How the City of San Leandro can help you strengthen your home for the next big earthquake in the Bay Area.

Easy Low Cost Ways to Wake Your Home Earthquake Survivable "If I only knew then what I know now! For a couple of hundred dollars in material, I could have bolted my house to its foundation. Now it is going to cost me \$50,000 to fix it."

STAT

STREET SWEEPING DPARKING 5 AM 19 7 AM TUESDAY STREET CLEANING

This pamphlet was funded by the City of San Leandro and the Federal Emergency Management Agency Hazard Mitigation Grant Program FEMA-919-DR-CA to illustrate basic retrofit techniques for single-family wood frame structures. It is not, nor can any checklist or "how-to" program be, a substitute for evaluation of a structure by a licensed structural engineer or architect; evaluation of a site by a licensed geologist or soil engineer; or retrofit by licensed construction professionals. Any use of trade, product, or firm name is for descriptive purposes only and does not imply endorsement by the City or the U.S. government.

A major earthquake

Services Division are pleased to help you make your San Leandro home more secure in our next big earthquake.

This program will show you how to conduct a simple check-up of your home's earthquake "fitness," and how to strengthen your home with three inexpensive "do-ityourself" steps.

Workshops

Experts

/ideos

Even if you decide not to do the work yourself, this program will help you understand the differences between good construction practices and bad; it will help you to make informed choices in hiring a contractor.

This handbook is your guide to the City's "Home Earthquake Strengthening Program," a community preparedness partnership to help you move your home safely into the 21st century. The program includes practical hands-on workshops with experts, educational videos, detailed construction drawings, and a streamlined package of plans and permits.

This self-help program is designed to address known earthquake weaknesses in older home construction and is tailored to single-family homes in our community. The program is based on contemporary engineering practices and improved construction techniques based on lessons learned from the 1994 Northridge earthquake. As a participant, you have the opportunity to assess deficiencies in the construction of your home, and take preventative steps now that will considerably improve your home's ability to remain intact in the event of an earthquake.

The program is available to San Leandro homeowners and their contractors for a minimal charge. The City has streamlined the permit process and offers you and your contractor a simple, fast-track method to get this vital job done — quickly, easily, and at low cost.

Follow these steps and the City of San Leandro will supply you with the permit and inspection documentation you need to show that your home has been strengthened to prescriptive standards.

Preserving your neighborhood begins with preserving your home. Get involved. Start today!

of 7.0 or greater by year

San Leandro – Living

How an earthquake can damage your house

During an earthquake the shaking of the ground is transferred upward into your house through its foundation. If your home's wood frame is strong enough, it suffers little structural damage. However, if it has a structural weakness, as most older homes do, the energy of the shaking will focus on that weakness and begin to damage your home.

The photographs in this handbook show what can happen to older homes when earthquakes occur on nearby faults. If there is one lesson to be learned from recent California earthquakes, it is that those who strengthen their homes spend far less on repairs after earthquakes. For a relatively small investment now, you can avoid extensive and expensive structural damage to your home following the next major earthquake.

San Leandro is located in an active area for earthquakes

Scientists agree that California has entered a period of increased seismic activity. Since 1989 the state has been rocked by four magnitude 7 earthquakes, and more are certainly on the way sooner or later. The Loma Prieta earthquake gave us a glimpse of what a large earthquake on the outskirts of the Bay Area can do to weak buildings 50 miles away. The Northridge earthquake opened our eyes even wider showing us the devastation neighborhoods can suffer when just a moderate earthquake strikes in the heart of an urban area.

> Get the benefit of expert guidance on strengthening techniques specific to the type of homes in your neighborhood. Use a "permit-ready" plan set available from the City's Building Regulations Division.

Earthquakes centered in the densely populated Bay Area will have a much more devastating impact

San Leandro is situated at a very active spot along the 60-mile length of the Hayward fault zone. More temblors happen here than anywhere else along the fault. Most go unnoticed. But the next big one here will damage weak houses and fragile chimneys throughout San Leandro and neighboring Bay Area cities.

