



NEHRP Seismic Design Technical Brief No. 1



Seismic Design of Reinforced Concrete Special Moment Frames: A Guide for Practicing Engineers

Jack P. Moehle
John D. Hooper
Chris D. Lubke

Disclaimers

The policy of the National Institute of Standards and Technology is to use the International System of Units (metric units) in all of its publications. However, in North America in the construction and building materials industry, certain non-SI units are so widely used instead of SI units that it is more practical and less confusing to include measurement values for customary units only.

This report was prepared for the Building and Fire Research Laboratory of the National Institute of Standards and Technology under contract number SC134107CQ0019, Task Order 68003. The statements and conclusions contained in this report are those of the authors and do not imply recommendations or endorsements by the National Institute of Standards and Technology.

This Technical Brief was produced under contract to NIST by the NEHRP Consultants Joint Venture, a joint venture of the Applied Technology Council (ATC) and the Consortium of Universities for Research in Earthquake Engineering (CUREE). While endeavoring to provide practical and accurate information in this publication, the NEHRP Consultants Joint Venture, the authors, and the reviewers do not assume liability for, nor make any expressed or implied warranty with regard to, the use of its information. Users of the information in this publication assume all liability arising from such use.

Cover photo – Reinforced concrete special moment frame under construction.

Seismic Design of Reinforced Concrete Special Moment Frames: A Guide for Practicing Engineers

Prepared for
*U.S. Department of Commerce
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600*

By
Jack P. Moehle, Ph.D., P.E.
Department of Civil and Environmental Engineering
University of California, Berkeley

John D. Hooper, P.E., S.E.
Magnusson Klemencic Associates
Seattle, Washington

Chris D. Lubke, P.E.
Magnusson Klemencic Associates
Seattle, Washington

August, 2008



U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

National Institute of Standards and Technology
James M. Turner, Deputy Director

NEHRP Seismic Design Technical Briefs

NEHRP (National Earthquake Hazards Reduction Program) Technical Briefs are published by NIST, the National Institute of Standards and Technology, as aids to the efficient transfer of NEHRP and other research into practice, thereby helping to reduce the nation's losses from earthquakes.

NIST National Institute of Standards and Technology

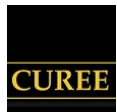
The National Institute of Standards and Technology (NIST) is a federal technology agency within the U.S. Department of Commerce that promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. It is the lead agency of the National Earthquake Hazards Reduction Program (NEHRP). Dr. John (Jack) R. Hayes is the Director of NEHRP, within NIST's Building and Fire Research Laboratory (BFRL).

NEHRP Consultants Joint Venture

This NIST-funded publication is one of the products of the work of the NEHRP Consultants Joint Venture carried out under Contract SB 134107CQ0019, Task Order 68003. The partners in the NEHRP Consultants Joint Venture are the Applied Technology Council (ATC) and the Consortium of Universities for Research in Earthquake Engineering (CUREE). The members of the Joint Venture Management Committee are James R. Harris, Robert Reitherman, Christopher Rojahn, and Andrew Whittaker, and the Program Manager is Jon A. Heintz.



Applied Technology Council (ATC)
201 Redwood Shores Parkway - Suite 240
Redwood City, California 94065
(650) 595-1542
www.atccouncil.org email: atc@atccouncil.org



**Consortium of Universities for Research in
Earthquake Engineering (CUREE)**
1301 South 46th Street - Building 420
Richmond, CA 94804
(510) 665-3529
www.curee.org email: curee@curee.org

About The Authors

Jack P. Moehle, Ph.D., P.E. is Professor of Civil and Environmental Engineering at the University of California, Berkeley, where he teaches and conducts research on earthquake-resistant concrete construction. He is a Fellow of the American Concrete Institute and has served on the ACI Code Committee 318 for 19 years, including 13 years as the chair of the seismic subcommittee. He is an Honorary Member of the Structural Engineers Association of Northern California.

John D. Hooper, P.E., S.E., is Director of Earthquake Engineering at Magnusson Klemencic Associates, a structural and civil engineering firm headquartered in Seattle, Washington. He is a member of the Building Seismic Safety Council's 2009 Provisions Update Committee and chair of the American Society of Civil Engineers Seismic Subcommittee for ASCE 7-10.

Chris D. Lubke, P.E., is a Design Engineer with Magnusson Klemencic Associates, a structural and civil engineering firm headquartered in Seattle, Washington. He is the firm's in-house reinforced concrete moment frame specialist, and has experience designing a number of building types, including laboratories, high-rise office and residential towers, and convention centers.

About the Review Panel

The contributions of the three review panelists for this publication are gratefully acknowledged.

John A. Martin, Jr., structural engineer, is the president of John A. Martin and Associates in Los Angeles, California. He is responsible for the firm's structural design and production services to clients and is a Fellow of the American Concrete Institute.

Sharon L. Wood is the Robert L. Parker, Sr. Centennial Professor in Engineering in the Department of Civil, Architectural, and Environmental Engineering at the University of Texas at Austin. She is the Director of the University's Ferguson Structural Engineering Laboratory, a member of the Structural Concrete Building Code Committee of the American Concrete Institute, and an ACI Fellow.

Loring A. Wyllie, Jr. is a structural engineer and principal of Degenkolb Engineers in San Francisco, California. He is the 2007 recipient of the American Society of Civil Engineers Outstanding Projects and Leaders (OPAL) design award. He is a past president of the Structural Engineers Association of California and the Earthquake Engineering Research Institute. He is a member of the Structural Concrete Building Code Committee of the American Concrete Institute and an Honorary Member of ACI.

How to Cite This Publication

Moehle, Jack P., Hooper, John D., and Lubke, Chris D. (2008). "Seismic design of reinforced concrete special moment frames: a guide for practicing engineers," *NEHRP Seismic Design Technical Brief No. 1*, produced by the NEHRP Consultants Joint Venture, a partnership of the Applied Technology Council and the Consortium of Universities for Research in Earthquake Engineering, for the National Institute of Standards and Technology, Gaithersburg, MD., NIST GCR 8-917-1

Contents

1. Introduction.....	1
2. The Use of Special Moment Frames.....	2
3. Principles for Design of Special Moment Frames.....	4
4. Analysis Guidance.....	6
5. Design Guidance.....	8
6. Additional Requirements.....	19
7. Detailing and Constructability Issues.....	21
8. References.....	24
9. Notation and Abbreviations.....	25
10. Credits.....	27