Appendix F
Severe Roof Weakness Present in some pre-1920 Houses

Most roofs overhang the walls of the house. An interior view of the most common framing method for constructing the overhanging portion of the roof is shown in Figure 1 and Figure 2. The rafter is cut to fit onto the top plate of the wall, and extends beyond the support to create the eave overhang. Ceiling joists span across to the rafters on the opposite side of the house and tie pairs of rafters together so they do not collapse and push the walls apart. Some sort of tie across the house is essential to keep this type of roof standing. A detailed discussion of roof framing is outside the scope of this book beyond saying that the rafter ties (usually joists) should be as close to the bottom of the rafters as possible. "Collar ties" near the peak of the roof may be needed to resist the roof opening at its peak due to wind uplift, but they do not resist the outward thrust at the base of the rafters.

Figure 1 GOOD: Typical roof rafter connection to wall and ceiling joist used in contemporary construction. The ceiling joist ties rafters on opposite sides of the house together so the walls do not spread apart. The "face-nailed" connection from the joist to the rafter is the most secure type of nailed connection.

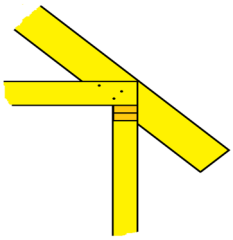
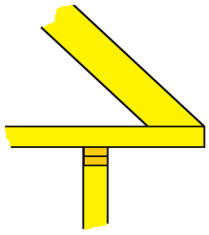


Figure 2 Typical rafter and ceiling joist connection with no soffit at eave.

The weakness under consideration occurs when builders wanted a level "soffit" (underside of the roof overhang). They extended the ceiling joists out from the walls to create an overhang, as shown in Figure 3. They then supported the rafters on the ends of the extended joists.



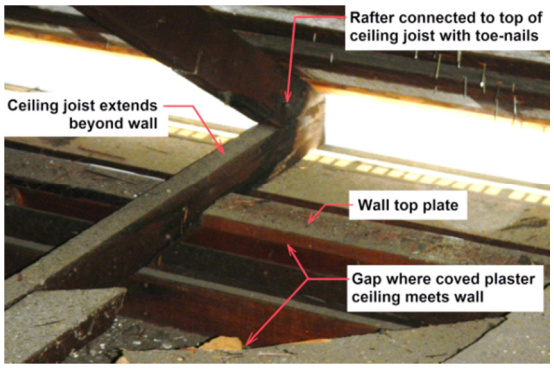


Figure 3 BAD: Archaic roof connection using extended ceiling joists to create soffit at eaves. The rafter connection to ceiling joist is marginal. Photo: Max Curtis, GGASHI

This method introduces a few problems, two of which apply to earthquake resistance. The primary concern is the connection between the rafters and the joists that tie them together. In the current method, the rafters and joists lap against each other and are connected with "face nails" between the members. In the archaic method, the connection was made with "toe-nails" driven from the rafters down into the joists. Toe-nails do not provide nearly the connection capacity of face nails. If this connection fails, the roof or portions of it could collapse onto the ceiling framing. This would likely result in significant damage to the house interior. In any case your house would no longer be protected from weather.

Many old houses have several layers of roofing on them, which can add several tons of material to the roof. The roof is the worst place to add weight to your house—especially if you have antiquated connections.

The obsolete framing method also lacks a direct load path from the roof diaphragm into the side walls of the house. I consider this less hazardous, but still a good thing to fix. One effective repair method would be installing "shear frames" between sets of rafters and joists. This method is described in Section 3.2.2 of "Wood-Framed Shear Wall Construction—an Illustrated Guide".

How to identify the condition from the exterior

This particular weakness is created when a level soffit overhangs the walls. However, a level soffit does not always indicate the weak connection. Figure 4 and Figure 5 show a secure rafter connection with a level soffit. The key difference is the soffit is dropped below the adjacent ceiling height.

Figure 6 shows an early 20th century house with a level soffit at the ceiling height. Compare the distance from the soffit to the tops of the windows for the houses in Figure 5 and Figure 6.

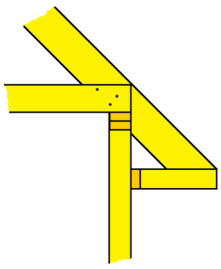


Figure 4 Framing method for "dropped" level soffit.

Figure 5 Dropped soffit (note level just above tops of door and window).

Figure 6 Level soffit at ceiling height. Note wide band between soffit and tops of windows. Photo: John Fryer, GGASHI