Eliminating the Confusion from Seismic Codes and Standards
Plus Design and Installation Instruction

By

Olivier S. Braquet
nVent CADDY Director, Global Seismic Business

Daniel C. Duggan
nVent CADDY Sr. Business Development Manager, Seismic
Member ASCE 19 Committee on Structural Applications
Member NFPA 13 Committee on Hanging and Bracing
Member UL 203 STP for Listing of Hangers and Seismic Braces

Daniel J. Duggan
nVent CADDY Business Development Manager, Seismic
Member NFPA 13 Committee on Hanging and Bracing
PART 1

Introduction to earthquakes
by
Olivier S. Braquet
nVent CADDY Director, Global Seismic Business
Brief introduction to Earthquakes

- **Earthquake** – Rapid vibration of the earth’s surface due to the sudden movements in the subsoil, leading to energy release spreading in the shape of waves propagating in all directions.

- **Focus (Hypocenter)** – Exact point in the subsoil where a rupture starts and from which the energy generated radiates.

- **Epicenter** – Hypocenter vertical projection onto the surface.
Measuring a quake’s intensity

Mercalli Scale
Estimates intensity on the surface based on the effect locally induced on structures, people and things.

Richter Scale
Measures energy released at focus (logarithmic scale)

Peak Ground Acceleration
Measures horizontal waves’ maximum acceleration on the surface in “g” (m/s²)
Most powerful earthquake recorded

**Chile - Valdivia (May 22\textsuperscript{nd}, 1960)**

- 3000 casualties
- 2.000.000 evacuees
- 6.000.000.000$ damages (actualized 2011)

**Details**

- Depth: 39km / 25mi
- Duration: 6 minutes
- Mercalli: XI/XII
- Richter: 9.5
- PGA: 0.33g

<table>
<thead>
<tr>
<th>Magnitude Change</th>
<th>Ground Motion Change (Displacement)</th>
<th>Approx. Energy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1.3 times</td>
<td>1.4 times</td>
</tr>
<tr>
<td>0.3</td>
<td>2.0 times</td>
<td>3 times</td>
</tr>
<tr>
<td>0.5</td>
<td>3.2 times</td>
<td>5.5 times</td>
</tr>
<tr>
<td>1.0</td>
<td>10 times</td>
<td>32 times</td>
</tr>
<tr>
<td>2.0</td>
<td>100 times</td>
<td>1,000 times</td>
</tr>
<tr>
<td>3.0</td>
<td>1,000 times</td>
<td>32,000 times</td>
</tr>
<tr>
<td>4.0</td>
<td>10,000 times</td>
<td>1,000,000 times</td>
</tr>
</tbody>
</table>
Seismic Maps
Structure not seismically engineered
Operating system not protected
Structural and non-structural seismic protection

3. SEISMIC STRUCTURE & BRACING:
   • THE BUILDING & THE SERVICES MAINTAIN THEIR FUNCTIONALITY AND OPERABILITY
How damage occurs

Swaying

Colliding
Brace to protect
How damage occurs

- Overturning of slender objects
- Sliding of stocky objects

Ground motion
Anchor to protect
Buildings that require seismic bracing

- Hospitals
- Resorts
- Airports
- Stadiums
- Dams
- Arenas
- Schools
- Prisons
- Casinos
- Power
- Water Treatment
- Pharmaceutical
Part 2
Eliminating the Confusion from Seismic Codes & Standards

by
Daniel C. Duggan
nVent CADDY Sr. Business Development Manager, Seismic
Member ASCE 19 Committee on Structural Applications
Member NFPA 13 Committee on Hanging and Bracing
Member UL 203 STP for Listing of Hangers and Seismic Braces
History

• 1977
  • Earthquake Hazards Reduction Act (Public law 95-124)
  • NEHRP Standards (National Earthquake Hazards Reduction Program)
  • No requirement for implementing NEHRP Standards

