

Seismic Shift

BY JOHN HARRIS, SE, PE, PHD, AND CONRAD PAULSON, SE, PE

Designers now have a new AISC specification focused on the seismic evaluation and retrofit of existing steel buildings.

AISC HAS ALWAYS BEEN forward-thinking when it comes to seismic design but is now also taking a look back—at existing buildings.

Over the past seven years, the AISC Committee on Specifications (COS) and its task committees have worked to develop a new standard, *AISC Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings* (ANSI/AISC 342-22). And it will be available this month at aisc.org/specifications.

Seismic Retrofit History

So how did it come to be? First, a little history on guidance for seismic retrofits. Engineers have long followed ASCE/SEI 41: *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE/SEI 41-17) to evaluate the seismic performance of an existing structural steel building. This standard represents the current state-of-the-practice in seismic evaluation and retrofit of existing buildings and is considered

a first-generation performance-based methodology. It and its preceding editions are referenced for use by the *International Existing Building Code*, the *California Building Code*, federal government building standards and guidelines—e.g., *Standards of Seismic Safety for Existing Federally Owned and Leased Buildings: ICSSC Recommended Practice 10 (RP 10-22)*—and mandatory seismic retrofit ordinances for several local jurisdictions. It provides analytical procedures and performance criteria for evaluating buildings and designing retrofits based on a defined performance objective.

In this context, seismic *evaluation* is defined as a methodology for evaluating deficiencies in components of a building that prevent the building from achieving the selected performance objective. Seismic *retrofit* is defined as the design of measures to improve the seismic performance of structural or nonstructural components of a building by correcting deficiencies identified in the seismic evaluation relative to the selected performance objective. ASCE/SEI 41-17 does not mandate the performance objective to be used in the evaluation. Instead, performance objectives are established in the policy of federal, state, or local jurisdictions or by the building owner.

ASCE/SEI 41-17 provides several analytical procedures to the engineer to determine the seismic demands on building components, classified as Tier 1, Tier 2, or Tier 3. Each tier differs in analytical complexity, and the selection of a particular tier will depend on what is being evaluated or retrofitted. The most detailed procedure is Tier 3, requiring the engineer to construct a model of the building and then subject that model to earthquake loading, similar to what would be done when designing a new building. ASCE/SEI 41-17, in Chapter 9, contains all the information needed to evaluate structural steel components. Three primary

characteristics are given for various types of components: 1) stiffness, 2) strength, and 3) acceptance criteria; the latter is a measure of the capacity of the component measured against the performance objective.

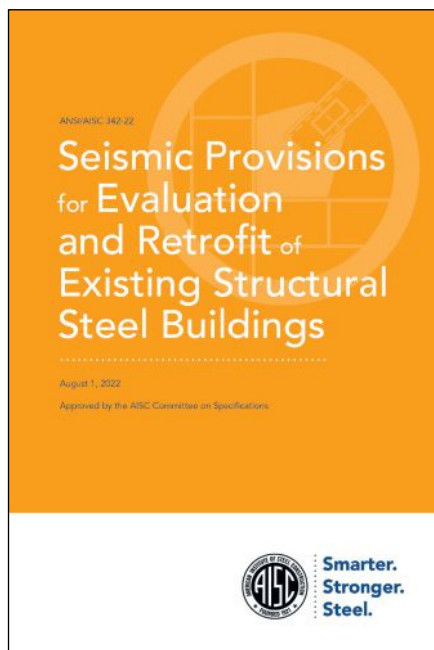
Transitioning Seismic Requirements to AISC

The information provided in Chapter 9 of ASCE/SEI 41-17 was introduced in 1997 in FEMA 273: *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* and subsequently updated over the course of two decades—and will be updated again this year in ASCE/SEI 41-23.

Over the same timeframe, AISC has been directly involved in developing seismic design provisions for structural steel components in new buildings. Today, the practice is to use ASCE/SEI 7: *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7), the *AISC Specification for Structural Steel Buildings* (ANSI/AISC 360), and the *AISC Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) for seismic design of new buildings.

Prior to these last seven years, AISC had not been directly involved in the seismic aspects of *existing* buildings, though some AISC committee members did sit on the respective FEMA project committees, the ASCE 41 main committee, and the ASCE 41 steel subcommittee. For the most part, Chapter 9 of ASCE/SEI 41-17 references the *AISC Specification* for component strengths and other characteristics. However, it became apparent that its update cycle was not happening as quickly as that of other seismic standards, such as the *AISC Seismic Provisions*.

After ASCE/SEI 41-13 was published, it was decided that AISC would develop companion provisions with the goal that they would be used as the resource document for new technical provisions in Chapter 9.





A memorandum of understanding between AISC and ASCE provided a pathway for this to occur, and the effort started as a work item for a subcommittee under AISC COS Task Committee 9—Seismic Systems, with the objective of preparing existing building seismic provisions as an appendix in AISC 341. It subsequently became a major work item for COS Task Committee 7—Evaluation and Repair, which took over and developed a completely new standard, the *Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings*. This development effort was completed in early 2022, and the ASCE 41 Committee recently approved that Chapter 9 of the ASCE/SEI 41-23 standard will reference this new AISC standard for structural steel requirements rather than reprinting these provisions in Chapter 9 (which avoids a circumstance where the exact requirements appear in two separate documents conforming to the distinct editorial formats of both AISC and ASCE). With this arrangement set, it is essential to recognize that the new *Seismic Provisions for Existing Structural*

Steel Buildings is to be used with ASCE/SEI 41, similar to how the AISC *Seismic Provisions* standard is used with ASCE/SEI 7 for new building design—i.e., *Seismic Provisions for Existing Structural Steel Buildings* is not a “standalone” document.

