KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS 1990 EDITION

NOTE: This special provision is generally written in the imperative mood. The subject, *"the Contractor"* is implied. Also implied in this language are *"shall"*, *"shall be"*, or similar words and phrases. The word *"will"* generally pertains to decisions or actions of the Kansas Department of Transportation.

Add a new Section to Division 700:

DIVISION 700

POST-TENSIONING
(Haunched Slab Bridges)

1.0 DESCRIPTION.

a. Post-tension the concrete haunched slab superstructure according to the Contract Documents.

b. Alternate Post-Tensioning Designs. Use 1 of the 2 alternate longitudinal post-tensioning systems shown in the Contract Documents. No other longitudinal post-tensioning system is allowed.

The Contractor may propose an alternate to the transverse post-tensioning system shown in the Contract Documents. Before materials are provided and before any post-tensioning operations begin, submit the proposed alternate to the Bureau of Design, State Bridge Office (SBO). The SBO will consider an alternate transverse post-tensioning system, provided:

- The tendon spacing and profile are the same as shown in the Contract Documents.
- The jacking force per tendon is the same as shown in the Contract Documents.
- The end anchorage assembly dimensions and duct size do not exceed the maximum dimensions shown in the Contract Documents.

The SBO will approve (or disapprove) the Contractor's proposed alternate transverse post-tensioning system within 5 working days of receiving the required information.

c. Qualification of the Post-Tensioning Manufacturer. Select a post-tensioning manufacturer with experience (in the United States) in post-tensioning concrete haunched slab or concrete box girder bridges that were designed and constructed according to AASHTO specifications.

A post-tensioning manufacturer may submit the necessary information to be considered for qualification at any time. The SBO will maintain a list of approved manufacturers. Once a manufacturer is approved, he will remain on the list at the discretion of the SBO.

Before materials are provided and before any post-tensioning operations begin, the post-tensioning manufacturer must be approved by the SBO. If the manufacturer has not been previously approved, provide the SBO with the necessary information to consider their qualifications. Provide the SBO with:

- Certificate of compliance with OSHA and other applicable industry standards for safety.
- In-house capability to design end anchorage assemblies, local zone and general zone design according to AASHTO specifications, certified by a Registered Professional Engineer.
- Certificate of compliance with AASHTO specifications for testing of the end anchorage assemblies, performed by an independent testing laboratory, and certified by a Registered Professional Engineer.
- In-house QC/QA implementation for manufacturing, assembling, storage, delivery, installation, stressing, and grouting supervision.
- Qualification and experience of the field personnel to be assigned to assist the Contractor and supervise installation, stressing, and grouting.
- Proof of continuous existence for the last 10 years. Firms with less than 10 years of experience may be approved if sufficient related project experience can be demonstrated, but in any event a minimum of 7 years of experience is required.
- List of unfavorable claims, if any, within the last 10 years.
- In-house capability of training KDOT personnel to inspect the post-tensioning operations, if requested by KDOT. Such training, if required, is not part of the work included in this specification.

The SBO will approve (or disapprove) the post-tensioning manufacturer within 5 working days of receiving the required information.

BID ITEM	**UNIT**
Post-Tensioning	Lump Sum

2.0 MATERIALS.

a. Prestressing Steel. Provide uncoated, seven wire, low-relaxation strands for prestressed concrete manufactured according to the requirements of AASHTO M 203M (ASTM A 416M). The strands must have a minimum strength of 1860 MPa. Fabricate the tendons with sufficient length beyond the anchor bearing plates to allow for stressing and anchor device installation.

The Engineer will accept the strands based on the requirements of **subsection 2f.**(1).

Protect all strands against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Reject strands that have sustained physical damage at any time. Use wire that is bright and uniformly colored, having no foreign matter or pitting on its surface.

