

**SPECIFICATION FOR STEEL, SHEET AND STRIP,
HOT-ROLLED, CARBON, STRUCTURAL,
HIGH-STRENGTH LOW-ALLOY, HIGH-STRENGTH
LOW-ALLOY WITH IMPROVED FORMABILITY, AND
ULTRA-HIGH-STRENGTH**



SA-1011/SA-1011M



(Identical with ASTM Specification A1011/A1011M-06b.)

SPECIFICATION FOR STEEL, SHEET AND STRIP, HOT-ROLLED, CARBON, STRUCTURAL, HIGH-STRENGTH LOW-ALLOY, HIGH-STRENGTH LOW-ALLOY WITH IMPROVED FORMABILITY, AND ULTRA-HIGH STRENGTH



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1. Scope

1.1 This specification covers hot-rolled, carbon, structural, high-strength low-alloy, high-strength low-alloy with improved formability, and ultra-high strength steel sheet and strip, in coils and cut lengths.

1.2 Hot rolled steel sheet and strip is available in the designations as listed in 4.1.

1.3 This specification is not applicable to the steel covered by Specification A 635/A 635M.

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.

2. Referenced Documents

2.1 ASTM Standards:

- 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 569/A 569M Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial
- A 622/A 622M Specification for Drawing Steel (DS), Sheet and Strip, Carbon, Hot-Rolled^w
- A 635/A 635M Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Structural,

High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for

A 749/A 749M Specification for Steel, Strip, Carbon and High-Strength, Low-Alloy, Hot-Rolled, General Requirements for

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

E 18 Test Methods for Rockwell Hardness of Metallic Materials

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 aging — loss of ductility with an increase in hardness, yield strength, and tensile strength that occurs when steel, which has been slightly cold worked (such as by temper rolling) is stored for some time.

3.2.1.1 Discussion — Aging also increases the tendency toward stretcher strains and fluting.

3.2.2 stabilization — addition of one or more nitride or carbide forming elements, or both, such as titanium and columbium, to control the level of the interstitial elements carbon and nitrogen in the steel.

3.2.2.1 Discussion — Stabilization improves formability and increases resistance to aging.

3.2.3 vacuum degassing — process of refining liquid steel in which the liquid is exposed to a vacuum as part

of a special technique for removing impurities or for decarburizing the steel.

4. Classification

4.1 Hot-rolled steel sheet and steel strip is available in the following designations:

4.1.1 Commercial Steel (CS Types A, B, C, and D),

4.1.2 Drawing Steel (DS Types A and B),

NOTE 1 — CS Type B and DS Type B describe the most common product previously included, respectively, in Specifications A 569/A 569M and A 622/A 622M.

4.1.3 Structural Steel (SS grades 30[205], 33[230], 36[250] Types 1 and 2, 40[275], 45[310], 50[340], 55[380], 60[410], 70[480], and 80[550]),

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

4.1.5 High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F grades 50[340], 60[410], 70[480], and 80[550]).

4.1.5.1 HSLAS-F steel has improved formability when compared to HSLAS. The steel is fully deoxidized, made to a fine grain practice, and includes microalloying elements such as columbium, vanadium, and zirconium. The steel shall be treated to achieve inclusion control.

4.1.6 Ultra-High Strength (UHSS Types 1 and 2, in Grades 90 [620] and 100 [690]).

4.1.6.1 UHSS steel has increased strength compared with HSLAS-F. The steel is killed and made to a fine ferritic grain practice, and includes microalloying elements such as columbium (niobium), titanium, vanadium, molybdenum, and so forth. The steel shall be treated to achieve inclusion control. The material is intended for miscellaneous applications where higher strength, savings in weight, and weldability are important. Atmospheric corrosion resistance of these steels is equivalent to plain carbon steels. With copper specified, the atmospheric corrosion resistance is somewhat enhanced.

4.1.7 When required for HSLAS, HSLAS-F, and UHSS steels, limitations on the use of one or more of the microalloy elements shall be specified on the order.

