The Homeowner's Guide to Earthquake Safety

2002 Edition

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On the cover: The restoration of this Victorian home (inset: Bill Leibman photo) did not include replacement of its pier-and-post foundation. It fell from its foundation and was severely damaged in the 1992 Petrolia Earthquake.

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Legislation

This guide has been developed and adopted by the Seismic Safety Commission as required by Assembly Bill 2959, authored by Assemblyman Johan Klehs (Chapter 1499, Statutes of 1990), and Assembly Bill 200, authored by Assemblyman Dominic Cortese (Chapter 699, Statutes of 1991).

Ordering Information

Copies of this booklet are available from the Seismic Safety Commission, 1755 Creekside Oaks Drive, Suite 100, Sacramento, CA 95833. To order call (916) 263-5506 or download via our website at http://www.seismic.ca.gov/sscpub.htm

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Acknowledgments

Seismic Safety Commission

Richard Alarcon, *Senator*
(Chris Modrzejewski)

Elaine White Alquist, *State Assembly*
(William L. Gates),

Lawrence Klein, *Utilities*

Mark Church, *Local Government*

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Bruce R. Clark, Ph.D., Chair, *Geology*

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Don Parker, *Fire Protection*

Seismic Safety Commission Staff

Richard McCarthy, *Executive Director*

Robert Anderson

Karen Cogan

Kathy Goodell

Henry Reyes

Henry Sepulveda

Fred Turner

Sue Celli

Abigail Browning

Kyshia Davis

Adam Myers

Vincent S. Vibat

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Introduction

Recent earthquakes have reminded us that they can be sudden, destructive, and deadly. But they also have proved that preparation saves lives and property. As a current or prospective homeowner, the foundation of your preparation should be to ensure the strength of your home. This booklet is designed to be a good place to begin that strengthening.

There are no guarantees of safety during earthquakes, but experience has demonstrated time and again that appropriately constructed or strengthened homes are unlikely to collapse or even be irreparably damaged during earthquakes. The California Seismic Safety Commission advises you to act on the suggestions outlined in this booklet and make yourself, your family, and your home safer. California is earthquake country and always will be; don't just worry about "The Big One"—plan for the next one.

Your Home and the Law

California state law contains several provisions to help protect buyers and sellers in home transactions. In respect to a home's ability to resist earthquakes, the law requires only that sellers tell buyers about known weaknesses.

No matter where you live in California, your home can be shaken by damaging earthquakes. There is no stopping the forces of geology. But there are some things we can do to reduce the risk. For example, the law that requires strapping water heaters so they don't tip over during earthquakes potentially saves the state in emergency response and recovery costs by preventing fires as well as broken gas and water distribution lines.

Building codes evolve continually, incorporating the latest scientific and engineering knowledge into construction practices. Houses built to earlier codes do not necessarily benefit from the latest knowledge. Upgrading all houses to current codes could be too cumbersome and too expensive. Instead, state and local laws occasionally require some types of upgrading (those that are both effective and economical) when certain older homes are sold.

Using This Booklet

This booklet describes the most common weaknesses that can cause damage to homes during earthquakes. If your home has any of these weaknesses, it is more likely to be damaged by an earthquake. Specifically, this booklet will:

- Help sellers meet the requirement of state law that seismic weaknesses in a home built before 1960 be disclosed when the home is sold.
- Enable sellers to meet the requirement of state law that this booklet be given to every buyer of a home built before 1960.
- Provide homeowners with basic information about finding and fixing earthquake-related weaknesses in a home.
- Provide general information about earthquakes and direction in finding more information.

Whether buyer or seller, you can be assured of a safer investment and a safer structure by following the guidelines in this booklet.

Filling Out the Disclosure Report

To fulfill the legal requirements for selling a home built before 1960, the seller must give the buyer a completed earthquake hazards disclosure report similiar to the one included at the back of this booklet on page 29.

As you complete the disclosure report, answer the questions to the best of your knowledge. If you do not understand a question, refer to the page of the booklet indicated for a description of that weakness. The description will help you identify the weakness and understand how it can be fixed.

If a question on the form describes only part of your house—for example, if part of your house is anchored to the foundation and part is not—answer the question "no," because a portion of the house is not anchored. You are not required to remove siding, drywall, or plaster to answer the questions. You are not required to hire anyone to inspect your house. You are not required to fix the weaknesses before you sell your home.

Recommendations If You Are Selling

Before you sell your house, the following steps are recommended:

- If you list your house for sale through a real estate broker or agent, give the agent the completed disclosure form when you sign the listing agreement. Your agent can give the booklet and the form to the buyer for you.
- Though you are not required to hire someone to answer the questions on the disclosure form, you may want to get assistance from a home inspector, contractor, architect, or engineer.
- Keep a copy of the form, signed by the buyer, as evidence that you have complied with the earthquake disclosure requirement.

You may find that you will get a better price for your house if you strengthen earthquake weaknesses before you sell.

Recommendations If You Are Buying

Before you agree to buy a house, consider the following recommendations:

- Have a home inspector, contractor, architect, or engineer inspect the house and give you an opinion regarding any earthquake weaknesses and an estimate of costs to strengthen these weaknesses.
- Consider the house's location: Is it in or near an earthquake fault zone or in an area where it might be damaged by a landslide, liquefaction, or a tsunami? You may wish to hire a geotechnical engineer and/or engineering geologist to check the stability of the land under the house.
- Negotiate the cost of strengthening, if required, with the seller. The law does not require either you or the seller to strengthen the home, but if these weaknesses are not fixed, you may find that repair costs after a damaging earthquake amount to more than your equity in the house.

Legal Requirements for Selling Your Home

When you sell a house in California, state law requires that you make certain disclosures to the buyer.

- When you sell your home, state law requires you to disclose earthquake weaknesses such as those described in this booklet (see "Earthquake Weaknesses," beginning on page 3).
- In addition, if your house was built before 1960, you must deliver a copy of this booklet, *The Homeowner's Guide to Earthquake Safety*, to the buyer. Your real estate agent is required to supply you with a copy of this booklet.
- You are required to brace the home's water heater to ensure that it will not fall and that gas and water lines will not break during an earthquake (see page 3).
- If your home is within an earthquake fault zone or in a seismic hazard zone, you are required to disclose this fact to a buyer (see "Geologic Hazards," page 17).

You are not required to hire someone to evaluate your home. You are not required to strengthen your home.

Earthquake Weaknesses

EARTHQUAKE WEAKNESS

Unbraced Water Heaters

The Problem

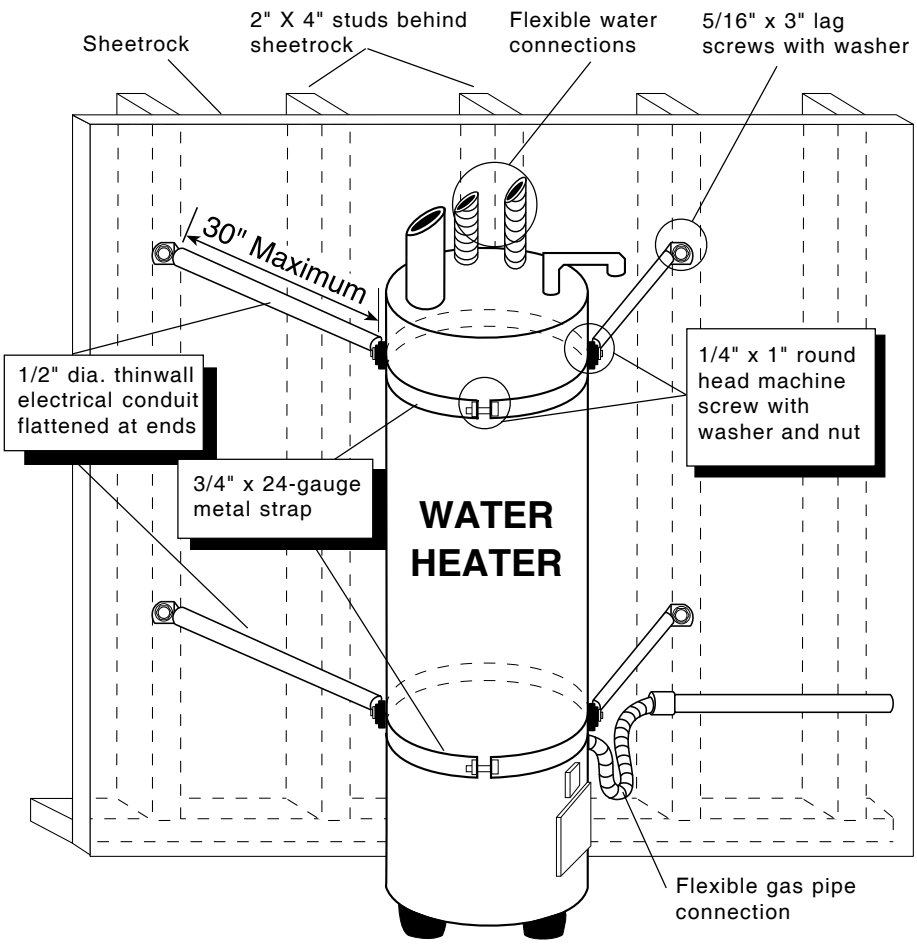
The water heater may not be securely attached to the wall and can topple during an earthquake. If gas or electrical lines are broken as it falls, a fire and water damage may result. This is a common and serious problem but is relatively easy and inexpensive to fix.

