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Shallow and Upper Crustal Amplification of Seismic Waves

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The aim of this study is to predict the amplification of seismic waves for various sites in Johannesburg by considering the parametric and ground motion uncertainty. The site response analyses were conducted at nine seismograph stations to investigate the amplification of seismic waves. The location map of all sites considered in the study is given in Figure 1. The results for each site are presented in the form of variation of PGA with depth, transfer function, amplification factors and response spectra at ground surface. The shear wave velocities (V_S) are measured by MASW. To model the uncertainty in V_S, profiles are prepared within its probability distribution. The variation in modulus reduction and damping curve with Seed and Idriss (1970) mean curve for sandy soils and Idriss (1990) for clay as a baseline are used at ± 1σ and ± 2σ. The variability in input ground motion (which is very significant) for ground response is adopted by selecting ten recorded motions of selective magnitude and distance range from the deaggregation results. It is observed that it has profound effect on amplification factors. The average amplification factors at all sites varied between 1.5 and 3.3. There were a few instances in the analyses, where amplification factors reached values above 10. The lower velocity values, weak and soft material at depths are responsible for the higher amplifications at some sites. The sedimentary layers are undulating in the region and hence, the amplification of seismic waves is very site specific. It has also been attempted to estimate the crustal amplifications. The crustal amplifications are found to be very low as compared to the amplification in the shallow depths. Crustal amplification factors for Fourier amplitude spectra computed for the upper-crustal model of the Central Basin area South African provinces are around 1.0 below 0.01Hz, reaching a maximum value above 2 Hz (0.5 sec). However, the presence of even small value of kappa will reduce the amplification above 2 Hz as well. The hard rock amplification with small velocity gradient has a maximum amplification close to one, therefore it could be ignored. However, this is not a case in the Central Basin area, where crustal amplification is greater than one in the range from 0.1 Hz to about 10Hz for assumed very small kappa = 0.005. In a worst scenario when maximum amplification of seismic waves coincides with the building's natural period, maximum damage can be expected for the building. From this study, it can be concluded that the predominant period of ground, amplification factors with respect to period and building class would be essential inputs for earthquake risk reduction.

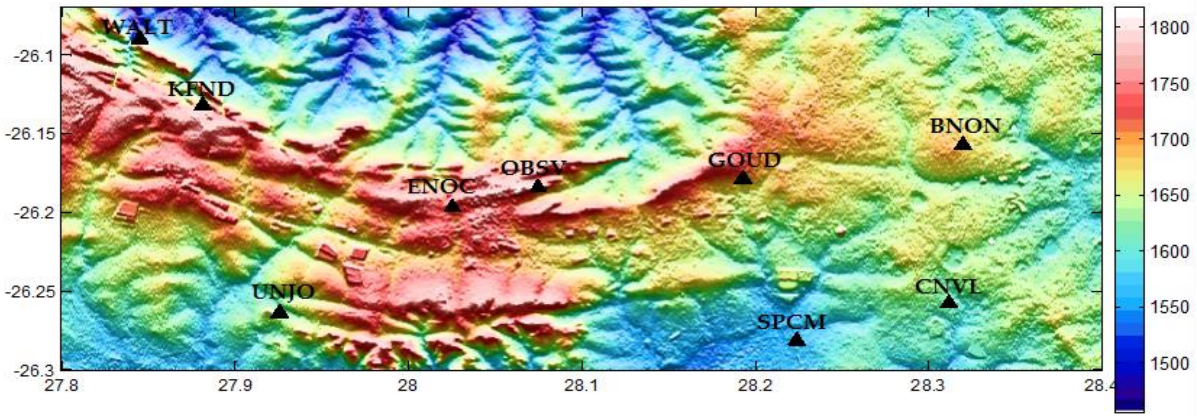

Figure 1: Location map of sites considered in the study

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