Designation: D 245 – 00$^{\epsilon 1}$

Standard Practice for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber[1]

This standard is issued under the fixed designation D 245; 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 Department of Defense.

ε[1] NOTE—Footnote 1 was editorially corrected in April 2001.

1. Scope

1.1 This practice **(1,2)**[2] covers the basic principles for establishing related unit stresses and stiffness values for design with visually-graded solid sawn structural lumber. This practice starts with property values from clear wood specimens and includes necessary procedures for the formulation of structural grades of any desired strength ratio.

1.2 The grading provisions used as illustrations herein are not intended to establish grades for purchase, but rather to show how stress-grading principles are applied. Detailed grading rules for commercial stress grades which serve as purchase specifications are established and published by agencies which formulate and maintain such rules and operate inspection facilities covering the various species.

1.3 The material covered in this practice appears in the following order:

	Section
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Allowable Properties for Timber Design	6
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1.4 The values given in parentheses are provided for information purposes only.

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:*

D 9 Terminology Relating to Wood[3]
D 143 Methods of Testing Small Clear Specimens of Timber[3]
D 2555 Test Methods for Establishing Clear-Wood Strength Values[3]
E 105 Practice for Probability Sampling of Materials[4]
E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[5]

3. Significance and Use

3.1 *Need for Lumber Grading*:

3.1.1 Individual pieces of lumber, as they come from the saw, represent a wide range in quality and appearance with respect to freedom from knots, cross grain, shakes, and other characteristics. Such random pieces likewise represent a wide range in strength, utility, serviceability, and value. One of the obvious requirements for the orderly marketing of lumber is the establishment of grades that permit the procurement of any required quality of lumber in any desired quantity. Maximum economy of material is obtained when the range of quality-determining characteristics in a grade is limited and all pieces are utilized to their full potential. Many of the grades are established on the basis of appearance and physical characteristics of the piece, but without regard for mechanical properties. Other grades, called structural or stress grades, are established on the basis of features that relate to mechanical properties. The latter designate near-minimum strength and near-average stiffness properties on which to base structural design.

3.1.2 The development of this practice is based on extensive research covering tests of small clear specimens and of full-sized structural members. Detailed studies have included the strength and variability of clear wood, and the effect on strength from various factors such as density, knots (See Terminology D 9), and other defects, seasoning, duration of stress, and temperature.

[1] This practice is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.02 on Lumber and Engineered Wood Products.

Current edition approved April 10, 2000. Published June 2000. Originally published as D 245 – 26. Last previous edition D 245 – 99.

[2] The boldface numbers in parentheses refer to references at the end of this practice.

[3] *Annual Book of ASTM Standards*, Vol 04.10.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 14.02 (excerpts in Vol 04.10).

3.2 *How Visual Grading is Accomplished*— Visual grading is accomplished from an examination of all four faces and the ends of the piece, in which the location as well as the size and nature of the knots and other features appearing on the surfaces are evaluated over the entire length. Basic principles of structural grading have been established that permit the evaluation of any piece of stress-graded lumber in terms of a strength ratio for each property being evaluated. The strength ratio of stress-graded lumber is the hypothetical ratio of the strength property being considered compared to that for the material with no strength-reducing characteristic. Thus a piece of stress-graded lumber with a strength ratio of 75 % in bending would be expected to have 75 % of the bending strength of the clear piece. In effect, the strength ratio system of visual structural grading is thus designed to permit practically unlimited choice in establishing grades of any desired quality to best meet production and utilization requirements.

3.3 *Classification of Stress-Graded Lumber*:

3.3.1 The various factors affecting strength, such as knots, deviations of grain, shakes, and checks, differ in their effect, depending on the kind of loading and stress to which the piece is subjected. Stress-graded lumber is often classified according to its size and use. Four classes are widely used, as follows:

3.3.1.1 *Dimension Lumber*—Pieces of rectangular cross section, from nominal 2 to 4 in. thick and 2 or more in. wide, graded primarily for strength in bending edgewise or flatwise, but also frequently used where tensile or compressive strength is important. Dimension lumber covers many sizes and end uses. Lumber graded for specific end uses may dictate a special emphasis in grading and require an identifying grade name.

NOTE 1—For example, in North American grading under the American Lumber Standards Committee, stress graded dimension lumber categories that reflect end use include Light Framing, Structural Light Framing, Structural Joists and Planks, and Studs.