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 (hot-rolled steel sheet) (include grade, type and class, as appropriate, for CS, DS, SS, HSLAS, HSLAS-F, and UHSS) (see 4.1),

5.1.2.1 When a type is not specified for CS or DS, Type B will be furnished (see 4.1),

5.1.2.2 When a class is not specified for HSLAS, Class 1 will be furnished (see 4.1),

5.1.2.3 When a type is not specified for SS Grade 36, Type 1 will be furnished (see 4.1),

5.1.2.4 When a type is not specified for UHSS, Type 1 shall be furnished (see 4.1).

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 Specifications A 568/A 568M for sheet and A 749/A 749M for strip.

NOTE 2 — Not all producers are capable of meeting all the limitations of the thickness tolerance tables in Specifications A 568/A 568M and A 749/A 749M. The purchaser should contact the producer prior to placing an order.

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),

5.1.11 Special requirements (if required), and

5.1.12 A report of heat analysis will be supplied, if requested, for CS and DS. For materials with required mechanical properties, SS, HSLAS, HSLAS-F, and UHSS, a report is required of heat analysis and mechanical properties as determined by the tension test.

NOTE 3 — A typical ordering description is as follows: ASTM A 1011-XX, hot rolled 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 1011M-XX, hot rolled steel sheet, CS Type B, pickled and oiled, cut edge, 3.7 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, 50 000 kg, for upper control arm.

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 sheets and Specification A 749/A 749M for strip, unless otherwise provided for herein.

7. Chemical Composition

7.1 The heat analysis of the steel shall conform to the chemical composition requirements of the appropriate designation shown in Table 1 for CS and DS and Table 2 for SS, HSLAS, HSLAS-F, and UHSS.

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%, report the analysis as <0.02% or the actual determined value. When the amount of vanadium, columbium, or titanium is less than 0.008%, report the analysis as <0.008% or the actual determined value. When the amount of boron is less than 0.0005%, report the analysis as <0.0005 % or the actual determined value.

7.3 Sheet steel grades defined by this specification are suitable for welding if appropriate welding conditions are selected. For certain welding processes, if more restrictive composition limits are desirable, they shall be specified at the time of inquiry and confirmed at the time of ordering.

8. Mechanical Properties

8.1 CS and DS:

8.1.1 Typical, nonmandatory mechanical properties for CS and DS are found in Table 3.

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 the section on bend test in Test Methods and Definitions A 370).

8.2 SS, HSLAS, HSLAS-F, and UHSS:

8.2.1 The available grades and corresponding mechanical properties for SS, HSLAS, HSLAS-F, and UHSS 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. These requirements do not apply to the uncropped ends of unprocessed coils.

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.

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-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 X1 and is discussed in more detail in Specifications A 568/A 568M (6.6) and A 749/A 749M (7.6). Where a tighter bend radius is required, 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 Unless otherwise specified, the material shall be furnished as rolled, that is, without removing the hot-rolled oxide or scale.

9.1.2 When required, it is permissible to specify that the material be pickled or blast cleaned (descaled).

9.2 Oiling:

9.2.1 Unless otherwise specified, as-rolled material shall be furnished not oiled (that is, dry), and pickled or blast cleaned material shall be furnished oiled.

9.3 Edges:

9.3.1 Steel sheet is available with mill edge or cut edge.

9.3.2 Steel strip is available with mill edge or cut edge.

10. Retests and Disposition of Non-Conforming Material

10.1 Retests, conducted in accordance with the requirements of Section 11.1 of Specification A 568/A 568M, are permitted when an unsatisfactorily test result is suspected

to be the consequence of the test method procedure.

10.2 Disposition of non-conforming material shall be subject to the requirements of Section 11.2 of Specification A 568/A 568M.

11. Certification

11.1 A report of heat analysis shall be supplied, if requested, for CS and DS steels. For material with required mechanical properties, SS, HSLAS, HSLAS-F, and UHSS a report is required of heat analysis and mechanical properties as determined by the tension test.

11.2 The report shall include the purchase order number; the ASTM designation number and year date; product designation; grade; type or class, as applicable; the heat number; and as required, heat analysis and mechanical properties as indicated by the tension test.

11.3 A signature is not required on the test report. However, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report.

