Strengthening Your Home Against Potential Earthquake Damage

Building Permits & Home Safety Open House
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Lessons learned from previous earthquakes
1983 Coalinga Earthquake

- 6.2 magnitude – a “moderate” event
- $10 million in property damage
1994 Northridge Earthquake

• 6.7 magnitude – a “moderate” event
• 57 deaths
• $13 to $50 billion in property damage

http://journal.firsttuesday.us
1994 Morgan Hill Earthquake

- 6.2 magnitude – a “moderate” event
- $7.5 million in damage
2014 Napa Earthquake

- 6.0 magnitude – a “moderate” event
- 1 death
- $400 million in property damage
Earthquakes

Fault ruptures at tectonic plate boundaries

UC Berkeley Seismic Lab
Earthquake Effects on Residential Buildings

Figure 1: Effect of Inertia in a building when shaken at its base

Earthquake demands on buildings

Typical, older California home construction issues
What Happens?

Construction view

- Floor you walk on
- Floor Joist
- Top Plate
- Cripple Wall
- Sill Plate
- Foundation
Cripple Walls

- House is supported on cripple walls
- Earthquake moves the foundation
- House rocks on the cripple walls
- House falls when cripple wall collapses
Cripple Walls
Cripple Walls
Take-aways

- The damage shown likely resulted in a “write-off” of the buildings.
- Most of the residential damage was reasonably preventable.

What to do?
Load Path

1. Building forces into floor
2. Into clip angles
3. Into top plate and nails in plywood
4. Through plywood
5. Nails in plywood to bottom plate/mudsill
6. Bolts in mudsill
7. Into foundation
Anchor Bolts

• Access and space to work
• Mud sill
• California Building Code:
  • 5/8” or ¾” diameter (A307 or A36)
  • At least 7” embedment into foundation
  • Spaced not more than 4’ apart
  • Minimum of 2 bolts per sill piece
    • One bolt located not more than 12”, and not less than 5 ½”, from each end of the sill piece
Sill Bolting (Wide Mud Sill)

• Wide Mud Sill
• Add New Sill Pieces
• Nail each new sill to mud sill w/ 6-10d Common Nails
• Anchor bolt thru both sills
Strengthen Cripple Walls

A cripple wall:

- Generally the **weakest** part of older building because it has **insufficiently strong** sheathing materials.
- Can cause **full or partial collapse** in an earthquake.
- Can be **strengthened for relatively low cost** by correctly applying **plywood sheathing** to the cripple walls.
Plywood Guidelines at Cripple Walls

- ½" thick, C-DX or Structural I plywood
- Minimum 4’ long wall segments, longer segments better
- Distribute along all cripple walls, all sides of house. Cover corners.
- Use 8d or 10d COMMON nails (3” long), not box, sinkers, or 1 ½” shorts
- Galvanized nails best
- Nail all edges of plywood – 4” or 6” o.c. Add blocking.
- Vent holes
Plywood Guidelines (cont)

• Install plywood sheets horizontally or vertically, but all the same way

• Install plywood from sill all the way up to wall top plate; no gaps; no partial height

• Nail plywood to mudsill, top plate and studs

• No gaps in the plywood sheathing between sill and top plate

• Add horizontal blocking at any horizontal plywood panel edges
Plywood Guidelines (cont)

• Add clips between rim blocking and top plate

• Clip @ 12” o.c. (“on center,” or “center-to-center spacing”), or minimum one clip at each rim block
Summary:

- Clip floor to top plate
- Bolt/attach mudsill to foundation
- Plywood over cripple wall
Nonstructural Items can cause damage, too!

- Water heaters
- Chimneys
- Appliances
- Lighting fixtures
- Wall hangings
- Furniture
Water Heaters

• Earthquake strap your water heater – it’s the law!
• 2 metal straps
• 1/3 points
• Anchor to studs, not just drywall
• Elevate
Standard Plans and Details

Endorsed by:

• Structural Engineers Association of Northern California (SEAONC)
• International Code Council (ICC)
• California Building Officials
• California Earthquake Authority
• Earthquake Engineering Research Institute (EERI)
• Association of Bay Area Governments (ABAG)

Helpful References

• San José Building Division – www.sanjoseca.gov/building
• San Francisco Department of Building Inspection (SF DBI) - https://sfdbi.org/earthquake-preparedness#PP
• California Earthquake Authority - www.earthquakeauthority.com
• FEMA 526 Earthquake Safety Checklist - www.fema.gov
• Association of Bay Area Governments (ABAG) – wwwquake.abag.ca.gov