SECTION 715

PRESTRESSED CONCRETE MEMBERS

715.1 DESCRIPTION

Manufacture, cure, handle and install prestressed concrete bridge beams and panels to the dimensions specified on the Contract Documents. Manufacture and cure concrete piling to the dimensions specified on the Contract Documents.

BID ITEMS	**UNITS**
Prestressed Concrete Beams (*)(**)	Linear Foot
Prestressed Concrete Panels	Square Foot
*Type	
**Size	

715.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	**SECTIONS 401 & 404**
Reinforcing Steel	**DIVISION 1600**
Bearings and Pads For Structures	**DIVISION 1700**
Steel Strand	**DIVISION 1600**
Welded Steel Wire Fabric	**DIVISION 1600**

Provide a copy of mill certifications for reinforcing bar and wire mesh, as required in **DIVISION 1600**, to the Inspector prior to concrete placement.

Steel strand mill certifications and KDOT test reports are required prior to concrete placement. Due to variations in the modulus of elasticity, only one source of strand will be allowed in any unit. No more than 1 broken wire will be permitted in a bed.

Bearing plate mill certification is required. Coating for the plate will be tested for the requirements of ASTM A 123 or **SECTION 714** for painting.

Mill certifications and KDOT test reports are required for miscellaneous items, such as bolts, etc.

715.3 MANUFACTURE OF CONCRETE BRIDGE BEAMS, PILING AND PANELS

a. General. A minimum of 2 weeks before starting the production of prestressed concrete units, submit shop drawings according to **SECTION 105**. With the exception of prestressed piles, which do not require drawings, do not perform any production until the approved shop drawings are in the hands of the Inspector and producer, and the Engineer has authorized production. Changes to approved shop drawings are subject to the approval of the Engineer. Do not revise the number or location of coil inserts or other connection devices shown on approved drawings without the approval of the Engineer. Submit revised sheets of the same size as the shop drawings originally approved. Include information covering the following items in the shop drawings.

- The method of forming, placing and securing the reinforcement.
- The plan for prestressing the units, including the type, number, size and location of the prestressing elements.
- The method of releasing units with draped strands.
- Descriptions and allowable loads for hardware items (e.g. hold down devices, threaded inserts, etc.).
- Identify the proposed concrete mix, including the slump desired at point of delivery.
- The casting length center to center of bearings and the calculated prestress shortening.

Manufacture units within the tolerances in **TABLE 715-1**, unless shown otherwise on the Contract Documents.

TABLE 715-1: DIMENSIONAL TOLERANCES	
DOUBLE TEE AND INVERTED BEAM	
Unit Feature	**Tolerance**
Length	± ½ in.
Width (overall)	± ¼ in.
Depth	± ¼ in.
Stem Thickness	± ⅛ in.
Flange Thickness	+ ¼ in., - ⅛ in.
Position of Block-out	± ½ in.
Horizontal Alignment (Deviation from straight line parallel to centerline of the member.)	¼ in. (up to 40 ft. lengths) ⅜ in. (40 ft. to 60 ft. lengths) ½ in. (greater than 60 ft. lengths)
Camber deviation from design camber	± ¼ in. per 10 ft, but not greater than ¾ in.
Differential camber between adjacent members of the same design	¼ in. per 10 ft, but not greater than ¾ in.
Tendon position	± ¼ in. in c.g. of strand group
Tolerance between tendons	± ⅛ in.
Position of handling devices	± 6 in.
Position of deflection points for deflected strands	± 6 in.
Stem to edge of top flange	± ⅛ in.
Distance between stems	± ⅛ in.
Position of weld plates	± 1 in.
Squareness of ends (vertical and horizontal alignment)	± ¼ in.
Stirrup bar spacing (individual or accumulative)	± 1 in.
Stirrup bar height	± ½ in.
SINGLE TEE BEAM	
Unit Feature	**Tolerance**
Length	± ¾ in.
Width (overall)	+ ⅜ in., - ¼ in
Depth	± ¼ in.
Width (stem)	+ ⅜ in., - ¼ in
Thickness (flanges and fillets)	+ ¼ in., - ⅛ in.
Position of block-outs	± ½ in.
Side inserts (center to center and center to end)	± ½ in.
Bearing area deviation from plane	± ⅛ in.
Bearing plate (center to end of beam)	± ¼ in.
Horizontal Alignment (Deviation from straight line parallel to centerline of the member.)	¼ in. (up to 40 ft. lengths) ⅜ in. (40 ft. to 60 ft. lengths) ½ in. (greater than 60 ft. lengths)
Camber deviation from design camber	± ¼ in. per 10 ft., but not greater than ±¾ in.
Differential camber between adjacent beams	¼ in. per 10 ft., but not greater than ¾ in.
Tendon position	± ¼ in. in c.g. of strand group
Tolerance between tendons	± ⅛ in.
Position of handling devices	± 6 in.
Position of deflection points for deflected strands	± 6 in.
Position of weld plates	± 1 in.
Squareness of ends (vertical and horizontal alignment)	± ½ in.
Stirrup bar spacing (individual or accumulative)	± 1 in.
Stirrup bar height	± ½ in.

