Quantification of Building Seismic Performance Factors

Prepared by

APPLIED TECHNOLOGY COUNCIL
201 Redwood Shores Parkway, Suite 240
Redwood City, California 94065
www.ATCouncil.org

Prepared for

FEDERAL EMERGENCY MANAGEMENT AGENCY
Michael Mahoney, Project Officer
Robert D. Hanson, Technical Monitor
Washington, D.C.

FEMA

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Preface

In September 2004 the Applied Technology Council (ATC) was awarded a "Seismic and Multi-Hazard Technical Guidance Development and Support" contract (HSFEHQ-04-D-0641) by the Federal Emergency Management Agency (FEMA) to conduct a variety of tasks, including one entitled "Quantification of Building System Performance and Response Parameters" (ATC-63 Project). The purpose of this project was to establish and document a recommended methodology for reliably quantifying building system performance and response parameters for use in seismic design. These factors include the response modification coefficient (R factor), the system overstrength factor (Ω_0), and the deflection amplification factor (C_d), collectively referred to as "seismic performance factors."

Seismic performance factors are used to estimate strength and deformation demands on systems that are designed using linear methods of analysis, but are responding in the nonlinear range. Their values are fundamentally critical in the specification of seismic loading. R factors were initially introduced in the ATC-3-06 report, *Tentative Provisions for the Development of Seismic Regulations for Buildings*, published in 1978, and subsequently replaced by the *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*, published by FEMA. Original R factors were based on judgment or on qualitative comparisons with the known response capabilities of seismic-force-resisting systems in use at the time. Since then, the number of systems addressed in current seismic codes and standards has increased substantially, and their ability to meet intended seismic performance objectives is largely unknown.

The recommended methodology described in this report is based on a review of relevant research on nonlinear response and collapse simulation, benchmarking studies of selected structural systems, and evaluations of additional structural systems to verify the technical soundness and applicability of the approach. Technical review and comment at critical developmental stages was provided by a panel of experts, which included representatives from the steel, concrete, masonry and wood material industry groups. A workshop of invited experts and other interested stakeholders was convened to receive feedback on the recommended methodology, and input from this group was instrumental in shaping the final product.

ATC is indebted to the leadership of Charlie Kircher, Project Technical Director, and to the members of the ATC-63 Project Team for their efforts in the development of this recommended methodology. The Project Management Committee, consisting of Michael Constantinou, Greg Deierlein, Jim Harris, John Hooper, and Allan Porush monitored and guided the technical efforts of the Project Working Groups, which included Andre Filiatrault, Helmut Krawinkler, Kelly Cobeen, Curt Haselton, Abbie Liel, Jiannis Christovasilis, Jason Chou, Stephen Cranford, Brian Dean, Kevin Haas, Jiro Takagi, Assawin Wanitkorkul, and Farzin Zareian. The Project Review Panel, consisting of Maryann Phipps (Chair), Amr Elnashai, S.K. Ghosh, Ramon Gilsanz, Ron Hamburger, Jack Hayes, Rich Klingner, Phil Line, Bonnie Manley, Andrei Reinhorn, and Rafael Sabelli 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.

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Jon A. Heintz
ATC Director of Projects

Christopher Rojahn
ATC Executive Director

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