: Construct steel side and bottom forms unless the Department allows other materials.

   1) Design the forms so the bridge members will be well within the tolerances specified in Subsection 865.2.01.B.11.

   2) Anchor the forms to prevent movement.

e. Stressing Equipment

   1) Jacks: Use jacks in good repair that do not leak. Calibrate them with the actual gauge or gauges that you will be using. You may use pressure gauges, load cells, or dynamometers.

      Ensure all jack systems have devices that prevent the gauge pointer from fluctuating.

   2) Calibration: Calibrate all devices to a reading accuracy of 2 percent within the proposed stressing range.

      Use an approved testing laboratory to calibrate the devices. Have the laboratory furnish at least five copies of the calibration chart for each device to the Engineer.

      Recalibrate all stressing systems at least every 6 months and as required by the Engineer. Use gauges that you can read from 6 ft (2 m) and have a capacity of twice the maximum load.

f. Elongation Measurement: Use a system approved by the Engineer and isolated from any movement in the bed or anchorages.

g. Curing Systems Equipment: Use one of the curing methods listed below. Do not use curing compounds on prestressed concrete units unless the Engineer gives written permission.

   1) Water Curing: Use equipment that consists of a clean, non-deleterious water source, a method of application, and enough burlap or other means of moisture retention that will keep all surfaces of the concrete wet during the curing cycle, except those in contact with the forms.

   2) Steam Curing: Use the following minimum basic equipment:

      - An enclosure tight enough to maintain a uniform atmospheric temperature around the concrete units.
      - A steam system that distributes live steam uniformly through nozzles, capable of maintaining a temperature of at least 120 ºF (50 ºC) in all weather. Do not eject steam directly against concrete or forms.
      - A controlling device installed in the steam line that helps maintain a constant temperature.
      - A recording thermometer for each 200 ft (60 m) of bed length.

   3) Heated Forms: Uniformly heat the forms with a recirculating system that distributes the heat evenly. Use a system that includes:

      - A means of retaining moisture on concrete surfaces, except those in contact with the forms.
      - A recording thermometer for each 200 ft (60 m) of bed length.
      - A weathertight covering for each bed to ensure uniform heating throughout the bed.

h. Vibrators: Use internal vibrators with at least 4,500 impulses per minute. Ensure the vibrator heads are small enough to reach through the prestressing and reinforcing steel to all portions of the form.

   1) Use enough vibrators to properly compact the concrete. Have an additional stand-by vibrator in good operating condition for each concrete placing operation.

   2) Get the Engineer's approval of the vibration procedure and of the number and types of vibrators before pouring.

   3) You may use external vibration in conjunction with internal vibration when the Engineer so approves.

i. Grout Pump: Use grout pumps that can pump the fluid grout and maintain a uniform pressure of 75 lbs/in² (520 kPa) for at least 15 seconds.

j. Storage Areas: Use plant storage areas that have surfaces capable of supporting the prestressed concrete bridge members without settlement. Ensure the storage area has blocks to support the units properly at the required points.

3. Substitution of Reinforcement

   You may substitute welded wire fabric for the bar reinforcement shown on the Plans. The Department will not pay extra for the substitution.

   The substitution is subject to the following:

   a. Design Notes: Submit detailed shop drawings and design notes, including any changes, to the Engineer for approval before using welded wire fabric.

   b. Indicate on the design notes that the welded wire fabric will provide the same or greater strength as that provided by the bar reinforcing shown on the Plans.

   c. Design fabric use according to the latest AASHTO Specification for Highway Bridges. Prepare the drawings on 22 x 36-in (550 x 990 mm) sheets.

   d. Have an Engineer registered in the State of Georgia stamp both drawings and notes.

   e. Design the yield strength for the wire fabric not to exceed 60,000 psi (415 MPa) but not be less than 40,000 psi (275 MPa). Do not splice by welding or mechanical coupling.

