# SESSION TU4C: The Steps Behind Building Resilience

## A 2020 NEHRP Effort: What Can You Expect on Major Changes on Seismic Provisions and US Seismic Value maps


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January 8, 2019

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nehrp FEMA USGS science for a changing world

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# OUTLINE

- *NEHRP at FEMA and Overview BSSC work, Mai Tong (JQ Yuan)*
- *Relations between NEHRP Provisions and ASCE 7 and IBC, SK Ghosh*
- *Update on the ongoing 2020 NEHRP  efforts (ASCE 7-22 and IBC 2024), SK Ghosh*
- *Update on the major changes on US Seismic Design value maps, Nico Luco (SK Ghosh)*

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# The National Earthquake Hazards Reduction Program (NEHRP) at FEMA

- Translate new research results, lessons learned information and best practices into code resource, mitigation solutions, technical guidelines, risk awareness and earthquake preparedness materials
  - 2015 NEHRP Provisions (FEMA P-1050)
  - Seismic Performance Assessment of Buildings (FEMA P-58-2)
  - Safer, Stronger and Smarter, A Guide to Improve School to Natural Hazard Safety (FEMA P-1000)
  - Hazus Estimated Annualized Earthquake Losses for the United States (FEMA P-366)
- Support States and local at-risk communities in earthquake preparedness, mitigation, response and recovery
  - Earthquake State Assistance Program
  - National Earthquake Technical Assistance Program (NETAP)
  - Earthquake Recover Advisories
  - Building codes update, adoption and enforcement

# Building Seismic Safety Council

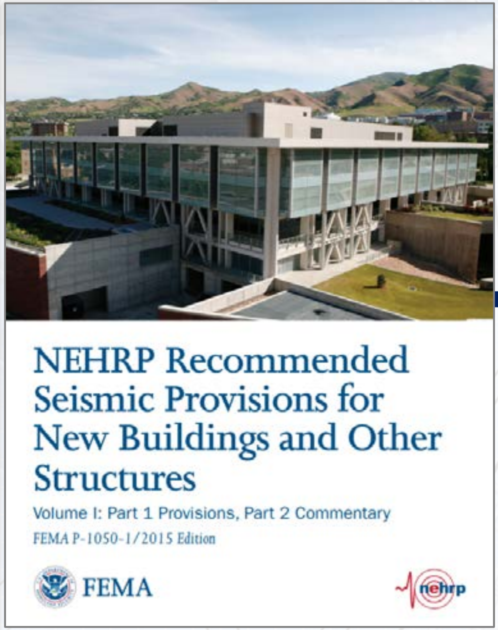
The BSSC is an independent, voluntary organizational membership body representing a wide variety of building community interests.

Its fundamental purpose is to enhance public safety by providing a national forum that fosters improved seismic planning, design, construction and regulation in the building community.

To fulfill its purpose, the BSSC: (1) recommends, encourages and promotes the improvement and update of seismic safety provisions for adoption by the national standards and model building codes; … .

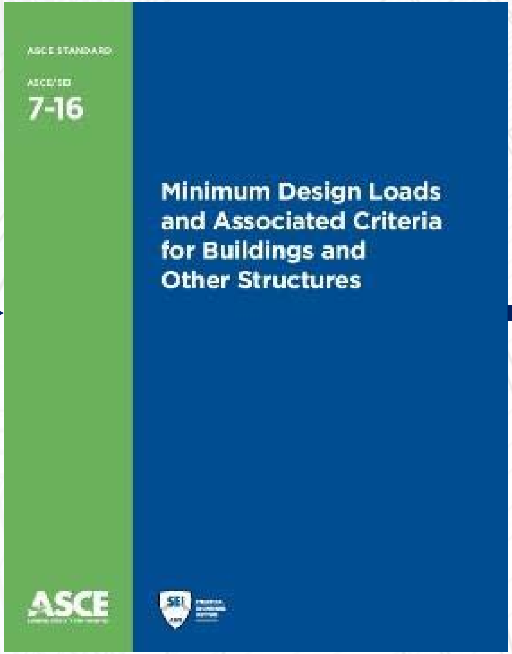
# What are NEHRP Provisions?

**2020**

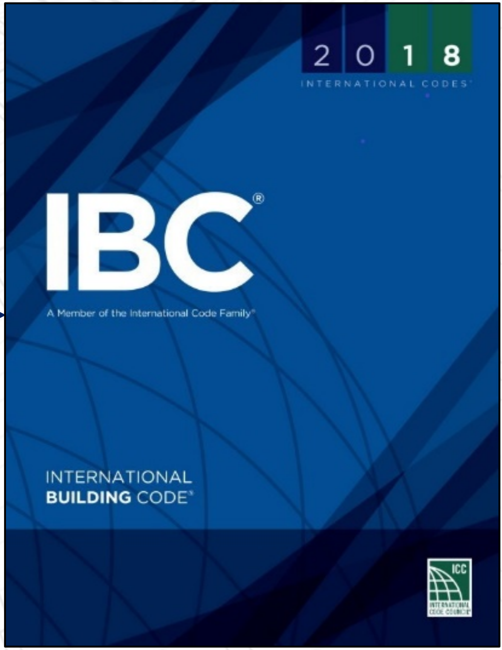



FEMA supported BSSC effort

**2022**




**2024**



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# 2020 NEHRP Provisions Proposals Development

## NIBS/Building Seismic Safety Council
## Provisions Update Committee (PUC)

Proposals developed by Issues Teams

Proposals by PUC members

Significant technical proposals by others, including those submitted by the ASCE Seismic Subcommittee.

**BSSC/PUC Main Committee:**

PUC balloting followed by Member Organization (MO) balloting and BSSC Board of Direction Approval

NEHRP Provisions

Used and Codified by ASCE/SEI 7

Adoption by IBC/IRC/IEBC

# BSSC Process

About | Board | Membership | PUC | Project 17 | CRSC

## 2020 NEHRP Provisions Update Committ

The *NEHRP Recommended Provisions for New Buildings and Other Structures* embodi
criteria for the design and construction of buildings subject to earthquake hazards
technologies contained in this resource document are diffused into several nation
Ameri ... *um Loads* that
mod ... CC).

## PUC and IT SMEs

The P ... UC) a techni
experts that identify and apply the most advanced seismic technology available. T
by expert issue teams (ITs) that address specific aspects of seismic design method
These committee and team members ensure that lessons learned from the buildi
earthquakes, as well as new research to improve earthquake resistance, are reflec
seismic requirements. The ITs develop proposals for requirements that are ballot
BSSC's consensus process, and subsequently balloted by the member organizatio

### PUC Committee Members

| Name | Organization | Role |
|---|---|---|
| David Bonneville | Degenkolb Engineers | Chair |
| Peter Carrato | Bechtel Power Corporation | Member |
| Kelly Cobeen | Wiss, Janney, Elstner Associates | Member |
| C.B. Crouse | AECOM | Member |
| Dan Dolan | Washington State University | Member |
| Anindya Dutta | Simpson Gumpertz & Heger | Member |
| S.K. Ghosh | S.K. Ghosh Associates | Member |
| John Gillengerten | John Gillengerten | Member |
| Ron Hamburger | Simpson Gumpertz & Heger | Member |
| Jim Harris | James Harris & Associates | Member |

## BSSC Member Organizations

- American Concrete Institute
- American Institute of Architects
- American Institute of Architects
- American Institute of Steel Construction
- American Iron and Steel Institute
- American Society of Civil Engineers
- Am
- APA
- App
- ASHRAE
- Builiding Owners and Managers Association
- DGS
- Concrete Masonry Association of California and Nevada
- Concrete Reinforcing Steel Institute
- Department of Veterans Affairs
- General Services Administration
- Insurance Institute for Business and Home Safety
- International Code Council
- Metal Building Manufacturers Association
- National Association of Homebuilders
- National Concrete Masonry Association
- National Council of Structural Engineers Associations
- Portland Cement Association
- Portland Cement Association
- Precast/Prestressed Concrete Institute
- Rack Manufacturers Institute
- Steel Deck Institute
- Structural Engineer Association of
- California
- Central California
- Structural Engineers Association of Colorado
- Structural Engineers Association of Illinois
- Structural Engineers Association of Kansas & Missouri
- Structural Engineers Association of Northern California
- Structural Engineers Association of San Diego (SEAOSD)
- Structural Engineers Association of Southern California
- Structural Engineers Association of Southern California
- Structural Engineers Association of Utah
- Steel Joist Institute
- The Masonry Society

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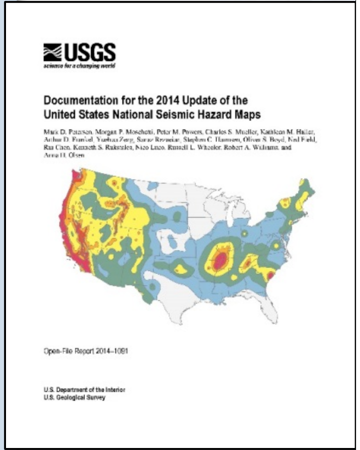
# 2020 Provisions Update Committee (PUC) – Issue Teams

