

723.07. ANCHORAGES FOR POSTTENSIONED TENDONS.

All anchorages shall be capable of detensioning or retensioning prestressing steel at any time prior to grouting. The load from the anchoring device shall be distributed to the concrete by means of approved devices.

Anchorage shall develop the specified ultimate strength of the tendons without exceeding anticipated set.

Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material. All parts of the anchoring devices will be at least 2 inches (50 mm) inside the final end surfaces of the members. Furnish a type A certification for each heat of anchorage plates.

723.08. COLD DRAWN STEEL WIRE.

Cold drawn steel wire for concrete reinforcement for spiral ties and other reinforcing designated on the Plans in "W" (Wire) sizes shall comply with AASHTO M 32.

723.09. EPOXY COATED REINFORCING BARS.

These Specifications cover organic protective coatings electrostatically applied to steel bars to be used for concrete reinforcement.

- (a) **Materials.** Epoxy coated reinforcing bars and epoxy coating material shall meet the requirements of AASHTO M 284 Specifications, except as otherwise stipulated under these Specifications.
1. **Reinforcing Steel.** Reinforcing steel bars shall meet the requirements of Subsections 723.01 or 723.02.
 2. **Coating Materials.** Coating materials prequalified for use may be obtained from the Materials Engineer's list of approved materials.
Supply a representative 8 ounce (200g) sample of coating material from each batch to the Materials Division for testing as deemed necessary.
 3. **Color.** The finished epoxy coating shall be of a color and tone that will give easily apparent visual indications of holidays, damage, or corrosion staining.
- (b) **Certification.** A type D certification shall be submitted in accordance with Subsection 106.04.
- (c) **Fabricator's Quality Control.** Epoxy coating will be accepted only from fabricators who have an approved quality control program. Submit the quality control program and schedule to the Department for review and approval prior to any coating and/or fabrication.

**SECTION 724
STRUCTURAL STEEL**

Description. This Section covers the requirements for structural steel, bolts, nuts and washers, shear connector studs, and filler material for welds in Section 506.

724.01. STRUCTURAL STEEL.

- (a) **General.** Furnish steel according to the following specifications. The grade or grades of steel to be furnished shall be as specified in the contract documents. Unless otherwise specified in the contract

documents, all structural steel shall be high-strength low-alloy structural steel conforming to AASHTO M 270 (ASTM A 709), Grade 50W (345W).

All steel for use in main load-carrying member components shall conform to the Charpy V-Notch (CVN) Impact Test requirements of AASHTO M 270 for Zone 2.

Components subject to CVN requirements include, but are not limited to, all flanges and webs of welded plate girders, rolled beams, cover plates, stiffeners (longitudinal, intermediate, or bearing), diaphragm and cross-frame components in curved girder bridges, all connection plates for main load carrying components (i.e., splice plates and filler plates over 6 millimeter), and all steel welded to any of the above.

Steel components not subject to CVN requirements include shoes, diaphragm and cross-frame components in straight girder bridges, lateral bracing, diagonals, armor joints, finger joints, expansion devices, handrails, and guardrails.

Rolled steel plates, shapes, sheet piling, and bars for structural steel shall conform to AASHTO M 160.

Furnish mill test reports for each heat of material, unless greater frequency testing and reporting is required by the materials Specification; in that case, furnish mill test reports at the greater frequency specified by the materials Specification.

- (b) **Carbon Steel.** Structural carbon steel for bolted or welded construction shall conform to AASHTO M 270 (ASTM A 709), Grade 36 (250).
- (c) **High-Strength Low-Alloy Structural Steel.** High-strength low-alloy structural steel shall conform to AASHTO M 270 (ASTM A 709), Grades 50 or 50W (345 or 345W).
- (d) **High-Strength Low-Alloy, Quenched and Tempered Structural Steel Plate.** High-strength low-alloy, quenched and tempered structural steel plate shall conform to AASHTO M 270 (ASTM A 709), Grade 70W (485W).
- (e) **High-Yield-Strength, Quenched and Tempered Alloy Steel Plate.** High-yield-strength, quenched and tempered alloy steel plate shall conform to AASHTO M 270 (ASTM A 709), Grades 100 or 100W (690 or 690W). Quenched and tempered alloy steel structural shapes and seamless mechanical tubing, meeting all of the mechanical and chemical requirements of AASHTO M 270 (ASTM A 709), Grades 100 or 100W (690 or 690W) steel, except that the specified maximum tensile strength may be 140 ksi (965 MPa) for structural shapes and 145 ksi (1000 MPa) for seamless mechanical tubing, shall be considered as AASHTO M 270 (ASTM A 709), Grades 100 or 100W (690 and 690W) steel.
- (f) **Structural Tubing.** Structural tubing shall be either cold-formed welded or seamless tubing conforming to ASTM A 500, Grade B, or hot-formed welded or seamless tubing conforming to ASTM A 501.