   f. If using welded wire fabric for stirrups of bar reinforcement, embed the wires perpendicular to the axis of the beam at least 6 in (150 mm) into the slab. Leave at most a clearance of 4 in (100 mm) from the top of slab to the welded wire fabric.

   g. Embed at least two cross wires (wires parallel to the longitudinal axis of the beam) in the slab, with the closer cross wire clearing the top of the beam by at least 2 in (50 mm).

   h. You may use welded wire fabric in the anchorage zone at the ends of the beam to replace the stirrups that enclose the prestressing steel in the bottom flange, and the vertical stirrups that do not protrude beyond the top of the beam.

   i. Ensure that the wires perpendicular to the longitudinal axis of the beam have the same steel area as that of the bar reinforcing.

   j. Use either smooth or deformed wires for welded wire fabric. Use the AASHTO Specification for Highway Bridges for the proper methods to embed and splice the fabric.

4. Substitution of Strands

   You may use strands of different arrangement, size, or arrangement and size. The Department will not pay extra for the substitution.

   The substitution is subject to the following structural and physical requirements:

   a. Ensure that the net prestressed force of the strands after losses equals that shown on the Plans.

   b. Ensure that the ultimate strength of the member meets the applicable requirements of AASHTO Specification for Highway Bridges.

   c. Ensure that the eccentricity pattern of the substituted strands is about the same as the pattern shown on the Plans.

   d. Before substituting strands, submit to the Engineer all changes and detailed shop drawings, with design notes. Ensure that the design notes indicate compliance with the requirements. Prepare drawings on 22 x 36-in (550 x 900 mm) sheets.

NOTE: If you propose to use strands that differ in size from those covered in ASTM A 416, submit complete data on the strands to the Engineer for approval.

Do not use individual strand couplings.

e. Have an Engineer registered in the State of Georgia stamp both drawings and notes.

5. Concrete Manufacture and Mixing

a. Manufacture and place concrete according to the requirements of Section 500.

b. Mix the concrete according to Subsection 500.3.04.E and Subsection 500.3.02.D.2 except when adding HRWR.

1) When adding HRWR, dose the HRWR at the casting yard under the direct supervision of the producer's Quality Control. Do not exceed the HRWR manufacturer's recommended dosage.

2) After dosing, mix the concrete at mixing speed for at least 70 revolutions.

NOTE: Do not exceed 360 total revolutions at mixing and agitating speeds.

3) After adding the plasticizer, no additional mixing water will be permitted.

6. Concrete Pouring

Fabricate the ends of all beams and girders to be vertical in the final erected position,.

a. Rough-float the tops of beams at approximately the initial set.

b. All nominal lengths shown on the plans are horizontal dimensions.

c. Ensure that the Fabricator adjusts the lengths, as necessary, to account for the final erected position of the member.

d. Slope bearing assemblies to accommodate the erected position of the member.

7. Methods of Prestressing

You may either pretension, post-tension, or combine these methods to prestress concrete bridge members.

a. Pretensioning: You may pretension with either the single-strand or the multi-strand jacking method.

NOTE: Do not use strands from more than one source in any one tensioning operation.

Ensure the method used meets these requirements:

1) Strand Splices: Get approval from the Engineer for splicing methods and devices.

Jacking Method	Action
Single-strand	Use only one splice per strand.
Multi-strand	Splice all strands or no more than 10% of the strands.

Ensure that the spliced strands have similar physical properties, are from the same source, and have the same "twist" or "lay." Locate splices outside the prestressed units.

2) Wire Failures: The Engineer may accept wire failures if the area of broken wires does not exceed 2 percent of the total area of the strands.

