Designation: A1030/A1030M – 16

Standard Practice for Measuring Flatness Characteristics of Steel Sheet Products[1]

This standard is issued under the fixed designation A1030/A1030M; 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 Flatness is a significant quality characteristic of steel sheet products. Sheet flatness is affected by mill process factors plus the grade, thickness and width of the material supplied. It is the purpose of this practice to define the different flatness characteristics and to describe the method(s) most commonly used to measure particular characteristics. The methods described are designed and intended to be used in mill situations and environments.

1.2 The sheet shall conform to all the requirements of the appropriate specifications as follows: Specifications A568/A568M or A924/A924M.

1.3 Quantitative limits are not addressed and are established in the general requirements, or individual product specifications, or both; or when applicable, as agreed to between supplier and user.

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.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A568/A568M Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

A924/A924M Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

3. Significance and Use

3.1 The definitions and procedures for measuring flatness characteristics of steel sheet products are provided so that purchasers and suppliers have common definitions and measuring procedures for flatness characteristics. The intention of these definitions and measuring methods is not to provide a dimensional specification for flatness characteristics, but rather common procedure(s) for quantifying flatness anomalies. For determining compliance with flatness specifications, references are provided to appropriate ASTM standards.

4. Interferences

4.1 Measurement of flatness often has been subjective, at best. Successful measurement of various flatness anomalies on quantitative terms requires recognition of several factors that can interfere with accurate measurements.

4.1.1 Flat surfaces are required. Measurement of several anomalies requires laying of a cut sheet sample, or a sheet area still attached to a coil, on a recognized flat surface. In most cases, laying of a cut sheet sample, or a sheet area still attached to a coil, on a floor will produce satisfactory results, as long as the floor is recognized as being flat. The flatness of sheet areas still attached to a coil is also measured on the flat tables of coil processing lines, with the sheet line tension released. If the measuring surface is not recognized as being flat, a machined flat surface is recommended.

4.1.2 Stepblock gauges or tapered gauges should be checked regularly with a calibrated hand micrometer. Wear or dirt build up will affect accuracy.

4.1.3 The flat tables of shape gauges capable of measuring flatness characteristics must be clean and the sensors must be in good condition.

4.1.4 The sheet sample must be damage free.

5. Apparatus

5.1 Appropriate tools to measure flatness anomalies are described along with drawings as indicated.

5.1.1 *Flat Surfaces*—Accurate measurements of flatness anomalies require a flat surface, machined flat preferred.

5.1.2 *Machined Stepblock Gauge*—See Fig. 1. Typically steps are in 1⁄16 in. [1 mm] increments.

[1] This practice is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.07 on Methods of Testing.

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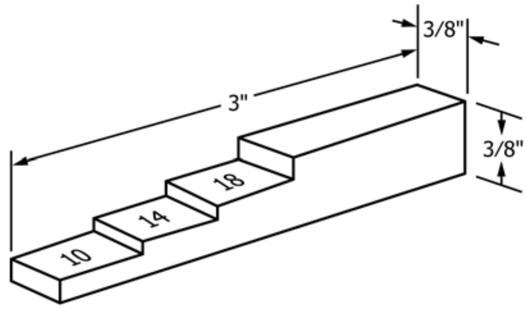
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard



NOTE 1—Stepblock gauge for all thicknesses and sizes of cut sheets.
NOTE 2—Dimensions given are approximate overall dimensions.

FIG. 1 Flatness Stepblock Gauge

5.1.3 *Tapered Gauge*—See Fig. 2.
5.1.4 *Standard Ruler or Tape Measure.*
5.1.5 *Hand Micrometer.*
5.1.6 *Lightweight Straightedge*—Rigid, but light enough not to affect the test result.

6. Procedure

6.1 *Wavy Edge (see Fig. 3):*

6.1.1 *Definition*—A series of rolling direction edge deviations or undulations of the sheet from a recognized flat surface, having a height (H) and a measurable cycle length (L).

6.1.2 *Measuring Methods:*

6.1.2.1 With a cut sheet sample, or sheet area still attached to a coil, of at least 4 ft [1.2 m] in length by coil width on a recognized flat surface, measure the height (H) at the peak point of each wave from the recognized flat surface with a ruler, tape measure, tapered gauge, or stepblock gauge. Also measure the cycle length (L) from peak to peak of each wave with a ruler or tape measure.

6.1.3 *Permissible Variations*

6.1.3.1 The height (H) of the highest peak measured in accordance with 6.1.2.1 shall comply with applicable limits, such as found in the tables on flatness tolerances of Specifications A568/A568M or A924/A924M. Note that the referenced tables apply to cut sheet that has received adequate flattening. While wavy edge height evident in a sheet area still attached to a coil is a reasonable indication of flatness, it is not bound by the limits of the referenced tables.