724.02. HIGH-STRENGTH FASTENERS.

- (a) **Materials.** High-strength bolts for structural steel joints shall conform to either AASHTO M 164 (ASTM A 325) or AASHTO M 253 (ASTM A 490). When high-strength bolts are used with weathering grades of steel, the bolts shall be Type 3.

The supplier shall provide a lot number appearing on the shipping package and a certification noting when and where all testing was done, including the rotational-capacity tests indicated below, and include zinc thickness when galvanized bolts and nuts are used.

Proof load tests (ASTM F 606, Method 1) shall be required for the bolts. Wedge tests of full-

size bolts are required in accordance with Section 8.3 of AASHTO M 164 (ASTM A 325). Galvanized bolts shall be wedge tested after galvanizing. Proof load tests specified by AASHTO M 291 (ASTM A 563) are required for the nuts. The proof load tests for nuts to be used with galvanized bolts shall be performed after galvanizing, over tapping, and lubricating.

Except as noted below, nuts for AASHTO M 164 (ASTM A 325) bolts shall conform to AASHTO M 291 (ASTM A 563), Property Class 8S, 8S3, 10S or 10S3. Nuts for AASHTO M 253 (ASTM A 490) conform to AASHTO M 291 (ASTM A 563), Property Class 10S or 10S3. The exceptions are nuts to be galvanized (hot-dip or mechanically galvanized) shall be Property Class 10S, nuts to be used with AASHTO M 164 (ASTM A 325) Type 3 (weathering) bolts shall be Property Class 8S3 or 10S3 and nuts to be used with AASHTO M 253 (ASTM A 490) Type 3 (weathering) bolts shall be Property Class 10S3.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye. Black bolts must be oily to touch when delivered and installed. Weathered or rusted bolts shall be cleaned and relubricated prior to installation

Washers shall be hardened steel washers conforming to the requirements of AASHTO M 293 (ASTM F 436) and washer requirements in Subsection 506.04(f)6.4. Washers to be used with Type 3 (weathering) bolts shall be Type 3.

- (b) **Identifying Marks.** AASHTO M 164 (ASTM A 325) for bolts and the specifications referenced therein for nuts require that bolts and nuts manufactured to the specification be identified by specific markings on the top of the bolt head and on one face of the nut. Head markings must identify the grade by the symbol “A325,” the manufacturer, and, if Type 3, the type. Nut markings must identify the property class, the manufacturer, and, if Type 3, the type. Markings on direct tension indicators (DTIs, ASTM F 959) must identify the manufacturer and type “8.8.” Other washer markings must identify the manufacturer and, if Type 3, the type.

AASHTO M 253 (ASTM A 490) for bolts and the specifications referenced therein for nuts require that bolts and nuts manufactured to the specification be identified by specific markings on the top of the bolt head and on one face of the nut. Head markings must identify the grade by the symbol “A490,” the manufacturer, and, if Type 2 or 3, the type. Nut markings must identify the property class, the manufacturer, and, if Type 3, the type. Markings on direct tension indicators must identify the manufacturer and type “10.9.” Other washer markings must identify the manufacturer and, if Type 3, the type.

- (c) **Dimensions.** Bolt and nut dimensions shall conform to the requirements for Metric Heavy Hexagon Structural Bolts and for Metric Heavy Semi-Finished Hexagon Nuts given in ANSI Standard B18.2.3.7M and B18.2.4.6M, respectively.
- (d) **Galvanized High-Strength Fasteners.** AASHTO M 253 (ASTM A 490) bolts shall not be galvanized.

When fasteners are to be galvanized, they shall be hot-dip galvanized in accordance with AASHTO M 232 (ASTM A 153), Class C, or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50 (345). Bolts to be galvanized shall be either AASHTO M 164 (ASTM A 325) Type 1 or Type 2, except that Type 2 bolts shall only be mechanically galvanized. Direct tension indicators shall only be mechanically galvanized. Galvanized bolts shall be tension tested after galvanizing. Washers, nuts, and bolts of any assembly shall be galvanized by the same process. The nuts should be overtapped to the minimum amount required for the fastener assembly, and shall be

lubricated with a lubricant containing a visible dye so a visual check can be made for the lubricant at the time of installation.

