SECTION 708 -- STEEL STRUCTURES

708.01 -- Description

1. a. This work shall consist of furnishing, fabricating, and erecting all bolted or welded steel structures. They shall be fabricated, constructed, and erected in accordance with the details shown in the contract and as required by these Specifications.

b. Construction of the steel superstructure for a new steel girder bridge is described by the pay item "Steel Superstructure at Station _____".

c. When the Department widens or repairs a bridge with steel components, the work is described by the pay items "Structural Steel for Superstructure and/or Substructure". These pay items are also found on new bridges when steel components are required to complete the construction. However, when these pay items are used, notes are placed in the contract to describe what steel items are to be constructed by the pay item "Structural Steel for Superstructure and/or Substructure".

2. The structural steel fabricating plants doing work for the NDOT shall be certified under the AISC Quality Certification Program:

a. Category "SBR" certification is required to fabricate main members of Simple Steel Bridge Structures.

b. Category "CBR" certification is required to fabricate main members of Major Steel Bridges (other than rolled beam structures).

c. When a fabricator holds either a SBR or CBR certificate, a Certified Welding Inspector must be present during all aspects of fabrication and painting. The Certified Welding Inspector must follow the specified duties for Quality Control according to AWS DW 1.5 Section 6.0.

d. Category "SBD or SBR" certification is required to fabricate secondary members.

e. Sole Plate fabrication for Bearing Devices is allowed without AISC certification.

3. a. All welding and weld qualification tests shall conform to the provisions of the current ANSI/AASHTO/AWS D1.5 Bridge Welding Code, referred to as *AWS Standard Specifications*.

b. The Quality Control personnel must be a Certified Welding Inspector and shall be separate from production. The Quality Control personnel shall be present at all times during fabrication and painting. The Quality Control personnel shall be knowledgeable of the specification requirements to insure that the fabrication performance is in conformance with the contract and the current AWS D1.5 Bridge Welding Code book.

4. Field Welding shall require a Welder Qualification Certification. The certification for the welder performing the work shall be submitted to the Engineer three weeks prior to starting the welding. The welder shall produce his/her credentials and photo ID at the jobsite.

5. Field welding is prohibited unless specifically shown in the contract.

6. Welder Certification:

a. All welders, operators, and tackers shall be competent, trained in the particular arc welding process to be used, experienced in the type of

welding required, and capable of producing reliable fillet and groove welds in the weld positions for which they are qualified.

b. (1) All welders shall be qualified under *AWS Standard Specification* criteria.

(2) Qualification testing is required.

(3) The testing may be done by the Engineer, a private laboratory recognized and accepted by the Engineer, or laboratories of other State Highway Departments. The qualifications of welders, operators, or tackers shall remain in effect indefinitely unless the person is not engaged in the given welding process for more than 6 months or unless there is some specific reason to question the person's ability.

(4) A certificate of the welder's qualifications shall be initially submitted to the Engineer. The initial certificate shall state:

(i) The name of the welder, operator, or tacker.

(ii) The name and title of the Engineer that observed the testing.

(iii) The arc welding process.

(iv) The welding position.

(v) The qualification positions.

(vi) Whether for groove or fillet weld.

(vii) Whether for limited or unlimited plate thickness.

(viii) The AWS Electrode and flux or electrode classification.

(ix) The date and results of the test and any other pertinent information.

(5) Failure to follow described welding procedures while performing the work may be cause for suspending a welder's qualifications in Nebraska.

(6) All suspensions may be contested by an appeal to the Engineer.

c. The Contractor shall furnish a certified statement for each welder, operator, or tacker stating that they have satisfactorily welded with the required processes in the 6-month period before the subject work.

d. To arrange Department Qualification Testing, the Contractor shall notify the Engineer as to the time and location of the test at least 48 hours in advance of the time the testing will begin so that the Engineer may observe the weld test.

e. *AWS Standard Specifications* weld test procedures shall be used to evaluate the welds made by automatic welding machines.

708.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 708.01.

Table 708.01

Applicable Materials	Section
Structural Steel	1045
Low Strength Bolts, Nuts and Washers	1057
Structural Threaded Fasteners	1057, 1058
Steel Forging	1048
Cold-Finished Bars and Shafting	1049
Steel Castings	1050
Gray Iron Castings	1051
Malleable Castings	1051
Sheet Lead	1055
Sheet Aluminum	1054
Iron Pipe	1039
Steel Pipe	1040
Welding Electrodes	1047
End Welded Studs	1046

2. Wherever steel shapes, plates, and miscellaneous steel items are specified, all designations and dimensional requirements shall be understood to be the same as those of the AISC *Manual of Steel Construction*.

3. Certified Mill Test Reports:

a. The Contractor shall furnish to the Engineer 3 copies of all mill orders or 3 copies of the Certified Mill Test Reports before starting fabrication of material covered by these reports.

b. Before the project is complete, the Certified Mill Test Reports must be provided to the Engineer.

4. The Contractor, through the fabricator, shall furnish to the NDOT Bridge Engineer a cutting list of all material to be used. The list shall include the direction of rolling (only for splice plates, bent plates, flanges, and webs), heat numbers, and fabrication piece marks.

5. All material shall be stored in such a manner as to prevent rust. Material shall not be stored so as to rest upon the ground or in water, but must be placed on suitable skids or platforms.

6. Threads for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC - ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 1.4 inches (35 mm) or more shall be threaded, 1 thread per each 0.16 inch (4 mm) of bolt length.

7. Sheared plates more than 5/8 inch (16 mm) thick which carry calculated stresses shall have the entire sheared surface planed, milled, ground, or thermally cut to remove 1/4 inch (6 mm) of the plate along the entire cut.

