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Course Description

Seismic Design for Non-West Coast Engineers – Part 2

August 17, 2017

This introductory, two-part webinar will address basic concepts of seismic design.

Part 2 of the webinar will focus on the performance of steel structures in past earthquakes, computing earthquake loads using the equivalent lateral force method, basic concepts on detailing of steel to achieve ductile response, options for structural steel lateral force resisting systems, and an overview of the AISC *Seismic Provisions*.

Learning Objectives

- Describe the performance of steel systems in past earthquakes
- Identify steps to determine seismic forces by ASCE 7
- Identify key features of steel seismic force resisting systems
- Locate additional seismic design references

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Seismic Design for Non-West Coast Engineers – Part 2

Presented by
Michael D. Engelhardt, PhD, PE
Professor
The University of Texas at Austin

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Seismic Design for Non-West Coast Engineers

Part 1 (August 10, 2017)

- **Causes, Location, and Impact of Earthquakes**
- **EQ Forces on Buildings**
- **Overall Philosophy and Approach for EQ-Resistant Design**
- **Role of Ductility in EQ-Resistant Design**

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Seismic Design for Non-West Coast Engineers

Part 2 (August 17, 2017)

- **Steel Structures: Performance in Past EQs**
- **EQ Resistant Design per ASCE 7-10**
- **Structural Steel Seismic Force-Resisting Systems in the AISC *Seismic Provisions***
- **References for Further Learning**

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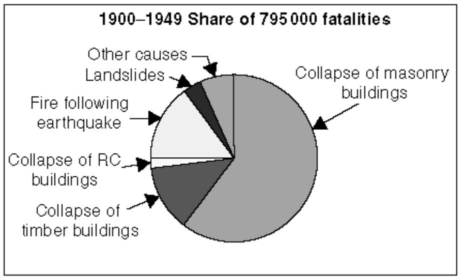
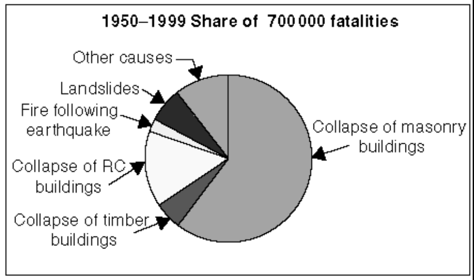
Earthquake Fatalities....Causes





Source: "Earthquake Protection," 2nd Ed.
Andrew Coburn and Robin Spence, Wiley, 2002

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1994 Northridge EQ

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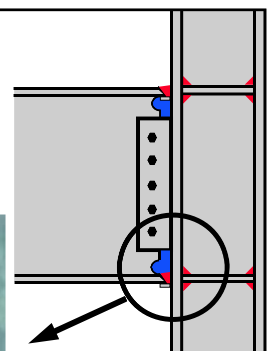

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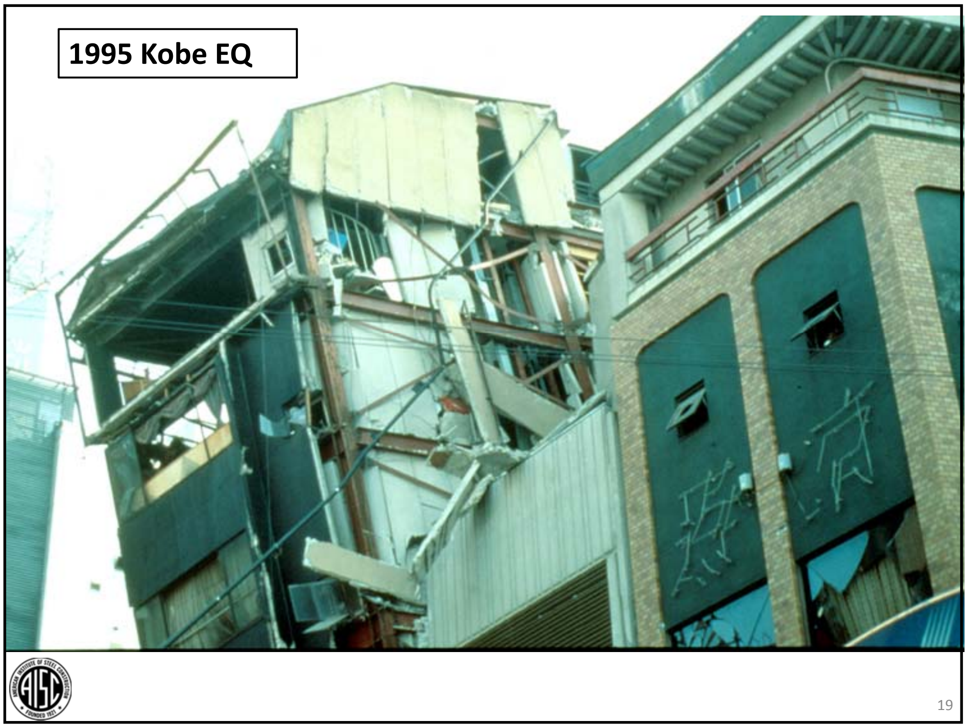
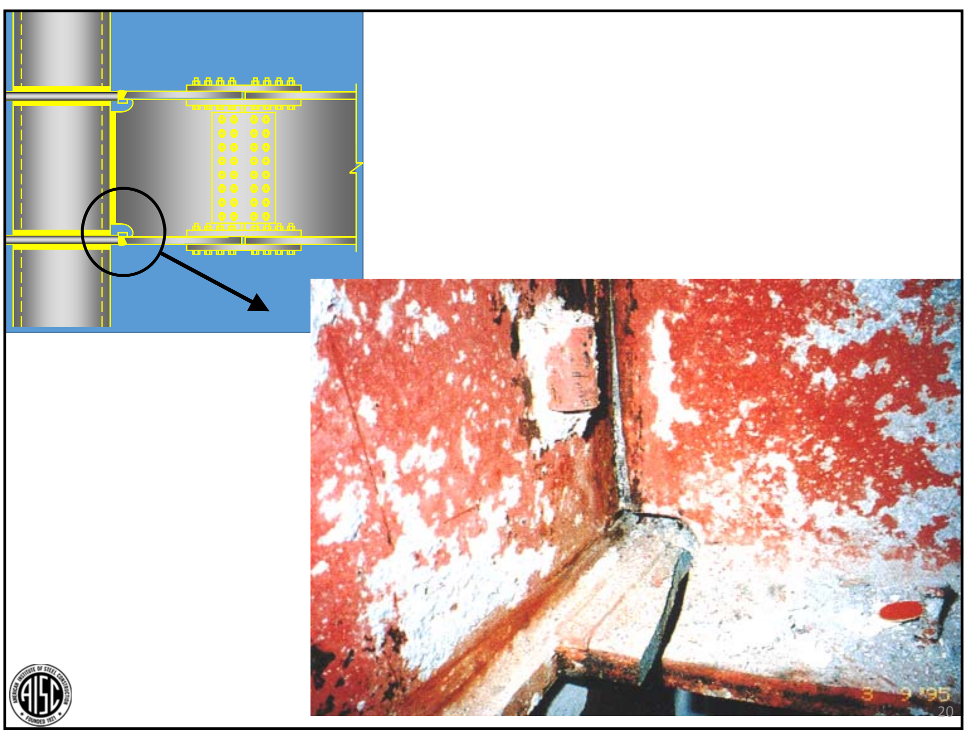

1995 Kobe EQ
19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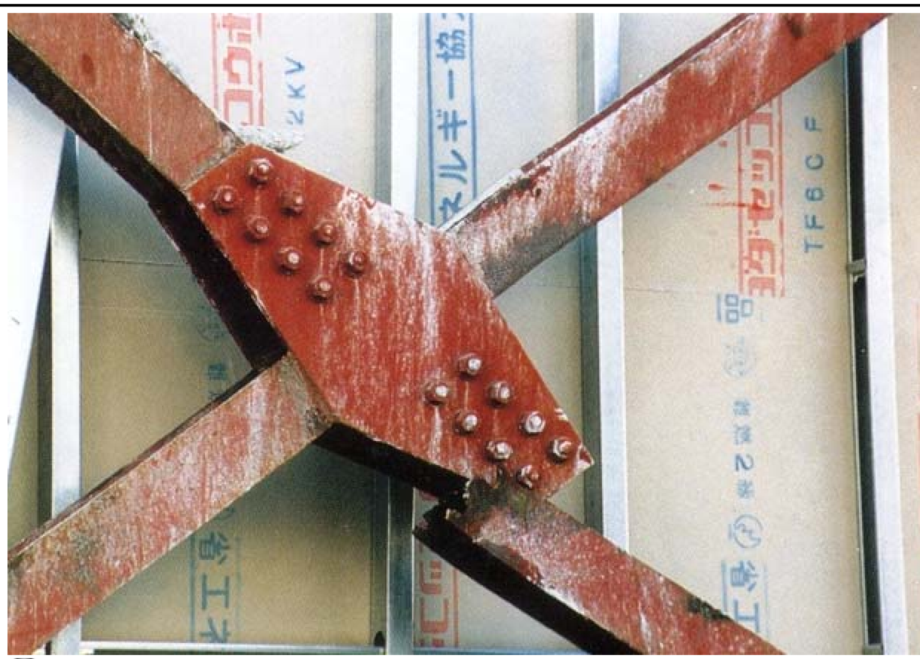

22

2010/2011 Earthquake Series – Christchurch, New Zealand

Photos courtesy of Charles Clifton, University of Auckland

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Photos courtesy of Charles Clifton, University of Auckland

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Seismic Resistant Design

Key Elements:

General Seismic Design Requirements and Required Lateral Strength and Stiffness

Specified by ASCE 7-10:
Minimum Design Loads for Buildings and Other Structures

↕

Ductile Detailing Requirements

For steel structures: Specified by AISC 341-10:
Seismic Provisions for Structural Steel Buildings

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Seismic Design for Non-West Coast Engineers

Part 2 (August 17, 2017)

- **Steel Structures: Performance in Past EQs**
- **EQ Resistant Design per ASCE 7-10**
- **Structural Steel Seismic Force-Resisting Systems in the AISC *Seismic Provisions***
- **References for Further Learning**

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ASCE 7-10

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ASCE 7-10

Seismic Design Requirements depend on the:

Seismic Design Category (SDC)

SDCs: **A B C D E F**

Increasing seismic risk and Increasingly stringent seismic design and detailing requirements

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Seismic Design Category (SDC)

Depends on:

- **Geographic Location**
- **Soil Conditions**
- **Importance of Structure**

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To Determine the Seismic Design Category (ASCE 7-10):

Determine *Risk Category*

↓

Determine S_S and S_1

S_S = spectral response acceleration for maximum considered earthquake at short periods

S_1 = spectral response acceleration for maximum considered earthquake at 1-sec period

S_s and S_1 are read from maps (or from USGS website)

↓

Determine *Site Class*

↓

Determine S_{MS} and S_{M1}

Spectral response accelerations for maximum considered earthquake adjusted for the Site Class;

$S_{MS} = F_a S_s$ $S_{M1} = F_v S_1$

↓

Determine S_{DS} and S_{D1}

Design spectral response accelerations

$S_{DS} = 2/3 \times S_{MS}$ $S_{D1} = 2/3 \times S_{M1}$

30

Risk Categories

Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent a low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life. Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure. Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.	III
Buildings and other structures designated as essential facilities. Buildings and other structures, the failure of which could pose a substantial hazard to the community. Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released.[a] Buildings and other structures required to maintain the functionality of other Risk Category IV structures.	IV

[a]Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for classification to a lower Risk Category if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the substances is commensurate with the risk associated with that Risk Category.

