CORRELATION OF DEFORMATION DEMANDS WITH STRONG GROUND MOTION PARAMETERS FOR RECENT EARTHQUAKES OF IRAN

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This article is devoted to relation between structural deformation demands and strong ground motion parameters of recent destructive earthquakes of Iran. In order to estimate seismic hazards, there is a need for measures that properly characterize the severity of ground motions. Such measures are used along with the ductility of structures to estimate the probability of failure. Strong ground motion parameters can be classified into two groups: 1- parameters computed from the ground motion records and 2- parameters calculated from the response spectra.The simplest and the most commonly known ground motion intensity parameters are peak ground velocity (PGV) and peak ground acceleration (PGA), which are readily available from the ground motion record. Other common intensity parameters are cumulative absolute velocity (CAV) and Arias intensity (AI) (Arias 1970). CAV, the absolute area under the ground motion trace, was introduced by (EPRI, 1998). AI and CAV are expressed, by following equations.

$$AI = \frac{\pi}{2g}\int_0^{t_d} a^2(t)dt \tag{1}$$

$$CAV = \int_0^{t_d} |a(t)|dt \tag{2}$$

Spectral acceleration at the fundamental period of the structure, *Sa*, is a widely employed parameter obtained from the pseudo acceleration response spectrum (Luco and Cornell, 2007). Other most common parameters that are computed from the response spectra of the ground motion record are Housner intensity (HI) (Housner, 1952), effective peak acceleration (EPA) (BSSC, 1984), acceleration spectrum intensity (ASI), and velocity spectrum intensity (VSI) (Von Thun et al., 1988).

Nonlinear time history analyses of single degree of freedom structure (SDOF) were performed under a wide range of earthquake records of Iran. The records contained in the ground motion database were intended to represent a wide range of seismic forces that impose various degrees of elastic as well as inelastic response of structures. This includes forward-directivity ground motions and ordinary ground motions from earthquakes with moment magnitude (M_w) greater than 6. Therefore, pulse components in near-field ground motions that were known to cause significant damage to flexible structures, are also considered. The structural systems considered in analyses covered various range of periods from stiff structures with low periods to flexible structures with high periods. Engineering Demand Parameters such as drift ratio, ductility demand, and story shear forces were monitored. However, the maximum story displacement ductility demand was selected to describe the inelastic response of the structures. The maximum interstory drift ratios (MIDR) computed was compared with the ground motion intensity parameters and correlations between them were investigated.

Results showed that pulse-like forward-directivity ground motions impose a larger ductility demand to the structure compared to ordinary ground motions because most of the energy in forward-directivity ground motions is concentrated in a narrow frequency band. In general, the spectral acceleration at the first-mode period of vibration is not the ideal intensity measure to capture structural response to pulse-like ground motions. Also, the results indicated that spectrum-based intensity parameters that account for the structural characteristics (predominant period) are the most reliable ground motion intensity parameters for the structures having periods between 0.2 and 1.1 s. The best ground motion intensity for the structures with periods between 0.2 and 0.5 s was observed to be PGA followed by VSI. For structures having periods between 0.5 and 1.1 s, on the other hand, VSI and HI appear to have the strongest correlation with MIDR.

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