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DIVISION 700
STRUCTURES

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.

BID ITEM	UNITS
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 the Temporary Shoring Plan (including the design calculations) sealed by a licensed Professional Engineer, according to **SECTION 105**, 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.

SECTION 702

CONTROLLED DEMOLITION

702.1 DESCRIPTION

Controlled demolition is the process of transporting, handling and disassembling the components of an open span structure to result in the complete or partial removal of the entire structure or elements of a structure according to the approved demolition plan. The Contract Documents will identify the category for each structure.

Information on existing structures is made accessible by the Owner, if the information is available. Evaluate project characteristics and prepare demolition plans according to the specified category listed in the General Notes.

Plan and execute all procedures necessary for full or partial removal of the structure in a safe and controlled manner that meets all applicable KDOT specifications and all applicable OSHA requirements.

After concrete removal, or before any steel repairs, test the paint for lead content. Properly handle any lead based paint. See **SECTION 714**.

702.2 DEMOLITION SUPERVISOR

The Demolition Supervisor is the person responsible for all rigging and handling of bridge primary and secondary members. The Demolition Supervisor shall be present at the construction site during the removal of Category B & C Structures.

All Demolition Supervisors must be pre-qualified for the scope, type and complexity of the existing structure. To become pre-qualified, provide proof of experience that the Demolition Supervisor has a minimum of 3 years of experience and at least 5 projects similar in scope, type and complexity.

KDOT will maintain a list of approved Demolition Supervisors on a Pre-Qualified List.

Complete the pre-qualification of the Demolition Supervisor prior to the pre-construction meeting, and/or submit to the KDOT Field Engineer proof of pre-qualification at the pre-construction meeting.

702.3 DEMOLITION PLANS

a. General. The Contract Documents will indicate the demolition category for each structure. Submit shop drawings according to **SECTION 105**.

Develop a unique Demolition Plan for each qualifying existing open span structure in the Contract Documents.

Submit a detailed Demolition Plan to the Owner's Engineer for each open span structure. Address all requirements for removal of the structure to the limits shown in the Contract Documents. Demolition may not proceed until a Demolition Plan has been approved.

During phased/staged demolition, the Contractor's responsibilities extend to the removal limits stated in the Contract Documents for each phase. Do not directly affect the remaining structure outside the removal limits for each phase, or affect the adjacent structure.

Include a Contingency Plan within the Demolition Plan indicating procedures to be carried out if the demolition stage completed does not comply with the Demolition Plan (i.e. the Plan states completion of rail removal, but due to unforeseen obstacles the majority of one rail has been partially disconnected from the existing structure, but it has not been removed).

b. Definitions. The level of review and the requirements for submittals by the Contractor to the Engineer are categorized by risk and complexity.

The Design Engineer will determine and assign the Category of the demolition and will indicate the demolition Category for each open span structure requiring removal on the design plans. Signing and Lighting structures, due to the typical removal procedures, will specify a demolition Category based upon the Signing and Lighting Engineer's engineering judgment. If this information is erroneously omitted, contact the State Bridge Office (SBO). Special considerations will control the selection of the demolition Category.

Controlled demolition of open span structures falls under three separate categories:

(1) Category A. This category requires approval of a Demolition Plan. Demolition typically includes open span structures that will not carry any type of traffic during the demolition operations, structures not adjacent to

traffic, or for structures that do not include a span over any type of traffic. Structures requiring phased removal will be considered for Category A demolition.

(2) Category B. This category requires approval of a Demolition Plan, and a pre-qualified Demolition Supervisor. Demolition will include open span structures with more complex traffic control. Although the removal, or partial removal, may be simple in nature, the structure may continue to carry traffic, be located adjacent to traffic, or include one or more spans over traffic or railroad. Deck or rail replacement, partial depth patching, substructure repair projects or similar controlled demolition activities have the potential to become projects which require a more stringent demolition Category, and as such may be included in this Category.

(3) Category C. This category requires an approved Demolition Plan reviewed by the SBO (or Bureau of Local Projects), a pre-qualified Demolition Supervisor, and the stamp of the Contractor's Professional Engineer. Demolition is defined as the category for open span structures with complex traffic control plans and removal sequences. Complex structures required to carry traffic during demolition operations, are adjacent to traffic, or structures that include one or more spans over traffic (curved structures, severely skewed structures, multi-level interchange structures, etc.) may be included in this Category. A structure with components being removed over traffic or with the potential to fall into traffic is considered to be a Category C structure.

c. Submittals.

Category A Demolition Plans. Provide the Field Engineer with one set of Demolition Plans before demolition begins. Demolition Plans will include at a minimum, as applicable:

(1) A list of all equipment that will be used;

(2) Sequence and limits of removal/partial removal/repair;

(3) Measures to contain falling, or rolling, debris;

(4) Heavy stockpile/equipment loads on the bridge, detailed in accordance with **subsection 702.6**; and

(5) Traffic Control Plan Modification will be according to **SECTION 805**.

No additional requirements apply to this Demolition Category.

Category B Demolition Plans. Provide the Field Engineer with one set of Demolition Plans 2 weeks prior to the demolition meeting. Meet each requirement for a Category A Demolition and at a minimum the following:

(1) A removal sequence showing gravity loads imposed by Contractor equipment and materials.

(2) Proposed methods of demolition, as applicable:

- A list of all equipment that will be used;
- Details of methods to brace the existing structure during demo process;
- Saw cut and/or break point locations;
- Crane pick locations, loads, positions, charts, and rigging;
- Location of protective covers or shields;
- Temporary drainage plan; and
- Proposed backfill after removal of below grade structures.

(3) Specific details for removal will be clearly defined, as applicable:

- Practical environmental conditions limits for removal;
- Detailed Pick descriptions (Length, Center of Gravity, weight, etc.);
- Cross-frame or diaphragm removal sequence; and
- Temporary shoring/falsework details in compliance with **SECTION 708**.

(4) On the Demolition Plans, list the name of the person who is responsible for all rigging and handling of all elements requiring removal. This person, referred to as the Demolition Supervisor, must be present at the site during the demolition of all elements requiring removal. All field operations and field changes are under the authority and responsibility of the Contractor's Demolition Supervisor.

(5) Do not suspend/swing any elements over highway traffic at any time during any stage of the removal procedure.

No additional requirements apply to this Demolition Category.

Category C Demolition Plans. Meet each requirement for a Category B Demolition. In addition, submit the final Demolition Plan details, according to **SECTION 105**, to the SBO (or Bureau of Local Projects) for review at least 4 weeks before the pre-demolition meeting.

(1) The Engineer will require a pre-demolition meeting before any Category C demolition operations begin. The Demolition Supervisor will attend this pre-demolition meeting to discuss any field concerns related to the demolition procedures and to increase familiarity with each existing structure to be removed.

(2) Intermediate Stability. Defined as the point in time when the composite nature, or redundancy of the as-built structure, or elements of the structure, can no longer be relied upon to be stable under dead or live loads. This condition may be due to general or localized degradation of the structure, or due to demolition preparations. Before any connection between the existing structure and the element being removed has been compromised, provide protective stability measures for the existing structure, and for the element being removed. The existing state of the overall structural stability, or stability of particular elements of the structure, may be a major factor in the decision for complete, or partial removal.

- The composite nature and structural integrity of an as-built structure shall be verified before it is relied upon. This requires calculations, procedures and drawings to be developed and sealed by the Contractor's Professional Engineer.
- Field changes causing increased load effects at any controlling portion of the structure must be approved and resealed by the Engineer who originally developed the plans before work begins. This work is under the authority of the Contractor's Professional Engineer.

In no case will the Engineer allow any type of traffic to travel under incomplete structures undergoing demolition without compliance of the Demolition Plan.

d. Calculations. Include the following as a minimum:

(1) Calculations to substantiate structural adequacy and stability for each stage of demolition, accounting for the structure's lack of completeness, various stages of partial connections, or complex structural geometry.

(2) Primary member bearing calculations clearly stating minimum net downward forces at bearing locations at critical stages of removal.

(3) Calculations to determine translations and rotations at intermediate removal conditions.

(4) Design calculations indicating and verifying the load capacity and stability of all temporary supports, falsework bents, shields or covers, and bracing when used to allow traffic to travel under the incomplete structure.

(5) Calculations indicating structural redundancy of the incomplete structure will be required at intermediate stages of demolition. These calculations will be required to account for unforeseen obstacles to the removal process that necessitate halting demolition at an undesignated stopping point.

(6) Using alternative dead and live loading patterns producing the maximum load effect at controlling locations of the as-built structure, the Contractor's Engineer may create an envelope of allowable means and methods for the demolition procedures.

702.4 DEMOLITION INFORMATION RESPONSIBILITY SUMMARY

The Contractor's Engineer shall provide the following information (Category C):

- Plan of the work area showing the as-built permanent support structures of the structure to be disconnected or removed, roads, railroad tracks, waterways (including navigational channel), overhead and underground utilities and other information pertinent to the demolition procedure.
- Removal sequence for all elements of the structure noting any temporary support conditions, such as holding crane positions, temporary supports or bracing, shoring, protective shields or covers, dead man cables, anchor blocks, etc.
- Details describing the number and location of the permanent, or temporary, cross-frames or diaphragms for each stage of removal.
- Details addressing the expected condition of each bearing device for each stage of construction. State the minimum number of positive bearing connections or supplemental connections to each bent cap which will resist potential destabilizing forces.
- Details addressing modified traffic control, utility and railroad issues.
- Demolition Plans to meet general falsework requirements in **DIVISION 700** if falsework bents, temporary shoring, or strong-backs are used to maintain the stability of the remaining structure.

- Contingency Plan specifying the various unintended partial stages of demolition and removal, including end-of-day bracing and stability requirements. The Contractor's Engineer will also need to address real-time concerns arising from the on-going demolition process.

The Contractor's Demolition Supervisor shall provide the following information (Category B or C):

- Verification to the Contractor and the Field Engineer that member reference marks, as described in the Demolition Plan, have been transferred to the existing structure to allow the Contractor and the Field Engineer to conduct a field review;
- Limits for windspeed/gust, or other environmental concerns for crane operations;
- Proposed crane locations for primary picks showing all necessary information;
- Capacity chart for each crane configuration;
- Center of gravity, lift weight (including rigging) for all picks;
- Primary/secondary element removal location and storage;
- Details of any temporary lifting devices to be bolted/welded to permanent members, including stage and method of attachment, capacity, and stage of removal and
- Temporary support details for bridge bearings.

The Owner's Inspector shall require the following (Category A, B and C):

- A dimensionally accurate Demolition Plan, clearly stating the limits of removal, girder line locations, etc., to permanently transfer to the existing structure;
- Requirements for bracing. At the end of each workday, remove, or temporarily brace, the structural elements not properly stabilized to bring these elements into compliance with the Demolition Contingency Plan; and
- All rigging must have capacity stamps, tags or be otherwise permanently marked on the device (per OSHA Standards).

702.5 PRECONSTRUCTION CONFERENCE

Discuss the Demolition Plan at the pre-construction or pre-demolition meeting.

Resolve any questions during the meeting concerning the Demolition Plan or specific demolition procedures to the satisfaction of the Contractor, Contractor's personnel, and the Engineer before demolition begins.

Additional circumstances may be addressed to include within the Contingency Plan. Modify the Contingency Plan to include all situations agreed upon during the meeting.

702.6 CONSTRUCTION REQUIREMENTS

Do not perform any demolition work without an approved Demolition Plan.

Keep the approved Demolition Plans available on site at all times.

Maintain a consistent, core group of staff (supervisors and laborers) through the completion of demolition.

Demolish the existing structure and perform all work required to remove the structure to the limits stated and as detailed in the Contract Documents. Upon completion of the demolition, remove all obstructions or debris resulting from these operations.

Without prior written approval by the KDOT Area Engineer, do not stock pile construction materials, debris, or rubble exceeding the lesser of the posted load limit, or 20 tons. Equipment on the structure must not exceed the lesser of the posted load limit, or the Operating Load Rating for the structure. To request written approval, provide the KDOT Area Engineer plans showing the location, quantity and weight of the proposed materials, debris and/or equipment exceeding the stated limits.

Perform demolition in a reasonable, controlled, methodical fashion. Demolition Plan approval by the Engineer will not and does not relieve the Contractor of the responsibility for the safety of the methods used, safety of the equipment, or from carrying out the work in full accordance with **SECTION 107**.

Demolition is complete when all elements are removed to the limits shown in the Contract Documents and any shoring and debris are removed.

702.7 MEASUREMENT AND PAYMENT

The Engineer will not measure Controlled Demolition, Demolition Plans and Contingency Plans for separate payment. All required work is subsidiary to the other bridge items in the contract.

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	UNITS
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.)

703.2 MATERIALS

a. Concrete. Unless otherwise shown in the Contract Documents, provide Grade 4.0 concrete that complies with **SECTIONS 401, 402 and 1102**. Provide a mix design with a target slump of 9 inches ± 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 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 pipe that complies with **DIVISION 1900**.

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.

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 ±⅜ 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.

For drilled shafts equal to or greater than 72 inches in diameter founded in shale, or as required in the Bridge Foundation Geology Report, perform the following, prior to placement of the reinforcing cage:

- Use a full diameter flight auger or core barrel. Extensions to the auger to increase the diameter of the hole are prohibited, except when excavating a belled rock socket with an under ream attachment;
- Use a full size, clean-out bucket a minimum of 95% of the diameter of the rock socket, when needed;

- In the presence of the Engineer, sound the bottom of the finished shaft. Use a weighted tape in a 12-inch grid across the base of the shaft;
- Provide access to the entire perimeter of the shaft;
- Flocculate the finished shaft to increase the visibility in the water, prior to using the underwater video camera. Use a commercially available flocculent agent per the manufacture's recommendations.
- Prior to concrete placement, perform a video inspection to inspect the sides and base of the rock socket. Along with the Engineer, review the video to verify the socket meets the cleanliness portion of this specification, prior to concrete placement;
- Perform sonic testing for all shafts. Submit test results to the Chief Geologist for review. No work will be done above the top of drilled shaft without the approval of the Chief Geologist; and
- Any required repairs or additional testing are the Contractor's expense.

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 either pour method. Use a minimum of 1 non-corrosive circular spacer per 30 inches of circumference of the reinforcing steel cage, within 2 to 4 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.

Remove any corrosion protection coating from the sonic testing pipes by sandblasting. Sandblast the pipes to bare metal. Place the sonic testing pipes within 7 days of sandblasting.

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.

Regardless of the connection used, conduct a pressure test of each pipe upon installation in the reinforcement cage.

Test all pipes after being placed and tied in the reinforcement cage. When the drilled shaft is greater than 30 feet in length, perform a second pressure test after the reinforcement and pipes are installed in the drilled shaft but prior to placing the concrete. Pressurize the pipe to 100 psi. Seal the pipe for 3 minutes. Pressure loss can not be greater than 5% in 3 minutes.

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 ½ inch of sediment. The Engineer will determine the shaft cleanliness before concrete placement by:

- Visual inspection; or
- Underwater inspection using probes; or
- Down hole television camera and video recordings

Provide access to 100% of the hole from probing purposes. Probing will be done by a tape with a minimum weight of 1 pound.

Review and inspection by the Engineer prior to concrete placement does not relieve the Contractor of the responsibility for producing a defect-free shaft per specifications.

When directed by the Engineer, operate the camera and recorder such that the optimum clarity of the details can be obtained and all surface areas of the shaft, including the rock socket sides and base can be observed. Record video and store tapes such that later review is possible. Label the recorded media, which will become the property of KDOT.

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:

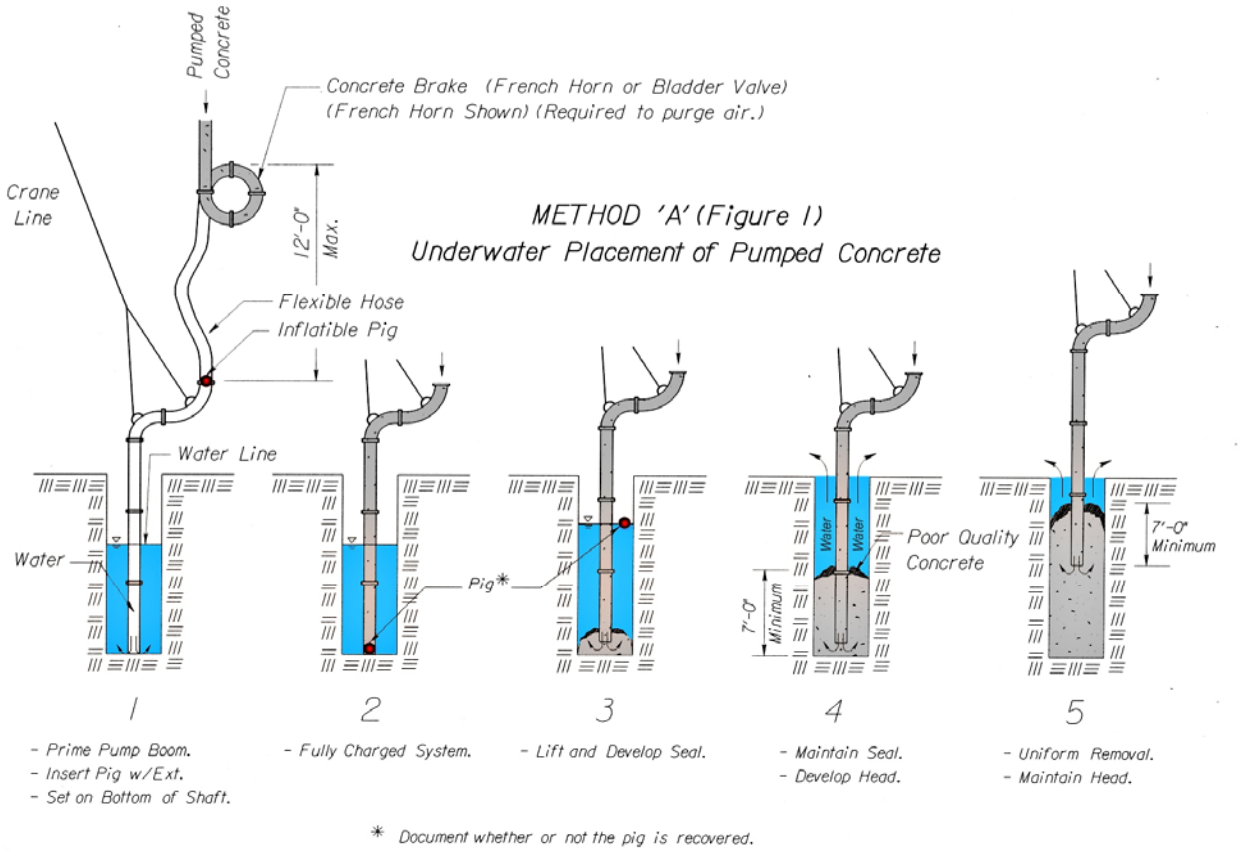
- Target slump is 9 inches ± 1 inch;
- Place concrete in the shaft with a continuous operation, without construction joints;
- Do not vibrate concrete;
- Determine the top elevation of the fresh concrete and inform the Engineer; and
- Do not use aluminum concrete pump discharge tubes or tremie tubes.

(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.

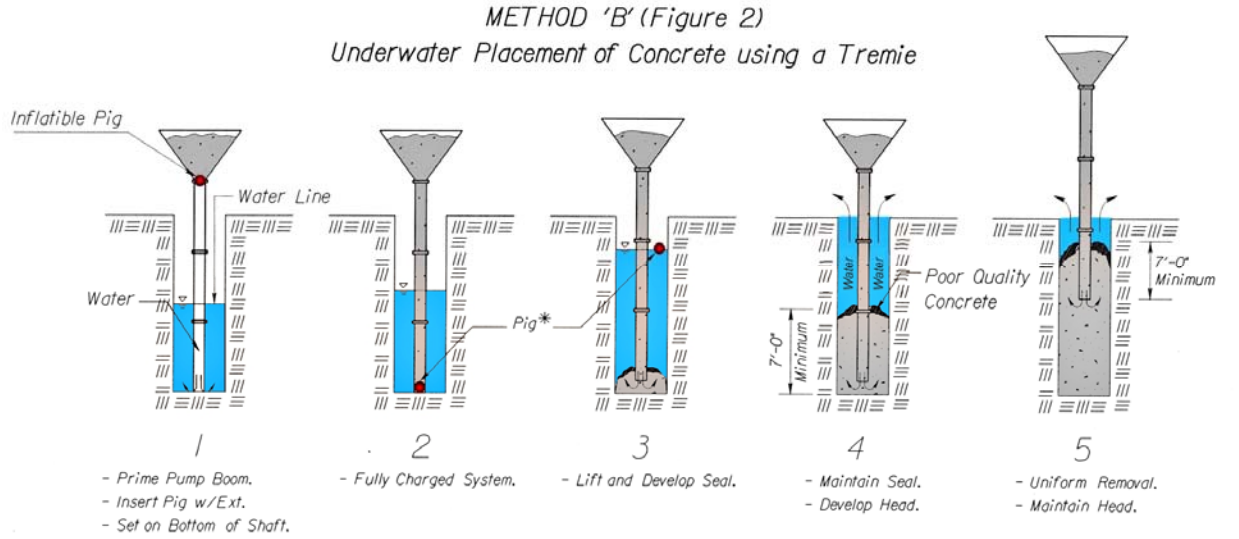
(2) Wet Pour Method. Prior to starting concrete placement, allow the water level in the shaft to reach its static level. Place concrete with either a sealed (watertight) tremie tube or pump with a rigid and watertight extension tube. In either case, use a device (i.e. commercially available pig or flap 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-foot 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:

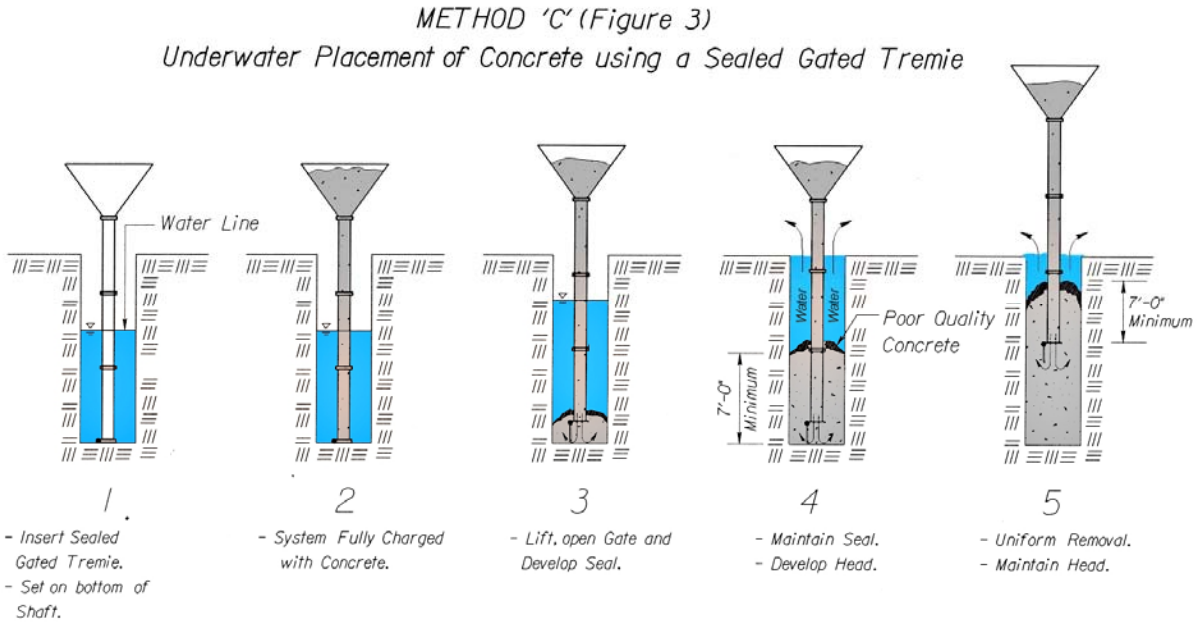


Method A (Figure 1): Use a pump and extension tube, with a pig separating the ground water and concrete, to place concrete into the shaft. Install a concrete brake (e.g. bladder valve or French horn) at the end of the pump boom to purge the air from the pump line. Fully charge the boom with concrete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



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): 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. If the casing extends above the planned shaft elevation the excess material must be expelled by providing an outlet in the casing above the planned elevation if the shaft. Do not bail the excess material out of the shaft. On all wet pours, regardless of the method used, the Engineer will make a set of 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
- If compressive strength does not meet 1800 psi, the Engineer may allow the Contractor to proceed when the shaft has cured 5 days 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 raising the temporary casing completely, 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 and issue reports. 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; and
- Select a gain to produce an amplitude signal that fills ⅔ to ¾ of the screen along the vertical access of the waveform plot for portions of the shaft that correspond to good quality concrete;

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.