6.1.3.2 As stated in the section on flatness tolerances of Specifications A568/A568M or A924/A924M, I-Unit and % Steepness rejection limits are subject to agreement between producer and purchaser. Using the procedures of Appendix X1, and the readings from 6.1.2.1, determine the I-Unit and % Steepness values, first using the distance between the two highest peaks, and second using the distance between two adjacent peaks. The highest I-Unit and % Steepness values obtained from these two situations shall be used to determine if the specification has been met.

6.1.3.3 If the I-Unit and % Steepness values are supplied directly using a shape gauge; determine if the results are within the maximum specified values.

6.2 *Ridge Buckle, Quarter Buckle, Center Buckle (see Fig. 4):*

6.2.1 *Definition*—Buckles are continuous deviations from a recognized flat surface, having a height (H) and a measurable cycle (L), and usually occur in narrow width areas parallel to the rolling direction other than at the sheet edges.

6.2.2 *Measuring Methods:*

6.2.2.1 With a cut sheet sample, or sheet area still attached to a coil, of at least 4 ft [1.2 m] by coil width resting on a recognized flat surface, place a lightweight straightedge on the highest portion of a buckle and on the highest portion of the next repeating buckle. Measure the height (H) between the straightedge and the sheet using a ruler, tape measure, tapered gauge, or stepblock gauge. Measure the cycle length (L) from peak to peak of each buckle with a ruler or tape measure.

6.2.2.2 In the case of a cut sheet sample, it is permissible to shear through the centerline of the flatness anomaly and measure as an edge wave (see 6.1.2.1) using a ruler, tape measure, tapered gauge, or stepblock gauge.

6.2.3 *Permissible Variations*

6.2.3.1 The height (H) of the highest peak measured in accordance with 6.2.2.1 or 6.2.2.2 shall comply with applicable limits, such as found in the tables on flatness tolerances of Specifications A568/A568M or A924/A924M. Note that the referenced tables apply to cut sheet that has received adequate flattening. While buckle height evident in a sheet area still attached to a coil is a reasonable indication of flatness, it is not bound by the limits of the referenced tables.

6.2.3.2 As stated in the section on flatness tolerances of Specifications A568/A568M or A924/A924M, I-Unit and % Steepness rejection limits are subject to agreement between producer and purchaser. Using the procedures of Appendix X1, and the readings from 6.2.2.1 or 6.2.2.2, determine the I-Unit and % Steepness values, first using the distance between the two highest peaks, and second using the distance between two adjacent peaks. The highest I-Unit and % Steepness values obtained from these two situations shall be used to determine if the specification has been met.

6.2.3.3 If the I-Unit and % Steepness values are supplied directly using a shape gauge; determine if the results are within the maximum specified values.

6.3 *Full Center (see Fig. 5):*

6.3.1 *Definition*—Any overall deviation of a sheet from a recognized flat surface, having a height (H) and a measurable

NOTE 1—Tapered gauge for all thicknesses and sizes of cut sheets.

