

### Section 708. PRESTRESSED CONCRETE

**708.01. Description.** This work consists of manufacturing and erecting prestressed concrete.

**708.02. Materials.** Provide materials in accordance with the following:

Mortar and Grout .....	<u>702</u>
Cement .....	<u>901</u>
Coarse Aggregate 6AA, 17A .....	<u>902</u>
Fine Aggregate 2NS .....	<u>902</u>
Admixtures .....	<u>903</u>
Fly Ash.....	<u>901</u>
Prestress Strand.....	<u>905</u>
Post-tensioning Strand or Bar .....	<u>905</u>
Reinforcing Steel .....	<u>905</u>
Steel Welded Wire Fabric.....	<u>905</u>
Structural Steel.....	<u>906</u>
Water .....	<u>911</u>

Provide natural aggregate for Coarse Aggregate 6AA or 17A in accordance with subsection 902.02.

The Contractor may substitute natural aggregate 17A for 6AA if 17A natural aggregate meets the physical requirements of 6AA in accordance with Table 902-2 and has a maximum freeze-thaw dilation of 0.010 percent per 100 cycles, based on 6AA gradation.

Use non-deformed steel rods in accordance with AASHTO M 270 Grade 36 and hot-dip galvanized in accordance with AASHTO M 111, as position dowels for precast beams.

Use prestress strand, free of oil, dirt, paint, rust and other results of corrosion, and deleterious material that prevents bonding between strands and concrete. Do not use a reel or pack of strand if one or more wires in the strand show a coating of adherent rust that light rubbing cannot remove. Do not use strand that contains adherent rust, pits visible to the naked eye, kinks, bends, nicks, or other defects. Cover prestress strand stored outside with waterproof tarps and block above the ground to prevent contact with soil and water. Do not use strand without identification.

Select a de-bonding compound for prestressed concrete 1800 Beam Flange from the Qualified Products List, or provide a Department-approved equal. Follow the manufacturer's specifications and procedures for mixing the compound.

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**708.03. Construction.**

**A. Construction of Prestressed Concrete.**

1. **Plant Certification.** For bridge beams, use plants certified by the Prestressed Concrete Institute (PCI) for Category B3, Prestressed Straight Strand Bridge Beams, or Category B4, Prestressed Deflected Strand Bridge Beams. For products requiring draped strands, use plants certified for Category B4, Prestressed Deflected Strand Bridge Beams. For miscellaneous prestressed concrete products, use plants certified for Category B2, Prestressed Miscellaneous Bridge Products, or Category C2, Prestressed Hollow Core and Repetitively Produced Products.

Immediately correct items that do not conform to PCI plant certification. Provide a copy of the certificate of conformance to the Engineer before beginning production. Display the certificate of conformance in each plant facility. Provide inspection facilities in accordance with section 809 and subsection 707.03.A.2.

2. **Shop Plans.** Submit shop plans in accordance with subsection 104.02. Show complete fabrication details and initial prestressing forces. Send three sets of drawings to the Engineer for review and approval. Do not start production until the Engineer approves the shop plans.
3. **Notifying the Engineer.** Notify the Engineer at least one week before beginning the manufacture of concrete beams.
4. **Equipment.**
  - a. **Forms.** Use metal forms. Ensure forms meet the requirements of subsection 706.03.D.

The fabricator may use wood forms for bulkheads.
  - b. **Specimen Molds.** Use specimen molds for making test specimen in accordance with ASTM C 470.
  - c. **Curing Tank.** Provide a Department-approved curing assembly, consisting of a water tank equipped with thermostatic controls. Maintain lime-saturated water at 70 °F ±5 °F. Provide a tank sized to contain the required number of 28-day test specimens.
  - d. **Compression Testing Machine.** Provide a compression testing machine in accordance with ASTM C 39. Submit to the Engineer, a calibration certificate no greater than 12 months old.

5. **Void Boxes, Inserts, and Attachments.** Design and construct void boxes, inserts, and attachments to withstand forces imposed during fabrication without bulging, sagging, collapse, or other deformation. Fasten void boxes, inserts, and attachments to maintain the proper position during concrete placement and compaction. Place weep-holes to provide drainage for voids. Puncture weep holes immediately after removal from casting bed.
6. **Design and Proportioning of Concrete Mixtures.** Design a concrete mixture meeting the following requirements:
  - a. Air content of 5.0 percent to 8.0 percent, except as specified in item e;
  - b. 28-day compressive strength as shown on the plans;
  - c. Slump from  $\frac{3}{4}$  inch to  $2\frac{1}{2}$  inches if not using water-reducing or retarding admixtures;
  - d. Slump no greater than 4 inches if using a Type A or Type D chemical admixture;
  - e. Slump no greater than 8 inches and an air content no greater than 8.5 percent if using a Type F or Type G chemical admixture; and
  - f. At least 564 pounds of cementitious material per cubic yard of concrete.

