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# Seismic vulnerability of buildings in Chennai

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Existing buildings can be made safe by retrofitting at a marginal cost, hence no need to panic, writes

Though not as seismically active as States in the northern and western parts of our country, small to moderate earthquakes have occurred in Tamil Nadu. Earthquakes in Tamil Nadu are mid-plate in nature and the frequency of earthquakes is low. That is, the gap between moderate-sized events is fairly long. Tremors have been felt in every part of the State, mostly from distant earthquakes or from adjoining States or from the Indian Ocean. Historically however, most earthquakes have occurred in the western and north-eastern regions. Seismic activity in the recent past has occurred in clusters along the borders with Andhra Pradesh, Karnataka and Kerala. Several faults have been identified in this region out of which a few show evidence of movement. Rightly, the latest seismic zoning map of the Bureau of Indian Standards classifies Tamil Nadu into two categories- Zone II and Zone III which are under low risk and moderate risk respectively. Chennai is in Zone III where earthquakes up to 5 to 5.5 on Richter Scale can be expected to occur. Note that Tamil Nadu is not classified either under high damage risk zone like Delhi (Zone IV) or very high damage risk zone

like Guwahati or Bhuj (Zone V).

## Buildings in Chennai

### (i) RCC buildings:

Most buildings in Chennai are made with RCC frames. Generally reinforced concrete frame buildings behave well under lateral seismic loading when they are designed based on Bureau of Indian Standards Codes. However, built-in weaknesses tend to make them unsafe. Well-designed buildings of this category have adequate earthquake resistance, especially when they are provided with strong columns and properly detailed beam-column connections.

### (ii) Masonry buildings

A majority of low-rise buildings are built with masonry. Masonry is a term covering a wide range of materials such as brick, stone, concrete block, hollow block or a combination of these. A good masonry construction forms a rigid box type unit. By following a few important construction techniques they are made earthquake resistant.

(iii) Buildings with light roofs Low cost tenements with light roofs such as a thatch shed pose a low risk for collapse under an earthquake. However, they are ex-

tremely vulnerable under cyclones and fire.

### Weaknesses in buildings

(i) Planning and architectural aspects

Simplicity is the key to ensure good seismic resistance. Simple square and rectangular plan forms perform well. Irregularities in plan or elevation invite torsion loads and cause failure during earthquakes.

### (ii) Structural deficiencies

Use of long cantilevers, floating columns, bottom storey car park with stilt floors are some of the deficiencies which cause collapse during earthquakes.

Long span flat slab structures have low earthquake resistance. They should be strengthened with shear walls for adequate seismic safety.

### (iii) Construction deficiencies

Quality of construction and fabrication and erection of steel reinforcement is an important aspect contributing to seismic safety. Proper detailing of reinforcement will ensure good ductility which is vital for good seismic performance.

## Vulnerability

Most buildings built properly by engineers as per codes and specifications and follow-

ing good construction practice perform well during earthquakes.

However, it may be necessary to assess the buildings for safety if they are old or not engineered by design or not constructed as per standards or have significant weaknesses, some of which have been mentioned in the previous paragraph.

It is indeed a simple matter to assess the vulnerability of a typical building based on a technique called "Rapid Visual Screening" as per the Bureau of Indian Standards Code. It involves the inspection of your building using visual and photographic method and coming to a decision regarding its safety.

Based on visual observation the weakness of the structure can be identified. This can be followed with a non-destructive evaluation of structure. This does not involve any chipping or breaking of component. One can use techniques such as ultrasonic pulse velocity and rebound hammer readings. These tests will help compute the available resistance both concrete and reinforcement of the existing building.

## Retrofitting

Even if your building is not safe as per evaluation, you need not panic. It can be made safe by retrofitting at a marginal cost. The most important aspect in retrofitting is that we should start from the foundation level and pro-

ceed up to the roof. The aim of retrofitting identified is to remove the weakness and make the building sound

The following are some of the retrofitting measures for buildings to make them safe and perform well during earthquakes:

(i) In the case of masonry buildings adequate horizontal and vertical bands will increase the ductility and overall stability.

(ii) In the case of buildings with open storey car park, judicious provision of bracing or shear walls will enhance the safety and stability of the structure.

