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

By

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&

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PART 1

Introduction to earthquakes

by

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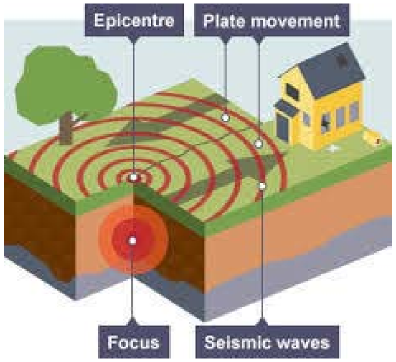
Brief introduction to Earthquakes



- 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.

I. Instrumental	Generally not felt by people unless in favorable conditions.
II. Weak	Felt only by a couple people that are sensitive, especially on the upper floors of buildings. Delicately suspended objects (including chandeliers) may swing slightly.
III. Slight	Felt quite noticeably by people indoors, especially on the upper floors of buildings. Many do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration similar to the passing of a truck. Duration can be estimated. Indoor objects (including chandeliers) may shake.
IV. Moderate	Felt indoors by many to all people, and outdoors by few people. Some awakened. Dishes, windows, and doors disturbed, and walls make cracking sounds. Chandeliers and indoor objects shake noticeably. The sensation is more like a heavy truck striking building. Standing automobiles rock noticeably. Dishes and windows rattle alarmingly. Damage none.
V. Rather Strong	Felt inside by most or all, and outside. Dishes and windows may break and bells will ring. Vibrations are more like a large train passing close to a house. Possible slight damage to buildings. Liquids may spill out of glasses or open containers. None to a few people are frightened and run outdoors.
VI. Strong	Felt by everyone, outside or inside; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight to moderate to poorly designed buildings, all others receive none to slight damage.
VII. Very Strong	Difficult to stand. Furniture broken. Damage light in building of good design and construction; slight to moderate in ordinarily built structures; considerable damage in poorly built or badly designed structures; some chimneys broken or heavily damaged. Noticed by people driving automobiles.
VIII. Destructive	Damage slight in structures of good design, considerable in normal buildings with a possible partial collapse. Damage great in poorly built structures. Brick buildings easily receive moderate to extremely heavy damage. Possible fall of chimneys, factory stacks, columns, monuments, walls, etc. Heavy furniture moved.
IX. Violent	General panic. Damage slight to moderate (possibly heavy) in well-designed structures. Well-designed structures thrown out of plumb. Damage moderate to great in substantial buildings, with a possible partial collapse. Some buildings may be shifted off foundations. Walls can fall down or collapse.
X. Intense	Many well-built structures destroyed, collapsed, or moderately to severely damaged. Most other structures destroyed, possibly shifted off foundation. Large landslides.
XI. Extreme	Few, if any structures remain standing. Numerous landslides, cracks and deformation of the ground.
XII. Catastrophic	Total destruction – everything is destroyed. Lines of sight and level distorted. Objects thrown into the air. The ground moves in waves or ripples. Large amounts of rock move position. Landscape altered, or leveled by several meters. Even the routes of rivers can be changed.

Richter Scale

Measures energy released at focus (logarithmic scale)

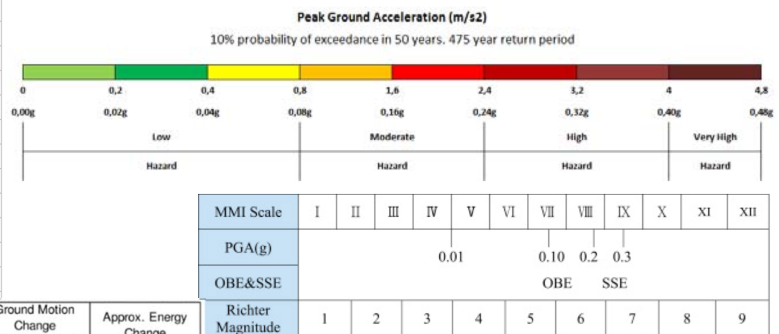
RICHTER SCALE

Magnitude	TNT Equivalent		Example
0	1.0	kg / 35 ounces	Breaking a rock on a lab table
0.5	5.6	kg / 12 lbs	
1	31.6	kg / 70 lbs	Large blast at a construction site
1.5	178.0	kg / 395 lbs	
2	1.0	ton	Large quarry or mine blast
2.5	5.6	tons	
3	31.6	tons	
3.5	178.0	tons	
4	1000.0	tons	Small nuclear weapon
4.5	56000.0	tons	Average tornado
5	316000.0	tons	
5.5	178000.0	tons	
6	1.0	million tons	
6.5	5.6	million tons	Northridge, CA quake, 1994
7	31.6	million tons	Largest thermonucle
7.5	178.0	million tons	
8	1.0	billion tons	
8.5	5.6	billion tons	
9	31.6	billion tons	
9.5	178.0	billion tons	Chilean quake, 1960
10	1.0	trillion tons	Never registered

Magnitude Change	Ground Motion Change (Displacement)	Approx. Energy Change
0.1	1.3 times	1.4 times
0.3	2.0 times	3 times
0.5	3.2 times	5.5 times
1.0	10 times	32 times
2.0	100 times	1,000 times
3.0	1,000 times	32,000 times
4.0	10,000 times	1,000,000 times

Peak Ground Acceleration

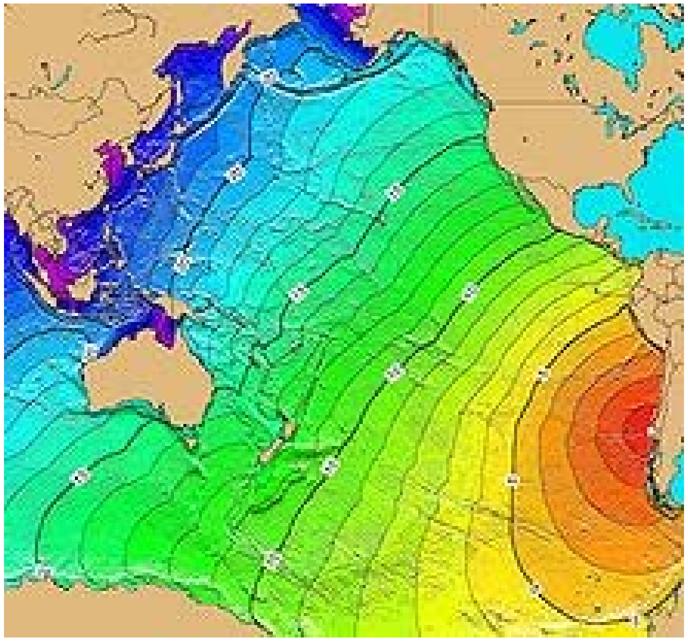
Measures horizontal waves’ maximum acceleration on the surface in “g” (m/s^2)



