

## SECTION 713 - STRUCTURAL STEEL AND RELATED MATERIALS

**713.01 Structural Steel.** The Contractor shall furnish the steel according \*|  
to the contract. The Contractor shall furnish structural carbon steel and \*|  
structural rivet steel. \*|

**(A) Structural Steel.**

(1) Structure carbon steel shall conform to ASTM A 36, Structural \*|  
Steel. \*|

(2) Steel for eyebars shall be of a weldable grade. These grades  
shall include:

(a) Structural Steel conforming to ASTM A 36,

(b) High-Strength Low Alloy Structural Steel of a weldable  
quality conforming to ASTM A 242, and

(c) High-Strength Low Alloy Structural Manganese Vanadium  
Steel conforming to ASTM A 441.

**(B) High-Strength Low Alloy Structural Steel.** High-Strength Low Alloy  
Structural Steel shall conform to ASTM A 242, ASTM A 441, ASTM A 572 or \*|  
ASTM A 588. \*|

**(C) High-Strength Low Alloy Structural Steel for Welding.** High-Strength  
Low Alloy Structural Manganese Vanadium Steel shall conform to ASTM A  
441 or ASTM A 242 of a weldable grade. \*|

**(D) High-Strength Structural Steel for Riveted or Bolted Construction.**  
High-Strength Structural Steel for riveted or bolted construction shall  
conform to ASTM A 572 or ASTM A 588. \*|

**713.02 Welded Stud Shear Connectors.** Stud shear connectors shall be of a  
design suitable for end welding to steel beams and girders with automatically  
timed stud welding equipment. The type, size or diameter, and length of stud  
shall be according to the contract. \*|

An arc shield (ferrule) of heat-resistant ceramic or other material  
shall be furnished with each stud. The material shall not be detrimental to  
the welds or cause excessive slag. Also, the material shall have sufficient  
strength so as not to crumble or break due to thermal or structural shock  
before completing the weld. \*|

Flux for welding shall be furnished with each stud, attached to the end  
of the stud or combined with the arc shield for automatic application in the  
welding operation.

The Contractor shall not paint or zinc-coat the studs. \*|

The Contractor shall use only qualified studs. A qualified stud shall \*|  
 have passed the Stud Weldability Qualification Procedure prescribed by the \*|  
 latest AASHTO Standard Specifications for Highway Bridges. The arch shield \*|  
 used in production shall be the same as used in the qualification tests. \*|  
 Qualification of the studs, before use under the contract, shall be at no \*|  
 cost to the State. \*|

Shear connector studs shall conform to ASTM A 108 grades 1015, 1017 or \*|  
 1020. If using flux retaining caps, the steel for the caps shall be of a \*|  
 low carbon grade suitable for welding and shall comply to ASTM A 109. \*|

Tensile properties established by tests of bar stock after drawing or of \*|  
 finished studs shall conform to following: \*|

Tensile Strength, psi (minimum)	60,000
Yield Strength <sup>1</sup> , psi (minimum)	50,000
Elongation, (minimum)	20% in 2 inches
Reduction of Area, percent (minimum)	50
<sup>1</sup> As established by a 0.2% offset method.	

The Contractor shall determine the tensile properties according to ASTM A \*|  
 370, Mechanical Testing of Steel Products. The Contractor shall make the \*|  
 tensile tests of finished studs on studs welded in test plates using a test \*|  
 fixture similar to that shown in Figure 2.10.23(B) of the latest AASHTO \*|  
 Standard Specifications for Highway Bridges. If fracture occurs outside the \*|  
 middle half of the gage length, the Contractor shall repeat the test. \*|

Finished studs shall be of uniform quality and condition, free from \*|  
 injurious laps, fins, seams, cracks, twists, bends or other injurious defects. \*|  
 The Contractor shall produce the finish by cold drawing, cold rolling or \*|  
 machining. \*|

The manufacturer shall certify that the studs delivered are according to \*|  
 the contract. The Contractor shall submit the certified copies of in-plant \*|  
 quality control test reports to the Engineer upon request. \*|

The Engineer may select studs of each type and size used as necessary for \*|  
 checking the requirements of this section at no cost to the State. \*|

Before the Contractor installs the studs, the Contractor shall submit the \*|  
 following information on the studs for acceptance: \*|

- (1) The name of the manufacturer.
- (2) A detailed description of the stud and arc shield.

(3) A certification from the manufacturer that the qualifying stud according to Article 2.10.23(C)(12) of the latest AASHTO Standard \* Specifications for Highway Bridges. \*

(4) A notarized copy of the qualification test report certified by the testing laboratory.

