



Designation: A501/A501M – 21

Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing¹

This standard is issued under the fixed designation A501/A501M; 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.

1. Scope*

1.1 This specification covers black and hot-dipped galvanized hot-formed welded and seamless carbon steel square, round, rectangular, or special shape structural tubing for welded, riveted, or bolted construction of bridges and buildings, and for general structural purposes.

1.2 Square and rectangular tubing is produced with flats of 1 to 16 in. [25 to 405 mm] and a specified wall thickness 0.095 to 1.0 in. [2.5 to 25 mm]. Round tubing is produced with diameters of 1 to 48 in. [25 to 1220 mm] and a specified wall thickness of 0.095 to 4.00 in. [2.5 to 100 mm].

1.3 This specification covers three grades: A, B, and C.

1.4 The text of this specification contains notes and footnotes that provide explanatory material. Such notes and footnotes, excluding those in tables and figures, do not contain any mandatory requirements.

1.5 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order specifies the applicable M specification designation (SI units), the inch-pound units shall apply. The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

Current edition approved Aug. 1, 2021. Published September 2021. Originally approved in 1964. Last previous edition approved in 2014 as A501/A501M – 14. DOI: 10.1520/A0501_A0501M-21.

2. Referenced Documents

2.1 ASTM Standards:²

A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A751 Test Methods and Practices for Chemical Analysis of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

2.2 AIAG Standard:³

B-1 Bar Code Symbology Standard

2.3 Federal Standard:⁴

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)

2.4 Military Standards:⁴

MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A941.

4. Ordering Information

4.1 Orders for material under this specification shall contain information concerning as many of the following items as are required to describe the desired material adequately:

4.1.1 Quantity (weight in metric tons, feet [meters], or number of lengths),

4.1.2 Name of material (hot-formed tubing),

4.1.3 Method of manufacture (seamless or welded); see Section 6,

4.1.4 Grade (A, B, or C),

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, <http://www.aiag.org>.

⁴ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

*A Summary of Changes section appears at the end of this standard

4.1.5 Size (outside diameter and wall thickness for round tubing and outside dimensions and wall thickness for square and rectangular tubing),

4.1.6 Finish (black or galvanized),

4.1.7 Length (random, multiple, or specific; see 12.4),

4.1.8 End condition (see 17.5),

4.1.9 Burr removal (see 17.5),

4.1.10 Certification (see Section 19),

4.1.11 ASTM specification designation and year of issue,

4.1.12 Bar coding (see 20.3),

4.1.13 Packaging, package marking, and loading for shipment (see Section 21),

4.1.14 Product analysis (see Supplementary Requirements S2),

4.1.15 End use, and

4.1.16 Special requirements.

5. Process

5.1 The steel shall be made by basic-oxygen or electric-arc-furnace steel making process.

5.2 Steel may be cast in ingots or may be strand cast.

5.3 When steels of different grades are sequentially strand cast, the steel producer shall identify the resultant transition material and remove it using an established procedure that positively separates the grades.

6. Manufacture

6.1 The tubing shall be made by one of the following processes: seamless; furnace-butt-welding (continuous welding); electric-resistance welding or submerged arc welding followed by reheating throughout the cross section and hot forming by a reducing or shaping process, or both.

6.2 The final shape formation shall be made by a hot forming process.

6.3 The weld shall not be located within the radius of the corners of any tube having one or more flat sides.

6.4 It shall be permissible to add a normalizing heat treatment for tubing with a wall thickness greater than ½ in. [13 mm].

7. Heat Analysis

7.1 Each heat analysis shall conform to the requirements specified in Table 1.

8. Product Analysis

8.1 When product analysis is ordered (see 4.1.14 and S2) the tubing shall be capable of conforming to the requirements specified in Table 1.

9. Tensile Requirements

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

9.2 The elongation may be determined on a gage length of either 2 in. or 8 in. [50 mm or 200 mm] at the manufacturer's choice.

10. Impact Requirements

10.1 The Charpy V-notch impact test specimens shall conform to requirements prescribed in Table 2. Impact tests are not required for thicknesses smaller than or equal to 0.250 in. [6.3 mm], unless specified.

10.2 Charpy V-notch tests shall be made in accordance with Test Methods and Definitions A370. One test shall consist of a set of three specimens. Standard specimens 10 by 10 mm [0.394 by 0.394 in.] in cross section shall be used unless the material to be tested is of insufficient thickness, in which case the largest obtainable subsize specimens shall be used. Acceptance criteria for subsize specimens shall be in accordance with Test Methods and Definitions A370.

10.3 One Charpy V-notch impact test shall be made from a length of tubing representing each lot.

10.4 The test results of standard full-size longitudinal specimens shall meet a minimum average per set of three specimens and minimum single value as specified in Table 2. The specimen axis shall be parallel to the tubing axis and the notch shall be normal to the surface of the material. For wall thicknesses 1.5 in. [38 mm] and less, the specimens shall be located with their surface at least 0.08 in. [2 mm] from the material surface; for wall thicknesses greater than 1.5 in. [38 mm], the specimens shall be located with their surface at least ¼ times the wall thickness from the material surface.

10.5 The maximum test temperature shall be 0°F [–18°C].

11. Dimensions

11.1 *Round Structural Tubing*—The dimensions are defined by outside diameter (OD) and the wall thickness (t).

TABLE 1 Chemical Requirements^A

Element	Composition, %			
	Grade A		Grade B, C	
	Heat analysis	Product analysis	Heat analysis	Product analysis
Carbon, max ^B	0.26	0.30	0.22	0.26
Manganese, max ^B	...	...	1.40	1.45
Phosphorus, max	0.035	0.045	0.030	0.040
Sulfur, max	0.035	0.045	0.020	0.030
Copper, when copper steel is specified, min	0.20	0.18	0.20	0.18

^A Where an ellipsis (...) appears in this table, there is no requirement.

^B For each reduction of 0.01 percentage point below the specified maximum for carbon, an increase of 0.06 percentage point above the specified maximum for manganese is permitted, up to a maximum of 1.60 % by heat analysis and 1.65 % by product analysis.