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DIVISION 700 STRUCTURES

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701 - TEMPORARY SHORING

SECTION 701

TEMPORARY SHORING

701.1 DESCRIPTION

Design and construct temporary shoring for the locations designated in the Contract Documents and any temporary shoring used for the Contractor's convenience.

<u>BID ITEM</u>	<u>UNITS</u>
Temporary Shoring	Lump Sum

701.2 MATERIALS

Provide the materials shown in the Temporary Shoring Plan. The Engineer will accept the temporary shoring materials based on compliance with the dimensional requirements and visual inspection for condition.

701.3 CONSTRUCTION REQUIREMENTS

For each location designated in the Contract Documents, submit 4 copies of a Temporary Shoring Plan (including the design calculations) sealed by a licensed Professional Engineer, to the Engineer for approval a minimum of 6 weeks before the scheduled beginning of temporary shoring operations, unless shown otherwise in the Contract Documents.

Shore, sheet, brace or otherwise support the excavation or the structure according to the Temporary Shoring Plan. Maintain the temporary shoring until the Engineer authorizes its removal.

701.4 MEASUREMENT AND PAYMENT

The Engineer will measure each location of temporary shoring designated in the Contract Documents by the lump sum. Temporary Shoring shown to be used in multiple locations in conjunction with a structure will be considered as one location for lump sum payment. Unless shown as a bid item in the Contract Documents, the Engineer will not measure for payment any temporary shoring needed to comply with safety standards or due to the Contractor's methods of operation.

Payment for "Temporary Shoring" at the contract unit price is full compensation for the specified work.

702 - CORRUGATED METAL SHEET PILING

SECTION 702

CORRUGATED METAL SHEET PILING

702.1 DESCRIPTION

Drive the specified size and type of corrugated metal sheet pile at the locations and to the penetration shown in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
* Corrugated Metal Sheet Piling	Linear Foot
*Type: Black or Galvanized	

702.2 MATERIALS

Provide steel sheet piling that complies with **DIVISION 1600**.

702.3 CONSTRUCTION REQUIREMENTS

The order list is the same as the estimated quantity (number and length of piles) shown in the Contract Documents.

Excavate as required to drive the piling. Do not excavate below the dredge line without approval from the Engineer. Backfill the excavation as shown in the Contract Documents after the piling is driven.

Drive the piles at the locations and to the vertical lines shown in the Contract Documents.

Drive the piles with a light hammer or a combination of water jetting and a light or vibratory hammer. Use a fabricated or cast driving head with corrugations to match the top of the sheeting while driving the sheet piling.

Drive the piling to the specified penetration. Stop driving the piling if, in the opinion of the Engineer, the specified penetration can not be attained without damage to the piling. If the piling can not be driven to the specified penetration, cut the piling off at the elevation designated by the Engineer.

Remove and replace piles damaged while driving. Remove and re-drive piles driven out of their proper location.

702.4 MEASUREMENT AND PAYMENT

The Engineer will measure corrugated metal sheet piles by the linear foot. The Engineer will not deduct pile cut-off, if any, from the measured quantity.

Payment for the various types of "Corrugated Metal Sheet Piling" at the contact unit price is full compensation for the specified work.

703 - DRILLED SHAFTS

SECTION 703

DRILLED SHAFTS

703.1 DESCRIPTION

Construct drilled shafts by the cased or uncased method depending upon site conditions and Contract Document requirements.

BID ITEMS

Drilled Shaft (*) (**)	Linear Foot
Permanent Casing (*) (Set Price)	Linear Foot
Sonic Test (Drilled Shaft) (Set Price)	Each
Core Hole (Investigative)	Linear Foot
*Size	
**Cased (If Contract Documents specify the cased method.)	

UNITS

Linear Foot
Linear Foot
Each
Linear Foot

703.2 MATERIALS

a. Concrete. Unless otherwise shown in the Contract Documents, provide Grade 4.0 concrete that complies with **SECTION 401**. Provide a mix design with a minimum field compressive strength of 3500 psi and target slump of 9 inches \pm 1 inch. Do not withhold mix water at the plant and do not add water at the site.

b. Grout/Flowable Fill. For backfilling the cross-hole sonic testing pipes and core holes, provide non-shrink cementitious grout (mixed according to the manufacturer's directions) that complies with **DIVISION 1700**.

Provide grout or flowable fill for backfilling the void space between the temporary and permanent casing with:

- 28 day strength of 1000 psi;
- mortar sand, FA-M (**SECTION 1102**) mixed with 2 bags of Type II portland cement per cubic yard; and
- water-to-cement ratio less than 1.

c. Granular Backfill Material. Provide granular backfill material for backfilling the void space between the temporary and permanent casing that is fine enough to fill the entire volume. The Engineer will accept the granular material based on a visual inspection.

d. Reinforcing Steel. Provide steel bars for concrete reinforcement that comply with **DIVISION 1600**.

e. Casing. Provide casing of sufficient thickness to carry the working stresses and loads imposed on the casing during construction. At a minimum, use 14-gage corrugated metal pipe (CMP) for the permanent casing.

If required, provide a permanent casing that is less than or equal to 1 inch out-of-round. The deviation of a chord from end to end shall be a maximum of 2 inches.

The Engineer will accept the casing based on compliance with the specified requirements, and visual inspection for condition.

f. Pipe for Sonic Testing. Provide 2 inch diameter steel pipe that complies with ASTM A 53/A 53M, Standard Weight. Provide clean pipe (both internal and external surfaces) with watertight joints. The internal joints shall be flush. Provide screw-on watertight shoes, couplers and caps for the pipes.

Provide a Type D certification that complies with **DIVISION 2600**.

703.3 CONSTRUCTION REQUIREMENTS

a. General. Drilled shaft lengths shown in the Contract Documents are an estimate from the top of formation elevations determined from borings. Actual formation elevations encountered at each shaft, may require the actual length of each drilled shaft be adjusted. If the Engineer changes the drilled shaft lengths, the Contractor will be advised (in writing) of the revised bottom of rock socket elevation.

703 - DRILLED SHAFTS

A minimum of 28 days before constructing the drilled shafts, submit an installation plan to the Engineer for review. Include the following:

- Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations;
- List of proposed equipment, such as cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, core-sampling equipment, tremies or concrete pumps and casing; and
- Details of concrete placement, including proposed operational procedures for tremie and pumping methods and method of achieving a sealed tremie or pump.

b. Investigative Core Hole. Provide NX sized (2.125 inches) core samples organized in descending elevation and stored in standard core cardboard boxes. Perform this work, from the existing ground surface elevation, 15 working days in advance of the drilled shaft construction, at locations shown in the Contract Documents or ordered by the Engineer. Extract and maintain a core of the foundation material from 4 feet above the top of the plan tip elevation to 6 feet below the plan tip elevation shown in the Contract Documents. Discard all material extracted above 4 feet above the top of the plan tip elevation. Maintain, protect and label (elevation and location) these samples for review by the KDOT. While drilling, prepare a continuous standard drilling/coring log. The logs shall remain with the sample for review. Survey the location of the core hole with the same construction tolerance as **subsection 703.3c**.

c. Excavating the Drilled Shaft. Prior to constructing drilled shafts, complete the excavation for the entire element.

Locate the top of the shaft within 2 inches of the location shown in the Contract Documents. Unless otherwise shown in the Contract Documents, bore all shafts plumb to within a tolerance of 1 inch per 10 feet of length of shaft, not to exceed 6 inches over the full length of the shaft. The bottom of the shaft shall be nearly flat. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of $\pm\frac{3}{8}$ inch per foot of diameter.

Depending upon site conditions and requirements in the Contract Documents, construct the drilled shaft by either the cased or uncased method:

(1) Uncased Method. Use this method at locations anticipated to be free of caving soil or excess water inflow into the excavated shaft. Do not use the uncased method if the actual conditions show the shaft is prone to caving soil, or has water inflow that exceeds the dry pour method requirements in **subsection 703.3f**.

Excavate the shaft without the use of added water or drilling fluid. Completely excavate the shaft in a continuous operation, unless encountering rock or obstructions. Place the concrete without delay.

(2) Cased Method. Use this method at locations with caving soil or excess water inflow into the excavated shaft. Use either a permanent smooth, thick-walled casing, or a combination of a smooth, thick-walled temporary and permanent CMP casing together. All permanent casings shall be watertight.

Advancing shaft excavation by stabilizing the hole with drilling fluid is acceptable. Do not allow drilling fluid to get into the rock socket.

The concrete placement method used in a cased shaft depends on the water inflow requirements in **subsection 703.3f**.

After removal of the overburden, complete the excavation below the top of rock as an uncased core (rock socket) of the diameter shown in the Contract Documents.

Do not excavate closely spaced drilled shafts (3 drilled shaft diameters or less, center to center) until adjacent shafts are completed and cured according to the following criteria:

- Completed shafts have been allowed to set for a minimum of 24 hours after the concrete placement; and
- Developed a compressive strength of 1800 psi; or
- Without testing, the Engineer may allow excavation to proceed when the shaft has cured 72 hours after completion of the concrete placement.

If the Contract Documents specify or the Contractor elects to use permanent thick-walled casing for the closely spaced shafts, the Contractor may excavate multiple closely spaced drilled shafts. Once the concrete is placed, it must be cured according to the criteria above before excavating additional closely spaced drilled shafts.

d. Placing Reinforcing Steel and Sonic Testing Pipes. Tie reinforcing steel at all intersections of reinforcement, and place reinforcing steel as a unit for the full length of the shaft, prior to placing any concrete by

703 - DRILLED SHAFTS

either pour method. Use a minimum of 1 non-corrosive circular spacer per 30 inches of circumference of the reinforcing steel cage, within 5 to 10 feet of the bottom and top, and at intervals not to exceed 10 feet vertically. If the shaft is deepened and additional reinforcing steel cage is required, make the splice at the bottom of the steel cage.

In each shaft, place the number of testing pipes shown in the Contract Documents. All sonic testing pipes shall be the full length of the shaft from the bottom of the rock socket a minimum of 12 inches above the top of the shaft concrete. Before placement, measure and record the length of the sonic testing pipes and elevation of any pipe joints.

If multiple sections of pipe are required to reach the full length, the joints shall be watertight. The joints for all testing pipes in the shaft shall be at the same elevation. Completely seal the bottom of the pipe. After installation, fill pipes with potable water and install threaded caps. All testing pipes shall remain watertight until testing is complete.

e. Final Inspection and Access. At the time of placing the concrete, a minimum of 75% of the base of the shaft must have less than $\frac{1}{2}$ inch of sediment. The Engineer will determine the shaft cleanliness before concrete placement by:

- Visual inspection; or
- Underwater inspection using probes.

f. Placing Drilled Shaft Concrete. Depending upon site conditions, place concrete by either the dry pour or wet pour method:

- Use the dry pour method if water inflow does not fill the shaft more than 4 inches in depth in a 5 minute period, and the shaft can be dewatered so a maximum of 2 inches of water is standing in the shaft when concrete placement begins.
- When the above 2 conditions can not be met, use the wet pour method.

For both the dry and wet pour methods the following common requirements for concrete placed in a cased or uncased shaft shall apply:

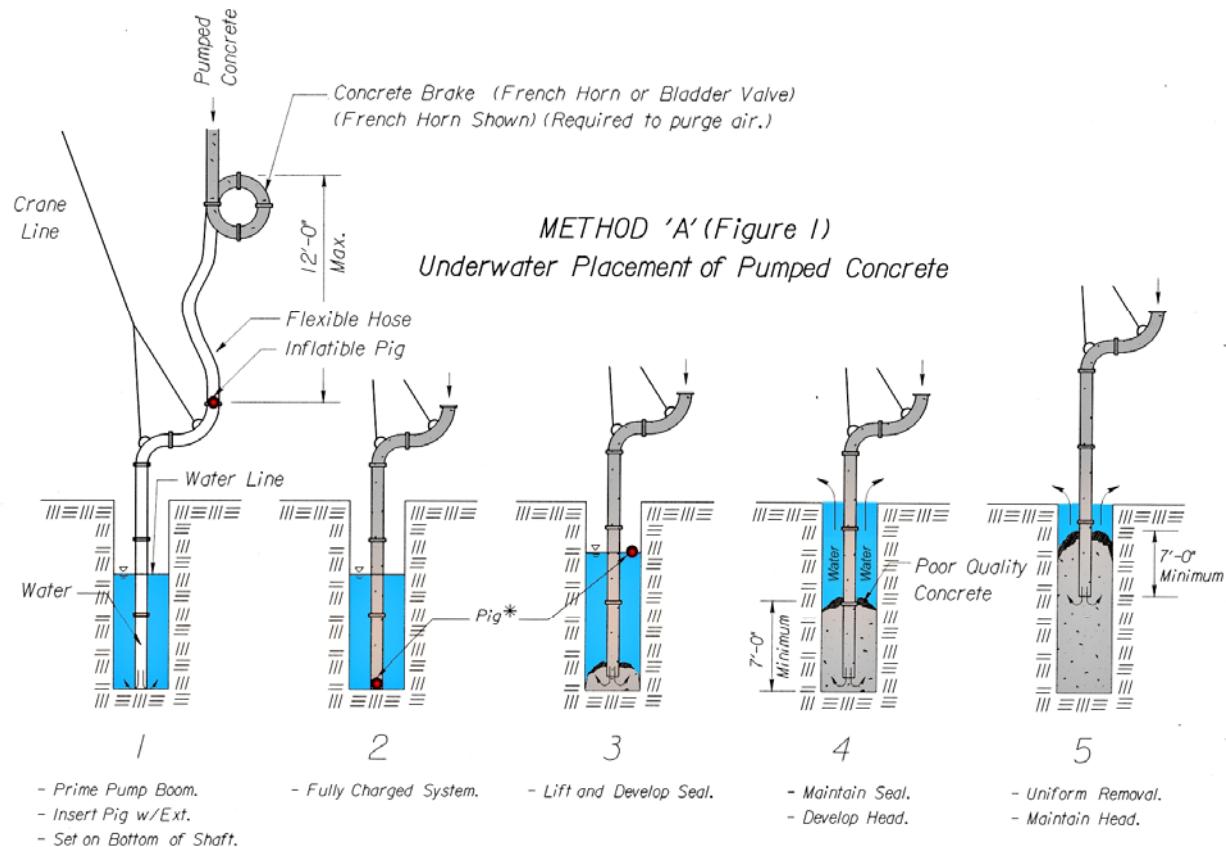
- Target slump is 9 inches \pm 1 inch;
- Place concrete in the shaft with a continuous operation, without construction joints;
- Do not vibrate concrete;
- Determine the top elevation of the fresh concrete and inform the Engineer; and
- Do not use aluminum concrete pump discharge tubes or tremie tubes.

(1) Dry Pour Method. Use a centering device to deposit concrete so the falling concrete shall not come into contact with vertical and horizontal reinforcing steel and wire supports. To control the fall, extend the centering device a minimum of 8 feet into the shaft. For a cased shaft, concrete may free fall to the bottom. For an uncased shaft, the maximum fall for concrete is 5 feet.

(2) Wet Pour Method. Prior to starting concrete placement, allow the water level in the shaft to reach its static level. Place concrete with either a sealed (watertight) tremie tube or pump with a rigid and watertight extension tube. In either case, use a device (i.e. commercially available pig or flap gate) that prevents water from entering the tube while charging with concrete. The commercially available pig shall be a minimum of 110% the diameter of the tube. Clearly label the outside of the tremie and pump tubes in 12 inch increments (starting at the bottom).

Lower the rigid tube into the shaft with the bottom of the tube resting on the bottom of the rock socket, and fully charge the system (tube and hopper or pumping system) with concrete. Once the system is fully charged, raise the tube off the bottom of the rock socket by 1 tube diameter, and allow the concrete to seal the discharge end of the tube. Maintain the tube at this elevation until a minimum of 7 feet head of concrete is developed. Maintain a minimum 7 foot head of concrete during the concrete placement. Prior to raising the tube, determine the top elevation of the fresh concrete and inform the Engineer.

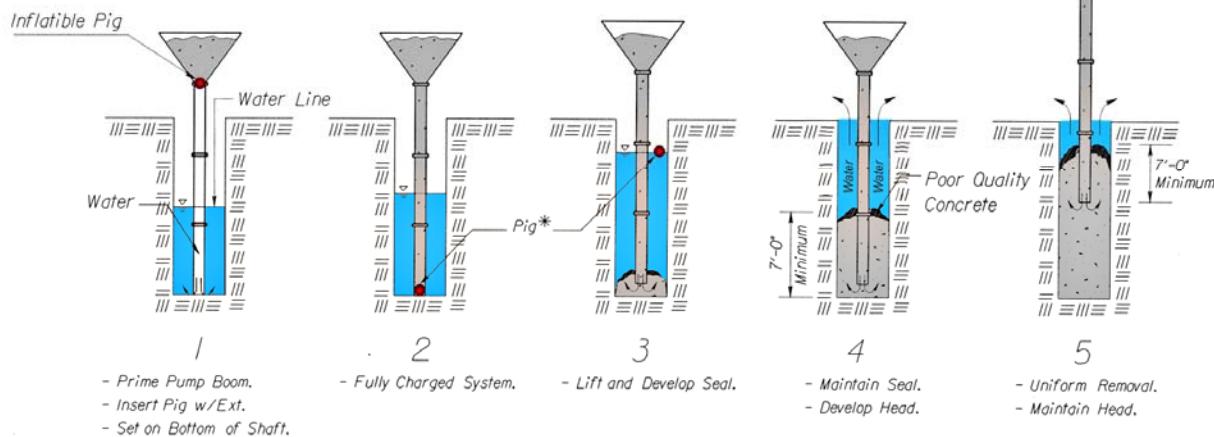
For wet pours, follow the steps listed in the previous paragraph, regardless of the Method (A, B or C) used to place concrete in the shaft:



Method A (Figure 1): Use a pump and extension tube, with a pig separating the ground water and concrete, to place concrete into the shaft. Install a concrete brake (e.g. bladder valve or French horn) at the end of the pump boom to purge the air from the pump line. Fully charge the boom with concrete (no air gaps) then install the pig in the top of the extension tube.

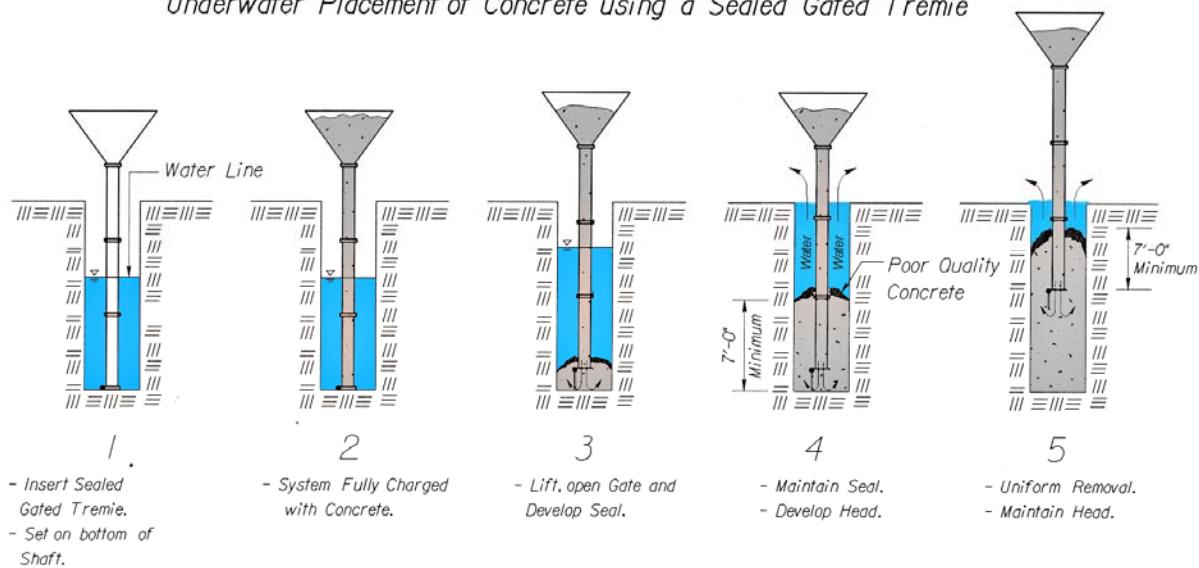
703 - DRILLED SHAFTS

METHOD 'B' (Figure 2)
Underwater Placement of Concrete using a Tremie



Method B (Figure 2): Use a tremie tube, with a pig separating the ground water and concrete, to place concrete into the shaft. Once the tremie tube is resting on the bottom of the shaft, install the pig just below the hopper in the top of the tremie tube. Fully charge the tremie tube and hopper (forcing the pig to the bottom of the tremie tube), then raise the tremie tube by 1 tremie diameter and seal the discharge end of the tremie tube with the fresh concrete.

METHOD 'C' (Figure 3)
Underwater Placement of Concrete using a Sealed Gated Tremie



Method C (Figure 3): Use a tremie tube, with a sealed gate separating ground water and concrete, to place concrete in the shaft. Fully charge the tremie tube and hopper, then raise the tremie tube by 1 tremie diameter and seal the discharge end of the tremie tube with the fresh concrete.

When the concrete reaches the top of the shaft, continue placing concrete (over-pump) to expel any excess water, debris or unsound concrete. On all wet pours, regardless of the method used, the Engineer will make a set of

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cylinders (in addition to normal concrete cylinder sampling requirements) from the top of the shaft after completing over-pumping. This set of cylinders will be used to verify a compressive strength of 1800 psi before proceeding with subsequent substructure (i.e. columns, abutments, etc.) construction.

Prior to constructing the portion of the substructure that attaches to the drilled shaft, thoroughly clean the top of the drilled shaft to facilitate the bond at the cold joint.

g. Raising Temporary Casing. Do not remove the temporary casing until the concrete in the shaft has met the following conditions:

- Completed shafts have been allowed to set for a minimum of 24 hours after the concrete placement; and
- Developed a compressive strength of 1800 psi; or
- Without testing, the Engineer may allow excavation to proceed when the shaft has cured 72 hours after completion of the concrete placement.

However, immediately after completing concrete placement in the permanent casing, it is acceptable to raise and hold the temporary casing at the embedment depth plus 6 inches.

Before completely raising the temporary casing, backfill the space between the 2 casings according to **subsection 703.3j**.

h. Curing. Cure the exposed surfaces of the shafts with wet burlap a minimum of 2 days. Do not use liquid membrane curing.

Cure all cylinders in the field, alongside and under the same conditions as the concrete they represent.

i. Sonic Testing.

(1) General. Perform sonic testing on all drilled shafts constructed by the wet pour method. Perform sonic testing on any dry pour method as directed by the Engineer. Conduct the sonic testing between 2 and 21 days after the drilled shaft is completed. The Engineer has the option to require additional testing.

Secure the services of an independent, experienced testing organization to take the cross-hole sonic logging measurements. Submit to the Engineer, the testing organization's record of experience, a written description of the testing procedures, operation manuals for the testing equipment, and samples of previous test results indicating both sound and defective concrete.

(2) Sonic Logging Equipment. Provide sonic logging equipment capable of identifying any faults, honeycombing or poor concrete at KDOT specified operating settings:

- A time base that shall provide the "zero signal" and "first arrival" are 2 to 3 divisions apart on the horizontal axis;
- Select an amplitude signal that fills $\frac{2}{3}$ to $\frac{3}{4}$ of the screen vertically; and
- Set the gain on 2.0.

Provide test results on thermal or graphical printouts with the vertical scale representing the vertical position along shaft, and the horizontal scale representing the propagation time.

(3) Sonic Logging Test Procedure. Immediately prior to testing, verify the pipes are free from blockages and filled with water. Determine the elevation of the top of the drilled shaft and the top of each pipe. Measure each pipe to determine the depth, and provide the information to the Engineer.

Conduct the sonic logging test procedure between all possible combinations of pipes (i.e. 4 pipes have 6 different combinations, 5 pipes have 10 different combinations, 6 pipes have 15 different combinations, 7 pipes have 21 different combinations, 8 pipes have 28 different combinations, etc.). If the sonic testing detects faults, the Engineer may require retesting with the probes in the same or different horizontal plane.

Configure sonic logging to settings in **subsection 703.3i.(2)**.

Use a winch to simultaneously raise the probes from the bottom of the pipes at a maximum rate of 12 inches per second. Take all slack out of the cables before switching on the analyzer.

(4) Record of Testing. After completing sonic testing, provide the Engineer the test results (recorded on thermal or graphical printouts) with the profiles referenced to the top of the pipe elevation. Inform the Engineer on site of any faults, honeycombing or poor concrete detected by a fainting of the signals and a sudden lengthening of the propagation time. Diagram (horizontal and vertical cross-sections) any defects found within the shaft to identify the location, width and thickness of the defect. Within 5 business days of conducting the sonic test, provide the

703 - DRILLED SHAFTS

Engineer a report (sealed by a licensed Professional Engineer) of the results and recommendations for acceptance or correction of each drilled shaft.

(5) Coring. If the sonic logging inspection indicates defective concrete, drill cores (NX size, 2.125 inches or larger) at locations directed by the Engineer. Mark the beginning and end of each core and record the total length of the core and the total length recovered. Provide the Engineer the recorded information and the core samples labeled with their location and relative elevation. If the concrete is defective, submit a written proposal to repair the drilled shaft. The proposal must be approved by the Engineer before repairs commence.

(6) Filling Core Holes. Fill core holes by pressure grouting with non-shrink grout described in **subsection 703.2b**. Use a pipe extending to the bottom of the hole to fill it from the bottom to the top.

(7) Filling Pipes. After completing sonic testing and final acceptance of the drilled shaft is made, fill the sonic testing pipes with the specified non-shrink grout. If the Contractor can expel enough water from sonic testing pipes leaving 2 feet or less of standing water in the sonic testing pipe, grout may free fall to the bottom of the pipe. If more than 2 feet of water remains in the bottom of the sonic testing pipe, prevent the grout from free falling through the water using a tremie tube extending to the bottom of the sonic testing pipe.

j. Backfill. When a temporary casing and a permanent casing are used, backfill the space (between casings) with the material specified in the Contract Documents:

- Granular material fine enough to fill the entire volume; or
- Grout or flowable fill described in **subsection 703.2b**.
 - If the space contains water, use a pump with an extension pipe or tremie (extending to the bottom of the space) to fill the space.
 - If the space is dry, the grout/flowable fill may free fall to the bottom of the shaft.
 - Fill the space with grout/flowable fill to the top of the casing, then, completely remove the temporary casing.

When the Contract Documents do not specify a material for backfill, use the granular material before extracting the temporary casing. After extracting the temporary casing, fill the rest of the space with granular material.

703.4 MEASUREMENT AND PAYMENT

The Engineer will measure drilled shafts by the linear foot measured from the bottom of the rock socket to the top of the completed drilled shaft. The Engineer will not consider a request for additional compensation, unless the overall length of a drilled shaft changes by more than 20%.

The Engineer will measure the accepted permanent casing by the linear foot, if a permanent casing is required, but not specified in the Contract Documents. The Engineer will not measure the permanent casing if:

- Contract Documents require Drilled Shafts (Cased).
- Contractor uses the casing for their convenience.
- Casing is a temporary casing.

The Engineer will measure each sonic test, at locations designated in the Contract Documents and added locations, per shaft (i.e. sonic logging between all possible combinations of pipes represents a single sonic test). If the sonic testing indicates defective concrete in the drilled shaft, the Engineer will measure the first sonic test for payment, and the Contractor is responsible for subsequent sonic testing of that shaft.

The Engineer will measure the investigative core hole by the linear foot, from the existing ground surface to 6 feet below the drilled shaft tip elevation.

Payment for "Drilled Shaft" and "Core Hole (Investigative)" at the contract unit prices, and "Permanent Casing" and "Sonic Test" at the contract set unit prices is full compensation for the specified work.

If the Engineer lengthens the drilled shaft during construction, the Engineer will measure and pay for additional reinforcing steel as Extra Work according to **subsection 104.6**. If the sonic testing indicates defective concrete in the shaft, and the Engineer requests cores from the shaft, the Engineer will not measure the cores for payment if the cores reveal defective concrete. If the cores reveal sound concrete, the Engineer will pay for the cores as Extra Work according to **subsection 104.6**.

704 - PILING

SECTION 704

PILING

704.1 DESCRIPTION

Drive the specified types of piles to the penetration and bearing values shown in the Contract Documents.

BID ITEMS

	<u>UNITS</u>
Piles (*) (**)	Linear Foot
Test Piles (*) (**)	Linear Foot
Test Piles (Special) (*) (**)	Linear Foot
Cast Steel Pile Points	Each
Pre-Drilled Pile Holes	Linear Foot
*Type of Pile or Test Pile: Cast-In-Place Concrete, Prestressed Concrete, Steel or Steel Sheet	
**Size	

704.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	DIVISION 400
Prestressed Concrete Piles	DIVISION 700
Steel Bars for Concrete Reinforcement	DIVISION 1600
Steel Piling and Steel Pile Points	DIVISION 1600
Type B Preformed Expansion Joint Filler	DIVISION 1500
Paint Materials	DIVISION 1800

704.3 CONSTRUCTION REQUIREMENTS

a. Order Lists and Test Piles. Drive the specified test piles at the locations shown in the Contract Documents. The Engineer will use the test pile information to determine the length that remains in the completed structure and to determine order length of piles.

A restrike is required by the Engineer and is subsidiary to "Test Piles". Follow **subsection 704.3e.** for restrike procedures. Provide piles for the structure according to the order list (number and length of piles) prepared by the Engineer.

If test piles are not specified, the order list is the same as the estimated quantity (number and length of piles) shown in the Contract Documents.

Provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of the Pre-construction Conference. The Engineer will forward this information to the State Geologist Office.

b. Test Pile (Special). Pile Driving Analyzer (PDA). The Engineer will use the PDA to monitor the driving of the test piles. Provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of the Pre-construction Conference. The Engineer will forward this information to the State Geologist Office.

In order to mobilize the PDA, notify the Engineer a minimum of 5 working days before driving the test piles. Prior to driving the test pile, the Engineer will require approximately 1½ hours to prepare the test piling and install the dynamic measuring equipment. After the test pile is placed in the leads, provide the Engineer with safe and reasonable means of access to the pile for preparing the pile and attaching the instruments.

A restrike is required by the Engineer and is subsidiary to "Test Pile Special". Follow **subsection 704.3e.** for restrike procedures.

To obtain the estimated ultimate loads, the Engineer will use the PDA to take dynamic measurements as the test pile is driven to the required driving resistance. If non-axial driving is indicated by dynamic test equipment measurements, immediately realign the driving system. The Engineer will use the PDA results to provide the Contractor with a blow count for production driving.

c. Driving Piles. Drive the piles with a gravity hammer, a diesel hammer, an air/steam hammer or a combination of pre-drilled holes or water jetting and a hammer. Use equipment that complies with **subsection 157.2**.

Drive the piles at the locations and to the vertical or battered lines shown in the Contract Documents. Use leads of sufficient length to allow them to be spiked into the ground at the onset of driving the pile.

Do not drive piles until the footing, webwall or abutment excavation is completed. Drive all of the piles required for the footing or abutment before placing any concrete in the footing or abutment, unless the foundation is a minimum of 20 feet away or has cured a minimum of 24 hours.

When specified, drill pile holes before driving the piles. Drill the holes accurately so that the piles are set as shown in the Contract Documents. The maximum size of the pre-drilled holes is equal to the diameter of the pile plus 3 inches. The depth of pre-drilled pile holes is shown in the Contract Documents. If pre-drilled pile holes are not specified, the Contractor may choose to pre-drill pile holes, provided the Engineer approves the Contractor's method and limits. After the piles are driven to their final positions in the pre-drilled holes, fill the holes with loose sand or material specified in the Contract Documents. If concrete is specified, allow sufficient concrete slump and provide vibration to fill all voids around the pile.

Drive all pile heads perpendicular to the longitudinal axis of the piles to prevent eccentric impacts from the drive head of the hammer. Use pile caps on all piles during the pile driving operations. For pile caps of concrete piles and prestressed concrete piles, use a suitable cushion next to the pile head that fits into a casting that supports a timber shock block. On pile caps for steel piles and steel sheet piles, provide grooves in the bottom of the cap to accommodate the shape of the piles to hold the axis of piles in line with the axis of the hammer.

If specified, use the type of cast steel pile points shown in the Contract Documents. Use pile points that provide full bearing for the piles. Provide an experienced welder to attach the cast steel pile points to the piles.

Use full-length piles where practicable. It is preferred that steel piling is not spliced. Splices may be made with the permission of the Engineer, or when shown in the Contract Documents. Make splices as shown in the Contract Documents. Use an approved welding process as provided in **DIVISION 700** to make the splices. Provide an experienced welder to make the welded splices for structural steel piling and shell piling. Correct or replace any failure in the splice at own expense.

Avoid extensions, splices or build-ups on prestressed concrete piles whenever possible. When splicing is necessary, make them as shown in the Contract Documents.

If the pile driving procedure causes crushing or spalling of the prestressed concrete piles, or deformation of the steel piles, remove and replace the damaged piles with new, longer piles. A second pile may be driven adjacent to the damaged pile, when approved by the Engineer and can be accomplished without detriment to the structure.

Do not force misaligned piles into proper position. Remove and replace piles driven out of their proper location with new, longer piles.

- If the driven pile is 35 feet or less in length, the maximum allowable variation from the vertical or battered lines shown in the Contract Documents is $\frac{1}{4}$ inch per foot of length.
- If the driven pile is greater than 35 feet in length, the maximum allowable variation from the vertical or battered lines shown in the Contract Documents is $\frac{1}{8}$ inch per foot of length.
- The maximum allowable variation on the head of the driven pile from the position shown on the Contract Documents is 2 inches for piles used in bents, and 6 inches for foundation piles.

Re-drive all piles pushed up by the driving of adjacent piles, or by any other cause.

d. Bearing Values and Required Penetration. Drive the piling to attain, as a minimum, the specified bearing value, penetration and pile tip elevation. Stop driving the piling (regardless of the penetration) if $1\frac{1}{2}$ times the specified minimum driving resistance is attained. Stop driving the piling if, in the opinion of the Engineer, the specified minimum driving resistance, penetration and pile tip elevation can not be attained without damage to the piling. If the specified minimum driving resistance is not attained with the specified number and length of piling, the Engineer may allow additional piling be driven so that the maximum load on any pile does not exceed its safe carrying capacity.

In the absence of loading tests, determine the safe bearing values of piles by the formulas in **TABLE 704-1**.

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TABLE 704-1: PILE FORMULAS		
Hammer	Pile Type	Formula
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3 W H}{S + 0.35} \left(\frac{W}{(W+X)} \right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2 W H}{S + 0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2 E}{S + 0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6 W H}{S + 0.1} \left(\frac{X^{**}}{W} \right)$
Link-Belt*	All Types	$P = \frac{1.6 E}{S + 0.1} \left(\frac{X^{**}}{W} \right)$

*diesel hammers

** For diesel hammers, the quantity X/W shall not be less than 1.

P = safe bearing power in pounds

W = weight in pounds, of striking part of hammer

H = height of fall in feet

E = energy of ram in foot-pounds per blow

S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers

X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

The above formulas are applicable only when:

- The hammer has a free fall;
- The penetration is reasonably quick and uniform; and
- There is no appreciable bounce after the blow.

If water jets are used in connection with the driving, determine the bearing capacity by the formulas above from the results of driving after the jets have been withdrawn, or a load test may be applied.

The energy rating used to determine if any type or brand of diesel hammer is of adequate size other than those shown in **TABLE 704-1**, is 80% of the energy rating as listed by the manufacturer.

Use an energy rating of 100% of the energy rating listed by the manufacturer for computing bearing values and to determine if an air/steam is of adequate size. If the number of blows per minute for an air/steam hammer deviates significantly from the number designated by the manufacturer, take corrective action as directed by the manufacturer.

e. Piling Restrike Procedure.

If a pile does not attain the minimum driving resistance within a few feet of the plan elevation, the pile restrike procedure may be used. Contact the Regional Geology Office for guidance before using the restrike procedure. Restrike procedures differ depending on whether a Test Pile, Test Pile (Special) or neither is called for in the Contract Documents. When a PDA is used, the restrike procedure will be as directed by the Regional Geologist.

(1) Use the following procedure when neither a Test Pile nor a Test Pile (Special) is called for in the Contract Documents, and the PDA is not available. The following procedure shall be used.

- Drive all of the piling in a group to within 2 feet of plan elevation;
- All of the piling in the pile group shall sit undisturbed for a minimum of 24 hours;
- Prior to starting the restrike procedure, warm the hammer up at a location as far away from the pile group as practical, preferably in another substructure member or pile group;
- One pile in the group is then immediately restruck with the warmed-up hammer for 30 blows or until the pile penetrates an additional 4 inches, whichever comes first. Record the penetration for every 5 blows. In the event the pile movement is less than $\frac{1}{2}$ inch during the restrike, the restrike may be terminated after 20 blows.

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The driving resistance of the piling is computed based on the average penetration, if any, for the first 5 blows. The driving resistance of each piling is the driving resistance computed for the pile that was restruck. If the computed driving resistance is less than the design pile load, splice additional length onto each piling in the group and resume driving each piling until the required driving resistance is achieved.

(2) Use the following procedure when a Test Pile is called for in the Contract Documents, and the PDA is not available. The following procedure must be used.

- Drive the Test Pile to within 2 feet of plan elevation;
- The Test Pile shall sit undisturbed for a minimum of 24 hours;
- Prior to starting the restrike procedure, warm the hammer up at a location as far away from the Test Pile as practical, preferably in another substructure member or pile group;
- The Test Pile is then immediately restruck with the warmed-up hammer for 30 blows or until the pile penetrates an additional 4 inches, whichever comes first. Record the penetration for every 5 blows. In the event the pile movement is less than $\frac{1}{2}$ inch during the restrike, the restrike may be terminated after 20 blows.

The driving resistance of the Test Pile is computed based on the average penetration, if any, for the first 5 blows. If the computed driving resistance is less than the design pile load, splice additional length and resume driving until the minimum driving resistance is achieved.

(3) When a Test Pile (Special) is called for on the plans, or a PDA is available, follow the recommendations of the Regional Geologist for the Restrike Procedure.

f. Pile Cut-Off and Pile Painting.

(1) After the piles are driven as specified, cut the piles off at the designated elevation. If capping is required, make the connection as shown in the Contract Documents.