After welding, the studs shall be free from defects or substances that would interfere with their function as shear connectors. |

**713.03 Bolts and Nuts.** Bolts and nuts shall conform to ASTM A 307. \*

The Contractor shall zinc-coat or sherardize the anchor bolts including nuts and washers. \*|

The Contractor shall submit certified test results certifying compliance of the bolts and nuts according to the contract. The Contractor shall submit the certifications before installation of the bolts. \*|

**713.04 High-Strength Bolts.**

(A) **Bolts, Nuts and Washers.** Bolts, nuts and washers shall conform to ASTM A 325 Type 1. The Contractor shall hot dip zinc-coat the bolts, nuts, and washers. Nuts shall be Grade DH or 2H. For bolts one (1) inch or less in diameter, the maximum tensile strength shall be one hundred fifty (150) kips per square inch. For bolts larger than one (1) inch in diameter, the maximum tensile strength shall be one hundred twenty (120) kips per square inch. The manufacturer shall mark the bolts, nuts and washers according to appropriate AASHTO/ASTM Specifications. The Contractor shall identify ASTM A 325 Type 1 bolts on the top of the head by the legend "A 325". The manufacturer may mark them with three (3) radial lines one hundred twenty (120) degrees apart. The manufacturer marks the nuts for Type 1 bolts on one (1) face with the grade symbol DH or 2H. The manufacturer shall depress the markings on the bearing surfaces of the nuts and washers. Bolts, nuts and washers shall have the manufacturer's marking on them. \*|

Bolt and nut dimensions shall conform to Table 713-I and to Heavy Hexagon Structural Bolts and for Heavy Semi-Finished Nuts given in ANSI B18.2 except as allowed in the following paragraph. The Contractor shall not use ASTM A 325 Type 2 bolts. \*|

TABLE 713-I - BOLT AND NUT DIMENSIONS					
Nominal Bolt Size, D	Bolt Dimension, Inches			Nut Dimension, Inches	
	Heavy Hexagon Structural Bolts			Heavy Semi-Finished Hexagon Nuts	
	Width Across Flats, F	Height H	Thread Length T	Width Across Flats, W	Height H
1/2	7/8	5/16	1	7/8	31/64
5/8	1- 1/16	25/64	1-1/4	1- 1/16	39/64
3/4	1- 1/4	15/32	1-3/8	1- 1/4	47/64
7/8	1- 7/16	35/64	1-1/2	1- 7/16	55/64
1	1- 5/8	39/64	1-3/4	1- 5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1- 7/64
1-1/4	2	25/32	2	2	1- 7/32
1-3/8	2- 3/16	27/32	2-1/4	2- 3/16	1-11/32
1-1/2	2- 3/8	15/16	2-1/4	2- 3/8	1-15/32

The Contractor may use other fasteners providing the Contractor \*|  
conforms to the: \*|

(1) chemical composition of ASTM A 325 Type 1 bolts; \*|

(2) mechanical requirements of ASTM A 325 Type 1 bolts in full-size \*|  
tests; and \*|

(3) body diameter and bearing areas under the head and nut or their \*|  
equivalent more than those provided by a bolt and nut of these same \*|  
nominal dimensions shown in Table 713-I. |

Such alternate fasteners may differ in other dimensions from those \*|  
specified for ASTM A 325 bolts and nuts. The Contractor shall not use \*|  
bolts containing boron in their chemical composition. \*|

The Rockwell C hardness of the bolts shall have a minimum and maximum of 24 and 32, respectively, after heat treating and before zinc-coating.

Hardened washers shall have flat and smooth surfaces and their nominal dimensions shall conform to the dimensions in Table 713-II. The manufacturer shall mark the washers for ASTM A325 Type 1 bolts with a symbol to identify the manufacturer. \*

TABLE 713-II - WASHER DIMENSIONS (Inches)							
Circular Washers			Square or Rectangle Beveled Washers for American Standard Beams and Channels				
Bolt Size D	Nominal Outside Diam. <sup>a</sup>	Nominal Diam. of Hole	Thickness		Minimum Side Dimension	Mean Thick- ness	Slope Thick- ness
			Min.	Max.			
1/2	1- 1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1- 5/16	11/16	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1- 3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/8	.136	.177	1-3/4	5/16	1:6
1-1/8	2- 1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2- 1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2- 3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3- 3/8	1-7/8	.178 <sup>b</sup>	.28 <sup>b</sup>	-	-	-
2	3- 3/4	2-1/8	.178 <sup>b</sup>	.28 <sup>b</sup>	-	-	-
Over 2 to 4 Incl.	2D-1/2	D +1/8	.24 <sup>c</sup>	.34 <sup>c</sup>	-	-	-

<sup>a</sup> May be exceeded by 1/4 inch  
<sup>b</sup> 3/16 inch nominal  
<sup>c</sup> 1/4 inch nominal

Beveled washers for American Standard beams and channels shall be square or rectangular, shall taper in thickness and shall conform to the dimensions in Table 713-II.