A Brief Overview

Engineers familiar with Chapter 9 of ASCE/SEI 41-17 will notice that the *Seismic Provisions for Existing Structural Steel Buildings* is formatted similarly to other AISC standards and that the layout between the two is very different. First, *Seismic Provisions for Existing Structural Steel Buildings* was set up to follow a workflow that engineers would most likely follow in practice. The standard starts with the information needed to conduct a condition assessment of the building and gather information pertinent to the development of the building model and analysis, such as material properties and information about components (members and connections). It has also extracted all component-related requirements from the sections on

structural systems (moment frames and braced frames) and put these requirements into one chapter. This format minimizes cross-referencing of components between systems and maximizes flexibility for modeling and evaluating the entire structural system that resists seismic forces and deformations (this was done in recognition of the fact that existing buildings may not contain a “designated” seismic force-resisting system). The chapter on components is broken down by type: beams, columns, braces, panel zones, connections, etc. Future editions may expand this chapter to include new components or rearrange components—e.g., columns and buckling braces separated into separate subsections. The last few chapters deal with system-level requirements—e.g., eccentrically braced frames—that reference individual components when applicable. A high-level “mapping” between the major sections of the new specification and Chapter 9 of ASCE/SEI 41 17 is given in Table 1.

This inaugural edition of the *Seismic Provisions for Existing Structural Steel*

TABLE 1:
AISC Seismic Provisions for Existing Structural Steel Buildings sections and their equivalent in Chapter 9 of ASCE/SEI 41-17

AISC: Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings	ASCE/SEI 41-17, Chapter 9
A General Provisions A1 Scope A2 Referenced Specifications, Codes, and Standards	9.1 Scope
A3 General Requirements A4 Document Review and Condition Assessment A5 Material Properties A6 Subassembly Tests	9.2 Material Properties and Condition Assessment
B General Requirements of Components	9.3 General Assumptions and Requirements
C Component Properties and Requirements	[No corresponding section in ASCE/SEI 41-17, Chapter 9. Component requirements were relocated from Section 9.4 and 9.5.]
D Structural Steel Moment Frames	9.4 Steel Moment Frames
E Structural Steel Braced Frame and Steel Plate Shear Wall Requirements	9.5 Steel Braced Frames
F Structural Steel Frames with Infills	9.6 Steel Frame with Infills
G Diaphragms	9.10 Diaphragms
H Structural Steel Pile Foundations	9.11 Steel Pile Foundations
I Cast and Wrought Iron	9.12 Cast and Wrought Iron



Buildings includes some technical improvements from ASCE/SEI 41-17. Some of the significant changes are as follows:

- The provisions on condition assessment, material properties, and existing welds received a thorough overhaul, and provisions for making new welds to existing steel have been added
- All beam types are consolidated into one section, and provisions for shear-controlled beams in a moment frame and shear-controlled beams in an eccentrically braced frame are in the same section
- The biaxial axial force-bending moment interaction equations were advanced to focus on the deformation-controlled action (i.e., flexure), which also aligns with ASCE/SEI 41-17, Chapter 7
- Provisions for fully restrained and partially restrained moment frame connections are improved and supplemented with new data
- Provisions for column splices were incorporated
- Provisions for braced frames with buckling braces and their connections were improved based on current research

Future Plans

With the first edition of the *Seismic Provisions for Existing Structural Steel Buildings* now complete, the COS and Task Committee 7 have turned their attention to the next development cycle, with the next edition planned for 2029. Future development of this standard is expected to match the ASCE/SEI 41 development cycle, which has typically been published one year after ASCE/SEI 7. This will also allow the development cycle of the *AISC Specification* and the *AISC Seismic Provisions* to be concluded in the prior year to facilitate referencing those provisions in the *Seismic Provisions for Existing Structural Steel Buildings*.

The publication of ANSI/AISC 342-22 marks the culmination of a multi-year effort by AISC to become technically established in the seismic evaluation and retrofit of existing structural steel buildings. The relationship between AISC and ASCE will undoubtedly enhance the usability and strength of ASCE/SEI 41, resulting in more efficient seismic evaluation and design of existing buildings. ■



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departments

- 6 EDITOR'S NOTE
- 9 STEEL INTERCHANGE
- 12 STEEL QUIZ
- 60 NEW PRODUCTS
- 61 NEWS & EVENTS
- 66 STRUCTURALLY SOUND

resources

- 65 ADVERTISER INDEX
- 65 MARKETPLACE & EMPLOYMENT

28

features

28 **Perfect Ten: The 2023 IDEAS² Awards**

A concert venue that raises the roof, a 1950s Mies van der Rohe design built seven decades after its creation, an art museum whose structural form is itself a work of art, and more comprise the winners of this year's AISC IDEAS² Awards.

columns

steelwise

16 **Seismic Shift**

BY JOHN HARRIS, SE, PE, PHD, AND CONRAD PAULSON, SE, PE

Designers now have a new AISC specification focused on the seismic evaluation and retrofit of existing steel buildings.

data driven

20 **Sustainability By the Numbers**

BY BRIAN RAFF

The numbers say it all: Steel is part of the solution, not the problem.

field notes

22 **Covering the Super Bowl(s)**

INTERVIEW BY GEOFF WEISENBERGER
Mark Waggoner's experience designing long-span steel roofs has led to his working on multiple massive stadiums, including several that have hosted the Super Bowl in recent years.

business issues

24 **Gather and Grow**

BY LAURIE GUEST

Refill your team's energy tank with these four steps.

ON THE COVER: SoFi Stadium keeps itself grounded, thanks to its playing field being 100 ft below grade. But its high-profile roof helps it visually soar above its surroundings, p. 28. (Photo: SoFi Stadium)

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