Pile cut-off material becomes the property of KDOT, if the Engineer determines the pile cut-off material is worth salvaging. Store the salvageable material at the site selected by the Engineer. Pile cut-off material determined to not be salvageable becomes the property of the Contractor.

(2) Paint the exposed portion of steel piles, steel sheet piles, or the shells or castings of cast-in-place concrete piles. Unless otherwise noted in the Contract Documents, apply the paint in the field. Use the same kind of paint and total number of coats as specified for the structural steel on the structure. If a paint system is not specified for the structure, use a prime coat of inorganic zinc as required for the shop coat and an acrylic or polyurethane finish coat, as specified in **DIVISION 700** for the final coat. Apply the paint to the pile for a distance of 1 foot below the bottom of the channel, top of the embankment, natural ground or normal low water elevation.

g. Cast-In-Place Concrete Piles. After the steel shells are driven as specified, remove all loose material from inside the steel shell. Unless specified otherwise in the Contract Documents, use Grade 3.5 concrete to fill the steel shells. Do not place concrete in the steel shell until the driving of all steel shells within a radius of 15 feet from the pile is completed, or until all the piles for any one bent are driven. If this can not be done, discontinue all driving within the above limits until the concrete in the last pile cast is a minimum of 7 days old. Remove accumulations of water from inside the steel shells before concrete is placed. Consolidate the concrete in the upper 15 feet of the steel shell by internal vibration.

704.4 MEASUREMENT AND PAYMENT

The Engineer will measure the length of steel pile, steel sheet pile, cast-in-place concrete pile and prestressed concrete pile remaining in the structure, by the linear foot.

The Engineer will measure the length of prestressed concrete from the tip of the pile to the point that concrete is removed to provide the connection with the cap or footing. This measurement does not include the length of reinforcing steel extending beyond the pile and into the cap or footing.

The Engineer will measure the actual length of ordered and accepted test pile by the linear foot.

The Engineer will measure each cast steel pile point used.

If after driving the ordered and accepted length of pile, plan bearing is not achieved and additional pile is required, the Engineer will measure for payment each pile splice needed to lengthen the pile to achieve bearing. The Engineer will not measure for payment pile splices shown in the Contract Documents or pile splices approved for the Contractor's convenience.

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The Engineer will measure pre-drilled pile holes by the linear foot. The Engineer will measure pre-drilled pile holes from the elevation at the bottom of the hole to the bottom of the footing or abutment elevation shown in the Contract Documents. If the Contractor drills the pile holes to an elevation below that shown in the Contract Documents for bottom of hole, the additional drilling below the elevation shown in the Contract Documents is not measured for payment. Pre-drilled pile holes not specified, but drilled for the Contractor's convenience are not measured for payment.

The Engineer will measure pile cut-off by the linear foot. Pile cut-off is the difference between the length of pile ordered and accepted and the actual length of pile remaining in the structure. If the Contractor (for convenience or method of operation) uses a length of pile that exceeds the length of pile ordered and accepted, the excess length is not measured as pile cut-off.

The Pile Restrike procedure shall not be paid for separately, but shall be subsidiary to the bid item "Piling", "Test Pile" and "Test Pile (Special)".

Payment for the various types of "Piles" and "Test Piles", "Cast Steel Pile Points" and "Pre-Drilled Pile Holes" at the contract unit prices is full compensation for the specified work.

Payment for pile splices at 4 times the contract unit price of the type of pile spliced is full compensation for the specified work.

Payment for pile cut-off per linear foot as shown in **TABLE 704-2** is full compensation for the specified work.

TABLE 704-2: PILE CUT-OFF PAYMENT	
Pile Type	% of Contract Unit Price Paid
Cast-in-place (Shell)	60
Pre-stressed concrete	75
Steel	75
Steel Sheet	75

The costs of all load tests ordered by the Engineer will be paid for as Extra Work as shown in **subsection 104.6**.

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SECTION 705

STRUCTURAL STEEL FABRICATION

705.1 DESCRIPTION

Fabricate the structural steel according to the Contract Documents.

705.2 MATERIALS

a. General. Provide materials that comply with the applicable requirements.

Castings	DIVISION 1600
Structural Steel	DIVISION 1600
Welded Stud Shear Connectors	DIVISION 1600
Fasteners	DIVISION 1600

When weathering steel is allowed or specified in the Contract Documents: ASTM A709 Grade 50W may be substituted for ASTM A709 Grade 36 or Grade 50, and AASHTO M270 Grade 50WT2 may be substituted for AASHTO M270 Grade 50T2. When substituting weathering steel for the structural steel shown in the Contract Documents, use the same size plate or rolled member. Do not use weathering steel in rocker bearing devices (or any component with finished surfaces), expansion devices or expansion device armoring.

b. Preliminary Shop Requirements.

(1) Point of Fabrication. Within 10 business days after signing the contract, notify the State Bridge Engineer and the Bureau Chief of Materials and Research in writing of the firm (name and location) that will fabricate the structure. Produce and fabricate all structural steel within the Continental United States (see **subsection 106.1c.**). Use fabricators of bridge beams and girders that are certified by the American Institute of Steel Construction in the appropriate category for the type of work being performed.

(2) Shop Drawings. The Contractor or fabricator must submit shop drawings of both structural steel and castings according to **subsection 105.10**. Do not perform any fabrication until the approved shop drawings are in the hands of the Inspector and fabricator, and the Engineer has authorized fabrication. Any purchase of materials before fabrication authorization is at the Contractor's risk.

Changes on approved shop drawings or contract plans are subject to the approval of the Engineer. Notify the Engineer with a record of such changes. Submit revised sheets of the same size as the shop drawings originally submitted.

Show approved welding procedure numbers in the tail of weld symbols on submitted shop drawings. Submit 2 copies of each procedure requiring approval to the Bureau of Materials and Research. All weld procedures referenced in a set of shop drawings must be approved before the shop drawings can be approved.

Provide a diagram on the shop detail plans for each span giving sufficient dimensions for accurate fabrication and inspection of the structure. These dimensions must include, but are not limited to:

- Bearing-to-bearing lengths; and
- Vertical and horizontal curvature offsets at bearing points and splices. Use the bottom of the web or the top of the bottom flange at the centerline of the web as the reference point.

The Contractor is responsible for the correctness of the shop fit-up and field connections, even though the shop drawings have been approved by the Engineer. See **subsection 105.10e**.

(3) Notice of Beginning of Work. In order to provide inspection, notify the Engineer before beginning work in the shop. Give a minimum of 24 hours notice before beginning work in shops in the State of Kansas, and give a minimum of 7 calendar days notice before beginning work in shops in the contiguous United States.

(4) Material Acceptance. Submit to the Bureau Chief of Materials and Research 1 copy of each mill test report for each heat number to be used before the layout, and use such steel in the fabrication of the structure.

Submit a fabricator's guarantee indicating that the attached certified mill test reports pertain to all heat numbers used in the structure, and all material complies with the Contract Documents. Include the following in the guarantee:

- fabricator's name;

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- KDOT project number;
- bridge or station number;
- fabricator's purchase order number;
- list heat numbers;
- size and shape of pieces;
- number of pieces to be used for each size of each heat; and
- steel manufacturer's name and the ASTM or AASHTO designation for the steel that is required in the Contract Documents.

The guarantee must include the notarized signature of an official of the company who is authorized to legally bind the statement on the company's behalf.

All structural steel shall comply with the ASTM A 6 quality requirements until released for shipment. Repair welding shall comply with the requirements of AASHTO/AWS D1.5 (2002), "Bridge Welding Code" with the exceptions and additions noted in this section.

The term "mill" means any rolling mill or foundry where material for the work is manufactured. When any ASTM or AASHTO steel is specified in the Contract Documents, the mill must certify that the material complies with the specified chemical and physical requirements. When the letter "T" or "F" and a temperature zone number follow the grade designation of an AASHTO or ASTM steel, the mill test report must include Charpy V-notch test results. The fabricator must obtain written permission from KDOT to substitute a grade of steel that is not indicated in the Contract Documents for one that is shown in the Contract Documents.

(5) Facilities for Inspection and Testing. During all hours of operation allow the Engineer free access to all parts of the work and the shop where fabrication is performed.

Provide an enclosed office area for the exclusive use of the Engineer at the location of fabrication. The area must satisfy the requirements of a Field Office (Special) in **SECTION 803**, except as modified below:

- Minimum floor area = 120 square feet;
- Single workbench or table - 30 inch by 8 feet (minimum dimensions);
- Desk - 30 inch by 5 feet, with drawers;
- Swivel desk chair with arm rests;
- Waste paper basket; and
- Storage/Filing cabinet with lock and key

When directed by the Engineer, promptly repair or replace any damaged or non-functioning items. Provide parking near the office with direct accessibility to the office and shop.

(6) Test Specimens. When directed by the Engineer, prepare 4 inch by 24 inch test specimens of the base metal. Orient the specimen so the direction of rolling is according to the latest edition of ASTM A 6. Provide "all-weld-metal" tension specimens and specimens for other weld tests as directed by the Engineer. Preparation and possible shipment of specimens are subsidiary to the fabrication of the structure.

(7) Heat Curving Procedure. Girders and rolled beams may be heat curved by either the continuous or "V" heating methods. Before starting any fabrication and before submittal of shop drawings for the structural steel, the Contractor or fabricator may request permission to heat-curve rolled beams in the shop or to heat-curve welded plate girders in lieu of flame cutting flanges to the desired horizontal curvature. Submit the request and proposed shop procedure to the Engineer for approval. The submittal must indicate the type of heating, heating temperature, position for heating, sequence of operations and the values to be used to compensate for possible loss of camber of heat-curved girders in service. The proposed procedure must comply with the latest editions of AASHTO/AWS D1.5, "Bridge Welding Code", AASHTO's "Standard Specifications for Highway Bridges" and AASHTO's "LRFD Bridge Construction Specifications".

c. Handling. Conduct the loading, transporting, unloading and storing of structural steel to keep the metal clean, above ground and free from injury. Use protective devices or softeners to safeguard plate edges.

Store structural steel, either plain or fabricated, above the ground on platforms, skids or other supports, and keep free from corrosion, dirt, grease and other foreign matter. Store girders and beams upright with sufficient support to prevent warping or change in design camber.

d. Shop Fabrication.

(1) Steel Identification. All pieces of all grades of steel used in fabrication of main members, including webs, flanges, bearing stiffeners, bearing devices, splice plates and any cross member carrying stringers and their connection plates, must bear the heat number assigned by the rolling mill. Preserve the heat number until the Engineer advises the fabricator that the unit is acceptable for cleaning and painting. Identify the grade as specified in ASTM A 6.

(2) Straightening Material. All mill material must be straight before being laid out for work. If straightening is required, do not injure the metal. Heat straightening must comply with the latest versions of AASHTO/AWS D1.5, "Bridge Welding Code"; AASHTO's "Standard Specifications for Highway Bridges"; AASHTO's "LRFD Bridge Construction Specifications"; and the FHWA report, "Heat-Straightening Repairs of Damaged Steel Bridges". Submit the proposed heat straightening procedure to the Engineer for approval. Sharp kinks and bends are cause for rejection of the material. Mill material must not exceed dimensional tolerances outlined in the latest edition of ASTM A 6.

(3) Welding and Gas Cutting. Perform welding and gas cutting of structural steel according to the applicable requirements of the AASHTO/AWS D1.5 (2002), "Bridge Welding Code" with the exceptions and additions noted in this specification.

Perform welding and gas cutting on steel bearings, drainage systems, finger plate or modular expansion devices, handrail, bridge rail, sign structures and other tubular structures according to the applicable requirements of AWS D1.1 "Structural Welding Code", latest edition. At the option of the Engineer, steel bearing device inspection will require either 1 piece in 10, or fraction thereof, be tested 100%, or 10% of each piece will be tested using liquid penetrant or magnetic particle. The welding of dissimilar metals is not prequalified.

(4) Finish. Neatly finish all work. Carefully and accurately shear and clip. Fabricate finished members true to line and detailed dimension, and free from twists, bends, open joints or other defects.

(5) Pins and Rollers. Accurately turn pins and rollers to the dimensions shown in the Contract Documents and keep them straight, smooth and free from flaws. Produce the final surface by a finishing cut.

Forge and anneal pins and rollers larger than 7 inches in diameter, unless shown otherwise in the Contract Documents.

In addition, for pins larger than 9 inches in diameter, after the forging has been allowed to cool to a temperature below the critical range, under normal conditions, and before being annealed, bore a hole a minimum of 2 inches in diameter full length along the axis.

(6) Boring Pin Holes. Bore pin holes true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise specified. Produce the final surface by a finishing cut.

Do not vary the distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression members from the specified dimension more than 1/32 inch. Bore holes in built-up members after final assembly.

(7) Pin Clearances. Do not exceed the diameter of the pin hole by that of the pin more than 1/50 inch for pins 5 inches or less in diameter, or 1/32 inch for pins greater than 5 inches in diameter.

(8) Threads. Closely match threads of bolts to the nut threads. Threads must be ANSI Unified Coarse Series (UNC), except make pin ends of diameters greater than 1 ½ inches, with 6 threads per inch.

(9) Pilot and Driving Nuts. Provide 2 pilot nuts and 2 driving nuts for each size of pin, unless otherwise specified.

(10) Fit of Stiffeners. Mill, grind or machine cut bearing stiffeners intended as supports for concentrated loads to secure full bearing against the flange. Use intermediate stiffeners with a tight fit and uniform distance between the flange plates and the ends of the stiffeners, unless shown otherwise in the Contract Documents.

(11) Facing of Bearing Surfaces. Plane or heat straighten the top and bottom surfaces of steel slabs, base plates, cap plates of columns and pedestals to have full contact when assembled to the main members. Mill parts of members in contact with these items to true surfaces and correct bevels, after the main sections of these members and the end connection angles have been fully welded or bolted.

For bearings to be welded to beams and girders, a minimum of 75% of the area shall be in contact with the flanges. Do not exceed a 1/32 inch gap between bearings and flanges. Plane or heat straighten bearing devices as needed. Plane cast pedestals on surfaces in contact with steel.

Unless shown otherwise in the Contract Documents, adhere to the following surface roughness requirements as defined in ANSI B46.1, Surface Texture, Roughness, Waviness, and Lay, Part 1 for the surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or concrete. Surfaces will be evaluated by visual or actual comparison with roughness comparison specimens.

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Sliding Bearings	ANSI	125 Microinches
Bridge Rollers and Rockers	ANSI	250 Microinches
Pins and Pin Holes	ANSI	125 Microinches
Steel Slabs	ANSI	2000 Microinches
Heavy Plates in Contact with Shoes to be Welded	ANSI	1000 Microinches
Milled Ends of Compression Members, Milled or Ground Ends of stiffeners and Fillers	ANSI	500 Microinches

(12) Welded Stud Shear Connectors. Apply welded stud shear connectors to the designated structural members during shop fabrication.

If the circumstances warrant, and if the Engineer approves the Contractor's procedures, welded stud shear connectors may be field applied. Approval is based on demonstrating to the Engineer's satisfaction, that the Contractor can:

- remove any shop applied coating removed from the top flange without damaging the structural member;
- weld the stud shear connectors to the structural member; and
- blast clean and prime coat the top flange and stud shear connectors.

(13) Field Connections. When field bolts are required, adjust the girders or beams so the maximum final clearance between abutting ends of the web plates or flange plates is $\frac{1}{4}$ inch. Attach the web splice plates using sub-drilled holes in each corner of the splice plate. Secure them with bolts and drill the remaining holes full diameter from the solid. Add additional bolts and full size pins as the holes are drilled to secure the splice plates to the web. Clamp the flange splice plates and bars into position, and drill the bolt holes full diameter from the solid.

Add additional bolts as the holes are drilled to secure the splice plates to the flanges. Other methods of preparing flange and web field splices may be utilized with written approval of the Engineer. Fill plate thicknesses shown in the Contract Documents are based on nominal ASTM A 6 shape dimensions. Revise plan fill plate thicknesses as necessary to account for as-rolled variations in flange and web thickness or overall beam depth. Minimum fill plate thickness is $\frac{1}{8}$ inch or as required so that surfaces to be in contact shall be offset a maximum of 1/16 inch.

Either punch or drill all holes for bolts except in flanges and webs of beams, girders or stringers. Material forming parts of a member composed of a maximum of 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the bolts whenever the total thickness of the material is a maximum of $\frac{3}{4}$ inch for structural steel, $\frac{5}{8}$ inch for high-strength steel or $\frac{1}{2}$ inch for quenched and tempered alloy steel.

If there are more than 5 thicknesses, or if the material is thicker than $\frac{3}{4}$ inch for structural steel, $\frac{5}{8}$ inch for high-strength steel, or $\frac{1}{2}$ inch for quenched and tempered alloy steel, either sub-drill and ream or drill all holes full size.

The diameter of the die for punched holes may not exceed the diameter of the punch more than 1/16 inch. If any holes must be enlarged to admit the bolts, ream such holes. Clean cut holes leaving no torn or ragged edges. Poor matching of holes will be cause for rejection.

(14) Shop Assembly for Final Inspection. Unless otherwise provided both in writing and shown on the approved shop drawings, assemble, securely support, adjust and maintain to proper line, grade, camber and suitable clearances all welded plate girders, rolled wide flange beams, trapezoidal plate "tub" sections and other sections of main members.

After the assembly is completely set up, the fabricator's quality control personnel must check blocking, sweep and bearing-to-bearing measurements prior to any checking by the Engineer.

Reference "affect" measurements to the bottom of the web or the top face of the bottom flange at or near the centerline of the web.

Drill all splice holes and adequately bolt or pin splice plates in place before the assembly is checked by the Engineer. Use a minimum of 6 drift pins, full size bolts or a combination of both pins and full size bolts at each flange and web splice for girders and rolled beams.

In making the final assembly, if re-cutting is necessary to form a uniform width opening across the joint, finish the butt joint by precision flame cutting or flame cutting and grinding to produce the same smoothness as the precision cut. Mechanical chipping is prohibited.

Fit, drill or ream and bolt into place erection angles, while the beams or girders are in the fit-up position so that standard drift pins can be driven through any combination of holes, and the beams or girders can be pulled to correct spacing for field welding when erected at the bridge location.

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The types of assemblies are as follows:

- Type "A" Assembly (For structures with horizontal curvature transitions, super elevation or ramp tie-ins) requires a minimum of 2 spans (bearing to bearing) laid-out full bridge width, with separators attached at pier points (minimum). When released, carry the pier pieces back for the next additions. Include the girder or beam expansion devices in position in the assembly, if attached directly to the structural steel. Requests for a lesser width of the assembly for lack of shop space must be approved in writing by the Bureau of Materials & Research. If the request is approved, the Contractor may be back charged for excessive shop inspection trips and expenses.
- Type "B" Assembly requires a minimum of 2 lines and 2 spans (bearing to bearing) in each line laid-out to correct line with webs vertical or horizontal. When released, carry 1 pier piece per line back for the next additions.
- Type "C" Assembly (for long span, deep girders) requires a minimum of 2 spans (bearing to bearing) laid-out to correct alignment with webs horizontal or vertical. The spans may all be from different lines. When released, carry 1 pier piece per line back for the next additions.

All assemblies are Type "B" unless stated otherwise in the Contract Documents. All desired changes to the requirements of the type of assembly for a particular structure must be approved in writing before submitting the shop drawings for approval. Submit requests for assembly changes to the Bureau of Materials and Research. Without written approval from the Bureau of Materials and Research, the fabricator must set up assemblies according to the original requirements in the Contract Documents, even if approved shop drawings show changes to the type of assembly.

Use numbered tapes calibrated by the National Institute of Standards and Technology (NIST) or tapes calibrated from a certified master tape in order to check assemblies for bridges with spans over 100 feet. Provide a copy of the certification papers, calibration charts, and tape identification numbers before the first assembly is set up. In addition, submit to the Engineer for approval, procedures for calibrating tapes and the shop's practices when using calibrated tapes. This approval is required prior to initial assembly set-up. Calibrate measuring tapes for a minimum tension of 5 lbs. Prior to calibrating or measuring, allow time for the tapes to reach uniform ambient temperatures so that temperature corrections are not required. Replace or repair, and re-certify or re-calibrate damaged tapes. Re-certify master and re-calibrate NIST tapes every 5 years, or as directed by the Engineer.

(15) Matchmarking. Matchmark all butt joints (girders, expansion devices, end separators under expansion devices or other specialties to be field assembled and welded or bolted into the final unit) while shop assembled, in the manner indicated as "Typical Matchmark", and shown on the approved shop drawings. Use a coordinate system of capital letter and numbers as follows:

- Mark each line of girders with a capital letter. Looking upstream, mark the outside line, left of centerline, with the first letter of a series. Mark the girders in the next line to the right with a second letter of the series, etc., until all lines have been marked; and
- Mark the field splices (points of contraflexure) with numbers. Place the lowest number on the splices nearest abutment number 1 and the highest number on the splices nearest abutment number 2. Number the splices consecutively from abutment number 1 to abutment number 2. Place these on each of the girder ends that comprise the splice and within 3 feet of the field splices in the center of the web. Use low stress steel die marks placed before shop blasting and painting. Orient letters and numbers so they are upright when the top flange is up.

Matchmark essential special fit-ups discovered in shop production. Provide a corrected set of shop details and erection drawings showing these special fit-ups.

Do not matchmark the exposed surface of "Weathering" Steels with paint, crayon or any other type of material which will impair the weathering process of the steel.

(16) Shop Painting. Prepare the structural steel surfaces and shop paint the prepared surfaces according to **SECTION 714**.

(17) Rejection. Do not release fabricated elements for shipment from the fabrication shop without approval of the Engineer. Repair or replace rejected items as directed by the Engineer.

(18) High Performance Steel (HPS). Fabricate Grade HPS 70W members according to this subsection and AASHTO's "Guide Specification for Highway Bridge Fabrication with HPS 70W Steel", second addition.

(19) Shop Connections by Bolting. Fasten members according to **SECTION 712**.

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e. Supplemental Requirements to the Welding Code. The section and paragraph references cited in the paragraphs below are to AASHTO/AWS D1.5 (2002).

SECTION 1. GENERAL PROVISIONS.

Delete paragraph 1.3.2 and add the following:

1.3.2 Electroslag or electrogas welding shall not be used.

Add 2 new paragraphs as follows:

1.12 EQUIPMENT CHECK: Each DC generator shall have a service check by an NEWA member, a commercial electrical equipment company or by the fabricating plant's electrical maintenance engineer once each year. A service certificate shall be issued with each equipment check and shall be available for inspection by the Engineer.

1.13 TEMPORARY WELDING AND TACKING: The attachment of temporary fabrication, erection and construction items to main members by welding or tacking is prohibited except by written permission from the Bureau Chief of Materials and Research. Permissible locations for such welds and tacks shall be only at locations shown on approved shop drawings or at locations designated in writing by the Engineer. All such tacks or temporary welds shall be made according to Paragraphs 3.3.6 and 3.3.7 and welders and/or tackers shall be qualified according to AWS requirements.

SECTION 2. DESIGN OF WELDED CONNECTIONS.

Add the following to paragraph 2.9.1.1:

Plug welding is prohibited without the written approval of the Engineer. As a requirement for approval, all plug welding shall be QC tested by nondestructive testing at no cost to the state. The type of testing shall be determined by the Engineer.

SECTION 3. WORKMANSHIP.

Delete paragraph 3.2.9.

SUBSECTION 3.5 DIMENSIONAL TOLERANCES.

Add the following to paragraph 3.5.1.2:

Permissible variations in straightness of rolled beams, regardless of cross-section, shall not exceed 0.01inch/foot of beam length or 1 inch.

Delete paragraph 3.5.1.3 and add the following:

3.5.1.3 Permissible variations in specified camber and blocking of welded girders and rolled beams, regardless of cross-section shall not exceed:

-0, + $\frac{1}{4}$ inch for spans (typ., bearing to bearing) 0 thru 100 feet

-0, + $\frac{1}{2}$ inch for spans greater than 100 feet

Permissible variations in blocking of rolled beams at field splices, regardless of cross-section, shall not exceed:

- $\frac{1}{4}$, + $\frac{1}{4}$ inch for spans 0 through 100 feet

- $\frac{3}{8}$, + $\frac{3}{8}$ inch for spans greater than 100 feet

Permissible variations in blocking of welded girders and rolled beams, regardless of cross-section, shall not exceed:

0 for all supports

Sign convention: (-) below, (+) above the detailed values or shape in the no-load condition.

Add 3 new paragraphs as follows:

3.5.1.16 The permissible variation in length of beams or girders between the center line of bearing devices shall not exceed plus or minus $\frac{1}{4}$ inch for any one span or plus or minus $\frac{3}{8}$ inch for any two or more spans. The actual centerline of any bearing device shall lie within the thickness of the bearing stiffener.

3.5.1.17 During shop assembly of horizontally curved welded beams or girders, the allowable variation in specified sweep at internal supports shall be $\frac{1}{4}$ inch.

3.5.1.18 During shop assembly of horizontally curved welded beams or girders, the allowable variation in specified sweep at any point between supports shall be the greater of: $\frac{1}{8}$ inch per 10 feet of length, calculated using the distance to the nearest support, or $\frac{1}{4}$ inch.

SECTION 4. TECHNIQUE.

Add the following notes to Table 4.1:

- Only low hydrogen electrodes shall be used.

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- E 7028 Electrodes may be used for shop fillet welds except for the attachment of gusset plates and bearing stiffeners to girders, bearing stiffeners to beams, web to flange welds and for welding floor beam truss assemblies. Welding shall be in the horizontal and flat positions only.

SECTION 5. QUALIFICATION, PART A.

Replace the first sentence of paragraph 5.2.3 with the following:

All welder, welding operator, and tack welder and PQR tests must be witnessed by the Engineer, another state's representative approved by the Engineer, or an independent third party approved by the Engineer. If representatives from other states or third parties witnessed a test, provide records of the test signed by the witness. All mechanical and nondestructive tests performed by independent laboratories on qualification specimens will be at no charge to the State. Provide signed documentation of the independent lab's test results to the Engineer. When requested by the Engineer, allow KDOT access to the test samples and the independent lab's radiographs for inspection.

Delete paragraph 5.2.4 and replace with the following:

5.2.4 Additional Testing. The Engineer may order tests of welders, welding operators, tack welders, or WPSs whenever there is evidence that unacceptable welds are being or have been produced. This additional testing is at the fabricator's expense. The Engineer may disqualify personnel working for the fabricator who fail the additional testing, who commit serious violations of the specifications, or who repeatedly exhibit poor workmanship on KDOT projects.

Revise paragraph 5.2.5 as follows:

Replace "those authorized to examine them." with "the Engineer."

SECTION 5. QUALIFICATION, PART B.

Add the following to paragraph 5.21.6.1:

All tests must be witnessed by the Engineer, another state's representative approved by the Engineer, or an independent third party approved by the Engineer.

Revise paragraph 5.21.7 as follows:

Replace "those authorized to examine them." with "the Engineer."

Add the following to paragraph 5.21.7:

If representatives from other states or third parties witnessed a test, records of the test must be signed by the witness.

SECTION 6. INSPECTION, PART A.

Delete paragraphs 6.7.1, 6.7.1.1, and 6.7.1.2 and add the following:

6.7.1 Groove welds in main members as identified in Contract Documents shall be QC tested by nondestructive testing. Unless otherwise specified, radiographic testing shall be used on butt joints. Groove welds in T and corner joints shall be tested by ultrasonic testing. The requirements for radiographic testing and ultrasonic testing apply equally to shop and field welds.

6.7.1.1 Radiographic testing of welds shall be performed according to the following requirements:

- (1) 100% of all welded girder and rolled beam flange butt joints.
- (2) All except the middle $\frac{1}{3}$ of all welded girder or rolled beam web butt joints.

6.7.1.2 Ultrasonic testing of welds shall be performed according to the following requirements:

- (1) 100% of each joint subject to calculated tension or stress reversal.
- (2) 25% of each joint subject to compression or shear. If unacceptable discontinuities are found in spot testing, the entire length shall be tested.

Delete paragraphs 6.7.6, 6.7.6.1, 6.7.6.2, 6.7.6.3, 6.7.6.4, and 6.7.6.5 and add the following:

6.7.6 When magnetic particle testing is used, the procedure and techniques shall be in accordance with the dry powder magnetic particle examination of welds using the yoke method.

6.7.6.1 The yoke method shall be performed according to ASTM E 709, and the standard of acceptance with 6.26 of the Code.

- (1) The yoke method shall be performed using half-wave rectified direct current or alternating current.
- (2) Electromagnetic yokes shall have lifting forces complying with **TABLE 705-1**.

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TABLE 705-1: ELECTROMAGNETIC YOKE SPACING		
Current Type	Yoke Pole Leg Spacing (YPS)	
	2"≤YPS<4"	4"≤YPS≤6"
AC	10 lbs.	Not Applicable
DC	30 lbs.	50 lbs.

6.7.6.2 Prior to magnetic particle testing, the surface shall be examined, and any adjacent area within a minimum of 1 inch of the surface to be tested, shall be dry and free of contaminants such as oil, grease, loose rust, loose sand, loose scale, lint, paint, welding flux, and weld spatter.

Cleaning may be accomplished by detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand or grit blasting, and ultrasonic cleaning methods.

6.7.6.3 The poles shall be oriented in two directions approximately 90 degrees apart at each inspection point, to detect both longitudinal and transverse discontinuities. The pole position shall overlap as testing progresses to insure 100 percent inspection of the areas to be tested. Discontinuities are best detected when their axis is normal to the magnetic lines of force. Therefore, the yoke technique is most sensitive to discontinuities whose major access is normal to a line drawn between the two poles.

6.7.6.4 A report of magnetic particle examination shall be prepared and provided to the owner.

(1) The report shall include the following minimum information:

- (a) Part identification
- (b) Examination procedure number (if applicable)
- (c) Date of examination
- (d) Technicians name, certification level, and signature
- (e) Name and signature of contractors or owners, Inspectors, or both who witnessed the examination
- (f) Examination results
- (g) Equipment make and model
- (h) Yoke spacing used
- (i) Particle manufacturer's name and color

(2) One copy of the report shall be provided to the contractor for the owner.

Delete paragraph 6.7.7 and add the following:

6.7.7 For detecting discontinuities in non-magnetic materials including stainless steel to stainless steel or stainless steel to carbon steel, liquid penetrate inspection will be used in lieu of magnetic particle inspection. The standard methods, set forth in ASTM E 165 shall be used for liquid penetrate, and the standards of acceptance shall be in accordance with 6.26 of this code.

SECTION 6. INSPECTION, PART B.

Delete paragraph 6.10.9 and add the following:

6.10.9 FILM SIZE - When the joint thickness is less than 3 inches, radiographs shall be 4 1/2 inches x 17 inches in size. When the length of the joint is such that more than one radiograph is required, one of the films may be shortened to 4 1/2 inches x 10 at the contractor option. When joint thicknesses are 3 inches or greater, the minimum film size shall be 7 inches x 17 inches. Larger radiographs may be required in areas where there have been excessive repairs or where there are joints with unusual dimensions.

Delete paragraph 6.10.12 and add the following:

6.10.12 One radiograph identification number shall be painted on the steel no closer than 3/4 inch from the weld edge at each radiograph location. Corresponding lead numbers shall be superimposed on the painted numbers to produce an image on the radiograph. A combination of letters and numbers may also be used. Two location dots shall be painted on the steel at each radiograph location no closer than 3/8 inch from the weld edge. The dots shall be placed at a random distance from the steel plate edges which are perpendicular to the length of the weld. The dots shall be placed in different locations for each radiograph location. One lead arrow shall be placed so that its tip is superimposed on each of the two location dots. A location letter shall be painted immediately under each arrow and a lead letter shall be superimposed on each painted letter. When radiographs are viewed, only those films representing the same joint should have location arrows and location letters perfectly superimposed. Any additional

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information shall be produced on the radiograph no less than 3/4 inches from the edge of the weld either by pre-printing or by placing lead letters and numbers on the steel. See Figure 1 and Figure 2.

Delete paragraph 6.10.13 and add the following:

6.10.13 Information required to be shown on the radiograph shall include: the complete KDOT bridge number, initials of the radiographic inspection company, initials of the fabricator, the fabricator's shop order number, the radiographic identification number, the date, and the weld repair number if applicable.

Add a new paragraph 6.10.15:

6.10.15 Unless otherwise noted on the shop drawings all butt welds will be evaluated as tension welds.

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FIGURE 1
ITEMS TO BE PAINTED FOR RADIOGRAPHIC IDENTIFICATION

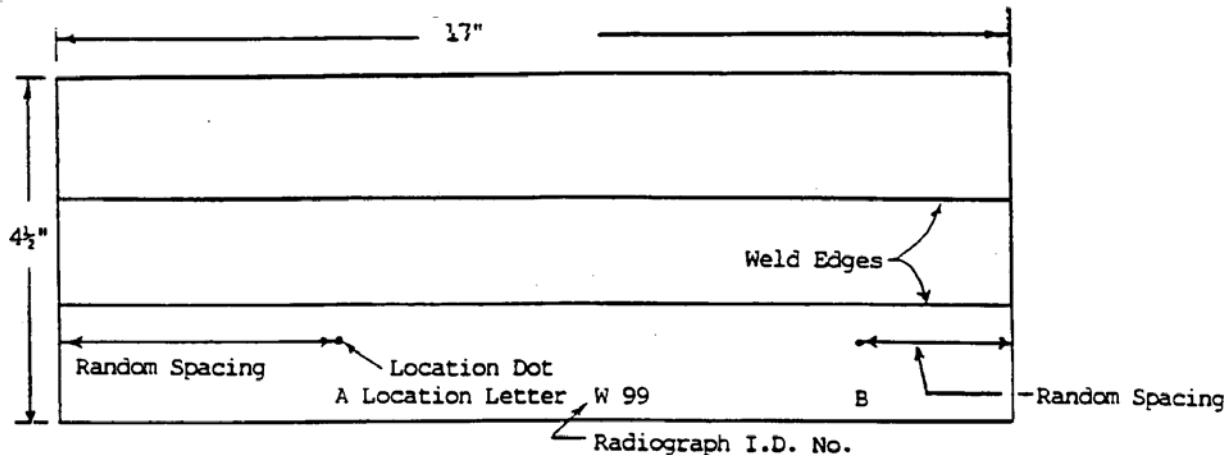
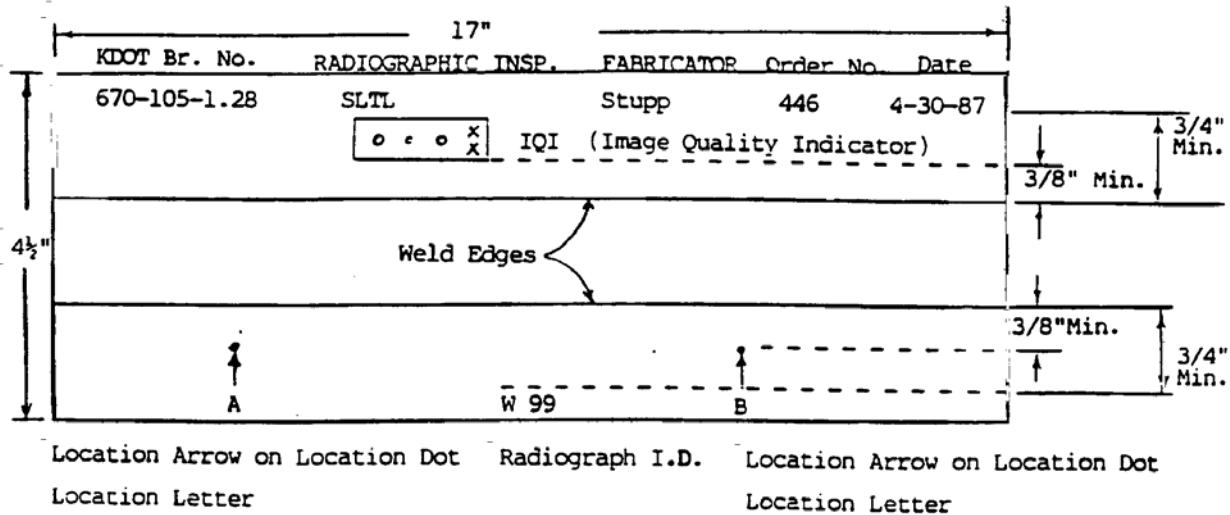


FIGURE 2
LEAD CHARACTER PLACEMENT FOR RADIOGRAPHIC IDENTIFICATION



705.3 MEASUREMENT AND PAYMENT

The Engineer will not measure fabrication of new structural steel for separate payment.

706 - BEARINGS AND PADS FOR STRUCTURES

SECTION 706 BEARINGS AND PADS FOR STRUCTURES

706.1 DESCRIPTION

Install the complete factory produced bearings and pads as designated in the Contract Documents.

BID ITEMS

	<u>UNITS</u>
Elastomeric Bearing Pad (**)	Each
Bearing (*) (**)	Each
*Type (Steel Reinforced Elastomeric, TFE/Elastomeric, Pot, Disc, Steel, Spherical, etc.)	
** Size, if applicable	

706.2 MATERIALS

Provide bearings and pads of the types, dimensions and configurations shown in the Contract Documents that comply with **DIVISION 1700**.

- Elastomeric bearing pads are non-reinforced pads consisting of elastomer only.
- Steel reinforced elastomeric bearings consist of layers of elastomer restrained at their interfaces by bonded non-elastic laminates. Provide bearings with the dimensions, material properties, elastomer grade and type of laminates shown in the Contract Documents.
- TFE/elastomeric bearings consist of a stainless steel sliding plate and a steel reinforced elastomeric bearing. Bond a stainless steel or structural steel back-up plate to the top of the steel reinforced elastomeric bearing. Bond the other side of the back-up plate with a layer of teflon.
- Pot and disc bearings consist of a circular non-reinforced neoprene, elastomer or rubber pad, of relatively thin section. For a pot bearing, this pad is confined and sealed in a steel pot or hydraulic cylinder. For a disc bearing, this pad is not confined.
- Steel bearings consist of rocker, roller and sliding bearings.
- Spherical bearings consist of bearings with spherical elements for unidirectional deflection rotation.

706.3 CONSTRUCTION REQUIREMENTS

Submit shop drawings for each location, type and model according to **subsection 105.10**. Show all details of fabrication and installation. With the exception of plain elastomeric pads, which do not require drawings, do not perform any fabrication until shop drawing are approved by the Engineer. Changes to approved shop drawings are subject to the approval of the Engineer. Submit revised sheets of the same size as those originally approved.

