TECHNICAL NOTE NUMBER 200

FOREST PRODUCTS LABORATORY - U. S. FOREST SERVICE - MADISON, WISCONSIN

BASIC GRADING RULES FOR STRUCTURAL TIMBERS

As a step towards standardization and more efficient utilization of structural timbers, the Forest Products Laboratory of the U. S. Forest Service presents the following basic grading rules for softwood and hardwood timbers. These rules are based on the results of hundreds of thousands of tests on small clear specimens and numerous tests on timbers containing defects.

In substance, the new rules provide for a simple classification of any or all species into four basic grades from the standpoint of strength requirements for various structural purposes, excepting columns. The difference in inherent strength and character of various species is taken care of in the recommended working stresses. (See Forest Products Laboratory Technical Note 201.)

The basic grades are formulated to take care of strength requirements only. It is expected that commercial grades will include provisions for any other properties that may be desirable in timber for particular uses.

GENERAL SPECIFICATIONS

The four grades and the general character of each grade are as follows. Select (S2) grade is especially adapted to heavy construction, such as railway bridge and mill work. Standard (S3) grade is primarily suitable for general building use and common mill construction. Common (S4) grade is especially recommended for small house construction where stiffness is a controlling factor and where strength requirements are not so critical. These three grades will furnish by far the greater portion of the structural timbers used. The Extra Select (S1) grade is an exceptional grade intended to meet the most exacting strength requirements for construction purposes.

LIGHT WEIGHT MATERIAL. All exceptionally light weight pieces in any species shall be lowered one grade.

DENSE MATERIAL. Southern yellow pine and Douglas fir which will classify as dense under the rules of the American Society for Testing Materials for these species take the stress of the next higher grade.

KNOTS AND KNOT HOLES. The measurement of knots or knot holes is made on the section appearing on the surface in question. The diameter of a knot on the narrow or horizontal face shall be taken as the width of the knot between lines parallel to the edges of the timber. On the wide or vertical face the smallest dimension of a knot shall be taken. Knots on the edge of wide faces are limited to the same size as on the adjacent portion of the narrow faces. Cluster knots on any face in any part of a beam shall cause its rejection except when specifically permitted. The diameter of cluster knots shall be measured between lines enclosing the cluster. Unsound or decayed knots in which the decay does not exceed the diameter of the knots are limited as are sound knots.

CHECKS, SHAKES, AND SPLITS. Checks, or combination of checks with shakes, which would reduce the strength to a greater extent than the allowable round shake shall not be permitted. Restrictions on shakes are given in each grade. The width of shakes shall be taken as the distance between lines parallel to the vertical edges of a timber. Splits shall be graded as checks or shakes.

DECAY. All grades shall contain only sound wood unless decay is specifically permitted.

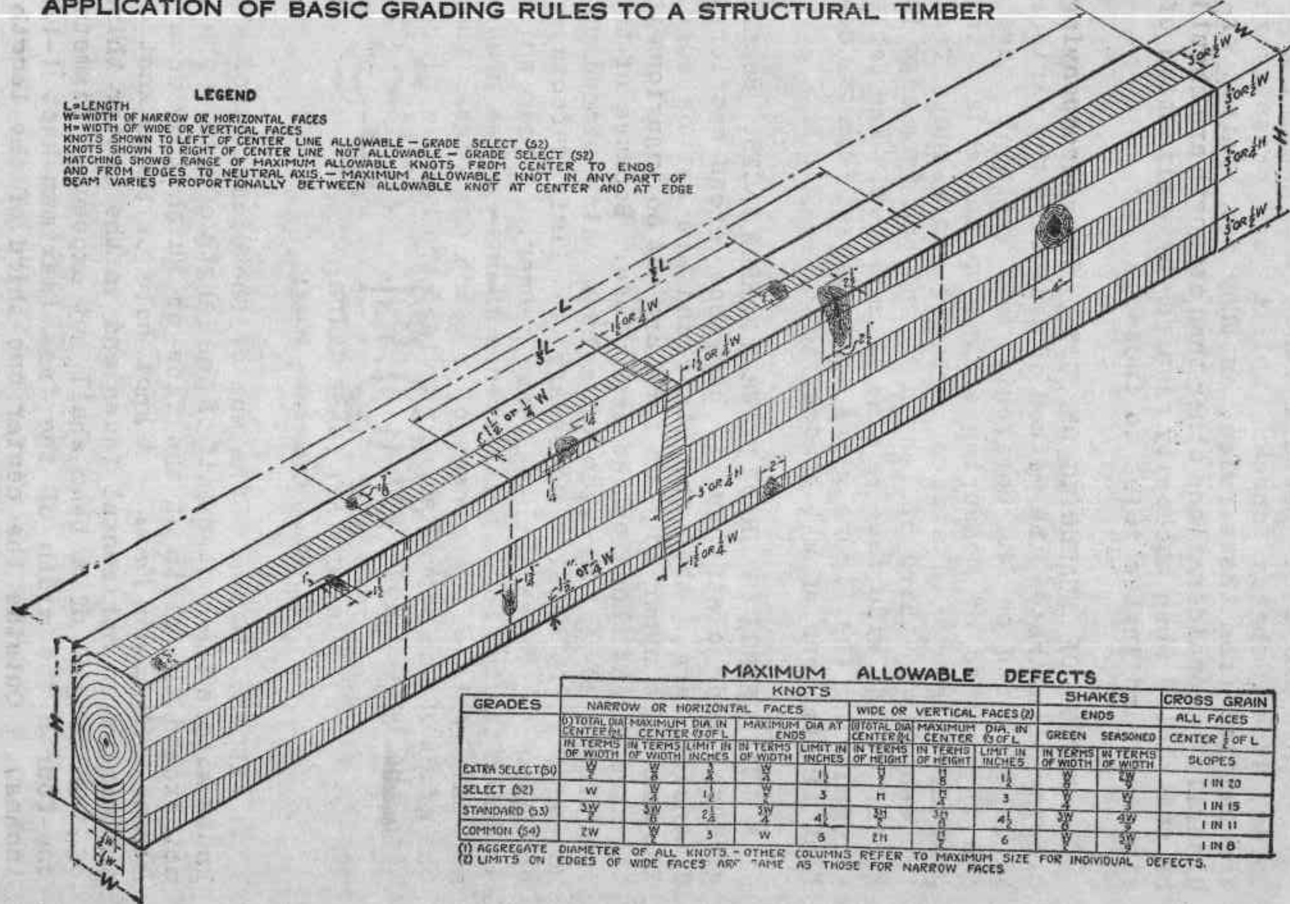
SAPWOOD. Unless otherwise specified any amount of sapwood is permitted in all grades.

