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Review of Past Performance and Further Development of Modeling Techniques for Collapse Assessment of Existing Reinforced Concrete Buildings

NEHRP Consultants Joint Venture
A Partnership of the Applied Technology Council and the Consortium of Universities for Research in Earthquake Engineering



NIST
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Cover photo – Damage to the Four Seasons Apartment Building resulting from the 1964 earthquake in Anchorage, Alaska (courtesy of the Karl V. Steinbrugge Collection, University of California, Berkeley, NISEE, 2013a, with permission).

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By
NEHRP Consultants Joint Venture
*A partnership of the Applied Technology Council and the
Consortium of Universities for Research in Earthquake Engineering*

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Preface

In 2007, the National Institute of Standards and Technology (NIST) awarded the NEHRP Consultants Joint Venture, a partnership of the Applied Technology Council (ATC) and the Consortium of Universities for Research in Earthquake Engineering (CUREE), a National Earthquake Hazards Reduction Program (NEHRP) “Earthquake Structural and Engineering Research” task order contract (SB1341-07-CQ-0019) to conduct a variety of tasks. In 2011, NIST initiated Task Order 11177 entitled “Development of a Collapse Indicator Methodology for Existing Reinforced Concrete Buildings.” The purpose of this project was to initiate the first phase of work related to the development of a methodology for identifying older reinforced concrete buildings that are at risk of collapse, as outlined in NIST GCR 10-917-7, *Program Plan for the Development of Collapse Assessment and Mitigation Strategies for Existing Reinforced Concrete Buildings* (NIST, 2010b).

The first phase of work of the *Program Plan*, documented in this report, included the identification of critical deficiencies, refinement of the list of common deficiencies, and development of collapse mitigation strategies for older reinforced concrete buildings. To facilitate the anticipated analysis program that is envisioned for developing collapse indicators, this phase also included identification of the latest analysis, modeling, and collapse simulation techniques for reinforced concrete components and systems. Because analytical capabilities are rapidly evolving, and the *Program Plan* includes several research initiatives related to improving collapse simulation that won’t be completed for many years, a key strategy in this effort was the conduct of a Collapse Simulation Workshop. In this workshop, leading researchers and practitioners were assembled to review and discuss current state-of-the-art techniques, and to define recommendations for analyzing and simulating degrading response of reinforced concrete systems, which can be used in the near term.

The NEHRP Consultants Joint Venture is indebted to the leadership of Ken Elwood, Project Director, and to the members of the Project Technical Committee, consisting of Jack Baker, Craig Comartin, Bill Holmes, Jack Moehle, and Peter Somers, for their significant contributions in the development of this report and the resulting recommendations. Technical review and comment at key developmental stages of the project were provided by the Project Review Panel, consisting of JoAnn Browning, Greg Deierlein, Jim Jirsa, Laura Lowes, Nico Luco, Terry Lundeen, and Mike Mehrain. The invited experts who attended the Collapse Simulation Workshop

were instrumental in identifying interim techniques for nonlinear collapse simulation included in this report. The names and affiliations of all who contributed to this project are provided in the list of Project Participants.

The NEHRP Consultants Joint Venture also gratefully acknowledges Jack Hayes (NEHRP Director) and Steve McCabe (NEHRP Deputy Director) for their input and guidance in the preparation of this report, Christopher Rojahn and Jon Kiland for ATC project management services, and Bernadette Hadnagy and Amber Houchen for ATC report production services.

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