A REVIEW ON DEVELOPMENT OF SEISMIC HAZARD ANALYSIS OF INDIA

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ABSTRACT—The present report highlights seismic vulnerability is closely dependent on the social and economic condition of the population. A brief review of past Probabilistic seismic hazard analysis (PSHA), Deterministic Seismic Hazard Analysis (DSHA) and site characterization of efforts for estimating seismic hazard in India Seismic hazard analysis (SHA) involves the quantitative estimation of ground shaking hazards at a particular site. Seismic hazard studies are needed for the preparation of earthquake loading regulations and for various earthquake risk management purposes. Probabilistic seismic hazard analysis (PSHA) is a technique for estimating the annual rate of exceedance of a specified ground motion at a site due to known and suspected earthquake sources. Probabilistic analysis provides a framework in which uncertainties in the size, location, and rate of recurrence and effects of earthquakes to be explicitly considered in the evaluation of seismic hazard. Well established probabilistic analysis procedure is adopted to compute the prevalent hazard in terms of peak ground acceleration (PGA), short period and long period spectral accelerations for different return periods.

Keywords – Earthquake PSHA, DSHA, PGA and spectral accelerations.

I. GENERAL INTRODUCTION

The earthquake is well-known fact that occurs without warning and involves violent shaking of the ground and everything over it. It’s sudden release of accumulated strain energy of the moving lithospheric or crustal plates. The earthquake hazard can be reduced by earthquake-resistant design which may require many precautions be taken to prevent the structures from most possible types of failures. The main goal of the earthquake-resistant design is to produce a structure or facility that can withstand a certain level of shaking without excessive damage [12]. Sufficient knowledge for ground conditions is important for analyses, design and construction of projects and also delays of the project, failures etc., to the soil investigations. Hence, includes soil investigation for the part of the design process. Site characterization is one of the processes of a collection of information, consideration of data, assessment and depiction through maps without which the hazards in the below ground the site cannot be known. Deterministic Seismic Hazard Analysis (DSHA) and another type of seismic hazard analysis is known as Probabilistic Seismic Hazard Analysis (PSHA). In this case, we considered the uncertainties involved in the size of the earthquake, the location of the earthquake, and the rate of recurrence that is in the interval through which earthquake repeats or reoccur that of the earthquake. Considering uncertainties involved in all these parameters, then the Probabilistic Seismic Hazard Analysis is done, it was initially developed by [9].

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II. LITERATURE REVIEW

Chandra (1977) attributed the interpolate seismicity by using different processes and also observed that some of the past earthquakes in Peninsular India. In this case, during earthquakes they were felt over a much larger area than one would expect earthquakes of equivalent magnitude to be felt in most other parts of the world. Researcher has been studied the seismicity of Peninsular India from a detailed consideration of the historical as well as recent earthquake data, and a catalogue of earthquakes. The average focal depths for these earthquakes are reported to be within the upper-crustal (0-12 km) layers complying with the depth of the Moho varying from 34 to 41 km beneath the region of southern India [18]; [13].

S. Akkar and J. J. Bommer (2010) in this article derive new equations using the strong-motion database for the seismically active areas of Europe and the Middle East. A total of 532 strong-motion accelerograms recorded at distances of up to 100 km from 131 earthquakes with moment magnitudes ranging from M 5 to 7.6 are used to obtain equations for both the larger and the geometric mean of the horizontal components Figure. 1 compares the predictions for earthquakes of surface-wave magnitude (Ms) 5.5 and 7.0 obtained from the Greek equation of [19] and the European equation of [27].

Das et al (2006) had prepared Seismic hazard maps for Northeast India based on uniform hazard response spectra for stiff sites. Through the use 261 recorded accelerograms had developed a new attenuation model for pseudo-spectral velocity. In this approach, the entire region is divided into a fine grid of around 2,500 nodes, and hazard level is predicted for each of the nodes by assuming it to be dependent on the earthquake events surrounded by 300 km radius area.

Peterson et al. (2004) Gujarat state (surrounded by Latitude 20°25.5°N and Longitude 68°75°E) is seismically one of the most active regions in India. There are three fault source models were adapted to the seismic hazard sensitivity test for the Kutch region of Gujarat, India. Developed Seismic hazard maps were for each of the 3 models for 2% and 10% probability of exceedance in 50 years. The PGA’s for 2% probability in 50 years was observed to be greater than 1g and for 10% probability in 50 years the was found to be between 0.2g and 0.7g.

