

Recent Changes to both the *International Building Code* (IBC) and ASCE/SEI 7-05 have introduced a learning curve for practicing structural engineers. The following *Code Update* articles highlight some of the changes, and serve as an introduction as structural engineers begin to use these new standards.■

Part 1 The ASCE 7-05 Reformat Project

By Susan M. Dowty, S.E.

Through a two-year effort funded by the Federal Emergency Management Agency (FEMA) through the Building Seismic Safety Council (BSSC) and the American Society of Civil Engineers (ASCE), the seismic provisions of ASCE 7-02, *Minimum Design Loads for Buildings and Other Structures*, have been completely reformatted and reorganized.

The ASCE 7-05 Reformat Project began in December 2002 and concluded with the release of *ASCE 7-05 Minimum Design Loads for Buildings and Other Structures* in November 2005. The project's work plan consisted of three major steps: 1) establish an outline for the reorganization of the provisions, 2) develop code changes deemed necessary to complete Step 1, and 3) incorporate ASCE 7-05 code changes approved through the regular ASCE 7 code development process. Steps overlapped and the entire project was an iterative process. As Steps 2 and 3 were being completed, the reorganization outline of Step 1 was continually revisited and revised.

Committees at Work

A 13-member subcommittee of ASCE 7's Seismic Task Committee and BSSC's Code Resource Support Committee (CRSC) completed the reorganization effort. This ASCE/CRSC Subcommittee met twelve times in the course of two years. The reformatted provisions were balloted through ASCE 7's Seismic Task Committee and the Main Committee, and also through the public ballot process.

ASCE 7-02 vs ASCE 7-05 Table of Contents

In order to gain an appreciation of the improvement in organization between ASCE 7-02 and ASCE 7-05, one only needs to compare the two Tables of Contents (*See the on-line version of this article by visiting www.structuremag.org, for a reprinting of the two Tables of Contents*). By taking what used to be in one section (ASCE 7-02 Section 9.0) and expanding the material into thirteen chapters, the organization of the provisions became more transparent and understandable. Making the transition from the numbering scheme in ASCE 7-02 to the numbering scheme in ASCE 7-05 was a major task that required the creation of a section cross reference index, to ensure that all sections had been accounted for and cross-references had been renumbered accordingly.

Ground Rules

At the first meeting of the ASCE/CRSC Subcommittee, it was established that the reformatting effort would have the following goal:

GOAL: Make ASCE 7-05 a good, user-friendly set of seismic provisions which can be understood and interpreted correctly and easily by an average engineer designing an average structure.

To achieve this goal and streamline the process, a set of ground rules was agreed upon by the Subcommittee. The ground rules were most helpful in completing Step 1: Establish an outline for the reorganization of seismic provisions. (*For a specific list of the ground rules, please refer to the on-line version of this article. The text in italics after the rules found on the website provides additional information on how rules were followed.*)

Discussion of ASCE 7-05 Chapters

Chapter 11: Seismic Design Criteria

Chapter 11, *Seismic Design Criteria*, was designed to include only introductory material, and specifically the following information, so that if the code user were not subject to complying with subsequent chapters, they need not go farther than Chapter 11:

- Exceptions
- Determination of Mapped Values
- Determination of Seismic Design Category (SDC)
- SDC A Requirements

Structures that qualify under the exceptions to Section 11.1.2 are exempt from the seismic requirements of ASCE 7-05. Structures assigned to SDC A need only comply with the requirements found in Section 11.7.

The material found in ASCE 7-05 Section 11.8, *Geologic Hazards and Geotechnical Investigation*, was previously in ASCE 7-02 Section 9.7, *Foundation Design Requirements*. These requirements deserved a more prominent presence at the beginning of the provisions, so that it is readily apparent to the user if a geotechnical investigation report is necessary.

Chapter 12: Seismic Design Requirements for Building Structures

This chapter follows the natural sequence of steps that are involved in the seismic design of a typical building structure. After the first paragraph in Section 12.1.1, *Basic Requirements*, there is the following exception:

Exception: As an alternative, the simplified design procedure of Section 12.14 is permitted to be used in lieu of the requirements of Sections 12.1 through 12.12, subject to all of the limitations contained in Section 12.14.

