FRAMING
LUMBER

Lumber runs roughly 15% to 20% of total house cost — enough that it pays to estimate amounts needed accurately. But don't discount the cost of callbacks due to changes in moisture content. Quality control has the potential to decimate your profit margins.

Selecting Dimensional Lumber

SELECTING DIMENSIONAL LUMBER

Dimensional lumber is differentiated by several species groups. The main species groups in the U.S. are Spruce-Pine-Fir (Canadian), Douglas Fir-Larch, Hem-Fir, and Southern Pine (typically pressure-treated). Each species group is available in a number of grades, but unless otherwise specified, most framing lumber is #2. Lower grades may be allowed for studs (Stud-Grade) and top plates (Utility-Grade).

Strength values for these and other North American species and species groups are shown in **Figure A**. If a species or group is not listed in the charts, use the spans for a species or group with the same or higher Fb value.

FIGURE A: DESIGN VALUES FOR 2X8 (NOMINAL) LUMBER[1]

This table shows comparative design values for the four main wood species used in this manual. The values assume the lumber will be loaded on the edge. Extreme fiber stress in bending (Fb) is a measure of the lumber's strength to resist loads applied perpendicular to the grain. This load produces tension in the wood fibers along the edge farthest from the applied load, and compression in the fibers along the edge nearest to the load. The Modulus of Elasticity (E) is a ratio of the amount the wood will deflect in proportion to the applied load. E is a measure of stiffness, whereas Fb is a measure of strength.

Species Group	Grade	Extreme Fiber Stress in Bending (Fb) [2]	Modulus of Elasticity [3]
D-Fir-L	Select Strength	1,620	1.9
	No. 1 / No. 2	1,020	1.6
	No. 3	570	1.4
SPF	Select Strength	1,500	1.5
	No. 1 / No. 2	1,050	1.4
	No. 3	600	1.2
Hem-Fir	Select Strength	1,560	1.7
	No. 1 / No. 2	1,200	1.6
	No. 3	690	1.4
SYP	Select Strength	2,300	1.8
	No. 1	1,500	1.7
	No. 2	1,200	1.6
	No. 3	600	1.4

1. These values include a size factor for 8-inch-wide nominal members used in normal conditions (lumber with a moisture content <= 19% placed on edge). Wet lumber or flat members require higher values.
2. psi
3. million psi

Selecting Dimensional Lumber

Shrinkage

Kiln-dried lumber is stamped K-D (kiln-dried) or S-Dry (surface dry), and is shipped with a moisture content of about 19%. Anything larger than a 6x6 is generally not available K-D.

In a completed building, framing eventually dries to an average of 6% to 11% moisture content, depending on climate. This drying causes the lumber to shrink across the grain; shrinkage along the grain is negligible. **Figure B** shows the degree of shrinkage in flat-sawn framing lumber.