Provide cementitious material with fly ash content no greater than 25 percent of the total weight of the cementitious material. Provide slag cement content no greater than 40 percent of the total weight. If using fly ash and slag cement in the same mixture, do not exceed 15 percent fly ash and 25 percent slag cement.

7. **Concrete Strength.** The Engineer will base acceptability of concrete strength on the results of compressive strength tests on standard 6 inch by 12 inch or 4 inch by 8 inch cylinders. Mold, store, and test cylinders at no additional cost to the Department.
  - a. **Molding and Curing.** Make at least six test cylinders from concrete for each prestressed product line. Make  $\frac{1}{3}$  of the cylinders from each of three separate batches or concrete loads in casting each product line.

The fabricator may mold and cure additional sets of three cylinders to determine concrete strength for acceptance at less than 28 days.

Mold and cure cylinders in accordance with ASTM C 31, except as modified by this subsection. Leave cylinders with the product or in the curing enclosure until stripping the member. Then,

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remove the 28-day cylinders from molds and place in a water curing tank until testing. Leave remaining cylinders with the product until testing.

- b. **Testing and Acceptance.** Conduct compressive strength tests in the Engineer's presence. Test in accordance with ASTM C 39, except test specimens in moist condition resulting from required curing conditions.

Use one set of three test cylinders to determine the time of transfer of prestress from end anchorages to concrete.

Test optional test cylinder sets before the end of the 28-day curing period. Test all three cylinders of an optional set at the same time. The Engineer will accept optional cylinder test results, in place of the 28-day tests, if optional cylinder test results equal or exceed the 28-day strength requirements.

If optional cylinder test results do not meet or exceed the 28-day strength requirements, continue curing remaining sets of three test cylinders for the full 28-day period. Test remaining three cylinders at 28 days to determine acceptability of the concrete strength.

Do not ship product until it meets 28-day strength requirements.

Ensure test specimen compressive strengths meet the following conditions:

- i. The average of the compressive strength of the three test specimens equals at least the required minimum compressive strength; and
- ii. At least two of three specimens meet the required minimum compressive strength and the third specimen exhibits at least 60 percent of the required minimum compressive strength.

If test specimens do not meet the criteria, the Engineer may either reject products represented by the tests, or determine if the concrete has sufficient structural strength. If the Engineer determines concrete has sufficient structural strength, the Engineer will prorate the unit price for the pay item and quantity represented based on Formula 708-1:

$$A = \frac{S_t}{S_r} \times U \qquad \text{Formula 708-1}$$

Where:

$A$  = The adjusted unit price,

$S_t$  = Tested strength,

$S_r$  = Required strength, and

$U$  = Unit price.

8. **Placing Reinforcing Steel.** Tie reinforcing steel. Tie epoxy coated steel with epoxy coated wire ties. Do not weld steel reinforcement.
9. **Bond Breaker.** If bond breaker is required, use two tubes, one inside the other, and turn the overlap in opposite directions.
10. **Placing Concrete.** Place concrete in accordance with subsection 706.03.H, and as modified as follows:
  - a. The fabricator may use external vibrators.
  - b. Protect fresh concrete from rain and cover forms during interruption of casting operations due to rain.
  - c. Maintain the concrete temperature from 45 °F to 90 °F, as close to 70 °F as practical, during placement.
11. **Curing Beams.** Protect concrete from cold weather. Construct curing enclosures to allow air or steam circulation around exposed portions of the concrete. Cure concrete at temperatures from 70 °F to 160 °F until concrete attains the release strength shown on the shop plans.

Maintain the required temperature during the curing period with steam or radiant heat.

Apply steam or radiant heat after concrete reaches initial set in accordance with ASTM C 403, without damaging the concrete. During the waiting period, maintain the ambient temperature in the curing enclosure from 50 °F to 70 °F.

Do not direct steam or radiant heat at the concrete or the forms, causing localized high temperatures. During initial application of steam or radiant heat, increase the ambient temperature in the curing enclosure by no greater than 80 °F per hour until reaching the curing temperature. Maintain the maximum curing temperature within the enclosure until concrete reaches the desired temperature and strength. Do not exceed a maximum concrete temperature of 195 °F during the curing cycle. Upon curing completion, reduce the ambient temperature in the enclosure at a rate no greater than 80 °F per hour.