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Table 1.5-2 Importance Factors by Risk Category of Buildings and Other Structures for Snow, Ice, and Earthquake Loads[a]

Risk Category from Table 1.5-1	Snow Importance Factor, I_s	Ice Importance Factor—Thickness, I_i	Ice Importance Factor—Wind, I_w	Seismic Importance Factor, I_e
I	0.80	0.80	1.00	1.00
II	1.00	1.00	1.00	1.00
III	1.10	1.25	1.00	1.25
IV	1.20	1.25	1.00	1.50

[a]The component importance factor, I_p, applicable to earthquake loads, is not included in this table because it is dependent on the importance of the individual component rather than that of the building as a whole, or its occupancy. Refer to Section 13.1.3.

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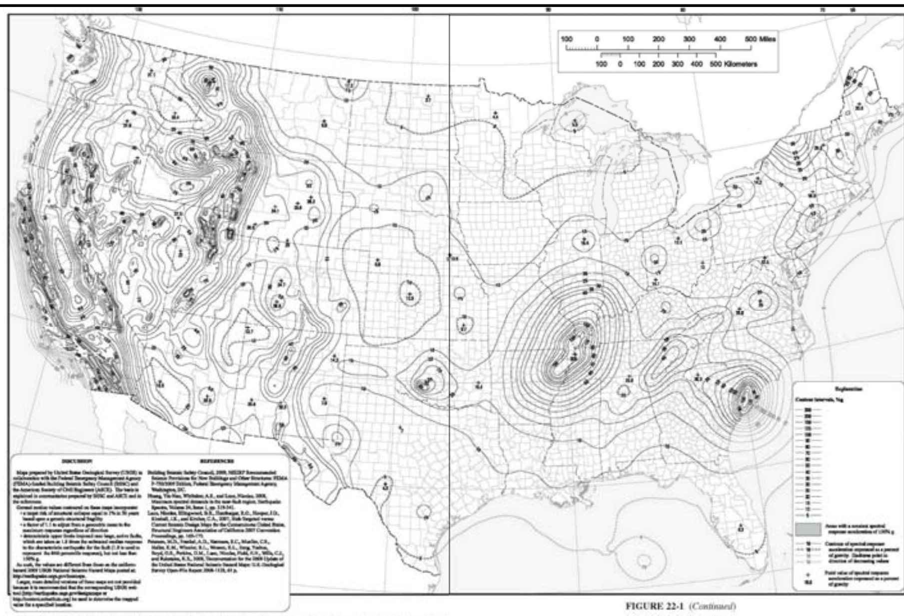

FIGURE 22-1 S_S Risk-Adjusted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

FIGURE 22-1 (Continued)

Map for S_S

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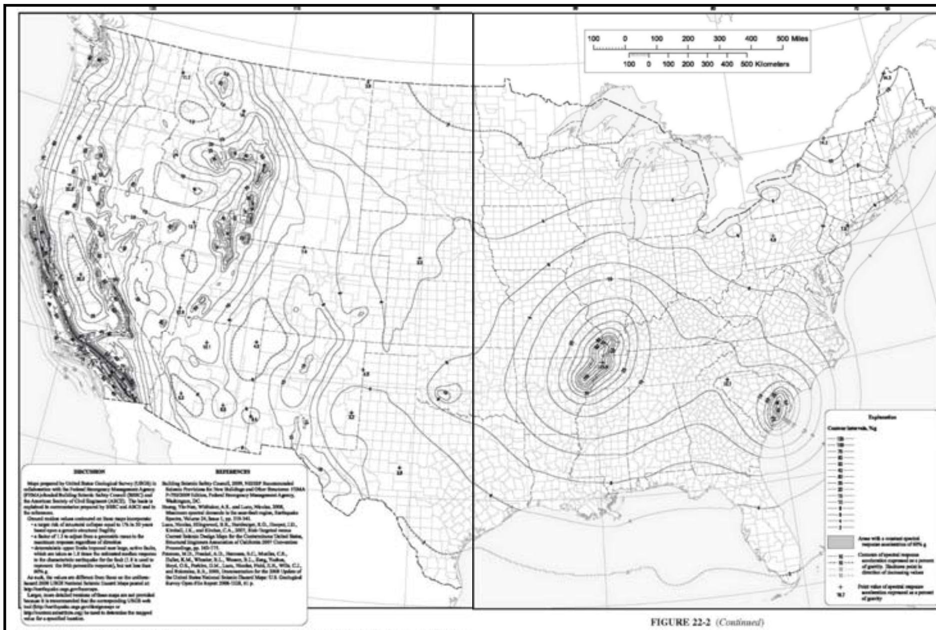

FIGURE 22-2 S_1 Risk-Adjusted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 1 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

FIGURE 22-2 (Continued)

Map for S_1

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Seismic Hazard Maps

- Interactive program available from USGS website.
  - Seismic design values for buildings
  - Input longitude and latitude at site
  - Output S_S and S_1
- http://earthquake.usgs.gov/hazards/designmaps/

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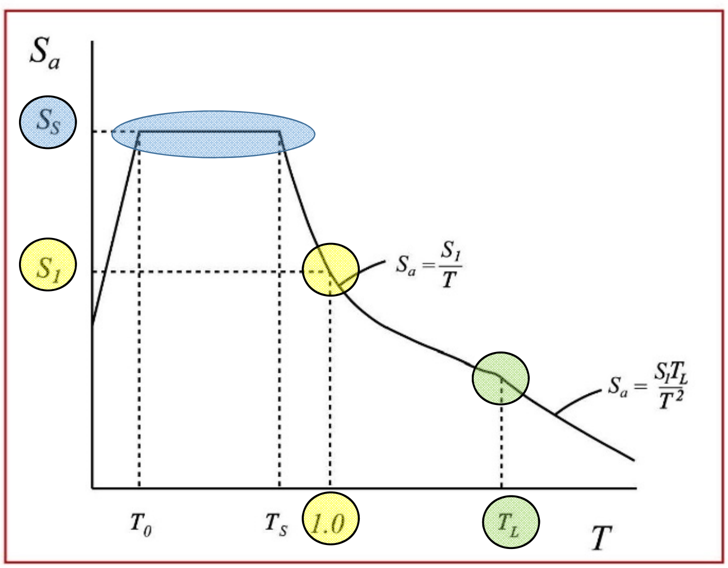
Generalized Shape of Smoothed Elastic Response Spectrum



Source: FEMA P-749

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Site Classification per ASCE 7-10

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: —Plasticity index $PI > 20$, —Moisture content $w \geq 40\%$, —Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

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Adjust Response Spectrum for Site Effects

$$S_{MS} = F_a \, S_s$$

Table 11.4-1 Site Coefficient, F_a

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of S_S.

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Adjust Response Spectrum for Site Effects

$$S_{M1} = F_v S_1$$

Table 11.4-2 Site Coefficient, F_v

	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at 1-s Period				
Site Class	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of S_1.

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Determine Design Spectral Accelerations

$$S_{DS} = \frac{2}{3} S_{MS}$$

$$S_{D1} = \frac{2}{3} S_{M1}$$

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Determine Seismic Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

	Risk Category	
Value of S_{DS}	I or II or III	IV
$S_{DS} < 0.167$	A	A
$0.167 \leq S_{DS} < 0.33$	B	C
$0.33 \leq S_{DS} < 0.50$	C	D
$0.50 \leq S_{DS}$	D	D

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Determine Seismic Category

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

	Risk Category	
Value of S_{D1}	I or II or III	IV
$S_{D1} < 0.067$	A	A
$0.067 \leq S_{D1} < 0.133$	B	C
$0.133 \leq S_{D1} < 0.20$	C	D
$0.20 \leq S_{D1}$	D	D

For Risk Category I, II, or III: $S_1 \geq 0.75g$ SDC = E

For Risk Category IV: $S_1 \geq 0.75g$ SDC = F

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Example: Site in Santa Clarita, California

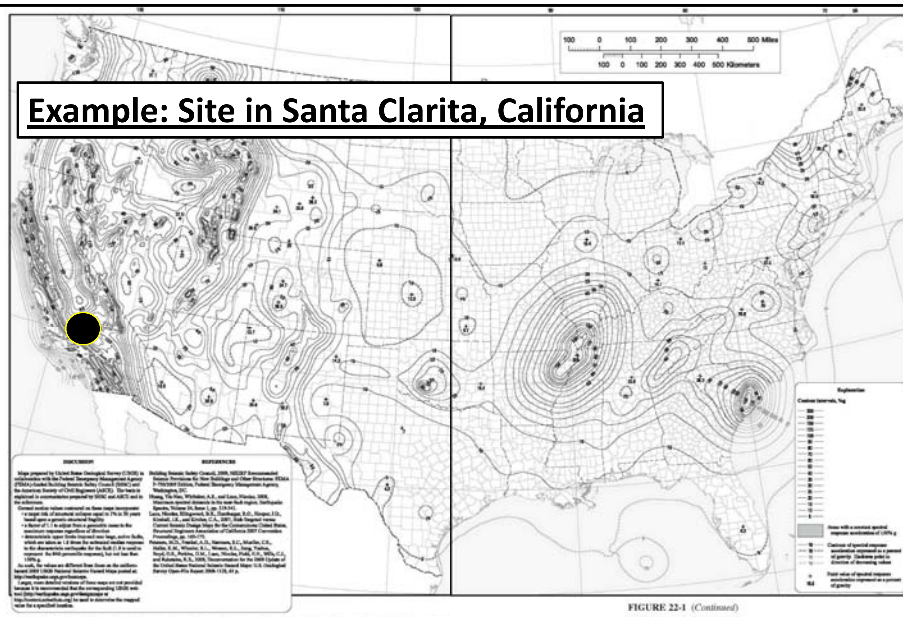

FIGURE 22-1 S_S Risk-Adjusted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

FIGURE 22-1 (Continued)

Map for S_S

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Example: Site in Santa Clarita, California

- **Low rise office building**
- **Risk Category II**
- **Assume Site Class D (Stiff Soil)**

Per ASCE 7-10:

S_s = 2.90g	S_1 = 0.91g
F_a = 1.0	F_v = 1.5 (Site Class D)
S_{MS} = 1.0 x 2.90g = 2.90g	S_{M1} = 1.5 x 0.91g = 1.37g
S_{DS} = (2/3) x 2.90g = 1.93g	S_{D1} = (2/3) x 1.37g = 0.91g

S_{DS} = 1.93 g **S_{D1} = 0.91 g**

***Seismic Design Category* = E**

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Example: Site in Memphis, Tennessee