Richter Magnitude formula according to MMI scale: M=1+MMI×(2/3)(Gutenberg & Richter, 956)

MMI scale formula according to PGA(g): MMI=3logA+1.5(Gutenberg & Richter, 1956)

Most powerful earthquake recorded



Chile - Valdivia (May 22nd, 1960)

- 3000 casualties
- 2.000.0000 evacuated
- 6.000.000.000$ damages (actualized 2011)

Details

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

Magnitude Change	Ground Motion Change (Displacement)	Approx. Energy Change
0.1	1.3 times	1.4 times
0.3	2.0 times	3 times
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1.0	10 times	32 times
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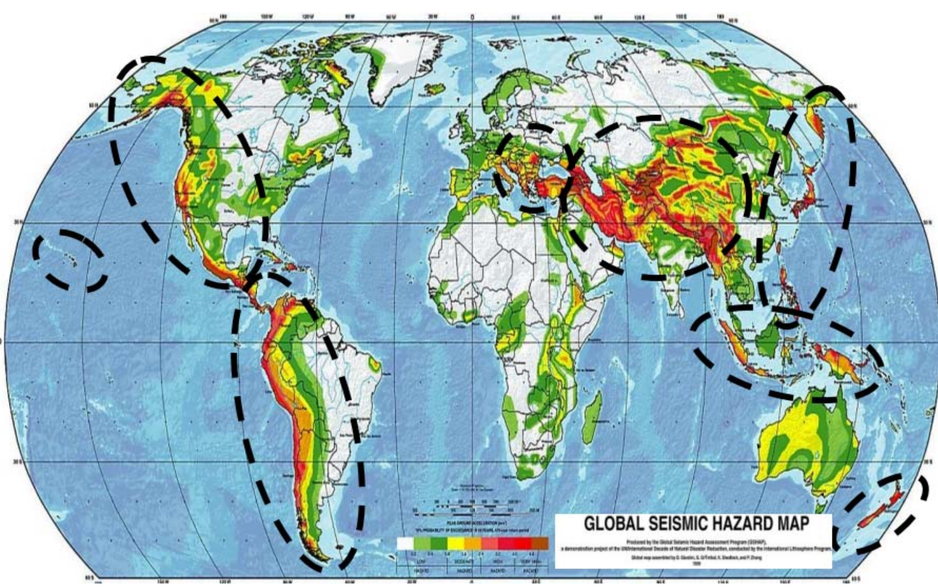
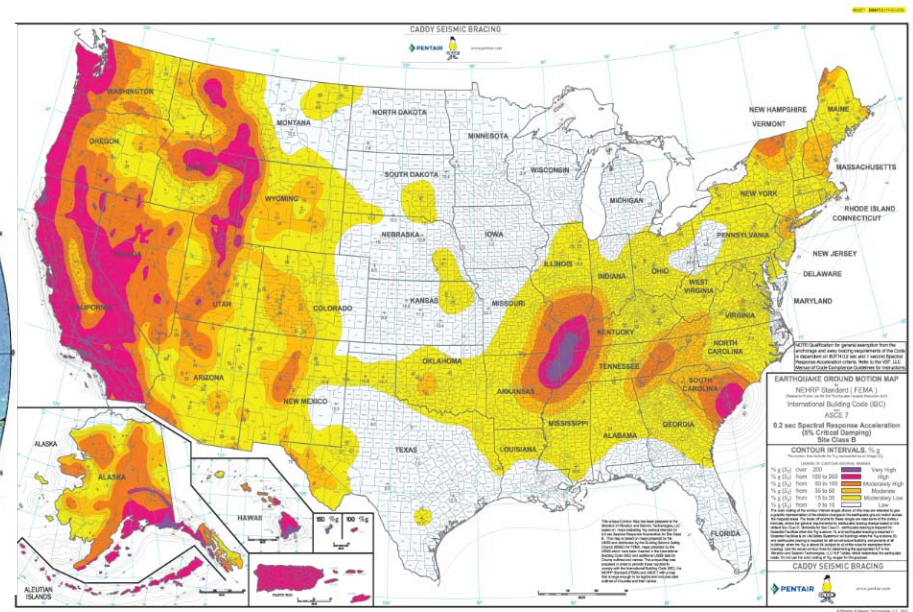
Seismic Maps





Structure not seismically engineered

Operating system not protected

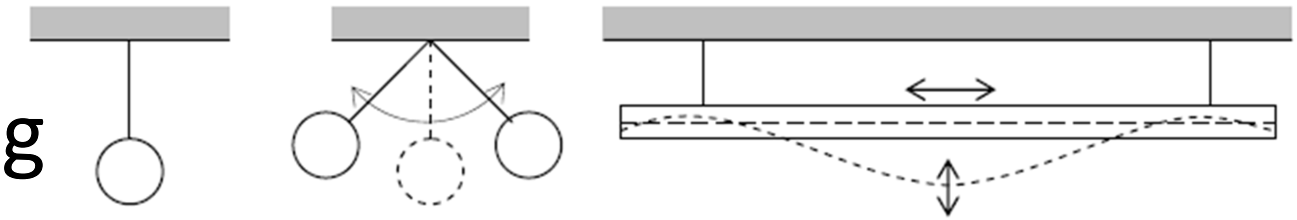
Structural and non-structural seismic protection

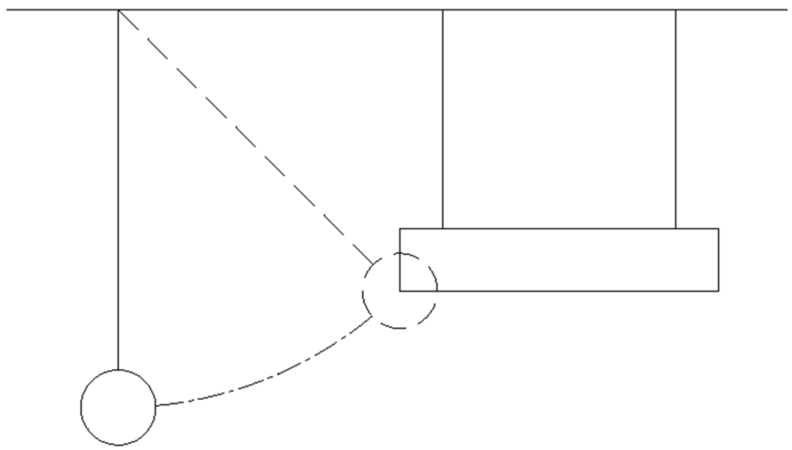
3. SEISMIC STRUCTURE & BRACING:

