Seismic Zonations at Micro and Macro-Level for Regions in the Peninsular India

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ABSTRACT

Due to the lack of proper preparedness in the country against natural disasters, even an earthquake of moderate magnitude can cause extensive damage. This necessitates seismic zonation. Seismic zonation is a process in which a large region is demarcated into small zones based on the levels of earthquake hazards. Seismic zonation is generally carried out at micro-level, meso-level and macro-level. Presently, there are only a few guidelines available regarding the use of a particular level of zonation for a given study area. The present study checks the suitability of various levels of seismic zonation for different regions and reviews the feasibility of various methodologies for site characterization and site effect estimation. Further the seismic zonation was carried out both at the micro (for the Kalpakkam) and macro-level (for Karnataka state) using the appropriate methodologies. Based on this, recommendations have been made regarding the suitability of various methodologies as well as the grid size to be adopted for different level of zonation based on actual studies.

KEYWORDS

Macro-Level, Micro-Level, Peninsular India, Seismic Hazard, Seismic Zonation, Site Effects

INTRODUCTION

Earthquakes are the deadliest of all natural hazards which always remain a serious threat for millions of people worldwide. The hazards from the earthquake can neither be predicted nor can its effects be evaded completely. Hence the only possible solution is to adopt necessary mitigation works in order to minimize the damage caused by these hazards on human settlements. In India, several earthquakes in the past have caused significant damage to the properties and casualties to the human lives. Major earthquakes in the last 20 years such as Khillari (30th September 1993), Jabalpur (22nd May 1997), Chamoli (29th March 1999) and Bhuj (26th January 2001) earthquakes have resulted in more than 23,000 deaths and extensive damage to infrastructures (NDMA, 2010). In India, high human casualty during any seismic event is rather due to the lack of awareness and proper preparation against the earthquake hazards than the magnitude of the earthquake. Moreover, the negligence towards the practice of earthquake resistant design procedures for building construction in the urban areas, aggravates the human casualty count during an earthquake. Even though India’s urban population is only 1/3rd of the total, its rampant growth along with urban sprawl has hit the quality of construction in urban areas. Thus, to mitigate the destructive impact of earthquakes there is a need to create awareness among the common people as well as the mandatory inclusion of earthquake resistant design procedures in the design of buildings and infrastructures. Seismic zonation is a first and foremost step towards the mitigation of the destructive impact of an earthquake. Seismic zonation is a process of dividing a large region into small zones based on the expected level of earthquake hazard. Seismic zonation
helps to identify vulnerable regions and also provide necessary outputs for the earthquake resistant design. Hence it is very much required in the modern world in order to minimize the casualty and economic losses during an earthquake. Jabalpur microzonation (PCRSMIUJA, 2005) is the first of such initiative in India towards seismic zonation. Subsequently the seismic microzonations are carried out for many regions in India such as 1) Delhi (Mukhopadhyay et al., 2002; Iyengar & Ghosh, 2004; Rao & Neelima Satyam, 2005; Mohanty et al., 2007), 2) Sikkim Himalaya (Nath, 2004) 3) Guwahati (Baranwal et al., 2005; Nath et al., 2008) 4) Dehradun (Barua, 2005; Ranjan, 2005; Gulati, 2006), 5) Bangalore city (Sitharam & Anbazhagan, 2008).

Issues Related to Seismic Zonation

One of the major issues related to the seismic zonation is that very few guidelines are available regarding the use of a particular level of zonation for a given study area. Seismic zonation is generally carried out at three different levels; micro-level, meso-level and macro-level. The macro-level zonation is generally performed for a large landmass, such as a state or a country, while the meso-level zoning is performed for the cities and urban centres having an area ranging from 20 sq.km to 300 sq.km with a population greater than 5,00,000 (NDMA, 2011). The micro-level zonation is carried out for small sites (with areas less than 20 sq.km) which host critical structures like nuclear power plants (NPP), dams and other important structures. The levels of zonation not only depend upon the areal extent of the study area, but also on the degree of reliability with which the earthquake hazard parameters required for zoning are to be estimated. The macro-level zonation is generally carried out without considering parameters such as the geological and geotechnical site conditions and site effects, while the same are considered in the meso and micro-level zonations. However, the reliability with which these parameters are estimated for the micro-level is more than that required for the meso-level zonation. These levels of zonation are to be adopted based on the area of the site, importance level of structures that the site hosts and the level of risk associated with the human life. Hence a micro-level zonation is very much required for critical facility like a NPP site situated even in a low seismic zone or a densely-populated city or urban area situated in a very high seismic zone. The government of India has already initiated the seismic zonation of major cities in India. However, the micro-level zoning cannot be performed for all these cities as very large resources are required for an extensive geotechnical and geophysical investigation and site effect estimation. Hence there is a need to define the level of zonation to be adopted for various study areas in the country.

Another major issue associated with the seismic zonation is the lack of understanding regarding the suitability of various methodologies for site characterization and site effect estimation for different levels of seismic zonation. As there are many methodologies available for the site characterization and site effect estimation, the suitability of these methodologies for each levels of zoning also needs to be assessed in order to optimize the resources for carrying out seismic zonation. Due to the availability of high computing power, seismic hazard analysis can be performed any scale level/grid sizes. However, this is not the case with the site characterization and site effect estimation. Hence it is necessary to determine the suitability of various methodologies for site characterization and assessment of site effects for different level of investigation.

The third issue related to the seismic zonation is the negligence of site effect estimation for macro-level seismic zonation. Generally, macro-level seismic zonation for a large study area are based on single parameter such as past seismicity (BIS-1893 2002) or peak horizontal acceleration (PHA) (Khattri et al. 1984, Bhatia et al. 1999 and Parvez et al., 2003). The inclusion of local site effects for macro-level zonation will be advantageous. In this study, attempts have been made to review the feasibility of various methodologies for site characterization and site effect estimation and thus carry out the seismic zonation, both at the micro and macro-level using the appropriate methodology. The micro-level zonation is carried out for the Kalpakkam nuclear power plant site, while the macro-level zonation is performed for the state of Karnataka. The micro-level zonations are also required, especially for the NPP sites. As there are lots of constraints for the selection of a
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