FIG. 2 Flatness Tapered Gauge

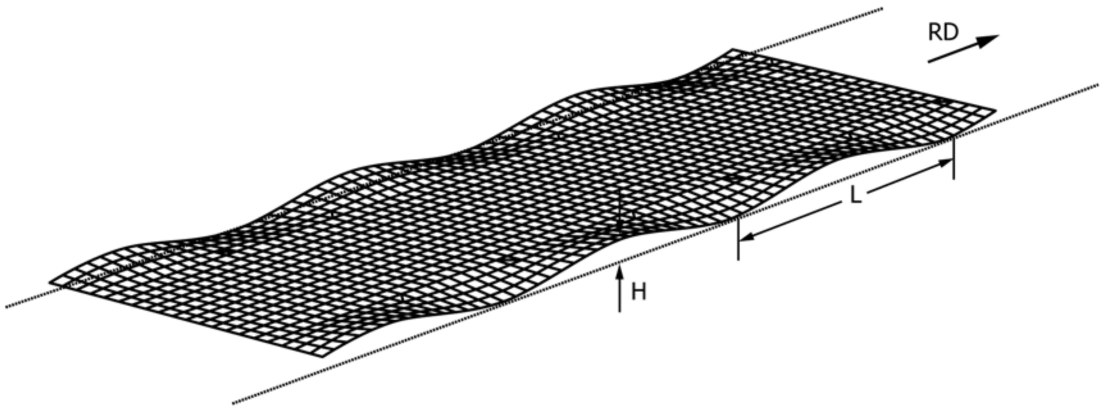


FIG. 3 Wavy Edge

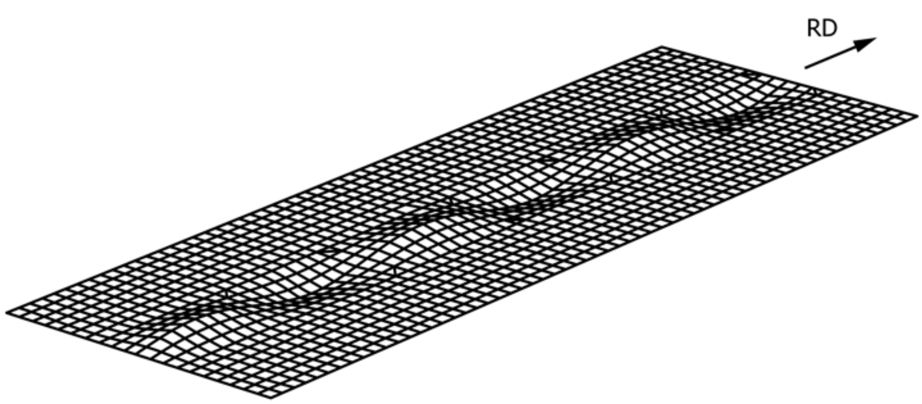


FIG. 4 Ridge Buckle, Quarter Buckle, Center Buckle

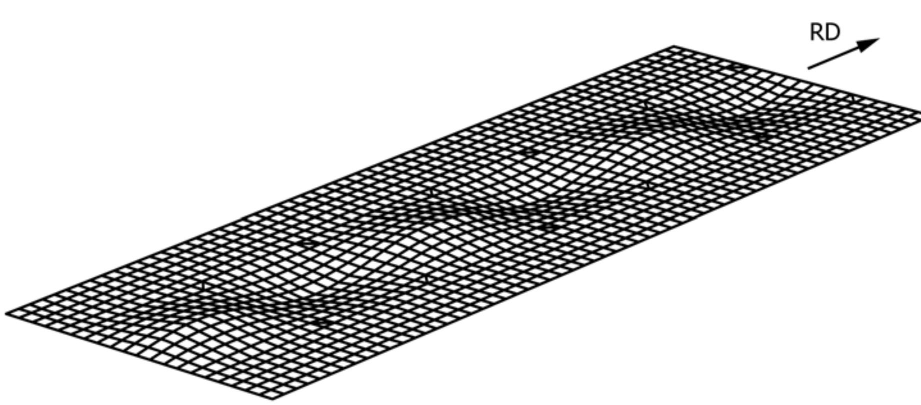


FIG. 5 Full Center

cycle (L), and occurring over a major portion of the sheet width parallel to the rolling direction other than at the sheet edges.

6.3.2 *Measuring Methods:*

6.3.2.1 With a cut sheet sample, or a sheet area still attached to a coil, of at least 4 ft [1.2 m] by coil width resting on a recognized flat surface, place a lightweight straightedge on the highest portion of a full center region and on the highest portion of the next repeating region of full center. Measure the height (H) between the straightedge and the sheet using a ruler, tape measure, tapered gauge, or stepblock gauge. Measure the

