The Commercial Property Owner's Guide to Earthquake Safety

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On the cover:

The walls of this *precast concrete (tiltup) building* pulled away from the floors and roof in the 1971 San Fernando earthquake. (H. J. Degenkolb Associates, courtesy of ABAG)

This shopping mall *parking structure* collapsed during the 1994 Northridge earthquake primarily because its parts were not well connected to each other. (*Los Angeles Times*)

This *apartment building* with tuck-under parking collapsed during the 1994 Northridge earthquake, crushing a row of parked cars. (*Los Angeles Times*)

This *six-story building* has two steel earthquake-resistant frames, one at each end. Virtually every joint in these two frames sustained at least one weld fracture during the 1994 Northridge earthquake. (EERI)

The *tilt-up wall* of a furniture warehouse collapsed after the 1994 Northridge earthquake. (EERI)

The Commerical Property Owner's Guide to Earthquake Safety

Publishing Information

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Legislation

This guide has been developed by the Seismic Safety Commission as required by Assembly Bills 1968 and 1963, authored by Assemblyman Rusty Areias (Chapter 859, Statutes of 1991, and Chapter 941, Statutes of 1992).

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Copies of this booklet are available by mail from the Seismic Safety Commission, 1900 K St., Sacramento, CA 95814-4186. The price is $5 each (includes tax and shipping) for up to 25 copies. To order, please send your delivery address with a check or money order for the full amount to the Seismic Safety Commission. To order 26 or more copies, call (916) 322-4917 for price and delivery information. Please do not send cash.

Contents

Page

Acknowledgments iv

Introduction 1

Earthquake Weaknesses

Walls Poorly Anchored to Floors and Roofs 3
Unreinforced Masonry Walls 5
Poorly Reinforced Concrete Walls or Columns 6
Steel Frame Buildings 8
Poorly Anchored Exterior Cladding 10
Unusual and Irregular Building Types 11
Vulnerable Features 12
Unbraced Ceiling Systems 13
Unbraced Equipment 14
Unbraced Building Contents 15
Large Windows 17

Geologic Hazards 18

Protect Your Investment 22

Prepare Your Business for Earthquakes 24

Earthquake Checklist for Building Contents 26

Resource Organizations 27

References 29

Commercial Property Earthquake Weakness Disclosure Report 31

Earthquakes and Buildings—What's the Law? 32

Page

Tables

1. Comparison of Costs: Preventing vs Repairing Earthquake Damage 23
2. Example of Property Tax Statement with Exclusion for Earthquake Strengthening 23

Figures

1. Anchoring walls 3
2. Header courses 5
3. Reinforcing steel 6
4. Steel frame 8
5. Bracing ceilings 13
6. Lighting fixtures 13
7. Bracing tanks 14
8. Bolting equipment 14
9. Securing shelves and furniture 16
10. Bolting file cabinets 16
11. Earthquake history 18
12. Seismic zones in California 19
13. Earthquake fault zone map 20
14. Seismic hazard zone map 20

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Introduction

Recent earthquakes reminded us that they can be sudden, destructive, and deadly. But they also proved that preparation saves lives and property. Owners and potential buyers and occupants of commercial property can significantly reduce the risk of earthquake damage by ensuring the strength of that property. Although modern California commercial buildings are among the safest in the world during earthquakes, some of the older buildings contain serious earthquake weaknesses that buyers frequently overlook. This booklet focuses on those weaknesses and ways to correct them.

Using This Booklet

If you plan to *buy* a commercial property, use this guide to help you spot earthquake-related concerns and get them corrected. No law requires sellers of commercial properties to disclose earthquake weaknesses (as is the case for residential properties), so it is up to you to find out about those weaknesses and decide whether the property is a good investment. You can ask the seller to complete a disclosure form, like the one at the back of this booklet, to help you decide.

The earthquake weaknesses listed on the form are those most likely to cause deaths and injuries in an earthquake; however, you should look for *all* the earthquake weaknesses and concerns mentioned in this booklet. You should consider the possibility that the property could be seriously damaged or subject to earthquake-strengthening ordinances, or that you could be liable for earthquake damage to tenants and passersby.

If you *own* commercial property, use this guide to help you assess and manage your earthquake risk so that your property can survive damaging earthquakes. It may be expensive to fix these weaknesses before an earthquake, but it could cost much more to repair the damage afterward.

If you *lease* space in a commercial building, use the guidelines in this booklet to help you decide whether the space is safe in earthquakes. This information can help you protect your business. This booklet will also help you to understand the geologic hazards of earthquakes and evaluate the financial implications of strengthening.

No guarantees of safety during earthquakes are possible, but precautions can increase the odds. The Seismic Safety Commission (SSC) hopes that you will act on the suggestions outlined in this booklet and make yourself, your business, and your commercial property safer before the next damaging earthquake.

Filling Out the Disclosure Report

The disclosure report provided at the back of this booklet can help you decide if a property is a good investment. If you do not understand a question, refer to the “Earthquake Weaknesses” section for a description of that weakness. The description will help you identify the weakness and understand how it can be fixed.

Recommendations If You Are Selling

Before you sell your commercial property you *must* give prospective buyers a copy of this guide if (1) the building was built before January 1, 1975, and has precast (tiltup) concrete or reinforced masonry walls and wood-frame floors or roof, *or* (2) the building has unreinforced masonry walls.

The following steps are recommended but not required:

- Get assistance from a qualified engineer or architect with experience in evaluating earthquake hazards to identify earthquake weaknesses in your property. Such a professional can prepare a written report for you that describes the weaknesses in detail.
- If you list your property for sale by a real estate broker or agent, give the agent a report that describes earthquake weaknesses (like the one at

the back of this booklet) when you sign the listing agreement. Your agent can give this guide and your building's report to the buyer.
- Keep a copy of your report, signed by the buyer, as evidence that you have disclosed the earthquake weaknesses.

You may get a better price for your property if you strengthen earthquake weaknesses, but you are not required to do so. Neither are you required to remove siding, drywall, or plaster to identify earthquake weaknesses.

Recommendations If You Are Buying

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

- Read this guide and review all information disclosed by the seller. Pay special attention to any items that indicate earthquake weaknesses.
- Find out how well the property's design would withstand earthquakes. You may wish to have a qualified architect or engineer with experience in evaluating earthquake weaknesses give you an opinion regarding your property and the cost to improve its ability to withstand earthquakes.
- Consider the property's location. Is it in or near a fault rupture zone or near a buried fault considered to be active? Is it 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 building.
- If weaknesses are found in the property, consider negotiating the cost of strengthening with the seller. If the weaknesses are not fixed you may find that repair costs after an earthquake could exceed your equity in your property or force you to sell at a loss. You could also be liable for deaths, injuries, or property losses.
- Develop emergency plans to deal with earthquake damage repairs and business recovery.
- Check whether the community has earthquake strengthening ordinances that would affect the property.

Legal Requirements for Selling Your California Commercial Property

If you are planning to sell a commercial building constructed before 1975, and it has precast (tiltup) concrete or reinforced masonry walls and wood-frame floors or roof, or if it has unreinforced masonry walls, state law requires you to give a copy of this booklet, *The Commercial Property Owner's Guide to Earthquake Safety*, to the buyer.

You are not required to hire anyone to evaluate your property, although you may find it in your best interest to do so. The state does not require you to strengthen your property to resist earthquakes, but you should check to see whether your local government requires such a measure.

Earthquake Weaknesses

EARTHQUAKE WEAKNESS

Walls Poorly Anchored to Floors and Roofs

The Problem

When earthquakes shake the ground, the various parts of buildings may move in different directions. If the connections (anchorage) between the walls, wood floors, and roof are weak, concrete or reinforced masonry walls can pull away (see figure 1: a, b, c) and the building, or a portion of it, may collapse. Until the mid-1970s, the *Uniform Building Code* did not require new buildings to have wall anchorage that was adequate to prevent separation between the walls and the roof.

How to Identify It

Check buildings with precast (tiltup) concrete or reinforced masonry walls that were built before 1975 for wall anchorage. The Northridge earthquake showed that some of the types of anchorages installed even after 1975 were not adequate to support the walls. It is a good idea to check all anchorages to post-Northridge standards. Poor wall anchorage is also common in unreinforced masonry buildings.

What Can Be Done

Contractors can add new anchorage on the roof or inside, above the ceiling (see figure 1e), at relatively low cost. If you suspect your building has poor wall anchorage, consider hiring a qualified engineer or architect to determine the most cost-effective way to strengthen it. A good time to check and fix wall anchorage is when you replace or patch your roof.

