An Earthquake Preparedness Guide

A ready reckoner for Home Dwellers...

ISSUED IN PUBLIC INTEREST BY:
LAND REVENUE AND DISASTER MANAGEMENT DEPARTMENT
GOVERNMENT OF SIKKIM
AND
NATIONAL DISASTER MANAGEMENT AUTHORITY
GOVT. OF INDIA
Past earthquakes in our country brought home the harsh reality that earthquakes don’t kill people, unsafe buildings do. About 60% of the land are of our country is susceptible to damaging levels of seismic hazard. We can’t avoid future earthquakes, but preparedness and safe building construction practices can certainly reduce the extent of damage and loss. To take necessary action it is mandatory for every citizen to have elementary knowledge of what is an earthquake, forces acting on structures, remedial measures to be taken for structural safety and knowledge of what to do before, during and after an earthquake.

This guide will serve as a reference tool to sensitize citizens about the issues concerning preparedness measures for an earthquake.

1. भूकंपचालालों के हो?

What is an earthquake?

The surface of earth is made of several plates

| पृथ्वी को सतह अनेको  प्लेटहरूले बनिएको छ। |
|---|---|
| The surface of earth is made of several plates |

| यी प्लेटहरू सँगी चलायमान रहेको  |
|---|---|
| These plates move all the time |

Due to this movement of plates the energy stored is suddenly released when rocks get crushed under stress and spreads in the form of waves inside the ground creating earthquakes.
At the joint of two interacting plates the rocks get crushed under great stress causing earthquake waves in all directions.

What cause damage to the building?

Each building and site may have different vulnerability.

Ground shaking generally decreases as it spreads.

Ground shaking increases in soft soil.

Sudden fault movement creates found shaking.
Imagine a sheet of cloth. By shaking it at one end, a wave is formed. This is what happens in an earthquake.

Because of the wave, horizontal force acts on the building. For this sideways movement the building has to be specifically designed.

Normally the weight of the building travels vertically down to the ground. All buildings are designed for this weight.

Crack, and in some cases failure, occur if the shape, material and details of the construction are not adequate to withstand sideways shaking.

Different structural systems: a Basic Guide

- **Load Bearing Structure**
- **Reinforced Concrete (R.C.) Frame Structure**
What happens during an earthquake?

Load bearing Structure

The load bearing walls act as a stiff box. The weakest point in this box is the openings for doors and windows and the junction between the wall and slab.
The RC frame structures where the ground storey is left open without any partition walls (of either Masonary or RC) between the columns are called Open Ground Storey buildings or, buildings on stilts. In this case it is relatively flexible and weak in the ground storey.

The presence of walls in the upper storeys makes them much stiffer than the open ground storey. Thus they move almost together as a single block. As the columns in the open storey are not strong enough in resisting sideways shaking from the earthquake, they get severely damaged, subsequently leading to collapse of the superstructure.

Experience has shown that buildings on slits do not perform well in earthquakes unless the column and beam connections on the ground floor have been specially designed to withstand the shaking load. A few option are shown in the figure below.
Mid-rise framed structures without open ground storey

RCC frames bend due to horizontal forces. This affects the joints of the columns and beams. They may crack.

Mid-rise frame structures with projected balcony and with open ground storey.

During the earthquake it is the columns that carry the upper part of the building. These columns are affected the most during the shaking.
c. Tower Block with open ground storey

Beyond ground + 4 floors

Due to the height, the horizontal force during an earthquake may cause the buildings to sway in both directions.

d. Tower Block with Podium

In such cases the Podium reduces the height of the tower.

The Podium tends to move horizontally during an earthquake. At the same time the tower will bend due to the horizontal force. The most affected area is the floor above the podium. This level should be checked carefully.

Inspect your Building

If you live in a multistoried building and if you are not sure it has been designed to resist earthquake forces, the first step that needs to be taken is to sensitize your fellow residents and the neighbourhood about the damages and losses they may face in an earthquake.

The next step would be to get your building reviewed for earthquake safety by a competent and experienced structural engineer.
A structural engineer is on who is trained and experienced to understand how buildings are constructed and how they behave and be able to recognize weakness which may cause them to collapse in an earthquake event. They will be able to survey your building and advise you on whether strengthening is necessary and if so how it can be done. Structural engineers will be able to supervise or get a competent person for supervision of repair work on your behalf to make sure that it is done properly. Select a structural engineer registered with the Local Authority.

Sequence in which structural elements are to be checked.

क. कुंडलका खंडा और निदाल
Corner columns and beams
ख. बाहिरी घरका खंडा और निदालहर
Peripheral columns and beams
ग. बाहिरी घरका खंडा और निदालहर (देवालेले बिचिमा क्रेनम संरचनाको बार्जिका लागि)
Cantilevered beams (for Balcony covered framed buildings)
घ. सिंहारका देवाल और खंडा और लिपिका देवालहर
Stair walls and columns and lift walls

Non-Structural Elements

Ways to reduce damage to and injury from the contents of your home.

