OVERVIEW OF STRUCTURAL ENGINEERING STANDARDS

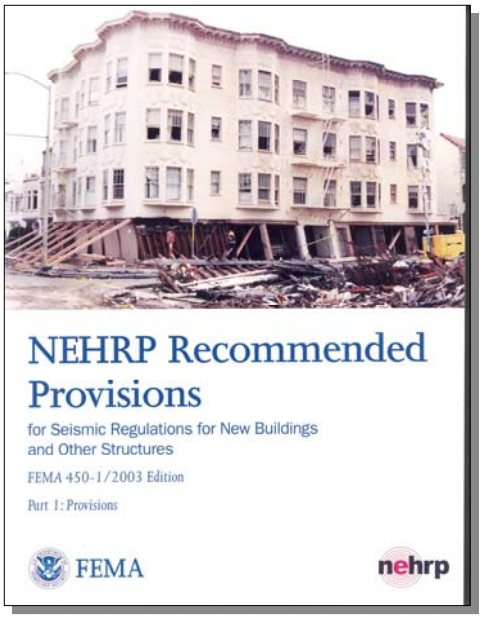
The Basic Implementation of the 2003 *NEHRP Recommended Provisions*

FEMA and BSSC have been very successful in placing the technical content of the *NEHRP Recommended Provisions* in model codes and structural engineering standards. Nearly all users of the *NEHRP Recommended Provisions* will be using them via the standards described in this lesson.

Scope

- Brief description of standards for design of basic building structures that implement the 2003 *NEHRP Recommended Provisions*
- Does not include standards referenced for design of nonstructural components and anchorages
- Does not include standards referenced for design of nonbuilding structures

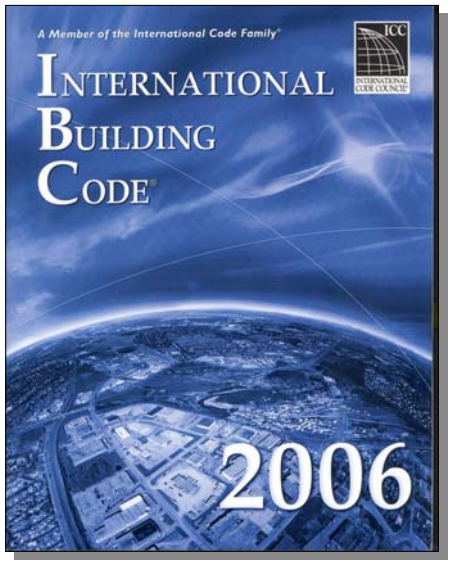
This lesson is limited to the most basic standards. The many standards for nonbuilding structures and nonstructural components are briefly touched upon in other lessons.



NEHRP Recommended Provisions

- Fundamentally a resource document
- Produced at the Building Seismic Safety Council
- 2003 edition influences many standards
- 3 year cycle till now

Remind students of background, described in previous lesson. The three year cycle has now been changed; the next edition will be in 2009.



IBC 2006

- Sets some basic requirements, but mostly cites structural design standards by reference.
- A distinct change from the UBC, more like SBC and BNBC.

If students are interested, the seismic provisions of NFPA 5000 are quite similar to the IBC; fundamentally both codes require compliance with ASCE 7-2005 for seismic design. For the youngest generation of students the last bullet item won't mean much. The Uniform Building Code had a long history of transcribing standards inside its covers; it meant that building officials purchased all the content they needed with the UBC and the associated UNC Standards, but it also meant that many small, sometimes annoying, changes were incorporated into the substance of those standards. The Standard Building Code and the BOCA National Building Code to a much greater extent cited national standards by reference in much the same fashion used by the 2006 IBC.

