Guest Editor's Note

Earthquake engineering : Problems and prospects

Three moderate-sized, but enormously disastrous, earthquakes hit India during the period 1988-1993 : Bihar earthquake of August 21, 1988, (magnitude 6.6; about 282 deaths in India and 722 in Nepal); Uttarkashi earthquake of October 20, 1991, (magnitude 6.6; about 768 deaths); and the Killari (Latur) earthquake of September 30, 1993, (magnitude 6.4; about 10,000 deaths). The maximum shaking intensity in these earthquakes was VIII-IX on the Modified Mercalli Intensity (MMI) scale. Comparable to these earthquakes in India, the Northridge earthquake of January 17, 1994, in California, USA, was of magnitude 6.6 and maximum shaking intensity of IX-X, but caused only 57 deaths. It is clear that an earthquake of similar magnitude and shaking intensity could be more disastrous in a developing country and this is due to differences in the types and quality of constructions.

India has also witnessed many "great" earthquakes of magnitude larger than 8.0. During the period 1897 to 1950, the country was hit by four such earthquakes : Assam earthquake of 1897 (magnitude 8.7); Kangra earthquake of 1905 (magnitude 8.6), Bihar-Nepal earthquake of 1934 (magnitude 8.4), and the 1950 Assam-Tibet earthquake (magnitude 8.7). The maximum intensity of shaking experienced during these earthquakes was also higher than what we have experienced in the recent years : MMI of XII in the Assam earthquakes of 1897 and 1950, and X in the Kangra and Bihar-Nepal earthquakes. Clearly, India faces the threat of earthquake disasters which may be far worst than those experienced in the 1988, 1991, and 1993 events.

Earthquakes, though tragic, also provide the momentum to the process of improvements in seismic design codes and construction practices. A spurt in the related professional activities in India in the last one year shows that the recent Killari earthquake has significantly enhanced the awareness of Indian engineering community towards the earthquake problem. However, there is a need to channelise this interest towards better construction practices, and it must be done before this interest fades away.

In the task of earthquake-disaster mitigation, acquiring the state-of-the-knowledge is only the first step; the more important, and perhaps the more difficult step, is to translate that knowledge into state-of-the-practice. Unfortunately, for several reasons, we in India have not been very successful in translating the knowledge into better earthquake-resistant construction practices.

To ensure aseismic construction, earthquake engineering knowledge needs to spread to a broad spectrum of professional engineers within the country, rather than confining it to a few organisations or individuals as if it were a super-speciality. While we do require "specialists" to tackle many aspects of earthquake engineering, it is also essential to popularise basic earthquake engineering practices widely enough so that the professional engineers themselves can carry out good aseismic construction, without having to seek the advice of "specialists". Earthquake-resistant construction requires seismic considerations at all stages : from architectural planning to structural design to actual construction and quality control. Such an overall approach to aseismic construction will not develop until earthquake engineering is integrated with the mainstream civil engineering and the professional engineers (and architects) are drawn into the process. In fact, too often we tend to equate aseismic design and construction with simply a dynamic analysis of the structure.

Seismic design codes are important tools by which knowledge in earthquake engineering is transferred to the practice, and we cannot afford to be complacent with regard to seismic codes. Unfortunately, our seismic codes have had numerous shortcomings, including conceptual errors[1]. Though the situation has improved somewhat in the recent years, we still have a long way to go. Even today, there are no provisions available in Indian codes for design and detailing of steel structures to make them ductile for high seismic regions. We have yet to develop good commentaries and handbooks to enable a user apply the codal provisions correctly. Also, the seismic codes need to be integrated into our general building codes. For instance, to design a reinforced concrete structure one needs to follow IS:456-1978[2] which does not include provisions for seismic detailing. To carry out seismic detailing, one has to refer IS:13920-1993[3] (alongwith IS:456). It would be in the best interest of all if both these codes could be seen in unision and appropriately tied. It will be far more effective if IS:456, currently under revision, were to include the seismic detailing requirements for reinforced concrete.

While we work towards transferring the knowledge to the practice, we also need to absorb in the country the latest developments in the fast-changing field of earthquake engineering, in areas such as the active and passive control of structures, non-linear analysis, soil-structure interaction studies, and seismic risk assessment. There are also a number of research problems we need to tackle which are unique to our country and for which solutions cannot be sought from research being conducted in the developed world. Some such problems are strong motion characterisation of Indian earthquakes, low-cost earthquake-resistant houses, seismic behaviour of masonry buildings, and the seismic design of framed buildings with brick infills. Many of these problems require that the "engineering" research be given due focus and attention, rather than combining it with the geophysical or seismological research, and that research programmes for earthquake engineering be developed at several institutions/organisations in the country.

Killari (Latur) earthquake caused the worst natural disaster in India since the 1934 earthquake in Bihar. This earthquake has also provided us a great opportunity by focusing attention towards the earthquake problem in our country. While vigorous research in earthquake engineering is necessary to attend to many problems unique to our country, it is sincerely felt that the maximum gains towards earthquake-disaster mitigation will be made by improving seismic codes, and by better training and involvement of professional engineers in earthquake engineering. Present issue of the *Journal* is meant towards these goals.

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[2] ______ *Indian Standard Code of Practice for Plain and Reinforced Concrete*, IS : 456-1978, Bureau of Indian Standards, New Delhi.

[3] ______ *Indian Standard Code of Practice for Ductility of Reinforced Concrete Structures Subjected to Seismic Forces*, IS : 13920-1993, Bureau of Indian Standards, New Delhi.