Designation: A 500 – 01a

An American National Standard

Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes[1]

This standard is issued under the fixed designation A 500; 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 cold-formed welded and seamless carbon steel round, square, rectangular, or special shape structural tubing for welded, riveted, or bolted construction of bridges and buildings, and for general structural purposes.

1.2 This tubing is produced in both welded and seamless sizes with a maximum periphery of 64 in. (1626 mm) and a maximum wall of 0.625 in. (15.88 mm). Grade D requires heat treatment.

NOTE 1—Products manufactured to this specification may not be suitable for those applications such as dynamically loaded elements in welded structures, etc., where low-temperature notch-toughness properties may be important.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions of the values in inch-pound units to values in SI units.

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.

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]

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys[4]

2.2 *Military Standards:*

MIL-STD-129 Marking for Shipment and Storage[5]

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage[5]

2.3 *Federal Standards:*

Fed. Std. No. 123 Marking for Shipment[5]

Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products[5]

2.4 *AIAG Standard:*

B-1 Bar Code Symbology Standard[6]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A 941.

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 (feet or number of lengths),

4.1.2 Name of material (cold-formed tubing),

4.1.3 Method of manufacture (seamless or welded),

4.1.4 Grade (A, B, C, or D),

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

4.1.6 Length (random, multiple, specific; see 11.3),

4.1.7 End condition (see 16.3),

4.1.8 Burr removal (see 16.3),

4.1.9 Certification (see Section 18),

4.1.10 ASTM specification designation and year of issue,

4.1.11 End use,

4.1.12 Special requirements, and

4.1.13 Bar coding (see 19.3).

5. Process

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

[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.

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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 01.01.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[6] Available from Automotive Industry Action Group, 26200 Lahser Road, Suite 200, Southfield, MI 48034.

5.2 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 a seamless or welding process.

6.2 Welded tubing shall be made from flat-rolled steel by the electric-resistance-welding process. The longitudinal butt joint of welded tubing shall be welded across its thickness in such a manner that the structural design strength of the tubing section is assured.

NOTE 2—Welded tubing is normally furnished without removal of the inside flash.

6.3 Except as required by 6.4, it shall be permissible for the tubing to be stress relieved or annealed.

6.4 Grade D tubing shall be heat treated at a temperature of at least 1100 °F (590 °C) for one hour per inch (25.4 mm) of thickness.

7. Heat Analysis

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

8. Product Analysis

8.1 The tubing shall be capable of conforming to the requirements specified in Table 1 for product analysis.

8.2 If product analyses are made, they shall be made using test specimens taken from two lengths of tubing from each lot of 500 lengths, or fraction thereof, or two pieces of flat-rolled stock from each lot of a corresponding quantity of flat-rolled stock. Methods and practices relating to chemical analysis shall be in accordance with Test Methods, Practices, and Terminology A 751. Such product analyses shall conform to the requirements specified in Table 1 for product analysis.

8.3 If both product analyses representing a lot fail to conform to the specified requirements, the lot shall be rejected.

8.4 If only one product analysis representing a lot fails to conform to the specified requirements, product analyses shall be made using two additional test specimens taken from the lot. Both additional product analyses shall conform to the specified requirements or the lot shall be rejected.

9. Tensile Requirements

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

TABLE 1 Chemical Requirements[A]

Element	Composition, %			
	Grades A, B, and D		Grade C	
	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis
Carbon, max	0.26	0.30	0.23	0.27
Manganese, max	. . .	. . .	1.35	1.40
Phosphorus, max	0.035	0.045	0.035	0.045
Sulfur, max	0.035	0.045	0.035	0.045
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.

10. Flattening Test

10.1 The flattening test shall be made on round structural tubing. A flattening test is not required for shaped structural tubing.

10.2 For welded round structural tubing, a specimen at least 4 in. (102 mm) in length shall be flattened cold between parallel plates in three steps, with the weld located at 90° from the line of direction of force. During the first step, which is a test for ductility of the weld, no cracks or breaks on the inside or outside surfaces shall occur until the distance between the plates is less than two thirds of the original outside diameter of the tubing. As a second step, the flattening shall be continued. During the second step, which is a test for ductility exclusive of the weld, no cracks or breaks on the inside or outside surfaces, except as provided for in 10.5, shall occur until the distance between the plates is less than one half of the original outside diameter of the tubing but is not less than five times the wall thickness of the tubing. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the tubing meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

10.3 For seamless round structural tubing 2⅜ in. (60.3 mm) outside diameter and larger, a section not less than 2½ in. (63.5 mm) in length shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility no cracks or breaks on the inside or outside surfaces, except as provided for in 10.5, shall occur until the distance between the plates is less than the value of "H" calculated by the following equation:

TABLE 2 Tensile Requirements

Round Structural Tubing	Grade A	Grade B	Grade C	Grade D
Tensile strength, min, psi (MPa)	45 000 (310)	58 000 (400)	62 000 (427)	58 000 (400)
Yield strength, min, psi (MPa)	33 000 (228)	42 000 (290)	46 000 (317)	36 000 (250)
Elongation in 2 in. (50.8 mm), min, %[D]	25[A]	23[B]	21[C]	23[B]
Shaped Structural Tubing	**Grade A**	**Grade B**	**Grade C**	**Grade D**
Tensile strength, min, psi (MPa)	45 000 (310)	58 000 (400)	62 000 (427)	58 000 (400)
Yield strength, min, psi (MPa)	39 000 (269)	46 000 (317)	50 000 (345)	36 000 (250)
Elongation in 2 in. (50.8 mm), min, %[D]	25[A]	23[B]	21[C]	23[B]

[A] Applies to specified wall thicknesses (t) equal to or greater than 0.120 in. (3.05 mm). For lighter specified wall thicknesses, the minimum elongation values shall be calculated by the formula: percent elongation in 2 in. (50.8 mm) = $56t + 17.5$, rounded to the nearest percent.

[B] Applies to specified wall thicknesses (t) equal to or greater than 0.180 in. (4.57 mm). For lighter specified wall thicknesses, the minimum elongation values shall be calculated by the formula: percent elongation in 2 in. (50.8 mm) = $61t + 12$, rounded to the nearest percent.

[C] Applies to specified wall thicknesses (t) equal to or greater than 0.120 in. (3.05 mm). For lighter specified wall thicknesses, the minimum elongation values shall be by agreement with the manufacturer.

[D] The minimum elongation values specified apply only to tests performed prior to shipment of the tubing.