3.3.1.2 *Beams and Stringers*—Pieces of rectangular cross section, 5 in. nominal and thicker, nominal width more than 2 in. greater than nominal thickness, graded for strength in bending when loaded on the narrow face.

3.3.1.3 *Posts and Timbers*—Pieces of square or nearly square cross section, 5 by 5 in., nominal dimensions and larger, nominal width not more than 2 in. greater than nominal thickness, graded primarily for use as posts or columns.

3.3.1.4 *Stress-Rated Boards*—Lumber less than 2 in. nominal in thickness and 2 in. or wider nominal width, graded primarily for mechanical properties.

3.3.2 The assignment of names indicating the uses for the various classes of stress-graded lumber does not preclude their use for other purposes. For example, posts and timbers may give service as beams. The principles of stress grading permit the assignment of any kind of allowable properties to any of the classes of stress-graded lumber, whether graded primarily for that property or not. Recommendations for allowable properties may include all properties for all grades or use classes. While such universal application may result in loss of efficiency in some particulars, it offers the advantage of a more simple system of grades of stress-graded lumber.

3.4 *Essential Elements in a Stress-Grade Description*:

3.4.1 A stress grade formulated by this practice contains the following essential elements:

3.4.2 A grade name that identifies the use-class as described in 3.3.

3.4.3 A description of permissible growth characteristics that affect mechanical properties. Characteristics that do not affect mechanical properties may also be included.

3.4.4 One or more allowable properties for the grade related to its strength ratio.

4. Basic Principles of Strength Ratios

4.1 *General Considerations*:

4.1.1 Strength ratios associated with knots in bending members have been derived as the ratio of moment-carrying capacity of a member with cross section reduced by the largest knot to the moment-carrying capacity of the member without defect. This gives the anticipated reduction in bending strength due to the knot. For simplicity, all knots on the wide face are treated as being either knots along the edge of the piece (edge knots) or knots along the centerline of the piece (centerline knots).

4.1.2 Strength ratios associated with slope of grain in bending members, and in members subjected to compression parallel to grain, were obtained, experimentally **(3)**.

4.1.3 Strength ratios associated with shakes, checks, and splits are assumed to affect only horizontal shear in bending members. These strength ratios were derived, as for knots, by assuming that a critical cross section is reduced by the amount of the shake, or by an equivalent split or check.

4.1.4 Strength ratios associated with knots in compression members have been derived as the ratio of load-carrying capacity of a member with cross section reduced by the largest knot to the load-carrying capacity of the member without defect. No assumption of combined compression and bending is made.

4.1.5 Tensile strength of lumber has been related to bending strength and bending strength ratio from experimental results **(4)**.

4.1.6 Strength in compression perpendicular to grain is little affected in lumber by strength-reducing characteristics, and strength ratios of 100 % are assumed for all grades.

4.1.7 Modulus of elasticity of a piece of lumber is known to be only approximately related to bending strength ratio. In this standard, the relationship between full-span, edgewise bending modulus of elasticity and strength ratio was obtained experimentally.

4.1.8 In developing a stress-grade rule, economy may be served by specifying strength ratios such that the allowable stresses for shear and for extreme fiber in bending will be in balance, under the loading for which the members are designed.

4.1.9 A strength ratio can also be associated with specific gravity. Three selection classes called dense, close grain, and medium grain are described herein, based on experimental findings **(5)**.

4.2 *Strength Ratios*:

4.2.1 Table 1 gives strength ratios, corresponding to various slopes of grain for stress in bending and compression parallel to grain.

4.2.2 Strength ratios for various combinations of size and

TABLE 1 Strength Ratios Corresponding to Various Slopes of Grain

Slope of Grain	Maximum Strength Ratio, %	
	Bending or Tension Parallel to Grain	Compression Parallel to Grain
1 in 6	40	56
1 in 8	53	66
1 in 10	61	74
1 in 12	69	82
1 in 14	74	87
1 in 15	76	100
1 in 16	80	...
1 in 18	85	...
1 in 20	100	...

location of knot and width of face are given in Table 2, Table 3, and Table 4. Since interpolation is often required in the development of grading rules, the use of formulas in Table 2, Table 3 and Table 4 is acceptable. These formulas are found in the Appendix.