The testing organization shall make suggestions for changes in the Crosshole Sonic Logging (CSL) testing procedure based on known shaft construction issues or survey access issues. Such changes could include, but would not be limited to changing the frequency of data collection along the length of the shaft or offsetting the transducers from the horizontal plane. Any such suggested changes in CSL data collection procedures must be approved in advance by the Engineer.

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. Plumb each pipe to determine the depth, and provide the information to the Engineer.

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 Chief Geologist the report of the CSL test results stamped by a licensed Professional Engineer that includes data plots (recorded on thermal or graphical printouts) with the profiles referenced to the top of the shaft or top of the pipe elevation. A copy of the report shall be sent by the testing organization to the Contractor. No work shall be done above the top of the drilled shaft without approval from the Chief Geologist. 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. Provide the report of CSL results, stamped by a licensed Professional Engineer, within 1 week of conducting the sonic test. The CSL practitioner does not have the information available to make recommendations for shaft acceptance or correction as part of the normal course of testing a shaft.

(5) Coring. If the sonic logging inspection indicates an anomaly for any zone of the shaft represented by loss of signal, a reduction in apparent sonic velocity greater than 15%, or where the velocity is equal to or less than 15% and as directed by the Chief Geologist, or where a survey was not complete due to problems associated with access tubes, drill cores (NX size, 2.125 inches or larger) at locations and depths approved by the Engineer. Drill cores NX size (2.125 inches, or larger), however if the location of the anomaly prevents an NX size core, with the approval of the Engineer, drill a smaller size (minimum A size, 1.25 inch) core. Mark the beginning and end of each core and record the total length of the core and the total length recovered, core recover must be greater than 95%. 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

a. Drilled Shafts. 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%.

b. Permanent Casing. 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.

c. Sonic Test (Drilled Shaft) (Set Price).

(1) Sonic Testing specified in Contract Documents. When shown in the Contract Documents, the Engineer will measure each designated sonic test, per shaft (i.e. sonic logging between all possible combinations of pipes represents a single sonic test).

(2) Sonic Testing requested by the Engineer.

- When the Engineer requests sonic tests not shown in the Contract Documents, and the sonic testing indicates the concrete is acceptable, the Engineer will measure each sonic test, per shaft (i.e. sonic logging between all possible combinations of pipes represents a single sonic test).
- When the Engineer requests sonic testing not shown in the Contract Documents, and the sonic testing indicates defective concrete in the drilled shaft, the Engineer will not measure for payment the sonic testing of that shaft.
- When the Engineer requests sonic testing not shown in the Contract Documents, the sonic testing indicates defective concrete in the drilled shaft, the Engineer requests cores from the shaft, and the cores reveal unsound concrete, the Engineer will not measure for payment the sonic testing or cores for that shaft.
- When the Engineer requests sonic testing not shown in the Contract Documents, the sonic testing indicates defective concrete in the drilled shaft, and the Engineer requests cores from the shaft, and the cores reveal sound concrete, the Engineer will measure for payment each sonic test, per shaft (i.e. sonic logging between all possible combinations of pipes represents a single sonic test). The Engineer will also pay for the cores as Extra Work according to **SECTION 104**.

(3) Core Hole (Investigative) specified in the Contract Documents. When shown in the Contract Documents, 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.

d. Payment. 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 **SECTION 104**.

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	UNITS
Piles (*) (**)	Linear Foot
Test Piles (*) (**)	Linear Foot
Test Piles (Special) (*) (**)	Linear Foot
Cast Steel Pile Points	Each
Pre-Drilled Pile Holes	Linear Foot

*Type: Cast-In-Place Concrete, Prestressed Concrete, Steel or Steel Sheet, Corrugated Metal Sheet [+]
**Size
[+]Black or Galvanized

704.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	**SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade	**SECTIONS 1102**
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 PILE DRIVING EQUIPMENT

a. General. Pile driving hammers other than drop hammers shall be of the size needed to develop the energy required to drive piles at a penetration rate of not less than 0.10 inches per blow at the minimum driving resistance according to the appropriate pile driving formula in **TABLE 704-1**.

In addition to all other requirements, single and double acting diesel hammers and air/steam hammers require the following.

(1) Open-End (Single Acting) Diesel Hammer. Equip open-end (single acting) diesel hammers with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder, to permit the Engineer to visually determine hammer stroke at all times during pile driving operation. Also, provide the Engineer a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used.

(2) Closed-End (Double Acting) Diesel Hammer. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge, mounted near ground level so as to be easily read by the Engineer. Also, provide the Engineer a chart, calibrated to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

(3) The weight of the striking part of air/steam hammers used shall be a minimum of ⅓ the weight of the pile and drive cap, and in no case shall the striking part have a weight less than 2,750 pounds.

b. Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Concrete Piles. If a gravity hammer is used for driving steel piles, steel sheet and shells for cast-in-place concrete piles, use one with a minimum weight of 3,500 pounds. In no case may the weight of the gravity hammer be less than the pile being driven plus the weight of the driving cap. In lieu of weighing the hammer, a certification may be provided by the Contractor. Equip all gravity hammers with hammer guides to maintain concentric impact on the drive head or pile cushion. Regulate the fall to avoid injury to the piles. The fall shall be a maximum of 12 feet. If diesel or air/steam hammers are used, the maximum fall shall be 90% of the maximum fall recommended by the hammer manufacturer.

If steam or diesel hammers are used, its rated gross energy in foot-pounds shall be a minimum of 2 ½ times the weight of the pile in pounds. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

c. Hammers for Pre-stressed Concrete Piles. Unless otherwise provided, drive pre-stressed concrete piles with a diesel or air/steam hammer that can develop an energy per blow at each full stroke of the piston of a minimum of 1 foot-pound for each pound of weight driven. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

d. Vibratory Hammers. Vibratory hammers may only be used when specifically allowed by the Contract Documents or in writing by the Engineer. If approved, vibratory hammers shall be used in combination with pile load testing and re-tapping with an impact hammer. In addition, 1 of every 10 piles driven with a vibratory hammer shall be re-tapped with an impact hammer of suitable energy to verify that acceptable load capacity was achieved.

e. Additional Equipment. The plant and equipment provided for air/steam hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. In case the required penetration or bearing is not obtained by the use of a hammer complying with the above minimum requirements, provide a hammer of greater energy or when permitted, resort to jetting or pre-drilling at Contractor expense. Use of the pile driving analyzer may be required when minimum requirements are not obtained or results are doubtful.

f. Leads. Construct pile-driving leads to afford freedom of movement for the hammer. Hold them in position with guys or stiff braces to support the pile during driving. Except where piles are driven through water, use leads of sufficient length that the use of a follower shall not be necessary. Leads shall be of sufficient length to allow them to be spiked into the ground at the onset of driving.

g. Hammer Cushion. Equip all impact pile driving equipment except gravity hammers with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to maintain uniform driving behavior. Use hammer cushions made of durable, manufactured material that shall retain uniform properties during driving. Wire rope and asbestos hammer cushions are prohibited. Place a striking plate on the hammer cushion to maintain uniform compression of the cushion material. Inspect the hammer cushion in the presence of the Engineer when beginning pile driving at each structure or after each 100 hours of pile driving, whichever is more frequent. Replace the hammer cushion whenever there is a reduction of hammer cushion thickness exceeding 25% of the original thickness, or when the cushion begins deteriorating, tearing, etc., before continuing driving.

The following are acceptable types of pile cap material. Other materials may be used with approval of the Bureau of Construction and Materials.

(1) Micarta (Conbest) - This is an electrical insulating material composed of fabric and phenol. Replace when it starts to powderize or when it disintegrates into various layers.

(2) Nylon (2-inch thick blocks) - Occasional vertical cracking is not detrimental. However, replace after the cushion develops horizontal cracks.

(3) Hamortex (metallized paper reels) - Pay attention as it may compress or disintegrate.

(4) Force 10, Forbon, and Fosterlon - These materials are provided by manufacturers of pile driving equipment.

(5) Aluminum - Aluminum is often used to separate layers of softer cushioning material. Replace once the aluminum is deformed or broken.

(6) Wood (plywood or hardwood) should only be used with gravity hammers.

h. Pile Driving Head. Fit piles driven with impact hammers with an adequate driving head to distribute the hammer blow to the pile head. Axially align the driving head with the hammer and the pile. The driving head is guided by the leads and shall not be free swinging. The driving head shall fit around the pile head in a manner that prevents transfer of torsional force during driving while maintaining proper alignment of hammer and pile.

i. Water Jets. When jets are permitted, the number of jets and the volume and pressure of water at the jet nozzle shall be sufficient to freely erode the material adjacent to the pile. Use a plant with sufficient capacity to deliver a minimum of 100 pounds per square inch pressure at ¾-inch jet nozzles at all times. At a minimum of 5 feet before the desired penetration is reached, withdraw the jets and drive the piles to secure the final penetration with an approved hammer.

704.4 CONSTRUCTION REQUIREMENTS

a. Order Lists, Piles and Test Piles. The order list is the same as the estimated quantity (number and length of piles) shown in the Contract Documents.

For piles and test piles, provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of driving piling. The Engineer will forward this information for Test Pile (Special) to the Chief Geologist.

When a restrike is required by the Engineer, follow **subsection 704.4e.** for restrike procedures. Provide piles for the structure according to the order list (number and length of piles) prepared by the Engineer.

Drive the specified test piles at the locations shown in the Contract Documents. The Engineer will use the test pile information to determine the pile tip elevation.

If multiple hammers are used on a project requiring test pile or test pile (special), drive a test pile or test pile (special), whichever is specified, with each hammer.

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

In order to mobilize the PDA, notify the Engineer a minimum of 5 working days before driving the test piles (special). Prior to driving the test pile (special), the Engineer will require approximately 1½ hours to prepare the test piling (special) and install the dynamic measuring equipment. If with prior approval, the piles are to be welded prior to the Engineer attaching the testing equipment, provide the Engineer with safe and reasonable means of access to the pile for preparing the pile and attaching the instruments.

When a restrike is required by the Engineer, follow **subsection 704.4e.(3).** for restrike procedures.

To obtain the estimated ultimate loads, the Engineer will use the PDA to take dynamic measurements as the test pile (special) 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 704.3**.

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. On pipe pile, use a helmet with a minimum interior guide of 6 inches.

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 qualified under **SECTION 713** 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 ¼ 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 ⅛ 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.
- Drive all piles in the orientation shown on the Plans. If the axial orientation of the pile rotates or twists by more than 10°, the Field Engineer will contact the Bureau of Structures and Geotechnical Services.

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 1½ 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**.

TABLE 704-1: PILE FORMULAS		
Hammer	**Pile Type**	**Formula**
Gravity	Timber	$P = \frac{2 \quad W \quad H}{S + 1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3 \quad W \quad H}{S + 0.35} \left(\frac{W}{(W+X)} \right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2 \quad W \quad H}{S + 0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2 \quad E}{S + 0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6 \quad W \quad H}{S + 0.1 \left(\frac{X^{**}}{W} \right)}$
Link-Belt*	All Types	$P = \frac{1.6 \quad E}{S + 0.1 \left(\frac{X^{**}}{W} \right)}$

*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;
- A group of piling is defined as all piles contained within a single footing.
- 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;

- Using the warmed up hammer, immediately restrike 20% of the piles in a group, with a minimum of 2 in a group restruck. Of these, restrike the piles in a single group with the furthest spacing away from each other. When possible, restrike those with the lowest resistance during driving.
- Restrike 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 ½ inch during the restrike, the restrike may be terminated after 20 blows.
- Restrike additional (the 20% or 2 minimum specified above) pile in the group as directed by the Engineer.

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 ½ 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.

h. Sheet Pile. Use a fabricated or cast driving head with corrugations to match the top of the sheeting while driving the sheet piling.

704.5 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 and test pile (special) 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.

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 for Pile (*) (**). 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 Engineer will not measure pile cut-off of Test Pile (*) (**) and Test Pile (Special) (*) (**) for payment. If the pile for these items is cutoff and used/spliced on the project, the pile will not be measured for separate payment. Splices will be paid for according to this subsection.

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 **SECTION 104**.

SECTION 705

STRUCTURAL STEEL FABRICATION - BRIDGES

705.1 DESCRIPTION

Shop fabricate the structural steel according to the Contract Documents. This specification applies to bridges on highways and public roads carrying vehicular traffic. See **SECTION 744** for all other steel or aluminum shop fabrication.

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**
Steel Fasteners	**DIVISION 1600**

b. Preliminary Shop Requirements.

(1) Point of Fabrication. Within 10 business days after signing the contract, notify the State Bridge Office and the Bureau Chief of Construction and Materials 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 **SECTION 106**). 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 **SECTION 105**. 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 Construction and Materials. 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 **SECTION 105**.

(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 Construction and Materials, 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;
- 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 D1.5-2010, "Bridge Welding Code" with the exceptions and additions noted later 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.

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.

Except as noted in the previous paragraph, 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 D1.5-2010, "Bridge Welding Code" with the exceptions and additions noted in this specification.

Perform welding and gas cutting on steel bearings, bridge drainage systems, finger plate or modular expansion devices, and bridge rails according to **SECTION 744**. At the option of the Engineer, steel bearing device inspection will require that either 1 device in 10, or fraction thereof, be tested 100%, or a10% of each device will be tested using liquid penetrant or magnetic particle. When tested at the 1 in 10 rate, the Engineer will select which device to test. When tested at the 10% rate, the Engineer will select the weld locations to test, which can vary from device to device. 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, bearing devices, 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. 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.

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) Holes for Bolted 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 ¼ 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 ⅛ 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 ¾ inch for structural steel, ⅝ inch for high-strength steel or ½ inch for quenched and tempered alloy steel.

If there are more than 5 thicknesses, or if the material is thicker than ¾ inch for structural steel, ⅝ inch for high-strength steel, or ½ 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. Alternate reference points may be accepted by the Engineer for Type "A" or "C" (vertical web) assemblies.

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 full size drift pins, full size bolts or a combination of both full size pins bolts at each flange and web splice for girders and rolled beams. For the purposes of checking the assembly, full size means the diameter equal to the diameter of the hole.

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.

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 (a minimum) or as directed by the Engineer. 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 Construction and Materials. 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 Construction and Materials. Without written approval from the Bureau of Construction and Materials, 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.

Take down the assembly only after being inspected and accepted by the Engineer. No welding on girders or beams will be permitted after the final assembly has been inspected and accepted by the Engineer.

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 pounds. 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) Shop Bolted Connections. Perform all bolting according to **SECTION 712**. The maximum deviation from detailed flatness for a connected plate (flange, web, splice, filler, etc.) shall not exceed $D/(144*T^{0.5})$ inches or 3/16 inch, whichever is greater. D equals the least clear dimension (in inches) of the panel from edge to edge, flange to flange, web to web, stiffener to stiffener, or any combination thereof and T equals the thickness (in inches) of the connected plate. After snug tightening all fasteners, no gaps between the connected layers can be present except at the edges of splice plates away from bolt holes.

(18) Enclosed structures not accessible after fabrication. All interior welds and connections as well as overall fit and finish must be inspected and accepted prior to full enclosure. Failure to provide the Engineer this opportunity will be cause for rejection of the fabricated element.

(19) Rejection. Repair or replace rejected items as directed by the Engineer.

(20) Release for Shipment. Do not release fabricated elements for shipment from the fabrication shop or paint shop without approval of the Engineer.

e. Supplemental Requirements to the Welding Code. The section and paragraph references cited in the paragraphs below are to AASHTO/AWS D1.5-2010.

SUBSECTION 1.3 WELDING PROCESSES

Delete paragraph 1.3.2 and add the following:

1.3.2 Electrogas welding shall not be used.

Replace the third sentence of paragraph 1.3.3 with the following:

Only the "narrow-gap improved" ESW process (ESW-NG) shall be permitted.

Add 2 new subsections as follows:

SUBSECTION 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.

SUBSECTION 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 Construction and Materials. 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.

SUBSECTION 2.9 DETAILS OF PLUG AND SLOT WELDS

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.

SUBSECTION 3.4 CONTROL OF DISTORTION AND SHRINKAGE

Add the following to paragraph 3.4.8:

Do not use mechanical straightening methods without the approval of the Engineer, even when used in conjunction with the application of heat.

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, +¼ inch for spans (typ., bearing to bearing) 0 thru 100 feet

-0, +½ inch for spans greater than 100 feet

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

-¼, +¼ inch for spans 0 through 100 feet
-⅜, +⅜ 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.

Delete paragraph 3.5.1.9 and replace with the following:

The bearing ends of bearing stiffeners shall be flush and square with the web and shall have no less than 75% of the end area in contact with the flanges.

"Contact" is achieved when a 0.005 inch feeler gauge cannot be inserted between stiffener and flange. The gap between stiffener and flange for the remaining "non-contact" area shall be no greater than 1/32 inch.

For steel slabs, base plates, bearing devices, cap plates of columns and pedestals bearings against or welded to beams and girders, no less than 75% of the common area shall be in contact with the flanges. Do not exceed a 1/32 inch gap for the 25% "non-contact" area.

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 ¼ inch for any one span or plus or minus ⅜ 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 ¼ 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: ⅛ inch per 10 feet of length, calculated using the distance to the nearest support, or ¼ inch.

SECTION 4. TECHNIQUE.

Add the following notes to Table 4.1:

- Only low hydrogen electrodes shall be used.
- 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.

SUBSECTION 5.2 WPS QUALIFICATION RESPONSIBILITY

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."

SUBSECTION 5.21 GENERAL REQUIREMENTS FOR WELDER QUALIFICATION

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 by signed by the witness.

SUBSECTION 6.1 INSPECTION – GENERAL REQUIREMENTS

Add the following to paragraph 6.1.1.1:

Within a KDOT project, QC shall not be performed by an inspector or their assistants who are, or were previously, engaged in the welding, the general assembly, or the application of coatings. This requirement also applies to work done under other AWS welding codes.

SUBSECTION 6.7 NONDESTRUCTIVE TESTING (NDT)

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 ⅓ 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**.

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.

SUBSECTION 6.10 RADIOGRAPHIC TESTING (RT) - PROCEDURE

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 information shall be produced on the radiograph no less the 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.

FIGURE 1

ITEMS TO BE PAINTED FOR RADIOGRAPHIC IDENTIFICATION

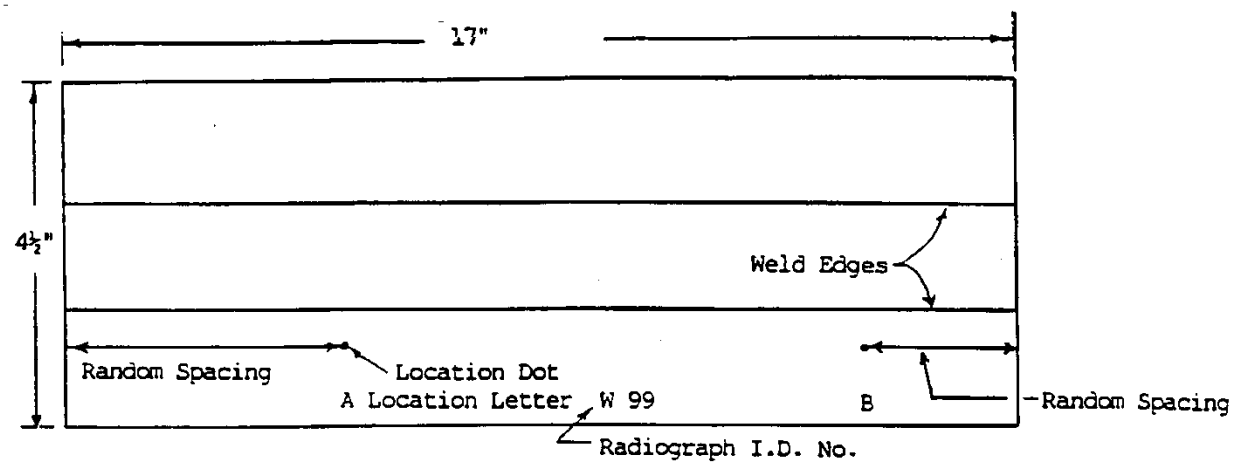
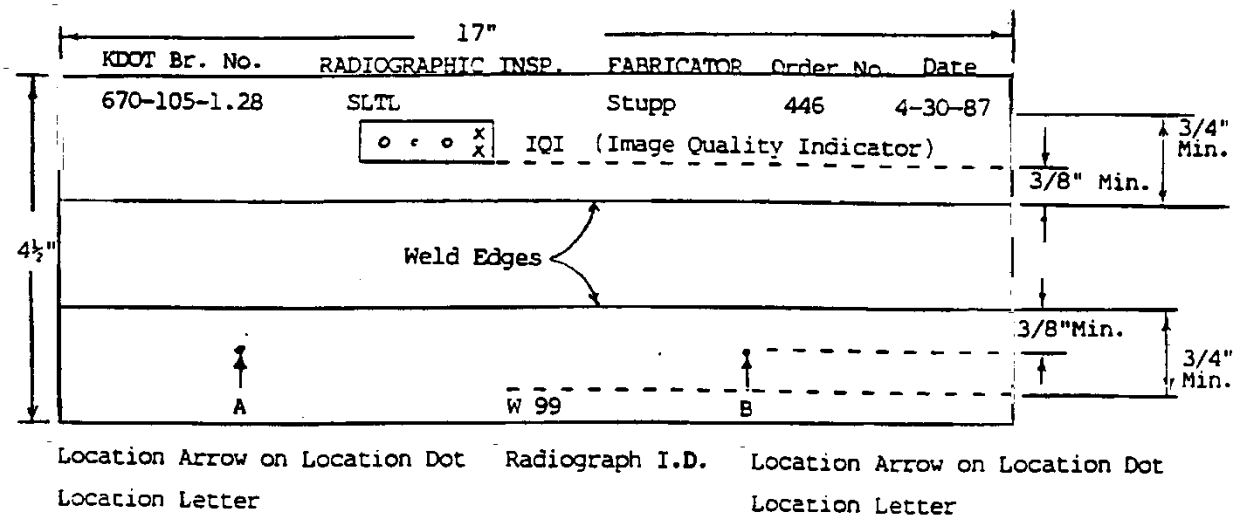


FIGURE 2

LEAD CHARACTER PLACEMENT FOR RADIOGRAPHIC IDENTIFICATION



705.3 MEASUREMENT AND PAYMENT

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

SECTION 706

BEARINGS AND PADS FOR STRUCTURES

706.1 DESCRIPTION

Install the complete factory produced bearings and pads as designated in the Contract Documents. See **SECTION 705** for fabrication of structural steel.

BID ITEMS	**UNITS**
Elastomeric Bearing Pad (**)	Each
Bearing (*) (**)	Each

*Type (Steel Reinforced Elastomeric, PTFE/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**.

706.3 CONSTRUCTION REQUIREMENTS

Submit shop drawings for each location, type and model according to **SECTION 105**. 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.

Paint steel bearings according to **SECTION 714**.

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.

SECTION 707

EXPANSION DEVICES

707.1 DESCRIPTION

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

BID ITEMS	UNITS
Expansion Device (*)	Linear Foot
*Type: Finger Plate, Sliding Plate or Modular	

707.2 MATERIALS

Provide materials that comply with the applicable requirements.

Materials for Plate Expansion Devices	**DIVISION 1600**
Fabric Troughs for Finger Plate/Sliding Plate	**DIVISION 1700**
Modular Expansion Devices	**DIVISION 1700**
Inorganic Zine Paint	**DIVISION 1800**

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 **SECTION 105**. 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 or sliding plate expansion devices, except support angles and finger plate or sliding 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 or Sliding Plate). Place alignment marks on the anchor plates and finger plates or sliding plates on each side of the expansion gap to facilitate accurate installation.

Align the finger plate or sliding plate 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 or sliding plates with all the armoring and anchorages in place. Install the finger joint centered over the expansion gap, for both finger plates and sliding plates. Verify that the joint is in plane and sloped per the roadway. For fingers plates, make sure 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 or sliding 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.

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 or Sliding Plate)".

Install the fabric trough and the finger or sliding 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 or SLIDING PLATE TORQUES (ft-lbs.)

Size (inches)	⅞	15/16	1	1 ⅛
AASHTO M 314 Grade 36	176	218	264	387
AASHTO M 314 Grade 55	277	342	415	608

After installation of the finger plates or sliding plates, the Engineer will inspect the plates for alignment. Any plates 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 or Sliding Plate)".

Install fabric troughs below the finger plate or sliding plate and 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 (*)" at the contract unit price is full compensation for the specified work.

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.

BID ITEM	UNITS
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, 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 **SECTION 105**) 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 **SECTION 105**) 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 cell spans greater than 16 feet or cell 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-though 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

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 ½ inch below the concrete surface. Non-metallic ties may be removed flush with the concrete surface. Cut wire ties back a minimum of ¼ 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 ¾-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

The Engineer will not measure Falsework Design, Falsework Construction or Forms (design or construction) for payment.

708 - FALSEWORK AND FORM CONSTRUCTION

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 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.