HOLES. Dog, picaroon, bird, insect, and rafting-pin holes shall be limited for each grade in the same manner as knot holes.

APPLICATION OF BASIC GRADING RULES TO A STRUCTURAL TIMBER

LEGEND

L=LENGTH
W=WIDTH OF NARROW OR HORIZONTAL FACES
H=WIDTH OF WIDE OR VERTICAL FACES
KNOTS SHOWN TO LEFT OF CENTER LINE ALLOWABLE — GRADE SELECT (S2)
KNOTS SHOWN TO RIGHT OF CENTER LINE NOT ALLOWABLE — GRADE SELECT (S2)
HATCHING SHOWS RANGE OF MAXIMUM ALLOWABLE KNOTS FROM CENTER TO ENDS AND FROM EDGES TO NEUTRAL AXIS. — MAXIMUM ALLOWABLE KNOT IN ANY PART OF BEAM VARIES PROPORTIONALLY BETWEEN ALLOWABLE KNOT AT CENTER AND AT EDGE



MAXIMUM ALLOWABLE DEFECTS

GRADES	KNOTS								SHAKES		CROSS GRAIN
	NARROW OR HORIZONTAL FACES					WIDE OR VERTICAL FACES (2)			ENDS		ALL FACES
	(1) TOTAL DIA CENTER 1/3 L	MAXIMUM DIA. IN CENTER 1/3 OF L		MAXIMUM DIA AT ENDS		(1) TOTAL DIA CENTER 1/3 L	MAXIMUM DIA. IN CENTER 1/3 OF L		GREEN	SEASONED	CENTER 1/2 OF L
	IN TERMS OF WIDTH	IN TERMS OF WIDTH	LIMIT IN INCHES	IN TERMS OF WIDTH	LIMIT IN INCHES	IN TERMS OF HEIGHT	IN TERMS OF HEIGHT	LIMIT IN INCHES	IN TERMS OF WIDTH	IN TERMS OF WIDTH	SLOPES
EXTRA SELECT (S1)	W/2	W/8	3/4	W/4	1 1/2	H/2	H/8	1 1/2	W/8	2W/9	1 IN 20
SELECT (S2)	W	W/4	1 1/2	W/2	3	H	H/4	3	W/4	W/3	1 IN 15
STANDARD (S3)	3W/2	3W/8	2 1/4	3W/4	4 1/2	3H/2	3H/8	4 1/2	3W/8	4W/9	1 IN 11
COMMON (S4)	2W	W/2	3	W	6	2H	H/2	6	W/2	5W/9	1 IN 8

(1) AGGREGATE DIAMETER OF ALL KNOTS. — OTHER COLUMNS REFER TO MAXIMUM SIZE FOR INDIVIDUAL DEFECTS.
(2) LIMITS ON EDGES OF WIDE FACES ARE SAME AS THOSE FOR NARROW FACES

OTHER DEFECTS. Defects other than knots, knot holes, decay, shakes, checks, splits, and cross grain are omitted from these rules, as they are limited ordinarily by considerations other than strength and should be restricted when necessity requires by application of standard yard lumber rules to faces.

METHOD OF MEASURING DEFECTS. The accompanying drawing illustrates the method of measuring the various kinds of knots on the horizontal and vertical faces, and the method of measuring shakes on the ends. The gradual increase in size of the allowable knots from the center one-third of length to end and from edge to center of the wide face is also illustrated. The table accompanying the figure gives in condensed form the defect limitations of all grades.

