IJG> Vol.2 No.4, November 2011

Site Dependence Earthquake Spectra Attenuation Modeling: Nigerian Case Study

PDF (Size:1184KB) PP. 549-561 DOI: 10.4236/ijg.2011.24058

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ABSTRACT

Recent seismic events recorded in South-western Nigeria indicate that the country may not be aseismic as had hitherto thought. Geologic and geodetic evidences suggest the existence of large fracture zones (Romanche and Charcot) beneath the area. Considering the existence of these fracture zones, and the paucity of seismicity information, the development (oil exploration and production) taking place in offshore Nigeria in the last two decades and the ambitious planning for large future projects urgently call for the implementation of a comprehensive earthquake ground motion modelling which is a useful tool in site-dependent seismic hazard assessment in low to moderate seismicity region. In this study, ground-attenuation modelling based on stochastic approach was applied to predict the expected peak ground velocity and acceleration and spectral amplifications in two geologic settings. The seismic ground motion has been modelled using the September 11, 2009 earthquake of magnitude 4.8 (Mw) as case study. Synthetic seismic waveforms from which parameters for engineering building design could be obtain have been derived. From the seismograms computed, the seismic hazard for south-western Nigeria, expressed in terms of peak ground acceleration and peak ground velocity have been estimated. The peak ground acceleration estimated for the study area ranges from 0.16 to 0.69 g, and the peak ground velocity from 18.0 to 58.3 m/sec. The high peak values of accelerations and amplifications delineated are possibly due to the presence of the low velocity layers. In general, a good correlation between the synthetic and field data was observed. These results attest to the efficacy of the modelling exercise, and assessment of the seismic risk that the region would likely be subjected to. Also, the earthquake engineering design parameters derived may be used to derive new civil engineering building codes for the affected area.

KEYWORDS

Ground-Motion, Modelling, Seismic, Fracture, Velocity, Acceleration

Cite this paper

A. Adepelumi, T. Yakubu, O. Alao and A. Adebayo, "Site Dependence Earthquake Spectra Attenuation Modeling: Nigerian Case Study," *International Journal of Geosciences*, Vol. 2 No. 4, 2011, pp. 549-561. doi: 10.4236/ijg.2011.24058.

References

[1] I. A. Beresnev and G. M. Atkinson, "Modelling Finite-Fault Radiation from the Spectrum," Bulletin of the Seismological Society of America, Vol. 87, No. 1, 1997, pp. 67-84.

[2] N. M. Newmark and W. J. Hall, "Earthquake Spectra and Design," Earthquake Engineering Research Institute Mo- nograph Series, 1982.

[3] M. E. Omatsola and O. S. Adegoke, "Tectonic Evolution and Cretaceous Stratigraphy of the Dahomey Basin," Journal of Mining and Geology, Vol. 18, No. 1, 1981, pp. 130-137.

[4] N. G. Obaje, "Geology and Mineral Resources of Nigeria," In S. Bhattacharji, et al., Eds., Lecture Notes in Earth Sciences, Springer-Verlag, Berlin, 2009, pp. 1-219.

[5] M. A. Rahaman and O. O. Ocan, "On Relationship in the Precambrian Migmatite Gneiss of Nigeria," Journal of Mining and Geology, Vol. 15, 1978, pp. 23-30.

[6] C. Barnaba, E. Priolo, A. Vuan and M. Romanelli, "Site Effect on the Strong Motion Site at Tolmezzo-Ambiesta Dam in Northeastern Italy," Bulletin of the Seismological Society of America, Vol. 97, No. 1B, 2007, pp. 339-346. doi:10.1785/0120060077

[7] S. Drouet, S. Chevrot, F. Cotton and A. Souriau, "Simultaneous Inversion of Source Spectra, Attenuation Parameters, and Site Responses: Application to the Data of the French Accelerometric Network," Bulletin of the Seismological Society of America, Vol. 98, No. 1, 2008, pp. 198-219. doi:10.1785/0120060215

[8] N. Lam, C. Sinadinovski, R. Koo and J. Wilson, "Peak Ground Velocity Modelling for Australian Intraplate Earthquake," Journal of Earthquake Engineering & Structural Dynamics, Vol. 5, No. 2, 2003, pp. 11-22.

[9] H. H. Tsang, N. T. K. Lam and S. H. Lo, "Site-Dependent Response Spectral Attenuation Modelling: A Case Study of Long Distance Earthquakes Affecting Singapore," International Journal of Geology, Vol. 1, No. 1, 2007, pp. 6-10.