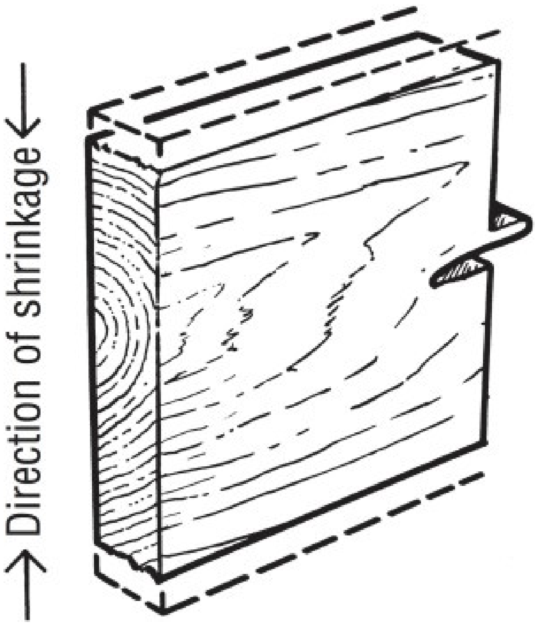


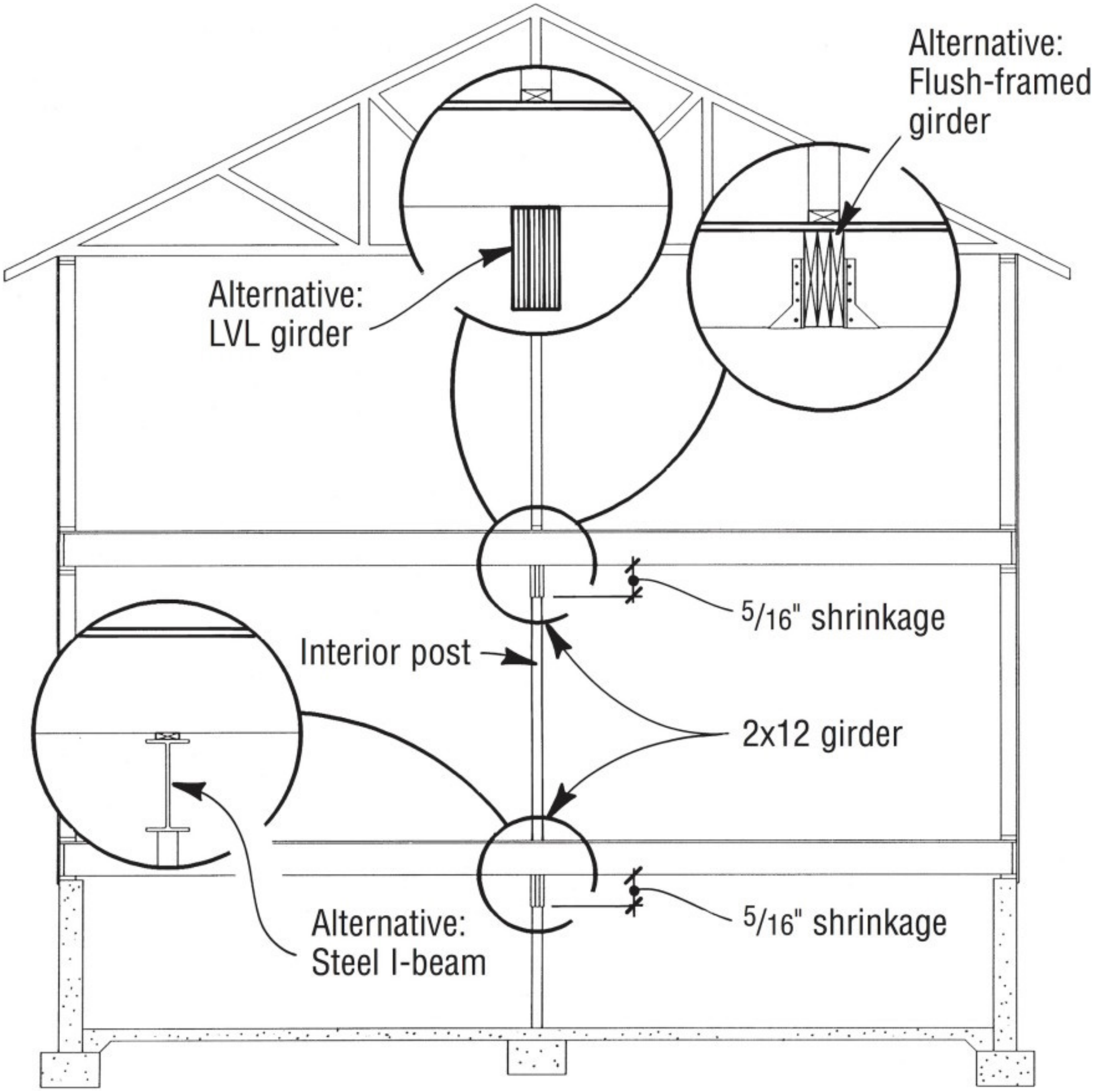
FIGURE B: PREDICTED SHRINKAGE OF DIMENSION LUMBER

Lumber Size	Actual Width	Width @ 19% MC (at Delivery)	Width @ 11% MC (Humid Climates)	Width @ 8% MC (Average Climates)	Width @ 6% MC (Arid Climates)
2x4	3 1/2"	3 1/2"	3 7/16"	3 3/8"	3 3/8"
2x6	5 1/2"	5 1/2"	5 3/8"	5 5/16"	5 5/16"
2x8	7 1/2"	7 1/4"	7 1/8"	7 1/16"	7"
2x10	9 1/4"	9 1/4"	9 1/16"	9"	8 15/16"
2x12	11 1/4"	11 1/4"	11"	10 15/16"	10 7/8"