Fabricate and paint steel bearings according to **SECTIONS 705** and **714**, respectively.

Install the bearings and pads as detailed in the Contract Documents.

Unless shown otherwise in the Contract Documents, place the bearing plates on bearing mats or pads that comply with **SECTION 1701**. Do not place steel masonry bearing plates upon bridge seat bearing areas that are improperly finished, deformed or irregular, or until elevations have been verified. Set bearing plates level in position as shown in the Contract Documents, and with a full and even bearing upon the masonry.

Adjust the nuts on anchor bolts at the expansion ends of spans to permit the free movement of the span. Provide lock nuts or burr the threads of the anchor bolts.

Protect bearings and pads from damage before installation. Clean the operating surfaces thoroughly before final assembly. Provide protection from contamination or damage by other construction operations during and after installation.

706.4 MEASUREMENT AND PAYMENT

The Engineer will measure each bearing and pad of the various types and sizes.

Payment for "Elastomeric Bearing Pad" and "Bearing" at the contract unit prices is full compensation for specified work.

707 - FINGER PLATE AND MODULAR EXPANSION DEVICE

SECTION 707

FINGER PLATE AND MODULAR EXPANSION DEVICE

707.1 DESCRIPTION

Install finger plate and modular expansion devices as designated in the Contract Documents.

BID ITEMS

Expansion Device (Finger Plate)
Expansion Device (Modular)

UNITS

Linear Foot
Linear Foot

707.2 MATERIALS

Provide fabric troughs for finger plate expansion devices that comply with **DIVISION 1700**.

Provide modular expansion devices that comply with **DIVISION 1700**.

707.3 CONSTRUCTION REQUIREMENT

a. General. The Contractor is responsible for preparing shop drawings and coordinating the fabrication of the joint assemblies.

Submit shop drawings, for each location, type and model of expansion device used, according to **subsection 105.10**. Include a table of temperature corrections, required for installation, for each expansion device on the shop drawings. Do not perform any fabrication until the approved shop drawings are in the hands of the Inspector and fabricator, and the Engineer has authorized fabrication. Any purchase of materials before fabrication authorization is at the Contractor's risk. Changes to approved shop drawings are subject to the approval of the Engineer. Submit revised sheets of the same size as those originally approved.

Fabricate expansion devices according to **SECTION 705**. After fabrication, hot-dip galvanize all carbon steel components of modular expansion devices. Shop paint or hot-dip galvanize steel components of finger plate expansion devices, except support angles and finger plates, which must be shop painted.

- Galvanize according to ASTM A 123.
- Prepare steel surfaces and apply inorganic zinc according to **SECTION 714**, except provide a nominal dry film thickness of 3 mils.

The Contractor is responsible for coordinating the fabricator of the expansion device with the fabricator of the structural steel members for the bridge superstructure.

Complete the final sealing of the finished expansion joint as soon as possible after installation. Fill all bolts, exposed ends, joints between units and other areas of possible leakage with sealant. Scrape excess sealant away before it has set.

b. Expansion Device (Finger Plate). Place alignment marks on the anchor plates and finger plates on each side of the expansion gap to facilitate accurate installation.

Align the finger joint assemblies in position and check the expansion opening. The expansion opening must be adjusted for temperature prior to bolting, welding or placing concrete on each side of the joint. To adjust for the effects of sunlight on the girders, place reference marks on the bridge prior to sunrise. Use these reference marks to set the expansion opening using the table on the plans and the average ambient temperature over the previous 24 hours.

Test fit the finger plates with all the armoring and anchorages in place. Install the finger joint centered over the expansion gap, in plane and slope as the roadway, and so the fingers do not rub during the full range of temperature movement.

The Engineer will confirm the procedure, opening and alignment prior to concrete placement. After confirmation, remove the finger plates before concreting. Place concrete around the joint and vibrate so the concrete paste comes up through the air vents and no voids exist under the anchor unit. Start concrete placement at the low end of the joint and work toward the high end. If the bridge has a normal crown, start at the edge and work toward the center from both sides.

707 - FINGER PLATE AND MODULAR EXPANSION DEVICE

Three days after concrete placement, the Engineer will check for voids and loose bolts by sounding the anchor plate. Fill any voids by drilling through the anchor plate and pumping in an approved epoxy mortar at a minimum pressure of 75 psi. This work will be subsidiary to the bid item "Expansion Device (Finger Plate)".

Install the fabric trough and the finger plates according to the Contract Documents.

Thoroughly clean the top of the anchor plates to remove dried concrete paste before final assembly. Lubricate anchor bolts with bee's wax or equivalent and torque the nut according to **TABLE 707-1**.

TABLE 707-1: FINGER PLATE TORQUES (ft-lbs.)				
Size (inches)	7/8	15/16	1	1 1/8
Type I	176	218	264	387
Type II	277	342	415	608

After installation of the finger plates, the Engineer will inspect the plates for alignment. Any fingers that the Engineer determines are misaligned so that they may be struck by a snow plow, shall be ground as directed by the Engineer. This work will be subsidiary to the bid item "Expansion Device (Finger Plate)".

Install fabric troughs below the finger plate types. Clean the trough of all foreign material after the completion of all superstructure work.

c. Expansion Device (Modular). Place the adjacent concrete deck before installing modular expansion devices. When placing the concrete, block-out for the modular expansion devices according to the Contract Documents.

Install expansion devices according to the Contract Documents, and the manufacturer's recommendations. Do not field cut expansion devices. The manufacturer of modular expansion devices shall have a technical service representative on the project site to review the fabrication of the devices and supervise the installation of the devices.

If the expansion devices are installed within 10°F above or below the mean temperature shown in the Contract Documents, place the modular type in a "relaxed" or "free" condition with the distance between anchor bolts as shown in the Contract Documents.

If the installation temperatures are outside the range specified, expand or contract the device before it is anchored in place, making temperature corrections for distance between anchor bolts according to the manufacturer's table of temperature corrections shown on the expansion device shop drawings or on the general plans.

707.4 MEASUREMENT AND PAYMENT

The Engineer will measure expansion devices by the linear foot, along the centerline of the expansion joint.

Payment for "Expansion Device (Finger Plate)" and "Expansion Device (Modular)" at the contract unit price is full compensation for the specified work.

708 - FALSEWORK AND FORM CONSTRUCTION

SECTION 708

FALSEWORK AND FORM CONSTRUCTION

708.1 DESCRIPTION

Design and construct safe, adequate falsework to provide the necessary rigidity, support the loads imposed and produce the final structure to the lines and grades shown in the Contract Documents. Falsework is defined to be any temporary structure which supports structural members or form work.

<u>BID ITEM</u>	<u>UNITS</u>
Falsework Inspection	Lump Sum

708.2 MATERIALS

Use sound falsework piling to withstand driving, is reasonably straight, and is of sufficient size to provide the strength to safely carry the actual loads imposed. Use sound timber in good condition and free from defects that might impair its strength.

All approved metal or wood forms shall present a smooth surface, be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including placement and vibration of the concrete.

Do not use aluminum forms in contact with concrete.

708.3 CONSTRUCTION REQUIREMENTS

a. Falsework Design.

(1) General Falsework Design Requirements. Design falsework according to the KDOT Bridge Design Manual, Section 5.0, Falsework Design, Analysis and Inspection.

Include the type, size, grade and finish of all lumber used. Provide adequate details of the proposed method of construction. The Engineer may request additional information.

In designing forms and centering, regard concrete as a liquid. In computing loads, assume a weight of 150 pounds per cubic foot for the vertical pressure, and a minimum of 85 pounds per cubic foot in computing horizontal pressure.

Do not place cast-in-place shear bolts, coil inserts or other devices used as falsework support in pier columns without the approval of the Engineer. Through bolts are permitted. Do not drill and grout bolts or other devices into the pier columns unless shown in the Contract Documents.

(2) Category 1 Structures. On the structures listed below, submit to the Engineer for review (See subsection 105.10e.) by the State Bridge Office (SBO) (or Bureau of Local Projects) and, if applicable, the railroad company, 7 copies of detailed falsework plans designed and sealed by a Professional Engineer.

- All structures over or under railroad tracks;
- All structures built over highways or streets carrying traffic;
- All structures requiring falsework that directly carries highway traffic loads during construction;
- Deck overhangs greater than beam depth or greater than 54 inches;
- Superstructure forming with "non-typical" support (i.e. needlebeams); and
- All structures that require falsework plans to be submitted to the SBO (or Bureau of Local Projects) as noted in the Contract Documents.

(3) Category 2 Structures. If not included in the Category 1 structures above, submit to the Engineer for review (See subsection 105.10e.) by the Field Engineer, 3 copies of detailed falsework plans designed and sealed by a Professional Engineer on the Category 2 structures listed below.

- All cast-in-place span structures supported on falsework;
- Concrete Box Structures with spans greater than 16 feet or heights greater than 14 feet;
- Decks with girder spacing equal to or greater than 14 feet; and
- Substructure forming with "non-typical" support.

Falsework or formwork details for deck construction are not required for all other structural steel, prestressed concrete girder and reinforced concrete box bridge construction.

b. Falsework Construction. Adhere to all falsework details.

Drive falsework piling to a satisfactory depth and bearing value to support all falsework that is not founded on rock, shale or thick deposits of other compact material in their natural beds. Do not use mudsills on earth, sand, gravel and similar materials, unless otherwise noted in the Contract Documents. Do not support falsework on any part of the structure, except the footings, without written approval from the Engineer. The number and spacing of falsework piling, the adequacy of sills, caps and stringers, and the amount of bracing in the falsework framing is subject to approval of the Engineer.

If the falsework piling or vertical members are of sufficient length to cap at the desired elevation for the horizontal members, cap them and construct frames to the proper elevation. If falsework piling are not of sufficient length, extend them using an approved pile splice. Do not use wedges at pile splices. Cut the ends of the piling or vertical members square for full bearing. If vertical splices are necessary, the abutting members shall be of the same approximate size, with the ends cut square for full bearing. Provide an adequate splice to maintain rigidity of the joint, including inserting a #9 reinforcing bar 18 inches into each end of the abutting members.

Upon completion, remove all forms and falsework according to **SECTION 710**. Pull or cut off falsework piling 12 inches below low water level, the natural ground or the bottom of a channel change. On grade separation structures, pull or cut off the falsework piling 12 inches below subgrade elevation of the roadbed that the piles are driven into. Pull or cut off all other falsework piling 12 inches below finished grade.

Unless the Contract Documents provide for permanent camber, construct the falsework to provide only sufficient camber to prevent final settlement below the finish grades shown in the Contract Documents. Use adequate hardwood wedges or screw jacks in all falsework construction, and place and adjust them to provide the proper form alignment. If required, provide a means for adjusting forms to offset any excessive settlement. When screw jacks are used, adequately brace and secure them to prevent tipping of the jacks in any direction.

c. Falsework Inspection Requirements. For Category 1 structures, the falsework designer of record shall make a Falsework Inspection of the as-built falsework for substantial compliance with the falsework plans prior to placing concrete in the structure.

Conduct an on-site review of the falsework. Items to be reviewed include but are not limited to:

- The condition of the materials used for piling, cross bracing, beams, plywood decking, shims and jacks.
- The size and spacing of all structural members regarding their compliance to the submitted falsework plan.
- The condition and compliance of all splices.

Provide written documentation to the Engineer stating the falsework as-built is acceptable and in compliance with the original sealed plans. If the falsework is not in compliance, make corrections to the falsework or submit a revised, sealed falsework design prior to the placement of any concrete. When modifications are made to the falsework, the designer of record shall make Falsework Inspections until written documentation is provided to the Engineer stating that the falsework is in compliance, at no additional cost to KDOT.

For Category 2 falsework plans, conduct a walk-through review of the falsework with the Field Engineer, prior to placing concrete in the structure. Variations and deficiencies from the plan will be noted in writing and supported with photos or sketches. Forward the documentation to the falsework designer. The designer must respond in writing that the deficiencies are minor and the falsework is in substantial compliance, or must propose a new falsework plan which addresses the deficiencies.

The Engineer will refuse approval to proceed with other phases of the work if the falsework is determined to be unsafe or inadequate to properly support the subjected loads.

d. Forms. Do not separate forms at joints. Design the forms to permit easy removal without injury to the concrete. Use form lining such as plywood or metal forms for all exterior exposed surfaces which shall be visible after backfilling. The inside surface of the walls and slab of box culverts and bridges, the inside arch ring of arch culverts and bridges, the underneath surface of all floor slabs and the interior vertical surfaces of girders do not require form lining. Extend the forms to low water level, 1 foot below the bottom of the channel, or the top of the completed backfill. Use forms in the largest practical panels to minimize joints. Do not use small panels. If wooden panels are used, place the adjacent panels so that the grain of the wood shall be in the same general

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direction (all horizontal or all vertical). Undressed lumber of uniform thickness may be used as backing for the form lining. Dressed, sized lumber of uniform thickness may be used for all other exposed surfaces. Wooden plyform of adequate thickness, which is supported to meet these requirements, may be used alone in lieu of the lined forms.

Maintain forms to eliminate warping and shrinkage. Check dimensions and condition immediately before placing concrete. The Engineer may at any time require the revision or reconstruction of forms to maintain satisfactory work, and may refuse approval to place concrete within the forms until they are satisfactorily constructed. If during or after placing the concrete, the forms show signs of sagging or bulging, remove the concrete to the extent directed by the Engineer, bring the forms to the proper position and place new concrete.

Metal forms shall be of such thickness that the forms shall remain true to shape, line and grade. Countersink all bolt and rivet heads. Design clamps, pins or other connecting devices to hold the forms rigidly together, and allow removal without injury to the concrete. Exercise care to keep metal forms free from rust, grease or other foreign matter. Any form which will leave permanent impressions or ridges will not be approved.

Before placing the reinforcing steel, oil the inside of all forms for exposed surfaces (except those lined with certain composition materials) with a light, clear, paraffin base oil that will not discolor or otherwise injure the surface of the concrete.

Moisten wooden forms with water before placing the concrete.

Consider the nature of the work when determining the width and thickness of the lumber, and the size and spacing of studs and wales. Provide the size and spacing of studs and wales to maintain rigidity of the forms, and prevent distortion of the forms due to the pressure of the concrete.

Use either steel or non-metallic form bolts, rods and ties. Use the type that permits the major part of the tie to remain permanently in the structure. Hold forms in place by devices attached to the wales capable of developing the strength of the ties. The Engineer may permit the use of wire ties on irregular sections and incidental construction if the concrete pressures are nominal and the form alignment is maintained by other means. Remove the ties on all exposed surfaces. Remove steel ties to a depth a minimum of $\frac{1}{2}$ inch below the concrete surface. Non-metallic ties may be removed flush with the concrete surface. Cut wire ties back a minimum of $\frac{1}{4}$ inch below the concrete surface. Fill the cavities on exposed surfaces with cement mortar and leave the surface sound, smooth, even and uniform in color. Tar or roofing cement is acceptable for filling cavities on unexposed surfaces. Do not use form ties through forms for handrail. Remove wood, or metal spreaders as the concrete is placed. Do not use cofferdam braces or struts that extend through the forms for any concrete section. An exception may be approved in unusual situations.

Where the bottom of the forms is inaccessible, make provisions so that extraneous material can be removed from the forms immediately before placing the concrete.

Bevel all exposed edges by using dressed, triangular molding having $\frac{3}{4}$ inch sides unless provided otherwise in the Contract Documents.

Steel traveling forms may be used on reinforced concrete box structures or other applications when approved by the Engineer. Continuance of the use of such forms is based on satisfactory performance. Steel traveling forms may be discontinued at any time the Engineer determines their use is unsatisfactory. If traveling forms are used, provide supports as listed in **TABLE 708-1** before loosening and moving the forms.

TABLE 708-1: MAXIMUM SPACING PERMITTED FOR SUPPORTS	
spans up to 9 feet	1 support located at center of span
spans 9 to 14 feet	2 supports located at third points of span
spans over 14 to 18 feet	3 supports located at quarter points of span

The maximum longitudinal spacing of the supports is at 4 foot centers. The time the supports must be left in place is specified in **TABLE 710-3**. Do not loosen and move the forms until the concrete has been in place a minimum of 14 hours. When concrete is exposed as a result of moving the forms after the minimum 14 hours, but before the stipulated curing time, immediately coat the concrete with liquid membrane-forming compound applied according to **DIVISION 700**.

708.4 MEASUREMENT AND PAYMENT

Falsework and forms are not measured for separate payment.

On structures designated as Category 1 by KDOT, the Engineer will measure falsework inspection by the Lump Sum. Falsework inspection on Category 2 structures is subsidiary to other items of the contract. If KDOT

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designated the structure as Category 2, and the Contractor's operations (use of non-typical supports) cause the falsework to become Category 1, the Engineer will not measure the falsework inspection for separate payment.

Payment for "Falsework Inspection" on structures designated by KDOT as Category 1 will be made on the paid invoice amount +5%, not to exceed the "Lump Sum" amount set in the contract and is full compensation for the specified work.

709 - STEEL PERMANENT DECK FORMS

SECTION 709

STEEL PERMANENT DECK FORMS

709.1 DESCRIPTION

If designated in the Contract Documents, the use of steel permanent deck forms (for forming the roadway slab between the exterior beams or girders) in lieu of conventional removable forms is the Contractor's option. Do not use steel permanent deck forms where longitudinal deck construction joints are located between stringers, or on the overhang.

709.2 MATERIALS

Provide steel permanent deck forms that comply with **DIVISION 1600**.

709.3 CONSTRUCTION REQUIREMENTS

Submit 7 copies of shop drawings for the steel permanent deck forms to the Engineer for approval (see **subsection 105.10**). Shop drawings must include the material, dimension details and the Contractor's erection procedures.

Form support hangers must be the non-welded support system. Make no welds to the structural steel, or welds that induce local heat spots on the structural steel. Field variations shall require the support angle to be field welded to the continuous edge angle and to the support strap across the structural steel flange. If steel permanent deck forms are to be used on concrete girder bridges, the method of attachment must be approved by the Engineer prior to fabrication of the girders.

Install the steel permanent deck forms according to the manufacturer's instructions.

Do not locate screed supports directly on the form sheets, form supports or reinforcing steel.

Locate transverse deck slab construction joints at the bottom of a flute, and field drill $\frac{1}{4}$ inch weep holes at 12 inch centers along the line of the joint.

Fabricate the corrugated metal sheets for the placement sequence used, with the joints between the sections of sheets overlapped or securely fastened to eliminate differential deflections between the sections. Close the ends of each piece. Pre-closed (tapered) ends or separate end closures may be used.

Provide care and protection for the metal form sheets, supports and accessory items during handling, shipping and storage. Do not damage ends, corners and edges of the form sheets, supports and accessory items during loading, hoisting and unloading operations. If the form units and accessories are to be stored prior to installation, do not place metal form sheets, supports, and accessories in contact with the ground. Cover and protect the material.

Repair damaged galvanized coating on any form metal that will be permanently exposed, by cleaning and wire brushing the damaged area, followed by painting with 2 coats of zinc rich paint as specified in **DIVISION 1800**, no color added. Minor heat discoloration in areas of welds need not be touched up. Before placing concrete, remove and replace any sheets damaged after setting.

All reinforcement must have the minimum specified concrete cover. Center bars in the bottom layer of the main reinforcement over the valleys of the form to achieve the minimum concrete cover. The distance from the top of the deck slab to the bottom layer of deck slab reinforcement may not be less than that shown in the Contract Documents. Do not leave loose sheets or miscellaneous hardware on the deck forms at the end of the working day.

The Engineer will spot check the underside for soundness. At the Engineer's discretion, form removal may be required to perform a visual inspection for soundness or surface irregularities.

709.4 MEASUREMENT AND PAYMENT

The Engineer will not measure the steel permanent deck forms for payment.

710 - CONCRETE STRUCTURE CONSTRUCTION

SECTION 710 CONCRETE STRUCTURE CONSTRUCTION

710.1 DESCRIPTION

Construct concrete structures according to the Contract Documents.

BID ITEMS	UNITS
Concrete (*) (**) (***)	Cubic Yard
*Grade of Concrete	
**AE (air-entrained), if specified	
***Aggregate, if specified	

710.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	DIVISION 400
Asphalt Materials for Poured Joints	DIVISION 1200
Concrete Curing Materials	DIVISION 1400
Joint Sealing Compounds	DIVISION 1500
Type B Preformed Expansion Joint Filler	DIVISION 1500
Preformed Elastomeric Compression Joint Seals	DIVISION 1500
Bridge Number Plates	DIVISION 1600

710.3 CONSTRUCTION REQUIREMENTS

a. **Falsework and Forms.** Construct falsework and forms according to SECTION 708.

b. **Handling and Placing Concrete.** At a progress project meeting prior to placing concrete, discuss with the Engineer the method and equipment used for deck placement; include the equipment for controlling the evaporation rate and procedures used to minimize the evaporation rate.

Use a method and sequence of placing concrete approved by the Engineer. Do not place concrete until the forms and reinforcing steel have been checked and approved. Before placing concrete, clean all forms of debris. Drive all foundation piling in any one pier or abutment before concrete is poured in any footing or column of that pier or abutment.

On bridges skewed greater than 10°, place concrete on the deck forms across the deck on the same skew as the bridge, unless approved otherwise by State Bridge Office (SBO). Operate the bridge deck finishing machine on the same skew as the bridge, unless approved otherwise by the SBO.

Maintain environmental conditions on the entire bridge deck such that the evaporation rate is less than 0.2 lb/sq ft/hr. This may require placing the deck at night, in the early morning or on another day. The evaporation rate (as determined in the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2) is a function of air temperature, concrete temperature, wind speed and humidity.

Just prior to and at least once per hour during placement of the concrete, the Engineer will measure and record the air temperature, concrete temperature, wind speed and humidity on the bridge deck. The Engineer will take the air temperature, wind and humidity measurements approximately 12 inches above the surface of the deck. With this information, the Engineer will determine the evaporation rate by using KDOT software or by using **FIGURE 710-1** (Figure 2.1.5 from the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2).

When the evaporation rate is equal to or above 0.2 lb/ft²/hr, take actions (such as cooling the concrete, installing wind breaks, sun screens etc.) to create and maintain an evaporation rate less than 0.2 lb/ft²/hr on the entire bridge deck.

Place concrete to avoid segregation of the materials and displacement of the reinforcement. Do not deposit concrete in large quantities at any point in the forms, and then run or work the concrete along the forms.

Deposit the concrete in the forms in horizontal layers. Perform the work rapidly and continuously between predetermined planes. Vibrate through each plane.

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Fill each part of the form by depositing the concrete as near to the final position as possible. If the chutes for placement of concrete are on steep slopes, equip them with baffle boards or assemble in short lengths that reverse the direction of movement. Do not drop concrete in the forms a distance of more than 5 feet, unless confined by clean, smooth, closed chutes or pipes.

Work the coarse aggregate back from the forms, and around the reinforcement without displacing the bars. After initial set of the concrete, do not disturb the forms, or place any strain on the ends of projecting reinforcement.

If placing concrete by pumping, place the concrete in the pipeline to avoid contamination or separation of the concrete. Obtain sample concrete for slump and air test requirements at the discharge end of the piping.

Do not use chutes, troughs or pipes made of aluminum.

Accomplish consolidation of the concrete on all span bridges that require finishing machines by means of a mechanical device on which internal (spud or tube type) concrete vibrators of the same type and size are mounted (**subsection 154.2**). Observe special requirements for vibrators in contact with epoxy coated reinforcing steel as specified in **subsection 154.2**. Provide stand-by vibrators for emergency use to avoid delays in case of failure.

Operate the mechanical device so vibrator insertions are made on a maximum spacing of 12 inch centers over the entire deck surface. Provide a uniform time per insertion of all vibrators of 3 to 15 seconds, unless otherwise designated by the Engineer. Provide positive control of vibrators using a timed light, buzzer, automatic control or other approved method. Extract the vibrators from the concrete at a rate to avoid leaving any large voids or holes in the concrete. Do not drag the vibrators horizontally through the concrete.

Use hand held vibrators (**subsection 154.2**) in inaccessible and confined areas such as along hubguards. When required, supplement vibrating by hand spading with suitable tools to provide required consolidation.

Reconsolidate any voids left by workers.

Deposit concrete in water, only with approval from the Engineer. Do not place concrete in running water. Use forms that are reasonably watertight to hold concrete deposited under water. Increase the minimum cement factor of the class of concrete being deposited in water by 10%, obtaining approximately a 6 inch slump. Carefully deposit the concrete in place, in a compact mass, using a tremie pumped through piping, bottom-dumping bucket or other approved method that does not permit the concrete to fall through the water. Do not pump water from the inside of the foundation forms while concrete is being placed. Do not disturb the concrete after being deposited. If necessary to prevent flooding, place a seal of concrete through a closed chute or tremie, and allow it to set.

Continuously place concrete in any floor slab until complete, unless shown otherwise in the Contract Documents.

The method used for transporting concrete batches, materials or equipment over previously placed single pour (non-overlaid) floor slabs or floor units, or over units of structures of continuous design types is subject to approval by the Engineer.

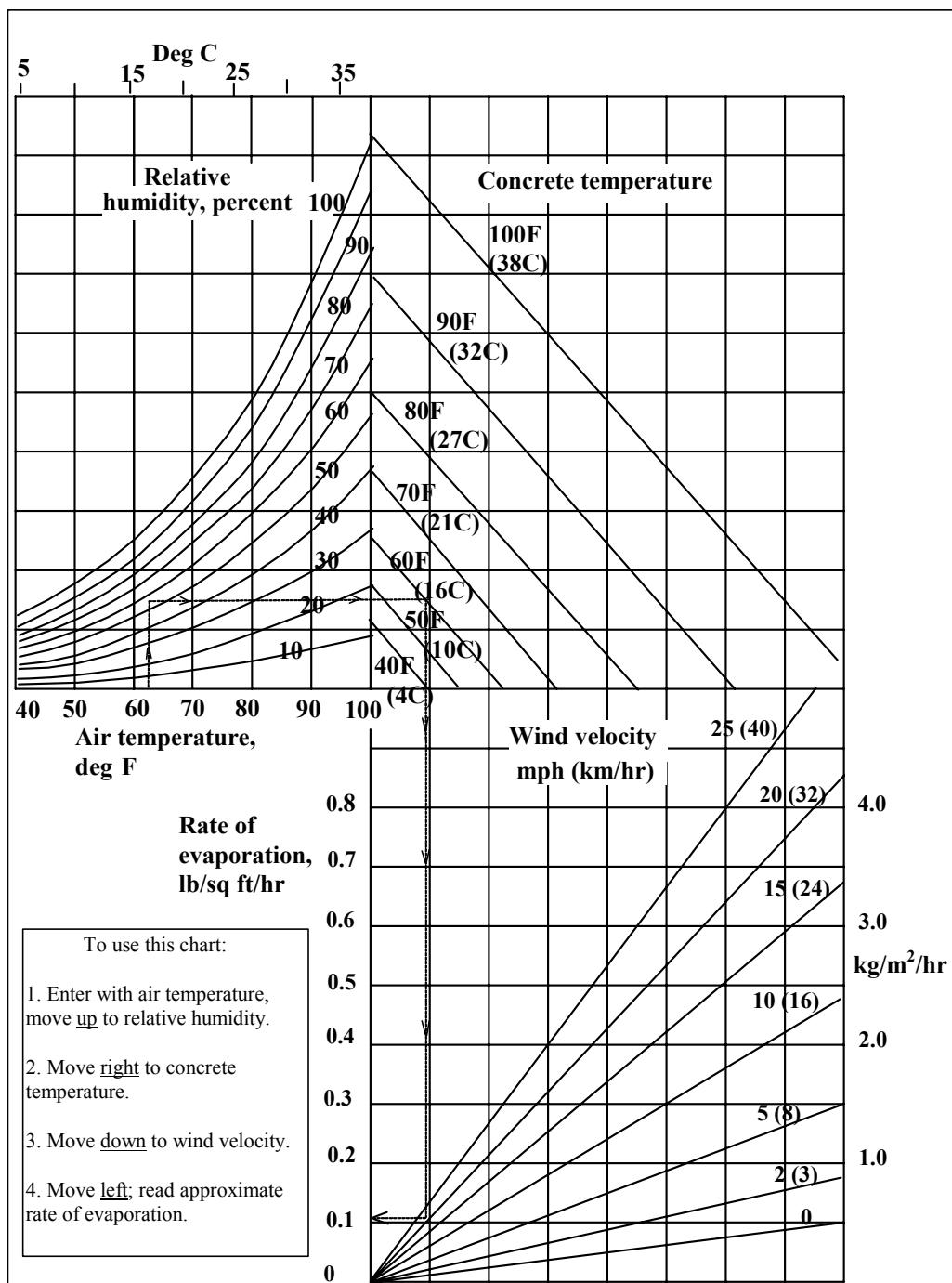
Do not operate bridge deck finishing equipment on previously placed concrete spans until:

- A minimum of 72 hours on structures that are fully supported with falsework;
- A minimum of 72 hours on structures with concrete girder spans with concrete decks; and
- A minimum of 96 hours on structures with steel girder spans with concrete decks.

The time delays begin after the day's pour has been completed.

Follow **TABLE 710-2** for load limitations after concrete placement. Prior to permitting approved traffic on the bridge deck, construct temporary bridge approaches and maintain them in a condition to prevent damage to the bridge ends.

FIGURE 710-1: STANDARD PRACTICE FOR CURING CONCRETE



Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft²/hr (1.0 kg/m²/hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate is less than 0.2 lb/ft²/hr (1.0 kg/m²/hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.

c. Construction Joints, Expansion Joints and End of Wearing Surface (EWS) Treatment. Locate the construction joints as shown in the Contract Documents. If construction joints are not shown in the Contract Documents, submit proposed locations for approval by the Engineer.

If the work of placing concrete is delayed and the concrete has taken its initial set, stop the placement, saw the nearest construction joint approved by the Engineer and remove all concrete beyond the construction joint. On post-tensioned structures construct a stepped joint as shown in the Contract Documents.

When the Contract Documents show a construction joint in the wall of the RCB 3 inches above the floor, the Contractor has the option of constructing the joint as shown on the Contract Documents, or constructing the joint level with the floor of the RCB. When the Contract Documents show a construction joint in the wall of the RFB 2 inches above the floor haunch, the Contractor has the option of constructing the joint as shown on the Contract Documents, or even with the top of the floor haunch of the RFB.

If dowels, reinforcing bars or other tie devices are not required by the Contract Documents, make a key in the construction joint. Construct keyed joints by embedding water-soaked beveled timbers of a size shown on the Contract Documents, into the soft concrete. Remove the timber when the concrete has set. When resuming work, thoroughly clean the surface of the concrete previously placed, and when required by the Engineer roughen the key with a steel tool. Before placing concrete against the keyed construction joint, thoroughly wash the surface of the keyed joint with clean water, and paint it with a thick coat of neat cement mortar.

(1) Bridges With Tied Approaches. When concrete is placed at the bridge EWS, embed 3 ($\frac{1}{2}$ inch by 8 inch) bolts to hold a header board for each traffic lane into the vertical surface of the EWS. Finish the surface of the EWS using an edging tool with a $\frac{1}{4}$ inch radius. Immediately after the vertical forms on the EWS are removed, protect the exposed EWS by bolting a wooden header (minimum dimension of $2 \frac{1}{8}$ inch by $7 \frac{1}{2}$ inch) to the exposed vertical surface of the EWS. Extend the header board the full width of the EWS, or use 1 section of header board for each lane of traffic. Shape the header board to comply with the crown of the bridge surface, and install it flush with the concrete wearing surface.

(2) Bridges Without Tied Approaches. Place the concrete for the approach slab, and at the end of the approach slab away from the EWS place bolts and attach a header board in the same manner required for bridges with tied approaches. If the Contractor needs to drive on the bridge before the approach slabs can be placed and cured construct a temporary bridge from the approach over the EWS capable of supporting the anticipated loads. Do not bend the reinforcing steel which will tie the approach slab to the EWS or damage the concrete at the EWS. The method of bridging must be approved by the Engineer.

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a finishing machine, either self-propelled or manually operated by winches and approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10° , operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding $\frac{1}{8}$ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay leaving them with an acceptable float or machine pan finish.

Unless shown otherwise in the Contract Documents, finish decks that do not receive an overlay in this manner:

- When a tight, uniform surface is achieved, give the surface a suitable texture by transverse grooving perpendicular to the center line of the bridge with a tining float or a vibratory tining float having a single row of fins. Make the grooving approximately $\frac{3}{16}$ inch in width at $\frac{3}{4}$ inch centers, with a depth of approximately $\frac{1}{8}$ inch.

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- Achieve the desired texture while minimizing displacement of the larger aggregate particles. For bridges without drains, the transverse grooving should terminate approximately 3 feet in from the outside edge of the deck and for bridges with drains, approximately 2 feet in from gutter line at the base of the curb. Finish the area adjacent to the curbs with a light, longitudinal broom finish. Provide suitable work bridges, which do not come in contact with the wearing surface.
- Begin fogging the bridge deck immediately behind the tining float. Maintain the fogging to produce a “gloss to semi-gloss water sheen” on the surface until the curing is applied. Apply the fog over the entire placement width. Reduce fogging only if excess water accumulates on the surface.
- Produce a fog spray from nozzles that atomize the droplets and a system capable of keeping a large surface area damp without depositing excess water. Use high pressure equipment that generates a minimum of 1200 psi at 2.2 gpm, or low pressure equipment having nozzles capable of supplying a maximum flow rate of 1.6 gpm.

Obtain reasonably true and even concrete surfaces, free from stone pockets, excessive depressions or projections on the surface. Strike off with a straightedge and float the concrete in bridge seats and walls flush with the finished top surface.

As soon as the forms are removed and the concrete is ready to hone, rub the concrete surfaces that are not in an acceptable condition, or are designated in the Contract Documents to be surface finished to a smooth and uniform texture with a carborundum brick and clean water. Remove the loose material formed on the surface, due to the rubbing with a carborundum brick as soon as it dries. The finished surface shall be free from all loose material. Do not use a neat cement wash.

Give handrails, handrail posts, the deck side, and the top and end of all curbs, except curbs of structures having the top of curb below the final shoulder elevation of the road, an acceptable troweled or floated finish. This includes the back of the inside rails of side by side structures, or any rails easily viewed by the traveling public.

Remove the forms as early as possible, and perform the float finish while the concrete is still green. Use mortar during the float finish operation to fill in air and water voids and supplement the float finish. Keep surfaces requiring a rubbed finish moist before and during the rubbing. Do not use a mortar coating after the concrete has cured.

Unless otherwise provided in the Contract Documents, all reasonably true and even surfaces, obtained by use of a form lining, which are of a uniform color, free from stone pockets, honeycomb, excessive depressions or projections beyond the surface, are considered as acceptable surfaces, and a rubbed surface finish is not required.

The Engineer may require the use of a dry carborundum brick for straightening moulding lines, removing fins or requiring a rubbed surface finish on all portions of the structure that do not present an acceptable surface even though a form lining is used.

e. Curing and Protection.

(1) General. Cover concrete surfaces with wet burlap, moisture proofed burlap, liquid membrane-forming compound, white polyethylene sheeting or other impermeable material approved by the Engineer. Maintain a damp surface until the wet burlap is placed. Burlap shall be wet before placing on concrete surface. Cover the concrete surfaces immediately after finishing the concrete, and at such time that marring of the concrete shall not occur. Provide a work bridge while applying the curing materials. Maintain the curing so that moisture is always present at the concrete surface.

The minimum curing periods are shown in **TABLE 710-1**. The determination of the time requirement for curing commences after all the concrete for the placement is in place and finished. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

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TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	Cure Time	Curing Medium
Bridge subdecks (decks with overlays)	7 days	Wet burlap covered with polyethylene sheeting
Bridge decks (full-depth decks)	7 days	Type 1-D liquid membrane forming compound (1 coat) covered with wet burlap and polyethylene sheeting
Other unformed or exposed surfaces	7 days	Wet burlap, moisture-proofed burlap, liquid membrane forming compound (2 coats), white polyethylene sheeting, or other impermeable material approved by the Engineer
Formed sides and ends of bridge wearing surfaces and bridge curbs	7 days	Forms*
Other formed surfaces	4 days	Forms*

*Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4 day cure period, cure the surface with an application of Type 1-D liquid membrane curing compound.

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage from the rain, or if the film is damaged by any other means, apply a new coat of the membrane to the affected portion equal in curing value to the original application.

When liquid membrane-forming compound is required, use spraying equipment capable of supplying a constant and uniform pressure to provide uniform distribution at the rates required. Agitate the liquid membrane-forming compound continuously during application. The surface must be kept wet from the time it is finished until the liquid membrane-forming compound is applied. Apply the liquid membrane-forming compound at a minimum rate per coat of 1 gallon per 200 square feet of concrete surface. Apply the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Give marred or otherwise disturbed applications an additional coating. Should the liquid membrane-forming compound be subjected to continuous damage, the Engineer will require wet burlap, polyethylene sheeting or other approved impermeable material to be applied at once.

When burlap is required, place and weight down the burlap so it will remain in intimate contact with the surface covered. When an impermeable sheeting material is used, lap each unit 18 inches with the adjacent unit. Place and weight down the impermeable sheeting material so it will remain in intimate contact with the surface covered. When any burlap or impermeable sheeting material becomes perforated or torn, immediately repair it, or discard and replace it with acceptable material.

(2) Bridge Decks. If the concrete surface temperature is above 90°F, do not use polyethylene sheeting in direct sunshine during the day for the first 24 hours of the 7 day curing period. White polyethylene sheeting may be used at night to maintain the required damp condition of the burlap. When polyethylene sheeting is used over the burlap at night during the first 24 hours and the concrete surface temperature is above 90°F, place the polyethylene sheeting a maximum of 1 hour before sunset, and remove the polyethylene sheeting within 1 hour after sunrise. After the first 24 hours, the polyethylene sheeting may be left in place continuously for the remainder of the curing period provided the burlap is kept damp.

Construction loads on the new bridge subdeck, new one-course deck or any concrete overlay are subject to the limitations in **TABLE 710-2**.

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TABLE 710-2: CONCRETE LOAD LIMITATIONS ON BRIDGE DECKS		
Days after concrete is placed	Element	Allowable Loads
1*	Subdeck, one-course deck or concrete overlay	Foot traffic only.
3*	One-course deck or concrete overlay	Work to place reinforcing steel or forms for the bridge rail or barrier.
7*	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10 (15)**	Subdeck, one-course deck or post-tensioned haunched slab bridges**	Light truck traffic (gross vehicle weight less than 5 tons).****
14 (21)**	Subdeck, one-course deck or post-tensioned haunched slab bridges**	Legal Loads; Heavy stationary loads with the Engineer's approval.***Overlays on new decks.
28	Bridge decks	Overloads, only with the State Bridge Engineer's approval.***

*Maintain a 7 day wet cure at all times.

