Designation: A506 – 16

Standard Specification for Alloy and Structural Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled[1]

This standard is issued under the fixed designation A506; 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 hot-rolled and cold-rolled alloy and structural alloy-steel sheet and strip. Alloy steel is furnished to chemical composition requirements and is intended primarily for general or miscellaneous use where bending and moderate forming is a requirement. Structural alloy steel is furnished to chemical composition requirements and to specific mechanical property requirements which may include tension tests, hardness tests, or other commonly accepted mechanical tests.

1.2 If material of a higher degree of uniformity of internal soundness and freedom from surface imperfections is required, reference should be made to Specification A507.

1.3 Alloy and structural alloy-steel sheet and strip are not produced to internal cleanliness requirements. Normally surface imperfections are not objectionable, and a good finish is not a prime requirement.

1.4 The formability of structural alloy steel decreases with increasing yield strength or hardness. Therefore, product design in relation to the mechanical properties of the grade used must be considered.

1.5 The material covered by this specification may be furnished in several conditions: heat treatments, surface conditions, and edges, as specified herein, in coils or cut lengths.

1.6 The values stated in inch-pound units are to be regarded as the standard. SI units are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A505 Specification for Steel, Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

A507 Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *alloy steel*—alloy-steel sheet and strip furnished to chemical composition requirements and intended for general or miscellaneous applications where normal surface imperfections are not objectionable and a good finish is not the prime requirement.

3.1.2 *SAE*—Society of Automotive Engineers.

3.1.3 *standard steels*—steel chemical compositions defined as "standard" by SAE, shown in Table 1.

3.1.4 *steels other than standard*—steel chemical compositions other than those defined as "standard," and furnished to the composition limits shown in Table 2.

3.1.5 *structural alloy steel*—alloy-steel sheet and strip meeting the requirements of regular quality and also produced to specific mechanical property requirements.

4. General Requirements and Ordering Information

4.1 Material supplied to this specification shall conform to Specification A505, which includes the general requirements and establishes the rules for the ordering information that should be complied with when purchasing material to this specification.

4.2 In addition to the ordering information required by Specification A505, the following shall also be included:

4.2.1 Mechanical properties required for structural quality, when applicable,

4.2.2 Surface finish, if other than standard (see 8.1), and

4.2.3 Surface treatment, if other than standard (see 8.2).

5. Materials and Manufacture

5.1 *Rolling*—The material shall be furnished either hot-rolled or cold-rolled, as specified on the order.

5.2 *Heat Treatment:*

[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 A01.19 on Steel Sheet and Strip.

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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**