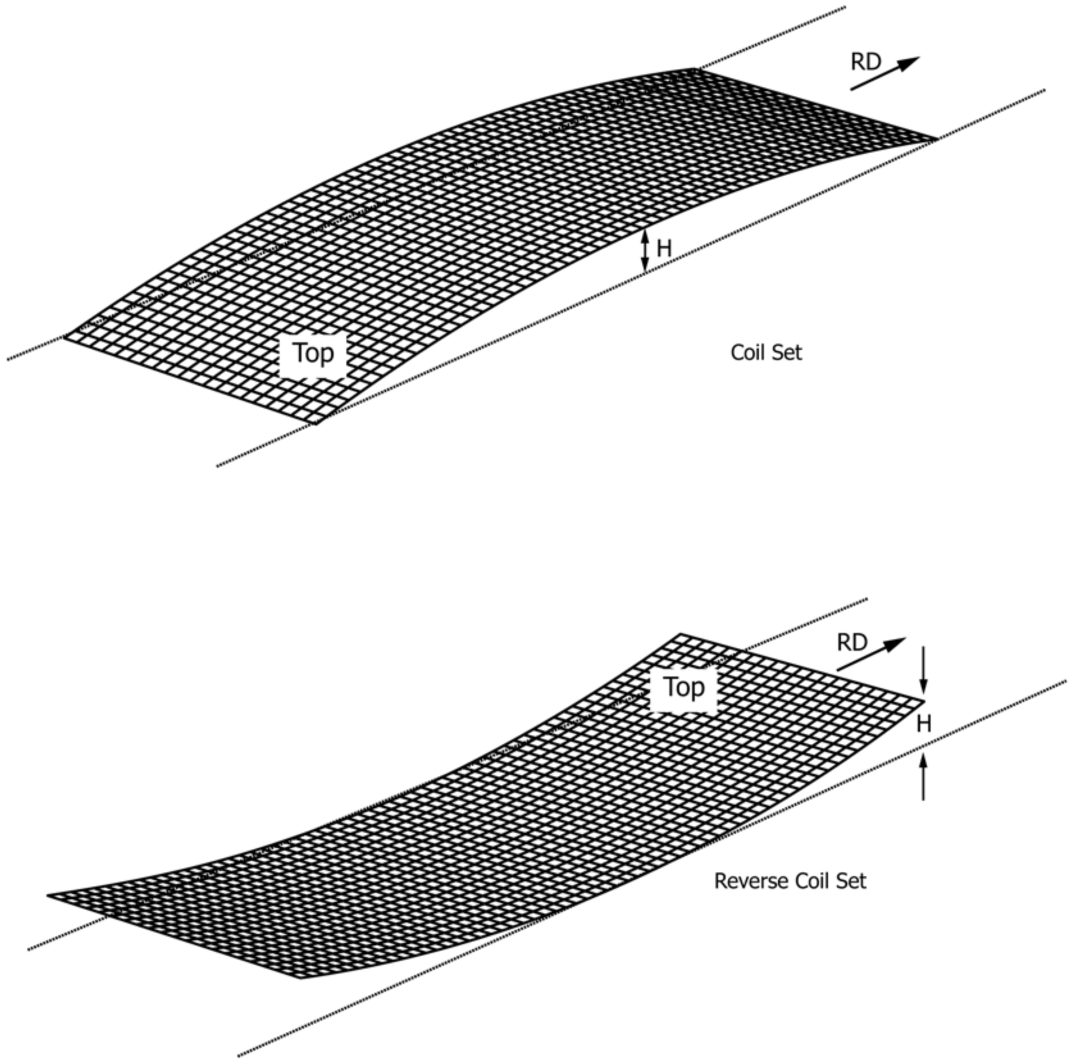


FIG. 6 Coil Set and Reverse Coil Set

cycle length (L) from peak to peak of a full center region with a ruler or tape measure.

6.3.2.2 In the case of a cut sheet sample, it is permissible to shear through the centerline of the flatness anomaly and measure as an edge wave (see 6.1.2.1) using a ruler, tape measure, tapered gauge, or stepblock gauge.

6.3.3 *Permissible Variations*

6.3.3.1 The height (H) of the highest peak measured in accordance with 6.3.2.1 or 6.3.2.2 shall comply with applicable limits, such as found in the tables on flatness tolerances of Specifications A568/A568M and A924/A924M. Note that the referenced tables apply to cut sheet that has received adequate flattening. While buckle height evident in a sheet area still attached to a coil is a reasonable indication of flatness, it is not bound by the limits of the referenced tables.

6.3.3.2 As stated in the section on flatness tolerances of Specifications A568/A568M or A924/A924M, I-Unit and % Steepness rejection limits are subject to agreement between producer and purchaser. Using the procedures of Appendix X1, and the readings from 6.3.2.1 or 6.3.2.2, determine the I-Unit and % Steepness values, first using the distance between the two highest peaks, and second using the distance between two adjacent peaks. The highest I-Unit and % Steepness values obtained from these two situations shall be used to determine if the specification has been met.

6.3.3.3 If the I-Unit and % Steepness values are supplied directly using a shape gauge; determine if the results are within the maximum specified values.

6.4 *Coil Set and Reverse Coil Set (see Fig. 6):*

6.4.1 *Definition*—A bow condition in the sheet, parallel with the rolling direction, as measured from a recognized flat surface. Coil set (also known as positive coil set) curves downward in the same direction as the upper outside lap of an overwound coil. Reverse coil set (also known as negative coil set) curves upward, opposite to the curvature of the upper outside lap of an overwound coil.

