Now let's talk about the code's requirements for roof and ceiling framing.
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GENERAL

• Roofs < 3:12 – Members supporting joists and rafters designed as beams
• Notches & holes controlled
• Joists & rafters supported laterally

A few general comments here about the IRC requirements:

For relatively flat roofs (slope less than 3:12) the joists and rafters have to be designed as beams. Notches and holes are controlled as they are in floors. And joists and rafters must be supported laterally.
The governing concept in the roof/ceiling framing provisions is that loads on the roof are going to attempt to push the walls out, and some resistance to that push must be provided. Ideally that resistance would be provided by connections between rafters and parallel ceiling joists.
However, there are situations in which joists aren’t parallel to the rafters and the IRC makes provisions for that. Here’s one such solution. However, the code doesn’t provide the details of how this is to be done.
This is another solution, but again there are no details.
A third solution is listed, but again no details. In fact the whole subject of rafter ties is muddled in the 2000 and 2003 editions of the IRC.
In the 2006 edition of the IRC, the subject of rafter/joist connection has been simplified. The general requirement is for all joist to be connected to rafters at the top of the wall.
Where joists are located above the top of the wall the joists have to be nailed to each rafter or a rafter tie is required.
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Where ceiling joists are perpendicular to rafters, a rafter tie is required.
The revised section in the 2006 IRC also requires collar ties (or straps over the ridge board) as shown here. The intent is to reduce uplift of the upper rafter ends in high wind loading similar to what’s seen in thunderstorms.
At first glance, this appears to be the ideal situation – rafters and joists parallel and meeting at the ends. However, if you'll look closely you'll see that the rafters don't actually meet the joists. For some reason there’s a horizontal 2x4 separating them. Even though both are apparently connected to that 2x4 the degree of continuity is questionable. And if you'll look at the ends of the rafters, some of them seem to have some sort of splice at the very end, and since it’s a very small splice the very continuity of the rafter – not to mention it’s connection to the joists – is likely to be compromised.
Let’s talk some more about specific code requirements. The code requires that the ends of rafters either be framed to each other, connected by gusset plate, or bear against a ridge board. The intent is to provide both solid bearing surface and a resistance to lateral movement. The caution here to avoid horizontal shear isn’t found in the code but rather is a recommendation from the wood industry.
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- RAFTER SPAN TABLES
- Pre-calculated
  - 2000 edition: Error in 2x12 (10 psf DL)
  - Corrected in 2003 edition
- Spans for 4 most common species
- Reference to AF&PA generic span tables

Like joist spans, there are rafter span tables in the code.
A provision that was carried over from the UBC and the old Dwelling Code is the use of struts and purlins to brace rafters and increase their spans.

The struts must be supported on a bearing wall. While it's conceivable that the struts could be supported by a beam designed for that purpose, they shouldn’t simply be supported by ceiling joists (even doubled ones).
We talked at some length about I-joists when we were talking about floor framing. Let’s mention some other related matters.
You can frame the roof out of I-joists, duplicating much of what’s done with solid sawn lumber, but it’s important that the manufacturer’s recommendations be followed just as was the case with floor framing.
Here’s another example of duplicating traditional construction using I-joists.
Keep in mind that the ridge in this application isn’t just a ridge board as we’ve seen with solid sawn construction, but rather is a beam and should be designed as such.
This is a variation of supporting I-joists on the ridge beam. Note that lateral support of the joists is still provided.
Notice in this example that the end of the I-joist is supported by a hanger that supports the full joist assembly. A detail like you see on the right may support the joist, but because it places all of the load on the web it may cause failure.
These are more examples of the flexibility of doing roof framing with I-joists.
As is always the case – but particularly in this type of framing where the loads may be concentrated in manners not seen with solid sawn framing – it’s important to provide a continuous load path to the foundation.
Now, let's talk about metal plate connected roof trusses. They are so common in construction today as to be almost invisible.

Be aware that the IRC provisions for trusses are much more extensive than what's been seen in the codes in the past. The code specifies specific information to be provided on the truss drawings, requires that bracing be provided in accordance with the drawings, and makes clear that alteration to trusses shouldn't be done without the approval of a design professional.
In contrast to what the older codes have required, the IRC increased the requirements that apply to trusses. Drawing are required to be submitted to the Building Official for approval before installation. The minimum contents of those drawings are contained in Section R802.10. What you see here is just a sampling.
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- Trusses made with traditional solid sawn lumber
- Normally use dimensional lumber as chords and webs
- Fastened with metal plate connectors

Typically trusses are made with solid sawn lumber chords and webs. The IRC references the ANSI/TPI standard that you see here for the design of metal plate connected wood trusses.
Trusses are designed to support loads in a plane parallel to the plane of the truss. They aren’t intended to support lateral loads, which is why bracing is required.
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- HB-91, *Commentary & Recommendations for Handling, Installing & Bracing Metal Plate Connected Trusses*
- DSB-89, *Recommended Design Specifications for Temporary Bracing of Metal Plate Connected Wood Trusses*
- Wood Truss Council of America (WTCA) job site warning poster

Temporary bracing, as well as permanent bracing that we’ll touch on in a moment, should be provided. The truss industry provides job site warning posters with bracing information.
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• Permanent bracing
  – Transfer lateral loads from wind, seismic, construction, or deadloads to the tops of the walls and to the foundation
  – Contribute to performance of individual trusses or groups of trusses over their service life

Temporary bracing insures that the trusses remain in place during construction, but permanent bracing insures that the truss system will perform properly during the life of the building.
Permanent bracing is required in the 3 planes shown here. Often final building elements – roof sheathing and ceiling finish in particular – may provide a portion of that bracing. But bracing in the web plane has to be added.
Even then lateral loading will still cause the trusses to bow. They just do so in chorus.
For that reason lateral bracing is needed.
The code is silent on who has responsibility to design what elements of roof truss systems. What you see here is the philosophy of the truss industry.
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The truss designers provide a truss erection plan, and when in doubt about some element of the roof framing, that plan should be consulted.
Even though truss design and erection can be tricky, it's important to realize that there are any number of serious problems that can be caught just by paying attention to the basics. Here's an example – improper spacing.
Here’s another example of a serious, but easily spotted, problem – missing metal plate connectors.
The 2003 edition of the IRC now requires the use of connectors of some sort to tie trusses to the top of the wall. Unless needed for uplift resistance greater than the capacity of the nails, nailed connections are still allowed for solid sawn rafters.
QUESTIONS?