Framing lumber shrinks primarily across its width; shrinkage from end to end is insignificant. Actual shrinkage varies depending on the lumber's moisture content when delivered and the area's climate.

Shrinkage in large carrying beams can cause one part of a house to settle more than others, causing drywall cracks and other problems (**Figure C**).

FIGURE C: AVOIDING CUMULATIVE SHRINKAGE

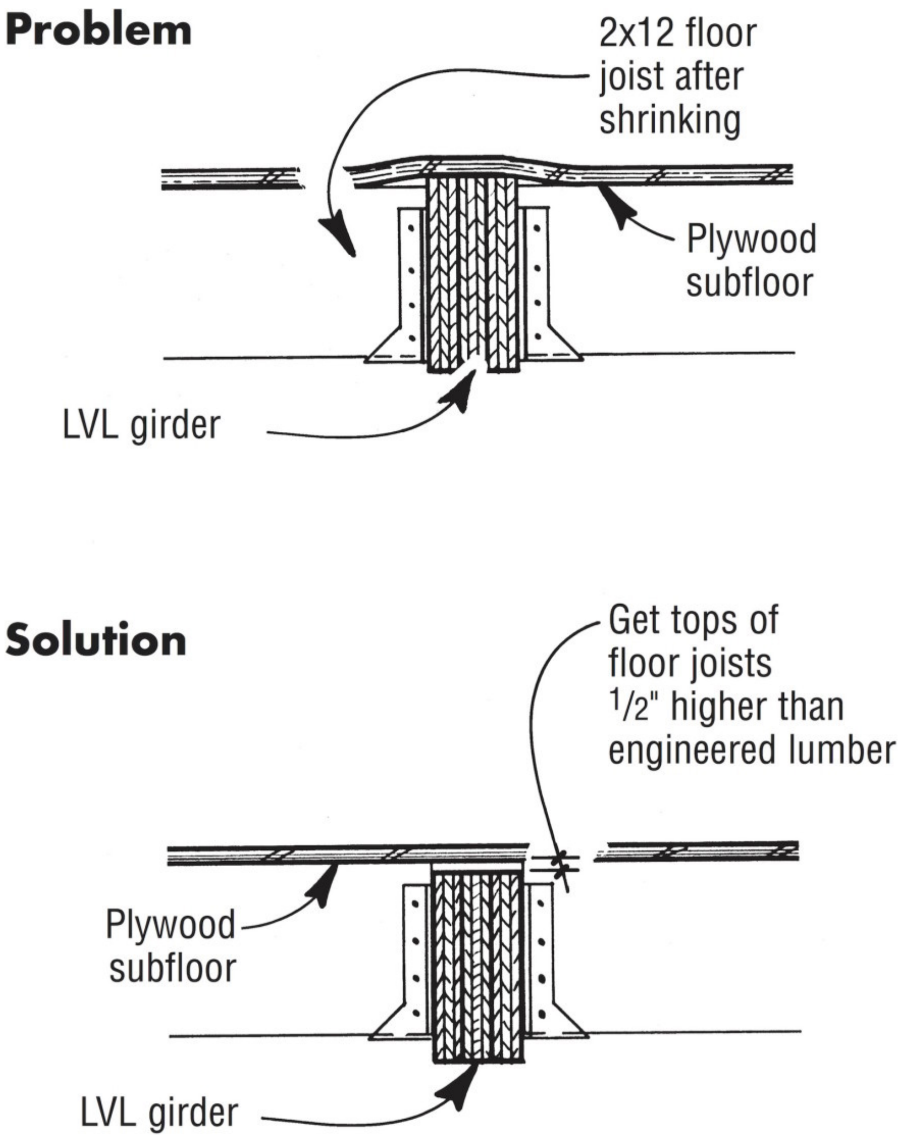


The two 2x12 girders in this building will shrink enough to cause a 1/2-in. drop in the second-floor level — enough to cause nail pops and cracks in the finishes. Use steel, engineered lumber, or flush framing to eliminate the problem.

