Chapter VII

EARTHQUAKE HAZARD IMPLICATION IN NORTHEAST INDIA DUE TO THE EARTHQUAKES ORIGINATED IN INDO-BURMA OROGENIC BELT

7.1 Introduction

Natural Hazards are unexpected and cannot be prevented, which threatens either the life of the people or their activities and destroys properties and infrastructure. Earthquake is such a natural hazard that occurs due to a sudden motion of the earth caused by an abrupt release of accumulating stress. Although more infrequent than other natural hazards, an earthquake can cause large scale devastation in terms of loss of life and property which is much more greater than any other individual natural hazard. Therefore generally, earthquakes are regarded as the most destructive natural events.

Past experience reveals that Northeast India is one of the most seismic hazard prone regions of India. Several major earthquakes shook the region and caused large scale devastation. There are three major source regions or seismic blocks in the region - the Eastern Himalayan Belt, the Indo-Burma Border region (study region) and the Shillong Plateau. The devastating earthquakes of 12th June, 1897 and 15th August, 1950 both having magnitude 8.7 mb in Richter scale occurred in this region and caused large scale devastation in the entire region, especially in Northeast India. The peak ground acceleration, which is the most
important parameter for seismic hazard assessment of a region, is observed to be 80% of g in most part of the region (Khattri et al, 1984). As per seismic zonation map of India prepared by the Bureau of Indian Standard (BIS), the area belongs to Zone-V (Fig 7.1), which represents the most vulnerable earthquake hazard zone in India. In view of the increased urbanization and population growth, the vulnerability of earthquake hazard in the region has increased significantly in recent years.

As a first hand information, evaluation of earthquake hazard in a certain region mainly includes the investigations on how frequent and how strong earthquake will be felt in the region in near future, which will facilitate to make preliminary assessment of the possible damages that may occur in the region due to the occurrence of an earthquake event. In the context of engineering design, seismic hazard is generally defined as the predicted level of ground acceleration which would be exceeded with 10% probability at the site under consideration due to the occurrence of an earthquake anywhere in the region, in the next 50 years. A lot of complex scientific perception and analytical modeling is involved in seismic hazard estimation. A computational scheme mainly involves the delineation of seismic source zones and their characterization, selection of an appropriate ground motion attenuation relation and a predictive model of seismic hazard. All these steps are region specific and the whole seismic hazard assessment scheme has the following main components –

(a) Preparation of a comprehensive homogeneous earthquake catalogue
(b) Seismo-tectonic and earthquake source delineation on the basis of seismotectonic map of the study area

(c) Return period analysis with the use of magnitude-frequency relationship

(d) Estimation of the probable maximum magnitude earthquake based on strain energy release characteristics

(e) Strong seismic ground motion studies

(f) Computation of predictive seismic hazard
Besides these components, the review of past major earthquakes disasters also reveal future hazard potential scenario of a region. In the light of the above discussion, as a first step to understand the future hazard scenario in the region, discussion on (1) review on the destruction of past earthquakes, (2) iso-seismals of some major earthquakes that rocked this region in the past and (3) spatial distribution of strain energy release pattern in relation to regional tectonics has been incorporated in this chapter. Preparation of a long homogeneous comprehensive earthquake data file, seismo-tectonic correlation and identification of source region, return period analysis of different magnitude earthquakes, strain energy accumulation and release pattern with time, and estimation of the probable maximum magnitude earthquake that may strike the region have already been discussed in Chapter-III, Chapter-IV, Chapter-V and Chapter-VI respectively.

7.2 Description of some Major Earthquakes

The followings are some major significant earthquakes that occurred in Indo-Burma border region, which affect the entire northeastern states of India.

(a) Cachar earthquake of 1869 (Latitude 25° N, Longitude 93° E)

The earthquake that struck Cachar, Assam on 10th January, 1869 caused heavy damage in the region. The epicenter of this earthquake was located in the Cachar region of Assam on the west of EBT. The impact of the shock was felt over 6,50,000 square kilometers. There was heavy damage in the towns of Cherrapunji, Silchar, Shillong and Sylhet and also
in Manipur. Fissures opened on the banks of the Surma River and sand vents threw up great amounts of sand and water. The epicentral tract was 30-45 kilometers long and 5-6 kilometers wide, lying on the northern border of the Jaintia Hills. The hypocenter had a depth of 50 kilometers.