3) Stressing Preparations: Prepare the members as follows:

a) Carefully place and thread all strands in the bed.

b) Avoid contaminating the strand with oil, grease, or other bond breaking material. If any strand is contaminated, clean the strand with a suitable solvent or replace the strand.

c) After final stressing, position all strands within the location tolerances specified in Subsection 865.2.01.B.11.

d) Use strand vises designed for the size of pretensioning strand to anchor the strand.

e) After anchoring, ensure that the vises sustain the pretensioning force without slipping until the release of stress. Ensure that the vise grips seat no more than 1/4 in (6 mm) each.

f) To prevent strands from bonding together, encase the strand in a conduit that can resist the pressure exerted by the concrete.

g) Use conduit with an ID allowing free movement of the encased strand, but no greater than the diameter of the strand plus 1/8 in (3 mm).

h) Secure the conduit to prevent both longitudinal movement along the strand and bonding at the location shown on the Plans, ± 1 in (25 mm).

i) Tape the conduit to keep concrete out. Use tape and conduit manufactured from a non-corrosive material compatible with both the concrete and steel. Do not debond the strand for the full length of members.

4) Pretensioning Operation: Use elongation to control this operation. Ensure that the hydraulic pressure gauge readings at the time of the measured net elongation are within 5 percent of the calculated gauge reading for that particular elongation.

Ensure that the net elongation and final gauge measurements agree within ± 5 percent of their computed theoretical values.

The measurements of force and elongation shall algebraically agree with each other within a 5% tolerance.

If any measurement varies by more than 5 percent, the Department will stop all work. Correct the defect before proceeding.

Pretension the members as follows:

a) Initial Tension: After threading the strand in the bed, apply an initial tensioning force to each strand.

Do not use elongation to measure the amount of initial tension, but use a dynamometer, hydraulic jack gauge, or dead weight.

b) Final Tension: Calculate the final stress from the final elongation measured between established reference points. Use points that are independent of any movement in the bed or anchorages that might occur during the pretensioning operation.

Calculate the design elongation as follows:

$$D = \frac{PL}{AE} \text{ where}$$

D = Design elongation in inches (millimeters).

P = Tensioning force, in pounds (kilonewtons); subtract the initial tensioning force from P.

L = Distance from dead end anchorage to reference point, measured in inches (millimeters)

A = Cross-sectional area of strand, in square inches (millimeters).

E = Modulus of elasticity of strand, in pounds per square inch (MPa).

c) Add correction factors to the design elongation for strand anchorage slip and temperature. Correct any movement in the anchorage abutments or in the overall anchorage system. Use the final elongation figure as the net elongation in jacking the strand.

d) Single-Strand Jacking: Do not let the jack ram rotate more than one revolution while stressing any strand.

e) Draped Strand Jacking: Partially jack draped strands from the end of the bed to add tension. Raise or lower the strands to their final position to get the final tension.

Ensure that the strands have no more than four points where the strand changes slope, two of which shall be at each anchorage.

Use approved, low friction devices at pick-up and hold-down points. Make the devices maintain the desired vertical and horizontal positioning of the strand.

After partial jacking, deflect the strands to their final position in a sequence approved by the Engineer.

f) Final Readings: After final stressing, position all strands within the location tolerances specified in Subsection 865.2.01.B.11.

g) Calculate the final elongation according to Subsection 865.2.01.B.7.a.4).b).

Uniformly distribute stress in the strands throughout the bed length.

5) Detensioning Operation: Before detensioning, submit the pattern and schedule for releasing the strands to the Engineer for advance approval.

Detension the members as follows:

a) Strip or loosen forms that tend to restrict the horizontal or vertical movement of the member prior to releasing the stress.

b) If curing with steam, carefully release the strand because of dimensional changes due to temperature and shrinkage changes. Where possible, release the pretensioned strand while the units are moist and warm.

c) In deflected strand construction, immediately release the hold down devices within the member or members after curing with steam.

