

## Earthquakes and Buildings In Mumbai

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Last week we discussed earthquakes as natural disasters and their relevance to India. Let us now understand how earthquakes can affect our buildings.

### Risk for Mumbai

There are three major earthquake fault lines around Mumbai. They lie under the Thane, Panvel and Dharamtar creeks. Mumbai falls in seismic risk zone III, which represents "moderate risk". Mumbai can experience earthquakes measuring up to 6.5 on the Richter scale. There are some more minor fault lines near the eastern suburbs, which make them more vulnerable than the western suburbs. The island city, however, needs more attention due to a twofold problem: reclaimed land and high rise buildings. Should an earthquake of magnitude 6 or more strike Mumbai, the stability of many high rise buildings and even multistoried buildings may emerge as a very serious concern.

### Earthquake Loads

Conventionally buildings in Mumbai have been designed for gravity loads such as dead loads (weight of the building itself) and live loads (load due to the occupants, furniture etc.). However, earthquake loads are very different from gravity loads.

- They are primarily lateral loads, which shake the building back and forth.
- They depend on the mass of building. Heavier the building, more the earthquake loads.
- In case of gravity loads, structural failure is gradual and with sufficient warning, whereas in case of an earthquake, failure may be sudden.

### Structural damage

Failure of an RCC framed building may occur as follows:

1. Cracks in walls
2. Cracks in structural components
3. Crushing of concrete
4. Buckling of reinforcement bars & columns
5. Collapse of doors and windows
6. Excessive cracking and distortion
7. Collapse

The actual damage to a building would depend on the amount and duration of shaking of ground and the structural capacity of the building to withstand it. Even if the building does not collapse, its distortion may be so much that it may become uninhabitable.

### Liquefaction of Soil

If a building is constructed on loose and sandy soil saturated with water, during an earthquake, such a soil behaves like a jelly leading to sinking, tilting or collapse of structure. This is called liquefaction of soil.

### Earthquake Resistant Buildings

It is not possible to construct "earthquake proof" buildings. However, it is certainly possible to construct "earthquake resistant" buildings, which can withstand earthquakes corresponding to the earthquake zone of their locations. To a large extent, the earthquake resistance of a building is the result of its structural system and structural design. However, its basic configuration, architectural planning, quality control during construction and maintenance during its service life are also important. Constructing an earthquake resistant building costs a little more. Nevertheless it is a very small price for long-term peace of mind. For many years, buildings have been constructed to resist only gravity loads and not earthquake loads. Therefore, a very large number of

buildings in Mumbai, Navi Mumbai and Thane may be deficient for the severity of earthquake that can be expected here.

### **Seismic Retrofitting**

It is possible to make existing buildings safe for the earthquakes of the expected severity, even if they were originally not designed for that. This is called seismic retrofitting and it is a highly specialized task. The cost of seismic retrofitting can be very high. Nevertheless, seismic retrofitting should be taken up on priority for assembly buildings such as schools, hospitals, theatres, markets, malls, government buildings and prayer halls and also for buildings from where important and emergency services such as electricity, telephone and basic food supplies are provided.

### **Preparedness**

Earthquakes do not kill; it is the unsafe buildings which do. True, earthquakes are unpredictable and have a low probability of occurrence. But if we remain careless and complacent, we are only making ourselves vulnerable to the possibility of huge destruction and loss of life and property. And this is something which Mumbai just cannot afford.

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