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Standard Specification for Steel, Sheet, Hot Rolled, Carbon, Commercial, Structural, and Structural, High-Strength Low-Alloy, Produced by the Twin-Roll Casting Process¹

This standard is issued under the fixed designation A 1039/A 1039M; 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.

1. Scope*

1.1 This specification covers commercial and structural steel sheet in coils and cut lengths produced by the twin-roll casting process.

1.2 The steel sheet is available in the designations listed in Section 4.

1.3 The material is available in the following sizes:

Thickness—0.027 in. [0.7 mm] to 0.078 in. [2.0 mm]

Width—up to 79 in. [2000 mm]

~~1.4 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 must be used independently of the other.~~

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

NOTE 1—A description of the Twin-Roll Casting Process is included in Appendix X1.

2. Referenced Documents

2.1 *ASTM Standards*:²

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

A 568/A 568M *Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for*

A 941 *Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys*

3. Terminology

3.1 *Definitions*—For definitions of other terms used in this specification refer to Terminology A 941.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *twin roll casting process, n*—production of steel sheet directly from liquid metal.

3.2.1.1 *Discussion*—The properties of the steel sheet are the result of the control of the casting conditions, and in some cases, through a combination of the casting process and hot rolling of the sheet.

4. Classification

4.1 Twin-roll cast steel sheet is available in the following designations:

~~4.1.1 Commercial steel (CS Types A and B), and~~

~~4.1.2 Structural steel (SS Grades 40 [275], 50 [340], 55 [380], 60 [410], 70 [480], and 80 [550]);~~

4.1.1 Commercial steel (CS Types A, B, and D), and

4.1.2 Structural steel (SS Grades 40 [275], 50 [340], 55 [380], 60 [410], 70 [480], and 80 [550]), and

4.1.3 High-Strength Low-Alloy steel (HSLAS, classes 1 and 2 in grades 45 [310], 50 [340], 55 [380], 60 [410], 65 [450], 70 [480] and 80 [550]).

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.

5. Ordering Information

5.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to describe the required material. Examples of such information include, but are not limited to, the following:

- 5.1.1 ASTM specification number and year of issue,
- 5.1.2 ~~Name of material and designation (direct cast or hot rolled sheet) (include grade, as appropriate, for CS, and SS) (see 5.1.2)~~ Name of material and designation (direct cast or hot rolled sheet) (include grade and class, and limits for Cu, Ni, Cr, and Mo as appropriate, for CS, SS, and HSLAS) (see 4.1),
- 5.1.2.1 When a type is not specified for CS, Type B will be furnished,
- 5.1.2.2 When a class for HSLAS is not specified, Class 1 will be furnished.
- 5.1.2.3 When limits for Cu, Ni, Cr, and Mo are not specified, limit H will be furnished.
- 5.1.3 Finish (see 9.1),
- 5.1.4 Type of edge (see 9.3),
- 5.1.5 Oiled or not oiled, as required (see 9.2),
- 5.1.6 Dimensions (thickness, thickness tolerance table (see 5.1.6.1), width, and whether cut lengths or coils),
 - 5.1.6.1 As agreed upon between the purchaser and the producer, material ordered to this specification will be supplied to meet the appropriate thickness tolerance table shown in Specification A 568/A 568M.
- 5.1.7 Coil size (inside diameter, outside diameter, and maximum weight),
- 5.1.8 Copper bearing steel, (if required),
- 5.1.9 Quantity,
- 5.1.10 Application (part identification and description), and
- 5.1.11 Special requirements,
- 5.1.12 A report of heat analysis will be supplied, if requested, for CS. For materials with required mechanical properties, SS, a report is required of heat analysis and mechanical properties as determined by the tension test.

NOTE 2—A typical ordering description is as follows: ASTM A 1039/A 1039M steel sheet, CS Type A, pickled and oiled, cut edge, 0.075 by 36 by 96 in., thickness tolerance Table 4 of Specification A 568/A 568M, 100 000 lb, for part no. 6310, for shelf bracket, or

ASTM A 1039/A 1039M, hot rolled steel sheet, SS Grade 40, pickled and oiled, cut edge, 1.5 by 117 mm by coil, ID 600 mm, OD 1500 mm, max weight 10 000 kg, thickness tolerance Table A1.1 of Specification A 568/A 568M, 100 000 kg, for part number A4885 for lower housing.

6. General Requirements for Delivery

6.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 568/A 568M for steel sheet.

7. Chemical Composition

7.1 The heat analysis of the steel shall conform to the chemical requirements of the appropriate designation shown in Table 1 ~~for CS and for CS~~, Table 2 ~~for SS~~, ~~for SS and HSLAS~~, and Table 3 for Cu, Ni, Cr, and Mo.

7.2 Each of the elements listed in Tables 1 and 2 shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium, or molybdenum is less than 0.02 %, the analysis shall be reported as “<0.02 %” or the actual determined value. When the amount of vanadium, columbium, or titanium is less than 0.008 %, the analysis shall be reported as “<0.008 %” or the actual determined value.

