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Earthquake Hazards and Mitigation in India with Special Reference to Central Region

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ABSTRACT

Earthquakes are one of the worst among the natural disasters. About 1 lakh earthquakes of magnitude more than three hit the earth every year. These lead to the loss of life, property damage and socio-economic disruption. Like any other natural disaster, it is not possible to prevent earthquakes from occurring. The disastrous effects of these, however, can be minimized considerably through scientific understanding of their nature, causes, frequency, magnitude and areas of influence. It is believed that the natural disasters have claimed more than 2.8 million lives during the past two decades.

Keywords: Earthquake Hazards, Mitigation and Preparedness

2. INTRODUCTION

Earthquake losses have grown over the years due to increase in population and physical resources. These losses are not evenly distributed and are more prevalent in the developing countries due to higher population concentration and low level of economic growth. The main objective of this proclamation was to reduce, through concerted international efforts, the loss of life, property damage and socio-economic disruption caused by the natural disasters particularly in the developing countries.

In India, casualty wise, the first three events are Kangra (>20,000), Bihar-Nepal (>10,653) and Killari (>10,000). Moreover, Indian-Subcontinent, particularly the northeastern region, is one of the most earthquakes-prone regions of the world.

The key word in this context is “Mitigation and Preparedness”. Earthquake disaster mitigation and preparedness strategies are the need of the hour to fight and reduce its miseries to mankind. Comprehensive mitigation and preparedness planning includes avoiding hazard for instance, by providing warning to enable evacuation preceding the hazard, determining the location and nature of the earthquake hazard, identifying the population and structures vulnerable for hazards and adopting strategies to combat the menace of these. In the light of the above, the author discusses the earthquake hazards in India with special reference to the northeastern region along with the mitigation strategies.

3. EARTHQUAKE HAZARDS IN INDIA

Seismic zonation map shows that India is highly vulnerable for earthquake hazards. India has witnessed more than 650 earthquakes of Magnitude >5 during the last hundred years and earthquake disaster is increasing alarmingly here. In addition to very active northern and northeastern seismicity, the recent events in Killari (Maharastra) and Jabalpur (Madhya Pradesh) in the Peninsular India have raised many problems to seismologists.

The important earthquakes that have occurred in the past are tabulated below:

Place	Year	Magnitude	Casualty
Kangra Valley	April 4, 1905	8.6	>20,000
Bihar-Nepal border	January 1, 1934	8.4	>10,653
Quetta	May 30, 1935	7.6	About 30,000
North Bihar	1988	6.5	1000 Approx.
Uttar Kashi	October 20, 1991	6.6	>2,000
Chamoli	March 29, 1999	6.8	>150
Hindukush	November 11, 1999	6.2	no death reported

This seismic hazard status of Peninsular India, which was once considered as a stable region, has increased due to the occurrence of damaging earthquakes (Pande, 1999). The recurrence intervals of these are, however, larger than those of the HFA and their magnitude is also lesser. These belong to intra-plate category of earthquakes. The following are the important events that have rocked the Peninsular India.

Place	Year	Magnitude	Casualty
Kutch	June 16, 1819	8.5	No record
Jabalpur	June 2, 1927	6.5	------
Indore	March 14, 1938	6.3	------
Bhadrachalam	April 14, 1969	6.0	------
Koyna	December 10, 1967	6.7	>200
Killari (Latur)	September 30, 1993	6.3	>10,000
Jabalpur	May 22, 1997	6.0	>55

Koyna event is a classic example of earthquake activity triggered by reservoir. Seismicity at Koyna has close correlation with the filling cycles of the Koyna reservoir. The most puzzling event in the Peninsular India is, however, the Killari earthquake, which occurred in the typical rural setting. This event was least expected from the tectonic consideration, as it is located in the Deccan Trap covered stable Indian shield. There is no record of any historical earthquake in this region. This has been considered as the most devastating SCR (Stable Continental Region) event in the world. Jabalpur event, which occurred in the urban centre, though moderate, is an important one because it is the first major earthquake in India to be recorded by the newly established broadband digital station in the shield region. Moreover, its spatial association with the Narmada Son lineament has triggered a lot of interest from the seismotectonic point of view (DST, 1999).

Damage to the property was, however, severe. All concrete structures within an area of 30,000 square miles were practically destroyed.