6.4.2 *Measuring Methods:*

6.4.2.1 For coil set, place an adequately leveled cut sheet sample of approximately 4 ft [1.2 m] by coil width on a

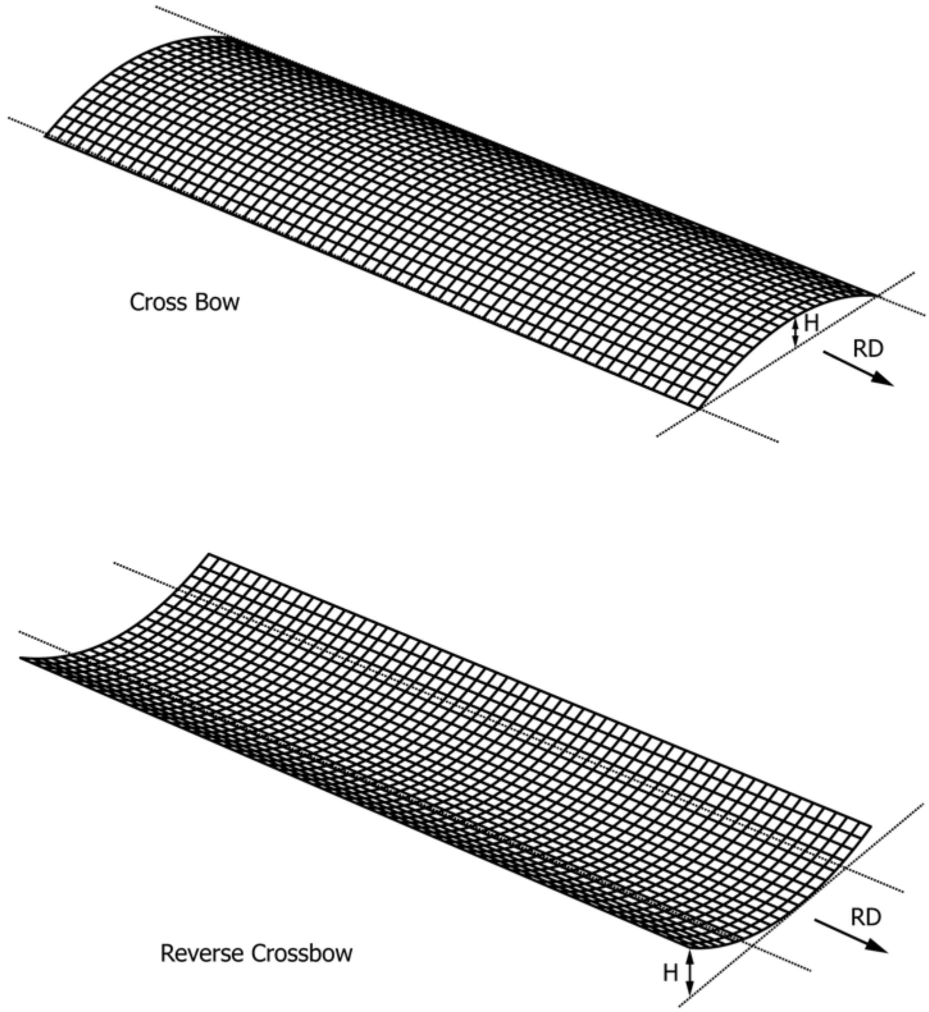


FIG. 7 Crossbow and Reverse Crossbow

recognized flat surface. Measure the highest rise (H) of the sheet edges from the flat surface. Use a ruler accurate to 1⁄16 in. [1 mm].

6.4.2.2 For reverse coil set, place an adequately leveled cut sheet sample of approximately 4 ft [1.2 m] by coil width on a recognized flat surface. Measure the highest rise (H) of the cut end(s) of the sheet from the flat surface. Use a ruler accurate to 1⁄16 in. [1 mm].

6.4.3 *Permissible Variations*

6.4.3.1 The height (H) of the highest deviation measured in accordance with 6.4.2.1 or 6.4.2.2 shall comply with applicable limits, such as found in the tables on flatness tolerances of Specifications A568/A568M or A924/A924M, or a value agreed upon between the producer and purchaser.

6.5 *Crossbow and Reverse Crossbow (see Fig. 7):*

6.5.1 *Definition*—A bow condition in the sheet, perpendicular to the rolling direction as measured from a recognized flat surface. Crossbow (also known as positive crossbow) curves downward, with the center portion of the sheet raised a measurable amount (H) above the sheet edges. Reverse crossbow (also known as negative crossbow) curves upward, with the edges of the sheet raised a measurable amount (H) above the center portion of the sheet. The degree of cross bow is determined in a horizontal position on a recognized flat surface.

6.5.2 *Measuring Methods:*

6.5.2.1 For crossbow, place an adequately leveled cut sheet sample, or sheet area still attached to a coil, of approximately 4 ft [1.2 m] by coil width on a recognized flat surface. Measure the highest rise (H) of the center of the sheet from the flat surface. Use a ruler accurate to 1⁄16 in. [1 mm].

6.5.2.2 For reverse crossbow, place an adequately leveled cut sheet sample, or sheet area still attached to a coil, of approximately 4 ft [1.2 m] by coil width on a recognized flat surface. Measure the highest rise (H) of the edges of the sheet from the flat surface. Use a ruler accurate to 1⁄16 in. [1 mm] or a lightweight straightedge as required.

6.5.3 *Permissible Variations*

6.5.3.1 The height (H) of the highest deviation measured in accordance with 6.5.2.1 or 6.5.2.2 shall comply with applicable limits, such as found in the tables on flatness tolerances of Specifications A568/A568M or A924/A924M, or a value agreed upon between the producer and purchaser.

