

Speaker:

Nicolas Luco
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Session:

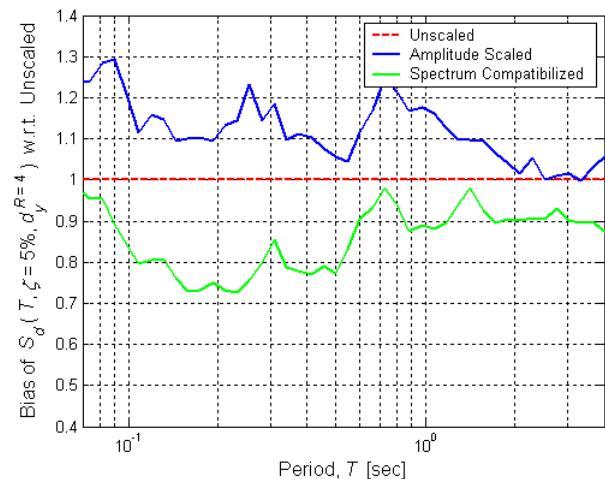
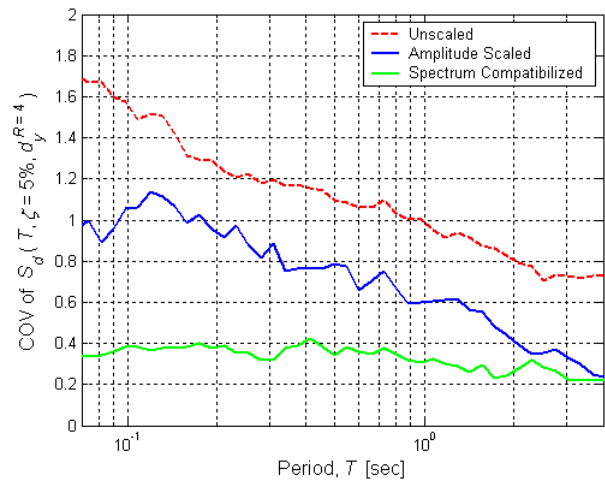
Earth Sciences Special Session
9:45–11:00am

Presentation title:

The Effect of Time Histories on Inelastic Response

Major points/topics:

- Variability of inelastic response to nominally similar time histories, and implications.
- Scaling time histories: Pro’s and con’s with respect to inelastic response.
- Spectral matching time histories: Effects on inelastic response.
- Inelastic response to simulated versus recorded time histories.



Abstract/Summary

The considerable variability of inelastic structural response, even to time histories of ground motion from nominally similar earthquake events (e.g., the thirty-one “near-source” time histories used to create the two figures above), makes the selection of appropriate time histories a challenging task. This is especially true for large-scale shake table experiments that must typically rely on a single time history. Even for other cases in which multiple time histories can be used, it is often not possible to use a sufficient number of time histories relative to the variability of inelastic response. Faced with such difficulties, various techniques for reducing the variability of inelastic response are applied in practice, whether for evaluations of designed/existing structures or for laboratory experiments. Such techniques include scaling (in amplitude only) time histories to a target spectral acceleration value, or “spectral matching” (both in amplitude and frequency/phasing content) a time history in order to match a target elastic response spectrum. As demonstrated in the top figure above, both scaling and spectral matching can significantly reduce the variability of inelastic response (in this case of elastic-perfectly-plastic single-degree-of-freedom oscillators with a range of vibration periods and a yield displacement corresponding to, on average, a strength reduction factor of four). As such, fewer scaled or spectral-matched time histories are necessary to accurately estimate, for example, the “average” inelastic response. This benefit does not come without a cost, however, as demonstrated in the bottom figure above, which shows that the inelastic response to scaled and spectral-matched time histories can be biased (i.e., systematically different) with respect to un-scaled time histories. An alternative to scaling and spectral matching time histories that have been recorded during past earthquakes is to use simulated time histories (e.g., from geophysical finite-fault models of earthquake ruptures). Like scaling and spectral matching, however, the inelastic response to simulated time histories can also be biased with respect to un-scaled recorded time histories; the variability of inelastic response, however, is in some cases smaller for simulated time histories.