1. सिराममा वा अप्रल बगल्मा लगाएका ब्रेकेटले
   ताकलाई इन्दिरिक बचाउँछौं।
   Brackets at top or, sides secure
   the shelves from toppling off.

2. धातु वा ताकरो राखको बन्दने पनि खुला ताकवार
   सामानहरूलाई इन्दिरिक बचाउँछौं।
   Metal or wire guardrails will also help
   keep objects from falling off open shelves

3. लामिलोकका लागि राखको
   विचिमा जोडिएको
   सिर्फु।
   Spring connected
   in between the
   guardrails for
   flexibility
Metal Plastics or, wood ledge barriers prevent objects from sliding off the shelves.

Pictures frames, bulletin boards and mirrors will fall during an earthquake if they are not securely fastened to the wall.

Do screw closed screw-eye to hang up picture frame/bulletin boards/mIRRors.

A typical water heater weighs between 30 to 60 kilograms when full. A sudden jolt and/or the rolling motion that accompanies most earthquakes can cause them to topple over.

Wrap heavy-gauge metal bands or nylon strapping 1½ times around the tank. Secure this band or strapping to the wall with several 6mm by 75mm or longer lag screws/expansion bolts with washers.
Secure your equipment/computer in the work place

Heavy objects such as televisions, computers and stereo are usually placed on top of cabinets, bookcases and tables. Fasten these items so they will not slide off during an earthquake. Such simple structural measures are vital to maintain safety during an earthquake.

6 वर्तमान अपना उपकरण कम्प्यूटर उपकरण सुरक्षित बनाएं

Secure your water tank

Secure the flower pots from falling off
7. Strengthen/Retrofit your building

Elements like to cause damage

Elements secured to avoid damage

Galvanized welded steel wire mesh
Horizontal Seismic Belts just above the lintels of door and window opening

Horizontal belts just below the roof

Vertical Seismic Belts at wall junctions (L&T junctions)

Seismic belt around doors and windows containing galvanised welded steel wire mesh as reinforcement

Seismic belts around the gable wall

**STEPS TO LAY THE SEISMIC BELTS IN YOUR HOUSE**

1. **First Step**
   - Remove plaster in the height of the belt.

2. **Second Step**
   - Rake out mortar joints to 12-15mm depth.

3. **Third Step**
   - Clean the surface and wet it with water.

4. **Fourth Step**
   - Apply neat cement slurry and thereafter apply the first coat of 12mm thickness cement mortar. Roughen the surface of the plaster before initial hardening.

5. **Fifth Step**
   - Fix the mesh with 150mm long nails at about 300mm apart while the first coat of plaster is in its initial hardening stage.

6. **Sixth Step**
   - Apply second coat of plaster of 16mm thickness.
What to do BEFORE and earthquake?

Three Points to remember:

1. Always remember: “Earthquake don’t kill people, unsafe buildings do.”

2. Be sure that the proper structural design and engineering practices are followed while constructing a house.

3. Evaluate the structural soundness of buildings; strengthen/retrofit if necessary.

Bureau of Indian Standards (BIS) has published the following seismic codes:

- IS 14723 (Part I) 2002, Indian Standard Criteria of Earthquake Resistant Design of Structures (5th Revision)
- IS 1893 (Part I) 1993, Indian Standard Criteria of Earthquake Resistant Design of Structures (2nd Revision)

If you are living in a house/flat, work to improve its safety.
If you are looking for a place to stay, you should look for safety.
What to do during an earthquake?

During earthquakes, drop to the floor, take cover under a sturdy desk or table, and hold on to it so that it doesn't move away from you. Wait there until the shaking stops.

Do not use elevators.

Do not rush to the exit point. Get out calmly in an orderly manner.

Do not panic; stay calm and take necessary action.

Stay away from buildings with glass panes.

If you are on a steep hill side, move away in case of landslides and falling rocks.

When driving a vehicle pull to the side of the road and stop.

Do not attempt to cross bridges/flyover which may have been damaged.
What to do after an earthquake?

Checklist of DO’s and DON'Ts

**DO’s**
- Always be prepared. Always check the safety of your buildings.
- Check for fire and, if any, have it controlled.
- Always check your water and electrical lines for defects.
- Always check your water and electrical lines for defects.
- Clean up household chemical spills, toxic and flammable materials to avoid any chain of unwanted events.
- Gather information and necessary instructions from battery operated radio.
- Obey Public Safety precautions.
- Leave a message stating where you are going if you must evacuate your residence.