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 shop drawings for the steel permanent deck forms to the Engineer for approval according to **SECTION 105**. 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 ¼-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.

SECTION 710

CONCRETE STRUCTURE CONSTRUCTION

710.1 DESCRIPTION

Construct concrete structures according to the Contract Documents. When Bridge Deck Grooving is a bid item in the contract, perform the grooving as shown in the Contract Documents.

BID ITEMS	UNITS
Concrete (*) (**) (***) (****)	Cubic Yard
Bridge Deck Grooving	Square Yard

*Grade of Concrete
**AE (air-entrained), if specified
***Aggregate, if specified
****MPC (Moderate Permeability Concrete), if specified

710.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete[+]	**SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade	**SECTION 1102**
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**

[+] If Moderate Permeability Concrete (MPC) is not specified, the concrete shall meet the requirements for Standard Permeability Concrete.

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, procedures used to minimize the evaporation rate, and method to place saturated burlap within the specified 15 minute limit.

Fogging using hand-held equipment may be required by the Engineer during unanticipated delays in the placing, finishing or curing operations. If fogging is required by the Engineer, do not allow water to drip, flow or puddle on the concrete surface during fogging, placement of absorptive material, or at any time before the concrete has achieved final set.

When needed, 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.

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 10º, 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 $lb/ft^2/hr$, take actions (such as cooling the concrete, installing wind breaks, sun screens etc.) to create and maintain an evaporation rate less than 0.2 $lb/ft^2/hr$ 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.

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, or loss of air by fitting the pump with a concrete brake (e.g. french horn or bladder valve) at the end of the pump boom. 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.

Uniformly consolidate the concrete without voids.

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, or until the course aggregate settles below the surface of the concrete, unless otherwise designated by the Engineer. Provide positive control of vibrators using a timed light, buzzer, automatic control. Smoothly extract the vibrators from the concrete at a rate to avoid leaving any large voids or holes in the consolidated 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 grade 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.

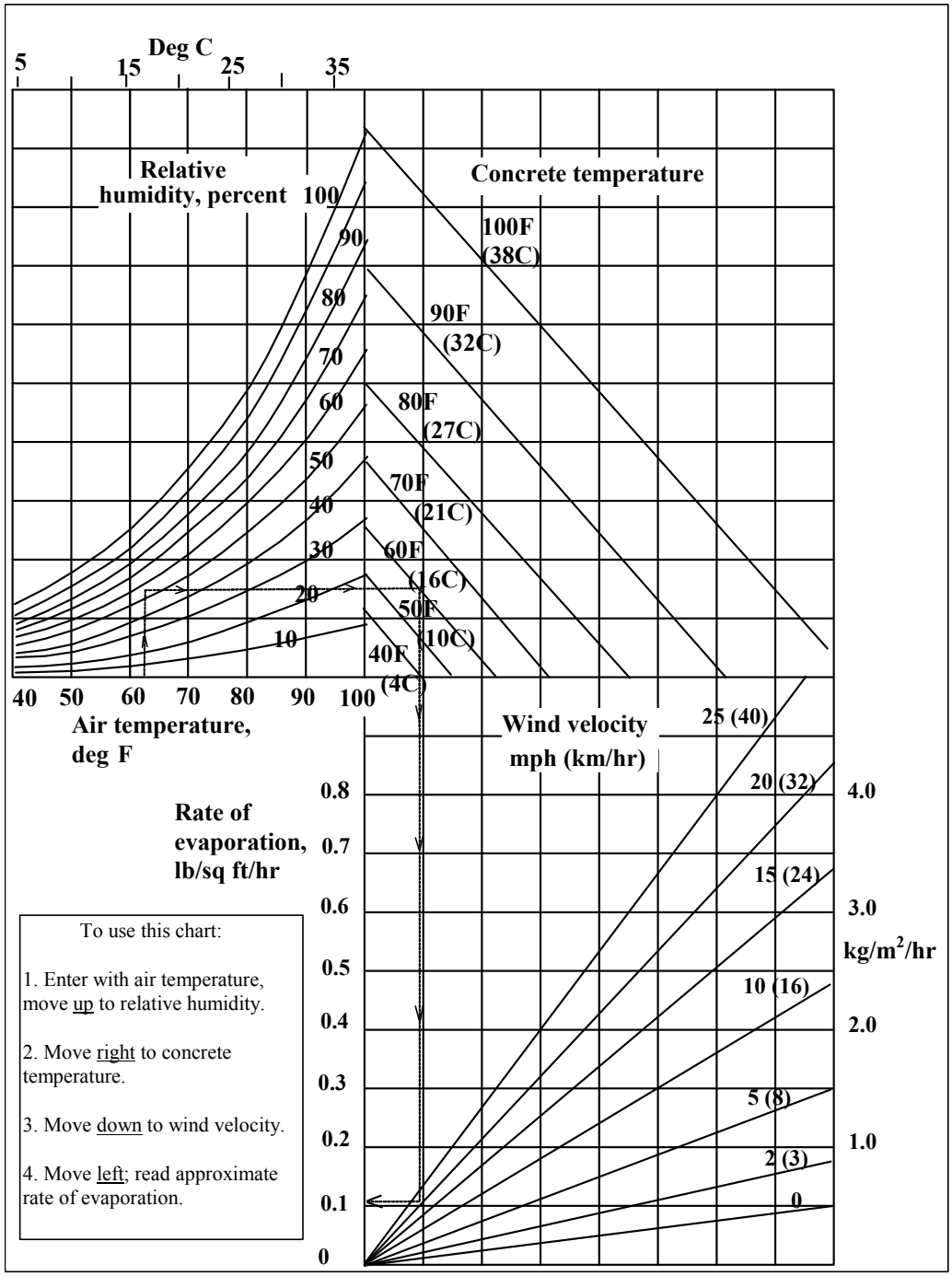
Do not operate bridge deck finishing equipment on previously placed concrete spans until:

- 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/ft^2/hr (1.0 kg/ m^2/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/ft^2/hr (1.0 kg/m^2/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, the joint shall be cleaned of surface laitance, curing compound, and all other foreign material, use of abrasive blasting may be required to achieve the level of cleanliness required. Thoroughly wash the surface of the keyed joint with clean water, and allow the joint to dry to a saturated surface dry condition immediately prior to placing fresh concrete against the joint key.

(1) Bridges With Tied Approaches. When concrete is placed at the bridge EWS, embed 3 (½-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 ¼ 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 ⅝ inches by 7 ½ inches) 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. Do not bend the reinforcing steel which will tie the approach slab to the EWS or damage the concrete at the EWS.

(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. 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 self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when 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 10º, 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 ⅛ 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.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see **subsection 710.3f.** for grooving requirements.

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 according to **TABLE 710-1**. Cure all pedestrian walkway surfaces in the same manner as the bridge deck. 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.

Maintain a damp surface until the wet burlap is placed. Fully saturate burlap before placing on concrete surface. Cover all concrete surfaces with saturated burlap within 15 minutes after finishing the concrete, do not mar concrete during placement of the wet burlap. Maintain the curing so that moisture is always present at the concrete surface.

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.

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	**Minimum Cure Time (days)**	**Curing Medium and Use**
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay) Bridge Overlays	14 Wet Plus 7 Curing Membrane	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place 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. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	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 forming compound.

(2) Liquid Membrane Forming Compounds. 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 liquid membrane forming compound at a minimum rate per coat of 1 gallon per 200 square feet of concrete surface.

Give marred or otherwise damaged applications an additional coating.

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.

(3) Bridge Subdecks and Decks. Provide a work bridge to facilitate application of all curing materials. Maintain the curing so that moisture is always present at the concrete surface.

Maintain the wet burlap in a fully wet condition using misting hoses, self-propelled, machine-mounted fogging equipment with effective fogging area spanning the deck width, moving continuously across the entire burlap-covered surface, or other approved devices until the concrete has set sufficiently to allow foot traffic. At that time, place soaker hoses on the burlap, and supply running water continuously to maintain continuous saturation of all burlap

material to the entire concrete surface. For bridge decks with superelevation, place a minimum of 1 soaker hose along the high edge of the deck to keep the entire deck wet during the curing period.

If the concrete surface temperature is above 90ºF, do not use polyethylene sheeting in direct sunshine during the day for the first 24 hours of the specified curing period (**TABLE 710-1**). 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 90ºF, 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**. The use of supplemental cementitious materials will require additional time before specified loading is allowed.

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*, Δ	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10 *, Δ (15)**, Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Light truck traffic (gross vehicle weight less than 5 tons).****
14 *, Δ (21)**, Δ	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 the specified wet cure at all times (**TABLE 710-1**).

** All haunched slab structures.

*** 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.

Δ Increase time period by 3 days when supplemental cementitious materials are used October 1 thru April 30.

(4) 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.

(5) 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 40ºF during the entire specified 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 90ºF 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 as defined in **TABLE 710-1**. Maintain the moisture barrier in intimate contact with the concrete during the entire specified curing period. After the completion of the required curing period, remove the curing and protection to prevent rapid cooling of the concrete.

(6) 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. Grinding and Grooving. Correct surface variations exceeding ⅛ inch in 10 feet by use of an approved profiling device, or other methods approved by the Engineer after the curing period. Perform grinding on hardened concrete after the specified curing membrane period (**TABLE 710-1**) to achieve a plane surface and grooving of the final wearing surface as shown in the Contract Documents. Apply the corrective measure to the full width of the lane. The corrected areas shall have uniform texture and appearance. The beginning and ending of the corrected areas shall be squared normal to centerline of the paved surface.

If at least 25% of the traveled way of the deck needs ground to correct surface variations, grind the entire deck.

Use a self-propelled grinding machine with diamond blades mounted on a multi-blade arbor. Avoid using equipment that causes excessive ravels, aggregate fractures or spalls. Remove from the project and properly dispose of the material. Do not allow the grinding slurry to flow across lanes being used by traffic, onto shoulder slopes, into streams, lakes, ponds or other bodies of water, or gutters or other drainage facilities. Do not place grinding slurry on foreslopes.

After any required grinding is complete and after the specified curing membrane period (**TABLE 710-1**), give the surface a suitable texture by transverse grooving. Use diamond blades mounted on a self-propelled machine that is designed for texturing pavement. Transverse grooving of the finished surface may be done with equipment that is not self-propelled providing that the Contractor can show proficiency with the equipment. Use equipment that does not cause strain, excessive raveling, aggregate fracture, spalls, disturbance of the transverse or longitudinal joint, or damage to the existing concrete surface. Make the grooving approximately $^{3}/_{16}$ inch in width at ¾ inch centers and the groove depth approximately ⅛ inch. Terminate the transverse bridge deck grooving approximately 2 feet in from the base of the rail, and 1 foot from any deck drains or other appurtenances.

If after corrective measures are made, more than ½ inch of the deck was ground at any location, the Engineer may require a multi-layer polymer concrete overlay over the whole deck, according to **SECTION 729**, at no additional cost to KDOT.

g. 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.

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^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [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^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
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^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

* 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 65% 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.

*** Remove the formwork from subdecks or one-course decks within 6 weeks after the deck has been placed.

$^{+}$ 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.

$^{\Delta}$ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.

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**.

h. 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. When shown as a bid item in the contract, the Engineer will measure for payment bridge deck grooving by the square yard.

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

SECTION 711

REINFORCING STEEL

711.1 DESCRIPTION

Place reinforcing steel as detailed in the Contract Documents.

BID ITEMS	UNITS
Reinforcing Steel (*) (**)	Pound
Reinforcing Steel (Repair) (*) (**) (Set Price)	Pound

*Grade
**Epoxy-Coated

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 and Cutting.

i. Epoxy Coated. Do not field bend or cut epoxy coated reinforcing steel without approval of the Engineer.

ii. Non-epoxy Coated. 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 +¼ 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.

(7) Area Prepared for Patching (Existing Concrete Bridge Decks) or other Structure Repairs. If during the course of patching or repair, deteriorated existing reinforcing steel is encountered, and the Engineer requires it replaced, provide and place new reinforcing steel according to this specification. This will be paid for as Reinforcing Steel (Repair) (Set Price).

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, 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**.

(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 unless 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 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 the 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.

The Engineer will measure Reinforcing Steel (Repair) (Set Price) by the pound. The Engineer will not measure reinforcing steel damaged or broken through Contractor's negligence. The Engineer will not measure 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.

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 castings 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 Fabrication and Painting	**DIVISION 700**
Cast Steel	**DIVISION 1600**
Structural Steel	**DIVISION 1600**
Steel Fasteners	**DIVISION 1600**
Welded Stud Shear Connectors	**DIVISION 1600**
Bearings 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-DRILLING AND GROUTING** 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 ¼ 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 ¼ of the holes in the splices and field connections. For structures carrying workers and equipment, fully tighten the bolts in ¾ 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 ¼ inch beyond the nut.

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

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 ¼ inch thick under nuts, with the threads burred. Ream the holes for machined bolts. The hole diameters may not be more than $^{1}/_{32}$ 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 $^{1}/_{16}$ 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 ⅝ 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 ≤ ⅞	$^{3}/_{16}$
d = 1	¼
d ≥ 1 ⅛	$^{5}/_{16}$

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 $^{1}/_{16}$ 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 ½ 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 $^{5}/_{16}$ 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 $^{5}/_{16}$ 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.

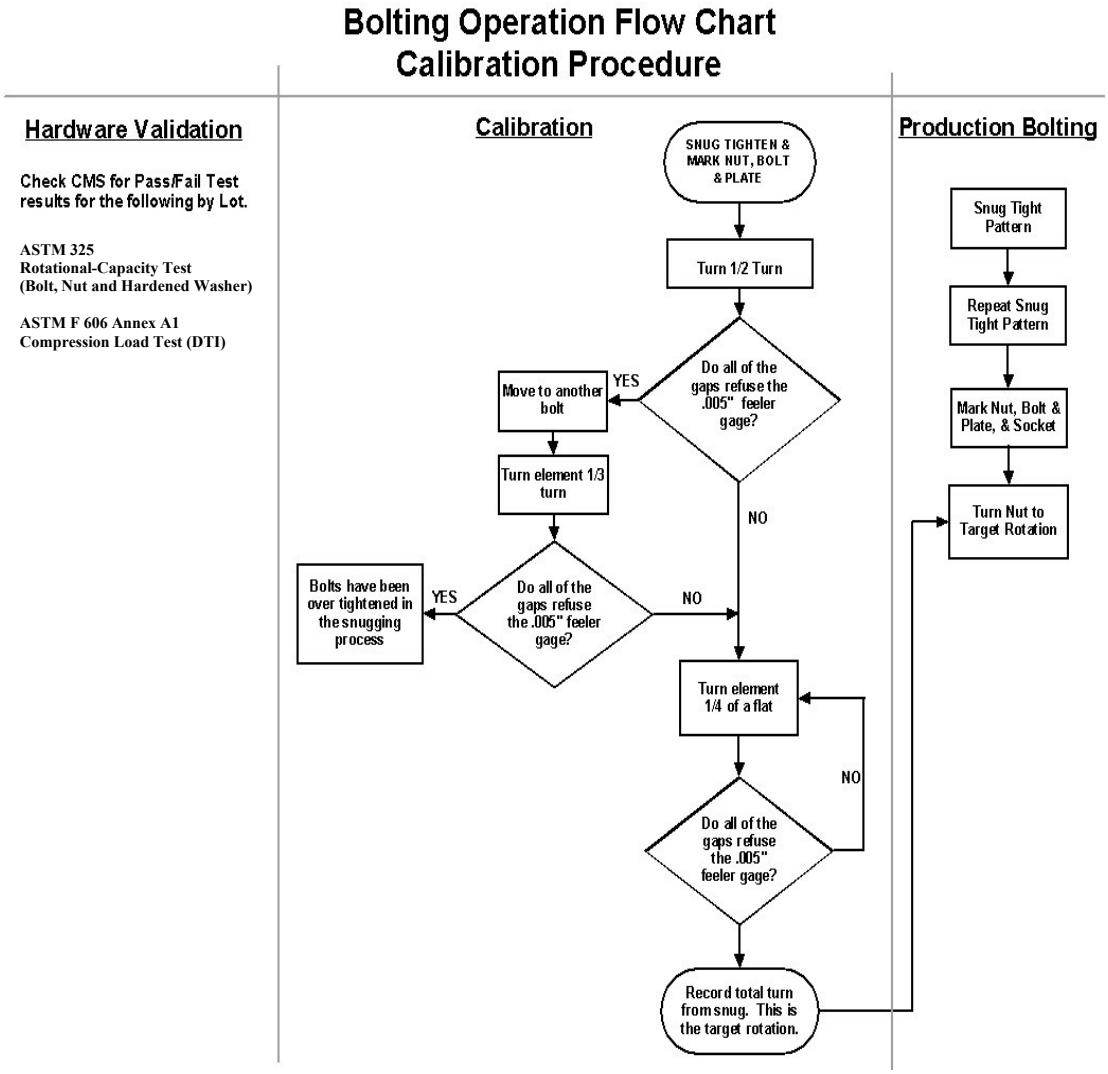
Provide the Engineer applicable test results and certifications for bolt and DTI lots being used on the project: Rotational-Capacity Test (Bolt, Nut and Hardened Washer) & ASTM F 606 Annex A1 Compression Load Test (DTI).

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 ⅓ 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



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.

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 ¼ 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 ½ turn and less, the tolerance is ± 30°; for bolts installed by ⅔ turn and more, the tolerance is ± 45°.

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 re-lubricate 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.

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**.

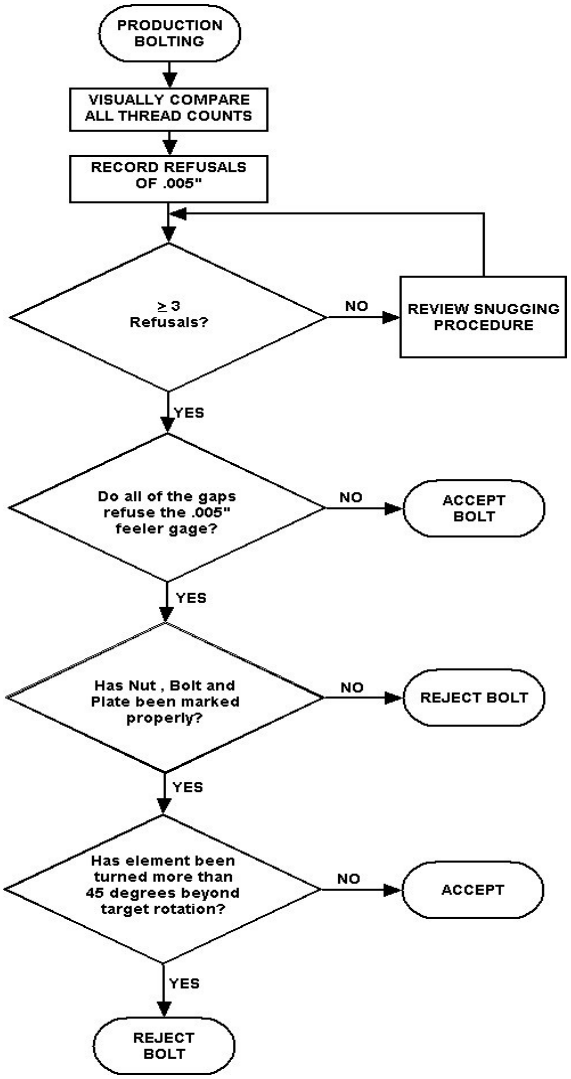
Commencing with each day's bolting operation, the Engineer will inspect each bolt until the Contractor's procedures for that day are confirmed. After the day's procedures are confirmed, a minimum of 20% of all the bolts in all splices will be checked with a feeler gauge. This check should be randomly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

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 **SECTION 705**. The company/individual performing non-destructive testing of field welds shall be separate and independent of the company/individual that performed the field welding. The company/individual performing non-destructive testing of field welds shall be separate and independent of the company/individual that performed the field welding.

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.

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 **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%.

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 the latest version AASHTO/AWS D1.5 "Bridge Welding Code" (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 ⅛ 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**.

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.

- ⅛ inch measured in any direction on the surface.
- ⅜ inch for the sum of the greatest dimensions of all discontinuities exceeding 1/32 inch, but less than or equal to ⅛ inch.
- ¼ inch for the maximum corner crack, except:
  - When that corner crack results from a visible slag inclusion or other fusion type discontinuity, the ⅛ inch maximum shall apply.
  - Specimens with corner cracks exceeding ¼ 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 ⅜ 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

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

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.

BID ITEMS	UNITS
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 5º 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.

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, ½ 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. Prime the welded stud shear connectors (including the underside of the stud head). Given the complexity, areas of thin primer and some shadows are permissible on the top 1 inch.

Except where otherwise indicated, coat all blast cleaned surfaces of the structural steel, including contact surfaces of high strength bolted 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. Prime the welded stud shear connectors (including the underside of the stud head). Given the complexity, areas of thin primer and some shadows are permissible on the top 1 inch.

(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;
- the top (and sides, if in contact with concrete) of the top flanges, including shear studs and the underside of the stud head. Given the complexity, areas of thin primer and some shadows are permissible on the top 1 inch of 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 ¼ 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.

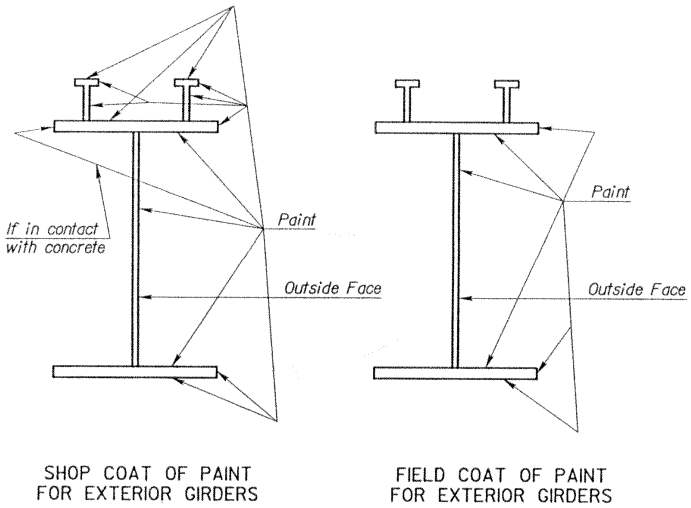
e. Field Painting New Weathering Steel. Apply a finish coat to all primed structural steel surfaces still exposed after the placement of superstructure concrete. The surface preparation of the top surface of the top flange (field applied welded stud shear connectors), and the application of the prime 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.

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 mills 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 Lead-based Paint Systems)

Provide environmental protection on a structure whether partially or completely removing an existing paint system that is defined as hazardous per federal Resource Conservation and Recovery Act (RCRA) Disposal

Regulations (40 CFR 261). The removal of existing lead-based paint may result in creation of waste subject to the above 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 ¾ inch in diameter and ½ 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.

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.

- 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 describe 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).

(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) Sampling and Analysis of Waste Material.

- 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.

(4) Disposal of Waste Material.

(a) If all samples indicate a lead content below 5 mg/L, dispose of the entire volume of waste generated as follows:

- 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; or
- Recycle according to **subsection 714.4f.(4)(b)**;
- DO NOT DISPOSE OF THIS MATERIAL AS A HAZARDOUS WASTE.

(b) If any sample indicates a lead content at or above 5 mg/L, recycle the entire volume of waste generated as follows.

- Recycle waste material 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.
- DO NOT DISPOSE OF THIS MATERIAL AS A HAZARDOUS WASTE.

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.

SECTION 715

PRESTRESSED CONCRETE MEMBERS

715.1 DESCRIPTION

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

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

715.2 MATERIALS

Provide materials that comply with the applicable requirements.

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

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

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

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

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

715.3 MANUFACTURE OF CONCRETE BRIDGE BEAMS, PILING AND PANELS

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

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

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

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

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

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

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

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

b. Equipment.

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

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

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

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

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

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

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

c. Manufacturing Requirements.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

d. Inspection and Testing.

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

(2) Testing Equipment.

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

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

(3) Test Cylinders.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

e. Handling, Storage and Transportation.

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

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

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

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

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

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

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

715.4 MEASUREMENT AND PAYMENT

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

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

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

SECTION 716

POST-TENSIONING
(Haunched 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.

BID ITEM	UNITS
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 PP0340B65884.

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, Acrylonitrite 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 that complies with **DIVISION 1700**. Use only one supplier for any single structure.

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

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 State Bridge Office (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. Submit shop drawings from the system manufacturer to the State Bridge Office (SBO) for all work related to post-tensioning according to **SECTION 105**. 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 ⅛ 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 State Bridge Office (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 72 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 ⅛ 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.

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 longitudinal post-tensioning tendons in pounds by measuring the theoretical plan length from end to end of wearing surface and for transverse post-tension tensions by measuring out-to-out of the bridge deck.

Use a unit weight of 0.74 pounds per foot for 0.6 inch diameter strand.

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

SECTION 717

BRIDGE OVERLAYS

717.1 DESCRIPTION

Construct the portland cement concrete overlay as shown on the Contract Documents.

