Section 708. PRESTRESSED CONCRETE BEAMS

708.01 Description. This work consists of the manufacture and erection of prestressed concrete beams.

708.02 Materials. Materials shall meet the following requirements.

The 6AA or 17A aggregate shall be a natural aggregate, as defined in subsection 902.02.

Where 6AA is called for 17A may be used, provided that 17A natural aggregate meets the physical requirements of 6AA according to table 902-2 and has a maximum freeze-thaw dilation of 0.010 percent per 100 cycles. Base freeze-thaw test results on 6AA gradation.

Position dowels for precast beams shall be non-deformed steel rods meeting AASHTO M 183 and shall hot dipped galvanized according to AASHTO M232.

Prestress strand shall be free of oil, dirt, paint, rust or other results of corrosion, or any foreign material that may prevent bond between the strands and the concrete at time of use. When a reel or pack is opened, if one or more wires in the strand show a coating of adherent rust (that cannot be removed by light rubbing) throughout the length, the reel or pack shall not be used. Any strand that contains adherent rust, pits visible to the naked eye, kinks, bends, nicks or other defects shall not be used. All prestress strand stored outside shall be covered with waterproof tarps and blocked above the ground to prevent contact with soil and water. Strand for which the identification has been lost shall not be used.

Select a debonding compound for the prestressed concrete 1800 beam flange from the Qualified Product List or provide an approved equal. Mix the compound, if required, according to the manufacturer's specifications and procedures. The compound color, when cured, must contrast with beam flanges enough to show evidence of application.

708.03 Construction.

A. **Construction of Prestressed Beams.**

1. **Plant Certification.** Plants shall be certified by the Prestressed Concrete Institute for Category B3, Prestressed Straight Strand Concrete Members or Category B4, Prestressed Draped Strand Concrete Members. A plant shall be certified as Category B4, Prestressed Draped Strand Concrete Members when fabricating products that require draped strands. Failure to conform to requirements set forth by PCI plant certification shall be corrected immediately. A copy of the certificate of conformance shall be furnished to the Engineer prior to the start of production. Certification of conformance shall be clearly displayed in each plant facility. Facilities for inspection shall be according to section 809 and subsection 707.03.A.2.

2. **Shop Plans.** Shop plans shall be submitted according to subsection 104.02. Three prints of each drawing shall be sent to the Engineer for review and acceptance. Production shall not start until the shop plans have been accepted. Shop plans shall show complete fabrication details and initial prestressing forces.

   Strand elongations, prestressing and detensioning procedures, a diagram of the proposed casting bed, and draped strand computations on the shop plans shall be submitted to the Engineer for acceptance prior to casting prestressed beams .

3. **Notifying the Engineer.** The manufacturer shall notify the Engineer at least one week in advance of manufacturing concrete beams so that testing and inspection arrangements can be made.

4. **Equipment.** Equipment used in the manufacturing of prestressed beams shall meet the following requirements.

   a. **Forms.** Metal forms are required except that wood forms may be used for bulkheads. Forms shall meet subsection 706.03.D.

   b. **Specimen Molds.** Specimen molds furnished by the manufacturer for making test specimen shall meet ASTM C 470.

   c. **Curing Tank.** An approved curing assembly consisting of a water tank equipped with thermostatic controls shall be required. The lime-saturated water shall be maintained at a temperature of 70 ± 5 °F. The tank shall be of adequate size to contain the 28-day test specimens.

   d. **Compression Testing Machine.** A compression testing machine for concrete cylinders specified in ASTM C 39 shall be provided. A certificate of verification, not more than 12 months old, shall be submitted to the Engineer.

5. **Void Boxes, Inserts, and Attachments.** Void boxes, inserts, and attachments shall be fastened securely to maintain the proper position during the placing and compacting of the concrete. They shall be of such design and material as will enable them to withstand

the forces imposed on them during fabrication without substantial deformation such as bulging, sagging, or collapse. Weep-holes shall be placed to provide drainage for all voids.

6. **Design and Proportioning of Concrete Mixtures.** The design of the concrete mixture shall be the responsibility of the prestressed beam manufacturer, and shall meet the following requirements:

   The concrete shall be designed to contain 6.5 ±1.5 percent air and to have a compressive strength of not less than 5000 psi at 28 days. The concrete shall have a slump of not less than ¾ inch nor more than 2½ inches when no water-reducing or retarding admixture is used. When a Type A or a Type D chemical admixture is used, the concrete shall have a slump of not more than 4 inches. When a Type F or a Type G chemical admixture is used, the concrete shall have a slump of not more than 7 inches and an air content not to exceed 8.5 percent.