8. Bolts, nuts, and washers used in the assembly of "weathering" steel shall conform to ASTM A325/A 325M Type 3.

9. This Specification covers swedged anchor bolts, nuts and washers for use on bridge bearing devices:

a. Anchor Bolts

(1) Unless specified otherwise in the contract, anchor bolts shall conform to the requirements of ASTM A307, Grade A.

(2) Coating. The anchor bolts shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(3) Threads. Anchor bolts shall be threaded to the length shown on the contract. Threads shall be the Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling. The minimum body diameter on products for which no minimum limits are shown in the dimensional tables shall not be less than the minimum pitch diameter of the thread (See ANSI B18.2.1 and ANSI B1.1).

(4) Deformations. The depth of the deformation of the swedged anchor bolt shall not be more than 1/8 inch (3 mm) with a radius not less than 1/2 inch (12.5 mm). There shall be no more than one deformation occurring in any plane perpendicular to the shaft of the bolt. There shall be at least one deformation within each 1 inch (25 mm) length of the bolt and the deformations shall be a minimum of 90 degrees out of phase with the adjacent deformation. No cutting is allowed to form deformation.

b. Nuts

(1) Dimension. Nuts for anchor bolts shall be Heavy Hex nuts as specified in ANSI B18.2.2.

(2) Strength. Nuts shall comply with the proof load or Brinell hardness requirements of ASTM A307.

(3) Threads. Threads shall be the Coarse Thread series as specified in ANSI B1.1.

(4) Coating. The nuts and washers shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(5) Thread fit. After galvanizing, the thread fit of the bolt-nut combination shall be snug and shall be such that the nuts can be turned on the bolts without the application of excessive torque. The Engineer may conduct proof load tests on the bolt-nut combination to check the thread fit.

c. Washers

(1) Washers for use with anchor bolts shall be Type A or Type B Regular as specified in ANSI B18.22.1 except that the following tolerances, based on uncoated washers, shall apply:

(i)	Inside diameter	± 1/16 inch (1.6 mm)
(ii)	Outside diameter	± 1/18 inch (1.4 mm)
(iii)	Thickness	-0.03, +0.05 inch (-.8 mm, +1.3 mm)

10. Any bolt lots which do not bear the Department inspection tags and markings will not be accepted by the Engineer.

11. If the fasteners are shipped to the job site directly from the manufacturer, fabricator, or supplier, they must be sampled by State personnel and submitted to the NDOT Materials and Research Division for testing.

12. Prestressed concrete girder structures:

a. All structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A709/A709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A123.

b. Bolts, nuts, and washers used to install and assemble steel diaphragms shall conform to ASTM A325 or ASTM A325M and shall be galvanized in accordance with ASTM A153.

13. Shear connectors shall conform to the requirements of Subsection 708.02 and Section 1046 of the *Standard Specifications.*

708.03 -- Construction Methods

1. General Requirements:

a. The Contractor shall assemble and place all structural steel as shown in the contract.

b. All structural steel shall be shaped by methods which will not damage the metal. Metal with sharp kinks or bends shall be rejected.

c. Bent steel shall be shaped using procedures that will not produce fractures or damage. The metal shall not be heated unless approved by the Engineer, in which case the heating shall not be done to a temperature higher than 1150°F (621°C). After heating, the metal shall be left to cool at ambient air temperatures above 40°F (4°C). Accelerated cooling is not allowed.

d. The work quality and finish shall equal or exceed ANSI, AASHTO, and AWS Standards.

e. Shearing, thermal cutting, and chipping shall be done accurately; and all portions of the work shall be finished neatly.

2. Plans and Working Drawings:

a. Plans shall be supplemented by the Contractor's working drawings provided in accordance with the requirements of Subsection 105.02.

3. Bolt Holes:

a. The Contractor shall punch or drill and ream all bolt holes. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch (1.5 mm) larger than the nominal diameter of the bolts whenever the thickness of the metal is not greater than 3/4 inch (19 mm) for structural steel or 5/8 inch (16 mm) for high strength low alloy steel.

b. When there are more than 5 thicknesses of material or when any of the main material is thicker than 3/4 inch (19 mm) in carbon steel or 5/8 inch (16 mm) in alloy steel, or when required under Paragraph 6. of this Subsection, all the holes shall be subpunched or subdrilled 3/16 inch (5 mm) smaller and, after assembling, reamed 1/16 inch (1.5 mm) larger or drilled 1/16 inch (1.5 mm) larger than the nominal diameter of the bolts.

4. Punched Holes:

The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch (1.5 mm). If any holes must be enlarged to admit the bolts, they shall be reamed. Holes must be clean cut and without torn or ragged edges. Material with poorly matching holes will be rejected.

5. Accuracy of Hole Group:

a. All holes punched full size, subpunched, or subdrilled shall, after assembling (before any reaming is done), allow a cylindrical pin 1/8 inch (3 mm) smaller in diameter than the nominal size of the punched hole to be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch (5 mm) smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

b. When holes are reamed or drilled, 85% of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/16 inch (15 mm) between adjacent thicknesses of metal.

c. Having met the foregoing criteria, remaining offsets may be corrected by further reaming to admit bolts perpendicular to the face of the member.

d. Except where restoration by welding is necessary for structural or other reasons, mislocated holes shall be left open or filled with bolts.

e. Reaming:

(1) Reamed or drilled holes shall be cylindrical, perpendicular to the member, and shall comply with Paragraph 3. of this Subsection as to size.

(2) Where practical, reamers shall be directed by mechanical means.

(3) Burrs on the outside surfaces shall be removed.

(4) Reaming and drilling shall be done with twist drills, twist reamers, or sluggers (rotobroach cutters).

(5) Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

f. Tolerances:

(1) Holes not more than 1/32 inch (0.75 mm) larger in diameter than the true decimal equivalent of the nominal diameter that may result from a drill or reamer of the nominal diameter are considered acceptable. The slightly conical hole that naturally results from punching operations is considered acceptable.

