Chapter 7
CHIMNEYS, FIREPLACES, BALCONIES, AND DECKS

This chapter provides an overview of the IRC provisions for earthquake-resistant design and construction of chimneys, fireplaces, balconies, and decks in houses. Above-code recommendations for improved earthquake performance are provided.

7.1 CHIMNEYS AND FIREPLACES

IRC Chapter 10 presents requirements for masonry fireplaces and chimneys and for factory-built fireplaces and chimneys enclosed in framing. The provisions of the IRC are intended for the moderately sized fireplaces and chimneys commonly found in houses.

Above-code Recommendation: Where fireplaces or chimneys are large or oddly configured, an engineered design is encouraged in order to fully address the design of the chimney and fireplace and their influence on the house.

7.1.1 Masonry Chimneys and Fireplaces

Although the IRC permits construction of masonry fireplaces and chimneys in earthquake-prone regions, masonry chimneys are particularly vulnerable to earthquake damage, and such damage has occurred in most moderate to severe U.S. earthquakes (Figures 7-1 and 7-2). Masonry fireplaces and chimneys can be heavy and rigid, and many chimneys in existing houses also are brittle. The movement of the fireplace and chimney in response to earthquake ground motions can be significantly different from the movement of the light-frame house itself, creating the potential for damage to both the chimney and the house.

Figure 7-1 Chimney damage.
Photo Courtesy National Information Service for Earthquake Engineering, University of California, Berkeley
The *IRC* triggers requirements for masonry fireplace and chimney reinforcing steel and anchorage to floors, roofs, and ceilings for houses in SDCs D₁ and D₂. Although these requirements cannot completely eliminate the possibility of damage to the fireplace and chimney in an earthquake, their use permits a chimney to better withstand earthquake loads and should lessen the falling hazard posed by a damaged chimney. Although it may be possible with systematic engineering design to mitigate the damage often seen in masonry chimneys and fireplaces, the lower weight and greater flexibility of factory-built fireplaces and chimneys make them the better choice for light-frame houses in earthquake-prone areas.

A substantial footing is necessary if a fireplace and chimney is to perform well under any type of loading. The footing should extend to a depth not less than that of surrounding footings. *IRC* Section R1003 contains minimum footing requirements.

*IRC* Section R1003.3 provides requirements for masonry chimney and fireplace reinforcing steel. The minimum amount of vertical reinforcing steel is four No. 4 bars for a chimney up to 40 inches wide (a depth of approximately 24 inches is common). An additional two No. 4 vertical bars are required for each additional flue or each additional 40 inches of width. Where the reinforcing bars cannot run full height, a lap splice of not less than 24 inches is needed. Grout, continuous from the footing to the top of the chimney, must surround the reinforcing steel. For horizontal reinforcing, a minimum of 1/4-inch ties at not more than 18 inches on center is required in the mortar joints. *IRC* Section R1003.3 also cites the Section R609 requirements for grouted masonry discussed in Chapter 5 of this guide. Proper grouting and consolidation around the reinforcing steel is needed in order for the reinforcing and anchorage to contribute to earthquake resistance. Lack of grout and poorly consolidated grout are common contributors to earthquake damage. It is also important to note that *IRC* Section R609 prohibits the use of Type N masonry mortar in SDCs D₁ and D₂.

Figure 7-2 Chimney damage in Northridge earthquake.
Anchorage of the masonry chimney to the framing at each above grade floor, roof, and ceiling level is necessary. *IRC* Section R1003.4 provides anchorage requirements applicable in SDCs D₁ and D₂. Steel straps not less than 3/16-inch by 1-inch are required to extend a minimum of 12 inches into the chimney masonry, hook around outer reinforcing bars, and extend not less than 6 inches beyond the hook. Chimney anchorage locations are illustrated in Figures 7-3 and 7-4. The *IRC* provisions specify anchorage to a minimum of four ceiling or roof joists with not less than two 1/2-inch bolts. This description does not give details of the intended configuration and does not address framing parallel to the chimney wall. Figures 7-5 and 7-6 illustrate implementation of this anchorage provision with detailing consistent with industry recommendations (MIA, 1995) and earlier *Uniform Building Code* provisions. Anchorage in general conformance with Figures 7-5 and 7-6 should be consistent with the intent of the *IRC*.

