Institute for Catastrophic Loss Reduction

Building resilient communities

Designed for safer living®

ICLR's QuakeSmart™ Program

Protect your home from

Earthquakes

Designed for safer living® *is a program endorsed by Canada's insurers to promote disaster-resilient homes.*

About the Institute for Catastrophic Loss Reduction

The Institute for Catastrophic Loss Reduction (ICLR), established in 1997, is a world-class centre for multidisciplinary disaster prevention research and communication. ICLR is an independent, not-for-profit research institute founded by the insurance industry and affiliated with Western University.

The Institute's mission is to *reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.*

ICLR's mandate is to confront the alarming increase in disaster losses caused by natural disasters and to work to reduce disaster deaths, injuries and property damage. Disaster damage has been doubling every five to seven years since the 1960s, an alarming trend. The greatest tragedy is that many disaster losses are preventable. ICLR is committed to the development and communication of disaster prevention knowledge. For the individual homeowner, this translates into the identification of natural hazards that threaten them and their home. The Institute further informs individual homeowners about steps that can be taken to better protect your family and your home.

The purpose of this handbook is to outline actions that homeowners can take to protect their homes from earthquake damage. Some of these measures are simple and free; others cost money. All contribute to reducing the risk of severe earthquake damage.

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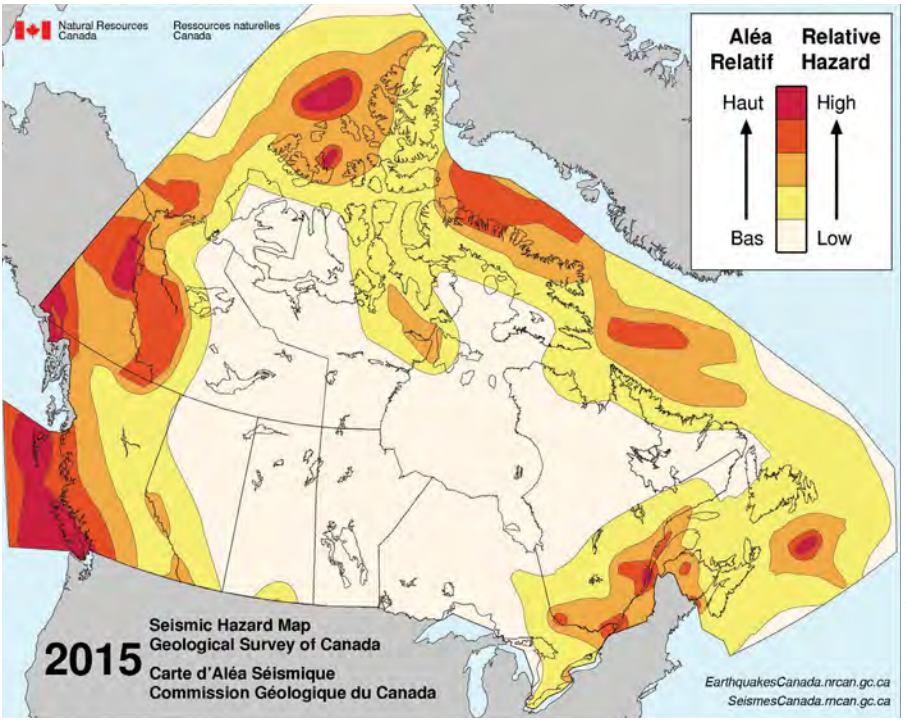
Start reducing your risk of earthquake damage