4. FREQUENCY OF THE EARTHQUAKES

Are earthquakes becoming more frequent than before! Seismologists seem not believe that there is upheaval in the occurrence of earthquakes. Gupta (1999) says that annually on an average about 18 earthquakes of magnitude, which hit Turkey, (Ma=7.4), Greece (Ma=7.2) and Taiwan (Ma=7.6) recently occur all over the world. However, these oftenly occur in uninhabited areas or virtually uninhabited areas. Unfortunately, these have now hit thickly populated areas and killed thousands of people. This does not mean that the earthquake frequency has increased. Increase in the loss of life and property damage is not due to increase in number and strength of earthquake frequency but for the rapidly increasing vulnerability of human civilization to these hazards. Therefore, if the earthquake of matching magnitude visits the region now, the devastation would be enormous. Timing of the event and epicenter also matters a lot. For instance, Killari event occurred at 3:00 hrs early in the winter morning when people were sleeping and hence the casualty was high (>10,000).

5. FORECASTING AN EARTHQUAKE

Research on earthquake prediction started since early sixties. Intensive work is going on all over the world in this regard involving expenditure of billions of dollars. According to R.R. Kelkar, Director General of Indian Meteorological Department (IMD), "Earthquake cannot be predicted by anyone, anywhere, in any country. This is a scientific truth". But seismologists continue their efforts in the hope of a major breakthrough in prediction technology in the near future.

Perhaps the first successful prediction of earthquake in the world was made by the Chinese. They predicted Haicheng event of Lioning Province (February 4, 1975, Ma=7.3) on the basis of micro seismic activity, ground tilting and unusual animal behaviour (Nandi, 1999). In India also efforts are going on for predicting earthquakes based on the statistical analysis of past events and their recurrence intervals, swarms activity and seismic gap. However, meaningful prediction is still alluding the seismologists. Khatri (1999) identified three seismic gaps in the Himalayan region, namely, the Kashmir gap, the Central gap and the Assam gap. The Kashmir gap lies west of Kangra event, the Central gap between Kangra and Bihar-Nepal events and the Assam gap between the two great earthquakes of Assam. The last big earthquake of magnitude 8.7 occurred in 1950.

6. EARTHQUAKE HAZARD ZONATION, RISK EVALUATION AND MITIGATION

The importance of seismological studies lies in the fact that information generated can be used to mitigate the earthquake hazards. Preparation of seismotectonic/seismic zonation maps is the first step in this direction. The basic data required for the preparation of these maps are (i) A carefully compiled earthquake catalogue incorporating details about magnitude, location of epicenter, depth of focus etc., (ii) Delineation of seismic source zones from all possible sources like recurrence relation, tectono-geological consideration, palaeoseismicity etc., (iii) Estimation of upper bound magnitude through statistical procedure, cumulative seismic energy release, active fault length etc. and (iv) Attenuation of ground shaking for better results (Das Gupta, 1999). Seismic microzonation is recommended for better result.

Indian Meteorological Department, National Geophysical Research Institute, Department of Science & Technology, Bhabha Atomic Research Centre and Regional Research Laboratory have established a large number of seismic monitoring network in the country including northeastern region. These stations are recording useful seismic data, which enables to determine the location of epicenter, useful seismic data which enables to determine the location of epicenter, depth of hypocenter, energy within the focus, orientation of the geological structure that has undergone deformation and many other parameters of earthquakes. These parameters are then utilised for preparing seismo-tectonic and seismic zoning maps. The work in seismic zoning in India was started by Indian Standard Institute (now Bureau of Indian Standard) in the year 1960 and the first map was included in the code IS: 1893-1962. A significant progress has been made since then both in seismic zoning and instrumental monitoring of seismicity.

seven states of the region. If the present trend of construction and population growth continues, the earthquake of magnitude > 7.5 will bring enormous damage to property and great loss of lives. Therefore, the administrative agencies have to strictly enforce the implementation of proper building codes and appropriate landuse policy in the region.

CONCLUSION

Himalayan Frontal Arc including northeastern region and Andaman & Nicobar Islands, Indo-Gangetic Plain and even Peninsular India are highly vulnerable for earthquake hazards. Earthquake, like other natural hazards, cannot be prevented from occurring. It seems socially relevant and useful earthquake prediction may not be possible in near future. Therefore, we have to learn to live with this disaster and try to minimise its adverse impact on human civilisation. Earthquake mitigation and preparedness programme is the key word in this context. Such programmes can be evolved through detailed study of the seismo-tectonics and seismic history of the region and by preparing seismic zonation map. Constant monitoring of the seismicity is prerequisite for this purpose.