When Bridge Deck Grooving is a bid item in the contract, perform the grooving as shown in the Contract Documents.

BID ITEMS	**UNITS**
Portland Cement Concrete Overlay (*)	Square Yard
Material for Portland Cement Concrete Overlay (Set Price)	Cubic Yard
Bridge Deck Grooving	Square Yard

* Thickness

717.2 MATERIALS

Provide materials that comply with the applicable requirements.

Grade 4.0 (AE) Concrete[+]	**SECTIONS 401 & 402**
Aggregate for Concrete Not On Grade	**DIVISION 1102**
Precure/Finishing Aid Material[++]	**DIVISION 1400**
Concrete Curing Materials	**DIVISION 1400**
Concrete Masonry Coating	**DIVISION 1700**

[+]Use concrete that meets requirements for low permeability concrete (LPC) as specified in **DIVISION 400**.

[++]When silica fume is used as an SCM, the use of Precure/Finish Aid may be used according to the manufacturer's instructions.

For overlays use Supplemental Cementitious Materials at allowable substitution rates as listed in **TABLE 401-2**.

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 consolidated 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**.

TABLE 717-1: PORTLAND CEMENT CONCRETE OVERLAY 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 placement of concrete, sand or shot blast the surface followed by an air blast to the bottom 3 inches of hubguard, and edges against which concrete is to be placed to remove all dirt, oil, pavement marking 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 deck 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 Concrete. 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.

Placing of the overlay 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 in **subsection 710.3b.** are taken to reduce the evaporation rate to below 0.2 pounds per square foot per hour.

Fogging may be necessary during placement of the overlay. Accomplish fogging according to **subsection 710.3b**.

The evaporation rate will be rechecked with the measures in place, using the procedures outlined above.

The elapsed time between depositing the concrete on the deck and final screeding may not exceed 15 minutes, unless otherwise authorized by the Engineer.

Manipulate and mechanically consolidate new concrete to a minimum of 98% of the consolidated 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.

d. Finishing. Strike off overlays with a self-propelled finishing machine. 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 overlays skewed greater than 10º, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the State Bridge Office.

Irregular sections may be finished by other methods approved by the Engineer. 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 ⅛ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

For decks without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks with the bid item Bridge Deck Grooving, see **subsection 710.3f.** for grooving requirements.

e. Curing and Protection. Cure and protect according to **subsection 710.3e**.

f. Weather Limitations. See **SECTION 401**. Also, discontinue concreting operations when a descending air temperature in the shade and away from artificial heat falls below 45ºF except with written approval from the Engineer. Do not start or resume operations until an ascending air temperature reaches 40ºF, or if night time temperatures are expected to fall below 35ºF.

g. Limitations of Operations. 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:

- 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.

h. Construction Joints. Make construction joints (either longitudinal or transverse) by placing and finishing the overlay approximately 6 inches beyond the desired location of the construction joint. After the overlay is cured, make a vertical saw cut at the location of the construction joint and chip away the excess overlay.

i. Sealing Vertical Faces of the Overlay. Seal all construction joints and vertical faces (such as the edge at the curb line) of the 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**. This work is subsidiary to the overlay.

j. 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 portland cement concrete overlay by the square yard.

The Engineer will measure material for portland cement concrete overlay by the cubic yard according to the following:

(1) When approved by District 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.

When shown as a bid item in the contract, the Engineer will measure for payment bridge deck grooving by the square yard.

Payment for "Portland Cement Concrete Overlay" and "Bridge Deck Grooving" at the contract unit price and "Material for Portland Cement Concrete Overlay (Set Price)" at the contract set unit price (when approved by the District Engineer) is full compensation for the specified work.

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.

SECTION 719

EXPANSION JOINTS

719.1 DESCRIPTION

Install expansion joints as designated in the Contract Documents. Do not substitute joint material without approval of the State Bridge Office.

BID ITEM	UNITS
Expansion Joint (*)	Linear Foot

*Strip Seal Assembly, Preformed Elastomeric Neoprene, Preformed Elastomeric Compression, Membrane Sealant** or other

**Type

719.2 MATERIALS

a. General. Provide the type of expansion joint system designated in the Contract Documents that complies with **DIVISION 1500**. When specified in the Contract Documents, use rapid set concrete patching material according to **SECTION 1716**.

b. Strip Seal Assembly. Provide strip seal assemblies and preformed pressurized elastomeric neoprene and compression joint seals that comply with **DIVISION 1500**.

Fabricate the strip seal assembly and armoring and support systems according to **DIVISION 700**.

c. Preformed Elastomeric Neoprene. Provide preformed elastomeric neoprene joints that comply with **DIVISION 1500**.

d. Preformed Elastomeric Compression. Fabricate the preformed elastomeric compression joint seals to extend across the roadway in 1 piece. The material may be trimmed at the ends.

e. Membrane Sealant. Provide membrane sealant that complies with **DIVISION 1500**.

719.3 CONSTRUCTION REQUIREMENTS

a. Strip Seal Assembly. Submit shop drawings according to **SECTION 105** 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. Provide a technical representative of the material manufacturer at the jobsite during installation.

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%.

Recess the top of the installed joint material a minimum of ⅛ inch, and a maximum of ⅜ inch below the top of the roadway deck adjacent to the joint material.

c. Membrane Sealant.

- Provide a technical representative from the material manufacturer at the jobsite during installation. Installation will not begin unless representative is present.
- Verify the joint opening size is correct based on the ambient temperature, correct as required.
- The minimum ambient air temperature during the installation and curing process is 40° F.
- Just prior to the sealant being applied, clean the faces of the joint by sand blasting each joint face followed by an air blast to clean incompressibles from the joint. Solvent clean bridge or approach joint surfaces. To obtain complete bonding with the adhesive, the concrete must be surface dry.
- Apply the epoxy adhesive to the prepared concrete joint surfaces according to the manufacturer recommendations.
- Install the membrane sealant material into the joint, positioning it either flush with, or with a maximum recess of ½ inch from the top surface of the joint, however recommended by the manufacturer.
- Apply the manufacturer recommended splice adhesive liberally to both mitered ends of the 2 sections of membrane sealant material that will meet in the joint as the final step before installation. Install successive lengths of membrane sealant material by maintaining pressure toward the previously installed section while positioning the length being installed. Do not stretch the membrane sealant material.

Provide an air supply that is proven to be oil free prior to blast cleaning and air blasting. This is done by covering the end of the air hose farthest from the compressor with a white rage and discharging air for 10 seconds in the presence of the Engineer.

d. 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.

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 Grade XX (AE)(SA) concrete for the bridge barrier that complies with **SECTIONS 401 & 402** and **SECTION 1102** with these exceptions:

- Determine the percent air using Kansas Test Method (KT-19); and
- The maximum slump allowed is ½ inch.

Provide set retarder admixture and liquid membrane forming compound Type 1-D, clear or translucent 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.

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.

SECTION 721

HANDRAIL FOR BRIDGES AND OTHER USES

721.1 DESCRIPTION

Fabricate and erect the metal handrails according to the Contract Documents.

BID ITEMS	UNITS
Bridge Handrail (*) (**)	Linear Foot
Handrail (*) (**)	Linear Foot

* Type
** Size

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 shop drawings to the State Bridge Office for approval (**SECTION 105)**.

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 ⅛ 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 ⅛ 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.

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 (*)(**)	Each
Butterfly Overhead Sign Structure (*)(**)	Each
Cantilever Sign Structure (*)(**)	Each
Overhead Sign Structure (*)(**)	Each
Overhead Sign Structure (Mast Arm Type) (*)(**)	Each
Overhead Sign Structure (Single Tapered Tube) (*)(**)	Each
Remove and Reset Sign Structure (***)	Each
Reset Sign Structure (***)	Each
Sign Structure Modification (***)	Each

* Size or Size Group
** Type of Material

722.2 MATERIALS

Provide materials that comply with the applicable requirements.

Grade 4.0 Concrete	**SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade	**SECTION 1102**
Cementitious Grout	**DIVISION 1700**
Castings	**DIVISION 1600**
Structural Steel	**DIVISION 1600**
Reinforcing Steel	**DIVISION 1600**
Steel Fasteners	**DIVISION 1600**

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 **SECTION 105**. 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 in accordance with **SECTION 744**.

(2) 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.

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 rodding 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, proceed with anchor bolt tightening procedures. 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) All Sign Structures.

- Do not use a pipe wrench to tighten nuts on Sign Structures;
- Use only a box end or socket wrench to snug tighten nuts;
- Maintain a minimum dimension of 6 inches from the top of foundation to finished grade;
- With approval of the Engineer, repair any marring of the galvanizing caused while lifting the structure into place;
- Submit specifications for the hydraulic wrench to the Construction Engineer (who will contact the Signing and Lighting Engineer) for approval; and
- If the four refusal maximum is exceeded on any DTI, discontinue tightening and contact the State Bridge Office;
- Grade the surrounding area to drain away from the structure.

(4) Existing Sign Structures. Verify the existing anchors will extend a minimum of one thread above the top tightened nut in the final condition. Do not damage the existing anchors during the removal of the existing hardware. Clean the threads of all rust and lubricate with an approved wax, prior to placing the new hardware.

Install DTIs on each anchor. Install a hardened washer on each anchor, if required. Use new hardware galvanized according to **SECTION 1616**. Verify the assembly (leveling nut, hardened washer(s), tower base plate, DTI, top nut) is in a snug tight condition before final tightening begins. Using the approved hydraulic wrench, tighten each nut to achieve a minimum of three refusals of the 0.005 gauge. Do not exceed four refusals of the 0.005 gauge. After tightening, score the remaining threads.

(5) New Sign Structures. Construct the elements of the structure according to the Contract Documents. Threads of the anchors shall be plumb and free of any construction debris.

Install DTIs on each anchor. Install a hardened washer on each anchor, if required. Use hardware galvanized according to **SECTION 1616**. Verify the assembly (leveling nut, hardened washer(s), tower base plate, DTI, top nut) is in a snug tight condition before final tightening begins. Using the approved hydraulic wrench tighten each nut to achieve a minimum of three refusals of the 0.005 gauge. Do not exceed four refusals of the 0.005 gauge. After tightening, score the remaining threads.

(6) 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.

(7) Dissimilar Materials. Whenever dissimilar materials are to be in permanent contact, provide an insulating barrier of alkali resistant asphalt paint or equivalent.

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 25 Ω resistance to ground.

722.4 MEASUREMENT AND PAYMENT

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.

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.

BID ITEM	UNITS
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.

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 and or the top surface of box culverts as specified in the Contract Documents.

BID ITEM	UNITS
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.

SECTION 725

ABUTMENT DRAINAGE SYSTEMS

725.1 DESCRIPTION

Install the abutment drainage system specified in the Contract Documents.

For an abutment strip drain, 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.

For an abutment aggregate drain, install a geocomposite drainage system consisting of geotextile enclosed aggregate materials layered with base coarse reinforcement and perforated and non-perforated underdrain pipes, as designated in the Contract Documents.

BID ITEMS	**UNITS**
Abutment Strip Drain	Square Yard
Abutment Aggregate Drain	Cubic Yard

725.2 MATERIALS

Provide materials that comply with the applicable requirements.

Abutment Strip Drain	**DIVISION 1700**
Geotextile Fabric	**DIVISION 1700**
Perforated Pipe for Underdrains	**DIVISION 1900**
Non-Perforated Pipe for Underdrains	**DIVISION 1900**
Geosynthetics (Class 2 Subsurface Drainage)	**DIVISION 1700**
Geosynthetics (Base Course Reinforcement)	**DIVISION 1700**
Geofoam	**DIVISION 1700**
Aggregate for Structures and Pipe Backfill*	**DIVISION 1100**

*Specified in the Contract Documents

725.3 CONSTRUCTION

a. General. Construct abutment drainage systems according to the Contract Documents.

b. Abutment Strip Drain. 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.

c. Abutment Aggregate Drain.

- If the abutment area was over-excavated, replace the over-excavated area with aggregate for structures and pipe backfill to the limits of the excavation shown in the Contract Documents. Compact aggregate to Type B compaction, **SECTION 205**. This work will be performed at no additional cost to KDOT.

- After installing the Bridge Backwall Protection System (constructed and paid for according to **SECTION 724**), grade, shape and compact the cohesive soils to the dimensions shown in the plans.
- Shape and secure the geofoam to the previously placed Bridge Backwall Protection System without damaging the geofoam. Protect the geofoam from damage due to hydrocarbons (gas, diesel, solvents, etc.) and sunlight.
- Place the Class 2 Subsurface Drainage geosynthetic between the geofoam and the limits of the excavation with enough material to fully enclose and overlap at the top 3.0 feet and to fold and enclose the ends. Secure folds, any seams or splices and overlaps by sewing or manufacture's approved methods.
- Place the perforated 4-inch pipe as shown in the plans. Verify that any couplers are secured, that the slope is correct and in the intended direction.
- Place the first lift of aggregate so that there is 8 inches of aggregate above the pipe, level the aggregate and compact to Type B compaction, **SECTION 205**, using a hand operated plate compactor or other means approved by the Engineer. If the granular material cannot be shaped and compacted, as shown in the plans, then wrap 3.0 feet of the ends of each lift with Class 2 Subsurface Drainage Geosynthetic.
- Place the Base Coarse Reinforcement geosynthetic on compacted aggregate without gaps or sags and to the limits shown in the plans. Using the same methods above, successively place aggregate and Base Coarse Reinforcement geosynthetic in 12 inch lifts to the dimensions shown on the plans.
- Overlap the Class 2 Subsurface Drainage Geosynthetic a minimum of 3 feet on the top of the completed fill. Fold ends of the Class 2 Subsurface Drainage geosynthetic to enclose the fill and cut an opening, at the correct elevation, allowing the 4-inch pipe to exit the contained fill, but not the retained aggregate. Secure the lap, folds or any splices by sewing or by other methods approved by the manufacturer.
- Place Class 2 Subsurface Drainage geosynthetic over geofoam and enclosed aggregate as shown in the plans. Place and compact to soil cap material to the limits shown in the Contract Documents. Use material with a Unified Soil Classification of ML or CL. Compact to Type A compaction, MR-90, **SECTION 205**.

When shown on the plans, taper the contained aggregate, Base Course Reinforcement geosynthetic, and Class 2 Subsurface Drainage geosynthetic at the edge of the roadway. Fold, wrap and secure to create shape shown on the plans. Terminate the geofoam at limits shown in the plans. Perform work outside these limits shown on the plans according to the Contract Documents.

d. Backfill. Do not damage the abutment 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.

The Engineer will measure abutment aggregate drains by the cubic yard to the limits shown in the Contract Documents.

Payment for "Abutment Strip Drain" and "Abutment Aggregate Drain" at the contract unit price is full compensation for the specified work. All other associated work is subsidiary.

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.

BID ITEM	UNITS
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.

SECTION 727

REPAIR (STRUCTURES)

727.1 DESCRIPTION

Perform the necessary procedures to repair the designated portion of the structure.

BID ITEMS	UNITS
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.

SECTION 728

BRIDGE CURB REPAIR

728.1 DESCRIPTION

Repair the bridge curb according to the Contract Documents. Use either the conventional method or the concrete surface repair-shotcrete method for placing the concrete.

BID ITEM	**UNITS**
Bridge Curb Repair	Linear Foot

728.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete (Conventional Method)	**SECTIONS 401 & 402**
Concrete Surface Repair-Shotcrete	**SECTION 826**
Aggregate for Concrete Not On Grade	**SECTION 1102**
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 concrete surface repair-shotcrete method, apply the concrete according to **SECTION 826**.

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.

SECTION 729

MULTI-LAYER POLYMER CONCRETE OVERLAY

729.1 DESCRIPTION

Prepare the surface of the reinforced concrete bridge deck and construct a multi-layer polymer concrete overlay (overlay) as shown on the Contract Documents.

Provide an overall combination of labor and equipment with the capability of proportioning and mixing the polymer resin components and placing the primer and aggregate, in accordance with this specification and the manufacturer/supplier's recommendations.

BID ITEM	**UNITS**
Multi-Layer Polymer Concrete Overlay	Square Yard

729.2 MATERIALS

a. General.

(1) Proportion all polymer materials according to the manufacturer/supplier's recommendations.

(2) Provide the Engineer with a copy of the polymer materials manufacturer/supplier's mixing and application recommendations.

(3) If concrete bridge deck patching is specified, polymer concrete materials may be used for patching of the concrete bridge deck. See **SECTION 731**.

b. Epoxy. Provide a Type III epoxy resin as defined in **DIVISION 1700**.

c. Polyester. Provide a polyester resin as defined in **DIVISION 1700**.

d. Aggregate.

(1) Provide FA-C aggregate meeting **TABLE 1102-5** and **TABLE 1102-6**, or

(2) As provided by the polymer concrete overlay supplier in a prequalified system, **DIVISION 1700**.

729.3 CONSTRUCTION REQUIREMENTS

a. General. Wet cure concrete on new bridge decks for 14 days and allow the deck to dry for 21 days before applying the overlay.

Portland cement concrete patches require a minimum cure period of 28 days before application of the overlay.

At the preconstruction conference, discuss the patching material and the corresponding curing period. Submit changes, including a written statement from the polymer manufacturer/supplier recommending changes, to the Engineer for approval.

b. Equipment. Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment.

(a) 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.

(b) Shot/Sand blast equipment capable of producing the required surface relief on the deck adjacent to bridge rails and barriers and areas not accessible with shot blast equipment.

(c) Empty shot blasters and dispose of waste material a minimum of 50 feet from the prepared bridge deck. On long structures empty shot blasters on the unprepared surface a minimum of 50 feet from prepared surface to prevent contamination of the deck by return of dust to the prepared surface.

(d) The Engineer must approve the use of scarifiers, scrablers or milling machines.

(e) Wet sand blasting is prohibited.

(2) Mechanical Application Equipment.

(a) Polymer mixing and distribution system capable of accurate and complete mixing of the polymer resin and hardening agent, verification of the mix ratio and uniform and accurate distribution of the polymer materials at the specified rate on 100% of the work area.

(b) A self-propelled aggregate spreader (if required) capable of uniform and accurate application of the dry aggregate over 100 % of the work area.

(c) An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material.

(d) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

(3) Hand Application Equipment.

(a) Calibrated containers for accurate measurement of the polymer components.

(b) Paddle type mixer or other mixing device capable of accurate and complete mixing of the polymer resin and hardening agent.

(c) Notched squeegees and brooms capable of spreading the polymer material in accordance with this specification and the manufacturer/supplier's recommendations.

(d) Aggregate spreader capable of uniform and accurate application of the dry aggregate.

(e) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

c. Preparation of Surface.

(1) When specified, perform any required repairs under **SECTION 731** and cure repairs, before preparation of the surface, unless placed with the overlay.

(2) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(3) Close deck drains so the overlay materials will not pass through the drains.

(4) Remove any remaining 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) 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 pavement marking, loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation and curing materials from patches and other foreign material from the surface of the deck.

(6) 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.

(7) Place the first coat of the overlay within 24 hours of preparing the deck surface. Prepared surfaces exposed for more than 24 hours must be lightly sand blasted prior to application of the overlay.

d. Placing the Multi-Coat Polymer Concrete Overlay. Place the overlay to the grades, thickness and cross-sections as shown in the Contract Documents. Provide a technical representative of the polymer manufacturer/supplier on the job site during the placement of the overlay at no additional cost. The representative is to provide technical expertise to the Contractor and the Engineer regarding safe handling, placement and curing of the overlay.

(1) 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).

(2) Rain will not necessarily contaminate the surface. However, take care so no contamination has occurred. Traffic adjacent to the prepared surface during a rain will contaminate the surface.

(3) Follow all manufacturer/supplier suggested safety precautions while mixing and handling polymer components.

(4) Apply High Molecular Weight Methacrylate Primer, if required, at application rates shown in **TABLE 729-1**, or as directed by the material's manufacturer/supplier.

(5) Place the overlay in 2 separate courses at application rates shown in **TABLE 729-2** for the system being placed.

(6) Use notched squeegees or mechanical application equipment to place the prepared polymer on the deck immediately and uniformly at the prescribed rate.

(7) If mechanical application equipment is used, take 2 ounce samples for each 100 gallons of resin placed to verify mix ratios and curing times. Place samples on the bridge rail or deck and note time to cure.

(8) The bridge deck and all polymer and aggregate components must be at least 60°F at the time of application.

(9) Apply the dry broadcast aggregate to cover the polymer uniformly and completely within 10 minutes of application.

(10) Remove and replace any first course areas that do not receive enough aggregate before gelling of the polymer.

(11) Vacuum or broom excess aggregate from the first course after sufficiently cured. If damage or tearing occurs, stop brooming or vacuuming and allow additional curing time. See **TABLE 729-3** for curing guidelines.

(12) Do not open the first course to traffic.

(13) Place the polymer and aggregate for the second course at the prescribed rate and in the same manner as the first course. The second course can be placed immediately after brooming of the first course is completed.

(14) Recoat second course areas that do not receive enough aggregate before gelling of the polymer with additional polymer and aggregate.

(15) Locate any longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

(16) Produce and place the overlay within the specified limits in a continuous and uniform operation.

(17) Correct completed surface variations exceeding ⅛ inch in 10 feet, unless directed otherwise by the Engineer.

(18) Tape all construction joints to provide a clean straight edge for adjacent polymer concrete placement. This includes joints between previously placed overlay materials and at centerline.

(19) Finish the exposed edges at the ends of the bridge and at expansion joints to minimize bridge deck roughness.

(20) Apply a bond breaker to all expansion joints.

(21) Vacuum or broom excess aggregate from the bridge deck after the polymer is sufficiently cured. If damage or tearing occurs, stop brooming or vacuuming and allow additional curing time.

e. Face of Curbs, Barriers, and Corral Rail Posts. Use a paintbrush or roller to apply the polymer resin on the face of curbs, barriers, and corral rail posts.

- On bridges with a corral rail, apply the polymer resin to the front face and adjacent sides of all posts.
- On bridges with curbs apply the polymer resin to the top of the curb face.
- On bridges without curbs apply the polymer resin to the edge of the deck.
- On bridges with continuous concrete barrier rails, apply the polymer resin to the first break in the geometry of the barrier or a minimum of 6 inches, uniform. Protect areas above the break line (or minimum of 6 inches) from resin. Apply so the top threshold of the resin follows a uniform line along the rail.

This work is subsidiary to the bid item Multi-Layer Polymer Concrete Overlay.

Apply primer (if required) and polymer to the curb or barrier as each of the overlay applications are performed.

f. **Application Rates**. Place epoxy and polyester materials at the same rate.

Place primer (if required) at the application rate shown in **TABLE 729-1**.

Place the overlay in 2 separate courses at application rates shown in **TABLE 729-2**.

TABLE 729-1: HIGH MOLECULAR METHACRYLATE PRIMER APPLICATION RATES for MULTI-LAYER POLYMER CONCRETE OVERLAYS

Primer	Each Coat Not Less Than 0.09 gal./sq yd

TABLE 729-2: APPLICATION RATES for MULTI-LAYER POLYMER CONCRETE OVERLAYS

Course	Polymer 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 polymer.

g. Curing.

(1) Epoxy. Minimum curing times are noted in **TABLE 729-3**.

TABLE 729-3: EPOXY CURE TIMES for MULTI-LAYER POLYMER CONCRETE OVERLAYS

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	6.5	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 before opening to traffic.

(2) Polyester. Proportion polyester courses so the cure times are between 30 and 120 minutes. Accelerators and inhibitors may be required to achieve proper set times. Proportion all materials as recommended by the material supplier.

(3) 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/supplier.

h. Testing. Perform Polymer Concrete Overlay Bond Evaluation as outlined in KT-70, Part V.

(1) Place a polymer concrete test patch of not less than 0.5 square yards per lane or planned completed day's work whichever is smaller. Submit a sequence plan to the Engineer. Test patches shall be full depth, placed by the normal construction sequence. Test patches should be representative of the work being performed.

(2) Perform a minimum of 4 pull-off tests on each patch as outlined in KT-70, Part V.

(3) Final acceptance will be based on the following results of the test outlined in KT-70, Part V:

- Type 1 – Failure in the concrete at a depth greater than or equal to ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Type 2 – Failure in the concrete at a depth less than ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Minimum Tensile Rupture Strength of 250 psi from an average of 3 out of 4 tests on a test patch regardless of depth of failure.

(4) If failure in the concrete is at a depth less than ¼ 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.

(5) A failure in the concrete below 250 psi and greater than ¼ inch deep indicates weak concrete, not poor overlay bond. No additional surface preparation is required.

(6) Do not perform tensile adhesion tests when ambient or deck temperatures are above 85°F.

i. Correction of Unbonded or Damaged Areas. Repair new overlay areas discovered to be unbonded by tapping or chaining and areas where the overlay was 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-pound class maximum) or shot blasting. Aggressively sandblast or shot blast the concrete bridge deck surface at the unbonded area to remove contaminants. Replace the overlay according to standard placement procedures at no additional compensation.

j. Weather Limitations.