ASCE/SEI 7 2005 edition
with Supplement 1

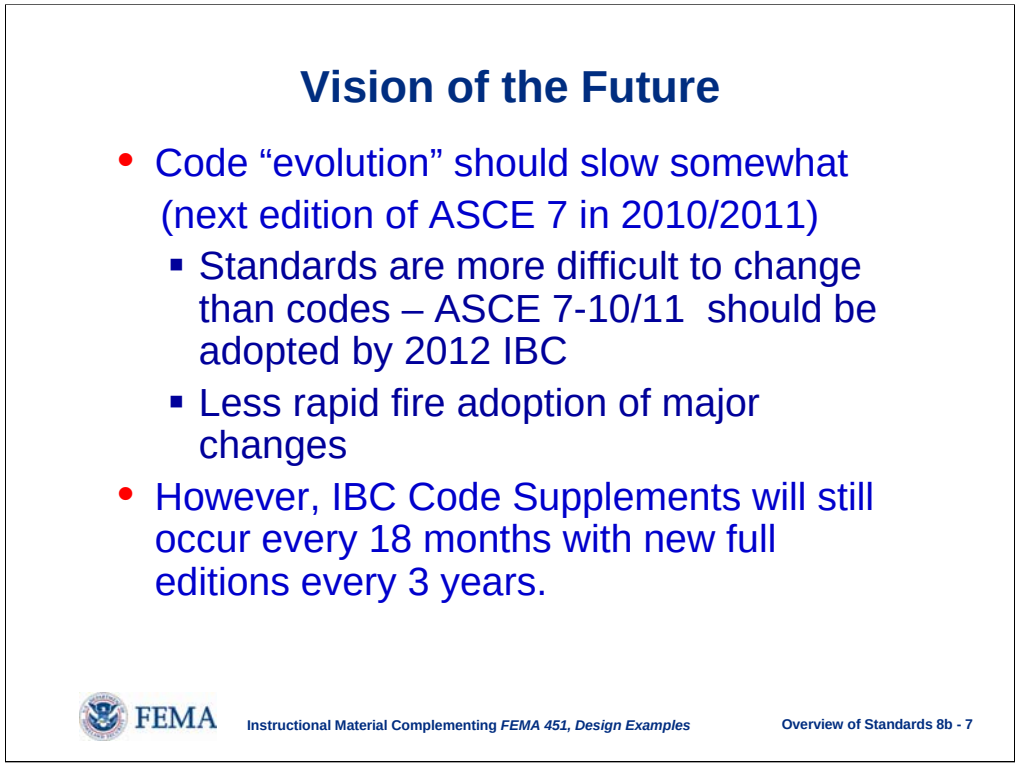
- Includes the bulk of 2003 *NEHRP Provisions* for its seismic chapters
- Reorganized and strongly edited

The next edition of the *NEHRP Recommended Provisions* will reference this edition of ASCE 7 and then recommend improvements. ASCE 7 is now the basic load standard for seismic design of new buildings.