11.4 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a

counterpart printed in the certifier’s facility. The content of the EDI transmitted document must meet the requirements of the invoked ASTM standard and the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

12. Product Marking

12.1 In addition to the requirements of Specification A 568/A 568M for sheet and Specification A 749/A 749M for strip, each lift or coil shall be marked with the designation shown on the order {CS (Type A, B, or C), DS (Type A or B), SS (Grade and for SS36, Type), HSLAS (Grade and Class), HSLAS-F (Grade), or UHSS (Type and Grade)}. The designation shall be legibly stenciled on the top of each lift or shown on a tag attached to each coil or shipping unit.

13. Keywords

13.1 carbon steel sheet; carbon steel strip; commercial steel; drawing steel; high strength-low alloy steel; high strength-low alloy steel with improved formability; hot-rolled steel sheet; hot-rolled steel strip; steel sheet; steel strip; structural steel; ultra-high strength steel

TABLE 1
CHEMICAL COMPOSITION^A FOR HOT ROLLED STEEL SHEET AND STRIP DESIGNATIONS CS AND DS

	Composition, % Heat Analysis Element Maximum Unless Otherwise Shown														
	C	Mn	P	S	Al	Si	Cu	Ni	Cr ^B	Mo	V	Cb	Ti ^C	N	B
CS Type A ^{D, E, F, G}	0.10	0.60	0.030	0.035	...	...	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	...	...
CS Type B ^F	0.02 to 0.15	0.60	0.030	0.035	...	...	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	...	...
CS Type C ^{D, E, F, G}	0.08	0.60	0.10	0.035	...	...	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	...	...
CS Type D ^F	0.10	0.70	0.030	0.035	...	...	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	...	...
DS Type A ^{D, E, G}	0.08	0.50	0.020	0.030	0.01 min	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...	...
DS Type B	0.02 to 0.08	0.50	0.020	0.030	0.01 min	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...	...

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

^B Chromium is permitted, at the producer’s option, to 0.25% maximum when the carbon content is less than or equal to 0.05%.

^C For steels containing more than 0.02% carbon, titanium is permitted at the producer’s options, to the lesser of 3.4N + 1.5S or 0.025%, for the purpose of stabilization.

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

^E For carbon levels less than or equal to 0.02%, it is permissible to use vanadium, columbium, or titanium, or combinations thereof, as stabilizing elements at the producer’s option. In such case, the limits for these elements are 0.10% for vanadium or columbium and 0.15% for titanium.

^F When an aluminum deoxidized steel is required, it is permissible to order to a minimum of 0.01% total aluminum.

^G It is permissible to furnish as a vacuum degassed or chemically stabilized steel, or both, at producer’s option.

^H When copper steel is specified, the copper limit is a minimum requirement. When copper steel is not specified, the copper limit is a maximum requirement.

TABLE 2
 CHEMICAL COMPOSITION^A FOR HOT ROLLED STEEL SHEET
 AND STRIP DESIGNATIONS SS, HSLAS, HSLAS-F, AND UHSS

Designation	% Heat Analysis, Element Maximum Unless Otherwise Shown													
	C	Mn	P	S	Al	Si	Cu ^B	Ni	Cr	Mo	V	Cb	Ti	N
SS: ^C														
Grade 30 [205]	0.25	0.90	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 33 [230]	0.25	0.90	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 36 [250] Type 1	0.25	0.90	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 36 [250] Type 2 ^D	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 40 [275]	0.25	0.90	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 45 [310] ^D	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 50 [340] ^D	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 55 [380] ^D	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 60 [410]	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 70 [480]	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
Grade 80 [550]	0.25	1.35	0.035	0.04	...	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
HSLAS: ^E														
Grade 45 [310] Class 1 ^D	0.22	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 45 [310] Class 2	0.15	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 50 [340] Class 1 ^D	0.23	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 50 [340] Class 2	0.15	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 55 [380] Class 1 ^D	0.25	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 55 [380] Class 2	0.15	1.35	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 60 [410] Class 1	0.26	1.50	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 60 [410] Class 2	0.15	1.50	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	...
Grade 65 [450] Class 1	0.26	1.50	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	^F
Grade 65 [450] Class 2	0.15	1.50	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	^F
Grade 70 [480] Class 1	0.26	1.65	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	^F
Grade 70 [480] Class 2	0.15	1.65	0.04	0.04	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	^F
HSLAS-F: ^E														
Grade 50 [340], 60 [410],	0.15	1.65	0.020	0.025	...	...	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	^F
Grade 70 [480], and 80 [550]	0.15	1.65	0.020	0.025	...	...	0.20	0.20	0.15	0.16	0.005 min	0.005 min	0.005 min	^F
UHSS: ^E														
Grade 90 [620] and 100	0.15	2.00	0.020	0.025	...	...	0.20	0.20	0.15	0.40	0.005 min	0.005 min	0.005 min	^F
[690] Type 1														
Grade 90 [620] and 100	0.15	2.00	0.020	0.025	...	...	0.60	0.50	0.30	0.40	0.005 min	0.005 min	0.005 min	^F
[690] Type 2														

