



Designation: A131/A131M – 14

Standard Specification for Structural Steel for Ships¹

This standard is issued under the fixed designation A131/A131M; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers structural steel plates, shapes, bars, and rivets intended primarily for use in ship construction.

1.2 Material under this specification is available in the following categories:

1.2.1 *Ordinary Strength*—Grades A, B, D, and E with a specified minimum yield point of 34 ksi [235 MPa], and

1.2.2 *Higher Strength*—Grades AH, DH, EH, and FH with a specified minimum yield point of 46 ksi [315 MPa], 51 ksi [350 MPa], or 57 ksi [390 MPa].

1.3 Shapes and bars are normally available as Grades A, AH32, and AH36. Other grades may be furnished by agreement between the purchaser and the manufacturer.

1.4 The maximum thickness of products furnished under this specification is 4 in. [100 mm] for plates and 2 in. [50 mm] for shapes and bars.

1.5 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 X3 of Specification A6/A6M for information on weldability.

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as the 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.

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.*

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 Oct. 1, 2014. Published October 2014. Originally approved in 1931. Last previous edition approved in 2013 as A131/A131M – 13. DOI: 10.1520/A0131_A0131M-14.

2. Referenced Documents

2.1 *ASTM Standards*:²

- 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
- E112 Test Methods for Determining Average Grain Size

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *control rolling (controlled rolling), n*—a hot deformation process intended to provide austenite (and hence ferrite) grain refinement by careful control of the pass-by-pass temperature/reduction schedule at high temperature regime where austenite recrystallizes after each rolling pass or at lower temperatures where the deformed austenite does not recrystallize between rolling passes, or both. In some cases, rolling may extend below the temperature (A_r^3) at which the transformation from austenite to ferrite begins, so the final rolling passes may involve deformation in the two-phase (austenite + ferrite) region.

3.1.2 *thermo-mechanical controlled processing, n*—a steel treatment that consists of strict control of the steel temperature and the rolling reduction. A high proportion of the rolling reduction is to be carried out close to or below the A_r^3 transformation temperature and may involve rolling towards the lower end of the temperature range of the intercritical dual-phase region, thus permitting little if any recrystallization of the austenite. The process may involve accelerated cooling on completion of rolling.

4. Ordering Information

4.1 Specification A6/A6M establishes the rules for the ordering information that should be complied with when purchasing material to this specification.

4.2 Additional ordering considerations specific to this specification are:

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

4.2.1 Condition (control rolled or thermo-mechanical control processed, if applicable).

5. Materials and Manufacture

5.1 The steel shall be killed.

5.2 Grades D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, and FH40 shall be made using a fine grain practice. For ordinary-strength grades, aluminum shall be used to obtain grain refinement. For higher-strength grades, aluminum, vanadium, or columbium (niobium) may be used for grain refinement.

5.3 Plates in all thicknesses ordered to Grade E shall be normalized, or thermo-mechanical control processed. Plates over 1 $\frac{3}{8}$ in. [35 mm] in thickness ordered to Grade D shall be normalized, control rolled, or thermo-mechanical control processed. See [Table 1](#).

5.4 Plates in all thicknesses ordered to Grades EH32 and EH36 shall be normalized, or thermo-mechanical control processed. Plates in all thicknesses ordered to Grade EH40, FH32, FH36, and FH40 shall be normalized, thermo-mechanical control processed, or quenched and tempered. Plates ordered to Grades AH32, AH36, AH40, DH32, DH36, and DH40 shall be normalized, control rolled, thermo-mechanical control processed, or quenched and tempered when so specified. See [Table 2](#).

5.5 In the case of shapes, the thicknesses referred to are those of the flange. Heat treatment and rolling requirements for shapes and bars are given in [Table 1](#) and [Table 2](#).

6. Chemical Requirements

6.1 The heat analysis shall conform to the requirements for chemical composition given in [Table 3](#) and [Table 4](#).

6.1.1 When specified, the steel shall conform on product analysis to the requirements given in [Table 3](#) and [Table 4](#), subject to the product analysis tolerances in Specification [A6/A6M](#).

6.2 For thermo-mechanical control process steel, the carbon equivalent shall be determined from the heat analysis and shall conform to the requirements given in [Table 5](#).

7. Metallurgical Structure

7.1 The steel grades indicated in [5.2](#) shall be made to fine grain practice, and the requirements for fine austenitic grain size in Specification [A6/A6M](#) shall be met.

