Earthquake strengthen
YOUR HOUSE

Ways to make your house better
cope with earthquakes

Let’s talk about earthquake strengthening your house

Depending on how and when your house was built, there may be things that you can do to make it more resilient to earthquakes.

This guide explains the stresses that earthquakes place on houses, and some risk factors that might make your home more or less susceptible to damage.

It also gives practical guidance on things you can do to your house that may reduce the risk of damage in an earthquake.

Could my house be at risk?

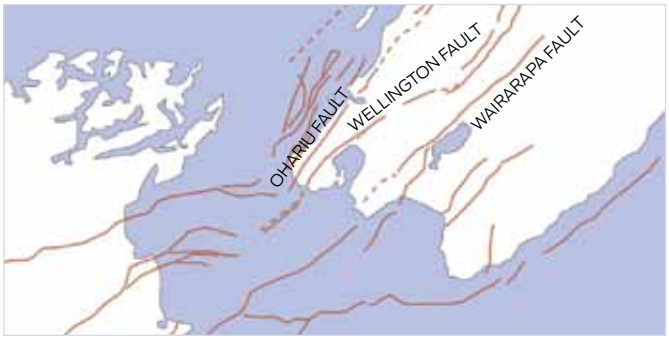
If you consider all the fault lines beneath our region, a major earthquake takes place every 150 years on average.

Earthquakes here are caused by movement at the boundary of the Pacific and Australian plates. These are parts of the outer layer of the earth that move into and against each other at a rate of about 4 cm per year.

The last big earthquake (about 8.2 magnitude) was on the Wairarapa Fault in 1855. The land moved 18 m sideways and 6 m vertically. It affected the whole region – land and seafloor near Wellington harbour rose about 1–1.5 m.

The Wellington Fault ruptures every 700–1000 years. The last one was 200–400 years ago. The likelihood of a big earthquake on this fault in the next century is estimated to be about 10-15%.

There are risks, but let's put them into context. It is believed that fewer than 500 people have died in earthquakes since humans arrived in New Zealand, but over 37,000 have died in car accidents. Improving the earthquake resilience of your home reduces your risk in an earthquake both from a life-safety and from an economic perspective.



What should I expect?

Earthquakes can cause violent movement both sideways and up and down. In addition to this rapid shaking, we can expect that in some areas:

- unstable ground will slump and fall, particularly on hillsides
- the ground will crack and pull apart
- liquid and silt will rise up from the ground – a process called liquefaction – particularly near rivers and the coast.

LIQUEFACTION

Soils most likely to liquefy are low-density sands and silts in an area with a high water table.

During an earthquake, the loose granular soil behaves like a liquid. It cannot support the weight of the surface layers of soil or concrete above it. The liquid is forced up through cracks and flows to the surface, taking sand and silt with it.

Liquefaction can result in:

- settlement of the land surface (and all or part of a building) due to underground soil compaction and ejection of sand
- loss of support to building foundations
- surface soil close to sloping ground (such as riverbanks) sliding sideways – this is called lateral spreading.

OTHER HAZARDS

Wellington region is also vulnerable to hazards caused by an earthquake, such as tsunamis and falling rocks and boulders. Be aware of these hazards and where they are likely to occur, and the likely impact they will have on your home and your surroundings.

The Greater Wellington Regional Council offers tsunami hazard maps and lists organised evacuation points. Visit www.gw.govt.nz.

What can happen to my house?

The effect an earthquake will have on your house depends on things such as its age, construction materials and techniques, layout, the type of ground it is built on, what maintenance you have done and whether your contents are secured.

The damage sustained by houses in an earthquake is generally due to inertia – where the mass of the house cannot respond to the shaking as quickly as the ground beneath.

Most homes in the Wellington and Wairarapa regions are built using timber framing, which is a lightweight construction with less inertia that can better withstand earthquake shaking. Houses built from brick and other heavy materials have higher mass. Unreinforced brick houses are more likely to be damaged.

A house where the brick chimney has failed.

Learnings from Christchurch

The Canterbury earthquakes showed that some buildings or building features are more likely to be damaged than others. These include:

- houses on the hills with large open internal spaces and large glazed windows along one wall, if the back wall has a lot fewer windows
- additions that are poorly fixed to the original house, especially if they are on different types of foundations
- houses with irregular shapes or several split levels
- houses with old building techniques, such as lath and plaster or unreinforced masonry. Houses with double skin brickwork and unreinforced concrete block walls suffered severe damage in Christchurch.

Some buildings performed well, including:

- houses with simple shapes
- houses with timber claddings, such as weatherboards
- houses with lightweight roofing materials (such as corrugated steel or metal tiles).

A modern hillside home.

How can I limit damage to my house?