(2) The width of slotted holes which are produced by thermal cutting or a combination of drilling or punching and thermal cutting shall generally be not more than 1/32 inch (0.75 mm) greater than the nominal width.

(3) The thermal cut surface shall be ground smooth.

6. Drilling, Subpunching, Reaming, and Shop Assembly:

a. (1) Unless otherwise specified, holes in all field connections and field splices of main members of trusses, arches, continuous beams, girders, or rigid frames shall be drilled full size or subpunched (or subdrilled) and reamed, with all members assembled in the shop.

(2) If splices are to be drilled full size, one splice plate from each flange or from each web splice may be predrilled full size and the predrilled plate used as a template for drilling the flange or web and opposite splice plates, provided the resulting holes are equal in quality to holes drilled completely or subdrilled (or subpunched) and reamed through the assembled plates.

(3) The assembly, including camber, alignment, and accuracy of holes and milled joints, shall be approved by the Engineer before reaming of under size holes or drilling of full size holes is commenced.

(4) The connecting parts shall be assembled and held securely while being reamed or drilled and shall be match-marked.

(5) No parts shall be interchanged. (See Paragraph 8. of this Subsection.)

b. All holes for field end connections of floor beam and stringers shall be subpunched and reamed to a steel templet or reamed while assembled.

c. The Contractor shall clean metal surfaces before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The members shall be free from twists, bends, and other deformation.

7. Drifting of Holes:

The drifting done during assembling shall be only that amount necessary to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the bolts, they shall be reamed.

8. Matchmarking:

a. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matchmarked by the Contractor, and a diagram showing such marks shall be furnished to the Engineer.

b. Where steel stamping is used, impressions shall be placed on the thicker tension-joint member in transition joints. Impressions shall not be made on tensile-stressed plate members except at field splices. The maximum allowable depth of the impression shall be 0.01 inch (250 μm). Any metal die stamping shall be done using low-stress dies with rounded edges conforming with the requirements in Table 708.02.

Table 708.02

Low Stress Die Edges	
Character Size inches(millimeter)	**Minimum Character Face Radius inches(micrometer)**
1/8 (3)	.007 (180)
3/16 (4.5)	.008 (212)
¼ (6)	.010 (250)

9. Unfinished Turned or Ribbed Bolt Connections (Not applicable to high-strength bolts):

a. The Contractor shall provide bolted connections as required by the contract.

b. Unless otherwise specified, approved lock washers shall be used on all bolts.

c. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal.

d. The bolts shall be of lengths which will extend entirely through their nuts and washers but not more than 1/4 inch (6 mm) beyond them.

e. All bolts shall have hexagonal heads and hexagonal nuts. The diameter of the bolt holes shall be not more than 1/16 inch (1.5 mm) greater than the diameter of the bolts used unless otherwise shown.

10. Structural Joints Using High Tensile Steel Fasteners:

a. When shown in the contract, high tensile steel bolts shall be used for the fabrication of structural steel forming rigid joints in installations where the initial tension in the bolt body is depended upon to produce resistance to shear loads through friction at the faying surfaces.

b. Fastener material requirements, as well as manufacturing, testing, documentation, and shipping requirements, shall be as set forth in Section 1058.

c. Testing:

(1) The rotational capacity test described in Section 1058 will also be performed by the NDOT Materials and Tests Division on each rotational capacity lot before bolt installation at the project site or fabricator's plant.

(2) This test will be performed by the Department in addition to the rotational capacity testing certified by the manufacturer or distributor.

(3) If the fasteners are shipped to the job site directly from the manufacturer, fabricator, or supplier, the Engineer has the option of performing the rotational capacity test and verification testing required in Section 1058 at the job site or fabricator's plant.

(4) If, however, the bolts have not been pretested in accordance with AASHTO M164 (ASTM A325) by State personnel, they must be sampled by State personnel and submitted to the NDOT Materials and Tests Division for testing.

(5) These requirements apply to shop bolts as well as field bolts.

d. Bolted parts shall fit solidly together when assembled. There shall be no compressible material such as gaskets or insulation within the grip. Holes may be punched, subpunched or reamed, or drilled as required by the applicable specifications and shall be of a diameter not more than 1/16 inch (1.5 mm) in excess of the nominal bolt diameter.

e. Faying Surface Preparation:

(1) The faying surfaces shall be free of burrs, pits, and other defects that would prevent solid seating of the parts or would interfere with the development of friction between the parts. The Contractor shall clean surfaces that are to be painted in accordance with Subsection 709.03, Paragraph 1.b.

(2) If unpainted "weathering" steel is specified, the faying surfaces shall be cleaned as described in Subsection 709.03, Paragraph 4.

f. Bolts:

(1) Heavy hex structural bolts and heavy hex nuts shall be required unless other dimensional requirements are stipulated in the contract.

(2) Bolts shall be assembled with a hardened washer under the nut, unless otherwise specified.

(3) A hardened steel flat washer shall be used when the abutting surface adjacent to the bolt head or nut does not have a slope of more than 1 to 20 with respect to a plane normal to the bolt axis.

(4) Where an outer face of the bolt part has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a smooth, hardened steel beveled washer shall be used to compensate for adjoining surfaces not being parallel.

g. Installation:

(1) The sequence of tightening the bolts in a connection shall be such that the stiffest or most restrained area is tightened first, with work progressing toward the free edges.

(2) Sufficient bolts shall be installed and brought to a "snug-tight" condition to ensure that all parts of the connection are in full contact.

(3) Snug-tight is defined as the tightness attained when an impact wrench begins to impact or when the full effort of a person using a standard 18 inch (450 mm) spud wrench is applied.