6) Stress Release Strength: You may transfer stress to the concrete, unless otherwise specified on the Plans or in the Special Provisions, based on the following requirements (minimum strength determined by cylinders cast of the same concrete):

Section	Minimum Strength	Age
Concrete I-beams, box beams, flat slab deck sections, or tee slab deck sections	4500psi (30 MPa)	18 hrs
Piling	4000 psi (28 MPa)	
Other members	As specified on the Plans	

7) Strand Release: Use the following table for each type of strand:

Type of Strand	Release
Single strand	Heat each strand and allow it to pull itself apart in the sequence of the approved pattern and schedule of release. Do not cut the strands.
Multiple strand	Release either a symmetrical group of strands or all of the strands simultaneously. Remove the load on the strands from the anchorage and place it on the jacking system. Gradually release the jack or jacks until the strands are relaxed.
Draped strand	Release according to a method where the weight of the beam is compared with twice the total amount of the vertical components of the hold-down forces.*

*Use one of the following two methods:

Method	Release as follows:
Method I (beam weight less than twice the total amount and vertical restraints cannot counteract the vertical components of the hold-down forces)	Heat each draped strand at the end of each member to failure in the sequence of the approved pattern and schedule of release. Release hold-downs and remove hold-down bolts. Release straight strands as noted in Subsection 865.2.01.B.7.a.(7)
Method II (beam weight more than twice the total amount)	Release hold-down devices within the beam. Release the strands from the top to the bottom by either heating or jacking in the sequence of the approved pattern and schedule of release.

b. Post-tensioning: Use either the system required by the Plans or an approved alternate system. Alternate systems may include the post-tensioning of both straight and draped tendons. Ensure that the system meets the appropriate requirements that follow:

1) Tendons: Do not splice post-tensioning tendons.

2) Ducts: Accurately position the ducts in which post-tensioning tendons are placed and securely fasten them to prevent movement during concrete placement. Use flexible metal conduit, metal tubing, or other acceptable material for the ducts.

3) Stressing Requirements: Prepare the members as follows:

a) Carefully thread tendons into the ducts.

b) Avoid contaminating the strand with oil, grease, or other bond breaking material. If any strand is contaminated, clean the strand with a suitable solvent or replace the strand.

c) Follow the stressing procedures and sequences approved by the Engineer.

d) After stressing, anchor the tendons against the ends of the members and fill the ducts with grout.

4) Concrete Strength: Stress the post-tensioning tendons after the concrete in the member has reached the minimum strength and age requirements, as follows:

Minimum Strength	Age
4500 psi (30 MPa)	3 days
4000 psi (28 MPa)	5 days

c. Post-tensioning Operation: In general, tension straight tendons from one end. Simultaneously tension draped tendons from each end.

Pretension the members as follows:

1) Initial Tension: After threading the tendon in the duct, apply an initial tensioning force of up to 5 percent of the final tensioning force with a jack.

Determine the initial tension by reading the gauge. Do not use elongation to measure the amount of initial tension.

2) Final Tension: Compute the final stress on tendons from the amount of the final elongation measurement, checked by the jack pressure gauge reading.

3) Gauge Reading: Ensure that the pressure gauge reading at the time of the measured elongation is within 5 percent of the calculated gauge reading for that particular elongation.

   If the gauge pressure reading varies by more than 5 percent from the calculated reading, stop the stressing operation and correct the defect before proceeding.

4) Jacking: While jacking draped tendons, ensure that jack pressures and elongations are kept as near equal as is possible at each of the two jacks so the elongation measurements and jack pressures remain proportional.

5) Anchor Devices: Design anchor devices that secure the tendon for the size of post-tensioning tendon used.

   After anchoring, ensure that the devices can maintain a prestressed load of 150 percent of the maximum design load and do not slip more than 1/8 in (3 mm) after anchoring.

   Place anchor devices exactly at right angles to the axes of the post-tensioned tendons. Carefully note anchorage losses and take the proper corrective measures to ensure that the tendon has the final design stress.