Anbazhagan et al. (2009) carried out probabilistic Seismic Hazard Analysis of Bangalore city taking into consideration the seismotectonic features within radius of 350 km around Bangalore city. The quantified hazard values in terms of the rock level peak ground acceleration (PGA) are mapped and 5% damping for 10% probability of exceedance in 50 years. Seismic hazard parameter ‘b’ was estimated to be 0.62 to 0.98 using G–R relation. Probabilistic seismic hazard analysis for Bangalore region was carried out considering six seismogenic sources.

Shukla and Choudhury (2012) carried out site-specific probabilistic seismic hazard analysis for four typical port sites of Gujarat namely, Kandla, Mundra, Hazira and Dahej ports. PSHA was performed using seven ground motion prediction equations (GMPEs) including attenuation relation given by [24]. It is observed that the Mundra and Kandla port sites are most vulnerable sites for seismic hazard as estimated contingency level earthquake (CLE) ground motion is in order of 0.79 and 0.48 g for Mundra and Kandla port sites, respectively. And other hand comparatively less hazard with estimated CLE ground motion of 0.17 and 0.11 g for Hazira and Dahej port sites, respectively.

Ramanna and Dodagaodar (2012) Probabilistic Seismic Hazard Analysis (PSHA) has been widely used to determine the peak ground acceleration in this paper the researcher have been estimated peak ground acceleration for 10% probability of exceedance in 50 years using three approaches namely, Cornell-McGuire approach, fixed kernel and adaptive kernel techniques.

Raghukanth and Iyenger (2006) present seismic hazard and obtained a recurrence relation for Mumbai region using a catalog of 1274 past earthquakes from AD 1594–2002 specific to the region around Mumbai. The parameters of the Gutenberg and Richter equation were found to be $a = 0.77 \pm
0.04 and $b = 0.86 \pm 0.02$. These were used to compute the probability of ground motion that can be induced by each of the twenty-three known faults that exist around the city.

Ghobadi M H and Fereidooni D (2012) conduct a seismic hazard analysis for the city of Hamedan at the west of Iran. In this case the both of DSHA and PSHA approaches have been used for the assessment of seismic hazards and earthquake risk evaluation. Gutenberg–Richter relationship method was used for available earthquake data for getting the ‘$a$’ and ‘$b$’ parameters were estimated 5.53 and 0.68, respectively.

III. STEP BY STEP PROCEDURE FOR SEISMIC HAZARD ANALYSIS

3.1. Introduction
A seismic hazard analysis is a physical phenomenon, which is ground shaking or ground failure. Seismic hazard is associated with an earthquake and that can produce adverse effects on human activities. To estimate the seismic hazards for a particular region, all possible sources of seismic activity have to be identified and their possible for generating future strong ground motion. Recognition of seismic sources requires some detective work like natures clues, some of which are clear and others quite obscure necessity to observed and interpreted. Seismic hazards may be analyzed deterministically, at particular earthquake scenario is assumed. Otherwise analyzed probabilistically, in which uncertainties in earthquake location, size and time of occurrence are explicitly considered. Although seismic hazard analysis is a critical part of the development of attenuation relations for design ground motions and site condition consists of four primary steps: 1) Identification and characterization of all sources 2) Selection of source-site distance parameter 3) Selection of “controlling earthquake” 4) Definition of hazard using controlling earthquake

3.1. Declustering process
Declustering is the process of removal of dependent earthquake events (foreshocks and aftershocks) from an earthquake catalogue. The Poisoning assumption of earthquake recurrence implies that the earthquake event occurs randomly with no memory of time, size or location of any preceding event. Therefore, foreshocks and aftershocks are removed from the earthquake catalogue when a PSHA based on the Cornell-McGuire method is employed.

3.2. Earthquake catalogue completeness
An important problem in defining a recurrence relation is ensuring completeness. For the time period under consideration, it is crucial to ensure that all earthquakes have been recorded for each magnitude range of interest. For example, there is a threshold magnitude below which earthquake occurrences have not been recorded completely in a given time frame for a given layout of seismographs and a given distribution of the population. The completeness interval for the higher magnitude classes would be relatively difficult to determine. The graph would exhibit a stepped behaviour due to the fact that stronger events tend to be separated by relatively long time intervals and sometimes occur within a short period, both owing to the physical nature of earthquakes in a seismogenic zone.