(4) Snug-tight is more specifically defined as the tightness necessary to produce approximately 15% (but no more than 50%) of the minimum bolt tension as shown in Table 708.03 (A or B), column (3).

(5) This snug-tight tension may be verified using an approved bolt tension calibrator.

(6) All remaining bolts shall be installed and tightened to a snug-tight fit.

(7) The Engineer may require bolts previously installed to be rechecked for tightness.

Table 708.03A

Bolt Tension ASTM A325 Bolts Used in Slip-Critical and Direct Tension Connections			
U.S. Standards			
(1)	(2)	(3)	(4)
Bolt Size	Snug-Tight Tension (kips)	* Minimum Bolt Tension (kips)	+5% Required Installation Tension (kips)
1/2”	2	12	13
5/8”	3	19	20
3/4”	4	28	29
7/8”	6	39	41
1”	8	51	54
1 1/8”	8	56	59
1 1/4”	11	71	75
1 3/8”	13	85	89
1 1/2”	15	103	108

* Minimum tension values shown in column (3) are equal to 70% of the specified tensile load as shown in ASTM A325 specifications (tested full size with UNC threads loaded in axial tension), rounded to the nearest kip (kN).

Table 708.03B

Bolt Tension ASTM A325M Bolts Used in Slip-Critical and Direct Tension Connections			
SI Standards			
(1)	(2)	(3)	(4)
Bolt Size (mm)	Snug-Tight Tension (kN)	* Minimum Bolt Tension (kN)	+5% Required Installation Tension (kN)
16	14	91	96
20	21	142	149
22	26	176	185
24	31	205	215
27	40	267	280
30	49	326	342
36	71	475	499

* Minimum tension values shown in column (3) are equal to 70% of the specified tensile load as shown in ASTM A325 specifications (tested full size with UNC (metric coarse) threads located in axial tension), rounded to the nearest kip (kN).

h. Bolt Tension Methods:

High strength fasteners must be installed using either the turn-of-nut method.

(1) Turn-of-Nut Method:

(i) The following requirements for installation of fasteners by this method apply in addition to the specifications in the AASHTO Standard Specifications for Highway Bridges, Division II, Section 11, when high-strength bolts are installed in the field or shop.

(ii) Bolts shall be installed in accordance with AASHTO Division II, Section 11, Article 11.5.6.4.4, for turn-of-nut tightening, using required hardened steel washers under the turned element (the turned element being the high strength nut, unless otherwise specified).

(iii) If the manufacturer's markings on the nuts are raised, the nuts must be installed so that the markings are not in contact with the hardened washer.

(iv) During installation, particular care should be exercised so that the required snug-tight condition is achieved.

(v) After all bolts in the connection have been properly snug-tightened (see Paragraph 10.g. of this Subsection), the nuts shall be match-marked by the Contractor or fabricator using paint, crayon, or other approved means in order to provide the Engineer a reference for determining the relative rotation of the parts during final tightening.

(vi) The outer face of the nut must be match-marked to the protruding end of the bolt after the joint has been snug-tightened, but before final tightening.

Table 708.04

Nut Rotation from Snug-Tight Condition Disposition of Outer Faces of Bolted Parts			
Bolt Length (as measured from underside of head to extreme end of point)	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 bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 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

Table Notes:

1. Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees. For bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.
2. No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.
3. Applicable only to connections in which all material within grip of the bolt is steel.

(vii) The element not being turned must be held stationary with a wrench or other suitable means to ensure that no rotation of the unturned element occurs.

(viii) After being properly match-marked, the bolts shall be tensioned by applying the amount of nut rotation as specified in Table 708.04.

(ix) If impact wrenches are used for tightening, they shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

(x) When all bolts in the connection are tight, each bolt should provide a tension at least 5% greater than the minimum tension values shown in Table 708.03 (A or B), column (3).

(xi) These minimum installation tension values are shown in column (4) of Table 708.03 (A or B).

i. Inspection:

(1) Fasteners of appropriately assigned and tested lot numbers shall be assembled together when installed.

(2) Such fasteners shall be protected from dirt and moisture at the job site (in protective storage from the outside elements) in the original containers. These containers or kegs will be sealed and tagged by Department personnel before shipment.

(3) Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from the protected storage. Fasteners not used shall be returned to the protective storage at the end of the shift.

(4) Any fasteners not properly stored or handled are subject to rejection by the Engineer.

(5) Fasteners shall not be cleaned of lubricant that is required to be present in the as-delivered condition.

(6) The Contractor in the field and the bridge fabricator in his/her shop shall provide a certified, calibrated, dial indicator type manual torque wrench and bolt tension measuring device (a Skidmore-Wilhelm calibrator or other acceptable bolt tension indicating device) when high-strength fasteners are being tightened and the Engineer requires a rotational capacity test as required in Section 1058 and/or to verify the tension requirements of Table 708.03 (A or B) for the complete fastener assembly.

(7) Calibration of this equipment will be performed by the Department's Materials and Research Division. Such devices must be submitted to the Department at least 1 week before their use is anticipated.

(8) Recalibration of the torque wrench and tension measuring device will be required at any time which, in the opinion of the Engineer, the equipment is not functioning properly or is out of calibration.

(9) Bolts tightened by the turn-of-nut method may be accepted by the Engineer on the basis of a visual inspection of the match-marks.

(10) If there is a disagreement or question as to the tension of the installed bolts, the Engineer shall require the following procedure to be used:

(i) Five bolts of the same brand, grade, diameter, length, and condition as those under inspection shall be placed individually in the calibration device. The samples selected must be representative of the fasteners used in the work and should be from the same manufacturer's lot if at all possible.

(ii) When the fasteners to be inspected have been installed in the structure for any significant length of time as determined by the Engineer and have been exposed to the elements, the samples should be selected from the fasteners in the work.