Common construction problems in San Leandro neighborhoods

Much of San Leandro's housing was built in phases or tracts. Housing tracts were constructed, usually by the same builder, using very similar building techniques. Some older construction techniques are inadequate for the forces we now know earthquakes can cause, but these older homes can be reinforced easily and inexpensively. The City of San Leandro has identified common design features in our neighborhoods to assist homeowners in locating and fixing these common earthquake-sensitive problem areas.



with the fault. In the



This home, over 13 miles away from the fault, suffered tens of thousands of dollars in damage in the Loma Prieta earthquake because it was not properly bolted down.

Older homes are typical victims . . .

Many wood-frame homes, particularly those built prior to the 1960s, may not be adequately bolted to their foundation. Many older homes in San Leandro were built without bolts. Without this anchorage, a large earthquake can jerk the ground and the foundation right out from under a house. Older homes have been damaged or destroyed in this manner by every major earthquake in California's history. The instructions in this handbook will help you be sure that your home is properly anchored to its foundation.

... but earthquakes can cripple modern, anchored homes, too

Some wood frame homes built as recently as the 1970s were shaken off their foundations in recent earthquakes. Even though these modern homes were bolted down, they failed because of another weak link called the "cripple wall." This is a short wall that connects the foundation to the floor of the house and encloses the home's "crawl space." The cripple wall is often not strong enough to survive the force of an earthquake. Therefore it is important that this wall be braced and strengthened. If not, the next earthquake may damage the cripple wall and knock your home off its foundation, even if the house is properly bolted.



This home, in the same neighborhood as the one above, was jerked three feet off its foundation during the Loma Prieta earthquake, due to inadequate cripple wall bracing, a common problem that is cheap and easy to fix.

Conduct your own survey

What to look for

To check your home's earthquake fitness, all you need is a flashlight and a willingness to get a little dirty. The place to start is the crawl space underneath your home.

1. Is your house properly bolted down to its foundation?

The wood 2x4 or 2x6 that rests directly on the foundation is called the "mud sill." Until the 1950s, home builders often did not bolt the mud sills to the foundation. This creates a serious structural weakness that can allow your home to slide off its foundation during an earthquake. The mud sill should be bolted at four to six-foot intervals (as specified on your plans), and a bolt should be located within one foot of every joint or step in the mud sill, but no closer than nine inches to the end of the board. If the mud sill is not bolted, or inadequately bolted, this is a job you can consider doing yourself.

2. Next, examine the cripple walls.

Check to make sure your cripple walls are braced with plywood to resist motion. Even if your cripple walls have cross-bracing, they are not strong enough for earthquakes unless you add plywood. Also a job you can do yourself.

3. Check for faulty materials in the concrete and the wood framing.

The foundation is a common area of structural weakness, so check your foundation to make sure it's in good condition. Sometimes the concrete used in foundations is too porous and crumbly to provide adequate strength. If so, your home is still subject to earthquake damage, even if you've bolted it down and installed plywood on the cripple walls.

Do you see any obvious evidence in the wood of dry rot or insect damage? If so, you will need to remove and replace the damaged wood. It's a good idea to hire a structural pest control inspector to look for damage not easily seen except by a trained eye. Bolting your mud sill to the foundation and adding plywood to the cripple walls are the two most cost-effective steps you can take to strengthen your home for earthquakes.



Bolts secure your home's mud sill to the concrete foundation. The mud sill should be bolted at four to six-foot intervals (as specified on your prescriptive plan set).





nailed to the cripple walls help to prevent damage from shaking in this typically weak area of your house. Cross-bracing within the framing is not enough.