TABLE 1 Standard Steels Commonly Produced for Alloy-Steel Sheet and Strip

Steel Designation No.	Chemical Composition Ranges and Limits, % (Heat Analysis)[A]								
	C	Mn	P	S	Si[B]	Ni	Cr	Mo	V
E3310[C]	0.08–0.13	0.45–0.60	0.025	0.025	0.15–0.35	3.25–3.75	1.40–1.75	. . .	. . .
4012[C]	0.09–0.14	0.75–1.00	0.025	0.025	0.15–0.35	. . .	. . .	0.15–0.25	. . .
4118	0.18–0.23	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.40–0.60	0.08–0.15	. . .
4130	0.28–0.33	0.40–0.60	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4135	0.33–0.38	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4137	0.35–0.40	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4140	0.38–0.43	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4142	0.40–0.45	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4145	0.43–0.48	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4147[C]	0.45–0.50	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4150	0.48–0.53	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.80–1.10	0.15–0.25	. . .
4320	0.17–0.22	0.45–0.65	0.025	0.025	0.15–0.35	1.65–2.00	0.40–0.60	0.20–0.30	. . .
4340	0.38–0.43	0.60–0.80	0.025	0.025	0.15–0.35	1.65–2.00	0.70–0.90	0.20–0.30	. . .
E4340	0.38–0.43	0.65–0.85	0.025	0.025	0.15–0.35	1.65–2.00	0.70–0.90	0.20–0.30	. . .
4520[C]	0.18–0.23	0.45–0.65	0.025	0.025	0.15–0.35	. . .	. . .	0.45–0.60	. . .
4615	0.13–0.18	0.45–0.65	0.025	0.025	0.15–0.35	1.65–2.00	. . .	0.20–0.30	. . .
4620	0.17–0.22	0.45–0.65	0.025	0.025	0.15–0.35	1.65–2.00	. . .	0.20–0.30	. . .
4718	0.16–0.21	0.70–0.90	0.025	0.025	0.15–0.35	0.90–1.20	0.30–0.50	0.30–0.40	. . .
4815	0.13–0.18	0.40–0.60	0.025	0.025	0.15–0.35	3.25–3.75	. . .	0.20–0.30	. . .
4820	0.18–0.23	0.50–0.70	0.025	0.025	0.15–0.35	3.25–3.75	. . .	0.20–0.30	. . .
5015	0.12–0.17	0.30–0.50	0.025	0.025	0.15–0.35	. . .	0.30–0.50	. . .	. . .
5046	0.43–0.50	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.20–0.35	. . .	. . .
5115	0.13–0.18	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.70–0.90	. . .	. . .
5120	0.17–0.22	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.70–0.90	. . .	. . .
5130	0.28–0.33	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.80–1.10	. . .	. . .
5132	0.30–0.35	0.60–0.80	0.025	0.025	0.15–0.35	. . .	0.75–1.00	. . .	. . .
5140	0.38–0.43	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.70–0.90	. . .	. . .
5150	0.48–0.53	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.70–0.90	. . .	. . .
5160	0.56–0.64	0.75–1.00	0.025	0.025	0.15–0.35	. . .	0.70–0.90	. . .	. . .
E51100[C]	0.95–1.10	0.25–0.45	0.025	0.025	0.15–0.35	. . .	0.90–1.15	. . .	. . .
E52100	0.98–1.10	0.25–0.45	0.025	0.025	0.15–0.35	. . .	1.30–1.60	. . .	. . .
6150	0.48–0.53	0.70–0.90	0.025	0.025	0.15–0.35	. . .	0.80–1.10	. . .	0.15 min
6158[C]	0.55–0.62	0.70–1.10	0.025	0.025	0.15–0.35	. . .	0.90–1.20	. . .	0.10–0.20
8615	0.13–0.18	0.70–0.90	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8617	0.15–0.20	0.70–0.90	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8620	0.18–0.23	0.70–0.90	0.035	0.035	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8630	0.28–0.33	0.70–0.90	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8640	0.38–0.43	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8642[C]	0.40–0.45	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8645	0.43–0.48	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8650[C]	0.48–0.53	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8655	0.51–0.59	0.75–100	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8660	0.55–0.65	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25	. . .
8720	0.18–0.23	0.70–0.90	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.20–0.30	. . .
8735[C]	0.33–0.38	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.20–0.30	. . .
8740[C]	0.38–0.43	0.75–1.00	0.025	0.025	0.15–0.35	0.40–0.70	0.40–0.60	0.20–0.30	. . .
9260	0.56–0.64	0.75–1.00	0.025	0.025	1.80–2.20	. . .	. . .	. . .	. . .
9262[C]	0.55–0.65	0.75–1.00	0.025	0.025	1.80–2.20	. . .	0.25–0.40	. . .	. . .
E9310[C]	0.08–0.13	0.45–0.65	0.025	0.025	0.20–0.35	3.00–3.50	1.00–1.40	0.08–0.15	. . .

[A] The chemical ranges and limits shown are subject to product analysis tolerances. See Specification A505.
[B] Other silicon ranges are available. Consult the producer.
[C] Not an S.A.E. Steel Designation.

5.2.1 *Hot-Rolled*—Hot-rolled material shall be furnished in one of the following conditions, as specified on the order:

5.2.1.1 As-rolled,

5.2.1.2 Annealed,

5.2.1.3 Normalized, or

5.2.1.4 Normalized-and-tempered.

5.2.2 *Cold-Rolled*—Cold-rolled material shall be fully annealed after cold-rolling. (Temper, skin, or roller leveling for the control of flatness, which does not significantly affect the properties, may be performed after annealing.)

6. Chemical Requirements

6.1 The heat analysis shall conform to the requirements for the grade specified on the order.

6.1.1 *Alloy Steel*—The grade shall be specified in accordance with either 6.1.1.1 or 6.1.1.2.

6.1.1.1 Standard steels listed in Table 1 are those commonly produced for alloy steel sheet and strip.

6.1.1.2 Nonstandard steel grades may be specified using the ranges and limits shown in Table 2.

TABLE 2 Heat (Cast) Analysis Ranges for Other than Standard Steel Alloy Sheet and Strip

Element	When Maximum of Specified Element Is, %	Range or Limit, %
Carbon	To 0.55 incl	0.05
	Over 0.55 to 0.70 incl	0.08
	Over 0.70 to 0.80 incl	0.10
	Over 0.80 to 0.95 incl	0.12
	Over 0.95 to 1.35 incl	0.13
Manganese	To 0.60 incl	0.20
	Over 0.60 to 0.90 incl	0.20
	Over 0.90 to 1.05 incl	0.25
	Over 1.05 to 1.90 incl	0.30
	Over 1.90 to 2.10 incl	0.40
Phosphorus	. . .	0.025 max
Sulfur	. . .	0.025 max
Silicon	To 0.15 incl	0.08
	Over 0.15 to 0.20 incl	0.10
	Over 0.20 to 0.40 incl	0.15
	Over 0.40 to 0.60 incl	0.20
	Over 0.60 to 1.00 incl	0.30
	Over 1.00 to 2.20 incl	0.40
Copper	To 0.60 incl	0.20
	Over 0.60 to 1.50 incl	0.30
	Over 1.50 to 2.00 incl	0.35
Nickel	To 0.50 incl	0.20
	Over 0.50 to 1.50 incl	0.30
	Over 1.50 to 2.00 incl	0.35
	Over 2.00 to 3.00 incl	0.40
	Over 3.00 to 5.30 incl	0.50
	Over 5.30 to 10.00 incl	1.00
Chromium	To 0.40 incl	0.15
	Over 0.40 to 0.90 incl	0.20
	Over 0.90 to 1.05 incl	0.25
	Over 1.05 to 1.60 incl	0.30
	Over 1.60 to 1.75 incl	0.35
	Over 1.75 to 2.10 incl	0.40
	Over 2.10 to 3.99 incl	0.50
Molybdenum	To 0.10 incl	0.05
	Over 0.10 to 0.20 incl	0.07
	Over 0.20 to 0.50 incl	0.10
	Over 0.50 to 0.80 incl	0.15
	Over 0.80 to 1.15 incl	0.20
Vanadium	To 0.25 incl	0.05
	Over 0.25 to 0.50 incl	0.10