** Conventional haunched slabs.

*** Submit the load information to the appropriate Engineer. Information that will be required is the weight of the material and the footprint of the load, or the axle (or truck) spacing and the width, the size of each tire (or track length and width) and their weight.

****An overlay may be placed using pumps or conveyors until legal loads are allowed on the bridge.

(3) Surfaces Requiring Rubbed Finish. Apply Type 1-D liquid membrane-forming compound immediately after the surface is completed, and while the concrete is still damp.

(4) Cold Weather Curing. If concrete is placed in cold weather, comply with **SECTION 401**.

If concrete is placed and the ambient air temperature is expected to drop below 40°F during the curing period, provide suitable measures such as straw, additional burlap or other suitable blanketing materials or housing and artificial heat to maintain the concrete temperature between 40 and 90°F as measured on the surface of the concrete. Keep the surface of the concrete moist by the use of an approved moisture barrier such as wet burlap or polyethylene sheeting or both. Maintain the moisture barrier in intimate contact with the concrete during the entire 7 day curing period. After the completion of the required 7 day curing period, remove the curing and protection to prevent rapid cooling of the concrete.

(5) If concrete is placed in cofferdams and subsequently flooded with ground water, the specified curing conditions are waived providing the surface of the water does not freeze.

f. Removal of Forms and Falsework. Do not remove forms and falsework without the Engineer's approval. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **TABLE 710-1**.

If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**. Remove forms on handrails, ornamental work and other vertical surfaces that require a rubbed finish as soon as the concrete has hardened sufficiently that it shall not be damaged.

Under normal conditions, the Engineer will allow removal of forms and falsework according to **TABLE 710-3**. The determination of the time requirement for the removal of forms commences after all the concrete for the placement is in place and finished. If high early strength concrete is used, the specified time limits may be decreased as determined by the Engineer, and agreed upon before placing the concrete.

710 - CONCRETE STRUCTURE CONSTRUCTION

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 [4]*	10 [6]*				
Column Bent Piers - Falsework supporting pier beam**	4			7 [4]*		10 [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets	4			7 [4]*	10 [6]*		15 [10]*
RCB and RFB top slabs not re-shored		7 [4]*		7 [4]*		10 [6]*	
Type of Work					Time (Days)		
Walls, Wing Walls and vertical sides of sides of RCB and RFB structures Do not Backfill until 3 days after forms are removed per SECTION 207 .					4 [3]*		
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns					4 [2]*		
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns					2		
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns					4 [2]*		
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam					4 [2]* 7 [4]*		
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam					2 4 [2]*		
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns					2		

*Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 75% of the specified f'_c . To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.

**Do not set girders or beams on the pier beams until the falsework under the pier beams is removed.

Reshoring of RCB and RFB (classified as culverts or bridges) top slab will be permitted if the Contractor uses traveling forms or to reduce the minimum time shown in **TABLE 710-2**. At the Preconstruction Conference, submit calculations, sealed by a Professional Engineer, to the Engineer that show that the concrete tensile stress is below $0.23 \sqrt{f'_c}$ (ksi) and the shoring has sufficient capacity.

In determining the time for the removal of forms, give consideration to the location and character of the structure, weather and other conditions influencing the setting of concrete. If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**.

For additional requirements regarding forms and falsework, see **SECTION 708**.

710 - CONCRETE STRUCTURE CONSTRUCTION

g. Bridge Number Marking. When designated in the Contract Documents, place bridge numbers on bridges by the use of plates recessed in the concrete during construction, using plates constructed as shown in the Contract Documents. The date placed on the plates is the year in which the structure is completed.

710.4 MEASUREMENT AND PAYMENT

The Engineer will measure the various grades of concrete placed in the structure by the cubic yard. No deductions are made for reinforcing steel and pile heads extending into the concrete.

Payment for the various grades of "Concrete" at the contract unit prices is full compensation for the specified work.

711 - REINFORCING STEEL

SECTION 711

REINFORCING STEEL

711.1 DESCRIPTION

Place reinforcing steel as detailed in the Contract Documents.

BID ITEMS

Reinforcing Steel (*) (**)
Reinforcing Steel (Repair) (*) (**)(Set Price)
*Grade
**Epoxy-Coated

UNITS

Pound
Pound

711.2 MATERIALS

Provide reinforcing steel, epoxy-coated reinforcing steel, epoxy patching material and reinforcing steel splices that comply with **DIVISION 1600**.

711.3 CONSTRUCTION REQUIREMENTS

a. General.

(1) Storage and Protection. Store the reinforcing steel above ground on platforms or skids, and in a manner that will allow the Engineer to inspect the material for condition and verify the quantity. Identify the reinforcing steel with durable tags or markings.

Protect the reinforcing steel from dirt, detrimental scale, oil and other foreign substances. Do not place contaminated reinforcing steel into the work.

(2) Field Bending. Field bend the reinforcing steel, only as allowed in **DIVISION 1600**. Bend the reinforcing bars cold, using the proper tools. Do not heat reinforcing bars to facilitate bending. Unless shown in the Contract Documents, do not bend reinforcing bars partially embedded in concrete.

(3) Placing, Supporting and Fastening. Place, support and fasten reinforcing steel in the position shown in the Contract Documents according to the recommended industry practices set forth by the Concrete Reinforcing Steel Institute (CRSI), except as noted otherwise in the Contract Documents. See the Manual of Standard Practice published by CRSI (933 North Plum Grove Road, Schaumburg, IL 60173-4758) for recommended industry practices.

The Engineer must inspect and approve the reinforcement placed in any member, before concrete is placed.

Except for inserting tie bars into concrete pavement, and other special applications approved by the Engineer, do not lay or drive reinforcing steel into the concrete after the concrete is placed. Support all horizontal reinforcement with wire bar supports, plastic bar supports or supplementary bars. Use Class 1 Protection wire bar supports for epoxy-coated reinforcement, and Class 1, 2 or 3 Protection wire bar supports for other reinforcement. Do not use stones, concrete or wood to support the reinforcement. Use bar supports of proper height to maintain the clearance between the reinforcing and the formed surface (or top surface of deck slabs) to within a $+1/4$ inch, -0 inch of that indicated in the Contract Documents. If lengths of continuous bar supports are used, lap the end legs so they are locked or tied together. Do not use alternate methods of supporting the reinforcement without the approval from the Engineer.

The Contract Documents show the (maximum) bar support spacing. The Engineer will determine if the Contractor has sufficient supports to hold the reinforcement in position. Use wire ties to secure the reinforcing steel at bar intersections, and to tie the reinforcing to the supports and spacers. Tie reinforcing steel bars at all intersections around the perimeter of each mat of reinforcement. Tie the remainder of each mat of reinforcement at a minimum of 2 foot centers, or at every intersection, whichever is greater. Bend all wire ties in the top mat of reinforcement downward. Do not weld reinforcing steel to the bar supports or other reinforcement, unless shown in the Contract Documents.

Provide support for work platforms on the forms, not on the reinforcing steel.

(4) Reinforcing Bar Trusses. Place, support and secure bar trusses in proper position. Unless the bar trusses are designed and fabricated with outstanding legs that are in contact with the forms, support them on metal supports and spacers. If the weight of the trusses causes the supporting legs of trusses to indent into the forms, use bar supports as auxiliary support for the truss legs.

(5) Mesh Reinforcement for Structures. Provide mesh reinforcement of the size and spacing shown in the Contract Documents. Lap the sheets of mesh as indicated in the Contract Documents. The method of placing the mesh and securing it in proper position must be approved by the Engineer.

(6) Box Culvert Reinforcing. Use Grade 60 reinforcing steel for road culverts and reinforced concrete box bridges, unless otherwise noted in the Contract Documents.

b. Epoxy-coated Reinforcement.

(1) Perform all fabrication and jobsite handling of epoxy-coated reinforcing bars, dowel bars and tie bars for pavement according to ASTM D 3963/D 3963M, "Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars". For epoxy-coated steel wire and welded wire fabric, follow ASTM A 884/A 884M, "Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement". Consider the appendix to ASTM A 884/A 884M (that is identified as nonmandatory information) to be mandatory for this specification. Coating applicators and fabricators must comply with all aspects of above referenced documents.

(2) Storage, Handling and Placement at the Jobsite. When handling coated steel reinforcement, avoid bundle-to-bundle or piece-to-piece abrasion. Do not drop or drag epoxy-coated reinforcement.

Protect contact areas on equipment used for handling coated steel reinforcement. Use padded or non-metallic slings and padded straps when unloading.

Off-load coated steel reinforcement as close as possible to its point of placement, or within reach of the crane so that the material can be hoisted to the area of placement with minimum re-handling.

Store coated steel off the ground on protective cribbing, with timbers placed between bundles if stacking is necessary. Space the supports sufficiently close to prevent sags in the bundles.

Store coated and uncoated steel reinforcement separately.

Minimize long term storage. Due to the uncertainty of how long epoxy-coated steel will remain on the job site before incorporation in concrete, cover it with opaque material immediately on delivery, unless it is placed as soon as it arrives. For stacked material, drape the protective cover around the perimeter of the stack. Secure the covering adequately allowing for air circulation around the coated reinforcement to prevent condensation under the covering.

Tie coated reinforcement with tie wire coated with epoxy, plastic, nylon or other non-conductive material that shall not damage or cut the coating.

Use supports coated with, or made of, a dielectric material compatible with concrete.

After placing, minimize walking on coated steel reinforcement. Plan the placement of mobile equipment to avoid damage to the coated steel. If the epoxy-coated reinforcing steel placed in a structure or on the roadway will not be incorporated in concrete within 30 days, cover the epoxy-coated reinforcing steel with opaque material until the concrete is placed.

For all epoxy-coated steel reinforcement, except dowel bars and tie bars for pavement, use vibrators with heads of rubber or other resilient material for concrete consolidation. Do not use bare steel-headed vibrators. Rubber covers, securely fastened over steel heads will be acceptable.

(3) Repair of Damaged Epoxy. If the extent of the damage to the epoxy coating, by any cause, is a maximum of 1% of the surface area in any 1 foot length, remove all rust from damaged areas, and repair according to patching material manufacturer's instructions.

Reject the damaged material if the extent of the coating damage exceeds 1% of the surface area of the coated steel reinforcement in any 1 foot length.

c. Splicing. If it is necessary to splice reinforcement at points other than those shown in the Contract Documents, before ordering the reinforcing steel, submit drawings showing the location of each splice to the Engineer for approval. Avoid splices at points of maximum stress. Where possible, stagger the splices, and design them to develop the strength of the bar without exceeding the allowable unit bond stress. Lap bars according to the details shown in the Contract Documents. Do not use lapped splices for bar sizes larger than No. 11 bar. Splicing of reinforcing steel by welding is permitted only when shown in the Contract Documents. Where the bar size exceeds No. 11 bar, use welded splices or other positive connections with the approval of the Engineer. Make welds of direct butt splices, according to the American Welding Society publication, ANSI/AWS D1.4 "Structural Welding Code-Reinforcing Steel". A welder certified by the American Welding Society is required.

d. Mechanical or Thermomechanical Splices. At locations shown in the Contract Documents, splice reinforcing bars, using a mechanical or thermomechanical splicing process, as specified herein using the designated type of splice. Provide splicing devices and systems prequalified as required in **DIVISION 1600**.

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(1) Splice Types.

(a) Thermomechanical splices are made using a process whereby molten filler metal is introduced into an annular space around the bars created by a high strength steel sleeve of larger diameter than the bars. The Engineer will require operator prequalification.

(b) For mechanical splices, use any mechanical device or system complying with the physical requirements in **DIVISION 1600**.

(2) Prequalification of Operators. Before commencing production splicing, operator qualification is required for all splicing systems. The individual that will perform the production splicing must prepare the test specimen. If more than one person will perform the splicing, make a separate set of specimens by each individual.

For qualification, the Contractor's operator must make a set of 3 test splices of the predominant bar size and orientation in the project. The Engineer will observe the Contractor's operator make the splices using manufacturer's standard jigs, clamps, ignition devices and other required accessories. Identify each operator by attaching their name to the test splice. Forward the test splices to the MRC (where they will be tension tested to destruction). The MRC will issue reports of the tests to the operator, Contractor and Field Engineer.

If the splice is attached to one of the bars in a fabricator's shop and the other end of the splice is performed in the field, or mechanical couplers are attached to bars for easy assembly in the field and the system is one identified as requiring operator prequalification, the fabricator must prepare test specimens as outlined above and forward them to the MRC for testing before shipping material to the project. In lieu of observation by the Engineer, the fabricator must provide a notarized certification of the operator's identity along with the specimens.

The Engineer will waive the operator prequalification requirement if the operator provides a copy of a satisfactory KDOT test report, dated within 2 years of the current date that was issued in conjunction with the operator's qualification testing for the same splicing system on previous projects, as outlined in **subsection 711.3d.(1)(a) or (b)**. Fabricators must provide a certified copy of such operator qualification to the Engineer along with the shipping documents.

(3) Construction Requirements. Prepare the ends of bars for splicing in compliance with the splice manufacturer's recommendations.

The Engineer will visually examine mechanical or thermal splices. Remove and replace all splices having visible defects. Do not encase any splice in concrete until approved by the Engineer.

For those splicing systems requiring operator qualification, make 1 tension test specimen splice to represent each lot of bars spliced in the field. Unless shown otherwise in the Contract Documents, a lot consists of all bars in a days run for all splices. When possible, take test specimens alternatively between the horizontal and vertical positions. Make specimens by the same operator and under the same conditions as the splices they represent.

If the splicing systems require the entire splice be prepared in a fabricator's shop for later assembly in the field, and the field assembly requires operator prequalification, each shipment to the project is considered a separate lot. One specimen is taken from each lot.

For those projects requiring daily sampling, deliver the specimens to the MRC (where they will be tension tested to destruction) as soon as possible. The specimens must develop a minimum of 125% of the specified yield strength of the bar.

To expedite testing for projects remote from the MRC, the Contractor may hire a private laboratory approved by the Engineer of Tests to perform the tests and issue reports. All costs of such testing and reports are borne by the Contractor. Provide 1 copy of all reports issued under such an arrangement to the Field Engineer, and forward 1 copy to the Engineer of Tests.

If any single test specimen fails to meet the strength requirements, cut 2 production splices from the lot represented by the specimen and tension test them. If both re-tests meet strength requirements, all splices in the lot are accepted. If 1 or both re-tests fail to meet the requirements, all splices in the lot are rejected. All costs of removal and re-splicing are borne by the Contractor.

Protect any concrete forms which may be close to thermal bar splices from the heat generated by the splicing operation by overlaying the affected surface of the form with fire protection sheeting, or by other means approved by the Engineer.

711.4 MEASUREMENT AND PAYMENT

The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer. No allowance is made for the clips, wire or other fastening devices for holding the steel in place. The Engineer will verify the quantities of

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materials provided and placed based on the calculated weight of the reinforcing steel placed according to these specifications. Additions and deletions from plan quantity will be computed using **TABLE 711-1**.

TABLE 711-1: BAR SIZE WEIGHTS		
Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

No allowance is made for the weight of weld metal used in the fabrication of bar trusses. No separate compensation is allowed for the cost of making and providing splices and test splices.

If during the course of structure repair, deteriorated existing reinforcing steel is encountered, and the Engineer requires it replaced, provide and place new reinforcing steel according to specification. Reinforcing steel used for repair is measured as provided above. No measurement is made for replacement of existing reinforcing steel damaged through negligence of the Contractor. No measurement is made for material in approved splices made for the Contractor's convenience.

Payment for "Reinforcing Steel" at the contract unit price and "Reinforcing Steel (Repair) (Set Price)" at the contract set unit price is full compensation for the specified work.

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SECTION 712

STRUCTURAL STEEL CONSTRUCTION

712.1 DESCRIPTION

Fabricate and erect the structural steel as designated in the Contract Documents. See **SECTION 705** for fabrication of structural steel. Provide and place the casting designated in the Contract Documents.

BID ITEMS	UNITS
Structural Steel (*)(**)(***)	Pound
Structural Steel (Merchant Quality)	Pound
Welded Stud Shear Connectors	Each
*Type	
**Grade	
***Use	

712.2 MATERIALS

Provide materials that comply with the applicable requirements.

Structural Steel	DIVISION 700
Castings	DIVISION 1600
Structural Steel	DIVISION 1600
Steel Fasteners	DIVISION 1600
Bearing Plate Mats or Pads	DIVISION 1700

712.3 CONSTRUCTION REQUIREMENTS

a. Erecting Structural Steel.

(1) General. Erect the fabricated structure as detailed in the Contract Documents. Provide all falsework, tools, machinery and appliances, including drift pins and erection bolts required to complete the work. After the structure is erected, remove all falsework, appliances and other obstructions or debris resulting from erection.

Provide the Engineer with safe means (such as scaffolding, safety lines, snoopers or hoist buckets) to inspect any portion of the structure during the erection operations.

(2) Handling Structural Steel. Use protective devices or softeners to safeguard plate edges, when loading, transporting, unloading, storing and erecting structural steel. Store the structural steel above ground on platforms, skids or other supports. Keep the structural steel properly drained, clean and free of dirt, grease and other foreign matter. Protect the structural steel from corrosion. Store girders and beams upright with sufficient support to prevent warping or change in design camber.

(3) Erection Plans. Provide the Engineer with detailed plans for the erection of the structure, including calculations, shop details, camber diagrams, list of field bolts and a copy of shipping statements showing a list of parts and their weights. Provide erection plans, sealed by a licensed Professional Engineer, for span lengths greater than 125 feet.

(4) Falsework. Comply with **DIVISION 700**.

(5) Bearings and Anchorage. Do not place masonry bearing plates upon bridge seat bearing areas which are improperly finished, deformed or irregular and not until the elevations have been verified. Set bearing plates level in exact position and have a full and even bearing upon the masonry. Unless otherwise shown in the Contract Documents, place bearing plates on mats or pads.

Set the anchor bolts according to **SECTION 842** and preferably, if construction conditions permit, by first setting the bearing devices and superstructure and then drilling the holes or using preformed holes for the anchor bolts. When drilling anchor bolts use a pacometer to avoid drilling in the existing reinforcing steel. When required, cast anchor bolts in place according to the Contract Documents. Vary the location of the anchor bolts in relation to the slotted holes in the expansion shoes with the prevailing temperature. Adjust the nuts on anchor bolts at the expansion ends of spans to permit the free movement of the span, and either provide lock nuts or burr the threads of the anchor bolts.

(6) Straightening Bent Material. Do not put bent or twisted members in place until all defects are corrected. The Engineer, (based on recommendations from the State Bridge Office) will reject damaged members. Straighten plates or other shapes by approved methods that will not produce fracture or other injury to the metal (i.e. yield strength, ductility, toughness). Do not heat the metal without approval of the Engineer. Submit the heat straightening procedure to the Engineer for approval. When permitted, perform the heat straightening procedure complying with AASHTO/AWS D1.5 (edition referenced in **subsection 705.2e.**) "Bridge Welding Code" and the latest versions of AASHTO's "Standard Specifications for Highway Bridges"; AASHTO's "LRFD Bridge Construction Specifications"; and the FHWA report, "Heat-Straightening Repairs of Damaged Steel Bridges". Following the straightening of a bend or buckle, the surface of the metal will be inspected by the Engineer for evidence of fracture, using the dye penetrant or magnetic particle inspection method.

(7) Assembling the Structural Steel. Use drift pins for all main member fit-up. Main members are defined as all girders and beams, cross-frames on curved girders or as specified in the Contract Documents. Assemble the parts as shown in the Contract Documents and erection diagrams, utilizing the matchmarks. Before the members are assembled, clean bearing surfaces and surfaces to be in permanent contact. Carefully handle the material so that no parts are bent, broken or otherwise damaged. Hammering that will injure or distort the members is prohibited. Misfitting may require revision of erection details and shop drawings by the Contractor with approval of the Engineer.

(8) Erecting Weathering Steel. Erect the fabricated weathering steel according to this subsection, with these additions:

Unless shown otherwise in the Contract Documents, protect the exposed surfaces of the substructure concrete from staining caused by the weathering steel. Cover the surface of piers and front faces of the abutments with polyethylene sheeting or other material approved by the Engineer before erecting the weathering steel. Maintain the protection until the bridge deck is completed.

After the bridge is completed, but before acceptance, sandblast the piers and front face of the abutment to a uniform appearance by removing all laitance, staining, any visible form lines, etc.

b. Bolted Field Connections.

(1) General. During field erection, follow the blocking diagram shown in the shop drawings. When designated, a "no-load" condition for blocking or laydown indicates the pieces were drilled/punched from solid plates laid on their sides without the deadload deflection included. Reproduce this geometry during erection by the use of falsework or cranes to "float" adjacent pieces together to facilitate proper fit-up.

Drift Pins: Use drift pins (cylindrical body pins with tapered ends) to facilitate driving and to line up the open holes in a connection. Use hardened steel drift pins with a minimum yield strength of 50 ksi and with the same nominal diameter as that of the open hole into which they are driven. Drive drift pins only to line up the holes. Do not deform the material.

Erection Bolts: Use A325 bolts the same size as the permanent bolts. Uniquely identify the erection bolts from the permanent bolts. Once erection bolts are no longer required, remove and replace with permanent bolts. Erection bolts may only be reused as such.

Fitting-Up: Accurately align all connections by driving drift pins in all corners and $\frac{1}{4}$ of the remaining holes in each plate in a well distributed pattern to align or "fair-up" the holes. Light drifting is permitted to affect this fairing-up of the holes. Heavy drifting which would deform the material is prohibited. Before removing any drift pins from structures being connected, or moving the connected members, fully tighten the bolts in a minimum of $\frac{1}{4}$ of the holes in the splices and field connections. For structures carrying workers and equipment, fully tighten the bolts in $\frac{3}{4}$ of the holes. Use high-strength erection bolts in combination with drift pins to hold the material together during fit-up.

Use pilot and driving nuts in driving pins (pin connections). Drive the pins so that the members take full bearing on them. Screw pin nuts up tight and burr the threads at the face of the nut with a pointed tool.

Immediately report to the Engineer any error in shop work that prevents the proper assembling and fitting up of parts. Reaming, chipping or cutting is prohibited without approval from the Engineer. Submit correction method for approval by the Engineer. Make the approved correction in the presence of the Engineer.

(2) Field Bolting with non-high-strength bolts. If non-high-strength bolts are specified for miscellaneous connections, use unfinished or machined bolts in bolted connections. Provide unfinished or machined bolts that have hexagonal heads and nuts and are of such length that they shall extend entirely through the nut a maximum of $\frac{1}{4}$ inch beyond the nut.

The diameter of the unfinished bolt may not be more than $\frac{1}{16}$ inch smaller than the diameter of the hole.

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The threads of machined bolts must be entirely outside the grip. The grip is the area from the finished head of the bolt to the finished nut. Use approved nut locks or flat washers $\frac{1}{4}$ inch thick under nuts, with the threads burred. Ream the holes for machined bolts. The hole diameters may not be more than $\frac{1}{32}$ inch greater than the diameter of the finished bolt. In bolted connections, draw the bolts up tight and burr the threads at the face of the nut with a pointed tool.

(3) Field Bolting with High-Strength Steel Bolts and Washers. No reaming, cutting and chipping is allowed for girder flange and web splices.

The slope of surfaces of bolted parts in contact with the bolt head and nut is a maximum of 1:20 with respect to a plane normal to the bolt axis. Do not separate bolted steel parts by gaskets. Steel parts must fit solidly together after the bolts are tightened. Standard holes have a diameter nominally $\frac{1}{16}$ inch in excess of the nominal bolt diameter. Use a hardened washer under the turned elements (head or nut) for all installations.

Where shown on approved shop drawings, oversized, short-slotted and long-slotted holes may be used with high strength bolts $\frac{5}{8}$ inch in diameter and larger in connections assembled as shown in **TABLE 712-1**.

TABLE 712-1: OVERSIZED HOLES	
Bolt diameter, d (inch)	Excess of nominal bolt diameter (inch)
$d \leq \frac{7}{8}$	$\frac{3}{16}$
$d = 1$	$\frac{1}{4}$
$d \geq 1 \frac{1}{8}$	$\frac{5}{16}$

Oversized holes may be used in only one of the connected parts of either a friction or bearing connection at an individual faying surface. Install hardened washers (of a sufficient size to completely cover the hole, after installation) over the oversized holes in an outer ply.*

Short-slotted holes shall be nominally equal to a standard hole width, and have a length that does not exceed the oversize diameter provisions for oversize holes by more than $\frac{1}{16}$ inch. Short-slotted holes may be used in only one of the connected parts of either a friction or bearing connection at an individual faying surface. The slots may be used without regard to direction of loading in friction connections, but must be normal to the direction of the load in bearing connections. Install hardened washers over short-slotted holes in the outer plies that have a size sufficient to completely cover the slots after installation.*

Long-slotted holes shall be nominally equal to a standard hole width and have a length more than allowed for short-slotted holes, but not more than $2 \frac{1}{2}$ times the nominal bolt diameter. Long-slotted holes may be used in only one of the connected parts of either a friction or bearing connection at an individual faying surface. The slots may be used without regard to direction of loading in friction connections, but must be normal to the direction of the load in bearing connections. Where long-slotted holes are used on an outer ply, provide a plate washer or continuous bar a minimum of $\frac{5}{16}$ inch thickness with standard holes. This washer or bar shall be of structural grade material, but need not be hardened. Provide washers or bars that have a size sufficient to completely cover the slots after installation. If hardened washers are required by the Contract Documents, place the hardened washers over the outer surface of the plate washer or bar.*

*When ASTM A490 bolts over 1 inch in diameter are used in slotted or oversized holes in external plies, use a single hardened washer complying with ASTM F436, except with $\frac{5}{16}$ inch minimum thickness, in lieu of the standard washer.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, burrs, dirt and other foreign material that would prevent solid seating of the parts. Tight mill scale may be accepted.

(4) Bolting Operation. See **FIGURE 712-1**. The Bolting Operation shall require Calibration, Installation and Inspection Verification.

Provide the Engineer applicable test results and certifications for bolt and DTI lots being used on the project: Rotational-Capacity Test (Bolt, Nut and Hardened Washer) & ASTM F 606 Annex A1 Compression Load Test (DTI).

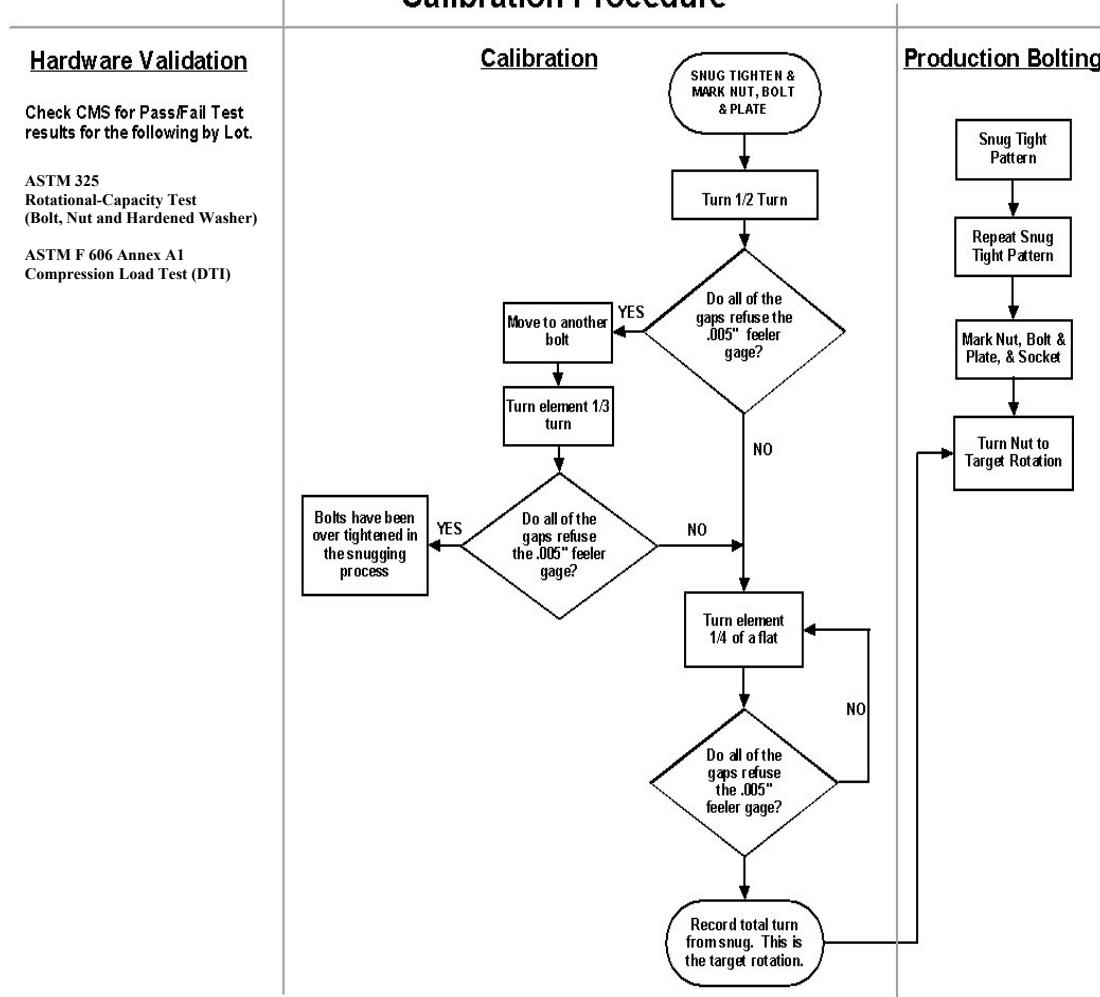
Calibration. Calibration (**FIGURE 712-1**) is the process of determining the correct tightening procedures so that consistency and accuracy are obtained. This procedure is only applicable to calibrating the turn of fasteners using DTI's. This is only used on girder splices and diaphragm connections or as noted in the Contract Documents.

The calibration procedure is as follows:

- Using plies with equivalent grip of the connection and correct bolt hole diameter, snug-tighten the fasteners such that all plates are in uniform contact;

- Place appropriate marks on the bolt, nut and plate so that the amount of nut rotation relative to the bolt can be verified;
- Hold the static element and rotate the turned element one half a turn. Record the number of gaps that refuse the 0.005 inch gage;
- If this rotation causes all of the gaps to refuse the feeler gage, move to another bolt and rotate the turned element $\frac{1}{3}$ of a turn and record the number of gaps that refuse the feeler gage;
- Continue rotating the turned element until all the gaps refuse the 0.005 inch gage. Record the rotation. This is the target rotation for the bolting operation for this bolt length and diameter;
- Repeat this procedure for every bolt length and diameter on the project.

FIGURE 712-1
Bolting Operation Flow Chart
Calibration Procedure



Installation. To achieve uniform results, install bolts after performing calibration tightening procedures.

Tighten threaded bolts by methods described below. If required because of bolt entering and wrench operation clearances, tightening may be accomplished by turning the bolt while the nut is prevented from rotating.

Use impact wrenches of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

Indicate in the shop drawings where washers are required. Only use hardened washers. Use an additional hardened washer with all ASTM A 490 bolts under the element not turned, if the material against which it bears has a specified minimum yield point less than 40 ksi.

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Where an outer face of the bolt part has a slope greater than 1:20 with respect to a plane normal to the bolt axis, use a beveled washer to compensate for the slope.

Use the turn-of-nut method to provide the required bolt tension for all bolted connections. Install bolts in a minimum of $\frac{1}{4}$ of the connection holes and bring them to a "snug tight" condition. Snug tight is defined as the condition that exists when the plies of the splice are in firm uniform contact. A few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench should attain this condition. Perform snug tightening systematically from the center of the splice to the free edges, and then re-tighten the bolts in a similar systematic manner until all bolts are snug tight and all splice plates are fully compacted. The connection is then ready for final tightening. For proper installation bring all bolts to "snug tight" in the same manner as in the calibration.

Only use a Direct Tension Indicator (DTI) for girder splices and diaphragm connections, or as noted in the Contract Documents.

Install the DTI's by one of the following methods:

- Place a DTI under the bolt head and turn nut to tighten. This method is preferred whenever possible. Face the protrusions on the DTI to the underside of the bolt head. Place a hardened flat washer under the nut;
- Place a DTI under the nut and turn the nut to tighten. Place a hardened washer between the nut and the DTI. Place the DTI against the plates with the protrusions facing the washer;
- Place a DTI under the nut and turn the bolt. Face the protrusion on the DTI to the nut. Place a hardened flat washer under the bolt head; or
- Place a DTI under the bolt head and turn the bolt head to tighten. This method is suggested when the nut can not be turned. Place hardened flat washer between bolt head and the DTI. Face the protrusions on the DTI to the underside of the flat washer and bolt head. Place a hardened flat washer under the nut.

On connections specifying the use of DTI's, use the turn-of-nut method and tighten all bolts in the connection as determined from the "Target Rotation" in **FIGURE 712-1**. During the tightening operation, there must be no rotation of the part not turned by the wrench. Perform tightening systematically from the most rigid part of the joint to its free edges. Place appropriate marks on the bolt, nut and plate so that the amount of nut rotation relative to the bolt can be verified. Use the turn specified in **TABLE 712-2** for all connections other than girder splices and diaphragm connections.

TABLE 712-2 - NUT ROTATION (*) FROM SNUG TIGHT CONDITION

Bolt Length (as measured from underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal bolt axis (bevel washer not used)
Up to and including 4 diameters	1/2 turn	1/2 turn	2/3 turn
Over 4 diameters, but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters, but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn
Over 12 diameters	The method of tightening bolts over 12 diameters in length is as shown on the shop details and approved by the Engineer		

*Nut rotation is relative to the bolt, regardless of the element (nut or bolt) being turned. For bolts installed by $\frac{1}{2}$ turn and less, the tolerance is $\pm 30^\circ$; for bolts installed by $\frac{2}{3}$ turn and more, the tolerance is $\pm 45^\circ$.

Lubricate all galvanized nuts with a lubricant containing a visible dye so a visual check can be made for the lubricant at the time of field installation. Black bolts must be "oily" to the touch when installed. Clean and relubricate weathered or rusted bolts before installation. Store bolts in closed containers, at all times when not in use.

Do not reuse ASTM A 490 and A 325 bolts, or any bolt that has been fully tightened.

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Inspection Verification. Inspection verification confirms end results of the bolting operation; the inspection provides acceptance or rejection of the finished connection. See **FIGURE 712-2**.

Commencing with each day's bolting operation, the Engineer will inspect each bolt until the Contractor's procedures for that day are confirmed. After the day's procedures are confirmed, a minimum of 20% of all the bolts in all splices will be checked with a feeler gauge. This check should be randomly distributed over all the plates within the splice.

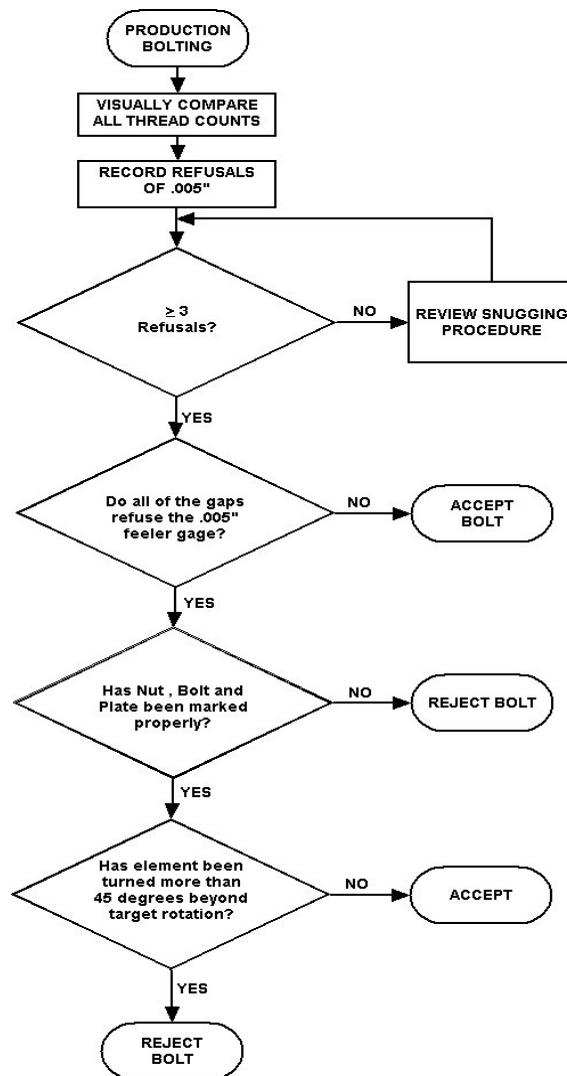
Visually compare the number of threads extending past the face of the nut for uniform appearance. Record the number of refusals using the 0.005 inch gage. (Note: some DTI suppliers provide both 0.005 inch and 0.015 inch gages. Use only the 0.005 inch gage). If the number of refusals is less than 3, tighten until there are a minimum of 3 refusals. If this occurred with the proper rotation, all the plies were not in proper snug-tight condition. If the number of refusals with the 0.005 inch gage is greater than or equal to 3, but less than the number of protrusions, accept the bolt. If all the gaps refuse the 0.005 inch gage, the actual rotation must be compared with the target rotation:

- If the element has been turned more than 45° beyond the target rotation, reject the bolt.
- If the element has been turned less than 45° beyond the target rotation, accept the bolt.

If the feeler gage is refused by all gaps and the bolt, nut and plate have not been marked, the bolt will be rejected.

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FIGURE 712-2 – Direct Tension Indicator Verification



Bolt Size	DTI Spaces		Minimum Installation Refusals	
	A 325	A 490	A 325	A 490
5/8	4	5	2	3
3/4	5	6	3	3
7/8	5	6	3	3
1	6	7	3	4
1-1/8	6	7	3	4
1-1/4	7	8	4	4
1-3/8	7	8	4	4

c. Welded Field Connections. Perform field welding and gas cutting of structural steel according to the applicable requirements of the AASHTO/AWS D1.5 (edition referenced in **subsection 705.2e.**), "Bridge Welding Code" with the exceptions and additions listed in **SECTION 705**.