• 1990
  • Public Law 101-614 amendments to 95-124
  • E.O. (Executive Order) 12699 is signed to implement the law
  • FEMA in charge of implementing NEHRP Standards
    • Recommended Seismic Provisions for New Buildings and Other Structures.
    • New construction started after January 4, 1993
    • Federally owned, regulated or funded by Federal loans, grants or loan guarantees
  • Building Seismic Safety Council
    • Certifies Model Building Codes for NEHRP compliance
      • ICBO UBC Uniform Building Code
      • BOCA National Building Code
      • SBCCI Standard Building Code
History Cont’d

• 1996
  • UBC, BOCA & SBCCI
    • Agree not to publish further updates to their Codes
    • Agree to promulgate the use of the IBC (International Building Code) when published

• 1997
  • UBC publishes a 1997 Edition of its Building Code

• 2000
  • ICC (International Code Conference) published its 1st Edition of the IBC
  • BSSC certified the 2000 IBC to satisfy NEHRP and the Federal Law
History Cont’d

• 2003
  • ICC (International Code Conference) published the 2003 IBC
  • BSSC certified the 2003 IBC to satisfy NEHRP and the Federal Law
  • 2003 IBC also generally references ASCE 7-02 Minimum Design Loads for Buildings for seismic protection

• 2006
  • ICC (International Code Conference) published the 2006 IBC
  • BSSC certified the 2006 IBC to satisfy NEHRP and the Federal Law
  • 2006 IBC specifically references ASCE 7-05 for seismic protection
    • ASCE 7-05 Chapter 13 Seismic Design Requirements for Nonstructural Components
History Cont’d

• 2009
  • ICC published the 2009 IBC
  • BSSC certified the 2009 IBC to satisfy NEHRP and the Federal Law
  • 2009 IBC specifically references ASCE 7-05 for seismic protection
    • ASCE 7-05 Chapter 13 Seismic Design Requirements for Nonstructural Components
• 2012
  • ICC (International Code Conference) published the 2012 IBC
  • BSSC certified the 2012 IBC to satisfy NEHRP and the Federal Law
  • 2012 IBC specifically references ASCE 7-10 for seismic protection
    • ASCE 7-10 Chapter 13 Seismic Design Requirements for Nonstructural Components
History Cont’d

• 2015
  • ICC published the 2015 IBC
  • BSSC certified the 2015 IBC to satisfy NEHRP and the Federal Law
  • 2015 IBC specifically references ASCE 7-10 for seismic protection
    • ASCE 7-10 Chapter 13 Seismic Design Requirements for Nonstructural Components

• 2016
  • E.O. (Executive Order) 13717
    • Cancels and replaces E.O. 12699
    • NIST (National Institute of Science and Technology) replaced FEMA as lead agency
    • ICSSC (Interagency Committee on Seismic Safety in Construction) replaced BSSC for implementation of NEHRP
    • Requires compliance with 2015 IBC or later seismic provisions
History Cont’d

• 2018
  • ICC published the 2018 IBC
  • ICSSC certified the 2018 IBC to satisfy NEHRP and the Federal Law
  • 2018 IBC specifically references ASCE 7-16 for seismic protection
    • ASCE 7-16 Chapter 13 Seismic Design Requirements for Nonstructural Components
Federal Documents

- NEHRP specifically references Seismic Provisions of ASCE 7
- ALL Federal Agencies are required to comply with NEHRP
  - CEGS (Corps of Engineers Guide Spec)
  - NAV-FAC (Naval Facilities Engineering Command)
  - UFGS (Unified Facilities Guide Specifications)
- ALL reference **ASCE 7 Chapter 13 Seismic Design Requirements for Nonstructural Components**
CBC / OSHPD

- CBC (California Building Code) is the IBC
- OSHPD Code is the CBC with further restrictions / exceptions
  - OSHPD Code is for California owned and regulated hospital facilities
  - Exceptions to the CBC are published “Express Terms”
  - Code Application Notices (CANs) to interpret specific sections of the CBC
  - Policy Intent Notice (PIN) is the OSHPD policy on a specific subject
  - ASCE 7-16 Chapter 13 Seismic Design Requirements for Nonstructural Components
2019 California Building Code (CBC 2019)
ASCE 7 Chapter 13

• Chapter 13 of ASCE 7-10 appears in pages 111-125
• Section 13.2 General Design Requirements
• Section 13.2.2 Special Certification Requirements for Designated Seismic Systems
  • Certain Active Mechanical & Electrical equipment
• Section 13.2.5 Testing Alternative for Seismic Capacity Determination
  • References ICC-ES (International Code Conference Evaluation Service) AC 156 shake table testing
  • While possibly desirable for marketing, NEBS Level 3 Zone 4 Compliance Testing per Telcordia Technologies GR-63 CORE is not recognized by the ICC or ASCE 7
ASCE 7 Chapter 13 Cont’d.

