



Earthquake

India has witnessed some of the most devastating earthquakes during the last century like the one in Kangra (1905), Bihar-Nepal (1934) and in Assam (1950). In the recent past, earthquakes have caused havoc in Uttarkashi (1991), Latur (1993), Jabalpur (1997), Chamoli (1999) and in Bhuj (2001).

On 26th January 2001, India experienced one of the worst earthquakes in recent times. Measuring 6.9 on the Richter scale, the earthquake caused incalculable damage not just to its epicenter, Bhuj but also to other towns of the district of Kutch and to about 500 villages out of the total of 900 villages. The reported damage to property in Gujarat was about Rs.21, 000crore and the number of human lives lost were about 14,000. Of these, more than 500 deaths were reported from Ahmedabad, situated at a distance of about 350 kms from Bhuj. In the same city, close to 150 multi-storied buildings crumbled down. Cities far away from the epicenter, like Surat, too reported damage to property.

MEASURES FOR EARTHQUAKE RISK REDUCTION

For better understanding of all the possibilities of earthquake risk reduction, it is important to classify them in terms of the role that each one of them could play. Therefore, in the pre-earthquake phase, preparedness, mitigation and prevention are concepts to work on. Post-disaster, immediate rescue and relief measures including temporary sheltering soon after an earthquake until about 3 months later and re-construction and re-habilitation measures for a period of about six months to three years need to follow.

To encapsulate, the most effective measures of risk reduction are pre-disaster mitigation, preparedness and preventive measures to reduce vulnerability and expeditious, effective rescue and relief actions immediately after the occurrence of the earthquake. Depending upon the calamity and its consequences, strategies can also be divided into long term (five to fifteen years), medium term (one to five years) and short term (to be

taken up immediately in high risk areas). Since it has been realized that earthquakes don't kill people but faulty constructed buildings do, the task of reducing vulnerability of structures and buildings will be the key to earthquake risk reduction. Also, pre-disaster preparedness through a post-earthquake response plan, including training of the concerned personnel in various roles, is considered essential for immediate and effective response after an earthquake occurrence. The major action points are highlighted in the following paragraphs.

PRE-DISASTER PREVENTIVE MEASURES

Long-term measures

- Re-framing buildings' codes, guidelines, manuals and byelaws and their strict implementation. Tougher legislation for highly seismic areas.
- Incorporating earthquake resistant features in all buildings at high-risk areas.
- Making all public utilities like water supply systems, communication networks, electricity lines etc. earthquake-proof. Creating alternative arrangements to reduce damages to infrastructure facilities.
- Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like schools, dharamshalas, hospitals, prayer halls, etc., especially in seismic zones of moderate to higher intensities.
- Supporting R&D in various aspects of disaster mitigation, preparedness and prevention and post-disaster management.
- Evolving educational curricula in architecture and engineering institutions and technical training in polytechnics and schools to include disaster related topics.

Medium term measures

- Retrofitting of weak structures in highly seismic zones.
- Preparation of disaster related literature in local languages with dos and don'ts for construction.
- Getting communities involved in the process of disaster mitigation through education and awareness.
- Networking of local NGOs working in the area of disaster management.

POST-DISASTER PREVENTIVE MEASURES

- Maintenance of law and order, prevention of trespassing, looting etc.
- Evacuation of people.
- Recovery of dead bodies and their disposal.
- Medical care for the injured.
- Supply of food and drinking water.
- Temporary shelters like tents, metal sheds etc.
- Repairing lines of communication and information.
- Restoring transport routes.

- Quick assessment of destruction and demarcation of destroyed areas, according to the grade of damage.
- Cordoning off severely damaged structures that are liable to collapse during aftershocks.

Co-ordination between various agencies involved in rescue and relief work is extremely important to avoid gaps (both in communication and field work) and duplication of effort. Pre-disaster preparation can be conceptualized on the basis of an exercise on hypothetical earthquake occurrence and well-thought out estimates of magnitude of work involved etc. The following efforts will be useful for preparedness:

- Train communities in high-risk areas in post-disaster search, rescue and relief.
- Practice an extensive programme of mass drills in high-risk areas for earthquake damage reduction.
- Train local NGOs and strengthen their capacity and capabilities.
- Inculcate basic know-how amongst school kids on earthquake dos and donts along with safety drills.
- Train field personnel in the science and art of carrying out post disaster damage surveys, for (a) urgent relief purposes and (b) for repair, reconstruction and retrofitting purposes.

During emergencies, affected people need to be involved in the relief activities so as to create a feeling of self-reliance. Also, the sooner they are integrated, the shorter will the period of relief will be.

Post-disaster work would involve:

- Detailed survey of buildings for assessment of damage and repair/ reconstruction and seismic strengthening or demolition.
- Selection of sites for new settlements, if required.
- Execution of the reconstruction programme.
- Review of the existing seismic zoning maps and risk maps.
- Review of seismic codes and norms of construction.
- Training of personnel, engineers, architects, builders and masons.

Seismic Hazard Mitigation in India

The seismic hazard mitigation programme in India can be linked to the efforts of RD Oldham, then Director of Geological Survey of India. He carried out detailed study and published a monograph on the great Assam earthquake of 1897. This probably the beginning of the efforts towards mitigation of earthquakes disasters in India. In this connection the first seismological observatory in the country was established in 1898 at Calcutta. Today, India Meteorological Department (IMD), which is the nodal agency for earthquake information, maintains a network of 45 national observatories and 13 special purpose observations (figure 1). In addition, there are number of institutions/organisations (NGRI, BARC) and universities / academic institutions (IIT,

Roorkee) that also carry out earthquake monitoring and research. Table 1 depicts the distribution of seismological observatories in India under various organisations. During the last few years, earthquake studies have acquired momentum, especially after recent earthquake of Latur. Ever since, seismic hazard assessment and risk analysis, updating the seismic Zonation maps, etc. have gained higher priority in seismological research. A brief description of seismic hazard Zonation map and various building codes available for earthquake resistant design is given in the following paragraphs.

Seismic Hazard Map of India

Seismic Zonation map of the country is a guide to seismic hazard status and its susceptibility to earthquakes. According to Bureau of Indian Standards (BIS), entire country has been divided into four seismic zones (Fig 2) Zone II being the region of lowest activity and Zone V is seismically most active, where earthquakes of magnitude 8.0 or more could occur. Table 2 shows the area of the country and probable intensities in each zone as per this map.

Zone V is the most vulnerable to earthquakes, where some of the country's most powerful shocks have occurred. This region includes the Andaman & Nicobar Islands, entire region of North-eastern India, parts of north-western Bihar, eastern sections of Uttaranchal, the Kangra Valley in Himachal Pradesh, area near Srinagar in Jammu & Kashmir and the Rann of Kutch in Gujarat. Earthquakes with magnitudes in excess of 7.0 have occurred in these areas, and have had intensities higher than IX. Much of India lies in Zone III, where a maximum intensity of VII can be expected. A large section of south-central India lies in Zone II along with a section stretching from eastern Rajasthan into northern Madhya Pradesh. Some areas of Orissa, Jharkhand and Chhatisgarh also lie in Zone II, Latur earthquake of magnitude 6.4 occurred in this zone. After this earthquake the seismic zone map of India has been revised into its present form.