- THE BUILDING & THE SERVICES MAINTAIN THEIR FUNCTIONALITY AND OPERABILITY

How damage occurs

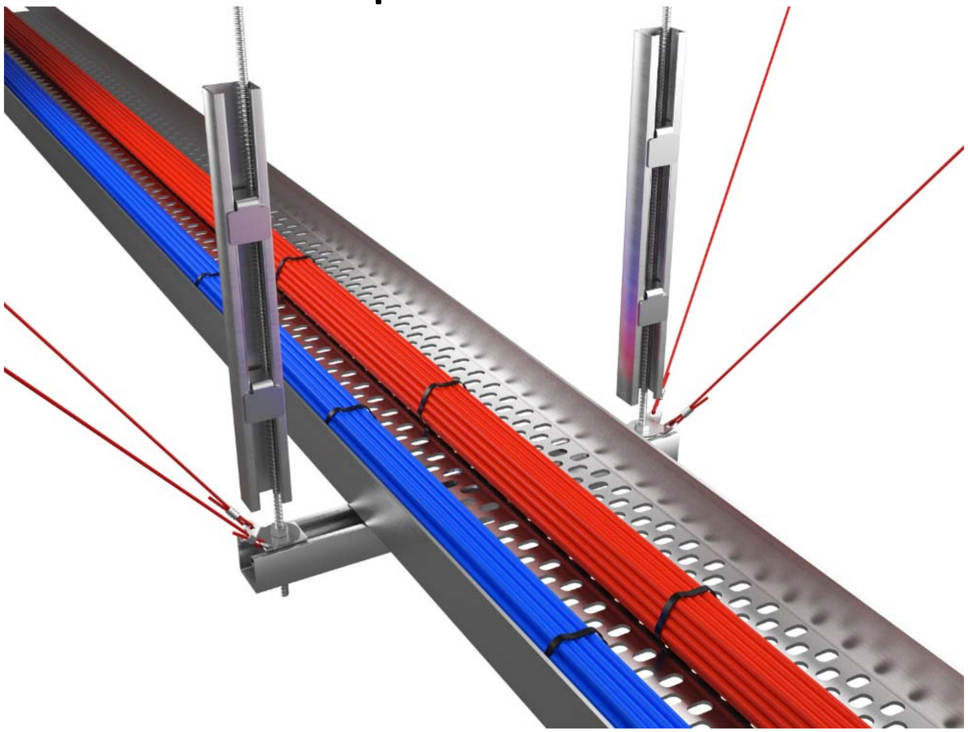
Swaying

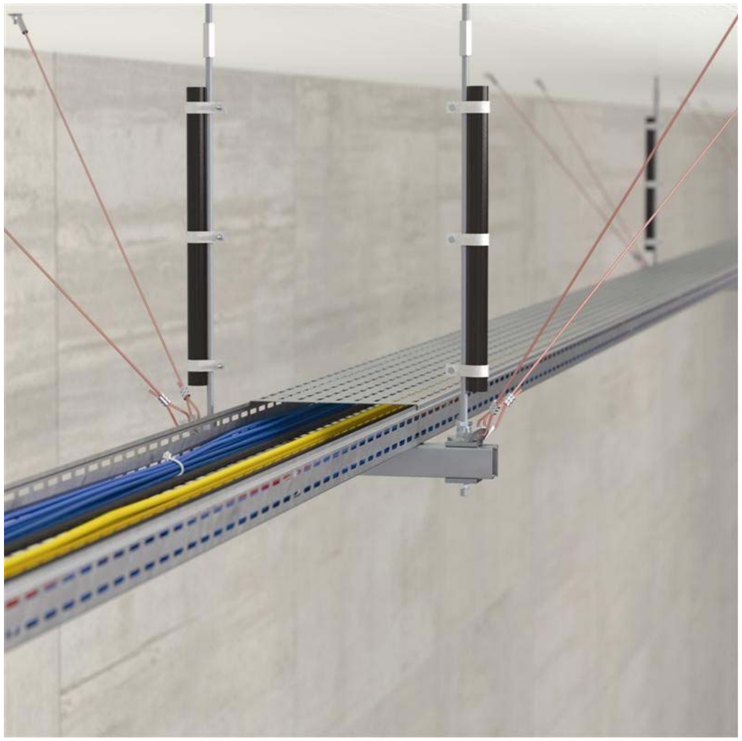




Colliding

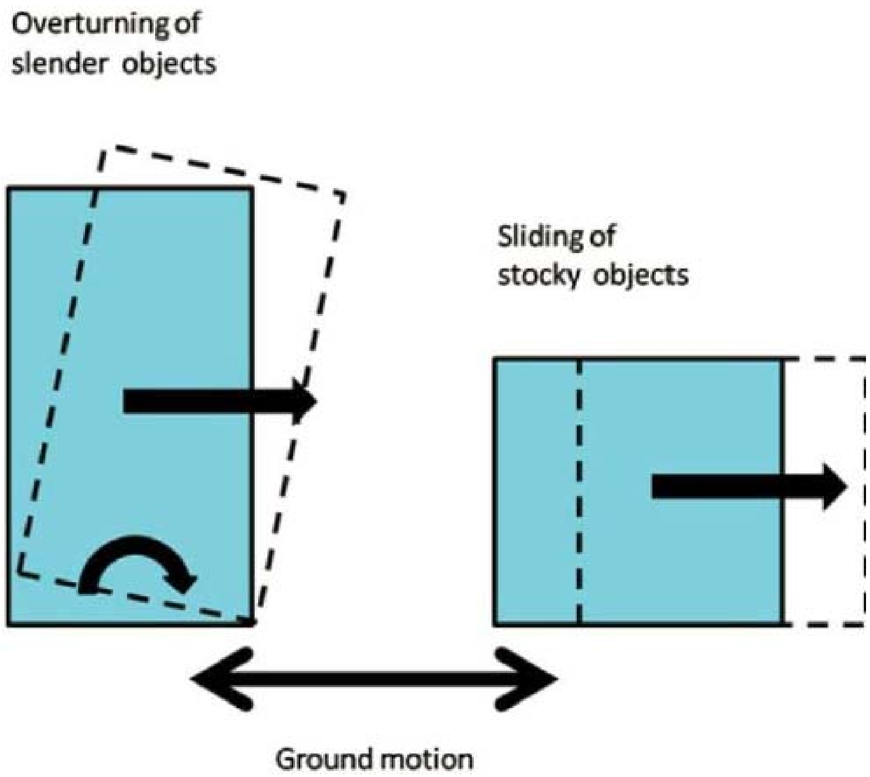
Brace to protect





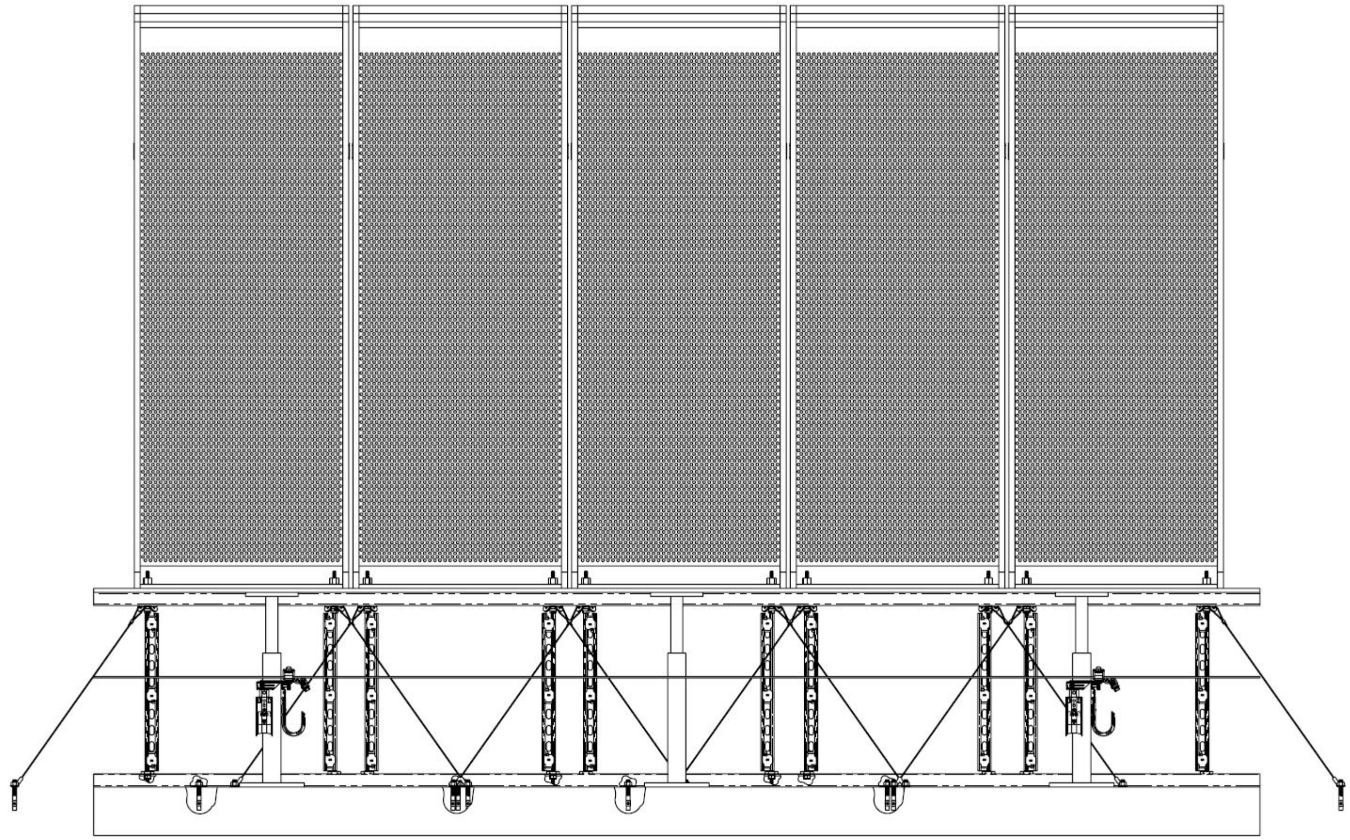
How damage occurs

Overturning



Sliding

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

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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

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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
- **ISO/IEC 14763-2: 2012,** Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation
- 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

- **ISO/IEC 14763-2 (2012),** Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation
  - **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
  - **EN 50173 Part 2,** Installation Planning and Practices Inside Buildings
- **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

No guidance

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

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nVent CADDY Business Development Manager, Seismic