(b) Assam earthquake of 1950 (28.38°N and 96.76°E)

This "Independence Day" earthquake was the 6th largest earthquake of the 20th century. Though it occurred in a mountainous region along India's international border with China, 1526 people were killed and large-scale geomorphological changes occurred due to this event. The resultant post-floods were the cause of most of the fatalities. The initial shock was followed by thousands of aftershocks, some of them big that were enough to be reckoned. It had a magnitude of 8.7 and struck a relatively sparsely populated region along the Indo-China border. This earthquake is often referred to as the "Assam Earthquake of 1950." The earthquake occurred at 19:39 P.M. on August 15, 1950. It was felt throughout northeastern India and in many parts of eastern India, Bangladesh, Bhutan, and Myanmar. Damage occurred in the entire region covering upto Kolkata. It was felt across a wide area of the subcontinent, over an area totaling 7.2 million square km. There was widespread devastation in Upper Assam, the Abor Hills, and the Mishmi Hills. The earthquake completely ravaged 45,000 square km with large-scale damage to lives and property (A few examples, illustrate the nature of damages due to this event, Fig. 7.2). This included the districts of Jorhat, Lahkimpur, Sibsagar, and Sadiya, in Assam. Dibrugarh and Saikoaghat were among the worst affected areas. There were fissures in the earth.
from which water and sand was emitted. These sand vents attribute to liquefaction due to intense ground shaking. Vast areas of land either were elevated or subsided, altering the drainage pattern of the river systems of the region. There were huge landslides in the mountains and these dammed tributaries of the Brahmaputra River, like - Dihang, Dihing and Subansiri tributaries. These dams were breached a few days later resulting in severe flooding. Most of the loss of lives and property was

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**Fig. 7.2**: Four major destructions of 1950 earthquake
caused due to the flooding of Subansiri, Dhansiri and Dihing River. As reported by Nandi (2001), 1,526 deaths were recorded out of which 600 were from Lakhimpur and Sibsagar districts alone. In the Arbor Hills, 70 villages were destroyed with 156 casualties due to landslides. Dykes blocked the tributaries of the Brahmaputra; that in the Dibang valley broke without causing damage, but that at Subansiri opened after an interval of 8 days and the wave, 7 metres high, submerged several villages and killed 532 persons. Mathur concluded that at least $5 \times 10^{10}$ cubic meters of material was involved in the sliding. This is about 30 times of the average load of detritus carried by the river Brahmaputra annually.

(c) Manipur-Burma earthquake of August 1988 (25°N and 95°E)

It was occurred on 6th August 1988 at Manipur-Burma border. The epicenter of the earthquake was at 25°N and 95°E, and the magnitude was 7.3 mb. The losses and damages due to the earthquake were widespread in the northeastern part of India. The earthquake caused considerable damages at Itanagar, Manipur, Imphal, Silchar, Nagaland, Sibsagarh and Jorhat besides several other places of northeast India region.

7.3 Iso-seismals of some Major Earthquakes

From the above discussion, it is clear that the occurrence of major earthquakes in the Indo-Burma border region has great impact on Northeast India. It is also clear from the iso-seismal maps of some major earthquakes occurred in the region. Iso-seismal maps of the earthquakes that strike on (a) 14th August, 1932, (b) 14th April, 1938, (c)
15th August, 1950 and (d) 21st March, 1954 earthquakes were presented in Figures 7.3 to 7.6. The locations of the important urban centers of the

![Iso-seismal map of 1932 earthquake (Lat 25°6'N, Long 96°8'E) with urban population of Northeast India](image)

**Fig. 7.3:** Iso-seismal map of 1932 earthquake (Lat 25°6'N, Long 96°8'E) with urban population of Northeast India
Fig. 7.4: Iso-seismal map of 1938 earthquake (Lat. 22.5°N, Long. 95°E) with urban population of Northeast India
Fig. 7.5: Iso-seismal map of 1954 earthquake (Lat 24° 5'N, Long 95°E) with urban population of Northeast India
Fig. 7.6: Iso-seismal map of 1950 earthquake (Lat. 28.38°N, Long. 96 76°E) with urban population of Northeast India
region are also shown in the figures. It has been observed that some of the iso-seismal lines cross over big cities of Northeast India. Thus, the iso-seismal maps reveal the vulnerability of different cities/towns of the region due to the respective earthquakes. This gives an idea about the urban locations which are at risk. Moreover, because of the rapid growth of these urban centers in recent decades has enhanced the risk significantly. Any future earthquake that may occur in the region can cause extensive damage of life and property in the region.

7.4 Spatial Distribution of Strain Energy Release

Based on the past earthquakes, Iso-strain energy released map drawn shows high-energy release all along the Indo-Burma boundary adjacent to Manipur, Nagaland and Mizorum. This observation indicates high seismic potential for future earthquake in this area (Fig. 7.7).

So, in view of the probable seismic hazard arising from earthquake occurring in this belt and to have a sustainable development prior administrative and awareness steps is very important.

7.5 Conclusion

From the above discussion, it may be concluded that the Indo-Burma Orogenic Belt is seismically very active. Therefore, the occurrence of large earthquakes in and around this belt cannot be ruled out, which may cause large scale damage in neighboring states of Assam, Arunachal Pradesh, Manipur and Nagaland, Mizorum, Tripura and Meghalaya. Iso-seismal maps of earlier large earthquakes that occurred in the belt indicate that the occurrence of any major earthquake in this area may
cause large-scale destructions/damages in the adjoining states of India.

The increasing urbanization, rapid growth of population, drastic change in land use pattern including infrastructure growth etc. has increased the risk factor manifold.

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