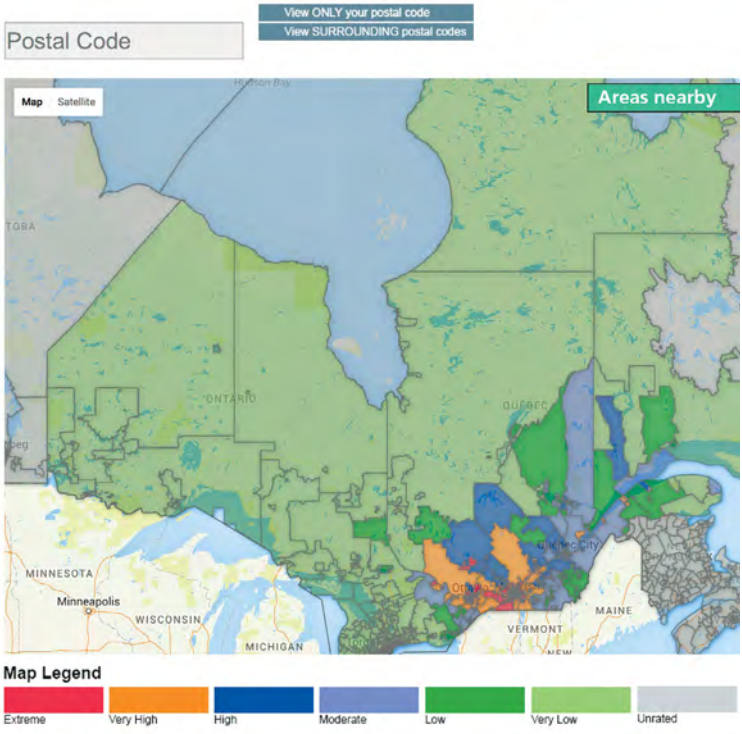
With population and development continuing to increase in at-risk areas, a growing number of Canadians are vulnerable to earthquake damage. Earthquakes are impossible to predict and can strike suddenly with no warning. They can occur at any time of the year and at any time of day.

Canada experiences up to 5,000 earthquakes each year, most of them small. While all provinces and territories have some degree of earthquake risk, the western and southwestern regions of British Columbia are most at risk. Other at-risk areas include the St. Lawrence and Ottawa River valleys, as well as parts of the three northern territories. The June 23, 2010 magnitude 5 earthquake in Val-des-Bois, Quebec served as a reminder of the risk that also exists in eastern Canada.



Map courtesy of Natural Resources Canada

This map provides an idea of the likelihood of experiencing strong earthquake shaking at various locations across Canada, using the relative seismic hazard for single family dwellings (1-2 story structures).



Individuals can determine the relative risk of earthquake in a given postal code Forward Sortation Area (FSA) using ICLR's Earthquake Risk Mapping Tool, available at www.iclr.org/earthquakerisktool.html

Small or moderate earthquakes commonly last only a few seconds and typically do not cause structural damage, although objects/items may move or fall. Larger earthquakes can last up to several minutes and can cause significant damage if the epicentre is near a densely populated area, or if the magnitude is sufficiently large for the region. Over the past 100 years, at least ten earthquakes in or near Canada have registered a magnitude greater than 7. A few have caused extensive damage. Even a magnitude 6 earthquake could cause extensive damage to poorly constructed buildings and other structures in major urban centres. A strong quake near one of Canada's heavily populated cities would likely be the most destructive natural disaster this country could ever experience.

While homeowners cannot predict earthquake activity, there are steps they can take to protect themselves and minimize damage to their homes. To minimize earthquake damage, a home must be able to absorb the quake's energy and provide a stable path to transfer these forces back into the ground. Structural damage is less likely if the roof is attached securely to the walls and the walls are fastened to each other and anchored to a strong foundation. Damage and personal injury within the home can be reduced significantly by securing large items in place. Engineered structures can be designed and built to resist earthquake forces because of the attention given to construction connections (joints, fasteners) and load paths (the path that seismic forces pass through to the foundation of the structure). Historically, little engineering design had been required or applied to any building constructed prior to 1985 and all residential construction. These buildings can be vulnerable to earthquake damage when open space at the ground floor (as is commonly found in commercial establishments and parking garages) is introduced without proper consideration of earthquake engineering.

If homeowners are not sure whether their homes are at risk from an earthquake, they can check with their local building officials, city engineers or planning and zoning administrators. These individuals can confirm whether the area in question is subject to more frequent seismic activity.