(1) Epoxy. Do not place the overlay if the air temperature is expected to drop below 55°F within 8 hours of placement.

(2) Polyester. Do not place any component of the overlay if the air or substrate temperature is at or expected to drop below 40°F during installation.

(3) General. Do not place the overlay when the deck temperature will exceed 90°F.

Do not place the overlay if gel time is less than 10 minutes.

The overlay may be placed outside the specified temperature ranges with the approval of the Engineer and the material manufacturer/supplier. Discuss changes to temperature limitations at the preconstruction conference.

Submit changes, including a written statement from the polymer manufacturer/supplier recommending the changes, to the Engineer for approval.

729.4 MEASUREMENT AND PAYMENT

The Engineer will measure multi-layer polymer concrete overlay by the square yard. The Engineer will measure the bridge roadway width and the bridge length from end of wearing surface to end of wearing surface.

Payment for "Multi-Layer Polymer Concrete Overlay" at the contract unit price is full compensation for the specified work.

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.

BID ITEM	UNITS
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 Surface Crack 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 Research must approve the Contractor's equipment before work starts on the project.

Arrange to have a representative of the Bureau of Research 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 Structures and Geotechnical Services.

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 ⅛ inch, and a width of ¾ 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.

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 ⅛ 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.

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
Area Prepared for Patching (Set Price)	Square Yard
Area Prepared for Patching (Full Depth) (Set Price)	Square Yard

731.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete ..... **SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade ..... **SECTION 1102**
Concrete Curing/Precure Materials ..... **DIVISION 1400**
Reinforcing Steel ..... **DIVISION 1600**
Epoxy Resin Base Bonding Systems ..... **DIVISION 1700**
Rapid Set Concrete Patching Materials* ..... **SECTION 1716**

***When specified in the Contract Documents.**

On bridge decks that do not 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.

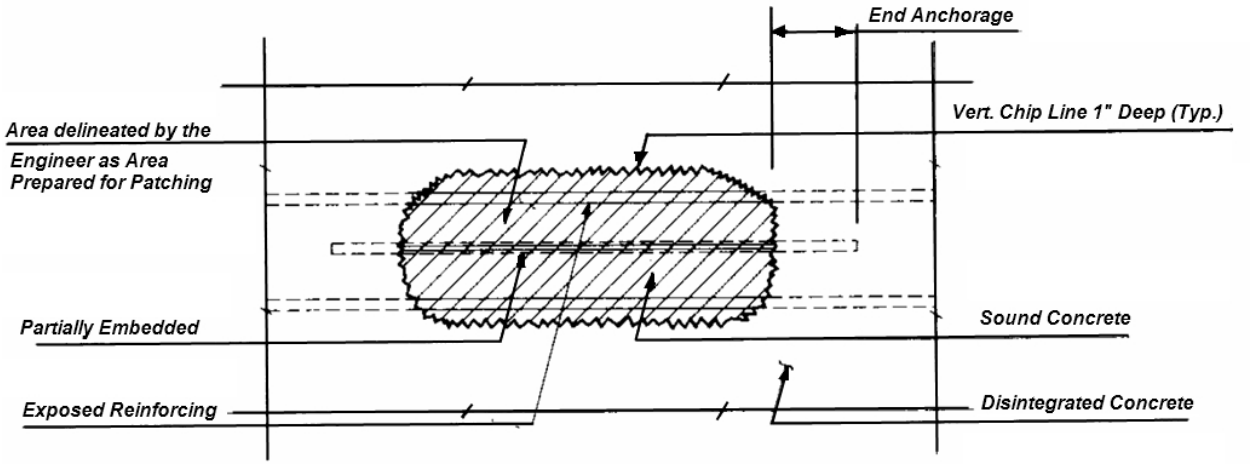
Unless specifically noted in the Contract Documents, the Contractor may choose to remove unsound concrete by other means capable of removing the required concrete, without injury to the sound concrete and reinforcing steel.

Unless specifically noted in the Contract Documents, the Contractor may **not** choose to remove unsound concrete by hydrodemolition. When hydrodemolition is allowed, remove the required concrete, without injury to the sound concrete and reinforcing steel. When hydrodemolition is allowed and used as the method of removal, the Engineer will determine the areas of unsound concrete after hydrodemolition.

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**.

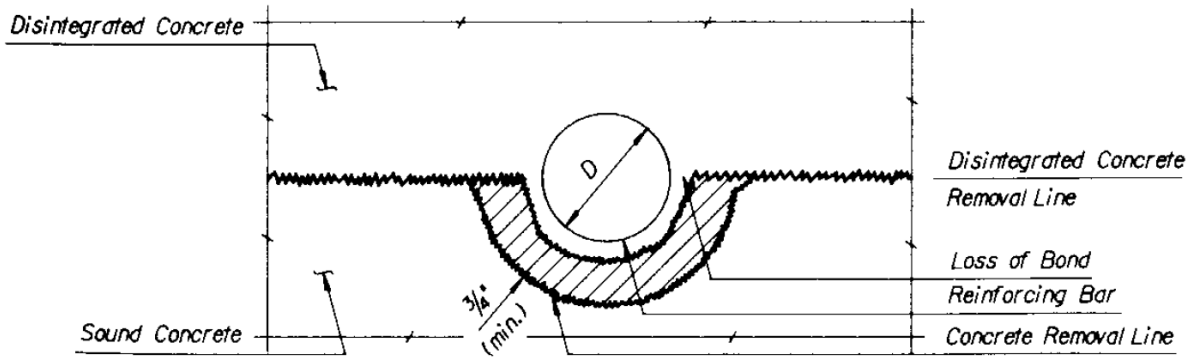
FIGURE 731-1



(2) Bonding of Reinforcing Steel.

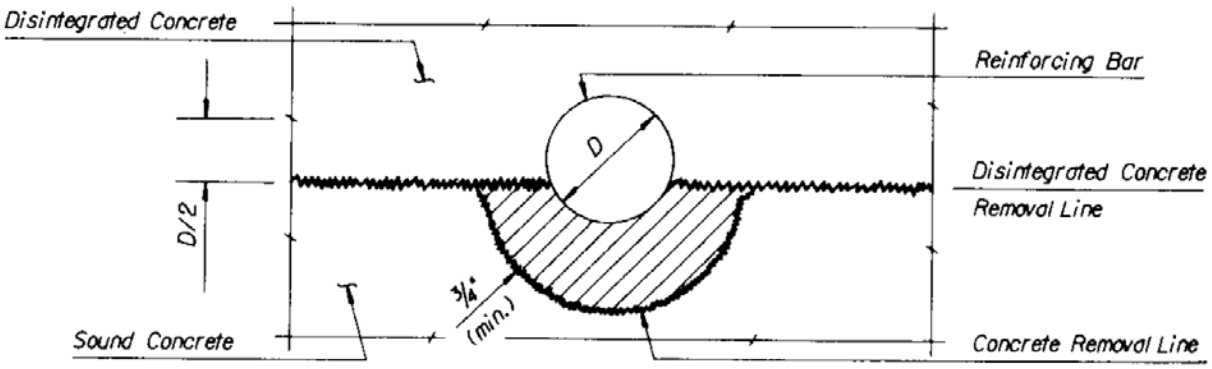
(a) Top Layer of Transverse Reinforcing Bars. Where the bond between existing concrete and the top layer of transverse reinforcing steel has been destroyed (**FIGURE 731-2**), remove the concrete adjacent to the bar to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of ¾ inch. A bar may be considered bonded by the Engineer even if less than ½ 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 ½ 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 ¾ inch.

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 precure to prevent rapid evaporation between the initial strike off and brooming prior to covering with the curing media at ambient air temperatures above 70ºF, 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 45ºF. Do not start or resume concreting operations until the ascending ambient air temperature reaches 40ºF.

b. Bridge Decks That Are To Receive An Overlay. Use aggregate specified for Grade 4.0(AE) concrete. Use the course aggregate specified for wearing surface. Patching concrete slump must be 2 ½ to 3 ½ 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 ¼ 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.

TABLE 731-2: BRIDGE PATCHING CURING	
Minimum length of Cure Time*	**Ambient Air Temperature Range (ºF)**
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.

d. Bridge Decks That Receive a Multi-Layer, Single-Layer or Slurry Polymer Concrete Overlay.

(1) Polymer concrete materials may be used for patching of the concrete bridge deck.

For shallow patches, 3 inches maximum depth, polymer concrete overlay resin and FA-C aggregate, **TABLES 1102-3** and **1102-4,** may be used.

For deep patches, greater than 3 inches polymer concrete overlay resin with an approved MA-1 or MA-2 aggregate, **TABLE 1102-6,** may be used.

The slurry polymer concrete system may be used for shallow and deep patching with the manufacturer/supplier's recommendation.

Mix and cure all patching according to manufacturer/supplier's recommendations.

(2) A Rapid Set Concrete Patching Material, compatible with the overlay may be used for patching the concrete bridge deck.

(3) Strike off patches to a level approximately ¼ inch below the top of the original concrete deck.

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 prices and "Area Prepared For Patching (Set Price)" and "Area Prepared For Patching (Full Depth) (Set Price)" at the contract set prices are full compensation for the specified work when shown in the contract.

731 - AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)

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 of "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 underside shall be paid for at a rate of 2 ¼ times the contract unit price per square yard of "Area Prepared For Patching".

Concrete used to fill patched areas shall be subsidiary to other items of the contract.

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.

BID ITEM	**UNITS**
Machine Preparation (*) *Thickness	Square Yard

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.

SECTION 733

BRIDGE DRAINAGE SYSTEMS & DECK DRAIN EXTENSIONS

733.1 DESCRIPTION

Provide and install the bridge drainage system as shown in the Contract Documents.

Submit to the Engineer for approval shop drawings of the bridge drainage systems showing methods for accommodating thermal expansion, if necessary. Use 15 x 10^{-6} in/in / ºF as the coefficient of thermal expansion for fiberglass systems.

Include in the shop drawings the methods to be used to properly position the bridge drainage system for the temperature at the time of installation. Show the amount of adjustment required for temperature changes (in 10° increments). The mean temperature shall be assumed 60ºF.

Provide material for and install bridge deck drain extensions as shown in the Contract Documents.

BID ITEMS	**UNITS**
Bridge Drainage System (*)	**
Bridge Deck Drain Extension	Each

*Steel or Fiberglass
**Unit of Measure Shown in the Contract Documents

733.2 MATERIALS

Provide materials that comply with the applicable requirements.

Structural Steel Fabrication and Painting	**DIVISION 700**
Structural Steel	**DIVISION 1600**
Castings	**DIVISION 1600**
Steel Fasteners	**DIVISION 1600**
Anchor Bolts for Structural Uses	**DIVISION 1600**
Steel Fasteners	**DIVISION 1600**
PVC Pipe	**DIVISION 1900**
Fiberglass Pipes and Fittings	**DIVISION 1900**

Joint Adhesive. Bond adhesive joint will be a vinyl ester resin based product with silica filler, polyester pigment, and methyl ethyl ketone peroxide catalyst. The adhesive formulation will be certified proven suitable for the intended application. Certify the resin to have no additives that leach out, catalysts which remain active or other ingredients that could lead to deterioration.

733.3 CONSTRUCTION REQUIREMENTS

a. Bridge Drainage System (Steel). Install the steel bridge drainage system according to **SECTION 712** and the Contract Documents.

b. Bridge Drainage System (Fiberglass). Use "bell and spigot" type adhesive bonded joints.

Use a standard sling, clamp or clevis hanger as used in steel pipe applications.

Use a split fiberglass pipe protective sleeve bonded in place at all support locations of a length no less than the pipe diameter being supported.

Install according to the approved shop drawing, Contract Documents, and guidelines and procedures recommended by the manufacturer.

Install the fiberglass bridge drainage systems that will not restrict movements between the substructure and superstructure or causes damage to the drainage system during expected thermal movements.

The strap thickness will be 3/16 inch for all hangers, a minimum width of 1 ½-inch for 8-inch and 10-inch pipe and 2 inches for greater than 10 inches. The sling, clamp for clevis will be sized to accommodate the pipe protective sleeve. Use a double nut on all connectors to prevent over tightening and to lock the nuts against each other.

Use bonded rigid couplers. Insert pipes so that the ends are centered.

Sand spigot ends to remove glossy finish and expose fibers. Insert pipe so it bottoms out within the bell fitting to create a fully fitted joint. Mix and apply 2 layers of adhesive according to the manufactures recommendations. Secure the joint so it cannot move, do not twist the joint. Do not disturb the joint until it has gelled according to the manufactures recommendations. An electric heat gun or heating collar may be used to accelerate gelation of the joint.

c. Bridge Deck Drain Extensions. Install angles equally spaced around the perimeter of PVC pipe using two 1 ¾-inch long by ½ -inch diameter bolts with a flat washer and lock nut. Place the bolt head on the inside of the PVC pipe.

Anchor the steel angles to the bottom of the deck using a concrete hex nut sleeve anchor. Use a 5/8-inch diameter sleeve anchor with an effective anchor length of 2 ½ inches and a bolt with a ½-inch diameter. Embed all anchors a minimum of 2 inches into the bottom of the concrete. Drill and place the anchors in accordance with the anchor manufacturer's recommendations.

Plumb the completed drain extension and place the PVC pipe flush against the bottom of the concrete.

Use PVC pipe lengths that extend a minimum of 12 inches below the bottom of the beam, girder, chord or slab. If the beam, girder, chord or slab is not of uniform depth, vary the length of each extension to provide the 12-inch minimum.

733.4 MEASUREMENT AND PAYMENT

The Engineer will measure bridge drainage system by the units shown in the Contract Documents.

The Engineer will measure each bridge deck drain extension.

Payment for "Bridge Drainage System" and "Bridge Deck Drain Extension" at the contract unit prices is full compensation for the specified work.

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	UNITS
(*) Structural Plate Pipe (**) (***)	Linear Foot
(*) Structural Plate Pipe Arch (**) (***)	Linear Foot
(*) Structural Plate Arch (**) (***)	Linear Foot

*Size, diameter or span and height
**Gauge
***Asphalt Coated

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.

Include a Load Rating Table on the working drawings and provide the SBO with a LFR and LRFR rating and support calculations for the structure. The load rating shall take into consideration varying fill depths and KDOT live load criteria. For LFR Load Rating, include HS-20-44, KDOT rating vehicles for Inventory and Operating rating factors. Rate the Heavy Equipment Transport (HET) vehicle for Operating rating factor. For LRFR, use HL-93 for Inventory and Operating. Submit a Load Rating Report along with the working drawings. Include in the Load Rating Report a summary rating table, assumptions used in the load rating, the depth of fill, material strengths and any other significant information required to load rate the precast culvert. The Load Rating will include all elements of the proposed system including, but not limited to stub-walls and connections.

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 ½ 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.

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.

Submit all working drawings according to **SECTION 105**.

BID ITEM	**UNITS**
Reinforced Concrete Box (*) (Precast) *Size	Linear Foot

DESIGN:

- Design the precast concrete box units in accordance with the AASHTO LRFD Bridge Design Specifications, latest version.
- Precast wings and headwalls are prohibited at stream crossings.
- Cast-in-place end sections shall conform to KDOT Standard BR031.

For fill heights less than or equal to 3 feet:

- Use epoxy coated reinforcing steel and air entrained concrete
- Use a distribution slab meeting the requirements of KDOT Standard BR031.
- Use an approved "non-coal tar" bridge backwall protection system to cover the middle 1/3 of the top of precast arch culverts, the complete top slab of precast rigid frame culverts and the uppermost 12 inches of the outside walls.
- Indicate on the shop drawings the limits of the bridge backwall protection system.

Prior to beginning foundation construction, submit complete design calculations, including loadings, for the Engineer's review. Design calculations and loadings may be submitted prior to the working drawing submittal. Submit design calculations sealed by a Kansas licensed Professional Engineer.

Prior to fabrication, submit to the Engineer for review and approval, working drawings including the supplier's manufacturing specifications, details of all phases of construction, including layout, joint details, lifting devices, casting methods, construction placement and details of any cast-in-place sections. Submit working drawings according to **SECTION 105**.

Designate proposed transportation methods, and submit over-height and overload permits, if required, with the working drawings.

When required, submit falsework plans and calculations sealed by a Kansas licensed Professional Engineer according to **SECTION 708**.

PRECAST CONCRETE BOX LOAD RATING:

Include a Load Rating Table on the working drawings and provide the State Bridge Office with a LFR and LRFR rating and support calculations for the structure. The load rating shall take into consideration varying fill depths and KDOT live load criteria. For LFR Load Rating, include HS-20-44, KDOT rating vehicles for Inventory and Operating rating factors. Rate the Heavy Equipment Transport (HET) vehicle for Operating rating factor. For LRFR, use HL-93 for Inventory and Operating. Submit a Load Rating Report along with the working drawings. Include in the Load Rating Report a summary rating table, assumptions used in the load rating, the depth of fill, material strengths and any other significant information required to load rate the precast culvert. The Load Rating will include all elements of the proposed system including, but not limited to stub-walls and connections.

735.2 MATERIALS

a. General. Use materials that comply with the applicable requirements:

Grade 4.0 and 4.0 (AE) Concrete ..... **SECTIONS 401 & 402***
Commercial Grade Concrete for Seal Course ..... **SECTIONS 401 & 402**

Aggregate for Concrete Not On Grade ..... **SECTION 1102**
Reinforcing Steel (Grade 60) ..... **DIVISION 1600**
Reinforcing Steel (Epoxy Coated) (Grade 60) ..... **DIVISION 1600**
Welded Wire Fabric ..... **DIVISION 1600**
Quality Control Program for Precast Concrete Products..... **DIVISION 1900**
Drilling and Grouting ……..... **DIVISION 800**
Joint Seals…… **DIVISION 1500**
Geotextile Fabric ..... **DIVISION 1700**
Bridge Backwall Protection…… ……. **DIVISION 1700**

*For precast reinforced concrete boxes constructed according to this specification, KT-73 testing is not required.

b. Precast Reinforced Concrete Box. Provide precast reinforced concrete box sections complying with ASTM C 1577 and this specification.

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 ¾ 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: ± ¼ inch.

(b) 11.9 Squareness of ends (vertical and horizontal): ± ¼ 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) Member thickness shall be the thickness specified by ASTM C 1577, ¾ the thickness of the corresponding member of an equivalent KDOT Standard cast-in-place rigid frame box culvert, or six inches, whichever is larger. When calculating the minimum thickness of the bottom slab, deduct ½ inch from the cast-in-place thickness before factoring by ¾.

(5) Provide minimum clearances to reinforcing of 1¼ inches ± ¼ 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 ½ inches ± ¼ inch. Develop all reinforcement according to the AASHTO LRFD Bridge Design Specifications.

(6) For fill heights less than or equal to 2 feet, use either epoxy coated reinforcement in the top slab or an approved "non-coal tar" "Bridge Backwall Protection System" to cover the top slab and uppermost 12 inches of the outside walls. Indicate on the shop drawing which option was used.

(7) 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.

(8) Provide minimum transverse steel areas in each face of 0.19 square inches per foot of barrel.

(9) The maximum shear reinforcement (in lip of joint) spacing in the longitudinal direction is 6 inches.

(10) Do not weld reinforcing bars or steel fabric, except the original welding required to manufacture the wire fabric.

(11) Air entrained concrete is not required for dry-cast units. Use air entrained concrete for wet-cast units where the depth of fill will be less than 2 feet, as shown in the Contract Documents.

(12) Minimum length of a precast section is 4 feet.

(13) 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. Do not modify the cell height shown on the Contract Documents, unless approved by the Engineer. Two single-cell boxes may be substituted for a double-cell box, when approved by the Engineer.

(14) Prior to fabrication, submit working drawings to the Engineer for approval (see **SECTION 105**). 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 working drawings.

(15) Legibly mark this information on an inside face of each box section using 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 according to **SECTION 1902**, and when deemed necessary by the Engineer, satisfactory results of material tests performed by the Engineer, compliance with dimensional requirements and visual inspection at the point of production or usage.

c. Foundation Materials for Precast Boxes. Provide either crushed stone or concrete seal course for the foundation of the precast box.

Provide crushed stone 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, or use any other concrete acceptable for use on the project.

735.3 CONSTRUCTION REQUIREMENTS

a. Foundation Preparation. 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 of commercial grade concrete for the foundation of the precast box.

b. Installation of Precast Boxes. Install the precast reinforced concrete box culvert with the groove end of each section up-grade. Join the sections tightly.

c. Sealing Joints of Precast Boxes. 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 D_{50} backfill larger than 6 inches onto the geotextile from a height greater than 1 foot;
- Do not drop any D_{50} backfill smaller than 6 inches 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.

d. Distribution Slab Requirements.

(1) Fill heights less than 2 feet require a distribution slab. Precast distribution slabs may be used for fill heights less than 2 feet but greater than 1 foot, otherwise use cast-in-place.

Construct or place the distribution slab to extend a minimum of 2 feet beyond the exterior walls of the barrel. Construct or place the distribution slab to the outside edge of the roadway shoulders.

Place a minimum of 3 inches of granular material between the box and a concrete distribution slab.

Cast-in-place distribution slabs require one of the following combinations of steel reinforcement:

- 1 layer of mesh and 1 layer of reinforcement bars, or
- 1 layer of reinforcement bars.

(2) Fill heights less than or equal to 1 foot.

Construct a cast-in-place distribution slab a minimum of 6 inches thick, reinforced with #4 bars spaced at 18 inches placed transverse to the centerline of the box, and #5 bars spaced at 12 inches placed parallel to the centerline of the box. Uniformly consolidate the concrete without voids. An equivalent welded wire fabric is acceptable.

(3) If the fill height is greater than 1 foot, but less than or equal to 2 feet.

- Use the cast-in-place criteria above.
- Use precast distribution slab sections constructed with the same criteria as the cast-in-place distribution slab above. Do not locate precast slab joints near precast box joints.
- Reinforced concrete pavement with reinforcement as specified for a cast-in-place slab mentioned above (minimum 6 inches thick) shall meet the requirements of a distribution slab.
- Asphalt pavement (minimum 6 inches thick) shall meet the requirements of a distribution slab with 6 inches of granular material provided between the asphalt and the precast box. Place a geogrid on top of the granular material.

(4) A special design is required for the distribution slab if the above options are not geometrically possible.

e. Cast-In-Place Construction. 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.

- Construct the cast-in-place box sections at a minimum to the member thicknesses and reinforcement shown in the Contract Documents. When the thicknesses between the cast-in-place and precast members are different, transition at a maximum rate of 4:1 without reducing the box opening size.
- Skewed precast structures with fill heights greater than 10 feet will not be attached to the cast-in-place end section(s).
- Do not drill and grout dowel bars in the field, but detail on the working drawings and install by the Fabricator.
- Use 16 foot minimum cast-in-place end section for structures where precast sections are not attached (unreinforced open joint) to the cast-in-place sections.
- For multiple precast sections placed on a skew, submit for approval by the Engineer, working drawings (sealed by a Kansas licensed Professional Engineer) with details of cast-in-place end sections.
- When the thicknesses between the cast-in-place and precast members are different, transition at a maximum rate of 4:1 without reducing the box opening size.

f. Top Slab Protection. When required by **subsection 735.2b.(6)**, cover the entire exterior face of the top slab and the uppermost 12 inches of the outside walls and both sides of the joint with a Bridge Backwall Protection System from the KDOT's prequalified list. Remove any dirt or latent concrete before applying the coating per the manufactures directions. Lap ends and stagger joints according to the manufacture's recommendation. Repair any flaws or damage to the coating before backfilling the structure.

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.

When shown as a bid item in the contract, foundation stabilization and concrete seal course will be measured and paid for according to **SECTION 204**. When not shown as a bid item in the contract, foundation stabilization and concrete seal course are subsidiary.

Payment for "Reinforced Concrete Box (Precast)" at the contract unit price is full compensation for the specified work.

When not shown as a bid item in the contract, the "Bridge Backwall Protection System" will be subsidiary to other bid items.

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.

SECTION 736

PRECAST CULVERTS

736.1 DESCRIPTION

Design, provide and install precast culvert units as shown in the Contract Documents. Do not substitute Precast Culvert elements with cast-in-place culvert elements without approval from the State Bridge Office (SBO).

BID ITEMS	UNITS
Precast Arch Culvert	Linear Foot
Precast Rigid Frame Culvert	Linear Foot

DESIGN:

- Design the precast culvert units in accordance with the AASHTO LRFD Bridge Design Specifications, latest version.
- Precast wings and headwalls are prohibited at stream crossings.
- Cast-in-place end sections shall conform to KDOT Standard BR031.

For fill heights less than or equal to 3 feet:

- Use epoxy coated reinforcing steel and air entrained concrete
- Use a distribution slab meeting the requirements of KDOT Standard BR031.
- Use an approved "non-coal tar" bridge backwall protection system to cover the middle 1/3 of the top of precast arch culverts, the complete top slab of precast rigid frame culverts and the uppermost 12 inches of the outside walls.
- Indicate on the shop drawings the limits of the bridge backwall protection system.