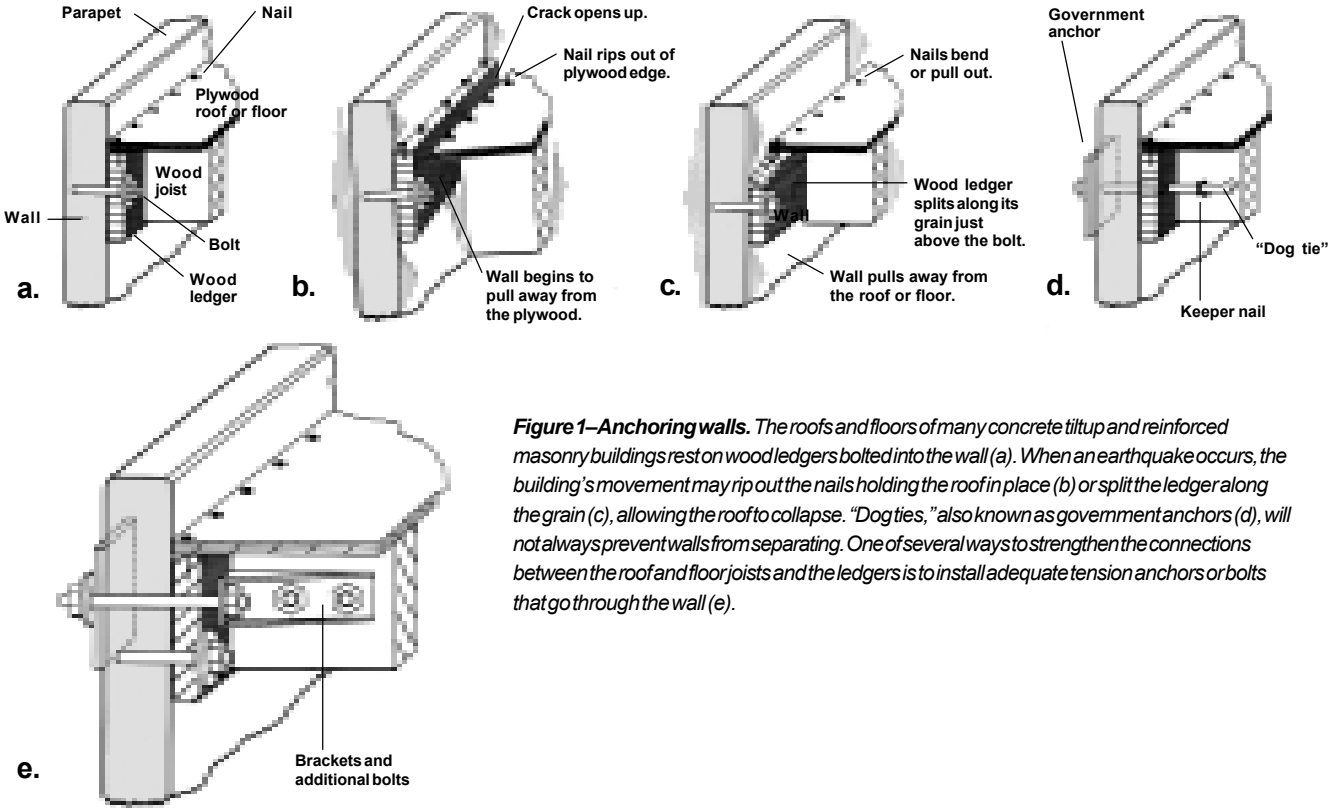

Figure 1–Anchoring walls. *The roofs and floors of many concrete tiltup and reinforced masonry buildings rest on wood ledgers bolted into the wall (a). When an earthquake occurs, the building's movement may rip out the nails holding the roof in place (b) or split the ledger along the grain (c), allowing the roof to collapse. "Dog ties," also known as government anchors (d), will not always prevent walls from separating. One of several ways to strengthen the connections between the roof and floor joists and the ledgers is to install adequate tension anchors or bolts that go through the wall (e).*

Walls Poorly Anchored to Floors and Roofs (continued)

Even newer buildings aren't immune to earthquakes. The wall anchorages of this reinforced masonry strip mall (right), built in the early 1980s, failed in the Landers earthquake of 1992 so that the parapet and the top of the front wall fell into the parking lot. The roof of a department store in Yucca Valley (below) was not well anchored to the walls; it partially collapsed in the same earthquake.

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EARTHQUAKE WEAKNESS

Unreinforced Masonry Walls

The Problem

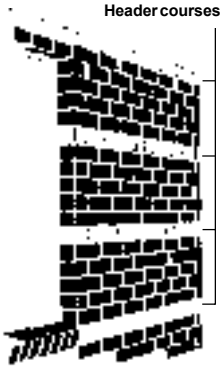
Buildings built of unreinforced masonry—brick, hollow clay tiles, stone, concrete blocks, or adobe—are very likely to be damaged in earthquakes because the mortar holding the masonry together may not be strong enough to resist earthquake forces. These buildings are usually brittle; they cannot flex and return to their original shapes as wood-frame buildings can. In addition to the danger of buildings' collapsing during earthquakes, masonry can peel off the tops of walls, pull away from floors or roofs, and fall on people, neighboring buildings, or streets below. Even if your building is safe, your neighbor's unreinforced masonry building may damage your building or injure your employees or tenants.

How to Identify It

If the walls are made of brick or stone (which you can determine from the outside unless the walls are covered), check them for "header courses" of bricks turned endwise every five or six rows (see figure 2) to hold unreinforced brick walls together. If the building was built before 1940, the walls are most likely unreinforced.

If the wall is made of concrete block, it can be difficult to determine whether reinforcing steel was added during construction. The services of an experienced testing laboratory may be able to determine whether reinforcing steel is present. Otherwise, consulting the building's plans, which may be on file with the building department, might be the only way to tell without damaging the wall.

Figure 2–Header courses. *Header courses of bricks are usually placed endwise every six or so rows in unreinforced masonry walls to tie the outer layer of bricks to the layers inside the wall. However, the mortar that holds all of the bricks in place usually is not strong enough to resist earthquake shaking.*



J. DEWEY, USGS, COURTESY OF NGDC

The second-story wall of this unreinforced masonry building was not well-tied to the roof, and the building collapsed during the 1994 Northridge earthquake.

What Can Be Done

Unreinforced masonry is a weakness that requires the services of a qualified and experienced engineer or architect to correct. Strengthening may require anchoring the walls to the floors and roof, adding interior partitions or walls, installing braces, or other measures. Strengthening will greatly reduce the hazards to life but may not guarantee that unreinforced masonry buildings will be repairable after an earthquake. Additional specific measures might be required for such assurance.

If your unreinforced masonry building is located in seismic zone 4 (see page 19) and you have received notice that it contains unreinforced masonry bearing-wall construction, you must post a sign that says, "**This is an unreinforced masonry building. Unreinforced masonry buildings may be unsafe in the event of a major earthquake**."

The sign must be in a conspicuous place at the entrance of the building, it must be at least 5 inches by 7 inches, and it must be lettered in bold type no smaller than 30 points in size. This posting requirement does not apply to unreinforced masonry buildings if the walls are non-load-bearing and have steel or concrete frames (*Government Code*, Section 8875.8(a)).

EARTHQUAKE WEAKNESS

Poorly Reinforced Concrete Walls or Columns

The Problem

By itself, concrete is brittle and easily cracked during an earthquake. But with the addition of reinforcing steel, concrete buildings can be made strong enough to withstand earthquake forces. However, the concrete walls or columns of structures erected before 1975 often lack enough reinforcing steel to keep them from collapsing or being damaged beyond repair. These buildings can pose the greatest threat to life in major earthquakes because, though total collapse of these buildings is rare, just one collapse could cause hundreds of deaths. In 1971, three concrete hospital buildings in the San Fernando Valley collapsed, killing 52 people; 43 people were killed in the collapse of a concrete freeway viaduct during the Loma Prieta earthquake of 1989. These structures lacked sufficient steel to confine the concrete and allow it to bend but not fall apart (see figure 3).

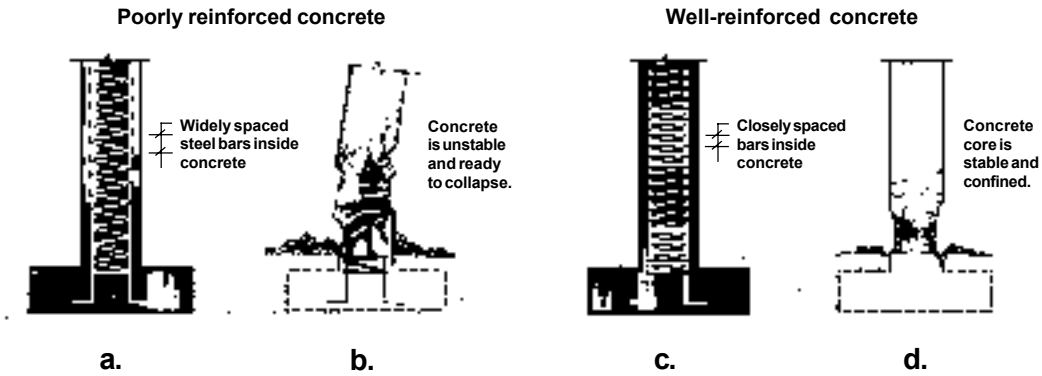
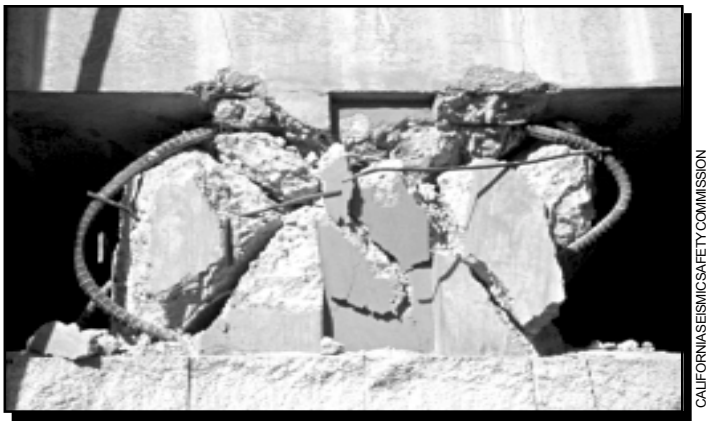


Figure 3–Reinforcing steel. *If the confining reinforcing steel in a column is too widely spaced (a), it will not be able to keep the vertical reinforcing bars and the concrete in place when it is shaken by an earthquake (b). The addition of more confining steel (c) keeps the vertical reinforcing bars from buckling and the concrete from shifting so that the building continues to be fully supported (d).*

Short columns in this parking structure failed in the 1994 Northridge earthquake. Modern building codes now require much more reinforcing steel for such short columns.



