

SECTION 604 PRESTRESSED CONCRETE BEAMS

604.01 DESCRIPTION.

This work consists of furnishing required materials as well as fabricating, transporting, erecting, finishing, and adjusting prestressed concrete beams.

604.02 MATERIALS.

- A. **Concrete for Beams.** All concrete shall be produced and composed of materials meeting Section 802. The concrete's compressive strength shall be based on tests of 6x12 inch cylinders. The prestressed beam concrete strength is considered satisfactory when test cylinders obtain a minimum compressive strength of 5,000 psi.

The Contractor shall furnish steel cylinder molds and cast the test specimens in the presence of the Department Engineer. Test specimens shall be cured for the same length of time and under identical conditions used for the beams. The Contractor shall cast, cure, and test a minimum of ten 6x12 inch compression test cylinders according to Section 802.01 F.6, using concrete proportioned according to the proposed concrete mix design and using ingredients representative of those proposed for the manufacture of the beams. Four specimens shall be tested at 14 days, and the remaining 6 at 28 days. These test results shall accompany the proposed concrete mix design which must be submitted to the Engineer at least 14 days before casting the beams. The trial mix of the proposed concrete design shall be produced in the presence of the Department's Engineer. Concrete test specimens shall be molded, cured, and tested under supervision of a Department Engineer.

After approval of the concrete mix design, no changes shall be made in the design or its ingredients without an approved revised mix design.

Portland Cement may be of any type permitted in Section 802 provided that when air-entraining or admixtures are used, the air content shall not be less than 4% nor more than 7% when tested according to Section 802.01 F.3.

Admixtures for water reduction to obtain increased compressive strength and workability may be used if provided for in the established mix design.

The same brand, grade, and kind of cement and admixture shall be used for all beams in any one bridge structure.

- B. **Wire, Strand, and Bars.** All wire, strands, and anchorage assemblies furnished shall be assigned a lot number and tagged for identification. This material shall meet Section 836.03 E.

Concrete reinforcement shall meet Section 612. Grade 60 shall be used unless otherwise specified.

C. Sampling and Testing.

1. **Concrete.** Test cylinders shall be cast in a sequence so all concrete utilized in the beams is represented by tests.

If a single beam is cast, a minimum of 5 test cylinders shall be cast and tested. Two cylinders will be tested for determining the concrete compressive strength at time of stress transfer and 3 for determining the compressive strength for delivery and obtaining acceptance by the Department on or before the standard 28-day test period.

If 2 or more beams are cast during one continuous operation, a minimum of 6 test cylinders shall be cast and tested. A minimum of 3 test cylinders will be tested per bed with one cylinder representing the first beam cast, one cylinder representing a beam near the center of the bed, and one cylinder from the last beam cast. The 3 remaining cylinders are for determining compressive strength to make delivery and obtaining acceptance by the Department on or before the standard 28-day test period.

Additional test cylinders may be cast for tests desired by the Contractor and the cost of testing paid for by the Contractor.

2. **Wire, Strand, and Bars.** A certified mill test report shall be submitted to the Engineer for these items supplied for the Project. This report shall contain an affidavit stating the material meets Specifications and show diameters, elongation at rupture, and ultimate tensile strengths.

The Engineer reserves the right to sample and test these materials, and test results shall govern acceptance or rejection of materials tested.

- D. Inspection.** A minimum of 2 weeks notice shall be provided before beams are manufactured so the Department can arrange for inspection.

The Engineer shall have free entry to all parts of the work involving the manufacture of beams under the Contract.

- E. Acceptance.** Acceptance of materials or finished work by the Engineer will not prevent subsequent rejection of defective work and materials.

Beams may be accepted and delivered to the Project when minimum strength requirements are obtained.

Beams not meeting these minimum strength requirements at 28 days will be rejected.

The Contractor shall furnish a certified statement, confirmed by the Department's representative, showing the number of girders cast in each continuous operation and the number of each girder.

