

Study of Building Collapse for Performance-Based Design Validation

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This paper summarizes the 2007 EERI/FEMA NEHRP Professional Fellowship project executed by the first author under supervision of the latter two authors. Project description follows.

Performance-based design is evolving as the preferred way for engineering of the built environment, especially for rehabilitation of existing structures. It is a preeminent subject within the U.S. earthquake engineering community, and guidelines are under development (e.g., the recently published ASCE 41-06, and the ongoing ATC-58 project).

Guidelines typically include a Collapse Prevention performance level evaluated using prescriptive computer-based methodology (modeling rules, analysis procedures and acceptance criteria). These implicitly contain significant engineering judgment because few (if any) actual building collapse experiments have been performed. It is essential that methods designed to characterize collapse be benchmarked against experiment to verify their efficacy. The project validates performance-based methodology by correlative study with Japanese building collapse experiments. Key questions addressed are:

- How well do current and proposed methods describe actual collapse?
- Do certain methods consistently predict a collapse-safe situation where experiments indicate otherwise (or vice versa)?
- Are there practical improvements to the methods given the findings from the correlative study exercise?

Steel moment-frame structures that were tested to collapse were used as case study buildings: 2-story specimens tested in 2006 at Kyoto University, and 4-story building tested in 2007 at Japan's new E-Defense shake table.

The following Performance-Based Engineering references were investigated.

- ASCE Standard 41-06: *Seismic Rehabilitation of Existing Buildings*.
- FEMA-351: *Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings*.
- Concepts emerging from ATC-58 and ATC-63 projects.

Collapse was evaluated numerous ways using the above methodologies, and the results compared against:

- Each other (e.g., ASCE 41-06 vs. FEMA 356, etc.).
- Results from studies performed by the Japanese using research-type analysis techniques (e.g., ABAQUS computer program).
- Observed collapse behaviors from experiments.

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