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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing[1]

This standard is issued under the fixed designation A 618; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers grades of hot-formed welded and seamless high-strength low-alloy square, rectangular, round, or special shape structural tubing for welded, riveted, or bolted construction of bridges and buildings and for general structural purposes. When the steel is used in welded construction, the welding procedure shall be suitable for the steel and the intended service.

1.2 Grade II has atmospheric corrosion resistance equivalent to that of carbon steel with copper (0.20 minimum Cu) Grades Ia and Ib have atmospheric corrosion resistance substantially better than that of Grade II (Note 1). When properly exposed to the atmosphere, Grades Ia and Ib can be used bare (unpainted) for many applications. When enhanced corrosion resistance is desired, Grade III, copper limits may be specified.

NOTE 1—For methods of estimating the atmospheric corrosion resistance of low alloy steels see Guide G 101 or actual data.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[2]

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment[3]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[2]

G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels[4]

3. Ordering Information

3.1 Orders for material under this specification should include the following as required to describe the material adequately:

3.1.1 Quantity (feet or number of lengths),

3.1.2 Grade (Table 1 and Table 2),

3.1.3 Material (round, square, or rectangular tubing),

3.1.4 Method of manufacture (seamless, buttwelded, or hot-stretch-reduced electric-resistance welded),

3.1.5 Size (outside diameter and nominal wall thickness for round tubing and the outside dimensions and calculated nominal wall thickness for square and rectangular tubing),

3.1.6 Length (specific or random, see 8.2),

3.1.7 End condition (see 9.2),

3.1.8 Burr removal (see 9.2),

3.1.9 Certification (see 12.1),

3.1.10 Specification designation,

3.1.11 End use, and

3.1.12 Special requirements.

4. Process

4.1 The steel shall be made by one or more of the following processes: open-hearth, basic-oxygen, or electric-furnace.

4.2 Steel may be cast in ingots or may be strand cast. When steels of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by any established procedure that positively separates the grades.

5. Manufacture

5.1 The tubing shall be made by the seamless, furnace-buttwelded (continuous-welded), or hot-stretch-reduced electric-resistance-welded process.

6. Chemical Composition

6.1 When subjected to the heat and product analysis, respectively, the steel shall conform to the requirements prescribed in Table 1.

6.1.1 For Grades Ia and Ib, the choice and use of alloying elements, combined with carbon, manganese, and sulfur within the limits prescribed in Table 1 to give the mechanical properties prescribed in Table 2 and to provide the atmospheric corrosion resistance of 1.2, should be made by the manufacturer and included and reported in the heat analysis for information purposes only to identify the type of steel applied. For Grades Ia and Ib material, the atmospheric corrosion-resistance index, calculated on the basis of the chemical

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 03.02.

TABLE 1 Chemical Requirements

Element	Composition, %							
	Grade Ia		Grade Ib		Grade II		Grade III	
	Heat	Product	Heat	Product	Heat	Product	Heat	Product
Carbon, max	0.15	0.18	0.20	. . .	0.22	0.26	0.23[A]	0.27[A]
Manganese	1.00 max	1.04 max	1.35 max	1.40 max	0.85–1.25	1.30 max	1.35 max[A]	1.40 max[A]
Phosphorus	0.07–0.15	0.07–0.16	0.025 max	0.035 max	0.025 max	0.035 max	0.025 max	0.035 max
Sulfur, max	0.025	0.045	0.025	0.035	0.025	0.035	0.025	0.035
Silicon, max	. . .	. . .	. . .	. . .	0.30	0.33	0.30	0.35
Copper, min	0.20	0.18	0.20[B]	0.18[B]	0.20	0.18	. . .	. . .
Vanadium, min	. . .	. . .	. . .	. . .	0.02	0.01	0.02[C]	0.01

[A] For each reduction of 0.01 % C below the specified carbon maximum, an increase of 0.05 % manganese above the specified maximum will be permitted up to 1.45 % for the heat analysis and up to 1.50 % for the product analysis.
[B] If chromium and silicon contents are each 0.50 % min, then the copper minimums do not apply.
[C] For Grade III, columbium may be used in conformance with the following limits: 0.005 %, min (heat) and 0.004 %, min (product).

