Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 6, Issue 2; April-June, 2019, pp. 65-67

http://www.krishisanskriti.org/Publication.html

Probabilistic Seismic Hazard Analysis of Jamia Millia Islamia Delhi

Dr. Akil Ahmed[1], Mr. Lakshmi Narayan Bharti[2] and Dr. Mohammad Umair[3]

[1]Department of Civil Engineering Jamia Millia Islamia (A Central University), New Delhi, India
[2]M. Tech. (Earthquake Engineering) Jamia Millia Islamia (A Central University), New Delhi, India
[3]Department of Civil Engineering Jamia Millia Islamia (A Central University), New Delhi, India
E-mail: [1]aahmed@jmi.ac.in, [2]lakshminarayanbharti@gmail.com, [3]mumair@jmi.ac.in

Abstract—*The study focuses on probabilistic seismic hazard analysis (PSHA) by considering Jamia Millia Islamia (A Central University) New Delhi as a site of Delhi region. For PSHA analysis of the selected site, earthquake prone sources are selected in near vicinity, based on the geological historical setup and geophysical characteristics of the seismogenic sources, and the existing tectonic characteristics of the region. The area around Delhi is divided into four zones - Himalayan Zone, Delhi- Hardwar Ridge Zone, Moradabad fault Zone, Rajasthan Great Boundary fault Zone. On the basis of above sources, earthquake data are taken from history with defined epicenter. The selected sources are line sources with assumed seismicity.*

Keywords: *Probabilistic seismic hazard analysis, total probability theorem, spatial uncertainty, size uncertainty, temporal uncertainty.*

1. INTRODUCTION

The region around Delhi, the capital of India, has been indicated as the region of severe earthquakes in the past. The damages recorded in the city of Delhi made it imperative to work out the seismic hazard posed by the seismogenic sources around the Delhi region. In the present study, the seismic zonation on the bed rock level is carried out for Delhi so that seismic microzonation can be further worked out considering the effects of local soil conditions and the topography. For the seismic zonation of the area, the peak ground horizontal acceleration at bedrock level is found out and utilized [3 - 5].

The Delhi region has the latitude 28^0 24' to 28^0 53' N and longitude 76^0 50'to 77^0 20' E. Generally, the terrain of Delhi is flat, apart from a low NNE-SSW trending ridge that is assumed as an extension of the Aravalli hill, ranges of Rajasthan. The seismicity in this region may be associated with which constitutes an important tectonic block between 28^0- 30^0 N and 76^0 – 79^0 E with a NE-SW trend [6 – 10]. For carrying out the assessment of seismic hazard in this region, the area is subdivided into various seismotectonic zones having different characteristics (Table 1). In the present study, starting with separate analysis, the seismicity of the different zones is combined together in the analysis to get a complete picture of hazards of the selected site [11 - 13].

2. PSHA ANALYSIS AND DISCUSSION

Probabilistic seismic hazard analysis was developed for taking into accounting many of the uncertainties that are involved in seismic hazard. PSHA acknowledges that certain important aspects to the problem are not known to us, like;

Future location earthquake (spatial uncertainty)

Future size of earthquake (size uncertainty)

Ground motions intensity at the site

Future time of earthquake (temporal uncertainty)

The total probability theorem states that the total probability of a system can be computed the by summing up the individual probabilities from each contributing component is the basis of PSHA [1 - 2].

The seismic hazard analysis has been carried out as follows:

For line source, probability of occurrence,

$P(R = r) = \mathbf{r}/\boldsymbol{L_f}\sqrt{\mathbf{r^2} - \mathbf{R_{min}^2}}$

r = epicentral distance considered,

$\boldsymbol{L_f}$ = length of source,

$\boldsymbol{R_{min}}$= minimum epicentral distance

For line source $P(M = m) = \frac{\mathbf{2.303e^{-2.303(m-M_o)}}}{\mathbf{1-e^{-2.303(M_u-M_o)}}}(\mathbf{M_i}\text{-}\mathbf{M_o})$

m = consider magnitude,

M_o = threshold magnitude,

M_i = minimum magnitude interval,

M_u = upper magnitude interval.

For PSHA analysis, the Cornell et al. (1979) relationship is used:

In PHA (gals) = 6.74 + 0.859M - 1.80ln (R + 25)

PHA = peak horizontal acceleration

Standard deviation, σ_{lny} = 0.57

The total seismic hazard is computed by combining from the contributions of source-to-site distance and earthquake magnitude for all the zones.

