FRAMING GUIDELINES

Cutting, Notching, and Boring Lumber Joists

<table>
<thead>
<tr>
<th>Joist Size</th>
<th>Maximum Hole</th>
<th>Maximum Notch Depth</th>
<th>Maximum End Notch</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x4</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>2x6</td>
<td>1 1/2</td>
<td>7/8</td>
<td>1 3/8</td>
</tr>
<tr>
<td>2x8</td>
<td>2 3/8</td>
<td>1 1/4</td>
<td>1 7/8</td>
</tr>
<tr>
<td>2x10</td>
<td>3</td>
<td>1 1/2</td>
<td>2 5/8</td>
</tr>
<tr>
<td>2x12</td>
<td>3 3/4</td>
<td>1 7/8</td>
<td>2 7/8</td>
</tr>
</tbody>
</table>

In joists, never cut holes closer than 2 inches to joist edges, nor make them larger than 1/3 the depth of the joist. Also, don’t make notches in the middle third of a span, where the bending forces are greatest. They should also not be deeper than 1/6 the depth of the joist, or 1/4 the depth if the notch is at the end of the joist. Limit the length of notches to 1/3 of the joint’s depth. Use actual, not nominal, dimensions. (“Field Guide to Common Framing Errors,” 10/91)

Hole-Cutting Rules for Wood I-Joists

With wood I-joists and other types of engineered lumber, it’s best to consult the manufacturer’s literature. The example provided here is courtesy of Trus Joist MacMillan. (“Repiping With PEX,” 10/99)

Min. Distance from Inside Face of Support to Near Edge of Hole

<table>
<thead>
<tr>
<th>Depth</th>
<th>TJI/Pro</th>
<th>2”</th>
<th>3”</th>
<th>4”</th>
<th>5”</th>
<th>6”</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 1/2”</td>
<td>150</td>
<td>1’0”</td>
<td>1’6”</td>
<td>3’0”</td>
<td>5’0”</td>
<td>6’6”</td>
</tr>
<tr>
<td>250</td>
<td>1’0”</td>
<td>2’6”</td>
<td>4’0”</td>
<td>5’6”</td>
<td>7’6”</td>
<td></td>
</tr>
<tr>
<td>11 7/8”</td>
<td>150</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
<td>2’0”</td>
<td>3’0”</td>
</tr>
<tr>
<td>250</td>
<td>1’0”</td>
<td>2’0”</td>
<td>3’0”</td>
<td>4’0”</td>
<td>5’6”</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>1’0”</td>
<td>2’0”</td>
<td>3’0”</td>
<td>4’6”</td>
<td>5’6”</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>1’0”</td>
<td>1’6”</td>
<td>3’0”</td>
<td>4’6”</td>
<td>6’0”</td>
<td></td>
</tr>
<tr>
<td>14”</td>
<td>250</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’6”</td>
<td>1’6”</td>
</tr>
<tr>
<td>350</td>
<td>1’0”</td>
<td>1’6”</td>
<td>2’0”</td>
<td>3’0”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>1’0”</td>
<td>1’6”</td>
<td>2’0”</td>
<td>4’0”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16”</td>
<td>250</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
</tr>
<tr>
<td>350</td>
<td>1’0”</td>
<td>1’6”</td>
<td>1’0”</td>
<td>1’0”</td>
<td>1’0”</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>1’0”</td>
<td>1’6”</td>
<td>1’0”</td>
<td>2’0”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

General Notes:
*Distances in the charts above are based on uniformly loaded joists using the maximum loads shown in TJM’s brochure. For other load conditions or hole configurations, contact TJM representative.
*For simple span (5-foot minimum) uniformly loaded joists, one maximum-size hole may be located at the center of the joist span provided no other holes occur in the joist. DO NOT cut into joint flanges when cutting out web.