There may be things you can do now to reduce the risk of damage to your home during a major earthquake.

In the next few pages, this guide shows you ways you can upgrade your home to better cope with a major earthquake.

A COST EFFECTIVE APPROACH

Some earthquake upgrades take considerable time and cost to complete. If you're considering renovating your home, making upgrades as part of a larger renovation saves time, inconvenience and is a lot more cost effective.

RULES AND REGULATIONS

All new building work in New Zealand must comply with the Building Code. This doesn't tell you how to design or build something: instead, it tells you how a new building must perform.

If the house upgrade is structural or if it affects the weathertightness of the building, the work is likely to fall into the category of 'restricted building work'. This means that you must employ licensed building practitioners (LBPs) to design and supervise or carry out the work. Registered architects and chartered professional engineers are an exception to this rule as they can do restricted work without being an LBP.

If you do restricted work yourself, you must complete a statutory declaration before you start the work, and future buyers of your house will be able to find out about the work you have done.

Minor repairs and maintenance that don't fall into the 'restricted' category can be done the same as before.

KNOW YOUR SKILL LEVEL

Work on the foundations, walls and roof framing of a house is not something to be taken lightly. Poor quality building work could have a negative effect on property values or your ability to sell your house. Only consider tackling the bigger upgrades yourself if you have the appropriate experience. For many homeowners, calling a chartered professional engineer or a licensed building practitioner will be the best course of action.

Unreinforced concrete foundations can fail in an earthquake.

MORE INFORMATION

If you have any doubts about how your house would cope in a large earthquake, especially if it is on sloping ground or has more than one type of foundation, consult a chartered professional engineer.

You can find a list of chartered professional engineers on the IPENZ website at www.ipenz.org.nz/ipenz/finding/cpeng

1 Under the floor

DAMAGED OR DECAYED PILE FOUNDATIONS

Problem

If your house sits on timber or concrete piles but it is not properly supported, it can fall off the piles during an earthquake.

To check

Look under your house. You should see short timber or concrete posts embedded in the ground that support the rest of your house. These are piles. Piles support the bearers, which in turn support the joists under the floor of your house.

Check your piles are in good order. The piles should stand upright and be regularly spaced, and evenly support the bearers.

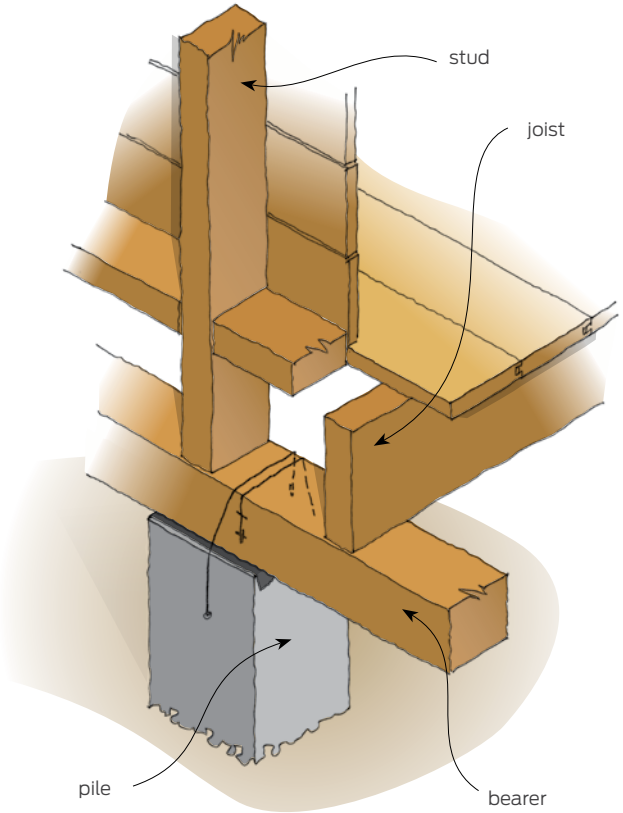
Timber piles should not show signs of rot or borer damage. You can check for rot by jabbing a screwdriver or knife into the pile - it shouldn't go in. Concrete piles should not be cracked or crumbling.

Check that your piles are not weakened or exposed by ground excavation or by being too close to the top of a bank.

Solution

If your piles are damaged, misaligned or undermined, they need to be repaired or replaced. This isn't an easy task, so get professional advice.

Pile support weakened by ground excavation.



MORE INFORMATION

BRANZ Bulletin 536 from www.branz.co.nz

POOR PILE/FOUNDATION CONNECTIONS

The problem

If your house is not properly tied to its pile foundation it can slide off the piles in an earthquake.