TABLE 715-1 (continued)	
BRIDGE I-BEAM	
Unit Feature	**Tolerance**
Length	± ¾ in.
Width (flanges and fillets)	+ ⅜ in., - ¼ in.
Depth (overall)	+ ½ in., - ¼ in.
Width (web)	+ ⅜ in., - ¼ in.
Depth (flanges and fillets)	± ¼ in.
Bearing plates (center to center)	± ⅛ in. per 10 ft., but not greater than ± ¾ in.
Horizontal Alignment (Deviation from straight line parallel to centerline of the member.)	⅛ in. per 10 ft. of span, but not greater than 1 in.
Camber deviation from design camber	± ⅛ in. per 10 ft. of span, but not greater than ± ½ in.
Differential camber between adjacent members	1 in. maximum
Stirrup Bars (projection above top of beam)	± ¾ in.
Tendon position	± ¼ in. in c.g. of strand group
Tolerance between tendons	± ⅛ in.
Position of handling devices	± 6 in.
Position of deflection points for deflected strands	± 6 in.
Exposed beam ends (deviation from square or designated skew)	Horizontal: ± ¼ in. Vertical: ± ⅛ in. per 1 ft. of beam depth
Bearing plates (center to end of beam)	± ¼ in.
Side Inserts (center to center and center to end)	± ½ in.
Bearing area deviation from plane	± ⅛ in.
Stirrup bar spacing (individual or accumulative)	± 1 in.
Stirrup bar height	± ¾ in.
Position of post tensioning duct	± ¼ in.
Position of weld plates	± 1 in.

PRESTRESSED PILE	
Unit Feature	**Tolerance**
Length	± 1 in.
Width or diameter	± ⅜ in., - ¼ in.
Head out of square	⅛ in. per 1 ft. of width
Horizontal alignment (deviation from straight line parallel to centerline of pile)	⅛ in. per 10 ft. of pile
Position of void	± ¼ in.
Position of stirrup bars and spirals	± ¾ in.
Position of tendons	± ¼ in.
Position of handling devices	± 6 in.
Position of steel driving tips	½ in.

PRESTRESSED PANELS	
Unit Feature	**Tolerance**
Length	± ¼ in.
Width	± ¼ in.
Thickness	+ ¼ in., - ⅛ in.
Square ends (deviation from square)	± ¼ in.
Deviation from straightness of mating edge	+ ⅛ in.
Position of strands	± ⅛ in. vertical, ± ½ in. horizontal

Notify the Engineer a minimum of 2 business days for in-state production and 5 business days for out-of-state production, in advance of the date when casting is to begin to afford an opportunity for inspection of the casting beds and forms, the equipment for placement and tensioning of the strands, the equipment for proportioning, mixing, placing and consolidating the concrete, and the equipment for handling the units.

b. Equipment.