- IT 1 - Seismic Performance Objectives
- IT 2 - Seismic Resisting Systems and Design Coefficients
- IT 3 - Modal Response Spectrum Analysis
- IT 4 - Shear Wall Design
- IT 5 - Nonstructural Components
- IT 6 - Nonbuilding Structures
- IT 7 - Soil Foundation Interaction
- IT 8 - Base Isolation and Energy Dissipation
- IT 9 - Diaphragm Issues
- **Project 17 - Updated Basis for National Seismic Design Values Maps**


USGS
science for a changing world

Documentation for the 2014 Update of the United States National Seismic Hazard Maps

Mark D. Petersen, Morgan P. Moschetti, Peter M. Powers, Charles S. Mueller, Kathleen M. Haller, Arthur D. Frankel, Yuehua Zeng, Sanaz Rezaeian, Stephen C. Harmsen, Oliver S. Boyd, Ned Field, Rui Chen, Kenneth S. Rukstales, Nico Luco, Russell L. Wheeler, Robert A. Williams, and Anna H. Olsen

Open-File Report 2014–1091

U.S. Department of the Interior
U.S. Geological Survey

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- *Update on the ongoing 2020 NEHRP efforts (ASCE 7-22 and IBC 2024), SK Ghosh*
- *Update on the major changes on US Seismic Design value maps, Nico Luco (SK Ghosh)*

# Overview of BSSC work, Relations between NEHRP *Provisions* and ASCE 7 and IBC
# Update on the Ongoing PUC efforts, Major Technical Changes Expected for 2020 NEHRP *Provisions* (ASCE 7-22 and IBC 2024)

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Palatine, IL and Aliso Viejo, CA

January 8, 2019

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# U.S. Codes and Standards

Legal Codes
California Building Code

↓

Model Codes
International Building Code

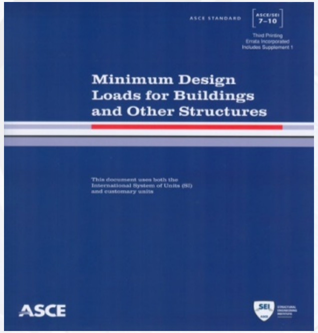
↓

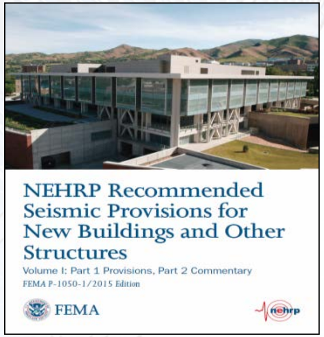
Standards
ASCE 7

↓

Resource Documents
NEHRP *Provisions*

# 2015 NEHRP *Provisions*

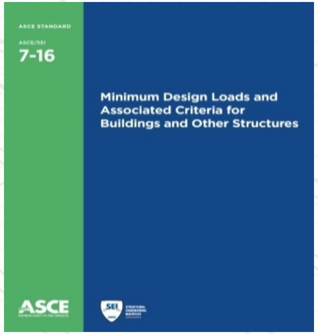


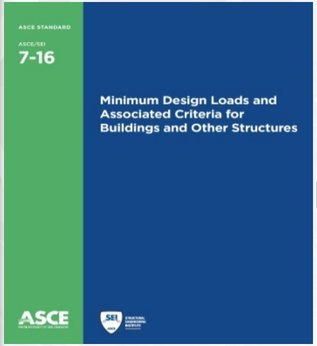

Part 1: Modifications to ASCE 7-10

Part 2: Commentary to Part 1

Part 3: Resource Papers




# 2020 NEHRP *Provisions*




2020 NEHRP *Provisions*

Part 1: Modifications to ASCE 7-16

Part 2: Commentary to Part 1

Part 3: Resource Papers

ASCE 7-22

2024 IBC

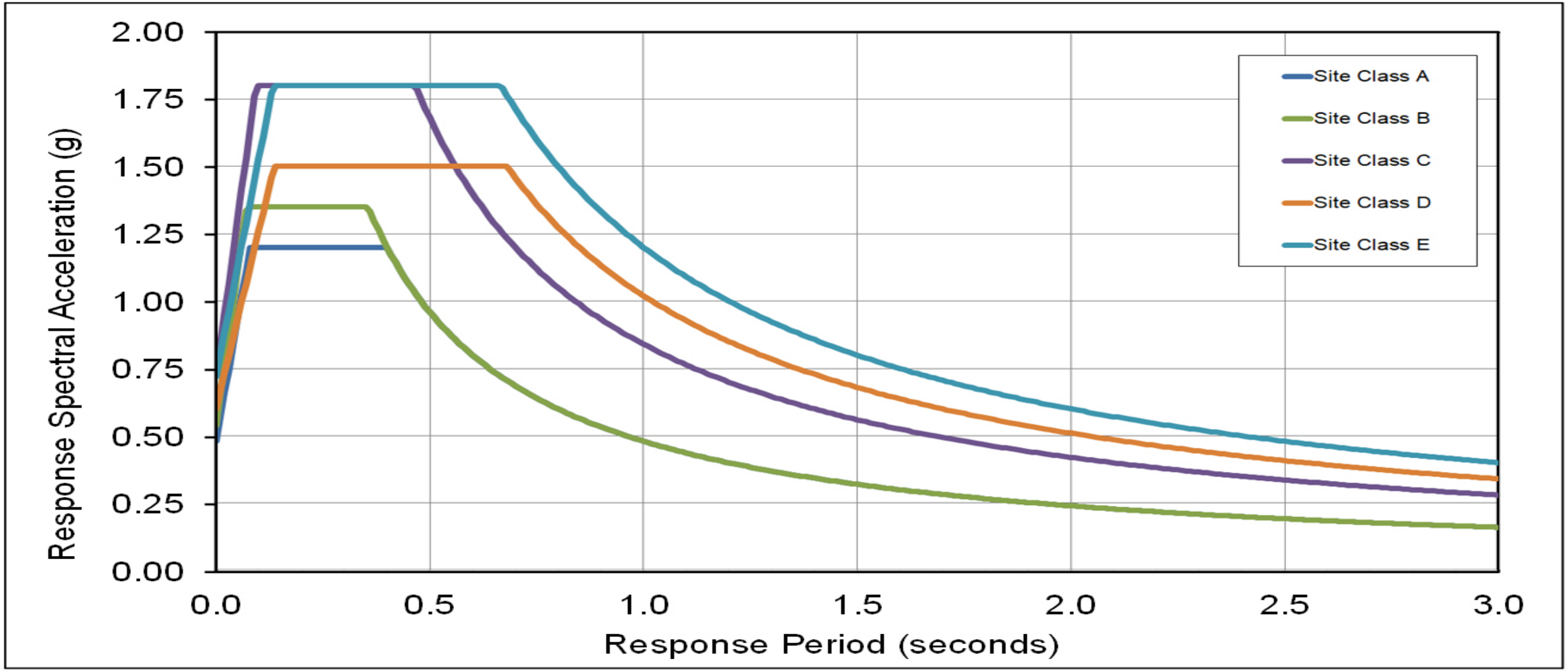
# ASCE 7-16 Site Classification

| 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 blows/ft | > 2,000 lb/ft$^2$ |
| **D. Stiff soil** | 600 to 1,200 ft/s | 15 to 50 blows/ft | 1,000 to 2,000 lb/ft$^2$ |
| **E. Soft clay soil** | < 600 ft/s | < 15 blows/ft | < 1,000 lb/ft$^2$ |
| | Any profile with more than 10 ft of soil that has the following characteristics:<br>— Plasticity index *PI* > 20,<br>— Moisture content $\omega \geq 40\%$ ,<br>— Undrained shear strength $\bar{s}_u < 500 \text{ lb / ft}^2$ | | |
| **F. Soils requiring site response analysis in accordance with Section 21.1** | See Section 20.3.1 | | |