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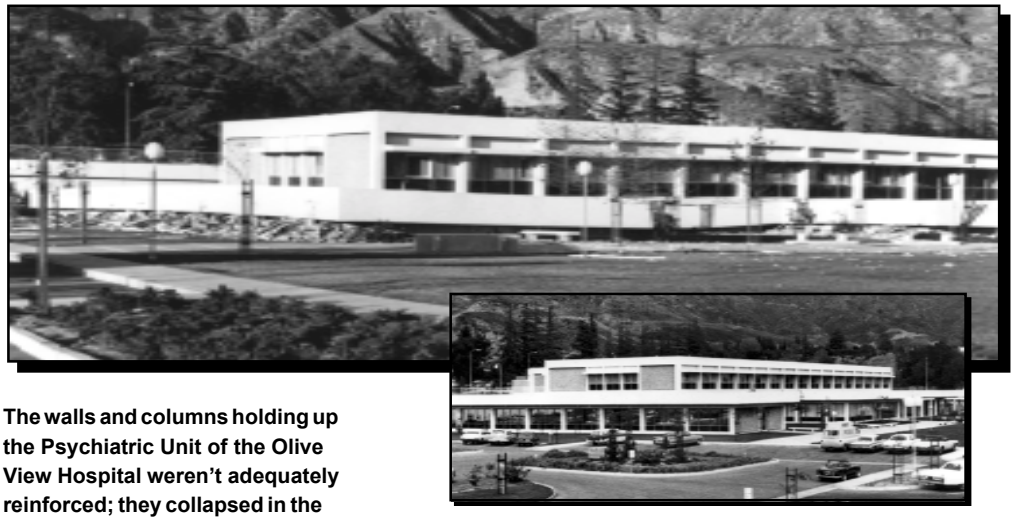
How to Identify It

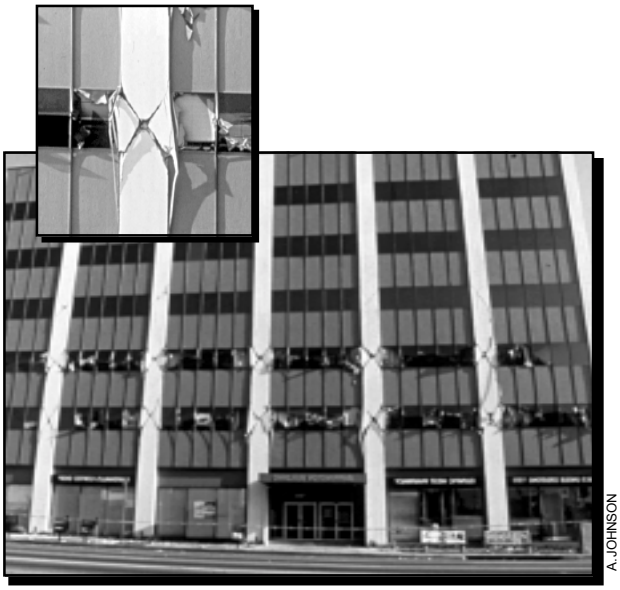
Hire an engineer or architect to help you review your building's plans and determine whether it has this weakness, particularly if the building has many large windows, an irregular shape, or a tall, open first floor.

What Can Be Done

New walls or bracing can be added, and columns can be wrapped with steel, new concrete, or other confining material, so that these buildings can survive ground shaking. A qualified engineer or architect can help you decide on the most cost-effective way to strengthen your building.



The walls and columns holding up the Psychiatric Unit of the Olive View Hospital weren't adequately reinforced; they collapsed in the San Fernando Earthquake of 1971. It was a two-story building before the earthquake (inset). This type of construction is common in older California commercial buildings.



A. JOHNSON

This medical office building's exterior cladding affected the way its frame responded to shaking, and the columns failed during the 1994 Northridge earthquake. The building was demolished and all medical records inside were destroyed.

EARTHQUAKE WEAKNESS

Steel Frame Buildings

The Problem

In past earthquakes, fractures (cracks) occurred in steel frame buildings built before 1995 in two locations: (1) in welds and steel elements in or near steel beam-to-column connections (see figure 4 and top photo, page 9); and (2) in column base plates (see bottom photo, page 9). Such fractures are often small and hard to detect because they may be covered by fireproofing, interior walls and ceilings, and exterior facades. Slender or thin-walled steel braces can buckle prematurely in buildings built before 1982. The reasons for damage to steel members are not fully known but may include workmanship, design, welding procedures, and material characteristics.

Some buildings with subtle structural damage also will suffer movement-related damage such as cracked finishes around columns and beams, cracked or out-of-plumb partitions or door frames, damaged ceilings, and broken glass. In cases of extreme damage, partial collapse may be possible.

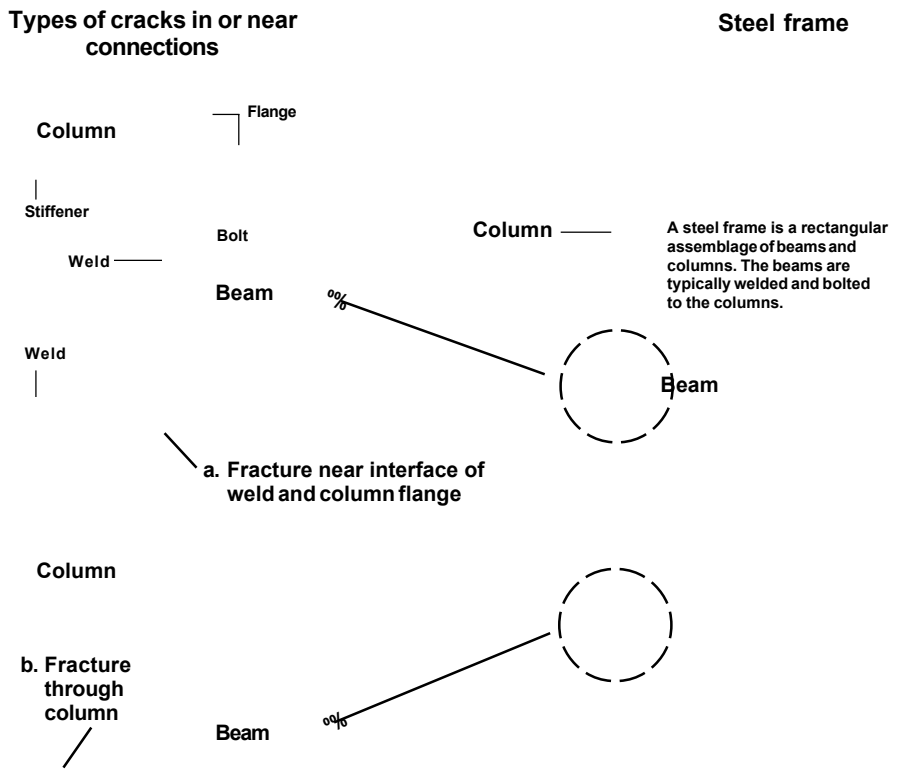


Figure 4–Steel frame. *Two types of cracks found in steel frame buildings after earthquakes.* (Adapted from photo provided by *Los Angeles Times.*)

How to Identify It

If your steel frame buildings have been exposed to strong ground shaking in the past and you have observed the damage described above, contact an appropriately experienced structural or civil engineer or architect to assess the need to investigate critical areas in the buildings. Owners of other steel buildings who are concerned about the potential for such damage are also encouraged to obtain qualified opinions.

Building investigations typically involve the localized removal of finishes and fireproofing, visual observations, and testing, where appropriate. This work may disrupt occupants for a short time.

What Can Be Done

Repair and retrofit techniques and recommended guidelines are currently available from the SAC Joint Venture for welded steel moment frame buildings (see “Resource Organizations,” page 27). Retrofit and repair guidelines are available from the Federal Emergency Management Agency (FEMA) and the International Conference of Building Officials (ICBO) for other types of steel buildings (see “Resource Organizations”). Engineers should obtain and consider these latest guidelines when designing retrofits or repairs.

Steel frame connections unexpectedly cracked in the 1994 Northridge earthquake.

A 4-inch-thick steel plate supporting the base of a column at the Oviatt Library at CSU Northridge fractured in the 1994 earthquake.

EARTHQUAKE WEAKNESS

Poorly Anchored Exterior Cladding

The Problem

The cladding on the outside of some buildings can sustain damage and even fall off if it does not allow the building to flex when the ground shakes. Precast concrete cladding, with or without stone facing, is heavy. The steel connections holding it to the building must be strong enough to allow the building to move in an earthquake without failing. In addition, gaps or joints between cladding units must be large enough and in the right places to accommodate building movement.