This exception is placed in the beginning of the chapter so that the user may take advantage of the simplified approach and skip the requirements of Sections 12.1 through 12.12. Section 12.13 is *Foundation Design* and does apply even if the simplified design procedure is used.

Early in the chapter, the selection of a structural system or systems is addressed. Table 12.2-1, *Design Coefficients and Factors for Seismic Force-Resisting Systems*, sets forth values of R , Ω_o , and C_d for seismic force-resisting systems. Section 12.2 explains in an improved organized, clear and concise manner, as compared to ASCE 7-02, what values to use when combinations of structural systems are used horizontally or vertically. Any requirements specific to a type of structural system have been collected and conveniently located in Section 12.2.5, *System Specific Requirements*.

Physical attributes of the building structure are next addressed in Section 12.3, *Diaphragm Flexibility, Configuration Irregularities and Redundancy*. Once the structural system has been selected, it naturally follows that these issues need to be addressed. The next section, Section 12.4, *Seismic Load Effects*, reflects a significant change in format, with no sub-

stantive change. The ASCE 7/CRSC Subcommittee felt very strongly that the seismic load combinations had long been misunderstood and that it was important to systematically and methodically present the seismic load combinations, so that it was perfectly transparent to the user how the equations were derived.

Section 12.5, *Direction of Loading*, Section 12.6, *Analysis Procedure Selection* and Section 12.7, *Modeling Criteria*, formed the next logical sequence of code provisions leading up to the determination of the seismic base shear, V . Depending upon the circumstances, the seismic base shear, V , is next determined in accordance with Section 12.8, *Equivalent Lateral Force Procedure*, Section 12.9, *Modal Response Spectrum Analysis Procedure*, Section 12.14, *Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems*, or for certain less common situations, Chapter 16, *Seismic Response History Procedures*.

Section 12.10, *Diaphragms, Chords and Collectors*, Section 12.11, *Structural Walls and Their Anchorage*, and Section 12.12, *Drift and Deformation* are the remaining sections in Chapter 12. These requirements have been rewritten for clarity and uniform application.

Chapter 13: Seismic Design Requirements for Nonstructural Components

This chapter was reformatted for user-friendliness and streamlined so that the information is presented in a logical sequence with redundancies eliminated. It was patterned after the corresponding chapter in the *2000 Reformatted NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (NEHRP 2000).

As can be seen from the ASCE 7-05 Table of Contents, general provisions applicable to all nonstructural components are presented, followed by those provisions specific to architectural components, followed by those provisions specific to mechanical and electrical components. In this chapter, it is readily apparent how helpful it is to have the reference documents referred to by their common name. In ASCE 7-02, there were Reference Standards 9.6-1 through 9.6-13 and Accepted Standards 9.6-14 through 9.6-21; instead of referring to these by reference number, they are now referred to by their common names, e.g. ASME B31, NFPA 13 and ASME A17.1.

Chapter 14: Material Specific Seismic Design and Detailing Requirements

This new chapter is a welcome relief from having to search for applicable ASCE 7 seismic design requirements for a given construction material. All of the material-specific requirements have been collected and organized according to material type and included in this chapter.

Chapter 15: Seismic Design Requirements for Nonbuilding Structures

This chapter contains provisions that were in ASCE 7-02 Section 9.14; however many substantive revisions have been made. ASCE 7-02 Table 9.14.5.1.1, *Seismic Coefficients for Nonbuilding Structures*, has been expanded into two tables: Table 15.4-1, *Seismic Coefficients for Nonbuilding Structures Similar to Buildings*, and Table 15.4-2, *Seismic Coefficients for Nonbuilding Structures Not Similar to Buildings*.

Chapter 16: Seismic Response History Procedures

This chapter includes the less commonly used dynamic analysis procedures: 1) linear response history procedure, and 2) nonlinear response history procedure. They have been relocated later in the standard since they are not used as often as other provisions.

Chapter 17: Seismic Design Requirements for Seismically Isolated Structures

This chapter contains provisions that were in ASCE 7-02 Section 9.13. Although there have been substantive revisions, the organization of the provisions has virtually not changed except that related definitions and notation from ASCE 7-02 Sections 9.2.1 and 9.2.2 were relocated to this chapter.