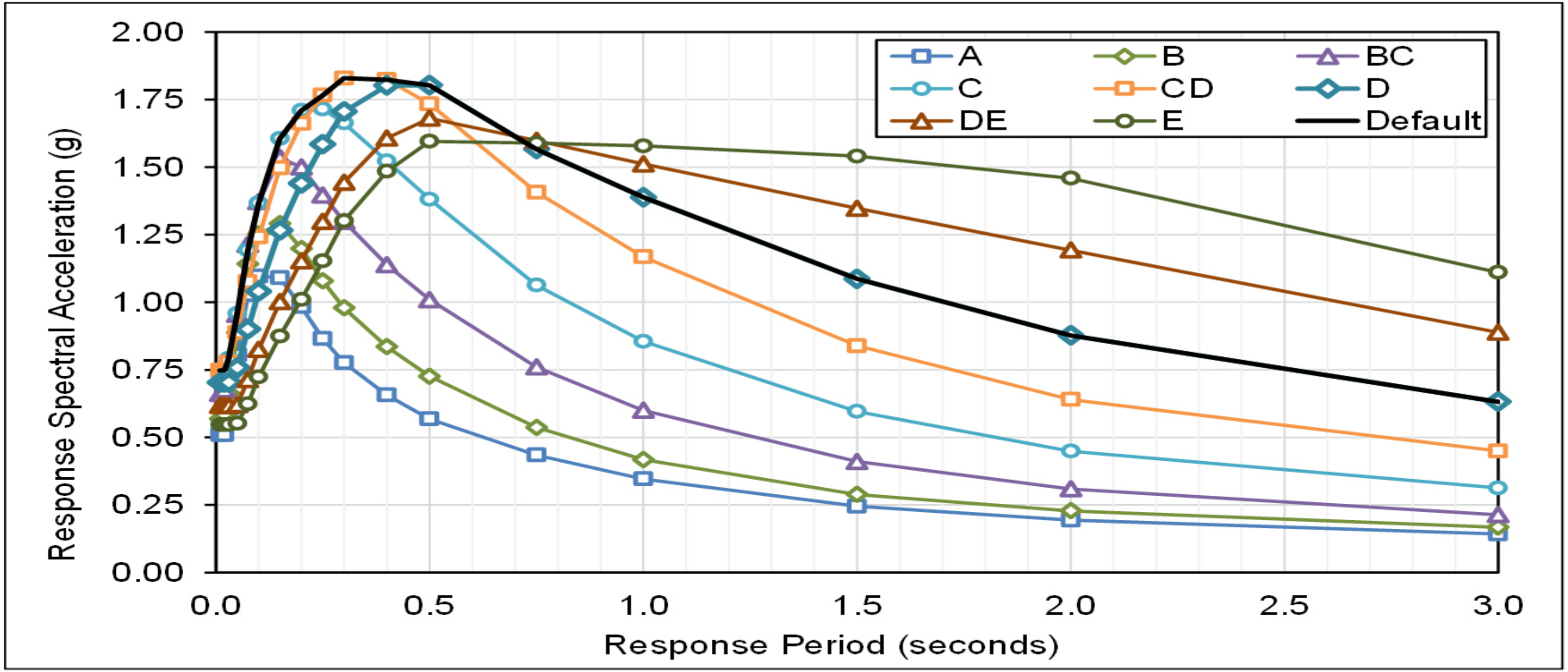
# Proposed Site Classification

| Site Class | Measured or Estimated, $\overline{v}_s$ |
| --- | --- |
| A. Hard rock | > 5,000 ft/s |
| B. Rock | 3,000 to 5,000 ft/s |
| BC. Soft Rock | 2,100 to 3,000 ft/s |
| C. Very dense sand or Hard clay | 1,450 to 2,100 ft/s |
| CD. Dense sand or Very stiff clay | 1,000 to 1,450 ft/s |
| D. Medium dense sand or Stiff clay | 700 to 1,000 ft/s |
| DE. Loose sand or Medium stiff clay | 500 to 700 ft/s |
| E. Very loose sand or Soft clay | < 500 ft/s |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.3.1 |

# ASCE 7-16 $MCE_R$ Spectra



# Proposed 2020 $MCE_R$ Spectra



# Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Spectral Response Acceleration Parameters.

No $S_S$, $S_1$, $PGA$

Only $S_{MS}$, $S_{M1}$, $PGA_M$

No site coefficients - $F_a$, $F_v$

$S_{MS}$ = the mapped $MCE_R$ spectral response acceleration parameter at short periods as determined in accordance with Section 11.4.3, and

$S_{M1}$ = the mapped $MCE_R$ spectral response acceleration parameter at a period of 1 s as determined in accordance with Section 11.4.3.

# Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Spectral Response Acceleration Parameters.

Risk-targeted maximum considered earthquake ($MCE_R$) spectral response acceleration parameters $S_{MS}$ and $S_{M1}$ shall be determined from the mapped values of these parameters provided at the U.S. Geological Survey (USGS) website at https://doi.org/10.5066/F7NK3C76 for the site class determined in accordance with the site class requirements of Section 11.4.2.

# Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Spectral Response Acceleration Parameters.

Where the soil properties are not known in sufficient detail to determine the site class and the default site class requirements of Section 11.4.2.1 apply, risk-targeted maximum considered earthquake ($MCE_R$) spectral response acceleration parameters $S_{MS}$ and $S_{M1}$ shall be determined from the mapped values of 0.2- and 1-s spectral response accelerations shown in Figs. 22-1, 22-3, 22-5, 22-6, 22-7, and 22-8 for $S_{MS}$ and Figs. 22-2, 22-4, 22-5, 22-6, 22-7, and 22-8 for $S_{M1}$.

# Proposed Consolidation of SDCs

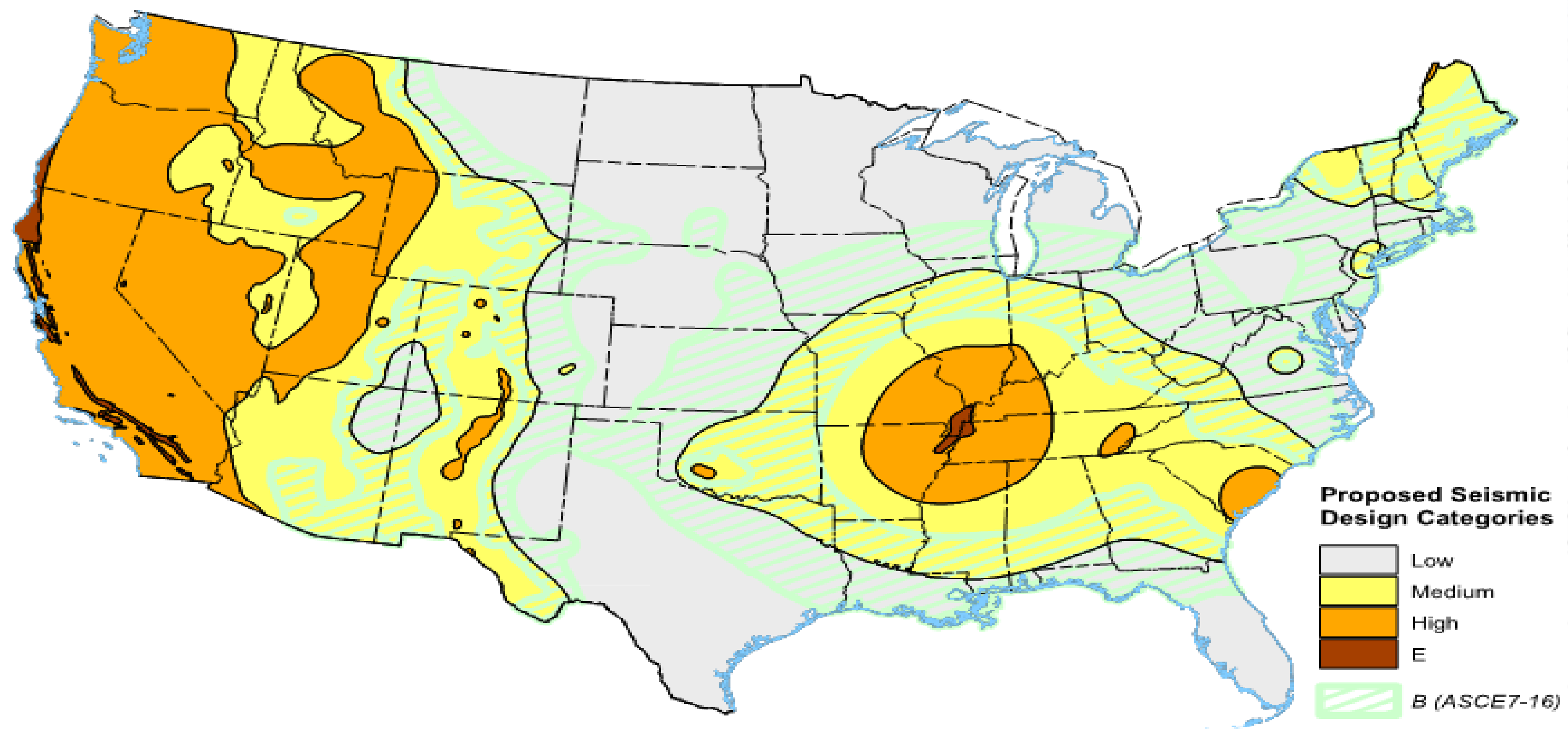
## ASCE 7-16

| Values of $S_{D1}$ | Values of $S_{M1}$ | Risk Category | |
|---|---|---|---|
| | | I or II or III | IV |
| $S_{D1} < 0.067$ | $S_{M1} < 0.10$ | A | A |
| $0.067 \leq S_{D1} < 0.133$ | $0.10 \leq S_{M1} < 0.20$ | B | C |
| $0.133 \leq S_{D1} < 0.20$ | $0.20 \leq S_{M1} < 0.30$ | C | D |
| $0.20 \leq S_{D1}$ | $0.30 \leq S_{M1}$ | D | D |

## Proposed

| Values of $S_{M1}$ | SDC |
|---|---|
| $S_{M1} < 0.15$ | Low |
| $0.15 \leq S_{M1} < 0.30$ | Moderate |
| $0.30 \leq S_{M1}$ | High |

# Proposed Consolidated SDC Map Based on Default Site Class



# Proposed 2020 NEHRP *Provisions* Definition for Default Site Class.

Where the soil properties are not known in sufficient detail to determine the site class, risk-targeted maximum considered earthquake ($MCE_R$) spectral response accelerations shall be based on the more critical spectral response acceleration of Site Class C, Site Class CD and Site Class D subsurface conditions, unless the authority having jurisdiction determines, based on geotechnical data, that Site Class DE, E or F soils are present at the site.