6.6 *Camber (see Fig. 8):*

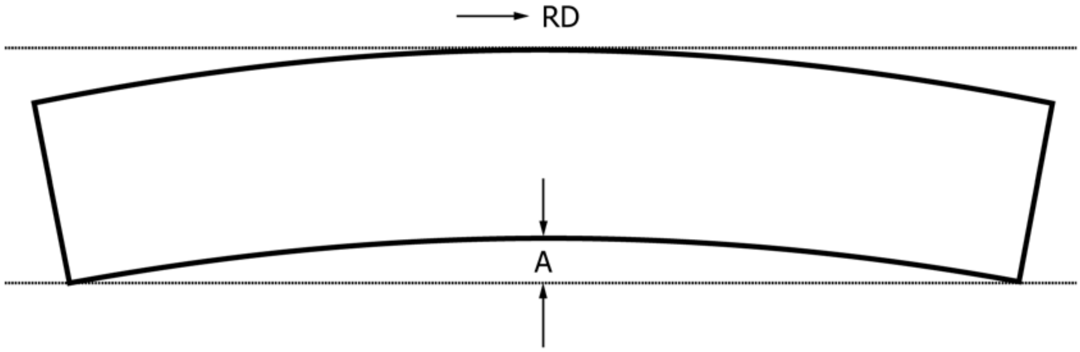


FIG. 8 Camber

6.6.1 *Definition*—The greatest deviation of a coil edge from a straight line. The measurement is taken on the concave side and is the perpendicular distance from a straight line to the point of maximum deviation (A).

6.6.2 *Measuring Methods:*

6.6.2.1 Lay a cut sheet sample of at least 20 ft [6 m] next to recognized straightedge. The perpendicular distance (A) is measured using a ruler accurate to 1⁄16 in. [1 mm].

6.6.2.2 Cut two 20 ft [6 m] consecutive cut sheets from the master coil. Butt together the sections lengthwise with the same edges together. At a 10 ft [3 m] distance from the end, measure the distance between the two edges. Divide this measurement in half to determine the actual camber (A).

6.6.3 *Permissible Variations*

6.6.3.1 The maximum deviation (A) measured in accordance with 6.6.2.1 or 6.6.2.2 shall comply with applicable limits of the table on camber tolerances of Specifications A568/A568M or A924/A924M, or a value agreed upon between the producer and purchaser.

7. I-Unit Calculation

7.1 This calculation assumes that flatness irregularities most closely conform to sinusoidal waveforms and uses the flatness wavelength and height for the calculation. An alternate approach is to use I-Unit or % Steepness as a measure of the severity of flatness anomalies. Refer to Appendix X1 for a complete discussion of I-Units.

7.2 Steel sheet processing units such as temper mills are sometimes equipped with sensor rolls and detection systems that directly measure flatness in terms of I-Units. These devices are an acceptable method of measuring flatness. While the operation of such devices is beyond the scope of this practice, the information they supply can be compared with the results obtained using this practice. I-Unit values obtained from such in-line measuring devices will not necessarily agree with those obtained using this practice.

8. Keywords

8.1 flatness; steel sheet; steel sheet—metallic-coated

APPENDIX

(Nonmandatory Information)

X1. ALTERNATIVE METHODS FOR EXPRESSING FLATNESS

X1.1 Introduction and Definitions :

X1.1.1 In addition to the conventional expression of flatness, the "maximum deviation from a horizontal flat surface," at least two other flatness parameters have been developed and are in use for characterizing sheet with longitudinal waves or buckles. These are Steepness Index and Flatness Index (or I-Unit), which are illustrated using the example in Fig. X1.1.

X1.1.2 *Steepness Index*—Fig. X1.1 (a) shows a representation of a sheet sample exhibiting edge waves of height H and interval L. The steepness index value for this sample is defined as follows:

$$steepness\ index = \frac{H}{L} \tag{X1.1}$$

$$\%\ steepness = S = \left(\frac{H}{L}\right) \times 100 \tag{X1.2}$$

X1.1.3 *I-Units*—Making a series of lengthwise cuts to the sample in Fig. X1.1 (a) relaxes elastic stresses present in the sheet and results in narrow strips of differing lengths, as shown in Fig. X1.1 (b). Using the length of the shortest strip as a reference (Lref), the I-unit value (I) for an individual strip is defined as follows:

$$I = \left(\frac{\Delta L}{L_{ref}}\right) \times 10^5 \tag{X1.3}$$

where

ΔL = difference between the length of a given strip and the reference strip.

X1.1.4 For the special case of waves/buckles that are perfectly sinusoidal in character, the following relationship applies:

$$I\left[\left(\frac{\pi}{2}\right)\left(\frac{H}{L}\right)\right]^2 \times 10^5 \tag{X1.4}$$

or

$$I = 24.7S^2 \tag{X1.5}$$

X1.1.4.1 Fig. X1.2 provides I-unit values based on the sinusoidal approximation for wave heights up to ½ in. [10 mm] (increments of 1⁄32 in. [0.5 mm]) and intervals between 10 and 40 in. [250 and 1000 mm] (increments of 1 in. [25 mm]). Mathematical relationships between the three representations of flatness described here are given in Table X1.1; these relationships can be used to convert between I-unit, % steepness, and wave height values (see examples in Table X1.1).