Fill erection holes in the girder webs with button head or hex head bolts equipped with regular hex nuts. Use only one type of bolt head. Place the heads of the bolts on the outside faces of the webs.

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Erection bolts or other methods approved by the Engineer may be used for closing erection holes in other parts of the structure.

All permanent field welded connections of structural steel, except splices in steel piles, shall be made by welders who have qualified in accordance with the requirements of the latest version of AASHTO/AWS D1.5, "Bridge Welding Code" and **SECTION 713**.

d. Welded Stud Shear Connectors. Welded Stud Shear Connectors may be applied during shop fabrication or in the field. If field applied, refer to **subsection 705.2d.(12)**.

e. Field Painting. Prepare the structural steel surfaces and field paint the prepared surfaces according to **DIVISION 700**.

712.4 MEASUREMENT AND PAYMENT

The Engineer will measure structural steel by the pound. The measured quantity for payment of structural steel is the quantity shown in the Contract Documents. If the Contract Documents are altered for changes in design, or if disagreement exists between the Contractor and the Engineer as to the accuracy of the quantities in the Contract Documents, either party has the right to request and cause the quantities involved to be measured. Use **TABLE 712-3** to compute the weights.

TABLE 712-3: CONVERSION UNIT WEIGHTS	
Type	Unit Weight (Lb. per Cu. In.)
Structural Steel	0.2833
Bronze	0.315
Cast Iron	0.26

The Engineer will not measure fasteners including erection bolts, button head bolts used for filling erection bolt holes, high-strength bolts for permanent connections, temporary laterals or similar items. The Engineer will not measure weld metal deposited in fillets, or otherwise outside the lines and surfaces of the connected parts; but no deductions are made from the computed quantities of such work to allow for material that is removed by beveling or other cutting, and subsequently replaced with weld metal.

The Engineer will measure each welded stud shear connector either applied during fabrication or in the field.

Payment for "Structural Steel", "Structural Steel (Merchant Quality)" and "Welded Stud Shear Connectors" at the contract unit prices is full compensation for the specified work.

The Engineer will pay for structural steel according to **TABLE 712-4**.

TABLE 712-4: PAYMENT FOR STRUCTURAL STEEL	
% Payment of the Contract Quantity	Milestone
90	All structural steel is completely fabricated, in place, inspected and ready to weld or bolt according to the Contract Documents.
95	All structural steel is welded or bolted according to the Contract Documents.*
100	All structural steel is painted according to the Contract Documents, when in the contract.

*If painting of structural steel is not required, pay 100%.

713 - QUALIFICATION OF FIELD WELDERS

SECTION 713

QUALIFICATION OF FIELD WELDERS

713.1 DESCRIPTION

To field weld structural steel on KDOT projects, become qualified for each welding process by passing tests witnessed by the Regional Materials Engineer or a designated representative, according to this specification and AASHTO/AWS D1.5 (except as modified by this section). Perform testing using portable equipment at an outdoor location selected by the Regional Materials Engineer.

713.2 TEST SPECIMENS

Supply test plates and backing bars. Present mill test reports for each heat used in the test plates and backing bars before the test begins.

a. Base Metal for Test Specimens. Qualification established with any of the steels listed shall be considered as qualification to weld or tack weld any of the other steels listed except qualification to weld or tack weld steel with a minimum yield strength of 90 ksi or greater shall be established with steel meeting the same specification as steel for the project. Use the following base metals for tests: AASHTO M 270 or ASTM A 709. Other steels may be approved by the Regional Materials Engineer.

b. Shielded Metal Arc Welding (SMAW) Restrictions. A welder qualified for SMAW using EXX18 electrodes shall be qualified to weld with all SMAW electrodes allowed by AASHTO/AWS D1.5 except welders required to use an electrode classification of E100XX-X or higher to join metals with a minimum specified yield strength of 90 ksi or greater shall be tested using E10018-X or E11018-X electrodes as necessary to match the yield strength of the base metal to be used in the work.

713.3 PREPARATION OF SPECIMENS

Use test plates as shown in AASHTO/AWS D1.5, Figure 5.17 and free from rust, grease, paint and dirt. Test in the vertical and in the overhead positions.

Securely tack or clamp the plates in position. Then, weld and prepare as follows:

- The weld reinforcing shall be sufficient to obtain full cross-sectional area and in no case shall it be greater than $\frac{1}{8}$ inch;
- Deposit all vertical welds from the bottom to the top;
- Use hand chipping and hand brushing to clean between weld passes. Power chippers or grinders are prohibited during the test. Do not modify root or intermediate weld contours by chipping, grinding, cutting, or other means before depositing subsequent weld passes. Perform weld cleaning without moving the test plates out of position during the test;
- Cut out the side bend specimens (see D1.5, Figure 5.17) with a saw. Smoothly cut the edges of the specimens with a grinding wheel or file. If the welder elects to have the test weld radiographically examined, do not make saw cuts; and
- Unless radiography is used, carefully remove the weld reinforcement and backing by grinding or machining so that the weld shall be flush with the parent metal. Perform all grinding or machine marks perpendicular to the weld. Emery cloth or a file finish is recommended. When radiography is used, leave a 3 inch minimum width backing bar in place.

713.4 TESTING OF SPECIMENS

a. General. All testing shall be by or in the presence of the Regional Materials Engineer or a designated representative.

With the exception of fracture critical welder testing, testing may be by mechanical means or by radiography at the welder's option. All radiography will be at the welder's expense. If all specimens meet the test requirements, the welder will be qualified and an identification card will be issued. A card will be issued yearly unless either **subsection 713.5a.** applies, or the welder fails to meet the reporting requirements of **subsection 713.6.**

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b. Test Procedure for Mechanical Testing. Each test specimen shall be subjected to a side bend test by bending around a 1 ½ inch diameter pin in a test jig. A specimen whose surface contains undercut or discontinuities exceeding the following dimensions will be considered to have failed the test.

- $\frac{1}{8}$ inch measured in any direction on the surface.
- $\frac{3}{8}$ inch for the sum of the greatest dimensions of all discontinuities exceeding 1/32 inch, but less than or equal to $\frac{1}{8}$ inch.
- $\frac{1}{4}$ inch for the maximum corner crack, except:
 - When that corner crack results from a visible slag inclusion or other fusion type discontinuity, the $\frac{1}{8}$ inch maximum shall apply.
 - Specimens with corner cracks exceeding $\frac{1}{4}$ inch with no evidence of slag inclusions or other fusion type discontinuities shall be disregarded, and a replacement test specimen from the original welding shall be tested.

c. Procedures for Radiographic Qualification. Ground the weld reinforcement flush with the surface of the test plate. Follow radiographic procedures and techniques that are in compliance with the latest edition of AASHTO/AWS D1.5.

d. Retesting. If any specimen fails to pass the above test requirements, the test may be repeated. The welder shall prepare 2 sets of specimens for retest for each position that failed. If both sets of specimens meet the requirements, the welder will be qualified. If either of the sets of specimens submitted for retest fails to meet the requirements, the welder will not be permitted to take qualification tests for a minimum of 6 months unless evidence of further training is provided.

713.5 REQUALIFICATION

a. General. With the exception of fracture critical field welding, the welder's qualification here-in specified shall be considered as remaining in effect indefinitely unless:

- (1) The welder has not welded steel for use on a KDOT project for a period of 1 year.
- (2) The welder has not welded for a period exceeding 6 months in a given process of welding for which the welder was qualified. The requalification test need be made only in the $\frac{3}{8}$ inch thickness.
- (3) The welder has been suspended while welding on a KDOT project due to one of the following:
 - Poor workmanship.
 - Unsatisfactory appearance of the weld.
 - Undercutting.
 - Slugging.
 - Using electrodes that have not been properly dried or stored.
 - Poor cable connection.
 - Excessive inclusions determined by radiographic inspection.

b. Test Required for Re-Qualification. When the quality of welder's work becomes unsatisfactory, as defined above, the welder will be suspended and will remain suspended until permitted to re-qualify by the Regional Materials Engineer.

Prepare and test all specimens required for re-qualification tests in the presence of the Regional Materials Engineer or a designated representative.

713.6 EVIDENCE OF WELDING ON KDOT PROJECTS

Regional Materials Engineers will maintain a record on each field welder who is qualified by their office to weld on KDOT projects. Annually submit to the qualifying Regional Materials Engineer a list of KDOT project numbers on which field welding was performed during the past 12 months.

713.7 QUALIFICATION FOR FILLET WELDING ONLY

Some KDOT projects require only fillet welds to attach stiffeners or bearings in the field. In this case, and with the approval of the Regional Materials Engineer, qualification for fillet welding will be done on a job by job

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basis by testing in the vertical and overhead fillet weld positions according to AASHTO/AWS D1.5 Section 5.26.3.1. See D1.5, Figure 5.21 for the test. No welder's card will be issued to fillet welders. The approval by the Regional Materials Engineer to accept this type of qualification will be based on the structure type, location of work within structure, and the overall complexity of work.

713.8 QUALIFICATION FOR FRACTURE CRITICAL WELDING

Perform fracture critical welder qualification according to AASHTO/AWS D1.5, Section 12.

713.9 REGIONAL MATERIAL'S LABS

Kansas City Regional Materials Lab
P.O. Box 860462
Shawnee Mission, KS 66286-0462
Phone: 913-441-0346

Wichita Regional Materials Lab:
3200 E. 45th St. N.
Wichita, KS 67220
Phone: 316-744-0421

714 - PAINTING STRUCTURAL STEEL

SECTION 714

PAINTING STRUCTURAL STEEL

714.1 DESCRIPTION

Prepare the structural steel surfaces, and paint the structural steel as shown in the Contract Documents. Provide environmental protection as necessary.

<u>BID ITEMS</u>	<u>UNITS</u>
Bridge Painting (*)	Lump Sum
Environmental Protection	Lump Sum
Power Wash	Lump Sum
*Type of Paint System	

714.2 MATERIALS

Provide paint materials that comply with **DIVISION 1800**.

Formulate the inorganic zinc or organic zinc coating to provide a tint which distinctly contrasts with blast cleaned metal surfaces and the finish coat.

714.3 CONSTRUCTION REQUIREMENTS

a. General Requirements for Painting Structural Steel.

(1) Surface Preparation Before Applying The Prime Coat. Blast all surfaces with abrasives to produce a height of profile of 1 to 3 mils.

Clean structural steel surfaces to meet the Society for Protective Coatings' (SSPC) specification SSPC-SP10, Near-White Blast Cleaning. Limit staining to a maximum of 5% of each square inch of surface area.

If specified (such as for unpainted surfaces of weathering steel or when repainting existing bridges in kind), clean structural steel surfaces to meet SSPC-SP6, Commercial Blast Cleaning, except wet blasting will not be permitted. Staining is limited to a maximum of 33% of each square inch of surface area. If the original surface is pitted, slight residues of rust and paint may be left in the bottom of pits.

Staining may consist of slight shadows, slight streaks or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. When viewed without magnification, the blast cleaned surface shall be free of visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter.

Remove all machine cutting oil by cleaning machined surfaces (ANSI 125 micro-inch or smoother). Carefully mask the machined surfaces before blast cleaning the remaining surfaces of the member.

After blast cleaning, remove any trace of blast products. Take care to remove abrasives from pockets and corners.

Give the blast cleaned surfaces a prime coat of paint within 12 hours of cleaning. Re-clean the blast cleaned surfaces if rust tinge appears before the prime coat is applied.

(2) Weather Conditions. Check the air temperature, the steel temperature and the dew point before painting begins each day, and after each suspension of painting due to weather or temperature, if painting is to resume. Do not apply paint if the ambient air temperature is below 40°F, when the air is misty, when the steel temperature is 5° or less above the dew point, or if the Engineer determines conditions are unsatisfactory for painting. Do not apply paint on damp or frosted surfaces. Stop paint application if the Engineer determines the air temperature is so high that the spray dries before reaching the surface, resulting in a dry, powdery coating.

(3) Mixing and Thinning Paint. Thoroughly mix the paint and keep the pigment in suspension. Strain the mixed paint when recommended by the manufacturer.

If multi-component inorganic zinc primer is used, follow the manufacturer's instructions regarding the amount and manner of adding the zinc dust to the liquid portion. Strain the mixed paint through a metal screen having a mesh recommended by the manufacturer. Mix multi-component inorganic zinc paint fresh each day and do not use it past the pot life time stated in the manufacturer's literature.

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The Engineer will permit paint thinning if required for proper application, but only as recommended by the manufacturer. If thinner is used, add it to the paint during the mixing process. Do not add additional thinner after the paint is thinned to the proper consistency.

Use thinner recommended by the manufacturer for inorganic zinc paints. Inorganic zinc paint should not require heating in cool weather, but is permitted provided care is taken that the paint is protected from all moisture.

(4) Application of Paint. Apply the paint according to the manufacturer's instructions. Provide the Field Engineer with a printed copy of the paint manufacturer's application instructions.

Apply the paint using either a conventional or an airless sprayer. Spray from a continuously agitated pot.

Apply uniform coatings in tight contact with the metal. Work the coating into all corners and crevices. Apply a coating that is free of all defects.

Allow ample time for each paint coating to dry. Do not apply the next coat of paint until the previous coat is inspected by the Engineer and found dry and hard throughout the entire film thickness.

Remove and replace defective or unauthorized paint. Prepare the surfaces for repainting and repaint the areas according to the requirements for painting structural steel.

When the finish coat is complete, stencil (in black paint) the date the bridge was painted and the code representing the type of paint system used on the bridge. Stencil the legend on the right side of the outside face of the far right stringer near each end of the bridge. Use capital letters, 2 to 3 inches in height. The date stencil shall contain the word "PAINTED" and show the month and the year that the painting was completed. Make the paint system code selection from the following list:

Inorganic Zinc/Acrylic	IZ/A
Inorganic Zinc/Polyurethane	IZ/P
Organic Zinc/Acrylic	OZ/A
Organic Zinc/Polyurethane	OZ/P

(5) Staging and Scaffolding. Use adequate staging and scaffolding while painting the structural steel. Do not climb or work on the finished painted members. Provide the Engineer with safe means (such as scaffolding, snoopers or cherry pickers) to inspect any portion of the structure during the cleaning and painting operations.

(6) Protection of Pedestrians and Property. When painting on the project site, protect all pedestrians, vehicles (on or underneath the bridge), adjoining property along the right-of-way, pipes or ducts owned by utility companies, and portions of the bridge superstructure and substructure against damage or disfigurement from paint material. The Contractor is responsible for repairing any damage resulting from the painting operations.

(7) Maintaining Traffic on Existing Bridges. Provide traffic control as shown in Contract Documents and **SECTION 805**. Unless traffic is detoured, maintain traffic on the existing bridge at all times during the work of cleaning and painting. At the option of the Contractor when work is being performed, $\frac{1}{2}$ of the roadway on that span may be closed to traffic, with one way traffic being maintained over the other half of the roadway. At all other times when work is not being performed, keep the entire bridge roadway open to traffic.

b. Shop Painting Structural Steel (Non-Weathering). The application of the prime coat in the shop must comply with the general requirements for painting structural steel, with these additions and exceptions:

Unless shown otherwise in the Contract Documents, apply 1 coat of inorganic zinc primer to the structural steel in the shop. Mask machined surfaces prior to painting. Use primer that is tinted to contrasts (in color) with the blast-cleaned steel and with the finish coat of paint.

Apply 2 primer coats (not less than 6 mils total thickness) to surfaces that are not in contact with the concrete, but that will be inaccessible after assembly or erection. Apply the second coat between 4 and 24 hours after application of the first coat.

Except where otherwise indicated, coat all blast cleaned surfaces of the structural steel, including contact surfaces of high strength bolt connections and areas in contact with concrete. The dry film thickness of the prime coat shall be 3 to 6 mils on flat areas. More thickness is allowed in fillet areas if there is no evidence of mud cracking, and if the coating is tight. The dry film thickness is measured from the peaks of the blast profile to the surface of the paint.

For contact surfaces of high strength bolted connections, the dry film thickness shall be 1.5 to 3 mils. Both sides of steel plates that have holes for high strength fasteners are considered contact surfaces because they come into contact with other steel plates, nuts, washers or fastener heads.

Apply 1.5 mils dry film thickness prime coat to top flanges of structural steel members that will have welded stud shear connectors applied in the field. Do not apply the prime coat to surfaces within 6 inches of field

welded connections. Coat unpainted surfaces near field welded connections with a rust preventive coating approved by the Engineer. The temporary coating must be easily removed with mineral spirits prior to field welding.

After the non-machined surfaces of structural steel are prime coated, remove the masking from the machined surfaces and apply a prequalified coating for use on machined surfaces approximately 3 mils thick.

If the dry film thickness of the prime coat is 2 to 3 mils, and less than 24 hours old, either blast clean the deficient area to bare metal and repaint, or apply additional primer. If additional inorganic zinc primer is applied, thin the primer 1:1 with a solvent recommended by the manufacturer of the paint.

If the dry film thickness of the prime coat is 2 to 3 mils thick and more than 24 hours old, or if the dry film thickness is less than 2 mils, blast clean the deficient area to bare metal and repaint. Remove excessive film thickness or dry spray.

Give the inorganic zinc prime coat a thorough single spray of clean water between 2 and 48 hours after application of the inorganic zinc prime coat, when recommended by the manufacturer.

Before the structural steel is shipped to the project site, blast clean to bare metal and repaint defective or damaged areas. Overlap the new prime coat onto the existing prime coat a minimum of 1 inch.

Shop painted structural items, except matchmarked girders and beams, that will receive a field coat of paint must have an identification mark painted on their surface, or they may be tagged with a weatherproof tag.

c. Field Painting New Structural Steel (Non-Weathering).

(1) Prime Coat. Apply a prime coat to the field connections, field welds, nuts, bolts and washers. Re-coat all damaged or defective areas of the shop-applied prime coat. Apply the prime coat in the field complying with the general requirements painting structural steel, with these additions and exceptions:

Overlap the shop coat by applying the field-applied prime coat a minimum of 1 inch beyond any surface preparation.

If the surface prepared for painting or re-coating is 1 square yard or less, apply organic zinc primer. Use organic zinc primer on bolts, nuts, washers and edges of bolted splice plates.

If the surface prepared for painting or re-coating is greater than 1 square yard, blast clean the entire flange or web of the area to be painted or re-coated, and apply inorganic zinc primer. Between 24 and 48 hours after the inorganic zinc primer is applied in the field, apply a coat of organic zinc primer (by brush or spray according to subsection 714.3b.) where the new inorganic zinc prime coat meets or overlaps the shop applied inorganic zinc prime coat.

If welded stud shear connectors are applied in the field, blast clean the top of the top flange to SSPC-SP6, Commercial Blast Cleaning. After the welded stud shear connectors are applied, blast clean the top flange and welded stud shear connectors to meet SSPC-SP6, Commercial Blast Cleaning. Thoroughly blast clean the welds. Apply organic zinc primer to the top flange and welded stud shear connectors. The top 1 inch of the welded stud shear connectors (including the underside of the stud head) need not receive a full coat of primer.

(2) Finish coat. Protect the primed structural steel from contamination during transport, storage and erection. Do not walk on the primed structural steel. If the primed structural steel is soiled, use water or light blast cleaning to remove the contamination before applying the finish coat of paint.

The application of the finish coat in the field shall comply with the general requirements for painting structural steel, with these additions and exceptions:

Unless otherwise noted in the Contract Documents, either apply an acrylic or a polyurethane finish coat after the primed structural steel is erected. Apply 1 coat with a dry film thickness of 3 to 6 mils on flat areas. A thickness in excess of 6 mils is allowed in fillet areas if there is no evidence of mud cracking, and if the coating is tight. If bubbles form, allow them to collapse and apply approximately 1 mil of the finish coat to the area where the bubbling occurred.

d. Shop Painting New Weathering Steel. Apply the shop painting of new weathering steel complying with the general requirements for painting structural steel and the shop painting of non-weathering structural steel, with these additions and exceptions:

Blast clean all surfaces of the weathering steel, including all contact surfaces of bolted connections, to meet SSPC-SP6, Commercial Blast Cleaning.

For weathering steel surfaces that require painting, blast clean to meet SSPC-SP10, Near-White Blast Cleaning.

Surfaces that require paint include:

- girder ends that are embedded in the abutment - the entire embedded portion of the girder, including diaphragms, plus an additional distance of 2 inches;

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- the top (and sides, if in contact with concrete) of the top flanges, including shear studs. Note: for welded stud shear connectors applied in the field, the top of the top flange does not require a shop prime coat;
- all surfaces of top flange top splice plates;
- all surfaces of fill plates less than $\frac{1}{4}$ inch thick. Note: Fill plates need not be weathering steel. Paint fill plates of non-weathering steel, regardless of thickness;
- all structural steel surfaces (not included above) within a distance of 2 times the depth of the girder (2D) on either side of an expansion joint. (Note: A nearby stiffener is a convenient location to stop painting.); and
- the exterior girders according to **FIGURE 714-1**, if drainage is allowed over the side of the deck on a plate girder bridge, and the entire length of the exterior girder is to be painted. Note: If drainage is allowed over the side of the deck on a rolled beam bridge, painting of the exterior beam, except top flange, is not required.

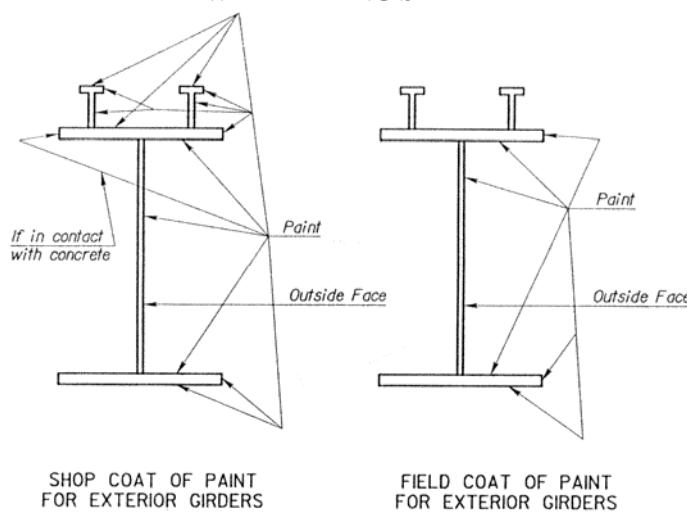
e. Field Painting New Weathering Steel. Apply a finish coat to all primed structural steel surfaces still exposed after the placement of superstructure concrete. The surface preparation of the top surface of the top flange (field applied welded stud shear connectors), and the application of the prime coat (including the top of the top flange after welded shear stud connectors have been applied in the field) and the finish coat in the field shall comply with the general requirements for painting structural steel and the field painting of new, non-weathering structural steel, with these additions and exceptions:

Unless noted otherwise in the Contract Documents, use a waterborne acrylic, brown finish coat color equivalent to Federal Standard No. 595a, Color No. 30045 (Carboline No. 2248).

If drainage is allowed over the side of the deck on a plate girder bridge, and the entire length of the exterior girder is to be painted, apply a finish coat to the exterior girders according to **FIGURE 714-1**.

Unless shown otherwise in the Contract Documents, blast clean the entire exterior facia of the unpainted exterior girders after erection to meet SSPC-SP6, Commercial Blast Cleaning.

**FIGURE 714-1
WEATHERING STEEL**



f. Painting Galvanized Steel. Follow ASTM D 6386 to prepare galvanized surfaces that are to be painted, then apply a primer tiecoat prior to application of the topcoat. Use a tiecoat that is compatible with the topcoat and approved by the Engineer. Follow the manufacturer's recommendations for application, including dry film thickness and cure time of the primer tiecoat.

g. Repainting Steel Bridges - Change Paint System. Repaint the steel bridges. Comply with the general requirements for painting structural steel, with these additions and exceptions:

Remove the existing paint system and repaint the bridge with a paint system of organic zinc or inorganic zinc prime coat and acrylic or polyurethane finish coat.

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Clean and prepare the steel surfaces, including iron or steel casings and metal railings previously painted that are accessible for field painting. Do not paint tops of expansion guard plates, bars or angles across the roadway at joints between adjacent spans on which vehicular traffic comes in direct contact, and pipes or ducts owned by utility companies.

If lower chords, braces of truss spans or other members are separated by tie plates or fills, clean the spaces between backs of angles or channels (equal to the thickness of the tie plates or fills) of all rust and loose paint. Tight paint found between splice plates, beneath rivet heads and in other such narrow openings may be left intact. Take special care to remove the rust often found along the edges of the top flanges of I-beams at their line of contact with a concrete deck.

Apply the type of prime coat specified in the Contract Documents with 3 to 6 mils dry film thickness of the prime coat on flat areas. More thickness will be allowed in fillet areas if there is no evidence of mud cracking, and if the coating is tight.

After the prime coat is dry, give the inorganic zinc prime coat a thorough spray of clean water a minimum of 24 hours before the finish coat is applied. Organic zinc paint does not require a water spray.

Spray painting may be waived in those places where it is not possible to blast clean. Clean these areas by hand as well as possible, and apply a heavy coat of organic zinc primer with a brush or dauber.

Apply 1 finish coat with 3 to 6 mils dry film thickness on flat areas. A thickness in excess of 6 mils is allowed in fillet areas if there is no evidence of mud cracking, and if the coating is tight. If bubbles form, allow them to collapse and apply an approximate 1 mil of the finish coat to the area where the bubbling occurred.

h. Repainting Steel Bridges - Painting In Kind (Bridges with either organic zinc or inorganic zinc prime coat and acrylic or polyurethane finish coat paint systems). Repaint the steel bridges. Comply with the general requirements for painting structural steel, with these additions and exceptions:

Prepare the metal surfaces and repaint the bridge with the same paint system as existing.

Clean and prepare the steel surfaces, including iron or steel casings and metal railings previously painted that are accessible for field painting. Do not paint tops of expansion guard plates, bars or angles across the roadway at joints between adjacent spans on which vehicular traffic comes in direct contact, and pipes or ducts owned by utility companies.

If lower chords, braces of truss spans or other members are separated by tie plates or fills, clean the spaces between backs of angles or channels (equal to the thickness of the tie plates or fills) of all rust and loose paint. Tight paint found between splice plates, beneath rivet heads and in other such narrow openings may be left intact. Take special care to remove the rust often found along the edges of the top flanges of I-beams at their line of contact with a concrete deck.

Blast clean the steel surfaces to remove any defective coating. Hand clean widely spaced damaged spots (3/16 inch or less in diameter) on an otherwise tight existing coating. Remove oil and grease using a non-flammable solvent approved by the Engineer.

Clean areas according to SSPC-SP6, Commercial Blast Cleaning to produce a height of profile of 1 to 3 mils.

Apply 1 coat of organic zinc (minimum dry film thickness of 3 mils) to bare metal. Cover the bare metal and overlap the existing finish coat by 1 inch.

Spray painting may be waived in those places where it is not possible to blast clean. Clean these areas by hand as well as possible, and apply a heavy coat of organic zinc primer with a brush or dauber.

Use the type of finish coat specified in the Contract Documents. Apply 1 finish coat with 3 to 6 mils dry film thickness on flat areas. A thickness in excess of 6 mils is allowed in fillet areas if there is no evidence of mud cracking, and if the coating is tight. If bubbles form, allow them to collapse and apply an approximate 1 mil of the finish coat to the area where the bubbling occurred.

714.4 ENVIRONMENTAL PROTECTION (Existing Paint Systems)

Provide environmental protection on a structure whether partially or completely removing an existing paint system. The removal of existing lead-based paint may result in creation of waste subject to hazardous waste regulations.

a. Structure Classification. The bridge classification will be included in the Contract Documents, prior to letting.

For the purpose of this specification, bridges are classified as:

(1) Class A: A bridge in which any part is within 300 feet of:

- a residence, a school, a public use area, a commercial/industrial property, agricultural buildings;
- or a protected natural area property.

(2) Class B: Any bridge that is not Class A.

b. Health and Environmental Sampling.

(1) The Environmental Services Section (ESS) of the Bureau of Design will conduct a bridge Site Review and Field Survey (SRFS) to document the details of the project and the environmental concerns in the vicinity.

(2) Soil samples will be collected by the ESS prior to and at the conclusion of paint removal operations. While conducting the SRFS, soil samples will be collected within KDOT right-of-way from a minimum of 1 test site 10 to 100 feet away from the structure in each of 4 directions. The specific location of each site will be documented. Each test site shall consist of a 1 square foot area. A composite sample will be obtained by collecting soil $\frac{3}{4}$ inch in diameter and $\frac{1}{2}$ inch in depth at the center of the square and at each of the 4 corners.

At the conclusion of the project, soil samples will be collected by the ESS in the same manner at a 1 square foot area within a radius of 5 feet of the original sample location. The pre-job and post-job samples will be analyzed for total lead at a Kansas Department of Health and Environment (KDHE) certified laboratory.

(3) The air sampling equipment shall be provided by the Contractor and will remain the property of the Contractor. Collect air samples, unless stated otherwise in the Contract Documents, on all Class A bridges. Collect the samples following the procedures specified in the Code of Federal Regulations (CFR), 40 CFR 58, Appendix G and the quality assurance procedures as specified in 40 CFR 58, Appendix B and 40 CFR 58.20. Employ high volume air samplers to assess the effects of blasting operations on ambient air quality outside the containment structure. Collect air samples each day paint is blasted from the structure. Place the air samplers on KDOT right-of-way in the upwind and downwind position to the prevailing wind at locations expected to experience maximum impact. Locations for air sampling will be approved by the Engineer. Remove and replace the sample filters each day. Store the used filters in air-tight bags, properly identified with date, sample location and KDOT project number.

Submit the air sample filters to a KDHE certified laboratory a minimum of once every 5 working days, where they will be analyzed for total lead. Lead concentrations in ambient air must be in compliance with 40 CFR 50, which allows a maximum of 0.05 mil/cubic yard (See Guide 6, Section 5.5.4). The laboratory analyses must be accelerated in order to have analytical results to the Engineer within 5 working days of the original transmittal to the laboratory. Identify the analytical results by the date of collection, type and location of sample, and KDOT project number.

If ambient air concentrations exceed regulatory limits, halt blasting operations until containment design controls have been implemented to reduce emissions to a satisfactory level.

(4) Collect surface water samples on all bridges located over any perennial stream, river or body of water. Sediment samples may also be required, at the discretion of the Engineer, where stream flow is extremely low, where containment has obviously failed or when paint removal operations exceed 30 calendar days. At the direction of the Engineer, a minimum of 1 sample shall be collected upgradient of the structure and 1 in the down gradient position of the structure during blasting operations. The samples will be representative of the project's potential impact to the water body and will be collected in the presence of the Engineer. If visible waste or paint chips are observed on the surface of the waterway, halt blasting operations until the containment has been modified to eliminate debris contact with the water surface. This determination will be made by the Engineer. Identify water samples by date, type and location of sample, and KDOT project number. Submit the water samples to a KDHE certified Laboratory for the analysis of total lead within 1 week from the time of collection. Submit the analytical results to the Engineer upon receipt from the laboratory. Identify the analytical results by date of collection, type of sample, Chain of Custody forms, and KDOT project number.

(5) Failure to submit analytical data for air and water samples on a timely basis as described above may result in work on the project being suspended by the Engineer until submittals are in compliance. Temporary suspension of work on the project due to non-compliance by the Contractor will not alter or waive the charging of working days for the project.

(6) Submit all documentation relative to air and water sample collection and analyses to the ESS within 30 days of completion of the paint removal process. If documentation is not submitted, the Engineer may stop work on the project until such documentation has been received by the Engineer and ESS.

c. Notifications and Record Keeping. The ESS will submit a SRFS report to the Bureau of Waste Management (BWM), KDHE, Forbes Field, Topeka, Kansas 66620-0001 a maximum of 60 days before beginning work on the bridges. At the same time, a copy will also be provided to the Bridge Management Section and the

appropriate KDOT District Office. The District Office will provide a copy of the Site Review and Field Survey report to the Contractor.

At the conclusion of the blasting operations, the ESS will submit a report to the BWM, which includes the results of all air, soil, and surface water samples obtained during the project. A copy of this report will also be provided to the appropriate District Office. The Contractor may receive a copy of this report upon request to the Engineer or ESS.

d. Lead Base Paint Removal. The Contractor engaged in lead base paint removal operations must carry a pollution liability (access liability) policy with a minimum coverage of \$1,000,000. Maintain this policy in force until the Secretary releases the Contractor from all obligations under the contract. The insurance contract must cover claims for such length of time as said claims are permitted by law. Provide a copy of this insurance certificate to the Engineer prior to beginning lead base paint removal operations.

Use best industry practices to protect the environment, persons and adjacent property from contamination due to blasting of the existing structure. When "Power Wash" is shown as a bid item, clean the existing steel before initiating the blasting operations. Use a power washer with pressure in the range of 700 to 1000 pounds per square inch to clean the structure, at a maximum rate of 4 gallons per minute, using potable water. Comply with all applicable regulations contained in K.A.R. 28-16-28 (b) through (f) for protection of water quality, K.A.R. 28-29-1 through 28-29-27 for disposal of solid waste and K.A.R. 28-31-1 through 28-31-14 for disposal of hazardous waste. In addition, comply with all applicable Occupational Safety and Health Administration standards including those found in 29 CFR 1910.1025 covering the occupational exposure to lead and 29 CFR 1926.62 outlining the requirements for the removal of lead-based paint from bridge repair and rehabilitation activities.

Contain paint chips, corrosion residues and spent abrasives, referred to as waste materials, resulting from blasting and other cleaning operations. The containment requirements are covered in **subsection 714.4e**. Use special containment methods or removal procedures over power lines, communication lines, railways or roadways not closed to traffic. Obtain the permits and permission from the line owner on the containment methods and removal procedures. The proposed containment method or removal procedures must be sealed by a licensed Professional Engineer, and submitted to the Engineer before commencing paint removal operations.

Clearing of the work area for containment purposes is the responsibility of the Contractor. Clearing may not extend beyond right-of-way. Burning on the right-of-way is prohibited. The area to be cleared and the clearing method must be approved by the Engineer before starting the clearing operation. Provide locations, approved by the Engineer, and dispose of all the debris at said locations.

e. Removal and Containment Requirements.

(1) Class A Bridges. On all Class A bridges, provide a KDHE certified Lead Abatement Supervisor for oversight of all paint removal, storage and disposal operation. These operations shall adhere to work practices established in K.A.R. 28-72-18(g) and K.A.R. 28-72-18d(a). The Lead Abatement Supervisor must have available at the job-site a telephone number for the nearest Local Emergency Planning Commission (LEPC), or if none can be found within a 50 mile radius, the nearest Haz-Mat Response Contractor.

Dry abrasive blasting or any other approved method which meets the paint specification may be used to remove the lead paint from the bridge. Use the containment methods shown below to maximize pollution control.

(a) Power Tools: Use containment unless the power tools are vacuum equipped and all parts of the vacuum equipment are in a condition that prevents emissions of waste material. This determination will be made by the Engineer.

(b) Dry Abrasive Blasting: Use 100% air impenetrable walls with rigid or flexible framing, fully sealed joints, airlock or resealable entryways, and negative air achieved by forced or natural air flow (verified by instrument or visual monitoring) and exhaust air filtration (See SSPC – Guide 6, Paragraph 4.2.2.1).

Design the containment to withstand the effects of negative air pressure equal to the combined volume of all blast nozzles inside the enclosure plus 4 air changes of the enclosure per hour. The method of attaching and the effects of dead load caused by the installation of the enclosure to the bridge shall be sealed by a licensed Professional Engineer. Provide a copy of such plans to the Engineer for approval before commencing paint removal operations.

Recyclable or non-recyclable abrasive may be used. Use recyclable abrasives with a classifier system rated to remove a minimum of 98% of the non-abrasive material, and free of oil substances.

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Do not allow the waste material to contact the ground or water surface. Plywood or other impermeable material may be used, subject to approval by the Engineer. When the roadway beneath the structure is closed, the hard surfaces such as asphalt and concrete roadway, sidewalks and sloped paving may be left uncovered if they have an unbroken surface, and can be cleaned by sweeping or vacuuming as described in **subsection 714.4f.(1)**. If the roadway surface is used for waste material collection, cover the storm drains.

(c) Visible emissions are permitted at given frequencies or durations provided they do not extend beyond KDOT right-of-way. Permissible visible emissions for Class A bridges are defined as random emissions of a cumulative duration of a maximum of 1% of the work day, equivalent to 5 minutes in an 8 hour period (See SSPC-Guide 6, Paragraph 5.5.1.1). The Engineer will determine if visible emissions limitations are being exceeded. Temporary suspension of work on the project may be ordered by the Engineer if visible emissions exceed limitations. The ordering of a temporary suspension for exceeding emissions limitations will not alter or waive the charging of working days for the project.

(2) Class B Bridges. Dry abrasive blasting or any other approved method which meets the paint specification may be used to remove the lead paint from the bridge. Use the containment methods shown below to maximize pollution control.

(a) Power Tools: The Contractor is subject to the limitations for Class A Bridges as described in **subsection 714.4e.(1)(a)**.

(b) Dry Abrasive Blasting: Use 100% impermeable tarpaulins or heavy plastic (6 mil minimum thickness) to prevent disposition of waste material on the soil or water surface. Plywood or other impermeable material may be used subject to approval by the Engineer. Overlap the ground cover a minimum of 1 ½ feet and weight them as needed to prevent separation. Cover all bare soil and vegetated areas inside the curtains required by items below, and extend a minimum of 20 feet beyond in all directions except at abutments. When the roadway beneath the structure is closed, the hard surfaces such as asphalt and concrete roadway, sidewalks and sloped paving may be left uncovered if they have an unbroken surface, and can be cleaned by sweeping or vacuuming as described in **subsection 714.4f.(1)**. If the roadway surface is used for waste material collection, cover the storm drains.

- Curtains: Use curtains in the form of rigid or flexible walls, rated by the manufacturer at a minimum of 85% impermeable to contain lead paint particles and dust generated from the blasting operation. Use curtains with adequate strength to withstand wind velocity. Plywood or other impermeable material may be used, subject to approval by the Engineer. Attach and overlap the edges of the walls a minimum of 3 feet, unless the edges are completely joined.
- Girders and Deck Trusses: Rigid or flexible walls may be suspended from the bridge deck to the ground so that the work area is contained on all 4 sides. Attach and overlap the edges of the walls a minimum of 3 feet, unless the edges are completely joined. Extend the wall up between the girders to seal this space. Extend the walls to the ground, and anchor or weight at the bottom. An exhaust fan with an adequate filter system may be required to protect the personnel within the confinement.
- Thru and Overhead Trusses: If the roadway is open to traffic, suspend rigid or flexible 85% impermeable walls both inside and outside of the truss from a height greater than the point to be removed, with the inside edge resting on the deck and secured by weights, and the bottom outside edges fastened within the lower walls attached to the bridge deck in the manner required for girders.

