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The Structural Engineers Association of California (SEAOC) is a professional association of four regional member organizations (Southern California, Northern California, San Diego, and Central California). SEAOC represents the structural engineering community in California. This document is published in keeping with SEAOC's stated mission:

> Empower our members and Member Organizations to advance the people, practice, and position of structural engineering.

Editor

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Suggestions for Improvement

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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 website at www.seaoc.org and on the ICC website at www.iccsafe.org.

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

Contents

IBC® SEAOC Structural/Seismic Design Manual

The *IBC® SEAOC Structural/Seismic 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 and engineers 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 may not ensure good seismic response. This manual presents various methods and procedures that extend beyond what one might use to comply with minimum code requirements and discussion of the reasons for using a specific method or procedure.

This manual comprises four volumes:

- Volume 1: Code Application Examples
- Volume 2: Examples for Light-Frame, Tilt-Up, and Masonry Buildings
- Volume 3: Examples for Concrete Buildings
- Volume 4: Examples for Steel-Framed Buildings

In general, the provisions for developing the design base shear, distributing the base-shear forces vertically and horizontally, checking for irregularities, and so on are illustrated in Volume 1. The other volumes contain more extensive design examples that address the requirements of material standards (for example, ACI 318 and AISC 341) that are adopted by the IBC. Building design examples in material-focused volumes intentionally omit repeating items addressed in Volume 1.

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

This manual is a valuable tool for engineers seeking to design buildings for good seismic response.

Kevin S. Moore, S.E.
Project Manager

Preface to Volume 4

Volume 4 of the 2024 *IBC SEAOC Structural/Seismic Design Manual* addresses the design of steel building systems for seismic loading. Examples include the illustration of the design requirements for braced frames and moment frames, 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 steel structural systems. The *Manual* includes a set of examples that illustrate a more complete design: the design of diaphragms and collectors is illustrated, as are the design of base plates and anchorages for moment-frame and braced-frame columns. With the addition of these items, this edition of the *Manual* offers more extensive guidance to engineers, addressing the design of these critical components of the seismic system.

The design of each of these systems is governed by standards developed by the American Institute of Steel Construction (AISC). AISC produces its own *Seismic Design Manual* to illustrate the correct application of the AISC *Seismic Provisions* (AISC 341) and the AISC *Prequalification Standard* (AISC 358). The AISC *Seismic Design Manual* is a valuable resource for designers, and this volume is not intended to duplicate AISC's efforts. This manual, for example, does not include the detailed range of options for gusset-plate design, as the AISC *Seismic Design Manual* addresses this design aspect thoroughly.

Nevertheless, there is a fundamental difference in purpose and approach between this manual and the AISC *Seismic Design Manual*. The AISC *Manual* illustrates the code requirements, while the SEAOC *Structural/ Seismic Design Manual* illustrates SEAOC's recommended practices, which traditionally have gone beyond the code (or in advance of it). The design examples for base plates are important examples of design methodologies not explicitly defined by building codes. Building code provisions for these connections are difficult to apply and at times do not correspond well to the mechanisms of resistance. The examples herein provide a convenient and valuable alternative methodology, one that is not an illustration of explicit code requirements.

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.

The *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 recommendations 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.

This edition updates the existing examples to reflect important changes in AISC 341, such as a significant revision to the method of determining the compactness of structural steel members used in seismic applications. Several examples have been expanded and revised for clarity and consistency with best practices. Examples are also revised to be consistent with changes in ASCE 7, such as revised irregularity and redundancy criteria. The diaphragm examples have also been revised to utilize the more advanced "alternative method" for diaphragm design. Additionally, recent developments in design guidance for base-plate anchorages are included, both for the special moment frame base plate example and the braced frame (BRBF) base plate example. Finally, a new example illustrating the design of concrete-filled composite plate shear walls (C-PSW/CF) is included.

Rafael Sabelli, S.E.
Volume 4 Manager

Acknowledgments

SEAOC is the author of the *IBC® SEAOC Structural/Seismic Design Manual*. Each edition comes about through the effort of highly qualified structural engineers who contribute their expertise to writing, reviewing and updating design examples to be consistent with best practices for seismic design. Each edition contains new examples as well as revisions to previous examples. As such, it is impractical to consistently assign authorship of examples, as most are the work, in varying degrees, of the original author and multiple later reviewers and revisers. Nevertheless, SEAOC gratefully acknowledges the contributions of these members to this volume over several editions:

Scott M. Adan, Ph.D., P.E., S.E.
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Equation numbers in the right-hand margin refer to the one of the standards (e.g., ACI 318, ASCE 7 or IBC). The default standard is given in the heading of each section of each example; equation numbers in that section refer to that standard unless another standard is explicitly cited.

Abbreviations used in the "Code Reference" column are

§ – Section T – Table

F – Figure Eq – Equation