X1.2 Flatness Evaluation Example and Determination of I-Unit or % Steepness Value:

X1.2.1 While the sheet is on an inspection table, find the locations on the sheet that are not lying flat on the table. If no flatness deviation can be found, that portion of the coil (head/middle/tail) can be described as flat (that is, zero I-unit or zero % steepness).

X1.2.2 If the sheet is not totally flat, the height of the deviation must be determined and recorded. If the sheet has edge waves, a step gauge (incremented in intervals of 1⁄16 or 1⁄32 in. [1 or 0.5 mm]) can be inserted under a wave to determine the height. If the sheet exhibits flatness deviation in the center of the strip, a lightweight straightedge can be placed on the highest portion of the buckle and on the highest portion of the next repeating buckle. The height can then be determined by inserting a step gauge between the straightedge and the strip.

X1.2.3 Along with the height, the wave period or wave interval must also be determined. The wave interval can be obtained by using a standard tape measure or straightedge to measure the distance between the highest point of one flatness deviation to the highest point of the next repeating flatness deviation.

X1.2.4 After determining the height and wave interval, either the I-unit or % steepness value can be obtained. To determine the I-unit flatness, locate the appropriate height and wave interval in Fig. X1.2 and read the I-unit value at the intersection of the two measurements. To determine % steepness, divide the height by the wave interval and multiply the result by 100.

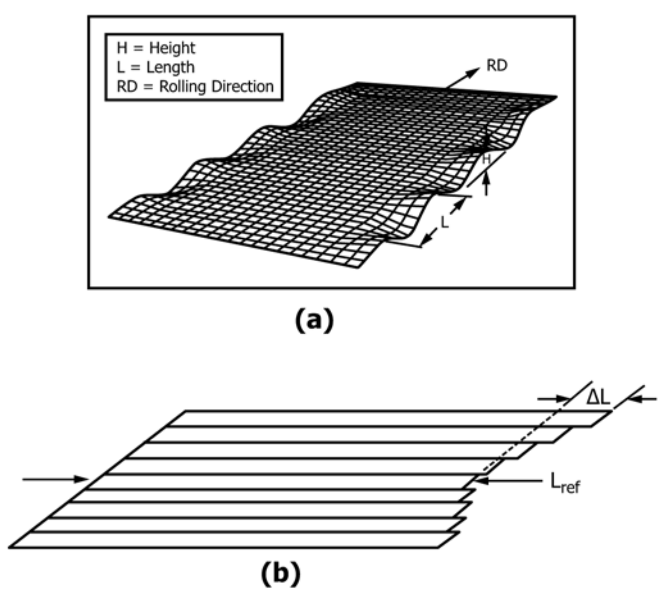


FIG. X1.1 Representation of Sheet Sample with Edge Waves (a) and Strips of Differing Length Which Result from Making Longitudinal Cuts Along the Sample (b)

Wave Height (in.)	Wavelength (in.) 10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1/32	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/16	10	8	7	6	5	4	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3/32	22	18	15	13	11	10	8	8	7	6	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1
1/8	39	32	27	23	20	17	15	13	12	11	10	9	8	7	7	6	6	5	5	5	4	4	4	4	3	3	3	3	3	3	2
5/32	60	50	42	36	31	27	24	21	19	17	15	14	12	11	10	10	9	8	8	7	7	6	6	6	5	5	5	4	4	4	4
3/16	87	72	60	51	44	39	34	30	27	24	22	20	18	16	15	14	13	12	11	10	10	9	8	8	8	7	7	6	6	6	5
7/32	118	98	82	70	60	53	46	41	36	33	30	27	24	22	21	19	17	16	15	14	13	12	12	11	10	10	9	9	8	8	7
1/4	154	128	107	91	79	69	60	53	48	43	39	35	32	29	27	25	23	21	20	18	17	16	15	14	13	13	12	11	11	10	10
9/32	195	161	136	116	100	87	76	68	60	54	49	44	40	37	34	31	29	27	25	23	22	20	19	18	17	16	15	14	14	13	12
5/16	241	199	168	143	123	107	94	83	74	67	60	55	50	46	42	39	36	33	31	29	27	25	24	22	21	20	19	18	17	16	15
11/32	292	241	203	173	149	130	114	101	90	81	73	66	60	55	51	47	43	40	37	35	32	30	29	27	25	24	23	21	20	19	18
3/8	347	287	241	206	177	154	136	120	107	96	87	79	72	66	60	56	51	48	44	41	39	36	34	32	30	28	27	25	24	23	22
13/32	408	337	283	241	208	181	159	141	126	113	102	92	84	77	71	65	60	56	52	48	45	42	40	37	35	33	31	30	28	27	25
7/16	473	391	328	280	241	210	185	164	146	131	118	107	98	89	82	76	70	65	60	56	53	49	46	43	41	39	36	35	33	31	30
15/32	543	449	377	321	277	241	212	188	168	150	136	123	112	103	94	87	80	74	69	65	60	56	53	50	47	44	42	40	38	36	34
1/2	618	510	429	365	315	274	241	214	191	171	154	140	128	117	107	99	91	85	79	73	69	64	60	57	53	50	48	45	43	41	39

