8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

SELECTION OF GROUND MOTION PREDICTION EQUATIONS FOR SEISMIC HAZARD ANALYSES IN MAKRAN REGION, IRAN

Hamid ZAFARANI
Associate Professor, IIEES, Tehran, Iran
h.zafarani@iiees.ac.ir

Mohammad Reza SOGHRAT
Ph.D., IIEES, Tehran, Iran
m.soghrat@iiees.ac.ir

Keywords: GMPEs, Iran, Makran, Statistical analyses, Simulation, Adjustment factors

Ground-motion prediction equations (GMPEs) have a key role in evaluating the intensity measures (for example, PGA, PGV or SA) for assessing seismic hazard in a given region. According to different GMPEs developed based on local, regional and global databases, the selection of the appropriate equations is necessary to reduce the uncertainty. According to tectonic characteristics in the Makran region, different categories of GMPEs are required for seismic hazard assessment including GMPEs for shallow crustal events and subduction zone earthquakes (in-slab and interface events). To distinguish the seismotectonic and seismicity characteristics in Iranian plateau, the model proposed by Mirzaei et al. (1998) is used in this study which consider five different tectonic regions including Azerbaijan–Alborz, Kopeh Dagh, Zagros, Makran and Central–East Iran.

The final dataset consists of 543 records from 309 earthquakes. We divided the dataset in two groups including: Group1; the earthquakes with at least two records (80 events and 314 records), and Group2; the earthquakes with single records (229 earthquakes and 229 records). Noted that, the dataset in Group1 is used for statistical analyses and correction the GMPEs while the whole dataset (Group1 and Gropu2) is employed for site effect studies. Moreover, the earthquakes in Group1 are classified in two categorize including the events with focal depth less than 40 km (shallow earthquake, 67 events and 210 records) and more than 40 km (in-slab earthquakes, 13 events and 104 records). There are no recorded data in the region for interface earthquakes.

The model proposed by Abrahamson et al. (2014); Aea14, Boore et al. (2014); BSSA14, Campbell and Bozorgnia (2014); CB14, Chiou and Youngs (2104); CY14, Akkar and Bommer (2010); AB10, Bindi et al. (2014); Bea14, Ghasemi et al. (2009); Ghea09, Kale et al. (2015); Kea15; Kano et al. (2006); Kea06, Zafarani et al. (2018); Zea18 and Zhao et al. (2006); Zea06 are candidate for selection of GMPEs based on shallow earthquakes. In addition, the relations developed by Kano et al. (2006); Kea06, Zhao et al. (2006); Zea06, Atkinson and Boore (2003); AB03, Lin and Lee (2008); LL08, Abrahamson et al. (2015); Aea15 are used for in-slab events.

Different statistical analyses including LH, LLH and EDR tests are used to show the performance of GMPEs for applicability in the studied region. Then, the correction term as following is added to the GMPEs to better performance in predicting the amplitude in PGA, PGV and SA at periods of 0.05, 0.1, 0.2, 0.3, 0.5, 0.75, 1, 2 and 3 sec. It should be mentioned that after correction the GMPEs the statistical analyses have been repeated.

$$\log Y_m = \log Y + \alpha R + \beta \tag{1}$$

where Y_m is the modified GMPEs, Y denoted the existing equations, R shows the distance parameter and α and β are the regression parameters. For PGA, α is obtained about 0.0004, 0.0001 and -0.0001 for the model proposed by Zea18, Kea15 and AB10, respectively. Also, the β is estimated 0.0017, -0.0338 and -0.0118 for the model developed by Zea18, Kea15 and AB10, respectively.

According to the results after correction the GMPEs, the model proposed by Zafarani et al. (2018), Kale et al. (2015), Zhao et al. (2006) and Akkar and Bommer (2010) have better performance in predicting ground motion among 11 candidate GMPEs. The process has been repeated for in-slab earthquakes. According to the results after correction of the models, the GMPE developed by Kano et al. (2006), Zhao et al. (2006) and Lin and Lee (2008) and Abrahamson et al. (2015) have a similar and good performance.