(iii) A hardened steel washer must be used under the nut's faying surface with a minimum of 3, but not more than 5, exposed threads included in the grip portion of the bolt.

(iv) Steel shim plates may have to be used as spacers between the washer and the calibrator in order to provide this spacing requirement.

(v) Bolts must first be brought to a snug-tight tension as shown in Table 708.03 (A or B).

(vi) Match-marks are then applied for the purpose of rotational referencing from snug-tight.

(vii) Each of the 5 bolts shall then be tightened in the calibration device, beyond snug-tight, by any convenient means to the minimum tension specified for its size as shown in Table 708.03 (A or B), column (3).

(viii) Tightening from the initial snug-tight condition must not produce greater nut rotation than that allowed in Table 708.05.

(ix) The inspecting wrench shall then be applied to each of the 5 tightened bolts and the torque necessary to turn the nut 5 degrees [1 inch (25 mm) in a 12 inch (300 mm) radius] in the tightening direction shall be determined.

(x) From a practical standpoint, this is the torque necessary to just start rotation of the nut. Record all 5 torque determinations.

(xi) The job inspection torque shall be taken as the average of the 3 remaining values after rejecting the high and low values.

(xii) This job inspection torque is to be used in the manner specified as follows:

(a) Bolts represented by the sample described in Paragraphs 10.i.(10)(x), and (xi) of this Subsection which have been tightened in the structure shall be inspected by applying the inspecting wrench with the accompanying job inspecting torque to a minimum of 10% of the bolts, but not less than 2 bolts, selected at random in each connection.

(b) If no nut is turned by this application of the job inspection torque, the connection shall be accepted as properly tightened. If any nut is turned by the application of job inspection torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut is turned by the job inspection torque shall be tightened and reinspected; or, alternatively, the fabricator or Contractor may retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

Table 708.05

Maximum Nut Rotation from Snug-Tight	
Bolt Length	**Rotation**
4 diameters or less	1/2 turn
Greater than 4 but not exceeding 8 diameters	3/4 turn
Greater than 8 diameters but not exceeding 12	1 turn

(11) The Engineer will monitor the fastener conditions in order to detect any change in the level of lubrication or accumulation of dirt or other detrimental fastener conditions. At any time during the erection process when the Engineer suspects there may have been a change in the lubrication or fastener conditions, he/she may require the Contractor to run a rotational capacity test as well as verification testing as indicated in these Specifications.

(12) Bolts tightened in-place, then removed, shall be discarded and not reused.

11. Bearing Surfaces and Abutting Joints:

a. Bearing surfaces shall conform to the ANSI B46.1, Surface Texture in Table 708.06.

Table 708.06

Surface Texture	
Surface	**Texture**
Steel slabs	2000
Heavy plates in contact with shoes	1000
Flame cut surfaces of members carrying calculated stress	1000
Flame cut surfaces of members not carrying calculated stress	2000
Mill ends of compression members	500
Bridge rollers and rockers	250
Pins and pinholes	125
Sliding bearings	125

b. Caps and base plates of columns, the sole plates of girders and trusses, and other steel components shall fit as required by AWS when assembled. The plates, if warped or deformed, shall be hot-straightened, planed, or otherwise treated to secure an accurate, uniform contact as approved by the Engineer. Correspondingly, the surfaces of base and sole plates which are to come in contact with concrete shall be rough finished and be free from warps or other deformations.

c. Abutting ends of compression members shall, after the members have been fastened, be accurately faced to secure an even bearing when assembled in the structure. (Applicable to truss bridge only.)

d. The contract shall state which ends of tension members at splices shall be faced to provide an even bearing. Where joints are not faced, the opening shall not exceed 1/4 inch (6 mm).

12. Pins and Rollers:

a. Pins and rollers shall be accurately manufactured to the contract dimensions and shall be smooth, straight, and free from flaws. The final surface shall be produced by a finishing cut and shall conform to the requirements of Paragraph 11. of this Subsection.

b. Pins and rollers more than 9 inches (225 mm) in diameter shall be forged and annealed. Pins and rollers 9 inches (225 mm) or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

c. Pinholes shall be bored true to detailed dimensions, smooth and straight, at right angles with the axis of the member, and parallel with each other. A finishing cut shall always be made.

d. The diameter of the pinhole shall not exceed that of the pin by more than 1/50 inch (0.5 mm) for pins 5 inches (125 mm) or less in diameter, or by 1/32 inch (0.75 mm) for larger pins.

e. The Contractor shall provide 2 pilot nuts and 2 driving nuts for each size of pin.

13. Thermal Cutting:

a. Structural steel may be thermally cut provided a smooth surface is attained by the use of a mechanical guide. Thermal cutting by hand shall be done only where approved by the Engineer; and the surface shall be made smooth by planing, chipping, or grinding according to ANSI B46.1 Surface Texture.

b. Cuts shall not go beyond the described limit lines.

c. Reentrant cuts shall be filleted to a radius of not less than 1/2 inch (13 mm). Thermal cut surfaces shall meet the ANSI surface roughness rating of 500 micro inches, except members carrying no calculated stress shall meet a rating of 2,000 micro inches.

d. Thermal cut surfaces of members carrying calculated stress shall have their corners rounded to a 1/16 inch (1.5 mm) radius by grinding after thermal cutting.

14. Bent Plates:

a. Cold-bent load-carrying rolled-steel plates shall conform to the following:

(1) They shall be bent at right angles to the direction of rolling.

(2) Cold bending shall be such that no cracking of the plate occurs. Minimum bending radii, measured to the concave face of the metal, are given in Table 708.07.

Table 708.07

Minimum Bending Radii			
	Thickness in Inches (millimeters) [t]		
	Up to ¼ (6 mm)	**Over ¼ to ½ (6 mm to 12 mm)**	**Over ½ to 1 (12 mm to 25 mm)**
Bending radii for all grades of structural steel	2t	3t	5t

(3) If a shorter radius is essential, the plates shall be bent hot. Hot bent plates shall conform to the requirements of Paragraph 14.a. of this Subsection.