- F. Waivers.** If the beam fabricators plant meets the requirements of the Department's Quality Assurance procedures, the sampling, testing, and inspection

requirements specified in Sections 604.02 A., 604.02 C., and 604.02 D. may be waived and the following substituted:

The Contractor shall furnish 6 copies of a certificate stating the source of materials and that the materials used in manufacturing and the construction of the beams meet the required Specifications.

The Contractor shall furnish the required certificate for the wire strand and reinforcing and a certificate analysis of the aggregates and stating that the aggregates have been tested and approved. Concrete test cylinders shall be cast, cured, and tested at the Contractor's expense. At the time of stress transfer, as specified on the shop drawings, 2 concrete test cylinders will be tested for a single beam pour, and 3 concrete test cylinders will be tested for a continuous pour representing the beams as provided for in Section 604.02 C.1.

The Department reserves the right to sample and test all materials at the point of manufacture or after delivery to the work site. The results of the tests shall govern acceptance or rejection of materials tested.

604.03 PLANT AND EQUIPMENT.

Plant and equipment used in this work shall meet Section 151.01 and 153. Written permission may be granted for using other types of concrete mixers.

Cement shall be weighed on a scale that is not used for other ingredients.

604.04 CONSTRUCTION REQUIREMENTS.

- A. **General.** The Contractor shall furnish skilled personnel to provide aid and instruction in using prestressing equipment and installing materials to obtain specified results.

The prestress force applied to the strands shall be determined by strand elongation, and checked by calibrated hydraulic jacks. The Contractor shall furnish a certified statement of curve giving the load elongation relationship at 75% (low relaxation strand) of ultimate stress for the prestress steel to be used. A certified calibration curve shall be furnished for each hydraulic jack.

Beams shall conform to dimensions specified or shown on the shop drawings.

Shop drawings generated by a computer automated drafting (CAD) system may be submitted on 11-inch by 17-inch detail sheets. Each sheet shall be consecutively numbered and have a title giving the project number, the bridge number, the fabricator's name, the fabricator's contract number, and a brief description of the details shown on the sheet.

Shop drawings shall show all beam dimensions; the size and location of all reinforcing and prestressing steel; the details of end anchorages if used, and any necessary revisions to bridge seats. Two copies of shop drawings shall be submitted to the Engineer for approval. If shop drawings are returned for revision, revisions shall be made and resubmitted to the Engineer. The time required for the approval of each submittal will not exceed 14 days after the shop drawings are received by the Engineer. Six copies of the approved and final drawings shall be furnished to the Engineer before fabrication.

- B. **Placing and Fastening Steel.** All steel units shall be accurately placed and firmly held in position during the placing and setting of concrete.

Distances between the forms and steel units shall be maintained by stays, ties, hangers, or other approved supports. Metal bar chairs and bolsters in contact with the forms shall be galvanized or noncorrosive metal. Wooden blocks shall not be left in the concrete.

To insure proper positioning, prestressing elements shall be straightened by applying low initial tension. This initial tension shall be included in the total tension applied. Suitable horizontal and vertical spacers shall be provided, if required, to hold elements in true position.

- C. **Placing Concrete.** Concrete shall be measured, mixed, handled, and placed according to applicable provisions of Sections 602 and 802.

Concrete for the beams shall be vibrated internally, or externally, or both. The vibrating shall be done without displacement of reinforcing, conduits, voids, or wire. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete without causing segregation.

- D. **Curing Concrete.** Members shall be water or steam cured until the compressive strength specified in the shop drawings for applying the prestress force is reached. Members shall be protected from rain, cold weather, and moisture loss between placement of the concrete and the beginning of the water or steam cure.

Steam cured members shall be covered with tarpaulins or other suitable covering to contain the live steam. The steam shall be uniformly distributed throughout the enclosure and shall not be jetted directly on the beam. The temperature of the enclosure shall not be raised above 90°F. until the beam has cured for a minimum of 3 hours. After this period the temperature within the beam enclosure may be raised to a maximum of 160°F. in increments not to exceed 40°F. per hour.

Water cure consists of covering all exposed surfaces with a fabric or double thickness of wet burlap and applying water to the covering so the concrete surface is kept continuously wet.