How to Identify It

Engage a qualified engineer or architect to help you evaluate the condition of cladding and its ability to allow for earthquake movement.

What Can Be Done

Poor connections can be strengthened or replaced. You will need to hire a qualified engineer or architect.

JOSEPH RYCHETNIK PHOTO, COURTESY OF EERC

Cladding on this store in Anchorage failed in the 1964 Alaska earthquake.

EARTHQUAKE WEAKNESS

Unusual and Irregular Building Types

The Problem

Buildings with irregular configurations, unusual designs, long spans, large assembly areas, or other unique features can be more vulnerable to earthquake damage than simple buildings. Numerous parking structures with ramps suffered partial collapse during the Northridge earthquake. Buildings with large, unbraced expanses of glass at the ground floor (soft stories) have been prone to collapse in major earthquakes throughout the world because the ground-floor interior walls and columns were not strong enough to hold up the building during earthquake shaking.

How to Identify It

Consult with a qualified engineer or architect to identify the hazards, if any, of unusual designs and features. A building that is anything other than a plain box with four walls, floors, and a roof needs careful engineering attention. For example, apartments with “tuck-under” parking garages can be irregular and perform poorly in earthquakes. Irregularities in the building’s footprint can be earthquake weaknesses. Buildings with long spans over large assembly areas such as theaters, auditoriums, and churches should be carefully evaluated, since a collapse could be catastrophic.

What Can Be Done

The earthquake weaknesses of irregular or unusual building features can be reduced by strengthening or other means. You should rely on the advice of a qualified engineer or architect.

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This modern wood-frame apartment building had a central driveway, and it collapsed inward over unbraced entrances to first-story parking during the 1994 Northridge earthquake.

J. DEWEY, USGS

(Top) Tuck-under parking structures like this can collapse. This building is leaning but did not collapse in the 1994 Northridge earthquake. (Bottom) This apartment building’s soft story collapsed on cars during the 1994 Northridge earthquake.

EARTHQUAKE WEAKNESS

Vulnerable Features

The Problem

Parapets–Parapets are the walls that project above the roof. It is very important that parapets are braced or reinforced so they cannot fall on passersby during an earthquake.

Chimneys–Unreinforced brick and stone chimneys often collapse in earthquakes. These chimneys should be braced or replaced to prevent injury or property damage.

Signs, marquees, canopies–These items should be braced so they do not pose a hazard to passersby. Check periodically to make sure their connections are not rusting away.

Heavy roofs–Buildings with heavy roofs (clay, tile, and slate, for example) shake more in an earthquake than buildings with lighter roofs. Such roofing materials may even fall off, injuring people and damaging objects below.

Stairs, balconies, overhangs–If these features aren't properly braced or attached to the building, they can collapse or prevent occupants from leaving the building after an earthquake.

Dry rot, insect infestation, deterioration–Dry rot, termites, boring beetles, or lack of maintenance can weaken a building and make it more prone to earthquake damage.

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This under-reinforced concrete parapet in Rio Dell only cracked in the Cape Mendocino earthquake of 1992. The one on the front of the building (right) fell off.

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The chimney on this building fell on the stairway in the 1992 Big Bear earthquake, cutting off a means of escape for persons on the second floor.

J. DEWEY, USGS

Stairs to an apartment building collapsed during the 1994 Northridge earthquake.

What Can Be Done

If your property has one or more of the features described above, get an architect or engineer who is experienced in earthquake strengthening of existing buildings to give you a quick, preliminary evaluation. Use such an analysis to help you decide what to do to make sure your building and its occupants can survive a damaging earthquake. Keep features such as children's play areas, outdoor restaurants, and storage areas out of the striking range of falling masonry, roof tiles, parapets, and overhangs. Replace infested or deteriorated building material before you strengthen.

EARTHQUAKE WEAKNESS

Unbraced Ceiling Systems

The Problem

Unbraced acoustic-tile ceiling systems can shake loose during earthquakes. Heavy light fixtures and duct vents are particularly hazardous to occupants if they are not properly connected to the roof or the floor above (see figures 5 and 6). Unbraced ceilings can hit fire sprinkler heads, which may release water and flood the building.

How to Identify It

Lift a ceiling tile and look up into the space above the ceiling. If the tiles seem loose in their frames, they may fall when the building begins to move. In rooms more than 12 feet wide, you should see diagonal wires and vertical pipe struts connecting the ceiling tiles' framework to the building's framing above, spaced every 12 feet. Look for wide, secure supports for the ceiling framework around the room's edges. Each light fixture and duct vent should be securely supported with at least two wires to the building framing above.

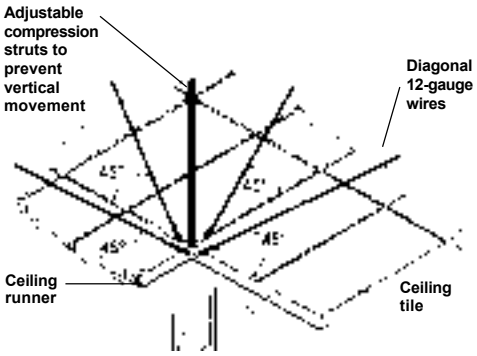


Figure 5–Bracing ceilings. *This view from the top of the ceiling tiles shows diagonal bracing and struts to keep the tiles from falling in earthquakes.*

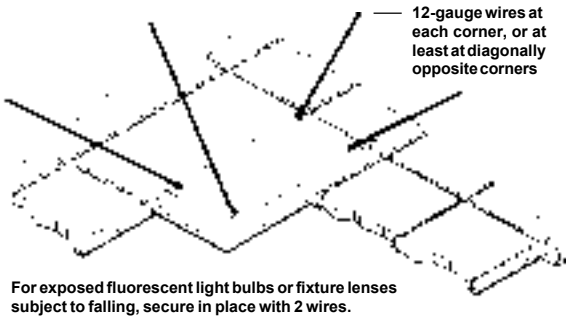
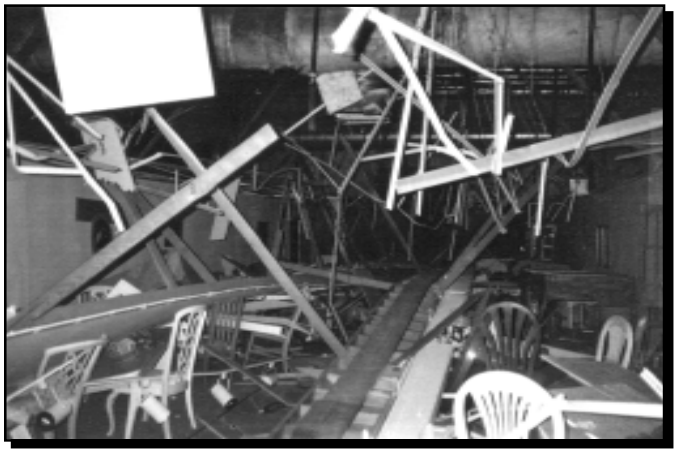


Figure 6–Lighting fixtures. *Fluorescent lighting fixtures should be secured so they will not present hazards.*

What Can Be Done

Wire hangers and braces can be added to ceiling systems, light fixtures, sprinklers, and vents. You can either make the additions yourself or hire a contractor. Make sure there are gaps that will allow pipes to move where they pass through ceilings and partitions.

This building sustained massive interior nonstructural damage, including complete failure of the partitions during the 1994 Northridge earthquake. Diagonal wooden members were bracing the tops of the partitions prior to their collapse. The entire ceiling grid as well as ceiling acoustical tiles have fallen.



J. MASEK, EERI

EARTHQUAKE WEAKNESS

Unbraced Equipment

The Problem

If mechanical and electrical equipment such as water heaters, air conditioners, water or propane tanks, boilers, and shop equipment are not securely attached to a wall, floor, or roof, it can topple or slide in earthquakes. If gas, electrical, water supply, or waste lines are broken when these items move, they may cause fire or flood damage.

How to Identify It

Examine your water heater and other mechanical or electrical equipment to see if there are anchors, metal straps, or braces around them that are bolted to the wall, floor, or roof. Make sure the bolts go into the wall studs or solid concrete, not just the drywall or plaster. Pull on the straps or braces to make sure they are secure and taut.

What Can Be Done

The equipment can be secured to the structure by using bolts or braces (see figures 7 and 8). Add flexible connections between the equipment and gas and water lines. Avoid rigid connectors to solid pipe, which may fail in earthquakes.