Prior to beginning foundation construction, submit complete design calculations, including loadings, for the Engineer's review. Design calculations and loadings may be submitted prior to the working drawing submittal. Submit design calculations sealed by a Kansas licensed Professional Engineer.

Prior to fabrication, submit to the Engineer for review and approval, working drawings including the supplier's manufacturing specifications, details of all phases of construction, including layout, joint details, lifting devices, casting methods, construction placement and details of any cast-in-place sections. Submit working drawings according to **SECTION 105**.

Designate proposed transportation methods, and submit over-height and overload permits, if required, with the working drawings.

When required, submit falsework plans and calculations sealed by a Kansas licensed Professional Engineer according to **SECTION 708**.

PRECAST CULVERT LOAD RATING:

Include a Load Rating Table on the working drawings and provide the SBO with a LFR and LRFR rating and support calculations for the structure. The load rating shall take into consideration varying fill depths and KDOT live load criteria. For LFR Load Rating, include HS-20-44, KDOT rating vehicles for Inventory and Operating rating factors. Rate the Heavy Equipment Transport (HET) vehicle for Operating rating factor. For LRFR, use HL-93 for Inventory and Operating. Submit a Load Rating Report along with the working drawings. Include in the Load Rating Report a summary rating table, assumptions used in the load rating, the depth of fill, material strengths and any other significant information required to load rate the precast culvert. The Load Rating will include all elements of the proposed system including, but not limited to stub-walls and connections.

736.2 MATERIALS

a. General. Submit to the Engineer a list of sources of material or fabrication locations for items which may require sampling, inspection or certification before use. Provide the Engineer samples of all materials requiring testing and approval, once the materials become available.

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 before work is started.

Use materials that comply with the applicable requirements:

Grade 4.0 and 4.0 (AE) Concrete	**SECTIONS 401 & 402***
Aggregates for Not On Grade Concrete	**SECTION 1102**
Reinforcing Steel (Grade 60)	**DIVISION 1600**
Reinforcing Steel (Epoxy Coated) (Grade 60)	**DIVISION 1600**
Welded Wire Fabric	**DIVISION 1600**
Bolts, Threaded Rods, Nuts	**DIVISION 1600**
Structural Steel	**DIVISION 1600**
Joint Seals	**DIVISION 1500**
Bridge Backwall Protection System	**DIVISION 1700**
Geotextile Fabric	**DIVISION 1700**
Aggregates for Backfill	**DIVISION 1100**

*For precast reinforced culverts constructed according to this specification, KT-73 testing is not required.

b. Precast Culvert.

(1) Calcium Chloride or admixtures containing Calcium Chloride are prohibited.

(2) Reinforcing Steel. Fabricate reinforcing steel for the precast elements and place in accordance with the detailed working drawings. Longitudinal distribution reinforcement may consist of welded wire fabric or deformed billet-steel bars. Welding is prohibited on reinforcing bars or wire fabric, except original welding required in manufacturing the wire fabric is acceptable.

(3) Hardware. Use the following:

- Structural steel anchors and plates to meet design, geometric and construction requirements.
- AISI type 304 stainless steel expanded coil inserts for detached headwall connections. Use AISI type 304 stainless steel coil rods and nuts in headwall connections. Use either AISI type 304 stainless steel plate washers or AASHTO M 270 (ASTM A709) Grade 36 plate washers hot dip galvanized as per AASHTO M 111 (ASTM A123) in connections.
- Dowel Bar Splicer System satisfying load requirements and geometric constraints.
- Provide corrosion protection coatings for all bolts, threaded rods, nut, fasteners, etc.
- Hook Bolts in the attached headwall connections per ASTM A307.
- All hardware shall either be AISI type 304 stainless steel or ASTM A 123 galvanized.

c. Materials for Sealing Joints of Precast Culverts. Provide Type III external sealing bands complying with ASTM C877. The basis of acceptance for external sealing bands will be a Type D Certification as specified in **SECTION 2600**.

d. Foundation Materials for Precast Culverts. Provide foundation materials to comply with the Contract Documents.

e. Markings. Legibly mark the following information on the outside face of each section with waterproof paint or other approved means:

- Date of manufacture;
- Name or trademark, and location of the manufacturer;
- Mass of culvert section in tons; and
- The top of the section.

f. Aggregates for Backfill. The backfill materials shall conform to SB-1, SB-2, or SCA-2, SCA-3 or SCA-5, **DIVISION 1100**.

g. Basis of Acceptance. Prequalification for the materials listed.

Precast culvert units 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.

736.3 CONSTRUCTION REQUIREMENTS

a. Foundation Preparation. Excavate and prepare the foundation according to the Contract Documents.

b. Installation of Precast Culvert. Provide a manufacturer's representative at the job site during the installation or placement of the first 10% of the structure sections and the installation or placement of the final 10% of the structure sections. Install according to the approved detailed working drawings.

c. Sealing Joints of Precast Culverts. Seal the joints as shown in the Contract Documents. Install the butyl rubber, rope-form joint sealant in the chamfer groove between all precast sections, prior to installing connection plates or hardware.

Install a Type III external sealing band at each precast joint, or cast-in-place cold joint. Completely cover the surface area of closure joints and extend the sealing bands an additional 6 inches beyond the limits of closure joints. Overlap the bands to shed water. Overlap the bands a minimum of 6 inches along the axis of the band; overlap the bands a minimum of 2 inches transverse to the axis of the band. Place the bonding material to extend a minimum of 18 inches from the joint location.

If geotextile is used to wrap the joint:

- Use only geotextile that has been properly stored. Store rolls in a manner which protects them from the elements. If stored outdoors, elevate and protect with a waterproof cover;
- Limit the exposure to the elements (between placement and covering) of the geotextile to a maximum of 7 calendar days;
- Do not drop any D_{50} backfill larger than 6 inches onto the geotextile from a height greater than 1 foot;
- Do not drop any D_{50} backfill smaller than 6 inches 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.

d. Cast-In-Place Construction. Construct cast-in-place foundations, closure joint systems, culvert sections, wingwalls, end caps, headwalls and other concrete elements according to the Contract Documents. Use epoxy coated reinforcement for all closure joints when the fill height, measured at the shoulder line, is less than or equal to 3 feet. Install pavement waterproofing membrane to extend 18 inches beyond the limits of all closure joint concrete or grout. This membrane is subsidiary to the culvert.

e. Backfill Thickness and Material. Use a minimum of 2 feet of approved granular material to backfill the sides and top of the structure. When manufacturer's recommendations require more granular material, install at no additional cost to KDOT.

f. Field Welding. Perform all field welding by an approved certified welder, using approved weld procedures.

736.4 MEASUREMENT AND PAYMENT

The Engineer will measure precast arch culverts and precast rigid frame culverts by the linear foot. Precast and cast-in-place end caps, headwalls and wingwalls are subsidiary to the culvert.

When shown as a bid item in the contract, foundation stabilization and concrete seal course will be measured and paid for according to **SECTION 204**. When not shown as a bid item in the contract, foundation stabilization and concrete seal course are subsidiary to the culvert.

Payment for "Precast Arch Culvert" and "Precast Rigid Frame Culvert" at the contract unit prices is full compensation for the specified work. The pavement waterproofing membrane is subsidiary to the culvert. The specified granular backfill is subsidiary to the culvert. Any additional granular backfill required by the manufacturer will be done at no additional cost to KDOT.

SECTION 737

FIELD ERECTION

737.1 DESCRIPTION

Evaluate project characteristics and develop unique Field Erection Plans for each qualifying structure within the Contract Documents according to this specification.

For the purposes of this specification, erection is the process of transporting, handling and assembling the bridge components to result in a bridge structure that meets all the geometric and structural requirements of the Contract Documents.

737.2 ERECTION SUPERVISOR

The Erection Supervisor is the person responsible for all rigging and handling of bridge primary members. The Erection Supervisor shall be present at the erection site during the erection of all primary members of Category B & C Structures.

All Erection Supervisors must be pre-qualified. To become pre-qualified, provide proof of experience that the Erection Supervisor has a minimum of 5 years experience and at least 10 projects similar in scope, type and complexity.

KDOT will maintain a list of approved Erection Supervisors on a Pre-Qualified List.

At the pre-construction meeting, submit to the KDOT Field Engineer proof of pre-qualification for the scope, type and complexity of the structure to be constructed.

737.3 ERECTION PLANS

a. General. The Contract Documents will indicate the field erection category for each structure. Submit shop drawings according to **SECTION 105**.

KDOT will review the Erection Plan for all Categories, and either decline, or recommend for approval. The Engineer must approve the Erection Plan before work may begin. The level of review and the requirements for submittals by the Contractor to the Engineer are categorized by risk and complexity. **FIGURE 737-1** defines the 3 categories for field erection.

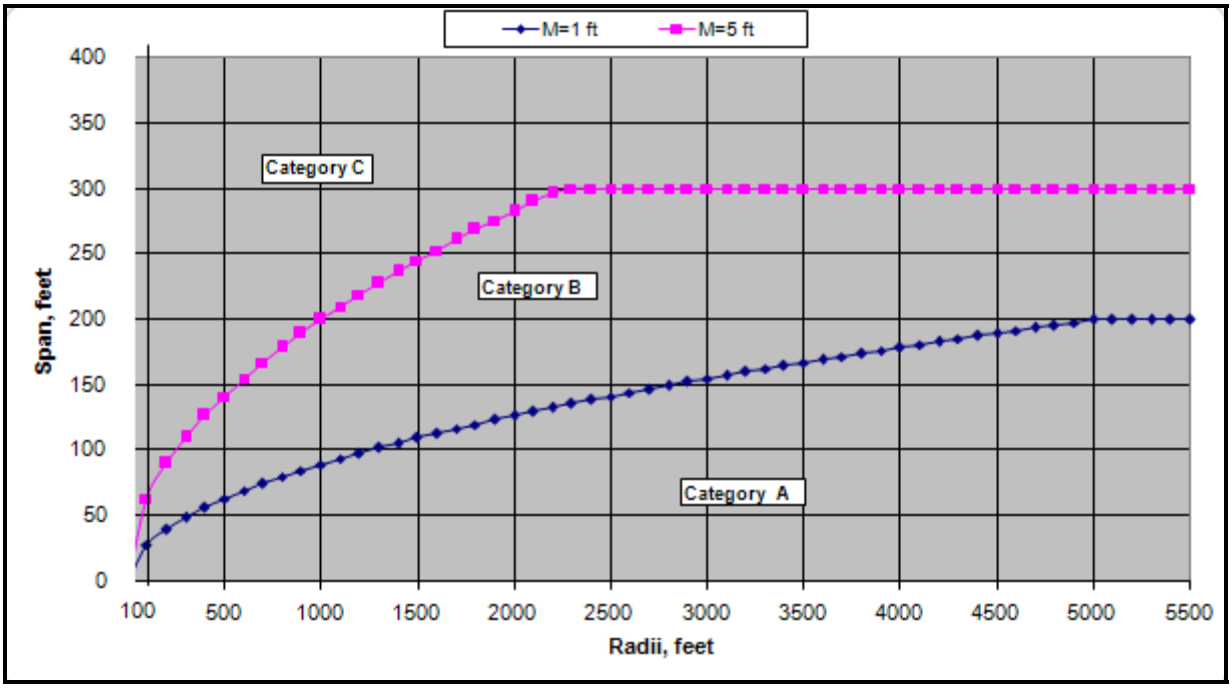


FIGURE 737-1
Special Requirements for Bridge Designers to Designate Erection Plan Categories

The initial Category is based on the chart which considers the length of the longest span, the curvature of the bridge and the skew angle.

If skew is greater than 30°, move up one Category (A to B or B to C).

If a structure crosses traffic or a railroad, require Category B as a minimum.

If the Contractor uses falsework bents or strong-backs for the field erection, Category C Erection Plans are required.

The designer may elevate a structure to the necessary Category based upon engineering judgment and unique circumstances.

b. Definitions and Submittals.

(1) Category A Erection Plan Requirements. Submit 1 copy of the detailed Field Erection Plans to the Field Engineer. At a minimum, include the following:

- Shop details, camber diagrams, list of field bolts, and shipping statements showing a list of parts and their respective weights
- Proposed methods of erection
  - A list of all equipment that will be used
  - Crane pick locations and loads
  - Falsework plans
  - Temporary bracing requirements
  - Blocking diagrams

- Specific details for structural erection shall be clearly defined
  - Spliced pieces
  - Multiple girders
  - Pick descriptions
  - Bolting locations
  - Number of fully tightened bolts at each splice
  - Cross-frames or diaphragms
  - Anchor bolts
  - Temporary bracing

(2) Category B Erection Plan Requirements. Meet the Category A Field Erection Plan Requirements in **subsection 737.3b.(1)** above. In addition, submit the detailed Field Erection Plans according to **SECTION 105** to the State Bridge Office (or Bureau of Local Projects) at least 4 weeks before beginning the erection process.

List on the Field Erection Plans the Erection Supervisor that shall be present at the site during the erection of all primary members.

Field Erection Plan development, authority, and responsibility fall under 3 separate Field Operations:

- **Traffic Control (Field Operation One):**
  This is site and structure specific control of traffic movements relative to the structural erection operations.
  - This portion of the operation is developed by the Contractor's personnel and will be reviewed and approved by KDOT's Field Engineer.
  - Field changes are under the authority of the Field Engineer.

- **Pick and Place (Field Operation Two):**
  This includes crane movements, rigging operations, storage, assembling, loading and unloading operations of primary, secondary and falsework members. This includes placing the assemblies into the structure.
  - This portion of the operation requires procedures, calculations and drawings and is developed by the Erection Supervisor.
  - All field operations and field changes are under the authority, and the responsibility, of the Contractor's Erection Supervisor.

- **Part of Permanent Structure (Field Operation Three)**:
  Defined as the point in time when the primary member becomes part of the structure. When the primary member is released from the rigging or when it rests solely on the bridge bent, bearing device or falsework bent as a part of the uncompleted structure, the primary member is considered to be part of the Permanent Structure.
  - This requires calculations, procedures and drawings to be developed and sealed by the Contractor's Professional Engineer.
  - Field changes must be approved and resealed by the Engineer who originally developed the plans before work begins. This work is under the authority of the Contractor's Professional Engineer.

(3) Category C Erection Plan Requirements. Meet the Category B Field Erection Plan Requirements in **subsection 737.3b.(2)** above. Additionally, there will be a pre-erection meeting before erection operations begin. The Erection Supervisor shall attend this pre-erection meeting to discuss any field concerns related to the erection procedures and to increase familiarity with each structure site.

c. Calculations.

The calculations, as a minimum, shall include the following information:

- Calculations to substantiate structural adequacy and stability for each stage of erection, accounting for the structures lack of completeness or complex structural geometry.
- Calculations to determine translations and rotations at intermediate erection conditions.
- Design calculations indicating and verifying the load capacity, the stability of all temporary supports, falsework bents, and bracing when used to allow traffic to travel under the incomplete structure.
- Calculations indicating structural redundancy of the incomplete structure shall be required at specific stages of erection. These calculations shall be required to account for unforeseen obstacles to the erection process that necessitate halting erection at an undesignated stopping point.

737.4 ERECTION INFORMATION

Submit a detailed Erection Procedure to the Owner for each bridge structural unit. In the Procedure, address all requirements for erection of the structure into the final designed configuration and satisfy all written Owner comments prior to the start of erection. As a minimum, include the following in the Erection Procedure:

a. The Contractor's Engineers shall provide the following information:

- Plan of the work area showing permanent support structures (piers and abutments), roads, railroad tracks, waterways (including navigational channel), overhead and underground utilities and other information pertinent to erection.
- Erection sequence for all members noting any temporary support conditions, such as holding crane positions, temporary supports, falsework, etc. Member reference marks, when reflected on the erection plan, should be the same as used on shop detail drawings.
- In the Field Erection Plans, describe the number, location and bolting requirements for the permanent cross-frames or diaphragms for each stage of construction.
- In the Field Erection Plans, address the expected condition of each bearing device for each stage of construction. State the minimum number of positive bearing connections or supplemental connections to each bent cap which will resist all potential destabilizing forces.
- In the Field Erection Plans, address traffic control and railroad issues.
- If falsework bents or strong-backs are used, the Field Erection Plans shall meet falsework requirements as defined in **SECTION 708**.

b. The Contractor's Erection Supervisor shall provide the following information:

- Location of each crane for primary picks showing all necessary information.
- Capacity chart for each crane configuration.
- Center of gravity, lift weight (including rigging) for all primary member picks.
- Primary member site delivery location and storage orientation.
- Details of any temporary lifting devices to be bolted/welded to or cast in to permanent members, including method and time (shop or field) of attachment, capacity and method, time and responsibility for removal.
- Temporary support details for bridge bearings.

c. The Owner's Inspector shall require the following:

- Requirements for bracing. At the end of the workday, remove the members not properly braced in compliance with the Field Erection Plan from the bridge substructure elements.
- All rigging must have capacity stamps, tags or be otherwise permanently marked on the device (per OSHA Standards)

737.5 CONSTRUCTION REQUIREMENTS

No erection work may begin without an approved Field Erection Plan. The Contractor is responsible for the erection, even though the Field Erection Plans have been approved by the Engineer. See **SECTION 105**. Keep the approved Field Erection Plans available on site at all times.

Before erection begins, resolve any questions that any party may have.

Prepare a Contingency Plan if the number of stable girder lines to be erected does not meet the Field Erection Plan number for a sequence proposed. (i.e. the plan says 6 girder lines and because of problems, 5 girder lines where erected before traffic delay penalties accrued).

It is required that all traffic must be stopped while overhead erection work involving the placement of primary members into the permanent structure is being performed. No members shall be suspended over highway traffic at any time during loading, unloading, moving, rigging or placing. In no case will KDOT allow highway/railroad traffic to travel under uncompleted structures without compliance of Field Operation Three above.

Erect the fabricated structure and perform all work required to complete the structure as specified in the Contract Documents. Provide all falsework, tools, machinery and appliances 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. The Engineer will refuse permission to proceed with erection work if the erection process is determined to be unsafe or substantially different than approved Field Erection Plans.

737.6 MEASUREMENT AND PAYMENT

Erection is considered complete when all field connections are completed to the final design condition and falsework is removed. The Engineer will not measure Field Erection and Field Erection Plans for separate payment.

SECTION 738

HIGH MAST LIGHT TOWERS

738.1 DESCRIPTION

Construct new high mast light towers as shown in the Contract Documents.
Repair existing high mast light towers as shown in the Contract Documents.
See **SECTION 814**, for Electric Lighting System work.

BID ITEM	**UNITS**
High Mast Light Tower (*) (**)	Each

(*) Size
(**) Foundation

738.2 MATERIALS

Provide high mast light tower structures from the prequalified list of fabricators. Comply with all requirements and dimensions designated in the Contract Documents.

Use material for High Mast Light Tower structures that comply with the applicable requirements:

Structural Steel Tubing	**DIVISION 1600**
Grade 4.0(AE) Concrete	**SECTIONS 401 & 402**
Aggregate for Concrete Not On Grade	**SECTION 1102**
Concrete Admixtures	**DIVISION 1400**
Reinforcing Steel (Grade 60)	**DIVISION 1600**
Anchor Bolts	**DIVISION 1600**

738.3 CONSTRUCTION REQUIREMENTS

a. General. Provide and install all incidental parts which are necessary to complete the electrical system or modify existing systems as shown in the Contract Documents. See **SECTION 744** for fabrication requirements. All utility hookups are subsidiary, unless shown otherwise in the Contract Documents.

b. Removals and Excavations. Perform removals of existing structures and excavations to minimize damage to existing structures and right-of-way.

Remove the existing concrete foundations (including anchor bolts) to the elevation shown in the Contract Documents. Backfill the resulting holes according to **DIVISION 200**. Dispose of the removed foundations and anchor bolts.

Excavate and prepare the foundation according to **DIVISION 200**. Grade the area surrounding the completed structure in accordance with the Contract Documents.

c. Foundations. Form the foundations and place the concrete according to **DIVISION 700**. Hold conduit ends and anchor bolts securely in the proper position when the concrete is placed.

Cure the concrete foundations with wet burlap or polyethylene for a period of 72 hours. Prevent concrete temperatures from falling below 32ºF.

Do not attach poles until the concrete has cured for 14 days.

If a foundation can not be constructed as shown in the Contract Documents because of an obstruction, the Engineer will determine how to construct the foundation.

d. Repair/Replace Existing Structures. Verify the existing anchors will extend a minimum of one thread above the tightened nut in the final condition. Do not damage the existing anchors during the removal of the existing hardware. Clean the threads of all rust and lubricate with an approved wax, prior to placing the new hardware.

Install DTIs on each anchor. Install a hardened washer on each anchor, if required. Use new hardware galvanized according to ASTM A 123. Verify the assembly (leveling nut, hardened washer(s), tower base plate, DTI, top nut) is in a snug tight condition before final tightening begins. Using the approved air pneumatic torque/tension

wrench, or a hydraulic wrench, tighten each nut to achieve a minimum of three refusals of the 0.005 gauge. Do not exceed four refusals of the 0.005 gauge. After tightening, score the remaining threads.

e. New Structures. Construct the elements of the structure according to the Contract Documents. Threads of the anchors shall be free of any construction debris.

Install DTIs on each anchor. Install a hardened washer on each anchor, if required. Use hardware galvanized according to **SECTION 1616**. Verify the assembly (leveling nut, hardened washer(s), tower base plate, DTI, top nut) is in a snug tight condition before final tightening begins. Using the approved air pneumatic torque/tension wrench or a hydraulic wrench tighten each nut to achieve a minimum of three refusals of the 0.005 gauge. Do not exceed four refusals of the 0.005 gauge. After tightening, score the remaining threads.

f. All Structures.

- Do not use a pipe wrench to tighten nuts on High Mast Light Tower structures;
- Use only a box end or socket wrench to snug tighten nuts;
- Maintain a minimum dimension of 6 inches from the top of foundation to finished grade;
- Repair any marring of the galvanizing caused while lifting the structure into place;
- Submit specifications for the air pneumatic torque/tension wrench or the hydraulic wrench to the Construction Engineer for approval;
- If the four refusal maximum is exceeded on any DTI, discontinue tightening and contact the State Bridge Office.

738.4 MEASUREMENT AND PAYMENT

The Engineer will measure each high mast light tower structure for payment.

Payment for "High Mast Light Tower" structures at the contract unit price is full compensation for the specified work.

SECTION 739

SLURRY POLYMER CONCRETE OVERLAY

739.1 DESCRIPTION

Prepare the surface of the reinforced concrete bridge deck and construct a slurry polymer concrete overlay (overlay) as shown on the Contract Documents.

Provide an overall combination of labor and equipment with the capability of proportioning and mixing the primer, polymer resin components, aggregate and seal coat, and placing the primer, slurry polymer overlay material, broadcast sand or aggregate, and seal coat in accordance with this specification and the manufacturer/supplier's recommendations.

BID ITEMS	**UNITS**
Slurry Polymer Concrete Overlay (*)	Square Yard
Material for Slurry Polymer Concrete Overlay (Set Price)	Cubic Yard

* Thickness

739.2 MATERIALS

a. General.

(1) Proportion all polymer materials according to the manufacturer/supplier's recommendations.

(2) Provide the Engineer with a copy of the polymer material's manufacturer/supplier's mixing and application recommendations.

(3) If concrete bridge deck patching is specified, polymer concrete materials may be used for patching of the concrete bridge deck. See **SECTION 731**.

b. Epoxy. Provide a Type III epoxy resin as defined in **DIVISION 1700**.

c. Polyester. Provide a polyester resin as defined in **DIVISION 1700**.

d. Methyl Methacrylate. Provide a methyl methacrylate resin as defined in **DIVISION 1700.**

e. Broadcast Aggregate and Broadcast Sand.

(1) Provide FA-C aggregate meeting **TABLE 1102-5** and **TABLE 1102-6**, or

(2) Aggregate provided by the slurry polymer concrete overlay manufacturer/supplier in a prequalified system, **DIVISION 1700**.

(3) Provide clean dry silica broadcast sand meeting a commercial blast sand 20/40 gradation.

(4) The use of broadcast aggregate and/or broadcast sand is determined by the slurry polymer overlay manufacturer/supplier.

739.3 CONSTRUCTION REQUIREMENTS

a. General. Wet cure concrete on new bridge decks for 14 days and allow the deck to dry for 21 days before applying the overlay.

Portland cement concrete patches require a minimum cure period of 28 days before application of the overlay.

At the preconstruction conference, discuss the patching material and the corresponding curing period. Submit changes, including a written statement from the polymer manufacturer/supplier recommending changes, to the Engineer for approval.

