Earthquake Protection of Building Equipment and Systems

BRIDGING THE IMPLEMENTATION GAP

Jeffrey A. Gatscher
Gary L. McGavin, AIA
Philip J. Caldwell

With a foreword by
James R. Harris, Ph.D., P.E.

ASCE PRESS

Earthquake Protection of Building Equipment and Systems

Other Titles of Interest

Earthquakes and Engineers: An International History, by Robert K. Reitherman (ASCE Press, 2012). Provides the first comprehensive treatment of the engineering techniques that have developed in various countries to address their particular seismic problems. (ISBN 978-0-7844-1071-4)

Guidelines for Seismic Evaluation and Design of Petrochemical Facilities, Task Committee on Seismic Evaluation and Design, ASCE Energy Division (ASCE Technical Report, 2011). Offers practical recommendations regarding the design and safety of petrochemical facilities during and following an earthquake. (ISBN 978-0-7844-1140-7)

Recommendations for Seismic Design of Hybrid Coupled Wall Systems, edited by Sherif El-Tawil, Patrick Fortney, Kent Harries, Bahram Sharooz, Yahya Kurama, Mohammad Hassan, and Xiandoing Tong (ASCE Technical Report, 2010). Synthesizes the existing information into helpful recommendations for engineers and practitioners involved with seismic analysis and design of hybrid coupled wall systems. (ISBN 978-0-7844-1060-8)

Seismic Loads: Guide to the Seismic Load Provisions of ASCE 7-05, by Finley A. Charney (ASCE Press, 2010). Illustrates key concepts and guides structural engineers in applying the most current thinking in this rapidly changing discipline to the design of new structures. (ISBN 978-0-7844-1076-9)

Earthquake Protection of Building Equipment and Systems

Bridging the Implementation Gap

Jeffrey A. Gatscher

Gary L. McGavin, AIA

Philip J. Caldwell

ASCE PRESS

Library of Congress Cataloging-in-Publication Data

Gatscher, Jeffrey A.
Earthquake protection of building equipment and systems : bridging the implementation gap / Jeffrey A. Gatscher, Gary L. McGavin, Philip J. Caldwell.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-7844-1152-0 (pbk. : alk. paper) — ISBN 978-0-7844-7643-7 (ebook)
1. Buildings—Earthquake effects. 2. Buildings—Mechanical equipment. I. McGavin, Gary L., 1948– II. Caldwell, Philip J. III. American Society of Civil Engineers. IV. Title.
TH1095.G38 2012
693.8′52—dc23

2011042505

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191
www.asce.org/pubs

ISBN 978-0-7844-1152-0 (paper)
ISBN 978-0-7844-7643-7 (e-book)
Manufactured in the United States of America.

18 17 16 15 14 13 12 11 1 2 3 4 5

This book is dedicated to the many people who have suffered hardship, affliction, or bereavement caused by earthquake disasters. May their losses not soon be forgotten.

This page intentionally left blank

Contents

Part 2: Nonstructural Capacity

Foreword

Earthquake engineering for buildings has seen tremendous change over the past several decades. Earthquake after earthquake has demonstrated the insufficiency of our knowledge and ability to protect people in buildings, let alone our ability to provide buildings in which key systems are functional following the earthquake. As new lessons have been learned in the aftermath of damaging earthquakes and in the laboratory, substantial efforts have been made to improve our standards of practice and model building codes. The majority of people who work on these standards are structural engineers, although several seismologists and geotechnical engineers, plus a few architects and mechanical and electrical engineers, work with those structural engineers. Interdisciplinary communication is not easy, and the authors of this book are among those few who have attempted to bridge the gaps and improve the treatment of nonstructural portions of buildings. For that alone Gatscher, McGavin, and Caldwell deserve commendation. Their work in this book is yet another excellent contribution.

This book fills a serious void in the earthquake engineering literature: it illustrates the importance of a true systems analysis approach in providing equipment that will perform as desired in buildings, especially equipment in those systems expected to be in working condition immediately following the earthquake. The book goes far beyond traditional concerns with anchorage and bracing of switchgear, pumps, fans, conduits, pipes, ducts, and the like. It provides the guidance that has been so sorely missing for engineers involved in product design; in fact, it highlights the importance of including seismic resistance concepts in the initial planning and design of equipment before bringing it to market.

After defining the kinds of nonstructural components and systems included in buildings and describing common problems with performance in past earthquakes, the authors go back to the beginning with an admirable briefing on the mechanics of earthquakes. They offer a concise but well-detailed description of the seismic demands on nonstructural systems and components found in the most current building codes. In describing the building code provisions, the authors make serious attempts to explain the why behind the what. This content is especially valuable because the competent professional needs solid understanding of the intent in order to adapt terse code rules to real-life situations. The second half of the book offers excellent guidance for equipment designers, code