Faulty materials such as rotten wood and porous concrete should be replaced. Risky conditions in concrete include cracks wider than 1/8 inch, large voids, or "honeycomb" concrete. If the concrete chips or flakes when you poke it with a screwdriver, it may be unsafe. NOTE: If you suspect faulty material, you may need the assistance of a licensed engineer or architect to design a solution.

Foundation Bolting

How to: Bolt Your Foundation

The first step to take if you find your home does not have anchor bolts, or has too few, is to install them! Bolting the mud sill to the foundation is one of the most cost-effective ways to protect your property from severe structural damage and one of the best investments you can make in your real estate "nest egg." Anchor bolts cost as little as \$2 each (depending on size) so the perimeter of the average size home can be bolted for a couple of hundred dollars. To install them, follow the procedure below.

> \$200 in bolts can prevent many thousands of dollars of earthquake damage.



*Chemical anchors are the preferred option. (see page 6)

Checklist

1	¹ /2" or ⁵ /8"
•	diameter
	foundation bolts
	that are at least 7"
	long with nuts
	and square plate
	washers*
1	Rotary hammer
✓	drill with an
	appropriately-
	sized carbide tip
	drill bit
/	Short-handled
✓	sledge hammer for
	setting the bolts
	3/2" diamatan
	% ulameter
	tubing
	tubilig
\checkmark	Adjustable wrench
1	Measuring tape
✓	and chalk line
1	Dust mask and
✓	protection for eves
	and ears
	lorque wrench

1. Measure & Mark

Mark the places for each bolt on the mud sill. Make the first mark between nine and twelve inches from the corner, and then measure another four to six feet for the next bolt, and so on. Continue this pattern along all of the foundation walls. Place an extra bolt within nine to twelve inches from any joint or step in the mud sill.

72" Maximum

Anchor bolts must be installed every four to six feet around the perimeter of your house as specified in your plans.

2. Drill the holes

Using the rotary hammer drill equipped with an appropriately-sized carbide bit, drill down through the mud sill at least five inches into the concrete. Pay special attention to the tool's operating instructions before drilling.

3. Clean the holes

Use flexible tubing to gently blow the concrete dust out of the hole. (This is especially important if you are using chemical anchors.)

4. Install the bolts

Expansion bolts are designed to be hammered into place. This can be done without damaging the bolt's threads by turning the washer and nut past the end of the bolt and tapping on the end of the bolt shaft to hammer the assembly into place. Once the bolt is in place, tighten the nut down firmly using an adjustable wrench.

Expansion Bolts

When you tighten the nut on an installed expansion bolt, the bolt's other end expands to grip the concrete. When the bolt is inserted properly, you will actually feel it "grab" the foundation as you tighten the nut. Test at least one out of every four new bolts for tightness with a torque wrench applying 40 foot-pounds of pressure.

Chemical Anchors (epoxy bolts)

If you have an older foundation and worry about cracking it with the pressure of expansion bolts, consider using chemical anchors (also called epoxy bolts). Always follow the manufacturer's installation instructions. Measure, drill and clean the holes per the manufacturer's instructions. Be careful not to drill deeper than the bolt's length. Before you place the bolt in the hole, inject the epoxy mixture into the hole.

Press the bolt into place and wait for the epoxy to harden (usually 24 hours). Once the epoxy has hardened, tighten the nut with an adjustable wrench until the washer just begins to indent the wood mud sill. Chemical anchors can be a bit more time-consuming to install. However, they are very effective, and are the preferred method.









Foundation Bolting



Shear Panels & Cripple Walls

Checklist



Bolts are not enough

Even when your house is bolted to its foundation, the sideways (lateral) force of an earthquake can make the weakest part of your house (typically the cripple walls) buckle and collapse. Plywood sheets should be nailed to the cripple walls on all sides of your house. These sheets create "shear panels" that give the house lateral strength. Oldfashioned 2 x 4 or 2 x 6

cross-braces and horizontal siding are not strong enough to resist earthquake forces.



