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Estimation of site amplification, attenuation and source spectra of S-waves in the East-Central Iran

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ABSTRACT

Generalized inversion of the S-wave amplitude spectra from the strong-motion network data in the East-Central Iran has been used to estimate simultaneously source parameters, site response and the S-wave attenuation (Q_s). In this regard, 190 three-component records were used corresponded to 40 earthquakes with the magnitudes M3.5–M7.3. These earthquakes were recorded at 42 stations in the hypocentral distance range from 9 to 200 km. The inverse problem was solved in 20 logarithmically equally spaced points in the frequency band from 0.4 to 15 Hz. The frequency-dependent site amplification was imposed, as a constraint, on two reference site responses in order to remove the undetermined degree of freedom in the inversion and obtain a unique inverse solution. Also, a geometrical spreading factor was assumed for removing the trade-off between geometrical spreading and anelastic attenuation. Different source parameters, such as seismic moment (M_0), seismic energy (E_s), corner frequency (f_c) and Brune stress drop ($\Delta\sigma$), were estimated for each event by fitting an ω^2 model to the spectra obtained from the inversion. The stress drop values of earthquakes, obtained in this research, are in good agreement with those of other studies. Also average site response values were correlated to the average shear wave velocities in the uppermost 30 m, in high and low frequency bands. The peak frequencies of site amplifications, estimated by the generalized inversion method, where in good agreement with those of horizontal to vertical (H/V) spectral ratios for the S-wave portion of records. However, no perfect matching in amplitude was obtained due to the deficiencies of the H/V ratio technique. By supposing a free shape for Q factor, a frequency dependent function was found, the logarithm of which could be approximated by a linear function, $Q(f)=151f^{0.75}$. The uncertainties of model parameters have been evaluated by covariance matrix of least-square fit. The residuals were also analyzed in order to assess the validity of the model. The analysis of residuals with respect to magnitude and distance indicates that they are distributed normally with approximately zero mean. The robustness of the results has been studied concerning their sensitivities to the omission of different datasets, selected randomly from original database. The results obtained here can be used in predicting ground-motion parameters applying stochastic methods.

1. Introduction

The Iranian plateau located in the Alpine–Himalayan orogenic belt is one of the most seismic regions in the word [1]. Iran has experienced large earthquakes ($M>6$) quite frequently in the past (e.g., Bam, 2003, *M* 6.5; Manjil, 1990, *M* 7.4; Tabas, 1978, *M* 7.4). Therefore, the necessity of more precise seismic hazard studies of the region has become a key issue in earthquake engineering applications.

Ground motion at a particular site is influenced by source, path and site effects. Source factors are e.g. magnitude, fault geometry, stress drop and rupture process. Travel path effects include geometrical attenuation, dissipation of seismic energy due the earth's anelasticity and elastic waves scattering in heterogeneous media. Site factors constitute of a combination of amplification through crustal profile and near-surface attenuation. In Iran, the available strong motion data are not sufficient for defining ground motions, particularly for near fields of large earthquakes. In addition, the existed high-quality strong motion data are not adequate for developing empirical attenuation relationships, regarding certain regions of the country. Therefore, in order to overcome the shortage, the reliance should be placed on physical models to interpolate and extrapolate the existing data [2,3]. The region-specific source, wave propagation parameters and seismic-site responses should be preferably studied in order to achieve a reliable estimation of seismic hazard by physical modeling,

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