

# Single-Family Homes in Earthquakes – Risk Management and Public Policy Opportunities

## What are the risks facing single-family homes associated with earthquakes?

*Structural damage* is the largest earthquake-related risk facing single-family homes. The amount and type of potential structural damage that a home faces depends upon the type of construction, its age and condition, and its location.

The highest risk homes include:

- Unretrofitted homes built before 1978 (these were constructed prior to the adoption of the most important earthquake-resistant building code changes).

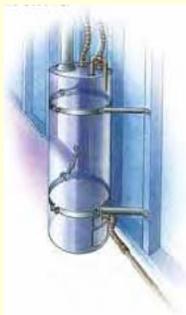


- Homes on hillsides
- Homes with living space above a garage (these are subject to collapse due to structural weaknesses due to the garage door openings).

While no home is earthquake proof, much of this risk can be reduced by identifying the risks to a home and conducting a proper retrofit of the home.

*Nonstructural damage* includes risks posed by falling furniture and other objects, as well as risks posed by fires after an earthquake.

- Water heaters pose fire risks if they fall over during an earthquake. The California Health and Safety Code requires that all new or replaced water heaters be braced to a wall in order to prevent collapse.

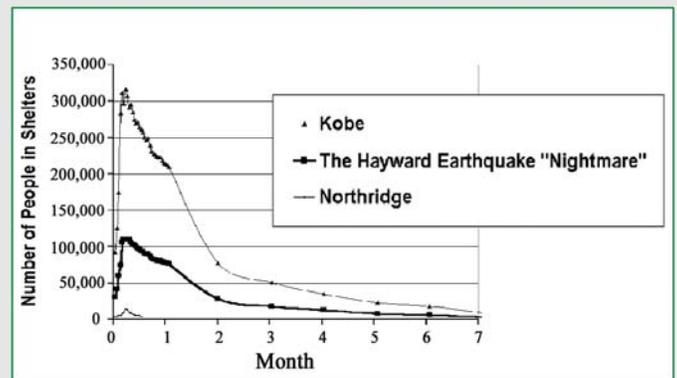


- Leaks (gas or water) caused by broken pipes pose fire and flooding risks to the home.
- Chimneys present collapse hazards even if they are braced. Porches and other nonstructural elements may collapse and should be retrofitted or replaced.
- Furniture or heavy objects can cause injury if they fall on a person during an earthquake.

## What happens when homes are destroyed in an earthquake?

**When homes are destroyed by an earthquake, it affects the functioning of the entire city, not just one department.**

While it may be only the structural elements of the home that cause a home to collapse, the resulting collapse can tax all local services. Emergency responders may need to provide life-saving services. Local hospitals may need to treat injuries of inhabitants. Temporary shelters will need to be established to provide for up to 160,000 residents across the region. All of these problems will be exacerbated by the fact that people with specific support needs (including the poor, elderly, and disabled) will be affected more than the regular population, expanding the need for local supportive services.



**As shown above, people will need emergency shelter for months after a major earthquake.**

In the long-term, the cities' economy will be affected by the loss of housing for workers and the property tax dollars associated with damaged homes. Increased prices of building materials and services caused by a surge in demand will provide a boon to the construction industry, but will affect other industries negatively as people will lack the money to spend on other goods.

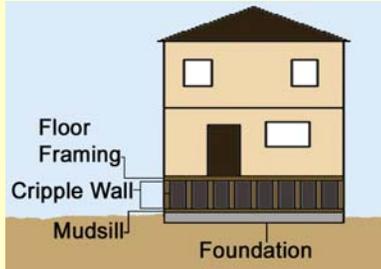
**Therefore, the efforts that local governments make to prevent structural damage to homes will have positive long-term consequences for the functioning of the entire city and the well-being of all residents of the city.**

# Establishing Retrofit Standards

## What is involved in a proper retrofit?

For a typical older house with a crawl space underneath the home, a retrofit consists of **no less** than three separate actions.

First, the base of the house (mudsill) is secured to the foundation using bolts to prevent the house from slipping off of the foundation.



Second, if the house has a cripple wall (which forms the perimeter of the crawl space), it is strengthened by adding plywood panels (shear walls) along the interior of all perimeter walls. The unbraced cripple wall is the most likely part of the home to collapse in an earthquake.

Finally, the floor framing is secured to the cripple walls to prevent the floor from slipping off these walls. If the home does not have cripple walls, then the floor framing is secured to the mudsills.

If any one of these actions does not occur, then there remains a large risk that the house will still collapse.

**Therefore, if all three of the above actions occur in a retrofit, the home will much better prepared for the next earthquake.**



If a home is on a hillside or has living space above a garage, the retrofit is likely to be more complex and will require the services of an engineer in addition to those of a qualified contractor.