4.2.2.1 Use of the tables is illustrated by the following example: The sizes of knots permitted in a 7½ by 15½-in. (190 by 394-mm) (actual) beam in a grade having a strength ratio of 70 % in bending are desired. The smallest ratio in the column for a 7½-in. (190-mm) face in Table 2 that equals or exceeds 70 % is opposite 2⅛ in. (54 mm) in the size-of-knot column. A similar ratio in the column for 15½-in. (394-mm) face in Table 3 is opposite 4¼in. (108 mm). Hence, the permissible sizes are 2⅛ in. (54 mm) on the 7½-in. (190-mm) face and at the edge of the wide face (see 5.3.5.2) and 4¼ in. (108 mm) on the centerline of the 15½-in. (394-mm) face.

4.2.3 For all lumber thicknesses, a strength ratio of 50 % shall be used for all sizes of shakes, checks and splits. A 50 % strength ratio is the maximum effect a shake, check or split can have on the load-carrying capacity of a bending member. Limitations in grading rules placed on the characteristics at time of manufacture are for appearance and general utility purposes, and these characteristics shall not be used as a basis for increasing lumber shear design values.

NOTE 2—The factor of 0.5 (50 %) is not strictly a "strength ratio" for horizontal shear, since the factor represents more than just the effects of shakes, checks and splits. The factor also includes differences between test values obtained in Methods D 143 shear block tests and full-size solid-sawn beam shear tests. The strength ratio terminology is retained for compatibility with prior versions of Practice D 245, but prior provisions permitting design increases for members with lesser-size cracks have been deleted since the factor is related to more than shakes, checks and splits.

4.2.4 Modulus of elasticity is modified by a quality factor that is related to bending strength ratio, as given in Table 5.

4.2.5 Strength ratios in tension parallel to grain are 55 % of the corresponding bending strength ratios.

4.2.6 Table 6 gives strength ratios and quality factors for the special specific gravity classes described in 4.1.9.

5. Estimation and Limitation of Growth Characteristics

5.1 *General Quality of Lumber*:

5.1.1 All lumber should be well manufactured.

5.1.2 Only sound wood, free from any form of decay, shall be permitted, unless otherwise specified. Unsound knots and limited amounts of decay in its early stages are permitted in some of the lower stress-rated grades of lumber intended for light frame construction.

5.1.3 In stress-grading, all four faces and the ends shall be considered.

5.2 *Slope of Grain*:

5.2.1 Slope of grain resulting from either diagonal sawing or from spiral or twisted grain in the tree is measured by the angle between the direction of the fibers and the edge of the piece. The angle is expressed as a slope. For instance, a slope of grain of 1 in 15 means that the grain deviates 1 in. (2.5 mm) from the edge in 15 in. (381 mm) of length.

5.2.2 When both diagonal and spiral grain are present, the combined slope of grain is taken as the effective slope.

5.2.3 Slope of grain is measured and limited at the zone in the length of a structural timber that shows the greatest slope. It shall be measured over a distance sufficiently great to define the general slope, disregarding such short local deviations as those around knots except as indicated in 5.2.5.

5.2.4 In 1-in. nominal boards (See Terminology D 9), or similar small sizes of lumber, a general slope of grain anywhere in the length shall not pass completely through the thickness of the piece in a longitudinal distance in inches less than the number expressing the specified permissible slope. Where such a slope varies across the width of the board, its average may be taken.

5.2.5 Local deviations must be considered in small sizes, and if a local deviation occurs in a piece less than 4 in. nominal in width or on the narrow face of a piece less than 2 in. nominal in thickness, and is not associated with a permissible knot in the piece, the measurement of slope shall include the local deviation.

5.3 *Knots*:

5.3.1 A knot cluster is treated as an individual knot. Two or more knots closely spaced, with the fibers deflected around each knot individually, are not a cluster.

5.3.2 Holes associated with knots are measured and limited in the same way as knots.

5.3.3 A knot on the wide face of a bending or tension member is considered to be at the edge of the wide face if the center of the knot lies within two thirds of the knot diameter from the edge.

5.3.4 *Knots in Dimension Lumber*:

5.3.4.1 Knots in dimension lumber may be measured by displacement method, in which the proportion of the cross section of the knot to the cross section of the piece is multiplied by actual face width to establish the equivalent knot size (see Fig. 1). This value is used in the strength ratio tables.