Package the strands in containers or forms for protection against damage and corrosion during shipping and storage. Place a corrosion inhibitor which prevents rust or other results of corrosion in the package or form, or incorporate a corrosion inhibitor carrier type packaging material, or apply directly to the steel if permitted by the Engineer. Use a corrosion inhibitor that has no deleterious effect on the strands or grout or bond strength of strands to grout. Provide an inhibitor carrier type packaging material conforming to the provisions of Federal Specifications MIL-P-3420F-87.

Mark the shipping package or form clearly with a statement that the package contains high-strength prestressing steel strands, and the care to be used in handling, and the type, kind and the

amount of corrosion inhibitor used, including the date when placed, safety orders, and instructions for use.

b. Post-Tension Ducts. Provide semi-rigid, mortar-tight ducts capable of withstanding concrete pressures without deforming or permitting the intrusion of cement paste during the placement of concrete. Provide ducts for multi-strand tendons with an inside area of at least 2.5 times the net area of the tendons. Provide ducts that do not cause electrolytic action or deterioration of the concrete or the duct. Provide ducts that will bend without crimping or flattening, and with sufficient strength to maintain their correct alignment during the placement of the concrete.

Provide galvanized, corrugated ferrous metal ducts for the longitudinal ducts. Provide either corrugated metal or plastic types for the transverse ducts. Provide the proper connectors and fasteners for the type of duct used.

c. Inlets and Outlets. Inlets shall be used for injecting the grout into the duct; outlets shall allow the escape of air, water, grout, and bleed water. Provide 12 mm minimum diameter galvanized pipe or plastic pipe for inlets and outlets. Provide pipes that are mortar-tight. If plastic pipes are used, provide plastic components that do not react with concrete or enhance corrosion of the strands, and are free of water soluble chlorides.

Provide the proper connectors and fasteners to attach the pipes to the ducts. Provide waterproof tape for use at all connections.

Provide positive mechanical shut-off valves for all inlets. Provide cap, valves, or other devices capable of withstanding the pumping pressures for all outlets.

d. Post-Tensioned End Anchorages. Provide end anchor devices that comply with the design and test requirements of **Division I, Article 9.21, Post-Tensioned Anchorage Zones** of the **AASHTO Standard Specification for Highway Bridges** and **Article 5.10.9, Post-Tensioned Anchorage Zones** and **10.3.2, Post-Tensioning Anchorages and Couplers** of the **AASHTO LRFD Bridge Design and Construction Specifications**, respectively.

Provide anchorage devices that are capable of developing 95 percent of the specified ultimate strength of the tendons. Design end anchorages such that the stresses in the plates and assemblies induced by the pull of the tendons do not exceed the yield point of the material or cause visible distortion in the anchorage plate when 100 percent of the ultimate strength of the tendon is applied.

Provide special local-zone reinforcing, such as epoxy coated spirals and grids, for all tendons.

Galvanize or otherwise protect all end anchorages and bearing plates against corrosion.

e. Grout. Provide a grout to use in the post-tension ducts consisting of Portland cement, water, and admixtures (if approved by the Engineer). Use Type II Portland cement and water that comply with the requirements of **Division 1000** of the **Standard Specifications**.

If used, provide admixtures that impart the properties of low water content, good flowability, minimum bleed and expansion, and contain no chemicals in quantities that have harmful effects on the strands, cement or the duct. Do not use fluorides, sulfites, or nitrites. If used, provide aluminum powder of the proper fineness and quantity or other approved gas evolving material which is well dispersed through the mixture to obtain a maximum of 5 percent unrestrained expansion of grout. Use all admixtures according to the instructions of the manufacturer.

f. Testing. Provide all materials for testing. Conduct all tests according to the applicable AASHTO and ASTM Specifications.

(1) Testing by the Engineer. Provide 3 samples of sufficient length to provide 1.5 m measured between fittings for each size strand from each heat, reel, or coil.

Provide the Engineer with a certification stating the manufacturer's minimum guaranteed ultimate strength of the strand for each size supplied from each lot.

(2) Testing by the Contractor. Provide the Engineer with a certificate of test performance from the manufacturer of the strand for each size from each heat, reel or coil to determine the modulus of elasticity prior to stressing the initial tendon in the bridge. Re-evaluate the theoretical elongations shown on the post-tensioning working drawings using the results of the tests and correct if necessary. Submit revisions of the theoretical elongations to the Engineer for approval.

