

TECHNICAL NOTE NUMBER 201

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

WORKING STRESSES FOR STRUCTURAL TIMBERS

The working stresses for structural timbers of various species given here are the result of a long series of tests by the Forest Products Laboratory at Madison, Wisconsin, on small clear specimens and timbers containing defects. They are applicable to beams, joists, girders, and short columns graded in accordance with the Forest Service basic grading rules for structural timbers. (See Forest Products Laboratory Technical Note 200.) Commercial grading rules were found in general to be too indefinite in their limitations of the size, number, and location of defects to make it practical to establish working stresses for them, even if tests could be carried out on every grade found in the local markets.

The stresses given in the table are for timbers of the Forest Service base grade, Select (S2). From them the stresses permissible for the other three basic grades can be easily computed. With Extra Select (S1) timbers of any species a stress $\frac{7}{6}$ as large as the stress given in the table may be used. Standard (S3) timbers should be subjected to only $\frac{5}{6}$ the listed stress. Common (S4) timbers can take only $\frac{4}{6}$ the stress given for Select (S2). The working stresses of the different grades of Douglas fir and southern yellow pine can be increased one-sixth the allowable stress given in the table for the basic or Select (S2) grade, if the material meets the density requirements of the American Society of Testing Materials.

A "factor of safety" adjustment of the test values has been made to take care of the loss in strength from defects, the effect of long continued loads, the variation of individual pieces from the average, and the possibility of slight accidental overloading. It is evident that a large part of this "factor of safety"

is required to correlate laboratory test results with actual conditions of use, and only a small part of it may be considered a true factor of safety. The application of a load which would produce three times the working stress given as allowable would be expected to cause the immediate failure of some of the timbers and the ultimate failure of 75 per cent of them. In fact, the application of loads which would produce stresses only one and one-half times the working stresses recommended would be expected to cause occasional failures if the loads were left on for any great length of time.

WORKING STRESSES FEASIBLE FOR STRUCTURAL TIMBERS OF SELECT (S2) GRADE¹

(pounds per square inch)