To check

Check the connections between the bearers and the piles, and between bearers and joists. They should be in good condition and not loose, rusted or broken.

The solution

Add or repair your pile connections.

Concrete piles:

Concrete piles should have a hole through them near the top, roughly the same distance from the top and each side of the pile.

Wire should be threaded through the hole and fixed to the opposite sides of the bearer.

Timber piles:

The timber pile and bearer should be connected together using Z-nails, one on each side of the pile and bearer. Place skew nails into the bearer to fix it to the top face of the pile.

Make sure you connect all your piles to bearers.

If you have no pile connections at all, you should consult a building professional.

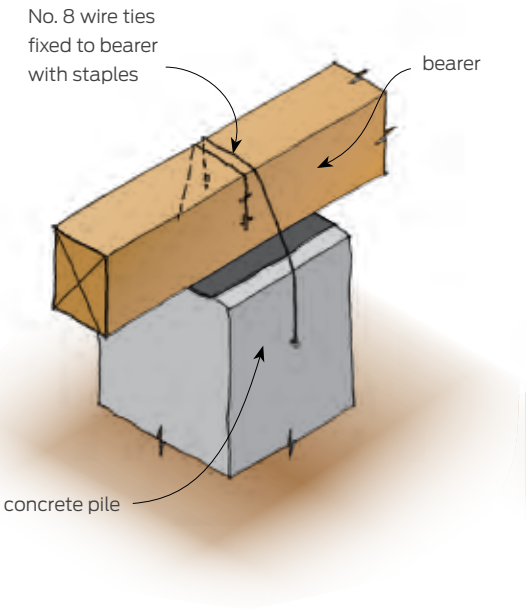
Remember

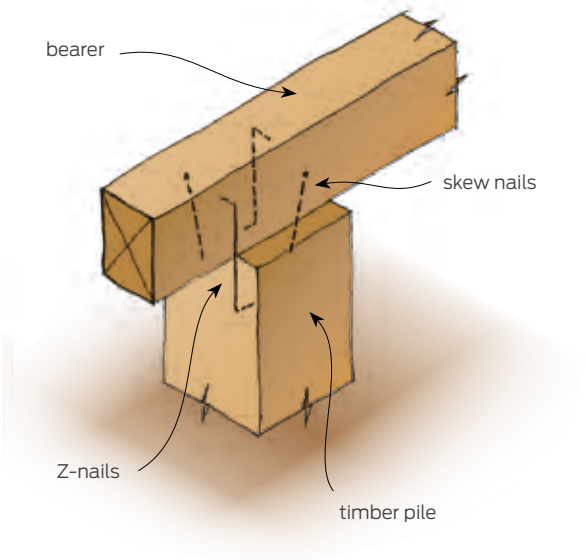
- Use galvanised wire and fasteners unless you live within 500 metres of a coastline or harbour, in which case Z-nails and skew nails should be made of stainless steel so they don't rust.
- There are special fixings on the market that can be fitted to existing timber and concrete piles.

MORE INFORMATION

BRANZ Bulletin 536 from www.branz.co.nz

An example of a house that has slid off its foundations.





UNBRACED PILE FOUNDATIONS

Problem

If your house is not braced to its piles, it can topple over in an earthquake.

To check

Look under your house and check if your piles are braced. If you see diagonal timber braces between the piles and bearers or joists, your house may be sufficiently braced. Houses built since 1980 may already have bracing or anchor piles, which are deep enough to stop them toppling over.

Next, check the outside perimeter of your foundations. If your house has no perimeter walls or only horizontal boards, you may benefit from additional foundation bracing.

If your house has concrete corner walls, consider adding bracing, especially if the walls are more than 600 mm tall.

If your house has a concrete perimeter foundation wall, your house may already be sufficiently braced. Just check that the wall is not cracked or crumbling and that the timber framing is still adequately connected to the wall and that the fasteners have not rusted away. If the wall is cracked, your pile foundations may have moved, so check them carefully.

Solution

Consult a chartered professional engineer to design the right bracing solution for your house, which may be timber or sheet bracing.

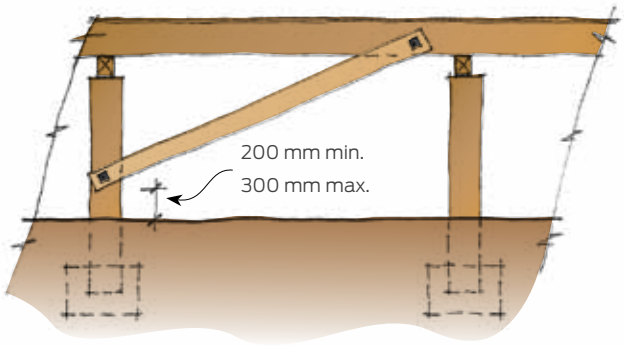
With timber bracing, braces at a slope of not more than 45º are fixed between piles and bearers/joists or concrete corner walls. (Each brace is connected to the underfloor framing that runs parallel to it, whether that is a bearer or joist.)