2 How to: Reinforce Walls with Plywood

1. How much and where?

Determine the number and size of plywood braced panels you will need and where they should be placed. The number and length of panels needed will depend on the height and the length of each section of cripple wall and how many stories the cripple wall supports. For all houses, panels should be placed at both ends of each cripple wall section. For a single-story house, additional panels should be spaced evenly so that not less than 50 percent of the total length of each cripple wall section is braced. For two story houses, panels should be spaced to cover not less than 80 percent of each cripple wall section. For optimum strength, use the longest piece of plywood possible; avoid using multiple pieces of plywood to form your four to eight foot panels. The distribution of plywood panels should be "balanced" by keeping the panels approximately equal in length and as evenly spaced as your condition allows. For example, a cripple wall which is 52 feet long and 12 inches in height in a single-story house would require a minimum of 26 feet of braced panels. A typical solution would be a 4 foot plywood panel at each end and three 6 foot panels evenly spaced between the end panels.

2. Measure, Mark and Cut

To provide adequate strength, each plywood sheet must be nailed along all edges, and along the interior studs. In most cases, the cripple wall studs are flush with the mud sill and with the "top plates" (located at the top of the cripple wall). This provides an even nailing surface for each plywood edge. However, if the cripple wall is set back from the edge of the mud sill, you will have to add blocking between the wall studs to create a nailing surface for the plywood.

Measure the height from the top of the double top plate to the bottom of the mud sill. If your condition requires blocking above the mud sill, then measure to the bottom of the cripple studs. Cut the plywood so that it covers this area and reaches from the center of one stud to the center of another. Mark the center of each stud on the foundation and above the top plates. These marks will provide a nailing guide. Remember, you must nail the plywood securely to all studs at the specified nail

spacing. Also, note the location of any pipes so you can cut rounded notches in the plywood to fit around them.

Shear Panels & Cripple Walls



3. Blocking

Often the mud sill is wider than the stud wall or embedded into the concrete foundation too deeply to allow nailing along its edge. If so, you will need to add a piece of wood 2 x 4 or 2 x 6 blocking on top of the mud sill, as shown above, to provide a nailing surface. Install blocking to fit over the anchor bolts per the city's plan set, and nail it to the mud sill using four 10-penny common nails. Blunt the tips of the nails and stagger them across the wood to prevent splitting. If the blocks still split, you may have to pre-drill the nail holes. To prevent dry rot or termite damage, it is a good idea to use foundation grade redwood or a pressure-treated wood for the blocking.

4. Nailing

This task requires a lot of nailing, and a nail gun speeds the work, eases the wear and tear on your arm, and minimizes wood splitting. Whether you use a nail gun or a hammer, nails are a critical part of effective bracing. Each sheet of plywood must be nailed every four inches around the edges and every twelve inches along all interior studs and cross bracing in the "field" area. The edge nails provide most of the strength and the field nails prevent the center of the sheet from bowing outward during an earthquake.

Perimeter 8d Common Nails 4" on Center I 2" on Center S Ply Plywood

Shear Panels & Cripple Walls



5. Ventilation Holes

With the plywood in place, drill $2^{1/2}$ " to 3" diameter ventilation holes in each sheet. These holes should be centered between each set of studs and $2^{1/2}$ " above the mud sill and $2^{1/2}$ " below the bottom of the top plates. The holes will provide ventilation and allow inspection of the cripple wall and mud sill bolts. Drill only one hole if the plywood sheet is less than 18" tall. If your wall has an exterior ventilation screen, you should cut a hole in the plywood opposite the screen and similar to it in size. Don't forget to add blocking around this vent hole and nail the plywood edges at 4" on center (see page 9, top).

6. Repeat on All Walls

With the first sheet of plywood nailed into place, repeat the process to create a braced wall of plywood in sheets no shorter than four feet in length. Remember, long continuous sheets provide maximum strength. When you are installing adjacent pieces of plywood, make sure they join at the center of a stud or that an additional stud has been added to provide for proper nailing. Also, check the cripple walls for termite and dry rot damage, and replace any damaged materials before installing the plywood shear panels.

