A building's frame is only as strong as its weakest link. Here are a dozen weak ones to avoid.

Over the past 17 years, first as a builder and then as a representative of the Western Wood Products Association, I have traveled extensively, talking to builders and code officials to see how framing is done throughout the country. While I've found regional differences, I've also found a few serious framing problems that tend to crop up everywhere, again and again.

All of these problems are covered by the model building codes. A given problem might occur because the builder doesn't know better, or because framers are paying more attention to other construction needs. Either way, these framing defects not only cause trouble with code officials, but cause problems big and small down the line.

Here are some of the most common framing errors I come across, along with code-approved, structurally sound solutions.

**Framing Openings Cut in Floors**

A common problem occurs with floors when subs cut through joists to make room for plumbing runs, hvac ductwork, or other mechanical elements. The loads these cut joists support must be properly transferred to other joists. You can do this using header joists, end-nailed across the cut ends of the interrupted joists, to carry loads to the adjacent trimmer joists. Where the header has to span a space less than 4 feet wide, a single header end-nailed to the trimmer joists will do.

Things get more complicated if the header must span more than 4 feet, as in Figure 1. If that's the case, both header and trimmer joists should be doubled. The doubled trimmer joists must be nailed together properly (with spaced pairs of 16-penny nails every 16 inches) so that they act as beams. The header joists must be appropriately anchored to the trimmers. End nails will do for header spans up to 6 feet; beyond that, use hangers. Any tail joists over 12 feet should also be hangered.

When you're framing the floor, check the blueprints to see where any such openings might go, and header off any joists that might be in the way in advance. It's much easier than trying to work from underneath the subfloor later.

**Holes and Notches**

When you cut a hole or notch in a joist, that joist is weakened. You (and your subs) should avoid this whenever possible. And when you absolutely have to cut or notch, you should know the rules for doing it in the least destructive manner.

Figure 2 shows proper guidelines for cutting holes and notches. Straying from these guidelines weakens the joists and risks a red tag from the code official. Use actual, not nominal, dimensions.

### Guide for Cutting, Notching, and Boring 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 1/8</td>
</tr>
<tr>
<td>2x8</td>
<td>2 3/8</td>
<td>1 1/4</td>
<td>1 1/8</td>
</tr>
<tr>
<td>2x10</td>
<td>3</td>
<td>1 1/2</td>
<td>2 1/8</td>
</tr>
<tr>
<td>2x12</td>
<td>3 3/4</td>
<td>1 1/8</td>
<td>2 1/8</td>
</tr>
</tbody>
</table>

Figure 1. Interrupted joists must be headed off to transfer their loads to adjacent joists. If the header spans more than 4 feet, it must be doubled and the loads transferred to double trimmer joists.

Figure 2. 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 joist's depth. Use actual, not nominal, dimensions.
When a cantilever supports a joist, as in Figure 4. So if you are a distance equal to the depth of the cantilevered section to a cantilever that supports a bearing wall, the distance it extends beyond its support (C) should not exceed the depth of the joist (D).

Broken Load Paths
A similar alignment problem relates to maintaining vertical load paths. All loads start at the roof and transfer vertically through the building to the foundation. If they aren’t transferred properly, you can end up with cracking of interior finishes or sagging framing. Many cracking problems written off to “settling” are actually due to what might be called broken load paths — paths that end up putting loads on areas not meant to carry them. This is one of the most common framing errors I see, and one to which many building inspectors pay close attention.

Misplaced struts. One example I see over and over again is a rafter-supporting strut carried down to a nonbearing partition below. Occasionally I even see these struts resting on “strong backs” — 2x bracing run across the top of the ceiling joists to help brace them. This is a sure way to create cracking in the walls and ceilings below.

Of course, rafters do need to be supported when their lengths exceed their recommended clear spans. But the struts should carry down to bearing partitions, as shown in Figure 5.

This code requirement applies only to solid sawn wood joists. Engineered products such as wood I-beams are required to have the loads line up directly over each other, and special blocking is required. Special engineering of either dimensional or engineered lumber may allow placing loads at other locations, but you shouldn’t try it without consulting an engineer first.

Figure 5. Struts supporting rafters should always land on bearing partitions. Also, the strut should not drop below a 45-degree angle.

Figure 6. 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.

Bearing Walls on Cantilevers
How far can a conventionally framed cantilever extend and still support a bearing wall?
Most of the confusion about how far a cantilever can extend beyond its support stems from an old rule of thumb used by builders and code officials. The rule of “one-to-three.” This statement that a joist should extend back inside the building at least three times the length of the cantilevered section — if the cantilevered section hangs 2 feet out, the joists should extend at least 6 feet in.

