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Prediction of Seismic Damage Using Scalar Intensity Measures Based on Integration of Spectral Values

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Abstract : A key issue in seismic risk analysis within the context of Performance-Based Earthquake Engineering is the evaluation of the expected seismic damage of structures under a specific earthquake ground motion. The assessment of the seismic performance strongly depends on the choice of the seismic Intensity Measure (IM), which quantifies the characteristics of a ground motion that are important to the nonlinear structural response. Several conventional IMs of ground motion have been used to estimate their damage potential to structures. Yet, none of them has been proved to be able to predict adequately the seismic damage. Therefore, alternative, scalar intensity measures, which take into account not only ground motion characteristics but also structural information have been proposed. Some of these IMs are based on integration of spectral values over a range of periods, in an attempt to account for the information that the shape of the acceleration, velocity or displacement spectrum provides. The adequacy of a number of these IMs in predicting the structural damage of 3D R/C buildings is investigated in the present paper. The investigated IMs, some of which are structure specific and some are nonstructure-specific, are defined via integration of spectral values. To achieve this purpose three symmetric in plan R/C buildings are studied. The buildings are subjected to 59 bidirectional earthquake ground motions. The two horizontal accelerograms of each ground motion are applied along the structural axes. The response is determined by nonlinear time history analysis. The structural damage is expressed in terms of the maximum interstory drift as well as the overall structural damage index. The values of the aforementioned seismic damage measures are correlated with seven scalar ground motion IMs. The comparative assessment of the results revealed that the structure-specific IMs present higher correlation with the seismic damage of the three buildings. However, the adequacy of the IMs for estimation of the structural damage depends on the response parameter adopted. Furthermore, it was confirmed that the widely used spectral acceleration at the fundamental period of the structure is a good indicator of the expected earthquake damage level.

Keywords : damage measures, bidirectional excitation, spectral based IMs, R/C buildings
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