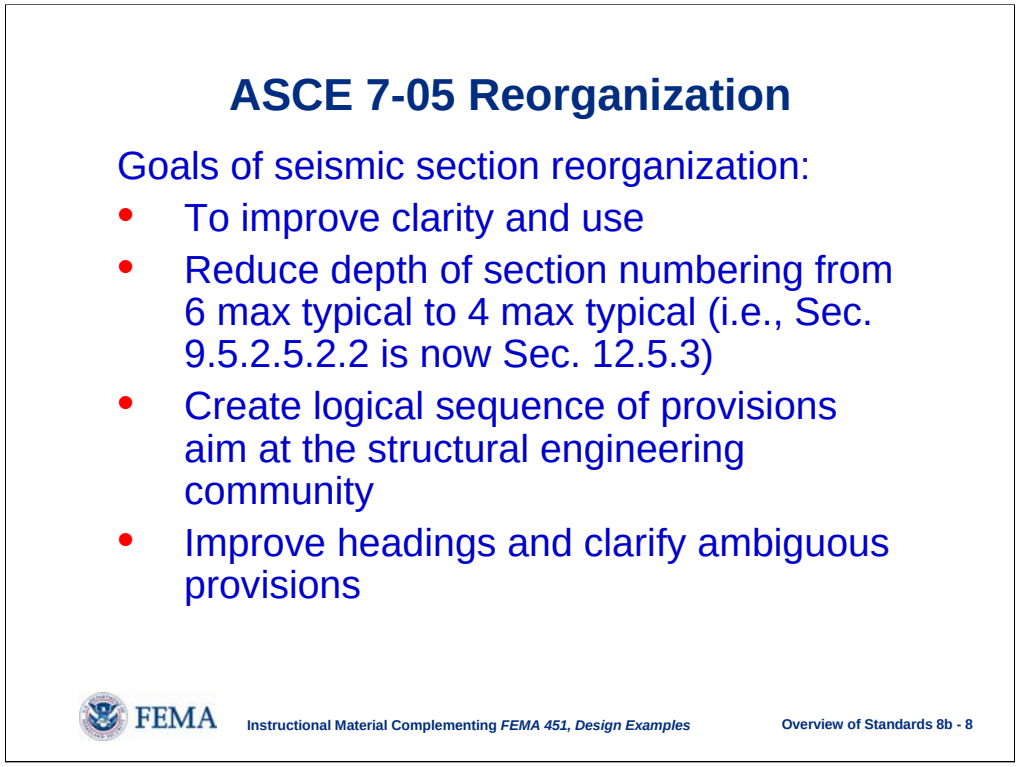
ASCE 7

- Developed by ASCE-SEI using ANSI standard consensus process
- Publication cycle varies (1988, 1993, 1995, 1998, 2002, 2005)
- Latest Version ASCE 7-05 Including Supplement 1 includes references to latest (2005 editions) material standards
- Extensive errata – go to www.seinstitute.org & click on publications

ASCE 7-2005 without Supplement 1 was a very limited printing primarily to permit coordination with other standards and the model codes; it was not sold to the public. Point out to the students that there are some very significant errata; recent printings include the errata as extra sheets bound in the back of the document (the corrections have not been made in the basic text).



Since the *NEHRP Recommended Provisions* began to strongly influence the model codes in 1992, the rate of change forced upon the structural engineering profession has been overwhelming. Remind students that most of this change emanates from lessons learned in the earthquakes of 1971 in San Fernando, 1985 in Mexico City, 1989 in Loma Prieta, and 1994 in Northridge.



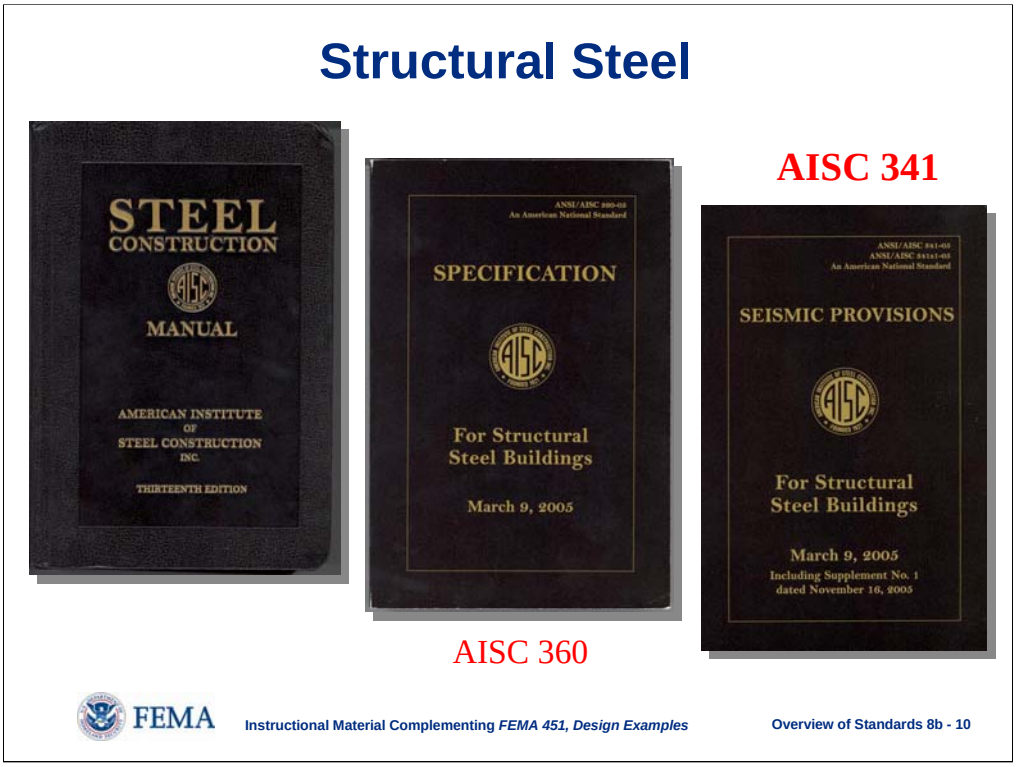
ASCE 7 previously adapted not only the content, but the organization of the *NEHRP Recommended Provisions*. For example, Section 5.2.5.2.2 of the 2000 *NEHRP Recommended Provisions* became 9.5.2.5.2.2 of ASCE 7-2002. NEHRP 2003 was reorganized from previous editions, but ASCE 7 took reorganization a big step further in 2005 (with assistance from BSSC). The technical substance of ASCE 7-2005, however is substantially the same, but not identical to, as the 2003 *NEHRP Provisions*.