With sheet bracing, material such as treated plywood or fibre-cement is used to bring rigidity and strength to the structure. Leave gaps or openings for under floor ventilation.

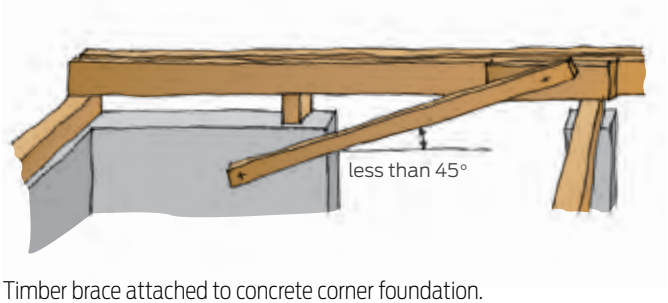
MORE INFORMATION

BRANZ Bulletin 536 from www.branz.co.nz

Unbraced pile foundations.



Typical timber brace.



Timber brace attached to concrete corner foundation.

UNBRACED FRAMING UNDER THE FLOOR

Problem

Wall framing and jack studs under a floor (see diagram below) are vulnerable to sideways motion and should be braced to prevent them from moving in an earthquake.

To check

Check if your under floor framing is braced (see the drawing on page 8).

If your exterior cladding is a sheet material, as long as it's in good condition and well fixed to the framing, this is likely to provide some under floor bracing.

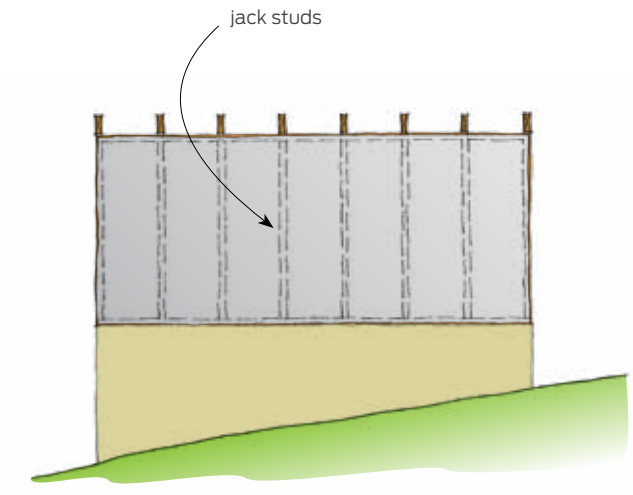
If you don't have either of these, you need to add bracing.

Solution

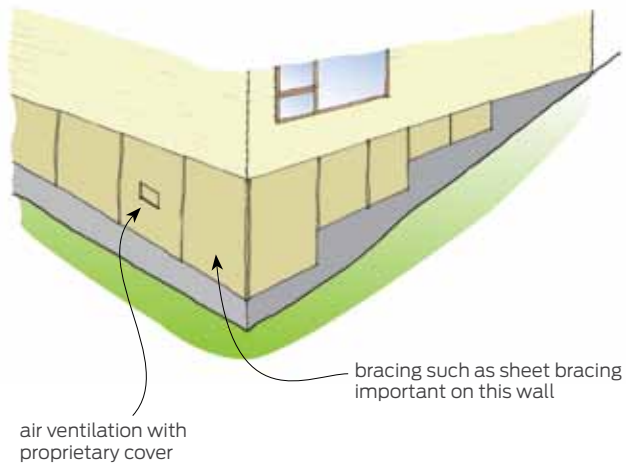
To brace framing under a floor, nail a bracing sheet to the inside of the frame.

Alternatively, replace the existing exterior cladding with a sheet cladding that also acts as a bracing sheet.

An example of floor support failure where the under floor framing has failed in an earthquake.



Sheet bracing to perimeter foundation wall.



DAMAGED UNDER FLOOR FRAMING

Problem

A damaged under floor frame has greatly reduced strength and can collapse in an earthquake.

To check

Due to the hills around the region, many houses are built on a slope and use timber frames to support the floor. Under floor areas are often used for storage. You should see piles, then a timber frame and then your floor joists.

Look at the timber frame for signs of damage, rot or borer infestation.

You can test the strength of the timber with a knife or screwdriver. If it is soft or breaks easily under the blade, the frame must be repaired.

If part of the frame is damaged or broken, it must be strengthened or replaced.

If the frame has borer holes, you can treat the timber with insecticide, preferably injected into the flight holes, to stop the attack.