3.0 CONSTRUCTION REQUIREMENTS.

a. Shop Drawings. Provide the SBO with shop drawings (maximum size 560 mm x 915 mm) from the manufacturer for all work related to post-tensioning. The shop drawings must be sealed by a Registered Professional Engineer. Provide 9 sets of the shop drawings. The shop drawings must be approved by the SBO before any fabrication begins.

Include in the shop drawings:

- anchorage and bearing plates,
- tendon placement,
- distance from top of slab to the top of duct and from bottom of slab to bottom of duct,
- support steel for tendon placement according to the Contract Documents,
- anchorage local-zone reinforcement,
- jacking forces and initial stresses,
- stressing operation and equipment data,
- all material specifications (e.g. strands, ducts, and grout),
- grouting operation and equipment data,
- safety procedures,
- elongations and tolerances,
- all required computations,
- if duct sizes different from the sizes shown in the Contract Documents are approved, modify the spacer frame details shown in the Contract Documents.
- computations and a typical tendon force diagram (for all types of tendons), after friction and anchor set losses, based on an expected actual friction coefficient for the system to be used.

b. Installation. Install the hardware including ducts, tendons, end anchorage assemblies, and special reinforcing according to the Contract Documents and the instructions of the post-tensioning manufacturer.

Provide a qualified representative of the manufacturer, who is skilled and thoroughly experienced in the use of the system to supervise or provide appropriate surveillance in the work, and to give the Engineer such pertinent information as required. Have such representative available full-time on all days during which the stressing and grouting of tendons are in progress. The following items require inspection and approval by the representative of the manufacturer:

- installation of all hardware,

- instructions to the Contractor regarding concrete placement around the ducts, end-anchorage assemblies, and other appurtenances,
- supervision of stressing procedures, record keeping, certification of stressing results,
- supervision of grouting operations.

Do not place any concrete in the bridge abutments and superstructure until the hardware installation is approved by the Engineer and the manufacturer's representative.

Reject all unidentified strands or anchorage assemblies.

Provide all ducts or anchorage assemblies with inlet/outlet pipes.

Place outlets at low points of longitudinal ducts to prevent accumulation and freezing of water within the ducts. Keep low point outlets open until grouting is started. Remove ends of inlets and outlets at least 25 mm below the concrete surface after the grout has set and fill the recess in the concrete with an epoxy grout that complies with the requirements of **Special Provision 90M-102** (latest version).

If stressing and grouting are completed within 7 calendar days after the installation of the strands, do not use a corrosion inhibitor. The rust which may form during the 7 days is not cause for rejection. If the strands are installed, but not grouted within 7 calendar days, use a corrosion inhibitor in the duct.

If approved by the Engineer, the strands in the members may be installed before the concrete is placed and cured. If this option is used, place a corrosion inhibitor in the ducts or apply the corrosion inhibitor to the strands. In any case, do not allow any strands installed in the ducts to remain ungrouted for a period exceeding 30 calendar days.

c. Stressing Tendons.

(1) Stresses. Tension all strands by means of hydraulic jacks. The force of the strands must not be less than the value shown on the approved shop drawings. Do not allow the maximum temporary tensile stress (jacking stress) in the strands to exceed 80 percent of the specified minimum ultimate tensile strength. Anchor the strands at stresses (initial stresses) that will result in the ultimate retention of permanent forces of not less than those shown on the plans. In any case, do not exceed, after anchor set, 70 percent of the specified minimum ultimate tensile strength. Consider permanent force and permanent stress as the force and stress remaining in the strands after all losses, including creep, shrinkage, and elastic shortening of concrete, relaxation of steel, post-tensioning losses due to the sequence of stressing, friction, take-up of anchorages, and any other losses due to the method or system of post-tensioning. Stressing of the strands must be completed within –0 to +5 percent of the forces shown on the Plans.

