Seismic Performance Assessment of Buildings

Volume 2 – Implementation Guide

FEMA P-58-2 / September 2012

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Prepared by

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Cover photograph – Collapsed building viewed through the archway of an adjacent building, 1999 Chi-Chi, Taiwan earthquake (courtesy of Farzad Naeim, John A. Martin & Associates, Los Angeles, California).

Preface

In 2001, the Applied Technology Council (ATC) was awarded the first in a series of contracts with the Federal Emergency Management Agency (FEMA) to develop Next-Generation Performance-Based Seismic Design Guidelines for New and Existing Buildings. These projects would become known as the ATC-58/ATC-58-1 Projects. The principal product under this combined 10-year work effort was the development of a methodology for seismic performance assessment of individual buildings that properly accounts for uncertainty in our ability to accurately predict response, and communicates performance in ways that better relate to the decision-making needs of stakeholders.

This report, *Seismic Performance Assessment of Buildings, Volume 2 – Implementation Guide*, is one in a series of volumes that together describe the resulting methodology and its implementation. The procedures are probabilistic, uncertainties are explicitly considered, and performance is expressed as the probable consequences, in terms of human losses (deaths and serious injuries), direct economic losses (building repair or replacement costs), and indirect losses (repair time and unsafe placarding) resulting from building damage due to earthquake shaking. The methodology is general enough to be applied to any building type, regardless of age, construction or occupancy; however, basic data on structural and nonstructural damageability and consequence are necessary for its implementation.

To allow for practical implementation of the methodology, work included the collection of fragility and consequence data for most common structural systems and building occupancies, and the development of an electronic *Performance Assessment Calculation Tool* (PACT) for performing the probabilistic computations and accumulation of losses. The purpose of this *Volume 2 –Implementation Guide* is to provide users with step-by-step guidance in the development of basic building information, response quantities, fragilities, and consequence data used as inputs to the methodology.

This work is the result of more than 130 consultants involved in the development of the methodology and underlying procedures, collection of available fragility data, estimation of consequences, development of supporting electronic tools, implementation of quality assurance procedures, and beta testing efforts. ATC is particularly indebted to the leadership of

Ron Hamburger, who served as Project Technical Director, John Hooper and Craig Comartin, who served as Risk Management Products Team Leaders, Andrew Whittaker, who served as Structural Performance Products Team Leader, Bob Bachman, who served as Nonstructural Performance Products Team Leader, and the members of the Project Management Committee, including John Gillengerten, Bill Holmes, Peter May, Jack Moehle, and Maryann Phipps. ATC is also indebted to Andy Merovich, Structural Performance Products Team Member, for his lead role in the development of this volume.

ATC would also like to thank the members of the Project Steering Committee, the Risk Management Products Team, the Structural Performance Products Team, the Nonstructural Performance Products Team, the Fragility Review Panel, the Validation/Verification Team, and the many consultants who assisted these teams. The names of individuals who served on these groups, along with their affiliations, are provided in the list of Project Participants at the end of this report.

ATC acknowledges the Pacific Earthquake Engineering Research Center (PEER), and its framework for performance-based earthquake engineering, as the technical basis underlying the methodology. In particular, the work of Tony Yang, Jack Moehle, Craig Comartin, and Armen Der Kiureghian, in developing and presenting the first practical application of the PEER framework, is recognized as the basis of how computations are performed and losses are accumulated in the methodology.

Special acknowledgment is extended to C. Allin Cornell and Helmut Krawinkler for their formative work in contributing to risk assessment and performance-based design methodologies, and to whom this work is dedicated.

ATC also gratefully acknowledges Michael Mahoney (FEMA Project Officer) and Robert Hanson (FEMA Technical Monitor) for their input and guidance in the conduct of this work, Ayse Hortacsu for managing the production of this report, and Bernadette Hadnagy, Peter N. Mork, and Laura Samant for ATC report production services.

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