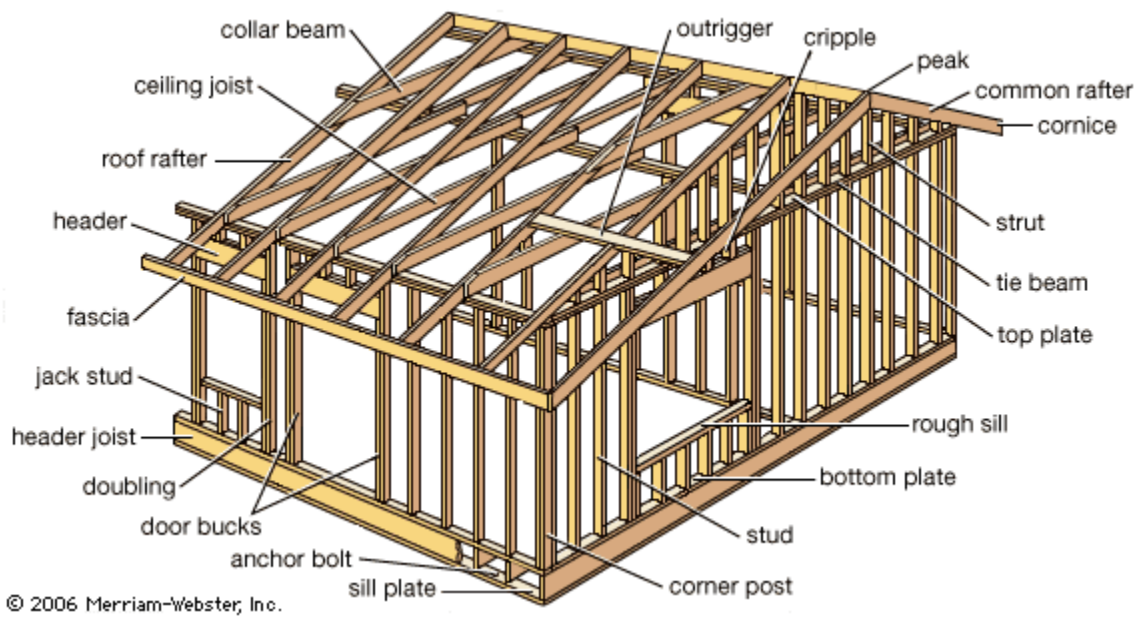
CONVERSION OF SHINGLE HOUSE TO A ROOF TILE HOUSE

WOOD FRAME CONSTRUCTION



The most common method used in residential construction in America is wood frame. This system owes it strength to the repetitive member assemblies that make up the walls, roofs and ceilings/ floors of the building. While this system may feature any number of variables, the basic guidelines for construction are presented in Section 2308 / Conventional Light-frame Construction of the International Building Code (IBC). Since nearly all jurisdictions throughout America reference the IBC, it is generally appropriate to use the information therein to determine the structural capabilities of any given structure when selecting roofing materials.

For new construction it is the structural engineer's responsibility to design the entire structure to withstand the loads imposed by the dead loads, live loads as well as wind, snow and seismic loads. In most cases the wind load will govern the overall lateral design and the combined dead and live load will determine the maximum span of the rafters, floor and ceiling joists. To facilitate the design process, the IBC contains span charts that provide the maximum spans for each assembly based on the grade and species of lumber being used and the on center spacing of the framing members. It should be noted that for the most part, the span charts are the only parts of this section showing difference based on weight factors; all other framing guidelines remain the same, regardless of the weight of the roofing material. This is the reason that most properly constructed homes need only to address the rafter systems when converting to heavier roof systems.

In simplest terms, if the horizontal spans measured in the attic are shorter than those shown in the designated span chart, then the roof system is capable of supporting the weight of the intended roofing material. If the measured spans exceed the maximum allowable span, then roof reinforcement will be required.

