Earthquake-safe Buildings

Article 1. India and Earthquakes

Decades, sometimes centuries, of relative slip between two adjacent large rock masses result in building up of stresses at their “locked” junction. The stress and energy are released by sudden and violent rupture of rock, causing an earthquake. Tectonic activities in the Himalayan range, and some intra-plate activities have caused a number of earthquakes in the Indian subcontinent leading to thousands of casualties, a greater number of injuries, and significant financial losses. Figure 1 shows the locations and magnitudes of some prominent earthquakes in the subcontinent.

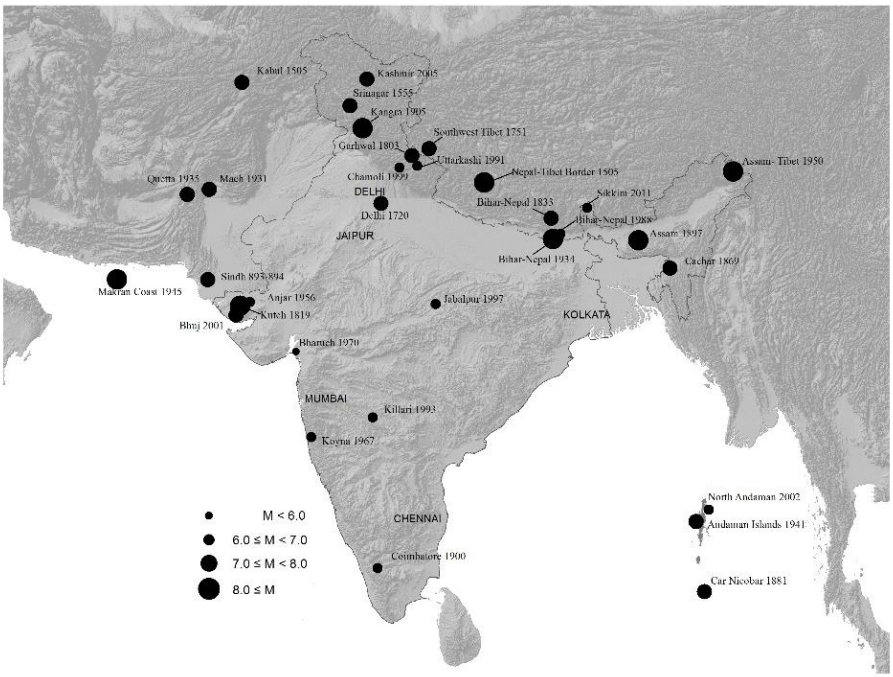

Figure 1. Prominent earthquakes in the Indian subcontinent (adopted from Jain (2016) under the terms of Creative Commons Attribution 4.0 International License available at http://creativecommons.org/licenses/by/4.0).

Northern states and union territories of India such as Jammu, Kashmir, Ladakh, Himachal Pradesh, Punjab, Delhi, Uttarakhand, Uttar Pradesh, Bihar and West Bengal are vulnerable to moderate to severe ground shaking. The north-eastern states such as Assam and Manipur have experienced severe shaking in the past. Severe shaking has also been observed in other states such as Gujarat and Maharashtra because of intra-plate activities. During an earthquake the ground moves to-and-fro quickly and randomly in all directions. Ground movements during a large earthquake may cause you to become so unsteady you can’t stand. The ground itself can be affected by this shaking, causing earthquake-induced landslides, and liquefaction where wet soil turns to mud. But usually, the buildings we live and work in every day, will suffer the most (Figure 2).

Buildings vibrate, shaking side-to-side during an earthquake. The higher parts or floors of buildings move sideways further than those below as buildings bend and distort during the shaking (Figure 3). This puts enormous stress on the structure supporting buildings, like columns, beams and walls. It’s like you standing tall with both feet on the ground, and a friend pushing you gently from behind. Your head and shoulders will move much more than your knees and shins. The muscles in your feet will be doing most of the work to keep you from falling over. This is similar to what a building experiences during an earthquake. Reinforced concrete columns and masonry walls are the most vulnerable. If they get damaged, buildings may collapse. We, our families, friends and others may be among the casualties.

(a) Before collapse *(b) After collapse*

Figure 2. A government building in Shillong, Meghalaya affected by 1897 Assam earthquake (Oldham 1899).

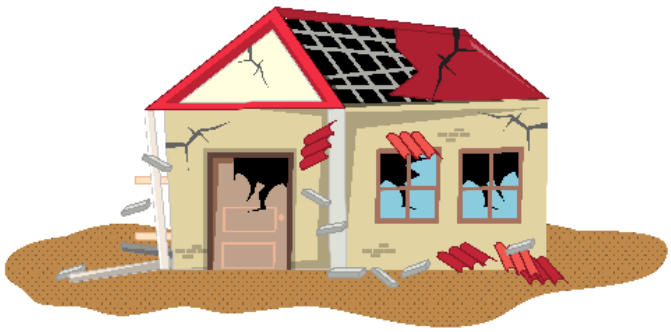

Figure 3. House during earthquake shaking.

Fortunately, it's straight forward and not overly expensive to design and construct buildings to resist earthquakes. Building damage during earthquakes is not inevitable. It can be prevented! Further articles in this series explain how in greater detail. For new buildings in India and in other countries to be both safe and avoid serious damage during earthquakes it's a matter of improving current practice and applying well-known and proven principles and practices. This is how we can keep ourselves, our families, and our future relatives safe during earthquakes.

The chance of a damaging quake severely damaging your building is relatively high for most parts of India. Higher than, for example, you having a serious traffic accident. Earthquake-safe buildings are readily achievable, but they don't happen without greater care than usual.

About this article series:

This is a series of articles about earthquakes, their effects on buildings, and how to ensure that buildings are safe against earthquakes. They are intended for potential owners of new houses and larger buildings and others involved in the building industry. The articles are written by Andrew Charleson and colleagues from the World Housing Encyclopedia (http://www.world-housing.net/) which is sponsored by the Earthquake Engineering Research Institute (https://www.eeri.org/) and the International Association of Earthquake Engineering (http://www.iaee.or.jp/). Manish Kumar has made modifications in the original article to make it reflect the Indian earthquake scenario.

References:

Oldham, R. D., 1899. Report on the Great Earthquake of 12th June 1897. *Memoirs of the Geological Survey of India*, Volume 29, pp. 1-379.

Jain, S. K., 2016. Earthquake Safety in India: Achievements, Challenges and Opportunities, *Bulletin of Earthquake Engineering*, Volume 14, pp. 1337-1436.