(1) Condition. Repair or replace unsafe or inadequately operating equipment.

(2) Concrete Mixers. Mix concrete in truck mixers or in a central mixing plant that comply with **SECTION 154**. When concrete is mixed in a central mixing plant and can not be adequately mixed according to **SECTION 401**, conduct tests, as required by the Engineer, to determine the minimum mixing time to achieve uniformity of the concrete mixture. For air-entrained concrete, the maximum mixing time may not exceed the mixing time established from uniformity tests by more than 60 seconds.

(3) Casting Beds. Portable casting beds are prohibited. The supporting foundations for casting beds must be such that no settlement will occur during the casting and curing of the units.

(4) Forms. Use forms that are true to line, mortar tight and provide access for placement of the reinforcement and concrete.

(5) Stressing Jacks. For stress application, use jacks equipped with hydraulic gauges or other approved stress measuring devices as a check against the applied load as measured by elongation. Recalibrate gauges when directed by the Engineer.

(6) Curing Enclosures. Use steam curing enclosures reasonably free from steam leakage and providing adequate circulation of steam. Arrange steam jets so that the steam shall not play directly on the forms or the concrete as it enters the enclosure. If non-waterproof tarpaulins are used for the enclosure, use a minimum of 2 layers. Use only waterproof tarpaulins or plastic sheeting for enclosures when prestressed concrete units are cured by radiant heat.

(7) Instruments. When accelerated curing is used, install instruments during the curing period for measuring and recording temperature and humidity inside curing enclosures and for measuring and recording temperature in the concrete for each 200 feet of casting bed. Provide a minimum of 2 instrument installations of each type for each enclosure. The location of each instrument must be approved by the Engineer. Humidity level indicators may be waived by the Engineer.

c. Manufacturing Requirements.

(1) General. Except as modified by the Contract Documents or approved by the Engineer, follow the latest edition of the Prestressed Concrete Institute's, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products".

(2) Reinforcement. Install reinforcing bars as shown in the Contract Documents, and rigidly secure them to prevent movement during placement of the concrete. Welding of reinforcing steel bars is prohibited.

Substituting deformed welded steel wire fabric in prestressed beams for reinforcing bars is acceptable, provided the spacing of the wires is less than or equal to the spacing shown in the plans, and the area of steel per foot is equivalent or greater than the reinforcing bars shown in the plans. Use the table shown in the plans for area of steel equivalences. Higher yield strength welded steel wire fabric is allowed, but will not change the equivalences. Post production welding of wire fabric is prohibited.

Accurately position steel strand within the tolerances specified in the Contract Documents. Rigidly secure the strand so it shall be retained in the specified locations. The minimum horizontal spacing, center to center of strands at the ends, is 2 inches. Install supports to prevent dead load sag. The roller size on the holddown device must match the strand size used. Provide strand supports as shown in the Contract Documents that consist of a device with freely turning rollers a minimum of ⅞ inch in diameter at each deflection point. A yoke type device may be used for top depressing of strands when approved by the Engineer. The prestress force and center of gravity must be as shown in the Contract Documents.

Perform tensioning and elongation according to the Contract Documents. No tensioning of strands or placement of concrete will be permitted when the ambient air temperature is below 20ºF. At the option of the Engineer, strand shall be brought to within 25°F of the concrete at placement in lieu of corrections in elongation due to temperature. The Engineer may use suitable equipment to determine if the strand tension is proper throughout the entire bed length. Make corrections as required.