DIFFERENCE OF GRADE BETWEEN NARROW FACES. Beams, girders, and joists usually have one cross-sectional dimension larger than the other and are set on edge. Knots on the upper edge or face are not so injurious to the strength as those on the lower face. Because of the likelihood of either side of a beam being placed up, however, it is usually necessary to limit defects on both narrow faces in the same manner. A beam which shows on the two edges a difference of one or more grades may safely take the stress of a grade one higher than the grade of the poorer edge, provided the beam is placed with the better edge down.

SELECT (S2) (BASE GRADE)
(For Heavy Construction Work)

KNOTS. *General* - The sum of the diameters of all knots within the center half of the length of a beam shall not exceed the width of the face on which they occur. *Narrow or Horizontal Faces* - A knot hole or sound knot on the narrow or horizontal faces and in the center third of the length of a beam shall not exceed in diameter one-fourth the width of the face (maximum knot 1-1/2 inches). Outside the center one-third of the length,

the size of a knot may increase gradually towards the end to one-half the width of the face (maximum knot 3 inches). *Wide or Vertical Faces* - Knot holes or sound knots on the edges of the wide faces shall be limited to the same size as on the adjacent portion of the narrow faces, but a knot may increase gradually in size towards the center of height to one-fourth the width of the face (maximum knot 3 inches).

SHAKES. Round or ring shakes showing on the end of a timber shall not measure more than one-fourth of the width in green material, nor more than one-third of the width in seasoned material.

CROSS GRAIN. Within the center half of a beam the slope in grain shall not exceed 1 in 15.

EXTRA SELECT (S1) GRADE
(For Most Exacting Construction Purposes)

KNOTS. *General* - The sum of the diameters of all knots within the center half of the length of a beam shall not exceed one-half the width of the face on which they occur. *Narrow or Horizontal Faces* - A knot hole or sound knot on the narrow or horizontal faces and in the center third of the length of a beam shall not exceed in diameter one-eighth the width of the face (maximum knot 3/4 inch). Outside the center one-third of the length, the size of a knot may increase gradually towards the end to one-fourth the width of the face (maximum knot 1-1/2 inches). *Wide or Vertical Faces* - Knot holes or sound knots on the edge of the wide faces shall be limited to the same size as on the adjacent portion of the narrow faces, but a knot may increase gradually in size towards the center of height to one-eighth the width of the face (maximum knot 1-1/2 inches).

SHAKES. Round or ring shakes showing on the end of a timber shall not measure more than one-eighth of the width in green material, nor more than two-ninths of the width in seasoned material.

CROSS GRAIN. Within the center half of a beam the slope in grain shall not exceed 1 in 20.

STANDARD (S3) GRADE
(For General Building Use)

KNOTS. *General* - The sum of the diameters of all knots within the center half of the length of a beam shall not exceed one and one-half times the width of the face on which they occur. *Narrow or Horizontal Faces* - A knot hole or sound knot on the narrow or horizontal faces and in the center third of the length of a beam shall not exceed in diameter three-eighths the width of the face (maximum knot 2-1/4 inches). Outside the center one-third of the length, the size of a knot may increase gradually towards the end to three-fourths the width of the face (maximum knot 4-1/2 inches). *Wide or Vertical Faces* - Knot holes or sound knots on the edge of the wide face shall be limited to the same size as on the adjacent portion of the narrow face, but the knot may increase gradually in size towards the center of height to three-eighths the width of the face (maximum knot 4-1/2 inches).

SHAKES. Round or ring shakes showing on the end of a timber shall not measure more than three-eighths the width in green material, nor more than four-ninths the width in seasoned material.

CROSS GRAIN. Within the center half of a beam the slope in grain shall not exceed 1 in 11.

COMMON (S4) GRADE
(For Small House Construction)

DECAY. A beam may contain heart rot not to exceed one-tenth the area of the cross section of the piece.

KNOTS. *General* - The sum of the diameters of all knots within the center half of the length of a beam shall not exceed twice the width of the face on which they occur. Unsound or decayed knots to one-half the

size of the sound knots are permitted in this grade. Cluster knots of the same diameter as sound knots are permitted in this grade. *Narrow or Horizontal Faces* - A knot hole or sound knot on the narrow or horizontal faces and in the center third of the length of a beam shall not exceed in diameter one-half the width of the face. The size of knots may increase gradually towards the end where it may be equal to the width of the face (maximum knot 6 inches). *Wide or Vertical Faces* - Knot holes or sound knots on the edges of the wide faces shall be limited to the same size as on the adjacent portion of the narrow face, but the knot may increase gradually in size towards the center of the height to one-half the width of the face (maximum knot 6 inches).

SHAKES. Round or ring shakes showing on the end of a timber shall not measure more than one-half of the width in green material, nor more than five-ninths the width in seasoned material.

CROSS GRAIN. Within the center half of a beam the slope in grain shall not exceed 1 in 8.