Some overlay systems require the placement of a polymer primer coat and/or a polymer seal top coat, with or without broadcast sand or aggregate. In the following requirements, the polymer primer coat and polymer seal top coat will be referenced with the understanding they are system specific.

b. Equipment. Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment.

(a) 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.

(b) Shot/Sand blast equipment capable of producing the required surface relief on the deck adjacent to bridge rails and barriers and areas not accessible with shot blast equipment.

(c) Empty shot blasters and dispose of waste material a minimum of 50 feet from the prepared bridge deck. On long structures empty shot blasters on the unprepared surface a minimum of 50 feet from prepared surface to prevent contamination of the deck by return of dust to the prepared surface.

(d) The Engineer must approve the use of scarifiers, scrablers or milling machines.

(e) Wet sand blasting is prohibited for final cleanup and preparation.

(f) Any surface preparation equipment used must produce a constant uniform surface that can be shot blasted if necessary and prevent overrun of the quantities of overlay material.

(2) Mechanical Application Equipment.

(a) A mixing and distribution system capable of metered mixing and uniform distribution of primer and seal coat uniformly at the specific rate on 100% of the work area.

(b) A polymer mixing and distribution system capable of accurate and complete mixing of the polymer resin, hardening agent and aggregates, metered verification of the mix ratio and aggregate proportions and uniform and accurate distribution of the polymer materials at the specified rate or thickness on 100% of the work area.

(c) A self-propelled aggregate spreader capable of uniform and accurate application of the broadcast sand and/or broadcast aggregate over 100% of the work area.

(d) An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material.

(e) Adequate additional hand tools to facilitate the placement of the overlay according to this specification and the manufacturer/supplier's recommendations.

(3) Hand Application Equipment.

(a) Calibrated containers for accurate measurement of the polymer components.

(b) Paddle type mixer or other mixing device capable of accurate and complete mixing of the polymer resin and hardening agent.

(c) Notched squeegees and brooms capable of spreading the polymer material in accordance with this specification and the manufacturer/supplier's recommendations.

(d) Gage rakes or manual/power screeds capable of placing the overlay according to this specification and the manufacturer/supplier's recommendations.

(e) Aggregate spreader capable of uniform and accurate application of the dry aggregate.

(f) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

c. Preparation of Surface.

(1) When specified, perform any required repairs under **SECTION 731** and cure repairs, before preparation of the surface, unless placed with the overlay.

(2) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(3) Close deck drains so the overlay materials will not pass through the drains.

(4) Remove any remaining 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) 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 pavement marking, loose disintegrated concrete, dirt, paint, oil, asphalt, laitance, carbonation and curing materials from patches and other foreign material from the surface of the deck.

(6) 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.

(7) Place the first coat of the overlay within 24 hours of preparing the deck surface. Prepared surfaces exposed for more than 24 hours must be lightly sand blasted prior to application of the overlay.

d. Placing the Slurry Polymer Concrete Overlay. Place the overlay to the grades, thickness and cross-sections as shown in the Contract Documents. Provide a technical representative of the polymer manufacturer/supplier on the job site during the placement of the overlay at no additional cost. The representative is to provide technical expertise to the Contractor and the Engineer regarding safe handling, placement and curing of the overlay.

(1) 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).

(2) Rain will not necessarily contaminate the surface. However, take care so no contamination has occurred. Traffic adjacent to the prepared surface during a rain will contaminate the surface.

(3) Follow all manufacturer/supplier suggested safety precautions while mixing and handling polymer components.

(4) Apply High Molecular Weight Methacrylate Primer and broadcast sand at application rates shown in **TABLE 739-1** or as directed by the materials manufacturer/supplier.

(5) Use gage rakes or mechanical application equipment to place the prepared slurry polymer concrete on the deck uniformly at the prescribed rate. Primers may require a cure time, **subsection 739.3g**.

(6) If mechanical application equipment is used, take 2 ounce samples for each 100 gallons of resin placed to verify resin and hardener mix ratios and curing times. Place samples on the bridge rail or deck and note time to cure.

(7) The bridge deck and all polymer and aggregate components must be at least 60°F at the time of application.

(8) Apply dry broadcast sand or broadcast aggregate, when required, to cover the polymer uniformly and completely within 10 minutes of application.

(9) Vacuum or broom excess sand/aggregate from the primer, the overlay and/or seal coats after sufficiently cured. If damage or tearing occurs, stop brooming or vacuuming and allow additional curing time. See **subsection 739.3g.** for curing guidelines.

(10) Recoat areas of primer, the overlay and/or seal coat that do not receive enough sand/aggregate before gelling of the polymer with additional polymer and sand/aggregate.

(11) Locate any longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

(12) Produce and place the overlay within the specified limits in a continuous and uniform operation.

(13) Correct completed surface variations exceeding ⅛ inch in 10 feet unless directed otherwise by the Engineer.

(14) Tape all construction joints to provide a clean straight edge for adjacent polymer concrete placement. This includes joints between previously placed overlay materials and at centerline.

(15) Finish the exposed edges at the ends of the bridge and at expansion joints to minimize bridge deck roughness.

(16) Apply a bond breaker to all expansion joints.

e. Face of Curbs, Barriers, and Corral Rail Posts. Use a paintbrush or roller to apply the polymer resin on the face of curbs, barriers, and corral rail posts.

- On bridges with a corral rail, apply the polymer resin to the front face and adjacent sides of all posts.
- On bridges with curbs, apply the polymer resin to the top of the curb face.
- On bridges without curbs, apply the polymer resin to the edge of the deck.
- On bridges with continuous concrete barrier rails, apply the polymer resin to the first break in the geometry of the barrier or a minimum of 6 inches, uniform. Protect areas above the break line (or minimum of 6 inches) from resin. Apply so the top threshold of the resin follows a uniform line along the rail.

This work is subsidiary to the bid item Slurry Polymer Concrete Overlay.
Apply polymer to the curb or barrier as each of the overlay applications are performed.

f. **Application Rates**. Place the overlay to the thickness and grades as shown in the Contract Documents. Place primer, broadcast sand and seal coat (if required) at the application rates shown in **TABLE 739-1**.

TABLE 739-1: PRIMER AND SEAL COAT APPLICATION RATE for SLURRY POLYMER CONCRETE OVERLAYS		
Course	**Material Rate**	**Broadcast Sand Rate ***
Primer	Not Less Than 0.09 gal./sq yd	Not Less Than 0.4 lbs./sq yd
Seal (one coat)	Not Less Than 0.23 gal./sq yd	N/A

*Apply enough broadcast sand to cover the primer coat uniformly and completely.

g. Curing.

(1) Epoxy. Minimum curing times are noted in **TABLE 739-2**.

TABLE 739-2: EPOXY CURE TIMES for SLURRY POLYMER CONCRETE OVERLAYS							
Course	**Average Temperature of Overlay Components, °F**						
	55-59	**60-64**	**65-69**	**70-74**	**75-79**	**80-85**	**85+**
	Minimum Cure Time (hours)						
Primer	5	4	3	2.5	2	1.5	1
Polymer Concrete	6.5	6.5	5	4	3	3	3

Cure the slurry polymer concrete for 8 hours if the air temperature falls below 55°F during the curing period before opening to traffic.

(2) Polyester. Polyester will be proportioned such that the cure times are between 30 and 120 minutes. Accelerators and inhibitors may be required to achieve proper set times. Proportion all materials as recommended by the material manufacturer/supplier.

(3) Methyl Methacrylate. Minimum curing times are noted in **TABLE 739-3**.

TABLE 739-3: METHYL METHACRYLATE CURE TIMES for SLURRY POLYMER CONCRETE OVERLAYS						
Course	**Ambient Temperature °F**					
	30-40	40-50	50-60	60-70	70-80	80-90
Primer	30	25	22	20	15	10
Polymer Concrete	50	40	35	30	25	20
Seal (one coat)	35	30	25	22	20	15

These times can be adjusted (longer or shorter) by changing the hardener in the mix as recommended by the manufacturer/supplier.

(4) 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/supplier.

h. Testing. Perform Polymer Concrete Overlay Bond Evaluation as outlined in KT-70, Part V.

(1) Place a polymer concrete test patch of not less than 0.5 square yards per lane or planned completed day's work whichever is smaller. Submit a sequence plan to the Engineer. Test patches shall be full depth, placed by the normal construction sequence. Test patches should be representative of the work being performed.

(2) Perform a minimum of 4 pull-off tests on each patch as outlined in KT-70, Part V.

(3) Final acceptance will be based on the following results of the test outlined in KT-70, Part V:

- Type 1 – Failure in the concrete at a depth greater than or equal to ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Type 2 – Failure in the concrete at a depth less than ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Minimum Tensile Rupture Strength of 250 psi from an average of 3 out of 4 tests on a test patch regardless of depth of failure.

(4) If failure in the concrete is at a depth less than ¼ 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.

(5) A failure in the concrete below 250 psi and greater than ¼ inch deep indicates weak concrete, not poor overlay bond. No additional surface preparation is required.

(6) Do not perform tensile adhesion tests when ambient or deck temperatures are above 85°F.

i. Weather Limitations.

(1) Epoxy. Do not place the overlay if the air temperature is expected to drop below 55°F within 8 hours of placement.

(2) Polyester. Do not place any component of the overlay if the air or substrate temperature is at or expected to drop below 40°F during installation.

(3) Methyl Methacrylate. Do not place any component of the polymer concrete overlay if the air or substrate temperature is at or expected to drop below 40°F during installation without inclusion of cold temperature additive at the dosage specified by methacrylate manufacturer/supplier's mixing guide.

(4) General. Do not place the overlay when the deck temperature will exceed 90°F.

Do not place the overlay if gel time is less than 10 minutes.

The overlay may be placed outside the specified temperature ranges with the approval of the Engineer and the material manufacturer/supplier. Discuss changes to temperature limitations at the preconstruction conference. Submit changes, including a written statement from the polymer manufacturer/supplier recommending the changes, to the Engineer for approval.

j. Correction of Unbonded or Damaged Areas. Repair new overlay areas discovered to be unbonded by tapping or chaining and areas where the overlay was 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-pound class maximum) or shot blasting. Aggressively sandblast or shot blast the concrete bridge deck surface at the unbonded area to remove contaminants. Replace the overlay according to standard placement procedures at no additional compensation.

739.4 MEASUREMENT AND PAYMENT

The Engineer will measure slurry polymer concrete overlay by the square yard. The Engineer will measure the bridge roadway width and the bridge length from end of wearing surface to end of wearing surface.

The Engineer will measure material for slurry polymer concrete overlay by the cubic yard according to the following:

(1) When approved by District 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 "Slurry Polymer Concrete Overlay" at the contract unit price and "Material for Slurry Polymer Concrete Overlay (Set Price)" at the contract set price is full compensation for the specified work.

SECTION 740

POLYMER CONCRETE OVERLAY REPAIR

740.1 DESCRIPTION

Repair the existing polymer concrete overlay surface.

Provide an overall combination of labor and equipment with the capability of preparing the surface, proportioning and mixing the polymer components, and placing the polymer material and aggregate in accordance with this specification and the manufacturer/supplier's recommendations.

When specified, construct a single coat polymer concrete overlay according to this specification.

BID ITEMS	**UNITS**
Polymer Concrete Overlay Repair	Square Yard
Single-Layer Polymer Concrete Overlay	Square Yard

740.2 MATERIALS

a. Polymer.

(1) Provide material that is compatible with the existing polymer concrete overlay material and polymer concrete patch material.

(2) Proportion all polymer materials according to the manufacturer/supplier's recommendations.

(3) Provide the Engineer with a copy of the polymer materials manufacturer/supplier's mixing and application recommendations.

b. Epoxy. Provide a Type III epoxy resin as defined in **DIVISION 1700**.

c. Polyester. Provide a polyester resin as defined in **DIVISION 1700**.

d. Methyl Methacrylate. Provide a methyl methacrylate resin as defined in **DIVISION 1700**.

e. Aggregate.

(1) Provide FA-C aggregate meeting requirements of **TABLES 1102-5 and 1102-6**, or.

(2) As provided by the polymer concrete overlay supplier in a prequalified system, **DIVISION 1700**.

(3) Provide MA-6 aggregate meeting **TABLE 1102-3**.

(4) Provide clean dry silica broadcast sand meeting a commercial blast sand 20/40 gradation.

(5) The use of broadcast aggregate and/or broadcast sand is determined by the type of polymer system used and the overlay manufacturer/supplier.

740.3 CONSTRUCTION REQUIREMENTS

a. General. Portland cement concrete patches require a minimum cure period of 28 days before application of the polymer concrete overlay. At the preconstruction conference, discuss the patching material and the corresponding curing period. Submit changes, including a written statement from the polymer manufacturer/supplier recommending changes, to the Engineer for approval.

b. Equipment. Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment.

(a) Shot blasting equipment capable of removing all contaminants from the existing polymer overlay without damaging the overlay surface.

(b) Shot/Sand blast equipment capable of removing all contaminants from the repair patches, existing polymer overlay adjacent to bridge rails and barriers and areas not accessible with shot blast equipment.

(c) Empty shot blasters and dispose of waste material a minimum of 50 feet from the prepared bridge deck, on long structures empty shot blasters on the unprepared surface a minimum of 50

feet from prepared surface to prevent contamination of the deck by return of dust to the prepared surface.

(d) The Engineer must approve the use of scarifiers, scrablers, or milling machines.

(e) Wet sand blasting is prohibited.

(f) Do not use hydrodemolition to remove polymer concrete overlay or unsound portland cement concrete.

(g) Do not use jack hammers or chipping hammers heavier than the nominal 15-pound class for removal of the polymer overlay.

(2) Mechanical Application Equipment.

(a) Polymer mixing and distribution system capable of accurate and complete mixing of the polymer resin and hardening agent, metered verification of the mix ratio and uniform and accurate distribution of the polymer materials at the specified rate on 100% of the work area.

(b) A self-propelled aggregate spreader (if required) capable of uniform and accurate application of the dry aggregate over 100 % of the work area.

(c) An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material.

(d) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

(3) Hand Application Equipment.

(a) Calibrated containers for accurate measurement of the polymer components.

(b) Paddle type mixer or other mixing device capable of accurate and complete mixing of the polymer resin and hardening agent.

(c) Notched squeegees and brooms capable of spreading the polymer material in accordance with this specification and the manufacturer/supplier's recommendations.

(d) Aggregate spreader capable of uniform and accurate application of the dry aggregate.

(e) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

c. Preparation For Polymer Concrete Overlay Repair.

(1) When specified, repair unsound bridge deck concrete according to **SECTION 731** and cure repairs prior to performing the polymer concrete overlay repair.

(2) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(3) Close deck drains so the overlay materials will not pass through the drains.

(4) Remove asphalt material and unsound, damaged or delaminated polymer concrete overlay as shown in the Contract Documents and as designated by the Engineer.

(5) Saw cut existing polymer concrete overlay to a depth ¼ to ½ inch below the polymer concrete overlay and Portland cement concrete bridge deck interface. Dispose of removed material on sites approved by the Engineer.

(6) Removal area should extend a minimum of 6 inches beyond the edges of the unsound, damaged or delaminated polymer concrete overlay or 6 inches beyond patching of the concrete bridge deck.

(7) Shot blast/sand blast or bush hammer portland cement concrete patch surfaces to produce an acceptable surface for placement of the polymer concrete overlay patch. 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.

(8) As the final preparation for the placement of the polymer concrete overlay patches, 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 pavement marking, loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation, curing materials and other foreign material from portland cement concrete patches and the surface of the existing polymer bridge deck overlay.

(9) Place the polymer concrete materials within 24 hours of preparing the surface. Prepared surfaces exposed for more than 24 hours must be lightly sand blasted prior to application of the polymer concrete overlay material.

d. Placing Polymer Concrete Overlay Patches.

(1) Visible moisture on the prepared surface at the time of placing the polymer concrete overlay is unacceptable. Identify moisture in the surface by taping a plastic sheet to the deck for a minimum of 2 hours (ASTM D 4263).

(2) Place the polymer concrete patches in the same manner as the single-layer polymer concrete overlay, according to **subsection 740.3e**.

(3) When an overlay is specified, the polymer concrete overlay patches may be placed when the overlay is placed using polymer overlay material per manufacturer/supplier recommendations.

(4) Rain will not necessarily contaminate the surface. However, take care so no contamination occurs. Traffic adjacent to the prepared surface during a rain will contaminate the surface.

e. Placing the Single-Layer Polymer Concrete Overlay. Place the overlay according to the grades, thickness and cross-sections shown in the Contract Documents. Provide a technical representative of the polymer manufacturer/supplier on the job site during the placement of the overlay at no additional cost. The representative is to provide technical expertise to the Contractor and the Engineer regarding safe handling, placement and curing of the overlay.

(1) Lightly sandblast the existing polymer overlay to remove all contaminants. Do not over blast and damage polymer concrete patches or the existing overlay.

(2) As the final preparation for the placement of the polymer concrete overlay, make a complete cleanup 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, curing materials from portland cement concrete patches and other foreign material from the surface of the existing polymer bridge deck overlay.

(3) Follow all manufacturer/supplier suggested safety precautions while mixing and handling polymer components.

(4) Some overlay systems require the placement of a polymer primer coat and/or a polymer seal top coat, with or without broadcast sand or aggregate. In the following requirements, the polymer primer coat and polymer seal top coat will be referenced with the understanding they are system specific. Apply primer, when needed, at the rate prescribed by the manufacturer/supplier. Place the prepared primer uniformly on the existing polymer concrete overlay with roller, brush, airless spray or mechanical application equipment.

(5) Place the polymer concrete overlay at the application rates shown in **TABLE 740-1**.

TABLE 740-1: POLYMER CONCRETE OVERLAY APPLICATION RATES

Polymer Rate	Aggregate Rate *
Not Less Than 0.45 gal./sq yd	14.5 lbs./sq yd

*Apply enough aggregate to completely cover the polymer.

(6) For slurry polymer concrete, place the material with a minimum thickness of 0.25 inches.

(7) Use notched squeegees, gage rakes or mechanical application equipment to place the prepared polymer on the existing polymer overlay immediately and uniformly at the prescribed rate.

(8) If mechanical application equipment is used, take 2 ounce samples for each 100 gallons of resin placed to verify resin and hardener mix ratios and curing times. Place samples on the bridge rail or deck and note time to cure.

(9) The bridge deck and all prepared polymer and aggregate components must be at least 60°F at the time of application.

(10) Apply the dry broadcast aggregate if required to cover the prepared polymer uniformly and completely within 10 minutes of application.

(11) Recoat areas that do not receive enough aggregate before gelling of the polymer with additional polymer and aggregate.

(12) Locate any longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

(13) Produce and place the overlay within the specified limits in a continuous and uniform operation.

(14) Correct completed surface variations exceeding ⅛ inch in 10 feet unless directed otherwise by the Engineer.

(15) Tape all construction joints to provide a clean straight edge for adjacent polymer concrete placement. This includes joints between previously placed polymer concrete overlay materials and at centerline.

(16) Finish the exposed edges at the ends of the bridge and at expansion joints to minimize bridge deck roughness.

(17) Apply a bond breaker to all expansion joints.

(18) Vacuum or broom excess aggregate from the bridge deck after the polymer is sufficiently cured. If damage or tearing occurs, stop brooming or vacuuming and allow additional curing time. See **subsection 740.3g.** for polymer overlay material curing guidelines.

f. Face of Curbs, Barriers, and Corral Rail Posts. Use a paintbrush or roller to apply the polymer resin on the face of curbs, barriers, and corral rail posts.

- On bridges with a corral rail, apply the polymer resin to the front face and adjacent sides of all posts.
- On bridges with curbs apply the polymer resin to the top of the curb face.
- On bridges without curbs apply the polymer resin to the edge of the deck.
- On bridges with continuous concrete barrier rails, apply the polymer resin to the first break in the geometry of the barrier or a minimum of 6 inches, uniform. Protect areas above the break line (or minimum of 6 inches) from resin. Apply so the top threshold of the resin follows a uniform line along the rail.

This work is subsidiary to the bid item Single-Layer Polymer Concrete Overlay.

Apply primer (if required) and polymer to the curb or barrier as each of the overlay applications are performed.

g. Curing. Polymer concrete material curing guidelines.

(1) Epoxy. Follow **TABLE 740-2**.

TABLE 740-2: EPOXY OVERLAY CURE TIMES						
Average Temperature of Overlay Components, °F						
55-59	60-64	65-69	70-74	75-79	80-85	85+
Minimum Cure Time (hours)						
6.5	6.5	5	4	3	3	3

Cure the epoxy polymer concrete overlay for a minimum of 8 hours if the air temperature falls below 55°F during the curing period.

(2) Methyl Methacrylate. Follow **TABLE 740-3**.

TABLE 740-3:METHYL METHACRYLATE CURE TIMES						
Course	**Ambient Temperature °F**					
	30-40	40-50	50-60	60-70	70-80	80-90
Primer	30	25	22	20	15	10
Polymer Overlay	50	40	35	30	25	20
Sealer	35	30	25	22	20	15

Methyl Methacrylate cure times can be adjusted (longer or shorter) by changing the amount of hardener in the mix.

(3) Polyester. Proportion polyester such that the cure times are between 30 and 120 minutes. Accelerators and inhibitors may be required to achieve proper set times. Proportion all materials as recommended by the material manufacturer/supplier.

(4) Plan and perform the work in such a way as to provide for the minimum curing times specified.

h. Testing. Polymer Concrete Overlay Bond Evaluation for Portland cement concrete patches, polymer concrete patches and existing polymer concrete overlay surfaces as outlined in KT-70, Part V.

(1) Place a polymer concrete test patch of not less than 0.5 square yards per lane or planned completed day's work whichever is smaller. Submit a sequence plan to the Engineer. Test patches shall be full depth, placed by the normal construction sequence. Test patches should be representative of the work being performed.

(2) Perform a minimum of 4 pull-off tests on each patch as outlined in KT-70, Part V.

(3) Final acceptance will be based on the following results of the test outlined in KT-70, Part V:

- Type 1 – Failure in the concrete at a depth greater than or equal to ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Type 2 – Failure in the concrete at a depth less than ¼ inch over more than 50% of the test area for 3 out of 4 tests in the test patch.
- Minimum Tensile Rupture Strength of 250 psi from an average of 3 out of 4 tests on a test patch regardless of depth of failure.

(4) If failure in the concrete is at a depth less than ¼ 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.

(5) If failure is at the polymer to polymer bond and below 250 psi, more surface preparation of the existing polymer overlay or polymer concrete patches is necessary.

(6) If failure is in the new or existing polymer overlay (Type 4), remove the overlay and evaluate the material before proceeding with placement.

(7) A failure in the concrete below 250 psi and greater than ¼ inch deep indicates weak concrete, not poor overlay bond. No additional surface preparation is required.

(8) Do not perform tensile adhesion tests when ambient or deck temperatures are above 85°F.

i. Correction of Unbonded or Damaged Areas On New Work. Repair new overlay areas discovered to be unbounded by tapping or chaining and areas where the overlay was damaged by the Contractor's operation.

(1) Saw cut the unbonded or damaged areas to the top of the concrete bridge deck surface or the existing polymer concrete overlay surface, remove the unbounded or damaged overlay with small air tools (15-pound class maximum) or shot blasting.

(2) Shot blast the existing concrete bridge deck surface or existing polymer concrete overlay surface of the unbonded area to remove contaminants, and replace the overlay according to standard placement procedures at no additional compensation.

j. Weather Limitations.

(1) Epoxy. Do not place the polymer concrete overlay if the air temperature is expected to drop below 55°F within 8 hours of placement.

(2) Methyl Methacrylate. Do not place any component of the polymer concrete overlay if the air or substrate temperature is at or expected to drop below 40°F during installation without inclusion of cold temperature additive at the dosage specified by methacrylate manufacturer/supplier's mixing guide.

(3) Polyester. Do not place any component of the polymer concrete overlay if the air or substrate temperature is at or expected to drop below 40°F during installation.

(4) General. Do not place the polymer concrete overlay when the deck temperature will exceed 90°F.

Do not place the polymer concrete overlay if gel time is less than 10 minutes.

Polymer concrete overlay can be placed outside the specified temperature ranges with the approval of the Engineer and the material manufacturer/supplier. Discuss changes to temperature limitations at the preconstruction conference. Submit changes, including a written statement from the material manufacturer/supplier recommending the changes, to the Engineer for approval.

740.4 MEASUREMENT AND PAYMENT

The Engineer will measure polymer concrete overlay repair areas by the square yard prior to placing the patch material. The measured pay quantity will be those areas sounded by the Engineer and marked as unsound or delaminated polymer concrete overlay.

The Engineer will measure single-layer polymer concrete overlay by the square yard. The Engineer will measure the bridge roadway width and the bridge length from end of wearing surface to end of wearing surface.

Payment for "Polymer Concrete Overlay Repair" and "Single-Layer Polymer Concrete Overlay" at the contract unit price is full compensation for the specified work.

SECTION 741

CASED PILING

741.1 DESCRIPTION

Construct and install a casing to enclose and isolate piling within a retaining wall mass. Brace, dewater, backfill and place steel cap plate on casing.