![Chimney Anchorage Locations](image)

**Figure 7-3** Locations for earthquake anchorage of masonry chimney at exterior house wall.
Figure 7-4 Chimney section showing earthquake anchorage.

Figure 7-5 Anchorage detail for framing parallel to exterior wall.
To reduce the fire hazard with respect to the surrounding wood structure, *IRC* Section R1001.15 requires a clearance of 1 to 2 inches (depending on configuration) between combustible framing materials and the masonry chimney. Detailing of earthquake-resistant anchorage at the floor, ceiling, and roof levels needs to maintain this required clearance with only the steel straps extending across this clearance gap.

Even when fireplaces and chimneys show no signs of damage after an earthquake, the masonry or flue liner may have cracked, and inspection before reuse is recommended.

### 7.1.2 Factory-Built Fireplaces and Flues

Factory-built fireplaces and flues generally are installed within light-frame fireplace enclosures and chimneys. During an earthquake, the deflections of the light-frame enclosure are compatible with those of the house, which greatly reduces the potential for damage. Detailing of framing anchorage, however, is important. At exterior walls, as shown in Figure 7-7, the framing for the chimney disrupts the typical wall and roof framing. Wall top plates often are discontinued and studs are balloon framed to the top of the light-frame chimney. Measures should be taken to restore the continuity of the top plates and to anchor the fireplace/chimney wall framing to the floor and roof. Figure 7-8 shows how one light-frame chimney without sufficient connections behaved. No specific requirements for this construction currently exist in the *IRC*. Clearances to combustible wood framing remain important with factory-built fireplaces and chimneys and are typically addressed in the installation instructions.
Use of stone or masonry veneer increases the weight of the light-frame chimney, thereby increasing earthquake loads proportionately. Particular care should be taken to tie the wood framing into the floor and roof when veneer is used. Veneer attachment to the framing should be in accordance with *IRC* Chapter 7. See Section 5.2 of this guide for a discussion of veneer attachment.

**Above-code Recommendations:** Factory-built fireplaces and flues typically are installed within light-frame fireplace enclosures and chimneys that generally perform well during earthquakes; therefore, their use in the higher Seismic Design Categories is recommended. However, special attention should be given to the detailing of the framing anchorage and to compliance with clearances to combustible wood framing addressed in installation instructions.

Use of stone or masonry veneer increases the weight of the light-frame chimney, thereby increasing earthquake loads proportionately. Particular care should be taken to tie the wood framing into the floor and roof when veneer is used. Veneer attachment to the framing should be in accordance with *IRC* Chapter 7. See Section 5.2 of this guide for a discussion of veneer attachment.

**Above-code Recommendation:** Use of reinforcing steel and chimney anchorage are recommended to improve the performance of fireplaces and chimneys across all Seismic Design Categories and particularly in SDC C. Adding reinforcement and anchorage for the chimney on the model house used in this guide would increase the cost of the structural portion of the house by approximately 2 percent, which is approximately 0.5 percent of the total cost.
7.2 BALCONIES AND DECKS

Balconies and decks often are prominent features of modern residential construction and, for many people, add much desired living space (see Figure 7-9). Although the IRC contains some provisions addressing balconies and decks, the earthquake resistance of balconies and decks has not been systematically considered in the development of the IRC provisions. This section addresses three aspects of balconies and decks that need consideration:

- The effect of added floor area beyond braced wall lines,
- Anchorage for earthquake loads, and
- Vertical support.

7.2.1 Added Floor Area Beyond Braced Wall Lines

The bracing provisions of the IRC reflect the need to support the floor area within the exterior braced wall lines. The addition of balconies and decks creates additional weight and increases earthquake loads, a fact that was not envisioned when required bracing lengths were determined. Although the addition of a small balcony or deck is not likely to greatly affect the earthquake performance of a house, the addition of a large balcony or deck may. Further, balconies and decks tend to concentrate the added earthquake load on one side of the house and one braced wall line. This can contribute to rotational behavior (see the discussion of plan irregularities in Section 2.3 of this guide) and concentrations of damage.