Now the probabilities that various target peak acceleration levels will be exceeded can be calculated.

The standard normal variable is obtained for a* = 0.0l g (9.81 gals) or as below:

$$\mathbf{Z^* = \frac{ln(a^*) - ln(PHA, ingals)}{\sigma_{lny}}}$$

P[m,r]=1- normalizes(Z*)

Annual rate of exceedance of a peak acceleration of 0.01g by an earthquake given by:

$$\boldsymbol{\lambda_{0.01g} = \nu * P[m, r] * P[M = m] * P[R = r]}$$

for magnitude m and epicentral distance of r km and an earthquake of M > m occurs.

To get equivalent exceedance rates of different source zone, the calculations are made for different combinations of magnitude, epicentral distance and PGA values for all the sources and they are combined together to get completed scenario of seismic hazard [1 - 2].

By repeating this process for different target accelerations, the seismic hazard curves have been developed for different zones (Figures 1 to 4) and finally combined for the region (Figure 5).

Table 1: Seismic hazard assessment parameter (assumed)

Seismogenic zone	1	2	3	4
Threshold magnitude	4	4	4	4
Length of source (km)	350	35	200	400
Maximum observed magnitude	6.8	6.5	6.7	6.5
Seismicity	1	1.585	2.512	3.981
Epicenter	CHAMOLI	DELHI	BULANDSHAHAR	MATHURA
Epicentral distance (km)	293	14	79.4	154