ASCE 7-05 Chapter 14: Material Specific Design and Detailing

- 1 – Steel
- 2 – Concrete
- 3 – Composite Steel and Concrete
- 4 – Masonry
- 5 – Wood

IBC 2006 does not cite Chapter 14 by reference; it includes the same information in its chapters dealing with the material of construction

These are the major materials for structural systems of building construction. The material-specific details of seismic design are mostly in standards for these various materials, not in ASCE 7.



The new specification (360) combines allowable stress and strength methods for design. It replaces the prior editions of both the ASD and LRFD specs. The seismic details are all in AISC 341, which is nearly as long as the main spec. Note that the seismic spec is not in the "Manual", it must be obtained separately, and that a new "Seismic Manual" has been published by AISC in 2007. The Seismic Manual includes another import seismic standard, AISC 358, 2005, *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications*.

Structural Steel

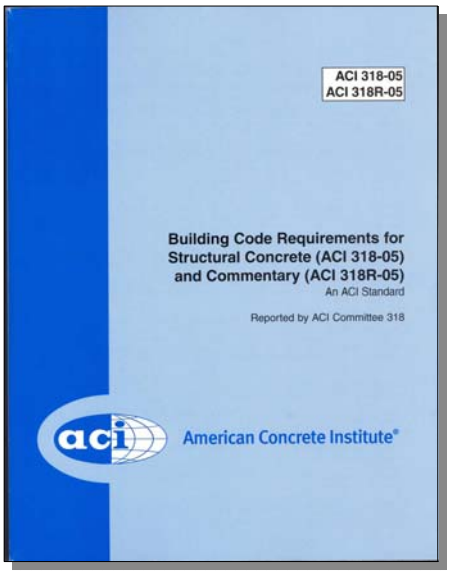
- Can ignore AISC 341 (seismic provisions) in Seismic Design Categories B, C if use *R* = 3
- Seismic provisions (341) required for all other situations
  - Special, intermediate, ordinary moment resisting frames
  - Special, ordinary concentrically braced frames
  - Eccentrically braced frames
  - Buckling restrained braced frames
  - Steel plate shear walls
  - Composite steel and concrete systems

By “ignoring” AISC 341, design is governed only by AISC 360 (the main standard for design of steel structures). AISC 341 is a supplement to 360; it is not free standing. Any system designed for an *R* factor for any of the named systems must use 341, regardless of location or Seismic Design Category.

Cold Formed Steel

The North American specifications for cold formed is a combined ASD and LRFD document. (The new AISC standard was patterned after this AISI standard.) The lateral design standard is new; some of the information in it was previously contained in the IBC and in model code Evaluation Service reports.

Values for the design of steel deck diaphragms must be obtained from approved testing programs. Several manufacturers have such data approved by model code Evaluation Services. The *Steel Deck Diaphragm Design Manual* is being updated by the Steel Deck Institute (it has been an allowable stress document focused on wind) and it is expected to become a useful reference in the future.



ACI 318-05

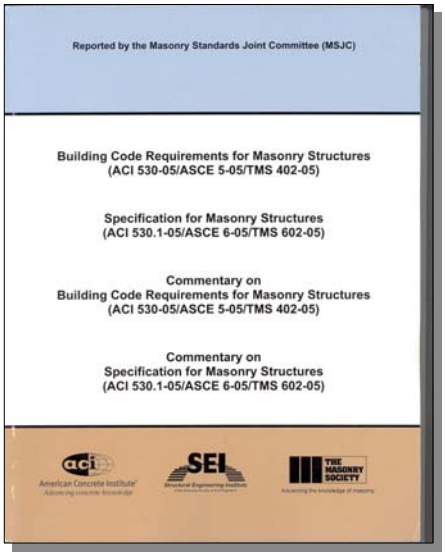
- Seismic requirements are primarily found in Chapter 21
- Composite steel and concrete is covered in AISC 341

ACI 318 does not (now) cover foundation piles and piers; ASCE 7 and the IBC both include supplementary provisions taken from the *NEHRP Recommended Provisions*.

