2012 IBC®

SEAOC STRUCTURAL/SEISMIC DESIGN MANUAL

Volume 2

EXAMPLES FOR LIGHT-FRAME, TILT-UP,
AND MASONRY BUILDINGS

Copyright

Publisher

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> To advance the structural engineering profession; to provide the public with structures of dependable performance through the application of state-of-the-art structural engineering principles; to assist the public in obtaining professional structural engineering services; to promote natural hazard mitigation; to provide continuing education and encourage research; to provide structural engineers with the most current information and tools to improve their practice; and to maintain the honor and dignity of the profession.

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Editor

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Suggestions for Improvement

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Errata Notification

SEAOC has made a substantial effort to ensure that the information in this document is accurate. In the event that corrections or clarifications are needed, these will be posted on the SEAOC web site at *www.seaoc.org* and on the ICC web site at *www.iccsafe.org*.

SEAOC, at its sole discretion, may issue written errata.

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Preface to the 2012 *IBC SEAOC Seismic/Structural Design Manual*

The *IBC SEAOC Seismic/Structural Design Manual*, throughout its many editions, has served the purpose of illustrating good seismic design and the correct application of building-code provisions. The manual has bridged the gap between the discursive treatment of topics in the SEAOC Blue Book (*Recommended Lateral Force Requirements and Commentary*) and real-world decisions that designers face in their practice.

The examples illustrate code-compliant designs engineered to achieve good performance under severe seismic loading. In some cases simply complying with building-code requirements does not ensure good seismic response. This manual takes the approach of exceeding the minimum code requirements in such cases, with discussion of the reasons for doing so.

Recent editions of the *IBC SEAOC Seismic/Structural Design Manual* have consisted of updates of previous editions, modified to address changes in the building code and referenced standards. Many of the adopted standards did not change between the 2006 edition of the *International Building Code* and the 2009 edition. The 2012 edition, which is the one used in this set of manuals, represents an extensive change of adopted standards, with many substantial changes in methodology.

Additionally, this edition has been substantially revised. New examples have been included to address new code provisions and new systems, as well as to address areas in which the codes and standards provide insufficient guidance. Important examples such as the design of base-plate anchorages for steel systems and the design of diaphragms have been added.

This expanded edition comprises five volumes:

- Volume 1: Code Application Examples
- Volume 2: Examples for Light-Frame, Tilt-Up, and Masonry Buildings
- Volume 3: Examples for Reinforced Concrete Buildings
- Volume 4: Examples for Steel-Framed Buildings
- Volume 5: Examples for Seismically Isolated Buildings and Buildings with Supplemental Damping

Previous editions have been three volumes. This expanded edition contains more types of systems for concrete buildings and steel buildings. These are no longer contained in the same volume. Volumes 3 and 4 of the 2012 edition replace Volume 3 of the 2009 edition. Additionally, we have fulfilled the long-standing goal of including examples addressing seismic isolation and supplemental damping. These examples are presented in the new Volume 5.

In general, the provisions for developing the design base shear, distributing the base-shear-forces vertically and horizontally, checking for irregularities, etc., are illustrated in Volume 1. The other volumes contain more extensive design examples that address the requirements of the material standards (for example, ACI 318 and AISC 341) that are adopted by the IBC. Building design examples do not illustrate many of the items addressed in Volume 1 in order to permit the inclusion of less-redundant content.

Each volume has been produced by a small group of authors under the direction of a manager. The managers have assembled reviewers to ensure coordination with other SEAOC work and publications, most notably the Blue Book, as well as numerical accuracy.

This manual can serve as valuable tool for engineers seeking to design buildings for good seismic response.

Rafael Sabelli
Project Manager

Preface to Volume 2

Volume 2 of the 2012 *IBC SEAOC Structural/Seismic Design Manual* addresses the design of light-frame, concrete tilt-up, and masonry shear wall building systems for seismic loading. These include the illustration of the design requirements for the shear walls and diaphragms, as were illustrated in previous editions, and also important interfaces with the rest of the structure.