This publication is designed to assist homeowners whose residences are at risk of damage from an earthquake. It provides an overview of key areas in and around the house that may require attention in order to reduce the risk of earthquake damage.

How earthquake forces affect a home.

First steps

1 Talk to your local government.

Local governments can often offer helpful advice to homeowners on how to protect their homes from earthquake damage. Municipal and provincial government websites, public works, utilities, building and emergency management departments are all useful sources of information. Towns and cities located in areas of increased seismic activity can offer a great deal of expertise on how to protect your home.

Some key questions worth asking:

- What advice can they offer?
- Are there engineering studies on your house/subdivision?
- How do you report damage from seismic activity?
- What actions does your local government suggest you take?
- Is there disaster-relief assistance available?
- Can they recommend any contractors with expertise in earthquake mitigation/protection?
- What permits, if any, are required to strengthen your home's defenses?

2 Talk to your insurance agent or broker.

Talk to your insurance agent or broker to find out about what types of water damages are covered under your policy. Trying to make a claim after you have suffered water damage is not a good way to find out that you don't have the proper coverage, or that overland flooding is uninsurable.

3 Have a building inspector evaluate your home

Each home is unique. An engineer or contractor who is fully versed in seismic safety can best help you protect your home. Understanding the risks of seismic damage and the nature of your residence will help to ensure that the best course of action is taken to reduce future earthquake damage to your home. Your municipality may help you find an engineer or contractor.

1. Taking action on your own

These initiatives cannot guarantee personal safety and the security of any property but, if properly addressed, will help to minimize the risk of earthquake damage to your home.

Secure light fixtures and suspended ceilings

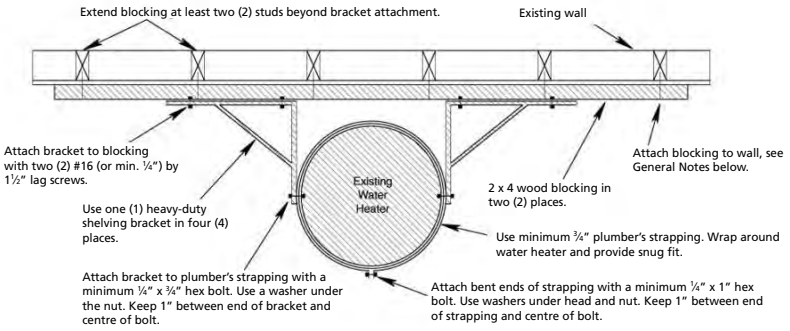
While a glass chandelier can be an attractive addition to a dining room or foyer, you may wish to consider other options if you live in an earthquake-prone area. Light fixtures hanging from the ceiling will sway during an earthquake and may fall. More earthquake-resistant light fixture selections include recessed lighting and track lighting. If a ceiling light has a cover, it should be fastened to the fixture itself. Installing plastic sleaves over fluorescent light tubes will keep the glass from scattering if they break.

Suspended ceilings should be attached to the structure of the home every few feet using chain straps, plumber's strapping or minimum 14-gauge wire. You can also prevent ceiling panels from flying upward by installing adjustable compression struts.

Brace water heaters and major appliances

The horizontal forces created by an earthquake can topple water heaters that are not braced to the structure. Once a water heater has tipped over, the broken water pipe will flood the home, damaging or destroying floors, walls, furniture and personal possessions. Homes are at additional risk to possible explosion and fire damage if the water heater is powered by natural gas, as gas lines are often severed during an earthquake. Bracing a water heater is a simple and affordable way to avoid this problem. Water tanks should be secured using an approved seismic restraint kit that is strong enough for your size of tank. Installation instructions should be followed carefully.