Strict enforcement of building codes for construction of masonry structures and even for small housing complex in the earthquake prone zones and strict legislation of landuse may help in fighting and reducing the miseries of earthquake hazard. However, it may never be possible for the mankind to live in "Zero Risk Situation" because even after full implementation of mitigation measures, there may be some unpredictable situation that may cause hazards (Acharrya, 1999). Satisfactory results may be obtained through pre, during and post event measures (Tiwari, 1999).

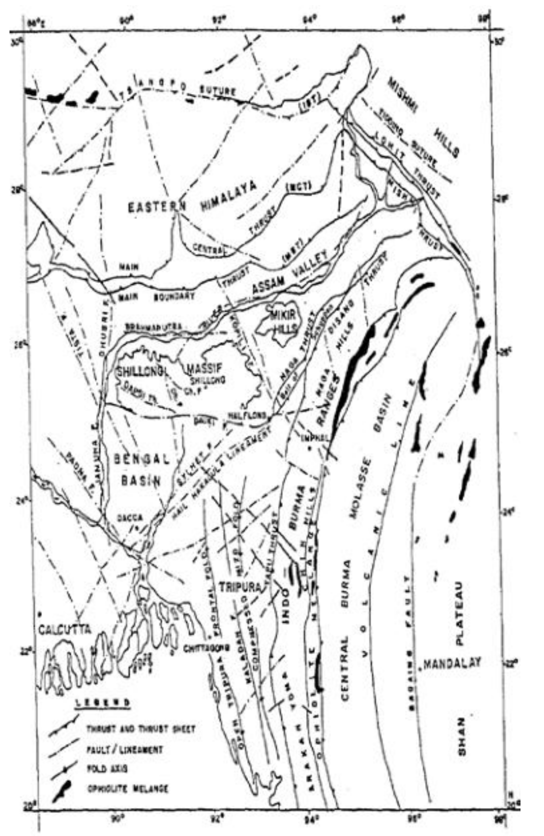

Figure 2. Tectonic setting of central India and surroundings (after Evans, 1964 and Krishnan, 1960).

REFERENCES

1.Acharrya, S.K. 1999. Natural Hazards: Earthquakes and Landslides in India during the nineties and mitigation strategy. Proc. Sem. on Earthquakes & landslides: Natural disaster mitigation, Calcutta, pp. 5-13. | 2. Special report of earthquakes. Down to Earth, December 31 issue, pp. 22-23. | Bapat, A. 1996. Creation of awareness about earthquakes- Case Histories. Prc. Int. Conf on Disaster & Mitigation, Madras, Vol.1, pp. A1. 1-3. | Bhagwan, N.G. and Sreenath, H.G. 1996. | 3.A seismic vulnerability reduction strategy for low rise building construction. Int. Conf. on Disaster & Mitigation, Madras, Vol. 1, pp. A3. 11-16. | 4. Chatterjee, S. The Drift of India: A Conflict in plate tectonics. Personal communication to Professor Ashok Sahni, CAS in Geology, Panjab Univ. Chandigarh, 18p. | Das Gupta, S.K. 1999. | 5. Seismic hazard assessment: local geological effects of strong ground motion. Proc. Sem. on Earthquakes and Landslides: Natural disaster mitigation, Calcutta, pp. 44-51. | 6. Das, T. and Sarmah, S.K. 1996. Earthquake expectancy in northeast India. Int. Conf. on Disaster & Mitigation, Madras, Vol. 1, pp. A1. 14-18. | Department of Science & Technology, Govt. of India (1999). Earthquake Researches in India. p. 13. | 7. Gupta, H.K. 1999. Big quakes more a norm than exception. Times of India, September 19, 1999, p. 12. | 8. Kayal, J.K. 1998. Seismicity of northeast India and surroundings- development over the past 100 years. Jour. Geophysics, XIX (1), pp. 9-34. | Kelkar, R.R. 1999. Big quakes more a norm than expectation. Times of India, September 19, 1999, p. 12. | 9. Khatri, K.N. 1999. Probabilities of occurrence of great earthquakes in the Himalayas. Earth & Planetary Sciences, 108 (2), pp. 87-92. | Lalliana, Mualchin. 1997. Management of natural disasters. A paper submitted to the Government of Mizoram. | 10. Nandi, D.R. 1999. Earthquake, earthquake hazards and hazards mitigation with special reference to India. Proc. Sem. on Earthquake & Landslides: Natural disaster mitigation, Calcutta, pp. 15-20. | Pande, P. 1999. Intraplate seismicity of Peninsular India. Jour. Engg. Geol, Vol. XXVII(4), pp. 152-163. |