8. Grouting
   a. Time Limitations: Complete all grouting within 48 hours after post-tensioning.
   b. Grout: Make grout to a consistency of thick paint.
      1) Mix, by volume, 1 part Portland cement, 0.75 part (max.) sand passing a No. 30 (600 µm) sieve, and 0.75 part (max.) water.
      2) Within the limit specified, vary the proportions of sand and water as required by the Engineer.
      3) If you need to fill enclosures as hereinafter specified, you may eliminate sand and use a neat cement grout in the mix.
      4) After adding all ingredients, mix the batch for three minutes.
      5) Make batches of grout small enough so that the batch may all be used up in less than 45 minutes.
      6) Immediately before grouting, blow out tendon ducts with compressed air. Ensure that the compressed air does not contain oil.
      7) Vent each duct at each end. Ensure the vent has the means for positive closure when subjected to a minimum pressure of 75 psi (515 kPa).
      8) Pump the grout into the duct towards an exit vent.
      9) After the grout has expelled all entrapped air and is flowing in a solid stream, close the exit vent and build the pumping pressure to a minimum of 75 psi (515 kPa). Hold it at that level for a minimum of 15 seconds.
      10) Close the grout entrance vent.
      11) Do not move or disturb the member at all for at least 48 hours after grouting.
9. Concrete Finish
   a. Beams
      1) Finish the outside face of certain exterior beams specified in the Table of "Bridge Areas Requiring a Type III Finish" in Subsection 500.3.05.AB with the Type III Special Surface Coating Finish.
      2) Finish all other beams with a steel form finish.
      3) Score the surfaces of the top flanges of all beams with a stiff wire brush or equivalent. Score the beams transverse to the longitudinal axis of the beams.
      4) Transversely scrub the entire beam top with a coarse brush to remove all laitance and to produce a roughened surface for bonding to the slab. Remove all concrete fins or projections to produce a vertical face at the edge of the beam.
      5) If using prestressed concrete deck panels, finish both sides of the beam's top flange with a trowel for 2 in (50 mm) from each panel edge to ensure a smooth and level bearing area.

b. Superstructure Deck Units: Finish the riding surface of superstructure deck units—flat slabs, channels, double tees, etc.—as specified in Subsection 500.3.05.T.9 and the Plans.

Finish the traffic face and top face of curbs on exterior units and the outside face of certain exterior beams as specified in the Table of "Bridge Areas Requiring a Type III Finish" in Subsection 500.3.05.AB.

c. Substructure Units: Finish the top surfaces of caps and piling with the Type IV—Floated Surface Finish specified in Subsection 500.3.05.AB.5.

d. Patching: The Engineer will inspect all honeycombed areas. The Engineer may reject bridge members with extensive honeycombs within bearing areas.

1) Patch as directed by the Engineer, as soon as possible after form stripping.

2) The Engineer may require that you use an epoxy bonding compound.

3) Remove hold-down devices from the bottoms of the beams.

4) Coat the resulting holes with an epoxy bonding compound and plug them with grout.

10. Concrete Curing

Cure concrete with one of the methods listed below. Provide means for keeping the temperature of bridge members above the freezing point for 6 days after concrete placement, except for steam curing. The Department may reject bridge members based on improper curing.

a. Water Curing: Cover all concrete surfaces that are not in contact with the forms with wet burlap or other suitable material.

Keep the member wet for 7 days or until the concrete has reached the stress release strength specified in Subsection 865.2.01.B.7.a.(6).

b. Steam Curing: Do not begin steam curing for at least four hours after final placement of concrete.

1) The Engineer may delay the start longer if the concrete has not taken its initial set. You may use sufficient heat during the delay to maintain the temperature of the concrete between 50 º and 70 ºF (10 º and 21 ºC).

2) Ensure the steam curing enclosures retain moisture and heat.

3) After steaming begins, you may raise the enclosure temperature at a maximum rate of 80 ºF (27 ºC) per hour until the surface temperature of the concrete reaches an optimum temperature, not to exceed 190 ºF (88 ºC).