Just as water heaters may shift and/or topple during an earthquake, so too can major appliances (e.g. refrigerators, stoves, dishwashers, washing machines and dryers). Each of these appliances may be attached to water and/or gas lines that can cause serious damage to the structure if the line is severed. You should replace all rigid appliance



General Notes: Blocking attachment to wall

1) Wood stud wall: Use two (2) #16 (or min. ¼") by 3½" lag screws with hex head and washer under head of screw.
2) Concrete or Masonry wall: Use ⅜" masonry anchors with 1⅝" embedment into existing wall at 12"–16" on centre.
3) Steel stud wall: Use two (2) #10–16 self-drilling sheet metal screws with hex head and washer under head of screw.
4) Wood and Steel stud walls: Centre screws on studs.

Method recommended by NIST. See NIST Report GCR 97-732 reference page 37.

connections with flexible metal armoured connectors and install automatic shut-off valves for both the gas and water supply to further reduce the possibility of a gas or water line break. Stoppers or wedges purchased at most any hardware or home improvement store can keep large appliances from moving during an earthquake.

A seismic natural gas shut-off valve located on your natural gas meter will turn off the gas supply to the home in the event of an earthquake. This could prevent explosion and fire in the event a gas line in your home is severed from the force of the shaking. Using a metal screen to protect the gas meter from falling bricks and/or a collapsing chimney is also a relatively inexpensive and easy measure to take to prevent gas leaks and possible explosion and fire.

Reposition heavy objects

Heavy objects such as television sets, stereos and personal computers are often placed on the tops of cabinets, bookcases, desks and tables. They can slide or fall off during an earthquake, causing damage and personal injury. These items should be secured to the furniture they are resting on using velcro or non-skid pads. You may wish to consider

fastening several wall units together to form a wider footprint using #8 machine screws (minimum 3"). The tops of top-heavy furniture should be secured to a wall by anchoring the furniture to studs using flexible fasteners.

Brace bookcases and other storage shelving

Bookcases can shake and tip over during an earthquake, causing damage or injury. To prevent these items from overturning, they should be attached to a structural member using L-brackets or Z-brackets. Heavier items such as large books should be placed on lower shelves to reduce the centre of gravity. Ledge barriers (wood, plastic, or metal) can be installed to prevent items from falling off shelves. The wheels on all rolling furniture should be locked. Ideally, casters should be removed all together.

Use lockable cabinets

During an earthquake, cabinets can tip over and their doors can open, spilling – even spraying – their contents. To prevent damage, you should use lockable file cabinets and attach them to the wall using the same method noted for bookcases and other storage shelving (above). Self-locking kitchen drawers and cabinets should be installed. For retrofits, a locking mechanism (eg. baby-proof latches) can be used. Although the locks may seem cumbersome at first, the mild inconvenience can prevent injury and potentially save you from replacing hundreds of dollars worth of expensive glassware.

Secure picture frames, mirrors and bulletin boards

Photographs, mirrors, bulletin boards and artwork can easily fall from walls during an earthquake and cause damage and personal injury. These items should not be placed over beds and should be secured to walls using closed-eye screws (where possible) instead of traditional picture hangers. The screw eye should be attached to a wooden stud. Multiple screw eyes may be required depending on the weight of the item.

