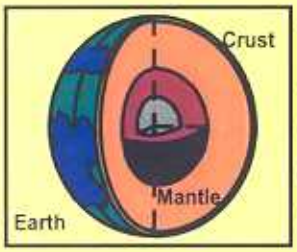
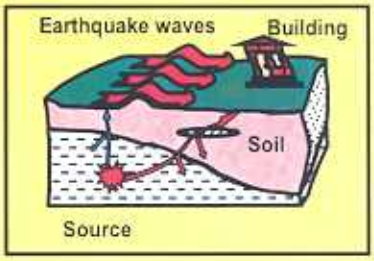
How to make your building earthquake-safe




How does an earthquake occur?



The inside of our earth consists of many layers (*crust*, *mantle*, *inner* and *outer cores*). Form ed by complex processes over countless years, they continue to be active. Once in a while, the disturbances below the earth get transmitted to the surface, causing earthquakes.

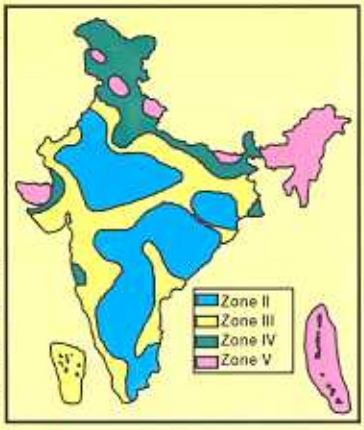


The *waves* generated in the soil during an earthquake travel long distances in many directions in a very short time, shaking the ground. The buildings that cannot resist this ground shaking can collapse, causing disaster and loss of human life.

Earthquakes are natural occurrences

Earthquake hazard in India

Based on historical occurrences, regions in India are classified into *low*, *moderate*, *severe* and *very severe* earthquake-prone zones. The zones are denoted as II, III, IV and V, respectively (see seismic zone map of India). More than half of the country's population lives in moderate to very severe regions, where high-magnitude earthquakes can occur.



Seismic zone map

The extent of damage to a building during an earthquake depends not only on the magnitude of the earthquake, but also on the soil, building configuration, quality of design and construction. In developed countries, because of better awareness and regulation of design and construction practices, the buildings survive earthquakes and damage and loss of life is less. India should also achieve this standard.

Earthquakes do not kill; unsafe buildings do!

Is your building safe?

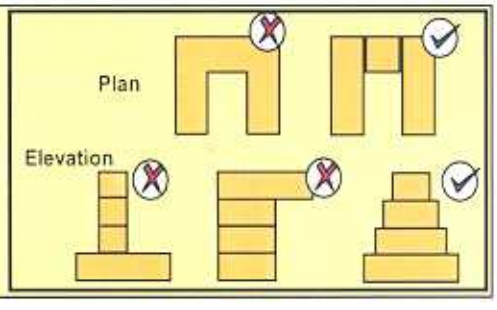
Consult a competent engineer if you have doubts about your building. Get it assessed and, if found deficient, get it suitably retrofitted. Information given here will give you some idea on what makes a building unsafe and how it can be retrofitted. ***Note that mere patchwork is not structural retrofit,*** and this will be exposed during an earthquake.

Also, if you are planning to invest in a new building, make sure that the builder provides the required earthquake resistant features. Use the information given here to ask the builder pointed questions.

Prevention is better than cure!

Importance of building configuration

The building configuration should be simple and regular in plan (as you see from top) and elevation (as you see from the front or side). Otherwise, the building can collapse during an earthquake.



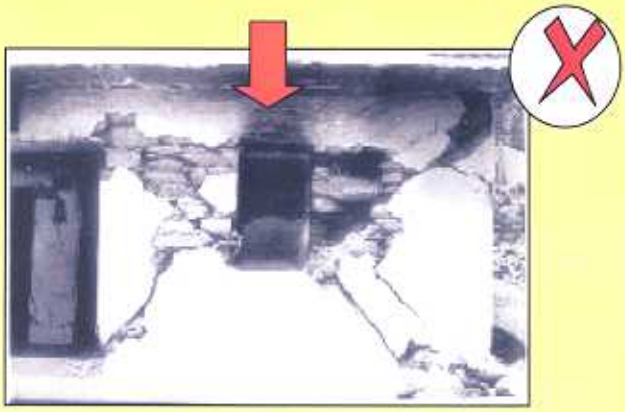
Good configuration is more important than fancy looks!

