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Comparative Study of Equivalent Linear and Non-Linear Ground Response Analysis for Rapar District of Kutch, India

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Abstract : Earthquakes are considered to be the most destructive rapid-onset disasters human beings are exposed to. The amount of loss it brings in is sufficient to take careful considerations for designing of structures and facilities. Seismic Hazard Analysis is one such tool which can be used for earthquake resistant design. Ground Response Analysis is one of the most crucial and decisive steps for seismic hazard analysis. Rapar district of Kutch, Gujarat falls in Zone 5 of earthquake zone map of India and thus has high seismicity because of which it is selected for analysis. In total 8 bore-log data were studied at different locations in and around Rapar district. Different soil engineering properties were analyzed and relevant empirical correlations were used to calculate maximum shear modulus (Gmax) and shear wave velocity (Vs) for the soil layers. The soil was modeled using Pressure-Dependent Modified Kodner Zelasko (MKZ) model and the reference curve used for fitting was Seed and Idriss (1970) for sand and Darendeli (2001) for clay. Both Equivalent linear (EL), as well as Non-linear (NL) ground response analysis, has been carried out with Masing Hysteretic Re/Unloading formulation for comparison. Commercially available DEEPSOIL v. 7.0 software is used for this analysis. In this study an attempt is made to quantify ground response regarding generated acceleration time-history at top of the soil column, Response spectra calculation at 5 % damping and Fourier amplitude spectrum calculation. Moreover, the variation of Peak Ground Acceleration (PGA), Maximum Displacement, Maximum Strain (in %), Maximum Stress Ratio, Mobilized Shear Stress with depth is also calculated. From the study, PGA values estimated in rocky strata are nearly same as bedrock motion and marginal amplification is observed in sandy silt and silty clays by both analyses. The NL analysis gives conservative results of maximum displacement as compared to EL analysis. Maximum strain predicted by both studies is very close to each other. And overall NL analysis is more efficient and realistic because it follows the actual hyperbolic stress-strain relationship, considers stiffness degradation and mobilizes stresses generated due to pore water pressure.

Keywords : DEEPSOIL v 7.0, ground response analysis, pressure-dependent modified Kodner Zelasko model, MKZ model, response spectra, shear wave velocity
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