How to Identify It

Examine your water heater to see if there are metal straps or braces around it that are screwed into the wall. Make sure the screws go into studs or into concrete and not just into drywall or plaster. Pull on the straps or braces to make sure they are secure and tight.

What Can Be Done

State law requires water heaters to be braced at the time of sale. Strap kits or bracing kits certified by the State Architect are available at your local hardware store and are easiest to install. Alternatively use metal tubing, heavy metal strapping, and lag screws and washers to secure the water heater to the wall studs (see figure 1). Flexible pipes for the gas and water lines are safer in an earthquake than rigid pipes.



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The unbraced water heater in this home fell during an earthquake; the resulting fire destroyed the home.

Figure 1—Water heater bracing. You will be able to see the straps and screws if your water heater is braced. Make sure that the screws are firmly anchored to studs or masonry. The illustration shows one method of bracing a water heater. Ask your local building department for details of local requirements, your home's type of construction, plans for recommended bracing procedures, or to answer any questions you have about bracing your water heater (illustration based on Office of Emergency Services detail).

EARTHQUAKE WEAKNESS

Foundations Not Anchored

The Problem

When an earthquake moves a house from side to side and up and down, the house can move off its foundation if it is not anchored. This can cause a fire from broken gas lines and damage the foundation, floors, walls, windows, and other utility connections as well as the contents of the home. It is very expensive to lift a house up, put it back on its foundation, and repair this damage.

How to Identify It

On a house that is built off the ground, the area between the first floor and the ground is called the crawl space. Look in the crawl space for the heads of anchor bolts that fasten the sill plate—the wooden board that sits directly on top of the foundation—securely to the foundation (see figure 2). You should be able to see the large nuts, washers, and anchor bolts, installed every 4 to 6 feet along the sill plate. Steel plates are sometimes used instead of anchor bolts. These fixtures connect the foundation to the house.

What Can Be Done

If the house is not anchored, drill holes through the sill plate into the foundation and install anchor bolts. If there is not enough room to drill, you can attach steel plates to the exterior to hold the sill plate to the foundation. Detailed specifications for different situations can be found in the *Guidelines for the Seismic Retrofit of Existing Buildings* (see "References").

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This home wasn't bolted and slid off its foundation.

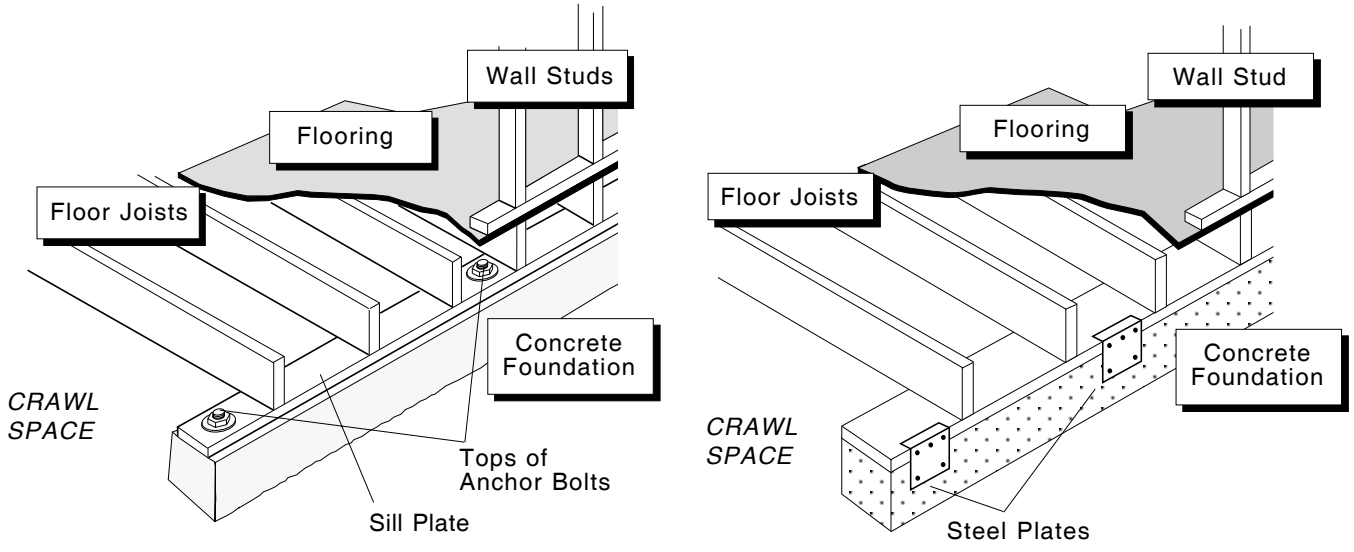

Figure 2—Anchor bolts or steel plates. *A home's crawl space may be formed by a cripple wall between the foundation and the floor joists (as illustrated in figure 3, page 5) or the floor joists may rest directly on the sill plate. In either case, you should be able to see the heads of anchor bolts or steel plates installed every 4 to 6 feet (not necessarily exactly as shown here). These fixtures fasten the sill plate to the foundation.*

EARTHQUAKE WEAKNESS

Weak Cripple Walls

The Problem

Wooden stud walls are sometimes used on top of an exterior foundation to support a house and create a crawl space (see figure 3). These are called cripple walls and they carry the weight of the house. When a house sways from side to side during an earthquake, these walls can collapse if not braced to resist swaying. If the cripple walls fail, the house may fall, causing damage to the foundation, floors, walls, windows, and utility connections as well as to the contents of the home. Such a collapse may also cause a fire as a result of broken gas lines. The damage may be very expensive to repair.

How to Identify It

Go under the house to see if there are any cripple walls and, if so, whether they are braced. If you can see a cripple wall, and there is no plywood or diagonal wood sheathing (see figure 3), the cripple walls are probably inadequately braced or are unbraced. Horizontal or vertical wood siding is not strong enough to brace cripple walls.

What Can Be Done

Plywood (or other wood product allowed by code) can be nailed between the studs. Material specifications and spacing of nails can be found in the *Guidelines for the Seismic Retrofit of Existing Buildings* (see "References").

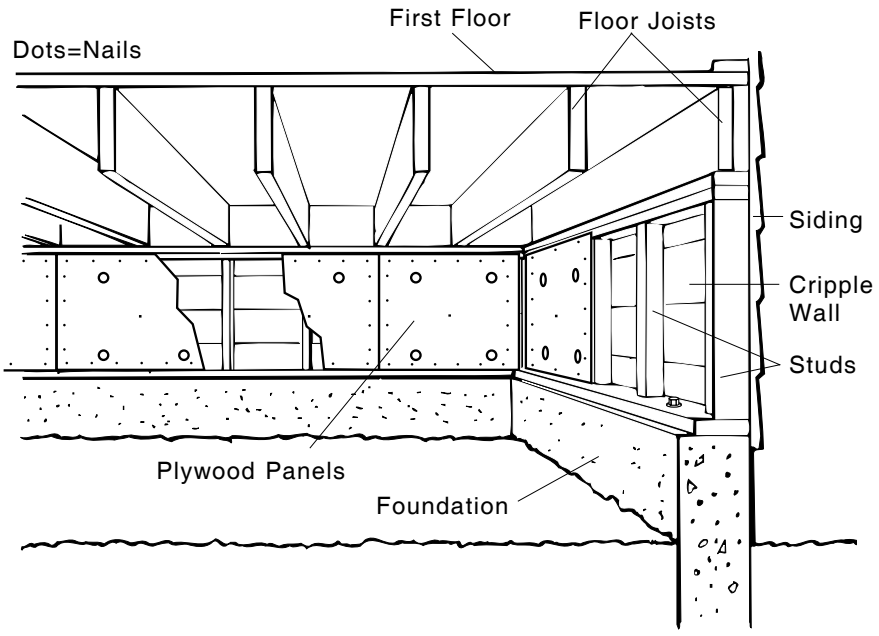

Figure 3—Plywood strengthens weak cripple walls. *If your home has a cripple wall between the foundation and the first floor, and the wall is not braced with plywood sheathing, the house may collapse during an earthquake.*

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When this home's cripple wall failed, the building fell to the left, leaving behind on the ground the cripple wall from the side of the house.

EARTHQUAKE WEAKNESS

Pier-and-Post Foundations

The Problem

Pier-and-post foundations are similar to cripple walls. In this type of construction, the outside wall of the house is supported by wood posts resting on unconnected concrete piers. Siding is often nailed to the outside of the posts.
If the posts are not braced against swaying, they may fall during an earthquake.

How to Identify It

From underneath the house, if you do not see a continuous foundation under the outside walls of the house, and you see only unconnected concrete piers and wood posts (or just wood posts) supporting the outside walls, your home may be vulnerable (see photos below). Horizontal or vertical wood siding is not strong enough to brace pier-and-post foundations.

What Can Be Done

You may require the advice of an architect or engineer as well as a foundation contractor to fix this problem. It may be possible to make the foundation safer by bracing the posts, but you might be better off to add a new foundation and plywood walls in the crawl space to make sure that the house will not fall off its foundation during an earthquake.