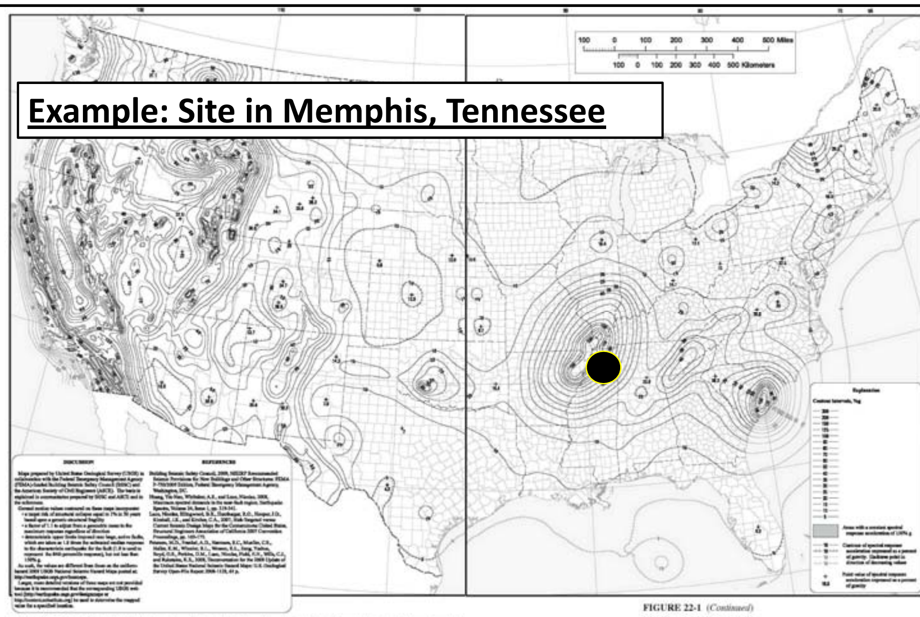

FIGURE 22-1 S_S Risk-Adjusted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

FIGURE 22-1 (*Continued*)

Map for S_S

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Example: Site in Memphis, Tennessee

- **Low rise office building**
- **Risk Category II**
- **Assume Site Class D (Stiff Soil)**

Per ASCE 7-10:

S_s = 0.87g	S_1 = 0.31g
F_a = 1.15	F_v = 1.78 (Site Class D)
S_{MS} = 1.15 x 0.87g = 1.01g	S_{M1} = 1.78 x 0.31g = 0.55g
S_{DS} = (2/3) x 1.01g = 0.67g	S_{D1} = (2/3) x 0.55g = 0.37g

S_{DS} = 0.67 g **S_{D1} = 0.37 g**

***Seismic Design Category* = D**

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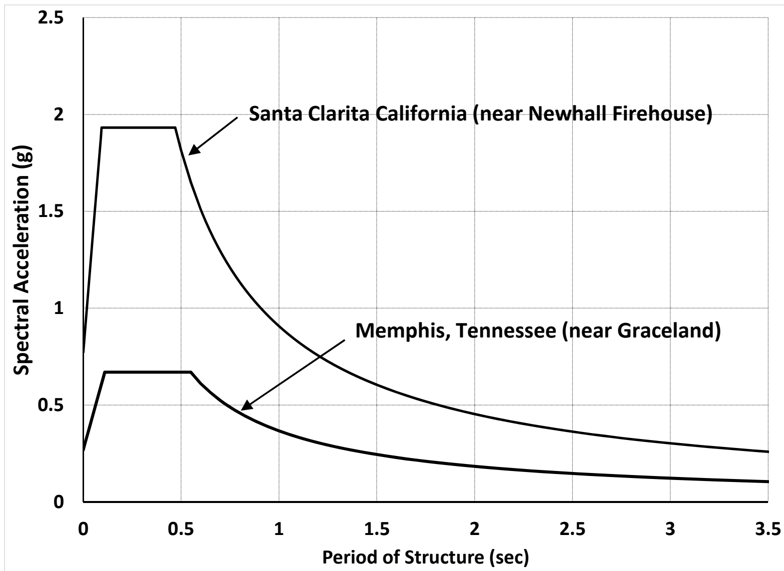
Examples of Elastic Design Response Spectra (per ASCE7-10)



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Seismic Design Requirements depend on the:

Seismic Design Category (SDC)

SDCs: A — *Minimal seismic design requirements*

B, C — *Relatively simple approaches possible*

D, E, F — *"High level" seismic design required*

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Analysis Options per ASCE 7-10

- **Equivalent Lateral Force Method**
- **Modal Response Spectrum Analysis**
- **Seismic Response History Analysis**
  - Linear
  - Nonlinear

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Analysis Options per ASCE 7-10

Table 12.6-1 Permitted Analytical Procedures

Seismic Design Category	Structural Characteristics	Equivalent Lateral Force Analysis, Section 12.8[a]	Modal Response Spectrum Analysis, Section 12.9[a]	Seismic Response History Procedures, Chapter 16[a]
B, C	All structures	P	P	P
D, E, F	Risk Category I or II buildings not exceeding 2 stories above the base	P	P	P
	Structures of light frame construction	P	P	P
	Structures with no structural irregularities and not exceeding 160 ft in structural height	P	P	P
	Structures exceeding 160 ft in structural height with no structural irregularities and with $T < 3.5T_s$	P	P	P
	Structures not exceeding 160 ft in structural height and having only horizontal irregularities of Type 2, 3, 4, or 5 in Table 12.3-1 or vertical irregularities of Type 4, 5a, or 5b in Table 12.3-2	P	P	P
	All other structures	NP	P	P

[a]P: Permitted; NP: Not Permitted; $T_s = S_{D1}/S_{DS}$.

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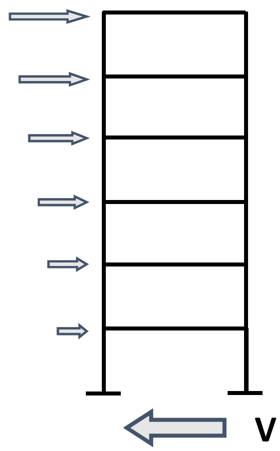
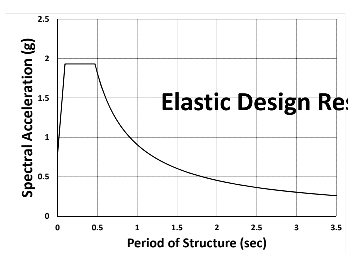
Equivalent Lateral Force Method

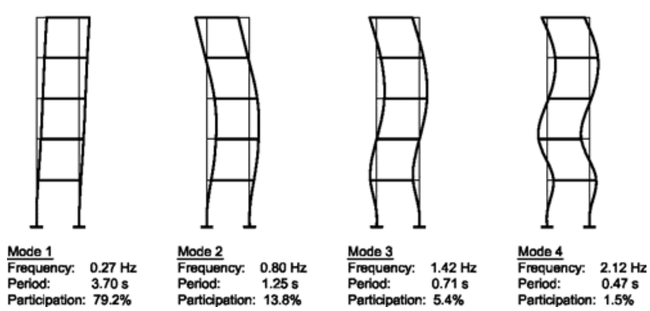


Treat EQ effects as a static lateral load

Modal Response Spectrum Analysis

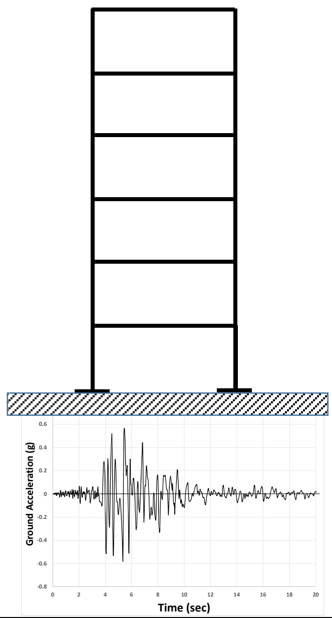


Elastic Design Response Spectrum



Source: AISC Seismic Design Manual

Seismic Response History Analysis



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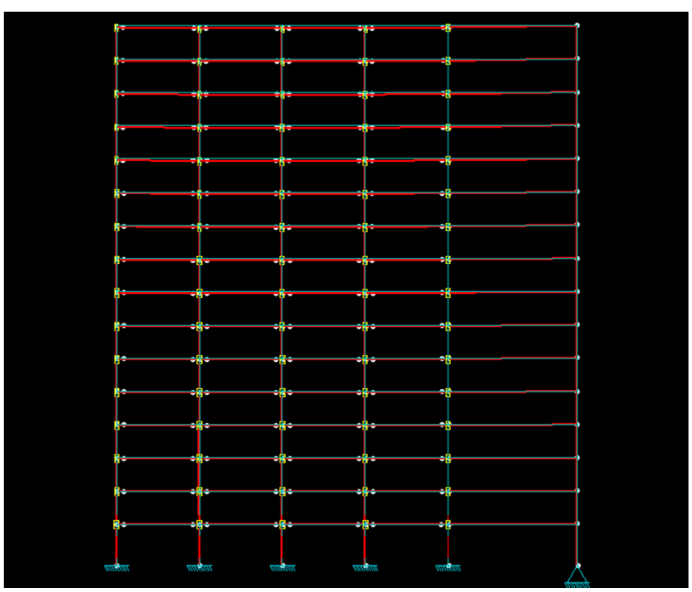
Seismic Response History Analysis



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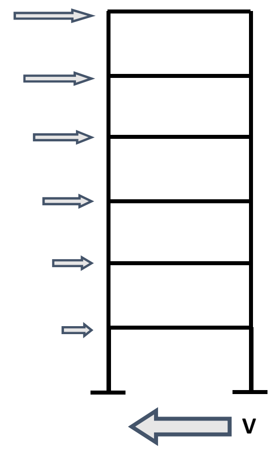
Equivalent Lateral Force Method

$$V = C_S\ W$$

V = total design lateral force or shear at base of structure

W = effective seismic weight of building

C_S = seismic response coefficient



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$$V = C_S W$$

$$C_S = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)} \leq \begin{cases} \dfrac{S_{D1}}{T\left(\frac{R}{I_e}\right)} & \text{for } T \leq T_L \\ \dfrac{S_{D1}T_L}{T^2\left(\frac{R}{I_e}\right)} & \text{for } T > T_L \end{cases}$$

S_{DS} = design spectral acceleration at short periods

S_{D1} = design spectral acceleration at 1-second period

I_e = importance factor

T = fundamental period of building

T_L = long period transition period

R = response modification coefficient

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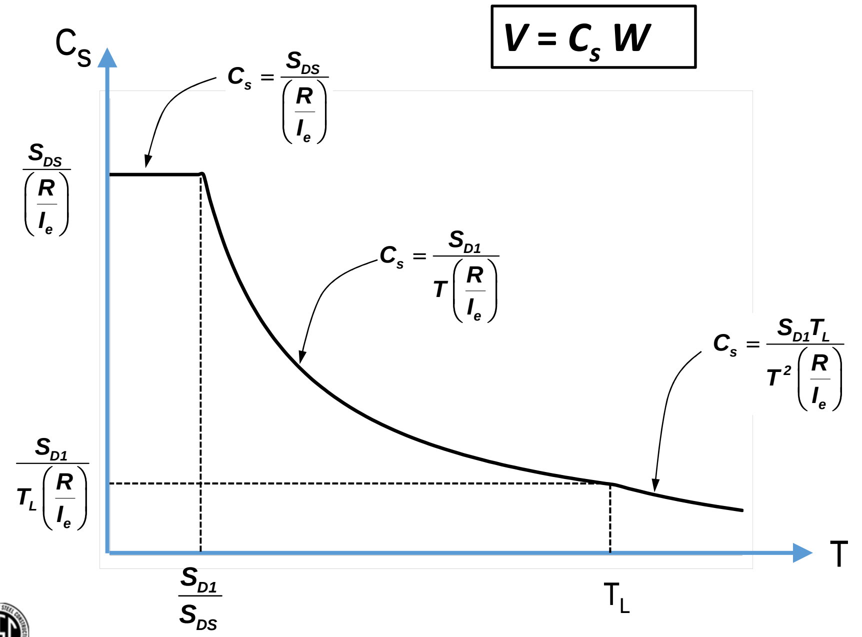

