



# Standard Specification for Structural Steel with Low Yield to Tensile Ratio for Use in Buildings<sup>1</sup>

This standard is issued under the fixed designation A1043/A1043M; 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 two grades, 36 [250] and 50 [345] of rolled steel structural shapes and plates with low yield to tensile ratio for use in building framing or for general structural purposes.

1.2 All shape profiles with a flange width of 6 in. [150 mm] and greater described in Specification **A6/A6M**, Annex A2, and plates up to and including 5 in. [125 mm] thick are included in this specification.

1.3 Supplementary requirements are provided for use where additional testing or additional restrictions are required by the purchaser. Such requirements apply only when specified in the purchase order.

1.4 When the steel is to be welded, a welding procedure suitable for the grade of steel and intended use or service is to be utilized. See Appendix X3 of Specification **A6/A6M** for information on weldability.

1.5 The text of this specification contains notes or footnotes, or both, that provide explanatory material; such notes and footnotes, excluding those in tables and figures, do not contain any mandatory requirements.

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system is to be used independently of the other without combining values in any way.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**A6/A6M** Specification for General Requirements for Rolled

Structural Steel Bars, Plates, Shapes, and Sheet Piling  
**A370** Test Methods and Definitions for Mechanical Testing  
of Steel Products  
**A673/A673M** Specification for Sampling Procedure for Im-  
pact Testing of Structural Steel  
**A770/A770M** Specification for Through-Thickness Tension  
Testing of Steel Plates for Special Applications

## 3. General Requirements for Delivery

3.1 Product furnished under this specification shall conform to the requirements of the current edition of Specification **A6/A6M** for the ordered product, unless a conflict exists, in which case this specification shall prevail.

## 4. Materials and Manufacture

4.1 The steel shall be killed, and such shall be affirmed in the test report by a statement of *killed steel*, a value of 0.10 % or more for the silicon content, a value of 0.015 % or more for the total aluminum content, or a value of 0.006 % or more for the titanium content.

## 5. Chemical Composition

5.1 The heat analysis shall conform to the requirements given in **Table 1**.

5.2 The steel shall conform on product analysis to the requirements given in **Table 1**, subject to the product analysis tolerances in Specification **A6/A6M**.

5.3 The maximum permissible carbon equivalent values shall be:

Grade	Thickness of Plate and Shape Flange	CE Value max %
36 [250]	All	0.37
50 [345]	≤ 2 in. [50 mm]	0.45
50 [345]	> 2 in. [50 mm]	0.47

5.3.1 The carbon equivalent value shall be based upon heat analysis. The required chemical analysis as well as the carbon equivalent shall be reported. The carbon equivalent shall be calculated using the following formula:

$$CE = C + (Mn)/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15 \quad (1)$$

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



TABLE 1 Chemical Requirements (Heat Analysis)

Element		Composition, %	
		Grade 36 [250]	Grade 50 [345]
Carbon, max	2 in. [50 mm] and less in thickness	0.20	0.20
	Over 2 in. [50 mm] in thickness	0.22	0.22
Manganese		0.50–1.40	0.50–1.60
Phosphorus, max		0.030	0.030
Sulfur, max		0.030	0.030
Silicon, max		0.35	0.55
Nitrogen, max		0.012	0.012
Nickel, max		0.45	0.45
Chromium, max		0.35	0.35
Molybdenum, max		0.15	0.15
Copper, max		0.50	0.50
Vanadium, max		0.15 <sup>A</sup>	0.15 <sup>A</sup>
Columbium, max		0.05 <sup>A</sup>	0.05 <sup>A</sup>
Titanium, max		0.03	0.03

<sup>A</sup> The sum of columbium and vanadium shall not exceed 0.15 %.

## 6. Tensile Requirements

6.1 The product as represented by the test specimens shall conform to the requirements for tensile properties given in Table 2.