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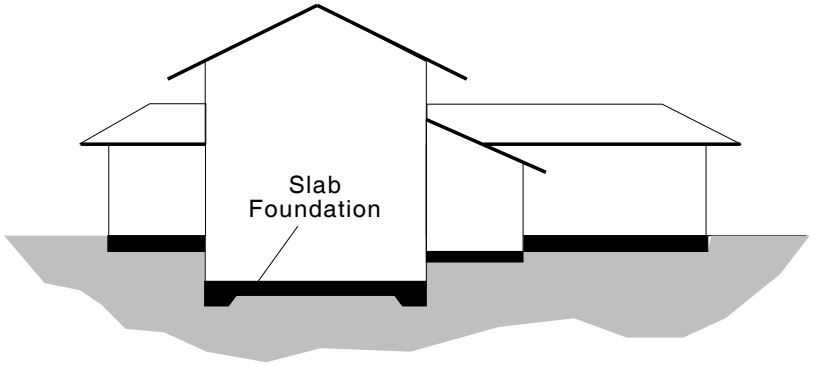

Figure 4—Slab foundations. *If your house was built on a concrete slab, it is probably bolted to its foundation.*

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The pier-and-post foundation under this home shifted during a recent earthquake.

Houses Built on Concrete Slabs

Many homes don't have crawl spaces because they are built directly on concrete slabs. These houses do not have cripple walls, and they generally have foundation anchor bolts that were installed when they were built. If you can't tell whether your house has anchor bolts without removing interior plaster or drywall, which is not required by the disclosure law, you can look to see if the house has an unfinished garage with anchor bolts visible. If they are there, it is an indication that the living area of the house may have them also.

EARTHQUAKE WEAKNESS

Unreinforced Masonry Foundations

The Problem

Unreinforced masonry—brick, concrete block, or stone—foundations often cannot resist earthquake shaking. They may break apart, or be too weak to hold anchor bolts. Homes may shift off such foundations during earthquakes, damaging the walls, floors, utility lines, and home contents.

How to Identify It

If your home's foundation is brick or stone and looks like one of the foundations shown in the photos below, it is probably unreinforced. If there is a space filled with grout between the inner and outer faces of a brick foundation (where anchor bolts and reinforcing steel would be installed), it is probably reinforced. Look underneath the house to see what your foundation is made of if the outside of the foundation is covered.

Concrete block foundations should have steel reinforcing bars embedded in grout in the cells of the individual blocks. Check the top of the foundation, at the sill plate, to see if there is concrete in the cells of the blocks. If the cells are hollow, the foundation is probably not reinforced.

What Can Be Done

Strengthening an unreinforced brick or stone foundation can be expensive. There are a number of ways to approach the problem; you may need the help of an architect or engineer as well as a foundation contractor. Commonly used fixes include jacking the house off the old foundation and replacing all or part of it with a poured concrete foundation.

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This is an unreinforced stone foundation, a type that typically fails during an earthquake.

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Note the bricks in an unreinforced masonry foundation.

EARTHQUAKE WEAKNESS

Houses on Tall Walls or Posts

The Problem

If a house is built on the side of a steep hill, it may be set on exposed posts or columns as shown in the illustration below. Sometimes the supports on the downhill side will be hidden behind a tall wall that encloses a large unfinished space similar to but taller than a crawl space underneath the first floor of a typical house built on flat ground (see photo, bottom left). If such posts or walls are not properly braced, they may collapse.

What Can Be Done

Typically, such houses are engineered—meaning that the structure was designed by an architect or engineer, rather than simply built by a contractor according to conventional construction techniques. If a house you own or are considering buying is on tall walls or posts, an architect or engineer should be consulted to determine whether the posts or unbraced walls need strengthening and how to get this work done.

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This hillside house was built on an unbraced tall wall that failed.

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This photograph shows an interior detail of a home similar to the one at the left, showing substantial damage to a building with an unbraced tall wall.

EARTHQUAKE WEAKNESS

Unreinforced Masonry Walls

The Problem

Houses built of unreinforced masonry—bricks, hollow clay tiles, stone, concrete blocks, or adobe—are very likely to be damaged during strong earthquakes. The mortar holding the masonry together may not be strong enough to resist earthquake forces. These houses cannot flex and then return to their original shapes as do wood-framed houses.

How to Identify It

You can usually see bricks or stone from the outside unless the walls are covered with plaster. If brick walls have "header courses" of bricks turned endways every five or six rows, or if the house was built before 1940, the walls are most likely unreinforced. If you can't tell from the outside, you can take the cover plate off one of the electrical outlet boxes on an outside wall (turn off the power first) and look for brick or other masonry.

If the wall is concrete or concrete block, it is very difficult to determine whether reinforcing steel was added during construction. An experienced testing firm may tell you whether any steel is present. Otherwise, consulting the house's plans, which may be on file with the building department, might be the only way to tell without damaging the wall.

What Can Be Done

This is another problem that requires the services of an architect or engineer. A solution may involve tying the walls to the floor and roof.

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The plaster-covered brick walls of this building collapsed during a recent earthquake.

EARTHQUAKE WEAKNESS

Rooms over Garages

The Problem

The large opening of a garage door and the weight of a second-story room built over a garage may mean the walls are too weak to withstand the shaking in a strong earthquake. This is a concern when narrow sections of wall on each side of the opening are not reinforced or braced. Some relatively new homes with this weakness have been damaged in past earthquakes.

How to Identify It

A room above the garage does not necessarily indicate an earthquake weakness. If the garage door opening is in line with the rest of the house (see figure 5), additional bracing around the door may not be needed. Check to see if there are braces or plywood panels around the garage door opening (see figure 6). It may be hard to determine whether strengthening is needed. This is an area where you may need the help of an architect or engineer.

What Can Be Done

Install a steel frame or plywood paneling around the door opening. You should consult an architect or engineer if you have a multistory house built over a garage.

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This mountain home was built over a garage, and its walls were not strong enough to withstand an earthquake.

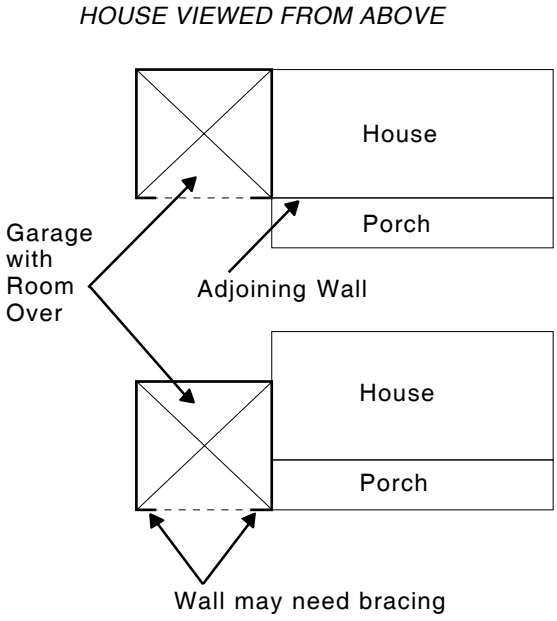

Figure 5—Additional bracing. *If the wall of the main house is in line with the wall containing the door of a garage with a room over it (top figure), the adjoining wall will help brace the garage. If the "in-line" wall consists only of porch supports (bottom figure), the garage may require additional bracing.*

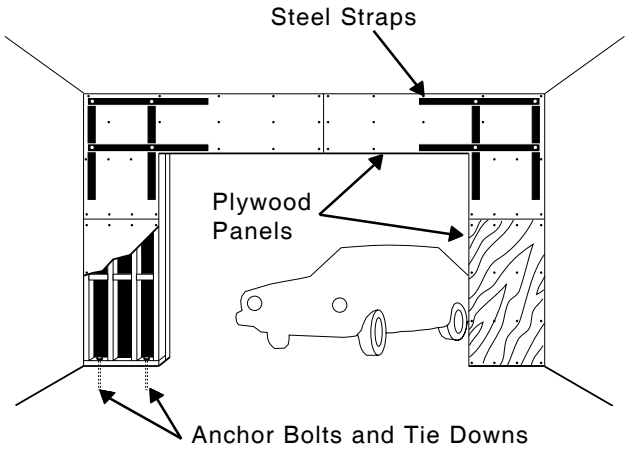

Figure 6—Bracing garage walls. *If your house has a room over the garage, the garage walls may not be strong enough to hold up during an earthquake unless they are braced with plywood panels.*

EARTHQUAKE WEAKNESS

Unreinforced Chimneys

The Problem

Many chimneys are built of unreinforced brick or stone and can collapse or fall over during earthquakes. If the chimney comes apart, the brick or stone may fall, damaging houses and cars and injuring people.

How to Identify It

Determining whether a chimney is susceptible to earthquakes is not easy. Tall, slender chimneys are most vulnerable to collapse. If the mortar between the brick or stone crumbles when you pick at it with a screwdriver, the chimney may be a hazard. Inspect the attic and floor spaces for the metal ties that should be holding the chimney to the house.

What Can Be Done

You can replace the chimney, or nail plywood panels above the ceiling, in the house's attic or under the shingles when you reroof, to prevent the brick or stone from falling into the house. Metal straps can be installed to tie the chimney to the house. Metal flues can replace the upper chimney if the mortar is good. Don't locate patios, children's play areas, or parking spaces near a questionable chimney. Tell your family members to get away from chimneys and fireplaces during earthquakes.

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This unreinforced chimney fell during a recent earthquake.