If necessary, the Contractor may clip the washers on one side to a point not closer than seven-eighths (7/8) of the bolt diameter from the center of the washer. \*

The Contractor shall overlap the hot-dip zinc-coated nuts required for proper assembly. The amount of overlap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition. The \*

amount of overlap shall conform to the mechanical requirements of ASTM A \*|  
563 and the rotational-capacity test of ASTM A 563. The Contractor shall \*|  
consider paragraph 7.4 as maximum values. \*|

The Contractor shall lubricate zinc-coated nuts with a lubricant \*|  
containing a visible dye so the Contractor can make a visual check for \*|  
the lubricant at the time of field installation. |

**(B) Testing** |

**(1) Bolts** |

(a) The contract requires proof load tests according to ASTM F \*|  
606 Method 1. Minimum frequency of tests shall be according to \*|  
AASHTO M 164 (ASTM A 325) Paragraph 9.2.4. |

(b) The contract requires wedge tests on full size bolts \*|  
according to ASTM F 606 Paragraph 3.5. The Contractor shall \*|  
test the bolts after zinc-coating the bolts. Minimum frequency \*|  
of tests shall be according to AASHTO M 164 (ASTM A 325) \*|  
Paragraph 9.2.4. |

(c) The Contractor shall measure the thickness of the zinc \*|  
coating on the wrench flats or top of bolt head. \*|

**(2) Nuts** |

(a) The contract requires proof load tests according to ASTM F \*|  
606 Paragraph 4.2. Minimum frequency of tests shall be \*|  
according to AASHTO M 291 (ASTM A 563) Paragraph 9.3 or AASHTO \*|  
M 292 (ASTM A 194) Paragraph 7.1.2.1. The Contractor shall test \*|  
after zinc-coating, overlapping and lubricating the nut. \*|

(b) The Contractor shall measure the thickness of the zinc \*|  
coating on the wrench flats. |

**(3) Washers** |

(a) The Contractor shall test the hardness after zinc-coating \*|  
the washers. The Contractor shall remove the coating before \*|  
taking the hardness measurements. \*|

(b) The Contractor shall measure the thickness of the zinc \*|  
coating. |

**(4) Assemblies.** The contract requires rotational-capacity tests. \*|  
The Contractor shall test the bolt, nut and washer assemblies after \*|  
zinc-coating and before shipping. The contract required the washers \*|  
as part of the test. The Contractor may not need the washer as part \*|  
of the installation procedure. |

The following shall apply: |

(a) The Contractor shall do the rotational-capacity test \*|  
according to AASHTO M 164 (ASTM A 325) Except as modified  
herein. |

(b) The Contractor shall test each production lot combination \*|  
of bolt, nut, and washer as an assembly. The Contractor may \*|  
not include the washers in the lot identification if not \*|  
required by the installation procedures. |

(c) The Contractor shall assign a rotational-capacity lot \*|  
number assigned to each combination of lots tested. |

(d) The minimum frequency of testing shall be two (2) |  
assemblies per rotational-capacity lot. |

(e) The Contractor shall assemble the bolt, nut and washer \*|  
assembly on the Skidmore-Wilhelm Calibrator or an acceptable |  
equivalent device. This requirement supersedes the current |  
AASHTO M 164 (ASTM A 325) requirement that the Contractor \*|  
do the test in a steel joint. The Contractor shall see \*|  
Subsection 713.04(B)(4)(i) for bolts that assembled too short \*|  
in the Skidmore-Wilhelm Calibrator. |

(f) The minimum rotation from a snug tight condition (ten |  
percent of the specified proof load) shall be: |

1. two hundred forty (240) degrees (2/3 turn) for bolt |  
lengths less than four (4) diameters; |

2. three hundred sixty (360) degrees (1 turn) for bolt |  
lengths greater than four (4) diameters and less than |  
eight (8) diameters; and |

3. four hundred eighty (480) degrees (1-1/3 turn) for |  
bolt lengths greater than eight (8) diameters. |

(NOTE: These values differ from Table 8 AASHTO M 164 |  
(Table 8 ASTM A 325 Specifications). |