Properly mount flat screen televisions

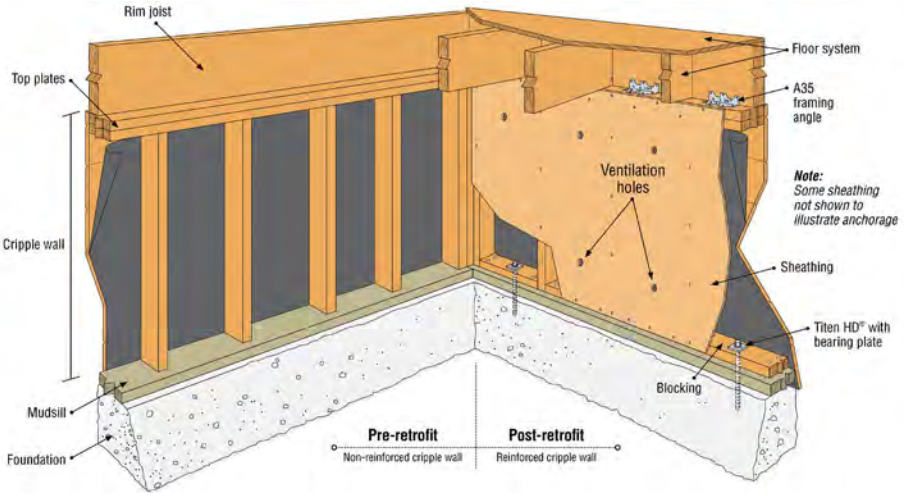
Wall-mounted flat screen televisions are often inadequately mounted on brackets that are attached either to a single framing stud or, in some cases, just to the drywall. There is a good chance that either of these installation methods will be inadequate when an earthquake strikes. Flat screen televisions should be mounted to at least two framing studs spaced no more than 24 inches apart on centre. Heavy-duty brackets should be installed using manufacturers' recommendations. For wall mount brackets that can only be installed to a single stud, the bracket might be retrofitted using items readily available from hardware or home improvement stores. However, before starting, ensure that the television is less than approximately 50 kilos (110 pounds, usually 60-inch diagonal screen size or smaller) and that framing studs behind the drywall are not more than 24 inches apart (on centre).

2. Structural improvements to your home

Homeowners undertaking renovations should be mindful of structural changes to the home that, while visually appealing, could increase the risk of earthquake damage. These include: replacing large portions of walls with windows and glass doors; adding large skylights or additional stories; opening large portions of existing floors (e.g. creating a two-story foyer); and additions that create an 'L' configuration.

Cripple walls

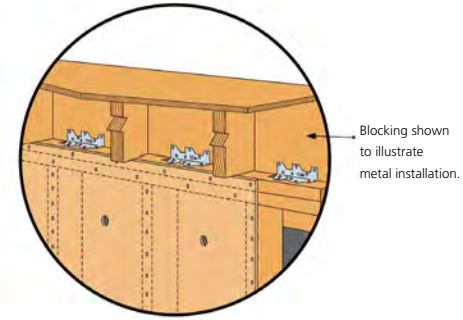
Cripple walls are short wood-frame walls that are situated between the foundation and the first floor framing. They are commonly found in wood-frame structures that have a basement or crawlspace. Because the pliable wood frame cripple wall is typically attached to a less flexible concrete foundation, the connection between these two different materials is vulnerable to earthquake-related failures. You can take steps to strengthen the cripple wall so that it and the foundation behave more as a single unit. To complete this retrofit, access to the cripple wall beneath the first floor framing is required. Structural grade plywood or oriented strand board (minimum ⅜") can be fastened to the inside of the cripple wall framing. While homeowners will benefit



more from bracing the entire cripple wall, only the corners of the cripple wall can be braced if budget is an issue. All edges should be attached to the structural framing. Air holes should be drilled in the structure so that moisture is not trapped within the bracing.

Building foundations

Homes that are not properly attached to the foundation can shift during an earthquake. It is important that the building is connected to the foundation with anchor bolts or other steel connectors (including anchors, steel plates or straps) that secure the sill plate (the wooden board that sits directly on top of the foundation) to the foundation. A professional engineer should be consulted if it is found that the foundation is in poor condition (e.g. made of unreinforced masonry) or uses a post-and-pier type configuration. It is important to note that properly securing a home to its foundation may also secure the structure against damage from severe wind.



Metal framing angles connect the cripple wall to the floor system.