# Proposed Consolidatd SDC Map Based on Default Site Class

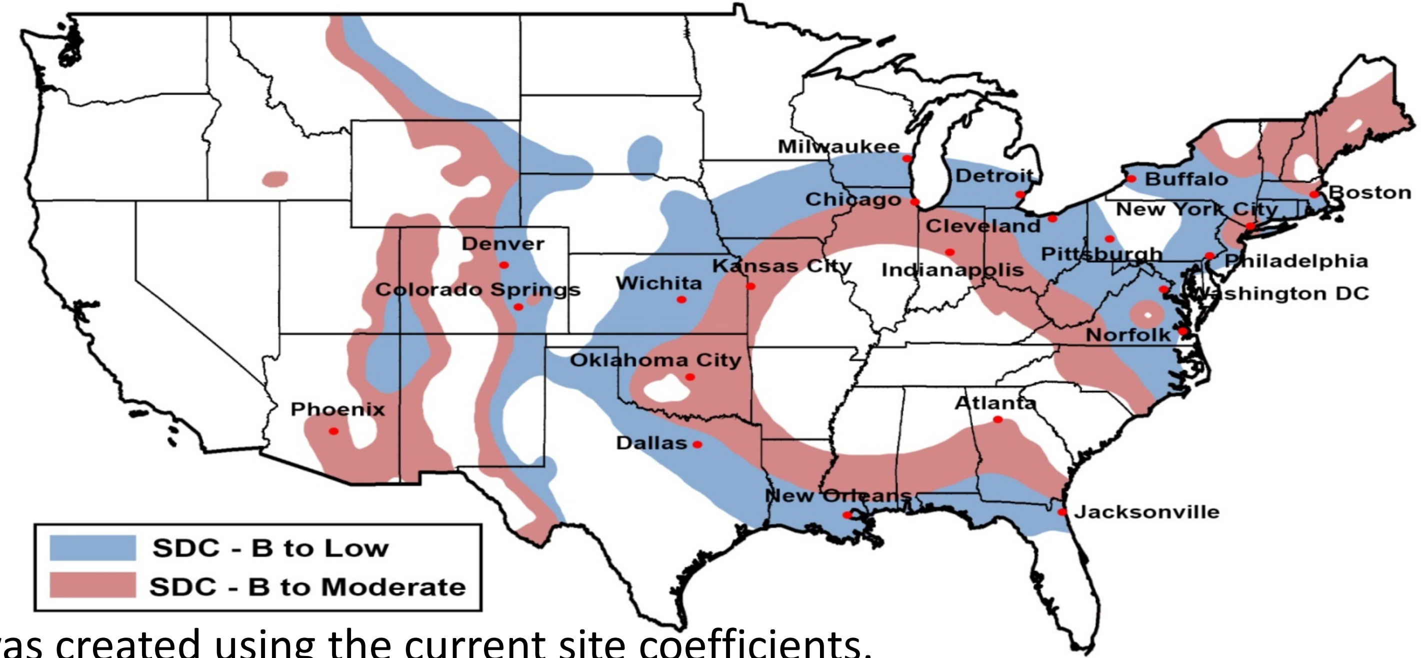



Image was created using the current site coefficients.
It will change somewhat once the MPRS is in use.