(g) The tension reached at the above rotation shall be equal |  
to or greater than 1.15 times the required installation |  
tension. The installation tension and the tension for the |  
turn test are shown below: |

TABLE 713-III - INSTALLATION TENSION AND TURN TEST TENSION		
Diameter (Inches)	Required Installation Tension (kips)	Turn Test Tension (kips)
1/2	12	14
5/8	19	22
3/4	28	32
7/8	39	45
1	51	59
1-1/8	56	64
1-1/4	71	82
1-3/8	85	98
1-1/2	103	118

(h) After exceeding the required installation tension listed \* above, the Contractor shall take and record one reading of \* tension and torque. The torque value shall conform to the \* following: |

$$\text{Torque} \leq 0.25 \text{ PD}$$

Where: Torque = Measured Torque, Foot-Pounds |

P = Measured Bolt Tension, Pounds |

D = Nominal Diameter (Feet) |

(i) The Contractor may test the Bolts that are too short to \* test in a Skidmore-Wilhelm Calibrator in a steel joint. The \* tension requirement of Subsection 713.04(B)(4)(g) need not \* apply. The Contractor shall compute the maximum torque \* requirement of Subsection 713.04(B)(4)(h) using a value of P \* equal to the turn test tension shown in the table in Subsection \* 713.04(B)(4)(g). |

#### (5) Reporting |

(a) The Contractor shall record the results of tests (including \* zinc coating thickness) required herein and in the appropriate \* AASHTO specifications on the appropriate document. |

(b) The Contractor shall report the location where the \* Contractor is doing tests and date of tests on the appropriate \* document. |



**(6) Witnessing**

(a) An inspection agency need not witness the tests. The manufacturer of distributor that does the tests shall certify that the results recorded are accurate.

**(C) Documentation****(1) Mill Test Reports (MTR)**

(a) The Contractor shall submit MTR for mill steel used in the manufacturing of the bolts, nuts, or washers.

(b) The MTR shall show where the manufacturer melted and made the material.

**(2) Manufactured Certified Test Reports (MCTR)**

(a) The Contractor shall submit the MCTR of the bolts, nuts, and washers.

(b) Each MCTR shall show the relevant information required in Subsection 713.04.(B)(5).

(c) The manufacturer performing the rotational-capacity test shall include on the MCTR:

(1) The lot number of each item tested;

(2) The rotational-capacity lot number as required in Subsection 713.04(B)(4)(c);

(3) The results of the tests required in Subsection 713.04(B)(4);

(4) The pertinent information required in Subsection 713.04(B)(5)(b);

(5) A statement that the MCTR for the nuts, bolts, and washers complies with Subsection 713.04 and the AASHTO specification; and

(6) The location where the manufacturer makes the bolt assembly components.

**(3) Distribution Certified Test Reports (DCTR)**

(a) The DCTR includes the MCTR from above for the various bolt assembly components;

(b) A distributor make do the rotational-capacity test and report the test on the DCTR;

(c) The DCTR shall have the results of the tests required in Subsection 713.04(B)(4);

(d) The DCTR shall have the pertinent information required in Subsection 713.04(B)(5)(b);

(e) The DCTR shall have the rotational-capacity lot number as required in Subsection 713.04(B)(4)(c); and

(f) The DCTR shall certify that the MCTR are according to Subsection 713.04 and the AASHTO specification. \*

**(D) Shipping**

(1) The Contractor shall ship bolts, nuts, and washers from each rotational-capacity lot in the same container. If only one (1) production lot number for each size of nut and washer exists, the Contractor may ship the nuts and washers in separate containers. The Contractor shall mark each container permanently with the rotational-capacity lot number such that identification will be possible at stages before installation. \*

(2) The Contractor shall submit the appropriate MTR, MCTR or DCTR required by the contract.

**(E) Installation.** AASHTO Division II, Section 10 and as modified herein applies when installing high-strength bolts in the field or shop: \*

(1) The Contractor shall install the bolts according to AASHTO, Division II, Article 10.17.4.6, "Direct Tension Indicator Tightening". During installation, the Contractor shall get the snug condition defined in Article 10.17.4.6. \*

(2) The Contractor shall do the rotational-capacity test described in Subsection 713.04(B)(4) on each rotational-capacity lot before the start of bolt installation. Required are hardened steel washers as part of the test even if the Contractor may not require the washers in the actual installation. \*

(3) The Contractor shall require a Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device at each job site during erection. The Contractor shall do periodic testing to assure compliance with the installation test procedures required on AASHTO Division II Article 10.17.4.1 "Direct Tension Indicator Tightening". The Contractor may test the bolts that are too short for the Skidmore-Wilhelm Calibrator using Direct Tension Indicators (DTI) with solid plates. The Contractor shall calibrate the DTI in the Skidmore-Wilhelm Calibrator using longer bolts. \*

(4) Bolt, nut, and washer (when required) combinations installed shall be from the same rotational-capacity lot.

