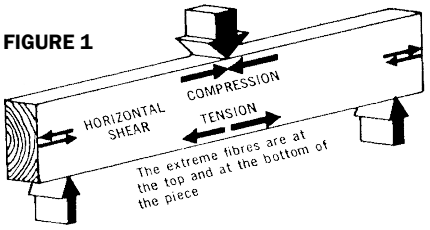
300. STRESS GRADES

310. STRESSES ILLUSTRATED

310a. Extreme Fibre in Bending "F_b" and Horizontal Shear - "F_v"

In structures, stress grades of lumber may carry loads on spans between supports and the lumber is stressed internally to the extent required to resist the external load. The loads cause pieces to bend, producing tension in the extreme fibres along the face farthest from the applied load and compression in the extreme fibres along the face nearest to the applied load. (**Figure 1**)
At the same time, over each support, there is a stress that tends to slide the fibres over each other horizontally. This action is similar to the way the ends of playing cards slide over each other when a deck is sharply bent. The internal force that resists this action is the horizontal shear value of the wood. The shearing stress is maximum at the centre of the depth of the piece.

FIGURE 1

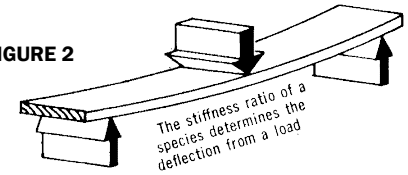


310b. Modulus of Elasticity - "E"

The relationship between the amount a piece deflects and the load causing the deflection determines its stiffness (**Figure 2**). This is called the Modulus of Elasticity. A piece may deflect slightly or a lot depending on its size, the span, the load and the modulus of elasticity for the particular species and grade. A large deflection is not necessarily a sign of insufficient strength.

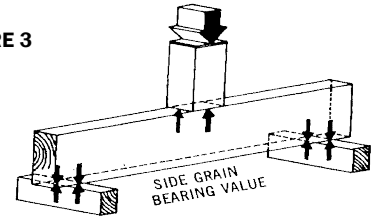
For example: the floors of a residence are usually limited to a deflection 1/360th of the span, or less, while a scaffold plank may deflect substantially more.

FIGURE 2

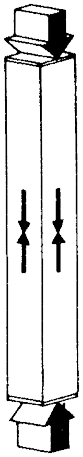


310c. Compression Perpendicular to Grain - "$F_{C_{perp}}$"
Where a joist, beam or similar piece of lumber bears on supports, the loads tend to compress the fibres (**Figure 3**). It is therefore necessary that the bearing area be sufficient to prevent side grain crushing.

FIGURE 3



310d. Compression Parallel to Grain - Fc_{II}
In many parts of a structure, stress-grades are used with the loads supported on the ends of the pieces. Such uses include studs, posts, columns and struts. (**Figure 4**)



The internal stress induced by this kind of loading is the same across the whole cross-section and the fibres are uniformly stressed parallel to and along the full length of the piece.

310e. Effect of Holes on Design Values
Many grades assigned design values for engineered and repetitive member uses permit not firmly fixed knots or knot holes. Holes and knots not firmly fixed do not reduce strength more than intergrown knots so no distinction need be made between knots and holes. For the sake of appearance, holes in certain grades are frequently restricted more severely than knots.

FIGURE 4

320. MEASUREMENT OF KNOTS FOR STRESS GRADES

i) The sum of the sizes of all knots in any 6" of length of a piece must not exceed twice the size of the largest knot permitted. More than one knot of maximum permissible size must not be in the same 6" of length and the combination of knots must not be serious.

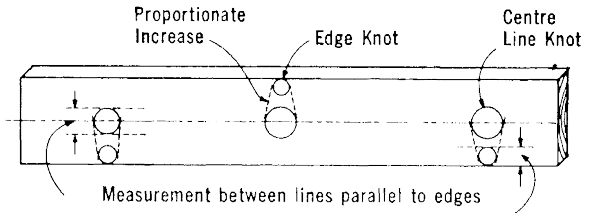
Note: *Illustrations on the following pages are examples only. Judgement must be used in measuring the many different knots that occur in natural growth for equivalent effect on a piece.*

ii) Displacement as used in the NLGA Grade Rule means the amount of clear wood displaced by a knot and considered in its relation to the amount it reduces the strength of the cross section of the piece of lumber under consideration.

iii) The size of a knot on a wide face is determined as shown in Para. 320b. Narrow face and spike knots are measured by the displacement method. Stress grades are graded full length with listed knot sizes applying full length.

iv) The allowable size of knots on the wide faces, when appearing away from the edge, shall be proportionately increased from the size specified for knots located along the centerline. The increase shall start at a distant from the edge equal to 1/2 the diameter of the allowable edge knot. (**Figure 5**)

FIGURE 5



STRESS GRADE MEASUREMENTS

320a. BOARD (Non-Structural) KNOTS

Unless otherwise specified, knots shall be measured as the average of the maximum and minimum diameters as illustrated in **Figure 6**.