[10] L. Malagnini, K. Mayeda, R. Uhrhammer, A. Akinci and B. R. Herrmann, "A Regional Ground-Motion Excitation/Attenuation Model for the San Francisco Region," Bulletin of the Seismological Society of America, Vol. 97, No. 3, 2007, pp. 843-862. doi:10.1785/0120060101

[11] T. I. Allen and D. J. Wald, "Evaluation of Ground-Motion Modeling Techniques for Use in Global ShakeMap—A Critique of Instrumental Ground-Motion Prediction Equations, Peak Ground Motion to Macroseismic Intensity Conversions, and Macroseismic Intensity Predictions in Different Tectonic Settings," US Geological Survey Open-File Report 2009-1047, 2009, p. 114.

[12] J. Douglas, "On the Regional Dependence of Earthquake Response Spectra," ISET Journal of Earthquake Technology, Vol. 44, No. 1, 2007, pp. 77-99.

[13] J. Douglas, "Investigating Possible Regional Dependence in Strong Ground Motions," Earthquake Data in Engineering Seismology, Vol. 14, Part 1, 2011, pp. 29-38.

[14] J. Zhang and C. Yang, "Characteristics of Seismic Responses at Liquefied and Non-Liquefied Sites with Same Site Conditions," Journal of Modern Transportation, Vol. 19, No. 2, 2011, pp. 134-142.

[15] E. H. Vanmarcke, "Seismic Risk and Engineering Decisions, Chapter 8," Elsevier Publishing Co., New York, 1977.

[16] R. K. McGuire, "A Simple Model for Estimating Fourier Amplitude Spectra of Horizontal Ground Acceleration," Bulletin of the Seismological Society of America, Vol. 68, No. 3, 1978, pp. 803-822.

[17] M. D. Trifunac, "Dependence of Fourier Spectrum Amplitudes of Recorded Earthquake Accelerations on Magnitude, Local Soil Conditions and on Depth of Sediments," Earthquake Engineering Structure Dynamics, Vol. 18, No. 7, 1989, pp. 999-1016. doi:10.1002/eqe.4290180706

[18] G. Gibson, "Artificial Ground Motions," Proceedings of a Seminar Held by the Australian Earthquake Engineering Society of The Institute for Engineers Australia, Melbourne, 1993, pp. 83-86

[19] K. W. Campbell, "The Dependence of Peak Horizontal Acceleration on Magnitude, Distance, and Site Effects for Small-Magnitude Earthquakes in California and Eastern North America," Bulletin of the Seismological Society of America, Vol. 79, No. 5, 1989, pp. 1311-1346

[20] G. M. Atkinson and D. M. Boore, "Ground Motion Relations for Eastern North America," Bulletin of the Seismological Society of America, Vol. 85, 1995, pp. 17-30.

[21] J. N. Brune, "Tectonic Stress and the Spectra of Seismic Shear Waves from Earthquakes," Journal of Geophysical Research, Vol. 75, No. 26, 1970, pp. 4997-5009.

[22] D. M. Boore, "Stochastic Simulation of High-Frequency Ground Motions Based on Seismological Model of the Radiated Spectra," Bulletin of the Seismological Society of America, Vol. 73, No. 6, 1983, pp. 1865-1894.

[23] D. M. Boore and G. Atkinson, "Stochastic Prediction of Ground Motion and Spectral Response Parameters at Hard-Rock Sites in Eastern North America," Bulletin of the Seismological Society of America, Vol. 73, 1987, pp. 1865-1894.

[24] T. C. Hanks and R. K. McGuire, "The Character of High-Frequency Strong Ground Motion," Bulletin of the Seismological Society of America, Vol. 71. No. 6, 1981, pp. 2071-2095.

[25] G. Atkinson and W. Silva, "An Empirical Study of Earthquake Source Spectra for Californian

Earthquakes," Bulletin of the Seismological Society of America, Vol. 87, No. 1, 1997, 97-113.

[26] I. A. Beresnev and G. M. Atkinson, "Source Parameter of Earthquakes in Eastern and Western North America Based on Finite-Fault Modelling," Bulletin Seismological Society of America, Vol. 92, No. 2, 2002, pp. 695-710. doi:10.1785/0120010101

[27] G. Atkinson and P. Somerville, "Calibration of Time History Simulation Methods," Bulletin of the Seismological Society of America, Vol. 84, 1994, pp. 400-414.

[28] A. M. Chandler, N. T. K. Lam and H. H. Tsang "Regional and Local Factors in Attenuation Modelling: Hong Kong Case Study," Journal of Asian Earth Sciences, Vol. 27, No. 6, 2006, pp. 892-906.