If the roadway is closed to traffic, suspend rigid or flexible 85% impermeable walls outside from a height greater than the point of paint removal with the lower edges fastened within the lower walls attached to the bridge deck in a manner required for girders; or suspend a rigid barrier outside the truss with the bottom edge resting on or directly above the roadway and inclined at an angle of 45° with the truss to deposit waste material on the closed roadway.

The height must be at a minimum, equal to the height of the truss, and with the space between the end of the barrier and truss closed with impermeable material. Suspend rigid or flexible walls across the bridge deck between the opposite trussed at both ends of the area to be blasted. On truss bridges provide a document sealed by a licensed Professional Engineer noting the amount of work area allowed for containment.

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- Over a Body of Water: If a project site is located within 0.5 mile upstream of any public water supply intake, the ESS will notify the applicable public entity of project activity within 30 days of commencing paint removal operations.

Rigid or flexible 100% impermeable material may be suspended horizontally beneath the bridge deck to contain the waste material; or suspend scaffolding that supports a platform beneath the bridge deck lined with impermeable material to contain the waste material; or for bridge decks within 50 feet of the water surface, anchor a barge beneath the bridge and use impermeable material to direct waste material to the barge; or for bridge decks that are within 50 feet of a frozen water surface, collect and remove waste material from the ice surface with ground cover as required in **subsection 714.4e.(2)(b)**. Extend the distance of ground cover in a downwind direction to a distance greater than the highest point of the paint removal. Extend the material used to contain the girders and trusses from outside the paint surfaces to inside of the containment walls, the platform, inside the barge or inside the containers on the barge.

Over a narrow body of water, the following methods may be used as an alternate to the methods shown above. Cover a platform above the water surface with 100% impermeable material that overlaps the ground covers; or suspend an impermeable material across the underside of the bridge deck at a point more than halfway across the water body to direct paint particles to the farther bank. Anchor the containment at the bank so that it overlaps the ground covers, and seal the space above the containment in between the beams. Repeat the procedure in the opposite direction. The rigid or flexible walls used to contain the material from the girders or the trusses shall extend from outside the painted surfaces to the platform or inside the horizontal containment material.

In addition, employ floating booms down gradient of the structure if any waste material is detected floating on the water surface. Use a skimmer or wet vacuum to capture any waste material or paint chips.

(3) Wind Speed Limitations: Do not conduct paint removal operations whenever wind speed or other weather conditions render the containment ineffective or unsafe. If excessive visible emissions of particulate matter occur in the air or in visible deposits on the ground or water surface due to adverse weather conditions, either halt operations until the weather and/or wind speed is at a workable level, or increase design controls to adequately accommodate weather related conditions. The Engineer shall make this determination.

(4) Alternative Method of Removal: Alternate methods of removal may be proposed. Submit the alternate proposal to the State Bridge Engineer a minimum of 30 days in advance of use. Include site-specific design and engineering controls appropriate for the proposed alternative method. The alternate method must be approved by KDHE and KDOT before initiation.

f. Waste Material Cleanup, Storage and Treatment.

(1) Cleanup of Waste Material: Clean up all visible deposits of waste materials at the end of each work day and store them in secured containers above normal high water elevation, within KDOT right-of-way as described in further detail in item **subsection 714.4f.(3)**. Recover this material by manual means or by vacuum with filtration. Do not use an air pressure or a water stream which redistributes, but does not remove the waste material. Collect material from the roadway and from floating booms as needed, and at a minimum at the end of each day.

(2) Storage of Waste Material: Consider generated waste material to be a hazardous waste until representative analytical results have been received by the ESS and the Engineer, indicating that the waste is non-hazardous, pursuant to 40 CFR 261 and the KDHE.

(a) While classified as a hazardous waste, store the waste material according to the requirements of K.A.R. 28-31(g) or (h). In addition to K.A.R. 28-31(g) or (h), in the plan for storage of waste material, include the following:

- Store the waste material in secured drums, bulk hoppers, bins or rolloffs. Clearly mark the containers with the words "Hazardous Waste", the KDOT project number and the date upon which the period of accumulation began for each container;
- Store the waste containers on an impermeable surface that accommodates sweeping or vacuuming;
- Do not accumulate hazardous waste for more than 90 days. If an extension of time is needed, seek approval from the ESS; and
- The Engineer is designated the "Emergency Response Coordinator" and is responsible for coordinating all emergency response measures outlined in K.A.R. 28-31-40(h).

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(b) In order to classify generated waste as non-hazardous for on site storage, obtain a minimum of 2 composite samples at the direction of and in the presence of the Engineer. The sample must be representative of the total volume of waste generated through that point in time, as determined by the Engineer. Submit the samples to a KDHE certified laboratory and test for lead according to the TCLP Method SW 1311/7420, pursuant to 40 CFR 261, Appendix II. Maintain proper Chain of Custody forms at all times. The Contractor shall bear the costs of all sampling and analyses.

- If the sample analyses indicate the waste to be non-hazardous, less than 5 mg/L, the analytical results serve as representative documentation for the remainder of the waste generated on that project site, provided changes are not made to the method of paint removal, the type of blast media or any other portion of the paint removal operation that would render the samples non-representative of the total volume of waste. These criteria will be evaluated at the discretion of the Engineer;
- KDOT reserves the right to conduct random sampling at any time to assure that paint removal operations have not been altered in such a way as to compromise the representative nature of the original samples. KDOT will bear the cost of any random sampling ordered unless said sample analyses determines the waste to be hazardous, whereupon the Contractor will be responsible for the cost of sample analyses. If the waste is found to be hazardous through random sampling, the entire volume of waste generated shall be considered hazardous;
- Store non-hazardous waste material in secured containers and place on an impermeable surface which accommodates sweeping or vacuuming; and
- Mark each storage container with the KDOT project number and date upon which the period of accumulation began.

(3) Treatment of Waste Material. Dispose of waste material generated from the blasting of KDOT bridge structures as non-hazardous waste, or recycle through an EPA approved lead recycling facility.

(a) Requirements for disposal of waste material determined to be non-hazardous waste:

- Collect representative composite samples of the waste material at the direction of and in the presence of the Engineer. Sampling and testing procedures and contaminant limits are described in **subsection 714.4f.(2)(b)**;
- A minimum of 2 samples are required and may be the same 2 samples described as initial waste characterization in **subsection 714.4f.(2)(b)**. Additional samples shall be required in order to total a minimum of 2 samples per ton of waste generated. The Contractor shall bear the cost of all sampling and analyses;
- All samples collected must fall below the 5 mg/L TCLP regulatory requirement in order to dispose of any of the waste as non-hazardous, pursuant to K.A.R. 28-29-109. If any sample indicates lead content above 5 mg/L, the entire volume of waste generated must be recycled according to paragraph (b) below; and
- Provide documentation confirming the disposal of said waste at a KDHE permitted landfill to the Engineer within 15 business days of the disposal. If documentation is not submitted, the Engineer may stop work on the project until such documentation has been received by the Engineer and ESS.

(b) Requirements for recycling of materials determined to be lead-bearing waste material:

- Waste material may be recycled through an EPA approved lead recycling facility, pursuant to 40 CFR 261.1. For the purposes of transport, the waste may be designated as “recyclable”;
- Prior to commencement of the project, provide the Engineer documentation confirming the pre-acceptance of the recyclable materials by the recycling facility;
- Provide the Engineer documentation identifying the volume of waste transported from the project site; and
- Within 15 business days of acceptance by the EPA approved recycling facility, provide the Engineer and ESS documentation confirming the acceptance of the waste and the volume as delineated above. If documentation is not submitted, the Engineer may stop work on the project until such documentation has been received by the Engineer and ESS.

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g. Inspection Staff. KDOT will not inspect the surfaces from which the paint has been removed by abrasive blasting until the air quality inside the enclosure is below the Permissible Exposure Limit (PEL), and preferably below the Action Level (AL). This inspection will occur before any paint is applied to the surface.

Provide the necessary facility for removal of and disposal of protective clothing. Provide a location and facility for the Inspector to wash exposed body areas.

h. General Site Cleanup. The Contractor is responsible for general cleanup of the job site after paint removal and painting operations have been completed. This includes but is not limited to cleanup of all debris associated with paint removal and painting operations, trash generated by Contractor personnel, as well as any excess blast media and/or paint chips. Cleanup will also include re-establishment of any vegetative cover disturbed by abatement activities, including damage caused by storing equipment and traffic at the site. Clean up lead-bearing waste according to **subsection 714.4f**. This determination will be made by the Engineer.

714.5 MEASUREMENT AND PAYMENT

The Engineer will not measure painting of new structural steel for payment. Payment for painting new structural steel is included in the payment for the structural steel.

The Engineer will measure bridge painting, environmental protection and power washing, of existing steel by the lump sum.

Payment for "Bridge Painting", "Environmental Protection" and "Power Wash" at the contract unit prices is full compensation for the specified work.

715 - PRESTRESSED CONCRETE MEMBERS

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.

<u>BID ITEMS</u>	<u>UNITS</u>
Prestressed Concrete Beams (*)(**)	Linear Foot
Prestressed Concrete Panels	Square Foot
*Type	
**Size	

715.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete and Admixtures	DIVISION 400
Reinforcing Steel	DIVISION 1600
Bearings and Pads For Structures	DIVISION 1700
Steel Strand	DIVISION 1600
Wire Mesh	DIVISION 1600
Water	DIVISION 2400

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 153 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 **subsection 105.10**. With the exception of prestressed piles, which do not require drawings, do not perform any fabrication until the approved shop drawings are in the hands of the Inspector and fabricator, and the Engineer has authorized fabrication. 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.

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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) ¾ 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)	+ ¾ in., - ¼ in
Depth	± ¼ in.
Width (stem)	+ ¾ 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) ¾ 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.

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TABLE 715-1 (continued)

BRIDGE I-BEAM

Unit Feature	Tolerance
Length	$\pm \frac{3}{4}$ in.
Width (flanges and fillets)	$+\frac{3}{8}$ in., $-\frac{1}{4}$ in.
Depth (overall)	$+\frac{1}{2}$ in., $-\frac{1}{4}$ in.
Width (web)	$+\frac{3}{8}$ in., $-\frac{1}{4}$ in.
Depth (flanges and fillets)	$\pm \frac{1}{4}$ in.
Bearing plates (center to center)	$\pm \frac{1}{8}$ in. per 10 ft., but not greater than $\pm \frac{3}{4}$ in.
Horizontal Alignment (Deviation from straight line parallel to centerline of the member.)	$\frac{1}{8}$ in. per 10 ft. of span, but not greater than 1 in.
Camber deviation from design camber	$\pm \frac{1}{8}$ in. per 10 ft. of span, but not greater than $\pm \frac{1}{2}$ in.
Differential camber between adjacent members	1 in. maximum
Stirrup Bars (projection above top of beam)	$\pm \frac{3}{4}$ in.
Tendon position	$\pm \frac{1}{4}$ in. in c.g. of strand group
Tolerance between tendons	$\pm \frac{1}{8}$ 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: $\pm \frac{1}{4}$ in. Vertical: $\pm \frac{1}{8}$ in. per 1 ft. of beam depth
Bearing plates (center to end of beam)	$\pm \frac{1}{4}$ in.
Side Inserts (center to center and center to end)	$\pm \frac{1}{2}$ in.
Bearing area deviation from plane	$\pm \frac{1}{8}$ in.
Stirrup bar spacing (individual or accumulative)	± 1 in.
Stirrup bar height	$\pm \frac{3}{4}$ in.
Position of post tensioning duct	$\pm \frac{1}{4}$ in.
Position of weld plates	± 1 in.

PRESTRESSED PILE

Unit Feature	Tolerance
Length	± 1 in.
Width or diameter	$\pm \frac{3}{8}$ in., $-\frac{1}{4}$ in.
Head out of square	$\frac{1}{8}$ in. per 1 ft. of width
Horizontal alignment (deviation from straight line parallel to centerline of pile)	$\frac{1}{8}$ in. per 10 ft. of pile
Position of void	$\pm \frac{1}{4}$ in.
Position of stirrup bars and spirals	$\pm \frac{3}{4}$ in.
Position of tendons	$\pm \frac{1}{4}$ in.
Position of handling devices	± 6 in.
Position of steel driving tips	$\frac{1}{2}$ in.

PRESTRESSED PANELS

Unit Feature	Tolerance
Length	$\pm \frac{1}{4}$ in.
Width	$\pm \frac{1}{4}$ in.
Thickness	$+\frac{1}{4}$ in., $-\frac{1}{8}$ in.
Square ends (deviation from square)	$\pm \frac{1}{4}$ in.
Deviation from straightness of mating edge	$+\frac{1}{8}$ in.
Position of strands	$\pm \frac{1}{8}$ in. vertical, $\pm \frac{1}{2}$ 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. Place reinforcing bars as shown in the Contract Documents, and rigidly secure them to prevent movement during placement of the concrete. Welding of reinforcing steel cages 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 $\frac{1}{8}$ 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 20°F. 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.

Place welded wire fabric as shown in the Contract Documents.

(3) Concrete. Manufacture the units using concrete that consists of a mixture of 50% coarse aggregate and 50% fine aggregate by weight, portland cement, air entraining agent and water, as shown in **TABLE 715-2**. Do not use calcium chloride.

The Contractor is responsible for the design of the concrete mix including the proportions of water, cement and aggregates within the limits of this specification. Submit the design mix to the Engineer for approval before casting the units. If there is a change in design or material source, resubmit a concrete mix design for approval.

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Unless shown otherwise in the Contract Documents, use Type I, Type IP, Type I(PM) or Type II portland cement to manufacture the units. Type III cement may be used for piling and beams, if they are to be covered by a reinforced concrete wearing surface. Only use cement from prequalified sources. The producer's certification must be available at the prestress plant for review by the Engineer.

For all aggregates being used, keep a copy of the KDOT Official Quality test report from the approved source on file at the prestress plant, and available for review by the Engineer.

For the approved source of water, keep a copy of the KDOT test report on file at the prestress plant and available for review by the Engineer.

The presence of any deleterious substance such a "bag paper" is cause for rejection.

No other additives may be used except with written approval from the Engineer. If approved, use admixtures that are prequalified. Maintain a copy of the Type C certification on file at the prestress plant and available for review by the Engineer.

TABLE 715-2: CONCRETE REQUIREMENTS					
Concrete Type	Maximum Slump* (Inches)	Cement, lb. per cubic yard		Mixing Water: Maximum lb. per lb. cement	% Air Content
		Minimum	Maximum		
Air Entrained	4 ± ¾	602	752	0.44	6.5 ± 1.5
Non-Air Entrained	4 ± ¾	602	752	0.49	

* Without mid-range or high-range water reducing admixtures. With water reducer, 7 inches ± 25%.

Non-air entrained concrete may be used in concrete piling not subject to freezing and thawing and wetting and drying.

At the option of the Contractor, fly ash from an approved source may be used as a partial replacement for portland cement.

Determine the consistency of the concrete by the standard slump test. The Contractor designates the slump desired at the point of delivery. A single re-dose of a water reducer is allowed at the bed site, when mixed in an approved manner. Flowing concrete shall be a cohesive mass with no evidence of separation or segregation regardless of the slump. The batch will be rejected if there is evidence of separation or segregation.

Unless shown otherwise in the Contract Documents, use concrete with the compressive strengths meeting **TABLE 715-3**. Cast all cylinders from the concrete used to manufacture the units. Determine the release and the shipping strength (required values shown in **TABLE 715-3**) by tests conducted on cylinders cured in the same manner as the units. Determine 28 day cylinder strengths by tests conducted on cylinders cured in the same manner as the units until the release strength is reached, after which they are removed from their molds and moist cured and tested in the standard manner.

TABLE 715-3: COMPRESSIVE STRENGTH OF CONCRETE		
Type of Unit	For Stress Application (Release) and/or moving* (Minimum) (psi)	Age 28 Days (Minimum)** (psi)
Prestressed Bridge Beams	4000	5000
Prestressed Piles	3000	5000
Prestressed Panels	4000	5000

* From casting bed to producer's storage only. Not a shipping strength.

** Also required shipping strength.

Handle and place the concrete by methods that shall produce a dense, uniform product, free from sand streaks and honeycomb areas. 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 40°F before the concrete may be placed. When necessary, continue heating the forms during the placement and finishing of the concrete.

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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 $\frac{1}{4}$ 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 50°F. 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 40°F per hour. The maximum curing temperature within the enclosure is 160°F, 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 50°F 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 40°F 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"Ø x 12" cylinders. The Engineer may approve the use of 4"Ø 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, and shall be cured under the same conditions as the concrete they represent except as specified above for 28 day cylinders. A group of cylinders is defined as a minimum of 3 sets of 3 cylinders. Make a minimum of 1 group of test cylinders for each 40 cubic yards of concrete or fraction thereof placed in each line, within each curing enclosure, during a continuous working period.

Make 1 set of 3 cylinders from the first third of the total concrete placement, a second set from the second third, and a third set from the last third. Note the location of the concrete represented by each of the sets of cylinders. Mark and identify all cylinders as set 1, 2 and 3 in the order of concrete placement. Mark cylinders within a group as 1A, 1B, 1C, 2A, 2B, 2C and 3A, 3B, 3C.

Follow the procedure of making sets of cylinders from early, middle and late production, 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 releasing and shipping strength at the producer's plant.

(i) Releasing Strength. Test 3 cylinders, 1 cylinder from each of the 3 sets of cylinders (i.e. 1A, 2A, 3A), prior to strand release to determine if the specified release strength shown in the Contract Documents has been reached. The average strength of the 3 tested cylinders must equal or exceed the design release strength. In addition, only 1 cylinder in the tested set may have a strength which is below the design release strength by a maximum of 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 sets is tested (i.e. 1B, 2B, 3B).

(ii) Shipping Strength. Before reaching 28 days of age, at the Contractor's option, 1 cylinder from each of 3 sets of cylinders (i.e. 1B, 2B, 3B) may be tested to determine if the specified 28 day strength shown in the Contract Documents has been reached. Test all 3 cylinders at the same age. All cylinders must 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 a cylinder from each of the 3 sets (i.e. 1B, 2B, 3B) is not available for testing, then early shipping will not be allowed.

(iii) 28 Day Strength. The remaining set of cylinders (i.e. 1C, 2C, 3C) shall be moist cured in the standard manner and tested when the concrete has reached an actual age of 28 days. Testing will take place at a location chosen 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 strength by no more than 5%.

The average strength of 1 set of 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

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consecutive sets of 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 consecutively 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 greater.

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.

SECTION 716

POST-TENSIONING
(Haunch Slab Bridges)

716.1 DESCRIPTION

Provide and install all post-tensioning system components as shown in the Contract Documents to construct a post-tensioned haunched slab bridge.

<u>BID ITEM</u>	<u>UNITS</u>
Post-Tensioning for Slab Bridge	Pound

716.2 MATERIALS

Comply with all material requirements in the Contract Documents in addition to **subsection 716.2**.

a. Prestressing Steel. Provide uncoated, 7 wire, Grade 270 (1860), low-relaxation strands for prestressed concrete complying with AASHTO M 203 (ASTM A 416). Provide strands with a minimum ultimate strength of 270 ksi. Fabricate the tendons with sufficient length beyond the anchor bearing plates to allow for stressing and anchorage device installation.

The Engineer will accept the strands based on **subsection 716.2h**. 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 surface pitting.

Package the strands in containers or forms to protect against damage and corrosion during shipping and storage. Provide an inhibitor carrier type packaging material complying with the provisions of Federal Specifications MIL-P-3420F-87. Place a rust preventative corrosion inhibitor or other corrosion inhibiting material in the package, incorporate a corrosion inhibitor carrier type packaging material or apply directly to the steel when approved by the Engineer. Use a corrosion inhibitor that has no deleterious effect on the strands or grout or bond strength of strands to grout.

Clearly mark the shipping package or forms with a statement that the package contains high-strength prestressing steel strands, the care to be used in handling, the type, kind and amount of corrosion inhibitor used, including the date when placed, safety orders and instructions for use.

b. Post-Tensioning System. Use an approved post-tensioning system of proper size and type to construct tendons as shown on the Contract Documents. Do not substitute components of the approved post-tensioning system. Do not use tendon couplers. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages, ducts and fully filled with approved grout.

Systems which transfer prestress force by bonding the prestress steel strand directly to concrete are prohibited.

c. Post-Tensioning Anchorage. Provide anchorages meeting or exceeding:

- Article 5.10.9 of the AASHTO LRFD Bridge Design Specifications, latest edition and interims; and
- Article 10.3.2 of the AASHTO LRFD Bridge Construction Specifications, latest edition and interims.

The Post-Tension Manufacturer shall supply the special reinforcement, such as spirals or grids, for the longitudinal and transverse tendons. Such reinforcement is required in the concrete end-zones of anchors. All anchorage devices shall develop 96% of the actual ultimate strength of the prestressing steel, when tested in an unbonded state, without exceeding anticipated set. The design of the end anchorages and end-zone reinforcing is the sole responsibility of the Post-Tension Manufacturer.

Galvanize the body of the anchorages according to ASTM 123. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent fiber reinforced plastic grout cap that encloses the whole wedge plate. Vent grout caps and bolt to the anchorage.

d. Post-Tensioning Ducts. Provide semi-rigid, mortar-tight plastic ducts, including connection joints, capable of withstanding concrete pressures without deforming or permitting the intrusion of cement paste during the placement of concrete. Use all duct material complying with AASHTO and the Post Tensioning Institute (PTI) for bonded tendons. Do not use ducts manufactured from recycled materials. Provide ducts for multi-strand tendons with an inside area a minimum of 2 ½ 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 corrugated plastic ducts for both the longitudinal and transverse ducts. Provide the proper fasteners for the ducts. Use an approved plastic on all parts of the clamps. Construct the ducts from either polyethylene or polypropylene. The minimum acceptable radius of curvature shall be established by the duct supplier according to standard testing methods. The material thickness of ducts is 0.08 inches ± 0.01 inch. Fabricate polyethylene ducts from resins complying with ASTM D 3350 with a cell classification of 345464A. Fabricate polypropylene ducts from resins complying with ASTM D 4101 with a cell classification of PP0340B44544 or PP0340B6584.

e. Inlets and Outlets. Use inlets for injecting grout into the duct. Use outlets to allow the escape of air, water, bleed water and grout. Provide inlets and outlets at locations shown in the Contract Documents. Provide ¾ inches minimum internal diameter plastic pipe for inlets and outlets made of ASTM A 240 Type 316 stainless steel, nylon or polyolefin materials. If nylon inlets/outlets are used, a cell class of S-PA0141 (weather resistant) is required. Only use polyolefin products which contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 a minimum of 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 350 psi, resulting in a minimum failure time of 3 hours. Provide pipes that are mortar-tight. 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 plastic connectors and fasteners to attach the pipes to the ducts. Provide positive mechanical shut-off valves for all inlets for a minimum pressure rating of 100 psi. Provide cap, valves or other devices capable of withstanding the pumping pressures for all outlets. No tape is allowed at any connection.

f. End Anchorages Permanent Grout Cap. Use permanent grout caps made from fiber reinforced polymer or ASTM A 240 Type 316L stainless steel. Use nylon, Acrylonitrile Butadiene Styrene (ABS) or polyester resins in the fiber reinforced polymer. For products made from nylon, a cell class of S-PA0141 (weather resistance) is required. Seal the cap with "O" ring seals or precision fitted flat gaskets placed against the bearing plate. Equip the grout cap with a top grout vent. Use grout caps rated for a minimum pressure of 100 psi. Use ASTM A 240 type 316L stainless steel bolts to secure the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

g. Grout. Provide grout of a brand listed in **TABLE 716-1** or approved by the Bureau Chief of Materials and Research, unless otherwise shown in the Contract Documents. Use only one supplier for any single structure.

TABLE 716-1: GROUT USED IN POST TENSIONING	
Supplier	Product
Sika Corporation	Sika Grout 300PT
Master Builder	Masterflow 1205
Euclid Chemical Company	Euco Cable Grout PTX

h. Testing Requirements. 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 prestressing strand of sufficient length to provide 5 feet 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

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working drawings using the results of the tests and correct as required. Submit revisions of the theoretical elongations to the Engineer for approval.

716.3 CONSTRUCTION REQUIREMENTS

a. Alternate Post-Tensioning Designs. Use 0.6 inch diameter strands longitudinal and transverse post-tensioning systems as shown in the Contract Documents.

The Contractor may propose an alternate to the transverse post-tensioning system shown in the Contract Documents. Before materials are provided and 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; and
- 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.

b. Qualification of the Post-Tensioning System Manufacturer (System Manufacturer). Select a system 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 LRFD Construction specifications.

Before materials are provided and any post-tensioning operations begin, the system manufacturer must be approved by the SBO. If the system 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, sealed by a Professional Engineer licensed in the state of Kansas;
- Certificate of compliance with AASHTO LRFD Construction specifications for testing of the end anchorage assemblies, performed by an independent testing laboratory, and sealed by a Professional Engineer licensed in the state of Kansas;
- In-house QC/QA implementation for manufacturing, assembling, storage, delivery, installation, stressing and grouting supervision;
- Names, qualification and experience of the field personnel to be assigned to assist the Contractor to supervise installation, stressing and grouting;
- The technician that supervises all grouting operations must be a valid American Segmental Bridge Institute (ASBI) Certified Grouting Technician. Provide the SBO with verification of the technician's ASBI Certification;
- Proof of continuous post-tensioning operations. Firms with less than 10 years of experience may be approved if sufficient related project experience is demonstrated, but in any event a minimum of 7 years of experience is required;
- List of post-tensioned haunched slab bridges completed within the past 5 years including owner and identifying bridge information; and
- List any unfavorable claims within the last 10 years.

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

A system manufacturer may submit the necessary information to be considered for qualification at any time. The SBO will maintain a list of approved system manufacturers. Any change in a system manufacturer's system or evidence of poor performance will require re-approval.

c. Shop Drawings. Provide the SBO with 9 sets of shop drawings from the system manufacturer for all work related to post-tensioning (see **subsection 105.10**). The shop drawings must be sealed by a Professional Engineer licensed in the state of Kansas. The shop drawings must be approved by the SBO before beginning fabrication.

As a minimum, include in the shop drawings:

- A Post-Tensioning System that meets the requirements in the Contract Documents;
- Tendon geometry and layouts;
- Distance from the bottom of slab to bottom of duct;
- Duct support detail and spacing according to the Contract Documents;
- The locations of grout ports and grout vents;
- Connection details such as duct coupler, anchorage to duct and grout ports/ vents to duct;
- Anchorage local-zone reinforcement;
- Permanent grout cap details, concrete recess, pour backs and temporary protection;
- Jacking forces and initial forces;
- Anchor set;
- Stressing operation and equipment data;
- All material specifications (e.g. strands, ducts and grout);
- Grouting operation and equipment data;
- Safety procedures;
- Elongation calculations 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; and
- 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.

d. Installation. Install the hardware including ducts, tendons, end anchorage assemblies and special reinforcing according to the Contract Documents and the instructions of the system manufacturer.

Provide a qualified on-site representative of the system manufacturer, who is skilled and thoroughly experienced in the use of the system to supervise or provide appropriate guidance of the work. The system manufacturer's representative will provide the Engineer pertinent information as required. The system manufacturer's representative must be available full-time during post-tensioning hardware installation for inspecting and approving all installation prior to concrete placement, stressing, anchoring all tendons and grouting operations.

As a minimum, the following items require inspection and approval by the system manufacturer's representative:

- Installation of all hardware;
- Instructions to the Contractor regarding concrete placement around the ducts, end-anchorage assemblies and other appurtenances; and
- Supervision of stressing procedures, record keeping, certification of stressing results and grouting operations

The representative of the system manufacturer that supervises all grouting operations must be a valid American Segmental Bridge Institute (ASBI) Certified Grouting Technician.

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

Reject all unidentified strands or anchorage assemblies.

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

Provide concrete test cylinders at both abutments. Do not begin stressing until testing of concrete cylinders verifies minimum bridge concrete strength for jacking has been obtained.

Do not begin the stressing before the concrete strength has reached the f_{ci} shown in the Contract Documents and a minimum of 72 hours after completing the slab pour. Complete the stressing within 7 days after completing the slab pour.

Vibrate the concrete slab, as required, to obtain proper consolidation and compaction of the concrete specified in the Contract Documents.

Proper vibration at the abutments and around the end anchorage assemblies is especially critical and should be considered a "confined" area. Exercise care to obtain concrete consolidation around the end anchorages without disturbing the reinforcing or post-tensioning assemblies.

e. Stressing Tendons.

(1) Stresses. Tension all strands using hydraulic jacks. The minimum force of the strands is the value shown on the approved shop drawings. Do not allow the maximum temporary tensile stress (jacking stress) in the strands to exceed 80% of the specified minimum ultimate tensile strength. Anchor the strands at stresses (initial stresses) that shall result in the ultimate retention of permanent forces of not less than those shown in the Contract Documents. After seating, do not exceed 70% of the specified minimum ultimate tensile strength at the anchorages locations and 74% of the specified minimum ultimate tensile strength in the span.

Consider permanent force and permanent stress as the force and stress remaining in the strands after all losses, including creep, shrinkage, 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. Complete stressing of the strands to within -0 to +5% of the forces shown in the Contract Documents.

(2) Stressing Jacks. Apply post-tensioning forces only after the concrete has attained the specified compressive strength as determined by the cylinder tests and within the time requirements in **subsection 716.3d**. Equip each jack used to stress tendons with a pressure gauge (a minimum of 6 inches in diameter) for determining the jacking pressure. Calibrate each jack and its pressure gauge as a unit with the cylinder extension in the approximate position that it will be at final jacking force. As a minimum, provide 2 jacks at each site to guard against breakdowns. Provide certified calibration charts (by an independent laboratory) with each jack, hydraulic system and pressure 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).

Provide a calibrated master gauge at each job site. 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 on the calibrated 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. Conduct hydraulic jack calibration a minimum of every 6 months.

(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. Using only a rigid metal ruler, measure elongations to the nearest $\frac{1}{8}$ inch.

Preload tendons to 20% 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% of the calculated measurable elongation, the tendon will be evaluated by the Engineer in conjunction with the SBO and subject to rejection.

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

Evaluation of out of tolerance elongations procedure:

It is of primary importance that the evaluation be performed as soon as the potential failure happens, since completion of the entire process is time critical.

In the event of a failure to meet the 7% requirements above, a tendon evaluation is required, and will consist of one or all of the following procedures as determined by the Engineer in conjunction with the SBO:

- 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.
- Re-calibration of the stressing jack: Verify elongation through jack or extension if used.
- Perform lift-off at dead end.

Submit to the Engineer and SBO for approval, a proposal of a tendon evaluation sealed by a Professional Engineer licensed in the State of Kansas, representing the system manufacturer.

Submit to the Engineer and 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 strands installed;

- Date strands stressed;
- Date grouted;
- Supervisor's and Inspector's names;
- Coil number for strands installed or heat number for bars installed;
- Jacking ends;
- The theoretical and actual elongation;
- The theoretical and actual anchor set;
- Actual tendon lengths;
- Gauge pressure and forces (initial, intermediate intervals, and before anchor set);
- Accepted or number of items rejected; and
- Comments as to problems.

Upon completion of the post-tensioning, submit to the Engineer for approval a record of gauge pressures and tendon elongations. The records submitted must be sealed by a Professional Engineer (licensed in the state of Kansas) representing the system manufacturer.

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

f. Grout. Provide the Engineer with a minimum of 3 days advance notice of the beginning of the grouting operations to allow adequate time for ASBI-certified KDOT inspection staff to get to the job site.

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.

Weather permitting, begin grouting immediately or within 24 hours after stressing all tendons within an independent unit.

(1) Equipment. Provide a grouting mixer capable of continuous mechanical mixing which shall produce grout free of lumps and undispersed cement. Batch all materials using batching equipment which provides accurate solid and liquid measures. Provide grout equipment capable of continuously grouting the longest tendon on the project within a maximum of 20 minutes.

Use grouting equipment utilizing gravity feed to the pump inlet from a hopper attached to and directly over it. Keep the grout 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 the outlet pressure required by the grout manufacturer. 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 at some point in the grouting line between the pumping outlet and the duct inlet, and having a full scale reading of a maximum of 300 psi. Use grouting equipment containing a screen having clear openings of $\frac{1}{8}$ inch maximum size to screen the grout prior to its introduction into the grout pump.

(2) Mixing. Mix the grout according to the manufacturer's directions. 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 the grouting operation begins. Allow grout to flow from the first outlet past the inlet until any residual flushing water or entrapped air has been removed, at which time close the outlet. Close remaining outlets in the same manner and in the order shown on the plans.

Perform normal grout pumping operations at 75 psi. Do not exceed 250 psi 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 can not be maintained as outlined above, flush the grout immediately out of the duct with water.

To keep the tendon filled with grout under pressure, close the outlets and inlets in the order shown on the plans, when the tendon duct section at the outlet and inlet is completely filled with grout. Do not remove or open positive shutoffs required at the inlets and outlets until the grout has set.

716 - POST-TENSIONING (Haunched Slab Bridges)

In temperatures below 32°F, keep ducts free of water to avoid damage due to freezing. Maintain the temperature of the concrete slab between 35 and 85°F from the time grouting begins until jobsite cured 4 inch diameter cylinders of grout reach a minimum compressive strength of 800 psi, when tested according to AASHTO T22. The maximum grout temperature is 90°F, during mixing or pumping. When required, cool the mixing water.

Remove ends of inlets and outlets a minimum of 1 ½ inches below the concrete surface after the grout has set and fill the recess in the concrete with an approved epoxy grout.

Grout all anchorages, before the winter shut down.

g. 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 4 mils.

h. Recess Pocket Filling. Fill all longitudinal and transverse end anchorage recess pockets as shown in the Contract Documents. Apply an approved epoxy resin bonding agent according to the manufacturer' prior to placing an approved non-shrink, non-metallic grout. Apply grout according to the grout manufacturer's instructions. Finish the outside exposed surfaces of the recess pockets smooth and flush with the surrounding concrete surface. Select grout to match the color of the surrounding concrete slab.

716.4 MEASUREMENT AND PAYMENT

The Engineer will compute the weight of the post-tensioning tendons in pounds by measuring the theoretical plan length, end to end of wearing surface, and using a unit weight of 0.6 inch strand of 0.74 pounds per foot.

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

717 - SILICA FUME OVERLAY

SECTION 717

SILICA FUME OVERLAY

717.1 DESCRIPTION

Construct the silica fume overlay as shown on the Contract Documents.

BID ITEMS

Silica Fume Overlay (*) (**)
Material for Silica Fume Overlay (Set Price)
* Denotes Thickness
**High Early Strength

UNITS

Square Yard
Cubic Yard

717.2 MATERIALS

Provide materials that comply with the applicable requirements.

Silica Fume Concrete	DIVISION 400
Precure/Finishing Aid Material	DIVISION 1400
Concrete Curing Materials	DIVISION 1400
Concrete Masonry Coating	DIVISION 1700

717.3 CONSTRUCTION REQUIREMENTS

a. **Equipment.** Use a finishing machine consisting of a mechanical strike-off capable of providing a uniform thickness of concrete slightly above finish grade in front of an oscillating screed or screeds. The finishing machine will be inspected and approved by the Engineer before work is started on each project.

Use a minimum of 1 oscillating screed capable of consolidating the concrete by vibration to 100% of the vibrated unit weight with the following features:

- Install identical vibrators so a minimum of 1 vibrator is provided for each 5 feet of screed length;
- Bottom face a minimum of 5 inches wide with a turned up or rounded leading edge;
- Effective weight a minimum of 75 pounds for each square foot bottom face area;
- Positive control of vertical position, the angle of tilt and the shape of the crown;
- Design together with appurtenant equipment to obtain positive machine screeding of the plastic concrete as close as practical to the face of the existing curb line;
- Length sufficient to uniformly strike-off and consolidate the width of the lane to be paved;
- Forward and reverse motion under positive control;
- Supporting rails which are fully adjustable (not shimmed) to obtain the correct profile, unless otherwise approved by the Engineer. Provide supports which are sufficiently rigid and do not deflect under the weight of the machine. Anchor the supporting rails to provide horizontal and vertical stability; and
- Equip to travel on the completed lane when placing concrete in a lane abutting a previously completed lane.

Manufacturer's specifications or certification may be used as verification of the oscillating screed requirements.

A drum roller equipped to perform all functions outlined for the oscillating screed above, may be used for finishing the overlay concrete in lieu of an oscillating screed. Equip the drum roller to vibrate by either a factory or field adaptation. The drum roller must be able to compact the concrete to a minimum of 100% of the vibrated unit weight.

Provide an overall combination of labor and equipment with the capability for proportioning, mixing, placing and finishing new concrete at the following minimum rates shown in **TABLE 717-1**.

717 - SILICA FUME OVERLAY

TABLE 717-1: SILICA FUME PRODUCTION REQUIREMENTS	
Total Placed Surface Area per Bridge (Square Yards)	Minimum Cubic Yards per Hour
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5

b. Preparation of Surface. Prior to final preparation for placement of new concrete, sand or shot blast the surface followed by an air blast to the bottom 3 inches of hubguard, and edges against which new concrete is to be placed to remove all dirt, oil and other foreign material, as well as any unsound concrete, laitance and curing material from the surface. Wet sand blasting may be used only with approval of the Engineer. It is desired that the surface be roughened by the sand or shot blast to provide satisfactory bond with the surfacing concrete. Protect metal floor drains and areas of the curb or railing above the proposed surface from the sand or shot blast.

Check the finish machine clearance above the prepared surface before concrete is placed to obtain the thickness specified in the Contract Documents.

A minimum of 2 hours before the placing of the concrete overlay, use clean water to thoroughly wet any concrete surfaces to which the concrete is to bond against. Blow or broom away all free water immediately ahead of the placing operation. Bonding surfaces should be maintained in a damp condition with no free water.

c. Placing and Finishing Concrete. The elapsed time between depositing the concrete on the floor and final screeding may not exceed 10 minutes, unless otherwise authorized by the Engineer.