There are different span charts due to the number of variables factored into the expected loads depending mostly on climate differentials. The other variable included into each span chart is the species of lumber and quality grade as determined by the lumber mill. The species and grade of lumber being used in local construction must be determined in advance of using the span chart. This can be ascertained in the field by examining the pieces of lumber for the identifying marks placed on the face of the framing member by the lumber mills.

An example of a typical span chart is shown below.

Criteria for mild climate regions where no snow load is considered:

Deflection limit L/180 (open attic)

ROOF RAFTERS **20# LIVE LOAD[1]** **15# DEAD LOAD** **L/180**

Table RR-3

Design Criteria: *Strength* - 20 lbs. per sq. ft. live load, plus 15 lbs. per sq. ft. dead load.
Deflection - Limited in span in inches divided by 180 for live load only.

Species or Group	Grade	Span (feet and inches)															
		2 x 6				2 x 8				2 x 10				2 x 12			
		spacing on center															
		12"	16"	19.2"	24"	12"	16"	19.2"	24"	12"	16"	19.2"	24"	12"	16"	19.2"	24"
Douglas Fir-Larch	Sel. Struc.	*18-0*	*16-4*	*15-5*	14-3	*23-9*	*21-7*	20-1	18-0	*30-4*	26-11	24-7	22-0	36-1	31-3	28-6	25-6
	No.1 & Btr.	*17-8*	15-7	14-3	12-9	22-9	19-9	18-0	16-1	27-10	24-1	22-0	19-8	32-3	27-11	25-6	22-10
	No.1	16-5	14-3	13-0	11-7	20-9	18-0	16-5	14-8	25-5	22-0	20-1	17-11	29-5	25-6	23-3	20-10
	No.2	15-7	13-6	12-4	11-0	19-9	17-1	15-7	13-11	24-1	20-10	19-0	17-0	27-11	24-2	22-1	19-9
	No.3	11-11	10-4	9-5	8-5	15-1	13-0	11-11	10-8	18-5	15-11	14-6	13-0	21-4	18-6	16-10	15-1
Douglas Fir-South	Sel. Struc.	*16-3*	*14-9*	*13-11*	*12-11*	*21-5*	*19-6*	*18-4*	*17-0*	*27-5*	*24-10*	23-4	20-10	*33-4*	29-7	27-0	24-2
	No.1	15-9	13-8	12-6	11-2	20-0	17-4	15-10	14-2	24-5	21-2	19-4	17-3	28-4	24-6	22-5	20-0
	No.2	15-2	13-1	12-0	10-8	19-2	16-7	15-2	13-7	23-5	20-3	18-6	16-7	27-2	23-6	21-5	19-2
	No.3	11-7	10-1	9-2	8-2	14-8	12-9	11-7	10-5	17-11	15-7	14-2	12-8	20-10	18-0	16-5	14-9
Hem-Fir	Sel. Struc.	*17-0*	*15-6*	*14-7*	*13-6*	*22-5*	*20-5*	*19-2*	17-5	*28-7*	*26-0*	23-9	21-3	*34-10*	30-2	27-6	24-8
	No.1 & Btr.	*16-8*	14-11	13-7	12-2	21-10	18-10	17-3	15-5	26-7	23-1	21-1	18-10	30-10	26-9	24-5	21-10
	No.1	16-2	14-0	12-10	11-5	20-6	17-9	16-3	14-6	25-1	21-8	19-10	17-9	29-1	25-2	23-0	20-7
	No.2	15-2	13-1	12-0	10-8	19-2	16-7	15-2	13-7	23-5	20-3	18-6	16-7	27-2	23-6	21-5	19-2
	No.3	11-7	10-1	9-2	8-2	14-8	12-9	11-7	10-5	17-11	15-7	14-2	12-8	20-10	18-0	16-5	14-9
Spruce-Pine-Fir (South)	Sel. Struc.	*15-11*	*14-5*	*13-7*	*12-7*	*20-11*	*19-0*	*17-11*	*16-7*	*26-9*	*24-3*	*22-10*	20-6	*32-6*	29-1	26-6	23-9
	No.1	15-4	13-3	12-2	10-10	19-5	16-10	15-4	13-9	23-9	20-7	18-9	16-9	27-6	23-10	21-9	19-6
	No.2	14-5	12-6	11-5	10-3	18-4	15-10	14-6	12-11	22-4	19-4	17-8	15-10	25-11	22-5	20-6	18-4
	No.3	11-0	9-6	8-8	7-9	13-11	12-1	11-0	9-10	17-0	14-9	13-6	12-0	19-9	17-1	15-7	14-0
Western Woods	Sel. Struc.	*15-6*	*13-6*	12-4	11-0	19-9	17-1	15-7	13-11	24-1	20-10	19-0	17-0	27-11	24-2	22-1	19-9
	No.1	13-6	11-8	10-8	9-6	17-1	14-9	13-6	12-1	20-10	18-1	16-6	14-9	24-2	20-11	19-1	17-1
	No.2	13-6	11-8	10-8	9-6	17-1	14-9	13-6	12-1	20-10	18-1	16-6	14-9	24-2	20-11	19-1	17-1
	No.3	10-1	8-8	7-11	7-1	12-9	11-0	10-1	9-0	15-7	13-6	12-3	11-0	18-0	15-7	14-3	12-9

