Earthquake risk assessment of buildings accounting for human evacuation

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Abstract

A primary goal of earthquake engineering is to protect society from the possible negative consequences of future earthquakes. Conventionally, this goal has been achieved indirectly by reducing seismic damage of the built environment through better building codes, or more comprehensibly, by minimizing seismic risk. However, the effect that building damage has on occupants is not explicitly taken into account while designing infrastructure. Consequently, this paper introduces a conceptual framework and numerical algorithm to assess earthquake risk on building occupants during seismic events, considering the evacuation process of the structure. The framework combines probabilistic seismic hazard analysis, inelastic structural response analysis and damage assessment, and couples these results with the response of evacuating agents. The results are cast as probability distributions of variables that measure the overall performance of the system (e.g., evacuation times, number of injured people, and repair costs) for specific time windows. As a testbed, the framework was applied to the response of a reinforced concrete frame building that exemplifies the use of all steps of the methodology. The results suggest that this seismic risk evaluation framework of structural systems that combine the response of a physical model with human agents can be extended to a wide variety of other situations, including the assessment of mitigation actions in communities and people to improve their earthquake resilience.

Keywords: Agent-based modeling||Evacuation model||human-structure interaction||performance-based engineering||risk assessment
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