Solution

Always consult a professional before dismantling, repairing or replacing any part of the under floor framing.

Borer beetle attack to wall framing timbers.

UNREINFORCED SLAB FOUNDATION

Problem

Solid concrete slab foundations cannot topple like pile foundations, but they are shallow and can be badly cracked by ground slumps and liquefaction, especially if the slab is unreinforced.

To check

Check if you have concrete slab foundations.

Unlike pile foundations, concrete slab foundations are solid and are supported by the surface layer of ground.

It is difficult to tell if a concrete slab is unreinforced by examining it, but your local council may have building details on file.

Solution

If you know you have an unreinforced concrete slab foundation, consult a chartered professional engineer or foundation specialist and ask for advice. Your options are likely to be limited.

Remember

- A properly reinforced slab can better withstand earthquake effects.

Unreinforced concrete slab foundations can crack in an earthquake if the ground spreads beneath the slab.

UNBRACED OR DAMAGED POLE CONSTRUCTION

Problem

Damaged, or poorly designed or constructed pole structures can twist and collapse in an earthquake, severely damaging or even collapsing the house above.

To check

Because of sloping ground or a split-level, some houses have a large area below the floor supported by a pole structure. These areas are often open and on steep ground.

Check if your pole construction is braced. You should see diagonal bracing timber bolted in place between adjacent poles.

Your poles and braces should all be in good condition and well connected, with no broken or split timber and no missing or corroded fasteners. Check the timber in the ground is also in good condition.

Solution

You should ask a building professional or engineer to inspect your house and advise on the best bracing option for your situation.

As a guide, if more than one side of the space is open, you will likely need bracing.

Foundation timber post and brace failure (the brace split in an earthquake because fixings were too close to the end).

2 Floor to ceiling

UNREINFORCED MASONRY WALLS

Problem

Unreinforced brick and masonry walls are very likely to collapse in a big earthquake.

To check

Unreinforced masonry was a common form of wall construction in Wellington and the Wairarapa in the past.

At greatest risk of earthquake damage are old double brick walls (two rows of brick with a gap between but no timber frame - see photograph below) and concrete block walls with no steel reinforcing inside.

As a guide, if you have external brick or block walls and your house was built before 1950, you probably have unreinforced masonry walls.

If you have a more recent brick house, your masonry is likely to be a veneer - the brick wall is tied to a timber frame behind. These perform much better in earthquakes.

Solution

Consult a professional engineer for advice on reinforcing or replacing any unreinforced brick or masonry walls.

UNBRACED WALL LININGS

Problem

Old wall linings should not be relied on to provide bracing.

To check

If you have one of the very old Wellington homes with lath and plaster or scrim on sarking, consider relining your walls. Properly fixed plasterboard linings will add structural stiffness and strength to your house.

It can be difficult to tell if your house uses these old linings. You may be able to check by carefully inspecting the edges of a removed power point or light switch. Check if you can see evidence of lath (wooden strips) under the plaster or scrim (a coarse jute fabric – see photograph below).

The age of the house is also an indication.

Solution

Reline your walls with plasterboard.

Either remove the existing lining and replace it with plasterboard or apply new plasterboard directly over the old lining, taking care to fix it properly to the framing behind.

These are both big jobs. Ask a professional for advice on how to best remove your old lining and install new plasterboard to provide good bracing.

Double brick walls are prone to damage during an earthquake.

Scrim on timber sarking.

UNRESTRAINED HOT WATER CYLINDER

Problem

An unrestrained hot water cylinder can move and cause a lot of damage during an earthquake either from its mass or from leaking water.

To check

Look around the sides and top of your hot water cylinder to check if it has retaining blocks and straps or other means to prevent it from moving (such as close-fitting shelves around it).

Solution

On the cylinder's exposed side, nail or screw timber blocks to the floor or shelf supporting the cylinder.