Masonry Buildings Do's and Don'ts

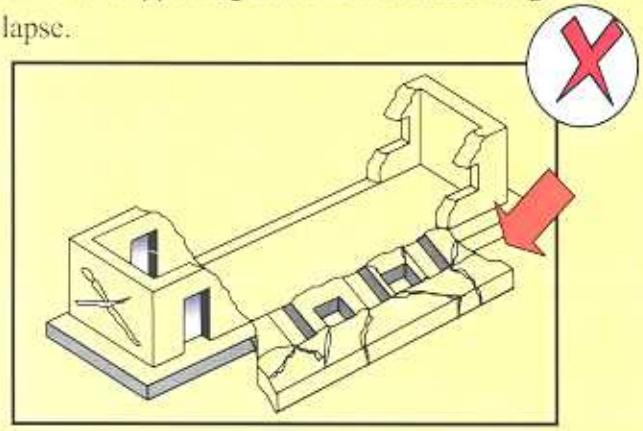
Deficiencies

- A heavy roof made of stones attracts large forces.
- Absence of plinth, sill, lintel and roof bands causes collapse of the walls.

- Absence of vertical steel bars at corners and around openings causes extensive 'X' type cracking.



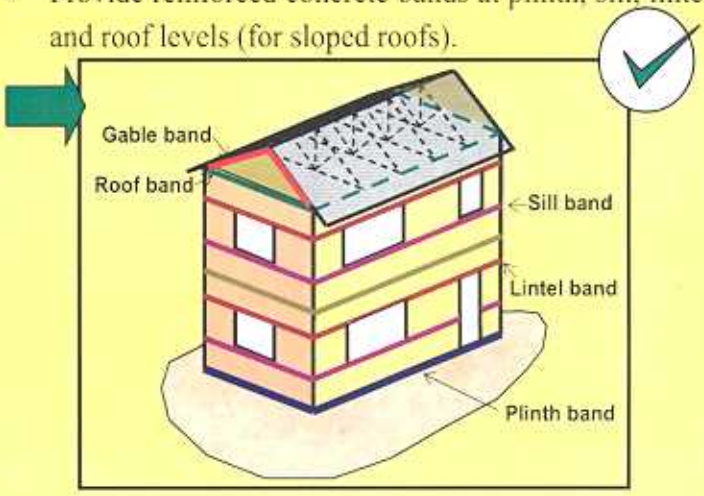
- Absence of supporting cross walls causes long walls to collapse.



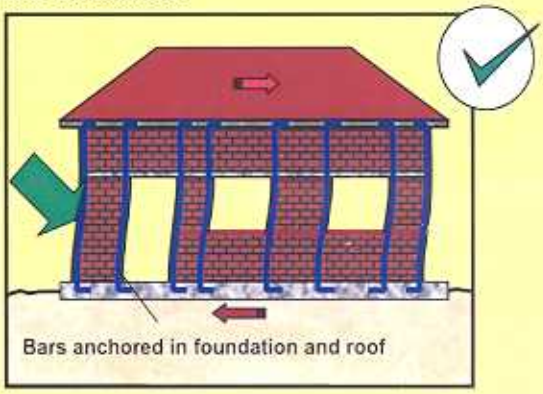
- Corners of walls collapse due to high stresses and lack of integrity.

Correct Design / Remedial Measures

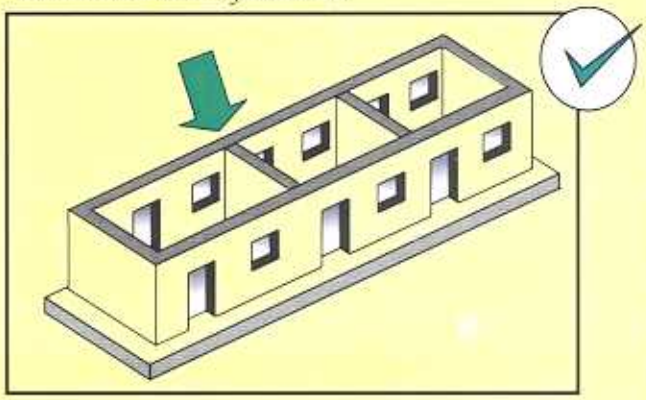
- Use light material for the roof.
- Provide reinforced concrete bands at plinth, sill, lintel and roof levels (for sloped roofs).