4) Ensure that the differential surface temperature of the concrete within a member does not exceed 40 ºF (4 ºC) during the curing period.

5) Continue steaming until reaching the stress release strength.

6) Lower the enclosure temperature at a maximum rate of 40 ºF (4 ºC) per hour.

7) Maintain a film of water on all exposed surfaces of the concrete during the steam curing cycle.

8) Do not exceed the maximum temperatures.

9) The Department may reject bridge members based on excessive temperature.

c. Heated Forms: When using approved heated forms, keep the exposed surfaces of the concrete wet at all times.

1) Enclose the beds with a suitable weather-tight covering supported to uniformly heat throughout the bed.

2) Apply the requirements stated in Subsection 865.2.01.B.10.b concerning the delay period, temperature control, curing duration, and basis of rejection.

11. Tolerances

a. Manufacture prestressed concrete bridge members within the dimensional tolerances listed in SOP-3, "Standard Operating Procedures for Precast/Prestressed Concrete". These tolerances generally will be the maximum deviation allowed, although normal manufacturing tolerances will be well within those listed.

b. The Department may reject bridge members based on excessive deviations.

12. Galvanized Coatings
    a. Before shipping beams, galvanize the exposed surfaces and edges of embedded structural steel bearing components and all exposed surfaces of attached structural steel bearing components according to ASTM A 123/ A 123M or A 153/ A 153M.
    b. Touch up all areas to be welded after the welded area has cooled, and the weld is completed and cleaned.
    c. Galvanize miscellaneous structural steel, hardware, bolts, and washers prior to storage at the casting yard or jobsite.
13. Marking

NOTE: This requirement does not apply to single point pick-up locations placed on piling.

    a. With the exception of the Department's inspection stamp, the Contractor is responsible for the placement and accuracy of all markings on bridge members according to these Specifications.
    b. The Inspector will not act for the manufacturer with respect to marking, but will cooperate with the plant personnel to ensure that the work is properly done with respect to time of marking, accuracy of description, and accuracy of location of marks and lettering.
    c. Locate the markings so they are hidden after completing Project construction.
    d. Do not ship any unit from the plant until it carries the official GDT stamp and number assigned by the Department to the Inspector at the plant, nor until the Inspector checks and approves the markings required by these Specifications.
    e. Required Markings: Clearly mark bridge members to indicate the Project identification, date of manufacture, beam identification number (properly located to coordinate with the erection drawing), pile length, and location of pile single-point pick up.
    f. Time of Marking
        1) Before Stress Transfer: Immediately after forms are removed and before transferring stress, individually identify and date members. This helps keep accurate records on each member's bed location and date of concrete placement.
        2) Before Shipping: Give the Inspector advance notice of shipping. After securing members for shipment, apply marking consisting of the Project identification to each member.
    g. The Inspector will place the GDT stamp and number on each member. The Inspector will not use the GDT stamp until after the members have been satisfactorily finished and stored.
14. Handling and Storing
    a. Prestressing Steel: Protect all prestressing steel from contact with dissimilar metals to prevent galvanic action and excessive rusting.
        1) The Department will not consider light rust that does not visibly etch the steel as detrimental.
        2) Keep prestressing steel free of harmful materials, such as grease, oil, wax, clay, dirt, paint, and loose rust.
        3) Use special care to keep prestressing steel free of form oil and other bond-reducing material that may be used on the forms.
        4) Handle prestressing steel at all times in such manner as to prevent kinks and nicks. The Department will not allow prestressing tendons that have kinks, nicks, bends, or other defects.
        5) Do not use torches or welding equipment adjacent to tensioned strand unless the strand is insulated against heating or burning.
    b. Reinforcement Steel: Handle, place, and support all reinforcement steel according to the requirements of Section 511.

c. Prestressed Concrete Bridge Members: Handle, store, and ship prestressed concrete bridge members in a way to eliminate the danger of cracks, fractures, and excessive bending stresses. Handle members by the two embedded pick-up points, unless the Engineer approves other methods.