Member NFPA 13 Committee on Hanging and Bracing

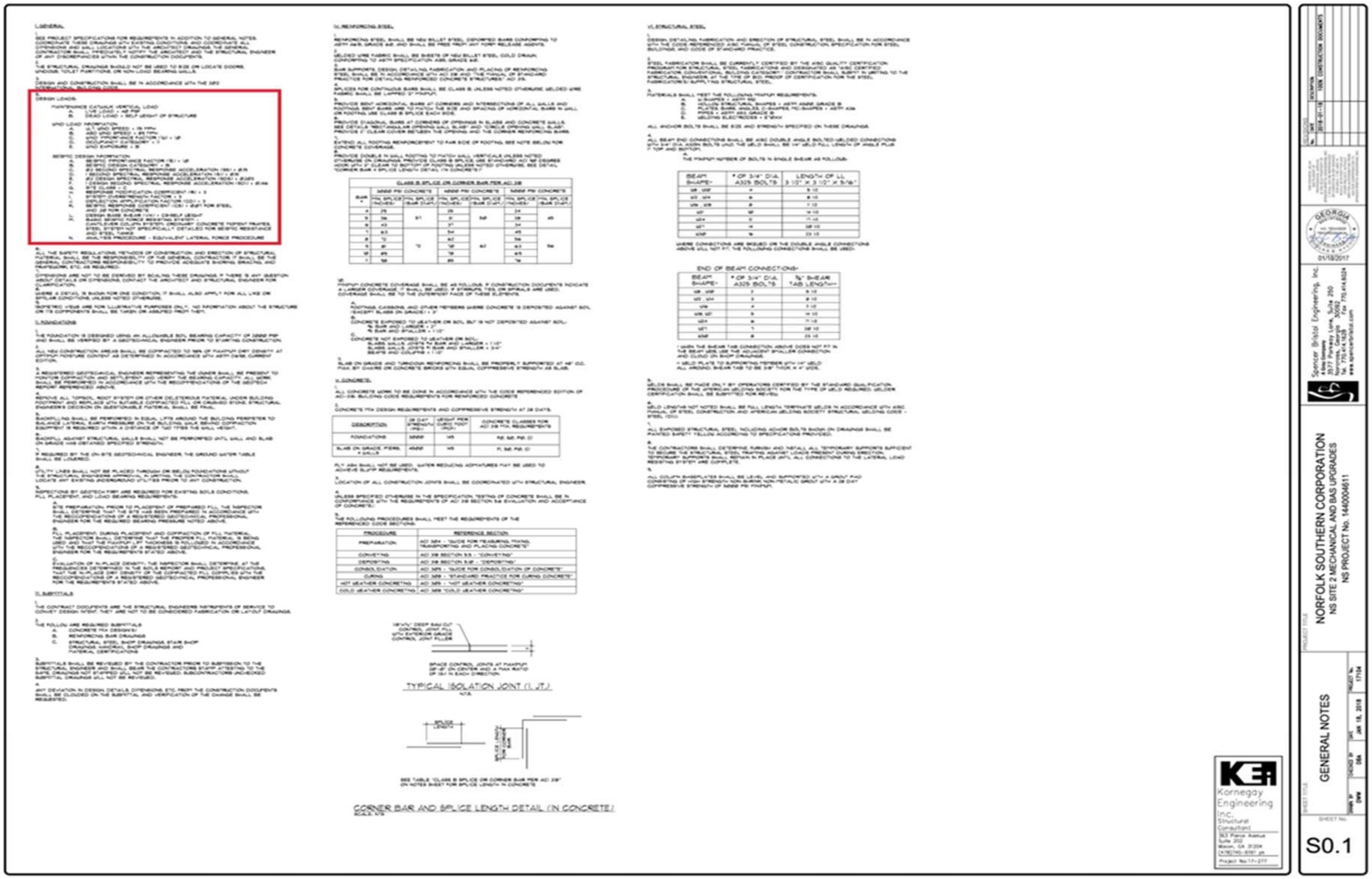
Building Code
ASCE 7-10 or 7-16

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

Seismic Design Category (SDC)	Importance Factor	
	I_p = 1.0	I_p = 1.5 (Life Safety or Hazardous)
A	EXEMPT – Seismic Not Required	EXEMPT – Seismic Not Required
B	EXEMPT – Seismic Not Required	EXEMPT – Seismic Not Required
C	EXEMPT – Seismic Not Required	REQUIRED
D	REQUIRED	REQUIRED
E	REQUIRED	REQUIRED
F	REQUIRED	REQUIRED



TYPICAL ISOLATION JOINT (I. JT.)
CORNER BAR AND SPLICE LENGTH DETAIL (IN CONCRETE)
Kornegay Engineering Inc.
Spencer Bristol Engineering, Inc.
01/19/2017
NORFOLK SOUTHERN CORPORATION
NS SITE 2 MECHANICAL AND BAS UPGRADES
NS PROJECT No. 1440004611
GENERAL NOTES
S0.1

I. 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. ULT. WIND SPEED = 115 MPH
- B. ASD WIND SPEED = 89 MPH
- C. WIND IMPORTANCE FACTOR (IW) = 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 (SS) = 0.19
- D. 1 SECOND SPECTRAL RESPONSE ACCELERATION (S1) = 0.91
- E. 0.2 DESIGN SPECTRAL RESPONSE ACCELERATION (SDS) = 0.203
- F. 1 DESIGN SECOND SPECTRAL RESPONSE ACCELERATION (SD1) = 0.146
- 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) = 0.07 FOR STEEL AND .20 FOR CONCRETE
- L. DESIGN BASE SHEAR (VX) = CS*SELF 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

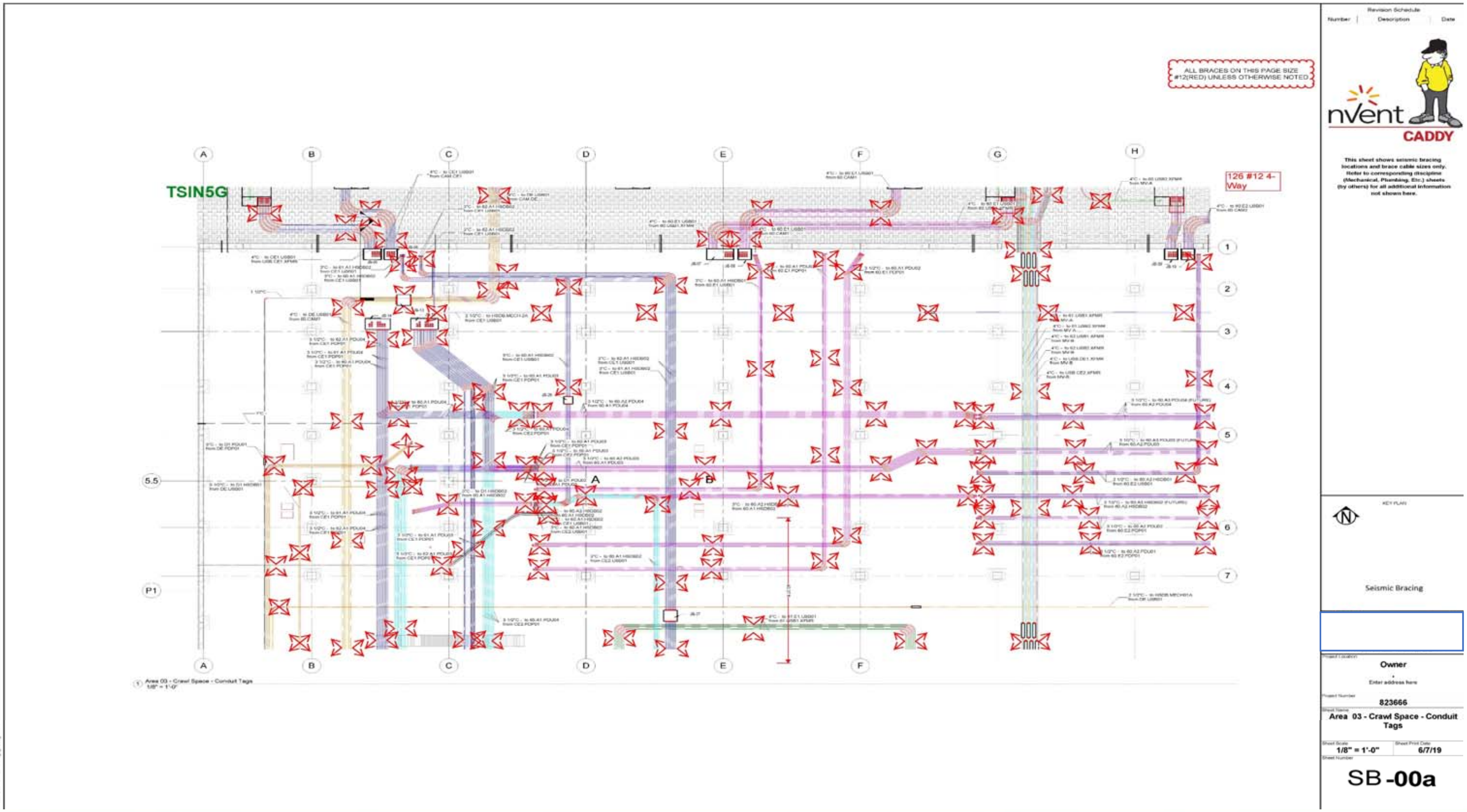
Conduit Size	SDC = C		SDC = D, E or F	
	I_p = 1.0	I_p = 1.5	I_p = 1.0	I_p = 1.5
≤ 1” (25mm)	Exempt	Exempt	Exempt	Exempt
1 1/4” (32 mm)	Exempt	Exempt	Exempt	Exempt
1 1/2” (40 mm)	Exempt	Exempt	Exempt	Exempt
2” (50 mm)	Exempt	Exempt	Exempt	Exempt
2 1/2” (65 mm)	Exempt	REQUIRED	REQUIRED	REQUIRED
3” (78 mm)	Exempt	REQUIRED	REQUIRED	REQUIRED
3 1/2” (88 mm)	Exempt	REQUIRED	REQUIRED	REQUIRED
≥ 4” (100 mm)	Exempt	REQUIRED	REQUIRED	REQUIRED

