

Seismic Assessment of Buildings, Considering Post-Earthquake Safety

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Advanced Seismic Assessment Guidelines, developed by researchers at Stanford University and tested by practitioners, offer improvement over previous methods for seismic evaluation of buildings where post-earthquake safety is a concern. This method allows engineers to quantify expected structural performance in terms of the post-earthquake occupancy classifications “Green Tag,” “Yellow Tag,” and “Red Tag.”

Analytical features of the *Guidelines* include an emphasis on correctly identifying the governing mechanism of nonlinear behavior, practical methods for addressing the effects of strength degradation and residual drift, and a probability-based approach that incorporates uncertainty.

The basic steps of the *Advanced Seismic Assessment* process are as follows:

Step 1: Nonlinear analysis of the intact structure

Step 2: Nonlinear analysis of the damaged structure in several hypothetical damaged conditions

Step 3: Occupancy limit states (Figure 1)

Step 4: Fragility curves for each limit state (Figure 2)

The authors have used this methodology to perform seismic assessments for several buildings in PG&E's utility network. This paper discusses key aspects of three example projects. For each building, PG&E identified seismic performance goals in terms of the post-earthquake occupancy "tagging" required to enable PG&E personnel to safely perform essential duties following an earthquake. In several cases, the method demonstrated that the desired performance can be achieved with a reduced scope of retrofitting compared to previous methods. PG&E has completed retrofit work for some of these buildings, and others are in progress.

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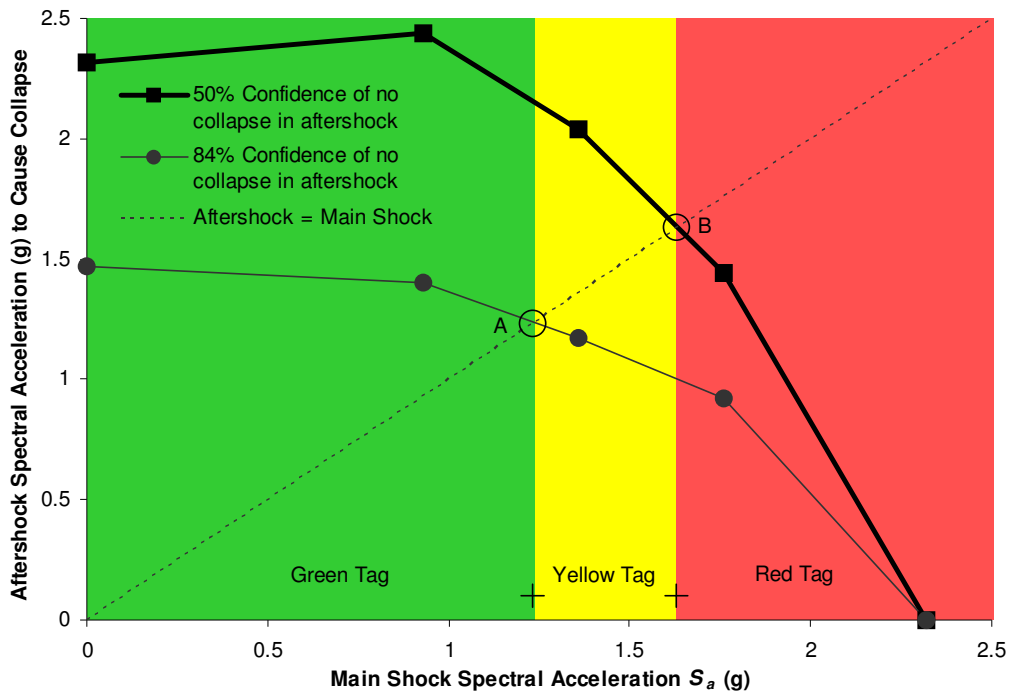


Figure 1. Occupancy limit states. For a given spectral acceleration demand, the building's expected seismic performance level (Green Tag, Yellow Tag, or Red Tag) is based on the capacity of the damaged structure (after an earthquake) to survive an aftershock without collapse. Point A marks the limit state "Onset of Yellow Tag"; point B marks "Onset of Red Tag".

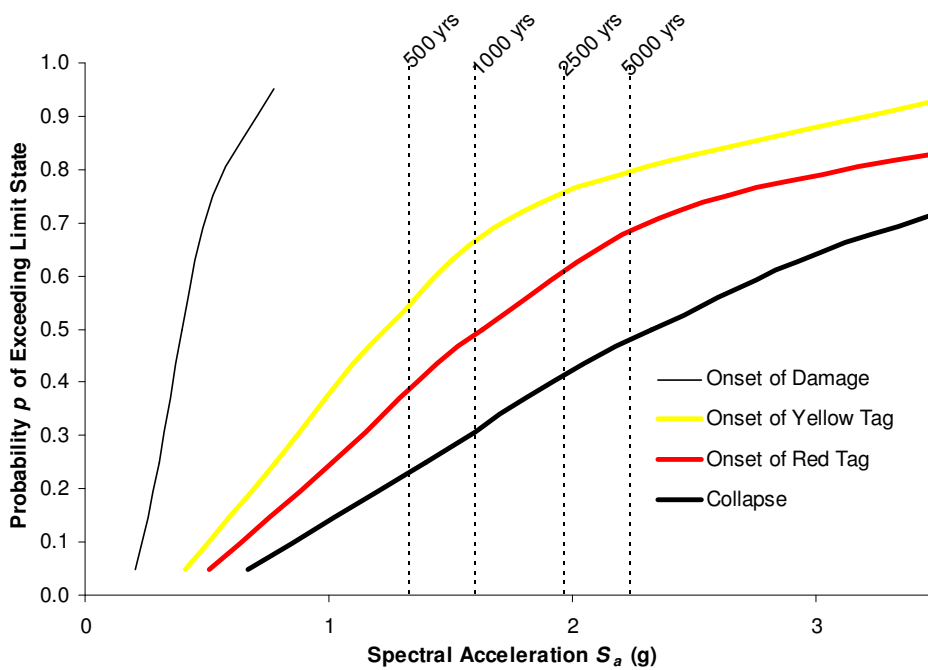


Figure 2. Fragility curves. Median ($p = 50\%$) values of spectral acceleration for each limit state correspond to the ordinates of Figure 1. Steep fragility curves indicate less uncertainty; flatter curves indicate more uncertainty. Earthquake return periods of interest are labeled at the corresponding spectral acceleration values, based on hazard data for the building site.