## 7. Charpy Impact Requirements

7.1 Charpy V-notch tests shall be conducted in accordance with Specification A673/A673M, frequency H. The test results

TABLE 2 Tensile Requirements<sup>A</sup>

	Grade	
	36 [250]	50 [345]
Tensile strength, min, ksi [MPa]	58 [400]	65 [450]
Yield point, ksi [MPa]	36 to 52	50 to 65
	[250 to 360]	[345 to 450]
Yield to tensile ratio, max	0.80	0.80
Elongation in 8 in. [200 mm], min % <sup>B</sup>	20	18
Elongation in 2 in. [50 mm], min % <sup>B</sup>	23	21

<sup>A</sup> See Specimen Orientation under the Tension Tests section of Specification A6/A6M.

<sup>B</sup> For plates wider than 24 in. [600 mm] the elongation requirement is reduced two percentage points. See Elongation Requirement Adjustments in the Tension Tests section of Specification A6/A6M.

for full-size test specimens shall conform to the following minimum average value for Grades 36 [250] and 50 [345]:

$$40 \text{ ft} \cdot \text{lb} \cdot \text{ft} [54 \text{ J}] \text{ at } 70^{\circ}\text{F} [21^{\circ}\text{C}]$$

or a lower test temperature as specified in the purchase order.

7.2 For shapes with a flange thickness equal to or greater than 1½ in. [38.1 mm] the test specimens shall be taken from the Alternate Core Location as defined in Specification A673/A673M.

## 8. Keywords

8.1 building framing; low yield to tensile ratio; plates; shapes; structural steel; welded construction

## SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the purchase order or contract. Standardized supplementary requirements for use at the option of the purchaser are listed in Specification A6/A6M. Those that are considered suitable for use with this specification are listed by title.

S1. Vacuum Treatment,  
S2. Product Analysis, and

S8. Ultrasonic Examination.

## ADDITIONAL SUPPLEMENTARY REQUIREMENTS

In addition, the following optional supplementary requirements are suitable for use with this specification.

### S71. Through-thickness Tension Tests

S71.1 Through-thickness tension test shall be made in accordance with the requirements of Specification A770/A770M except for test frequency. The test frequency shall be the same as the tension test frequency.

### S72. P<sub>cm</sub> Carbon Equivalent Limit

S72.1 The P<sub>cm</sub> carbon equivalent for each heat, based upon heat analysis, shall not exceed 0.26 % for grade 36 [250] or 0.29 % for Grade 50 [345], calculated using the following formula:

$$P_{cm} = C + \text{Si}/30 + (\text{Mn} + \text{Cu} + \text{Cr})/20 + \text{Ni}/60 + \text{Mo}/15 + \text{V}/10 + 5\text{B} \%$$

### S73. Grade 50 Plates Restricted Carbon Equivalent Limit

S73.1 The plates shall be produced by the thermo-mechanical control process (TMCP) or shall be quenched and tempered.

S73.2 The carbon equivalent for each heat, based upon heat analysis, shall not exceed 0.38 % for plates 2 in. [50 mm] or under in thickness and 0.40 % for plates over 2 in. [50 mm] in thickness, calculated using the following formula:

$$CE = C + \text{Mn}/6 + (\text{Cr} + \text{Mo} + \text{V})/5 + (\text{Cu} + \text{Ni})/15 \%$$



S73.3 For plates produced by the thermo-mechanical control process, in addition to the marking required by Specification **A6/A6M**, the letters “TMC” shall be marked following the specification designation mark.

#### **S74. Grade 50 Plates Restricted $P_{cm}$ Carbon Equivalent Limit**

S74.1 The plates shall be produced by the thermo-mechanical control process (TMCP) or shall be quenched and tempered.

S74.2 The  $P_{cm}$  carbon equivalent for each heat, based upon heat analysis, shall not exceed 0.24 % for plates 2 in. [50 mm] or under in thickness and 0.26 % for plates over 2 in. [50 mm] in thickness, calculated using the following formula:

$$P_{cm} = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B \%$$

S74.3 For plates produced by the thermo-mechanical control process, in addition to the marking required by Specification **A6/A6M**, the letters “TMC” shall be marked following the specification designation mark.

### **SUMMARY OF CHANGES**

Committee A01 has identified the location of selected changes to this standard since the last issue (A1043/A1043M – 05 (2009)) that may impact the use of this standard. (Approved Oct 1, 2014.)

(1) Revised **Table 1**.

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