EARTHQUAKE WEAKNESS

Natural Gas Safety

The Problem

Natural gas piping and appliances in homes can be damaged resulting in releases of natural gas that can lead to fires if ignition sources are present. Natural gas is typically a factor in about one out of four fire ignitions following earthquakes. However, the total number of earthquake-related fires, their sources and amounts of destruction can vary greatly depending upon a number of factors. Structural weaknesses or the absence of appliance anchors and flexible pipe connections lead to a greater possibility of gas leaks following earthquakes. Experience has shown that living in a seismically active area increases the risk of fire from all causes by a small amount. Since residential dwellings generally have several safe exit paths, the potential for life loss is limited. Therefore, the primary concern for homeowners is property loss from fire damage.

How to Identify It

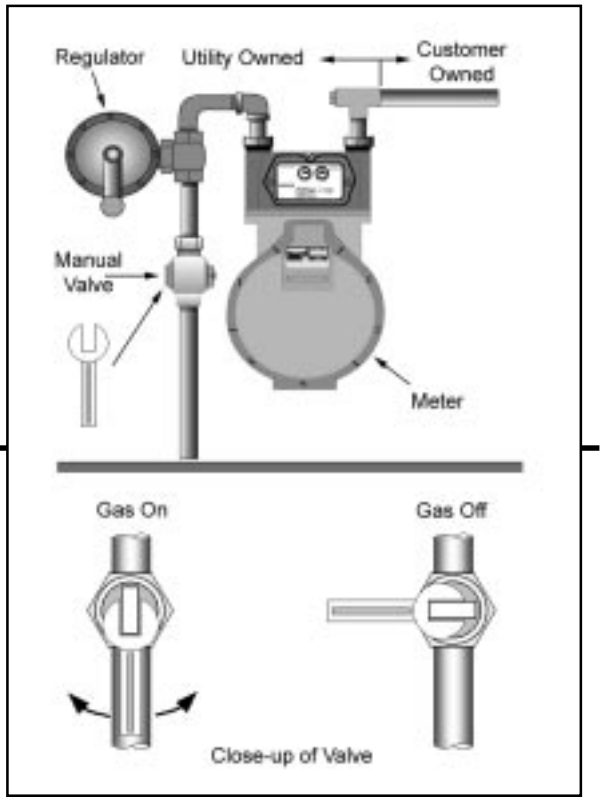
Examine all natural gas appliances (water heaters, dryers, stoves, ovens, furnaces) to see if they are anchored to the floor or walls and have flexible pipe connections.

What Can Be Done

Relying on manual gas shutoff valves is an effective means to stop the flow of gas if persons are present after earthquakes. If you smell gas, hear gas escaping, or suspect a broken gas pipe, appliance, vent or flue, use a wrench to turn off the gas valve located at the gas meter. In addition, options such as earthquake actuated valves, excess flow valves, methane detectors, and hybrid systems can further reduce the risk of gas leaks and ignitions. However once the gas has been shutoff, service can only be restored by utility personnel or qualified plumbers. Demands for qualified personnel following earthquakes may lead to substantial delays in restoring service.

Homeowners should consider their specific circumstances and the suitability of these options. See Page 16 for the benefits and drawbacks of various options.

Figure 7—Manual Shutoff Valve Location



Other Concerns

No Foundation

The Problem Some older houses were built on wood beams laid directly on the ground, without foundations. These houses may move during earthquakes, causing structural damage and breaking utility lines.

How to Identify It Look under the house. If you see no concrete or masonry around the outside walls, the house may lack a foundation.

What Can Be Done You may need to add a foundation to make the house earthquake resistant. Just as when strengthening or replacing an unreinforced masonry foundation, you will require the advice of an architect, engineer, or foundation contractor.

Old Concrete Foundation

The Problem Some older concrete foundations were made with sands or aggregates that interacted chemically over time and the concrete eventually crumbled and became too soft to withstand earthquake forces.

How to Identify It Inspect the foundation for large cracks in the concrete, concrete crumbling off the foundation, or concrete crumbling when you pick at it with a screwdriver.

What Can Be Done You may need to replace some of the foundation. You should consult a foundation contractor or an engineer.

Home Design

The Problem The design and construction features of some homes make them vulnerable to earthquake damage, especially if these homes are not properly planned and built. Homes at risk are those with irregular shapes, large windows (which can break in earthquakes and scatter shards of glass), more than two stories, irregular walls, or porches and overhangs.

How to Identify It Many homes with these features are strong enough to withstand earthquakes, and it is difficult to tell whether such homes need strengthening. If you have doubts about one or more of these features in your home, or in a home you are planning to buy, you should consult an architect or engineer for an assessment.

What Can Be Done A professional can advise you on how to identify and fix earthquake weaknesses if necessary. Large windows can be made safer by applying plastic film to them.

Getting the Work Done

For your family's safety and financial security, you should strengthen your home to resist earthquakes. This booklet can help you decide which projects to tackle first. If your home has an unanchored water heater, an unbolted foundation, or an unbraced cripple wall, fixing these weaknesses will give you the most protection in return for money spent.

If you are a do-it-yourselfer, you may be able to do the simpler strengthening projects. Your local building department can provide guidelines for the project, and a contractor may charge only a nominal fee, if any, to provide the advice you may need to plan the work.

You will need building permits for the projects suggested in this booklet. The projects described are intended only to give you an idea of what needs to be done; they are not "how-to" instructions. There are many publications that go into detail about how to do these strengthening projects; see "References," page 26. You should review one or two of these publications to get a better idea of what your architect, engineer, or contractor is doing, even if you don't plan to do the work yourself.

In addition to assessing the earthquake weaknesses of your house, these professionals can estimate the costs of correcting the weaknesses and prepare the plans and specifications you will need to get a building permit. An architect or engineer can design the earthquake strengthening project and then advise you about selecting a contractor.

When obtaining help, make sure the professionals have experience in residential earthquake strengthening and the appropriate state licenses. Check references carefully. Call former customers to make sure you are contracting with reliable people, and ask for examples of previous jobs similar to yours. Talk to two or three professionals and be sure to compare their experience, ideas, and fees. Select someone you can talk to, someone who can explain what is to be done in terms that you can understand.

You should get several bids for construction work. Remember, though, that the low bid may not be the best choice. Opinions on the best way to do the job may vary.

Be sure to keep the plans, permits, and other paperwork related to your strengthening project to show future buyers.

If your home has been designated as "historical," you will be required to comply with the *California Historical Building Code*. Your local building department can help you determine how this affects the methods and materials you use.

Money Matters

Repairing earthquake damage to a home can be very expensive. Typically, it costs less to correct earthquake weaknesses than to repair earthquake damage. After an earthquake, you may have lodging costs in addition to repair costs if you can't live in your home until the damage is repaired.

Strengthen or Repair?

Table 1 on page 15 shows the typical range of costs to strengthen a home. The low end of the range includes the approximate costs of simple jobs for materials only, assuming you do the work. The upper end is for jobs done by professionals. Costs vary from job to job; ask your architect, engineer, or contractor to explain how the cost of your job is estimated.

The costs provided are for an average-sized house on a level lot. Your costs may vary. The table also gives you some idea of the risks of leaving the work undone. Usually it is far cheaper and safer to strengthen your home before the earthquake than to fix it afterward.

Earthquake Insurance

Earthquake coverage can add a considerable amount to your homeowner's insurance premium, depending on your location, the size and type of your house, and other factors. These coverages can carry deductibles of 5 to 15 percent or more of the house's replacement value. A 15 percent deductible means an earthquake must do more than $30,000 worth of damage to a $200,000 house before the insurance company pays for any damage; you must pay the first $30,000 worth of repairs.

The California Earthquake Authority and all other insurers are required to provide discounts on earthquake insurance premiums for older homes that have been strengthened to resist earthquake damage. For more information, contact your insurance agent.

Table 1—Comparison of Costs: Preventing Vs Repairing Earthquake Damage

Earthquake Strengthening Project	*Cost of Project*	*Cost to Repair Unstrengthened House After Earthquake*	*See Page*
Bracing water heaters	$25 – 200	$200 – Total*	3
Anchoring foundations	250 – 5,000	25,000 – Total*	4
Bracing cripple walls	500 – 2,500	25,000 – Total*	5
Strengthening foundations	15,000 – 50,000	15,000 – Total*	6, 7
Bracing tall walls or posts	1,000 – 25,000	1,000 – Total*	8
Bracing garages with rooms above	200 – 25,000	1,000 – Total*	10
Bracing or replacing chimneys	2,000 – 12,000	1,000 – 15,000	11

*Total—full cost of home, which may be completely destroyed by this failure.

Building Permits

You will need a building permit for seismic retrofits whether you do the work yourself or hire a contractor. The *Guidelines for Seismic Retrofit of Existing Buildings,* Chapter 3 contains the current best guidelines for strengthening older homes to resist earthquake damage. Most municipal building departments will allow you to review a copy of this code at their plan-check counters.

Property Tax Exclusion

The state provides a property tax exclusion to encourage homeowners to undertake earthquake strengthening projects. If you make an addition such as a swimming pool or a new den to your home, your property tax bill will increase. But a strengthening project to help your home resist earthquakes will not add to your property taxes. You must file a claim form with your county assessor to receive the exclusion. The work must also be approved as appropriate seismic strengthening by your local building department.

