ABSTRACT

Northeast India and its adjoining region constitutes an important geotectonic element of Southeast Asia and is connected to India via a narrow corridor squeezed between Nepal and Bangladesh. It comprises the Seven Sister States — Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Geotectonically, the entire Northeast India is located in an earthquake prone zone of the Indian subcontinent. This region is characterized by collision tectonics in the north between the Eurasian plate and Indian plate and subduction tectonics in the east between the Indian plate and Burmese plate. This region display tectonically distinct geological domains on which this study is based. The seismic hazard map prepared will help to identify more seismic hazard prone areas from the lesser ones. In this context, this thesis has been developed incorporating the aspects of seismicity and seismotectonics, earthquake hazard and plate tectonic motion that occurred in the region bounded by 22° N − 30° N latitudes and 89° E − 98° E longitudes.

The Northeast India and its adjoining region is a region of complex geotectonic settings with very high seismicity. The region is one of the critical regions of the world for the study of the phenomenon of earthquake generation and such study with input from recent database would provide further insight into the seismogenic process of the region. Moreover, it will reveal the status of the collision process in the north between the Indian plate and the Eurasian plate and the subduction process in the east between the Indian plate and the Burmese Plate. The seismic microzonation map of the region will throw light on the present scenario of the seismicity of the region. In recent years, the region has undergone a splurge in developmental activities with the establishment of many industries, better infra-structure facilities, like a vast railway network and good roads connecting different states of the region, number of high rise buildings to accommodate the ever increasing population, etc. As such, the seismic hazard analysis map would be of immense help to prevent huge loss due to the occurrence of seismic event in the region. The seismicity of the region has been studied from time immemorial and seismic hazard maps have also been prepared by many research workers and agencies. But with the advancement of technology, better sensitive seismographs have been developed which have increased the quality of seismic data
recently. The establishment of local seismic networks in the region has also added in improving the quality of data. Also the adequate accuracy with which hypocenters can now be determined has made it possible to add significant details and refinements into the seismicity study. It would thus present much clear picture of the occurrence of earthquake in time and space and encourage application of new methods to study earthquake generation processes in the region.

The basic objective of the study is to analyze the seismicity of the region and application of some aspects of seismic zoning techniques towards hazard reduction. Broadly, the objectives of the study is to prepare a comprehensive earthquake datafile for the region and to study the spatial variation of earthquakes and identify quiescent regions together with the temporal variation of earthquakes in the region and expected return periods of large earthquakes. The strain release characteristics of different tectonic blocks has been analysed and iso-strain mapping of the region. Peak Ground Acceleration (PGA) has also been computed and its spatial variation is investigated. Seismic hazard has also been estimated together with identification of hazard prone areas.

To study seismic hazard of any region, a large volume of earthquake data covering a long period of time is necessary. These data files have been compiled by various organizations in different formats that are not homogenous. Therefore, on the basis of available datafile for the region, a comprehensive data file was prepared for the region by considering all the events of magnitude greater than 3.1 mb and its completeness was tested. All the computations and analysis was based on this comprehensive earthquake datafile. The organizations whose earthquake catalogues were used as data source of earthquake events are – U.S.G.S and ISC.

The distribution pattern of seismic events of the study region was analyzed and quiescent regions were identified. Return periods of seismic events were being determined by magnitude-frequency relationship and by Knopoff and Kagan and Gumbel’s Type I and Type III methods. The ‘b’ values obtained from magnitude-frequency relationship were mapped to have crustal information. The amount of strain energy released was studied with the help of Benioff Curve which helped in the estimation of the size of coming future earthquakes. Peak Ground Acceleration of the
study region has been determined by the relation proposed by Margaris et al. (2001). Probabilistic seismic hazard analysis has been done by Poisson’s and Bayesian method.

The present work has been presented in nine chapters. The topic of the work is introduced in the first chapter. The second chapter describes the geodynamics of the region together with the seismic history. The third chapter deals with the review of relevant literature. Earthquake data file has been analysed in the fourth chapter. The fifth chapter deals with earthquake distribution pattern and identification of quiescent region. The seismicity of the region has been studied in chapter six and chapter seven. The eight chapter deals with the seismic hazard analysis of the region including computation of Peak Ground Acceleration. Seismic hazard analysis was done by Poisson’s method and Bayesian method. The summary of the whole work is presented in the last chapter i.e.in the ninth chapter.

The outcomes of the study may be summarized as follows- the use of modified Richter’s relation between Ms and mb together with the application of body wave magnitude in the seismicity study of the region results in less error. Also, the earthquake datafile is not complete for small magnitude earthquakes. The data file for this region should have a minimum length of 100 years for magnitude ≥ 7 mb, 90 years for magnitude ≥ 6 mb, 60 years for magnitude ≥ 5 mb and 50 years for events greater than 3.1 mb. The distribution pattern of earthquakes and geo-tectonic features reveal that the region can be divided into six geo-tectonic blocks. Seismic activity in each block was studied together with the region as a whole. It has been observed that the region is seismically active but there is a significant variation of seismic activity among the different tectonic blocks of the region. The concentration of events was found to be the maximum in the subduction zone along Indo-Myanmar border followed by the region along the MBT and MCT in the north and then around the Lohit and Mishmi thrust. Epicentral plot of the earthquakes of magnitude greater than 5.0 mb depict some regions which are almost elliptical in shape where there is no seismic event and may be called as quiescent regions. Investigation on the temporal variation of earthquakes reveals that the data series may be considered as incomplete upto 1977. After, 1977 only Arakan-Yoma region and Eastern Himalayas show proper reporting of earthquakes. In other regions, the earthquake data series can be considered to be of complete reporting from 1984 onwards. The seismic activity decreases after 2008 in all
the tectonic blocks. The correlation among the number of earthquakes occurred in different tectonic blocks was analyzed to have an idea regarding the association of stress fields of different blocks. It has been found that the correlation is the maximum between Arakan-Yoma region and the Naga Hills (0.50), while it is the minimum between Shillong Plateau region and the Eastern Himalayas (0.009). The return period analysis revealed that the return periods of earthquakes of all the magnitudes are minimum in the Arakan Yoma region. It has been observed that for a return period of 25yrs and 50yrs estimated magnitude of an earthquake is the maximum in Eastern Himalayas and it is 7.33 mb and 7.68 mb respectively. In case of return period 75yrs and 100 yrs the value of estimated earthquake has been found to be the maximum in Arakan Yoma region which is 7.89 mb and 8.18 mb respectively. The b-value and the fractal dimension mapping in NE India have identified the seismogenic structures along the Kopili Fault and the Indo-Burma ranges. The contour map also suggested high deposition of sediments in the Bengal Basin region which is attributed to low seismic activity of the region. Brahmaputra Valley is a region of comparatively less seismic activity. Rate of strain energy accumulation is maximum in the Arakan-Yoma region and minimum in the Brahmaputra Valley. It is also observed from the amount of strain energy accumulated in the study region as off 31st July, 2012, that there is a probability of occurrence of an earthquake of magnitude of 7.05 mb in the area. The effect of release of strain energy by a tectonic block on other nearby blocks is also studied. It has been found that strain energy released by a tectonic block is large it might effect the stress building process in the rocks of adjacent tectonic blocks. It has been found that the entire Northeast region and its adjoining area does not fall under Zone V of seismic hazard map. The region has seismicity varying between zone III and zone V. A relationship between the economic life of a structure with return period and probability of exceedance is determined for eleven cities. Seismic loading is found to be maximum in Tezu for the same risk level and economic life.