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Example:

- 7 story steel office building
- Risk Category II: $I_e = 1.0$
- $T \approx 0.7$ sec

Location: Santa Clarita, California (near Newhall Firehouse)

$S_{DS} = 1.93g$

$S_{D1} = 0.91g$

$T_L = 8$ sec

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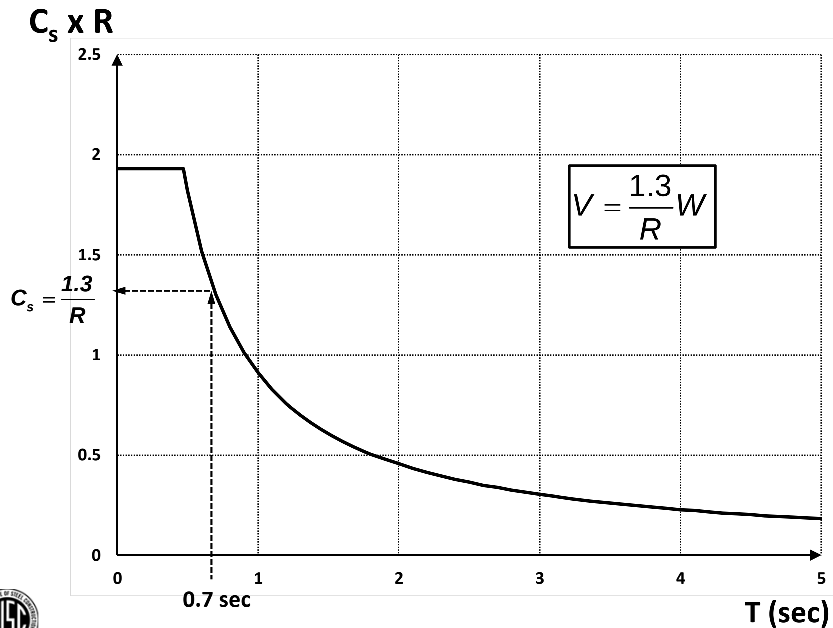
Location: Santa Clarita



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Example:

- 7 story steel office building
- Risk Category II: I_e = 1.0
- T ≈ 0.7 sec

Location: **Memphis, Tennessee (near Graceland)**

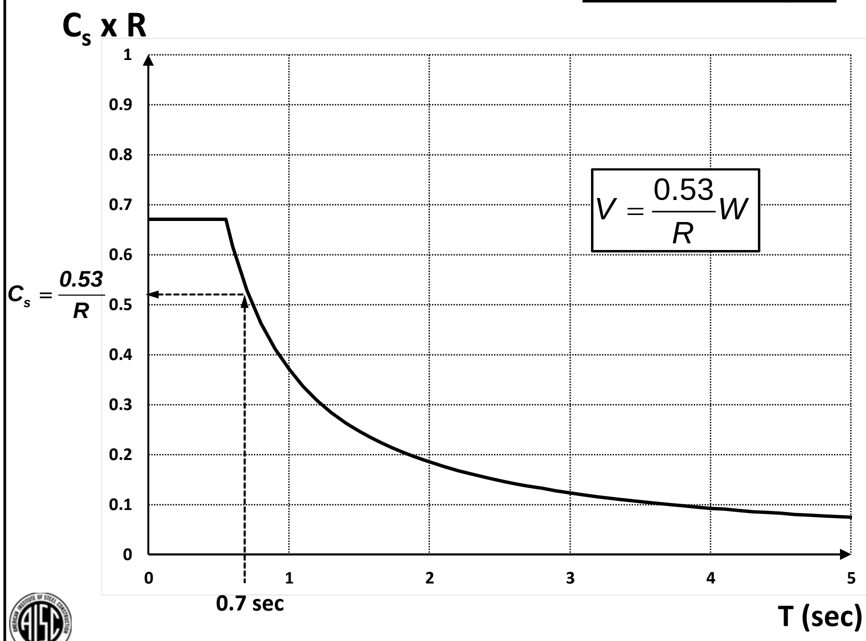
S_{DS} = 0.67g

S_{D1} = 0.37g

T_L = 12 sec

60

Location: Memphis



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Example:

- 7 story steel office building
- Risk Category II: $I_e = 1.0$
- T ≈ 0.7 sec

Location: Santa Clarita, California

$$V = \frac{1.3}{R}W$$

Location: Memphis, Tennessee

$$V = \frac{0.53}{R}W$$

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R factors for Selected Steel Systems (ASCE 7-10):

SMF	(*Special Moment Resisting Frames*):	**R = 8**
IMF	(*Intermediate Moment Resisting Frames*):	**R = 4.5**
OMF	(*Ordinary Moment Resisting Frames*):	**R = 3.5**
EBF	(*Eccentrically Braced Frames*):	**R = 8**
SCBF	(*Special Concentrically Braced Frames*):	**R = 6**
OCBF	(*Ordinary Concentrically Braced Frames*):	**R = 3.25**
BRBF	(*Buckling Restrained Braced Frame*):	**R = 8**
SPSW	(*Special Plate Shear Walls*):	**R = 7**

Undetailed Steel Systems in Seismic Design Categories B or C (AISC Seismic Provisions not needed) **R = 3**

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Example:

- 7 story steel office building
- Risk Category II: I_e = 1.0
- T ≈ 0.7 sec
- System designed and detailed as a **Special Moment Frame (SMF): *R* = 8**

Location: Santa Clarita, California

$$V = \frac{1.3}{R}W = \frac{1.3}{8}W = 0.16\,W$$

Location: Memphis, Tennessee

$$V = \frac{0.53}{R}W = \frac{0.53}{8}W = 0.066\,W$$

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Seismic Resistant Design

Key Elements:

General Seismic Design Requirements and required Lateral Strength and Stiffness

Specified by ASCE 7-10:
Minimum Design Loads for Buildings and Other Structures

↕

Ductile Detailing Requirements

For steel structures: Specified by AISC 341-10:
Seismic Provisions for Structural Steel Buildings

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Seismic Design for Non-West Coast Engineers

Part 2 (August 17, 2017)

- **Steel Structures: Performance in Past EQs**
- **EQ Resistant Design per ASCE 7-10**
- **Structural Steel Seismic Force-Resisting Systems in the AISC *Seismic Provisions***
- **References for Further Learning**

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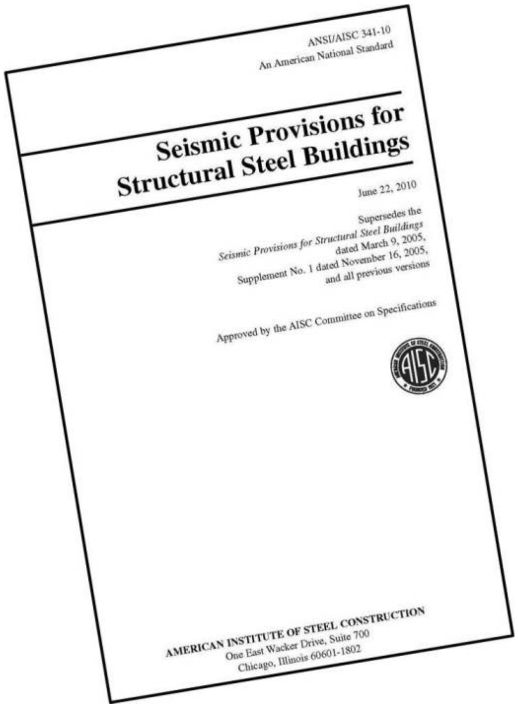

AISC 341-10

Free download at www.aisc.org

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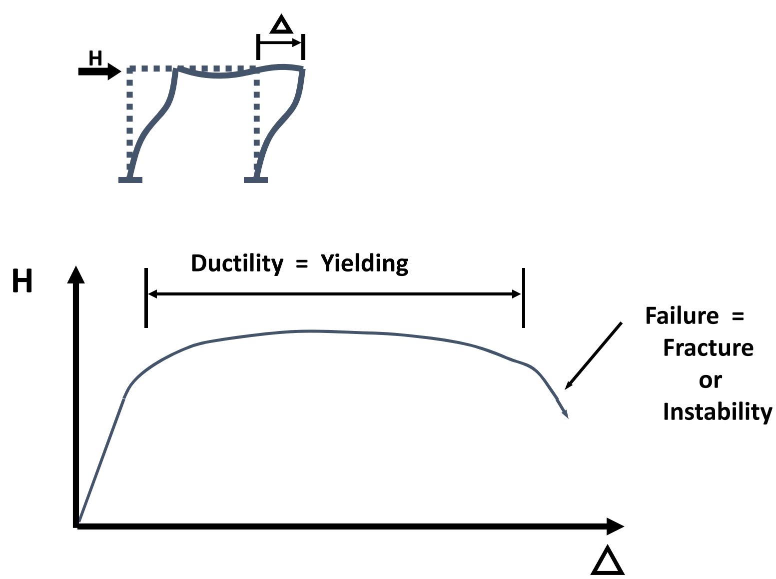

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Developing Ductile Behavior – *Capacity Design*:

- **Choose frame elements ("fuses") that will yield in an earthquake; e.g. beams in moment resisting frames, braces in concentrically braced frames, links in eccentrically braced frames, etc.**
- **Detail "fuses" to sustain large inelastic deformations prior to the onset of fracture or instability (i.e. detail fuses for ductility).**
- **Design all other frame elements to be stronger than the fuses, i.e. design all other frame elements to develop the plastic *capacity* of the fuses.**

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Seismic Force-Resisting Systems for Steel Buildings in AISC 341-10

- Moment Resisting Frames
- Concentrically Braced Frames
- Eccentrically Braced Frames
- Buckling Restrained Braced Frames
- Special Plate Shear Walls

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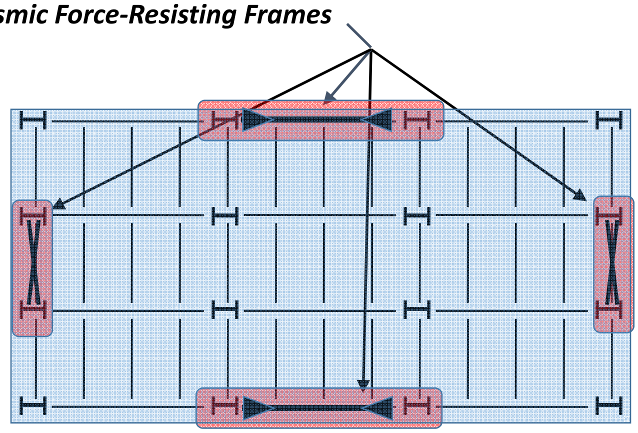
Seismic Force-Resisting Frames



Plan View of Typical Steel Building

71

MOMENT RESISTING FRAMES (SMF, IMF, OMF)

Beams and columns with moment resisting connections; resist lateral forces by flexure and shear in beams and columns - i.e. by frame action.

Develop ductility primarily by flexural yielding of the beams.