REFERENCES

Abrahamson, N., Gregor, N., and Addo, K. (2016). BC Hydro ground motion prediction equations for subduction earthquakes. *Earthquake Spectra*, *32*(1), 23-44

Abrahamson, N.A., Silva, W.J., and Kamai, R. (2014). Summary of the ASK14 ground motion relation for active crustal regions. *Earthquake Spectra*, *30*(3), 1025-1055.

Akkar, S. and Bommer, J.J. (2010). Empirical equations for the prediction of PGA, PGV, and spectral accelerations in Europe, the Mediterranean region, and the Middle East. *Seismological Research Letters*, *81*(2), 195-206.

Atkinson, G.M. and Boore, D.M. (2003). Empirical ground-motion relations for subduction-zone earthquakes and their application to Cascadia and other regions. *Bulletin of the Seismological Society of America*, *93*(4), 1703-1729.

Bindi, D., Massa, M., Luzi, L., Ameri, G., Pacor, F., Puglia, R., and Augliera, P. (2014). Pan-European ground-motion prediction equations for the average horizontal component of PGA, PGV, and 5%-damped PSA at spectral periods up to 3.0 s using the RESORCE dataset. *Bulletin of Earthquake Engineering*, *12*(1), 391-430.

Boore, D.M., Stewart, J.P., Seyhan, E., and Atkinson, G. (2014). Summary of the BSSA14 GMPE. *Earthquake Spectra*, *30*.

Campbell, K.W. and Bozorgnia, Y. (2014). NGA-West2 ground motion model for the average horizontal components of PGA, PGV, and 5% damped linear acceleration response spectra. *Earthquake Spectra*, *30*(3), 1087-1115.

Chiou, B.S.J. and Youngs, R.R. (2014). Update of the Chiou and Youngs NGA model for the average horizontal component of peak ground motion and response spectra. *Earthquake Spectra*, *30*(3), 1117-1153.

Ghasemi, H., Zare, M., Fukushima, Y., and Koketsu, K. (2009). An empirical spectral ground-motion model for Iran. *Journal of Seismology*, *13*(4), 499-515.

Kale, Ö., Akkar, S., Ansari, A., and Hamzehloo, H. (2015). A ground-motion predictive model for Iran and Turkey for horizontal PGA, PGV, and 5% damped response spectrum: Investigation of possible regional effects. *Bulletin of the Seismological Society of America*, *105*(2A), 963-980.

Kanno, T., Narita, A., Morikawa, N., Fujiwara, H., and Fukushima, Y. (2006). A new attenuation relation for strong ground motion in Japan based on recorded data. *Bulletin of the Seismological Society of America*, *96*(3), 879-897.

Lin, P.S. and Lee, C.T. (2008). Ground-motion attenuation relationships for subduction-zone earthquakes in northeastern Taiwan. *Bulletin of the Seismological Society of America*, *98*(1), 220-240.

Mirzaei, N., Mengtan, G., and Yuntai, C. (1998). Seismic source regionalization for seismic zoning of Iran: major seismotectonic provinces. *Journal of Earthquake Prediction Research*, *7*, 465-495.

Zafarani, H., Luzi, L., Lanzano, G., and Soghrat, M.R. (2018). Empirical equations for the prediction of PGA and pseudo spectral accelerations using Iranian strong-motion data. *Journal of Seismology*, *22*(1), 263-285.

Zhao, J. X., Zhang, J., Asano, A., Ohno, Y., Oouchi, T., Takahashi, T., Ogawa, H., Irikura, K., Thio, H.K., Somerville, P.G., Fukushima, Y., and Fukushima, Y. (2006). Attenuation relations of strong ground motion in Japan using site classification based on predominant period. *Bulletin of the Seismological Society of America*, *96*(3), 898-913.