Designation: A 514/A514M – 00a

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 When 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 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 must be used independently of the other. Combining values from the two systems may result in nonconformance with this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 6/A 6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling[2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[3]

E 112 Test Methods for Determining the Average Grain Size[4]

3. General Requirements for Delivery

3.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 6/A 6M, for the ordered material, unless a conflict exists in which case this specification shall prevail.

4. Materials and Manufacture

4.1 The requirements for fine austenitic grain size in Specification A 6/A 6M shall be met.

5. Heat Treatment

5.1 The material shall be heat treated by the manufacturer to conform to the tensile and hardness requirements of 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-treating temperatures shall be reported on the test certificates.

6. Chemical Composition

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

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

7. Mechanical Properties

7.1 *Tension Test*—The material as represented by the tension test specimens shall conform to the tensile properties prescribed 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 and thickness, same 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 shall meet the requirements shown in Table 2.

8. Number of Tests

8.1 Except as described in 7.2, one tension test shall be taken from a corner of each plate as heat treated. Plates wider than 24 in. [600 mm] shall be tested in the transverse direction and are subject to the modifications for elongation and reduction of area contained in Footnote C of Table 2.

9. Retest

9.1 Plates subjected to Brinell hardness tests and which fail

---

[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.

Current edition approved Sept. 10, 2000. Published November 2000. Originally published as A 514 – 64. Last previous edition A 514/A 514M – 00.

[2] *Annual Book of ASTM Standards*, Vol 01.04.

[3] *Annual Book of ASTM Standards*, Vol 01.03.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

TABLE 1 Chemical Requirements (Heat Analysis)

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

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

[A] May be substituted for part or all of titanium content on a one for one basis.
[B] 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.

	Grade K, %	Grade M, %	Grade P, %	Grade Q, %	Grade R, %	Grade S, %	Grade T, %
Maximum Thickness, in. [mm]	2 [50]	2 [50]	6 [150]	6 [150]	2½ [65]	2½ [65]	2 [50]
Carbon	0.10–0.20	0.12–0.21	0.12–0.21	0.14–0.21	0.15–0.20	0.11–0.21	0.08–0.14
Manganese	1.10–1.50	0.45–0.70	0.45–0.70	0.95–1.30	0.85–1.15	1.10–1.50	1.20–1.50
Phosphorus, max	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	0.020	0.010
Silicon	0.15–0.30	0.20–0.35	0.20–0.35	0.15–0.35	0.20–0.35	0.15–0.45	0.40–0.60
Nickel	. . .	1.20–1.50	1.20–1.50	1.20–1.50	0.90–1.10	...	...
Chromium	. . .	...	0.85–1.20	1.00–1.50	0.35–0.65	...	...
Molybdenum	0.45–0.55	0.45–0.60	0.45–0.60	0.40–0.60	0.15–0.25	0.10–0.60	0.45–0.60
Vanadium, max	. . .	...	...	0.03–0.08	0.03–0.08	0.06	0.03–0.08
Titanium	. . .	...	...	...	...	[A]	...
Zirconium	. . .	...	...	...	...	...	...
Copper	. . .	...	...	...	...	...	...
Boron	0.001–0.005	0.001–0.005	0.001–0.005	...	...	0.001–0.005	0.001–0.005
Columbium, max	. . .	...	...	...	...	0.06	. . .

[A] Titanium may be present in levels up to 0.06 % to protect the boron additions.

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]	Ultimate Tensile Strength, ksi [MPa]	Yield Strength[A] min, ksi [MPa]	Elongation in 2 in. [50 mm],[BCD] min, %	Reduction of Area[BC], min, %	Brinell Hardness[E] Number
To ¾ [20], incl	110 to 130 [760 to 895]	100 [690]	18	40[F]	235 to 293
Over ¾ to 2½ [20 to 65], incl	110 to 130 [760 to 895]	100 [690]	18	40[F], 50[G]	...
Over 2½ to 6 [65 to 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 not required to 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] When measured on the Fig. 3 (Test Methods and Definitions A 370) 1½-in. [40-mm] wide specimen, the elongation is determined in a 2-in. [50-mm] gage length that includes the fracture and shows the greatest elongation.
[E] See Section 8 of this specification.
[F] When measured on the Fig. 3 (Test Methods and Definitions A 370) 1½-in. [40-mm] wide specimen.
[G] When measured on the Fig. 4 (Test Methods and Definitions A 370) ½-in. [12.5-mm] round specimen.

to meet the hardness requirements, at the manufacturer's option, may be subjected to tension testing and shall be accepted if the results conform to the requirements of Table 2.

9.2 The manufacturer may reheat-treat plates that fail to meet the mechanical property requirements of this specification. All mechanical property tests shall be repeated when material is resubmitted for inspection.

10. Test Specimens

10.1 When possible, all test specimens shall be cut from the plate in its heat-treated condition as shipped. If it is necessary to prepare test specimens from separate pieces, these pieces shall be full thickness, and all pieces shall be similarly and simultaneously heat treated with the material. All such separate

pieces shall be of such size that the prepared test specimens are free of any variation in properties due to edge effects.

10.2 The purchaser shall specify on the purchase order any additional thermal treatments which shall be given to the test specimens in addition to the heat treatment specified in Section 5. (This is intended to simulate thermal treatments which subsequently may be done by the fabricator.)

11. Keywords

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