Chapter 18: Seismic Design Requirements for Structures with Damping Systems

This chapter contains completely new material and is based on Chapter 15 of the *2003 NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (NEHRP 2003).

Chapter 19: Soil Structure Interaction for Seismic Design

This chapter contains provisions that were in ASCE 7-02 Section 9.5.9 and the provisions are virtually unchanged. Again, because these provisions are not commonly used, they have been relocated to a later chapter.

Chapter 20: Site Classification Procedure for Seismic Design

This chapter isolates the site classification provisions in one chapter for the ease of the user. The provisions have been reformatted for clarity and understandability.

Chapter 21: Site-Specific Ground Motion Procedures for Seismic Design

This chapter sets forth the requirements for the following two types of site-specific ground motion procedures: 1) site response analysis and 2) ground motion hazard analysis. The triggers requiring such analyses are found in Chapter 11; rather than using space in Chapter 11 to include the requirements, they were relocated to Chapter 21.

Chapter 22: Seismic Ground Motion and Long Period Transition Maps

Chapter 22 contains the subject maps that are approximately 23 pages in length. Users of the standard will appreciate the location of these maps at the end of the provisions, so as not to interrupt the flow of the main set of seismic design requirements.

Chapter 23: Seismic Design Reference Documents

Chapter 23 includes a list of the reference documents referred to in the provisions. This list is organized by the promulgating agency, and includes helpful information about how to obtain the document and which edition is being referred to.

Conclusion

The ASCE 7-05 Reformat Project will serve the engineering and building code enforcement communities well for many years. It is expected that users will embrace this publication and that usability problems with ASCE 7-02 have been resolved. ■

Susan Dowty, S.E. is an associate with S.K. Ghosh Associates, www.skghoshassociates.com, and can be reached at dowtyaska@cox.net.

ASCE 7-05 Reformat Project

Committee Members

Mike Valley, Chairman

Bob Bachman, ASCE Seismic Task Committee (STC)
Chairman

David Bonneville, Degenkolb Engineers

Alan Carr, ICC

John Gillengerten, OSHPD

Ronald Hamburger, Simpson Gumpertz and Heger, Inc.

Jim Harris, ASCE 7 Main Committee Chairman

John Hooper, Magnusson Klemencic Associates, Inc.

E.V. Leyendecker, USGS

Bonnie Manley, NFPA

Jim Rossberg, ASCE

Tim Scheckler and Mike Mahoney, FEMA

Ben Yousefi, City of Santa Monica

Final Set of Ground Rules

1. Separate out all provisions for SDC A. (*Note: The SDC A provisions are found in ASCE 7-05 Section 11.7.*)
2. Streamline presentation of provisions so that typical design steps are placed in a “main line.” Requirements that apply to a smaller population of structures should be located at the end. (*Note: ASCE 7-05 Chapters 15 through 23 and the Appendices are dedicated to requirements that apply to a smaller population of structures.*)
3. Relocate maps to the end. Write ASCE 7-05 in such a way that the maps are automatically part of the body of ASCE 7-05. (*Note: Maps are located in ASCE 7-05 Chapter 22.*)
4. Handle references differently. Refer to them by their common name (e.g. ACI 318) and list all of them in one section. (*Note: ASCE 7-05 refers to reference documents by the common name and they are all listed in Chapter 23.*)
5. Embed tables and figures within text rather than locating them at end of chapter.
6. Make every attempt to give each paragraph its own section number.
7. Make every attempt to reformat so that section numbers are no more than 4 deep (e.g. Section 9.2.5.1). (*Note: This has been done throughout ASCE 7-05 with a few exceptions. In many cases the section numbers used to go up to 6 deep, however, now the same section numbers are only 3 or 4 deep*)
8. Discontinue the “cascading” approach for SDC A-F requirements.
9. Eliminate the use of appendices except for quality assurance provisions and existing building provisions. (*Note: Appendix 11A is entitled: Quality Assurance Provisions and Appendix 11B is entitled: Existing Building Provisions.*)
10. Use tables, figures and flowcharts wherever it would improve clarity and result in less text. (*Note: Figure 12.3-1 Flexible Diaphragm, Figure 12.8-1 Torsional Amplification Factor, Ax, Figure 12.8-2 Story Drift Determination and Figure 12.10-1 Collectors, among other new figures and tables, have been added.*)
11. Tables and figures (with the exception of the maps) should be conveniently located in the section where they are first referenced. They should be numbered according to the section number, but not according to the subsection number. For example, Table 9.13-1, not Table 9.13.4.2-1. This same numbering rule should apply to equations as well. (*Note: The most commonly used table in the ASCE 7 seismic provisions is: Design Coefficients and Factors*