BID ITEM	UNITS
Cased Pile	Linear Foot

741.2 MATERIALS

a. Casing. Provide a casing with a diameter 12 inches larger than the diameter of the pile, and 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. When specified, 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 of condition.

b. Aggregate. Provide meeting the following requirements:

Sieve Size	Percent Retained by Weight
3/8"	0 - 20%
No.8	40 - 80%
No.100	98 - 100%

Provide clean, naturally rounded (not crushed) aggregate. Provide aggregate free of deleterious substances such as shale, with a maximum limestone content of 10%. Obtain the Regional Geologist's approval of the aggregate, before installing it in the casing backfill system. Such approval could take up to 7 days.

Aggregates covered by this subsection are accepted based on the procedures described in **subsection 1101.5**.

c. Cap Plate. Provide structural steel cap plate conforming to ASTM–A36 materials and galvanized according to ASTM 123. Fabricate a round cap plate that is ¾-inch thick and 6 inches larger in diameter than the casing which it covers. The cap plate will fit the profile of the pile being used so that there is a maximum of a ½-inch gap between the cap plate and the pile. Cut out the shape of the pile into the cap plate, prior to galvanizing.

Submit shop drawings according to **SECTION 105**.

741.3 CONSTRUCTION REQUIREMENTS

- Prior to driving the pile, construct the cased pile by first pre-drilling a minimum of 5 feet into in-situ material at the location shown on the plans. Center the pre-drilled hole at the pile locations. Construct the pre-drilled hole 3 inches larger than the nominal diameter of the casing defined above. Locate and construct the casing according to the tolerances in **subsection 704.3c**.
- After driving the pile, install the casing over the pile and embed into the predrilled hole. Plumb and center the casing with the pile.
- Install the cap plate to rest on top of the casing and center on the pile and the casing.
- Brace the casing to prevent movement during backfilling and retaining wall construction.
- Backfill casing with the aggregate to within 15 feet of the top of the pile; the remainder will be left open.

741.4 MEASUREMENT AND PAYMENT

The Engineer will measure the cased pile by the linear foot.

Payment for "Cased Pile" at the contract unit price is full compensation for the specified work. Piling construction, measurement and payment will be handled under **SECTION 704**.

SECTION 742

HEAT STRAIGHTENING (IN-PLACE) OF DAMAGED STRUCTURAL STEEL

742.1 DESCRIPTION

Use heat straightening to repair damaged sections of the existing structural steel beams and girders shown in the Contract Documents, or designated by the Engineer.

BID ITEM	UNITS
Heat Straightening Repair	Linear Foot

742.2 MATERIALS

Provide materials that comply with the applicable requirements.

Organic Zinc Primer	**SECTION 1802**
Waterborne Acrylic Top Coat	**SECTION 1806**
Calcium Sulfonate Alkyd Paint System	**SECTION 1808**

742.3 CONSTRUCTION REQUIREMENTS

a. General. Heat Straightening is a repair procedure in which a limited amount of heat is applied in specific patterns to plastically deformed regions of damaged steel in repetitive cycles of heating and cooling to produce a gradual straightening of the member. A limited amount of force may be used to restrain the member from excessive out of plane movement during heating. Force is not the primary method of straightening.

Procedures using forces that result in stresses over the yield stress of the material at the applied temperature, such as Hot Mechanical Straightening and Hot Working, are prohibited.

The repair must be directly supervised by a person with successful experience in heat straightening repairs of comparable bridge structures. Provide the Engineer with written documentation of past experience before beginning the repair work.

b. Equipment. Use an oxygen-fuel combination for heating. For fuel, use propane, acetylene or a similar fuel. Apply heat using either single or multiple orifice tips only. The maximum tip size is limited to 1 inch.

Verify temperatures during heat straightening with temperature sensitive crayons, a pyrometer, or an infrared non-contact thermometer. Provide the heat indicating device, and make it available to the Engineer at all times.

Use either hydraulic or mechanical jacks, come-alongs or other force application devices.

c. Application of Heat. Apply heat to the member with vee (triangular shaped) heats or line heats to the flange and with vee, line or strip heats to the web. The base of individual vee heats shall not exceed 10 inches.

A series of heats applied consecutively to different elements of the member at the same cross section is referred to as a heating pattern. Select heating patterns and sequences to match the type of damage and cross section shape.

Do not heat the steel over 1100°F during heat straightening unless specified otherwise in the Contract Documents. Heat the steel in a single pass following the heating pattern and allow cooling to 250°F prior to reheating. Water-cooling is not permitted.

Shift vee heats along the zone of yielded material on successive heating patterns. Simultaneous vee heats are permitted provided that the clear spacing between vees is greater than the width of the plate element.

Heating patterns other than those suggested in the Contract Documents may be used if approved by the Engineer. If no suggested heating patterns are provided in the Contract Documents, submit proposed heating patterns to the Engineer for approval.

d. Application of Jacking Forces. Only use jacking forces to restrain the members or elements against undesired movement associated with expansion during the cycles of applying heats. Place jacks to resist forces during the heating process. As the straightening occurs during cooling, the forces should be relieved.

The maximum allowable jacking force for members may be calculated by a licensed Professional Engineer, in accordance with the methods outlined in US DOT report no. FHWA-IF-99-004, "Heat-Straightening Repairs of Damaged Steel Bridges", with calculations submitted for approval by the Bridge Office before work begins; or, the limit may be estimated in the field by limiting the jacking force to the force required to produce the following deflections on the unheated steel members.

For 36 ksi Steel:
$\delta_{max} = 1/y_{max} * (L/140)^2$

For 50 ksi Steel:
$\delta_{max} = 1/y_{max} * (L/120)^2$

where: δ = The maximum deflection (in inches) between supports for a jacking force producing a maximum bending stress equal to ½ of the yield stress. For lateral displacements this would be the lateral deflection.
y_{max} = The distance (in inches) from the centroid of the steel section to the extreme fiber about the axis of bending. For lateral displacement of an "I" shaped beam this would be ½ of the flange width.
L = The distance (in inches) between supports, for lateral displacements this is the distance between the cross frames/diaphragms in place during heat straightening.

Do not increase the jacking force during heating or until the steel is cool to the touch between heats.

Assume that the existing steel has a yield strength of 36,000 psi, unless specified otherwise in the Contract Documents.

No deflection is allowed for other bridge members being used as supports for the jacking device.

For repairs of local flange bending, the jacking force is limited to that which produces no deflection of the unheated flange.

e. Tolerances. Completed tolerances for straightness of the bottom flange are within ¼ inch of horizontal at the flange edge and ½ inch of horizontal sweep in 20 feet at the point of impact. The completed tolerances for the web are $1/100^{th}$ of the web depth or ¼ inch, whichever is greater, out of vertical alignment; and no more than ¼ inch of localized deviation as measured with a straightedge vertically and horizontally against the web. Meet these tolerances before attaching any cross frames. Do not force the member into position and then attach the cross frame to hold the member in position.

f. Crack and Gouge Repair. Grind smooth all nicks, gouges and scrapes. Arrest all web cracks by drilling a 1 inch hole at each end of each crack. Locate the end of each crack by dye penetrant, magnetic particle or other approved non-destructive testing method.

g. Inspection. After straightening is complete inspect the flanges for crack by dye penetrant, magnetic particle or other approved non-destructive testing method. The Engineer will witness this testing. Remove minor (< ½ inch) cracks found by this inspection by grinding. Larger cracks found will be reviewed by the Engineer and repaired as directed by the Engineer. Any crack repair, unless shown in the Contract Documents, by methods other than grinding or drilling is considered Extra Work, **SECTION 104**.

h. Painting. Restore the paint on the damaged portions of the beams, girders, cross frames and diaphragms, including paint damaged by the repair process.

If the existing surface is a lead based paint system, clean the surfaces of loose material and oil, then coat the cleaned surfaces with a calcium sulfonate alkyd paint system according to the manufacturer's recommendations.

If the existing surface is not a lead based paint system, sandblast the surfaces clean, then coat the cleaned surfaces with an organic zinc primer and waterborne acrylic top coat according to "Repainting Existing Steel Bridges- Painting in Kind", **SECTION 702**.

As far as it is practicable, match the finish coat to the existing paint color. The Engineer is the final arbitrator of color match.

742.4 MEASUREMENT AND PAYMENT

The Engineer will measure the linear feet of primary member that requires heat straightening repair. Inspection, non-destructive testing, crack and gouge repair, secondary member heat straightening and painting are subsidiary.

Payment for "Heat Straightening Repair" at the contract unit price is full compensation for the specified work.

SECTION 743

ROLLED BEAM DETOUR BRIDGE

743.1 DESCRIPTION

Erect and Remove or Furnish the Rolled Beam Detour Bridge as shown in the Contract Documents.

BID ITEMS	UNITS
Erect and Remove Rolled Beam Detour Bridge	Lump Sum
Furnish Rolled Beam Detour Bridge	Lump Sum

743.2 MATERIALS

Use material complying with the details shown in the Contract Documents.

The Engineer will accept the material on the basis of compliance with dimensional requirements, condition, and visual inspection at the point of usage.

743.3 CONSTRUCTION REQUIREMENTS

Construct the rolled beam detour bridge as shown on the Contract Documents.

743.4 MEASUREMENT AND PAYMENT

The Engineer will measure the erect and remove rolled beam detour bridge and furnish rolled beam detour bridge by the Lump Sum.

Payment for "Erect and Remove Rolled Beam Detour Bridge" and "Furnish Rolled Beam Detour Bridge" at the contract unit price is full compensation for the specified work.

The Engineer will pay for Erect and Remove Rolled Beam Detour Bridge according to **TABLE 743-1**.

TABLE 743-1: PAYMENT FOR ERECT AND REMOVE ROLLED BEAM DETOUR BRIDGE

Pay % of Contract Unit Price	Milestone
75	Erection of the structure has been completed.
100	When the structure has been dismantled and all the parts to be returned have been properly inventoried and stockpiled at the storage site listed in the Contract Documents.

SECTION 744

STRUCTURAL STEEL FABRICATION - GENERAL

744.1 DESCRIPTION

Shop fabricate the structural steel according to the Contract Documents. This specification applies to all welded steel structures or items covered by American Welding Society (AWS) D1.1-2010, "Structural Welding Code – Steel", all welded aluminum alloy structures covered by the AWS D1.2-2014, "Structural Welding Code – Aluminum", and all stainless steel items covered by the AWS D1.6-2007, "Structural Welding Code – Stainless Steel". See **SECTION 705** for the fabrication of structural steel for bridges on highway and public roads carrying vehicular traffic and the field welding of structural steel to highway bridges.

744.2 MATERIALS

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

Castings	**DIVISION 1600**
Structural Steel	**DIVISION 1600**
Structural Steel Tubing	**DIVISION 1600**
Steel For Bridge Drain Systems	**DIVISION 1600**
Welded Stud Shear Connectors	**DIVISION 1600**
Steel Fasteners	**DIVISION 1600**
Steel Pipe	**DIVISION 1600**
Aluminum Alloys	**DIVISION 1600**

b. Preliminary Shop Requirements.

(1) Point of Fabrication. Within 10 business days after signing the contract, notify the appropriate KDOT office and the Bureau Chief of Construction and Materials 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 **SECTION 106.1**).

(2) Shop Drawings. The Contractor or fabricator must submit shop drawings of structural steel, structural aluminum alloys, and castings according to **SECTION 105**. 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 Construction and Materials. 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 giving sufficient dimensions for accurate fabrication and inspection of the structure.

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 **SECTION 105**.

(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 Construction and Materials, 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. If no shop inspection is provided by KDOT, submit mill test reports (Type A certifications) in accordance with **SECTION 2601**.

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;
- KDOT project number;
- structure 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 or aluminum alloy producer's name and the ASTM or AASHTO designation for the material 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.

Dependent on the material being used, repair welding shall comply with the requirements of AWS D1.1, "Structural Welding Code - Steel" or AWS D1.2, "Structural Welding Code – Aluminum", with the corresponding exceptions and additions noted later in this section, or AWS D1.6, "Structural Welding Code – Stainless Steel".

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.

The fabricator must obtain written permission from KDOT to substitute a grade of steel or aluminum alloy 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 - 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.

(6.1) – Steel Bar, Plate, Shapes. 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.

(6.2) – Steel Tubes and Pipes, Aluminum Alloy Products – When directed by the Engineer, prepare base metal or product specimens of the dimensions specified by the Engineer.

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) Identification. All pieces of all grades of steel and aluminum alloy used in fabrication of main members 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 of steel 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 AWS D1.1, "Structural

Welding Code - Steel" or AWS D1.2, “Structural Welding Code – Aluminum”, as applicable for the material being used. Submit the proposed heat straightening procedure to the Engineer for approval. Sharp kinks and bends are cause for rejection of the material. Steel mill material must not exceed dimensional tolerances outlined in the latest edition of ASTM A 6.

(3) Welding and Gas Cutting. Dependent on the material be used, perform welding and gas cutting of structural steel and aluminum alloy according to the requirements of the AWS D1.1, "Structural Welding Code - Steel" or AWS D1.2, “Structural Welding Code – Aluminum”, with the corresponding exceptions and additions noted later in this section, or AWS D1.6, “Structural Welding Code – Stainless Steel”.

(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) Welded Stud Shear Connectors. Apply welded stud shear connectors to the designated structural steel 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.

(6) 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 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.

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

(8) Shop Bolted Connections. Perform all bolting according to **SECTION 712.**

(9) Overhead Sign Structures, Cantilever Sign Structures, Bridge Mounted Sign Attachments, High Mast Light Poles, Lighting and Traffic Signal Poles:

(9.1) except as noted in (9.2), nondestructively test 100% of all complete joint penetration (CJP) groove welds.

(9.1.1) use Radiography Testing (RT) or Ultrasonic Testing (UT) when the thickness of the thinnest connecting material is 1/4 inches or more.

(9.1.2) except as noted in (9.1.3), use Magnetic Particle Testing (MT) when the thickness of the thinnest connecting material is less than 1/4 inches.

(9.1.3) use RT for all CJP welds in High Mast Light Poles when the thickness of the thinnest connecting material is less than 1/4 inches.

(9.2) For mast arms having an OD of less than 6 inches (measured anywhere along it length), MT 100% of the mast arm to pole connection CJP welds on a random 1 out of 4 structures, or fraction thereof.

(9.3) Inspect partial penetration groove welds and fillet welds on a random 1 out of 4 structures, or fraction thereof. For each structure selected, inspect:

(9.3.1) a minimum of 4 inches out of every 48 inches of all partial penetration groove welds, including the 4 inches nearest a connection. Use MT.

(9.3.2) 100% of all tube-to-transverse plate (i.e. flanges, base plates, connection plate, etc.) welds. Use MT.

(9.3.3) 100% of the perimeter hand hole welds. Use MT.

(9.3.4) 100% of all welds connecting a device or accessory to the tube wall. Use MT.

(9.3.5) 100% of the mast arm-to-pole connection welds when the OD of the mast arm is less than 6 inches (measured anywhere along it length). Use Visible Liquid Penetrant Testing (PT).

(9.3.6) 100% of all tube-to-transverse plate welds of aluminum alloy structures or structural elements. Use PT while being witnessed by the Engineer.

(9.4) after galvanizing, UT only the tube-to-transverse plate CJP groove welds noted on the shop drawings as needing this additional inspection.

(10) Overhead Sign Structures. After heading the 7/8 inch diameter rivet used in the Truss to End Support Coupling, the minimum flange thickness can be no less than 3/8 inches, measured at any point along the head's circumference.

(11) Steel Bridge Bearings. At the option of the Engineer, steel bearing device inspection will require that either 1 device in 10, or fraction thereof, be tested 100%, or a10% of each device will be tested using PT or MT. When tested at the 1 in 10 rate, the Engineer will select which device to test. When tested at the 10% rate, the Engineer will select the weld locations to test, which can vary from device to device. The welding of dissimilar metals is not prequalified.

(12) Rejection. Repair or replace rejected items as directed by the Engineer.

(13) Release for Shipment. Do not release fabricated elements for shipment from the fabrication or paint shop without approval of the Engineer.

e. Supplemental Requirements to the Structural Welding Code - Steel. The section and paragraph references cited in the paragraphs below are to AWS D1.1-2010.

Add 2 new subsections as follows:

SUBSECTION 1.10 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.

SUBSECTION 1.11 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 Construction and Materials. 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.

SUBSECTION 2.4.5 PLUG AND SLOT WELDS

Add the following paragraph 2.4.5.5:

Plug and slot welding is prohibited without the written approval of the Engineer. As a requirement for approval, all plug and slot 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 PREQUALIFICATION OF WPSs

Add the following notes to Table 3.1:

- Only low hydrogen electrodes shall be used.

SUBSECTION 3.2 WELDING PROCESSES

Delete the first sentence of paragraph 3.2.2 and replace with the following:

ESW or EGW shall not be used. GTAW and GMAW-S welding may be used, provided the WPSs are qualified in conformance with the requirements of Clause 4.

SUBSECTION 4.2 GENERAL REQUIREMENTS - QUALIFICATION

Add the follow to paragraph 4.2.1.1:

All 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.

Add the following to paragraph 4.2.2.2:

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

Add a new paragraph 4.2.4:

4.2.4 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 4.3.3 as follows:

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

SUBSECTION 5.26 REPAIRS

Add the following to paragraph 5.26.2:

Do not use mechanical straightening methods without the approval of the Engineer, even when used in conjunction with the application of heat.

SUBSECTION 6.1 INSPECTION – GENERAL REQUIREMENTS

Add the following to paragraph 6.1.2.1:

This type of inspection shall not be performed by an inspector or their assistants who are, or were previously, engaged in the welding, the general assembly, or the application of coatings.

SUBSECTION 6.14 NONDESTRUCTIVE TESTING (NDT) PROCEDURES

Delete paragraphs 6.14.4 and replace with the following:

6.14.4 When magnetic particle testing (MT) is used, the procedure and techniques shall be in accordance with the dry powder magnetic particle examination of welds using the yoke method. The yoke method shall be performed according to ASTM E 709, and the standard of acceptance shall conform with Clause 6, Part C, of this 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 744-1**.

TABLE 744-1: 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.

6.14.4.1 Prior to MT, 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.

6.14.4.2 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.

6.14.4.3 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.

Add the following to paragraph 6.14.5:

For detecting discontinuities in non-magnetic materials including stainless steel to stainless steel or stainless steel to carbon steel, visible liquid penetrate testing (PT) will be used in lieu of MT. The standard methods, set forth in ASTM E 165 shall be used for PT inspection, and the standards of acceptance shall conform to Clause 6, Part C, of this code.

SUBSECTION 6.17 RADIOGRAPHIC TESTING (RT) - PROCEDURE

Delete paragraph 6.17.9 and replace with the following:

6.17.9 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 6.17.12 and replace with the following:

6.17.12 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 information shall be produced on the radiograph no less the 3/4 inches from the edge of the weld either by pre-printing or by placing lead letters and numbers on the steel. See Figures 1 and 2. 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 6.17.14:

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

f. Supplemental Requirements to the Structural Welding Code - Aluminum. The section and paragraph references cited in the paragraphs below are to AWS D1.2-2014.

Add 2 new subsections as follows:

SUBSECTION 1.9 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.

SUBSECTION 1.10 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 Construction and Materials. 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.

SUBSECTION 2.6 PLUG AND SLOT WELDS

Add the following paragraph 2.6.9:

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

SUBSECTION 3.1 GENERAL REQUIREMENTS – QUALIFICATION

Revise item (5) as follows:

Replace “those authorized to examine them.” with ”the Engineer.”

Add 3 new paragraphs as follows:

3.1.1 All 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.

3.1.2 All welder, welding operator, and tack welder 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, records of the test must be signed by the witness.

3.1.3 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.

SUBSECTION 4.22 CONTROL OF DISTORTION AND SHRINKAGE

Add the following to paragraph 4.22.4:

Do not use mechanical straightening methods without the approval of the Engineer, even when used in conjunction with the application of heat.

SUBSECTION 5.1 INSPECTION – GENERAL REQUIREMENTS

Add the following to the first section of paragraph 5.1.1:

Fabrication/erection inspection by the contractor shall not be performed by an inspector or their assistants who are, or were previously, engaged in the welding, the general assembly, or the application of coatings.

SUBSECTION 5.10 RADIOGRAPHIC TESTING (RT) - PROCEDURE

Delete paragraph 5.10.9 and replace with the following:

5.10.9 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 5.10.12 and replace with the following:

5.10.12 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 information shall be produced on the radiograph no less the 3/4 inches from the edge of the weld either by pre-printing or by placing lead letters and numbers on the steel. See Figures 1 and 2. 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 5.10.14:

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

FIGURE 1

ITEMS TO BE PAINTED FOR RADIOGRAPHIC IDENTIFICATION

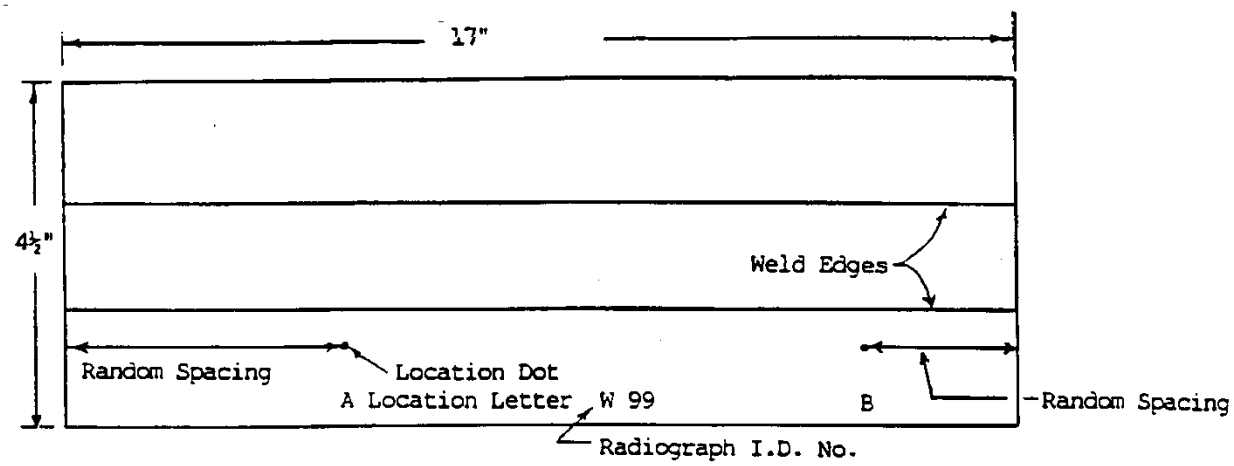
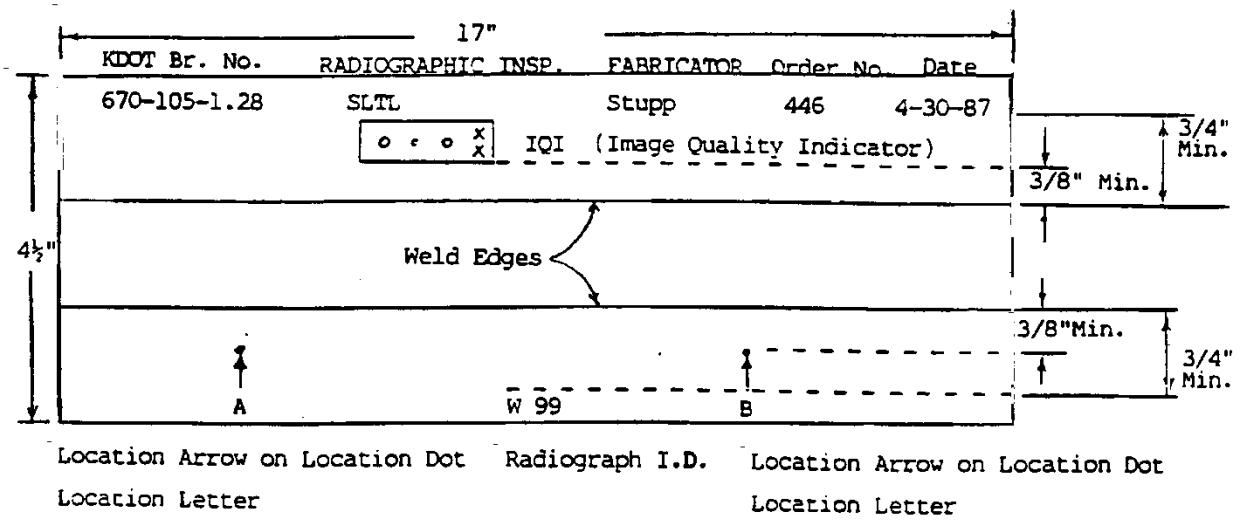


FIGURE 2

LEAD CHARACTER PLACEMENT FOR RADIOGRAPHIC IDENTIFICATION



744.3 MEASUREMENT AND PAYMENT

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