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Damage Potential of Near-Source Ground Motion Records

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The assessment of structural response induced by earthquakes for both design and evaluation is often made using ground motion intensity measures, IMs, as predictors. The most widely used IM is the spectral acceleration, S_a, at the structure fundamental period of vibration, T_1. Unless the response of the structure is first-mode dominated and not significantly beyond the onset of structural damage, the response variability caused by records with the same value of $S_a(T_1)$ is still considerable. The International Building Code suggests using as few as three recordings to establish via nonlinear dynamic analysis a relationship between the IM and the response severity. Given the record-to-record response variability, how can the “right” accelerograms be selected to estimate the median response for that level of IM with more confidence? In this study we investigate whether we can identify "non-stationary" features of near-source, forward-directivity accelerograms that, in addition to S_a, improve structural response prediction. To simplify the search for useful signal characteristics beyond the spectral values, the records are compatibilized to a common spectrum prior to use. For the considered structures, characteristics of the velocity pulse and the duration of the record do not appreciably improve the accuracy of the response estimates beyond that achieved by using spectral values alone. Furthermore, this study demonstrates that accelerograms cannot be labeled as "damaging" or "benign" without considering a particular structural vibration period and specific yield strength, F_y. Hence, record characteristics that do not account for T_1 and F_y are not likely to be "good" response predictors.