# Proposed Consolidatd SDC Map Based on Site Class C

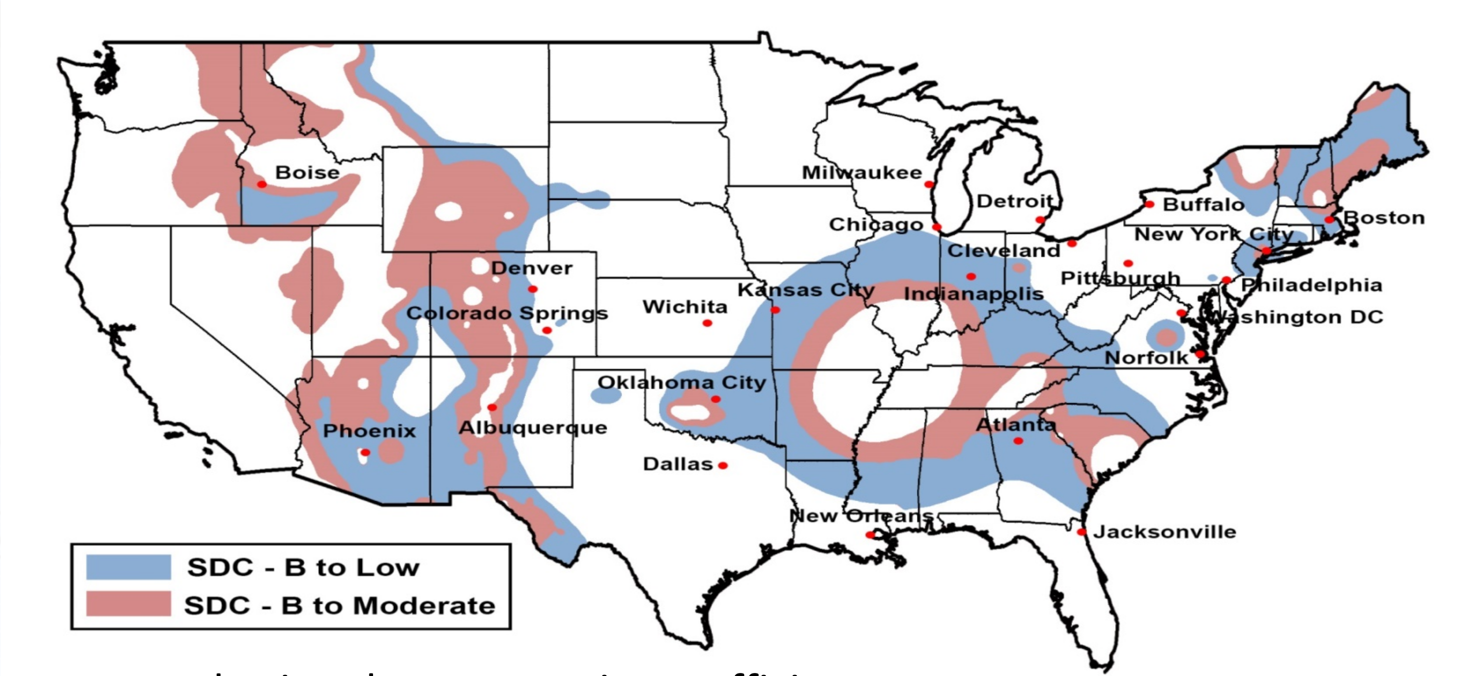
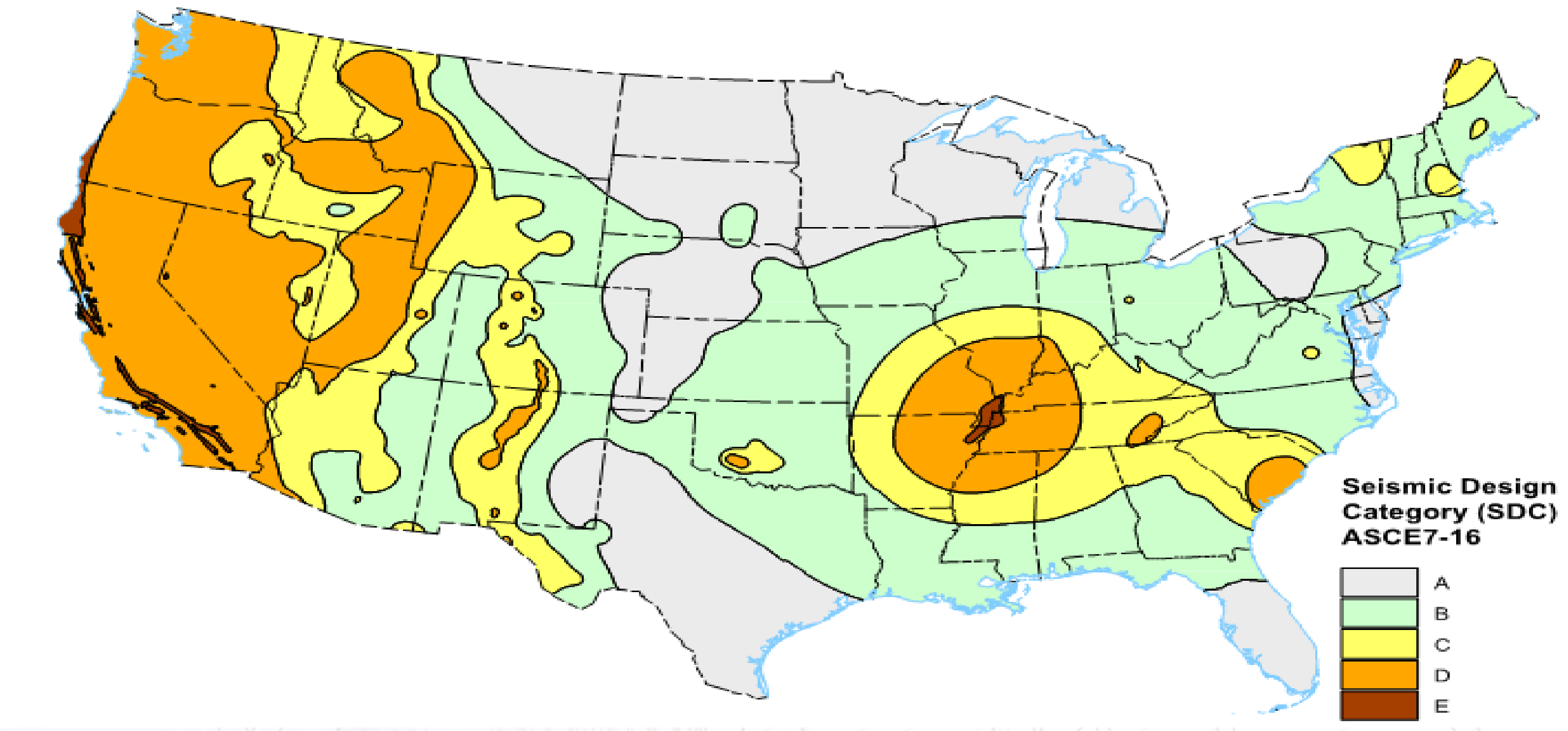
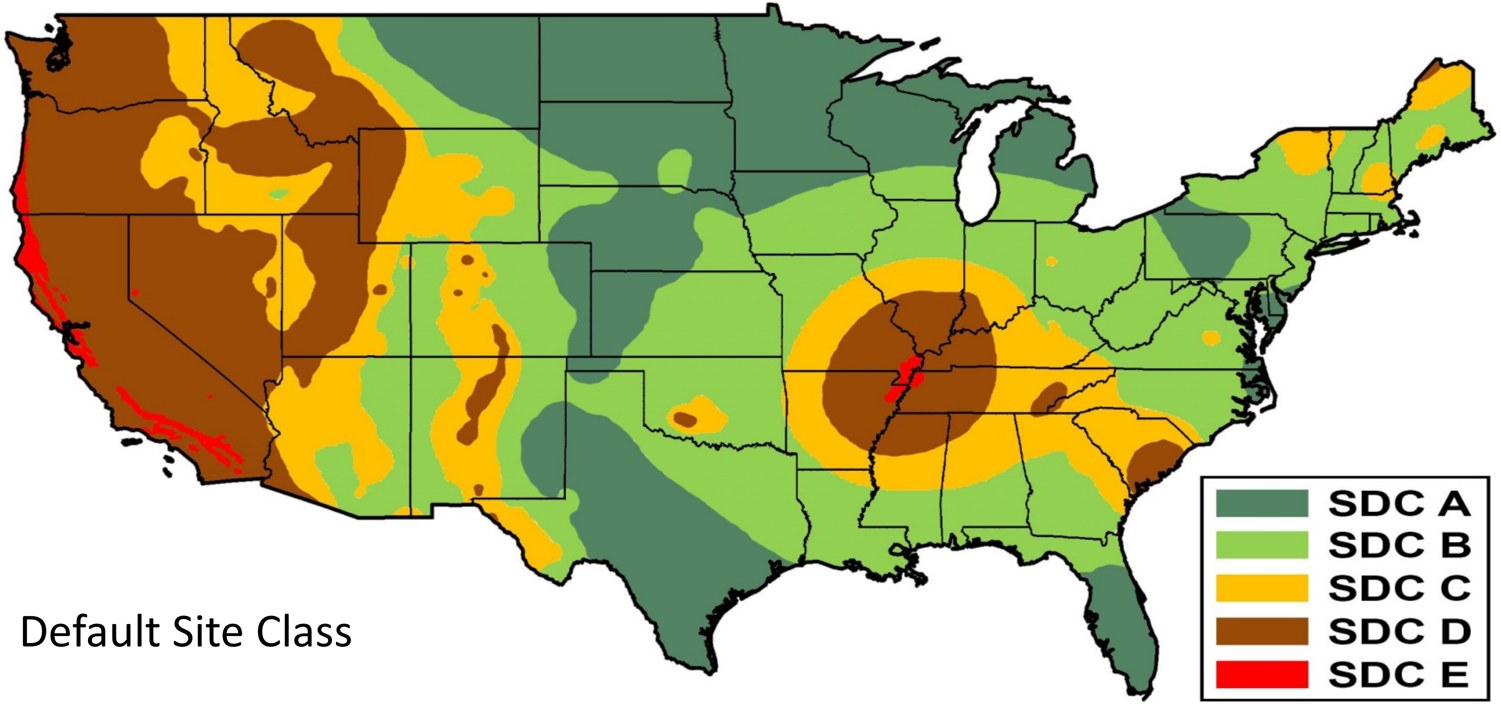



Image was created using the current site coefficients.
It will change somewhat once the MPRS is in use.