5.3.4.2 Alternatively, knots in dimension lumber may be measured on the surface of the piece. Methods of measuring knots by this alternative are given in 5.3.4.3-5.3.4.5.

5.3.4.3 The size of a knot on a narrow face is its width between lines enclosing the knot and parallel to the edges of the piece (Fig. 2). A narrow-face knot that appears also in the wide face of a side-cut piece (but does not contain the intersection of those faces) is measured and graded on the wide face.

5.3.4.4 The size of a knot on a wide face is the average of

TABLE 2 Strength Ratios Corresponding to Knots in the Narrow Face of Bending Members

Knot Size, in. (mm)[A]	Percentage Strength Ratio When Actual Width of Narrow Face, in. (mm), is[A]																									
	1 (25)	1½ (38)	2 (51)	2½ (64)	3 (76)	3½ (89)	4 (102)	4½ (114)	5 (127)	5½ (140)	6 (152)	7 (178)	7½ (190)	8 (203)	9 (229)	9½ (241)	10 (254)	11 (279)	11½ (292)	12 (305)	13 (330)	13½ (343)	14 (356)	15 (381)	15½ (394)	16 (406)
¼(6)	85	89	91	93	94	95	95	96	96	96	97	97	97	97	97	97	97	97	98	98	98	98	98	98	98	98
½(13)	67	76	81	84	86	88	90	91	91	92	93	93	93	94	94	94	94	94	95	95	95	95	95	95	95	95
¾(19)	48	62	70	75	79	82	84	85	87	88	89	89	90	90	91	91	91	91	92	92	92	92	92	93	93	93
1 (25)	4	49	60	68	72	75	78	80	82	84	85	86	86	87	87	88	88	88	89	89	89	90	90	90	90	90
1¼ (32)	...	...	49	58	64	69	72	75	78	79	81	82	83	83	84	84	85	85	86	86	87	87	87	87	88	88
1½ (38)	...	...	27	49	57	62	67	70	73	75	77	78	79	80	81	81	82	82	83	83	84	84	84	85	85	85
1¾ (44)	...	...	15	32	49	56	61	65	68	71	73	75	75	76	77	78	78	79	80	80	81	81	82	82	83	83
2 (51)	...	...	...	22	35	49	55	60	64	67	69	71	72	73	74	75	75	76	77	77	78	79	79	80	80	80
2¼ (57)	...	...	...	...	26	37	50	55	59	62	65	67	68	69	71	71	72	73	74	75	75	76	76	77	77	78
2½ (64)	...	...	...	...	18	30	39	50	54	58	61	63	64	66	67	68	69	70	71	72	73	73	74	75	75	75
2¾ (70)	...	...	...	...	...	23	32	40	50	54	57	60	61	62	64	65	66	67	68	69	70	70	71	72	72	73
3 (76)	...	...	...	...	...	...	26	34	41	50	53	56	57	59	61	62	63	64	65	66	67	68	68	69	70	70
3¼ (83)	...	...	...	...	...	...	...	...	36	45	49	52	54	55	57	59	60	61	62	63	64	65	66	67	67	68
3½ (89)	...	...	...	...	...	...	...	...	...	37	46	48	50	52	54	55	56	58	59	60	62	62	63	64	65	65
3¾ (95)	...	...	...	...	...	...	...	...	...	...	...	45	46	48	51	52	53	55	56	57	59	60	60	61	62	63
4 (102)	...	...	...	...	...	...	...	...	...	...	...	...	...	45	48	49	50	52	53	54	56	57	58	59	60	60
4¼ (108)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46	47	49	50	51	53	54	55	56	57	58
4½ (114)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46	47	49	50	51	52	54	55	55
4¾ (121)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46	48	49	50	51	52	53
5 (127)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	45	46	47	49	49	50

[A] Ratios corresponding to other sizes of knots and face widths can be found by linear interpolation.