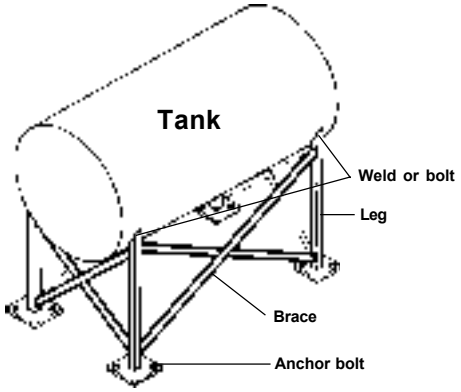


Figure 7–Bracing tanks. *Tank supports should be cross-braced as well as bolted to the floor. (BAREPP)*

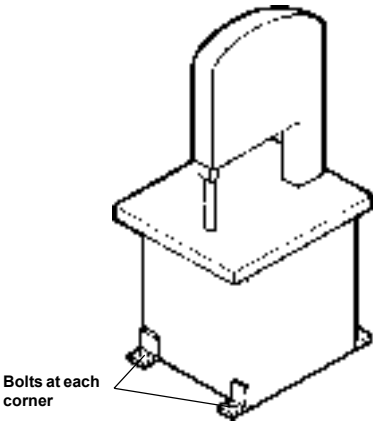
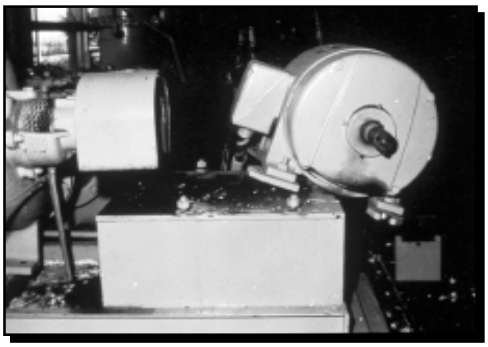


Figure 8–Bolting equipment. *Light equipment can be bolted to a concrete floor with expansion bolts. For methods of securing heavier equipment, consult an engineer. (BAREPP)*

DON JEPHCOTT, EERI

The support pedestal system of this oxygen tank at Olive View Medical Center was damaged after the 1994 Northridge earthquake, leaving the tank leaning. The tank is shown after it was removed to allow for installation of a replacement unit.



CALIFORNIA SEISMIC SAFETY COMMISSION

This motor slid out from under the heads of the bolts holding it down. Tight bolts installed in holes—rather than slots—in its base would have held it in place.

EARTHQUAKE WEAKNESS

Unbraced Building Contents

The Problem

The contents of your building can be damaged or can cause damage in earthquakes. They may injure your building occupants or block emergency exits; it can be expensive to repair and replace items that are broken. You should be concerned about contents, not only to protect your property but also to guard against liabilities for deaths or injuries.

Earthquake shaking may cause light fixtures and bookshelves to fall, and other large items to topple or move across the floor (see figures 9 and 10). Equipment may be disabled or severely damaged. It may take considerable time and money to replace or repair computers, vital records, and specialized technical equipment. Heavy crates or boxes stacked high, such as those in warehouses or discount stores, can fall on tenants, employees, or customers.

How to Identify It

Look around your building for items that could fall or move during earthquakes. Could your file cabinets fly open, allowing the contents to scatter on the floor? Could unanchored storage or display shelves topple or lose their contents?

What Can Be Done

Door latches, braces, and fasteners to fix nonstructural hazards can be installed as part of your regular maintenance activities. Fasten heavy equipment and furniture to the floor or to the studs in the walls. Store heavy objects on low shelves or in areas that pose fewer hazards. Make sure your employees or tenants secure items such as tall furniture or equipment when it is installed or moved. See the “Earthquake Checklist for Building Contents,” “Resource Organizations,” and “References” sections (pages 26–30) for help in identifying and dealing with these hazards.

H.J. DEGENKOLB ASSOCIATES

Shelves like these can topple like dominos.

BILL McKEVITT, EERI

The storage rack collapsed in this warehouse-style retail store during the 1994 Northridge earthquake. Heavy items such as the sofa in the center of the photo crashed to the ground and could have injured employees and shoppers.

Unbraced Building Contents (continued)

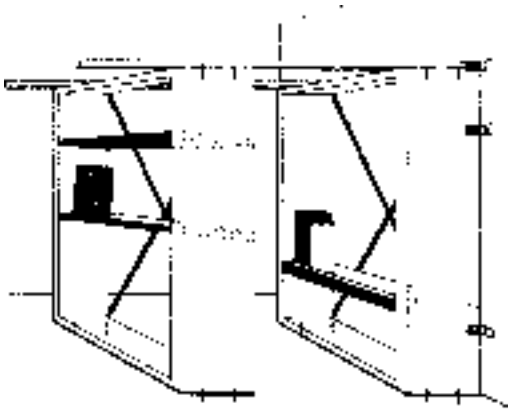


Figure 9–Securing shelves and furniture. *Attach rows of shelving and other tall pieces of furniture to the wall and to each other for support; tilt the shelves or install shelf parapets or other restraints to keep objects from falling off shelves. (BAREPP)*

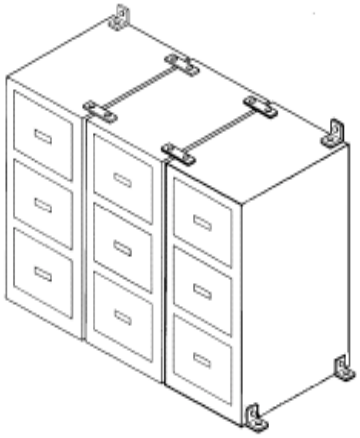


Figure 10–Bolting file cabinets. *Bookcases and file cabinets should be bolted to the wall and to each other to keep them from falling. File drawers should have latches so they can't open in earthquakes. (BAREPP)*

CALIFORNIA SEISMIC SAFETY COMMISSION

The pallets of canned goods stored here fell off the shelving during the 1989 Loma Prieta earthquake and pushed out the concrete wall of this Hollister warehouse.

EARTHQUAKE WEAKNESS

Large Windows

The Problem

If a building has large windows, the glass may break when the ground shakes, especially if there are only narrow walls on each side of the windows. In a major earthquake, buildings with large storefront windows can lean over and even collapse if the front wall is inadequately braced. Buildings on crowded city blocks are especially prone to damage if the buildings are near enough to pound against each other during earthquakes.

How to Identify It

Check to see if there are solid walls, diagonal braces, plywood panels, or heavy steel frames next to any large window. Such a window does not always indicate an earthquake weakness. There are no simple rules of thumb for determining whether or how much bracing is needed or where it should go. You will need the help of an architect or engineer with experience in earthquake strengthening.

What Can Be Done

New steel framing or plywood paneling can be installed around a storefront window. New window mullions can be added to replace a large piece of plate glass; this change will allow for more movement. Plastic film can be applied to the windows to keep the pieces from scattering if a window does break. You should consult a qualified architect or engineer if you have large or numerous windows, especially on the ground floor of your building.

CALIFORNIA SEISMIC SAFETY COMMISSION

The front window of this Fortuna auto parts store broke in the 1992 Cape Mendocino earthquake.

CALIFORNIA SEISMIC SAFETY COMMISSION

The windows in this San Francisco building probably broke because its frame flexed too much in the Loma Prieta earthquake of 1989.

Geologic Hazards

Your building can be damaged by the direct effects of an earthquake on the nearby ground, such as strong shaking, rupture, landslide, or liquefaction; or by indirect effects such as tsunamis or dam failure. All these hazards are possible, but they are more likely to affect certain areas (see figures 11 and 12) and certain types of buildings. To supplement the basic information about possible problems within buildings presented earlier in this book, this section has the following purposes:

- To describe briefly the basic geologic or geology-related hazards
- To introduce the government mapping programs that propose to define which areas are susceptible to those hazards

Ground Shaking—Ground shaking causes more than 90 percent of the earthquake damage to California buildings. Geologists believe that areas near large active faults (see figure 13) are more likely to be shaken than areas in the rest of the state. All the precautions and strengthening measures described so far prepare a building to resist strong shaking and are likely to be the most effective and economical means to help prevent damage.

Figure 11–Earthquake history. *California has experienced many damaging earthquakes over the last 150 years. The sizes of the dots on this map indicate the relative magnitude of earthquakes that occurred at these locations.*

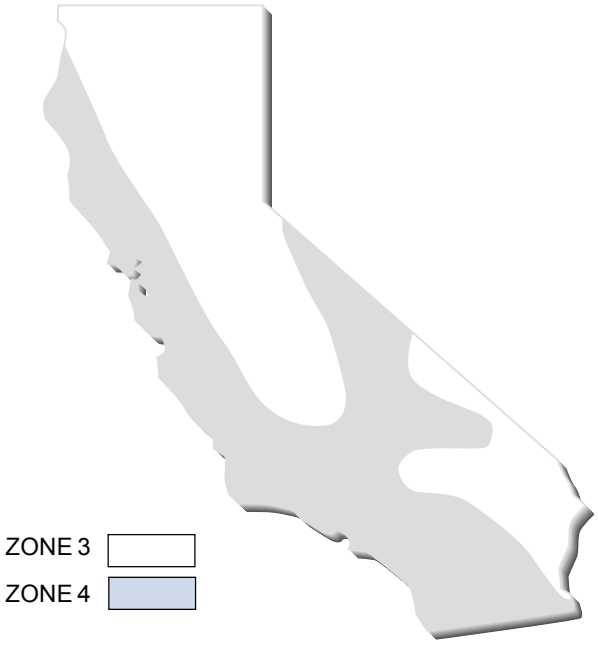


Figure 12–Seismic zones in California. *All of California is in seismic zone 3 or 4 on Uniform Building Code maps. There are four U.S. zones; the higher the number, the higher the earthquake danger. Stronger standards for buildings in zones 3 and 4 have been adopted in the* Uniform Building Code.

Fault Rupture—Fault rupture is an actual crack or breaking of the ground along a fault during an earthquake. A building located over an active fault can be torn apart if the ground ruptures. If the building is located over a "creeping" fault—one that moves in a series of very small earthquakes rather than 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 buildings on the slope and crushing buildings downhill.