Wave Height (mm)	Wavelength (mm) 250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825	850	875	900	925	950	975	1000
0.5	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.0	4	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1.5	9	7	6	5	5	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2.0	16	13	11	9	8	7	6	5	5	4	4	4	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
2.5	25	20	17	15	13	11	10	9	8	7	6	6	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2
3.0	36	29	25	21	18	16	14	12	11	10	9	8	7	7	6	6	5	5	5	4	4	4	3	3	3	3	3	3	2	2	2
3.5	48	40	34	29	25	22	19	17	15	13	12	11	10	9	8	8	7	7	6	6	5	5	5	4	4	4	4	4	3	3	3
4.0	63	52	44	37	32	28	25	22	20	18	16	14	13	12	11	10	9	9	8	8	7	7	6	6	5	5	5	5	4	4	4
4.5	80	66	56	47	41	36	31	28	25	22	20	18	17	15	14	13	12	11	10	10	9	8	8	7	7	7	6	6	6	5	5
5.0	99	82	69	58	50	44	39	34	30	27	25	22	20	19	17	16	15	14	13	12	11	10	10	9	9	8	8	7	7	6	6
5.5	120	99	83	71	61	53	47	41	37	33	30	27	25	23	21	19	18	16	15	14	13	12	12	11	10	10	9	9	8	8	7
6.0	142	118	99	84	73	63	56	49	44	39	36	32	29	27	25	23	21	20	18	17	16	15	14	13	12	12	11	10	10	9	9
6.5	167	138	116	99	85	74	65	58	52	46	42	38	34	32	29	27	25	23	21	20	19	17	16	15	14	14	13	12	12	11	10
7.0	194	160	134	115	99	86	76	67	60	54	48	44	40	37	34	31	29	27	25	23	22	20	19	18	17	16	15	14	13	13	12
7.5	222	184	154	132	113	99	87	77	69	62	56	50	46	42	39	36	33	30	28	26	25	23	22	20	19	18	17	16	15	15	14
8.0	253	209	176	150	129	112	99	88	78	70	63	57	52	48	44	40	37	35	32	30	28	26	25	23	22	21	20	18	18	17	16
8.5	286	236	198	169	146	127	112	99	88	79	71	65	59	54	50	46	42	39	36	34	32	30	28	26	25	23	22	21	20	19	18
9.0	320	265	222	189	163	142	125	111	99	89	80	73	66	61	56	51	47	44	41	38	36	33	31	29	28	26	25	23	22	21	20
9.5	357	295	248	211	182	159	139	123	110	99	89	81	74	67	62	57	53	49	45	42	40	37	35	33	31	29	28	26	25	23	22
10.0	395	327	274	234	202	176	154	137	122	109	99	90	82	75	69	63	58	54	50	47	44	41	39	36	34	32	30	29	27	26	25

FIG. X1.2 Unit Conversion Chart

TABLE X1.1 Flatness Conversion Factors[A,B]

	I-Unit	Height	% Steepness
I-Unit	1	$\frac{2L}{\pi}\sqrt{I\,10^{-5}}$	$\frac{2}{\pi}\sqrt{I\,10^{-1}}$
Height, H, peak to peak	$\left(\frac{H\pi}{2L}\right)^{2} 10^{5}$	1	(100&#10⁄H)
% Steepness, S	$2.5\,(\pi\,S)^{2}$	(LS)⁄100	1

[A] L = wave interval as defined in Fig. X1.1 (a).
[B] Examples:
(1) Assume % steepness is given as 1.5 and the corresponding I-unit value is desired. From Table Table X1.1, $I = 2.5(\pi\ S)^2 = 2.5[(3.14)(1.5)]^2 = 55.5$.
(2) Assume an I-unit value of 25 is given and the corresponding % steepness is desired. From Table X1.1, $S = 2/\pi\ (I \times 10^{-1})^{1/2} = 2/3.14(25\times10^{-1})^{1/2} = 1.0$.

SUMMARY OF CHANGES

Committee A05 has identified the location of selected changes to this standard since the last issue, A1030/A1030M - 11, that may impact the use of this standard. (May 1, 2016)

(1) Clarified the nomenclature related to the use of the term "sheet" throughout this practice, as it relates to cut sheet versus sheet in coil form.

(2) Replaced the term "strip" with "sheet" throughout.