Gas Shutoff Options

In addition to manual natural gas shutoff valves shown in figure 7 on page 12, several options are available to the public that can further reduce the risk of gas leaks and ignitions after earthquakes. The following tables describe Earthquake Actuated Valves, Excess Flow Valves, Methane Detectors, and Hybrid Systems and how they compare with each other and manual shutoff valves. Homeowners should consider their specific circumstances and suitability of these options for the customer-owned portion of the gas system. The information on page 16 can help homeowners reach their own conclusions on the benefits and drawbacks of various options. Earthquake Actuated Valves and Excess Flow Valves should be certified by the State Architect. Some installations will require building permits, so consult your local jurisdiction. Homeowners should be aware that some local jurisdictions have adopted ordinances requiring gas shutoff devices at time of sale or when significant renovations are undertaken.

Table 2: Gas Shutoff Option Costs

Device[1]	Hardware Cost	Installation Cost[2]
Restrain individual gas appliance	$15-$50	$0 - $100
Manual shutoff valve & wrench	$5-$20	$0
Earthquake actuated valve	$100 - $300	$100 - over $300 [3, 4, 5]
Excess flow valve at meter	$20 - $100	$100 - over $300 [3, 4]
Excess flow valve at appliance	$5 - $15	$0 - $100
Methane detector	$25 - $75	$0
Hybrid system	$150 - over $5006	$100 - over $5007

NOTES:

1. There are significant differences in the operation of the various devices listed.
2. All costs are approximate and do not include permit and inspections fees that may range from $25 to cover $100 depending upon the local jurisdiction. Installations that can be performed by the building owner are assumed to have no cost.
3. Installation costs do not include a survey of the gas system that can cost over $200.
4. Higher Installation costs may occur if substantial modifications of plumbing are necessary.
5. Higher installation costs may occur if substantial modifications to attach the valve to the building are necessary.
6. Costs for hybrid systems depend on the number and type of components installed.
7. Higher installation costs can be incurred for hybrid systems that require installation of wiring to connect multiple sensing units.

Table 3: Gas Shutoff Comparisons

Consideration	Manual Shutoff Valve and Wrench	Earthquake Actuated Valve	Excess Flow Valve	Methane Detector	Hybrid System
Basis of Operation	Utilities have installed manual shutoff valves near gas meters allowing owners with proper wrenches to shutoff gas in emergencies.	Senses shaking in a building that is above a design level of shaking and automatically shuts off gas.	Senses gas flows that are above a design shutoff flow rate and automatically shuts off gas	Senses the presence of natural gas in the air and triggers an alarm.	A variety of modular devices that could include a main control unit, shake sensors, excess flow sensors, methane detectors, valves, and alarms.
Benefits	All gas services already have valves installed. Guidance for occupants is currently provided in many public information documents like the phone book.	Actuates only in cases when building shaking may be sufficient to cause damage to the gas system. Someone does not need to be present to ensure shutoff.	Actuates only in cases when excess gas flows downstream of the device. Someone does not need to be present to ensure shutoff.	Alerts occupants when detectable gas concentrations are present before they reach hazardous levels, allowing time for shutoff and evacuation.	Systems are modular and can be customized for desired applications. Each module has benefits associated with specific action (e.g., motion sensing, flow sensing, methane detection).
Potential Drawbacks	Only effective if someone is present, knows the valve location, has access to the valve, and has a wrench suitable to close the valve.	Can actuate even if damage and hazards do not exist. Aftershocks can cause the device to actuate after service has been restored. May actuate from shaking not related to earthquakes.	Will not shut off gas if leakage is below the design shutoff flow rate, even if a slow leak exists. May not activate if the occupant changes gas systems downstream without modifying the device.	Someone needs to be present to respond to the alarm. Alarm may trigger for other flammable vapors in addition to natural gas.	Each module has drawbacks associated with specific actions (e.g., motion sensing, flow sensing, methane detection).

Geologic Hazards

California and earthquakes—it's a natural connection. California is partly on one tectonic plate and partly on another. In fact, at the far northern edge of the state, three plates collide just offshore. Our state is the product of geologic forces that have created an unstable landmass. There's no avoiding it—that's where we live; that's where we build our homes (see figure 8).

Your home can be damaged by the direct effects of an earthquake (changes in the nearby ground, such as strong shaking, rupture, landslide, or liquefaction) or by indirect effects (for example, tsunamis or dam failures). All these hazards are possible, but are more likely to affect certain areas (see figures 8, 9, 10, 11) and certain types of homes. To supplement the basic information about possible problems within homes earlier in this book, the following section:

- Describes briefly the basic geological or geology-related hazards
- Introduces the government mapping programs that propose to define which areas are susceptible to those hazards

Ground Shaking—Ground shaking causes 99 percent of the earthquake damage to California homes. Geologists believe that areas near large active faults (see figure 9) are more likely to be shaken than areas in the rest of the state. All the precautions and preparations described so far prepare a house to resist strong shaking and are, therefore, the ones likely to be the most effective and economical means to help prevent damage to your home.

Fault Rupture—Fault rupture is an actual crack or breaking of the ground along a fault during an earthquake. A house built over an active fault can be torn

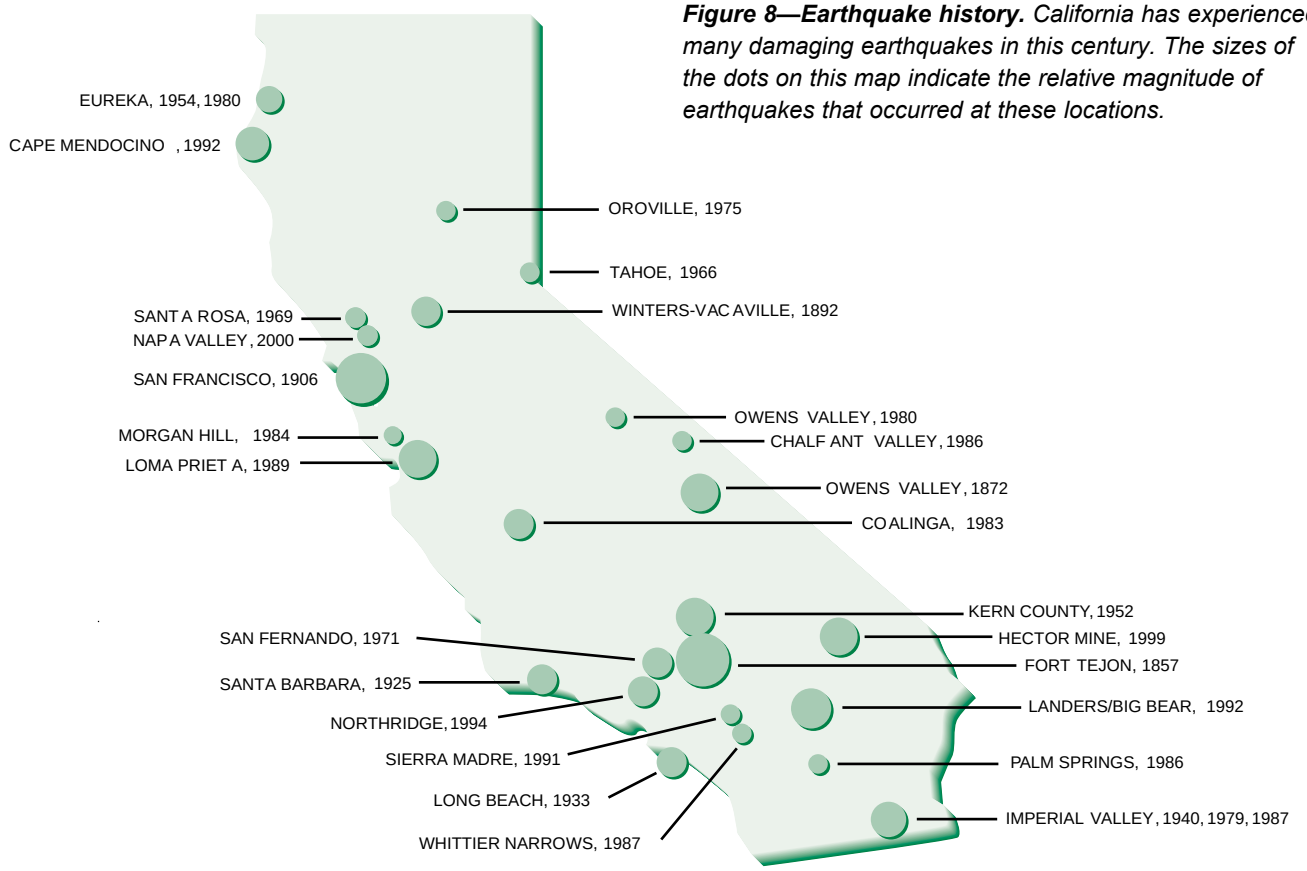


Figure 8—Earthquake history. *California has experienced many damaging earthquakes in this century. The sizes of the dots on this map indicate the relative magnitude of earthquakes that occurred at these locations.*

Source: California Geological Survey, 1986; Earthquake History of the U.S., U.S. Department of Commerce and Interior, 1982; records of California Office of Emergency Services; compiled and revised by California Seismic Safety Commission, 2002

Figure 9—Seismic zones in California. *All of California is in seimic zone 3 or 4 on U.S. Geological Survey maps. There are four zones; the higher the number the higher the earthquake danger. Stronger standards for buildings in zones 3 and 4 have been adopted in the Uniform Building Code.*

apart if the ground ruptures. If the house is built over a "creeping" fault—one that moves in a series of very small earthquakes rather than as the result of a strong shock—the damage may not be noticed for some time.

Landslide—Earthquakes can also trigger landslides. The shaking of an earthquake can cause the soil and rock to slide off a slope, ripping apart homes on the slope and crushing homes downhill.