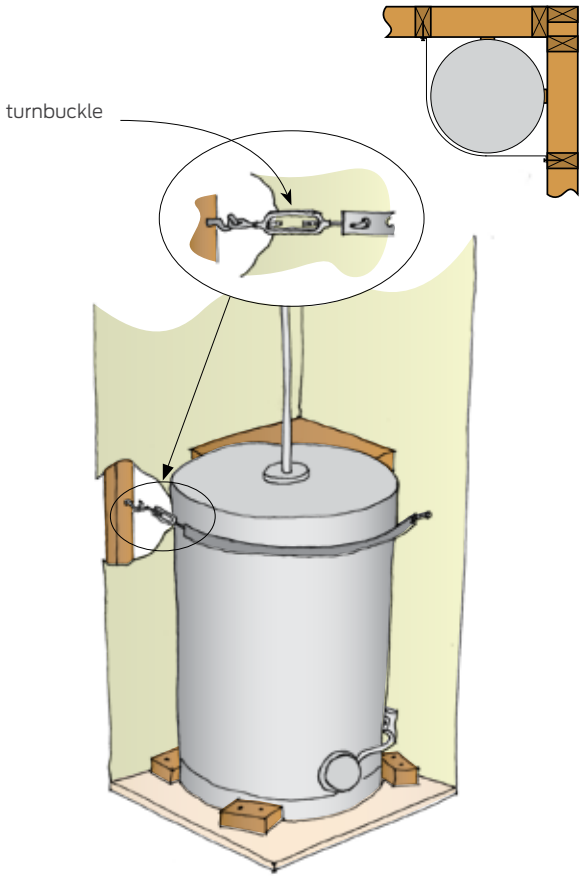
For the sides that face the wall, glue timber blocks to the walls, so they fit snugly between the wall and cylinder. Put blocks at the top and bottom of the cylinder.

Place 8 mm screw hooks into your wall frame near the top and on both sides of the cylinder.

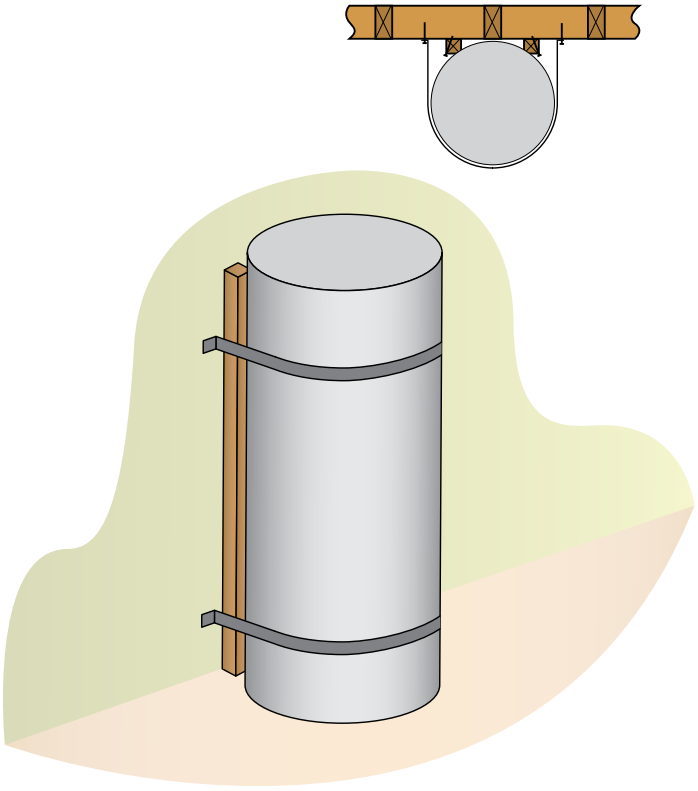
Attach a 6 mm turnbuckle to one hook and cut a length of 25 x 1 mm metal strap so it fits around the cylinder. Connect the strap to the other hook and use a turnbuckle to make it tight (see drawings at right).

Remember

- Some houses use a gas califont to heat water and don't have a hot water cylinder.
- You can buy kits from hardware stores that contain the strap, screws and turnbuckle you need to secure your hot water cylinder.



Hot water cylinder with retaining blocks and restraining strap fitted.



Another method of restraint for the hot water cylinder.

MORE INFORMATION

You can find out how to quake safe the contents of your home at www.eq-iq.org.nz

3 Ceiling to roof

UNREINFORCED MASONRY CHIMNEY

Problem

Many homes in the region built before the 1970s have a brick or concrete masonry chimney, although the fireplace may no longer be used.

In an earthquake, these chimneys can collapse and cause damage to the house below. Cracked chimneys can also start house fires if open fireplaces are still used.

To check

Have a close look at your chimney. If it is a lightweight metal flue there is little risk, but if it is a heavy brick or older concrete chimney it is likely to be unreinforced, and you should have it checked by a professional engineer.

If you see cracks, or loose or broken bricks, masonry or plaster, or if the chimney is leaning over or has a twist, these are signs that you have a more serious problem that needs immediate attention. Contact a building professional for advice.

Solution

Consider replacing the chimney with a modern metal flue version. Or, if you haven't used the chimney for some time, think about removing it entirely.

Remember

- Brick chimneys built after 1990 use a reinforced concrete flue within the brickwork and are tied to the house framing to prevent collapse.

A typical unreinforced chimney found in many New Zealand houses.