(5) The Contractor shall submit the test reports and accurate \*|  
 direct measurement procedures to the Engineer for acceptance before \*|  
 beginning the work to show that the high strength bolts tightened \*|  
 by the use of the Direct Tension Indicator conforms to Subsection \*|  
 713.04(B)(4)(g) for Required Installation Tension. \*|

**713.05 Pins and Rollers.** The Contractor shall turn the pins and rollers \*|  
 accurately to the dimensions shown in the contract. The pins and rollers \*|  
 be straight, smooth and free from flaws. |

The Contractor shall forge and heat-treat the pins and rollers more than \*|  
 nine (9) inches in diameter according to Article 1.7.4 of the latest AASHTO \*|  
 Standard Specifications for Highway Bridges. The Contractor may forge and \*|  
 heat-treat the pins and rollers nine (9) inches or less in diameter or cold- \*|  
 finish carbon-steel shafting. |

In pins larger than nine (9) inches in diameter, the Contractor shall \*|  
 bore a hole more than two (2) inches in diameter full length along the axis. \*|  
 The Contractor shall bore the hole only after allowing the forging to cool to \*|  
 a temperature below the critical range under suitable conditions. \*|

**713.06 (Unassigned)**

**713.07 Steel Forgings and Steel Shafting.**

**(A) Carbon Steel Forgings.** Steel forgings shall conform to ASTM A 668. \*|  
 The Contractor shall furnish Class 1 forgings. \*|

**(B) Cold-Finished Carbon Steel Shafting.** Cold-Finished Carbon Steel \*|  
 Shafting shall conform to ASTM A 108. The Contractor shall furnish \*|  
 Grade Designation 1016-1030 shall be furnished. \*|

**713.08 Steel Castings.**

**-(A) Steel Castings for Highway Bridges.** Steel castings shall conform \*|  
 to ASTM A 27. The Contractor shall furnish Grade 65-35. \*|

The Contractor shall anneal steel castings thoroughly. \*|

Steel castings shall be:

- (1) true to pattern in form and dimensions,
- (2) free from pouring faults,
- (3) free from sponginess,
- (4) free from cracks,
- (5) free from blowholes and

(6) free from other defects in positions affecting their strength and value for the service intended.

The Contractor shall locate blowholes appearing on finished castings \*| so that a straight line laid in any direction shall not cut a total length of cavity greater than one (1) inch in twelve (12) inches. Also, single blowholes shall not exceed one (1) inch in any dimension or have \*| an area greater than half (1/2) square inch. Blowholes shall not have a depth injuriously affecting the strength of the casting. The Contractor may weld minor defects, with permission, by an accepted process that do \*| not impair the strength. \*|

The Contractor shall remove the defects to solid metal by chipping, \*| drilling or other accepted method. After removing the defects, the Contractor shall deposit the weld metal in the depression to at least \*| one-eighth (1/8) inch above the surface. The deposited metal shall be sound throughout and shall be free from excessive oxides, non-metallic inclusions, and gas pockets. The weld metal shall penetrate every recess in the base metal. The Contractor shall fuse the weld metal thoroughly \*| with the base metal along surfaces and edges of fusion. The weld metal along the edges of the deposit shall merge with a gradual taper into the base metal without reentrant projection (overlap). The Contractor shall \*| not reduce the base metal along the edges of the removed area in thickness (undercut or robbed) by the welding operation. Only qualified \*| operators shall do the welding using equipment according to the contract. \*|

The Engineer will reject non-inspected or non-accepted welded \*| castings. \*|

If required, the Contractor shall suspend and hammer the large \*| castings. No cracks, flaws or other defects shall appear after such \*| treatment.

The Engineer will not allow sharp, unfilleted angles or corners. \*|

(B) Chromium Alloy-Steel Castings. Chromium Alloy-Steel Castings shall conform to ASTM A 743 or ASTM A 744. The Contractor shall furnish Grade \*| CA 15. \*|

713.09 Gray Iron Castings. Gray iron castings shall conform to ASTM A 48. The Contractor shall furnish Class No. 30. \*|

Iron castings shall be:

- (1) true to pattern, in form and dimensions,
- (2) free from pouring faults,
- (3) free from sponginess,
- (4) free from cracks,

(5) free from blowholes, and

(6) free from other defects affecting their strength and value for the service intended.