7.2 Where the use of fine grain practice using columbium, vanadium, or combinations is permitted in [5.2](#), one or more of the following shall be met:

7.2.1 Minimum columbium (niobium) content of 0.020 % or minimum vanadium content of 0.050 % for each heat, or

7.2.2 When vanadium and aluminum are used in combination, minimum vanadium content of 0.030 % and minimum acid-soluble aluminum content of 0.010 %, or minimum total aluminum content of 0.015 %.

7.2.3 When columbium (niobium) and aluminum are used in combination, minimum columbium (niobium) content of 0.010 % and minimum acid-soluble aluminum content of 0.010 %, or minimum total aluminum content of 0.015 %.

7.2.4 A McQuaid-Ehn austenitic grain size of 5 or finer in accordance with Test Methods [E112](#) for each ladle of each heat.

8. Mechanical Requirements

8.1 Tension Test:

8.1.1 Except as specified in the following paragraphs, the material as represented by the test specimens shall conform to the tensile requirements prescribed in [Table 6](#).

8.1.1.1 Shapes less than 1 in.² [645 mm²] in cross section, and bars, other than flats, less than $\frac{1}{2}$ in. [12.5 mm] in thickness or diameter need not be subjected to tension tests by the manufacturer, but chemistry consistent with the required tensile properties must be applied.

8.1.1.2 The elongation requirement of [Table 6](#) does not apply to floor plates with a raised pattern. However, for floor plates over $\frac{1}{2}$ in. [12.5 mm] in thickness, test specimens shall be bent cold with the raised pattern on the inside of the specimen through an angle of 180° without cracking when subjected to a bend test in which the inside diameter is three times plate thickness. Sampling for bend testing shall be as specified for the tension tests in [8.1.2](#).

TABLE 1 Condition of Supply and Frequency of Impact Tests for Ordinary-Strength Structural Steel

Grade	Deoxidation	Product ^A	Condition of Supply ^B (Frequency of Impact Test ^C)			
			Thickness (<i>t</i>), in. [mm]			
			<i>t</i> > 0.25 [6.4] <i>t</i> ≤ 1.0 [25]	<i>t</i> > 1.0 [25] <i>t</i> ≤ 1.375 [35]	<i>t</i> > 1.375 [35] <i>t</i> ≤ 2.0 [50]	<i>t</i> > 2.0 [50] <i>t</i> ≤ 4.0 [100]
A	Killed	P	A (-)			
		S				
B	Killed	P	A (-)	A (50 [45])		
		S		NA ^D		
D	Killed, Fine Grain Practice	P	A (50 [45]), N (50 [45])		N (50 [45]), TM (50 [45]), CR (50 [45])	N (50 [45]), TM (50 [45]), CR (25 [23])
		S				NA ^D
E	Killed, Fine Grain Practice	P	N (P), TM (P)			N (P), TM (P)
		S	N (25 [23]), TM (25 [23]), CR (15 [14])			NA ^D

^A Product: P = plate; S = shapes and bars.

^B Condition of Supply: A = any condition; AR = as-rolled; N = normalized; CR = control rolled; TM = thermo-mechanical controlled processing.

^C Frequency of Impact Test: (impact test lot size in tons [Mg] from each heat); (-) = no impact test required; (P) = each plate-as-rolled.

^D Condition of supply is not applicable.

^E Impact tests for Grade A are not required if material is produced using a fine grain practice and normalized.

TABLE 2 Condition of Supply and Frequency of Impact Tests for Higher-Strength Structural Steel