# Proposed SDC Map for RC I, II, or III Structures (Stabilization)

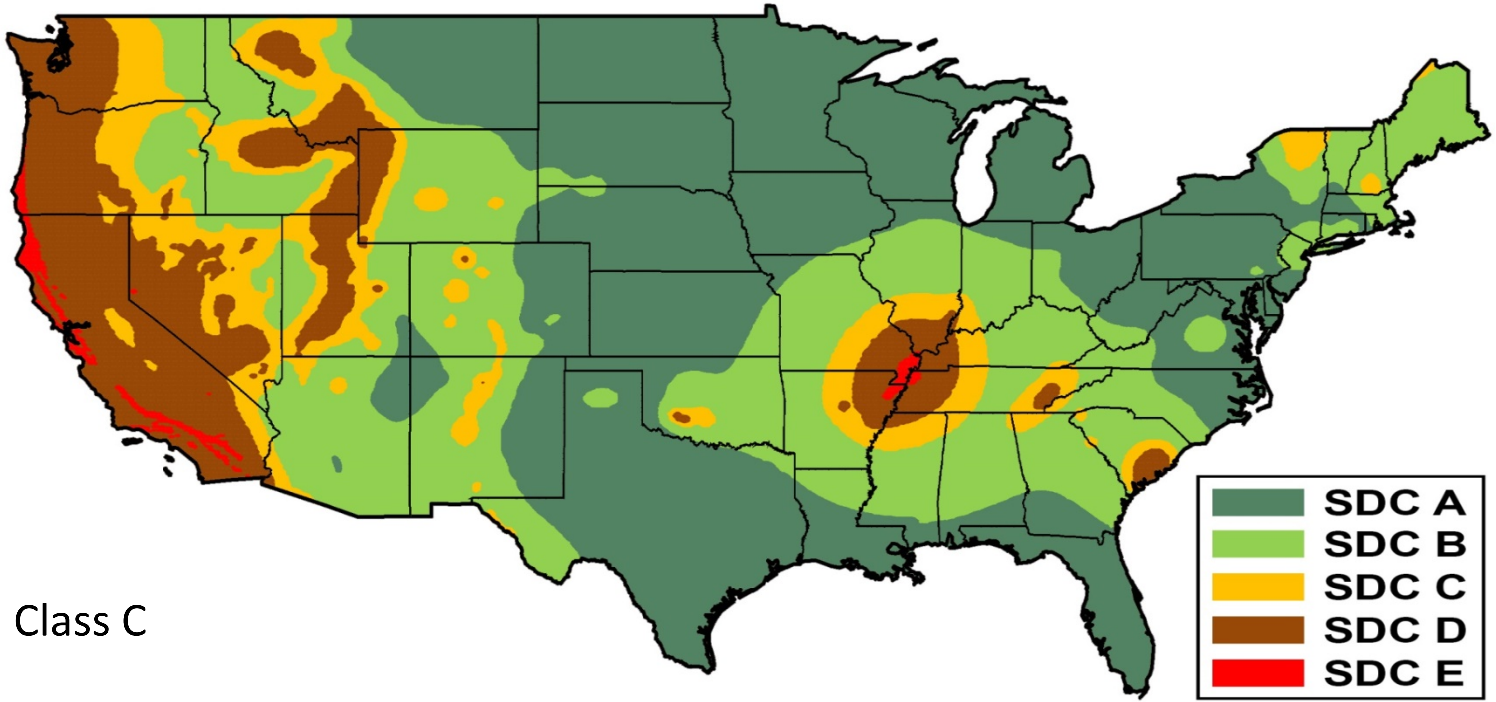


# ASCE 7-16 SDC Map for RC I, II, or III Structures



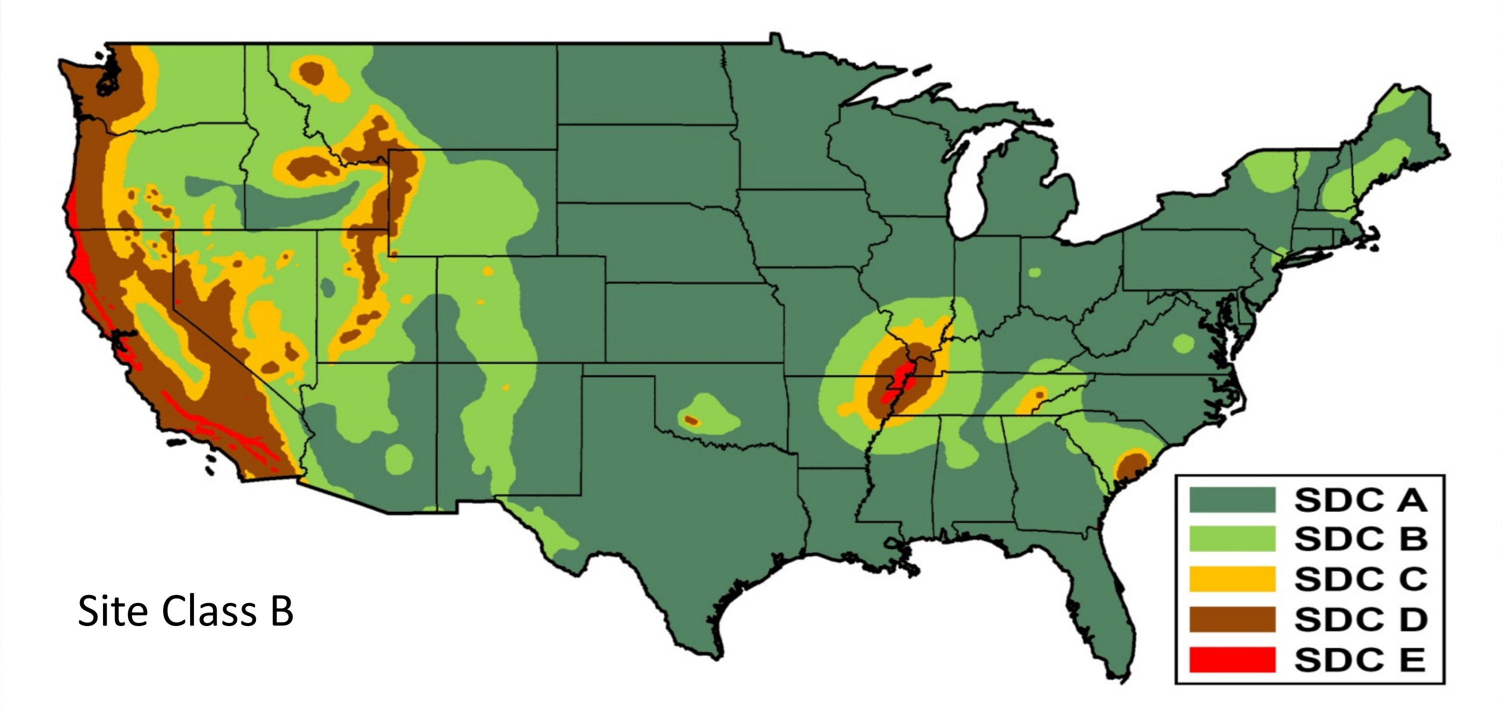

Default Site Class

# ASCE 7-16 SDC Map for RC I, II, or III Structures

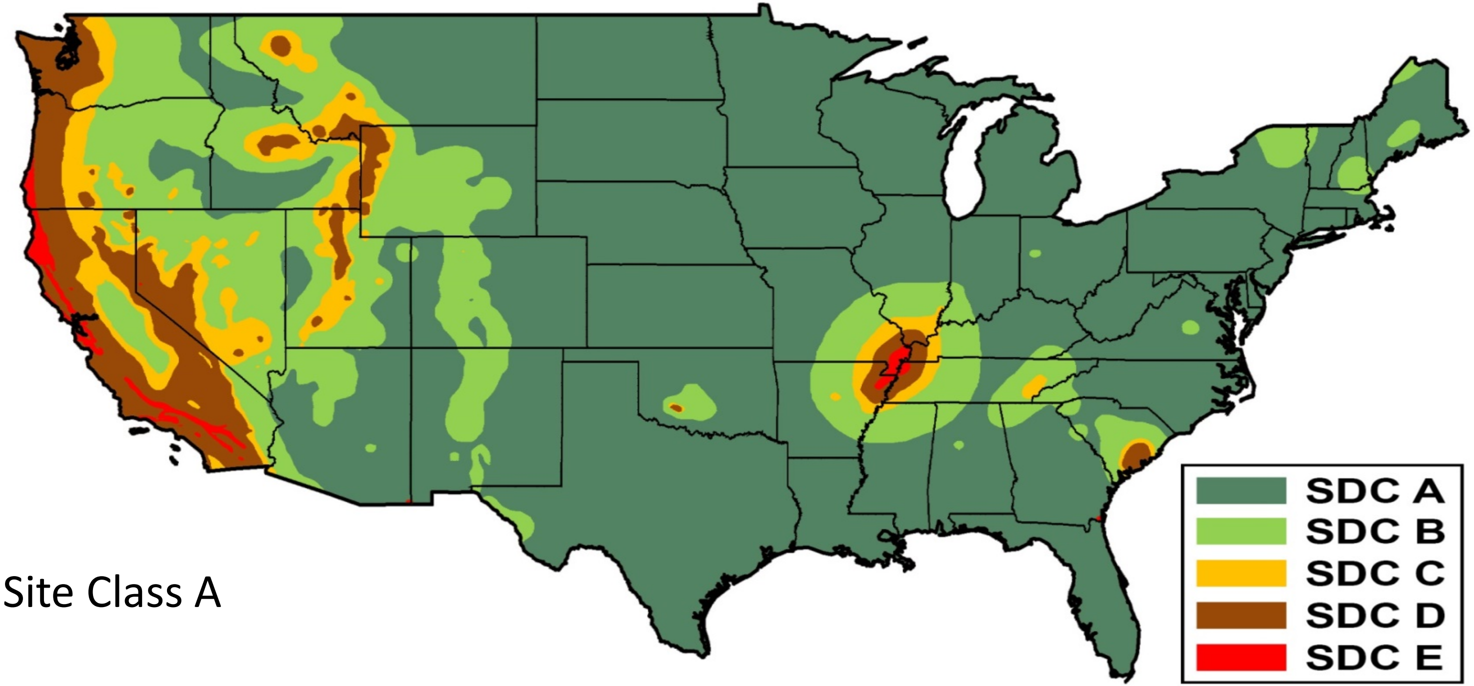



Site Class C

# ASCE 7-16 SDC Map for RC I, II, or III Structures

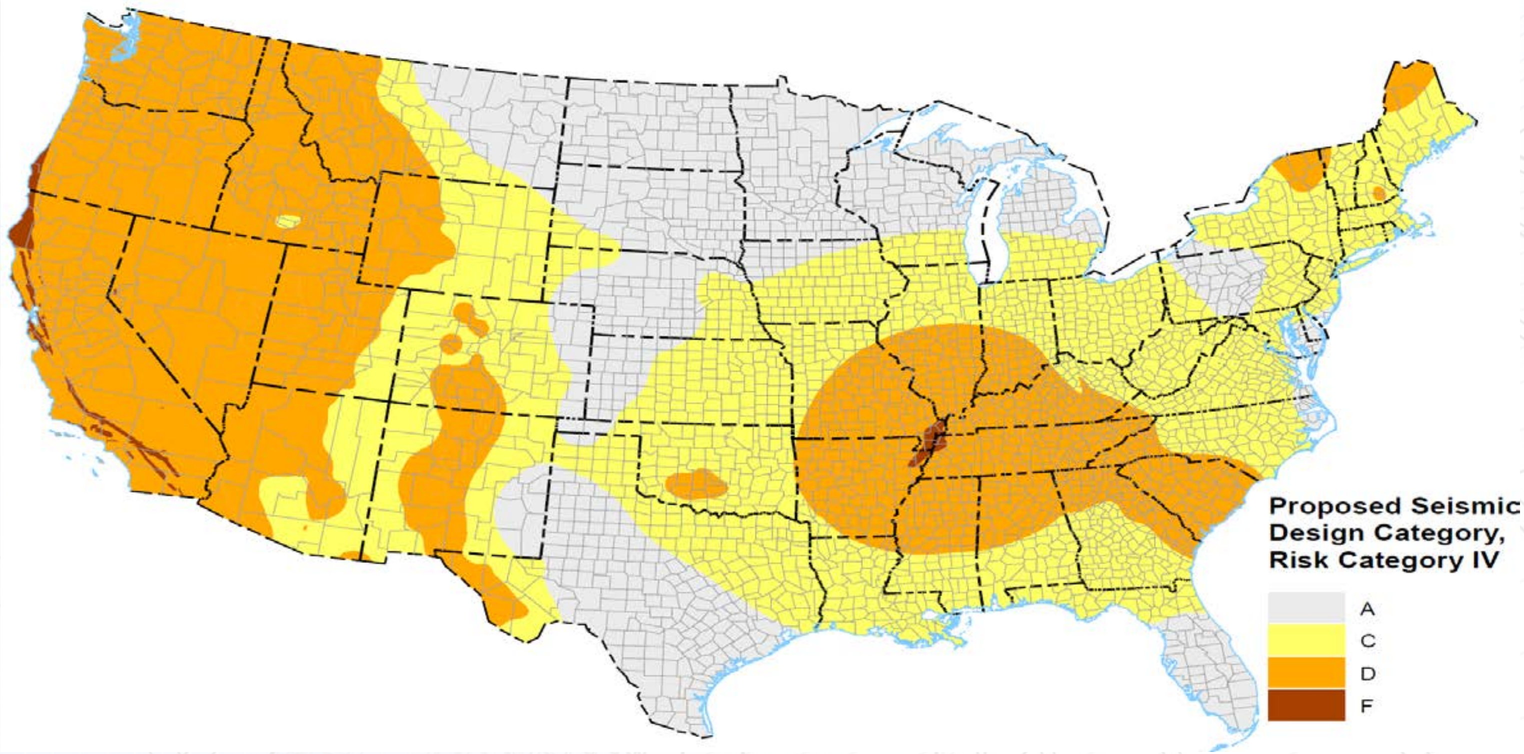


# ASCE 7-16 SDC Map for RC I, II, or III Structures

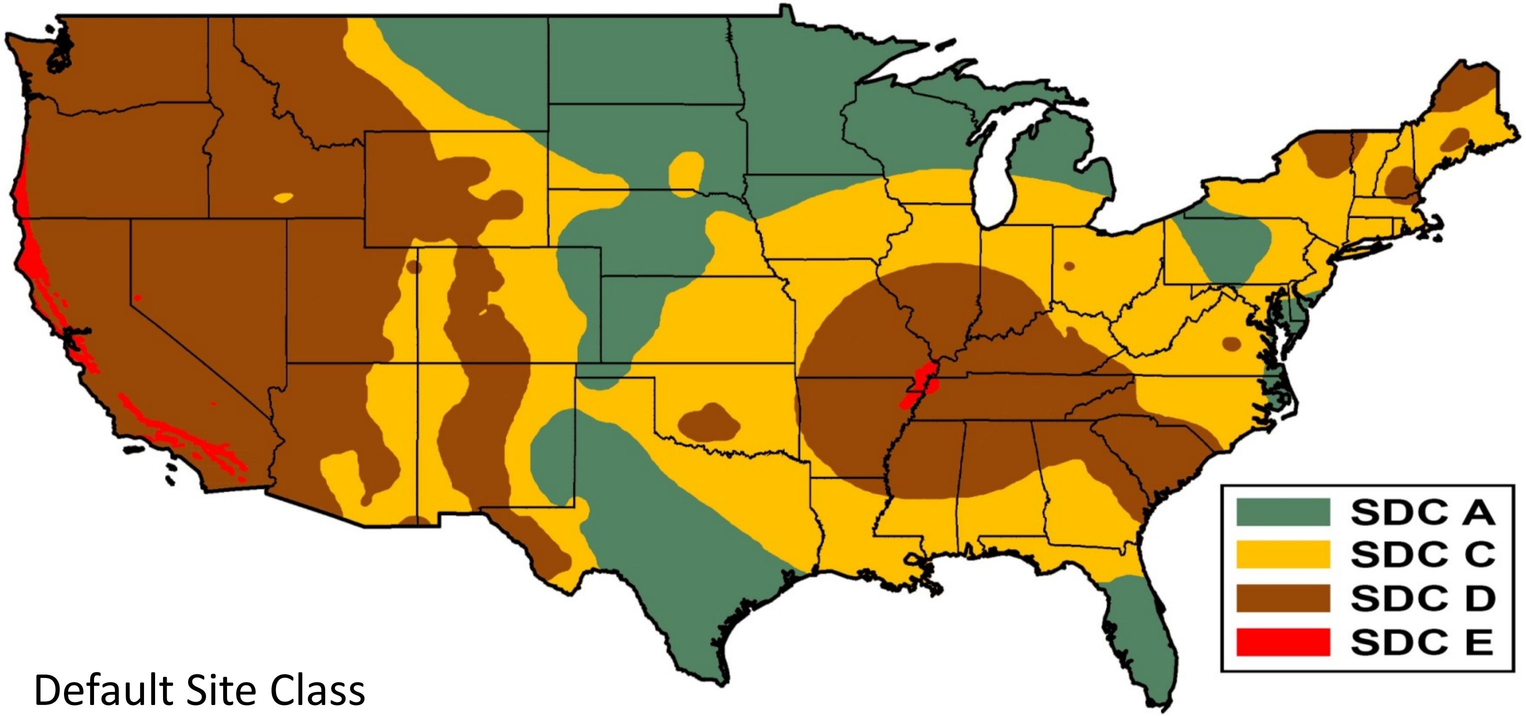



Site Class A

# Proposed SDC Map for RC IV Structures (Stabilization)



# ASCE 7-16 SDC Map for RC IV Structures




Default Site Class

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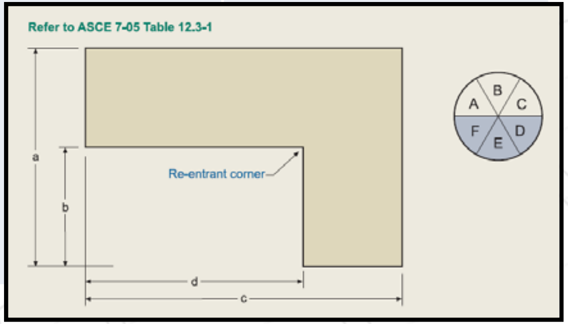
# Horizontal Irregularity Type 2, 3 Triggers

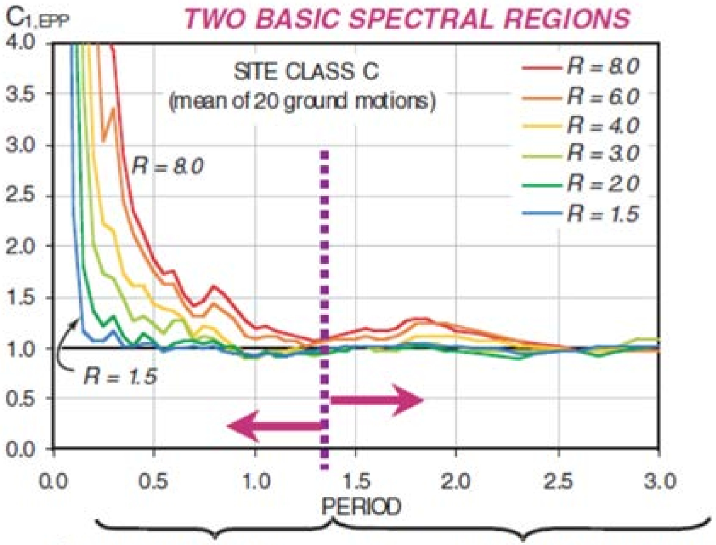
| Type | Description | Reference Section | Seismic Design Category Application |
|---|---|---|---|
| 2. | Reentrant Corner Irregularity: Reentrant corner irregularity is defined to exist where both plan projections of the structure beyond a reentrant corner are greater than ~~15%~~ 20% of the plan dimension of the structure in the given direction. | 12.3.3.4 | D, E, and F |
| 3. | Diaphragm Discontinuity Irregularity: Diaphragm discontinuity irregularity is defined to exist where there is a diaphragm with an abrupt discontinuity or variation in stiffness, including one that has a cutout or open area greater than ~~50%~~ 25% of the gross enclosed diaphragm area, or a change in effective diaphragm stiffness of more than 50% from one story to the next. | 12.3.3.4 | D, E, and F |



# Vertical Irregularity Type 2 Eliminated

| Type | Description | Reference Section | Seismic Design Category Application |
|---|---|---|---|
| **Table 12.6-1** | D, E, and F | | |
| ~~2.~~ | ~~Weight (Mass) Irregularity: Weight (mass) irregularity is defined to exist where the effective mass of any story is more than 150% of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.~~ | ~~Table 12.6-1~~ | ~~D, E, and F~~ |

