Seismic Loads

Guide to the Seismic Load Provisions of ASCE 7-10

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Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-10 (ASCE, 2013): Provides requirements for general structural design and includes means for determining dead, live, soil, flood, snow, rain, atmospheric ice, earthquake, and wind loads, as well as their combinations, which are suitable for inclusion in building codes and other documents. Includes a detailed commentary with explanatory and supplementary information.

Books Related to ASCE 7-10

Significant Changes to the Seismic Load Provisions of ASCE 7-10: An Illustrated Guide **by S.K. Ghosh, Ph.D.; Susan Dowty, P.E.; and Prabuddha Dasgupta, Ph.D., P.E.** (ASCE, 2010): Summarizes changes to the seismic provisions of ASCE 7-10 that might affect actual practice or enforcement, including the precise wording of the change.

Significant Changes to the Wind Load Provisions of ASCE 7-10: An Illustrated Guide **by T. Eric Stafford, P.E.** (ASCE, 2010): Translates changes to the wind load provisions of ASCE 7-10 into a form readily accessible by structural engineers, architects, contractors, building officials and inspectors, and allied professionals.

Snow Loads: Guide to the Snow Load Provisions of ASCE 7-10 **by Michael O'Rourke, Ph.D., P.E.** (ASCE, 2010): Illustrates key concepts and guides for applying the provisions of ASCE 7-10 to the design of new and existing structures that could collect falling or drifting snow.

Wind Loads: Guide to the Wind Load Provisions of ASCE 7-10 **by Kishor C. Mehta, Ph.D., P.E., and William Coulbourne, P.E.** (ASCE, 2013): Explains the wind load provisions of ASCE/SEI 7-10 as they affect the planning, design, and construction of buildings for residential and commercial purposes.

Books on Seismic Engineering

Earthquake Protection of Building Equipment and Systems: Bridging the Implementation Gap **by Jeffrey A. Gatscher, Gary L. McGavin, and Philip J. Caldwell** (ASCE, 2012): Offers a framework for applying the latest earthquake engineering research to the nonstructural elements of individual building projects, concentrating on mechanical and electrical systems.

Earthquakes and Engineers: An International History **by Robert K. Reitherman** (ASCE, 2012): Traces the evolution of humankind's understanding of the causes and characteristics of earthquakes and the development of methods to design structures that resist seismic shocks.

Guidelines for Seismic Evaluation and Design of Petrochemical Facilities **by the Task Committee on Seismic Evaluation and Design of Petrochemical Facilities** (ASCE, 2011): Presents practical recommendations regarding the design and safety of petrochemical facilities during and after an earthquake, including guidance on design details and considerations that are not included in building codes.

Seismic Evaluation and Retrofit of Existing Buildings, ASCE/SEI 41-13 (ASCE, 2014): Describes deficiency-based and systematic procedures that use performance-based principles to evaluate and retrofit existing buildings to withstand the effects of earthquakes.

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Preface

The purpose of this guide is to provide examples related to the use of the Standard ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures* (often referred to as ASCE 7). The guide is also pertinent to users of the *2012 International Building Code* (ICC, 2011) because the IBC refers directly to ASCE 7.

Sections of ASCE 7 Pertinent to the Guide

Seismic Loads: Guide to the Seismic Load Provisions of ASCE 7-10 (the *Guide*) has examples pertinent to the following chapters of ASCE 7:

Chapter 1: General
Chapter 2: Combinations of Loads
Chapter 11: Seismic Design Criteria
Chapter 12: Seismic Design Requirements for Building Structures
Chapter 16: Seismic Response History Procedures
Chapter 20: Site Classification Procedure for Seismic Design
Chapter 22: Seismic Ground Motion and Long Period Maps

Seismic material excluded from the *Guide* are Chapter 13 (Nonstructural Components), Chapter 14 (Material-Specific Design and Detailing Requirements), Chapter 15 (Nonbuilding structures), Chapter 17 (Seismic Design Requirements for Seismically Isolated Structures), Chapter 18 (Seismic Design Requirements for Structures with Damping Systems), Chapter 19 (Soil-Structure Interaction for Seismic Design), and Chapter 21 (Site-Specific Procedures for Seismic Design).

The vast majority of the examples in the *Guide* relate to Chapters 1, 2, 11, 12, and 16 of ASCE 7, with buildings as the principal subject. The materials on nonstructural components and on nonbuilding structures will be expanded in a later edition of the *Guide*, or in a separate volume. The materials presented for Chapter 16 relate to the selection and scaling of ground motions for response history analysis and the use of linear response history analysis.