Selecting Dimensional Lumber

However, using flush beams with hangers, or engineered lumber or steel, can reduce the potential for shrinkage problems. If dimensional lumber is hung flush from a beam made of steel or engineered lumber, the result can be a bulge at the beam (**Figure D**).

FIGURE D: FLUSH-FRAMED FLOOR JOISTS



When installing dimensional-lumber floor joists flush with the top of engineered or steel beams, install the joists 1/2 in. higher than the girder to accommodate shrinkage.

CONVERTING LINEAR FEET TO BOARD-FEET

Formula method. To find board-feet, multiply the total length (in ft.) by the nominal lumber thickness by the width (in in.), and then divide the total by 12. For example: Ten 8-ft. 2x4s = (80 × 2 × 4) ÷12 = 53.3 board-feet

Converting Linear Feet To Board-Feet

(L × T × W) ÷ 12

Factor method. Alternatively, use the conversion factors in **Figure E**.

FIGURE E: LINEAR FEET TO BOARD-FEET CONVERSION

Nominal Lumber Size	Conversion Factor
1X4	.33333
1X6	.50000
1X8	.66667
1X10	.833333
1X12	1.00000
2X3	.50000
2X4	.666667
2X6	1.00000
2X8	1.33333
2X10	1.66667
4X4	1.33333
4X6	2.00000
6X6	3.00000

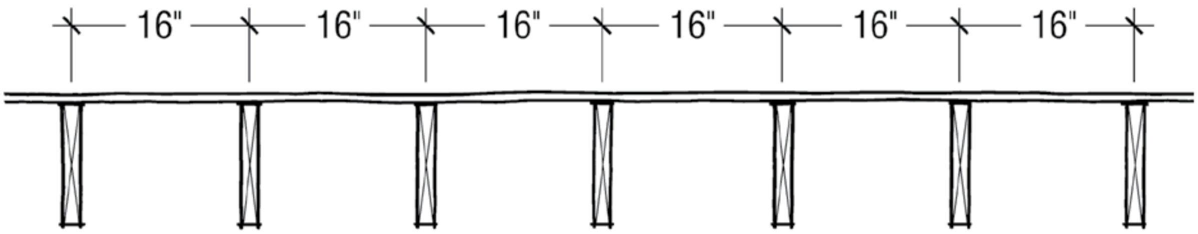
As an alternative method of calculating board-feet, multiply the lin. ft. of each lumber size you are using by the corresponding conversion factor. Example: Ten 8-ft. 2x4s = 80 × .666667 = 53.3 board-feet

ESTIMATING FLOOR AND CEILING FRAMING

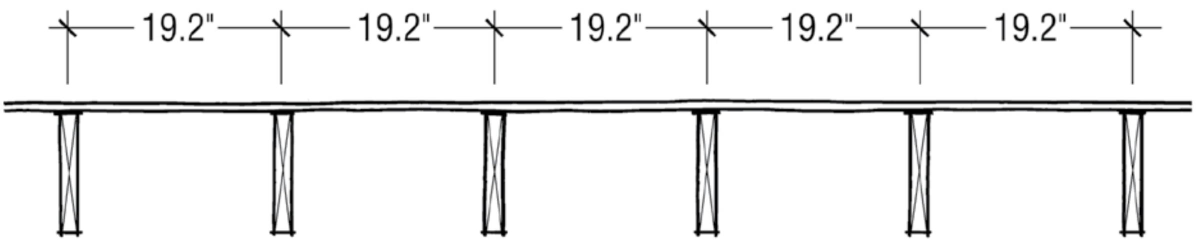
To calculate the number of joists, use the formulas shown in **Figure F** for the appropriate on-center spacing.