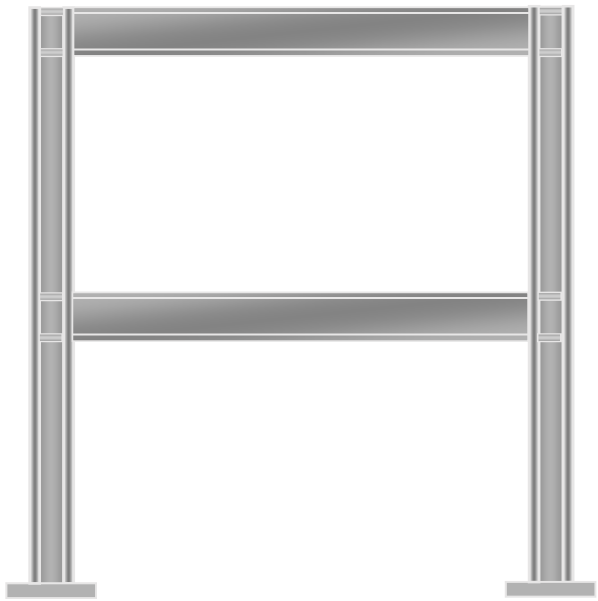
Advantages

- Architectural Versatility
- High Ductility and Safety

Disadvantages

- Low Elastic Stiffness

72



Moment Resisting Frame

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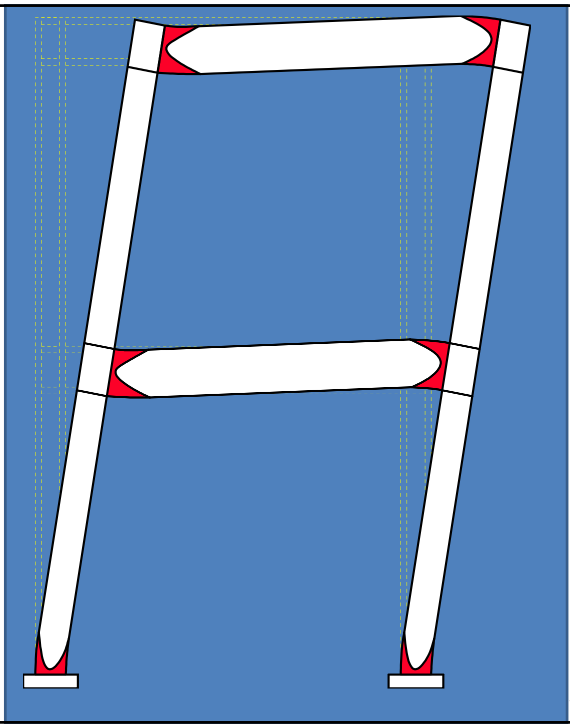
Inelastic Response of a Steel Moment Resisting Frame



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Concentrically Braced Frames (SCBF, OCBF)

Beams, columns and braces arranged to form a vertical truss.
Resist lateral earthquake forces by truss action.

Develop ductility through inelastic action in braces.

- braces yield in tension
- braces buckle in compression

Advantages

- high elastic stiffness

Disadvantages

- less ductile than other systems (SMFs, EBFs, BRBFs)
- reduced architectural versatility

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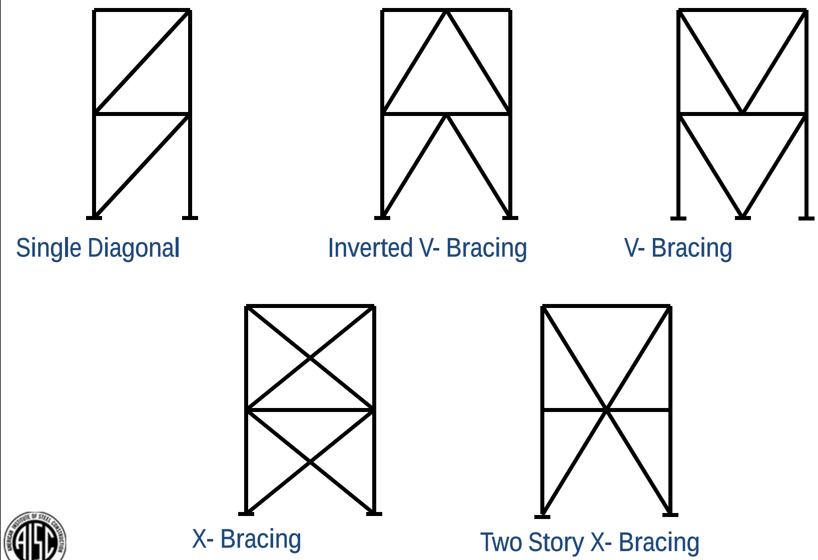
Types of CBFs



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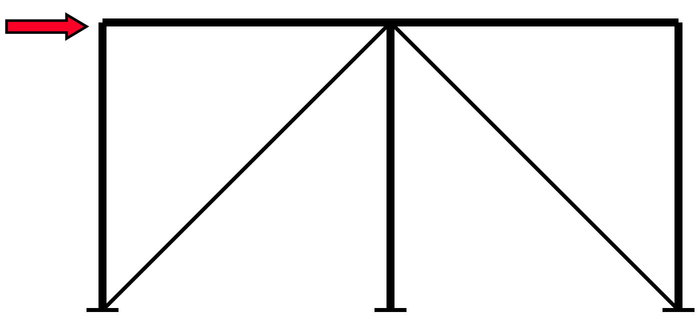
Inelastic Response of CBFs under Earthquake Loading



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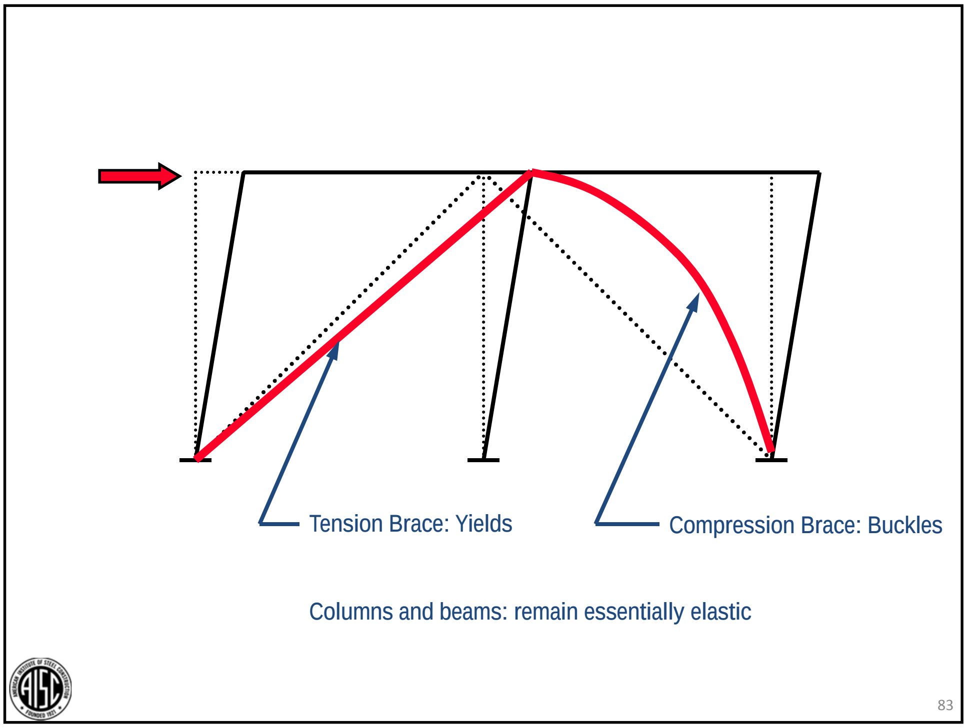
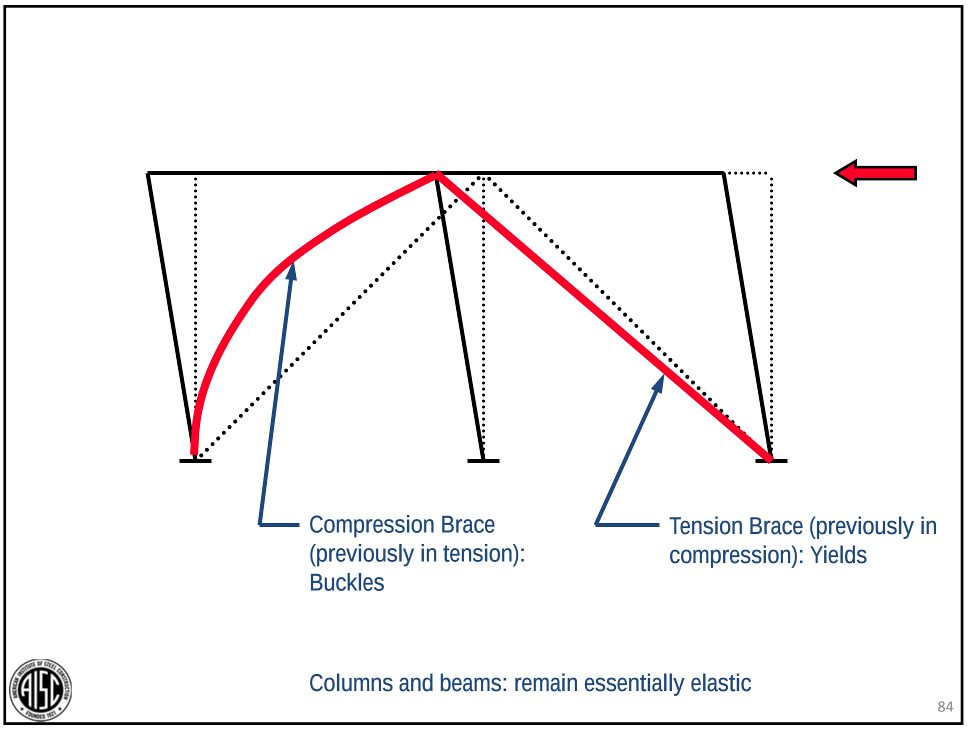
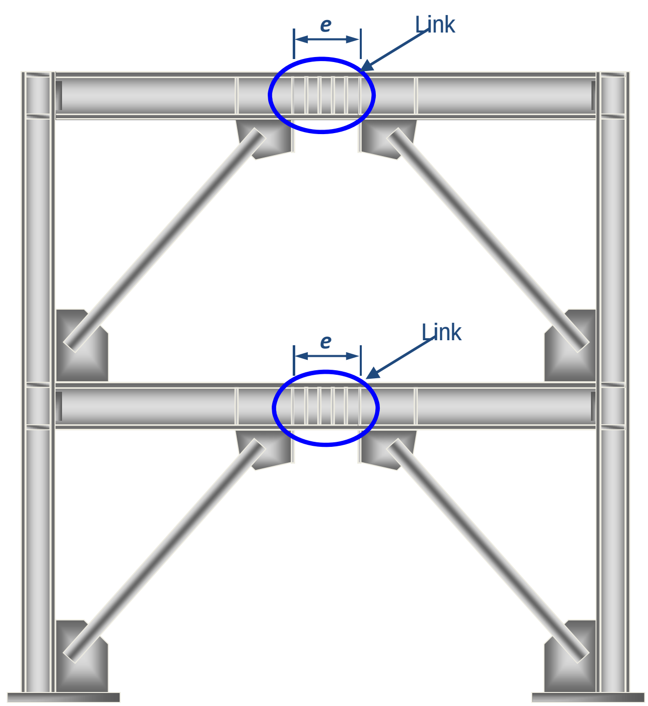

Tension Brace: Yields
Compression Brace: Buckles
Columns and beams: remain essentially elastic
83


Compression Brace (previously in tension): Buckles
Tension Brace (previously in compression): Yields
Columns and beams: remain essentially elastic
84

Eccentrically Braced Frames (EBFs)