Placing of silica fume concrete is prohibited when conditions on the bridge deck are such that the evaporation rate is estimated to equal or exceed 0.2 pounds per square foot per hour, or is predicted to exceed that rate during the course of the placement, unless corrective measures listed below are taken to reduce the evaporation rate to below 0.2 pounds per square foot per hour.

Just prior to and at least once per hour during placement of the concrete, the Engineer will measure and record the air temperature, concrete temperature, wind speed and humidity on the bridge deck. The Engineer will take the air temperature, wind and humidity measurements approximately 12 inches above the surface of the deck. With this information, the Engineer will determine the evaporation rate by using KDOT software or by using **FIGURE 710-1** (Figure 2.1.5 from the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2).

When the evaporation rate is equal to or above 0.2 lb/ft²/hr, take actions (such as cooling the concrete, installing wind breaks, sun screens etc.) to create and maintain an evaporation rate less than 0.2 lb/ft²/hr on the entire area where the silica fume is to be placed.

Accomplish fogging by using high pressure equipment that generates a minimum of 1200 psi at 2.2 gpm, or with low pressure equipment having nozzles capable of supplying a maximum flow rate of 1.6 gpm. In either case, the fog spray is produced from nozzles which atomize the droplets, and are capable of keeping a large surface area damp without depositing noticeable water.

The evaporation rate will be rechecked with the measures in place, using the procedures outlined above.

Place and fasten the screed rails in position to obtain finished concrete at the required profile. Place the supporting rails upon which the finishing machine travels outside the area to be concreted. A hold-down device shot into concrete is prohibited, unless the concrete is to be subsequently overlaid. Hold-down devices of other types leaving holes in exposed areas will be approved provided the holes remaining are grouted full. Methods for anchoring and supporting the rails and the concrete placing procedure require approval by the Engineer.

Locate longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

Manipulate, mechanically strike off and mechanically consolidate new concrete to a minimum of 98% of the vibrated unit weight and screed to final grade. In irregular areas or along the curb where the finishing screed does not reach, hand tamp with a 6 inch by 6 inch metal plate device to assist in consolidation and bonding of the concrete. When concrete for partial depth patches is placed with the overlay, apply additional vibration or hand tamping in the patch areas to assist in consolidation and bonding of the concrete.

The Engineer will use an approved nuclear density measuring device to monitor in-place density. Hand floating operations may be required to produce a tight, uniform surface. Take every reasonable precaution to secure a smooth riding bridge deck. Correct surface variations exceeding $\frac{1}{8}$ inch in 10 feet, unless directed otherwise by the Engineer.

717 - SILICA FUME OVERLAY

Silica fume concrete is prone to plastic shrinkage because it has no bleed water. To help reduce or eliminate shrinkage cracking, treat with fogging equipment and pre-cure material immediately after strike-off of the surface. If fogging has not been required during placement, start at this point and continue throughout the finishing operation. When the evaporation rate is above 0.2 lbs. per square foot provide continuous fogging. When the evaporation rate is below 0.2 lbs. per square foot, use an intermittent pattern of fogging during the placing and finishing operation to maintain a visually damp surface on the concrete. Close observation of conditions and judgment should be used to maintain a damp surface on the concrete without flooding the surface with excessive water.

When a tight, uniform surface has been achieved, give the surface a suitable texture by transverse grooving with a finned float having a single row of fins. Make the grooving approximately $\frac{3}{16}$ inch in width on $\frac{3}{4}$ inch centers, with a groove depth of approximately $\frac{1}{8}$ inch. Perform this operation at such time and in such manner that the desired texture shall be achieved while minimizing displacement of the larger aggregate particles. For bridges having drains, the transverse grooving should terminate approximately 2 foot in from the gutter line at the base of the curb. Give the area adjacent to the curbs a light broom finish, longitudinally.

Using an edger having a $\frac{1}{4}$ inch radius, finish the exposed edges of the end spans of bridges which form a part of the road surface.

d. Curing. Apply Type 1-D liquid membrane forming curing compound immediately behind the tining float. The final cure shall be with wet burlap covered with polyethylene sheeting.

Continue fogging the entire placement to maintain a damp surface until the wet burlap can be applied.

Place the wet burlap as soon as possible without damaging the surface, and keep wet during the 7 day cure period, using soaker hoses or occasional spraying.

If the concrete surface temperature is above 90°F, and air temperatures are predicted to remain above 60°F, do not use polyethylene sheeting in direct sunshine during the day for the first 24 hours of the 7 day curing period. White polyethylene sheeting may be used at night to maintain the required damp condition of the burlap. When polyethylene sheeting is used over the burlap at night during the first 24 hours and the concrete surface temperature is above 90°F, place the polyethylene sheeting a maximum of 1 hour before sunset, and remove the polyethylene sheeting within 1 hour after sunrise. After the first 24 hours, the polyethylene sheeting may be left in place continuously for the remainder of the curing period provided the burlap is kept damp.

At air temperatures below 70°F, black or clear polyethylene sheeting may be used. However, the concrete temperature must not be allowed to exceed 90°F. If the concrete temperature exceeds 90°F, remove the polyethylene sheeting, or replace with white sheeting.

Perform cold weather curing as outlined in **subsection 710.3e.(4)**.

Adhere to **TABLE 710-2** for allowable concrete loads.

e. Weather Limitations. See **subsection 401.8**. Also, discontinue concreting operations when a descending air temperature in the shade and away from artificial heat falls below 45°F except with written approval from the Engineer. Do not start or resume operations until an ascending air temperature reaches 40°F, or if night time temperatures are expected to fall below 35°F.

f. Limitations of Operations. Provide a technical representative of the silica fume manufacturer on the job site during the initial placement of the concrete at no additional cost to KDOT. The representative is to provide technical expertise to the Contractor, concrete producer and the Engineer regarding batching, transport, placement and curing of silica fume concrete. This requirement may be waived for experienced contractors. Submit to the Engineer a request along with a list of silica fume concrete overlay projects completed.

A minimum of 1 day prior to the placement, make a trial placement to gain experience with all aspects of this construction. This requirement may be waived by the Engineer if the Contractor and concrete producer can show significant similar experience with silica fume concrete. Submit to the Engineer a request along with a list of silica fume concrete overlay projects completed by the Contractor and the concrete producer.

When a new deck is involved, do not commence work on the wearing surface until the lower course meets the time requirements of **SECTION 710**, unless specified otherwise.

Do not place concrete adjacent to a surface course, less than 36 hours old. This restriction does not apply to a continuation of placement in a lane or strip beyond a transverse joint in the same lane or strip.

In areas where there is no traffic, preparation of the area may be started in a lane or strip adjacent to newly placed surface the day following its placement. If this work is started before the end of the 7 day curing period, restrict the work as follows:

717 - SILICA FUME OVERLAY

- Sawing or other operations may interfere with the curing process in the immediate work area for the minimum practical time only;
- Resume the curing promptly upon completion of the work;
- Keep the exposed areas damp until such time as curing media is replaced; and
- Do not use power driven tools heavier than a 15 pound chipping hammer.

g. Construction Joints. Make construction joints (either longitudinal or transverse) by placing and finishing the silica fume concrete approximately 6 inches beyond the desired location of the construction joint. After the silica fume overlay is cured, make a vertical saw cut at the location of the construction joint and chip away the excess silica fume overlay.

h. Sealing Vertical Faces of the Silica Fume Overlay. Seal all construction joints and vertical faces (such as the edge at the curb line) of the silica fume overlay. Sand or shot blast the construction joints and vertical faces, and apply a concrete masonry coating to the cleaned vertical surfaces according to **SECTION 726**.

i. Correction of Unbonded Areas. If during construction of the project, newly overlain areas are discovered to be unbonded by tapping or chaining, outline the concrete from such areas by sawing, remove it with small air tools (15 pound maximum) and replace it at no additional compensation.

717.4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

The Engineer will measure silica fume overlay by the square yard.

The Engineer will measure material for silica fume overlay by the cubic yard according to the following:

(1) When approved by the District Engineer on repair of existing bridges, this pay item will be used to compensate the Contractor for the additional overlay material that will be required to fill the areas greater than the thickness of overlay shown in the Contract Documents. The Contractor is responsible for maintaining adequate quality control of the demolition process to minimize deviations from the plan grades.

(2) The Engineer will keep a running account of the volume of overlay material that is produced and delivered to the deck. When approved, the Contractor will be paid, at the set price per cubic yard, for all overlay material in excess of 110% of the theoretical volume to cover the deck area with the thickness of overlay shown in the Contract Documents.

Payment for "Silica Fume Overlay" at the contract unit price and "Material for Silica Fume Overlay" at the contract set unit price (when approved by the District Engineer), will be full compensation for the specified work.

718 - ELASTOMERIC CONCRETE

SECTION 718

ELASTOMERIC CONCRETE

718.1 DESCRIPTION

Construct elastomeric concrete according to the Contract Documents.

718.2 MATERIALS

Provide materials that comply with **DIVISION 1500**.

718.3 CONSTRUCTION REQUIREMENTS

Provide the Engineer with a copy of the product manufacturer's instructions for use of this material.

Mix, transport, place and cure the elastomeric concrete as recommended by the material manufacturer.

Provide a technical representative of the material manufacturer at the jobsite during the initial placement of the elastomeric concrete. The manufacturer's representative shall provide technical expertise regarding the mixing, transporting, placement, and curing of the elastomeric concrete. This requirement may be waived for experienced contractors. Submit request for waving a technical representative, along with a list of successfully completed elastomeric concrete projects, to the Engineer.

718.4 MEASUREMENT AND PAYMENT

The Engineer will not measure the elastomeric concrete separately; it will be subsidiary to other items of the contract.

**719 - EXPANSION JOINTS (STRIP SEAL ASSEMBLY,
PREFORMED ELASTOMERIC (NEOPRENE AND COMPRESSION) AND OTHER)**

SECTION 719

**EXPANSION JOINTS (STRIP SEAL ASSEMBLY,
PREFORMED ELASTOMERIC (NEOPRENE AND COMPRESSION) AND OTHER)**

719.1 DESCRIPTION

Install expansion joints as designated in the Contract Documents.

BID ITEM

Expansion Joint (*)

*Strip Seal Assembly, Preformed Elastomeric Neoprene, Preformed Elastomeric Compression or other

UNITS

Linear Foot

719.2 MATERIALS

Provide strip seal assemblies and preformed elastomeric neoprene and compression joint seals that comply with **DIVISION 1500**.

Fabricate the strip seal assembly and preformed elastomeric compression seal according to **DIVISION 700**.

Fabricate the preformed elastomeric compression joint seals to extend across the roadway in 1 piece. The material may be trimmed at the ends.

Provide the type of expansion joint system designated in the Contract Documents that complies with **DIVISION 1500**.

719.3 CONSTRUCTION REQUIREMENTS

a. Strip Seal Assembly. Submit shop drawings (see **subsection 105.10**) for each location, type and model of strip seal assembly used, according to **DIVISION 700**. The Contractor is responsible for preparing shop drawings and coordinating the fabrication of the strip seal assemblies that require structural steel protection angles with the fabricator of the structural steel angles.

Install the strip seal assemblies according to the Contract Documents and the manufacturer's recommendations.

Place either a butt joint at each break in the pavement cross slope, or bend a unit of the device to comply closely to the break in cross slope. Do not field cut the device without approval of the Engineer.

If the assembly is installed in sections, show the sequence of unit installation on the shop drawings. Install the first unit and adjust it so that the anchor bolts shall center in the mounting slots. Install washers and tighten bolts to the torque recommended by the manufacturer. Wire brush both ends of the successive units, and butt them tightly against installed units. Do not apply the sealant until the unit is ready to be bolted down. Cut the corner at the face of curb, and grind to match normal curb dimensions. Tighten all bolts and scrape excess sealant off the surface.

If the assembly is installed in one continuous length with no field splices, proceed with the installation in a uniform manner to maintain continuity of the seal.

Complete final sealing of the finished expansion joint as soon as possible after installation. Fill all bolts, exposed ends, joints between units and other areas of possible leakage with sealant. Scrape excess sealant away before it has set.

b. Preformed Elastomeric Neoprene and Compression Joint Seals. When constructing the concrete forms for the ends of the bridge deck and adjacent abutment backwalls, form block-outs for the preformed elastomeric compression joint seals, according to the Contract Documents. The block-outs in the poured concrete must be uniform in depth and width, and free of irregularities.

Before installing the elastomeric joint seals, thoroughly clean the surfaces of the indentation formed for the elastomeric joint material, and swab it with a uniform coating of the lubricant-adhesive as recommended by the manufacturer.

Install the elastomeric joint material according to the manufacturer's recommendations. Use equipment capable of placing the strips at the specified depth without increasing or decreasing the length as taken from the roll or box by more than 5%.

**719 - EXPANSION JOINTS (STRIP SEAL ASSEMBLY,
PREFORMED ELASTOMERIC (NEOPRENE AND COMPRESSION) AND OTHER)**

Recess the top of the installed joint material a minimum of $\frac{1}{8}$ inch, and a maximum of $\frac{3}{8}$ inch below the top of the roadway deck adjacent to the joint material.

c. Other Expansion Joints. Provide a qualified representative of the expansion joint system manufacturer to instruct the Contractor and KDOT personnel in the correct installation procedures for the expansion joint system used.

Prepare the expansion gap area and install the expansion joint system according to the manufacturer's recommendations. Allow the expansion joint system to cure as recommended by the manufacturer before permitting traffic on the joint.

The Engineer will inspect the expansion gap area for the proper depth, width and alignment, as shown in the Contract Documents.

719.4 MEASUREMENT AND PAYMENT

The Engineer will measure expansion joints by the linear foot, measured along the centerline of the expansion joint.

Payment for "Expansion Joint (*)" at the contract unit price is full compensation for the specified work.

720 - SLIPFORMING CONCRETE BARRIER FOR BRIDGES

SECTION 720

SLIPFORMING CONCRETE BARRIER FOR BRIDGES

720.1 DESCRIPTION

At the Contractor's option, slipform the concrete barrier for the bridge.

720.2 MATERIALS

Provide concrete for the bridge barrier that complies with **SECTION 401**, with these exceptions:

- Use Type II cement;
- Use an aggregate combination that contains approximately 55% coarse aggregate. For coarse aggregate, use traprock, chat or calcite-cemented sandstone that complies with **TABLE 720-1**;

TABLE 720-1: PERCENT RETAINED – SQUARE MESH SIEVES

1 inch	¾ inch	½ inch	⅜ inch	No. 4	No. 8
0	5-20	30-65	55-90	90-100	95-100

- Use a concrete mixture that complies with **TABLE 720-2**;

TABLE 720-2: CONCRETE FOR SLIPFORMING CONCRETE BARRIER FOR BRIDGES

Lbs. of cement per Cu. Yd. (min.)	Lbs. of water per lbs of cement (max.)	Percent Air by Volume
658	0.40	6.5±1.5

- Determine the percent air using Kansas Test Method (KT-19); and
- The maximum slump allowed is ½ inch.

Provide set retarder admixture and Type 1-D clear or translucent curing compound with fugitive dye that complies with **DIVISION 1400**.

720.3 CONSTRUCTION REQUIREMENTS

Form the ends of the bridge barrier. Brace all formed sections. Include bolt holes in the pattern and location required for installing guardrail. Form barrier sections with bridge name plates, deck drain boxes, light standards and expansion devices a minimum of 4 feet on each side of these locations.

Before placing concrete, check the clearance between the slipform machine and the reinforcing steel throughout the length of the barrier. While placing the concrete barrier, monitor the reinforcing steel at the entrance to the slipform machine to verify location and clearance. Brace reinforcing steel to prevent racking.

Place concrete in the uphill direction when slipforming concrete barriers on bridges with grades exceeding 2%.

See **DIVISION 700** for curing times required for the deck before using construction equipment or concrete delivery on new bridge decks.

If using trucks to deliver concrete to the slipform machine, limit the quantity of concrete each truck is allowed to haul to the load carrying capacity of the bridge, or 75% of the truck's rated capacity, whichever is less. Control the speed of vehicles entering or leaving the deck in order to limit deck movement. Except for vehicles necessary for the concrete placement operations, limit heavy vehicles on the bridge deck for 24 hours following the concrete placement of the barrier.

Construct a test section approximately 100 feet long to demonstrate the acceptability of the slipforming method. Repair or replace the test section, and form the remaining barrier in the conventional manner if the Engineer rejects the test section.

720 - SLIPFORMING CONCRETE BARRIER FOR BRIDGES

Correct surface irregularities and other defects. With the Engineer's approval of the methods, repair or remove and replace unacceptable portions of the barrier.

Following the slipforming, lightly broom both sides of the barrier vertically. Broom the top of the barrier perpendicular to the longitudinal axis of the barrier.

Cut contraction joints as shown in the Contract Documents without spalling, just prior to initial set.

Apply 2 coats of curing compound immediately after the brooming operation. The minimum application rate is 1 gallon per 250 square feet of barrier for both applications. Apply the second application immediately after the first application, and at right angles to the first application.

720.4 MEASUREMENT AND PAYMENT

Slipforming of concrete barrier is not measured for payment.

721 - HANDRAIL FOR BRIDGES AND OTHER USES

SECTION 721

HANDRAIL FOR BRIDGES AND OTHER USES

721.1 DESCRIPTION

Fabricate and erect the metal handrails according to the Contract Documents.

BID ITEMS

Bridge Handrail (*) (**)

Handrail (*) (**)

* Type

** Size

UNITS

Linear Foot

Linear Foot

721.2 MATERIALS

Provide materials that comply with **DIVISION 1600**.

721.3 CONSTRUCTION REQUIREMENTS

a. General. Fabricate, weld, paint and erect the metal handrails according to **DIVISION 700**.

Before ordering or fabricating the materials, submit 7 copies of the shop drawings to the State Bridge Office for approval (see **subsection 105.10**).

Store handrail materials above ground on platforms or skids, with spacer blocks to keep the members separated. Protect the stored materials from contaminants and moisture.

Before placing concrete, protect the portion of the anchor bolts above the finished concrete line with wrappings or coatings of a release material. Use a template to verify the correct spacing and alignment of the anchor bolts. Remove the wrappings or coatings before erecting the handrails.

Before erecting the handrail posts, true the concrete surfaces where the posts will rest. Grind the concrete surfaces for proper seating, when required.

Erect the handrail by groups of posts corresponding to the length of each rail piece. Fully support handrail by posts at the time it is placed. The maximum deviation allowed from the correct alignment is $\frac{1}{8}$ inch. Abrupt breaks in alignment must be corrected. Drifting of holes during assembly is permitted only to bring the parts into position. Do not enlarge the holes or distort the metal. Use beveled washers on beveled surfaces to give full bearing to both the head and nut. After the handrail is erected, align it and tighten the nuts on the anchor bolts.

b. Steel Handrail. Erect the handrail to line and grade using surveying instruments. Shim the handrail posts as required. For shims $\frac{1}{8}$ inch or greater, use either steel or sheet lead shims. Only use 1 shim per post.

Unless the handrail is galvanized, apply 1 shop coat of paint after fabrication and one finish coat of paint after erection. Apply 2 shop coats of paint to surfaces that are inaccessible after assembly or erection. See **SECTION 714** for painting requirements.

c. Aluminum Handrail. Erect the handrail to line and grade using surveying instruments. Shim the handrail posts between the post and concrete surfaces, or between the post and base plate, as required. Use aluminum shims. If the shims are in contact with another metal or the concrete surfaces, coat the shims with caulking compound, or paint the shims with paint specifically used on aluminum, or use a synthetic rubber gasket.

721.4 MEASUREMENT AND PAYMENT

The Engineer will measure handrail from the center of end post to center of end post by the linear foot.

Payment for the "Bridge Handrail" or "Handrail" at the contract unit prices is full compensation for the specified work.

722 - SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS

SECTION 722

SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS

722.1 DESCRIPTION

Fabricate and erect bridge mounted sign attachments and sign structures to support signs over or adjacent to highways and streets as designated in the Contract Documents. The structures consist of:

- footings, including electrical grounding and conduit sleeves, when applicable;
- vertical support poles;
- vertical end support units;
- overhead trusses;
- structural attachment assembly;
- truss type arm; and
- maintenance walkway.

Remove, modify and reset the existing sign structures as designated in the Contract Documents.

BID ITEMS	UNITS
Bridge Mounted Sign Attachment (*)(**)	Linear Feet
Butterfly Overhead Sign Structure (*)(**)	Linear Feet
Cantilever Sign Structure (*)(**)	Linear Feet
Overhead Sign Structure (*)(**)	Linear Feet
Overhead Sign Structure (Mast Arm Type) (*)(**)	Linear Feet
Overhead Sign Structure (Single Tapered Tube) (*)(**)	Linear Feet
Remove and Reset Sign Structure (***)	Each
Reset Sign Structure (***)	Each
Sign Structure Modification (***)	Each

* Size or Size Group
** Type of Material
*** Station

722.2 MATERIALS

a. General. Provide new, unweathered materials of the type, and complying with the sizes, dimensions and tolerances shown in the Contract Documents.

Submit shop drawings according to **subsection 105.10**. Include a "cutting list" or "shop bill" that provides the piece mark length, outside diameter and wall thickness of each piece used in the fabrication of the structure. Provide an erection sketch, detailing the location of each piece in the final assembly. Do not perform any fabrication until the approved shop drawings are in the hands of the Inspector and fabricator, and the Engineer has authorized fabrication. Any purchase of materials before fabrication authorization is at the Contractor's risk. Changes to approved shop drawings are subject to the approval of the Engineer. Submit revised sheets of the same size as those originally approved.

Mark each bundle or package of material with letters, numbers or a combination of letters and numbers that are identified in the test report for that material. Mark each piece of material with letters, numbers or a combination of letters and numbers that are identified in the shop drawings. The marking must be legible, but not noticeable after erection of the structure.

b. Fabrication.

(1) Shop Welding. Perform welding and repairs according to the applicable requirements of the latest versions of AWS D1.1, "Structural Welding Code – Steel" and AWS D1.2, "Structural Welding Code – Aluminum".

(2) Dye Penetrant (DP) Testing. DP testing according to ASTM E 165 of welded flanges and base plates is required. The Engineer will accept the DP tests according to AWS D1.1 for steel, and AWS D1.2 for aluminum. DP testing must be witnessed by the Engineer.

722 - SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS

(3) Test Loading. Test loading of fabricated trusses is required only when inspection indicates the fabrication to be of doubtful or unacceptable quality requiring repairs before acceptance. Test load the structure to demonstrate the adequacy of the repair. The Contractor will bear the cost of test loading.

c. Electrical Equipment and Materials. Provide the electrical equipment and materials shown in the Contract Documents.

Submit to the Engineer for approval a schedule of electrical equipment and materials proposed for installation before beginning construction. Include catalog cuts, diagrams, drawings and other descriptive data required by the Engineer.

d. Concrete and Grout.

(1) Concrete for Footings. Provide Grade 3.5 concrete that complies with **DIVISION 400**.

(2) Grout. Provide non-shrink cementitious grout that complies with **DIVISION 1700**.

e. Reinforcing Steel. Provide Reinforcing Steel that complies with **DIVISION 1600**.

722.3 CONSTRUCTION REQUIREMENTS

a. General. Do not damage the existing cables and conduits. If necessary, relocate the existing cables and conduits to clear the footing locations. Repair or replace existing cables and conduits damaged during construction of the footings.

If temporary signs interfere with the erection of the permanent signs, relocate the temporary signs to the locations determined by the Engineer.

When "Contractor Construction Staking" is not shown as a bid item, the Engineer will stake the locations of sign structure footings. For each footing location, the Engineer will provide the Contractor with the vertical measurement from the crown grade of the pavement to the top of the footing.

Erect the bridge mounted sign attachments and sign structures according the Contract Documents.

If removing, modifying or resetting sign structures, do not damage the existing sign structures. Repair or replace, as directed by the Engineer, sign structures damaged through the negligence of the Contractor.

b. Concrete Footings. Construct the concrete footings according to the Contract Documents. When placing the concrete, consolidate the concrete in the footings by rodging and vibrating. Allow the concrete footings to cure a minimum of 4 days before attaching the sign structures.

c. Sign Structures.

(1) Bolted Joint Connections. Before assembling the sign structures, use a soft wire brush to clean the contact surfaces of the bolted connections. Remove all corrosion and coatings, except galvanizing. Wipe the cleaned contact surfaces with rags soaked with acetone, syol or toluol. Remove excess solvent from the contact surfaces using clean, dry rags.

Assemble the sign structures according to the Contract Documents. Seal all bolted joints immediately, using a sealant intended for this purpose, and applied according to the sealant manufacturer's recommendations.

(2) Attachment to Anchor Bolts. Place the sign structure with anchor plate on the anchor bolts. After all signs are mounted on the structure, and the sign pole (or bridge support) is plumb, tighten the top and bottom anchor bolt nuts and lock nuts. Fill the gap between the top of the footing and the bottom of the anchor plate with concrete grout according to the details in the Contract Documents.

(3) Overhead Truss. In erection of the truss, allow the dead load deflection to take place before fully tightening all the connectors. Fully tighten the vertical portion which clamps the column in all corners, but tighten only the top of 1 end of the horizontal portion of the truss-to-end-support connector while the truss is fully suspended from the crane. The rest of the truss-to-end supports shall be fully tightened after the dead load of the truss is being supported by the connectors, but still attached to the crane with a slack line. Erect the signs within 24 hours of erecting the truss.

(4) Dissimilar Materials. Whenever dissimilar materials are to be in permanent contact, provide an insulating barrier of alkali resistant asphalt paint or equivalent.

722 - SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS

d. Electrical Work. Comply with all Local, State and Federal ordinances.

(1) Conduit. Install conduit entrances through the concrete footing as indicated in the Contract Documents. Place temporary screwed caps on the conduit ends.

(2) Grounding. Ground all structures and sign bridges as detailed in the Contract Documents. Measure the resistance of the installed grounding system; the Engineer will observe the testing. The grounding system must have less than 25Ω resistance to ground.

722.4 MEASUREMENT AND PAYMENT

The Engineer will measure bridge mounted sign attachments, butterfly overhead sign structures, cantilever sign structures and overhead sign structures by the linear foot.

The Engineer will measure each sign structure, bridge mounted sign attachment, removal and resetting of a sign structure and modification of a sign structure.

Payment for each "Bridge Mounted Sign Attachment", "Butterfly Overhead Sign Structure", "Cantilever Sign Structure", "Overhead Sign Structure", "Overhead Sign Structure (Mast Arm Type)", "Overhead Sign Structure (Single Tapered Tube)", "Remove and Reset Sign Structure", "Reset Sign Structure" and "Sign Structure Modification" at the contract unit prices is full compensation for the specified work.

723 - SUBSTRUCTURE WATERPROOFING MEMBRANE

SECTION 723

SUBSTRUCTURE WATERPROOFING MEMBRANE

723.1 DESCRIPTION

Apply an epoxy primer or an epoxy system to areas of the substructure as specified in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Substructure Waterproofing Membrane	Square Yard

723.2 MATERIALS

Provide materials that comply with **DIVISION 1700**.

723.3 CONSTRUCTION REQUIREMENT

Clean all surfaces that are to be waterproofed.

Apply the waterproofing membrane according to the manufacturer's recommendations.

Apply the membrane to a minimum 40 mils dry film thickness on the bridge seat as shown in the Contract Documents. Apply waterproofing membrane to promote drainage of the bridge seats, and to fill any low areas that may retain moisture. The average coverage should be approximately 3 ¾ gallons per 100 square feet.

723.4 MEASUREMENT AND PAYMENT

The Engineer will measure the substructure waterproofing membrane by the square yard to the limits shown in the Contract Documents.

Payment for the "Substructure Waterproofing Membrane" at the contract unit price will be full compensation for the specified work.

724 - BRIDGE BACKWALL PROTECTION SYSTEM

SECTION 724

BRIDGE BACKWALL PROTECTION SYSTEM

724.1 DESCRIPTION

Prepare the concrete surface and apply a bridge backwall protection system to the face of the concrete abutment as specified in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Bridge Backwall Protection System	Square Yard

724.2 MATERIALS

Provide materials for bridge backwall protection systems that comply with **DIVISION 1700**.

724.3 CONSTRUCTION REQUIREMENTS

Provide the Engineer with a copy of the manufacturer's recommendations for application. If approved by the Engineer, apply the bridge backwall protection system as recommended by the manufacturer.

724.4 MEASUREMENT AND PAYMENT

The Engineer will measure the bridge backwall protection system by the square yard to the limits shown in the Contract Documents.

Payment for the "Bridge Backwall Protection System" at the contract unit price will be full compensation for the specified work.

725 - ABUTMENT DRAINAGE SYSTEMS

SECTION 725

ABUTMENT DRAINAGE SYSTEMS

725.1 DESCRIPTION

Install a geocomposite drainage system consisting of a prefabricated abutment strip drain, and perforated and non-perforated underdrain pipes as designated in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Abutment Strip Drain	Square Yard

725.2 MATERIALS

Provide materials that comply with the applicable requirements.

Abutment Strip Drain	DIVISION 1700
Perforated Pipe for Underdrains	DIVISION 1900
Non-Perforated Pipe for Underdrains	DIVISION 1900

725.3 CONSTRUCTION

Construct abutment drainage systems according to the Contract Documents.

Clean the surfaces against which the geocomposite drains will be placed. Remove all soil, debris and irregularities that will prevent intimate contact between the surface and the drain.

Install the geocomposite drains either vertically or horizontally, according to the Contract Documents. Secure the geocomposite drains using metal stick clips or adhesives. When a waterproofing membrane is included in the Contract Documents do not use nails to attach the geocomposite drain, unless the waterproofing membrane is self healing.

Form all joints and splices according to the manufacturer's recommendations.

Cover all exposed edges of the geocomposite drainage core with geotextile filter fabric. Tuck and secure a minimum of 4 inches of fabric behind the core. This may be done by utilizing the excess fabric at the ends, or using a 12 inch strip of fabric in the same manner, taping it to the exposed fabric 8 inches in from the edge with a continuous strip of 3 inch, waterproof plastic tape and folding the remaining 4 inches over and tucking behind the core edge.

If the fabric is torn, perforated or ripped, patch it with a second layer of fabric having a 4 inch overlap, and secure the edges with 3 inch waterproof plastic tape. Replace damaged core sections.

Place the underdrain pipes as shown on the Contract Documents. Separate the fabric from the core. Wrap it around the circumference of the perforated underdrain pipe and tuck it behind the core.

Do not damage the geocomposite drainage system when backfilling the structure. Use backfill soils with a liquid limit of less than 50.

725.4 MEASUREMENT AND PAYMENT

The Engineer will measure abutment strip drains by the square yard to the limits shown in the Contract Documents.

Payment for "Abutment Strip Drain" at the contract unit price is full compensation for the specified work.

726 - CONCRETE MASONRY COATING

SECTION 726

CONCRETE MASONRY COATING

726.1 DESCRIPTION

Prepare the concrete surfaces and apply a concrete masonry coating to the concrete surfaces designated in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Concrete Masonry Coating	Square Yard

726.2 MATERIALS

Provide concrete masonry coatings that comply with **DIVISION 1700**.

726.3 CONSTRUCTION REQUIREMENTS

Provide the Engineer with a copy of the coating manufacturer's recommendations for application.

Submit a sample panel exhibiting the color specified and the uniformity of the finish for approval by the Engineer.

Clean the concrete surfaces that will receive the coatings, before applying the concrete masonry coatings. Remove all projections and loose mortar particles from the concrete surfaces.

Store, mix, apply and cure the concrete masonry coating as recommended by the manufacturer.

726.4 MEASUREMENT AND PAYMENT

When shown is a bid item in the contract, the Engineer will measure concrete masonry coating by the square yard to the limits shown in the Contract Documents.

Payment for "Concrete Masonry Coating" at the contract unit price will be full compensation for the specified work.

727 - REPAIR (STRUCTURES)

SECTION 727

REPAIR (STRUCTURES)

727.1 DESCRIPTION

Perform the necessary procedures to repair the designated portion of the structure.

<u>BID ITEMS</u>	<u>UNITS</u>
Bridge Repair	Lump Sum
Jacking of Existing Structure	Lump Sum
Raise Expansion Device	Each
Remove and Reset Expansion Device	Each
Reset Existing Bearing	Each

727.2 MATERIALS

Provide the materials indicated in the Contract Documents. Provide the specified materials that comply with the materials' divisions (**DIVISIONS 1000 – 2500**).

727.3 CONSTRUCTION REQUIREMENTS

a. General. Repair the structure according to the Contract Documents and **DIVISION 700**.

If the Contract Documents require the superstructure be raised and supported on falsework while the repairs are made, allow the repaired areas to cure before resetting the structure.

Remove the old concrete to the limits shown in the Contract Documents. Dispose of the old concrete removed from the structure.

Do not damage the existing concrete that is to remain in-place. Repair any damage to the existing structure caused by the Contractor.

Before any new concrete is placed, clean all reinforcing steel exposed during concrete removal. When specified, place new reinforcing steel as detailed in the Contract Documents.

When specified, apply an epoxy resin base bonding system to the adjacent concrete surfaces before placing the new concrete.

b. Jacking of Existing Structures. Use jacks, supported on falsework or by other methods, to raise the designated spans as units. When specified, move the spans as indicated in the Contract Documents.

c. Raise Expansion Device. Raise the expansion device as shown in the Contract Documents.

d. Remove and Reset Existing Expansion Devices. Relocate the existing expansion devices according to the Contract Documents and **DIVISION 700**.

e. Resetting Existing Bearing. Use jacks to raise and support the existing superstructure. Raise the existing superstructure no more than necessary to remove the load from the existing bearings.

Reset the existing bearing to the position shown in the Contract Documents.

Any welding required for the resetting of the existing bearing must comply with **DIVISION 700**.

Repaint areas damaged during the resetting of existing bearing according to the Contract Documents.

727.4 MEASUREMENT AND PAYMENT

The Engineer will measure jacking of existing structure by the lump sum. The Engineer will measure each raised or reset expansion device and reset bearing. The Engineer will measure the various types of structure repairs by the units shown in the Contract Documents.

Payment for "Bridge Repair", "Jacking of Existing Structure", "Raise Expansion Device", "Remove and Reset Expansion Device" and "Reset Existing Bearing" at the contract unit prices is full compensation for the specified work.

728 - BRIDGE CURB REPAIR

SECTION 728

BRIDGE CURB REPAIR

728.1 DESCRIPTION

Repair the bridge curb according to the Contract Documents. Use either the conventional method or the shot-crete method for placing the concrete.

<u>BID ITEM</u>	<u>UNITS</u>
Bridge Curb Repair	Linear Foot

728.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete (Conventional Method)	DIVISION 400
Concrete (Shot-Crete)	DIVISION 800
Concrete Curing Materials	DIVISION 1400
Expansion Joint Materials	DIVISION 1500
Reinforcement Materials	DIVISION 1600
Epoxy Resin Base Bonding Systems	DIVISION 1700

728.3 CONSTRUCTION REQUIREMENTS

Remove and dispose of the unsound concrete to the limits shown in the Contract Documents.

Do not damage sound concrete that is to remain in-place. Repair any damage to the existing structure caused during removal.

Prior to placing any new concrete, clean all reinforcing steel exposed during the removal of the unsound concrete.

Apply an epoxy resin base bonding system to the adjacent concrete surfaces before placing any new concrete. If epoxy resin dries, reapply another coating.

If the new concrete is placed using conventional methods, construct and cure the bridge curb according to **DIVISION 700**.

If the new concrete is placed by the shot-crete method, apply the concrete according to **DIVISION 800**.

728.4 MEASUREMENT AND PAYMENT

The Engineer will measure repaired bridge curb along the base of the curb by the linear foot.

Payment for "Bridge Curb Repair" at the contract unit price is full compensation for the specified work.

729 - MULTI-LAYER POLYMER CONCRETE OVERLAY

SECTION 729

MULTI-LAYER POLYMER CONCRETE OVERLAY

729.1 DESCRIPTION

Prepare the surface of the existing reinforced concrete bridge deck, and construct a multi-layer polymer concrete overlay (overlay).

<u>BID ITEM</u>	<u>UNITS</u>
Multi-Layer Polymer Concrete Overlay	Square Yard

729.2 MATERIALS

a. **Epoxy.** Provide a Type III overlay epoxy as defined in **SECTION 1705**.

The epoxy supplied must have a minimum application history of 3 years in the State of Kansas. Include a list of bridges in Kansas on which the material has been applied, the name of the owner agency and a contact at the owner agency for each structure submitted.

b. **Aggregate.** Provide aggregates meeting **SECTION 1102**.

729.3 CONSTRUCTION REQUIREMENTS

This procedure may involve hazardous materials, operations and equipment.

a. **Equipment.** Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment. Shot-blasting equipment capable of producing a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch. Final acceptance is based on testing procedures as outlined in KT-70, Part V.

(2) Mechanical Application Equipment. Use the following equipment.

- An epoxy distribution system capable of accurate and complete mixing of the epoxy resin and hardening agent, verification of the mix ratio and uniform and accurate distribution of the epoxy materials at the specified rate on 100% of the work area;
- A self propelled aggregate spreader capable of uniform and accurate application of the dry aggregate over 100% of the work area;
- An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material; and
- Adequate additional hand tools to facilitate the placement of the overlay according to this specification and the manufacturer's recommendations.

(3) Hand Application Equipment. Use the following equipment.

- Calibrated containers for accurate measurement of epoxy components;
- A paddle type or other mixing device capable of accurate and complete mixing of the epoxy resin and hardening agent;
- Notched squeegees and brooms capable of spreading the epoxy material according to this specification and the manufacturer's recommendations;
- An aggregate spreader capable of uniform and accurate application of the dry aggregate; and
- Adequate additional hand tools to facilitate the placement of the overlay according to this specification and the manufacturer's recommendations.

(4) General. Provide an overall combination of labor and equipment with the capability of proportioning and mixing the epoxy components, and placing the epoxy and aggregate in accordance with this specification and the manufacturer's recommendations.

(5) Provide the Engineer with a copy of the epoxy materials manufacturer's recommendations.

729 - MULTI-LAYER POLYMER CONCRETE OVERLAY

(6) Do not use power driven tools heavier than a 15 pound chipping hammer, during deck preparation.

b. Proportioning. Proportion all epoxy materials according to the manufacturer's recommendations.

c. Preparation of Surface.

(1) Before preparation of the surface remove deteriorated concrete and repair the area with suitable patch material. Polymer concrete bridge deck material is acceptable. Strike off patches so they are level with the existing deck and finish with wooden floats.