for Seismic Force-Resisting Systems, which used to be Table 9.5.2.2 and is now Table 12.1-1.)

12. Alphanumeric numbering should not be used. In the case of the map figure numbers, they should be numbered using the main section they are within followed by -1, -2, -3, etc. (*Note: In the case of the seismic ground motion maps, they are now referred to as Figures 22-1 through 22-14.*)
13. Keep a comprehensive list of definitions in Seismic Design Criteria, Section 11, as is similarly done in ASCE 7-02, except:
 - a. Relocate the seismic isolation related definitions and notation to Seismic Design Requirements for Seismically Isolated Structures, Section 17, and
 - b. Relocate the damping related definitions and notation to Seismic Design Requirements for Structures with Damping, Section 18.
14. Page numbering is to remain 1 – end page rather than become 10-1, 10-2, etc and 11-1, 11-2, etc.
15. The title of Section 23 is to be REFERENCE DOCUMENTS. The term “reference documents” is to be used consistently throughout Sections 11 – 23. The reference documents listed in Section 23 will be considered as either:
 - i. Consensus Standards or
 - ii. Other Reference DocumentsAny non-consensus standard will fall under the title “Other reference documents” and will be identified as such with an asterisk in Section 23. No distinction between consensus standards and non-consensus standards will be made in other sections.
16. The term “SEISMIC FORCE-RESISTING SYSTEM” (with one hyphen as indicated) is to be used consistently throughout the seismic provisions. Lateral force-resisting system should only be used for cases that address both the seismic- and the wind-force resisting systems. The term “basic” is to be deleted from wherever it appeared before “seismic force-resisting system”.
17. The term “REDUNDANCY FACTOR” will be used consistently for ρ .
18. The word “may” shall not be used for requirements. Instead “is permitted” or “are permitted” shall be used. The phrase “shall be permitted to be” shall not be used.
19. The term “effective seismic weight” shall be used in lieu of “gravity load” or “weight” or another variation thereof.

ASCE 7-02 TABLE OF CONTENTS

9.0 Earthquake Loads

- 9.1 General Provisions
- 9.2 Definitions and Symbols
- 9.3 Intentionally Left Blank
- 9.4 Procedures for Determining MCE and Design Earthquake Ground Accelerations and Response Spectra; Seismic Design Category; Quality Assurance
- 9.5 Structural Design Criteria, Analysis, and Procedures
- 9.6 Architectural, Mechanical, and Electrical Components and Systems
- 9.7 Foundation Design Requirements
- 9.8 Steel
- 9.9 Structural Concrete
- 9.10 Composite Structures
- 9.11 Masonry
- 9.12 Wood
- 9.13 Provisions for Seismically Isolated Structures
- 9.14 Nonbuilding Structures

Appendix A.9 Supplemental Provisions

- A.9.1 Purpose
- A.9.2 (Intentionally Left Blank)
- A.9.3 Quality Assurance
- A.9.4 through A.9.6 (Intentionally Left Blank)
- A.9.7 Supplementary Foundation Requirements
- A.9.8 Supplementary Provisions for Steel
- A.9.9 Supplemental Provisions for Concrete
- A.9.10 (Intentionally Left Blank)
- A.9.11 Supplementary Provisions for Masonry