ROOFSPACE BELOW A MASONRY CHIMNEY

Problem

A collapsing brick or masonry chimney can damage or break through the roof or ceiling below

To check

If you cannot replace the chimney, you should strengthen the roof space below to protect your house and its occupants.

Solution

First, check the strength of the existing rafters and ceiling joists. If the ceiling is not properly supported, for example, you may need to add a timber beam – sometimes called a strongback – to the roofspace.

Then, lay lengths of timber across the tops of the ceiling joists near the chimney. The timber must be close to the chimney, but it is acceptable to leave small gaps between each length.

The timber should extend roughly the same distance as the height of the chimney in all directions.

An example of additional roof bracing.

UNBRACED GABLE-ENDED ROOF

Problem

An unbraced gable end (a triangle-shaped area of wall at one end of the roof) with a brick veneer attached may be damaged by severe earthquake shaking.

To check

Look in the roof space inside your gable end. You should see diagonal pieces of timber or metal bracing your roof.

The braces should either cross your rafters from the top of the gable down to the ceiling at the opposite end, or connect from the peak of the roof down to your ceiling frame through the ceiling space.

Check the braces are tightly attached each end. If they cross your rafters, make sure they are tightly attached to each one.

Solution

If any gable-end braces are broken or missing, install new ones. Attach a brace from the peak of your gable end to the ceiling framing below on about a 45° angle. Place braces from both gable ends to create a pair. Add extra brace pairs down the central ridgeline.

Remember

- If you have more than one gable end, brace them all.

A double skin brick gable end. These are prone to damage in an earthquake.

LOOSE CONCRETE OR CLAY ROOF TILES

Problem

Clay or concrete tiles are heavy and can damage each other and your roof in an earthquake.

To check

Look in the roof space of your house.

Check your tiles are fastened to horizontal pieces of timber in the roof. These are called battens.

Your tiles will likely be tied to the battens with wire, but some tiles can be fastened with clips, nails or screws.

If your roof has underlay, you will not be able to easily see the underside of the tiles, but you should still be able to check the tie to the battens.

Check each tile to make sure the fastenings are in good condition and not loose, rusted or broken.

Solution

Replace damaged connecting ties with the same style of wire, clip, nail or screw, or install the correct new ones if they are missing.

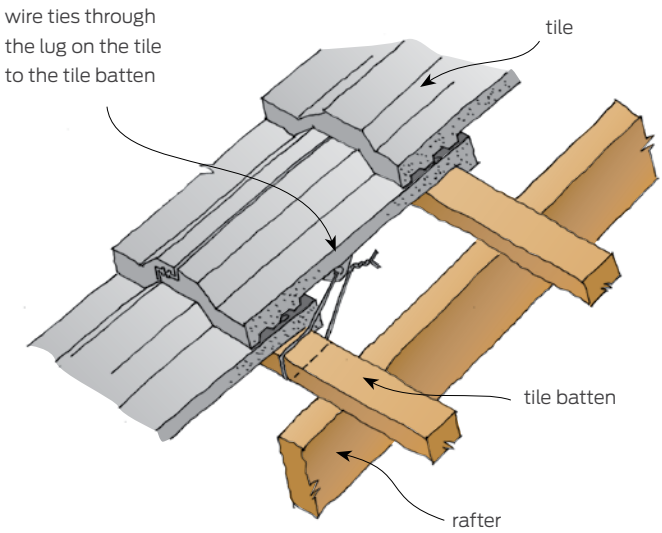
When fastening with wire, use galvanised wire and thread the wire through the lugs on the tile, wrap it around the lower batten, and twist the wire together firmly with pliers.

Make sure you fasten at least every second tile - every tile is even better.

Remember

- If you live within 500 metres of the coast, use stainless steel fastenings so they don't rust.
- Concrete and clay roof tiles have a useful life of about 60–70 years, so if you have a house built before 1950 with original tiles, they may need replacing soon.
- If you are thinking of replacing your roof, consider using lighter materials, such as sheet metal or metal tiles.

Clay roofing tiles.



Typical detail of tiled roof.

UNRESTRAINED HEADER TANK

Problem

Some houses use a tank to feed water into the hot water cylinder. This header tank is very heavy when full of water and can cause a lot of damage if it moves in an earthquake.

To check

If you have a header tank, it will be outside on top of the roof or inside the roof space. If you have a low-pitch roof, it will be outside.

As a quick check, if you have a disc-shaped device connected to a pipe to your hot water cylinder, you probably don't have a header tank. This device is a pressure-reducing valve (see photograph below right), which does the same job as the tank.

Houses built after 1985 are less likely to have a header tank.

Solution

Bolt or nail the header tank platform to the roof or ceiling frame.