Liquefaction—When earthquakes shake loose, wet, sandy soil, the soil can become almost like quicksand, losing its ability to support structures and allowing the foundation of a building 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 structures 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 over 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 United States. 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 (see figure 12). Essentially all the most populous areas of California are in seismic hazard zone 4.

State Fault and Hazard Zones—The California Division of Mines and Geology (CDMG), part of the Department of Conservation, works closely with the U.S. Geological Survey (USGS) by sharing seismic and geologic data. Because of its California orientation, the CDMG maps our state hazards in detail. Two of CDMG's mapping programs are of direct significance to commercial property owners:

- *Earthquake Fault Zone Maps*—showing active faults and defining zones surrounding the fault that require special geotechnical studies before they can be used for building
- *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

In addition, *Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada* are now available from the International Conference of Building Officials (see "References").

Earthquake Fault Zones

The Alquist-Priolo Earthquake Fault Zone maps (see figure 13) show known active earthquake faults and identify a quarter-mile-wide zone with the fault line at the center. The law that requires the creation of these maps also requires that the information be incorporated into local general plans. Your local building department should be able to show you the Alquist-Priolo maps for your area. The "Resource Organizations" section also tells how to contact the Division of Mines and Geology.

Figure 13–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.*

Seismic Hazard Zones

In effect since 1991, the Seismic Hazards Mapping Act focuses on two hazards: liquefaction and landslides (see figure 14). The Seismic Hazards Mapping program is patterned after the Alquist-Priolo Earthquake Fault Zoning Act, which addresses surface fault rupture. The following features apply to 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.

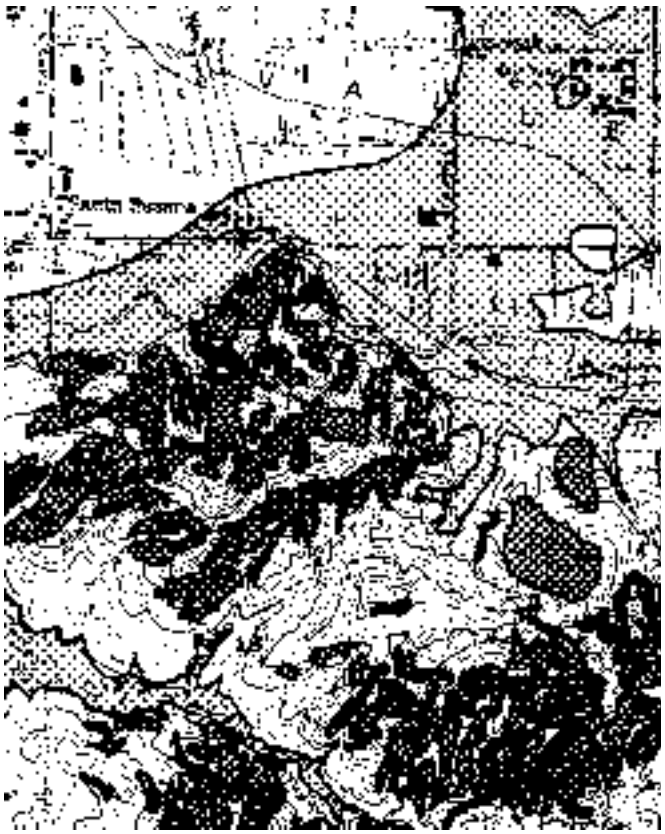


Figure 14–Seismic hazard zone map*. This area near Simi Valley is shown on a map produced in accordance with the Seismic Hazards Mapping Act. The map designates zones that have the potential for liquefaction (dotted pattern) or landslide (crosshatch pattern).*

- At the time of sale, sellers of real property within a hazard zone must disclose that the property lies within such a zone.

The Seismic Hazards Mapping Act and related regulations establish a statewide minimum standard for construction that should reduce the chances that a building will collapse so completely that it kills its occupants. Saving lives is the first priority; however, doing so does not mean that the building will still be usable after the quake.

The first seismic hazard zone maps were released in April 1997. A large portion of California has not yet been mapped. The requirements of the mapping act become effective for a location when the maps for that location are 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.

How Does the Information Affect You?

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, the earthquake occurred in an area where faults had already been discovered, so the potential for an earthquake in that general location was well-known.

Also keep in mind that, should an earthquake occur, effects of the types of potential hazards 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.

Protect Your Investment

One of the first questions you will have to answer before you strengthen your building is: How strong should it be? Making it strong enough to prevent collapse and protect tenants, employees, and passersby from death or injury is a minimum; you may also want to spend the additional money that could be required for assurance that equipment and inventory remain intact or that you will be able to resume operations within a short time. Your potential liability for deaths, injuries, and property damage is yet another consideration.

Getting the Work Done

You will need building permits to strengthen most earthquake weaknesses except for minor projects that do not require structural changes (bracing your water heater, shelving, ceilings, and building contents, for example). The projects described in this guide are intended only to give you an idea of what needs to be done; they are not "how to" instructions. Many publications describe ways to complete these strengthening projects. See the "References" and "Resource Organizations" sections in this booklet. Even if you don't plan to do some of the work yourself, you should review several of the publications to get a better idea of what your architect or engineer and contractor might recommend.

For more complex projects, you will need a qualified engineer or architect for help in assessing the earthquake weaknesses of your property, estimating the costs of correcting them, and preparing the plans and specifications required for a building permit. Such experts can also advise you about selecting a contractor.

When obtaining help, make sure the professionals are properly qualified. They should have experience in earthquake strengthening and possess the appropriate state licenses. See the "References" and "Resource Organizations" sections in this booklet. Check references carefully and ask for examples of previous jobs similar to yours.

If your building has been designated a "historical property," you will be required to comply with the *State Historical Building Code* to preserve your building's historical features when you strengthen it.

Strengthen or Repair?

Repairing damage to property after earthquakes can be very expensive. Repairs will be only part of your costs; you may also lose rents and you or your tenants may lose sales or customers. After an earthquake, you or your tenants may not be able to occupy your building until the damage is repaired. Table 1 shows the typical range of costs to strengthen a building. The low end is the approximate cost of a simple job on an average building. The upper end is for a more complex job. Costs vary from job to job so ask your architect, engineer, or contractor to explain how the cost of your job was estimated.

Although your costs may vary from these estimates, they give you some idea of the risks of not doing the work. Usually it is less expensive and safer to strengthen your building *before* the earthquake than to fix it afterward. These figures do not compare costs of business interruption and rent loss during strengthening to costs of postearthquake repairs. You have the flexibility of planning around a strengthening project, but a repair project may catch you off guard. After an earthquake you will have far more trouble hiring architects, engineers, and contractors when so many people in your area are trying to get repairs done. And, most importantly, strengthening will reduce deaths, injuries, and litigation in future earthquakes.

Property Tax Exclusion

To encourage property owners to complete earthquake strengthening projects, the state provides a property tax exclusion for such projects. Usually, if you make an improvement to your building, your assessed value and property tax bill will go up. However, a strengthening project to help your building resist earthquakes will not increase your property taxes even though it should increase the value of your property when you decide to sell. Table 2 shows how your property tax might be affected by improvements.

You must file a form to claim the exclusion if you have an earthquake strengthening project on your property. Talk to your county assessor's office to find out the local procedure for filing for a tax exclusion.

(For more information, see "Earthquakes and Buildings—What's the Law?" at the back of this guide.)

Earthquake Insurance and Disaster Aid

Affordable earthquake insurance may not be available for your property, especially if it has earthquake weaknesses such as poor wall anchorage, unreinforced masonry, or poorly reinforced concrete. If you have strengthened your property, make sure your insurer knows about it. Get a report from your engineer or architect that describes the work that was done and evaluates the property's ability to withstand a damaging earthquake. You and your tenants may want to consider taking out inventory and business interruption insurance. Even if your building is not damaged in an earthquake, your street may be closed or utilities may not be available afterward.

Earthquake insurance charges are added to your normal property insurance premium. They depend on your location, the size and type of your building, and other factors. The policies generally carry a 10 percent deductible of the property's replacement value. A 10 percent deductible means an earthquake must do more than $40,000 worth of damage to a $400,000 property before the insurance company pays for any damage; you must pay the first $40,000 to repair the property.

The state and federal government have programs that may help you rebuild or reopen your business after an earthquake. However, these are primarily *loan* programs; many property owners or businesses cannot afford to take on the additional debt and have difficulty in meeting the application requirements, especially if business records weren't well kept or were destroyed in the earthquake. Moreover, funds are limited and it may take weeks or months to process applications. A small business can disappear while waiting for its loan to be approved. According to the *Disaster Recovery Journal,* 43 percent of companies struck by a catastrophe, such as a major earthquake, never resume operations, and 28 percent of those that do close within three years.

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

Earthquake strengthening project	*Cost* to strengthen building before earthquake*	*Cost* to repair unstrengthened building after earthquake*	*See page*
Anchor building walls to floors and roof	$0.80–$5.00	$10.00 to total**	3
Strengthen unreinforced masonry building	$10.00–$60.00	$30.00 to total**	5
Strengthen older concrete building	$10.00–$60.00	$10.00 to total**	6
Brace ceiling systems and building contents	$0.20–$2.00	$1.00–$100	13, 14, 15

*Cost—amount quoted per square foot
**Total—cost to replace building, which may be damaged beyond repair

Table 2—Example of Property Tax Statement with Exclusion for Earthquake Strengthening

Taxable item	*Cost*	*Property tax amount**	*Total property tax***
Property purchase	$400,000	$4,000	$4,000
Major tenant improvements	$100,000	$1,000	$5,000
Strengthening earthquake weaknesses	$60,000	$600	$5,600
Less: Exclusion for earthquake strengthening		–$600	$5,000

*Calculated at 1 percent of value.
**Cumulative total.