Liquefaction—When earthquakes shake loose, wet, sandy soil, the soil can become almost like quicksand, losing its ability to support structures, allowing the foundation of a house, for example, to sink, break apart, or tilt.

Tsunami—A tsunami is a large sea wave caused by an earthquake. Tsunami damage is rare in California; however, the wave can come from a great distance and can cause considerable damage if it hits low-lying areas along the shore. For example, ten people were killed when the tsunami caused by the 1964 Alaskan earthquake hit Crescent City in northern California.

Dam Failure—Earthquake damage to a dam can cause a flood. A dam above the San Fernando Valley was damaged in the 1971 earthquake; if it had failed, it might have flooded the homes below, causing many deaths and injuries. Dam failure is unlikely; California has one of the world's most rigorous systems for building and inspecting dams.

Earthquake Hazard Mapping

The state has endured several well-known, damaging earthquakes just in the decade starting with the Loma Prieta quake of 1989. For more than a century, scientists have tried to understand how the land below us works. They have made enormous progress in understanding, especially in mapping areas that have the highest probability of damaging effects from earthquakes. Three mapping programs are applying some of this knowledge to make Californians safer in earthquake country.

National Seismic Zones—The International Conference of Building Officials (ICBO) has designed a general map of the seismic hazards in the U.S. (see figure 9). The map uses lines to divide seismic zones on the basis of the likelihood of strong ground shaking. There are four zones. The higher the number, the higher the earthquake danger. All areas of California fall into either zone 3 or 4. Essentially all the most populous areas of California are in Seismic Hazard Zone 4.

State Seismic Zones—The California Geological Survey (CGS), part of the California Department of Conservation, works closely with the U.S. Geological Survey (USGS) by sharing seismic and geologic data. Because of its California orientation, the CGS maps our state hazards in detail. Two of CGS's mapping programs are of direct significance to homeowners:

1. *Earthquake Fault Zone Maps*—showing active faults and defining zones surrounding the fault that require special geotechnical studies before certain types of buildings can be constructed
2. *Seismic Hazard Zone Maps*—showing the areas of the state where landslides and liquefaction are most likely to occur and require investigation before some types of buildings can be constructed

Earthquake Fault Zones

The Alquist-Priolo Earthquake Fault Zone maps (see figure 10) show known active earthquake faults and identify a 1,000-foot-wide zone with the fault line at the center. State law requires that the information from these maps be incorporated into local general plans. Your local planning department should be able to show you the Alquist-Priolo maps for your area. The resource list at the end of this booklet also tells how to contact the California Geological Survey.

Seismic Hazard Zones

The Seismic Hazards Mapping Act went into effect on April 1, 1991. Currently, this mapping program focuses on two hazards: liquefaction and landslides (see figure 11). The Seismic Hazards Mapping Program is patterned after the Alquist-Priolo Earthquake Fault Zoning Act (which addresses surface fault-rupture). In both programs:

- The state geologist delineates certain seismic hazards zones.
- Cities and counties establish regulations governing development within the zones.
- The State Mining and Geology Board provides additional regulations, policies, and criteria to guide cities and counties in implementing the law.
- Sellers of real property within a hazard zone must disclose that the property lies within such a zone at the time of sale.

The Seismic Hazards Mapping Act and related regulations establish a statewide minimum standard for construction that should reduce the chances that a

Figure 10—Earthquake fault zone map. *This sample map shows the Hayward Fault as it runs through downtown San Pablo. The map provides an example of an Alquist-Priolo Earthquake Fault Zone that borders active fault traces in California.*

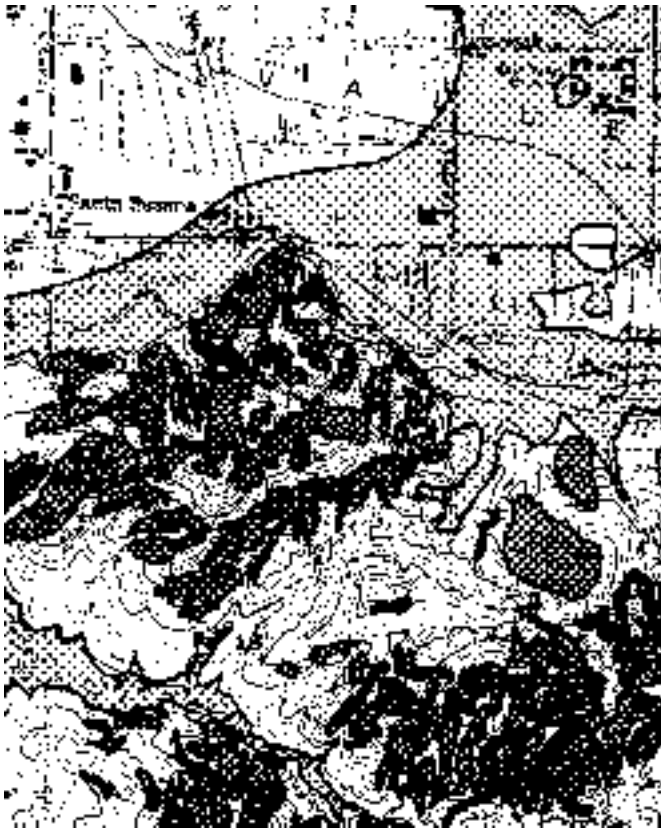


Figure 11—Seismic hazard zone map. *This area near Simi Valley is shown on a map produced in accordance with the Seismic Hazards Mapping Act. The map designates zones that have the potential for liquefaction (dotted pattern) or landslide (crosshatch pattern).*

building will collapse so completely that it kills its occupants. Saving lives is the first priority; however, that does not mean that the building will still be usable after the quake.

The first seismic hazard zone maps were released in April, 1997. The requirements of the mapping act become effective for a location when the map for that location is released. The zones defined by the maps are at greatest potential risk when a major earthquake occurs during or shortly after a heavy rainfall that helps saturate potential liquefaction and landslide areas.

The law directs cities and counties to "take into account the information provided in available seismic hazard maps" when they adopt or revise the public safety portions of their general plans and any land-use planning or permitting ordinances.

What Does It Mean for You?

Table 4, below, shows the major types of geological vulnerabilities. It shows the underlying geologic conditions, the mapping program that covers such conditions, and the source of those maps.

The fault zone and seismic hazard zone maps are based on known geologic data; they do not cover all possible hazards or faults. For example, the fault that moved and caused the Northridge earthquake of 1994 was previously unmapped. However, it occurred in an area known to contain that type of fault; thus the potential for that kind of earthquake in that general location was well known.

Also keep in mind that, should an earthquake occur, effects of the types of potential hazards shown in the table will not happen in isolation. Strong shaking can trigger both landsliding and liquefaction. Some soil types that are susceptible to liquefaction (such as land fill and sedimentary soils) can actually amplify an earthquake's shock waves, making the local shaking even stronger.

Table 4—Identifying Earthquake Effects That May Damage Your Home

Effect	*Information Useful in Identifying Effect*	*Map Creator*	*Local Access to Maps*
Strong shaking	National zone maps; state fault and earthquake-shaking-potential maps	ICBO	See page 18, figure 9 for actual map
Fault rupture	Alquist-Priolo Earthquake Fault Zone maps	CGS	Local planning department
Landslide	Seismic Hazard Zone maps*	CGS	Local planning department
Liquefaction	Seismic Hazard Zone maps*	CGS	Local planning department

ICBO—International Conference of Building Officials

CGS—California Geological Survey

* When available (first maps were released in late spring, 1997; others will be released as finished)

For updated information and the latest WWW links, visit the Seismic Safety Commission Web site at www.seismic.ca.gov

What to Do Before, During, and After an Earthquake

Use the following information to reduce risks to yourself, your family, and your home. These lists are only highlights of the actions you should take; refer to the organizations and publications in "Resource Organizations" and "References," pages 26-27, for more details.

Gather Emergency Supplies

Be sure you have these basic supplies on hand:

1. Fire extinguisher.
2. Adequate supplies of medications that you or family members are taking.
3. Crescent and pipe wrenches to turn off gas and water supplies.
4. First-aid kit and handbook.
5. Flashlights with extra bulbs and batteries.
6. Portable radio with extra batteries.
7. Water for each family member for at least three days (allow at least one gallon per person per day) and purification tablets or chlorine bleach to purify drinking water from other sources.
8. Canned and packaged foods, enough for several days, and a mechanical can opener. Don't forget extra pet food.
9. Camp stove or barbecue to cook on outdoors. (Store fuel out of the reach of children.)
10. Waterproof, heavy-duty plastic bags for waste disposal.

Plan Ahead

1. Make sure each member of your family knows what to do no matter where they are when earthquakes occur.
   - Establish a meeting place where you can all reunite afterward.
   - Find out about the earthquake plan developed by your children's school or day care.
   - Remember that since transportation may be disrupted, you may have to stay at your workplace for a day or two following a major earthquake. Keep some emergency supplies—food, liquids, and comfortable shoes, for example—at work.
2. Know where your gas, electric, and water main shutoffs are and how to turn them off if there is a leak or electrical short; if in doubt, ask your utility companies. Make sure that all the older members of your family can shut off the utilities.

Plan Ahead
(continued)

3. Locate your nearest fire and police stations and emergency medical facility. Remember that you probably won't be able to telephone for help after an earthquake.
4. Talk to your neighbors—how could they help you, or you help them, after an earthquake?
5. Take a Red Cross first aid and cardiopulmonary resuscitation (CPR) training course.