Portland cement concrete patches require a minimum cure period of 28 days before application of the overlay.

(2) As the final preparation for the placement of the overlay, make a complete cleanup by shot blasting and/or other approved means, followed by an air blast with dry, oil free air or vacuum. Brooming is not acceptable. Remove all loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation and curing materials from patches and other foreign material from the surface of the deck.

(3) Produce a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch. The following test will determine if additional surface preparation is necessary.

(a) Place a polymer concrete test patch a minimum of 0.5 square yards for each span or every 300 square yards of prepared deck surface, which ever is smaller. The test patch shall be full depth, placed by the normal construction sequence.

(b) Final acceptance will be based on the following results of the test outlined in KT-70, Part V:

- Minimum Tensile Rupture Strength of 250 psi from an average of 3 tests on a test patch regardless of depth of failure (See KT-70); or
- Failure in the concrete at a depth greater than or equal to $\frac{1}{4}$ inch over more than 50% of the test area for 3 of the 4 tests in the test patch.

(c) If failure in the concrete is at a depth less than $\frac{1}{4}$ inch and the Minimum Tensile Rupture Strength is less than 250 psi, or the failure in the concrete is less than 50% of the test area, additional surface preparation is necessary.

(d) A failure in the concrete below 250 psi and greater than $\frac{1}{4}$ inch deep indicates weak concrete, not poor overlay bond.

(e) Do not perform tensile adhesion tests when temperatures are above 85°F.

(4) Remove any contamination of the prepared deck surface or surface of subsequent courses. Sand blast or bush hammer contaminated areas to produce an acceptable surface for placement of the overlay.

(5) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(6) Close deck drains so the epoxy and aggregate shall not pass through the drains.

(7) Rain will not necessarily contaminate the surface. However, care must be taken so no contamination occurs.

(8) Visible moisture on the prepared deck at the time of placing the overlay is unacceptable. Identify moisture in the deck by taping a plastic sheet to the deck for a minimum of 2 hours (ASTM D 4263).

(9) Place the first course within 24 hours of preparing the deck surface. Deck surfaces exposed for more than 24 hours must be sand blasted prior to application of the overlay.

(10) The Engineer must approve the use of scarifiers, scrubbers or milling machines.

(11) Wet sand blasting shall not be allowed.

d. Placing the Polymer Concrete Overlay. Place the wearing course to the grades, thickness and cross-sections as shown in the Contract Documents. Provide a technical representative of the epoxy manufacturer on the job site during the placement of both courses of the overlay at no additional cost to KDOT. The representative is to provide technical expertise to the Contractor and the Engineer regarding safe handling, placement and curing of the overlay.

Follow all manufacturer suggested safety precautions while mixing and handling epoxy components.

Place the overlay in 2 separate courses at application rates shown in **TABLE 729-1**.

729 - MULTI-LAYER POLYMER CONCRETE OVERLAY

TABLE 729-1: POLYMER CONCRETE OVERLAY APPLICATION RATES		
Course	Epoxy Rate	Aggregate Rate *
1	Not Less Than 0.22 gal./sq yd	10 lbs./sq yd
2	Not Less Than 0.45 gal./sq yd	14.5 lbs./sq yd

*Apply enough aggregate to completely cover the epoxy.

Use notched squeegees or mechanical application equipment to place the prepared epoxy on the deck immediately and uniformly at the prescribed rate.

If mechanical application equipment is used, take 2 ounce samples for each 100 gallons of material placed to verify mix ratios and curing times. Place samples on the bridge rail or deck and note time to cure.

Use a paintbrush or roller to apply the epoxy on the face of curbs to the top of the curb. On bridges with continuous concrete barrier rails apply the epoxy to the first break in the geometry of the barrier to a minimum height of 6 inches above the deck.

Apply epoxy to the curb or barrier as each of the overlay applications are performed.

The bridge deck and all epoxy and aggregate components must be a minimum of 60°F at the time of application.

Apply the dry aggregate to cover the epoxy completely within 10 minutes of application.

Remove and replace any first course areas that do not receive enough aggregate before gelling of the epoxy occurs.

Vacuum or broom excess aggregate from the first course after sufficiently cured. If damage or tearing occurs, stop brooming or vacuuming.

Do not open the first course to traffic.

Place the epoxy and aggregate for the second course at the prescribed rate and in the same manner as the first course.

Second course areas that do not receive enough aggregate before gelling of the epoxy may be re-coated with epoxy and aggregate.

Locate any longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

Produce and place the overlay within the specified limits in a continuous and uniform operation.

Correct surface variations exceeding $\frac{1}{8}$ inch in 10 feet unless directed otherwise by the Engineer.

Tape all construction joints to provide a clean straight edge for adjacent polymer concrete placement. This includes joints between previously placed polymer overlay materials and at centerline.

Finish the exposed edges at the ends of the bridge and at expansion joints to minimize bridge deck roughness.

Apply a bond breaker to all expansion joints.

e. Curing. Minimum curing times are noted in TABLE 729-2.

Course	Average Temperature of Overlay Components, °F						
	55-59	60-64	65-69	70-74	75-79	80-85	85+
	Minimum Cure Time (hours)						
1	5	4	3	2.5	2	1.5	1
2	6½	6.5	5	4	3	3	3

Cure the second course for 8 hours if the air temperature falls below 55°F during the curing period.

Plan and perform the work in such a way as to provide for the minimum curing times specified in this specification or as specified by the material manufacturer.

f. Weather Limitations. Do not place polymer concrete prior to April 1 or after September 30. The polymer concrete may be placed outside of the allowable dates with approval of the Engineer and the material supplier.

Do not place the overlay when conditions are such that the deck temperature will exceed 100°F.

Do not place the overlay if conditions are such that gel time is less than 10 minutes.

729 - MULTI-LAYER POLYMER CONCRETE OVERLAY

Do not place the overlay if the air temperature is expected to drop below 55°F within 8 hours of placement.

g. Correction of Unbonded or Damaged Areas. Repair newly overlain areas (discovered to be unbonded by tapping or chaining) and areas of the overlay damaged by the Contractor's operation. Saw cut the unbonded or damaged areas to the top of the deck surface, remove the overlay with small air tools (15 pounds maximum) or shotblasting. Shotblast the concrete bridge deck surface at the unbonded area to remove contaminants, and replace the overlay according to standard placement procedures at no additional compensation.

729.4 MEASUREMENT AND PAYMENT

The Engineer will measure multi-layer polymer concrete overlay by the square yard.

Payment for "Multi-Layer Polymer Concrete Overlay" at the contract unit price is full compensation for the specified work.

730 - EPOXY RESIN CRACK REPAIR

SECTION 730

EPOXY RESIN CRACK REPAIR

730.1 DESCRIPTION

Repair cracks in the concrete by epoxy injection at the locations shown in the Contract Documents, or as designated by the Engineer.

<u>BID ITEM</u>	<u>UNITS</u>
Epoxy Resin Crack Repair	Linear Foot

730.2 MATERIALS

Provide a Type IV, Grade 1, Class B or C epoxy material for injection purposes that complies with **SECTION 1705** and is compatible with the concrete temperature at the time of repair.

For sealing surface cracks, provide either:

- Silicone Rubber Building Sealant (clear or gray) that complies with **SECTION 1724**.
- Type IV, Grade 3, epoxy material that complies with **SECTION 1705**.

730.3 CONSTRUCTION REQUIREMENTS

a. General. A representative of the Bureau of Materials and Research, Research Unit must approve the Contractor's equipment before work starts on the project.

Arrange to have a representative of the Bureau of Materials and Research, Research Unit present when the work begins. The KDOT representative will remain on the project until both the Contractor and Inspectors have an understanding of the proper procedures for this work.

Provide a log and record the following data as injection proceeds:

- The date the injection ports are set;
- The date the injection is performed;
- The length of the crack injected;
- The amount of epoxy used;
- The temperature of the concrete in which the injection is performed; and
- The air temperatures when injection is performed.

The Project Engineer must approve the injection log and verify the correctness of the recorded data. Upon completion of the project, provide the Project Engineer with the recorded data. The Project Engineer will forward this information to the Bureau of Design, Bridge Section.

Make a representative of the material manufacturer available at the request of the Engineer.

Injected epoxy resin must be allowed to set a minimum of 4 hours before allowing traffic on the structure.

The materials, construction procedures, and the completed project will be inspected and approved by the Engineer.

b. Sealing Surface Cracks. Seal all visible surface cracks in the concrete. Before sealing the surface cracks, clean the surface to which the sealant will be applied.

Do not apply the sealant to wet surfaces. Apply the sealant with a minimum thickness of $\frac{1}{8}$ inch, and a width of $\frac{3}{4}$ inch on both sides and ends of the crack.

If silicone rubber sealant is used, allow the sealant to cure a minimum of 24 hours. If an epoxy sealant is used, follow the epoxy manufacturer's recommendations for minimum cure time requirements based on substrate and ambient temperatures.

c. Epoxy Resin Crack Injection. Drilled ports or surface mount ports are acceptable. If drilled ports are used, vacuum drilling of the port holes is required. Place drilled injection ports at a depth recommended by the injection equipment manufacturer.

730 - EPOXY RESIN CRACK REPAIR

Space the epoxy injection ports as recommended by the material supplier and/or the epoxy injection equipment manufacturer.

Allow adhesive used to attach injection ports to cure for 24 hours before injecting the epoxy resin.

Begin injecting at the lowest part of the concrete and work upward as the cracks are filled. This will be evidenced by the presence of epoxy in the next port above. On horizontal cracks proceed with injection from one end of the crack and work toward the other.

Check for leaks in the surface sealed cracks during the epoxy injection operations. If leaks are found, repair the sealant with hot glue and tongue depressors or other methods approved by the Engineer.

On cracks of $\frac{1}{8}$ inch or wider, limit the back pressure to a maximum of 30 psi. On all other cracks, maintain the back pressure between 80 and 100 psi.

After the injection is complete clean all surfaces of sealer and epoxy materials.

730.4 MEASUREMENT AND PAYMENT

The Engineer will measure epoxy resin crack repair by the linear foot.

Payment for "Epoxy Resin Crack Repair" at the Contract unit price is full compensation for the specified work.

731 - AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

SECTION 731

AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

731.1 DESCRIPTION

Perform all work necessary to remove all asphalt material and unsound concrete from the existing bridge or the designated area to the depth specified in the Contract Documents, or as designated by the Engineer.

BID ITEMS	UNITS
Area Prepared for Patching	Square Yard
Area Prepared for Patching (Full Depth)	Square Yard
Area Prepared for Patching (Poured with Overlay)	Square Yard
Reinforcing Steel (Repair) (*) (**) (Set Price)	Pound
* Grade	
** Epoxy-Coated	

731.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	DIVISION 400
Concrete Curing Materials	DIVISION 1400
Reinforcing Steel	DIVISION 1600
Epoxy Resin Base Bonding Systems	DIVISION 1700

On bridge decks that do no receive a concrete overlay, use coarse aggregate complying with SECTION 1102, except grading must adhere to TABLE 731-1.

TABLE 731-1: AGGREGATE GRADATION	
Sieve Size	Percentage Retained
¾ "	0
½ "	0-10
⅜ "	15-50
#8	90-100

731.3 CONSTRUCTION REQUIREMENTS

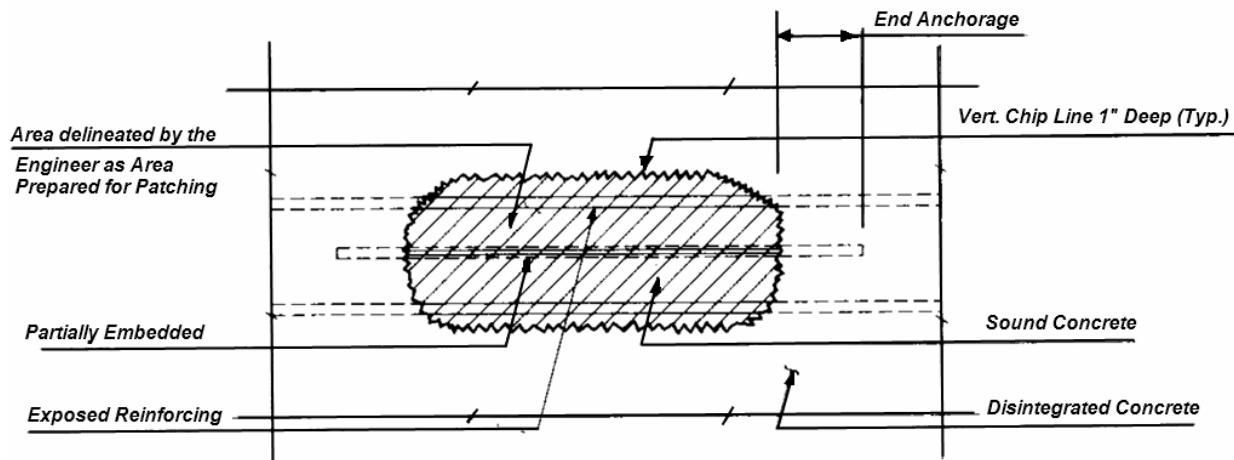
a. **General (All Decks).** Remove asphalt material and unsound concrete as shown in the Contract Documents and as designated by the Engineer, to the depth required to reach sound concrete and rust free reinforcing steel. Dispose of removed material on sites approved by the Engineer. When hydrodemolition is used as the method of removal, the Engineer will determine the areas of unsound concrete after hydrodemolition.

Unless specifically noted in the Contract Documents, the Contractor may choose to remove unsound concrete by hydrodemolition or by other means capable of removing the required concrete, without injury to the sound concrete and reinforcing steel. Do not use jack hammers or chipping hammers heavier than the nominal 15 pound class on any partial depth concrete removal. Jack hammers up to the nominal 30 pound class may be used in areas of full depth patching to within 6 inches of the edges of the designated areas. Do not use chipping hammers heavier than a nominal 15 pound class to remove the 6 inch edge. Operate jack hammers and chipping hammers at an angle to prevent damage to the sound concrete.

(1) Reinforcing. Remove all scale and heavy rust from steel bars. When concrete is removed by jack hammers, wet sandblasting is prohibited. If reinforcing is left exposed, and signs of rust appear, the Engineer may require that the cleaning be repeated. Do not cut, stretch or damage any exposed reinforcing steel. Do not break the bond between the reinforcing steel and concrete where bars are partially exposed yet remain anchored in sound concrete, near the ends or where more than half the bar is beneath the concrete removal line. See FIGURE 731-1.

731 - AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

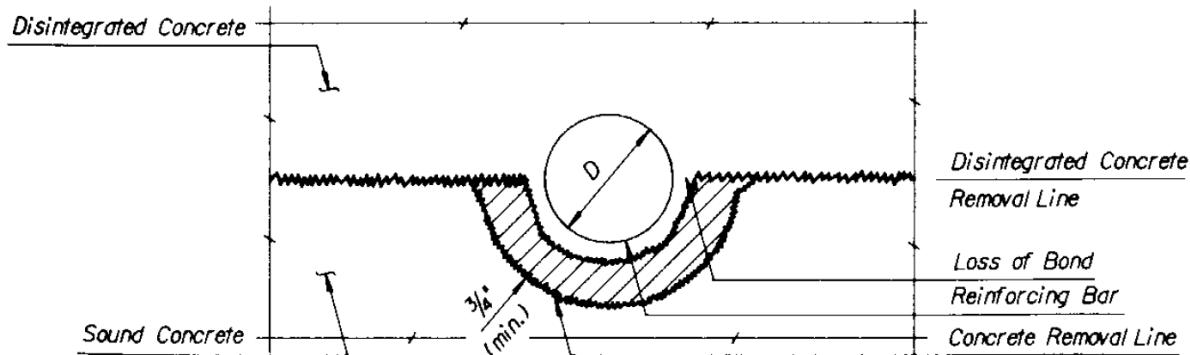
FIGURE 731-1



(2) Bonding of Reinforcing Steel.

(a) Top Layer of Transverse Reinforcing Bars. Where the bond between existing concrete and the top layer of transverse reinforcing steel has been destroyed (**FIGURE 731-2**), remove the concrete adjacent to the bar to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of $\frac{3}{4}$ inch. A bar may be considered bonded by the Engineer even if less than $\frac{1}{2}$ the bar depth is embedded in concrete.

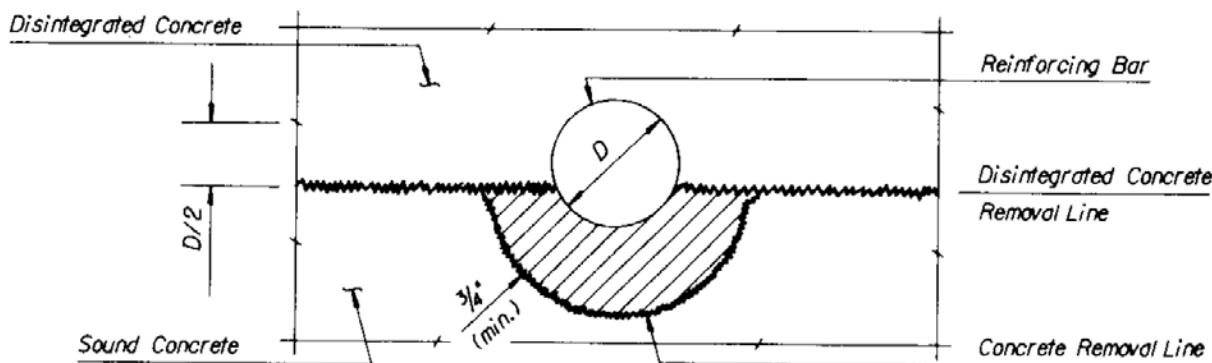
FIGURE 731-2



(b) All Reinforcing Bars Other Than the Top Layer of Transverse Bars. Where more than $\frac{1}{2}$ the diameter of the steel is exposed (**FIGURE 731-3**) or where the bond between existing concrete and reinforcing steel has been destroyed (**FIGURE 731-2**), remove the concrete adjacent to the bars to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of $\frac{3}{4}$ inch.

731 - AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

FIGURE 731-3



(3) Concrete Surface Preparation. Wet the surface with water, but prevent free standing water. No grout is required.

(4) Epoxy Resin Base Bonding Agent. Coat all abutting vertical edges in full depth patches with an epoxy resin bonding agent. Apply the adhesive material according to the manufacturer's recommendations, just prior to the placement of patching concrete. Provide good bond of the patch material at the edges of the patch area by applying additional vibration or hand tamping. If epoxy resin dries, reapply another coating.

(5) Concrete Placement. Place concrete according to **SECTION 710**.

(6) Segmental Construction. When large scale patches in the deck result in the debonding of the reinforcing steel, patch in segments to the size and spacing shown in the Contract Documents or as designated by the Engineer. After the initial segments have cured, if required, patch the areas between segments. Heavy equipment, such as volumetric mixing equipment, is prohibited on full depth patches for a minimum of 24 hours after the curing period has ended.

(7) Concreting in Hot Weather. Adhere to **subsection 710.3** when concreting in hot weather. A monomolecular film may be used to prevent rapid evaporation of water rising to the surface of the concrete. Do not use the film to work up grout as an aid to finishing operations. Use monomolecular film to prevent rapid evaporation between the initial strike off and brooming prior to covering with the curing media at ambient air temperatures above 70°F, or when combinations of temperature, low humidity and wind create conditions which, in the judgment of the Engineer, require hot weather procedure. Apply 1 or more light applications of monomolecular film as required by weather and finishing conditions. Complete curing as noted in **subsection 731.3c.(4)**.

(8) Concreting in Cold Weather. Except by specific written authorization, concreting operations are prohibited when a descending air temperature falls below 45°F. Do not start or resume concreting operations until the ascending ambient air temperature reaches 40°F.

b. Bridge Decks That Are To Receive An Overlay. Use aggregate specified for Grade 4.0(AE) concrete. Use the coarse aggregate specified for wearing surface. Patching concrete slump must be $2 \frac{1}{2}$ to $3 \frac{1}{2}$ inches.

Cure a minimum of 24 hours prior to placing the new overlay.

On partial depth areas where there is no loss of bond with the reinforcing steel, fill patched with Grade 4.0(AE) concrete or with the type of concrete specified for the overlay. Place partial depth patches less than 1 inch thick along with the overlay. The remaining patches may be placed just before or as the overlay is placed, unless shown otherwise in the Contract Documents. Fill all prepoured patches to a level approximately $\frac{1}{4}$ inch below the top of the old existing deck. Cure the prepoured patches a minimum of 24 hours.

Adhere to **TABLE 731-2** for the minimum length of cure time after the placement of all full depth concrete patches and/or removal of adjacent concrete on segmental patching and prior to placing overlay.

731 - AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

TABLE 731-2: BRIDGE PATCHING CURING	
Minimum length of Cure Time*	Ambient Air Temperature Range (°F)
48 hours	Above 60
72 hours	40 to 60
120 hours	32 to 40

*In special circumstances, longer cure times may be required by the Engineer.

Use wet burlap or polyethylene sheet for curing or cure according to **subsection 710.3e.** and **TABLE 710-1** for subdecks.

c. Bridge Decks That Do Not Receive An Overlay.

(1) Removal of Old Concrete. Remove unsound concrete to the limits designated in the Contract Documents or by the Engineer. Prior to removal, saw the perimeter of the patch, but do not saw into the reinforcing steel. Chip out the connecting edges below the sawed portion to nearly true lines. Do not damage sound concrete and dispose of the removed materials on sites approved by the Engineer. Perform final cleanup with a high pressure water jet with a minimum pressure of 3,500 psi or by sandblasting methods.

(2) Composition and Consistency of Concrete. Use Grade 4.0(AE) concrete with a slump between 2 ½ to 3 ½ inches at the point of placement.

(3) Placing, Consolidating and Finishing Concrete. Carefully place concrete to prevent segregation. Vibrate using a spud vibrator. Do not touch the old concrete underneath. Tamp the concrete in place using hand tamps with a maximum of 36 square inches of face. Strike off and finish the patch with wooden floats, followed by a light brooming for final finish.

(4) Curing. Apply the curing material after the finishing operation when marring the surface shall not occur. Cure the concrete surface using wet burlap and polyethylene sheets according to **subsection 710.3e.** and **TABLE 710-1** for bridge deck wearing surfaces. Keep the curing material in place for a minimum of 72 hours, unless designated otherwise by the Engineer. Keep burlap continuously wet during the curing period.

731.4 MEASUREMENT AND PAYMENT

The Engineer will measure the area prepared for patching by the square yard after the designated thickness of surface has been removed. The measured pay quantity will be those areas sounded by the Engineer and marked as unsound or delaminated concrete.

The Engineer will measure full depth patching prior to placement of patching concrete.

The Engineer will measure areas of partial depth patching poured with the overlay before the overlay is placed. Pay quantity for partial depth patching will be the marked areas of unsound or delaminated concrete minus the sum of the partial depth patching poured with the overlay and the full depth patching.

Payment for "Area Prepared For Patching" and "Area Prepared For Patching (Full Depth)" at the contract unit price is full compensation for the specified work when shown in the contract.

When the contract items include both "Area Prepared for Patching" and "Area Prepared for Patching (Full Depth)", the price bid for "Area Prepared for Patching (Full Depth)" shall be a minimum of 1 ¼ times the price bid for "Area Prepared for Patching". Failure to comply with this requirement is cause for rejection of the bid.

"Area Prepared for Patching (Poured with Overlay)" will be paid at 70% of the contract unit price for "Area Prepared for Patching" and is full compensation for the specified work. Payments made for "Area Prepared for Patching (Poured with Overlay)" will be shown as an added item to the contract. Concrete for the partial depth patching poured with the overlay will be paid for as provided in the overlay specification.

When no contract item is shown for "Area Prepared For Patching (Full Depth)" and upon approval of the Engineer, areas prepared for patching that are full depth requiring forming on the under side shall be paid for at a rate of 2 ¼ times the contract unit price per square yard of "Area Prepared For Patching".

Bars severely damaged or broken by the Contractor due to neglect shall be replaced at the Contractor's expense. Other bars that require replacement shall be replaced and paid for as pounds of "Reinforcing Steel (Repair) (Set Price)". The price per pound to be paid shall be the set price as shown in the contract.

Payment for "Reinforcing Steel (Repair) (Set Price)" at the contract unit set price is full compensation for the specified work.

Concrete used to fill patched areas shall be subsidiary to other items of the contract.

732 - MACHINE PREPARATION (EXISTING CONCRETE BRIDGE DECKS)

SECTION 732

MACHINE PREPARATION (EXISTING CONCRETE BRIDGE DECKS)

732.1 DESCRIPTION

Prepare the bridge deck surface for a concrete bridge deck overlay by removing the existing concrete and asphaltic material from bridge deck and approaches as shown in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Machine Preparation (*)	Square Yard
*Thickness	

732.2 MATERIALS - None specified.

732.3 CONSTRUCTION REQUIREMENTS

Remove concrete and asphaltic materials from the existing surface to the specified depth over the area of the deck by means of milling or cutting procedure capable of removing the specified material without injury to the sound concrete.

When specified, mill the approaches according to the Contract Documents.

732.4 MEASUREMENT AND PAYMENT

The Engineer will measure machine preparation by the square yard. Milling of approaches is subsidiary to the machine preparation bid item.

Payment for "Machine Preparation" at the contract unit price is full compensation for the specified work.

733 - HYDRODEMOLITION

SECTION 733

HYDRODEMOLITION

733.1 DESCRIPTION

Use hydrodemolition to prepare the bridge deck surface for patching and overlay. Remove concrete and asphalt surfacing to the limits shown in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Hydrodemolition	Square Yard

733.2 MATERIALS - None specified.

733.3 CONSTRUCTION REQUIREMENTS

When hydrodemolition is used on the project, in addition to any permits required by **DIVISION 100**, obtain a National Pollutant Discharge Elimination System (NPDES) permit. Apply for NPDES permit a minimum of 60 days before beginning the hydrodemolition operations. The permit application is obtained through the (Permit Section) Kansas Department of Health and Environment (KDHE), headquarters in Topeka, Kansas.

Use a hydrodemolition machine that is capable of producing a water jet through an orifice at a pressure a minimum of 17,000 psi. Use a machine with forward and backward motion that is capable of moving the water jet transversely across the concrete surface. The machine must operate with sufficient pressure to remove the unsound concrete. The machine must be capable of controlling these functions:

- the water pressure;
- the angle and distance of the orifice in relation to the concrete surface;
- the limits of transverse and longitudinal movement of the orifice;
- the speed of the orifice in transverse and longitudinal directions.

Adjust the hydrodemolition machine to remove the concrete to the approximate depth shown in the Contract Documents. Do not remove sound concrete below the top of the transverse layer of reinforcing steel. Perform the hydrodemolition to comply with the construction sequence shown in the Contract Documents.

Remove all unsound concrete. The Engineer will check the results of the hydrodemolition machine to verify that the machine is removing all of the unsound concrete, but is not removing sound concrete.

The Engineer will establish a hydrodemolition test area on the bridge deck. In the test area the Engineer will locate and record the limits of an area of unsound concrete. After the hydrodemolition machine is operated over this test area, the Engineer will measure the area that requires a deck patch. If the area requiring a deck patch is greater than 15% more than the area initially recorded by the Engineer, adjust the hydrodemolition machine to operate within the 15% tolerance.

Shield the water jet on the hydrodemolition machine to protect workers and the traveling public. Do not allow water to accumulate on the bridge. Do not damage areas adjacent to or below the bridge when draining the water from the bridge.

Remove and dispose of all asphalt surfacing and broken concrete removed from the bridge deck.

733.4 MEASUREMENT AND PAYMENT

When shown is a bid item in the contract, the Engineer will measure hydrodemolition by the square yard. Payment for "Hydrodemolition" at the contract unit price is full compensation for the specified work.

734 - STRUCTURAL PLATE STRUCTURES

SECTION 734

STRUCTURAL PLATE STRUCTURES

734.1 DESCRIPTION

Assemble and install the size and type of structural plate structure specified in the Contract Documents.

BID ITEMS

(*) Structural Plate Pipe (***)
(*) Structural Plate Pipe Arch (***)
(*) Structural Plate Arch (***)
*Size, diameter or span and height
**Gauge
***Asphalt Coated

UNITS

Linear Foot
Linear Foot
Linear Foot

734.2 MATERIALS

Provide structural plate for pipe, pipe arches and arches that comply with **DIVISION 1900**.

734.3 CONSTRUCTION REQUIREMENTS

Submit the design to the Engineer for approval, before installing any structural plate structure.

If the Contract Documents require a concrete footing, construct the footing according to **DIVISION 700**.

Excavate for and form the bed for the structural plate structures according to **DIVISION 200**. If placing 2 or more structural plate structures adjacent to each other, separate them by a distance equal to $\frac{1}{2}$ the diameter of the pipe for structural plate pipe, and by a distance of 2 feet for structural plate pipe arch.

Do not damage the plates during assembly and erection. Replace plates that are damaged during shipping or assembly. Repair any damaged coating after erection

Assemble the structural plate structure true to the dimensions shown in the Contract Documents, with all connections tight. When required by the Contract Documents, provide and erect strutting within the structure during construction, leaving it in place until the structure is backfilled.

Backfill the structure according to **DIVISION 200**.

734.4 MEASUREMENT AND PAYMENT

The Engineer will measure structural plate structure by the linear foot, along the centerline of the structure. The Engineer will measure structural plate structures with vertical ends from end to end. The Engineer will measure structural plate structures with sloping ends from the center point of the slope on one end to the center point of the slope on the opposite end.

Payment for the "Structural Plate Pipe", "Structural Plate Pipe Arch" and "Structural Plate Arch" at the contract unit prices is full compensation for the specified work.

735 - PRECAST REINFORCED CONCRETE BOX

SECTION 735

PRECAST REINFORCED CONCRETE BOX

735.1 DESCRIPTION

Install the specified sizes of precast reinforced concrete boxes at the locations designated in the Contract Documents.

Unless specified otherwise in the Contract Documents, the Contractor has the option to substitute precast reinforced concrete boxes for the cast-in-place reinforced concrete boxes shown in the Contract Documents.

<u>BID ITEM</u>	<u>UNITS</u>
Reinforced Concrete Box (*) (Precast)	Linear Foot
*Size	

735.2 MATERIALS

a. **Precast Reinforced Concrete Box.** Provide precast reinforced concrete box sections complying with ASTM C 1433, Table 2.

Exceptions and additions to the above requirements are:

(1) ASTM Section 11. PERMISSIBLE VARIATIONS. Revise the first sentence of subsection 11.1 to read: The internal dimensions may not vary more than 1% or $\frac{3}{4}$ inch, whichever is less, from the design dimensions.

(2) ASTM Section 11. PERMISSIBLE VARIATIONS. Add the following subsections:

- (a) 11.8 Deviation from straightness of mating edge: $\pm \frac{1}{4}$ inch.
- (b) 11.9 Squareness of ends (vertical and horizontal): $\pm \frac{1}{4}$ inch.

(c) 11.10 With any new production start-up or change in set-up, join a minimum of the first 5 production units at the fabrication plant for inspection of joint fit-up and alignment of boxes. Continue joining each unit until production is satisfactory. Check approximately 10% of the remaining production at random, using a minimum 3 unit assembly. The Engineer may order a 3 or more unit assembly at any time measurements or observations indicate a problem exists.

(3) Design multiple-cell precast reinforced concrete boxes according to the criteria used to develop the single-cell precast boxes.

(4) The minimum member thickness is not less than $\frac{3}{4}$ the thickness of the corresponding member of an equivalent KDOT Standard cast-in-place rigid frame box culvert, but not less than 6 inches. When calculating the minimum thickness of the bottom slab, deduct $\frac{1}{2}$ inch from the cast-in-place thickness before factoring by $\frac{3}{4}$.

(5) Provide minimum clearances to reinforcing of $1\frac{1}{4}$ inches $\pm \frac{1}{4}$ inch from all faces except when the depth of fill is less than 2 feet. In that case, make the clearance in the top of the top slab $2\frac{1}{2}$ inches $\pm \frac{1}{4}$ inch.

(6) Use epoxy coated reinforcing in the top slab when the fill at the shoulder line is 6 inches or less.

(7) Fill heights less than 2 feet require a distribution slab. Precast distribution slabs may be used for fill heights over 1 foot, otherwise use cast-in-place.

(8) For the cast-in-place distribution slab, 1 of the following combinations of steel reinforcement may be used:

- 1 layer of mesh and 1 layer of reinforcement bars, or
- 1 layer of reinforcement bars.

Develop the reinforcement according to the applicable parts of Section 5, of the AASHTO LRFD Bridge Design Specifications.

(9) Provide a minimum of 0.06 square inches per foot of longitudinal reinforcing for shrinkage and temperature requirements in each face, except at the joint as shown in the Contract Documents).

(10) Provide minimum transverse steel areas in each face of 0.19 square inches per foot of barrel.

(11) The maximum shear reinforcement spacing in the longitudinal direction is 6 inches.

(12) Welding is not allowed on reinforcing bars or steel fabric, except that the original welding required to manufacture wire fabric is acceptable.

(13) Air entrainment is not required for dry-cast units. Use air entrainment for wet-cast units where the depth of fill will be less than 2 feet, as shown in the Contract Documents.

(14) Use material for precast reinforced concrete boxes that complies with the applicable requirements:

Grade 4.0(AE) Concrete **DIVISION 400**

735 - PRECAST REINFORCED CONCRETE BOX

Concrete Admixtures	DIVISION 1400
Reinforcing Steel (Grade 60)	DIVISION 1600
Reinforcing Steel (Epoxy Coated) (Grade 60)	DIVISION 1600

(15) Minimum length of a precast section is 4 feet.

(16) A single-cell box of equivalent area may be substituted for a double-cell box with cell spans less than or equal to 6 feet. Any revision in the cell height from that shown on the Contract Documents shall not be permitted unless approved by the Engineer. Two single-cell boxes may be substituted for a double-cell box, if approved by the Engineer.

(17) Prior to fabrication, submit shop drawings to the Engineer for approval (see **subsection 105.10**). Detail all phases of construction including layout, joint details, lifting devices, casting methods, construction placement and details of any cast-in-place sections. Note the proposed transportation methods on the shop drawings.

(18) Legibly mark this information on an inside face of each box section by waterproof paint or other approved means:

- Date of manufacture;
- Name or trademark, and location of the manufacturer;
- Weight of box section in tons; and
- The top of the box.

Allow the Engineer free access to the manufacturing plant at all times for the purpose of inspecting materials, plant facilities and manufacturing and curing procedures. Inform the Engineer of planned concrete placement and curing schedule 5 business days before work is started.

Precast reinforced concrete boxes will be accepted on the basis of satisfactory results of material tests performed by the Engineer, compliance with dimensional requirements and visual inspection at the point of usage.

b. Materials for Sealing Joints of Precast Boxes. Provide a compound type joint filler or rubber gasket that complies with **DIVISION 1500**.

Provide an external sealing band that complies with ASTM C877. The basis of acceptance for external sealing bands will be a Type D Certification as specified in **DIVISION 2600**.

Provide geotextile fabric complying with the following requirements:

In the manufacture of geotextile filter fabric, use fibers consisting of long chain synthetic polymers, polyesters or olyamides. Form into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges. Use materials complying with the physical requirements shown below.

Apparent Opening Size	ASTM D 4751	U.S. Standard Sieve 50
Permittivity	ASTM D 4491	0.5 per sec. minimum
Grab Strength	ASTM D 4632	100 lb. minimum, either pr direction
Seam Strength	ASTM D 4632	90 lb. minimum
Ultraviolet Degradation at 150 hrs	ASTM D 4355	70% retained

Provide geotextile rolls with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Label or tag each roll to provide product identification sufficient for inventory and quality control purposes. Store rolls in a manner which protects them from the elements. If stored outdoors, elevate and protect with a waterproof cover.

The geotextile will be accepted on the basis of a Type A Certification as specified in **DIVISION 2600**. Submit certification to the Engineer that the materials meet the minimum average roll values as shown above.

c. Foundation Materials for Precast Boxes. Provide either crushed stone or concrete seal course for the foundation of the precast box.

Provide crushed stone that is free of soapstone, shale, shalelike or other easily disintegrated material. Provide crushed stone with adequate gradation to provide a uniform foundation. The Engineer will accept the crushed stone based on visual inspection at the point of usage.

For concrete seal course, provide commercial grade concrete that complies with **SECTION 401**, or use any other concrete acceptable for use on the project.

735 - PRECAST REINFORCED CONCRETE BOX

735.3 CONSTRUCTION REQUIREMENTS

Excavate and prepare the foundation according to **DIVISION 200**. Construct a 6 inch (minimum) thickness of crushed stone, or 3 inches of concrete seal course for the foundation of the precast box.

Lay the precast reinforced concrete box culvert with the groove end of each section up-grade. Join the sections tightly.

Seal the joints using one of the options shown in the Contract Documents. Install the joint sealant according to the manufacturer's recommendations.

If geotextile is used to wrap the joint:

- Use only geotextile that has been properly stored;
- Limit the exposure to the elements (between placement and covering) of the geotextile to a maximum of 7 calendar days;
- Do not drop any backfill larger than 6 inches D₅₀ size onto the geotextile from a height greater than 1 foot;
- Do not drop any backfill smaller than 6 inches D₅₀ size onto the geotextile from a height greater than 3 feet; and
- Do not contaminate the geotextile with grease, mud or other foreign substances. Replace contaminated or damaged geotextile. If approved by the Engineer, repair damaged geotextile by placing a patch over the damaged area and sewing the patch to the geotextile. Extend the patch a minimum of 1 foot beyond the perimeter of the damaged area. Replace contaminated or damaged geotextile, or repair if approved, at the Contractor's expense.

Fill the lifting holes with precast plugs sealed with mastic or mortar.

Unless otherwise approved by the Engineer, construct cast-in-place collars at horizontal and vertical changes in RCB alignment.

Construct the cast-in-place sections, end sections and wingwalls, according to **DIVISION 700**, and as detailed in the Contract Documents.

735.4 MEASUREMENT AND PAYMENT

The Engineer will measure precast reinforced concrete boxes by the linear foot. Precast end sections, and cast-in-place end sections and wingwalls will not be measured for payment.

Payment for "Reinforced Concrete Box (Precast)" at the contract unit price is full compensation for the specified work.

If constructed as an option to cast-in-place RCB's, the Engineer will not measure the precast reinforced concrete boxes for payment. The cast-in-place quantities are the basis of payment. Payment of the cast-in-place quantities at the contract unit prices is full compensation for the specified work.