• Section 13.5.7 Access Floors
• Section 13.6.4 Electrical Components
• Section 13.6.5.6 Conduit, Cable Tray, and Other Electrical Distribution Systems (Raceways)
• Section 13.6.11 Other Mechanical and Electrical Components
• Section 13.1.4 EXEMPTIONS
Moral of the Story

• Get the ASCE 7 edition referenced by the applicable Code
  • Read Chapter 13.
  • Mystery Solved!
PART 3
Overview of the
International legal and code landscape
by
Olivier S. Braquet
nVent CADDY Director, Global Seismic Business
Examples of standards Internationally Used

- ISO/IEC 11801, Generic Cabling for Customer Premises
- ISO/IEC 18010:2002, Pathways and Spaces
- ISO/IEC 24764, Generic Cabling Systems for Data Centres
- ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-606-A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centres
- IEEE 802.3af, Power over Ethernet (PoE) Standard
...
Example of standard language

  • Section 5.3.5. Environmental conditions
    • Section 5.3.5.1 Requirements
      ... the following environmental considerations shall be taken into consideration:
      impact of natural events e.g. lightning strike, earthquake
Examples of regionally used standards Cont’d.

• **EU**
  – **EN 50173**, Information Technology – General Cabling Systems

• **Australia / New Zealand**
  – **AS/NZS 3080:2013**, Information technology – Generic cabling for customer premises
  – **AS/NZS 3084:2003(R2013)**, Telecommunications installations - Telecommunications pathways and spaces for commercial buildings
  – **EIA/TIA 568 & 569**, Generic Telecommunications Cabling for Customer Premises & Pathways and Spaces

• **China**
  – **GB 50174:2017** Code for design of electronic information system rooms and data centers
Moral of the International Landscape

• No international legal or code document provide enough guidance,

• Most national laws guide designers towards using regionally recognized codes and standards when the national level is not enough, and using international codes and standards when the regional level is in turn not enough,

So, since outside of the U.S. laws and codes do not specify what to do and how to do it:

• Get the latest edition of ASCE 7

• Read Chapter 13.

• Problem Solved!
Q & A
BREAK
5 Minutes
PART 4

Seismic Design & Installation

by

Daniel J. Duggan

nVent CADDY Business Development Manager, Seismic Member NFPA 13 Committee on Hanging and Bracing
Building Code
ASCE 7-10 or 7-16

Why do we need to brace

- Required by the building code
- Protects property
- Protects critical/mission critical systems
- Most Importantly, protects People
Seismic Design Category C, D, E, or F

<table>
<thead>
<tr>
<th>Seismic Design Category (SDC)</th>
<th>Importance Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_p = 1.0$</td>
</tr>
<tr>
<td>A</td>
<td>EXEMPT – Seismic Not Required</td>
</tr>
<tr>
<td>B</td>
<td>EXEMPT – Seismic Not Required</td>
</tr>
<tr>
<td>C</td>
<td>EXEMPT – Seismic Not Required</td>
</tr>
<tr>
<td>D</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>E</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>F</td>
<td>REQUIRED</td>
</tr>
</tbody>
</table>
1. GENERAL

1. SEE PROJECT SPECIFICATIONS FOR REQUIREMENTS IN ADDITION TO GENERAL NOTES. COORDINATE THESE DRAWINGS WITH EXISTING CONDITIONS AND COORDINATE ALL DIMENSIONS AND WALL LOCATIONS WITH THE ARCHITECT DRAWINGS. THE GENERAL CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ARCHITECT AND THE STRUCTURAL ENGINEER OF ANY DISCREPANCIES WITHIN THE CONSTRUCTION DOCUMENTS.