(4) Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch (1.5 m) throughout that portion of the plate at which the bending is to occur.

(5) Allowance for the springback of Grades 100 and 100W steels should be about 3 times that for Grade 36 steel. For break press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

b. If a radius shorter than the minimum specified for cold bending is essential, the plates shall be bent hot at a temperature not greater than 1,200°F (649°C), except for Grades 70W, 100, and 100W. If Grades 100 and 100W steel plates are to be bent and are heated to a temperature greater than 1,100°F (593°C), and if Grade 70W plates are heated to a temperature greater than 1,050°F (565°C), they must be requenched and tempered in accordance with the producing mill's standard practices.

15. Fabrication of Steel Girders:

a. Welding Procedure:

(1) The Contractor shall submit shop drawings for girders and a proposed Welding Procedure Specification (WPS) to the Engineer for review before any fabrication is started. The WPS is maintained on file in the Department.

(2) The fabricator may submit a WPS directly to the Department's Bridge Engineer.

(3) The WPS shall include the following:

(i) Joint description or preparation.

(ii) Welding process and type of welding equipment.

(iii) Base-metal material specifications.

(iv) Welding position.

(v) Amperage, voltage, and travel speed.

(vi) Type current, polarity, and electrical stickout.

(vii) Electrode or electrode-flux classification and manufacturer.

(viii) Gas shielding type and flow rate.

(ix) Preheat and other heating requirements.

(x) Procedure Qualification Record (PQR) used to derive the WPS.

(xi) Other data to fully describe the WPS.

b. The Contractor shall complete the following work before welding webs to flanges:

(1) Butt splices in the flanges and webs shall be welded and radiographed by the fabricator before being approved by the Engineer. The maximum number of weld repairs is three.

(2) The tee joint shall be freed from carbon, rust, pits, dirt, scale, moisture, and other deleterious material.

(3) An external source of heat or force shall be applied to bend the flanges of irregular shaped girders. After the heat or the force is removed, the flange shall fit the contour of the web. If heat is used, it shall be limited to a steel temperature of 1,150°F (621°C). After heating, the metal shall be left to cool at ambient air temperatures above 41°F (5°C) and the velocity of the air shall not exceed 5 mph (8 km/h) throughout the cooling period. Accelerated cooling is not allowed.

c. (1) The girder material shall be held securely in position during welding, and the welding sequence shall be such as to minimize internal stresses and distortion.

(2) Heating and cooling shall be controlled to produce a product within the dimensional tolerances specified.

d. All fillet or groove welds connecting flange plates to web plates shall be made with a submerged-arc automatic welder. Other welds may be made with an automatic, semi-automatic, or manual welder.

e. Unauthorized welds are prohibited. The Engineer's written permission is required before producing any temporary or permanent welds not shown in the contract or allowed in the specifications.

f. All repairs must be Pre-Approved and must have a Welding Procedure and a final report submitted.

g. Preassembly:

(1) In the shop, preassembly of field connections for steel girders is required to verify the geometry of the completed structure and prepare field joints. The details and methods of preassembly of field connections shall be consistent with the erection plan and blocking diagrams prepared by the Contractor and approved by the Engineer.

(2) Camber and blocking tolerances shall be according to AWS Standard Specifications, Section 3.5.1.3. The span length is the length of girder between the end support and a field splice or between field splices.

(3) Only minor weld repairs shall be allowed following preassembly of field connections. Girders placed while checking preassembly of field connections shall have the following items completed:

(i) Welding.

(ii) Cambering.

(iii) Curving.

(iv) Straightening.

(v) Flattening of bearing surfaces.

(vi) Flange Tilt

(4) (i) Preassembly of field connections shall consist of 3 or more contiguous girders accurately adjusted for line and camber. Successive segments shall consist of at least 1 girder from the previous assembly plus 2 or more girders at the advancing end.

(ii) The Department will approve a 2-girder laydown if the fabricator's shop is too small to handle the 3-girder laydown.

16. Heat Curved Girders:

a. Rolled beams and plate girders which are manufactured to a specified yield point of 50,000 psi (345 MPa) or less may be heat curved in accordance with the Standard Specifications when so indicated in the contract.

b. Heating:

(1) Heating Procedures are required for the following:

(i) Camber Correction

(ii) Horizontal Curving of Beams and Girders

(iii) Correcting of flange tilt

(iv) Web Flatness Correction

(2) (i) Beams and girders may be curved by either continuous or V-Type heating as approved by the Engineer.

(ii) For the continuous method, a strip along the edge of the top and bottom flanges shall be heated simultaneously; the strip shall be of sufficient width and temperature to obtain the required curvature.

(iii) For the V-Type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. The spacing and temperature shall be as required to obtain the required curvature, and heating shall progress along the top and bottom flanges at approximately the same rate.

(iv) For the V-Type heating, the apex of the truncated triangular area applied to the inside flange surface shall terminate just before the junction of the web and the flange is reached. To avoid unnecessary web distortion, special care shall be taken when heating the inside flange surfaces (the surfaces that intersect the web) so that heat is not applied directly to the web.

(v) When the radius of curvature is 1,000 feet (305 m) or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web.

(vi) When the radius of curvature is less than 1,000 feet (305 m), the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to 20% of the flange width or 3 inches (75 mm), whichever is less.

(vii) The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 10 inches (250 mm).

(viii) Variations in the patterns described above may be made with the approval of the Engineer.

