SECTION 16442

METAL FOR STRUCTURES

PART 1 DESCRIPTION

A. Provide structural steel, high-strength bolts, forgings, steel castings, iron castings, wrought iron, steel pipe and tubing, aluminum castings and tubing, or other metals used in structures, except reinforcing steel and metal culvert pipe.

PART 2 MATERIALS

A. Furnish mill test reports (MTRs), supplemental test documentation, and certifications required by this and other pertinent Items.

2.01 STRUCTURAL STEEL

A. The Owner's Representative may sample and test steel in accordance with ASTM A 370.

1. Bridge Structures

a. Provide the grade of ASTM A 709 steel shown on the plans. Grade 50W, 50S, or HPS 50W may be substituted for Grade 50 at no additional cost to the City. For tension members and components, provide steel that meets test requirements for non-fracture-critical applications fracture-critical applications. If no AASHTO temperature zone is shown on the plans, use Zone 1.

2. Non-Bridge Structures

a. Steel Classifications

(1). Provide the types and grades of steel listed in this Section unless otherwise shown on the plans.

(a). Carbon Steel.

I. Meet ASTM A 36

(b). Low-Alloy Steel

I. Meet the requirements of one of the following standards:

i. ASTM A 572 Grade 50 or 55;

ii. ASTM A 588;

iii. ASTM A 709 Grade 50, 50S, 50W, or HPS 50W; or

iv. ASTM A 992.

II. Specify ASTM A 6 supplemental requirement S18, "Maximum Tensile Strength," for material used for sign, signal, and luminaire supports.

b. Impact Testing

(1). Tension members and components of the following structure types, if more than 1/2 in. thick, and other members designated on the plans must meet the Charpy V notch (CVN) requirements of Table 1:

(a). base plates for roadway illumination assemblies, traffic signal pole assemblies, high mast illumination poles, and overhead sign supports;

(b). arm mounting plates and clamp-on plates for traffic signal pole assemblies;

(c). pole shafts, ground sleeves, and handhole frames for high mast illumination poles; and

(d). W-columns, tower pipes, multiple-sided shafts, tower pipe and multiple-sided shaft connection plates, chord angles, chord splice plates or angles, and truss bearing angles for overhead sign supports.

Table 1
CVN Requirements for Non-Bridge Steel

Material	**Thickness**	**Minimum CVN Toughness**
ASTM A 36, A 53, A 242, A 500, A 501, A 709 Gr. 36, any other steel with minimum specified yield point below 40 ksi	up to 4"	15 ft.-lb. at 70°F
ASTM A 572[1], A 588[1], A 633[1], any other steel with minimum specified yield point between 40 and 65 ksi, inclusive	up to 2"	15 ft.-lb. at 70°F
	over 2" to 4", mechanically fastened	15 ft.-lb. at 70°F
	over 2" to 4", welded	20 ft.-lb. at 70°F
Any steel with minimum specified yield point over 65 ksi and under 90 ksi[2]	up to 2-1/2"	20 ft.-lb. at 50°F
	over 2-1/2" to 4", mechanically fastened	20 ft.-lb. at 50°F
	over 2-1/2" to 4", welded	25 ft.-lb. at 50°F

1. If the yield point of the material given on the MTR exceeds 65 ksi, reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 65 ksi.
2. If the yield point of the material given on the MTR exceeds 85 ksi, reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 85 ksi.

c. Use the (H) frequency of testing for material with minimum specified yield point up to and including 50 ksi. Use the (P) frequency of testing for material with minimum specified yield point over 50 ksi. Ensure that steel is sampled and tested in accordance with ASTM A 673.

3. Other Components

a. Miscellaneous Bridge Components

(1). For members such as steel bearing components not bid under other Items, steel diaphragms for use with concrete bridges, armor joints, and finger joints, provide steel that meets ASTM A 36, A 709 Grade 36, or A 500 Grade B unless otherwise shown on the plans.

b. Shear Connectors and Anchors

(1). For stud shear connectors, slab anchors, and anchors on armor joints and finger joints, provide cold-drawn bars that meet the requirements of ASTM A 108, Grade 1010, 1015, 1018, or 1020, either semi-killed or killed, and that have the tensile properties given in Table 2 after drawing or finishing. Determine tensile properties in accordance with ASTM A 370.

Table 2
Minimum Tensile Properties for Bar Stock

Tensile strength	60 ksi
Yield strength	50 ksi
Elongation	20% (2")
Reduction of area	50%

(2). Provide certification from the manufacturer that the studs or anchors as delivered have the required material properties.

c. Fasteners

(1). Provide high-strength bolts that meet ASTM A 325 or A 490 as shown on the plans. The Owner's Representative may sample high-strength bolts, nuts, and washers for structural connections.

(2). Follow the requirements of Item 16447, "Structural Bolting," for tests, test reports, and supplemental requirements for high-strength bolts, nuts, and washers.

(3). When ASTM A 325 or A 490 bolts are not shown on the plans, use bolts that meet ASTM A 307 and nuts that meet ASTM A 563.

d. Slip-resistant Deck Plates

(1). For deck plates, furnish steel that meets ASTM A 786 and one of A 242, A 588, or A 709 Gr. 50W. State the type and trade name of material to be used on the shop drawings.

e. Rail Posts

(1). Provide material for rail posts that meets ASTM A 36 or ASTM A 709 Grade 36 unless otherwise shown on the plans.