TABLE 3 Strength Ratios Corresponding to Centerline Knots in the Wide Face of Bending Members, and to Knots in Compression Members

Size of Knot, in. (mm)[A]	Percentage Strength Ratio When Actual Width of Wide Face, in. (mm), is[A]																									
	3 (76)	3½ (89)	4 (102)	4½ (114)	5 (127)	5½ (140)	6 (152)	7 (178)	7½ (190)	8 (203)	9 (229)	9½ (241)	10 (254)	11 (279)	11½ (292)	12 (302)	13 (330)	13½ (343)	14 (356)	15 (381)	15½ (394)	16 (406)	18 (457)	20 (508)	22 (559)	24 (610)
¼(6)	94	95	95	96	96	96	97	97	97	97	98	98	98	98	98	98	98	98	98	98	98	99	99	99	99	99
½(13)	86	88	90	91	91	92	93	94	94	95	95	95	96	96	96	96	96	96	97	97	97	97	97	97	97	97
¾(19)	79	82	84	85	87	88	89	91	91	92	92	93	93	94	94	94	94	95	95	95	95	95	95	95	96	96
1 (25)	72	75	78	80	82	84	85	87	88	89	90	90	91	92	92	92	92	93	93	93	93	93	94	94	94	94
1¼ (32)	64	69	72	75	78	79	81	84	85	86	87	88	89	90	90	90	90	91	91	91	91	91	92	92	93	93
1½ (38)	57	62	67	70	73	75	78	81	82	83	85	85	86	87	88	88	89	89	89	89	90	90	90	91	91	91
1¾ (44)	49	56	61	65	68	71	74	77	79	80	82	83	84	85	86	86	87	87	87	87	88	88	89	89	90	90
2 (51)	35	49	55	60	64	67	70	74	76	77	79	80	81	83	84	84	85	85	85	86	86	86	87	88	88	89
2¼ (57)	26	37	50	55	59	62	66	71	72	73	77	78	79	81	82	82	83	83	83	84	84	84	85	86	87	87
2½ (64)	18	30	39	50	54	58	62	67	69	71	74	75	77	79	80	80	81	81	81	82	82	83	84	84	85	86
2¾ (70)	...	23	32	40	50	54	58	64	66	68	71	73	74	76	77	78	79	79	79	80	80	81	82	83	84	84
3 (76)	...	...	26	34	41	50	54	61	63	65	69	70	72	74	75	76	77	77	78	78	79	79	80	81	82	83
3¼ (83)	...	...	...	29	36	45	51	57	60	62	66	68	69	72	73	74	75	75	76	76	77	77	78	80	80	81
3½ (89)	...	...	...	23	31	37	47	54	57	59	64	65	67	70	71	72	73	73	74	75	75	75	77	78	79	80
3¾ (95)	...	...	...	...	26	32	38	51	54	56	61	63	65	68	69	70	71	71	72	73	73	74	75	76	77	78
4 (102)	...	...	...	...	21	28	34	47	50	53	58	60	62	66	67	68	69	69	70	71	71	72	73	75	76	77
4¼ (108)	...	...	...	...	...	23	30	40	46	50	56	58	60	63	65	66	67	68	68	69	70	70	72	73	74	75
4½ (114)	...	...	...	...	...	19	26	36	41	48	53	55	58	61	63	64	65	66	66	67	68	68	70	72	73	74
4¾ (121)	...	...	...	...	...	...	21	33	37	41	50	53	55	59	61	62	63	64	64	65	66	67	68	70	71	73
5 (127)	...	...	...	...	...	...	17	29	34	38	48	50	53	57	59	60	61	62	62	64	64	65	67	68	70	71
5¼ (133)	...	...	...	...	...	...	...	25	30	35	45	48	50	55	57	58	59	60	61	62	62	63	65	67	68	70
5½ (140)	...	...	...	...	...	...	...	22	27	32	39	45	48	52	54	56	57	58	59	60	61	61	63	65	67	68
5¾ (146)	...	...	...	...	...	...	...	...	24	29	37	40	46	50	52	54	55	56	57	58	59	59	62	64	65	67
6 (152)	...	...	...	...	...	...	. . .	...	...	26	34	37	40	48	50	52	53	54	55	56	57	58	60	62	64	65
6½ (165)	...	...	...	...	...	...	...	...	...	19	28	32	35	41	46	48	49	50	51	53	53	54	57	59	61	62
7 (178)	...	...	...	...	...	...	...	...	...	13	23	27	30	37	40	42	45	46	47	49	50	51	53	56	58	59
7½ (190)	...	...	...	...	...	...	...	...	...	...	17	22	25	32	35	38	40	41	42	45	46	47	50	52	55	57
8 (203)	...	...	...	...	...	...	...	...	...	...	...	...	20	28	31	34	36	37	39	41	42	43	47	49	52	54
8½ (216)	...	...	...	...	...	...	...	...	...	...	...	...	15	23	26	30	32	33	35	37	38	39	41	46	49	51

[A] Ratios corresponding to other sizes of knots and face widths can be found by linear interpolation.