(3) For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is only mandatory when the flange thickness is 1 1/4 inches (32 mm) or greater, in which case, the 2 surfaces shall be heated concurrently. The maximum temperature shall be 1,150°F (621°C).

c. The girder shall not be artificially cooled, cooled below 41°F, nor shall the velocity of the air exceed 5 mph (8 km/h) throughout the cooling period.

d. Heating Position:

(1) The girder may be heat-curved with the web in either a vertical or a horizontal position.

(2) When curved in the vertical position, the girder must be braced or supported so that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn or be damaged.

(3) When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required, to obtain a uniform curvature. The bending stress in the flanges due to the dead weight of the girder must not exceed the usual allowable design stress.

(4) When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within 2 inches (50 mm) of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

e. The girder shall be heat-curved in the fabrication shop before it is painted. The heat-curving operation may be conducted either before or after all the required welding of transverse intermediate stiffeners is completed.

(1) However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat curving.

(2) If longitudinal stiffeners are required, they shall be heat-curved or thermal-cut separately and then welded to the curved girder.

(3) When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 2 1/2 inches (64 mm) and the radius of curvature is greater than 1,000 feet (305 m).

(4) For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached. Cover plates must be either heat-curved or thermal-cut separately and then welded to the curved beam.

f. Girders shall be cambered before heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the Engineer. For plate girders, the web shall be cut to the described camber with suitable allowance for shrinkage due to cutting, welding, and heat curving.

g. Tolerance Checking:

(1) Horizontal curvature and vertical camber shall not be measured for final acceptance before all welding and heating operations are completed and the flanges have cooled to the ambient air temperature.

(2) Horizontal curvature shall be measured with the girder blocked with the web in a normal, vertical position.

(3) Vertical camber may be measured in an unloaded position.

h. Moderate deviations from specified camber may be corrected by carefully supervised heating subject to the approval of the Engineer.

i. The bearing ends of bearing stiffeners shall be flush and square with the web and shall be connected to the bottom with a full penetration weld. As an alternate, the stiffener shall be ground to bear and attached with fillet welds. Grind to bear shall mean that at least 75% of the area under the stiffener is in contact with the flange. Contact is defined as being such that a 0.001 inch gage will not pass between the stiffener and the flange.

17. Welding:

a. The Contractor shall perform all preapproved welding using the following processes; shielded metal-arc, submerged arc, gas metal-arc, or flux cored arc process.

b. Steel Backing:

(1) Welds made with the use of steel backing shall have the weld metal thoroughly fused with the backing.

(2) Steel backing shall be continuous for the full length of the weld with run-off plates in place. All necessary joints in the steel backing shall have complete joint penetration welds in butt joints.

(3) Steel backing of welds that are transverse to the direction of computed stress shall be removed, and the joints shall be ground or finished smooth. Steel backing of welds that are parallel to the direction of stress or are not subject to computed stress need not be removed, unless specified by the Engineer or shown in the contract. Where the steel backing of longitudinal welds is externally attached to the base metal by welding, such welding shall be continuous for the length of the backing.

c. When back gouging is required, the surface to be welded shall be cleaned of all spatter and ground smooth.

d. Run-off Plates:

(1) Run-off plates shall be similar to the plate being welded and be sized to provide a reasonable run-off length and allow adequate heat dissipation.

(2) Run-off plates shall be removed when the weld has cooled. The edges of the weld shall be ground smooth and flush with the edges of abutting parts.

e. Tack welds shall not be made outside of the weld area.

f. Preheat and interpass temperature shall be sufficient to prevent weld cracking. The minimum preheat and interpass temperature shall be in accordance with AWS Standard Specifications.

g. The Contractor shall match filler metal to base metal in accordance with the AWS Standard Specifications.

h. Aluminum welding shall be done in accordance with the requirements of Section 418.

18. End Welded Studs:

Stud welding shall be accomplished in accordance with the AWS D1.5 Standard Specifications Section 7.

19. Drip Plates:

When drip plates are required on the exterior girders the weld material shall stop 1/2 inch from the end of the drip plate and 1/2 inch from the edge of the girder. The edges are required to be filled as shown in the contract with a clear colored, 100% silicone product from the Department's Approved Products List.

20. Steel Diaphragms:

a. Flatness or deflection of steel diaphragms and separators after bending shall not exceed half the thickness of the material being bent.

b. The item "Steel Diaphragms" shall include furnishing and installation of all cross frames, bent plate separators, angles, plates, bolts, and other incidentals necessary to complete the installation of the diaphragms as shown in the contract.

c. For prestressed concrete girder structures, all structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A709/A709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A123.

d. Bolts, nuts, and washers shall conform to ASTM A325/A325M and shall be galvanized in accordance with ASTM A153.

21. Shop and Field Inspection:

a. The Contractor shall give the Engineer 30 days advanced notice of shop work and provide a copy of the anticipated production schedule. The Engineer will schedule a Prefabrication Meeting at the fabrication shop to review the applicable codes and specifications and the production schedule. The Engineer shall be notified three working days (Saturdays, Sundays, and Holidays are excluded) before actual fabrication start time so inspection can be scheduled.

b. The Contractor shall perform inspection and testing at least to the extent specified in the current AWS D1.5 Standard Specifications and additionally as necessary to assure conformance with the requirements of the contract.

c. The Contractor shall facilitate the inspection of material and work quality in the shop, and the Engineer shall be allowed free access to the plant.

(1) The Contractor shall have the fabricator of main members for structural steel bridges provide an office area for the exclusive use of the Department inspectors assigned to the fabrication plant. The office shall be accessible during all fabrication operations. Parking shall be provided nearby.

(2) The office facility shall have a floor area of approximately 110 square feet (10 m^2). It shall be weatherproof, insulated, lighted, and secured. An office key shall be furnished to each assigned inspector.

(3) The office shall be equipped with 115 volt, 60 cycle A/C electrical outlets, telephone with direct outside line and intra-plant capabilities, and a heating-cooling-ventilation system which circulates clean smoke-free air and will maintain an ambient air temperature of 72°F (22°C).