Structural Concrete

- Special, intermediate, ordinary moment resisting frames
- Special, ordinary shear walls (structural walls)
- Special, intermediate, ordinary precast concrete shear walls
- Special precast concrete moment frames
- Provisions for concrete structure not designed as part of seismic force resisting systems

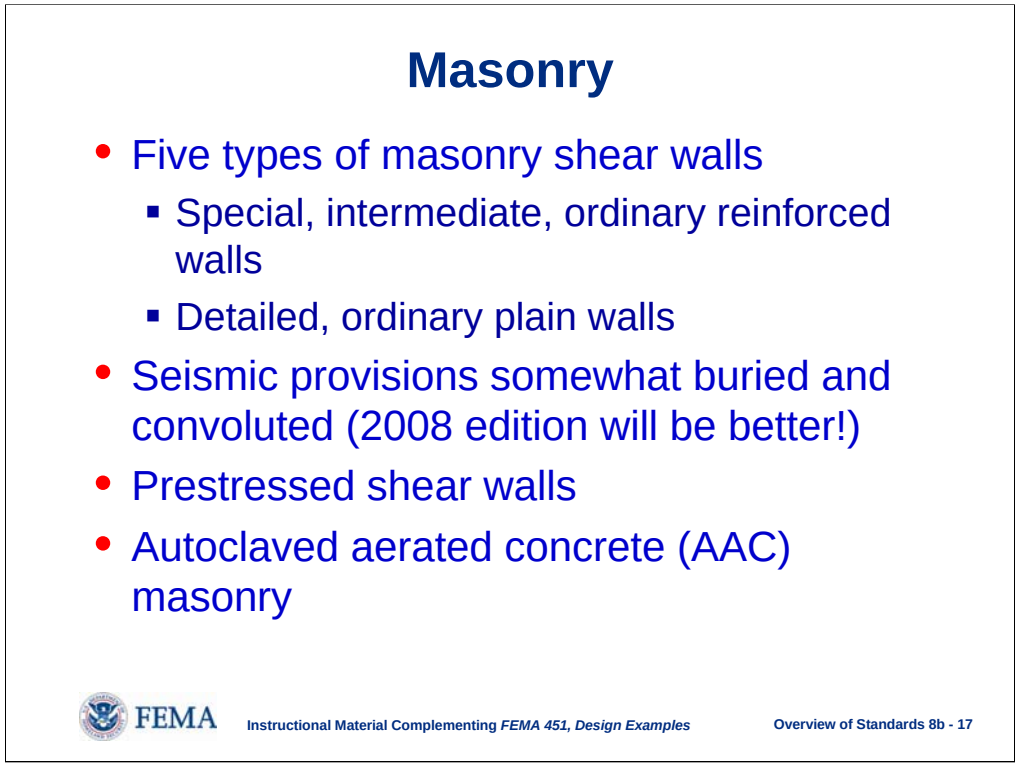
ACI 318 includes terminology in its seismic chapter to enable use with the 1997 UBC (zones), the current NEHRP-based codes and standards (seismic design category), and the older generations of NEHRP-based codes and standards (eismic performance category).



TMS 401-05
ACI 530-05
ASCE 5-05
(MSJC Code)

- Mostly incorporated into IBC chapter 21 by transcription as opposed to citation by reference

MSJC means Masonry Standards Joint Committee. ATC 3 and the early editions of the *NEHRP Recommended Provisions* were driving forces in stimulating the joint effort for a unified masonry standard. Previously there had been standards for different types of masonry in different potions of the country. TMS, The Masonry Society, is now the home for development of this standard although ACI and SEI of ASCE still do contribute to the effort.



Prestressed masonry and autoclaved aerated concrete masonry are recently standardized systems that are both restricted by ASCE 7 and the IBC for some seismic applications.

The newest NDS is also a combined allowable stress and strength design standard. The wind and seismic supplement is a new standard.

Timber Structures: Seismic Supplement

- Diaphragms and shear walls
- Various sheathing types
- Framing and configuration requirements
- Note that much of this information was formerly included directly in the model building code rather than a design standard.

Some of the numerical values for diaphragms and shear walls have been adjusted in recent years. The 1994 Northridge earthquake has stimulated substantial research on timber seismic systems

Structural Standards: Summary

- IBC 2006 cites ASCE 7-05; based on 2003 *NEHRP Recommended Provisions*
- Both IBC and ASCE 7 cite and supplement the 2005 material design standards:
  - AISC for structural steel and composite steel/concrete
  - AISI for cold formed steel
  - ACI for concrete
  - TMS 402 (MSJC) for masonry
  - AF&PA NDS for timber

No one document provides all the information needed to design a structure.