Estimating Floor and Ceiling Framing

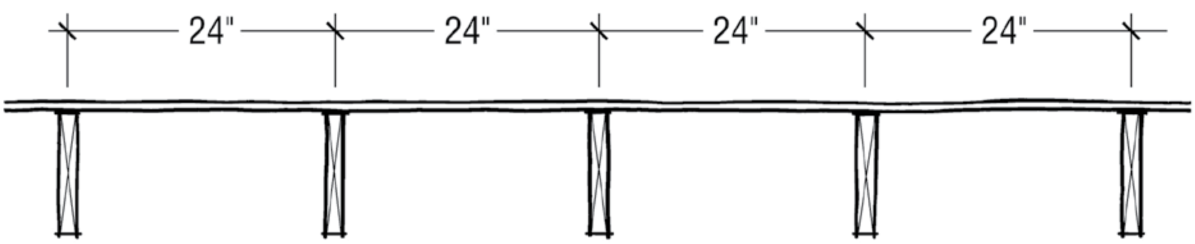
FIGURE F: ESTIMATING JOISTS AND RAFTERS



L ÷ 1.25 + 1



L ÷ 1.5 + 1



L ÷ 2 + 1

To calculate the number of joists needed:
1) Measure the width of the room (ft.);
2) divide by the appropriate o.c. spacing (ft.);
3) add one to start.

Estimating Floor and Ceiling Framing

Estimating Wall Framing

Estimating Rim Joists

Remember to include rim stock in the total joist count. Rim joist stock is calculated as follows:

Building Length (ft.) × 2 ÷ Lumber Length

Lumber lengths should be multiples of the o.c. spacing. For example, use 12s, 16s, 20s, etc., for 16-in. o.c. joist spacing. Depending on the length of the building, it may be more efficient to count these individually, mixing lumber lengths that break evenly on the joists.

Estimating Subflooring

The most accurate method of estimating subflooring is to graph scaled lines over the floor plans in 4x8-ft. increments. For a quick alternative, calculate as follows:

- For each section of subfloor, square off any jogs or cantilevers from the outside perimeter on the plans to form one large perimeter rectangle.
- For each section, multiply the length by the width of the perimeter rectangle.
- Divide by 32 (for 4x8 panels).

Floor Area = Length × Width

Sheathing (4x8 panels) = Floor Area ÷ 32

Remember to add a couple of sheets to the total panel count to accommodate cutting error and waste, especially if there are jogs in the floor plan.

ESTIMATING WALL FRAMING

Estimating Plate Stock

Order wall plates in a quantity that's at least four times the total length of the walls. On walls that run in the same direction as the trusses or joists, an additional plate is needed for drywall backing at the ceiling. More will be needed to cover waste, miscellaneous backing, and continuous fire blocking for walls over 8 ft. high.

Estimating Studs

For a small house (less than 2,000 sq. ft.) with 16-in. o.c. framing, order 1 stud for each lin. ft. of wall framing — both interior and exterior. For a larger house framed 16 in. o.c., order 1.25 studs for each lin. ft. of wall framing.

Estimating Wall Framing

Estimating Headers

In a house with windows under 36 in. wide, use the following shortcuts:

For solid-sawn headers:

1. Count the number of windows and doors; count French doors or sliders as 2;
2. Divide by 3 and order that many 10-footers.

For doubled-2x headers:

1. Count the number of windows and doors; count French doors or sliders as 2;
2. Multiply by 2;
3. Divide by 3 and order that many 10-footers.

For extra large or extra narrow windows, calculate headers individually.

Estimating Wall Sheathing

For rectangular wall areas:

Wall Area = Total Wall Length × Wall Height

Sheathing (4x8 panels) = Wall Area ÷ 32

1. Multiply the total length of exterior walls by the wall height to get total wall area;
2. Subtract the areas of major openings such as sliders or large windows;
3. Divide by 32 (for 4x8 panels).

Remember to account for gable-end walls.

For regular gables (same pitch both sides of ridge):

Multiply span by total rise. This gives you the total for two gable-ends.