7.3 Sheet steel grades defined by this specification are suitable for welding if appropriate welding conditions are selected. Certain welding processes may require more restrictive composition limits than those included in Table 1 or Table 2, and in these cases, the restrictive limits shall be reviewed with the producer at the time of inquiry and ordering.

NOTE 3—The twin-roll cast product may be deoxidized using either silicon or aluminum.

8. Mechanical Properties

8.1 CS:

8.1.1 Typical, non-mandatory mechanical properties for CS are found in ~~Table 3~~ Table 4.

8.1.2 The material shall be capable of being bent at room temperature in any direction through 180° flat on itself without cracking on the outside of the bent portion (see section on bend test of Test Methods and Definitions A 370).

TABLE 1 Chemical Requirements^A for Twin Roll Cast Hot Rolled Steel Sheet Designations CS

	Composition, % Heat Analysis, Element Maximum Unless Otherwise Shown													
	C	Mn	P	S	Al ^B	Si	Cu ^C	Ni	Cr	Mo	V	Cb	Ti	N
CS Type A ^D	0.10	0.70	0.030	0.035	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.008	...
CS Type B	0.02 to 0.15	0.70	0.030	0.035	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.008	...
CS Type D	0.02 to 0.15	0.80	0.030	0.035	...	...	0.50	0.30	0.30	0.15	0.008	0.008	0.008	...

^A Where an ellipsis (...) appears in the table, there is no requirement, but the analysis shall be reported.

^B When aluminum deoxidized steel is required, it may be ordered to a minimum of 0.01 % total aluminum.

^C When copper steel is specified, the copper limit is a minimum of 0.20 %.

^D Specify Type B or Type D to avoid carbon levels below 0.02 %.

TABLE 2 Chemical Requirements^{A, B} for Twin Roll Cast Hot Rolled Steel Sheet Designations SS and HSLAS

Designation	% Heat Analysis, Element Maximum Unless Otherwise Shown													
	C	Mn	P	S	Al	Si	Cu	Ni	Cr	Mo	V	Cb	Ti	N
SS:														
Grade 40 [275]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 50 [345]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 55 [380]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 60 [410]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 70 [480]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 80 [550]	0.25	1.35	0.035	0.04	...	...	0.35	0.20	0.15	0.06	0.008	0.008	0.008	...
Grade 80 [550]	0.25	1.35	0.035	0.04	...	...	0.008	0.008	0.008	...				
HSLAS:^C														
HSLAS: ^C	0.008	0.008	0.008											
Grade 45 [310] Class 1 ^D	0.22	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 45 [310] Class 2	0.15	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 50 [340] Class 1 ^D	0.23	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 50 [340] Class 2	0.15	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 55 [380] Class 1 ^D	0.25	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 55 [380] Class 2	0.15	1.35	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 60 [410] Class 1	0.26	1.50	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 60 [410] Class 2	0.15	1.50	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 65 [450] Class 1	0.26	1.50	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 65 [450] Class 2	0.15	1.50	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 70 [480] Class 1	0.26	1.65	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 70 [480] Class 2	0.15	1.65	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 80 [550] class 1	0.26	1.65	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				
Grade 80 [550] class 2	0.15	1.65	0.04	0.04	...	...	0.005 min	0.005 min	0.005 min	...				

^A Where an ellipsis (...) appears in the table, there is no requirement but the analysis shall be reported.

^B The limits for copper, nickel, chromium and molybdenum are shown in Table 3.

^C HSLAS steels contain the strengthening elements columbium (niobium), vanadium, titanium, and molybdenum added singly or in combination. The minimum requirements only apply to the microalloy elements selected for strengthening of the steel.

^D For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to a maximum of 1.50 %.

^E The purchaser has the option of restricting the nitrogen content. It should be noted that, depending on the microalloying scheme (for example, use of vanadium) of the producer, nitrogen is permitted as a deliberate addition. Consideration should be made for the use of nitrogen binding elements (for exam

TABLE 3 Chemical Requirements: Cu, Ni, Cr, and Mo for Structural Steels and High-Strength Low-Alloy Steels

Designation	Limits	% Heat Analysis, maximum Unless Otherwise Specified			
		Cu ^{A, B}	Ni ^B	Cr ^{B, C}	Mo ^{B, C}
SS:					
All grades	L	0.35	0.20	0.15	0.06
	H	0.50	0.30	0.30	0.16
HSLAS:					
All grades and classes	L	0.35	0.20	0.15	0.06
	H	0.50	0.30	0.30	0.16

^A When copper is specified, a minimum of 0.20 % is required. When copper steel is not specified, the copper limit is a maximum requirement.

^B For limit H steels, the sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00 % on heat analysis. When one or more of these elements are specified by the purchaser, the sum does not apply; in which case only the individual limits on the remaining elements shall apply.

