Quantification of Building Seismic Performance Factors

ATC-63 Project Report - 90% Draft

FEMA P695 / April 2008

FEMA

nehrp

Quantification of Building Seismic Performance Factors

ATC-63 Project Report - 90% Draft

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.

April 22, 2008

FEMA

Notice

Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of the Department of Homeland Security's Federal Emergency Management Agency (FEMA) or the Applied Technology Council (ATC). Additionally, neither ATC, DHS, FEMA, nor any of their employees makes any warranty, expressed or implied, nor assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process included in this publication. Users of information from this publication assume all liability arising from such use.

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 is to establish and document a recommended methodology for reliably quantifying building system performance and response parameters for use in seismic design. A key parameter to be addressed is the response modification coefficient (*R* factor), but related design parameters such as the system overstrength factor (Ω_0) and deflection amplification factor (C_d) are also addressed. Collectively these factors are referred to as "Seismic Performance Factors".

R factors are used to estimate strength demands on systems that are designed using linear methods 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 largely on judgment and on qualitative comparisons with the known response capabilities of relatively few lateral-force resisting systems in use at the time. Since then, the number of systems addressed in current seismic codes and the most recent edition of the *NEHRP Recommended Provisions* has increased substantially. The potential response characteristics of these recently defined systems, and their ability to meet seismic design performance objectives, are both untested and unknown.

The recommended methodology described in this report is a refinement of an earlier preliminary version of the methodology. It is based on a review of relevant research on nonlinear response and collapse simulation, benchmarking studies of selected structural systems, feedback from an expanded group of experts and potential users, and evaluations of additional structural systems to verify the technical soundness and applicability of the approach.

ATC is indebted to the members of the ATC-63 Project Team for their efforts in the technical development of the recommended methodology, and to the leadership of Charlie Kircher, Project Technical Director. 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, Jianis Christovasilis, Jason Chou, Stephen Cranford, Brian Dean, Kevin Haas, Jiro Takagi, Assawin Wanitkorkul, and Farzin Zareian. The affiliations of these individuals are provided in the list of Project Participants.

ATC also gratefully acknowledges Michael Mahoney (FEMA Project Officer), Robert Hanson (FEMA Technical Monitor), and William Holmes (ATC Project Technical Monitor) for their input and guidance in the preparation of this report, Peter N. Mork for ATC report production services, and Ramon Gilsanz as ATC Board Contact.

Jon A. Heintz
ATC Director of Projects

Christopher Rojahn
ATC Executive Director

Table of Contents

List of Figures