   The quantity of cementitious material (cement plus fly ash, if used) shall be 564 pounds per cubic yard of concrete, minimum. The quantity of fly ash shall not exceed 20 percent of the total weight of cementitious material.

7. **Concrete Strength.** Acceptability of the concrete for strength will be based on the results of compressive strength tests on standard 6- by 12-inch cylinders. The fabricator shall supply labor as required by the Engineer for molding, storing, and testing the cylinders without cost to the Department.

   a. **Molding and Curing.** Six test cylinders shall be made from concrete for each prestressed beam line, or nine cylinders if an extra set of three is requested by the fabricator. One third of the cylinders shall be made from each of three separate batches or loads of concrete used in casting each beam line. The optional three cylinders shall be used to determine strength for acceptance of the concrete at less than 28 days.

      The cylinders shall be molded and cured as specified in ASTM C 31, except as modified herein. All the cylinders shall remain with the beams or in the curing enclosure until the member is stripped. At that time, the 28-day cylinders shall be removed from their molds and placed in a water curing tank until time for testing. The remaining cylinders shall remain with the beams until testing.

   b. **Testing and Acceptance.** All compressive strength tests conducted by the manufacturer shall be in the presence of the Engineer. Testing shall be as specified in ASTM C 39, except the specimens will be tested in the moist condition resulting from the specified curing conditions.

      One set of three test cylinders will be used by the fabricator for the determination of the time of transfer of stress from the end anchorages to the concrete.

      When an optional set of three test cylinders has been made, the optional set may be tested at a time determined by the fabricator before the end of the 28-day curing

period. If the test results of these three cylinders equal or exceed the 28-day strength requirements, these tests will be accepted in place of the 28-day tests. All three cylinders of this optional set shall be tested the same time.

If the cylinders tested before the 28-day curing period is completed do not meet or exceed the 28-day strength requirements, the curing of the remaining set of three test cylinders shall continue for the full 28-day period. The remaining three cylinders shall be tested at 28 days to determine the acceptability of the strength of the concrete.

The beams shall not be shipped until the 28-day strength requirements have been met.

The compressive strength of the test specimens must meet both of the following:

(i) The average of the compressive strength of the three test specimens shall be at least equal to the required minimum compressive strength.

(ii) At least two of the three specimens will meet the required minimum compressive strength and the third specimen shall have not less than 60 percent of the required minimum compressive strength.

If the above criteria are not met, the Engineer may:

- Reject the beam(s) represented by these tests.
- Determine if the concrete has sufficient structural strength, if so, prorate the unit price for the pay item and quantity represented based on the following formula:

  $$\text{Adjusted unit price} = \frac{\text{Tested Strength}}{\text{Required Strength}} \times (\text{Unit Price})$$

8. **Placing Reinforcing Steel.** Reinforcing steel shall be securely tied. Tack welding of steel reinforcement is prohibited.

9. **Bond Breaker.** When a bond breaker is required, it shall consist of two tubes (one inside the other) with the overlap turned in opposite directions.

10. **Placing Concrete.** Concrete placement shall be according to subsection 706.03.H, with the following modifications:

    a. The use of external vibrators will be permitted.

    b. Protective material shall be available for the protection of fresh concrete from rain. The forms shall be covered during the interruption of any casting operation because of rain.

c. The concrete shall have a temperature of not less than 45 °F nor more than 90 °F, and shall be as near 70 °F as practical at the time it is placed in the forms.

11. **Curing of Beams.** Concrete shall be protected to prevent damage from cold weather. The curing enclosure shall be constructed to allow circulation of air or steam around the exposed portions of the beam. The beams shall be cured at an ambient temperature between 70 °F and 160 °F until the concrete attains the release strength shown on the shop plans unless otherwise approved by the Engineer.

    The strength will be determined by the test cylinders cured in the same manner as the beams. Steam or radiant heat for curing the beams shall maintain the required temperature during the curing period.

    When curing beams with steam or radiant heat, the initial application of heat shall be a minimum of two hours after the final placement of concrete to allow the initial set of concrete to take place. Application of steam or radiant heat for curing concrete shall begin only after concrete has reached its initial set as determined by ASTM C 403, and shall be accomplished without damaging the concrete. During the waiting period, the temperature within the curing enclosure shall not be less than 50 °F nor more than 70 °F.

