Basic Seismic Design Workflow with Examples for Low Seismicity

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On the Cover

This map of Seismic Design Categories (SDCs) for default site conditions was prepared by the U.S. Geological Survey (USGS) using its 2018 National Seismic Hazard Model for the conterminous United States, the ASCE/SEI 7-22 Chapter 21 ground motion procedures, and the definition of SDC from ASCE/SEI 7-22 Chapter 11. Also defined there, the default site conditions used for this map correspond to the most critical ground motions across Site Classes C, CD, and D. More detailed mapping of these SDCs can be resolved using corresponding web tools, as can SDCs for other site classes (e.g., see https://doi.org/10.5066/F7NK3C76). Graphic from: 2020 NEHRP Recommended Seismic Provisions: Seismic Design Category Maps for 2024 International Residential Code (IRC) and International Building Code (IBC) FEMA P-2192-4, April 2023.

Suggestions for Improvement, Errata

Comments, suggestions for improvement, potential errata are welcomed and should be sent to NCSEA Seismic Provisions committee chair at NCSEA.com, Committees, Code Advisory, Seismic Provisions.

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Chapter 3 Steel Braced Frame
Chapter 4 Steel Moment Frame, Three Story

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Preface

by Thomas F. Heausler, PE, SE

Seismic design is challenging! Unfortunately, it is necessarily so. This is due to the complex and erratic nature of earthquake motions and the complex ductile methods employed to achieve reliable and affordable resistance to those loads.

During my service on the ASCE 7 Seismic Committee, I observed and participated in the process of debating, vetting, and approving new proposals. Many of the new proposals included new and advanced methodologies. I like to think of the new proposals as the tip of the pyramid of knowledge, and it was impressive to watch the pyramid pierce higher upwards. However, each new proposal brought more complexity to the design process.

I developed my expertise in earthquake resistant design in downtown San Francisco and acquired my California SE license. After which, I moved to Kansas City and had the unique opportunity to provide earthquake consulting to Central and Eastern United States engineering firms, often for projects with low seismic risk. During this time, I grew concerned about structural engineers at the beginning of their career, and other engineers throughout the United States unfamiliar with designing in low seismic regions. How are they to learn or adapt to the Low Seismic Building Code provisions mandated for their structural design?

I concluded that there was a need to bolster and enhance the wide bottom of the pyramid. During the ASCE 7-22 cycle, I chaired the ASCE 7 Simplified Seismic Committee. There we drafted, vetted, and voted on a Workflow methodology. The Workflow provided a road map to provide a consistent and reliable approach to seismic design. The consensus was that the Workflow was of high value, however it was concluded that it would be better suited for a Design Guide rather than incorporated within the ASCE 7 Provisions or Commentary.

NCSEA Seismic Provisions Committee thus took on the task of providing the Design Guide. Members of the NCSEA Seismic Codes Advisory Committee have contributed individual chapters to this guide and the Committee has discussed and vetted these examples. Their expertise and contribution are invaluable.

This NCSEA design guide presents simple examples for low seismic regions. It is intended that this guide may be used as a workflow and checklist while designing larger, more complicated buildings. And thus, it will promote more consistent and reliable calculations while minimizing errors or omissions.

Introduction

Chapter 1 describes the Workflow. It considers buildings as well as nonstructural components and nonbuilding structures.

The remaining chapters provide design examples for simple buildings with braced frames, moment frames, and shear walls as the seismic load resisting systems—composed of various materials such as steel, concrete, and wood.

The learning objectives are as follows:

- Learn how to navigate through the ASCE 7 Seismic Provisions by following a defined Workflow procedure.
- Learn seismic design application by reviewing example calculations for simple buildings.
- Learn the benefits of following the Workflow and a simple example while designing a similar but more complex building.

It is intended that referencing the Workflow and these simple design examples will improve the knowledge and understanding of structural engineers who are at the beginning of their career or have minimal seismic design experience. Additionally, experienced structural engineers designing structures in both low and high seismic locations will benefit from the Guide as it will confirm knowledge, help minimize errors, and provide a consistent format for calculations.