What To Do During an Earthquake

1. If you are indoors—stay there! Get under a desk or table and hang on to it, or move into a hallway or get against an inside wall. Stay clear of windows, fireplaces, and heavy furniture or appliances. Get out of the kitchen, which is a dangerous place in earthquakes since it's full of things that can fall on you. Don't run downstairs or rush outside while the building is shaking or while there is danger of falling and hurting yourself or being hit by falling glass or debris.
2. If you are outside—get into the open, away from buildings, power lines, chimneys, and anything else that might fall on you.
3. If you are driving—stop, but carefully. Move your car as far out of traffic as possible. Do not stop on or under a bridge or overpass or under trees, light posts, power lines, or signs. Stay inside your car until the shaking stops. When you resume driving, watch for breaks in the pavement, fallen rocks, and bumps in the road at bridge approaches.
4. If you are in a mountainous area—watch out for falling rock, landslides, trees, and other debris that could be loosened by quakes.

Do Not . . .

- **Do not** eat or drink anything from open containers near shattered glass.
- **Do not** turn the gas on again if you turned it off; let the gas company do it.
- **Do not** use matches, lighters, camp stoves or barbecues, electrical equipment—including telephones—or appliances until you are sure there are no gas leaks. They may create sparks that could ignite leaking gas and cause an explosion and fire.
- **Do not** use your telephone, except for a medical or fire emergency. You could tie up lines needed for emergency response. If the phone doesn't work, send someone for help.
- **Do not** expect firefighters, police, or paramedics to help you. They may not be available.

What To Do After an Earthquake

Wear sturdy shoes to avoid injury from broken glass and debris. Expect aftershocks.

1. **Check for injuries:**
   - If a person is bleeding, put direct pressure on the wound. Use clean gauze or cloth, if available.
   - If a person is not breathing, administer rescue breathing. The front pages of many telephone books contain instructions on how to do it along with detailed instructions on other first-aid measures.
   - Do not attempt to move seriously injured persons unless they are in immediate danger of further injury.
   - Cover injured persons with blankets to keep them warm.
   - Seek medical help for serious injuries.

2. **Check for hazards:**
   - *Fire or fire hazards.* Put out fires in your home or neighborhood immediately. Call for help, but don't wait for the fire department.
   - *Gas leaks.* Shut off the main gas valve only if you suspect a leak because of broken pipes or the odor of natural gas. Don't turn it back on yourself—wait for the gas company to check for leaks.
   - *Damaged electrical wiring.* Shut off power at the control box if there is any damage to your house wiring.
   - *Downed or damaged utility lines.* Do not touch downed power lines or any objects in contact with them.
   - *Spills.* Clean up any spilled medicines, drugs, or other potentially harmful materials such as bleach, lye, and gasoline or other petroleum products.
   - *Downed or damaged chimneys.* Approach chimneys with caution. They may be weakened and could topple during aftershocks. Don't use a fireplace with a damaged chimney—it could start a fire or let poisonous gases into your house.
   - *Fallen items.* Beware of items tumbling off shelves when you open the doors of closets and cupboards.

3. **Check your food and water supplies:**
   - If power is off, plan meals to use up foods that will spoil quickly, or frozen foods. If you keep the door closed, food in your freezer should be good for at least a couple of days.
   - Don't light your kitchen stove if you suspect a gas leak.
   - Use barbecues or camp stoves, outdoors only, for emergency cooking.
   - If your water is off, you can drink supplies from water heaters, melted ice cubes, or canned vegetables. Try to avoid drinking water from swimming pools or, especially, spas—it may have too many chemicals in it to be safe.

Resource Organizations

Some of the organizations listed below have information to help you strengthen your home against earthquakes and help you and your family prepare a personal earthquake response plan. Other resources that can help you may be available in your community; check your local telephone directory.

Home Safety Information

Office of Emergency Services
Information and Public Affairs
3650 Schriever Avenue
Mather, CA 95655
Telephone: [916] 845-8400
[916] 845-8911
Earthquake Programs of the Office of Emergency Services

Coastal Region
1300 Clay Street, Suite 400
Oakland, CA 94612
Telephone: [510] 286-0895

Inland Region Northern Office
2395 N. Bechelli Lane
Redding, CA 96002
Telephone: [530] 224-4835

Inland Region Southern Office
2550 Mariposa Mall, Room 13-181
Fresno, CA 93721
Telephone: [559] 445-5672

Southern Region Main Office
11200 Lexington Drive
Los Alamitos CA 90720-5002
Telephone: [562] 795-2900

Southern Region San Diego Office
1350 Front Street, Station 2041
San Diego, CA 92101
Telephone: [619] 525-4287

Southern Region Santa Barbara Office
117 West Micheltorena, Station D
Santa Barbara, CA 93101
Telephone: [805] 568-1207

Structural Safety Information

American Institute of Architects
Local chapters have referral lists of architects; consult telephone directory listing for "American Institute of Architects."

American Society of Home Inspectors
Telephone: [800] 821-6046

Referral list of inspectors.

Building Education Center
812 Page Street
Berkeley, CA 94710
Telephone: [510] 525-7610

California Real Estate Inspection Association
4370 La Jolla Village Dr., Suite 400
San Diego, CA 92122
Telephone: [800] 848-7342 (information)
Telephone: [800] 388-8443 (referrals)

Call for pamphlet describing house inspection services offered by members and referrals to qualified members.

Consulting Engineers and Land Surveyors of California
Telephone: [916] 441-7991

A referral list for engineers is available.

Los Angeles Basin Chapter, International Council of Building Officials
900 South Fremont Avenue
Alhambra, CA 91803
Telephone: [818] 458-3187

Sources for Geologic Information

Association of Bay Area Governments
P.O. Box 2050
Oakland, CA 94604
Telephone: [510] 464-7900
http://www.abag.ca.gov

A consortium of local governments in the San Francisco Bay Area, offering a variety of information, including lists of local resources.

California Academy of Sciences
Golden Gate Park
San Francisco, CA 94118
Telephone: [415] 750-7145

The academy offers earthquake-related displays and lectures.

California Geological Survey
California Department of Conservation
801 K Street
Sacramento, CA 95814
Telephone: [916] 445-5716
http://www.consrv.ca.gov/cgs/

The CGS is the state agency responsible for geological research, mapping, and policy. It provides maps and other information to the general public.

Southern California Earthquake Center
University of Southern California
Telephone: [213] 740-1560
http://www/scec.org

A research, outreach, and education source.

United States Geological Survey
Earth Science Information Center
345 Middlefield Road
Menlo Park, CA 94025
Telephone: [415] 329-4390

This is the federal agency responsible for geological research, mapping, and policy. It provides maps and other information to the general public.

Cities and Counties

Consult your telephone directory under city or county government listings for the office of emergency services or disaster management.

- City or county building and planning department
- City or county government geologist

Sources for Emergency Planning Information

American Red Cross
Consult your telephone directory for the address and phone number of your local chapter.

Federal Emergency Management Agency
Region IX
1111 Broadway, 12th Floor
Oakland, CA 94612
Telephone: 510-627-7000

This agency offers publication lists and referrals to preparedness organizations.

References

Many of the publications in the list that follows—or similar publications—are in your local library's collection or are available through interlibrary loan. Many libraries now lend how-to videos on earthquake safety subjects. Publications without price information can be ordered from bookstores. Neither the State of California nor the Seismic Safety Commission endorses or guarantees the results of any of the procedures described in these publications.

Home Strengthening

Earthquake Hazards and Wood Frame Houses. Center for Environmental Design. 46 pages. (Center for Environmental Design, 390 Wurster Hall, University of California, Berkeley, CA 94720, [510] 642-2896, #CEDR-02-82, $6.50 including postage and handling.)

Earthquake: Home Safe Home. Building Education Center. This 28-minute video program uses animation, computer graphics, onsite demonstrations, and a bus ride to explain how earthquakes can damage your house and what you can do to strengthen it. (Building Education Center, 812 Page Street, Berkeley, CA 94710, [510] 525-7610, $19.95 plus tax, postage, and handling.)

Helfant, David Benaroya. *Earthquake Safe: A Hazard Reduction Manual for Homes.* Seismic retrofitting and technical information is provided in this manual. Fifty-six pages. (Builders Booksource, 1817 Fourth Street, Berkeley, CA 94710, [510] 845-6874, $5.95 plus $3.49 for tax and handling.)

The Home Builder's Guide for Earthquake Design, ATC-4-1. Applied Technology Council. This book offers technical information aimed at engineers and architects. Sixty-three pages. (Applied Technology Council, 555 Twin Dolphin Drive, Suite 550, Redwood City, CA 94065, [415] 595-1542, $17.50 plus tax and postage.)

Introduction to Earthquake Retrofitting. Building Education Center. This is a step-by-step guide to the tools and techniques needed to complete the primary retrofitting projects. 80 pages, illustrated with 60 photos. (Building Education Center, 812 Page Street, Berkeley, CA 94710, [510] 525-7610, $9.95 plus tax, postage, and handling.)

Kimball, Virginia. *Earthquake Ready.* Roundtable, 1988. Advice on preparations for home, office, and school as well as on special care for infants, the elderly, and pets is provided in this book. (Roundtable Publishing, Inc., Santa Monica, CA, $13.95.)