(2) Stressing Jacks. Equip each jack used to stress tendons with a pressure gauge (at least 150 mm in diameter) for determining the jacking pressure. Calibrate each jack and its gauge as a unit with the cylinder extension in the approximate position that it will be at final jacking force. Perform the calibration before stressing the initial tendon. Before stressing the initial tendon, provide certified calibration charts (by an independent laboratory) with each jack, hydraulic system and gauge used on the project. Perform the calibration while the jack is in the identical configuration as will be used on the site (e.g., the same length hydraulic lines). As an option, use a master gauge for calibrations subsequent to the initial jack calibration by a load. Supply the master gauge in a protective waterproof container capable of protecting the calibration of the master gauge during shipment to a laboratory. Provide a quick-attach coupler next to the permanent gauge in the hydraulic lines which enables the quick and easy installation of the master gauge to verify the permanent gauge readings. Calibrate and provide the Engineer with the master gauge for the duration of the Project.

Any repair of the jacks, such as replacing the seals or changing the length of the hydraulic lines, will be cause for re-calibration of the jack with a load cell.

Apply post-tensioning forces only after the concrete has attained the specified compressive strength as determined by the cylinder tests.

(3) Elongations. Conduct the tensioning process so that the tension being applied and the resulting elongation of the strands may be measured at all times. Keep a permanent record of gauge pressures and elongations and submit it to the Engineer. Measure elongations to the nearest 2 mm using a metal or rigid ruler (a flexible tape is not permitted).

Preload tendons to 10 percent of their total jacking force. Inspect dead end anchors for adequacy before completing the post-tensioning of the tendon.

If a tendon's measurable elongation is greater by more than 7 percent of the calculated measurable elongation, the tendon will be evaluated and subject to rejection.

If a tendon's measurable elongation is less than the calculated measurable elongation by more than 7 percent, overjack the tendon to 80 percent of its ultimate strength from either end. If this yields an elongation within 7 percent of the calculated measurable elongation, the tendon will be accepted; otherwise it will be evaluated and subject to rejection.

In the event of a failure to meet the 7 percent requirements above, a tendon evaluation is required, and will consist of one or all of the following procedures:

- Modification of the friction and wobble coefficient: Perform in-place friction tests or modify the K-factor by using the data from the tendon in question.
- Verification of the tendon modulus of elasticity: Perform additional bench tests.
- Recalibration of the stressing jack: Verify elongation through jack or extension if used.
- Perform lift-off at dead end.

Submit to the SBO for approval, a proposal of a tendon evaluation from a Registered Professional Engineer representing the post-tension manufacturer.

Submit to the SBO the results of the tendon evaluation.

Should the evaluation fail to justify the discrepancy between the actual and calculated measurable elongation, the tendons will be rejected.

(4)Record of the Post-Tensioning Operation. Keep a record of the following post-tensioning operations for each tendon installed:

- date strand installed
- date stressed
- date grouted
- coil number for strands installed or heat number for bars installed
- jacked ends
- theoretical and actual elongation
- theoretical and actual anchor set
- actual length
- gauge pressure and forces (initial, before anchor set, after anchor set)
- accepted or number of items rejected
- comments as to problems.

Upon completion of the post-tensioning, submit to the Project Engineer for approval a record of gauge pressures and tendon elongations. The records submitted must be certified by a Registered Professional Engineer of the post-tensioning manufacturer.

Do not cut off stressing tails of tendons until the stressing records have been approved. Do not torch cut strands or bars at any time.

d. Grout. Grout the annular space between the duct and the tendons after the tensioning of all tendons has been completed and the strands have been anchored

(1) Equipment. Provide a grouting equipment mixer capable of continuous mechanical mixing which will produce a grout free of lumps and undispersed cement. Use accessory equipment which will provide for accurate solid and liquid measures to batch all materials. Provide grout equipment capable of continuously grouting the longest tendon on the project in not more than 20 minutes.