The design examples in this volume represent a range of structural systems and seismic systems. The design of each of these systems is governed by standards developed by the American Concrete Institute (ACI) and the American Wood Council (AWC). The methods illustrated herein represent approaches consistent with the ductility expectations for each system and with the desired seismic response. In most cases there are several details or mechanisms that can be utilized to achieve the ductility and resistance required, and the author of each example has selected an appropriate option. In many cases alternatives are discussed. This manual is not intended to serve as a building code, or to be an exhaustive catalogue of all valid approaches and details.

This manual is presented as a set of examples in which the engineer has considered the building-code requirements in conjunction with the optimal seismic response of the system. The examples follow the guidelines of the SEAOC Blue Book and other SEAOC recommendations. The examples are intended to aid conscientious designers in crafting designs that are likely to achieve good seismic performance consistent with expectations inherent in the requirements for the systems.

Four examples have been included in past editions of this manual and are updated in this edition: four-story wood light-frame structure, light-gage framed building on podium structure, masonry shear wall building, and tilt-up building with windows. One example—wood diaphragm—is new and is included in this edition of the manual.

Douglas Thompson
Volume 2 Manager

Acknowledgements

Volume 2 of the 2012 *IBC SEAOC Seismic/Structural Design Manual* was written by a group of highly qualified structural engineers, chosen for their knowledge and experience with structural engineering practice and seismic design. The authors are:

Douglas S. Thompson, S.E., S.E.C.B. – Volume Manager and Example 1
Doug Thompson has over 35 years of experience in designing of wood structures. He is author several publications in timber design including the WoodWorks publications*: Four-story Wood-frame Structure over Podium Slab* and *Five-story Wood-frame Structure over Podium Slab*. Doug has instructed license review classes in timber design for the PE and SE exams for 20 years. He is the 2013-2014 president of the Structural Engineers Association of Southern California and holds licenses in six states. www.stbse.com

John Lawson, S.E. – Examples 2 and 5
Assistant Professor John Lawson has provided structural engineering consulting services for over 30 years, including overseeing more than 100 million square feet of low-sloped roof and tilt-up concrete engineering. He now teaches in the Architectural Engineering department at California Polytechnic State University in San Luis Obispo. John is the recipient of the 2006 Tilt-up Concrete Association's David L. Kelly Distinguished Engineer Award. www.arce.calpoly.edu

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Michael Cochran is an Associate Principal with Weidlinger Associates, Inc. in Marina del Rey, California, with over 25 years of design experience. He has an extensive background in the design of multi-story light-framed commercial and multifamily residential wood and cold-formed steel-stud buildings. He is a registered structural engineer in California, an active member of the AISC Connection Prequalification Review Panel, a past president of the Structural Engineers Association of Southern California (SEAOSC), and incoming 2013-2014 president for the Structural Engineers Association of California.

Jeff Ellis, S.E. – Example 3
Manager of Codes, Standards, and Special Projects for Simpson Strong-Tie Company Inc., he has more than 22 years of experience in the construction industry. Mr. Ellis manages the company code and standards involvement as well as code reports. Additionally, he is involved in product development and offers technical guidance to customers for connectors, fastening systems, and lateral systems. He was a practicing design engineer for commercial, residential, and forensic projects for more than nine years prior to joining Simpson Strong-Tie at the end of 2000. He has served on the Board of Directors for SEAOSC, as chair of the 2011 and 2012 SEAOSC Buildings At Risk Summit, as chair of the AISI COFS Lateral Design Subcommittee, as president of the CFSEI and authored the Cold-Formed Steel Engineers Institute's (CFSEI) *Design Guide: Cold-Formed Steel Framed Wood Panel or Steel Sheet Sheathed Shear Wall Assemblies.*

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Additionally, a number of SEAOC members and other structural engineers helped check the examples in this volume. During its development, drafts of the examples were sent to these individuals. Their help was sought in review of code interpretations as well as detailed checking of the numerical computations. The reviewers include:

James Lai, S.E.

Alan Robinson, S.E.

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