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Provide recording thermometers for steam or radiant heat curing, capable of showing the time-temperature relationship in the curing enclosure from the time of concrete covering, to transfer of prestress. Use at least two recording thermometers per product line, at locations determined by the Engineer, to monitor the concrete and the curing rate. Graph time-temperature documentation and provide a copy to the Engineer for evaluation.

12. **Cracks in the Concrete.** The Engineer will evaluate cracked concrete for approval.
13. **Workmanship.**
  - a. **Concrete Defects.** Immediately after removing forms, patch air holes larger than 1 inch with Type R-2 mortar, as directed by the Engineer. The Engineer will evaluate concrete with honeycomb areas for approval.
  - b. **Finishing I-Beams.** Smooth finish the outer 1 inch of the top surface of the I-beam. Rough finish remaining I-beam top surfaces to provide a ¼ inch surface texture.
  - c. **Finishing 1800 Beams.** Smooth finish the outer 6 inches of 1800 beam top surfaces. Rough finish remaining 1800 beam top surfaces to provide a ¼ inch surface texture. Clean the outer 6 inches of the top surface and apply a de-bonding compound in accordance with the manufacturer's recommendations. Use a compound color that contrasts with 1800 beam flanges to show application after curing. Prevent compound from spreading over 1800 beam flanges or toward the center of the beam. Remove compound that exceeds the 6 inch boundary before it cures. Use solvents approved by the de-bonding compound manufacturer.
  - d. **Finishing Box Beams.** Smooth finish the outer 1 inch of the box beam top surface. Rough finish remaining box beam top surfaces to provide a ¼ inch surface texture unless otherwise required. If hot mix asphalt overlay is required, provide a wood float finish on the top surface.
  - e. **Sole Plates.** Hot-dip galvanize sole plates in accordance with AASHTO M 111.
  - f. **Bearing Surfaces.** Ensure bearing surfaces meet a flatness tolerance of ⅛ inch over 12 inches.
14. **Tolerances.** The Engineer will evaluate beams that do not conform to the dimensional tolerances specified in Table 708-1.

<b>Table 708-1 Dimensional Tolerances for Beams</b>	
<b>Beam Type</b>	<b>Tolerance</b>
Length of I-Beams and 1800 Beams	$\pm\frac{1}{4}$ in/25 ft, 1 in max
Length of Box Beams	$\pm\frac{3}{4}$ in
Width of I-Beams and 1800 Beams	$+\frac{1}{2}$ in, $-\frac{1}{8}$ in
Width of Box Beams	$\pm\frac{1}{2}$ in
Height of I-Beams, 1800 Beams, or Box Beams	$+\frac{1}{4}$ in, $-\frac{1}{8}$ in
Camber Deviation From Design Value (Measured Within 24 h of Strand Release)	$\frac{1}{8}$ in/10 ft
Thickness of Top Slab of Box Beam	$+\frac{1}{2}$ in, $-\frac{1}{4}$ in
Length of I-Beam End Blocks	+2 ft, -0 in
Sweep of I-Beams and 1800 Beams (Horizontal Deviation of Centerline from a Straight Line Between Ends Measured at Both Top and bottom)	$\frac{1}{4}$ in/10 ft
Sweep of Box Beams (Horizontal Deviation of Centerline from a Straight Line Between Ends Measured at Both Top and Bottom)	$\frac{3}{8}$ in up to 60 ft, $\frac{1}{2}$ in over 60 ft
Vertical Deviation of Side Forms Between Top and Bottom of Beam	$\leq\frac{1}{4}$ in from plan location
Prestress Strand	$\leq\frac{1}{4}$ in from plan location
Location of Conduit for Transverse Post Tensioning	$\leq\frac{1}{2}$ in from plan location
Location of Holes for Position Dowels (I-beams and 1800 Beams)	$\leq\frac{1}{2}$ in from plan location
Location of Holes for Position Dowels Box Beams	$\leq 1$ in from plan location

15. **Stress Transfer.** Do not transfer bond stress to concrete, or release end anchorages until concrete attains the required compressive release strength. Cut or release prestressing strand to minimize lateral eccentricity of prestress.

After detensioning strands, cut flush with the concrete surface and cover ends and depressions around cable ends with asphaltic material approved by the Engineer.