Species	Bending				Allowable stress parallel to grain *Short Columns ² for Select (S2) grade	Compressions									
	Pump or wet location (depth, bearing and dail)	Outside, not in contact with soil (below ground level, open sheds)	Under shelter in dry location (under eaves, warehouses)	Allowable horizontal stress (S2)		Allowable modulus of elasticity for all grades	Dry inside location	Wet location	Dry outside location	Wet location	Dry outside location				
												Allowable stress perpendicular to grain for all grades			
Ash, black	800	900	1000	90	1,100,000	500	560	660	150	200	200	200	200	200	200
Ash, commercial white (green, blizzard, white)	1000	1000	1000	135	1,400,000	900	1000	1100	160	200	200	200	200	200	200
Aspen and larchtooth aspen	600	650	800	80	900,000	415	550	700	100	100	100	100	100	100	100
Balsam poplar	600	650	800	80	900,000	415	550	700	100	100	100	100	100	100	100
Basswood	1000	1200	1500	125	1,600,000	900	1100	1300	200	200	200	200	200	200	200
Birch, paper	600	750	900	80	1,000,000	450	550	650	100	100	100	100	100	100	100
Birch, yellow and sweet	600	750	900	80	1,000,000	450	550	650	100	100	100	100	100	100	100
Cedar, western	750	800	1000	80	1,100,000	450	550	650	100	100	100	100	100	100	100
Cedar, western red	750	800	1000	80	1,100,000	450	550	650	100	100	100	100	100	100	100
Cedar, northern and southern white	500	550	750	70	800,000	400	500	600	80	80	80	80	80	80	80
Cedar, Port Orford	900	1000	1100	100	1,200,000	750	850	900	150	160	160	160	160	160	160
Cherry	700	800	950	80	1,000,000	450	550	650	100	100	100	100	100	100	100
Cottonwood, common and black	500	550	700	60	900,000	400	500	600	80	80	80	80	80	80	80
Cypress, N.A.	1000	1000	1000	130	1,400,000	850	900	950	150	150	150	150	150	150	150
Douglas fir (western Washington and Oregon)	1000	1200	1500	130	1,600,000	900	1100	1300	200	200	200	200	200	200	200
Douglas fir (Rocky Mountain type)	700	900	1100	85	1,200,000	700	800	900	100	100	100	100	100	100	100
Elm, coast	100	100	100	200	1,800,000	650	750	850	150	150	150	150	150	150	150
Elm, coast	100	100	100	200	1,800,000	650	750	850	150	150	150	150	150	150	150
Fir, balsam	600	750	900	80	1,000,000	450	550	650	100	100	100	100	100	100	100
Fir, white	600	750	900	80	1,000,000	450	550	650	100	100	100	100	100	100	100
Fir, commercial white (white, noble, grand)	800	900	1100	70	1,300,000	650	750	800	150	150	150	150	150	150	150
Gum, black and cotton	600	600	1100	100	1,200,000	500	750	800	150	150	150	150	150	150	150
Gum, red	600	600	1100	100	1,200,000	500	750	800	150	150	150	150	150	150	150
Hemlock, western	900	1100	1300	75	1,400,000	850	950	1000	150	150	150	150	150	150	150
Hemlock, (eastern)	900	1100	1300	75	1,400,000	850	950	1000	150	150	150	150	150	150	150
Juniper, (tree and pease)	1200	1500	1900	140	1,900,000	1000	1200	1500	250	250	250	250	250	250	250
Larch, western	900	1100	1300	100	1,200,000	800	1000	1100	150	150	150	150	150	150	150
Larch, sugar and black	1000	1200	1400	100	1,200,000	800	1000	1100	150	150	150	150	150	150	150
Larch, yellow	1000	1200	1400	100	1,200,000	800	1000	1100	150	150	150	150	150	150	150
Oak, commercial red and white	1000	1200	1400	125	1,600,000	900	1000	1100	150	150	150	150	150	150	150
Pine, southern yellow	1000	1200	1400	110	1,600,000	850	950	1000	150	150	150	150	150	150	150
Pine, white, sugar, western white, western yellow	750	800	900	85	1,000,000	650	750	760	125	125	125	125	125	125	125
Pine, white, sugar, western white, western yellow	750	800	900	85	1,000,000	650	750	760	125	125	125	125	125	125	125
Poplar, yellow	600	900	1000	80	1,100,000	600	700	800	100	100	100	100	100	100	100
Poplar, yellow	600	900	1000	80	1,100,000	600	700	800	100	100	100	100	100	100	100
Rubberwood	600	1200	1500	75	1,200,000	750	900	1000	125	125	125	125	125	125	125
Spruce, red, white, sitka	600	900	1100	85	1,200,000	650	750	800	125	125	125	125	125	125	125
Spruce, Engelmann	500	650	750	70	800,000	400	550	600	100	100	100	100	100	100	100
Spruce, Sitka	600	900	1100	85	1,200,000	650	750	800	125	125	125	125	125	125	125
Spruce, (eastern)	950	1100	1300	85	1,200,000	850	950	1000	150	150	150	150	150	150	150

1 Working stresses for Extra Select (S1), Extra Select (S1), and Common (S4) grades are obtained by multiplying the basic stress by 7/6, 8/6, 9/6, and 4/6 respectively.

2 The influence of basic compressive strength of columns of constant cross section decreases as the length increases. When the length reaches 30 times the least dimension, knots such as are allowed in Select (S2) timbers have no effect on the strength as a column.

3 The working stresses of any grade of timbers of Douglas fir and spruce, white pine which meet the density requirements of the American Society of Testing Materials shall be increased one-sixth the allowable stress given in the table for the least or better (S2) grade.