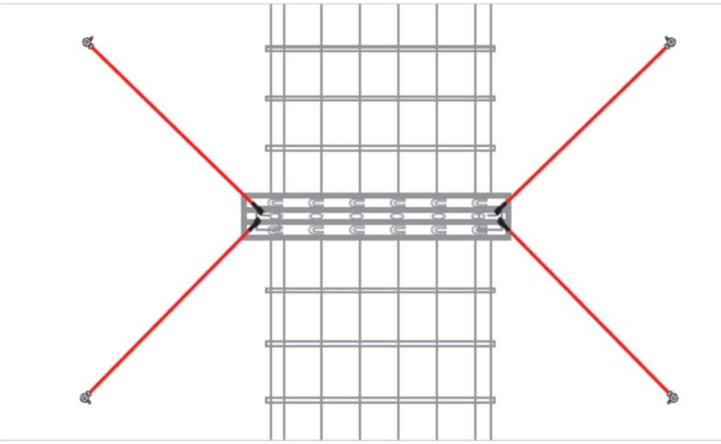
Suspended Trapeze, Cable Tray, Ladder Tray, Basket Tray Exemptions ASCE 7-10

Tray weight per Ft.	SDC = C		SDC = D, E or F	
	I_p = 1.0	I_p = 1.5	I_p = 1.0	I_p = 1.5
≥ 5 Lbs/Ft	Exempt	REQUIRED	REQUIRED	REQUIRED
≥ 10 Lbs/Ft	Exempt	REQUIRED	REQUIRED	REQUIRED

Suspended Equipment Exemptions ASCE 7-10

Equipment Weight	SDC = C		SDC = D, E or F	
	I_p = 1.0	I_p = 1.5	I_p = 1.0	I_p = 1.5
< 20 Lbs.	Exempt	Exempt	Exempt	Exempt
≥ 20 Lbs.	Exempt	REQUIRED	REQUIRED	REQUIRED

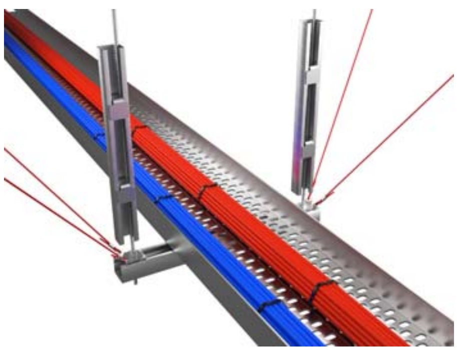

ALL BRACES ON THIS PAGE SIZE #12(RED) UNLESS OTHERWISE NOTED
TSIN5G
126 #12 4-Way
Revision Schedule
Number Description Date
nVent CADDY
This sheet shows seismic bracing locations and brace cable sizes only. Refer to corresponding discipline (Mechanical, Plumbing, Etc.) sheets (by others) for all additional information not shown here.
KEY PLAN
Seismic Bracing
Owner
Enter address here
823666
Area 03 - Crawl Space - Conduit Tags
1/8" = 1'-0"
6/7/19
SB-00a



Cable tray

Wire basket

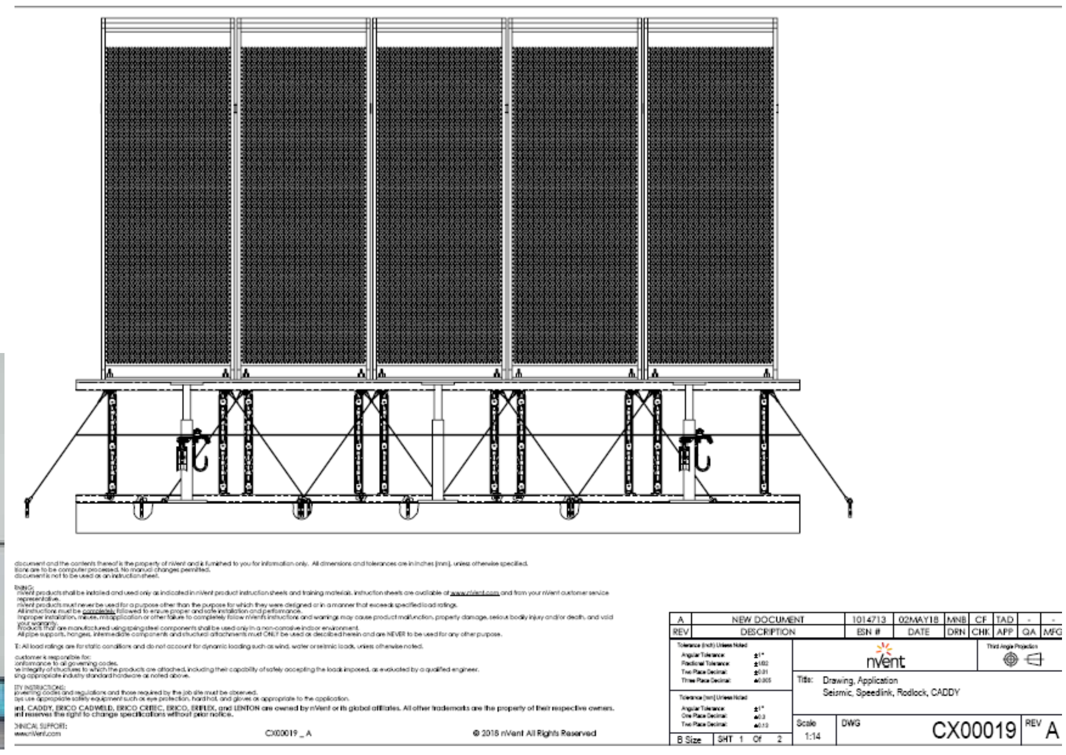
Ladder



Racks & cabinets

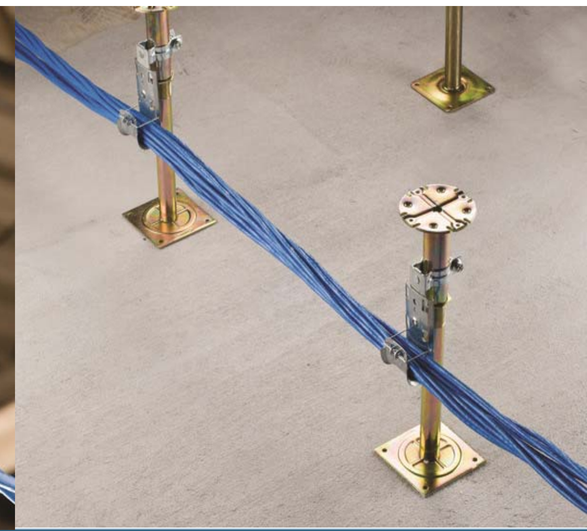
Raised floor installation

Concrete



Non-continuous supports
(J-Hooks for example)

Various types of installation – wall mount, suspended via wire, threaded rod, etc.