(3) Concrete. Handle and place the concrete by methods that shall produce a dense, uniform product, free from sand streaks and honeycomb areas. The presence of any deleterious substance such as "bag paper" is cause for rejection. Deliver concrete to the producer's site of the work and complete placement within the time limits specified in **SECTION 401**. Deliver and place successive batches at a constant rate and before the preceding batch has been perceptibly hardened or dried, or is no longer pliable, and in no case may the interval between successive batches in a unit exceed 20 minutes, or if the concrete mix or environmental conditions require otherwise, a period established by the Engineer. Do not add water to temper deposited concrete.

Place concrete during cold weather according to **SECTION 401**. In addition, the form temperature shall be a minimum of 40ºF before the concrete may be placed. When necessary, continue heating the forms during the placement and finishing of the concrete.

Provide concrete units meeting the tolerances specified in **TABLE 715-1**, unless shown otherwise in the Contract Documents.

(4) Surface Finish. Make all surfaces of the units reasonably straight and true to lines and grades, and free from fins or other projections. Form joint marks will be permitted. Give top surfaces of beams a wire brush or stiff broom finish applied transverse to the length of the beam. Rake the top surfaces of the panels, perpendicular to the prestressing strand, making depressions of approximately ¼ inch. Do not pull out the coarse aggregate when raking.

(5) Cracks. Produce concrete units free from cracks of sufficient width to impair the unit's strength and durability.

(6) Curing. Curing may be accomplished by either the moist curing method or accelerated curing with low pressure steam or radiant heat.

(a) Moist Curing Method (Normal Curing Temperatures). As soon as possible after the units have been cast, cover them with a minimum of 2 layers of burlap and keep wet until the side forms are removed. After the side forms are removed, protect the units with wet burlap or a vapor proof cover until they have attained the strength requirement for release shown in the Contract Documents.

If repairs to the concrete surface are required or to give the units a surface finish, remove the protective covering and complete the surface work, but keep the surfaces of the unit moist during the entire time that the protective covering is removed.

(b) Accelerated Curing with Low Pressure Steam or Radiant Heat. Perform low pressure steam curing or radiant heat curing under an enclosure to contain the live steam or the heat. Allow the initial set of the concrete to take place by delaying the initial application of steam or heat from 2 to 4 hours after the final placement of concrete. If retarders are used, increase the waiting period before application of the steam or radiant heat to 4 to 6 hours. If the time of initial set is determined by the standard method of test for "Time of Setting of Concrete Mixtures by Penetration Resistance", ASTM C 403, the time limits described above may be waived.

Do not apply live steam directly on the concrete forms causing localized high temperatures.

Radiant heat may be applied by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. Perform radiant heat curing under a suitable waterproof enclosure to contain both heat and moisture. Minimize moisture loss by covering all exposed concrete surfaces with 2 layers of wet burlap.

While waiting for the initial set, the minimum temperature within the curing chamber shall be 50ºF. During this time, live steam or radiant heat may only be used to maintain the curing chamber at the minimum temperature.

During the initial application of live steam or radiant heat, increase the ambient air temperature within the curing enclosure at a maximum average rate of 40ºF per hour. The maximum curing temperature within the enclosure is 160ºF, while the maximum internal concrete temperature shall be limited to 180°F. Hold the maximum temperature until the concrete has reached the desired strength. Immediately after the steam or heat curing has been discontinued, accomplish release. Additional curing is not required after release.

Do not allow the temperature of the concrete to drop below 50ºF at any time.

Provide recording thermometers showing the time-temperature relationship throughout the curing period from placing concrete to transfer of prestress. All temperature records will be retained by the Engineer as part of the curing records. Missing or incomplete time-temperature records shall be cause for rejection of the corresponding prestressed units.

Temperature limits and use of recording thermometers are the same when curing with steam or radiant heat. Due to the slow rise of ambient temperatures with radiant heat, application of heat

cycles may be accelerated to meet climatic conditions, however, do not increase the ambient air temperature within the curing enclosure by more than 40ºF per hour. In all cases, the curing procedure to be used must be well established and carefully controlled.