TABLE 2 Tensile Requirements

	Grades Ia, Ib, and II		Walls over ¾ to 1½ in. (19.05 to 38.1 mm), incl		Grade III	
	Walls ¾in. (19.05 mm) and Under					
Tensile strength, min, ksi (MPa)[A]	70	(485)	67	(460)	65	(450)
Yield strength, min, ksi (MPa)[A]	50	(345)	46	(315)	50	(345)
Elongation in 2 in. or 50 mm, min, %	22		22		20	
Elongation in 8 in. or 200 mm, min, %	19		18		18	

[A] For Grade II, when the material is normalized, the minimum yield strength and minimum tensile strength required shall be reduced by 5 ksi (35 MPa).

composition of the steel as described in Guide G 101, shall be 6.0 or higher.

NOTE 2—The user is cautioned that the Guide G 101 predictive equation for calculation of an atmospheric corrosion–resistance index has been verified only for the composition limits stated in that guide.

6.1.2 When Grade III is required for enhanced corrosion resistance, copper limits may be specified and the minimum content shall be 0.20 % by heat analysis and 0.18 % by product analysis.

6.2 *Heat Analysis*—An analysis of each heat of open-hearth, basic-oxygen, or electric-furnace steel shall be made by the manufacturer. This analysis shall be made from a test ingot taken during the pouring of the heat. The chemical composition thus determined shall conform to the requirements specified in Table 1 for heat analysis.

6.3 *Product Analysis*:

6.3.1 An analysis may be made by the purchaser from finished tubing manufactured in accordance with this specification, or an analysis may be made from flat-rolled stock from which the welded tubing is manufactured. When product analyses are made, two sample lengths from a lot of each 500 lengths, or fraction thereof, shall be selected. The specimens for chemical analysis shall be taken from the sample lengths in accordance with the applicable procedures of Test Methods, Practices, and Terminology A 751. The chemical composition thus determined shall conform to the requirements specified in Table 1 for product analysis.

6.3.2 In the event the chemical composition of one of the sample lengths does not conform to the requirements shown in Table 1 for product analysis, an analysis of two additional lengths selected from the same lot shall be made, each of which shall conform to the requirements shown in Table 1 for product analysis, or the lot is subject to rejection.

7. Mechanical Requirements

7.1 *Tensile Properties*:

7.1.1 The material, as represented by the test specimen, shall conform to the requirements prescribed in Table 2.

7.1.2 Elongation may be determined on a gage length of either 2 in. (50 mm) or 8 in. (200 mm) at the manufacturer's option.

7.1.3 For material under 5⁄16 in. (7.94 mm) in thickness, a deduction from the percentage elongation of 1.25 percentage points in 8 in. specified in Table 2 shall be made for each decrease of 1⁄32in. (0.79 mm) of the specified thickness under 5⁄16 in. (7.94 mm).

7.2 *Bend Test*—The bend test specimen shall stand being bent cold through 180° without cracking on the outside of the bent portion, to an inside diameter which shall have a relation to the thickness of the specimen as prescribed in Table 3.

7.3 *Number of Tests*—Two tension and two bend tests, as specified in 7.4.2, and 7.4.3, shall be made from tubing representing each heat. However, if tubing from one heat differs in the ordered nominal wall thickness, one tension test and one bend test shall be made from both the heaviest and lightest wall thicknesses processed.

7.4 *Test Specimens*:

7.4.1 The test specimens required by this specification shall conform to those described in the latest issue of Test Methods and Definitions A 370.

7.4.2 The tension test specimen shall be taken longitudinally from a section of the finished tubing, at a location at least 90° from the weld in the case of welded tubing, and shall not be flattened between gage marks. If desired, the tension test may be made on the full section of the tubing; otherwise, a longitudinal strip test specimen shall be used as prescribed in Test Methods and Definitions A 370, Annex A2. The specimens shall have all burrs removed and shall not contain surface imperfections that would interfere with the proper determination of the tensile properties of the metal.

7.4.3 The bend test specimen shall be taken longitudinally from the tubing, and shall represent the full wall thickness of

TABLE 3 Bend Test Requirements

Thickness of Material, in. (mm)	Ratio of Bend Diameter to Specimen Thickness
¾ (19.05) and under	1
Over ¾ to 1 (19.05 to 25.4), incl	1½
Over 1 (25.4)	2