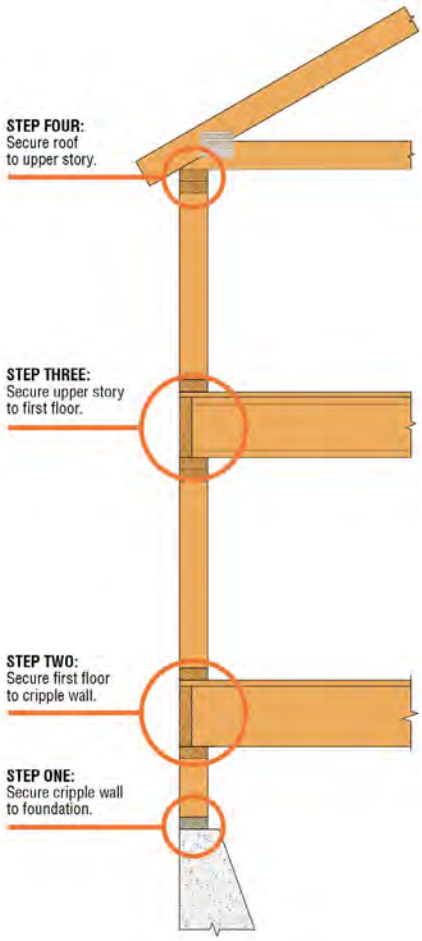
Floor systems

Floor systems typically consist of floor joists, floor sheathing and band joists, which are located along the floor's perimeter. An earthquake exposes the floor to substantial forces that can distort and damage it. Floor systems should be tied together with the sub-floor securely connected to underlying floor joists. To reduce the possibility of rotation in an earthquake, each joist should be nailed to a band joist.

Blocking or bridging can also be placed between joists to keep them from falling over. The forces absorbed by the band joist or blocking must, in turn, be transferred to the foundation. The connection should be secured using metal ties or framing anchors.

Wood-framed walls

Traditionally, the exterior walls of woodframe houses are supported with wood studs attached to structural-grade plywood, oriented strand board or diagonal wood sheathing. To protect the exterior walls from the elements, they are covered with lap siding, stucco, stone or brick veneer. In order for this system to resist damage from earthquake forces, it must be well designed with the appropriate hardware in place to ensure a strong connection between all of the elements.



Masonry walls

A home whose walls are made entirely of brick, stone, clay tile, concrete block or adobe could be susceptible to earthquake damage. In newer masonry homes, these types of walls are often reinforced with steel bars grouted inside the walls. If the walls are reinforced and well anchored to the foundations, floors and roofs, they can usually withstand an earthquake. But masonry that is in poor condition, unreinforced or not securely tied to the rest of the structure, has the potential to collapse. A proper retrofit generally requires anchorage designed specifically for earthquakes. Since evaluating structural masonry walls for general soundness and specific seismic features is quite complex, it is best for you to consult a professional engineer.

Roof systems

For homes to adequately resist the force of an earthquake, the roof structure must keep the walls tied together. The typical roof system includes a roof covering, roof sheathing and supporting roof frame. You should inspect the roof covering. It should be in good condition with no evidence of excessive wear and tear. Nonstructural lightweight coverings (such as wood or asphalt shingles) behave well during an earthquake. Tile and slate coverings (which are heavy) are susceptible to sliding or falling off the roof during an earthquake. Both plywood and OSB roof sheathing give strength to the roof regardless of the roof style. Roofs fully sheathed with structural grade plywood or OSB provide the greatest stability to the overall structure. Large dormers, skylight openings and any other features that interrupt the sheathing can weaken the roof structure. You should also consider the roof system's framing (trusses or rafters that support the roof covering and sheathing). Similar to floor systems, roof-framing systems can rotate or fall over when your home starts to move in an earthquake. To prevent this, blocking can be placed between the rafters or trusses where they rest on the wall. The blocking should be nailed to the roof sheathing in order to transfer the lateral loads into the wall. Metal strap connectors (i.e. hurricane straps or clips) or properly placed toe-nailing ensure that the blocking is adequately connected to the wall and rafters.

Garage door openings

Garages are particularly vulnerable to earthquake damage, especially if there is living space above. To avoid earthquake damage, the narrow walls on either side of the garage opening must be able to support the seismic load that is transferred from the roof and additional living space above the garage (if one exists) into the foundation below. In order for

Home before earthquake.