Water Heaters & Chimneys

3 Strap Your Water Heater...

If a water heater falls during an earthquake, it could break a gas line and start a fire. To minimize this risk from your water heater, add flexible connections to both the gas and water lines to reduce the danger from fire or a water leak. To keep the water heater from toppling over, wrap it with two bands of 3/4" x 24 gauge perforated steel (commonly known as plumber's tape).

Connect the bands to nearby wall studs with metal struts cut to length from 1/2" diameter wall "EMT" conduit. Each end of the strut is then flattened, drilled and bent at an angle to fit the wall. For more details and instructions contact the Building Regulations Division.





...BRACE YOUR CHIMNEY

If you have a masonry chimney, it may not withstand the force of a strong earthquake. You should have your chimney evaluated by a licensed professional. The Building Regulations Division has handouts illustrating various strengthening methods. The safest chimney is a lightweight metal one.



OOL-LENDING

For City residents who complete the Home Strengthening Program, every major tool you need to "do-it-yourself" (except a circular saw) is available free of charge at our Permit Center in City Hall.

Caution: Tool Safety

Always read instructions before operating any power tools. If you are unfamiliar with the operation of any tool, ask an expert for some advice before you start. Rotary hammer drills and hole saws can be tricky and especially jarring to your body if you are not experienced in their proper use. Be sure to wear adequate eye protection, earplugs and gloves.

TROUBLE-FREE PERMITS



The City of San Leandro wants to simplify your home earthquake strengthening project. We have developed a streamlined permitting process which provides plans and drawings tailored for most San Leandro homes. Pick up your "permit-ready" plan set at our Permit Center at City Hall. The plans are free to San Leandro residents.



OF TVO STORES, OR TVO UNITS (WHEN CRIPPLE STUDS 14" IN LENCTH THE CRAVL SPACE SHALL BE CONSIDERED RST STORY.) STRUCTURES EXCEEDING THESE PARAMETERS JRE ENGNEERD DETAILS.

CITY OF SAN LEANDRO, CALIFORNIA PRESCRIPTIVE SEISMIC STRENGTHENING PLAN FOR LIGHT WOOD FRAME RESIDENTIAL STRUCTURES

Additional Resources and Agencies

Contractor Information

There are four things to keep in mind when seeking a contractor:

- 1. Find out if the contractor is licensed.
- 2. Request references.
- 3. Determine that the contractor has had previous experience with seismic safety-related projects.
- 4. Always get at least three bids for any job you are planning.

Contractors State License Board Offices:

To obtain a helpful handbook entitled "What You Should Know Before You Hire a Contractor," call your local Contractors State License Board Office at (510) 577-2429.

www.cslb.ca.gov

The following are additional sources of information.

Association of Bay Area Governments

(ABAG) keeps a list of contractors who have attended their one-day seminar on retrofit of woodframe buildings. Call (510) 464-7900.

www.abag.ca.gov/bayarea/eqmaps/fixit/fixit.html

Structural Engineers Association of

Northern California (SEAONC) in San Francisco has a list of their engineers who specialize in this type of work. If you think you need the services of an engineer to answer complicated design or technical questions, call (415) 974-5147.

www.seaoc.org

American Institute of Architects (AIA)

East Bay Chapter can help you in preparation of plans, specifications and design, or technical questions. Call (510) 464-3600.

City of San Leandro Emergency Services

Division is also a valuable resource about earthquake safety preparedness for your home and family. To schedule a neighborhood preparedness workshop, call (510) 577-3333.

City of San Leandro Building Regulations Division offers seminars for homeowners who want to improve their homes. The Building Regulations Division wants your building project to go smoothly and quickly. Call (510) 577-3404 or 577-3406.