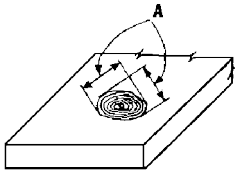


FIGURE 6

A - Measure average dimension

320b. DIMENSION KNOTS

In grades of Studs, Light Framing, Structural Framing and other grades where specified, knots on wide faces are measured between lines parallel to the edges as shown in **Figure 7.** When tapering knots are encountered, their equivalent displacement is determined as shown in **Figure 8.** Narrow face and spike knots are judged by the amount of cross section they occupy as illustrated in **Figures 9 & 10**.

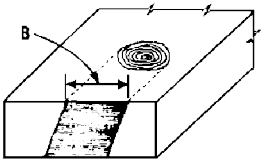
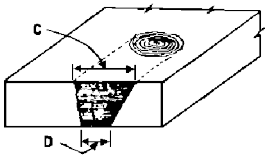
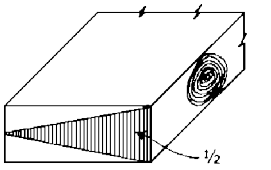


FIGURE 7



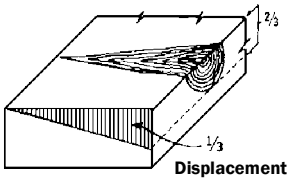
Divide sum of measurement C and D by 2

FIGURE 8



Displacement

FIGURE 9



Displacement

FIGURE 10

330. POST & TIMBERS - SHAKE, CHECKS AND SPLITS

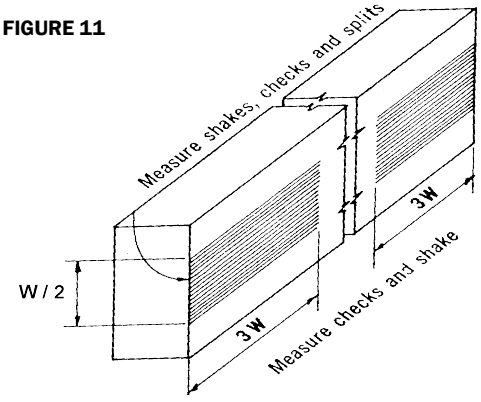
Due to the nature of shake, checks and splits, judgement must be used in evaluating their extent.

330a. Shake and checks, as a rule, have little influence on the strength of a post or column, unless so extensive as to split the piece practically in two. The grade limitations are applied primarily for appearance.

340. B & S's and P & T's - MEASUREMENT OF SHAKE, CHECKS & SPLITS

The measurement of shake, checks and splits in Beams and Stringers is confined to the middle 1/2 of the height of the piece and restrictions on checks are applied only for a distance from the ends equal to three times the width of the wide face. (**Figure 11**)

FIGURE 11

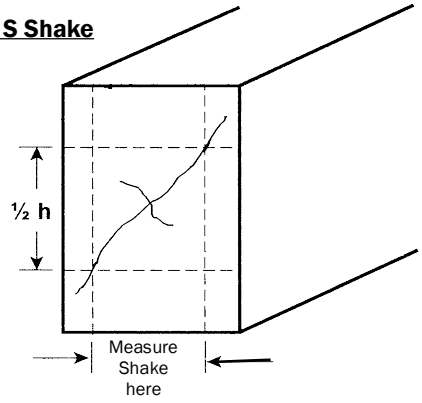


340a. SHAKE

1) Shake in **Beams & Stringers** are measured at the ends of pieces, between lines enclosing the shake and parallel to the wide faces as illustrated in **Figure 12**.

B & S Shake

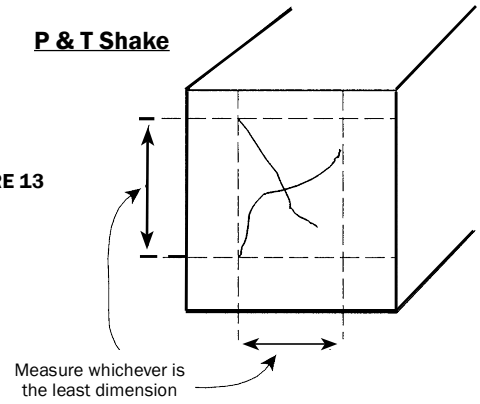
FIGURE 12



2) Shake in **Posts & Timbers** are measured at the ends of pieces, between lines parallel with the two faces that give the least dimension as illustrated in **Figure 13**.