- (e) **Alternative Fasteners.** Other fasteners which meet the materials, manufacturing, and chemical composition requirements of AASHTO M 164 (ASTM A 325) or AASHTO M 253 (ASTM A 490), and which meet the mechanical property requirements of the same Specification in full size tests and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions prescribed in article (c) above, may be used, subject to the approval of the Engineer. Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

Subject to the approval of the Engineer, high-strength steel lock-pin and collar fasteners may be used as an alternate for high-strength bolts as shown in the contract documents. The shank and head of the high-strength steel lock-pin and collar fasteners shall meet the requirements of article (c). Each fastener shall meet the following criteria: a solid shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than that of the bolt specified in the contract documents; a cold-forged head on one end, of type and dimensions as approved by the Engineer; a shank length suitable for material thickness when fastened; and locking grooves, breakneck groove and pull grooves (all annular grooves) on the opposite end. Each fastener shall provide a steel locking collar of proper size for the shank diameter used which, by means of suitable installation tools, is cold swaged into the locking grooves forming head for the grooved end of the fastener after the pull groove section has been removed. The steel locking collar shall be a standard product of an established manufacturer of lock-pin and collar fasteners, as approved by the Engineer.

- (f) **Load Indicator Devices.** Load indicating devices may be used in conjunction with bolts, nuts, and washers specified in article (a). Load indicating devices shall conform to the requirements of ASTM Specification for Compressible-Washer Type Direct Tension Indicators for Use with Structural Fasteners, ASTM F 959, except as provided in the following paragraph.

Subject to the approval of the Engineer, alternative design direct tension indicating devices may be used provided they satisfy the requirements of article 506.04(f)6.4 under *Installation of Alternative Design Fasteners*, or other requirements detailed in specifications provided by the manufacturer and subject to the approval of Engineer.

When used with weathering steel, direct tension indicators shall be galvanized and coated with "baked epoxy" as specified in ASTM F 959.

724.03. WELDING.

- (a) **General.** All shop and field welding shall be arc welding and shall be done in accordance with the current ANSI/AASHTO/AWS D1.5, Bridge Welding Code.

No welding will be allowed when the air temperature is lower than

20°F (-6°C), when surfaces are wet or exposed to rain, snow, or wind, or when operators are exposed to inclement conditions that will hamper good workmanship.

Any moisture present at the point of welding shall be driven off by heat before welding commences.

Wind breaks shall be required for the protection of all welding operations.

The welder shall place a permanent identification mark with a low-stress stencil adjacent to all welds made as soon as they are completed.

If a fabricating shop prequalifies its welders, welding operators, and tackers in accordance with this Specification— and certifies to the Engineer that the welder, welding operator, or tacker has been

prequalified within 12 months previous to the beginning of work on the subject structure— the Engineer may consider the worker qualified.

The certificate shall state that the welder, welding operator, or tacker has been doing satisfactory welding of the required type within the three month period previous to the subject work. A certification shall be submitted for each welder, welding operator, or tacker and for each project, stating the following : (1) name of the welder, welding operator, or tacker, (2) the name and title of the person who conducted the examination, (3) the kind of specimens, (4) the position of welds, (5) the results of the tests, and (6) the date of the examination.

Such a certification of prequalification may also be accepted as proof that a welder, welding operator, and tacker on the field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination, or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

(b) **Qualification of Welders.**

1. **Field Welders.** Field welders shall be qualified by the Department of Transportation , Materials Division, in accordance with the current ANSI/AASHTO/AWS D1.5, Bridge Welding Code, and in accordance with instructions provided by the Materials Engineer.

Test plates will be furnished by the Laboratory, but the applicant shall pay all expenses necessary for cutting and machining test specimens from the test weld plates.

Field welders will be issued a certificate of qualification on the basis of qualification tests given by the Department of Transportation. "Field welder" as used herein refers to a unit consisting of the welder, the welding machine, and a class or group of manual shielded electrodes suitable for welding structural grades of steel.

A certificate of qualification shall become void following any 12- month period after its issuance in which the field welder has not accomplished satisfactory welding on an Oklahoma Department of Transportation project. Submit the evidence of qualification of each field welder to be accepted by the Engineer before starting any welding operation.