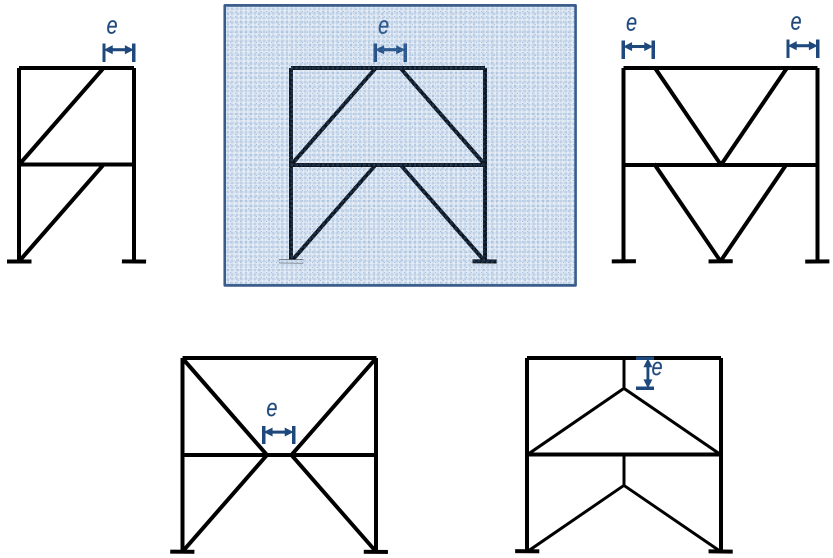
- Framing system with beam, columns and braces. At least one end of every brace is connected to isolate a segment of the beam called a *link.*
- Resist lateral load through a combination of frame action and truss action. EBFs can be viewed as a hybrid system between moment frames and concentrically braced frames.
- Develop ductility through inelastic action in the links.
- EBFs can supply high levels of ductility (similar to MRFs), but can also provide high levels of elastic stiffness (similar to CBFs)

85



86

Some possible bracing arrangement for EBFS



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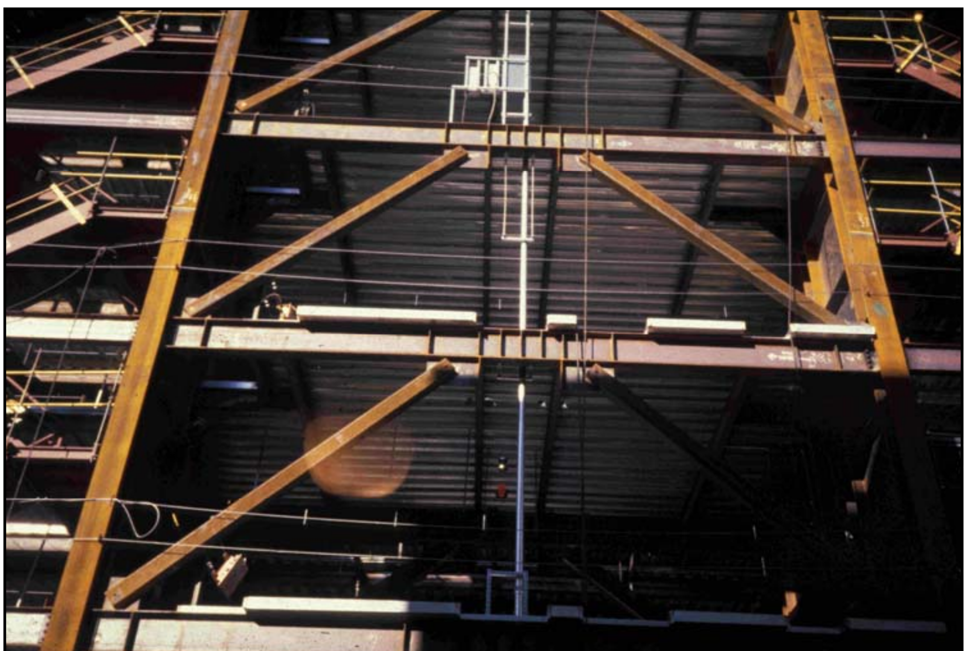

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Herrick
KEEP
OUT

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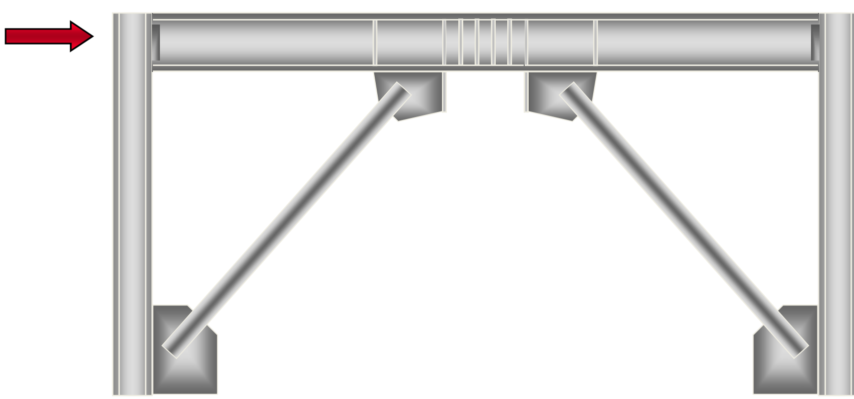
Inelastic Response of EBFs



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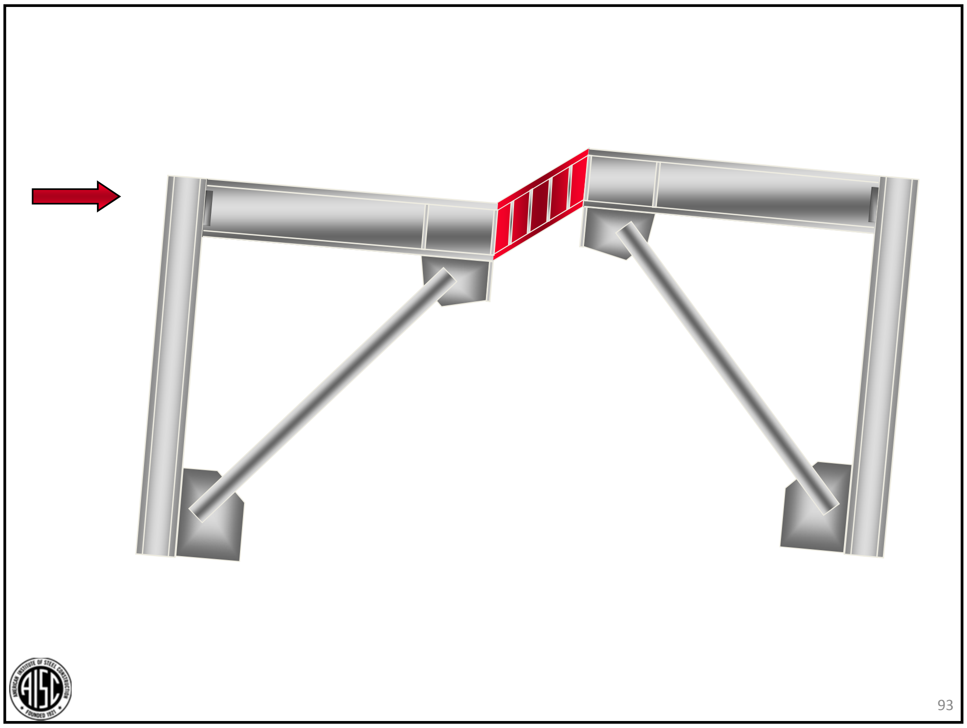
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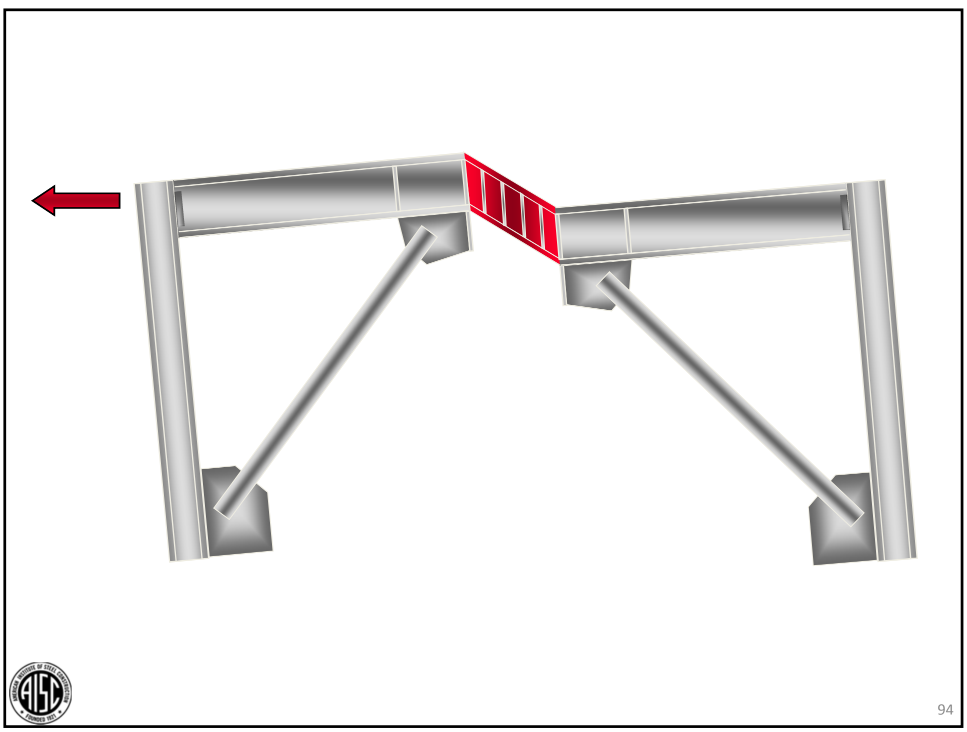
94

Buckling-Restrained Braced Frames (BRBFs)

- Type of concentrically braced frame.
- Beams, columns and braces arranged to form a vertical truss. Resist lateral earthquake forces by truss action.
- Special type of brace members used: *Buckling-Restrained Braces (BRBs)*. BRBS yield both in tension and compression - *no buckling !!*
- Develop ductility through inelastic action (cyclic tension and compression yielding) in BRBs.
- System combines high stiffness with high ductility.