Prepare Your Business for Earthquakes

California has experienced at least five damaging earthquakes since 1989. The U.S. Geological Survey predicts a 90-percent chance of at least one major earthquake's striking an urban area in California in the next 30 years. Two recent earthquakes, Loma Prieta in 1989 and Northridge in 1994, caused over 100 deaths and more than $100 billion in reported damage and indirect losses. In the Northridge earthquake alone, 82,000 residential and commercial structures were damaged or destroyed. Entire business districts closed for several months. Businesses were forced to relocate, and some closed for good.

As a commercial property or business owner, you cannot afford to be unprepared. It is up to you to make sure that your employees or tenants are safe and that your business survives.

Why You Should Plan

It is emotionally shattering when an employee, tenant, customer, or client is injured or killed in an earthquake, and it may be financially shattering as well for a property owner who is found negligent for not taking earthquake precautions. The following list presents additional reasons why pre-earthquake planning is essential:

- Lives are saved and business interruption and loss are minimized. Planning for an earthquake will prepare your organization for other disasters as well. The thorough look at the operations that your disaster plan requires will give you a better understanding of critical functions.
- Resources are consumed more cost effectively. The more you eliminate weaknesses (unsafe buildings, careless storage practices, and unsecured equipment) before an earthquake, the less money and time you will have to spend to repair and replace afterward.
- Employees and tenants develop confidence in their ability to survive and recover from an earthquake when they participate in drills and response exercises.
- A disaster can open opportunities in new markets or increase market share if you are prepared.

How to Build Your Plan

Your company needs an earthquake response and business recovery plan, whether you own or lease your building. The following steps are recommended in preparing your plan:

- Identify building and equipment weaknesses. See "Earthquake Weaknesses" section and the "Earthquake Checklist for Building Contents" on page 26.
- Arrange for emergency power, communications, and transportation.
- Write down evacuation, fire response, search-and-rescue, and first-aid procedures. Then train employees to follow them. Your local fire department can assist you in all of these areas.
- List and acquire these basic emergency supplies: fire extinguishers, crescent and pipe wrenches to turn off gas and water supplies, first-aid kits and handbooks, flashlights with extra bulbs and batteries, and portable radios with extra batteries. Rotate the battery supplies annually.
- Set up an ongoing program to reduce earthquake weaknesses in the office and on the shop floor.
- Encourage employees and tenants to reduce earthquake weaknesses at home and plan for family earthquake response.
- Arrange alternate supply and distribution procedures.
- Write contingency contracts for a postearthquake engineering evaluation of building safety.
- Set work-at-home policies and identify emergency work sites.
- Establish emergency accounting and payroll procedures.

- Store backups of vital records, including electronic data files, off-site.
- Plan for postearthquake security and inventory protection.
- Arrange for contingency financing for postearthquake business recovery.
- Amend leases with a statement of who will be responsible for repairing building damage and paying rent on an alternate, temporary location, if necessary.
- Include provisions for delivery delay in contracts.
- Plan for media announcements and prearranged advertising to inform clients that you are back in business.
- Set up intercompany and industry group agreements to assist recovery.
- Arrange for emergency means of communication such as portable or cellular phones and call forwarding. Remember that your office phones may not ring when the power is off.
- Talk to your neighbors. Discuss how you could help each other after an earthquake.
- Encourage employees and tenants to keep some emergency supplies such as food, liquids, and prescriptions at work.
- Train employees by (1) holding “duck and cover” and similar drills, (2) establishing responsibilities for carrying out the emergency response plan, and (3) teaching them to act immediately to put fires out. Police and fire services may not be available for up to three days after an earthquake. Employees should know where gas, electric, and water main shutoffs are located and how to turn them off if there is a leak or electrical short. Encourage or require your employees to take a first-aid and CPR training course. Make sure that people who have had this training are on duty during business hours.

Earthquake Checklist for Building Contents

Every box you can check ahead of time is one less source of damage and expense after an earthquake. Review the “Earthquake Weaknesses” section of this booklet for additional weaknesses and concerns that you may need to fix.

- o Desktop computer equipment is securely fastened down so it can’t slide in an earthquake.
- o Data backup copies are kept off-site.
- o Wall decorations, mirrors, hanging plants, fire extinguishers, and other heavy objects are attached with closed-eye hooks so they can’t fall.
- o Fragile objects (vases, display cases, and framed photographs, for example) are protected against tipping over or sliding off shelves.
- o Tall filing and storage cabinets are attached to the wall or, if they are installed in rows, the rows are attached to each other so they cannot topple.
- o File cabinet drawers have latches so they cannot open during earthquake shaking, and heavy boxes or equipment stored on top of the files are secured so they cannot slide off.
- o Office machines (copiers, faxes, and printers, for example) and shop equipment are secured so they cannot slide or roll across the floor or fall off their stands.
- o Storage racks and shelves are braced and bolted to the floors and walls, and their contents are secured so they cannot slide off.
- o Compressed gas cylinders are fastened with a nylon strap, strong chains near the top and bottom, or a secure rack.
- o Containers of laboratory chemicals or other hazardous materials are restrained so that they can’t spill or slide off their shelves and break.
- o Movable partitions are securely braced, especially if they support bookshelves or contain breakable glass.

Resource Organizations

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

Earthquake Programs of the Office of Emergency Services

Coastal Region
1300 Clay St., Suite 400
Oakland, CA 94612
Telephone: (510) 286-0895

Inland Region Northern Office
2395 N. Bechelli Ln., Suite A
Redding, CA 96002
Telephone: (530) 224-4835

Inland Region Southern Office
2550 Mariposa Mall, Room 13-181
Fresno, CA 93721
Telephone: (209) 445-5672

Southern Region Main Office
11200 Lexington Dr.
Los Alamitos, CA 90720
Telephone: (562) 795-2900

Southern Region San Diego Office
1350 Front St., Suite 2041
San Diego, CA 92101
Telephone: (619) 525-4287

Southern Region Santa Barbara Office
117 West Micheltorena, Suite D
Santa Barbara, CA 93101
Telephone: (805) 568-1207

Structural Safety Information

American Institute of Architects, California Council

Local chapters have referral lists of architects; consult telephone directory listing for "American Institute of Architects" or World Wide Web at http://www.aia.org/.

Board of Geology and Geophysicists
2535 Capitol Oaks Dr., Suite 300A
Sacramento, CA 95833
Telephone: (916) 263-2113

California Department of Consumer Affairs
400 R St.
Sacramento, CA 95814
Telephone: (800) 952-5210
http://www.dca.ca.gov/r_r/r_rguide.htm

This department can provide names of state-licensed individuals and businesses that can be hired to identify earthquake weaknesses and perform work required to correct those weaknesses.

Consulting Engineers and Land Surveyors of California
Telephone: (916) 441-7991
A referral list for engineers is available.

Earthquake Engineering Research Center (EERC)
University of California
1301 S. 46th St.
Richmond, CA 94804-4698
Telephone: (510) 231-9554

International Conference of Building Officials (ICBO)
5360 Workman Mill Rd.
Whittier, CA 90601
Telephone: (800) 284-4406
http://www.icbo.org

SAC Steel Project Technical Office
1301 S. 46th St.
Richmond, CA 94804-4698
Telephone: (510) 231-9477
http://quiver.eerc.berkeley.edu:8080

SAC is a joint venture of three nonprofit organizations: The Structural Engineers Association of California, the Applied Technology Council, and California Universities for Research in Earthquake Engineering.

Structural Engineers Association of California
555 University Ave., Suite 126
Sacramento, CA 95825
Telephone: (916) 427-3647
http://www.seaint.org

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

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

Division of Mines and Geology
California Department of Conservation
801 K St.
Sacramento, CA 95814
Telephone: (916) 445-5716
http://www.consrv.ca.gov/dmg/

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

United States Geological Survey
Earth Science Information Center
345 Middlefield Rd.
Menlo Park, CA 94025
Telephone: (415) 329-4390

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
Presidio of San Francisco
Building 105
San Francisco, CA 94129
Telephone: (415) 923-7175
http://www.fema.gov

Cities and Counties

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

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. 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.

Liability of Business and Industries for Earthquake Hazards and Losses. A Guide to the Law, Its Impacts and Safety Implications. Discusses legal liability for earthquake losses, the effect of liability on earthquake safety measures, and several hypothetical situations. 1984. (California Office of Emergency Services, Earthquake Program, 1300 Clay St., Suite 400, Oakland, CA 94612, (510) 286-0895, $12.00. Executive Summary also available for $1.00.)

The following publications are available from the Seismic Safety Commission, 1900 K St., Suite 100, Sacramento, CA 95814, (916) 322-4917:

- *Architectural Practice and Earthquake Hazards. A Report of the Committee on the Architect's Role in Earthquake Hazard Mitigation.* Contains checklists to help clarify responsibilities for earthquake safety for building owners, architects, and other design professionals. $4.00.
- *Homeowner's Guide to Earthquake Safety.* Applies to commercial property that is converted from or built like wood frame residential construction. It describes typical earthquake weaknesses in residential construction in California and recommends steps to strengthen those weaknesses. $3.25.