Span Charts

One of the most common questions that we hear during inquiries on tile roofing is regarding the structural requirements of the building to be roofed. It is one of the least understood aspects of the installation despite the fact that there are very clear guidelines available to help determine the facts. Since the majority of the roofs that are considered for tile installations are on residential buildings, this section will attempt to provide some basic guidelines for the user to determine the suitability of the roof framing to support a tile roof.

Based on the guidelines provided for Conventional Light-Frame Construction contained in the International Building Codes, foundation and wall supports are not specifically affected by roof loads and are typically constructed in the same manner regardless of roof type. Accordingly, this document will confine its discussion to roof systems only and offers the attached information simply for the sake of qualifying information.

The span tables shown here are taken from the Western Wood Products Association Western Lumber Span Tables for Floor and Ceiling Joists and Roof Rafters (Revised September, 2001) and are essentially identical to those contained in the IBC. Selecting the correct span table requires the user to identify the local requirements regarding how much of a snow load is predicted by local building officials; this can usually be determined by contacting the building department or local engineer. To understand how a span chart works, it is helpful to become familiar with the terms referenced in these tables.

Pertinent Terms

- Dead load is the total weight of all the components of the roof system that are permanently in place. Components include the roof rafters, roof sheathing, roof tiles, etc.
- Live Load – Live load is a weight factor that an engineer is required to consider into design to allow for short-term loads produced by foot traffic during maintenance or movement of equipment and materials. In essence, it is a safety factor that protects the roof from damage during construction. A typical live load for dry climates is 20 lbs. per square foot (psf) although code allows for a reduction to 16 lbs. for slopes above 4:12. Wind loads and snow loads will sometimes be much greater than the live load, in which case the engineer must use the highest load for determining rafter strength.
- The combined load results when the dead load and live load are added together. This is the load that the engineer must design for.

Using Span Charts

- Span charts deal only with gravity loads and the support capabilities of the rafters; that is, the ability of the rafters to carry the load without developing noticeable deflection (sagging). Code allows a certain amount of deflection with L/180 being the limit for rafters not also carrying a ceiling load. (L/180 means – L = the number of inches of span divided by 180. For example, a rafter span of 11’3” = 135 inches divided by 180 = approximately .75 inches. This means that any rafter spanning 11’3” is not allowed to sag more than ¾- inch. L/240 calculation, which is the limit for rafters carrying a ceiling load, would limit the deflection to ½inch for the same span.)
- When the measured spans exceed span chart criteria, additional bracing is required. Bracing performed must be in accordance with IBC Conventional Construction Provisions unless otherwise instructed by a licensed engineer. Although many bracing techniques may be employed, the goal is to strengthen the roof system in the most economical yet effective way possible. The most common methods involve the use of purlins or doubling of framing members to meet the criteria shown in the span charts.

- (Figure 1 – How to measure a horizontal span)