IV. CASE STUDY
Seismic hazard for Gujarat region has been studied, its located central western part of Gujarat state and which is surrounded by Arabian Sea. The area of Gujarat region has been subdivided into three major regions are: one is Kachchh region; second is Saurashtra region; and third one is Mainland Gujarat region. These cover the area of the 25 cities, which are selected for case study of present analysis. Further later on, four port sites: Kandla port, Mundra port, Hazira port and Dahej port are also considered for site specific ground estimation analysis [16].

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Figure 4 shows the seismic zonation map of Gujarat state of India. These are the four colour codes like red, orange, yellow and blue. These are showing four different zones of the Gujarat state: zone 5, zone 4, zone 3 and zone 2. Among these, zone 5 is the most vulnerable one; zone 4 is lesser than that; zone 3 is lesser than that; and, zone 2 is least vulnerable in the Gujarat region. So, Gujarat is having seismic hazard for all the four zones as per our IS seismic design code 1893-part 1. Another reason is 2001 Bhuj earthquake is very well-known, very damaging earthquake, which occurred in Bhuj region of Gujarat state. And, it affected several other parts of the Gujarat as well [16].

V. ANALYSIS AND RESULTS

5.1. Deterministic seismic hazard analysis (DSHA)
Here carried out the DSHA, it describes the potential for dangerous earthquake related natural phenomenon, is that the maximum realistic earthquake or maximum considered earthquake. The earthquake hazard for the site is peak ground acceleration is 0.57 g, which is resulting from an earthquake magnitude of 5.7 on a particular fault. It has been obtained Narmada Son fault at a distance of 11.42 kilometer from the site. This is just for one particular site for the DSHA result for any other site in the entire Gujarat region [16].

5.2. Ground motion prediction equations (GMPEs)
Ground Motion Prediction Equations are needed for the select to do the seismic hazard analysis. So that, these are six ground motion prediction equations, are mentioned over here – [2]; [6]; [7]; [25]; [26]., 1997; and [23]. So, among these seven ground motion prediction equations or attenuation relationships, which they were used for this seismic hazard analysis, only the last one is for peninsular India; remaining all other from worldwide data, not from Indian data

5.3. Probabilistic seismic hazard analysis (PSHA)
After study of all standard attenuation relationships, had calculated PSHA also, above study requires some parameters. 1) 40 number of major faults has been identified and those are considered only for
further calculation, 2) number of magnitude recurrence relation which they were used, 3) 7 numbers of GMPE’s were used. So, to create the PSHA map with the grid points of 8430 that will mean that you have to get the value of 8430 times of 4 and 7. Because already mentioned earlier that magnitude recurrence relation and the attenuation relation are gives the independency to these two. There are several computer software are available which can perform the probabilistic seismic hazard analysis like Seisrisk 3 crisis 2007 e z-frisk 88 etcetera. And using the M S excel of course, after getting all these grid point values have to assign them and prepare a two dimensional chart [16].

VI. CONCLUSION AND DISCUSSIONS

Several; study’s of seismic hazards assessments have been carried out whole country of India have been revived, in this conclusions. From the sismotectonic map city area has been developed. Comparison between instrumented PGA values from the Koyna-Warna region [15]. [22] independently carried out PSHA for the city of Mumbai. Seismicity of India has been addressed by many researchers in particular [11], [8], [24], [17], [19], [15] and [4]. As per IS 1893 (BIS 2002), seismic study area falls in the zones II and III in the seismic zonation map of India. Gujarat region has carryout the seismic hazard analysis for using regional seismicity parameters which are consistent with present state of seismicity in the Gujarat. The seismicity parameter (b-value) is calculated by two different approaches namely Least Square Fit method and Maximum Likelihood method. These parameters constitute the basic framework required for seismic hazard assessment for Gujarat region. The b-values obtained using Least Square Fit are 0.41, 0.64 and 0.62 for Kachchh, Saurashtra and Mainland Gujarat, respectively. Though the peak ground acceleration (PGA) values are not in close agreement with those recommended by IS:1893 Part 1 (2002) for some cities but overall seismic ground motion distribution across the Gujarat region is more or less in agreement with regional distribution recommended by IS: 1893 Part 1 (2002). The present PSHA study results in close agreement with the seismic ground motions recommended by IS: 1893 Part 1 (2002).

REFERENCES