Grade	Deoxidation	Grain Refining Element	Product ^A	Condition of Supply ^B (Frequency of Impact Test ^C)					
				Thickness (<i>t</i>), in. [mm]					
				<i>t</i> > 0.25 [6.4] <i>t</i> ≤ 0.5 [12.5]	<i>t</i> > 0.5 [12.5] <i>t</i> ≤ 0.80 [20]	<i>t</i> > 0.80 [20] <i>t</i> ≤ 1.0 [25]	<i>t</i> > 1.0 [25] <i>t</i> ≤ 1.375 [35]	<i>t</i> > 1.375 [35] <i>t</i> ≤ 2.0 [50]	<i>t</i> > 2.0 [50] <i>t</i> ≤ 4.0 [100]
AH32 AH36	Killed, Fine Grain Practice	Cb V	P	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])			N (50 [45]), TM (50 [45]), CR (25 [23])	
			S	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45]), AR (25 [23])			NA ^D	
		Al	P	A (50 [45])	AR (25 [23]), N (50 [45]), TM (50 [45]), CR (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])		N (50 [45]), TM (50 [45]), CR (25 [23])	
			S	A (50 [45])	AR (25 [23]), N (50 [45]), TM (50 [45]), CR (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45]), AR (25 [23])		NA ^D	
DH32 DH36	Killed, Fine Grain Practice	Cb V	P	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])			N (50 [45]), TM (50 [45]), CR (25 [23])	
			S	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])			NA ^D	
		Al	P	A (50 [45])	AR (25 [23]), N (50 [45]), TM (50 [45]), CR (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])		N (50 [45]), TM (50 [45]), CR (25 [23])	
			S	A (50 [45])	AR (25 [23]), N (50 [45]), TM (50 [45]), CR (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])		NA ^D	
EH32 EH36	Killed, Fine Grain Practice	Any	P	N (P), TM (P)				N (P), TM (P)	
			S	N (25 [23]), TM (25 [23]), CR (15 [14])				NA ^D	
FH32 FH36	Killed, Fine Grain Practice	Any	P	N (P), TM (P), QT (P)				N (P), TM (P), QT	
			S	N (25 [23]), TM (25 [23]), QT (25 [23])				NA ^D	
AH40	Killed, Fine Grain Practice	Any	P	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])			N (50 [45]), TM (50 [45]), QT (P)	
			S	A (50 [45])	N (50 [45]), TM (50 [45]), CR (50 [45])			NA ^D	
DH40	Killed, Fine Grain Practice	Any	P	N (50 [45]), TM (50 [45]), CR (50 [45])				N (50 [45]), TM (50 [45]), QT (P)	
			S	N (50 [45]), TM (50 [45]), CR (50 [45])				NA ^D	
EH40	Killed, Fine Grain Practice	Any	P	N (P), TM (P), QT (P)				N (P), TM (P), QT (P)	
			S	N (25 [23]), TM (25 [23]), CR (25 [23])				NA ^D	
FH40	Killed, Fine Grain Practice	Any	P	N (P), TM (P), QQT (P)				N (P), TM (P), QT (P)	
			S	N (25 [23]), TM (25), CR (25 [23])				NA ^D	

^A Product: P = plate; S = shapes and bars.

^B Condition of Supply: A = any condition; AR = as-rolled; TM = thermo-mechanical controlled processing; CR = control rolled; QT = quenched and tempered; N = normalized.

^C Frequency of Impact Test: (impact test lot size in tons [Mg] from each heat); (P) = each plate-as-rolled.

^D Condition of supply is not applicable.

8.1.2 One tension test shall be made from each of two different plates, shapes, or bars from each heat of structural steel unless the finished product from a heat is less than 50 tons [45 Mg], in which case one tension test is sufficient. If, however, product from one heat differs $\frac{3}{8}$ in. [10 mm] or more in thickness or diameter, one tension test shall be made from both the thickest and the thinnest structural product rolled, regardless of the weight [mass] represented.

8.1.3 For quenched and tempered steel, including Grades EH40, FH32, FH36, and FH40, one tension test shall be made on each plate as quenched and tempered.

8.2 Toughness Tests:

8.2.1 Charpy V-notch tests shall be made on Grade A material over 2 in. [50 mm] in thickness, on Grade B material over 1 in. [25 mm] in thickness and on material over $\frac{1}{4}$ in. [6.4 mm] in thickness of Grades D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, and FH40, as

required by Table 1 and Table 2. The frequency of Charpy V-notch impact tests shall be as given in Table 1 and Table 2. The test results shall conform to the requirements given in Table 7.

8.2.2 For Grades EH32, EH36, EH40, FH32, FH36, and FH40 plate material, one set of three impact specimens shall be made from each plate-as-rolled.

8.2.3 For Grade A, B, D, AH32, AH36, AH40, DH32, DH36, and DH40 plate material, and for all shape material, and all bar material, one set of three impact specimens shall be made from the thickest material in each test lot size of each heat, as required by Table 1 and Table 2. If heat testing is required, a set of three specimens shall be tested for each test lot size indicated in Table 1 and Table 2, of the same type of product produced on the same mill from each heat of steel. The set of impact specimens shall be taken from different as-rolled or heat-treated pieces of the heaviest gage produced. An