ASCE 7-05 TABLE OF CONTENTS

Chapter 11 Seismic Design Criteria

- 11.1 General
- 11.2 Definitions
- 11.3 Notation
- 11.4 Seismic Ground Motion Values
- 11.5 Importance Factor and Occupancy Category
- 11.6 Seismic Design Category
- 11.7 Design Requirements for Seismic Design Category A
- 11.8 Geologic Hazards and Geotechnical Investigation

Chapter 12 Seismic Design Requirements for Building Structures

- 12.1 Structural Design Basis
- 12.2 Structural System Selection
- 12.3 Diaphragm Flexibility, Configuration Irregularities and Redundancy
- 12.4 Seismic Load Effects and Combinations
- 12.5 Direction of Loading
- 12.6 Analysis Procedure Selection
- 12.7 Modeling Criteria
- 12.8 Equivalent Lateral Force Procedure
- 12.9 Modal Response Spectrum Analysis
- 12.10 Diaphragms, Chords and Collectors
- 12.11 Structural Walls and Their Anchorage
- 12.12 Drift and Deformation
- 12.13 Foundation Design
- 12.14 Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems

Chapter 13 Seismic Design Requirements for Nonstructural Components

- 13.1 General
- 13.2 General Design Requirements
- 13.3 Seismic Demands on Nonstructural Components
- 13.4 Nonstructural Component Anchorage
- 13.5 Architectural Components
- 13.6 Mechanical and Electrical Components

Chapter 14 Material Specific Seismic Design and Detailing Requirements

- 14.0 Scope
- 14.1 Steel
- 14.2 Concrete
- 14.3 Composite Steel and Concrete Structures
- 14.4 Masonry
- 14.5 Wood

Chapter 15 Seismic Design Requirements for Nonbuilding Structures

- 15.1 General
- 15.2 Reference Documents
- 15.3 Nonbuilding Structures Supported by Other Structures
- 15.4 Structural Design Requirements

- 15.5 Nonbuilding Structures Similar to Buildings
- 15.6 General Requirements for Nonbuilding Structures Not Similar to Buildings
- 15.7 Tanks and Vessels

Chapter 16 Seismic Response History Procedures

- 16.1 Linear Response History Procedure
- 16.2 Nonlinear Response History Procedure

Chapter 17 Seismic Design Requirements for Seismically Isolated Structures

- 17.1 General
- 17.2 General Design Requirements
- 17.3 Ground Motion for Isolated Systems
- 17.4 Analysis Procedure Selection
- 17.5 Equivalent Lateral Force Procedure
- 17.6 Dynamic Analysis Procedures
- 17.7 Design Review
- 17.8 Testing

Chapter 18 Seismic Design Requirements for Structures with Damping Systems

- 18.1 General
- 18.2 General Design Requirements
- 18.3 Nonlinear Procedures
- 18.4 Response Spectrum Procedure
- 18.5 Equivalent Lateral Force Procedure
- 18.6 Damped Response Modification
- 18.7 Seismic Load Conditions and Acceptance Criteria
- 18.8 Design Review
- 18.9 Testing

Chapter 19 Soil Structure Interaction for Seismic Design

- 19.1 General
- 19.2 Equivalent Lateral Force Procedure
- 19.3 Modal Analysis Procedure

Chapter 20 Site Classification Procedure for Seismic Design

- 20.1 Site Classification
- 20.2 Site Response Analysis for Site Class F Soil
- 20.3 Site Class Definitions
- 20.4 Definitions of Site Class Parameters

Chapter 21 Site-Specific Ground Motion Procedures for Seismic Design

- 21.1 Site Response Analysis
- 21.2 Ground Motion Hazard Analysis

Chapter 22 Seismic Ground Motion and Long Period Transition Maps

Chapter 23 Seismic Design Reference Documents

- 23.1 Consensus Standards and Other Reference Documents
- 23.2 Reference Documents

Appendix 11A Quality Assurance Provisions

- 11A.1 Quality Assurance
- 11A.2 Testing
- 11A.3 Structural Observations
- 11A.4 Reporting and Compliance Procedures

Appendix 11B Existing Building Provisions

- 11B.1 Scope
- 11B.2 Structurally Independent Additions
- 11B.3 Structurally Dependent Additions
- 11B.4 Alterations
- 11B.5 Change of Use