Special Issue

Seismology in India–An Overview

A DEDICATED ORGANIZATION FOR EARTHQUAKE STUDIES

Among the different natural hazards that our planet is subjected to, earthquakes happen to be the most feared because of their sudden impact and the devastation they cause in a matter of a few seconds. Even hills, which are permanent features of the landscape, are shaken in much the same was as a terrier shakes a rat in its grip. The noise that accompanies an earthquake is also terrific. By all accounts the experience is one of great terror and bewilderment. India has had its share of destructive earthquakes. A list of earthquakes that have hit India in historic times was first compiled by Oldham (*Mem. Geol. Surv. India,* 1885, XIX, Pt. 5) and the same is updated with the passage of time. The more important of these are Delhi, 1670; Calcutta, 1737; Eastern Bengal and the Arakan coast, 1862, Kutch, 1819; Kashmir, 1885; Bengal, 1885; Assam, 1897; Kangra, 1905; North Bihar, 1934; Baluchisthan, 1935; Mekran, 1945; and North-east Assam, 1950. The Uttar Kashi earthquake of October 20, 1991 had a magnitude of 6.5 and claimed over 1500 human lives. Similar destructive earthquakes will occur in the future. Prudence requires that we should be prepared to meet such hazards and take effective steps to reduce their ill effects. An earthquake of magnitude 8.0 can cause damage to property worth tens of millions of rupees, and affect over a hundred thousand people and render millions homeless.

The Himalayan mountain ranges are believed to mark the zone of junction between a stationary Asian land mass and a moving Indian fragment that originally formed a part of a vast land mass in the southern latitudes. This land mass broke up into fragments, and the Indian fragment separated from its neighbours, Africa, Madagascar, Antarctica and Australia and started moving northwards some 150 million years ago. The collision with the main land mass in the north occurred nearly 40 million years ago. The northward thrust which the collision caused, deforming the rocks and pushing them and piling them one upon the other to form the high Himalaya, is believed to be still continuing. It is this that has made the zone highly disturbed geologically and vulnerable to earthquake activity.

The Indian Peninsular region is also vulnerable to earthquake shocks. The Koyna earthquake was a clear demonstration of the danger. The west coast of India is characterized by faults which are active.

More than 650 earthquakes in excess of magnitude 5.0 have been recorded since 1890. It is estimated that over 50 per cent of the Indian land mass is subjected to varying degrees of earthquake shocks. Although the Himalaya is known to be a zone of earthquakes and several disastrous earthquakes have occurred in the past, the absence of a great earthquake during the last 40 years has created a sense of complacency and a lack of public concern about the destructive potential of earthquakes. School children, and even adults, are not prepared to face the disastrous consequences of earthquakes. The subject is also not taught in depth in our schools and colleges, and it has to be admitted that earth scientists in general have not taken sufficient interest in seismological studies.

Seismology must be made interesting for the non-technical person. The general public needs to be educated about the implication of drifting continents, of collision zones, of thrusting and faulting. The public must be provided with timely and useful information on earthquakes. This is all the more important because the chance of an imminent earthquake in the Himalayan region is high. It has remained quiet for so long that the pent-up strain may be released any time now. Public-safety issues, precautions that must be taken for mitigation of the hazard in the event of expectation of disaster

striking a particular region, and the question of prediction of an earthquake beforehand are matters of great concern to the people. Ignoring studies of these aspects in depth will only be at our own peril. A series of studies must be undertaken and a host of problems solved before we can consider ourselves ready to face such disasters.

Fundamental concepts of the genesis of earthquakes require to be tested. Geological and geophysical models must be erected. The great volume of data accumulated through geological, geophysical, geomorphic, geodetic and seismological studies must be analysed for identifying specific earthquake prone belts and for taking precautionary measures for mitigation of disaster if one were to hit any particular region. The extent of rupture that has occurred during severe earthquakes in the past must be carefully evaluated. The existing network of observation centres must be updated and international cooperation established. Such a national seismograph network can be expected to provide necessary information for a more effective mitigation of earthquake hazards. Data must be gathered in a routine but efficient way, and made available to all who are interested, without any restrictions.

Geomorphic expression of the many faults must be studied on the basis of aerial photographs and satellite imagery. Broken and sheared rocks of fault zones are likely to show up as valleys. Detailed study of damage may reveal offsets pointing to faults and slips along the fault line. Such studies aimed at locating fault zones are important as these zones may prove to be the loci for movement and consequently the likely centres of future earthquakes. All identified faults must be mapped, and shown prominently. Epicentres of major and minor earthquakes must be indicated on a map with reference to the major faults identified. Major structures proposed to be built near fault zones should be suitably designed. Maps of specific zones likely to be subjected to seismic activity must be continuously projected before the minds of people residing in such regions.

Deformation during the last one or two million years requires special study as the extent of deformation structures like folds, faults, uplift and subsidence is likely to provide quantitative evidence of the changes that have occurred and serve as guide for the recognition of zones of future earthquake activity. Areas that were subjected to Quaternary tectonism must be isolated and shown separately in maps.

The history of earthquakes during the last two hundred years must be compiled, with emphasis on major earthquakes and the extent and nature of the damage caused.

The important role that fluids play in effecting changes in the lithosphere is slowly being realized. It is observed that vast quantities of fluids move along thrust zones. The part these fluids play, and the changes in pore pressure that cause slips and earthquakes are poorly understood.

Erosion is causing the movement of vast quantities of material from the high hills and deposition of this mass in the deltas. To what extent the upsetting of the isostatic balance is affecting the stability of the ground must be ascertained.

Realization of the vulnerability of a region to earthquake hazard can lead to mitigation of the effects of disastrous earthquakes. It is obvious that India should take a leading part in seismological research, which is likely to reveal much information of value, and contribute to the designing of earthquake-resistant structures and enable adoption of a building code for earthquake-prone zones. Research aimed at earthquake prediction is being pursued actively in other earthquake-prone countries like the U.S., the Soviet Union, Japan and China. It is imperative that India keeps abreast of research in those countries. Data relevant to earthquakes — past, present and future — must be continuously updated. There should be a continuous and lively discussion and an evaluation of the changing concepts about the structure of the lithosphere.

All these tasks will become possible only if there is an independent organisation for earthquake monitoring and research charged with the task of engaging itself in all aspects of earthquake-related studies. We make a strong plea for the establishment of a dedicated organisation for earthquake studies in India.

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