Use grouting equipment utilizing gravity feed to the pump inlet from a hopper attached to and directly over it. Keep the hopper at least partially full of grout at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Use positive displacement type pumps, capable of producing an outlet pressure of at least 1035 kPa. Use a pump with seals, adequate to prevent introduction of oil, air, or other foreign substance into the grout, and to prevent loss of grout or water. Place a pressure gauge having a full scale reading of no greater than 2100 kPa at some point in the grouting line between the pumping outlet and the duct inlet. Use grouting equipment containing a screen having clear openings of 3 mm maximum size to screen the grout prior to its introduction into the grout pump. Provide a screen opening of 5 mm maximum if a grout with an additive is used. Provide easy access to this screen for inspection and cleaning.

(2) Mixing. Add water to the mixer first, followed by Portland cement and admixture, or as required by the admixture manufacturer. Perform mixing for such duration as to obtain a uniform and thoroughly blended grout, without excessive temperature increase or loss of expansive properties of the admixture. Agitate the grout continuously until it is pumped. Do not add additional water to increase grout flowability.

Proportion material based on tests made on the grout before grouting is begun, or prior documented experience with similar materials and equipment and under comparable field conditions (weather, temperature, etc.).

Provide minimum water content necessary for proper placement, and do not exceed the water-cement ratio of 0.45 or approximately 19 liters of water per sack (43 kg) of cement. Establish the water content requirement for the particular brand, based on tests. The pumpability of the grout may be determined by the Engineer according to ASTM C 939. When this method is used, do not exceed 11 seconds for the efflux time of the grout sample immediately after mixing. Do not use the flow cone to test grout which incorporates a thixotropic additive.

(3) Grout Operations. Keep all grout inlets and high point outlets open when grouting starts. Allow grout to flow from the first outlet after the inlet until any residual flushing water or entrapped air has been removed, at which time close the outlet. Close remaining outlets in order in same manner.

Perform normal grout pumping operations at 520 kPa. Do not exceed 1725 kPa for pumping pressure at the inlet. Pump the grout through the duct and continuously waste at the outlets until there is no evidence of water or air being ejected.

If the actual grouting pressure exceeds the maximum recommended pumping pressure, inject grout at any outlet that has been, or is ready to be closed as long as a one-way flow of grout is maintained. If this procedure is used, fit the outlet that is to be used for injection with a positive shutoff. When one-way flow of grout cannot be maintained as outline above, flush the grout immediately out of the duct with water.

To insure that the tendon remains filled with grout, close the outlets and inlets, in order, under pressure when the tendon duct is completely filled with grout. Do not remove or open positive shutoffs required at the inlets and outlets until the grout has set. In temperatures below 0°C, keep ducts free of water to avoid damage due to freezing. Maintain the temperature of the concrete 2°C or higher from the time of grouting until jobsite cured 100 mm diameter cylinders of grout reach a minimum compressive strength of 5.5 MPa when tested in accordance with AASHTO T22. Do not exceed 32°C in the grout during mixing or pumping. If necessary, cool the mixing water.

Grout all duct enclosures that contain prestress steel before winter shut down.

e. Protection of End Anchorages. Clean exposed end anchorages, strands, and other metal accessories of rust, misplaced mortar, grout, and other such materials as soon as possible after tensioning and grouting is completed. Immediately following the cleaning operation, apply a coat of zinc-rich epoxy paint (minimum thickness of 100 µm).

f. Recess Pocket Filling. Fill all longitudinal end anchorage recess pockets as shown in the Contract Documents. Fill the recess pockets at transverse end anchorages with a cementitious grout that is applied with an epoxy-resin bonding agent that complies with the requirements of **Special Provision 90M-102** (latest version). Finish the outside exposed surfaces of the recess pockets smooth and flush with the surrounding concrete surface.

4.0 MEASUREMENT AND PAYMENT.

The Engineer will measure the completed and accepted post-tensioning as a unit.

Payment for "Post-Tensioning" at the Contract unit price is full compensation for the specified work.

06-27-00 BD(BS) (GC/LR)
typographical correction 12-09-00