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Vulnerability assessment of RC frames considering the characteristic of pulse-like ground motions

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Pulse-like ground motions are a special class of ground motions that are particularly challenging to characterize for earthquake hazard assessment. These motions are characterized by a “pulse” in the velocity time history of the motion, and they are typically very intense and have been observed to cause severe damage to structures in past earthquakes. So it is particularly important to characterize these ground motions. Previous studies show that the severe response of structure is not entirely accounted for by measuring the intensity of the ground motion using spectral acceleration of the elastic first-mode period of a structure (Sa(T1)). This paper will use several alternative intensity measures to characterize the effect of pulse-like ground motions in vulnerability assessment. The ability of these intensity measures to characterize pulse-like ground motions will be evaluated.
Pulse-like ground motions and ordinary ground motions are selected as input to carry out incremental dynamic analysis. Structural response and vulnerability are estimated by using Sa(T1) as the intensity measure. The impact of pulse period on structural response is studied through residual analysis. By comparing the difference between the structural response and vulnerability curves using pulse-like ground motions and ordinary ground motions as the input, the impact of velocity pulse on vulnerability is investigated and the shortcoming of using Sa(T1) to characterize pulse-like ground motion is analyzed. Then, vector-valued ground motion intensity measures(Sa(T1)&RT1,T2, Sa(T1)&RPGV,Sa) and inelastic displacement spectra(Sdi(T1)) are used to characterize the damage potential of pulse-like ground motions, the efficiency and sufficiency of these intensity measures are evaluated. The study shows that: have strong the damage potential of near fault ground motions with velocity pulse is closely related to the pulse period of strong motion as well as first mode period of vibration and nonlinear features of the structure. The above factors should be taken into account when choosing a reasonable ground motion parameter to characterize the damage potential of pulse-like ground motions. Vulnerability curves based on Sa(T1) show obvious differences between using near fault ground motions and ordinary ground motions, as well as pulse-like ground motions with different pulse periods as the input. When using vector-valued intensity measures such as Sa(T1)&RT1,T2, Sa(T1)&RPGV,Sa and inelastic displacement spectra, the results of vulnerability analysis are roughly the same. These ground motion intensity measures are more efficient and sufficient to characterize the damage potential of near fault ground motions with velocity pulse.