    Application of steam or of radiant heat shall not be directed on the concrete or on the forms so as to cause localized high temperatures. During the initial application of steam or of radiant heat, the ambient temperature within the curing enclosure shall increase at a uniform rate not to exceed 80 °F per hour (1.33 °F per minute) until the desired curing temperature is reached. The maximum ambient curing temperature within the enclosure shall not exceed 160 °F. The maximum curing temperature within the enclosure shall be held until the concrete has reached the desired concrete temperature and strength. The maximum concrete temperature during the curing cycle shall not exceed 195 °F. After the concrete has undergone a period of curing at the sustained temperature, a cooling period within the enclosure shall be induced at a rate not to exceed 80 °F per hour (1.33 °F per minute).

    Recording thermometers shall be provided when steam or radiant heat curing is used showing the time-temperature relationship within the curing enclosure through the curing period from placing concrete to transfer of prestress. All time-temperature documentation shall be clearly shown by graph and a copy given to the Engineer for evaluation. At least two recording thermometers per product line shall be used to monitor the concrete and curing rates at locations determined by the Engineer.

12. **Cracks in the Beams.** The Engineer will evaluate beams with cracks for acceptance.

13. **Workmanship.**

    a. **Concrete Defects.** The Engineer will evaluate beams with honeycomb areas for acceptance. Air holes larger than one inch shall be patched with Type R-2 mortar, as directed by the Engineer. The patching shall be done immediately after the removal of the forms.

b. **Finishing I-Beams.** The outer one inch of the top surface of the beam shall be finished smooth. The remainder of the top surface of the I-beams shall be rough finished to give a ¼ inch surface texture.

c. **Finishing 1800 beams.** The outer 6 inches of the top surface of the beam shall be finished smooth. The remainder of the top surface of the I-beams shall be rough finished to give a ¼ inch surface texture. Clean the outer 6 inches of the top surface and apply the debonding compound according to the manufacturer's recommendations. Care shall be taken to prevent any compound from spreading over the beam flange or toward the center of the beam. Any compound that has exceeded the 6-inch boundary shall be removed with manufacturer's approved solvents before it has cured.

d. **Finishing Box Beams.** The outer one inch of the top surface of the beam shall be finished smooth. The remainder of the top surface of box beams shall be rough finished to give a ¼ inch surface texture unless a bituminous overlay is specified then the top surface shall be given a wood float finish.

e. **Sole Plates.** Sole plates shall be hot-dip galvanized according to ASTM A 123.

f. **Bearing Surfaces.** Any divergence in any bearing surface greater than ⅛ inch in 12 inches must be corrected.

14. **Tolerances.** The Engineer will evaluate beams not conforming to the dimensional tolerances in Table 708-1.

15. **Stress Transfer.** No bond stress shall be transferred to the concrete nor shall end anchorages be released until the concrete has attained the specified compressive release strength. The prestressing cables shall be cut or released in such an order that lateral eccentricity of prestress will be kept at a minimum.

    After the cables have been detensioned, the cables shall be cut flush with the surface of the concrete and the ends of the cables and any depressions around the ends of cables shall be covered with a bituminous material approved by the Engineer.

16. **Handling Storage and Transporting Beams.** Handle and store beams to prevent damage. The beams shall be kept upright at all times.

    When a beam is to be moved it shall be lifted by the loop devices detailed on the plans unless alternate lifting devices and procedures have been approved by the Engineer. Equal loads shall be applied to each pair of lifting devices when lifting beams.

    Stockpiled beams shall be fully supported across their width on two battens, not less than 4 inches wide, placed not to exceed 1½ times the depth of the beams, but in no case more than 3 feet , from the ends of the beams. For skew beams this distance shall be measured along the centerline of the beam. The battens shall be high enough to eliminate any intermediate support and in no case shall beams be supported at more

than two points. Battens supporting beams stacked one above the other shall be in the same vertical plane at each end of the beams.

The requirements applying to stockpiling shall also apply to beams being transported, except that trucks with two rear bolsters may be used. If truck bolsters are worn, wood shingles shall be used as wedges to give proper bearing.

Wood blocks shall be placed under the chains which are used to hold the beams in place on the trucks to avoid chipping.