*Current California building codes* for new construction are adequate to protect new homes from collapse due to earthquakes. It is essential that local governments properly enforce these codes for all new construction to guarantee that new buildings can withstand earthquakes without collapse and to limit damage.

## Not all retrofits are created equal.

Depending on the city, somewhere between 15% and 80% of the homes have had **any** retrofit work done. Unfortunately, just because a house has been retrofitted does not necessarily mean that the home has been **properly** retrofitted and is therefore protected against earthquakes. In a 1999 survey of 341 homes, ABAG found that anywhere from **1/3 to 2/3 of retrofitted homes were not adequately prepared for a future quake** (the percentage varied by city). In a 2006 survey of 35 homes published in the *Contra Costa Times* on March 5, 2006, 2/3 of **retrofitted** homes were not adequately retrofitted to prevent collapse and limit damage.

*Contractors* may be untrained in retrofits and may therefore be unaware of proper retrofit procedure. The work they do may therefore be inadequate (for example, they may only add bolts to the foundation and not perform the other two actions). In addition, contractors may intentionally deceive clients even if they are aware of proper retrofit procedure, as few homeowners would know how to inspect the work.

*Home inspectors* and *local government building inspectors* may be untrained in retrofits and therefore unable to judge whether the contractor has performed a proper retrofit. In addition home inspectors may be unable to judge whether a home needs a retrofit in the first place.

*Licensed professionals (engineers or architects with applicable experience)* are required for homes on hillsides or with living spaces above garages. If these professionals are not included in the design process when retrofitting these homes, it is unlikely that the home will be protected against collapse.

**Local governments should play a strong role in promoting retrofits as well as increasing the quality of retrofits by establishing a retrofit standard and enforcing that standard.**

A retrofit standard clearly establishes the requirements for a retrofit, and gives local governments the power to enforce the standard.

The standard applies not only to what is done in the retrofit, but also who is involved in the retrofit. Local governments can also require that engineers be involved in complex retrofits of homes on hillsides or on split-level homes with living spaces above a garage.



## Strategies Applying to Retrofit and Building Codes

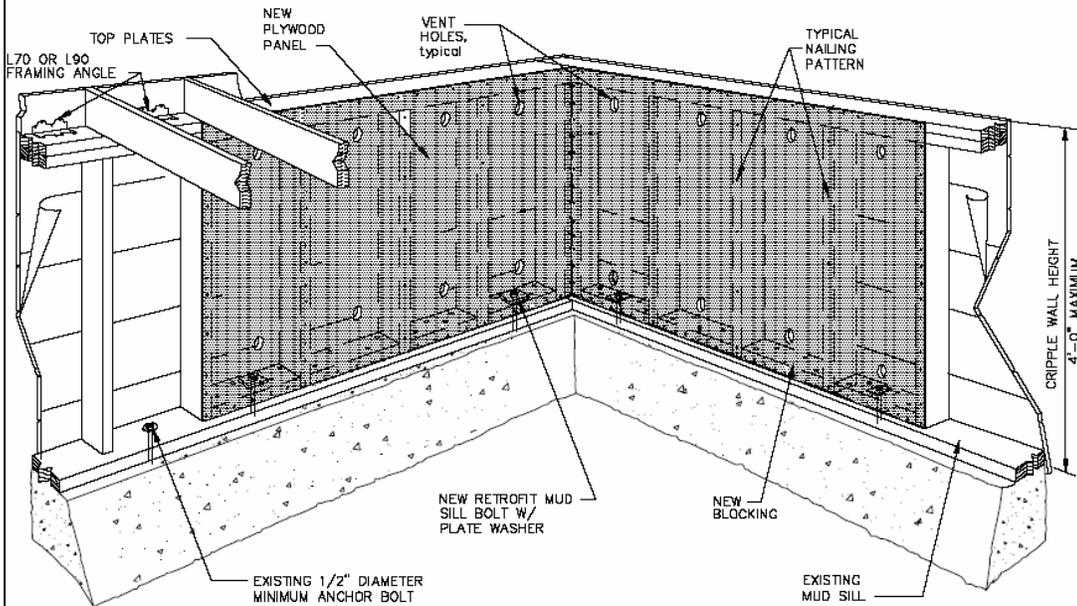
These strategies should be incorporated into your local government's codes and plans.

Utilize or recommend adoption of a retrofit standard that includes standard plan sets and construction details for voluntary bolting of homes to their foundations and bracing of outside walls of crawl spaces ("cripple walls"), such as that being developed by a committee representing the East Bay-Peninsula-Monterey Bay Chapters of the International Code Council (ICC), California Building Officials (CALBO), the Structural Engineers Association of Northern California (SEAONC), the Northern California Chapter of the Earthquake Engineering Research Institute ((EERI-NC), and ABAG's Earthquake Program.

Local Hazard Mitigation Plan Mitigation Strategy HSNG-b-1

Require engineered plan sets for retrofitting of heavy (with stucco walls and tile roofs) two-story homes with living areas over garages, as well as for split-level homes, until standard plan sets and construction details become available.