The Contractor shall fillet the castings boldly at angles. The arrises \*| shall be sharp and perfect.

The Contractor shall sandblast and clean the castings of scale and sand \*| to present a smooth, clean, and uniform surface.

**713.10 Malleable Casting.** Malleable castings shall conform to ASTM A 47. \*|  
The Contractor shall furnish Grade No. 35018. \*|

Malleable castings shall be:

(1) true to pattern in form and dimensions,

(2) free from pouring faults,

(3) free from sponginess,

(4) free from cracks,

(5) free from blowholes, and

(6) free from other defects affecting their strength and value for the service intended.

The Contractor shall fillet the castings boldly at angles. The arrises \*| shall be sharp and perfect. The surfaces shall have a finish according to \*| the contract. \*|

The Contractor shall sandblast and clean the castings of scale and sand \*| to present a smooth, clean, and uniform surface.

### 713.11 Sign Posts.

**(A) Pipe Posts.** Pipe posts shall be zinc-coated standard weight steel \*| pipe conforming to ASTM A 120. The Contractor shall equip the portion of \*| the post that the Contractor will embed below finish grade with an \*| accepted device to resist turning of the post after installation. The \*| post shall be a one (1) piece pipe of the required length. If permitted, \*| the Contractor may use pipe posts with one (1) welded joint. The joint \*| shall be below the finished grade. The pipe post shall have two (2) \*| three-eighths (3/8) inch diameter holes, appropriately located, or \*| accepted adjustable band brackets. \*|

**(B) Channel Posts.** Channel posts shall be of a uniform flanged channel \*| section produced from high strength rail steel according to ASTM A 499, \*| grade 60 and zinc-coated according to ASTM A 123. \*|

The weight of each anchor base post and sign post, before punching holes, shall be two and a half (2-1/2) or four (4) pounds per foot \*| according to the contract. The weight tolerance shall be  $\pm$  three and a \*| half (3-1/2) percent.

The Contractor shall punch the anchor base post with a minimum of \*| ten (10) seven-sixteenths (7/16) inch diameter holes. The Contractor \*| shall center the in the web. The Contractor shall space the holes one (1) \*| inch on centers except that the first and fifth holes shall be seven-sixteenths (7/16) inch by half (1/2) inch slots. The first hole shall be one (1) inch from the top. The Contractor shall point the base. \*|

The Contractor shall punch the sign post with seven-sixteenths (7/16) inch diameter holes centered in the web and spaced one (1) inch on centers, full length. The first and last holes shall be one (1) inch from the ends.

(C) **Square Tube Posts.** Square tube posts shall be low carbon cold rolled steel. The tube shall have a hot-dip zinc-coated 1.25 ounce coating conforming to ASTM A 525. The Contractor shall make the corner \*| welds by high frequency resistance welding, externally scarfed, and zinc-coated after scarfing. Four (4) sides of the square tube post shall have \*| seven-sixteenths (7/16) inch diameter holes spaced one (1) inch on centers along the entire length of the post. Permissible tolerances are shown in Table 713-IV. |

TABLE 713-IV - SQUARE TUBE POST TOLERANCE							
Physical Property	Nominal Outside Size, inch						
	1-1/2 Square	1-3/4 Square	2 Square	2-1/4 Square	2-1/2 Square	2-3/16 Square	2-1/2 Square
U.S. Standard Gage	12			10			
Wall Thickness Inch	0.105, +0.011, -0.008				0.135, +0.011, -0.008		
Min. Wt. Lbs/Ft	1.7	2.0	2.4	2.7	3.1	3.4	4.0
Outside Dimension Inch	$\pm 0.006$	$\pm 0.008$	$\pm 0.008$	$\pm 0.010$	$\pm 0.010$	$\pm 0.010$	$\pm 0.010$

Side Squareness Inch	CON'T						
	+0.009	+0.010	+0.012	+0.014	+0.015	+0.014	+0.015
Twist Permitted Inch/Foot	.50/3	.062/3	.062/3	.062/3	.075/3	.062/3	.075/3
Straightness	1/16 inch in 3 feet						
Telescoping	Consecutive size tubes shall telescope freely for 10 feet						
Hole Size Inch	±1/64						
Hole Spacing Inch	±1/8 in 20 feet						

Single square tube post used to support signs shall have an accepted device to resist turning after installation. The Contractor \* shall attach this device to the post and embed this device below finish \* grade.

