FEMA P-807 for Soft-Story Retrofits

Technical Considerations for Engineers

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Prescriptive Performance-Based Design: An Innovative Approach to Retrofitting Soft/Weak-Story Buildings (STRUCTURE, September 2019) describes the approach contained in the Federal Emergency Management Agency (FEMA) P-807 guideline. P-807 is a method to retrofit a weak first story of wood buildings to mitigate side-sway pancake-type collapse, as depicted in the *Figure*. The hazard posed by such buildings was underscored by their damage in the 1989 Loma Prieta earthquake affecting the San Francisco Bay area, as well as in the 1994 Northridge earthquake in the Los Angeles region. Some cities in California have enacted ordinances mandating retrofit of soft-story buildings.

Performance-based engineering (PBE) is an evolving paradigm in earthquake engineering in which the goal is to proportion a building to meet specific, predictable performance requirements. The benefits of PBE are generally recognized, but predicting structural performance is challenging. This contrasts with traditional building codes that are mostly prescriptive and do not require explicit performance prediction. Prescriptive design is simpler than PBE.

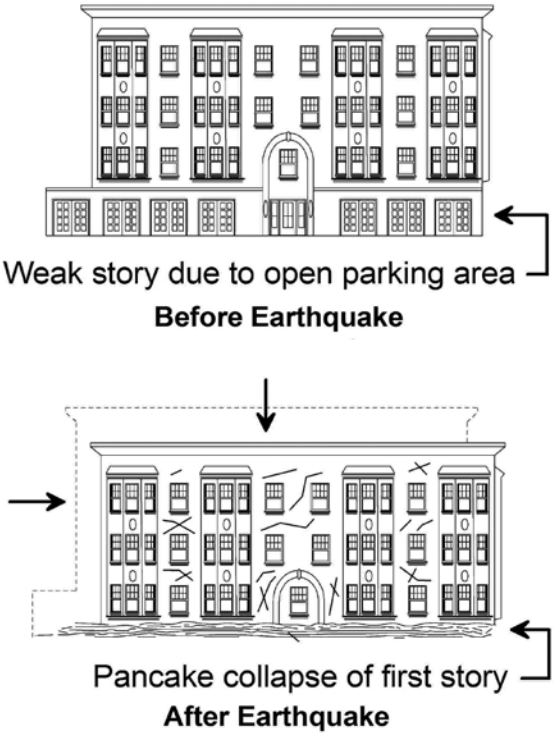
The "prescriptive performance-based design" advocated in the article could be appealing since it suggests the benefits of PBE are within the relative ease of prescriptive design. However, P-807 is a novel approach that quantifies performance in probabilistic terms. Implicit is the notion that the probability associated with actual building response can be estimated with reasonable accuracy. P-807 has not been thoroughly peer-reviewed and, as such, caution must be exercised regarding its use – especially on the efficacy of performance prediction. The shake table experiments mentioned in the article, in fact, *do not* validate P-807. (*Please see reference 2 in the online version of this article for an explanation.*)

It is essential to recognize that P-807 has *not* been vetted through a rigorous ANSI type consensus process typically used in the development of codes and standards. It also lacks a formal mechanism for revision as necessitated by emerging new information. Hence, P-807 is not an industry consensus method and due diligence must be performed before proposing it as an alternative method in building codes.

The author, in conjunction with several other San Francisco Bay Area practicing structural engineers, performed an independent review of P-807. Below is a summary of the technical aspects that engineers should be aware of before deciding on its use.

- Component (e.g., wood structural panel) lateral load-drift relationships (i.e., backbone curves) are not indicative of those expected for wood-frame buildings – most notably by having relatively limited ductility.
- The drift acceptance criteria do not reflect a severe condition such as near-collapse and, hence, do not signify damage states of practical value.
- Using the *default* performance objective can result in first story retrofits having lateral strength *greater* than those from IBC building code for new construction. The default is a 20% probability of exceeding the drift associated with near-collapse under a maximum considered earthquake (20% POE under 100% MCE).
- Using a *relaxed* performance objective such as that in the San Francisco soft-story building retrofit ordinance (30% POE under 50% MCE) can result in first-story retrofits having lateral strength *smaller* than that from traditional retrofit practice (e.g., 75% code per IEBC Appendix Chapter A4).
- It used a single suite of earthquake ground motions to account for all site classes (rock, soil, etc.), and, as a consequence, P-807 is likely to overestimate the ruggedness of buildings located on soil sites (near-collapse probability too low).

It was concluded that P-807 might be an efficient methodology for relative ranking and selection of retrofit designs, but it has questionable accuracy for predicting actual building performance within a PBE context. That is, it cannot reliably compute the probability that a particular seismic intensity will result in a meaningful state of damage for a specific building. Engineers are encouraged to read references 6 and 7 in the online version of this article that serves as the basis of the brief summary presented here.▪



Depiction of a collapse mechanism for a San Francisco type 1920s soft-story apartment building.

The online version of this article contains references. Please visit **www.STRUCTUREmag.org**.

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