2. THE STRUCTURAL DRAWINGS SHOULD NOT BE USED TO SIZE OR LOCATE DOORS, WINDOWS, TOILET PARTITIONS, OR NON-LOAD BEARING WALLS.

3. DESIGN AND CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE 2012 INTERNATIONAL BUILDING CODE.

5. DESIGN LOADS:

MAINTENANCE CATWALK VERTICAL LOAD

A. LIVE LOAD = 40 PSF
B. DEAD LOAD = SELF WEIGHT OF STRUCTURE

WIND LOAD INFORMATION

A. ULS WIND SPEED = 115 MPH
B. ASD WIND SPEED = 88 MPH
C. WIND IMPORTANCE FACTOR (IU) = 1.0
D. OCCUPANCY CATEGORY = II
E. WIND EXPOSURE = B

SEISMIC DESIGN INFORMATION

A. SEISMIC IMPORTANCE FACTOR (IE) = 1.0
B. SEISMIC DESIGN CATEGORY = B
C. 0.2 SECOND SPECTRAL RESPONSE ACCELERATION (S0) = 0.19
D. 1 SECOND SPECTRAL RESPONSE ACCELERATION (S1) = 0.31
E. 0.2 DESIGN SPECTRAL RESPONSE ACCELERATION (S0(2)) = 0.203
F. 1 DESIGN SPECTRAL RESPONSE ACCELERATION (S1(1)) = 0.46
G. SITE CLASS = C
H. RESPONSE MODIFICATION COEFFICIENT (R) = 3
I. SYSTEM OVERSTRENGTH FACTOR = 3
J. DEFLECTION AMPLIFICATION FACTOR (CD) = 3
K. SEISMIC RESPONSE COEFFICIENT (CS) = 0.21 FOR STEEL AND 2.0 FOR CONCRETE
L. DESIGN BASE SHEAR (VX) = CSxSELF WEIGHT
M. BASIC SEISMIC FORCE RESISTING SYSTEM - CANTILEVER COLUMN SYSTEM; ORDINARY CONCRETE MOMENT FRAMES; STEEL SYSTEM NOT SPECIFICALLY DETAILED FOR SEISMIC RESISTANCE AND STEEL TANKS
N. ANALYSIS PROCEDURE - EQUIVALENT LATERAL FORCE PROCEDURE
# Single Hanger Conduit Exemptions ASCE 7-10

<table>
<thead>
<tr>
<th>Conduit Size</th>
<th>SDC = C</th>
<th>SDC = D, E or F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_p = 1.0$</td>
<td>$I_p = 1.5$</td>
</tr>
<tr>
<td>≤ 1” (25mm)</td>
<td>Exempt</td>
<td>Exempt</td>
</tr>
<tr>
<td>1 1/4” (32 mm)</td>
<td>Exempt</td>
<td>Exempt</td>
</tr>
<tr>
<td>1 1/2” (40 mm)</td>
<td>Exempt</td>
<td>Exempt</td>
</tr>
<tr>
<td>2” (50 mm)</td>
<td>Exempt</td>
<td>Exempt</td>
</tr>
<tr>
<td>2 1/2” (65 mm)</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>3” (78 mm)</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>3 1/2” (88 mm)</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>≥ 4” (100 mm)</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
</tbody>
</table>
### Suspended Trapeze, Cable Tray, Ladder Tray, Basket Tray Exemptions

**ASCE 7-10**

<table>
<thead>
<tr>
<th>Tray weight per Ft.</th>
<th><strong>SDC = C</strong></th>
<th><strong>SDC = D, E or F</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_p = 1.0$</td>
<td>$I_p = 1.5$</td>
</tr>
<tr>
<td>$\geq 5$ Lbs/Ft</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>$\geq 10$ Lbs/Ft</td>
<td>Exempt</td>
<td>REQUIRED</td>
</tr>
</tbody>
</table>