This rule works fine for nonbearing situations. But it does not apply to a cantilever that supports a bearing wall. In this situation, the maximum distance that joists can be cantilevered without engineering them is a distance equal to the depth of the joists, as in Figure 4. So if you are using 2x10 floor joists, the maximum cantilever for those joists supporting a bearing wall is 9 3/4 inches. Beyond this distance, shear becomes a serious factor, as does the bending moment at the support. This combination could eventually cause splitting of the cantilevered joists. The only way to work around this problem is to have it engineered.
inside the rim joist, the full depth and
width of the column base, so that the
load is transferred through the block-
ing to the foundation.

**Puny Hangers**

A simple but common framing
error is hanging a three-member beam (such as three 2x10s nailed
together) from a double joist hanger.
This usually occurs because triple
hangers are hard to find. But if only
two of the three members are sup-
ported, then only two carry the load.
The third member just goes along for
the ride. Toe nails or end nails are
not going to make it carry the load.

If you're going to use a hanger, use
one that holds everything, and use
the right size and the correct nails.
Undersized hangers and inappropri-
ate nails will weaken the system.

There is a tendency to carry the vertical load as well as to
laterally support the member to pre-
vent rotation. And without the cor-
rect nails, the hanger doesn't mean
much. Eight-penny galvanized nails
or roofing nails won't do. You can
buy regular joist hanger nails that are
heavy enough to handle the shear
stress, yet only 1½ inches long so
that they won't go clear through the
lumber and possibly cause a split.

Of course, the best way to support
a beam is from beneath. When possi-
ble, use a beam pocket or a column
directly under the end of the beam.
Be sure the full bearing surface of the
beam is supported clear to the foun-
dation.

**Tapering Beams and Joists**

It's sometimes necessary (or at least convenient) to taper the ends
of ceiling joists or beams to keep
them under the plane of the roof, as
in Figure 7. But by reducing the
depth of the joist or beam, you reduce
its load-carrying capacity.

If you must taper-cut the ends of
ceiling joists, make sure the length of
the taper cut does not exceed three
times the depth of the member, and
that the end of the joist or beam is at
least one-half the member's original
depth.

With taper-cut beams, you should
also check the shear rating. If you
can't meet this criteria, you'll proba-
ably have to lower the beam into a
socket so that enough cross-section
be can be left, after taper-cutting, to
carry the applied load.

**Rafter Cuts**

A nother area that inspires excess-
ive cutting is the level cut of the
seat of a rafter. Many times, espe-
cially on low slope rafters, this level cut
becomes a long taper cut on the ten-
sion (lower) side of the rafter, as in
Figure 8. If the bearing point on the
rafter is at the heel (interior side) of
the cut, there is no problem. But usu-
ally these long cuts put the bearing
point near the toe. This reduces the
effective size of the rafter, producing
 stresses that can create splits at the
bearing point, and eventually a sagg-
ing rafter.

To prevent this, cut your rafters so
that the heel rests on the plate. This
will mean using a slightly longer
rafter. It will also give you a few extra
inches between the top of the exter-
ior wall and the roof sheathing. This
translates into more room for attic
insulation to extend over your out-
side wall, reducing those cold spots
that can cause condensation or ice-
dam problems at the eaves.

**Raising the Rafter**

A nother way to add room for attic
insulation at the eaves is to set the
rafters atop a ledger board running
perpendicular over the ceiling joists.

As in Figure 9. Unfortunately, builders
who do this often fail to put in a rim
joist or block the ends of the joists to
prevent them from rolling over. The
resulting design creates, in essence,
hinges at the top and bottom edge of
each joist. With a strong enough lat-
teral force, such as a high wind or a
strong tremor, all the joists could
rotate and fall over — bringing ledges,
rafters, and roof crashing down on the
new-flat joists.

To prevent this, install full depth
blocking between all joist ends or a
rim joist nailed against the ends of
the joists. Either solution will also
provide a baffle to prevent air from
generating the ends of the batts and
keep the (or blown-in insulation)
from creeping into the eaves.

**Connecting Rafter to Wall**

Conventional construction leaves
so little connection between rafters
and walls. Nails connect rafter to
plate and plate to stud, but do noth-
ing to connect the rafters to the wall
itself. Such structures are subject to
damage from the high, near-hurrica-
ne force winds that sooner or later
dam problems at the eaves.

As a result, the building codes are
beginning to get more restrictive
about how rafters and trusses are
connected to the rest of the building.
For example, the 1991 Uniform
Building Code has added Appendix
Chapter 25, which applies to high wind
areas. Under its requirements, rafters
or trusses must be tied not just to the
top plate but to the studs below at 4-
foot intervals. This means using
some kind of metal connector to pro-
vide a positive tie to the studs.

The answer is the hurricane anchor
(see Figure 10). You don't need to face a hurricane to need it —
high winds of roof-damaging gale force
blow in most parts of the country. If
you build in an area subject to high
winds (or seismic conditions), you
should consider using these or other
hollowdow.