Notching and Boring Studs

Never notch in the middle third of a joist span, and limit the length of notches to one-third the depth of the member. The rules for notching and boring studs differ for bearing and nonbearing walls. (“Ten Common Framing Flaws,” 4/95)
FRAMING GUIDELINES

Cantilevers

When a cantilever supports a bearing wall, the distance it extends beyond its support (C) should not exceed the depth of the joist (D). (“Field Guide to Common Framing Errors,” 10/91)

Purlin Design

A properly constructed purlin must be at least the same dimension as the rafters that it supports. Supporting struts should be notched into the purlin and installed at an angle not less than 45 degrees to transfer the load of the roof to a bearing wall. (“Ten Common Framing Flaws,” 4/95)

Rafter Bearing

It’s best to rest the rafter heel on the plate (left), not on the toe (center). Where this isn’t possible, you can sometimes support it with a joist hanger (right). The joist hanger also keeps the rafter from rotating, a job that normally requires ceiling joists or solid blocking. (“Field Guide to Common Framing Errors,” 10/91)

Splicing Top Plates in Bearing Walls

Double top plates must be lapped at corners and intersections, and splices must be staggered by at least 48 inches. (“Ten Common Framing Flaws,” 4/95)

Aligning Bearing Walls

If a bearing wall doesn’t line up with the support below, it should lie no farther away than the depth of the joists (D). If the joists are engineered lumber, the walls and support must align exactly. (“Field Guide to Common Framing Errors,” 10/91)
Installing Plywood Sheathing

When all the panel edges are supported by solid framing, 1/2-inch plywood sheathing is stronger against racking forces when installed horizontally (top sketch). If there’s no blocking at the 4-foot mark, the sheathing is stronger installed vertically, as long as all edges are supported (bottom sketch). (“Frequently Asked Framing Questions,” 4/98)

Calculating Snow Loads

When adding up the weight of snow of a sloping roof, use the horizontal run of the roof, since the same amount of snow would accumulate on a perfectly flat roof. The code also allows you to apply a slope reduction factor, to account for snow blowing or sliding off a sloping surface. (“Frequently Asked Framing Questions,” 4/98)

Tapered Joist Ends

Overtapering joists to fit beneath roofs creates inadequate joist depth at the plate. A proper cut leaves at least half the depth of the joist. (“Field Guide to Common Framing Errors,” 10/91)

Toe-Nails Are Stronger

When nailing a stud to a plate, a toe-nailed connection is typically stronger against lateral forces than an end-nailed connection. (“Frequently Asked Framing Questions,” 4/98)

Balloon-Framed Half-Walls

When adding a shed dormer above balloon-framed half-walls, don’t build the wall extension directly on top of the balloon wall top plate. Instead, either remove the top plate and carefully splice on stud extensions or cut the balloon studs flush and build a new full-height stud wall. (“Taking the Sag out of Shed Dormers,” 9/93)
ROOF FRAMING GUIDELINES

Drop-Ridge Dormers

A. With Structural Ridge

Support posts as required

Original rafter removed

Dormer rafter

2x4 hanger

Metal twist-strip hangers

Existing 2x ridge

Dropped structural ridge

Metal hanger

B. Without Structural Ridge

(2) 1/2" carriage bolts

(1) 1/2" carriage bolt

Dormer rafter

Original rafter removed

Ridge Retrofit

Strap ties

Existing ridge

Reinforcing beam

Engineered eaves connections

In cases where an existing ridge board is inadequate for carrying vertical roof loads, as in a shed dormer retrofit, you can use strap ties to suspend a reinforcing beam below the original ridge. (Practical Engineering, 5/97)

Shed dormer designs sometimes drop the shed ridge below the main ridge of the house. With a center bearing wall or structural ridge (A), this presents no problem; just tie in the dormer rafters and add short non-structural rafters above. The drawing shows three options for tying the dormer rafters to the structural ridge. However, in situations without a structural ridge (B), special attention must be given to connecting the dormer rafters. The author recommends 1/2-inch carriage bolts at all connections. (“Taking the Sag out of Shed Dormers,” 9/93)
Structural Ridge Connections

**A.**
- Rafter hangers
- Dormer rafters
- Original rafters
- Structural ridge installed in place of nonstructural ridge

**B.**
- Original rafters
- 2x braces
- Structural ridge retrofitted below nonstructural ridge

**Note:** This table is based on a sample house 24 feet wide (eaves to eaves), with design snow loads of 30 psf.

* Fb = 760 psi min. (new grading tables), or 1,000 psi with the old tables
Calculating Load on a King Truss

To design a rafter-joist king truss to support the end of a structural ridge, the engineer must calculate the tension force, \( T \), that will be induced in the joist. First, the tributary roof load flowing to the end of the ridge beam is calculated, then this point load, \( P \), is used to calculate the tension force in the joist. The designer then specifies the bolts needed to carry this tension force at the rafter-joist connections. ([Practical Engineering], 9/97)