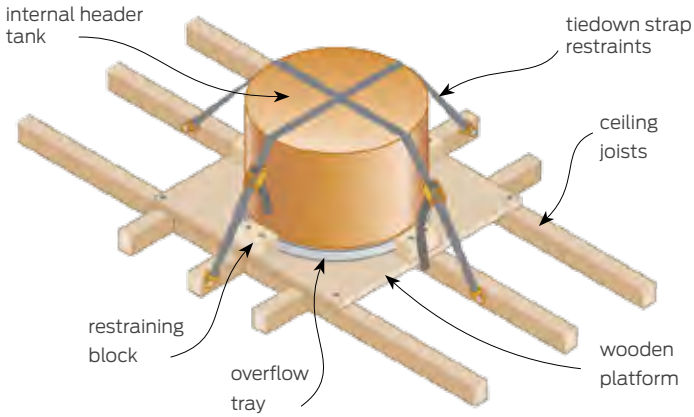
Nail timber blocks to the platform at the base of the tank tray to stop it sliding.

The drawing at right shows you what should be done for tanks in the roof space. With tanks on the roof, the straps may weaken with long sun exposure and should be replaced regularly.

Remember

- If your header tank is on the roof and you live within 500 m of the coast, use stainless steel fasteners to stop them rusting.
- If you're renovating or replacing your hot water cylinder, replace your header tank with a pressure-reducing valve at the same time.
- An empty and unused header tank poses little earthquake risk, but it's best to remove it if possible.

External header tanks can fall over in an earthquake and damage your water supply pipes, roof and guttering.



Pressure reducing valve.

4 Grounds and surroundings

DAMAGED RETAINING WALL

Problem

In hilly areas, retaining walls damaged in an earthquake can allow the land to slump and slide behind them.

To check

You may have timber or concrete retaining walls above, on or below your property holding back earth on a slope or at a change of level.

Look at the retaining wall from the end. Check that the wall is upright or leans slightly into the slope.

Look for missing timber or concrete, and for cracks and signs of damage.

Solution

Ask a chartered professional engineer for advice before repairing or replacing a retaining wall.

Remember

- If you build a retaining wall more than 1.5 m high you need a building consent.
- A retaining wall that has buildings or carparking or a road just above it also requires a building consent.

Unreinforced retaining wall collapsed in an earthquake.

OLD PIPES AND CABLES

Problem

Service pipes and cables for water, sewage, stormwater, electricity and gas can break during an earthquake.

To check

If you have old earthenware sewage or stormwater pipes, consider replacing them with modern plastic pipes that are less likely to break. Old pipes are especially vulnerable on hillsides where ground movement is more likely.

Check if your electrical connection is above ground. It's a thick black cable that runs overhead from the street, and it should be securely fixed to your house with a strain relief connection. Do not touch the cable or its connections.

Do not confuse this cable with overhead data cables that are also found in many parts of the region.

Solution

Always ask a professional to repair or replace the services to your home. Consult a plumber or drainlayer about your pipes and an electrician about your cables.

Remember

- Find out where the water and gas lines enter your property and how to turn them off after an earthquake.

Before you start work on replacing sewer and stormwater piping, check you have identified the correct council drainage connection.

More information

SECURE YOUR HOME CONTENTS

You can find out how to quake safe the contents of your home on the website of the Earthquake Commission (EQC)

www.eq-iq.org.nz

WHAT TO DO IN AN EARTHQUAKE

You can find information about what you should do when an earthquake strikes on the Getthru website.

www.getthru.govt.nz

BACKGROUND INFORMATION ABOUT EARTHQUAKES

You can find great information about earthquakes in New Zealand on the website of GNS Science, a Crown research institute.

GNS has produced several YouTube videos, including one about the tectonic plates that cause our earthquakes, and another specifically about the Wellington fault.

www.gns.cri.nz

EARTHQUAKE HAZARD MAPS AND FACT SHEETS

You can find maps and fact sheets for Kapiti, Porirua, Hutt Valley and Wellington on the website of the Greater Wellington Regional Council.

www.gw.govt.nz

FINDING A LICENSED BUILDING PRACTITIONER

You can search online for an LBP in your area.

www.dbh.govt.nz/lbp-consumer

FINDING A CHARTERED PROFESSIONAL ENGINEER

You can search online for a chartered professional engineer in your area.

www.ipenz.org.nz

BRANZ RESEARCH

You can find information about how BRANZ engineers helped out after the Canterbury earthquakes, and about how to strengthen the foundations of your home, on the BRANZ website.

www.branz.co.nz

How would your house stand up?

A major earthquake in Wellington or Wairarapa would severely damage thousands of houses.

With a few basic upgrades, you may be able to reduce the risk of costly repairs and enjoy a home that protects you and your family through disaster.

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