(iii) In the case of framed buildings with weak columns, column jacketing will make the structure a strong column-weak beam system ensuring adequate reliability in performance.

#### New buildings

When buying a new apartment, along with the design drawings, the buyer should insist on structural drawings and structural certificate. One can ask for the soil report too. In the soil report the Standard Cone Penetration value is an important indicator. The SCP value indicates the capacity of the soil to withstand load. An SCP value above 15 indicates a good soil condition. When the SCP value exceeds 40, the terrain is a rocky surface. The builder along with the structural plans must provide a structural certificate, which states

that the building has been designed for lateral loads. It should also certify that the earthquake design guidelines have been complied with.

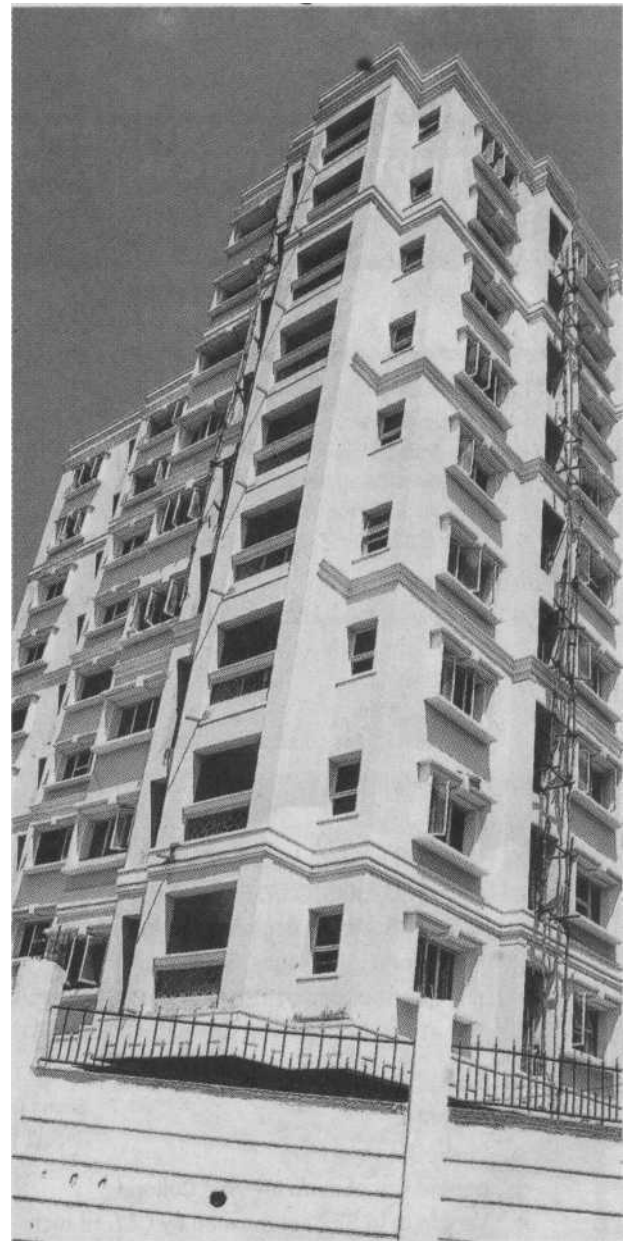
#### Use of structural steel

Many of our industrial buildings are made of structural steel. They have more robustness, ductility and energy dissipation capacity. The performance of any building can be enhanced to the desired level in a variety of ways using concentric or eccentric bracing or by introducing movement resistant connection made with structural steel by a proper retrofitting scheme.

#### Conclusion

Chennai is in Zone III as per BIS classification. Reputed contractors and consultants are available for providing good earthquake resistant designs in the case of private development. We should be prepared for moderate seismic activity in this region and need not panic. Buildings can be examined as per current code requirements. If we find the building inadequate, we can always retrofit and upgrade them at a marginal cost for safety. We also should not forget that Chennai falls under very high damage risk zone with respect to wind and cyclone.

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**QUAKE PROOF?:** Most buildings built properly by engineers as per codes and specifications and following good construction practice perform well during earthquakes. - PHOTO: B. JOTHI RAMALINGAM