Chapter 14 of ASCE 7 is not included because the *Guide* focuses principally on seismic load analysis and not seismic design. The reader is referred to the Reference section of the *Guide* for resources containing design examples. The materials included in Chapters 17 through 19 are considered "advanced topics" and may be included in a future volume of examples.

The principal purpose of the *Guide* is to illustrate the provisions of ASCE 7 and not to provide background on the theoretical basis of the provisions. Hence, theoretical discussion is kept to a minimum. However, explanations are provided in a few instances. The reference section contains

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several sources for understanding the theoretical basis of the ASCE 7 seismic loading provisions. Specifically, the reader is referred to the expanded commentary to the *ASCE Seismic Provisions*. Note that this commentary was first available in the third printing of ASCE 7. Additional useful documents provided by FEMA (at no charge) are as follows:

FEMA P-749, "Earthquake Resistant Design Concepts" (FEMA, 2010);
FEMA P-750, "NEHRP Recommended Seismic Provisions for New Buildings and Other Structures" (FEMA, 2009a); and
FEMA P-751, "NEHRP Recommended Provisions: Design Examples" (FEMA, 2012).

FEMA P-751 contains numerous detailed design examples that incorporate many of the requirements of ASCE 7-05 and ASCE 7-10. These examples are much more detailed than those provided in this *Guide* and concentrate on the structural design aspects of earthquake engineering, rather than just the loads and analysis side, which is the focus of the *Guide*.

The National Institute of Building Standards (NIST) provides another excellent set of seismic analysis and design references. These "technical briefs" cover various subjects, including diaphragm behavior, design of moment frames, design of braced frames, and nonlinear structural analysis. The briefs can be downloaded at no charge from www.nehrp-consultants.org.

How to Use the Guide

The *Guide* is organized into a series of individual examples. With minor exceptions, each example "stands alone" and does not depend on information provided in other examples. This means that, in some cases, information is provided in the beginning of the example that requires some substantial calculations, but these calculations are not shown. For instance, in the example on drift and P-delta effects (Example 19), the details for computing the lateral forces used in the analysis are not provided, and insufficient information is provided for the reader to back-calculate these forces. However, reference is made to other examples in the *Guide* where similar calculations (e.g., finding lateral forces) are presented. The reader should always be able to follow and reproduce all new numbers (not part of the given information) that are generated in the example.

Table and Figure Numbering

The examples presented in the *Guide* often refer to sections, equations, tables, and figures in ASCE 7. All such items are referred to directly, without specific reference to ASCE 7. For instance, a specific example might contain the statement, "The response modification factor R for the system is provided by Table 12.2-1."

References to sections, equations, tables, and figures that are unique to the *Guide* are always preceded by the letter G and use bold text. For example,

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the text may state that the distribution of forces along the height of the structure are listed in **Table G12-3** and illustrated in **Fig. G12-5**. In this citation, the number 12 is the example number, and the number after the dash is the sequence number of the item (that is, third table or fifth figure).

Notation and Definitions

The mathematical notation in the *Guide* follows directly the notation provided in Chapter 11 of ASCE 7. However, as the *Guide* does not use all of the symbols in ASCE 7, a separate list of symbols actually used in the *Guide* is provided in a separate section titled "Symbols Unique to the *Guide*." This list also provides definitions for new symbols that have been introduced in the *Guide*.

Computational Units

All examples in the *Guide* are developed in the U.S. customary (English) system, as follows (with the standard abbreviation in parentheses):

Length units: inches (in.) or feet (ft)
Force units: pounds (lb) or kips (k)
Time units: seconds (s).

All other units (e.g., mass) are formed as combinations of the aforementioned units. A unit conversion table is provided.

Appendices and Frequently Asked Questions

In addition to the 22 individual examples, the *Guide* contains three appendices. The first appendix provides interpolation tables that simplify the process of calculating some of the values (e.g., site coefficients F_a and F_v) required by ASCE 7. The second and third appendices explain the use of web-based utilities for determining ground motion parameters and for selection of ground motion records for response history analysis.

The *Guide* also contains a special section titled "Frequently Asked Questions," where several common questions are listed, together with the author's answers. In some cases, this requires an interpretation of ASCE 7, especially when the standard is ambiguous.

User Comments

Users are requested to notify the author of any ambiguities or errors that are found in this *Guide*. Suggestions for improvement or additions are welcomed and will be included in future versions of the *Guide*.

Disclaimer

The interpretations of ASCE 7 requirements and any and all other opinions presented in this guide are those of the author and do not necessarily represent the views of the ASCE 7 Standard Committee or the American Society of Civil Engineers.

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