(7) Releasing Prestressed Units with Draped Strands. Units may be de-tensioned as soon as they have attained the strength requirements shown in Contract Documents. If the units have been cured by accelerated curing methods, transfer the stressing force to the concrete as soon as the release strength of the concrete has been reached, and while the concrete is still warm.

d. Inspection and Testing.

(1) General. Provide the Engineer free access to the manufacturing plant at all times for inspecting materials, plant facilities, manufacturing and curing procedures. Inform the Engineer of the planned concrete placement and curing schedule in advance of the start of any work. The Engineer will require time for testing of materials, inspection of equipment and reviewing of procedures that will be used in casting units, prior to beginning casting.

(2) Testing Equipment.

(a) Cylinder Molds. Provide an ample supply of cylinder molds for the casting of test cylinders. All molds are subject to approval of the Engineer. Use 6"∅ x 12" cylinders. The Engineer may approve the use of 4"∅ x 8" cylinders, provided reliable correction factors have been developed and submitted, along with supporting data, for review and acceptance.

(b) Compression Machine. Provide a machine capable of measuring the compressive strengths of concrete cylinders cast during the manufacturing of the units. All testing machines must be calibrated and approved by the Engineer.

(3) Test Cylinders.

(a) Casting and Curing. All test cylinders are the responsibility of the Contractor. With the exception of 28 day cylinders, cure all cylinders under the same conditions (environment) as the concrete they represent. Initially store then cure 28 day cylinders as per KT-22.

For the testing purposes described below, the “total volume of concrete placed” is defined as each 40 cubic yards of concrete or fraction thereof placed in each line, within each curing enclosure, between bulkheads, during a continuous working period.

Make 1 group of 3 or more cylinders for each third of the total volume of concrete to be placed. Note the limits of the concrete in the beds represented by each of the groups of cylinders. Mark and identify all cylinders groups as 1, 2 and 3 with marked group 1 representing the first third of the total volume of concrete placed, marked group 2 representing the second third of the total concrete placed, and marked group 3 representing the final third of the total concrete placed. To facilitate the testing of multiple sets of cylinders for release or shipping, each group may contain more than 3 cylinders. Mark cylinders within a group as xA, xB, xC, xD, xE where “x” is the group number (always 1, 2, or 3) and A through E are the unique cylinder identifying marks within the group. Letters D and E, etc., are optional additional cylinders which allow more than one set of test cylinders for release or shipping. Identify which cylinders will be used for 28 day testing (i.e. 1E, 2E, 3E). Store and cure these three cylinders as per KT-22.

Follow the procedure of making sets of cylinders from early, middle and late placement, during normal production operations. When operations are interrupted or changed (i.e. equipment break-down, very small placements, etc.), adjust the cylinder fabrication schedule to match the production, and provide adequate cylinders for later release and shipping strength testing. Coordinate this revised schedule with the Engineer on the production site.

(b) Testing. With the Engineer observing, test cylinders to measure the release and shipping strength at the producer’s plant.

(i) Release Strength. Test 3 cylinders, 1 cylinder from each of the 3 groups of cylinders (i.e. 1A, 2A, 3A) prior to strand release to determine if the specified (design) release strength shown in the Contract Documents has been reached. Release strength is attained when the average compressive strength of the 3 tested cylinders equals or exceeds the design release strength and no more than 1 cylinder in the tested set has a compressive strength which is below the design release strength by no more than 100 psi. If the above conditions are not met, a minimum of 1 hour must pass before a second cylinder from each of the same 3 groups is tested (i.e. 1B, 2B, 3B).