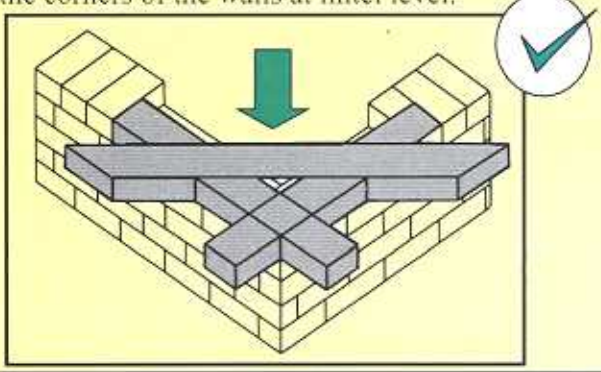
- Provide vertical steel bars at corners of wall segments and between openings to improve seismic resistance.



- Provide adequate cross walls, with proper connection at the junctions.



- Provide collar bands (wooden or reinforced concrete) at the corners of the walls at lintel level.



Concrete Buildings Do's and Don'ts

Deficiencies

- Inadequate frames to resist seismic forces. A frame consists of beams and columns with foundation.
- Faulty detailing of reinforcing bars and poor quality of construction.

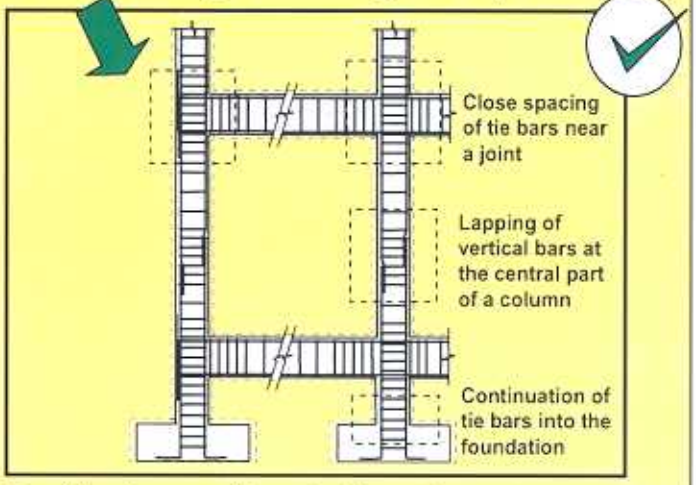
- A ground storey without walls (for car parking) can cave in, leading to collapse of the building.

- Weak beams and columns without proper amount and anchorage of reinforcing bars lead to failure.

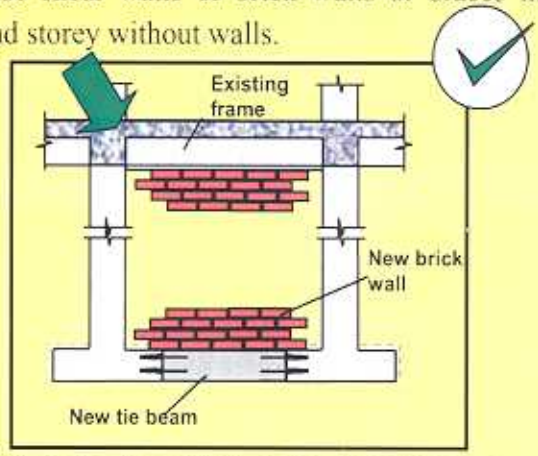
- Staircases are often the first to collapse, blocking escape from the building.

Correct Design / Remedial Measures

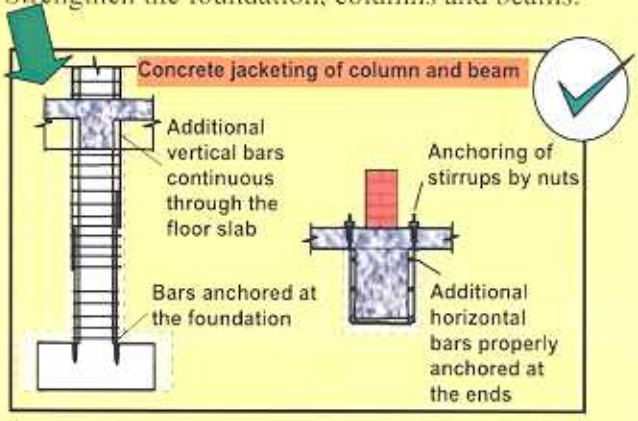
- Provide adequate number of continuous frames in two perpendicular directions in plan.
- Provide detailing of reinforcing bars as per the code.



- Provide shear walls or brick walls or braces in the ground storey without walls.