6.1.2 *Structural Alloy Steel*—The grade shall be specified as outlined in 6.1.1. However, since different mechanical properties may be expected for each of the many chemical compositions and conditions (heat treatment) that may be specified, consideration must be given to these factors in selecting the chemical composition to be specified.

7. Mechanical Requirements

7.1 *Alloy Steel*—Mechanical tests are not applicable to regular quality alloy steel sheet and strip.

7.2 *Structural Alloy Steel:*

7.2.1 *Tension Tests:*

7.2.1.1 *Requirements*—The tension test requirements shall conform to the requirements specified on the order. Yield strength, tensile strength, and elongation requirements may be specified. The tensile properties will vary depending on the chemical composition, condition, and heat treatment. Producers are frequently consulted as to grade, resultant mechanical properties, recommended heat treatment, and other information needed to establish the property parameters to meet end use requirements. Rockwell hardness requirements may be specified, providing the requirements are compatible with the tension test requirements.

7.2.1.2 *Number of Tests*—Two tension tests and two hardness tests, when specified, shall be made from coupons obtained from each heat (cast) and heat treatment lot.

7.2.2 *Bend Tests:*

7.2.2.1 *Requirements*—Material in the annealed, normalized, or normalized-and-tempered condition shall be capable of meeting the longitudinal bend test requirements of Table 3.

7.2.2.2 *Number of Tests*—Two bend tests shall be made on specimens representative of each lot. A lot shall consist of material from the same heat (cast), of the same condition and finish, the same nominal thickness, and subjected to the same heat treatment.

7.2.2.3 Bend test specimens shall be at least ¾ in. (19 mm) wide, or the same width of the material if it is less than ¾ in. (19 mm) wide. The length shall be sufficient to permit bending to the angle specified.

7.2.2.4 The edges of bend test specimens shall be practically free of burrs. Filing or machining to remove burrs is permissible.

8. Workmanship, Finish, and Appearance

8.1 *Surface Finish:*

TABLE 3 Bend Requirements

Thickness, in. (mm)	Carbon Content, %	Degree of Bend	Ratio of Bend Radius to Thickness of Specimen	Type of Test Specimen
All	Up to 0.30, incl	180	1/2*t*	longitudinal
0.1250 (3.175) and under	Over 0.30	180	1/2*t*	longitudinal
Over 0.1250–0.2499 (3.175–6.347), incl	Over 0.30	180	*t*	longitudinal

8.1.1 *Hot-Rolled*—Unless otherwise specified, hot-rolled material shall be furnished without removing the hot-rolled oxide or scale. (That is, with the as-rolled or as-heat-treated scale.) The material may be specified to be descaled.

8.1.2 *Cold-Rolled*—Unless otherwise specified, cold-rolled material shall be furnished with a commercial dull matte finish.

8.2 *Oiling:*

8.2.1 *Hot-Rolled*—Unless otherwise specified, as-rolled or as-heat-treated material shall be furnished without oiling, and descaled material shall be oiled. Descaled material may be specified to be furnished dry, without oiling.

8.2.2 *Cold-Rolled*—Unless otherwise specified, cold-rolled material shall be furnished oiled. Cold-rolled material may be specified to be furnished dry, without oiling.

8.3 *Edges:*

8.3.1 *Hot-Rolled*—Unless otherwise specified, hot-rolled material shall be furnished with Mill Edge. The material may be specified to have other types of edges, in accordance with Specification A505.

8.3.2 *Cold-Rolled*—Unless otherwise specified, cold-rolled sheet shall be furnished with Cut Edge and cold-rolled strip shall be furnished with No. 3 Edge. The material may be specified to have other types of edges, in accordance with Specification A505.

9. Keywords

9.1 alloy steel sheet; alloy steel strip; cold-rolled alloy steel; hot-rolled alloy steel; standard alloy steel; structural alloy steel

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A506 – 12) that may impact the use of this standard. (Approved May 1, 2016.)

(1) Revised the Si column of Table 1.