#### 713.12 Fasteners for Signs.

(A) The Contractor shall secure the regulatory signs, warning signs and route marker assemblies, mounted on pipe posts, in position by using \* stainless steel washers with neoprene gaskets. The Contractor shall \* install them between the post and sign and under the bolt head on the \* sign surface. Bolts and other metal washers shall be wrought iron zinc- \* coated by the hot-dip process according to ASTM A 153. \*

(B) Post Clips for extruded aluminum sign panels shall be of aluminum conforming to ASTM B 108, alloy 356-T6. Post clip bolt assemblies shall \* have: \*

(1) aluminum bolts conforming to ASTM B 211, alloy 2024-T4, \*

(2) aluminum lock nuts conforming to ASTM B 211, alloy 2017-T4, \* (0.0002-inch minimum anodic coating thickness with dichromate or \* boiling water seal) and \*

(3) the flat washers or aluminum-alloy Alcaid 2024-T4, ASTM B 209. \*

**713.13 Ground Mounted Destination and Expressway Sign Supports.** Structural steel members and anchor bolts shall conform to ASTM A 283, A 663 or A 675. Structural steel members and the upper ten (10) inches of the anchor bolts \* shall be hot-dip zinc-coated according to ASTM A 123. \*

## 713.14 Overhead Expressway Sign Supports.

## (A) Steel Supports.

(1) **Tapered Posts And Cross Arms.** Sheet steel shall conform to ASTM A 570, Grade D or ASTM A 611, Grade D. Also, they may be of \*) weldable grade with a minimum yield point of forty thousand (40,000) \*) pounds per square inch.

Posts and arms shall be tubular and have a constant taper. |

The manufacturer shall make tubular section with only one (1) \*) continuous longitudinal weld to each section. The Contractor shall \*) welding the tubular section by an accepted submerged arc welding \*) process. The manufacturer shall make the tubular sections from full \*) length sheets or from sheets not shorter than ten (10) feet in length. The Engineer will permit only one (1) transverse joint per \*) post and per arm. The Contractor shall reinforce the butt welded \*) transverse joints by inserting a metal sleeve at each joint. The \*) sleeve shall be No. 10 US gage or thicker steel and have the same chemical composition as the metal joined. The sleeve shall be No. 10 U.S. gage or thicker steel and have the same chemical composition as the metal joined. The metal sleeve shall:

- (a) be at least one (1) inch long,
- (b) be centered at the joint,
- (c) have the same taper as the section joined, and
- (d) have full contact throughout its length and circumference.

The variation of the centerline of the post or arm shall not exceed three-quarters (3/4) inch. The Contractor shall measure at \*) mid-length, from a straight line drawn from from the centers of the \*) ends of a theoretically straight post of similar length. The diameter of the tubular section shall not vary + one (1) percent from the theoretical diameter at cross sections of the cross arm and the post.

The Contractor shall construct two (2) ply post tubes \*) separately according to the above. The Engineer will not permit \*) transverse joints. The Contractor shall then telescope the tubes \*) together and reroll the tubes as a unit on a hardened steel mandrel. \*)

Gages shall be of the following thicknesses:



A two (2) ply No. 3 gage means a tapered tube of two (2) ply thickness, each ply being No. 3 gage.

**(2) Uniform Tubes, Posts and Cross Arms.** The poles shall be seamless welded black and hot-dipped zinc-coated steel that conform to ASTM A 53 Grade B, Type S (Seamless) or Type E (Electrical-resistance Weld).

Structural shapes shall conform to ASTM A 36 and hot-dipped components shall conform to ASTM A 123.

High strength bolts, nuts and washers shall conform to ASTM A 325. The Contractor shall zinc-coat them according to ASTM A 153. \*)

The design shall conform to "AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminated and Traffic Signs."

**(3) Base Plate.** Steel for base plates shall conform to ASTM A 36. The Contractor shall finish the exposed edges smooth and round the exposed corners neatly. \*)

**(4) Structural Steel and Anchor Bolts.** Structural steel and anchor bolts shall conform to ASTM A 36 and A 307. The Contractor shall furnish anchor bolts with two (2) nuts, one (1) lock washer and one (1) plain washer. \*)

**(5) Fastenings.** Fastenings used at locations other than in sign panels shall be zinc-coated wrought iron. |

High-strength bolts and nuts shall conform to ASTM A 325 except that the Rockwell C hardness of the bolts shall not exceed thirty-two (32) after heat treating and before zinc-coating. The certification for the bolts shall be the inspection test report specified in paragraph 9.3.7 or 9.4.6 of ASTM A 325. \*)

