- Allowable bending and allowable shear stress vary with different wood species, grades, and the design code used.
- Wood does not act the same in all directions.

Mechanical Properties of a Piece of Wood
Subjected to normal stresses, wood is stronger if the load is parallel to the grain rather than perpendicular
It's shear resistance, is much weaker in the direction parallel to the grain.

Steps for Timber Beam Design

Step 1: Determine the beam span, support conditions, allowable stresses, and other design limitations. Identify or compute the loads.

Step 2: Determine the maximum shear force and the maximum bending moment along the beam. For simple loadings, use the formulas from Table 13-1.

Step 3: Using the largest value of the bending moment, regardless of the sign, compute the minimum required section modulus from the flexure formula:

$$S_{req} = \frac{M_{max}}{\sigma_{allow}}$$

Step 4: Timber beams are usually available in rectangular sections for which the maximum shear stress is 1.5 times the average shear stress (Equation 14-11). In view of the weak shear stress resistance parallel to the grain, the minimum rectangular cross-sectional area required must be calculated from

$$A_{req} = \frac{1.5\ V_{max}}{\tau_{allow}}$$

Step 5: Scan Table A-6 in the appendix and select the lightest rectangular timber section that has a section modulus (about the strong axis) slightly greater than the required value computed in step 3 and an area slightly greater than the required area computed in step 4. Compute the percentage of the extra section modulus provided and the percentage of extra cross-sectional area provided, and make sure that these percentages are greater than the percentage of the ratio of the weight of the beam selected to the total design load.

In general, the preferred aspect ratio (depth/width) is between 1.5 - 3
Narrow and deep is more effective against bending moments.

Remember,
Nominal Dimension = true or named, i.e 2x4 ➔ 2" x 4"
Dressed Dimension = actual, i.e. Table A-6 2x4 ➔ 1½" x 3½"

TABLE 15–2 Allowable Stresses for Timber

Species	Extreme Fiber in Bending psi (kPa)	Tension Parallel to Grain psi (kPa)	Longitudinal Shear psi (kPa)	Compression: Perpendicular to Grain psi (kPa)	Compression: Parallel to Grain psi (kPa)
Douglas fir	1450 (10 000)	625 (4310)	95 (660)	385 (2650)	1050 (7240)
Eastern hemlock	1350 (9310)	925 (6380)	80 (550)	360 (2480)	950 (6550)
Southern pine	1600 (11 000)	825 (5690)	90 (620)	410 (2830)	1250 (8620)
Ponderosa pine	1100 (7580)	725 (5000)	65 (450)	235 (1620)	750 (5170)
California redwood	1350 (9310)	650 (4480)	100 (690)	270 (1860)	1050 (7240)

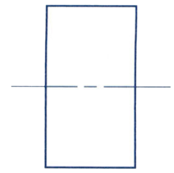


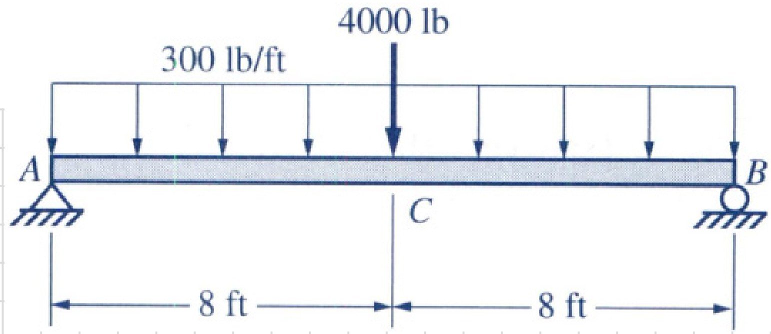
TABLE A–6(a) Properties of Structural Timber: U.S. Customary Units

Nominal Size (in.)	Standard Dressed Size (in.)	Area of Section A (in.^{2})	Moment of Inertia I (in.^{4})	Section Modulus S (in.^{3})	Weight per ft w (lb/ft)
2×4	$1\frac{1}{2} \times 3\frac{1}{2}$	5.25	5.36	3.06	1.46
$\times 6$	$\times 5\frac{1}{2}$	8.25	20.8	7.56	2.29
$\times 8$	$\times 7\frac{1}{4}$	10.9	47.6	13.14	3.02
$\times 10$	$\times 9\frac{1}{4}$	13.9	98.9	21.4	3.85
3×4	$2\frac{1}{2} \times 3\frac{1}{2}$	8.75	8.93	5.10	2.43
$\times 6$	$\times 5\frac{1}{2}$	13.8	34.7	12.6	3.82
$\times 8$	$\times 7\frac{1}{4}$	18.1	79.4	21.9	5.04
$\times 10$	$\times 9\frac{1}{4}$	23.1	165	35.7	6.42
$\times 12$	$\times 11\frac{1}{4}$	28.1	297	52.7	7.81
4×4	$3\frac{1}{2} \times 3\frac{1}{2}$	12.3	12.5	7.15	3.40
$\times 6$	$\times 5\frac{1}{2}$	19.3	48.5	17.6	5.35
$\times 8$	$\times 7\frac{1}{4}$	25.4	111	30.7	7.05
$\times 10$	$\times 9\frac{1}{4}$	32.4	231	49.9	8.93
$\times 12$	$\times 11\frac{1}{4}$	39.4	415	73.8	10.9
$\times 14$	$\times 13\frac{1}{4}$	46.4	678	102	12.9
6×6	$5\frac{1}{2} \times 5\frac{1}{2}$	30.3	76.3	27.7	8.40
$\times 8$	$\times 7\frac{1}{2}$	41.3	193	51.6	11.5
$\times 10$	$\times 9\frac{1}{2}$	52.3	393	82.7	14.5
$\times 12$	$\times 11\frac{1}{2}$	63.3	697	121	17.6
$\times 14$	$\times 13\frac{1}{2}$	74.3	1128	167	20.6
$\times 16$	$\times 15\frac{1}{2}$	85.3	1707	220	23.7
$\times 18$	$\times 17\frac{1}{2}$	96.3	2456	281	26.7
8×8	$7\frac{1}{2} \times 7\frac{1}{2}$	56.3	264	70.3	15.6
$\times 10$	$\times 9\frac{1}{2}$	71.3	536	113	19.8
$\times 12$	$\times 11\frac{1}{2}$	86.3	951	165	24.0
$\times 14$	$\times 13\frac{1}{2}$	101	1538	228	28.1
$\times 16$	$\times 15\frac{1}{2}$	116	2327	300	32.3
$\times 18$	$\times 17\frac{1}{2}$	131	3350	383	36.5
$\times 20$	$\times 19\frac{1}{2}$	146	4634	475	40.6
10×10	$9\frac{1}{2} \times 9\frac{1}{2}$	90.3	679	143	25.1
$\times 12$	$\times 11\frac{1}{2}$	109	1204	209	30.3
$\times 14$	$\times 13\frac{1}{2}$	128	1948	289	35.6
$\times 16$	$\times 15\frac{1}{2}$	147	2948	380	40.9
$\times 18$	$\times 17\frac{1}{2}$	166	4243	485	46.2
$\times 20$	$\times 19\frac{1}{2}$	185	5870	602	51.5
$\times 22$	$\times 21\frac{1}{2}$	204	7868	732	56.7

Note: Properties and weights are for dressed sizes. Weight per unit foot is based on an assumed average weight of 40 lb/ft^3. Moment of inertia and section modulus are about the strong axis.

Example P15-16

Select the lightest, rectangular Southern pine section for the simply supported girder subjected to the loading shown in Fig. P15-16.



Solution.