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Simulation of the 2017 M7.3 Sarpol-e-Zahab earthquake by empirical Green's function method

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Extended Abstract

Summary

On November 12, 2017, an earthquake with the moment magnitude of 7.3 occurred in Kermanshah, Iran (Zagros Zone). To estimate the source parameters and how the rupture of this earthquake propagated, the accelerograms, obtained from this earthquake, were simulated using the empirical Green's function method in the frequency range of 0.1 to 10 Hz. For this purpose, records of seven strong motion stations having good quality were used. In this study, the earthquake fault was divided into seven sub-faults along the strike and seven sub-faults along the slope, and the asperity of 21*10.5 km was obtained. The rupture starting point has been located in the western part of the strong motion generation area. The coordinates of the rupture starting point indicate that the rupture propagation on the fault plane was unilateral from west to east. The focal mechanism indicates the existence of a thrust fault with a dip-slip component at a shallow depth. Accordin``gly, the strike, dip and the rake of the fault plane have been estimated as 118, 97 and 78 degrees, respectively. After calculating design spectrum of horizontal component of all records, the results were compared to those obtained by Code (2005). The results are in well agreement with those obtained by Code (2005). However, the calculated design spectrum of Sarpol-e-Zahab station is higher than the design spectrum obtained by Code (2005) that suggests the re-evaluation of the Code (2005) for this area.

Introduction

Kermanshah earthquake occurred on November 12, 2017 at 21:48:16 local time. According to the Iranian Seismological Center (IRSC), the epicenter coordinates of the earthquake was reported at 34.77°N and 45.76°E with a moment magnitude (M) of 7.3 and depth of 18 km. Examination of the earthquake fault mechanism shows that the earthquake had a dip-slip mechanism due to the thrust faulting with a dip-slip component at a shallow depth. This devastating earthquake occurred in the Zagros zone, causing many deaths and financial losses. The death toll of 620, more than 7000 injured, and about 70000 homeless can be mentioned as a result of this earthquake (Ahmadi and Bazargan-Hejazi 2018; Miyamjima et al. 2018). The earthquake had two foreshocks with a magnitude greater than 4.5, and it also had more than 100 aftershocks with a magnitude less than 5.4 in the first month after the mainshock. The area has also witnessed devastating earthquakes in recent years. Historically, the recorded earthquakes included the April 958 earthquake of M6.4, the April 23 1008 earthquake of M7 (56000 deaths), and June 1872 (1500 deaths) (Ambraseys and Melville 1982). Due to the increase of destructive earthquakes in this area, seismic hazard assessment and design of earthquake resistant structures in order to reduce the damages in the area should be made.

Methodology and Approaches

Hartzell (1978) introduced the method of investigating major earthquakes using the foreshock or aftershock (small events) entitled as the empirical Green's function. The basic idea is that the source, path, and site information that are present in the main event, are also present in the small event. The empirical Green's function approach has the advantage of taking into account the complex path, site effects, and complexity of the inhomogeneous structure of the Earth between the source and the recording site. In the empirical Green's function simulation, the fault plane is considered as a rectangular plane divided into N*N components (Irikura 1986). The relationship between main even and small event parameters has been defined by the scaling relationships of Kanamori and Anderson (1975).

Results and Conclusions

In this study, the Sarpol-e-Zahab earthquake source parameters were estimated using ground strong motion simulation by the empirical Green's function method in the frequency range of 0.1 to 10 Hz. For this purpose, the initial parameters for simulation were obtained on the basis of grid search approach.