Assuming a total (dead + live) roof design load of 40 psf:

\[
P = \frac{26'}{2} \times \frac{16'}{2} \times 40\text{psf} = 13' \times 8' \times 40\text{psf} = 4160\text{ lb.}
\]

\[
T = \frac{1}{2}P \times \frac{\text{Run}}{\text{Rise}} = \frac{4160}{2} \times \frac{12}{10} = 2496\text{ lb.}
\]

Divide \( T \) by bolt capacity to calculate number of bolts (\( N \)) required for joist-rafter connection:

\[
N = \frac{T}{\text{bolt capacity}}
\]

To design a rafter-joist king truss to support the end of a structural ridge, the engineer must calculate the tension force, \( T \), that will be induced in the joist. First, the tributary roof load flowing to the end of the ridge beam is calculated, then this point load, \( P \), is used to calculate the tension force in the joist. The designer then specifies the bolts needed to carry this tension force at the rafter-joist connections. ([Practical Engineering], 9/97)

Structural Ridge Installation Details

When supporting a structural ridge with a rafter truss, the beam can be sandwiched in place just like a nonstructural ridge (left), supported by a hanger attached to a gusset plate (middle), or even hung by straps from an existing ridge board (right). ([Practical Engineering], 9/97)
Number of Bolts Required for
King Truss Joist-Rafter Connections

To use this chart, calculate the point load, $P$, at the top of the king truss (always round up), then find the number of bolts required for the roof pitch. Note that where seven or more $\frac{1}{2}$-inch bolts are not recommended, fewer 1-inch bolts may work. The number of required bolts assumes a single-shear connection. Reduce bolts by half for double-shear connections. The chart is based on use of S-P-F 2-by lumber (specific gravity = 0.42). In some, but not all, cases, fewer bolts would be required if a stronger grade of lumber were used. Use of lower grades, such as redwood, eastern softwoods, S-P-F (south), western cedars, western woods, or northern species, would in some cases require more bolts. When in doubt, the designer should refer to the NDS tabulated bolt design values, which were used as the basis for this chart.

<table>
<thead>
<tr>
<th>Roof Pitch</th>
<th>Point Load (P) on King Truss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 lb.</td>
</tr>
<tr>
<td>12/12</td>
<td>2</td>
</tr>
<tr>
<td>10/12</td>
<td>2</td>
</tr>
<tr>
<td>8/12</td>
<td>3</td>
</tr>
<tr>
<td>6/12</td>
<td>3</td>
</tr>
<tr>
<td>4/12</td>
<td>4</td>
</tr>
<tr>
<td>3/12</td>
<td>5</td>
</tr>
</tbody>
</table>

*Not recommended

Number of $\frac{1}{2}$-inch-diameter bolts
Number of 1-inch-diameter bolts

Single-Shear Connection
Double-Shear Connections

(Practical Engineering, 9/97)
The raised rafter plate (A) allows room for insulation above the wall plate, but the lateral thrust of the roof must be accounted for in the design. When using a raised rafter plate, Simpson strap ties (B) are the easiest way to resist roof thrust, according to the author. When an attic floor is in the way, twist straps will work (C). Extending the attic joists beyond the walls (D) provides a strong rafter-joist connection, but may require additional hurricane ties to resist wind uplift. (Practical Engineering, 7/96)

The most effective way to reduce outward roof thrust is to use a structural ridge beam. Either rest the rafters on top of a structural ridge (top left) or use joist hangers attached to the ridge beam (left). The notch at the bottom of the plumb cut should be no deeper than one-fourth the rafter width. (“Common Roof-Framing Errors,” 8/95)
ROOF FRAMING GUIDELINES

Tension Tie

In the absence of a structural ridge or center bearing wall, ceiling joists are critical for preventing rafters from spreading. Where the joists are interrupted by a flush-framed beam, strap ties make an ideal tension connection. (Practical Engineering, 5/97)

Strapping the Roof Together

Where ceiling joists run perpendicular to the rafters, coil strap makes an excellent rafter tie. (Practical Engineering, 5/97)

Upset Beam

An “upset” girder is often easier to frame than a flush-framed beam. The joists hang by twist straps, installed in pairs. (Practical Engineering, 5/97)

Strongest Joist Hangers

Double-shear connectors provide greater strength with fewer nails than ordinary hangers. The angled nail configuration also makes it easier to drive the nails in a joist bay. (Practical Engineering, 5/97)

The Right Angle

Heavy-duty angles like Simpson’s HL or USP’s KHL are a good solution for attaching that last deck joist to the ledger board. (Practical Engineering, 5/97)