Two IRC sections limit balcony and deck size:

- IRC Section R502.3.3 addresses floor framing cantilevers, including exterior balconies. IRC Table R502.3.3(2) specifies permitted cantilevers as a function of framing size and spacing and live load. Permissible cantilevers range up to a maximum of 6 feet (see additional discussion of back-span connections in Section 4.3 of this guide).

- For SDCs D1 and D2, IRC Section R301.2.2.2.2, Item 2, requires braced wall lines on all edges of a floor or roof. The exception to Item 2 permits floors that do not support braced wall panels to extend up to 6 feet beyond a braced wall line.
Balconies extending more than 6 feet beyond the exterior house wall in all Seismic Design Categories fall outside of the framing provisions of the *IRC* and require engineered design.

Where balconies or decks extend more than 6 feet beyond the house exterior, additional lines of bracing for earthquake and wind loads are sometimes provided. When this approach is taken, it is important that loading in both the longitudinal and transverse directions be considered. In addition, when both the house and supplemental bracing are used to support the balcony or deck, the load-deformation behavior of the bracing system must be compatible with that of the house. Where this is not the case, it is best to completely separate the balcony or deck from the house and provide a gap large enough to permit independent movement.
7.2.2 Anchorage for Earthquake Loads

Where a balcony or deck is laterally supported by the house, adequate connection to the house is key to good earthquake performance. The IRC includes two provisions that address anchorage to the house:

- **IRC** Section R311.2.1 requires that the connections used to attach exterior balconies, stairs, and similar exit facilities to the rest of the structure provide for resistance to both vertical and lateral loads, but the magnitude of loads to be resisted is not specified. Use of toe nails or nails subject to withdrawal is prohibited.

- **IRC** Section R502.2.1 provides similar requirements for decks.

Because balcony framing generally has a back span that extends into the interior of the house, adequate connection generally is not an issue; however, care should be taken to ensure that the back span is adequately fastened to the floor sheathing or to lapped floor framing and that blocking is provided where the cantilever bears on the exterior wall.

**Above-code Recommendation:** Deck framing, on the other hand, does not generally have inherent continuity into the house. Attachment only to the floor band (rim) joist is not sufficient and will result in failures between the band joist and the rest of the floor system. **Engineered design of connections is recommended as is use of a positive connection,** such as the hold-down device shown in Figure 7-10.

![Hold-down device providing positive connection of deck framing to house framing.](image)

Figure 7-10  Hold-down device providing positive connection of deck framing to house framing.
7.2.3 Vertical Support Issues

Although beyond the scope of earthquake resistance, two issues – vertical load connections and moisture and decay – related to vertical support of decks and balconies are of enough significance to warrant discussion.

Deck construction is notoriously problematic and typically at least one deck collapse occurs somewhere in the United States every week. Inadequate connection between the deck and the house for vertical loads is the biggest problem. Where an engineered design is not provided, connections for vertical loads very often are inadequate. Inadequate connection for lateral loading also can be a contributor. Attention to adequacy of vertical load connections is imperative for safety.

**Above code Recommendation:** Providing a line of vertical support (posts and beams) alongside the exterior house wall can help to reduce the load on the deck-to-house connection.

The interface between a balcony or deck and the exterior house wall is critical for the waterproofing system. Penetration of moisture at this interface can endanger not only the capacity of the connection but also the interior and exterior framing members. *IRC* Section R319.1.2 requires that the joints of exterior balconies be designed such that moisture will not collect in the connection area or that the connection be otherwise protected from moisture.

**Above-code Recommendation:** The joints of exterior decks should be designed such that moisture will not collect in the connection area or that the connection is otherwise protected from moisture.

The resource list provided in Appendix E includes references addressing deck connections and moisture and decay issues.

**Above-code Recommendation:** As noted, balconies and decks often are subjected to significant lateral loads during an earthquake. As an above-code measure for houses located in SDCs C, D₁ and D₂, the connections used to attach the deck to the house should be designed by a registered design professional to ensure that the loads acting on the deck are properly transferred to the framing of the house. In addition, the lateral bracing of the deck for the sides not attached to the house and for all sides of free-standing decks must be sufficient to prevent a torsional response.