Building Strengthening

Yanev, Peter. *Peace of Mind in Earthquake Country.* Provides basic nontechnical reference material on earthquake hazards. This book describes geologic, architectural, and structural hazards and recommends techniques for avoiding or correcting them. (Chronicle Books, San Francisco, 1990.)

The following publications can be obtained at no charge from the FEMA Distribution Center, P.O. Box 2012, Jessup, MD 20794. (800) 480-2520; FAX (301) 497-6378:

- *Interim Guidelines: Evaluation, Repair, Modification and Design of Steel Moment Frames* (FEMA-267, 1995.)
- *NEHRP Guidelines for the Seismic Rehabilitation of Existing Buildings* (FEMA-273, 274, 1998.)
- *NEHRP Handbook for the Seismic Evaluation of Existing Buildings - A Prestandard* (FEMA-310, 1998.)
- *NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings* (FEMA-172, 1992.)
- *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook* (FEMA-154, 1988.)
- *Typical Costs for Seismic Rehabilitation of Existing Buildings: Summary, Second Edition* (FEMA-156, 1994.)

The following publications are available from the California Office of Emergency Services, Earthquake Program, 1300 Clay St., Suite 400, Oakland, CA 94612, (510) 286-0895:

- *Hazardous Buildings: Case Studies*. Provides examples of hazardous buildings and how they were fixed. (P89004BAR, $9.75 plus tax.)
- *Identification of Nonstructural Earthquake Hazards in California Schools*. Provides generic bracing details for common nonstructural hazards. Although the intended audience is California schools, the publication is also applicable to commercial property.

Geologic Hazards

Bolt, Bruce A. *Earthquakes*. 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 emergency responses that are more effective. 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, 1997 (revised). Includes maps that comply with the Alquist-Priolo Special Studies Zones Act of 1972. An index to special studies zone maps is provided. (California Division of Mines and Geology, Department of Conservation, P.O. Box 2980, Sacramento, CA 95812-2980, (916) 445-5716, $3.00.)

Geology and Active Faults in the San Francisco Bay Area. Map. (Point Reyes National Seashore Association, Point Reyes, CA 94956, (415) 663-1155, $5.19.)

Living on the Fault and *Living on the Fault II.* Field guides to the visible evidence of the Hayward Fault. Bay Area Regional Earthquake Preparedness Project, 1988 and 1990. (Available from the California Office of Emergency Services, Earthquake Program, 1300 Clay St., Suite 400, Oakland, CA 94612, (510) 286-0895, P88004BAR and P90003BAR, $5.00 each.)

Los Angeles Building Code, latest edition, chapter 95, "Earthquake Hazard Reduction in Existing Reinforced Concrete and Masonry Buildings and Concrete Frame Buildings with Masonry Infills"; and chapter 96, "Voluntary Earthquake Hazard Reduction in Existing Reinforced Concrete and Reinforced Masonry Wall Buildings with Flexible Diaphragms." (City of Los Angeles Department of Building & Safety, 221 N. Figueroa St., Suite 660, Los Angeles, CA 90012-2601.)

Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada. (Available from International Conference of Building Officials, 5360 Workman Mill Rd., Whittier, CA 90601, (800) 284-4406. $39.00.)

Uniform Code for Building Conservation, latest edition, "Earthquake Hazard Reduction in Existing Tiltup Concrete Wall Buildings." The International Conference of Building Officials, 5360 Workman Mill Rd., Whittier, CA 90601.

Emergency Planning

Calhoun, Fryar. *Earthquake Survival Guide: Emergency Planning for Family, Building, Workplace, and School.* 1990. (Magnet Press, P.O. Box 3580, Berkeley, CA 94703, (510) 540-0800, $3.15.)

Lafferty, Libby. *Earthquake Preparation for Office, Building, Family, and Community. (*Lafferty and Associates, P.O. Box 1026, La Cañada, CA 91011, (818) 952-5483. $5.00.)

Lykes, Richard S. *Are You Ready for a Disaster? A Corporate Guide for Preparedness and Response*. MAPI Economic Report, ER-170, April 1990. Discusses corporate disaster planning and provides guidelines for chief executives. (Manufacturers Alliance for Productivity and Innovations, 1200 18th Street, NW, Washington, DC 20036, (292) 331-8430, $15.00.)

The following are available from the Red Cross Disaster Resource Center, 1550 Sutter Street, San Francisco, CA 94109, (415) 776-1500:

- *Employee Earthquake Preparedness for the Workplace and Home.* A workbook for employees. $1.00.
- *Employee Earthquake Preparedness for the Workplace and Home.* Contains a 20-minute slide or videocassette program designed to be presented with the workbook. Purchase $50.00; rental $25.00 per day.
- *San Francisco Corporate Disaster Planning Guide, (*second edition.) American Red Cross. Presents excerpts from many San Francisco corporation disaster plans; emergency equipment vendors list; lists of supplies, kits, and training materials. $20.00.

Hiring a Building Inspector, Architect, Engineer, or Contractor

A Consumer's Guide to Engineering and Land Surveying Services. (Board of Registration, Professional Engineers and Land Surveyors, 2535 Capital Oaks Dr., Suite 300, Sacramento, CA 95833, Attn. Enforcement Unit, (916) 263-2222, free.)

Consumer's Guide to Hiring an Architect. (California Board of Architectural Examiners, Box 944258, 400 R St., 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/.

Commercial Property Earthquake Weakness Disclosure Report

Refer to Section 8897 *et seq.*, California *Government Code* and Section 10147, *Business and Professions Code.*

OWNER'S 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 or not, answer "Don't Know." If you know that a weakness exists or has been corrected or that the building has been seismically retrofitted, explain on a separate sheet. If your property does not have the feature mentioned, answer "Doesn't Apply." The page numbers in the right-hand column indicate where in this guide you can find information about each of these features.

	Yes	No	Doesn't Apply	Don't Know	See Page
1. If the building has precast (tiltup) concrete or reinforced masonry walls with wood-frame floors or roof, are the exterior walls adequately anchored to the floors and the roof in accordance with local building codes?	n	n	n	n	3
2. If the exterior walls, or part of them, are made of unreinforced masonry, have they been strengthened?	n	n	n	n	5
3. If the building has unreinforced masonry bearing walls and is located in Seismic Zone 4, has it been posted as potentially unsafe?	n	n	n	n	5
4. If the building has concrete columns, were they adequately reinforced to resist earthquakes or have they been strengthened?	n	n	n	n	6
5. If the building has a steel frame built before 1995, has it been inspected for fractures in welds in or near steel connections?	n	n	n	n	8
6. Does the building have well-anchored exterior cladding with no unusual or irregular building features?	n	n	n	n	10
7. Is the water heater braced, strapped, or anchored in accordance with local building codes?	n	n	n	n	14
8. Is the building outside an Alquist-Priolo Earthquake Fault Zone (an area prone to fault rupture immediately surrounding active earthquake faults)?	n	n	n	n	20
9. Is the building outside a Seismic Hazard Zone (zone identified as susceptible to liquefaction or landsliding)?	n	n	n	n	20

As seller of the property described herein, I have answered the questions above to the best of my knowledge. Other earthquake concerns may be present but are not disclosed.

EXECUTED BY

(Seller) (Seller) Date

I acknowledge receipt of this form, completed and signed by seller. I understand that questions on this form that the seller has answered "No" or "Don't Know" indicate possible earthquake weaknesses in this property.

(Buyer) (Buyer) Date

This earthquake weakness disclosure is made in addition to the standard real estate transfer disclosures.

Keep your copy of this form for future reference

Earthquakes and Buildings—What's the Law?

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

Publishing this guide—The Seismic Safety Commission is required to develop, adopt, publish, and update *The Commercial Property Owner's Guide to Earthquake Safety* containing information on geologic and seismic hazards, explanations of structural and nonstructural earthquake weaknesses, and recommendations for mitigating the weaknesses (*Business and Professions Code,* Section 10147). This guide is to be distributed to buyers of commercial property (*Civil Code,* Section 2079.9) and also made available to the general public.

Delivering this guide—California's modern earthquake codes are among the strongest in the world, and its buildings are among the safest. However, because many older buildings were not built to these codes, since January 1, 1993 sellers of commercial property built before 1975 that have precast (tiltup) concrete or reinforced masonry walls and wood-frame floors or roofs must deliver to the buyer, "as soon as practicable before the transfer," a copy of *The Commercial Property Owner's Guide to Earthquake Safety* (this booklet) to inform the buyer of earthquake weaknesses that the property might have (*Government Code,* Section 8893 et seq.).

Disclosing weaknesses—Local governments in Seismic Zone 4, where a damaging earthquake is most likely to happen (see map, page 19), must inventory their unreinforced masonry buildings and establish a seismic risk mitigation program for these buildings that includes the disclosure of the risk to the building owner (*Government Code,* Section 8875 et seq.). Owners of buildings in Seismic Zone 4 who have received notice that their buildings have load-bearing unreinforced masonry walls must post their buildings with signs warning that they may be unsafe in an earthquake (*Government Code,* Section 8875.8).

Earthquake faults—Sellers of real estate and their agents or brokers must disclose whether the property is located in an Alquist-Priolo Earthquake Fault Zone, where earthquake faults have ruptured the ground (*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—Until July of the year 2000, California law allows property owners to retrofit their buildings 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).