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Adequacy of Advanced Earthquake Intensity Measures for Estimation of Damage under Seismic Excitation with Arbitrary Orientation

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Abstract : An important area of research in seismic risk analysis is the evaluation of expected seismic damage of structures under a specific earthquake ground motion. Several conventional intensity measures of ground motion have been used to estimate their damage potential to structures. Yet, none of them was proved to be able to predict adequately the seismic damage of any structural system. Therefore, alternative advanced intensity measures which take into account not only ground motion characteristics but also structural information have been proposed. The adequacy of a number of advanced earthquake intensity measures in prediction of structural damage of 3D R/C buildings under seismic excitation which attacks the building with arbitrary incident angle is investigated in the present paper. To achieve this purpose, a symmetric in plan and an asymmetric 5-story R/C building are studied. The two buildings are subjected to 20 bidirectional earthquake ground motions. The two horizontal accelerograms of each ground motion are applied along horizontal orthogonal axes forming 72 different angles with the structural axes. The response is computed by non-linear 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 determined for incident angle 0° as well as their maximum values over all seismic incident angles are correlated with 9 structure-specific ground motion intensity measures. The research identified certain intensity measures which exhibited strong correlation with the seismic damage of the two buildings. However, their adequacy 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 indices, non-linear response, seismic excitation angle, structure-specific intensity measures
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