# $C_d = R$ For Deformation Compatibility




- $C_1$ IS ON AVERAGE LARGER THAN ONE
- $C_1$ INCREASES WITH DECREASING T
- $C_1$ INCREASES WITH INCREASING R

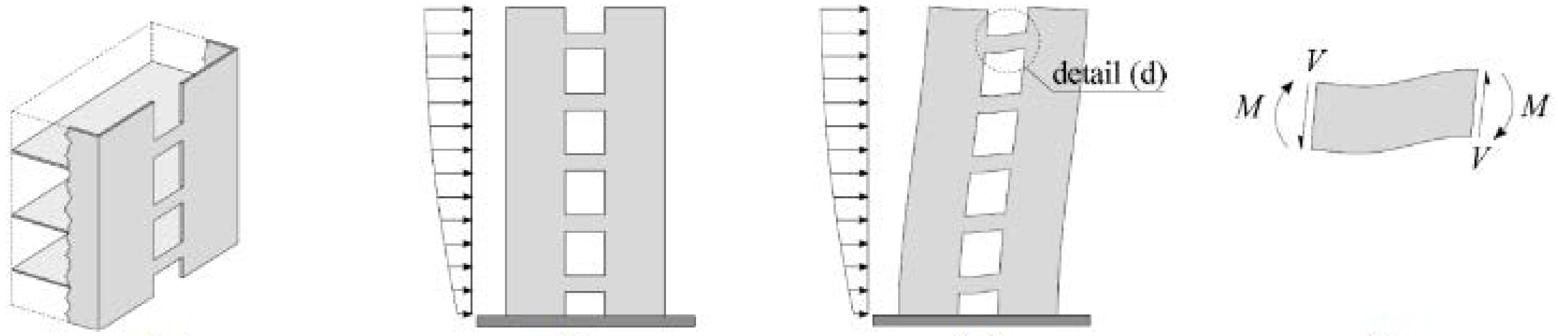
- $C_1$ IS APPROXIMATELY CONSTANT WITH CHANGES IN T
- $C_1$ DOES NOT CHANGE MUCH WITH CHANGES IN R
- $C_1$ IS ON AVERAGE APPROXIMATELY EQUAL TO ONE

# Accidental Torsion Modifications

The ATC-123 project (Improving Seismic Design of Buildings with Configuration Irregularities) found that the current design provisions are generally conservative for most building configurations, with the exception of buildings that rely heavily on lines of lateral resistance orthogonal to the design earthquake force to resist torsion.

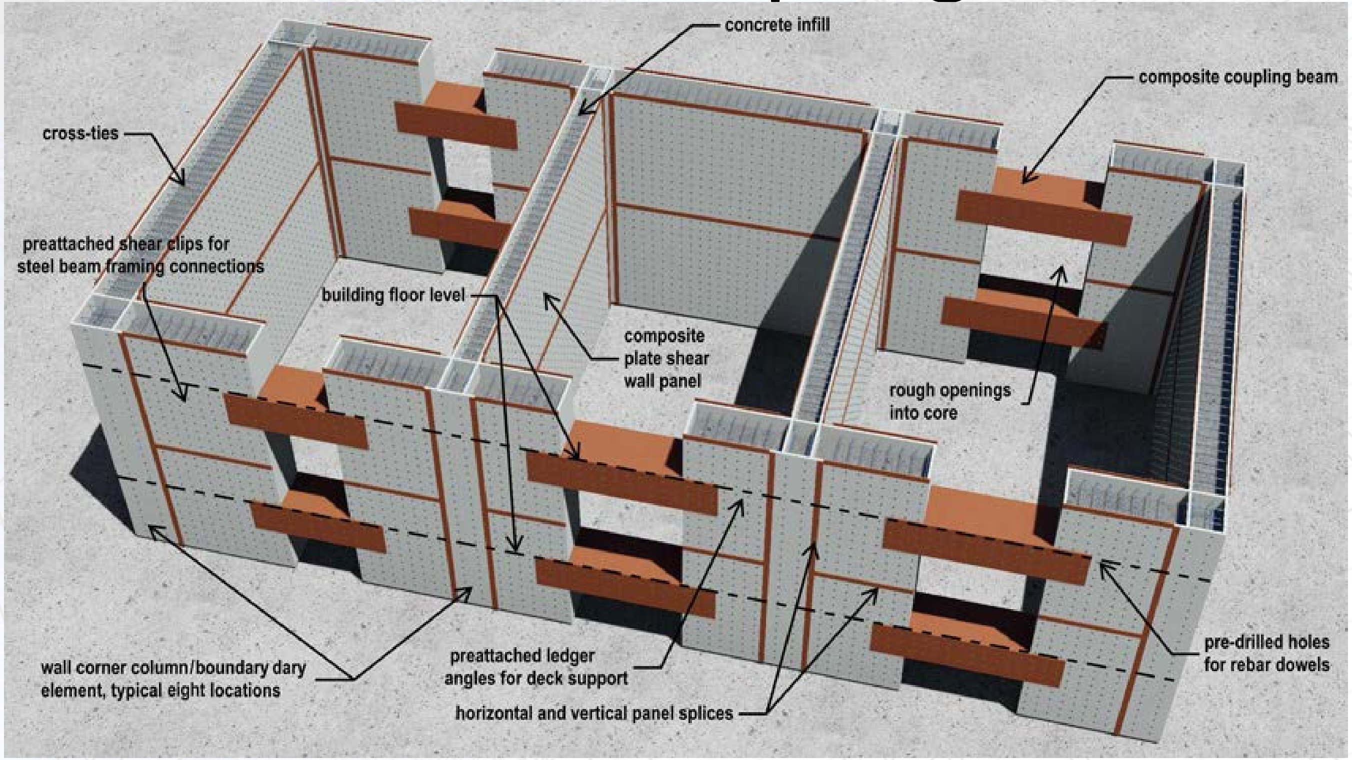
The ATC-123 project set out to modify the current provisions in a way to provide a more uniform collapse reliability across structures with increasing degrees of torsional irregularity. A Part 1 modification to ASCE 7-16 strips out some of the unnecessary conservatism from the current code provisions, while adding requirements for building configurations not adequately addressed by the current provisions.

# Ductile Coupled Reinforced Concrete Shear Walls



# Composite Steel Plate Shear Walls with Coupling

# Composite Steel Plate Shear Walls with Coupling



# Scope of Nonstructural Provisions

**13.1.1 Scope.**

This chapter establishes minimum design criteria for nonstructural components ~~that are permanently attached to structures~~ and for their supports and attachments.

<u>Nonstructural components shall meet the requirements of this chapter, including components that are in or supported by a structure, are outside of a structure, or are permanently attached to the mechanical or electrical systems of a structure.</u> …

# Corrugated Steel Liquid Storage Tanks

# Corrugated Steel Liquid Storage Tanks

Corrugated steel tanks once used only for bulk product storage are increasingly being used for water storage.  Requirements have been added to provide an equivalent level of safety as provided by other types of tanks covered by ASCE 7.  Similar provisions are added for corrugated steel tanks used for the storage of petrochemical and industrial liquids in anticipation of their use in the industrial sector.

# Fiberglass Cooling Towers

# Fiberglass Cooling Towers

Historically, concrete and steel cooling towers have performed well in seismic events. Wood cooling towers have also generally performed well in seismic events when relatively new. The primary cause of damage to wood cooling towers in earthquakes has been deteriorated condition prior to an earthquake . Because of deterioration to wood cooling towers, fiberglass cooling towers have been replacing wood cooling towers in recent years.

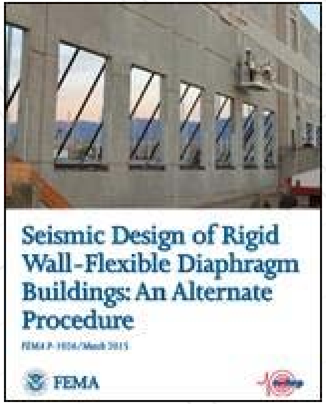
ASCE is in the process of developing a draft standard “Load and Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures,” which includes seismic design parameters for fiber glass cooling towers. Including the parameters for fiberglass cooling towers from this draft standard in Table 15.4-2 will make it convenient for engineers to evaluate the seismic design of various potential structural systems for cooling towers used in many industrial applications.

# Alternative Diaphragm Design Provisions for One-Story Structures with Flexible Diaphragms and Rigid Vertical Elements

# Alternative Diaphragm Design Provisions for One-Story Structures with Flexible Diaphragms and Rigid Vertical Elements

FEMA P-1026 recommendations for seismic design of the Rigid Wall – Flexible Diaphragm building type included:

- Recognition that the diaphragms often yield and dominate the building behavior while the walls typically remain mostly in the elastic range for in-plane loading,
- Recognizing the distinct periods of both the shear wall system and the diaphragm, and using a two-stage equivalent lateral force analysis to capture this distinct behavior,
- Proposing the creation of a zone of reduced nailing away from the diaphragm perimeter, where distributed yielding can occur without jeopardizing the diaphragm connection to the vertical element.



# Alternative Diaphragm Design Provisions for One-Story Structures with Flexible Diaphragms and Rigid Vertical Elements

One change addresses the first and the third bullet points, while a second proposal addresses the second. Use of the alternative diaphragm design forces of Section 12.10.4 is permitted for any structure meeting the limitations of Sec. 12.10.4.1, and irrespective of whether or not the two-stage analysis procedure is used. Use of the two-stage analysis is dependent on use of the new Section 12.10.4 diaphragm design forces.

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