---

**Note:**
- **Exempt** indicates no requirement.
- **REQUIRED** indicates a requirement based on the specified criteria.

**Explanation:**
- For **SDC = C**, the tray weight per foot is considered for a requirement of $I_p = 1.0$ or $I_p = 1.5$.
- For **SDC = D, E or F**, the tray weight per foot is also considered for a requirement of $I_p = 1.0$ or $I_p = 1.5$.
## Suspended Equipment Exemptions ASCE 7-10

<table>
<thead>
<tr>
<th>Equipment Weight</th>
<th>SDC = C</th>
<th>SDC = D, E or F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_p = 1.0$</td>
<td>$I_p = 1.5$</td>
</tr>
<tr>
<td>&lt; 20 Lbs.</td>
<td>Exempt</td>
<td>Exempt</td>
</tr>
<tr>
<td>≥ 20 Lbs.</td>
<td>Exempt</td>
<td><strong>REQUIRED</strong></td>
</tr>
</tbody>
</table>
Cable tray
Wire basket
Ladder
Racks & cabinets
Raised floor installation
Concrete
Non-continuous supports
(J-Hooks for example)
Various types of installation – wall mount, suspended via wire, threaded rod, etc.
media installed by the LV industry

Camera
WAP’s – Wireless Access Points
Speakers – Can vary greatly in weight
Projectors
Zone distribution cabinets
Earthquake Damage
Codes & Standards
enterprise & OSP (Outside Plant Cabling)
Where seismic bracing may be enforced more strictly

Mission Critical Data Centers
Government buildings and other critical potential bomb/explosion (ATFP issues) buildings/structures
Hospitals
K-12 and other education facilities
Q & A
BREAK

5 Minutes
Part 5

Seismic Design

by

Daniel C. Duggan
nVent CADDY Sr. Business Development Manager, Seismic Member ASCE 19 Committee on Structural Applications Member NFPA 13 Committee on Hanging and Bracing Member UL 203 STP for Listing of Hangers and Seismic Braces
Primary Seismic Design Requirements of ASCE 7-16

All nonstructural components

• Braced to resist seismic force 360° horizontally
  ➢ Horizontal Seismic Force = $F_p$

• Consideration of vertical loads & reactions
  ➢ Upward (rod stiffeners)
  ➢ Downward

• Some components are exempted
  ➢ Seismic Design Category ($SDC$)
  ➢ Component Importance Factor ($I_p$)
  ➢ Component Size
  ➢ Method of Attachment
Seismic Brace Orientation

• Transverse Brace
  • Perpendicular to run

• Longitudinal Brace
  • Parallel to run

• 4-way Brace
  • Transverse & Longitudinal at same point
Seismic Brace Locations

• Horizontal Runs of Conduit, Trapeze Supported Equipment, Cable Trays, etc.

• Changes of Direction
Seismic Brace Spacing

• 40 ft. Max. Transverse Spacing
• 80 ft. Max. Longitudinal Spacing
• 40 ft. Max. 4-way Spacing

• Achievable spacing limited by brace assembly strength
Types of Bracing

• **Tension/Compression Bracing**
  - Pipe, Angle Iron & Strut
  - Resists loads ½ in tension – ½ in compression
  - Length limited by \( K_1/r \approx 200 \)
  - Brace element on one side of braced component
Types of Bracing

- **Tension Only Bracing**
  - Aircraft Cable
  - Resists loads in tension 100% of the time
  - Unlimited length – NO $K/r$ limitation
  - Brace element on both sides of braced component
13.3.1.1 Horizontal Force. The horizontal seismic design force \( F_p \) shall be applied at the component’s center of gravity and distributed relative to the component’s mass distribution and shall be determined in accordance with Eq. (13.3-1):

\[
F_p = 0.4a_p S_{DS} W_p \left( 1 + 2 \frac{z}{h} \right)
\]  

(13.3-1)

\( F_p \) is not required to be taken as greater than

\[
F_p = 1.6 S_{DS} I_p W_p
\]  

(13.3-2)

and \( F_p \) shall not be taken as less than

\[
F_p = 0.3 S_{DS} I_p W_p
\]  

(13.3-3)
Horizontal Seismic Force cont’d.