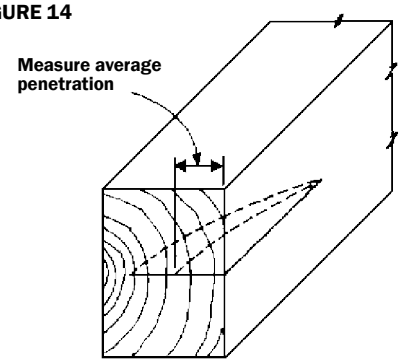
P & T Shake

FIGURE 13



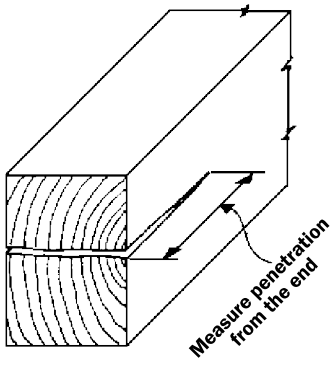
340b. CHECKS - are measured as an average of the penetration perpendicular to the wide face (**Figure 14**). Where two or more checks appear on the same face, only the deepest one is measured. Where two checks are directly opposite each other, the sum of their depths is considered.

FIGURE 14



340c. SPLITS - are measured as the average penetration of a split from the end of the piece and parallel to the edges of the piece (**Figure 15**).

FIGURE 15



350. DENSITY AND RATE OF GROWTH

The greater the specific gravity of lumber, the greater is the strength of wood fibres.

One method of measuring specific gravity is described in ASTM D245. The method visually measures the growth rings per inch along with the amount of summerwood in the growth rings.
Rate of growth requirements are sometimes a part of a grading rule for reasons of texture as well as for strength.

350a. MEDIUM GRAIN - means an average of approximately 4 or more annual rings per inch on either one end or the other of a piece, measured as described in Para. 350c. In Douglas Fir and Larch, pieces averaging less than 4 rings per inch are accepted if averaging 1/3 or more summerwood- the dark portion of the annual ring.

350b. CLOSE GRAIN - means an average of approximately 6, but not more than approximately 30, annual rings per inch on either one end or the other of a piece, measured as described in Para. 350c. In Douglas Fir and Larch, pieces averaging 5 rings or more than 30 rings per inch, are accepted as close grain if averaging 1/3 or more summerwood.

350c. MEASURING AVERAGE RATE OF GROWTH

i) Average rate of growth is measured on a line at a right angle to the rings in an area representative of the average growth in the cross section at either one end or the other. If the size of the piece permits, the measuring line should be 3" long.

ii) In boxed heart (pith present) pieces the measurement may exclude an inner portion of the radius amounting to approximately one quarter of the least dimension (**Figure 16**).

iii) In F.O.H.C. (side cut) pieces the length shall be centrally located (**Figure 17**).

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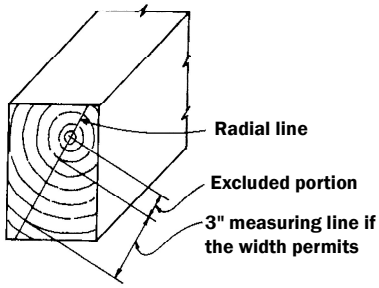
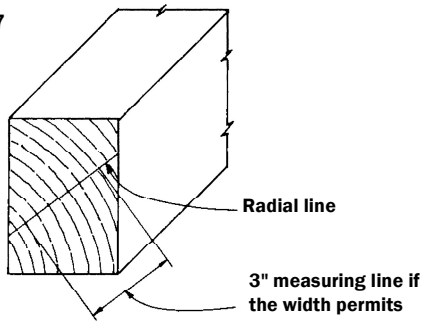
BOXED HEART (Pith present)

FIGURE 16



F.O.H.C. (side-cut)

FIGURE 17



Note: *Stress grades specify minimum requirements and maximum characteristics, all of which may be present in the same piece.*

The grading rule commonly prohibits any serious combination of characteristics which reduces strength. Relative density, however, may compensate in part for such a combination; that is, if a piece is above average in density, that fact may be taken into account in assessing the effect of a combination of characteristics.

STRESS GRADE MEASUREMENTS

360. SLOPE OF GRAIN

Slope of Grain is the deviation of the wood fibre from a line parallel to the edges of a piece. (**Figure 18**)

The deviation is expressed as a ratio such as a slope of grain of 1 in 8, 1 in 10, 1 in 12 and 1 in 15.

This provides slope of grain grading requirements which relate to the assignment of design values to small lumber sections.

In lumber 2 inches nominal and thicker and 4 inches nominal and wider, slope of grain is measured over a sufficient length and area to be representative of the general slope of the fibres. Local deviations around knots and elsewhere are disregarded in the general slope measurement.

In thinner or narrower lumber, the displacement of local grain deviation (other than around knots) which exceeds the slope provisions of the grade is limited to the knot displacement permitted.

In lumber, less than one inch net in thickness, the average slope of grain anywhere in the length shall not pass completely through the thickness of the piece in a length less than the allowable slope. For instance, for an allowable slope of 1 in 8, the average slope of grain shall not pass completely through the piece in a distance less than 8 inches regardless of the thickness.

FIGURE 18