2. **Shop Welders and Welding Operators.** Shop welders and welding operators shall be qualified by the official "Shop Inspection" Testing Laboratory of the Department in accordance with the Section on "Qualification" of the ANSI/AASHTO/AWS D1.5 Bridge Welding Code, and in accordance with instructions provided by the Materials Engineer. The shop shall provide base material test plates for the qualification tests.

(c) **Procedure.**

1. **General.** Beam and girder splices shall be made using the sequences shown in Figure 1, except that some members will require fewer or more passes than shown. Welds shall be alternated from side to side to prevent heat build-up on one flange edge. The progression for all passes in the vertical position shall be upwards.

2. **Welding Procedure for Splices.** Groove welds shall begin and terminate at the ends of a joint on extension bars. Edge preparation and thickness of extension bars shall be the same as that of the member being welded and shall extend a minimum of 3/4 inch (20 mm) beyond the joint. Extension bars shall be removed with a cutting torch upon completion and cooling of the weld; the flange edges shall be ground smooth.

All welded flange splices, both shop and field, shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, along the longitudinal axis of the girder, leaving surfaces free from depression.

- (d) **Filler Metal.** When shown on the Plans or in the Proposal that the structural steel is to be left bare and unpainted, the deposited weld metal must have a similar atmospheric corrosion resistance and coloring characteristics as the base metal used. Follow the steel producer's recommendation and ANSI/AASHTO/AWS D1.5, Bridge Welding Code, paragraph 4.1.
1. Shielded metal arc welding (SMAW) electrodes shall conform to the requirements of ANSI/AWS A5.1.
 2. Electrodes and fluxes for submerged arc welding shall conform to ANSI/AWS A5.17.
 3. Electrodes for gas metal arc welding shall conform to the requirements of ANSI/AWS A5.18.
 4. Electrodes for flux-cored arc welding shall conform to the requirements of ANSI/AWS A5.20.
- All electrodes and electrodes-flux combinations shall be compatible with the type and thickness of steel to be welded. Use them only with the type current, the polarity, and in the positions permitted by the applicable AWS Specification.

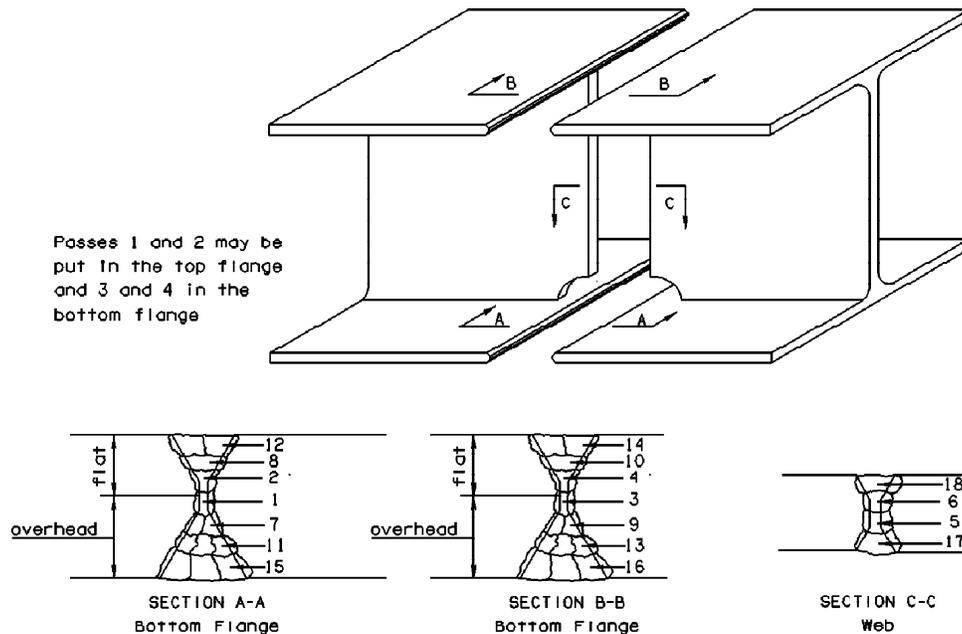


FIGURE 1
Welding Procedure for Splices

724.04. WELDED STUD SHEAR CONNECTORS.

- (a) **General.** The materials, installation, and inspection of end-welded stud shear connectors where welded to steel beams, girders, or plates to connect the members to concrete in composite steel-concrete construction shall be in accordance with the ANSI/AASHTO/AWS D1.5, Bridge Welding Code and as follows:

Before placing orders for studs, submit to the Engineer for approval the following information on the studs to be purchased:

1. The name of the manufacturer.
 2. A detailed description of the stud and arc shield to be furnished.
 3. A certification from the manufacturer that the stud base is qualified.
 4. A copy of the qualification test report as certified by the testing laboratory.
- (b) **Materials.** Shear connector studs shall conform to the requirements of Cold Finished-Carbon Steel Bars and Shafting, AASHTO M 169 (ASTM A 108), cold drawn bars, Grades 1015, 1018, or 1020, either semi-killed or fully killed deoxidation. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with Cold-Rolled Carbon Steel Strip, ASTM A 109M.