Visit us at:

www.ci.san-leandro.ca.us/slbuildingregsdivision.html

Seismic Strengthening Q&A

1. What are the benefits of strengthening my home?

When an earthquake occurs, your home will have a better chance of surviving and may only sustain minimal damage. Also, retrofitting may lower your earthquake insurance premiums and deductible. In some cases, insurance companies will not insure a home that is not strengthened. Increasing your home's earthquake fitness enhances its value and improves its salability.

2. Is a Building Permit required?

Yes. The San Leandro Building Regulations Division has made the permit process a one-stop, over-the-counter transaction. We are available to assist you while you prepare your plans and we provide ongoing classes on how to perform the work.

3. Is it important that I obtain a Building Permit?

Absolutely. Insurance companies, universities, local building departments, the engineering community, and the media all recognize that the Bay Area has entered a period of increased seismic risk and that proper strengthening can prevent earthquake damage to homes. A Building Permit protects you via the inspection process and provides a record that the work was done in accordance with accepted standards.

4. How much does seismic strengthening cost?

Studies have shown that the typical costs of home strengthening range from a few hundred dollars to around three thousand dollars. You can save money by doing some or all of the work yourself.

5. If I strengthen my home, will my property taxes be increased?

Not at all. This type of work is specifically exempt from tax re-assessment. For more information, contact the Alameda County Office of the Assessor at (510) 272-3787.

6. Do I have to hire a Contractor?

All of the work prescribed on our permit-ready plan set can be performed by a homeowner with basic carpentry skills. If you want to hire a contractor, use the permit-ready plan set to help shop for bids. You will save time and money because each contractor is bidding on the same scope of work.

7. Do I have to hire an Architect or Engineer?

No. Our permit-ready plan set is so simple to prepare that it can be easily completed in an evening or on a weekend. If you have questions preparing the plan, let the San Leandro Building Regulations Division help you. An Engineer or an Architect may be required if you have special conditions such as a brick foundation, poor quality concrete, or unusual structural conditions in your home.

8. How do I find a Contractor?

The best way to find a contractor is through personal references, or through some of the agencies listed in this handbook. In any case, ask the contractor that you choose to provide at least three references.

9. Can the City recommend contractors?

No. However, the San Leandro Building Regulations Division maintains a file on contractors who have participated in our contractor's course for seismic strengthening. The file contains specific information about the contractor. Some of the items included in the file are license status, actions against the licensee, their insurance policy information, and a list of properties in San Leandro where the contractor has performed seismic strengthening work.

10. What tools do I need?

The most common tools used in retrofit work are a circular saw, electric drill and drill bits, rotary hammer drill, torque wrench, hole saw, pneumatic nail gun, palm nailer, and typical small carpentry tools.

11. Where can I get these tools?

Through the San Leandro Tool Lending Library! Many of the tools (with the exception of circular saws) are available, free of charge to residents who have completed the City's Home Earthquake Strengthening Program. At the San Leandro Permit Center, the Counter Techni-cians can assist you in checking out the tools.

Are you prepared for the next earthquake?

"It was so easy to strengthen my house with San Leandro's program"

What You Should Know

Even in moderate earthquakes, your house can shake violently from side to side, toppling the chimney, cracking walls, and even shifting off its foundation. To protect your family and secure your investment here in earthquake country, your house should have an "earthquake check-up."

This handbook introduces a low-cost program provided by the City of San Leandro that will help you improve your home's chances of surviving an earthquake quickly, easily and inexpensively.

Please take the time to read it. Then sign up for the program.

The City of San Leandro Development Services, Building Regulations Division 835 East 14th Street, San Leandro, CA 94577 • (510) 577-3405

Credits:

San Leandro Development Services, Building Regulations Division

City of San Leandro Emergency Services Division

San Leandro's Vision Task Force Community Preparedness Subcommittee

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Easy Low Cost Ways to Make Your Home Earthquake

Survivable