



Designation: A1077/A1077M – 21

# Standard Specification for Structural Steel with Improved Yield Strength at High Temperature for Use in Buildings<sup>1</sup>

This standard is issued under the fixed designation A1077/A1077M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification covers alloy steel in bars, plates up to and including 4 in. [100 mm] in thickness and shapes of structural quality with improved yield strength at high temperature. Two grades, 36 [250] and 50 [345] are available for use in bolted or welded buildings or for general structural purposes. Class 2 requires a maximum yield to tensile ratio – this ratio is not required for Class 1.

1.2 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.

1.3 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.

1.4 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.

1.5 For structural products produced from coil and furnished without heat treatment or with stress relieving only, the additional requirements, including additional testing requirements and the reporting of additional test results, of Specification A6/A6M apply.

1.6 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.

1.7 *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.*

## 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 Impact Testing of Structural Steel
- A770/A770M Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials

## 3. General Requirements for Delivery

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

3.2 Coils are excluded from qualification to this specification until they are processed into a finished structural product. Structural products produced from coil means structural products that have been cut to individual lengths from a coil. The processor directly controls, or is responsible for, the operations involved in the processing of a coil into a finished structural product. Such operations include decoiling, leveling or straightening, hot-forming or cold-forming (if applicable), cutting to length, testing, inspection, conditioning, heat treatment (if applicable), packaging, marking, loading for shipment, and certification.

NOTE 1—For structural products produced from coil and furnished without heat treatment or with stress relieving only, two test results are to

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships.

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<sup>2</sup> 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.

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

be reported for each qualifying coil. Additional requirements regarding structural products produced from coil are described in Specification **A6/A6M**.

#### 4. Materials and Manufacture

4.1 The steel shall be killed, and this shall be confirmed by one of the following statements: (1) *killed steel*, (2) the silicon content is 0.10 % or more, (3) the total aluminum content is 0.015 % or more, or (4) the titanium content is 0.006 % or more.

#### 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 Pcm carbon equivalent values shall be:

Grade	Pcm Value, max %
36 [250]	0.26
50 [345]	0.29

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

$$Pcm = C = \frac{Si}{30} + \frac{(Mn + Cu + Cr)}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5B \% \quad (1)$$

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

7.1.1 20 ft lbf [27 J] at 32°F [0°C]

#### 8. Elevated Temperature Tension Test for Yield

8.1 Conduct the elevated-temperature tensile test at 1110°F [600°C].

8.1.1 The test results of 0.2 % offset yield strength shall conform to the following values for Grade 36 [250] and 50 [345]:

8.1.1.1 Grade 36 [250]: minimum 24 ksi [165 MPa]

8.1.1.2 Grade 50 [345]: minimum 33 ksi [230 MPa]

8.2 The elevated-temperature strength of the steel shall be determined by an elevated-temperature tensile test that conforms to Test Methods **E21**.

8.3 *Sampling*:

8.3.1 Conform to the relevant section of Specification **A6/A6M**, except that full-section specimens need not be used.

8.3.2 The elevated-temperature test specimen shall be taken from the same area in the plate or shape and have the same orientation as the specimen used to determine room-temperature properties.

8.4 *Frequency*:

8.4.1 Test one specimen per heat from the largest thickness in the heat.

8.5 *Specimen Geometry*:

8.5.1 Standard round and flat sheet-type specimens are acceptable. In particular, specimens allowed are identified in Test Methods and Definitions **A370**, Figure 4, and Test Methods **E8/E8M**, Figures 1, 7, or 8. Other acceptable specimens that meet the requirements of **8.5.2** are identified in Test Methods **E21**, Section 7.

8.5.2 The diameter, for round specimens, or smaller gauge dimension, for sheet or plate specimens, shall be at least 0.250 in. [6 mm] or the largest size allowed by the thickness of the product, except that the diameter need not be greater than 0.500 in. [12.7 mm].

8.6 *Testing*:

8.6.1 Conduct the elevated-temperature tensile test according to Test Methods **E21**.

8.6.2 Any control mode, such as position control, load control, or strain control, is acceptable as long as strain rate limits are followed.

**TABLE 1 Chemical Requirements (Heat Analysis)**

Product	Shapes		Plates		Bars	
	36 [250]	50 [345]	36 [250]	50 [345]	36 [250]	50 [345]
Carbon, max %	0.15	0.15	0.15	0.15	0.15	0.15
Manganese, %	0.50 – 1.40	0.50 – 1.40	0.50 – 1.40	0.50 – 1.40	0.50 – 1.40	0.50 – 1.40
Phosphorus, max %	0.035	0.035	0.030	0.030	0.035	0.035
Sulfur, max %	0.035	0.035	0.030	0.030	0.035	0.035
Silicon, max %	0.35	0.35	0.35	0.35	0.35	0.35
Nickel, max %	0.50	0.50	0.50	0.50	0.50	0.50
Chromium, max %	1.00	1.00	1.00	1.00	1.00	1.00
Molybdenum %	0.20 – 0.70	0.20 – 0.70	0.20 – 0.70	0.20 – 0.70	0.20 – 0.70	0.20 – 0.70
Copper, max %	0.50	0.50	0.50	0.50	0.50	0.50
Vanadium, max %	0.15	0.15	0.15	0.15	0.15	0.15
Columbium/niobium, <sup>A</sup> max %	0.05	0.05	0.05	0.05	0.05	0.05
Titanium, max %	0.03	0.03	0.03	0.03	0.03	0.03
Boron, max %	0.002	0.002	0.002	0.002	0.002	0.002

<sup>A</sup> Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in A01 specifications.

**TABLE 2 Tensile Requirements**

NOTE 1—Where “...” appears in this table, there is no requirement.

NOTE 2—See Specimen Orientation under the Tension Tests section of Specification **A6/A6M**.

	Grade			
	36 [250]		50 [345]	
	Class 1	Class 2	Class 1	Class 2
Tensile strength, ksi [MPa], min	58 [400]	58 [400]	65 [450]	65 [450]
Yield point, ksi [MPa]	36 [250] min	36 [250] – 52 [360]	50 [345] min	50 [345] – 65 [450]
Yield to tensile ratio, max	...	0.80	...	0.80
Elongation in 8 in. [200 mm], min % <sup>A</sup>	20	20	18	18
Elongation in 2 in. [50 mm], min % <sup>A</sup>	23	23	21	21

<sup>A</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**.

8.6.3 The test may be terminated after the yield strength is determined and before the specimen fails.

**8.7 Report:**

8.7.1 Report the 0.2 % offset yield strength (YS 0.2 % offset) at 1110°F [600°C] as required by Test Methods **E21**.

**9. Keywords**

9.1 bars; bolted construction; buildings; carbon steel; high strength low-alloy; plates; shapes; structural steel; welded construction

**SUPPLEMENTARY REQUIREMENTS**

**S1. Vacuum Treatment**

**S2. Product Analysis**

**S8. Ultrasonic Examination**

**ADDITIONAL SUPPLEMENTARY REQUIREMENTS**

[ASTM A1077/A1077M-21](https://standards.iteh.ai/catalog/standards/sist/859bbe3f-ecc2-4f8b-a153-fa37283f6777/astm-a1077-a1077m-21)

**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.

**SUMMARY OF CHANGES**

Committee A01 has identified the location of selected changes to this standard since the last issue (A1077/A1077M – 14) that may impact the use of this standard. (Approved Sept. 1, 2021.)

(1) Revised **Table 1**.