

Chapter 12 Other Earthquake Hazards

12.1 Masonry chimneys are killers

I admit—I love the look of well-crafted masonry. But if they are above waist level, masonry chimneys are too dangerous in earthquakes to justify keeping. Brick patios, benches, planters, and walkways can be very charming ways to recycle your chimney.

The Modified Mercalli Intensity (MMI) scale is the preferred way to measure earthquake intensity. It relates directly to how humans and structures react to a quake. Earthquake intensity of VII on the MMI scale corresponds to “*some chimneys broken or heavily damaged.*” (This corresponds to about 5.5 to 6.0 on the Richter scale.) If an earthquake caused occasional “*fall of chimneys,*” it was around VIII on the MMI scale. (Note: There are *four* intensity levels that are higher than the level that knocks chimneys over!). I ask my clients, “Why would you want to live next to an earthquake indicator?”

12.1.1 The pure economic approach

The 2006 IEBC Commentary suggests that removing a chimney and filling in the empty space left in your house costs about the same as repairing the typical damage it would suffer in an earthquake. Given the choice of spending money now to remove the chimney, or waiting for an earthquake that may never come during your lifetime, it’s tempting to not spend the money. But if your chimney falls down and kills you or injures someone, you made the wrong choice.

12.1.2 Mortar disintegration

Until 1930 or so, most mortar was made with lime instead of the more modern Portland cement. Lime mortar gains strength for a while after construction; at some point its strength peaks, then it begins to deteriorate from exposure to moisture, acid rain, small earthquakes, death metal music, etc. In my experience, all lime mortar used in chimneys reached peak strength and is now in significant decline. Often the disintegrating mortar is hidden in an attic, crawlspace, or fireplace-surround, or perhaps concealed under paint or stucco; Figure 12-2 shows some examples of chimney deterioration and damage.



Figure 12-1 Many people look at a chimney and think “home.” Engineers and home inspectors think “danger.” Seismologists think “earthquake sensor.”

		
<p>Mortar vanished from brick joints in basement. There is about 20' of chimney above this point.</p>	<p>Exterior brick joints losing enough mortar to approach imminent collapse.</p>	<p>Mortar loss about 8 feet from bottom of a two-story chimney</p>
		
<p>Fireplace under demolition—the single layer of brick is typical of older fireplaces, leaving a hollow, very weak structure.</p>	<p>Many chimneys have very shallow footings (as little as 8 inches deep) and may already be leaning. Note the gap between the chimney and the siding.</p>	<p>Weak mortar joints shaken apart by prior earthquakes. Photo by Roger Robinson</p>
<p>Figure 12-2 Various chimney conditions. Inspectors find conditions like the ones shown above with alarming frequency. When I started my engineering career in 1990, a simple test of mortar strength was whether you could scrape it away with a house key. Most California chimneys are now 20 to 50 percent older now, and I often find mortar that I can brush away with my fingertips.</p>		

12.1.3 Chimneys of death, or at least destruction

Figure 12-3 shows chimney damage caused by various earthquakes. After the Napa earthquake of 2014 I will recommend chimney removal even more strongly. When replacing roofs, some roofing contractors would rather remove your chimney down to the roofline at no charge than worry about waterproofing the joint between the brick and the roofing.

For a fun video showing two people pulling an old chimney over from what they *thought* was a safe distance, see: <http://www.youtube.com/watch?v=XgvhANUF1kQ&feature=youtu.be>



12.1.4 Bracing is not effective

Many building owners had braces installed on their chimneys. These may help keep the chimney from falling in moderate earthquakes, but are unlikely to help in larger quakes. One problem is the earthquake loads associated with chimney can easily double the force on the surrounding building (chimneys weigh a *lot*). Another problem is that a brick chimney is much more rigid than a wood-framed house—initially the chimney will brace the

Chimney Braces & Your Insurance Company

Chimney braces are so common that the public perceives them to be more effective than they really are. In some cases, insurance companies support this myth by requiring chimney bracing, with the implication that a braced chimney is “safe.” *(continued next page)*

house, not the other way around. By bracing the chimney you are essentially assuring that it will break; what you hope is the braces (and all the connections in the load path from the braces to the foundation) are strong enough to hold the column of newly-loosened bricks in place during the shaking.

Strengthening a house enough to brace 10 tons of bricks shaking around is a very complicated and expensive undertaking, though. Running a couple of braces from a steel bracket around the chimney down to the roof is only the beginning; if you stop there, you have simply installed warning devices: if you are not speared when the braces punch through your ceiling during a quake, you will know that 10,000 pounds of brick is about to follow.

12.1.5 Change your fireplace to burn natural gas or propane

For the three nights a year when you want a cozy fire, install a gas-burning insert in the fireplace with tight-fitting glass doors and a metal vent system that replaces the chimney.

12.1.6 So, you really need centuries-old heating technology?

Wood-burning fireplaces cause air pollution, create drafts in your house that waste energy, and are expensive to operate. But if you really think a wasteful, polluting, messy heating appliance is for you, the following document shows how to replace the chimney above your fireplace with metal flue pipe: http://ladbs.org/LADBSWeb/LADBS_Forms/InformationBulletins/IB-P-BC2008-070EQDamagedChimney.pdf

As I was taking photos of this very tasteful replacement of a Berkeley chimney, a curious neighbor struck up a conversation. When I explained myself, he excitedly told me how many chimneys had fallen or suffered serious damage in the Loma Prieta earthquake, which was centered 60 miles away. The Hayward Fault will shake about 20 times harder when it breaks loose, toppling many chimneys that are now older and weaker.

Chimney Braces & Your Insurance Company

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Another structural engineer related a telephone conversation she had with an insurance company representative about chimney bracing requirements:

Insurance agent: “We won’t issue earthquake insurance unless the chimney is braced.”

Engineer: “You know that bracing doesn’t keep the chimney from falling, right?”

Agent: “Yes, but our studies show that if you brace the chimney, it is less likely to fall away from the house and damage a neighboring property. If it falls on the property next door, then we have to pay two claims instead of just one.”

Is it worth increasing the danger to your life in exchange for lower insurance premiums?

Wood-framed replacement “chimney”



Are Newer Chimneys Better?

Portland cement mortar is much more durable than lime mortar, so are new chimneys “safe?” Many failures would indicate the contrary.

After talking with contractors who specialize in chimney maintenance and repair, one GGASHI member states, **“I don't trust any chimney to have sufficient reinforcing.”**

Chimney repair specialists are trained only to address the condition of a chimney as it relates to conveying hot smoke up away from the fireplace—they typically don't even check to see if the chimney will withstand an earthquake.

The photo below shows one of many “modern” chimney failures. FEMA photo



Figure 12-4 Left: A chimney toppled by the 2014 Napa, CA earthquake. This chimney was built around 1980, over 30 years after codes began requiring steel reinforcing in chimneys. By then an entire generation of masons should have known about the “new” code requirements for this basic and essential reinforcing; how much do you trust *your* chimney?

Right: Floor framing crushed by the chimney where it landed.

Photos courtesy of Dan TerAvest, newly-avowed advocate against chimneys.