16. **Handling, Storage, and Transporting.** Handle and store products to prevent damage. Keep beams upright.

When moving a product, lift by the loop devices shown on the plans, unless the Engineer approves alternate lifting devices and procedures. Apply equal loads to each pair of lifting devices.

Support stockpiled beams across the full width on two battens, each greater than 4 inches wide. Do not support beams at more than two points.

Use battens to hold beams off the ground over the full length. Place battens in from the beam ends no greater than  $1\frac{1}{2}$  times the depth of the beams, or 3 feet, whichever is less. For skew beams, measure the distance along the centerline of the beam. Place battens to

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support stacked beams, one above the other, along the same vertical plane, at each end of the beams.

Support beams during transport the same as stockpiled beams, except the Contractor may use trucks with two rear bolsters. If truck bolsters are worn, use wood shingles to give bearing. Place wood blocks under chains to hold beams in place on the trucks.

**B. Erection of Prestressed Beams.**

1. **Box Beams.** Shim beam bearing pads during erection to provide full bearing contact with the bottom of the beam. Place seal washers, or other devices meeting the Engineer's approval, between the beams at the transverse conduit holes. After setting beams, drill position dowel holes into bridge seats through holes provided in each beam end. Insert dowels.

At the expansion bearings, fill position dowel holes with hot-poured rubber-asphalt type filler to at least 3 inches above the position dowels. Fill the remainder of the hole with Type H-1 grout. Fill holes at fixed bearings with Type H-1 grout.

After setting beams in final position, clean the beams with water, and grout longitudinal joints and the surfaces between beams. Use Type R-2 grout with a slump of 5 inches and place when the air temperature rises above 40 °F. Fill spaces between beams full-depth. Rod the grout into the space to form a tight, solid joint. Cure for 48 hours. After grout cures, post-tension the deck transversely. Tension tendons to the force required, except do not exceed the yield stress of the material.

After tensioning, clean the annular space between the tendon and hole by flushing with water. Remove water with compressed air. With the grouting vent open at one end of the hole, inject Type E-1 grout under pressure at the other end. Continue injecting grout until material comes out through open vents. Close open vents while maintaining grout pressure. Gradually increase pressure to at least 50 psi and hold for 15 seconds. Close the inlet valve. Remove lifting devices.

2. **I-Beams and 1800 Beams.** Place beam bearing pads over the position dowel and shim to provide full bearing contact with the bottom of the beam. Position beams on the substructure and rigidly block them in place before beginning deck and diaphragm forming. Remove lifting devices.

**708.04. Measurement and Payment.**

<b>Pay Item</b>	<b>Pay Unit</b>
Prest Conc Deck, __ inch .....	Square Foot
Post Tensioning (Structure No.) .....	Lump Sum
Prest Conc Box Beam, Furn, __ inch .....	Foot
Prest Conc Box Beam, Erect, __ inch .....	Foot
Prest Conc I Beam, Furn, __ inch .....	Foot
Prest Conc I Beam, Erect, __ inch .....	Foot
Prest Conc 1800 Beam, Furn .....	Foot
Prest Conc 1800 Beam, Erect .....	Foot

The unit prices for **Prest Conc, Erect** pay items include the cost of position dowels, shimming to provide full bearing contact, and bracing and blocking.

The Engineer will measure prestressed concrete box beams, placed a nominal 1½ inches apart, as **Prest Conc Deck**, based on the nominal overall length of the units, multiplied by the overall plan width. Plan width is the sum of the widths of the beams plus the sum of the 1½-inch spaces between beams.

The Engineer will measure prestressed concrete box beams, placed more than a nominal 1½ inches apart, as **Prest Conc Box Beam, Furn, \_\_ inch**, and **Prest Conc Box Beam, Erect, \_\_ inch**, and based on the nominal length of the unit.

The Engineer will measure **Prest Conc I Beam Furn, \_\_ inch**, and **Prest Conc I Beam, Erect, \_\_ inch**; and **Prest Conc 1800 Beam, Furn**, and **Prest Conc 1800 Beam, Erect**, based on the nominal length of the units. The unit prices for **Prest Conc I Beam, Furn, \_\_ inch**, and **Prest Conc 1800 Beam, Furn**, include the cost of de-bonding beam flange

The Engineer will measure and the Department will pay for elastomeric bearings in accordance with subsection 707.04.

The Department will not allow additional compensation for costs incurred in the certification of prestressed concrete plants, or claims by the Contractor for delays or costs associated with prestressed concrete fabrication plant certification.