LHMP Mitigation Strategy HSNG-b-2



An example figure demonstrating the proper retrofit of a standard crawl space. Figures such as these should be included when developing a standard retrofit code.

(A) TYPICAL CRIPPLE WALL BRACING DETAIL

Require engineered plan sets for retrofitting of homes on steep hillsides using a retrofit standard similar to that adopted by the City of Los Angeles. (This action will prevent homeowners from spending \$50,000 - \$60,000 on an inadequate retrofit.)

LHMP Mitigation Strategy HSNG-b-3

Encourage local government building inspectors to take classes on a periodic basis (such as the FEMA-developed training classes offered by ABAG) on retrofitting single-family homes. In addition, ensure the building inspectors actually inspect retrofit work.

LHMP Mitigation Strategy HSNG-b-4

Encourage private contractors and home inspectors doing work in your area to take retrofit classes on a periodic basis (such as the FEMA-developed training classes offered by ABAG) on retrofitting single-family homes. This training is being updated and revised in 2006.

LHMP Mitigation Strategy HSNG-b-5

Continue to require that all new housing be constructed in compliance with structural requirements of the most-recently adopted version of the California Building Code.

LHMP Mitigation Strategy HSNG-f-1

Conduct appropriate employee training and support continuing education to ensure enforcement of building codes and construction standards, as well as identification of typical housing design inadequacies and recommended improvements.

LHMP Mitigation Strategy HSNG-f-2

# Public Awareness of Retrofitting Single-Family Homes

## Why should local governments promote educating the public?

The best building codes in the world do nothing for buildings built before that code was enacted. Fixing problems in older buildings – retrofitting – is typically the responsibility of the building's owner. Local governments should, however, promote retrofitting through targeted education of building owners and tenants. The cost to retrofit **most** homes is a small percentage of the value of the home.



**Encouraging residents to retrofit their homes is an essential part of any effective local government's earthquake mitigation program. The money spent now in retrofitting homes will be worth every penny when, after the earthquake, people are sleeping in their own beds, not in a shelter.**

## ABAG has information.

Not all homes are in need of retrofits. ABAG has developed a quiz for owners and residents of single-family homes to help them determine if their buildings are significantly at risk. The quiz, on the ABAG web site at <http://quake.abag.ca.gov/fixit>, asks simple questions to gauge if a building is healthy enough to stand up to a quake. This web site also has links to engineers to help design an appropriate way to improve the strength of these buildings. It also contains links to contractors who have taken FEMA-designed retrofit training courses from ABAG and others. This training is being updated and revised in 2006.

Local governments can include this link on their web site and add information on retrofitting in their newsletters.

This site also provides information for owners of multi-family building, mobile homes, and renters.

## Strategies Applying To Public Awareness

Be aware of past problems of inadequate hazard disclosure and work with real estate agents to improve enforcement of real estate disclosure requirements for hazards, for example, by making those agents and the disclosure firms aware of the hazard maps incorporated in this plan and available on the ABAG web site at <http://quake.abag.ca.gov/mitigation>, as well as locally developed maps.

LHMP Mitigation Strategy HSNG-a-1

Create incentives for owners of historic or architecturally significant buildings to undertake mitigation to levels that will minimize the likelihood that these buildings will need to be demolished after a disaster, particularly if those alterations conform to the federal Secretary of the Interior's *Guidelines for Rehabilitation* and the *California Historical Building Code*.

LHMP Mitigation Strategy HSNG-a-2

Conduct demonstration projects on common existing housing types demonstrating structural and nonstructural mitigation techniques as community models for earthquake mitigation.

LHMP Mitigation Strategy HSNG-b-6

Provide retrofit classes or workshops for homeowners.

LHMP Mitigation Strategy HSNG-b-7

Establish tool-lending libraries with common tools needed for retrofitting for use by homeowners with appropriate training.

LHMP Mitigation Strategy HSNG-b-8

Provide financial incentives to owners of homes needing retrofitting. (Typical retrofits cost a few thousand dollars.)

LHMP Mitigation Strategy HSNG-b-9

Make use of other materials on the ABAG website at <http://quake.abag.ca.gov/fixit> and other websites to increase residential mitigation activities related to earthquakes (ABAG plans to improve the quality of these materials over time).

LHMP Mitigation Strategy HSNG-k-13

**CREDITS** – This pamphlet was prepared by J. Perkins, Earthquake and Hazards Program Manager, and J. Strunin, Regional Planner, Association of Bay Area Governments (ABAG), using funding, in part, from FEMA for the development of the Bay Area Local Hazard Mitigation Plan. The information has been reviewed by the ABAG Earthquake and Hazards Outreach Review Committee. Figures courtesy of USGS, the City of San Leandro, and the Aurora Regional Fire Museum.