\[ F_p = \text{seismic design force}; \]
\[ S_{DS} = \text{spectral acceleration, short period, as determined from Section 11.4.5}; \]
\[ a_p = \text{component amplification factor that varies from 1.00 to 2.50 (select appropriate value from Table 13.5-1 or 13.6-1)}; \]
\[ I_p = \text{component Importance Factor that varies from 1.00 to 1.50 (see Section 13.1.3)}; \]
\[ W_p = \text{component operating weight}; \]
\[ R_p = \text{component response modification factor that varies from 1.00 to 12 (select appropriate value from Table 13.5-1 or 13.6-1)}; \]
\[ z = \text{height in structure of point of attachment of component with respect to the base. For items at or below the base, } z \text{ shall be taken as 0. The value of } z/h \text{ need not exceed 1.0; and} \]
\[ h = \text{average roof height of structure with respect to the base.} \]
11.4.5 Design Spectral Acceleration Parameters. Design earthquake spectral response acceleration parameters at short periods, $S_{DS}$, and at 1-s periods, $S_{D1}$, shall be determined from Eqs. (11.4-3) and (11.4-4), respectively. Where the alternate simplified design procedure of Section 12.14 is used, the value of $S_{DS}$ shall be determined in accordance with Section 12.14.8.1, and the value for $S_{D1}$ need not be determined.

$$S_{DS} = \frac{2}{3} S_{MS} \quad (11.4-3)$$

$$S_{D1} = \frac{2}{3} S_{M1} \quad (11.4-4)$$
11.4.4 Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters. The MCE_R spectral response acceleration parameters for short periods \( S_{MS} \) and at 1 s \( S_{M1} \), adjusted for site class effects, shall be determined by Eqs. (11.4-1) and (11.4-2), respectively.

\[
S_{MS} = F_a S_s \quad (11.4-1)
\]

\[
S_{M1} = F_v S_1 \quad (11.4-2)
\]
## Table 11.4-1 Short-Period Site Coefficient, $F_a$

<table>
<thead>
<tr>
<th>Site Class</th>
<th>$S_s \leq 0.25$</th>
<th>$S_s = 0.5$</th>
<th>$S_s = 0.75$</th>
<th>$S_s = 1.0$</th>
<th>$S_s = 1.25$</th>
<th>$S_s \geq 1.5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>C</td>
<td>1.3</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>D</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>E</td>
<td>2.4</td>
<td>1.7</td>
<td>1.3</td>
<td>See Section</td>
<td>See Section</td>
<td>See Section</td>
</tr>
<tr>
<td>F</td>
<td>See Section</td>
<td>See Section</td>
<td>See Section</td>
<td>See Section</td>
<td>See Section</td>
<td>See Section</td>
</tr>
</tbody>
</table>

$S_s$ denotes the spectral response acceleration parameter at short period.
IBC Seismic Activity Maps
ASCE 7

• 0.2 sec Spectral Response Acceleration Map
  • Used to determine HLF
  • Also used in determining bracing exemption

• 1 sec Spectral Response Acceleration Map
  • Used in determining bracing exemption
0.2 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)
<table>
<thead>
<tr>
<th>Components</th>
<th>$a_p^a$</th>
<th>$R_p^b$</th>
<th>$\Omega_b^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication equipment, computers, instrumentation, and controls</td>
<td>1</td>
<td>2½</td>
<td>2</td>
</tr>
<tr>
<td>Roof-mounted stacks, cooling and electrical towers laterally braced below</td>
<td>2½</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>their center of mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof-mounted stacks, cooling and electrical towers laterally braced above</td>
<td>1</td>
<td>2½</td>
<td>2</td>
</tr>
<tr>
<td>their center of mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting fixtures</td>
<td>1</td>
<td>1½</td>
<td>2</td>
</tr>
<tr>
<td>Other mechanical or electrical components</td>
<td>1</td>
<td>1½</td>
<td>2</td>
</tr>
<tr>
<td>Electrical conduit and cable trays</td>
<td>2½</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>
The overstrength factor, $\Omega_0$, in Table 13.5-1 and Table 13.6-1, is applicable only to anchorage of components to concrete and
Critical Brace Strength Points