Tensile properties, as determined by tests of bar stock after drawing or of finished studs, shall conform to the following requirements in Table 724-1 in which the yield strength is as determined by a 0.2% offset method:

TABLE 724-1

Tensile Properties of Shear Connectors	
Tensile Strength, minimum	60 ksi (415 MPa)
Yield Strength, minimum	50 ksi (345 MPa)
Elongation, minimum	20% in 2 inches (50 mm)
Reduction of area, minimum	50%

- (c) **Test Methods.** Tensile properties shall be determined in accordance with the applicable sections of AASHTO T 244 (ASTM A 370), Mechanical Testing of Steel Products. Make tensile tests of finished studs on studs welded to test plates using a test fixture similar to that shown in Figure 7.2 of ANSI/AASHTO/AWS D1.5 Bridge Welding Code. If fracture occurs outside of the middle half of the gage length, repeat the test.
- (d) **Finish.** Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Finish shall be as produced by cold drawing, cold rolling, or machining.
- (e) **Certification.** Furnish certification from the manufacturer that the studs as delivered are in accordance with the Specification. Furnish certified copies of in-plant quality control test reports to the Engineer.
- (f) **Installation Testing.** After the first two studs welded on each beam or girder have been allowed to cool, bend them 45 degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, correct the procedure and successfully weld and test two successive studs before any more studs are welded to the beam or girder. Promptly inform the Engineer of any changes in the welding procedure at any time during construction.

When the temperature of the base metal is below 32°F (0°C), one stud in each 100 studs welded shall be bent 45 degrees in addition to the first two bent as specified above.

- (g) **Check Samples.** The Engineer may select, at the Contractor's expense, studs of each type and size used under the contract documents as necessary for checking the requirements of the subsection.

724.05. ANCHOR BOLTS FOR BRIDGE STRUCTURES.

Anchor bolts for bridge structures shall be continuously threaded steel bars conforming to AASHTO M 270, Grade 50W (345W) with metric coarse thread series, ANSI B1.13M for the bolt size specified in the contract documents.

Grade 50W (345W) anchor bolts shall be used with nuts and washers made of weathering steels as specified for high-strength bolts, AASHTO M 164 (ASTM A 325) in subsection 724.02.

Anchor assemblies shall be galvanized when used with painted or galvanized anchor plates.

724.06. GALVANIZING.

When galvanizing is specified in the contract documents, ferrous metal products, other than fasteners and hardware items, shall be galvanized in accordance with the Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, AASHTO M 111 (ASTM A 123). Fasteners and hardware items shall be galvanized in accordance with the Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, AASHTO M 232 (ASTM A 153), except as noted in subsection 724.02.

**SECTION 725
MISCELLANEOUS METALS****725.01. DESCRIPTION.**

This Section covers steel forging, cold-rolled shafting for pins and rollers, steel castings, iron castings (gray and ductile), and bronze castings.

725.02. STEEL FORGINGS AND STEEL STAFTING.

- (a) **Steel Forgings.** Steel forgings shall conform to the Specifications for Steel Forgings Carbon and Alloy for General Use, AASHTO M 102 (ASTM A 668), Classes C, D, F, or G.
- (b) **Cold Rolled Shafting for Pins and Rollers.** Pins and rollers up to 8 inches (200 mm) in diameter, unless marked as forging on the Plans, may be furnished from cold finished shafting meeting the requirements of the Standard Specifications for Commercial Cold Finished Carbon Steel Bars and Shafting, AASHTO M 169, Grade 1035 or 1045 (UNS Designations G10350 or G10450), providing that tensile tests made on specimens machined from the finished shafting shall develop a minimum tensile strength of 75 ksi (515 MPa).

725.03. STEEL CASTINGS.

- (a) **General.** Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. All covers and gratings that fit into frames shall fit properly and seat uniformly and solidly.

Sandblast or otherwise effectively clean all castings of scale and sand so they present a smooth, clean, and uniform surface.