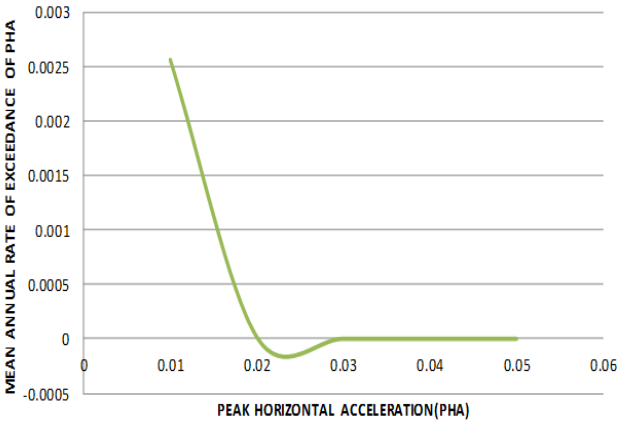

Figure 1. Seismic hazard curve for source-1

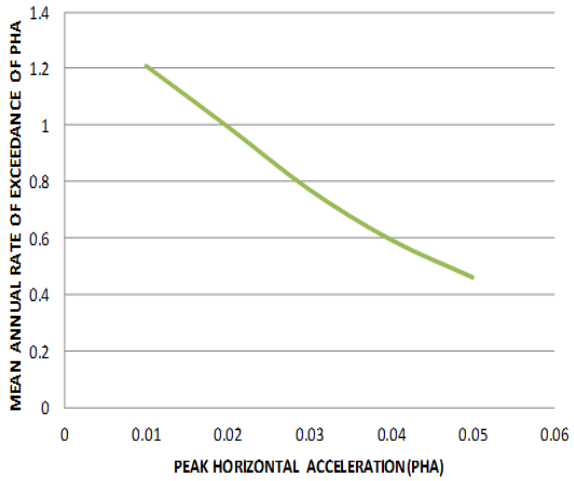

Figure 2. Seismic hazard curve for source-2

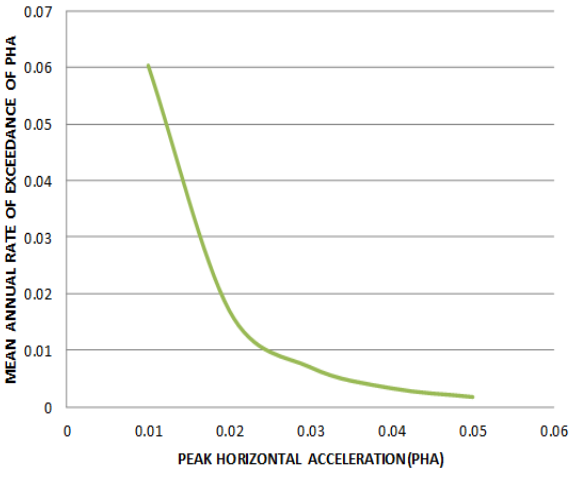

Figure 3. Seismic hazard curve for source-3

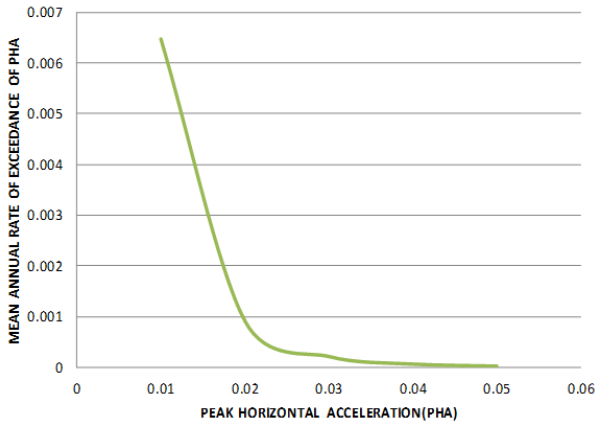

Figure 4. Seismic hazard curve for source-4

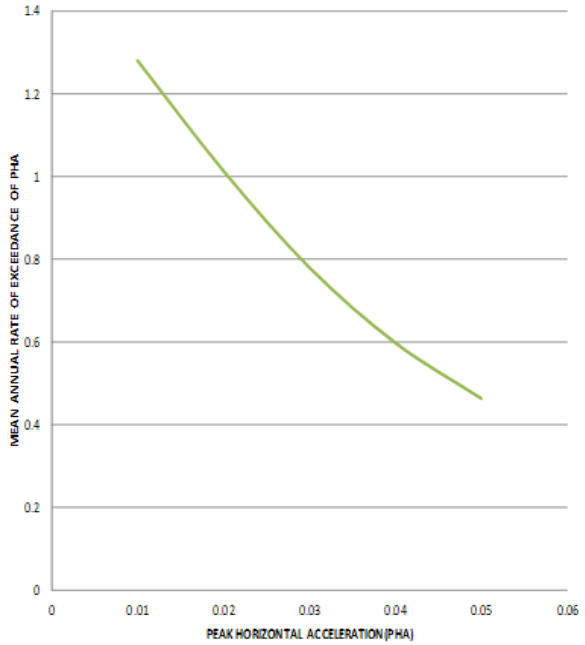

Figure 5. Combined seismic hazard curve of all sources

3. CONCLUSIONS

The probabilistic seismic hazard analysis (PSHA) is carried out in this work by considering Jamia Millia Islamia Delhi as a site in Delhi region. The seismic hazard parameters are taken from historical data and the unavailable data are assumed in the analysis. Seismic hazard curves show the graphical variation of the target acceleration that will exceed by an earthquake of M > m on any source zone. These curves show the plot of annual rate of exceedance versus PGA. Combined seismic hazard curves of all sources resemble with source -2, as source-2 is comparatively very near than other source zones.

REFERENCES

[1] Geotechnical Earthquake Engineering, Steven Lawrence Kramer, Prentice Hall, 1996.

[2] Seismic Analysis of Structures, T. K. Datta, John Wiley & Sons, 2010.

[3] Active transverse features in the central portion of the Himalaya, S Dasgupta, M Mukhopadhyay, DR Nandy, Tectonophysics, 136, 255-264, 1987.

[4] A fault-rupture model for seismic risk analysis, A. Der Kiureghian A. H-S. Ang, Bulletin of the Seismological Society of America, 1977, 67 (4), 1173-1194.

[5] https://en.wikipedia.org/wiki/Geographic_information_system

[6] A report on Seismic Microzonation of NCT Delhi on 1:10,000 scale(moes.gov.in/writereaddata/files/Delhi_microzonation_report.pdf)

[7] Hazard and risk assessment of Delhi (delhi.gov.in/DoIT/DOIT_DM/risks%20and%20vulnerability-1.pdf)

[8] Geological Survey of India (https://www.gsi.gov.in/)

[9] Seismic hazard mapping of Delhi city, R. N. Iyengar and S. Ghosh, 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 180

[10] Estimation of Seismic Hazard and seismic zonation at bed rock level for Delhi region, India, Mukat Lal Sharma and H. R. Wason, 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 180

[11] M. L. Sharma. "Seismic Zonation of the Delhi Region for Bedrock Ground Motion", Pure and Applied Geophysics, 12/01/2003

[12] Girish C. Joshi. "Uncertainties in the estimation of M max", Journal of Earth System Science, 11/2008

[13] Rao, K. Seshagiri, and Ganesh W. Rathod. "Seismic Microzonation of Indian Megacities: A Case Study of NCR Delhi", Indian Geotechnical Journal, 2014.