**(B) Aluminum Supports.**

**(1) General.** The Contractor shall check every span assembly for alignment and sound welds according to the contract. Every span shall be dead load tested at the factory before delivery. \*)

Welding shall conform to the latest AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals." \*)

The fabricator shall submit certified proof of the qualifications for a minimum of four (4) welders at the time of submission of the shop drawings. Certification shall be from a commercial or public testing laboratory. The Contractor shall base the qualifications upon welding of aluminum 6061-T6 with \*)

consumable electrode type welding using aluminum alloy 4043 filler materials. Welders shall qualify by passing the United States Military Specifications MIL-T-5021, Group IV, Class A. Certified welders shall weld using the inert-gas shielded-arc method. The fabricator shall check the welding carefully by visual inspection of welds, proof testing of welds, and by destructive testing of weld samples fabricated during the production welding. \*

The fabricator shall have a functioning quality control or inspection department with qualified inspector. The fabricator shall equip the inspector properly so they can consistently do their duties at a level reflecting the normal state of the art. \*

The Contractor shall make the field erection connections and assure the integrity of the truss and span design. The intent of this section is not to use welding in the course of the field erection. If the Contractor requires field welding to complete the erection, the Engineer will impose the same controls imposed on the fabricator. \*

The Contractor shall weld with consumable electrodes using Aluminum Alloy 4043 as filler. \*

The Contractor shall be responsible for furnishing the basic components required in the fabrication and erection of the signs according to the following schedule: \*

STRUCTURAL COMPONENTS		
Item	Alloy <sup>1</sup>	Temper <sup>1</sup>
Structural shapes, including 1 beam post	6061	T-6
Tubular members including tubular posts	6061	T-6
Castings	356	T-6
<sup>1</sup> If the Contractor elects to substitute an alloy or temper, the Contractor shall request permission of the substitution in the submittal of the shop drawing.		

(2) **Truss Section.** The Contractor shall fabricate the truss sections as all-welded one (1) piece units with braces welded to main chords. The Contractor shall cut and trim the braces for proper fit. Certified welders shall do the welding. The Contractor shall join the sections by cast aluminum flanges welded to the chords with a double weld and bolted together. Two (2) or more span sections bolted together and suitably fastened to the supporting frames shall comprise the complete structure. The Contractor shall cap the chords \*

of the end sections. The span shall have sufficient camber to overcome dead load deflection and illusion of sag. \*

**(3) Frame.** The frame that support the span structure shall be rectangular in shape and include two (2) tapered shafts joined by braces of the proper size welded between them. The Contractor shall construct the frame so the frame can receive the lower chords of the span end on supporting platforms. Fasten the chords by stainless steel "U" bolts. The Contractor shall fasten the upper chords of the span directly to the frame shafts by stainless steel "U" bolts. \*

The shaft shall be seamless, tapered tube of sufficient diameters and wall thickness to withstand full design loads. The Contractor shall double weld the bottom end of the shaft to the shoe base. The Contractor shall provide the top of the shaft with a pole cap. The Contractor shall mount the frames on the footings by fastening the shoe bases on the embedded anchor bolts. The base shall have not less than four (4) holes (ninety degrees apart) on a bolt circle to accept the anchor bolts with the proper clearance. The Contractor shall coat the under side of the base with bituminous paint. \*

**(4) Fastenings.** The Contractor shall be responsible for furnishing the fastenings required for fabrication and erection of the sign posts, frames, spans, signs and items according to the following requirements: \*

(a) Stainless steel bolts shall be of a size, alloy and temper that shall provide the structural strength required in the completed connection. The Contractor shall furnish the Stainless steel bolts with stainless steel flat washers, stainless steel lock washers, where required, and hex head, elastic stop stainless steel nuts. \*

(b) Aluminum bolts, including "J" bolts, shall be five-sixteenths (5/16) inch - 8x length required and shall be Alloy 2024, Temper T-4. The Contractor shall furnish aluminum bolts with aluminum flat washer, aluminum lock washer, where required, and hex head nuts. The Contractor shall finish the bolts, washers and nuts with alumilite finish 204. \*

(c) Anchor bolts shall be of a size that shall provide the structural strength required in the completed connection. Anchor bolts shall have a proper right angle hook to develop a structurally sound bond in the transferring of the loads to the concrete foundation. Anchor rod material shall have a minimum tensile yield strength of fifty thousand (50,000) pounds per square inch. The Contractor shall hot dip zinc-coat the threaded ends hex head leveling nut, hex head securing nut, flat washer and lock washer. \*