2.02 STEEL FORGINGS

A. Provide steel forgings for pins, rollers, trunnions, or other forged parts that meet ASTM A 668, Class C, D, F or G, as shown on the plans. For pins 4 in. or smaller in diameter for non-railroad structures, material that meets ASTM A 108, Grades 1016 to 1030, with a minimum yield strength of 36 ksi, may be used instead.

2.03 STEEL CASTINGS

A. Provide steel castings that meet ASTM A 27, Grade 70 36.

2.04 IRON CASTINGS

A. Provide iron castings that are true to pattern in form and dimensions; are free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended; and meet the standards shown in Table 3.

Table 3
Standards for Iron Castings

Casting Material	ASTM Standard	Grade or Class
Gray iron	A 48	35B
Malleable iron	A 47	32510
Ductile iron	A 536	65-45-12

2.05 STEEL TUBING

A. Provide steel tubing that meets ASTM A 500, Grade B unless otherwise shown on the plans. Tubing that meets API Standard 5L, Grade X52 may be used if produced by a mill listed in the standard API specifications as authorized to produce pipe with the API monogram. Hydrostatic tests are not required for API 5L steel, and instead of a mill test report the manufacturer may furnish a certificate for each lot or shipment certifying that the tubing meets the requirements of this Section.

2.06 PIPE RAIL

A. "Pipe" includes special extruded and bent shapes. Provide pipe that is rolled, extruded, or cold-pressed from a round pipe or flat plate, and of the section shown on the plans.

B. If pipe is cold-pressed, ensure that the design of the press and dies results in a pipe of uniform section free from die marks. After the pipe has been formed to the required section, cut it to the lengths required. Make the end cuts and notches at the angles to the axis of the pipe required to produce vertical end faces and plumb posts when required by the plans. Provide a neat and workmanlike finish when cutting and notching pipe.

2.07 ALUMINUM

A. Unless otherwise shown on the plans, provide aluminum materials that meet the standards shown in Table 4.

Table 4
Aluminum Standards

Material	ASTM Standard	Alloy-Temper
Castings	B 108	A444.0-T4
Extrusions	B 221	6061-T6
Sheet or plate	B 209	6061-T6

B. When testing is required, cut test specimens from castings from the lower 14 in. of the tension flange but not at the junction of the rib or base. Flatten the curved surfaces before machining. Provide standard test specimens in conformance with ASTM E 8.

PART 3 CONSTRUCTION

3.01 FABRICATION, ERECTION, AND PAINTING

A. Fabricate, weld, and erect structural metal in accordance with Item 16441, "Steel Structures"; Item 16447, "Structural Bolting"; Item 16448, "Structural Field Welding"; and the applicable AWS welding code. Paint in accordance with Item 16446, "Cleaning and Painting Steel." Aluminum or galvanized steel members do not require painting unless otherwise shown on the plans.

3.02 GALVANIZING

A. Galvanize fabricated steel items, steel or iron castings, bolts, nuts, screws, washers, and other miscellaneous hardware in accordance with Item 16445, "Galvanizing." Galvanizing is not required unless specified.

PART 4 MEASUREMENT

A. This Item will be measured by the pound of structural metal furnished and placed in a complete structure not including the weight of erection bolts, paint, or weld metal.

B. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal. Additional measurements or calculations will be made if adjustments of quantities are required.

C. The maximum percent variance from the plans quantity will be as given in Table 5.

Table 5
Percent Variance

Quantity	Variance
Over 1,000,000 lb.	1/2%
100,000 through 1,000,000 lb.	1%
Under 100,000 lb.	1-1/2%

D. If the Owner's Representative approves requests for increases in sizes or weights of members, measurement will be made on the sizes or weights shown on the plans.

E. Castings, bearing plates, anchor bolts, drains, deck plates, armor joints, finger joints, and other metal for which no separate measurement is specified will be included in the total quantity of structural steel.

F. The weights of rolled materials (such as structural shapes and plate) will be computed on the basis of nominal weights and dimensions using measurements shown on the plans. Deductions will not be made for material that is removed for copes, clips, planing, or weld preparation. The weight of castings will be computed from the dimensions shown on the approved shop drawings. Shoes will be measured by the weights shown on the plans.

G. Weight of high-strength fasteners will be based on Table 6. Weight of other metal will be based on Table 7.

H. Splices will be measured as follows:

1. No additional weight will be allowed for weld metal in a welded splice.

2. Where a bolted splice is permitted as an alternate for a welded splice, measurement will be made on the basis of a welded splice.

3. Where a bolted splice is required, the weight of the splice material, bolt heads, washers, and nuts will be measured with no deduction for holes.

Table 6
Pay Weight for High-Strength Fasteners, Pounds per Hundred Units

Diameter	**Item**		
	Bolt heads	**Nuts**	**Washers**
3/4"	15	19	4.8
7/8"	23	30	7.0
1"	32	43	9.4
1-1/8"	45	59	11
1-1/4"	64	79	14

Table 7
Pay Weight for Metals

Material	**Weight (lb./cu. in)**
Steel	0.2836
Cast iron	0.2604
Wrought iron	0.2777

PART 5 PAYMENT

A. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Structural Steel" of the type (Rolled Beam, Plate Girder, Tub Girder, Box Girder, Miscellaneous) specified. This price is full compensation for materials, fabrication, transportation, erection, paint, painting, galvanizing, equipment, tools, labor, and incidentals.

END OF SECTION