ATC 134 - BENCHMARKING ASCE 41
PREDICTED PERFORMANCE TO
OBSERVED PERFORMANCE

R. Berkowitz

ABSTRACT

The goal of the ATC 134 project is to conduct an objective comparison of the evaluation and assessment procedures contained in ASCE/SEI 41 in relation to other design and evaluation standards and to data recorded for reinforced concrete buildings. The project will consider both the current standard, ASCE/SEI 41-13, and recently published ASCE/SEI 41-17. A group of six to eight buildings will be studied in the project - two structures that have been tested on shake tables, and the remaining structures selected from buildings damaged by major earthquakes. The structures will be evaluated using the Tier 3 analysis methods of ASCE 41 including nonlinear dynamic, nonlinear static, linear static, and linear dynamic procedures. A subset of the buildings will be further evaluated using the procedures of ATC 78, Eurocode 8, ATC 58, and the New Zealand Society for Earthquake Engineering seismic evaluation document to compare the damage estimates predicted to those of ASCE 41. The findings of the study will be used to highlight areas for possible future study to improve the predicted performance of buildings for future versions of ASCE 41.

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ATC 134 Project Director

ATC 134 - Benchmarking ASCE 41 Predicted Performance to Observed Performance

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Introduction


ASCE/SEI 41 is the current standard for evaluating existing buildings in the United States; however, there has not been a systematic benchmarking that illustrates how accurately ASCE/SEI 41 predicts actual damage levels that could be realized under strong shaking, which is part of what the evaluation process is intended to determine. This project aims to evaluate the accuracy of the assessment process for existing concrete buildings subjected to strong earthquake ground motions. In addition to ASCE/SEI 41, other evaluation methodologies will be reviewed to compare how they address performance-based building assessment of existing buildings.

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Current Assessment Methodologies and Standards

The first task of the ATC 134 project is to conduct a literature review to identify the current state-of-knowledge in the United States and internationally, in relation to performance-based assessment of existing buildings. A short summary will be prepared for each assessment methodology or standard identified that outlines the source of information, briefly describes the analysis methods, generalized component models and associated parameters, and performance measurements. The documents being reviewed include:

- ASCE/SEI 41-13 and 41-17, Seismic Evaluation and Retrofit of Existing Buildings
- ATC-78, Identification and Mitigation of Non-Ductile Concrete Buildings [3]

In addition to summary information about each methodology, a literature review will be conducted to find published articles documenting overall strengths and weaknesses, comparisons of the identified assessment methodologies, with a focus on recommendations for improving the evaluation methodologies. The findings of these existing comparison studies will be summarized and included in the state-of-the-art document.

Identification of Buildings for Study

The project will study six-to-eight buildings, including a minimum of two reinforced concrete moment frame buildings; a minimum of two reinforced concrete shear wall buildings; a range of building heights from three stories to approximately 20 stories; a minimum of one moment frame designed to US building codes and built prior to 1980; a minimum of one reinforced concrete shear wall building designed to US building codes and built prior to 1980.

The building selection process includes consideration of the following filter criteria:

- Similarity of structural system to those common in the United States.
- Availability of detailed post-event reconnaissance survey data documenting damage
- Availability of detailed building information, e.g., drawings, photos, and design calculations.
- Availability of recorded ground motion data
- Availability of site soil information

Assessment and Evaluation

Each of the buildings selected for study will be assessed using a variety of evaluation methods. Detailed analytical studies will be conducted using the Tier 3 procedures of ASCE 41/SEI,
including nonlinear dynamic, nonlinear static, linear dynamic and linear static. The models will be developed using a combination of commercially available software and OpenSees [7]. The initial models will be developed using the ASCE/SEI 41 modeling and analysis criteria in a “by the book” fashion, such that they follow the requirements as closely as possible. After this initial evaluation, the analytical models will be further modified using component modelling techniques that go beyond what is currently contained in ASCE/SEI 41. The damage inferred from the evaluation results will be compared to the observed damage. To the extent possible, actual recorded ground motions from the locale for actual buildings damaged by shaking, or the ground motions used for testing in the case of shake table results, will be utilized.

Results from different evaluation methods including ATC 78, FEMA P-58, Eurocode 8, and the New Zealand code will also be compared to the ASCE/SEI 41 findings to establish relative accuracies.

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