^C For limit H steels, the sum of chromium and molybdenum shall not exceed 0.32 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements shall apply.

8.2SS

8.2 SS and HSLAS:

8.2.1 The available grades and corresponding mechanical property requirements for SS and HSLAS steels are shown in Table 4.

8.2.2 Tension Tests:

8.2.2.1 Requirements—Material as represented by the test specimen shall conform to the mechanical property requirements specified in Table 4.

8.2.2.2 Number of Tests—Two tension tests shall be made from each heat or from each 50 tons [45 000 kg]. When the amount of finished material from a heat is less than 50 tons [45 000 kg], one tension test shall be made. When material rolled from one heat differs 0.050 in. [1.27 mm] or more in thickness, one tension test shall be made from the thickest and thinnest material regardless of the weight represented.

**TABLE 3 4 Typical Ranges of Mechanical Properties^A
(Nonmandatory)^B for Twin Roll Cast Hot Rolled Steel Sheet
Designations CS**

Designation	Yield Strength		Elongation in 2 in. [50 mm] % ^C
	ksi	MPa	
CS Types A and B	40 to 50	[250 to 340]	22
CS Type D	40 to 60	[250 to 410]	20

^A The yield strength tends to increase and the elongation tends to decrease as the sheet thickness decreases. These properties represent those typical of material in the thickness range of 0.050 in. [1.27 mm] to 0.065 in. [1.65 mm].

^B The typical mechanical property values presented here are non mandatory.

^C Yield strength and elongation are measured in the longitudinal direction in accordance with Test Methods and Definitions A 370.

TABLE 4 5 Mechanical Property Requirements for Twin Roll Cast Hot Rolled Steel Sheet Designations SS and HSLAS

Designation	Yield Strength ksi [MPa] min	Tensile Strength ksi [MPa] min	Elongation in 2 in. [50 mm], min % for Thickness	
			Under 0.078 in. [2.0 mm] to 0.064 in. [1.6 mm]	Under 0.064 in. [1.6 mm] to 0.027 in. [0.7 mm]
SS:				
Grade 40 [275]	40 [275]	55 [380]	20	15
Grade 50 [340]	50 [340]	65 [450]	16	11
Grade 55 [380]	55 [380]	70 [480]	14	9
Grade 60 [410]	60 [410]	70 [480]	13	8
Grade 70 [480]	70 [480]	80 [550]	12	7
Grade 80 [550]	80 [550]	90 [620]	11	6
HSLAS:			0.078 [2.0 mm] to 0.064 [1.3mm]	Less than 0.064 [1.3mm]
Grade 45 [310] Class 1	45 [310]	60 [410]	18	18
Grade 45 [310] Class 2	45 [310]	55 [380]	18	18
Grade 50 [340] Class 1	50 [340]	65 [450]	15	15
Grade 50 [340] Class 2	50 [340]	60 [410]	15	15
Grade 55 [380] Class 1	55 [380]	70 [480]	13	13
Grade 55 [380] Class 2	55 [380]	65 [450]	13	13
Grade 60 [410] Class 1	60 [410]	75 [520]	11	11
Grade 60 [410] Class 2	60 [410]	70 [480]	11	11
Grade 65 [450] Class 1	65 [450]	80 [550]	11	11
Grade 65 [450] Class 2	65 [450]	75 [520]	11	11
Grade 70 [480] Class 1	70 [480]	85 [585]	8	8
Grade 70 [480] Class 2	70 [480]	80 [550]	8	8
Grade 80 [550] Class 1	80 [550]	90 [620]	8	7
Grade 80 [550] Class 2	80 [550]	90 [620]	8	7

8.2.2.3 Tension test specimens shall be taken at a point immediately adjacent to the material to be qualified.

8.2.2.4 Tension test specimens shall be taken from the full thickness of the sheet as rolled.

8.2.2.5 Tension test specimens shall be taken from a location approximately halfway between the center of sheet and the edge of the material as-cast or as-rolled.

8.2.2.6 Tension test specimens shall be taken with the lengthwise axis of the test specimen parallel to the rolling direction (longitudinal test).

8.2.2.7 *Test Method*—Yield strength shall be determined by either the 0.2 % offset method or the 0.5 % extension under load method unless otherwise specified.

8.2.3 Bending Properties:

8.2.3.1 The suggested minimum inside radii for cold bending are listed in Appendix X2. More detail on this topic is provided in the section on Mechanical Properties of Specification A 568/A 568M. Where a tighter bend radius is required, or where curved or offset bends are involved, or where stretching or drawing are also a consideration, the producer shall be consulted.

9. Finish and Appearance

9.1 Surface Finish:

9.1.1 The material shall be furnished as-cast or as-rolled, (that is, without removing the surface oxide or scale), unless otherwise specified.

9.1.2 When required, the material shall be specified as pickled or blast cleaned (descaled).

9.2 Oiling: