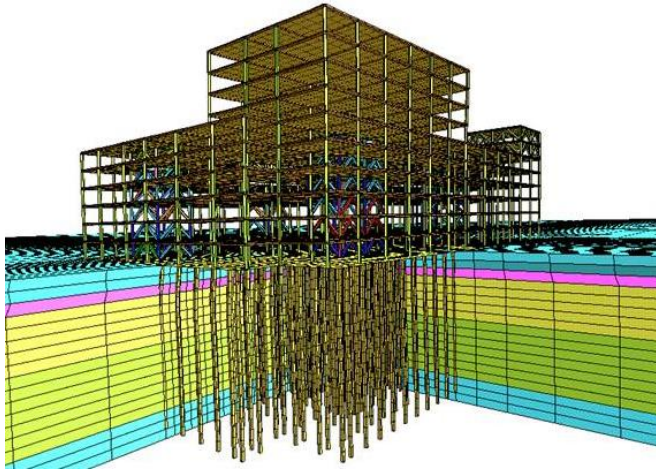


NIST GCR 14-917-27



**Nonlinear Analysis
Research
and Development
Program for
Performance-Based
Seismic Engineering**

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



NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

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Cover image – Soil-structure interaction simulation model (courtesy of M. Willford)

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Prepared for
*U.S. Department of Commerce
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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

The NEHRP Consultants Joint Venture is a partnership between the Applied Technology Council (ATC) and the Consortium of Universities for Research in Earthquake Engineering (CUREE). In 2007, the National Institute of Standards and Technology (NIST) awarded the NEHRP Consultants Joint Venture 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 11174 entitled, “Analysis, Modeling, and Simulation for Performance-Based Seismic Engineering.” The objective of this project was to develop a comprehensive, long-range research and development program to establish best-practice guidelines for practitioners to conduct nonlinear analysis, structural modeling, and computer simulation for seismic applications, and to support the ongoing the development and implementation of performance-based seismic engineering.

This work is an extension of NIST GCR 09-917-2, *Research Required to Support Full Implementation of Performance-Based Seismic Design*, in which several research topics were identified as high-priority in terms of fostering full development and implementation of performance-based seismic engineering. These included: (1) improvement in analytical modeling and demand assessment capabilities for buildings in near-collapse seismic loading; and (2) clarification and coordination in the translation of test results to currently used performance levels.

This project intends to advance the practice of nonlinear dynamic analysis so that it can be used more widely and with more confidence, enabling widespread adoption of performance-based seismic engineering. This entails addressing the gap between state-of-the-art academic research and state-of-the-practice engineering applications of nonlinear analysis, structural modeling, and computer simulation. It also entails improving state-of-the-art techniques to more reliably capture the full range of structural response than is currently possible with methods that are in use today. Taken as a whole, the program presents a suite of initiatives that, if implemented, would improve nonlinear dynamic analysis capabilities, and identify procedures that are suitable and attractive to practitioners, while maintaining levels of accuracy commensurate with research models.

The NEHRP Consultants Joint Venture is indebted to the leadership of Greg Deierlein, Project Director, and to the members of the Project Technical Committee, consisting of Peter Behnam, Finley Charney, Laura Lowes, Jonathan Stewart, and Michael Willford for their contributions in developing this report and the resulting

recommendations. The Project Review Panel, consisting of C.B. Crouse, Jeremy Isenberg, Ali Karakaplan, Michael Korolyk, Bret Lizundia, Graham Powell, and Andrei Reinhorn provided technical review and comment at key developmental milestones during the project. The names and affiliations of all who contributed to this report are provided in the list of Project Participants.

The NEHRP Consultants Joint Venture also gratefully acknowledges Jack Hayes (NEHRP Director), Steve McCabe (NEHRP Deputy Director), and Kevin Wong (NIST Project Manager) for their input and guidance in the preparation of this report, Laura Samant for ATC project management, and Amber Houchen and Bernadette Hadnagy for ATC report production services.

Jon A. Heintz
Program Manager

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