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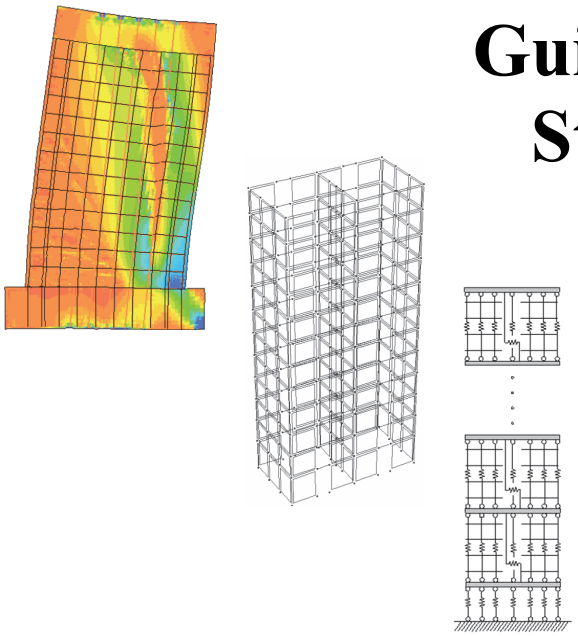

Guidelines for Nonlinear Structural Analysis for Design of Buildings

Part I – General

Applied Technology Council

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Cover image – Illustrative concrete shear wall models showing alternative strategies (Ohmura and Deierlein, 2010).

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Guidelines for Nonlinear Structural Analysis and Design of Buildings

Part I – General

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Preface

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In September 2014, the Applied Technology Council (ATC) commenced a task order project under National Institute of Standards and Technology (NIST) Contract SB1341-13-CQ-0009 to develop guidance for nonlinear dynamic analysis (ATC-114 Project). The need for such guidance is identified as high-priority research and development topic (Proposed Research Initiative 6) in NIST GCR 14-917-27 report, *Nonlinear Analysis Research and Development Program for Performance-Based Seismic Engineering* (NIST, 2013), which outlines a research and development program for addressing the gap between state-of-the-art academic research and state-of-practice engineering applications for nonlinear structural analysis, analytical structural modeling, and computer simulation in support of performance-based seismic engineering. In addition, the NIST GCR 09-917-2 report, *Research Required to Support Full Implementation of Performance-Based Seismic Design* (NIST, 2009), also identified the need to improve analytical models for buildings and their components in near-collapse seismic loading.

To help fill this gap, the ATC-114 Project developed a series of reports that provide general nonlinear modeling and nonlinear analysis guidance, as well as guidance specific to the following two structural systems: structural steel moment frames and reinforced concrete moment frames. This *Part I Guidelines* document is the first in the series and provides general guidance. The companion *Part II Guidelines* (NIST GCR 17-917-46v2 and 17-917-46v3) provide further details for steel moment frame and reinforced moment frame systems, respectively. It is envisioned that these *Guidelines* will be used in conjunction with available performance-assessment provisions, or their equivalent, that are appropriate for the specific circumstances.

This *Part I Guidelines* document was developed by the members of the ATC-114 Phase 2 (*Steel Moment Frames*) and ATC-114 Phase 3 (*Reinforced Concrete Moment Frames*) project teams. ATC is indebted to the leadership of Greg Deierlein and Curt Haselton, who served as Project Directors of Phase 2 and 3, respectively. The Project Technical Committee of Phase 2 and 3, consisting of Stephen Bono, Wassim Ghannoum, Mahmoud Hachem, John Hooper, Jim Malley, Silvia Mazzoni, Santiago Pujol, and Chia-Ming Uang monitored and guided the technical efforts of the Project Working Groups, which included Dustin Cook, Ian McFarlane, Gulen Ozkula, Hee Jae Yang, and Zhi Zhou. The Project Review Panel, consisting of Tony Ghodsi, Jerry Hajjar, Yuli Huang, Mike Mehrain, Farzad Naeim, Charles Roeder, Tom Sabol, Mark Saunders, John Wallace, and Kent Yu (ATC Board Representative) provided

technical advice and consultation over the duration of the work. The names and affiliations of all who contributed to this report are provided in the list of Project Participants.

ATC also gratefully acknowledges Steven L. McCabe (Contracting Officer's Representative), Jay Harris, Siamak Sattar, Matthew Speicher, and Kevin Wong for their input and guidance throughout the project development process. ATC staff members Veronica Cedillos and Carrie Perna provided project management support and report production services, respectively.

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