(4) The office shall be furnished with an office desk [approximately 30 inches (750 mm) x 60 inches (1500 mm)] with drawers, a swivel chair, and a locking storage cabinet.

d. When structural steel is fabricated outside of Nebraska, the Engineer may elect to make complete inspections of all fabricated work after delivery to the site.

22. Cleaning, Painting and Storage of Material

a. Cleaning and Painting of all final structural members with the exception of Cross Frames and Diaphragms/Separartors shall conform to Section 709.

b. Storage of all final structural members shall conform to Section 106.04.

c. All bearing devices while on the job site must be protected from the elements of weather. Devices shall either be stored in a job trailer or properly covered with tarps until the devices are put into place. Devices with sole plates and fabric pads require final field inspection by the Bridge Fabrication Manager and approved prior to installation.

23. Marking and Shipping:

a. Each structural member shall be scribed or paint marked for identification. An erection drawing shall be furnished showing identification marks.

b. When the weight of a member exceeds 3 tons (3 Mg), then the weight shall be marked on the member.

c. Bolts of one length and diameter and loose nuts and washers of each size shall be packed separately.

d. Pins, small parts, and small packages of bolts, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels of convenient sizes. An inventory list with a complete description of each item shall be plainly marked on the outside of each shipping container.

e. The loading, transporting, unloading, and storing of all material shall be conducted so that the material is kept clean and is not damaged.

24. Field Assembly:

a. Methods:

(1) The Contractor shall request the Engineer's approval of the proposed assembly methods at least 2 NDOT work days before starting the work.

(2) Work shall not begin until the Engineer's approval has been obtained.

(3) Approval of these methods does not relieve the Contractor of responsibility for performing the work safely in accordance with the contract.

b. The Contractor's preparation of bearing areas shall include:

(1) Contractor shall contact the Department’s Bridge Office a minimum of two weeks prior to installation of Bearing Plates for final inspection.

(2) Column bases and bearing devices shall have full and uniform bearing upon the substructure concrete. Bearing plates or pads shall not be placed upon bridge seat areas of piers or abutments which are deformed, irregular, or improperly finished.

(3) The bearing devices and the bases of columns shall be rigidly and permanently located to the correct alignment and elevations.

(4) A 1/8 inch (3 mm) thick lead sheet shall be placed between all steel and concrete at all areas where a bearing load is transferred. For example, a 1/8 inch (3 mm) lead sheet is required under all pot bearings and special bearings.

(5) Anchor bolts shall be cast in the concrete as shown in the contract.

c. The Contractor's methods and equipment used to assemble the structure shall not damage the members. Damaged members shall be rejected.

d. The Contractor shall adjust the structure to its correct grade, alignment, and elevations and confirm splices are properly aligned before installing bolts. The correct camber and relative elevations shall be established before tightening the bolts.

e. The Contractor shall block those girder segments assembled on the ground according to the camber and blocking diagram before bolted field splices are tightened.

f. Plates, angles, and other shapes shall be straightened by methods that will not produce fracture or other damage. Metal shall not be heated unless allowed by the Engineer. If the Contractor uses heat, a proposal for its use shall be provided. The proposal shall include methods of heating, cooling, and other pertinent details.

g. After straightening a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

h. Corrections:

(1) Minor corrections involving reaming, cutting, and chipping are expected. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting of parts by the moderate use of drift pins or by a limited reaming, chipping, or cutting shall be reported immediately to the Engineer.

(2) Correction using approved methods shall be made in the Engineer's presence.

(3) The Contractor shall be responsible for all misfits, errors, and damage and shall make the necessary corrections and replacements.

25. Falsework:

Falsework shall be designed, constructed, and removed as described in Subsection 704.03, Paragraphs 5. and 7.

26. Installation of shear connectors shall be in accordance with ANSI/AASHTO/AWS *Bridge Welding Code.*

708.04 -- Method of Measurement

1. a. "Steel Superstructure at Station _____" is measured as a lump sum.

b. Structural steel for substructures and superstructures is measured by the pound (kilogram).

c. Steel diaphragms are measured by the each.

d. Payment quantities are shown in the contract.

2. a. "Steel Superstructure at Station _____", "Structural Steel for Superstructure", and "Structural Steel for Substructure" shall include all structural steel and miscellaneous metals, except railing and handrails, necessary for the construction as shown in the contract.

b. The weight of structural steel shall be computed by the Department on the basis of the dimensions shown in the contract.

c. In the computation of quantities, no deductions will be made for copes, cuts, and open holes, except that in cases of gusset plates, tapered plates, and irregular shaped plates such as the webs and cover plates of tapered columns and the webs of curved plate girders, skewed bearing plates, and shim plates, the actual sizes as assembled in the completed structure shall be measured for payment. In the case of rolled plates which have been beveled by milling, payment will be made on the basis of full maximum thickness throughout.

d. The weight of paint or weld metal on structural steel will not be included in the quantities.

708.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Steel Superstructure at Station _____	Lump Sum (LS)
Structural Steel for Substructure	Pound (lb) [Kilogram (kg)]
Structural Steel for Superstructure	Pound (lb) [Kilogram (kg)]
Steel Diaphragm	Each (ea)

2. Direct payment for arc welding and prequalification testing, including all labor, equipment, materials, tools, and incidentals shall not be made but shall be considered subsidiary to the relevant items for which the contract provides direct payment.

3. The cost of furnishing and maintaining an inspection office will not be paid directly, but shall be considered subsidiary to the relevant items for which direct payment will be made.

4. All bolts and fasteners, including anchor and swedge bolts for bearing devices, shall not be paid for directly but shall be considered subsidiary to the various structural steel and steel diaphragm pay items.

5. Payment is full compensation for all work described in this Section.