(ii) Shipping Strength. Before reaching 28 days of age, the Contractor, may test 3 cylinders, 1 cylinder from each of 3 groups of cylinders (i.e. 1C, 2C, 3C) to determine if the specified 28 day

strength shown in the Contract Documents has been reached. Shipping strength is attained when all 3 tested cylinders meet or exceed the specified minimum 28 day strength. If this requirement is met, the products represented by these cylinders are accepted for strength requirements and may be shipped 1 day (approximately 24 hours) after meeting the compressive strength requirement and 5 days (approximately 120 hours) after concrete placement, whichever is greater. If the above condition is not met, a minimum of 2 hours must pass before a second cylinder from each of the same 3 groups is tested (i.e. 1D, 2D, 3D). If a cylinder from each of the 3 groups is not available for testing, then early shipping will not be allowed. Cylinders earmarked for 28 day testing cannot be tested for shipping.

(iii) 28 Day Strength. A previously identified set of 3 cylinders, 1 cylinder from each group of cylinders (i.e. 1E, 2E, 3E) shall be stored and moist cured as per KT-22 and then tested when the concrete has reached an actual age of 28 days. Testing will take place at a location chosen by the Engineer while being observed by the Engineer. When the early shipping requirements described above have not been met, the average strength of these 3 cylinders must meet or exceed the specified minimum 28 day strength. In addition, only 1 of the cylinders in the tested set may be below the minimum specified 28 day strength by no more than 5%.

The average strength of 1 set of 3 cylinders may be less than the specified minimum 28 day strength by no more than 5% or 300 psi, whichever is less, provided that the previous 9 consecutive sets of 28 day cylinders manufactured for the same KDOT project and using the same mix design complied with the 28 day strength criteria described above.

(iv) Coring. When either (but not both) of the following occur:

- the 28 day strength of an individual cylinder is less than the 5% criteria described above or
- a second of any 10 consecutive manufactured cylinder sets attains an average compressive strength below the specified minimum 28 day strength by no more than 5% or 300 psi, whichever is less.

The Contractor may, with the approval of the Engineer, core the unit (or units) represented by such cylinder (or cylinders) and have them tested. The location of the cores must be approved by the Engineer. Follow AASHTO T 24 when obtaining, preparing, testing and calculating the strength of drilled cores.

If the adjusted compressive strengths of any of the cores are below the specified minimum 28 day compressive strength, the represented units will be rejected. Coring is not allowed on product represented by more than 1 out of any 10 consecutively manufactured cylinder sets, regardless of reason, and can only take place after the concrete has reached an age of 28 days.

e. Handling, Storage and Transportation.

(1) Handling. Do not lift or strain the units in any way before the stress application strength has developed. While lifting and handling, support the units only at points designated in the Contract Documents.

(2) Storage. When units are stacked for storage, support each unit at designated bearing points.

(3) Transportation. The units may be shipped 1 day (approximately 24 hours) after test cylinders have reached the specified 28 day compressive strength, and the units have attained a minimum age of 5 days (approximately 120 hours), whichever is greater. Support beams in an upright position. The required points of support and direction of reactions with respect to the beam are approximately the same during transportation as when the beam is in its final position in the structure. Transport piling and panels with the points of support approximately below the lifting points designated in the Contract Documents.

If during transportation, units are supported at points so that a portion of the unit is cantilevered past the points designated above, the unit must be adequately reinforced or the overhanging portion adequately supported to prevent damage.

(4) Damage. Units damaged in shipment or placement may be accepted provided the damage does not impair the structural qualities of the unit, and such damage can be repaired at the work site to the satisfaction of the Engineer.

f. Field Construction. Do not place concrete on prestressed bridge beam units until they have reached a minimum age of 28 days, or as noted in the Contract Documents. Install bridge beams as shown in the Contract Documents.

g. Piling. Do not place piling before the specified 28 day strength has been attained. See **SECTION 704** for placing piling.

715.4 MEASUREMENT AND PAYMENT

The Engineer will measure the length of prestressed concrete beams by the linear foot.

The Engineer will measure the area of prestressed concrete panels by the square foot.

Payment for "Prestressed Concrete Beams" and "Prestressed Concrete Panels" at the contract unit prices is full compensation for the specified work.