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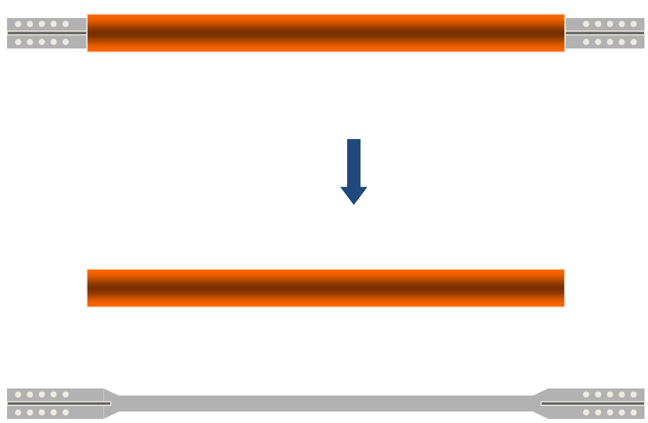
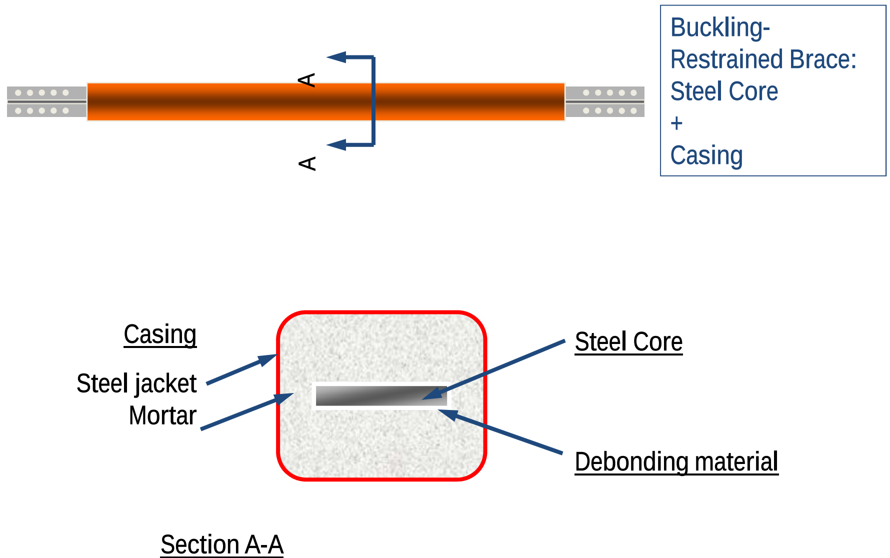
Buckling-Restrained Brace



96

Buckling-Restrained Brace



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Buckling-Restrained Brace

Steel core resists entire axial force P

Casing is debonded from steel core
- casing does not resist axial force P
- flexural stiffness of casing restrains buckling of core

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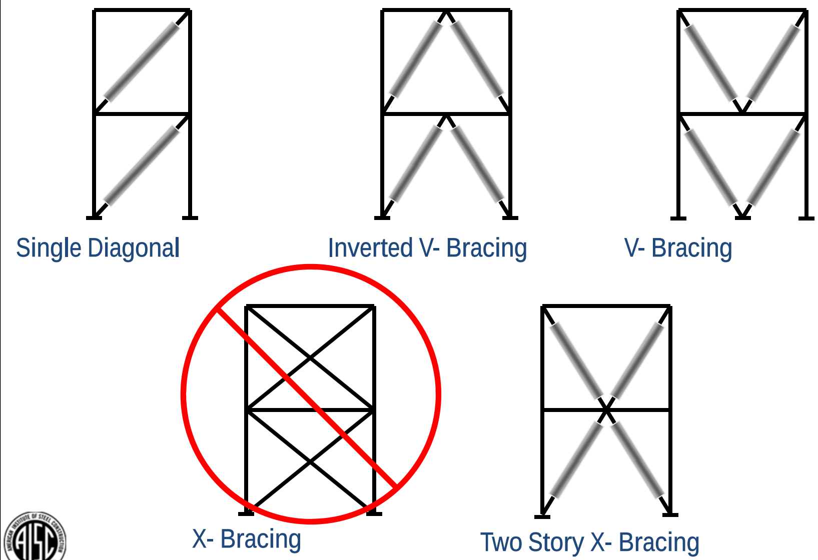
Bracing Configurations for BRBFs



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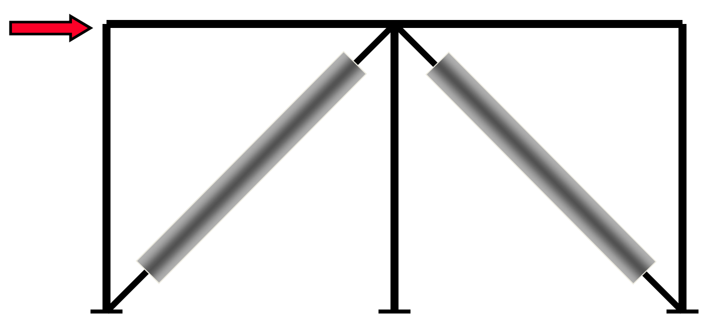
Inelastic Response of BRBFs under Earthquake Loading



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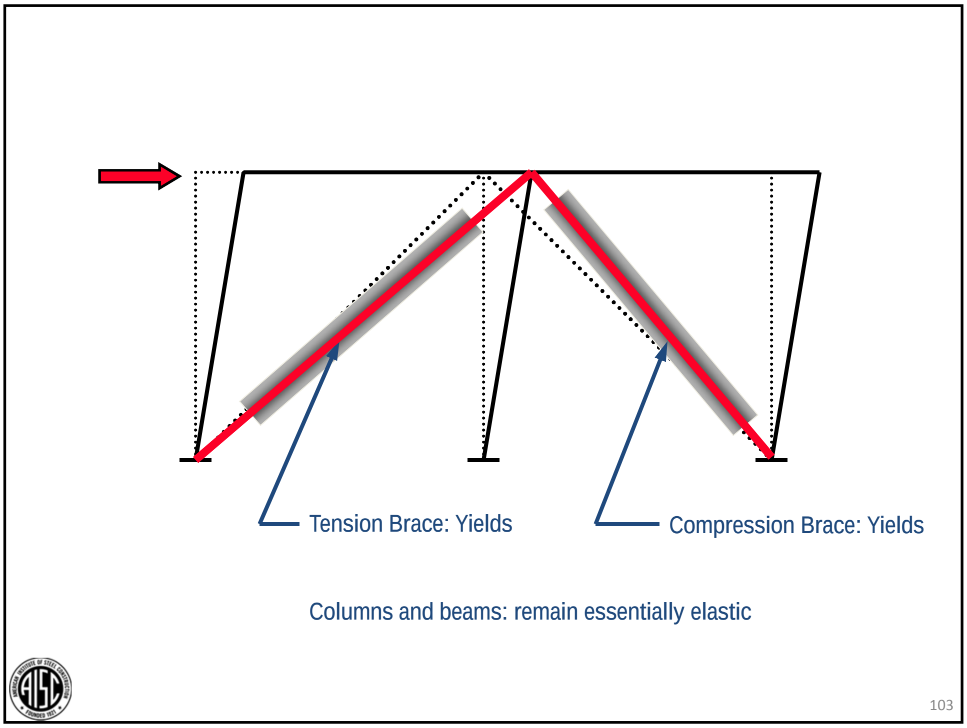
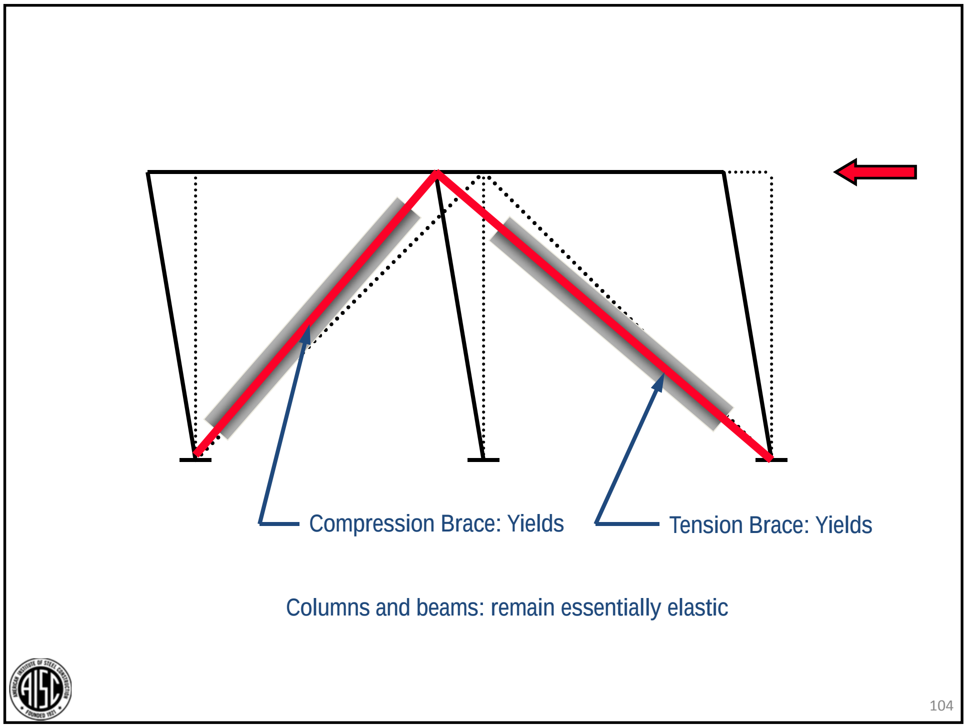

Tension Brace: Yields
Compression Brace: Yields
Columns and beams: remain essentially elastic
103


Compression Brace: Yields
Tension Brace: Yields
Columns and beams: remain essentially elastic
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Special Plate Shear Walls (SPSW)

- Assemblage of consisting of rigid frame, infilled with thin steel plates.
- Under lateral load, system behaves similar to a plate girder. Wall plate buckles under diagonal compression and forms tension field.
- Develop ductility through tension yielding of wall plate along diagonal tension field.
- System combines high stiffness with high ductility.

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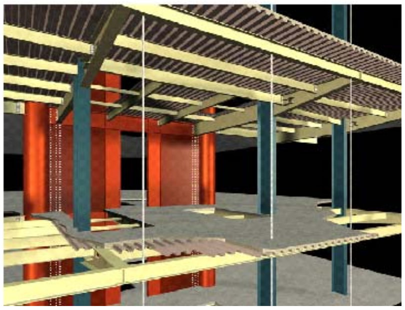

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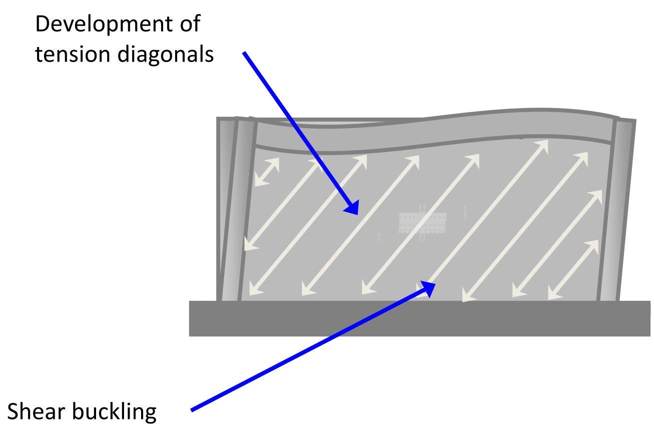
Inelastic Response of a SPSW



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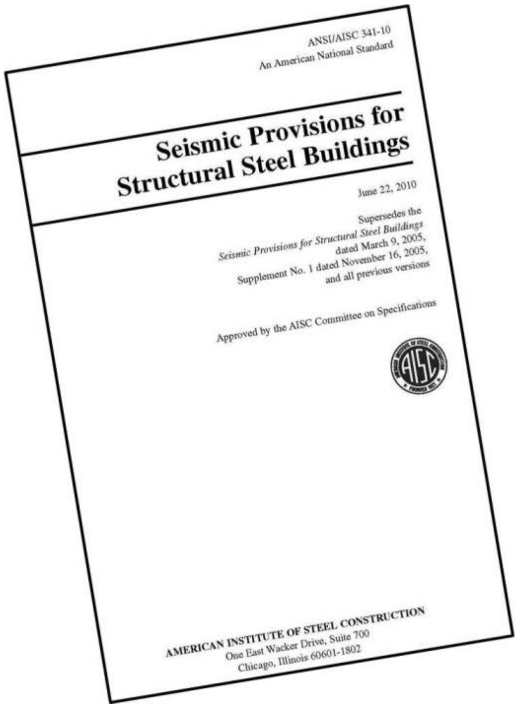