Strengthening Wood Frame Houses for Earthquake Safety. California Office of Emergency Services, Earthquake Progress, Coastal Region. This book covers 15 ways to make houses safer. Thirty-two pages, 16 photos and line drawings. (Association of Bay Area Governments, P.O. Box 2050, Oakland, CA 94604, P90004BAR,
$6 plus tax)

Surviving the Big One: How to Prepare for a Major Earthquake. Los Angeles PBS Station KCET. One-hour videotape. Video stores may carry it in their how-to sections. ($19.95 plus tax and $5 for handling; call [800] 343-4727.)

Yanev, Peter. *Peace of Mind in Earthquake Country.* This basic nontechnical reference on earthquake hazards describes geologic, architectural, and structural hazards and recommends techniques to avoid or correct them. 1990, 200 pages. (Chronicle Books, 85 Second Street, San Francisco, CA 94105, [415] 777-7240, $14.95 plus tax, postage, and handling.)

Guidelines for Seismic Retrofit of Existing Buildings. International Conference of Building Officials, 2001. www.icbo.org 800-423-6587

Geologic Hazards

Bolt, Bruce A. *Earthquakes.* The writer describes the origins, impacts, and aftermath of some devastating earthquakes and what has been learned from them to predict earthquakes more accurately, build structures that resist earthquakes better, and plan more effective emergency responses. 272 pages, New York: W. H. Freeman & Co.,1991.

Davis, James, and others. *Fault-Rupture Hazard Zones in California.* California Department of Conservation, Division of Mines and Geology Special Publication 42, 1988 (revised). This publication includes maps prepared in compliance with the Alquist-Priolo Special Studies Zones Act of 1972. An index to special studies zone maps is provided. 24 pages. (California Division of Mines and Geology, Department of Conservation, P.O. Box 2980, Sacramento, CA 95812-2980, [916] 445-5716, $1 including tax, postage, and handling.)

Iacopi, R. *Earthquake Country.* (Menlo Park, Calif.: Lane Publishing Co., 1978, 6th edition.)

Living on the Fault: A Field Guide to the Visible Evidence of the Hayward Fault. Bay Area Regional Earthquake Preparedness Project, 1988, 16 pages. (Available from the Association of Bay Area Governments, P.O. Box 2050, Oakland, CA 94604, [510] 464-7900, P88004BAR, $5 including postage and handling, plus tax.)

Living on The Fault II: A Field Guide to the Visible Evidence of the San Andreas Fault. Bay Area Regional Earthquake Preparedness Project. 1990, 16 pages. (Association of Bay Area Governments, P.O. Box 2050, Oakland, CA 94604, P90003BAR, $5 plus tax.)

Sharp, R. *Field Guide: Geology of Southern California.* (Dubuque, Iowa Kendall/Hunt Publishing Co., 1994, 3rd edition.)

Emergency Planning at Home

Calhoun, Fryar. *Earthquake Survival Guide: Emergency Planning for Family, Home, Workplace, and School.* 1990, 24 pages. (Magnet Press, P.O. Box 3580, Berkeley, CA 94703, [510] 540-0800, $3.15 including tax, postage, and handling. Call for quantity orders.)

Gere, James M., and Haresh C. Shah. *Terra Non Firma: Understanding and Preparing for Earthquakes.* New York: W. H. Freeman, 1984.

Lafferty, Libby. *Earthquake Preparation for Office, Home, Family, and Community*. (Lafferty and Associates, P.O. Box 1026, La Cañada, CA 91012, [818] 952-5483, $5 plus your local tax.)

Lafferty, Libby. *Earthquake Preparedness.* (La Cañada, Calif.: Lafferty & Associates, Inc., 1986.)

Leach, Joel. *Earthquake Prepared.* (Northridge, Calif.: Studio 4 Productions, 1993.)

Safety and Survival in an Earthquake. American Red Cross. 52 pages. (American Red Cross, 2700 Wilshire Blvd., Los Angeles, CA 90057, [213] 739-5289, $3 plus $1 postage and handling.)

Hiring a Home Inspector, Architect, Engineer, or Contractor

A Consumer's Guide to Engineering and Land Surveying Services. Board of Registration, Professional Engineers and Land Surveyors, 2535 Capitol Oaks Dr., Suite 300, Sacramento, CA 95833, [916] 263-2222, free.

Consumer's Guide to Hiring an Architect. California Board of Architectural Examiners, 400 R Street, Suite 4000, Sacramento, CA 95814-6238, [916] 445-3394, free.

What You Should Know Before You Hire a Contractor. Contractors' State License Board, P.O. Box 26000, Sacramento, CA 95826; [916] 255-3900, free.

For additional references check the Seismic Safety Commission Web site for related links at www.seismic.ca.gov

Residential Earthquake Hazards Report

(See the back of this form for applicable government codes.)

NAME	ASSESSOR'S PARCEL NO.
STREET ADDRESS	YEAR BUILT
CITY AND COUNTY	ZIP CODE

Answer these questions to the best of your knowledge. If you do not have actual knowledge as to whether the weakness exists, answer "Don't Know." If your house does not have the feature, answer "Doesn't Apply." The page numbers in the right-hand column indicate where in this guide you can find information on each of these features.

	Yes	No	Doesn't Apply	Don't Know	See Page
1. Is the water heater braced, strapped, or anchored to resist falling during an earthquake?	☐	☐	☐	☐	3
2. Is the house anchored or bolted to the foundation?	☐	☐	☐	☐	4
3. If the house has cripple walls:					
• Are the exterior cripple walls braced?	☐	☐	☐	☐	5
• If the exterior foundation consists of unconnected concrete piers and posts, have they been strengthened?	☐	☐	☐	☐	6
4. If the exterior foundation, or part of it, is made of unreinforced masonry, has it been strengthened?	☐	☐	☐	☐	7
5. If the house is built on a hillside:					
• Are the exterior tall foundation walls braced?	☐	☐	☐	☐	8
• Were the tall posts or columns either built to resist earthquakes or have they been strengthened?	☐	☐	☐	☐	8
6. If the exterior walls of the house, or part of them, are made of unreinforced masonry, have they been strengthened?	☐	☐	☐	☐	9
7. If the house has a living area over the garage, was the wall around the garage door opening either built to resist earthquakes or has it been strengthened?	☐	☐	☐	☐	10
8. Is the house outside an Alquist-Priolo Earthquake Fault Zone (zones immediately surrounding known earthquake faults)?	☐	☐		☐	19
9. Is the house outside a Seismic Hazard Zone (zone identified as susceptible to liquefaction or landsliding)?	☐	☐		☐	19

If any of the questions are answered "No," the house is likely to have an earthquake weakness. Questions answered "Don't Know" may indicate a need for further evaluation. If you corrected one or more of these weaknesses, describe the work on a separate page.

As seller of the property described herein, I have answered the questions above to the best of my knowledge in an effort to disclose fully any potential earthquake weaknesses it may have.

EXECUTED BY

_____ _____ _____

(Seller) (Seller) Date

I acknowledge receipt of this form, completed and signed by the seller. I understand that if the seller has answered "No" to one or more questions, or if seller has indicated a lack of knowledge, there may be one or more earthquake weaknesses in this house.

_____ _____ _____

(Buyer) (Buyer) Date

This earthquake disclosure is made in addition to the standard real estate transfer disclosure statement also required by law.

Keep your copy of this form for future reference

Earthquakes and Homes—What's the Law?

The following list is a quick summary of the major laws governing seismic safety for residences in California along with code sections for looking up details. Full wording of all California codes is available at the following internet address: http://www.leginfo.ca.gov (Internet access is available at most local libraries).

Publishing this guide—The Seismic Safety Commission is required to develop, adopt, update, and publish *The Homeowner's Guide to Earthquake Safety* containing information on geologic and seismic hazards, explanations of structural and nonstructural earthquake hazards, and recommendations for mitigating these hazards (*Business and Professions Code,* Section 10149).

Delivering this guide—Sellers of homes built before 1960 must deliver to the buyer, "as soon as practicable before the transfer," a copy of *The Homeowner's Guide to Earthquake Safety* (this booklet) and disclose certain earthquake deficiencies (*Government Code,* Title 2, Division 1, Chapter 13.8). The seller's real estate agent is to provide the seller with a copy of the booklet to give to the buyer (*Government Code,* Section 8897.5).

Water heater bracing—All water heaters are required to be anchored or strapped to resist falling during an earthquake. A seller must certify to a prospective buyer that a home's water heater is braced (*Health and Safety Code,* Section 19211).

Disclosing weaknesses—Sellers of real property must disclose known defects and deficiencies in the property—including earthquake weaknesses and hazards—to prospective purchasers (*Civil Code,* Section 1102 et seq.).

Earthquake faults—The Alquist-Priolo Earthquake Fault Zoning Act prohibits building for human occupancy astride active faults. Sellers of existing residences must disclose to potential buyers that the property is located in a designated fault zone (*Public Resources Code,* Section 2621 et seq.).

Landslide and liquefaction—The Seismic Hazards Mapping Act requires the state to prepare maps of the zones in California most susceptible to landsliding and liquefaction hazards during earthquakes. Sellers must disclose to buyers whether the property is in such a zone after the map for that area has been issued officially (*Public Resources Code,* Section 2690 et seq.).

Tax exclusion—California law allows homeowners to strengthen their homes with approved seismic strengthening techniques and to be excluded from reappraisal requirements that usually raise the property value and the tax owed (*Revenue and Tax Code,* Section 74.5).