Designation: A 514/A514M – 05

American Association State Highway and Transportation Officials Standard AASHTO No.: M 244

Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding[1]

This standard is issued under the fixed designation A 514/A514M; 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 quenched and tempered alloy steel plates of structural quality in thicknesses of 6 in. [150 mm] and under intended primarily for use in welded bridges and other structures.

NOTE 1—All grades are not available in a maximum thickness of 6 in. [150 mm]. See Table 1 for thicknesses available in each grade.

1.2 If the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized. See Appendix X 3 of Specification A 6/A 6M 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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 6/A 6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

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

3. General Requirements for Delivery

3.1 Plates furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 6/A 6M unless a conflict exists in which case this specification shall prevail.

4. Materials and Manufacture

4.1 The steel shall be killed and conform to the requirements for fine austenitic grain size in Specification A 6/A 6M.

5. Heat Treatment

5.1 Except as allowed by 5.2, plates shall be heat treated to conform to the tensile and hardness requirements given in Table 2 by heating to not less than 1650°F [900°C], quenching in water or oil, and tempering at not less than 1150°F [620°C]. The heat-treatment temperatures shall be reported in the test report.

5.2 Plates ordered without the heat treatment specified in 5.1 shall be stress relieved by the manufacturer, and subsequent heat treatment of the plates to conform to 5.1 shall be the responsibility of the purchaser.

6. Chemical Composition

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

6.2 The product analysis shall conform to the requirements given in Table 1, subject to the product analysis tolerances in Specification A 6/A 6M.

7. Mechanical Properties

7.1 *Tension Test*—The plates as represented by the tension test specimens shall conform to the tensile requirements given in Table 2.

7.2 *Hardness Test*—For plates ⅜ in. [10 mm] and under in thickness, a Brinell hardness test may be used instead of tension testing each plate, in which case a tension test shall be made from a corner of each of two plates per lot. A lot shall consist of plates from the same heat, thickness, prior condition, and scheduled heat treatment and shall not exceed 15 tons [15 Mg] in weight [mass]. A Brinell hardness test shall be made on each plate not tension tested and the results shall conform to the hardness requirements given in Table 2.

[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 A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock, and Ships.

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[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.

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

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TABLE 1 Chemical Requirements (Heat Analysis)

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

	Chemical Composition, %							
	Grade A	Grade B	Grade E	Grade F	Grade H	Grade P	Grade Q	Grade S
	Maximum Thickness, in. [mm]							
Element	1¼ [32]	1¼ [32]	6 [150]	2½ [65]	2 [50]	6 [150]	6 [150]	2½ [65]
Carbon	0.15–0.21	0.12–0.21	0.12–0.20	0.10–0.20	0.12–0.21	0.12–0.21	0.14–0.21	0.11–0.21
Manganese	0.80–1.10	0.70–1.00	0.40–0.70	0.60–1.00	0.95–1.30	0.45–0.70	0.95–1.30	1.10–1.50
Phosphorus, max	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Sulfur, max	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.020
Silicon	0.40–0.80	0.20–0.35	0.20–0.40	0.15–0.35	0.20–0.35	0.20–0.35	0.15–0.35	0.15–0.45
Nickel	...	...	...	0.70–1.00	0.30–0.70	1.20–1.50	1.20–1.50	...
Chromium	0.50–0.80	0.40–0.65	1.40–2.00	0.40–0.65	0.40–0.65	0.85–1.20	1.00–1.50	...
Molybdenum	0.18–0.28	0.15–0.25	0.40–0.60	0.40–0.60	0.20–0.30	0.45–0.60	0.40–0.60	0.10–0.60
Vanadium	...	0.03–0.08	[A]	0.03–0.08	0.03–0.08	...	0.03–0.08	0.06
Titanium	...	0.01–0.04	0.01–0.10	...	...	...	...	[B]
Zirconium	0.05–0.15[C]	...	...	...	...	...	...	...
Copper	...	...	...	0.15–0.50	...	...	...	...
Boron	0.0025 max	0.0005–0.005	0.001–0.005	0.0005–0.006	0.0005–0.005	0.001–0.005	...	0.001–0.005
Columbium, max	...	...	...	...	...	...	...	0.06

[A] May be substituted for part or all of titanium content on a one for one basis.
[B] Titanium may be present in levels up to 0.06 % to protect the boron additions.
[C] Zirconium may be replaced by cerium. When cerium is added, the cerium/sulfur ratio should be approximately 1.5 to 1, based upon heat analysis.