For irregular gables or single gable-end walls:

1. Multiply total run by total rise for each gable end;
2. Divide by 32.

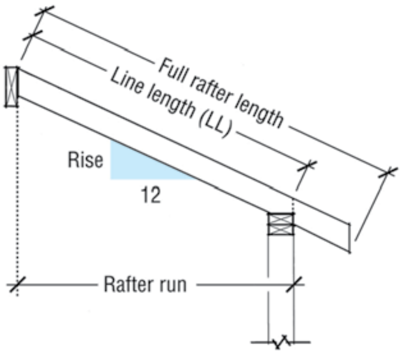
Estimating Roof Framing

ESTIMATING ROOF FRAMING

Estimating Rafter Length

To find the full rafter length, multiply the correct line length ratio in **Figure G**, below, by the horizontal run of the rafter. This gives the net rafter length, or line length, from top plate to ridge. Then add for the plumb cut at the ridge and overhang to find the full rafter length.

FIGURE G: RAFTER LINE LENGTH RATIOS



To convert Rafter Run to Line Length:

1. Select LL ration for given slope in table below;
2. Multiply rafter run by LL ration.

To find Full Rafter Length (add for any overhang at the eaves):

1. Multiply the horizontal length of overhang by the same LL ratio;
2. Add this overhang length to the rafter LL.

Rafter Line-Length (LL) Ratios

Roof Pitch/12	COM LL Ratio	H/V LL Ratio
1	1.0035	1.4167
1 1/2	1.0078	1.4197
2	1.0138	1.4240
2 1/2	1.0215	1.4295
3	1.0308	1.4361
3 1/2	1.0417	1.4440
4	1.0541	1.4530
4 1/2	1.0680	1.4631
5	1.0833	1.4743
5 1/2	1.1000	1.4866
6	1.1180	1.5000
6 1/2	1.1373	1.5144
7	1.1577	1.5298
7 1/2	1.1792	1.5462

Roof Pitch/12	COM LL Ratio	H/V LL Ratio
8	1.2019	1.5635
8 1/2	1.2254	1.5817
9	1.2500	1.6008
9 1/2	1.2754	1.6207
10	1.3017	1.6415
10 1/2	1.3288	1.6630
11	1.3566	1.6853
11 1/2	1.3851	1.7083
12	1.4142	1.7321
14	1.5366	1.8333
16	1.6667	1.9437
18	1.8028	2.0616
24	2.2361	2.4495

When estimating rafter lengths and calculating spans, convert the rafter run (horizontal distance) to a sloped distance (line length) using these ratios.

Examples: On a 6/12 roof with a run of 15 ft., find the net rafter length for the common rafters: 15 ft. × 1.118 = 16.77 ft. or 16 ft. 91/4 in. Round up to the next 2-ft. increment for the lumber length needed (18-footers).

If the roof has a 16-in. overhang, measured along the rafter, the job will require 20-ft. rafters: 16 in. × 1.118 = 1.491 ft. + 16.77 ft. = 18.261 ft. or 18 ft. 31/4 in. Round up to 20-footers.

Estimating Roof Framing

Estimating Number of Common Rafters
To calculate the number of common rafters, use the formulas provided in **Figure F** for the appropriate on-center spacing.

Remember to include ridge stock.

Estimating Hip and Valley Rafter Lengths
To calculate the length of each hip rafter, use the Hip/Valley LL ratio shown in **Figure G**.

Estimating Jack Rafters
For a simple hip or valley, each pair of jack rafters is equal in length to one common (one long jack + one short jack = one common).

Estimating Roof Sheathing
Roof Area = Perimeter Wall Lengths (incl. overhangs) × Rafter Line Length

Sheathing (4x8 panels) = Roof Area ÷ 32

1. Add overhang distance to exterior wall lengths;
2. Multiply the total length of the perimeter (wall length + overhang) by the rafter line length (**Figure G**) to get total roof area (on gable roofs, don't include the gable-end wall in the total length);
3. Divide by 32 (for 4x8 panels).

Calculate roofs of different pitches individually.

Remember to add a couple of sheets to the total to account for error and waste.