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

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

^C Titanium is permitted for SS designations, at the producer's option, to the lesser of 3.4N + 1.5S or 0.025%, for the purpose of stabilization.

^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 HSLAS, HSLAS-F, and UHSS 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.

^F 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 may be a deliberate addition. Consideration should be made for the use of nitrogen binding elements (for example, vanadium, titanium).

TABLE 3
 TYPICAL RANGES OF MECHANICAL PROPERTIES^A
 (NONMANDATORY)^B FOR HOT-ROLLED STEEL SHEET
 AND STRIP DESIGNATIONS CS AND DS

Designation	Yield Strength ^C		Elongation in 2 in. [50 mm] % ^C
	ksi	MPa	
CS Types A, B, C, and D	30 to 50	[205 to 340]	≥ 25
DS Types A and B	30 to 45	[205 to 310]	≥ 28

^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 0.100 to 0.150 in. [2.5 to 3.5 mm] for CS Types A, B, and DS Types A and B and in the thickness ranges of 0.060 to 0.075 in. [1.5 to 1.9 mm] for CS Type D.

^B The typical mechanical property values presented here are non-mandatory. They are provided to assist the purchaser in specifying a suitable steel for a given application. Values outside these ranges are to be expected.

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

TABLE 4
MECHANICAL PROPERTY REQUIREMENTS^A
FOR HOT ROLLED STEEL SHEET AND STRIP DESIGNATIONS SS, HSLAS, HSLAS-F, AND UHSS

Designation	Yield Strength ksi [MPa] min	Tensile Strength ^B ksi [MPa] min	Elongation in 2 in. [50 mm] min, % for Thicknesses:			Elongation in 8 in. [200 mm], % for Thickness: Under 0.230 [6.0 mm]
			Under 0.230 [6.0 mm] to 0.097 [2.5 mm]	Under 0.097 [2.5 mm] to 0.064 [1.6 mm]	Under 0.064 [1.6 mm] to 0.025 [0.65 mm]	
SS:						
Grade 30 [205]	30 [205]	49 [340]	25	24	21	19
Grade 33 [230]	33 [230]	52 [360]	23	22	18	18
Grade 36 [250] Type 1	36 [250]	53 [365]	22	21	17	17
Grade 36 [250] Type 2	36 [250]	58-80 [400-550]	21	20	16	16
Grade 40 [275]	40 [275]	55 [380]	21	20	15	16
Grade 45 [310]	45 [310]	60 [410]	19	18	13	14
Grade 50 [340]	50 [340]	65 [450]	17	16	11	12
Grade 55 [380]	55 [380]	70 [480]	15	14	9	10
Grade 60 [410]	60 [410]	75 [480]	14	13	8	9
Grade 70 [480]	70 [480]	85 [550]	13	12	7	8
Grade 80 [550]	80 [550]	95 [620]	12	11	6	7
HSLAS:						
			Over 0.097 in. [2.5 mm]	Up to 0.097 in. [2.5 mm]		
Grade 45 [310] Class 1	45 [310]	60 [410]	25	...	23	...
Grade 45 [310] Class 2	45 [310]	55 [380]	25	...	23	...
Grade 50 [340] Class 1	50 [340]	65 [450]	22	...	20	...
Grade 50 [340] Class 2	50 [340]	60 [410]	22	...	20	...
Grade 55 [380] Class 1	55 [380]	70 [480]	20	...	18	...
Grade 55 [380] Class 2	55 [380]	65 [450]	20	...	18	...
Grade 60 [410] Class 1	60 [410]	75 [520]	18	...	16	...
Grade 60 [410] Class 2	60 [410]	70 [480]	18	...	16	...
Grade 65 [450] Class 1	65 [450]	80 [550]	16	...	14	...
Grade 65 [450] Class 2	65 [450]	75 [520]	16	...	14	...
Grade 70 [480] Class 1	70 [480]	85 [585]	14	...	12	...
Grade 70 [480] Class 2	70 [480]	80 [550]	14	...	12	...
HSLAS-F:						
Grade 50 [340]	50 [340]	60 [410]	24	...	22	...
Grade 60 [410]	60 [410]	70 [480]	22	...	20	...
Grade 70 [480]	70 [480]	80 [550]	20	...	18	...
Grade 80 [550]	80 [550]	90 [620]	18	...	16	...
UHSS:						
Grade 90 [620] Types 1 and 2	90 [620]	100 [690]	16	...	14	...
Grade 100 [690] Types 1 and 2	100 [690]	110 [760]	14	...	12	...