TABLE 4 Strength Ratios Corresponding to Edge Knots in the Wide Face of Bending Members

Knot Size, in. (mm)[A]	Percentage Strength Ratio When Actual Width of Wide Face, in. (mm), is[A]																											
	2 (51)	2½ (64)	3 (76)	3½ (89)	4 (102)	4½ (114)	5 (127)	5½ (140)	6 (152)	7 (178)	7½ (190)	8 (203)	9 (229)	9½ (241)	10 (254)	11 (279)	11½ (292)	12 (305)	13 (330)	13½ (343)	14 (356)	15 (381)	15½ (394)	16 (406)	18 (457)	20 (508)	22 (559)	24 (610)
¼(6)	83	86	88	89	91	91	92	93	94	94	94	95	95	96	96	96	97	97	97	97	97	97	97	97	97	97	97	98
½(13)	65	71	75	78	80	82	84	85	86	88	89	90	90	91	91	92	92	93	93	93	93	93	93	94	94	94	94	95
¾(19)	49	57	62	67	70	73	75	77	79	82	83	84	86	86	87	88	89	89	89	89	90	90	90	90	91	91	92	92
1 (25)	27	38	51	57	61	65	68	70	73	76	77	79	81	82	83	84	85	85	85	86	86	86	87	87	88	88	89	89
1¼ (32)	16	27	36	47	52	57	60	63	66	71	72	74	76	77	78	80	81	82	82	82	83	83	83	84	84	85	86	86
1½ (38)	...	17	26	34	40	49	53	57	60	64	67	69	72	73	74	76	77	78	78	79	79	80	80	80	81	82	83	84
1¾ (44)	...	...	19	26	33	38	47	50	54	60	62	64	67	69	70	72	74	75	75	75	76	77	77	77	78	79	80	81
2 (51)	...	...	...	19	26	32	37	45	49	55	57	59	63	65	66	69	70	71	72	72	73	73	74	74	75	77	78	78
2¼ (57)	...	...	...	...	20	26	31	36	40	50	52	55	59	61	62	65	66	68	68	69	69	70	71	71	73	74	75	76
2½ (64)	...	...	...	...	15	21	26	31	35	45	48	51	55	57	59	62	63	65	65	66	66	67	68	68	70	71	72	73
2¾ (70)	...	...	...	...	...	16	21	26	30	38	41	46	51	53	55	59	60	61	62	63	63	64	65	65	67	68	70	71
3 (76)	...	...	...	...	...	...	17	21	26	33	37	40	47	50	52	55	57	58	59	60	60	61	62	62	64	66	67	68
3¼ (83)	...	...	...	...	...	...	...	17	22	29	32	36	41	46	48	52	54	55	56	57	57	58	59	60	62	63	65	66
3½ (89)	...	...	...	...	...	...	...	...	18	26	29	32	39	41	43	49	52	52	53	54	54	56	56	56	59	61	62	63
3¾ (95)	...	...	...	...	...	...	...	...	...	23	26	29	35	37	40	46	48	49	50	51	52	53	54	54	56	58	60	61
4 (102)	...	...	...	...	...	...	...	...	...	...	22	26	32	34	37	41	45	47	48	48	49	50	51	52	54	56	58	59
4¼ (108)	...	...	...	...	...	...	...	...	...	...	...	22	28	31	34	38	40	42	44	45	46	48	48	49	51	54	55	57
4½ (114)	...	...	...	...	...	...	...	...	...	...	...	20	26	28	31	35	37	39	41	42	43	45	46	47	49	51	53	54
4¾ (121)	...	...	...	...	...	...	...	...	...	...	...	...	23	26	28	33	35	37	39	40	41	42	43	44	47	49	51	52
5 (127)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25	30	32	34	36	37	38	40	40	41	44	47	49	50

[A]Ratios corresponding to other sizes of knots and face widths can be found by linear interpolation.