**DON'Ts**
- Always be prepared. Always check the safety of your buildings.
- Take your earthquake survival kit with you.
- Always check your water and electrical lines for defects.
- It should contain all necessary items for your protection and comfort.
- Don’t enter partially damaged buildings. Strong aftershocks can cause further damage to the buildings and weak structures may collapse.
- Don’t use your telephones to call relatives and friends, call only for medical help.
- Don’t use your two-wheeler/car to drive around the ares of damage. Rescue and relief operations need the road for mobility.

**Jogosam Kushalai Surakshit Chopati Gitrawal Woh Maram Dawa Huiden Jogsam:**

Until your building is declared safe, or, repair have been complete.

1. Do not fill the overhead tank completely.
2. Do not carry out haphazard repairs. Repairs should be done only under the supervision of a structural engineer.
3. Do not put additional supports without the guidance of an experienced/qualified structural engineer.
4. Do not use the lift until it has been checked and certified by the lift company.
Some Important Facts

- Prediction of earthquakes is not possible. Do not listen to or, spread rumours.
- Except aftershocks. Aftershocks are normally less intense and gradually die out.
- Long term strengthening or, retrofitting must be done to avoid future failures. The technology, expertise and the codes of practice for this exist in the country.
- The extra cost of earthquake resistant features in severe earthquake zone for masonry buildings shall be 4-6% and for R.C. buildings (4-8 storeys) would be 5-6%.
- Retrofitting of buildings not initially designed for earthquake will cost 2 to 3 times as much as the extra cost of the earthquake resistant features in the new buildings.

References:
1. Going Back to your Home - An Earthquake Primer for City Dwellers, CEPT Ahmedabad
2. Public Information Toolkit - Marikina Safety Program

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<thead>
<tr>
<th>Intensities* of Earthquakes in each Zone</th>
<th>Zone</th>
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<tr>
<td>This Zone is susceptible to earthquake that can be felt by all and may frighten people enough to run outdoors. Dishes and glassware break, books fall down, heavy furniture gets moved. Few instances of fallen plaster and some damage to buildings may also be observed.</td>
<td>II</td>
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<td>In Zone III, earthquakes of higher intensity may be felt. Earthquakes that frighten everyone, making it difficult for people to stand. Even people in moving vehicles may feel such quakes. Structures/buildings of good design or construction suffer slight damage, while poorly designed/built ones suffer considerable damages.</td>
<td>III</td>
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<td>This zone is susceptible to strong earthquakes, which create panic all over, moving even heavy furniture. Such earthquakes could cause moderate damage in well designed/built structures/buildings, while poorly built structures suffer great damages. Other effects could be landslides on steep slopes, cracks in ground up to widths of a few centimeters and water in lakes could become turbid.</td>
<td>IV</td>
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<td>This is the maximum risk zone in the country and is susceptible to great earthquakes. Quakes that can cause total panic and considerable damage to life and property. Considerable damages happen even in specially designed structures. Great damage in buildings with partial or total collapse. railway tracks bend and roadway get damaged; ground cracks to widths of several cm, underground pipes break, landslides, rockfalls and mud flows occur, large waves in water. Where intensities exceed XI, total destruction may be caused with changes in landscape that could even change the courses of rivers.</td>
<td>V</td>
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प्रयोक्ता जोनमा भुईचालोको प्रचण्डता

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<td>यस जोनमा यसौ भुईचालोको संभावना हुँदै जो सबैले चाल पाउन सक्दैन तथा मानिसहरू इत्यः बाहिर भनुमै जेल हुनु। प्रेरक कार्यक्रममा पृथ्वी जङ्गलको सुस्त बिताइहुन जरुरत र गर्भित पौधो वर्षपर साझेदार। प्लास्टर उक्तिले र घरलाई कतिपय क्षति पनि हुनुका भएको।</td>
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<td>यो देशमा सबैभन्दा छन्द जोन हो र यसमा दुई भुईचालोको संभावना हुँदै। यसौ भुईचालो जसले पौरै खेलाडिलाई परेकाले तथा ज्याको परेको भारी नेक्स्ट गर्नसक्ने हुँदै। घारहुमा भारी क्षति जसले सी आँकिकतामा दूरी छ भन्ने अवलोकन जसले रूपमा रूढै खुन्सकको। रेलमा तृणको पटकिरिनुपर र निस्तारको क्षतिको हुनसक्छ, जसमा धेरै सेटिमेटर सट्टा क्षतिहुने। धेरै जसमा घर जडने देको बन थाली, पानीमा विसार लापर्को नाइन यसमा भन्ने हुननसक्को। जहाँ भुईचालोको प्रचण्डता ५५ भट्टा घेरुहुँदै त्यहाँमा जमीनको नाक-नाक बदलिनुका साथी पूरै विनाश हुनसक्छ जसमा नदीहरूको बाटो घेर्नुहुन्छ।</td>
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