TABLE 2 Tensile and Hardness Requirements

NOTE 1— See the Orientation and Preparation subsections in the Tension Tests section of Specification A 6/A 6M.
NOTE 2—Where ". . ." appears in this table there is no requirement.

Thickness, in. [mm]	Tensile Strength, ksi [MPa]	Yield Strength, min[A], ksi [MPa]	Elongation in 2 in. [50 mm], min[BCD], %	Reduction of Area, min[BC], %	Brinell Hardness Number[E]
To ¾ [20], incl	110 to 130 [760 to 895]	100 [690]	18	40[F]	235 to 293 HBW
Over ¾ [20] to 2½ [65], incl	110 to 130 [760 to 895]	100 [690]	18	40[F], 50[G]	...
Over 2½ [65] to 6 [150], incl	100 to 130 [690 to 895]	90 [620]	16	50[G]	...

[A] Measured at 0.2 % offset or 0.5 % extension under load as described in the Determination of Tensile Properties section of Test Methods and Definitions A 370.
[B] Elongation and reduction of area need not be determined for floor plates.
[C] For plates tested in the transverse direction, the elongation requirement is reduced by two percentage points and the reduction of area minimum requirement is reduced by five percentage points. See elongation requirement adjustments in the Tension Tests section of Specification A 6/A 6M.
[D] If measured on the Fig. 3 (Test Methods and Definitions A 370) 1½-in. [40-mm] wide tension test specimen, the elongation is determined in a 2-in. [50-mm] gage length that includes the fracture and shows the greatest elongation.
[E] See 7.2.
[F] If measured on the Fig. 3 (Test Methods and Definitions A 370) 1½-in. [40-mm] wide tension test specimen.
[G] If measured on the Fig. 4 (Test Methods and Definitions A 370) ½-in. [12.5-mm] round tension test specimen.

8. Number of Tests

8.1 Except as allowed by 7.2, one tension test shall be taken from a corner of each plate as heat treated.

9. Retest

9.1 Plates that were subjected to Brinell hardness testing and failed to conform the specified hardness requirements may be subjected, at the manufacturer's option, to tension testing and shall be accepted if the results conform to the tensile requirements given in Table 2.

9.2 The manufacturer may re-heat treat plates that fail to meet the mechanical property requirements of this specification. All mechanical property tests shall be repeated after such heat treatment.

10. Test Specimens

10.1 If possible, all test specimens shall be cut from the plate in its heat-treated condition. If it is necessary to prepare test specimens from separate pieces, such pieces shall be full thickness, and shall be similarly and simultaneously heat treated with the plate. All such separate pieces shall be of such a size that the prepared test specimens are free of any variation in properties due to edge effects.

10.2 If specified in the purchase order, the test pieces shall be subjected to additional thermal treatments intended to simulate thermal treatments that subsequently might be done by the fabricator.

11. Keywords

11.1 alloy; bridges; high-yield-strength; plates; quenched; steel; structural steel; tempered; welded construction

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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 A /A 6M. Those that are considered suitable for use with this specification are listed by title:

S5. Charpy V-Notch Impact Test

S8. Ultrasonic Examination

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 514/A 514 M – 00a) that may impact the use of this standard.

(1) Section 5.2 was added.
(2) Tables 1 and 2 were revised.
(3) A supplementary requirements section was added.
(4) Section 4.1 was revised.

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