1. SWAY BRACE FITTING
2. STRUCTURE ATTACHMENT FITTING
3. BRACED COMPONENT (PIPE)
4. FASTENER
5. STRUCTURE
Concrete Anchors (Prying)
Concrete Anchors

• **ASCE 7 Requires Anchor Calculations**
  - In accordance with ACI 318
    - ACI 355.2 Seismic Simulation Testing
  - Determination of forces to take into account effects of prying and eccentricities
  - Consideration of Overstrength $\Omega_0$
    - Maximum $\Omega_0 = 2.0$
Vertical Seismic Force

13.3.1.2 Vertical Force. The component shall be designed for a concurrent vertical force $\pm 0.2S_{DS}W_p$.

**EXCEPTION:** The concurrent vertical seismic force need not be considered for lay-in access floor panels and lay-in ceiling panels.
Upward resultant vertical force

• Same reaction for BOTH brace types
  ➢ Rod stiffeners required
  WHEN there is net upward resultant
  AND $Kl/r$ is less than 200
Upward Vertical Force (\( E_v \))

- Upward Vertical forces:
  - Vertical Reaction = Horizontal Force divided by Tangent Brace Angle from Vertical
    - minus 0.6 \( D \) in some cases
  - ASCE 7 additional vertical force = 0.2\( S_{DS} \)\( D \)
Downward resultant vertical force

• ONLY for Tension/Compression Braces
  ➢ Occurs when braces resist loads in compression
Downward Vertical Force \( (E_v) \)

- Downward Vertical forces:
  - Downward Vertical Reaction = Horizontal Force divided by Tangent Brace Angle from Vertical plus \( D \) for 1 hanger
  - ASCE 7 additional vertical force \( = 0.2S_{DS}D \)

NOTE: Downward does not apply to cable bracing
Component Exemptions Based on SDC & Ip

- All components in SDC A and B
- All components in SDC C provided that either
  - The component \( Ip = 1.0 \) and the component is positively attached to the structure, or
  - The component weigh 20 lbs (89 N) or less or, in the case of a distributive system, 5 lbs/ft (74 N/m) or less.
- Individual Components in SDC D, E or F, that are positively attached to the structure provided that either
  - \( Ip = 1.0 \) and the component weighs 400 lb (1,779 N) or less and the center of gravity is 4 ft (1.22 m) or less above the floor and with flexible connections between the component and conduit, or
Component Exemptions cont’d.
Based on SDC & Ip

- Individual Components in SDC D, E or F, that are positively attached to the structure provided that either
  - The component Ip = 1.0 and
    - The component weighs 400 lb (1,779 N) or less and
    - The component center of gravity is 4 ft (1.22 m) or less above the floor and
    - Flexible connections between the component and associated conduit
  or
  - The component weighs 20 lbs (89 N) or less
  or
  - The component is a distributed system weight 5 lbs/ft (74 N/m)
Component Exemptions cont’d.
Based on $SDC \& Ip$

- All conduit less than 2.5 in (64 mm) trade size.
- Cable trays or raceways where $Ip = 1.0$, flexible connections to associated equipment are provided and the cable tray or raceway is positively attached to the structure and one of the following applies:
  - Trapeze assemblies with 3/8 in (10mm) rod hangers not exceeding 12 in (305mm) from the support point to the structure connection and total weight on a single trapeze is 100 is (445 N) or less, or
  - Trapeze assemblies with 1/2 in (13mm) rod hangers not exceeding 12 in (305mm) from the support point to the structure connection and total weight on a single trapeze is 200 is (890 N) or less, or
  - Trapeze assemblies with 1/2 in (13mm) rod hangers not exceeding 24 in (610mm) from the support point to the structure connection and total weight on a single trapeze is 100 is (445 N) or less, or
  - Trapeze assemblies with 3/8 in (10mm) or 1/2 in (13mm) rod hangers not exceeding 12 in (305mm) from the support point to the structure connection and total weight on a single trapeze is 50 is (220 N) or less.
Q & A
THANK YOU