The exposed surfaces of each unit shall be covered when the fabric or wet burlap can be placed without damaging the concrete.

A uniform curing temperature shall be maintained.

- E. **Pretensioning Method.** The prestressing tendons shall be accurately held in position and stressed by jacks. A record shall be kept of the jacking force and the elongation produced. Several units may be cast in one continuous line and stressed at one time. No bond stress shall be transferred to the concrete or end anchorages released until test cylinders have reached the detensioning strength specified on the shop drawings.

Tendons shall not be cut without first being heated to relieve the stress. Cutting shall be done so the lateral eccentricity of prestress force is minimized.

- F. **Posttensioning Method.** The type of prestressing system and the method of computing the prestress losses shall be as approved. The tensioning process shall be

conducted so the tension being applied and the elongation of the prestressing elements may be measured. The prestressing sequence shall keep the lateral eccentricity of the prestress to a minimum. For “draped” prestressing elements, the jacking shall be done from both ends of the beams when the angle between the horizontal and the directions of the element at its end exceeds 5 degrees. A record of the jacking force and elongation during jacking shall be kept and submitted for approval. A stress of approximately 400 psi shall be placed on the prestressing steel before elongation measurements are started. The enclosures for prestressing steel shall be an approved type and shall be accurately placed at the locations shown. The enclosures shall be watertight and securely held to avoid vertical or horizontal displacement from true alignment during concrete placement. Enclosure tubes shall be provided with pipes or suitable connections for the injection of grout.

After tensioning is completed and the prestressing steel is anchored, the enclosures shall be bonded by pressure grouting the space between the inside perimeter of the tube and the prestressing steel. The final pressure placed on the grout shall be sufficient to force the grout completely through the tube and to ensure penetration into all voids in the enclosures. The final grout pressure shall range from 50 to 100 psi.

The grout shall be mixed to the consistency of thick paint and shall be proportional by volume consisting of one part Portland Cement, 0.75 part (maximum) of sand passing a No. 30 sieve, and 0.75 part (maximum) of water.

- G. **Transportation and Storage.** Precast beams shall be transported in an upright position, and points of support and directions of the reactions with respect to the beam should be approximately the same during transportation and storage as when the beam is in its final position.

Beams damaged before final acceptance shall be replaced or repaired at the Contractor’s expense.

- H. **Adjacent Beams.** A variance in the top surface of adjacent beams by 3/8 inch or more shall be corrected using one of the following methods:

1. Weighting or shimming the beams.
2. Addition of extra grout at the keyway joint to provide a transverse slope no steeper than 24:1 between adjacent beams. Contact surfaces shall be cleaned before grouting.

604.05 METHOD OF MEASUREMENT.

Prestressed Beams will be measured by the Linear Foot complete and in place.

The end anchor plates and devices, all reinforcing bars, prestressing wires, and other accessories embedded in the beam (including sole plates when required) and the required grout will be considered incidental to the item of Prestressed Beams. End caps and diaphragms required to be cast in place after the beams are placed on the supports will be measured as concrete by the cubic yard.

604.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item
 Prestressed Beams
 Concrete

Pay Unit
 Linear Foot
 Cubic Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 606
 PRECAST REINFORCED CONCRETE
 BOX CULVERTS**

606.01 DESCRIPTION.

This work consists of furnishing required materials as well as fabricating, transporting, and installing precast reinforced concrete box culverts.

606.02 MATERIALS.

Prestressing strands, wire, and bars shall meet Section 836.03E.

Geotextile fabric shall meet Section 709.

606.03 DESIGN AND MANUFACTURE.

The design and manufacture of the precast RCB shall satisfy the applicable portions of *AASHTO Standard Specifications for Highway Bridges*, Division I, Section 17, and "AASHTO Materials Specification M259." The design shall also meet or exceed the following criteria:

A. **Live Load.** HS25

B. **Load Factor Design.**

1. Dead Load Factor = 1.30
2. Live Load Factor = 2.17
3. Strength Reduction (Phi) Factors
 - a. Shear = .85
 - b. Flexure = .9

C. **Dead Loads.**