Table 708-1 Dimensional Tolerances for Beams

Length of I-Beams and 1800 Beams	± ¼ inch per 25 feet, 1 inch max
Length of Box Beams	± ¾ inch
Width of I-Beams and 1800 Beams	+ ½ inch, - ⅛ inch
Width of Box Beams	± ½ inch
Height of I-Beams, 1800 Beams, or Box Beams	+ ¼ inch, - ⅛ inch
Camber Deviation From Design Value (Measured Within 24 Hours of Strand Release)	⅛ inch per 10 feet
Thickness of Top Slab of Box Beam	+ ½ inch, - ¼ inch
Length of I-Beam Blocks	+ 2 feet, - 0 inches
Sweep of I-Beams and 1800 Beams (Horizontal Deviation of Centerline from a Straight Line Between Ends Measured at Both Top and bottom)	¼ inch per 10 feet
Sweep of Box Beams (Horizontal Deviation of Centerline from a Straight Line Between Ends Measured at Both Top and Bottom)	⅜ inch up to 60 feet, ½ inch over 60 feet
Vertical Deviation of Side Forms Between Top and Bottom of Beam	¼ inch maximum from plan location
Prestress Strand	¼ inch maximum from plan location
Location of Conduit for Transverse Post Tensioning	½ inch maximum from plan location
Location of Holes for Position Dowels (I-beams and 1800 Beams)	½ inch maximum from plan location
Location of Holes for Position Dowels Box Beams	1 inch maximum from plan location

B. **Erection of Prestressed Beams.**

1. **Box Beams.** During erection, beam bearing pads shall be shimmed, in an approved manner, as necessary to provide full bearing contact with the bottom of the beam. Seal washers, or other devices meeting the approval of the Engineer, shall be placed between the beams at the transverse conduit holes. After the beams are set, anchor dowel holes shall be drilled into the bridge seats through the holes provided in the ends of each beam. When the dowels have been placed, the anchor dowel holes at the expansion bearings shall be filled with hot-poured rubber-asphalt type filler to at least

3 inches above the anchor dowels. Fill the remainder of the holes with Type H-1 grout. The holes at the fixed bearings shall be completely filled with Type H-1 grout.

After the prestressed concrete beams are firmly set in their final position, the longitudinal joints and the surfaces between the beams shall be thoroughly cleaned with water and grouted. Grout shall not be placed when the temperature is less than 40 °F. The space between the beams shall be filled full-depth with Type R-2 grout having a slump of approximately 5 inches. The grout shall be rodded into the space to form a tight, solid joint. The grouted joints shall be cured for 48 hours. After the grout has cured, the deck shall be post-tensioned transversely. The tendons shall be tensioned to the force shown on the contract drawings; however, care shall be taken not to exceed the yield stress of the material.

After tensioning, the conduit shall be grouted. Prior to placing the grout, the annular space between the tendon and the hole shall be thoroughly cleaned by flushing with water and removing the water with compressed air.

With the grouting vent open at one end of the hole, Type E-1 grout shall be continuously applied under moderate pressure at the other end, until all entrapped air is forced out through the open grout vent as indicated by grout emitting from that vent. Maintaining pressure, close the open vent. Then gradually increase pressure to at least 50 psi and hold for approximately 15 seconds, after which the inlet valve shall be closed. Lifting devices shall be removed.

2. **I-Beams and 1800 Beams.** The beams shall be positioned on the substructure units with care and shall be rigidly blocked in place prior to proceeding with deck and diaphragm forming. Lifting devices shall be removed. During erection, I-beam bearing pads shall be placed over the position dowel and shimmed, in an approved manner, as necessary to provide full bearing contact with the bottom of the beam.

708.04 Measurement and Payment.

Contract Item (Pay Item)	**Pay Unit**
Prest Conc Deck, __ inch	Square Foot
Post Tensioning	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

A. Payment for prestressed concrete beams includes position dowels and shimming to provide full bearing contact.

B. Prestressed concrete box beams that are placed a nominal distance of 1½ inches apart will be measured as **Prest Conc Deck** by area, 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 the beams.

C. **Post Tensioning** shall include labor, equipment, and materials necessary to complete the work.

D. **Prest Conc Box Beams**, placed greater than a nominal 1½ inches from each other will be measured by length, based on the nominal overall length of the units.

E. **Prest Conc I Beams** and **Prest Conc 1800 Beam**, will be measured by length based on the nominal overall length of the units and shall include providing position dowels, shimming to provide full bearing contact, and debonding the beam flanges.

F. **Bearing, Elastomeric** will be measured and paid for according to subsection 707.04.

G. Claims by the Contractor for delays or costs associated with prestressed concrete fabrication plant certification will not be allowed.

Costs incurred in the certification of prestressed concrete plants shall be the responsibility of the Contractor/Fabricator and no additional compensation shall be allowed. Claims by the Contractor/Fabricator for delays and inconveniences due to certification operations will not be considered.