^A For coil products, testing by the producer is limited to the end of the coil. Mechanical properties throughout the coil shall comply with the minimum values specified.

^B A minimum and maximum tensile strength has been specified for SS36 Type 2.

APPENDIXES

(Nonmandatory Information)

X1. BENDING PROPERTIES**X2. RELATED ISO STANDARDS**

The ISO standards listed below may be reviewed for comparison with this ASTM standard. The relationship between the standards may only be approximate; therefore, the respective standards should be consulted for actual requirements. Those who use these documents must determine which specifications address their needs.

ISO 3573 Hot-rolled Carbon Steel Sheet of Commercial and Drawing Qualities

ISO 4995 Hot-rolled Steel Sheet of Structural Quality

ISO 4996 Hot-rolled Steel Sheet of High Yield Stress Structural Quality

ISO 5951 Hot-rolled Steel Sheet of Higher Yield Strength with Improved Formability

ISO 6316 Hot-rolled Carbon Steel Strip of Structural Quality

ISO 6317 Hot-rolled Carbon Steel Strip of Commercial and Drawing Qualities

X3. HARDNESS PROPERTIES

X3.1 Table X3.1 lists the typical hardness values.

TABLE X1.1
SUGGESTED MINIMUM INSIDE RADIUS FOR COLD BENDING

Designation	Grade	Minimum Inside Radius for Cold Bending	
		Class 1	Class 2
Structural Steel	30 [205]	1 t	
	33 [230]	1 t	
	36 [250] Type 1	1½ t	
	36 [250] Type 2	2 t	
	40 [275]	2 t	
	45 [310]	2 t	
	50 [340]	2½ t	
	55 [380]	3 t	
	60 [410]	3½ t	
	70 [480]	4 t	
High-Strength Low-Alloy Steel	80 [550]	4 t	
High-Strength Low-Alloy Steel with Improved Formability	50 [340]	1 t	
	60 [410]	1½ t	
	70 [480]	2 t	
	80 [550]	2 t	
Ultra-High Strength Steel Types 1 and 2	90 [620]	2½ t	
	100 [690]	2½ t	

NOTE 1 — (t) Equals a radius equivalent to the steel thickness.

NOTE 2 — The suggested radius should be used as a minimum for 90° bends in actual shop practice.

NOTE 3 — Material which does not perform satisfactorily, when fabricated in accordance with the above requirements, may be subject to rejection pending negotiation with the steel supplier.

TABLE X3.1
TYPICAL HARDNESS VALUES

Designation	Hardness-Rockwell B Scale
CS Type A	75 or less
CS Type B	75 or less
CS Type C	75 or less
DS	65 or less

NOTE 1 — The hardness values shown are at the time of shipment.

NOTE 2 — Tests for hardness shall be conducted in accordance with the requirements of Test Methods E 18.

NOTE 3 — The hardness values are Rockwell B scale as measured or converted from the appropriate Rockwell scales.

NOTE 4 — The typical hardness values apply to the full range of steel sheet thickness. Hardness tends to increase as the steel sheet thickness decreases.

NOTE 5 — Hardness testing is commonly used to assess the relative formability of various designations of uncoated steel sheet. This assessment done by many users is recognized to be only an approximation of the relative formability and therefore cannot be used as a specification requirement.