1) Except for piling, handle members so their vertical axes remain plumb at all times.

2) Support members in storage on firm blocking located immediately below the two embedded pick up points. In multiple layer storage, support members in the stack with blocks of uniform thicknesses and in a vertical line.

3) Set all blocking at right angles to the longitudinal axis of the member, and the longitudinal axis of the blocking shall be horizontal. Do not ship members until the concrete reaches its ultimate design strength.

NOTE: Replace members that were damaged in handling or storage at no additional expense to the Department. However, the Engineer may determine that the damage is minor and may approve use of the member.

d. Piling: Handle, store, and ship piling after stress release.

1) The Department may reject any piling cracked in handling, storing, or loading if the crack warrants.

2) The Department will reject any cracked piling destined for locations involving sea water or alkali soils.

3) Mark rejected pile as rejected.

4) Store piling in groups with the same length.

5) Transport piling in a manner approved by the Engineer. Upon request, the Engineer will furnish drawings giving the limits of truck bolster spacing for various sizes and lengths of piling.

e. Beams: Handle or store fully pretensioned beams after stress release.

1) Use pick-up and support points within 3 ft (900 mm) of the beam ends.

2) Support beams on firm blocking located within 3 ft (900 mm) of the permanent bearing area of the beam.

3) You may handle or store fully post-tensioned beams 48 hours after the grout has been placed in the tendon ducts.

4) For beams manufactured by the combined method of pretensioning and post-tensioning, you may handle and store them after the pretensioning phase is completed. Do not handle again until 48 hours after grout placement.

5) Do not ship beams and other superstructure units until after their strength reaches the required minimum 28-day design strength.

6) Store beams in single layers, not in stacks. Support beams so they meet the following requirements concerning warp and sweep:

Twist of vertical axes of the ends of beams due to misalignment of blocking	The maximum deviation between the vertical axes of the ends of beams shall be 1/4 in/ft (20 mm/m) of beam height.
Tilt of vertical axis of an end of beam from the vertical due to deviation of blocking from the horizontal	The maximum deviation of the vertical axis of an end of a beam shall be 1/4 in/ft (20 mm/m) of beam height.
Lateral sweep due to manner of storage	There shall be no discernible sweep induced by the manner in which a beam is stored.

C. Acceptance

1. Plant Inspection

a. Give Notice to the Engineer: Give the Engineer ample notice before starting work so that the Engineer can inspect all plant facilities involved in the production. Do not manufacture anything until the Engineer approves all facilities.

b. Facilities for Inspection: Allow free access to the Inspector to all parts of the plant involved in the production process.

c. Inspector Authority: The Inspector has the authority to reject materials or quality of work that do not meet the Specifications. In cases of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

2. Rejections

If any material or finished members are defective, they will be rejected, even though the Inspector may have accepted them.

a. Promptly replace rejected material or quality of work or make it good at your own expense.

3. Provisions for Testing

Furnish and maintain sufficient testing equipment so that the Inspector can conduct the following tests at the casting yard:

Material	Test Method
Fine Aggregate	AASHTO T 27
Coarse Aggregate	AASHTO T 27
Hardened Concrete	GDT 35

a. Hardened Concrete: Make cylindrical molds available for use on each casting bed.

b. Provide and maintain a machine and other accessories, such as capping molds, heating pots, and capping compound, sufficient to test compression specimens according to AASHTO T 22.

c. Furnish all testing materials, without cost to the Department, well in advance of the anticipated time of use. The Department will not compensate the Contractor if the work is delayed waiting for approval of the materials furnished for testing.

4. Facilities for the Inspector: Furnish for the sole use of the Inspector a suitable field laboratory according to Subsection 106.04, Subsection 106.11, and Subsection 152.

D. Materials Warranty

General Provisions 101 through 150.