ANSI/AISC 341-10
An American National Standard

Seismic Provisions for
Structural Steel Buildings

June 22, 2010

Supersedes the
Seismic Provisions for Structural Steel Buildings
dated March 9, 2005,
Supplement No. 1 dated November 16, 2005,
and all previous versions

Approved by the AISC Committee on Specifications

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
One East Wacker Drive, Suite 700
Chicago, Illinois 60601-1802

AISC 341-10

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2010 AISC Seismic Provisions for Structural Steel Buildings

Symbols

Glossary

A. General Requirements

B. General Design Requirements

C. Analysis

D. General Member and Connection Design Requirements

E. Moment Frame Systems

F. Braced Frames and Shear-Wall Systems

G. Composite Moment Frame Systems

H. Composite Braced Frame and Shear-Wall Systems

I. Fabrication and Erection

J. Quality Control and Quality Assurance

K. Prequalification and Cyclic Qualification Testing Provisions

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Seismic Design for Non-West Coast Engineers

Part 2 (August 17, 2017)

- **Steel Structures: Performance in Past EQs**
- **EQ Resistant Design per ASCE 7-10**
- **Structural Steel Seismic Force-Resisting Systems in the AISC *Seismic Provisions***
- **References for Further Learning**

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Some References for Further Learning

- **Basic text on structural dynamics**

  "Dynamics of Structures; Theory and Applications to Earthquake Engineering"
  Anil Chopra, 2011

  "Dynamics of Structures"
  Ray Clough and Joseph Penzien, 2010

- **Text on Seismic Design of Steel Structures**

  "Ductile Design of Steel Structures"
  Michel Bruneau, Chia-Ming Uang, Rafael Sabelli, 2011

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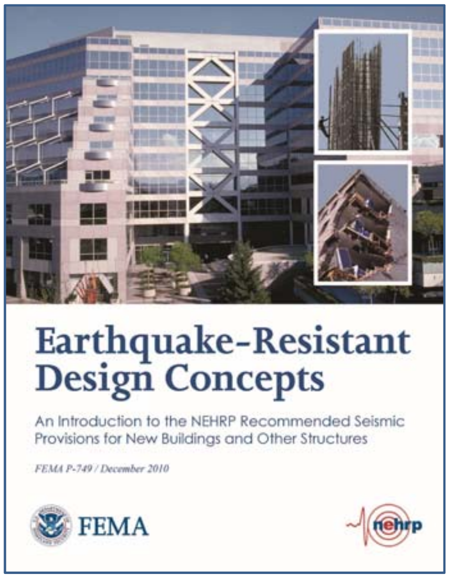

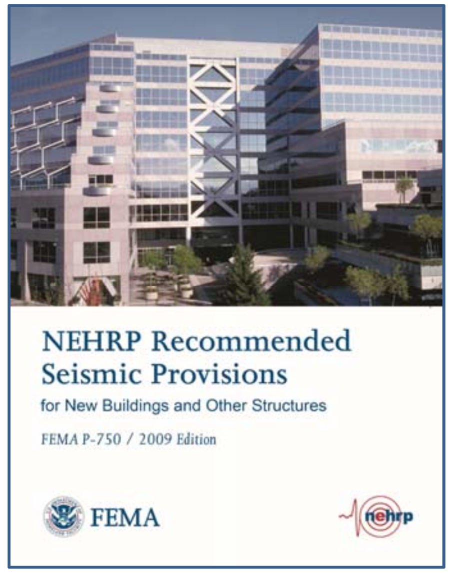

FEMA P-749 **FEMA P-750**

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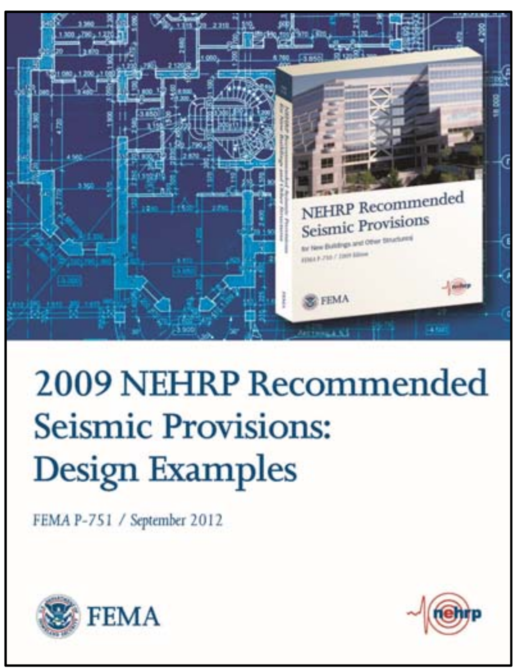

FEMA P-751

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NEHRP Seismic Design Technical Briefs

http://www.nehrp.gov/library/techbriefs.htm

- Tech Brief No. 2
  Seismic Design of Steel Special Moment Frames:
  A Guide for Practicing Engineers

- Tech Brief No. 4
  Nonlinear Structural Analysis For Seismic Design:
  A Guide for Practicing Engineers

- Tech Brief No. 5
  Seismic Design of Composite Steel Deck and Concrete-filled
  Diaphragms: A Guide for Practicing Engineers

- Tech Brief No. 8
  Seismic Design of Steel Special Concentrically Braced Frame
  Systems: A Guide for Practicing Engineers

- Tech Brief No. 11
  Seismic Design of Steel Buckling Restrained Braced Frames

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NEHRP Seismic Design Technical Brief No. 2

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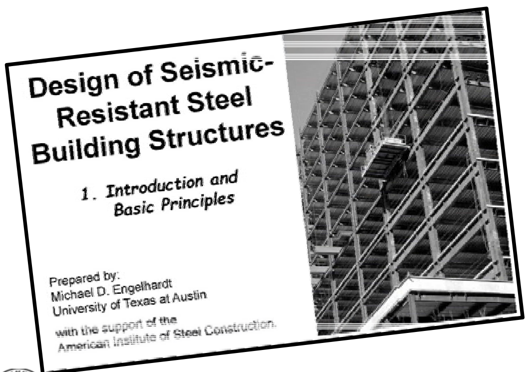
AISC Teaching Aid

Teaching Principles of Seismic Resistant Design of Steel Building Structures



www.aisc.org
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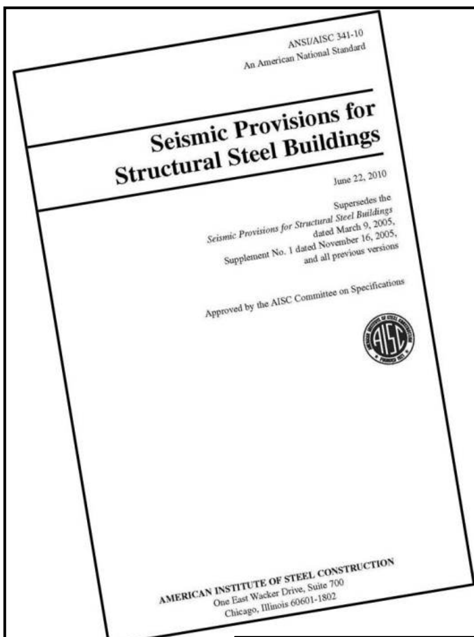
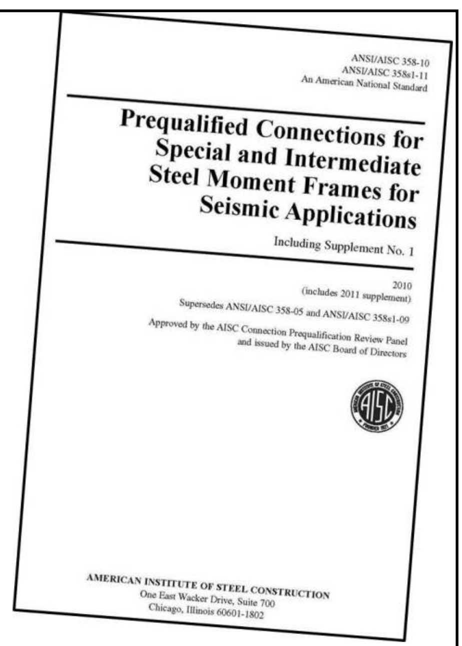


AISC 341-10



AISC 358-10

Free download at www.aisc.org

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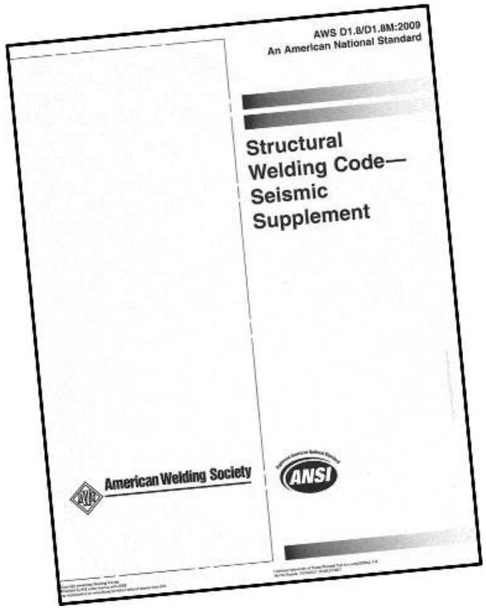

Additional Key Reference: "Structural Welding Code – Seismic Supplement." AWS D1.8-2009

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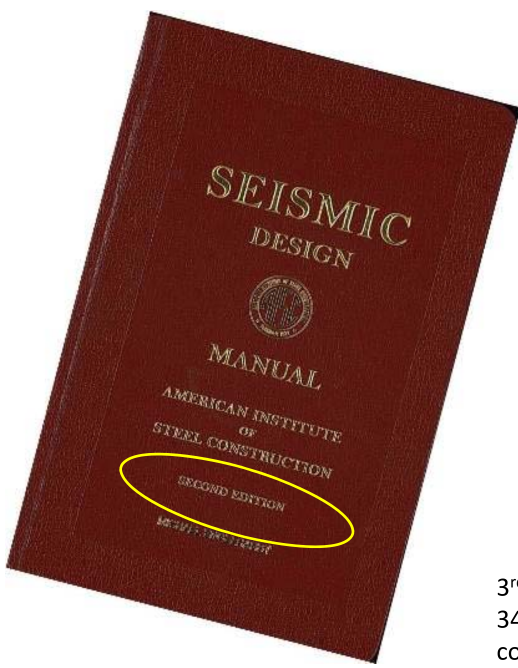

3rd Edition – Keyed to AISC 341-16 and AISC358-16: coming Summer 2018

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- **Structural Steel Seismic Force-Resisting Systems in the AISC *Seismic Provisions***
- **References for Further Learning**

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Question 1

The Seismic Design Category (SDC) assigned to a building depends on:

a) geographic location of the building with the U.S.
b) soil conditions at the site of the building
c) importance of the building
d) all of the above

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Question 2

True or False: In a steel Special Concentrically Braced Frame (SCBF), the design intent of AISC 341 is that the braces are the weakest structural element in the system.

a) True
b) False

PDH Certificates

Within 2 business days…

- You will receive an email on how to report attendance from: registration@aisc.org.
- Be on the lookout: Check your spam filter! Check your junk folder!
- Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

PDH Certificates

Within 2 business days…

- Reporting site (URL will be provided in the forthcoming email).
- Username: Same as AISC website username.
- Password: Same as AISC website password.

There's always a solution in steel.

Thank You

Please give us your feedback!
Survey at conclusion of webinar.

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