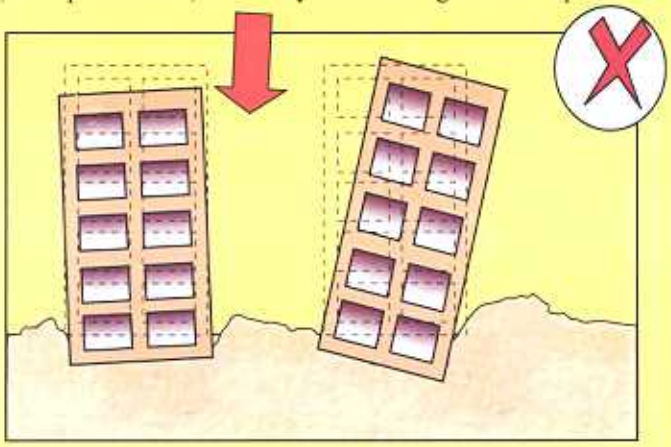
- Strengthen the foundation, columns and beams.



- Stair slabs supported on inclined beams framing into columns provide integrity.

Other Issues

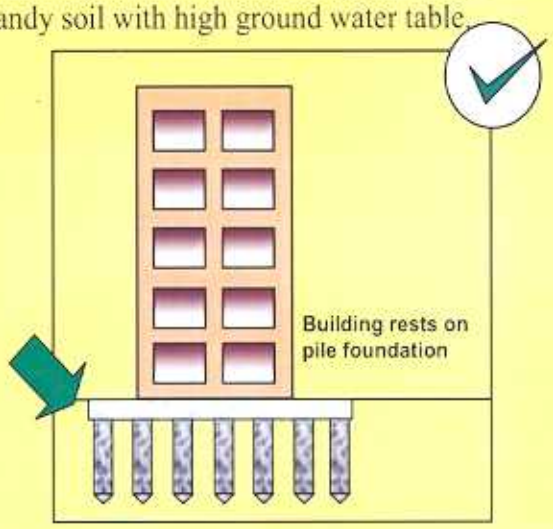
- Tilting or overturning of the building due to liquefaction (like quick sand) of sandy soil during an earthquake.



- Twisting effect due to roof top water tank at one side.
- Collapse of roof top water tank, parapet walls and heavy projections, such as balconies, portico slabs.
- Damage from improperly fitted false ceilings, air conditioning ducts and heavy appliances.

Correct Design / Remedial Measures

- Provide pile foundation for large buildings located in sandy soil with high ground water table.



- Relocate the water tank or retrofit the building to gain symmetry. Support the water tanks on strong columns.
- Provide intermittent supports to the parapet walls. Anchor the heavy projections to the building structure.
- Fasten the heavy items firmly to the building structure.

Key questions to ask the builder before buying a house

- Is the configuration of the building simple and regular? Is the roof made of heavy stones?
- For a one- or two-storeyed house, are there features for seismic resistance as per IS 4326: 1993?
  ¾ Plinth bands? Sill bands? Lintel bands? Gable and roof bands?
- For a building with more than two storeys, whether it was designed for earthquake resistance as per IS 1893: 2002 and proof-checked for compliance with the National Building Code of India 2005?
- For a concrete building in Zones III and above, have the special detailing requirements as per IS 13920: 1993 been incorporated in design and construction?
- Was a proper soil investigation conducted for the site? Is there a fill of soil at the site?
- If there are no walls in the ground storey, have the columns been specially designed as per IS 1893: 2002?
- Is there any large overhanging projection? If so, is the projection anchored to the main structure of the building?
- Have the stair slabs been integrally connected to the frames? If there are doubts or conflicts, consult an expert.

Additional questions to ask before buying an old house

- Is there any sign of deterioration, such as cracks, corrosion stains, spalling of plaster, growth of plants, tilting of walls?
- Have storeys been added after initial construction?
- Has any major repair work been carried out recently?
- If any of the above is true or the quality of construction appears to be poor, consult an expert.

References

1. IS 1893: 2002, "Criteria for Earthquake Resistant Design of Structures", Bureau of Indian Standards (BIS).
2. IS 4326: 1993, "Earthquake Resistant Design and Construction of Buildings", BIS.
3. IS 13920: 1993, "Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces", BIS.
4. Murty, C. V. R. (2005), "Earthquake Tips", Indian Institute of Technology Kanpur. Project sponsored by Building Material and Technology Promotion Council.
5. National Information Centre of Earthquake Engineering, Indian Institute of Technology Kanpur (www.nicee.org).

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