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Comparison of Equivalent Linear and Non-Linear Site Response Model Performance in Kathmandu Valley

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Abstract : Evaluation of ground response under earthquake shaking is crucial in geotechnical earthquake engineering. Damage due to seismic excitation is mainly correlated to local geological and geotechnical conditions. It is evident from the past earthquakes (e.g. 1906 San Francisco, USA, 1923 Kanto, Japan) that the local geology has strong influence on amplitude and duration of ground motions. Since then significant studies has been conducted on ground motion amplification revealing the importance of influence of local geology on ground. Observations from the damaging earthquakes (e.g. Nigata and San Francisco, 1964; Irpinia, 1980; Mexico, 1985; Kobe, 1995; L'Aquila, 2009) divulged that non-uniform damage pattern, particularly in soft fluvio-lacustrine deposit is due to the local amplification of seismic ground motion. Non-uniform damage patterns are also observed in Kathmandu Valley during 1934 Bihar Nepal earthquake and recent 2015 Gorkha earthquake seemingly due to the modification of earthquake ground motion parameters. In this study, site effects resulting from amplification of soft soil in Kathmandu are presented. A large amount of subsoil data was collected and used for defining the appropriate subsoil model for the Kathamandu valley. A comparative study of one-dimensional total-stress equivalent linear and non-linear site response is performed using four strong ground motions for six sites of Kathmandu valley. In general, one-dimensional (1D) site-response analysis involves the excitation of a soil profile using the horizontal component and calculating the response at individual soil layers. In the present study, both equivalent linear and non-linear site response analyses were conducted using the computer program DEEPSOIL. The results show that there is no significant deviation between equivalent linear and non-linear site response models until the maximum strain reaches to 0.06-0.1%. Overall, it is clearly observed from the results that non-linear site response model perform better as compared to equivalent linear model. However, the significant deviation between two models is resulted from other influencing factors such as assumptions made in 1D site response, lack of accurate values of shear wave velocity and nonlinear properties of the soil deposit. The results are also presented in terms of amplification factors which are predicted to be around four times more in case of non-linear analysis as compared to equivalent linear analysis. Hence, the nonlinear behavior of soil prevails the urgent need of study of dynamic characteristics of the soft soil deposit that can specifically represent the site-specific design spectra for the Kathmandu valley for building resilient structures from future damaging earthquakes.

Keywords : deep soil, equivalent linear analysis, non-linear analysis, site response
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