Home tears apart during earthquake.

Home detaches and garage collapses.

these narrow walls to support this load, they must be properly braced. The bracing can be done using steel bracing or specially detailed plywood panels that are recommended by a registered professional engineer.

Chimneys

Until recently, most building codes did not require homes with masonry chimneys to be reinforced and braced to the structure. Chimneys that are not properly reinforced and braced often break away from homes and topple, even during moderately-sized earthquakes. (As such, property owners should ensure that beds and chairs are located away from chimneys, which can collapse through roofs and severely injure or kill an individual.)

A few strategically placed metal straps secured to structural members (floor, ceiling and roof joists) can help to brace the chimney. Chimneys should be inspected regularly for signs of significant cracking (greater than the width of a dime) along the mortar joints. You should ensure that the mortar is in good condition and does not easily crumble when scraped with a metal tool. Registered professional engineers can be a good source for information on how to adequately brace a chimney.

Windows and glass doors

Brittle materials like glass can fail suddenly during an earthquake, spraying shards throughout a room and injuring those nearby. Tempered glass (similar to that installed in automobiles) is designed to break into small pieces that are far less likely to injure anyone. If you are contemplating window replacements, you should consider replacing your windows with tempered glass. If your budget does not allow for window replacement, a much less expensive option is to install a protective film (4 millimetres minimum thickness) on the inside of the windows. The film can be purchased at home improvement stores.

3. Measuring your risk of earthquake damage

Assign yourself the indicated number of points for each question. The fewer the points you score, the more protected your property is against earthquake damage.

If a question does not apply to your home, assign a score of 0.

Question	Answer	Points	Risk Score
Foundation and Walls			
Is the masonry reinforced and the sill plate secured to the foundation?	Yes No	0 25	
Are the cripple walls reinforced?	Braced entirely Braced at the corners No reinforcement	0 10 20	
Are the floor systems connected using metal ties or framing anchors?	Yes No	0 10	
Are the wall elements reinforced, well connected and anchored to the foundation?	Yes No	0 10	
Is the garage door opening secured with steel bracing or plywood panels?	Yes No	0 10	
Are the windows and glass doors protected against breakage?	Tempered glass Protective film (Minimum 4 millimetres) No	0 5 10	

Question	Answer	Points	Risk Score
Roof Systems			
What roof covering does the home have?	Nonstructural lightweight covering (wood/asphalt shingles) Tile/slate covering	0 5	
Does the roof sheathing include structural grade plywood or OSB?	Yes No	0 5	
Is there blocking between rafters/ trusses for the roof framing and is it anchored to the wall?	Yes No	0 10	
Does the home have a large skylight?	No Yes	0 5	
Is the chimney properly reinforced and braced?	Yes No	0 10	
Inside the Home			
Are light fixtures secured?	Recessed/track lighting and/or hanging light fixtures are secured Light fixtures are not secured	0 5	
Are the home's suspended ceilings attached to the structure with safety cables?	Yes No	0 5	
Are major appliance and the water heater anchored to the wall using safety cables?	Braced to the structure No	0 15	
	My total Risk Score is ►		

Low 21 or less, **Moderate** 21-29
High 30-35, **Extreme** 35 or more

Repair or upgrade to-do-list

Description

Location | Start date | Completed

☐ Repair ☐ Upgrade ☐ Replace | $ Budgeted | Actual cost

Description

Location | Start date | Completed

☐ Repair ☐ Upgrade ☐ Replace | $ Budgeted | Actual cost

Description

Location | Start date | Completed

☐ Repair ☐ Upgrade ☐ Replace | $ Budgeted | Actual cost

Description

Location | Start date | Completed

☐ Repair ☐ Upgrade ☐ Replace | $ Budgeted | Actual cost

Important questions

Important contact information

Insurance company

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Insurance broker or agent

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Municipal government

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Contractor

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

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