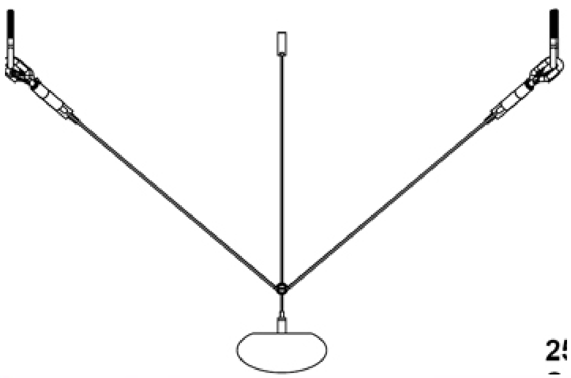
media installed by the LV industry

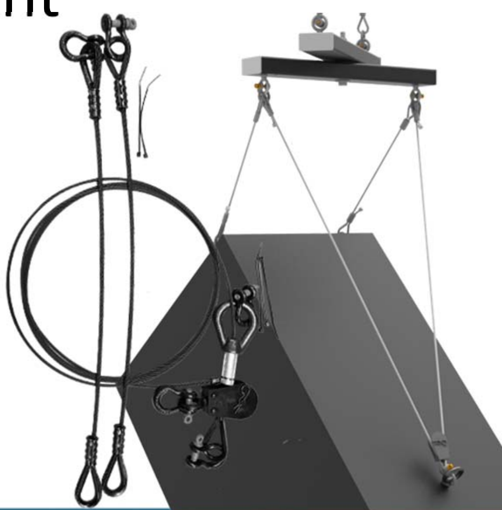
Camera

WAP's –Wireless Access Points

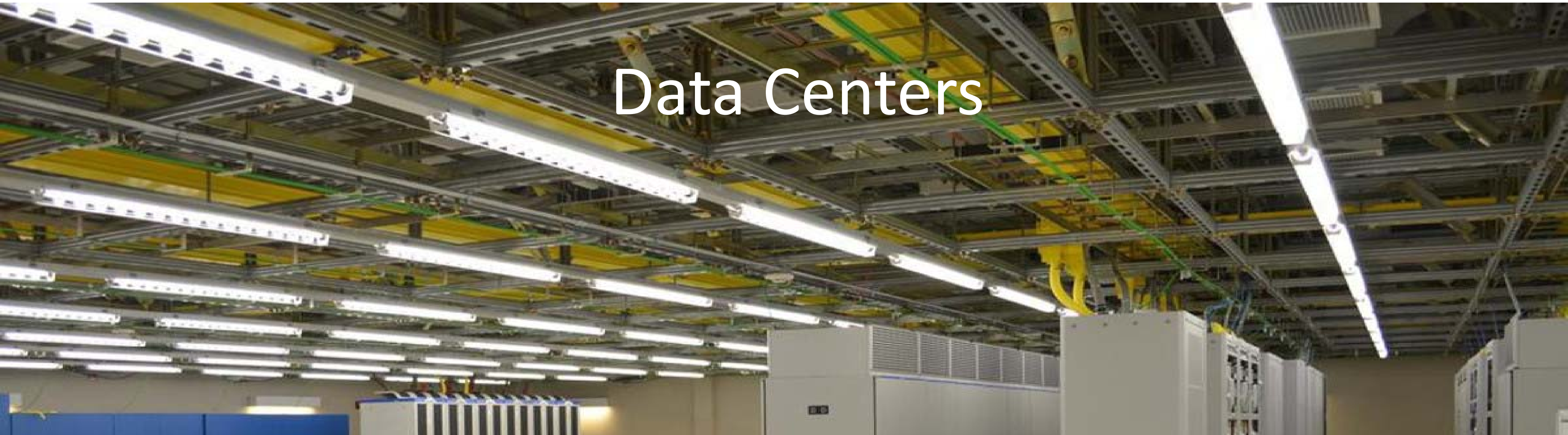
Speakers – Can vary greatly in weight

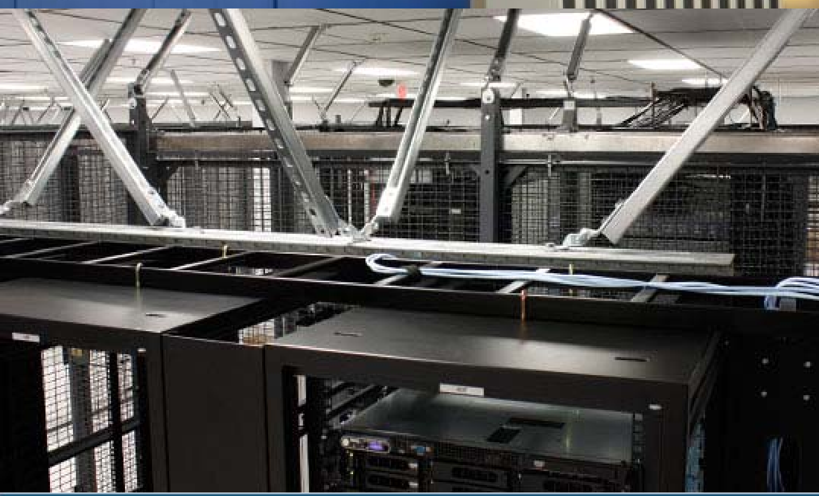
Projectors



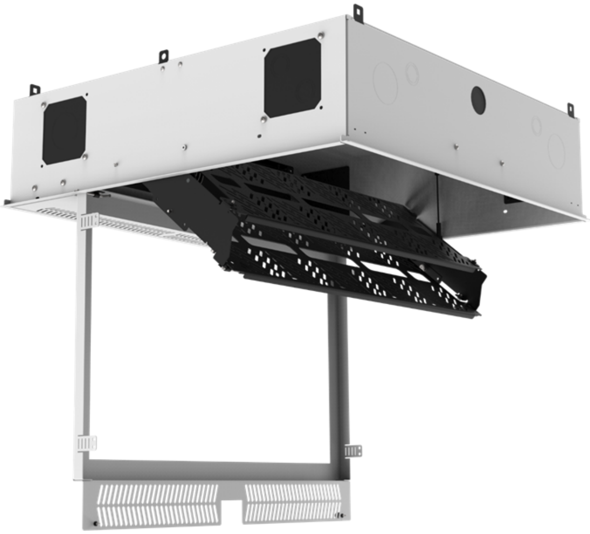


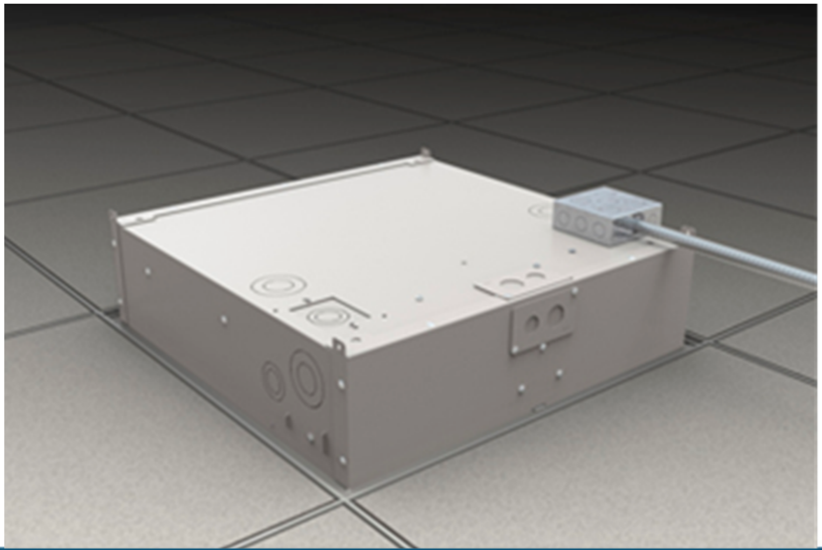
Data Centers





Zone distribution cabinets

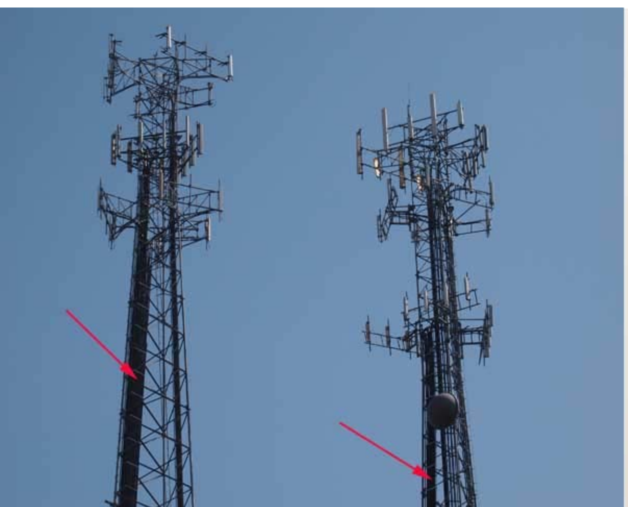


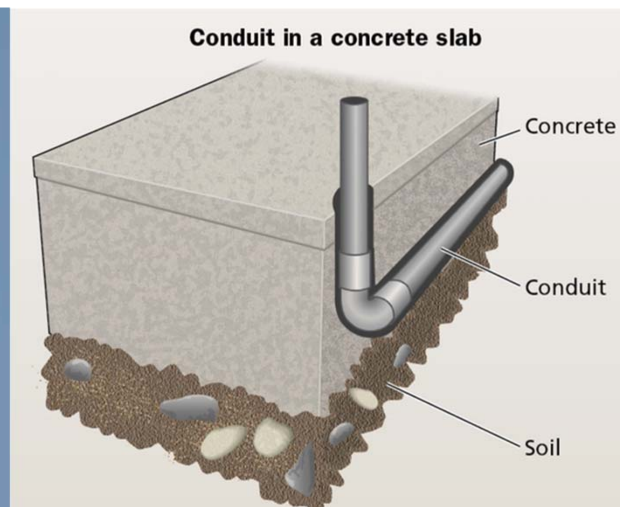


Earthquake Damage

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
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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

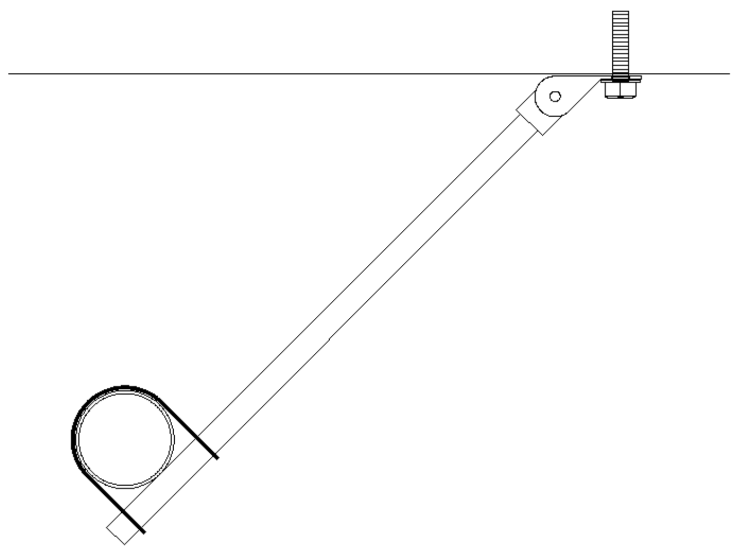
Seismic Brace Spacing

- **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 *K1/r* 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 *Kl/r* limitation
  - Brace element on both sides of braced component

Horizontal Seismic Force

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):

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)} \left(1 + 2\frac{z}{h}\right) \qquad (13.3\text{-}1)$$

F_p is not required to be taken as greater than

$$F_p = 1.6 S_{DS} I_p W_p \qquad (13.3\text{-}2)$$

and F_p shall not be taken as less than

$$F_p = 0.3 S_{DS} I_p W_p \qquad (13.3\text{-}3)$$

Horizontal Seismic Force cont'd.

F_p = seismic design force;

S_{DS} = spectral acceleration, short period, as determined from Section 11.4.5;

a_p = 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 = component Importance Factor that varies from 1.00 to 1.50 (see Section 13.1.3);

W_p = component operating weight;

R_p = component response modification factor that varies from 1.00 to 12 (select appropriate value from Table 13.5-1 or 13.6-1);

z = height in structure of point of attachment of component with respect to the base. For items at or below the base, z shall be taken as 0. The value of z/h need not exceed 1.0; and

h = 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.

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

$$S_{D1} = \frac{2}{3} S_{M1} \qquad (11.4\text{-}4)$$

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.

$$S_{MS} = F_a S_S \qquad (11.4\text{-}1)$$

$$S_{M1} = F_v S_1 \qquad (11.4\text{-}2)$$

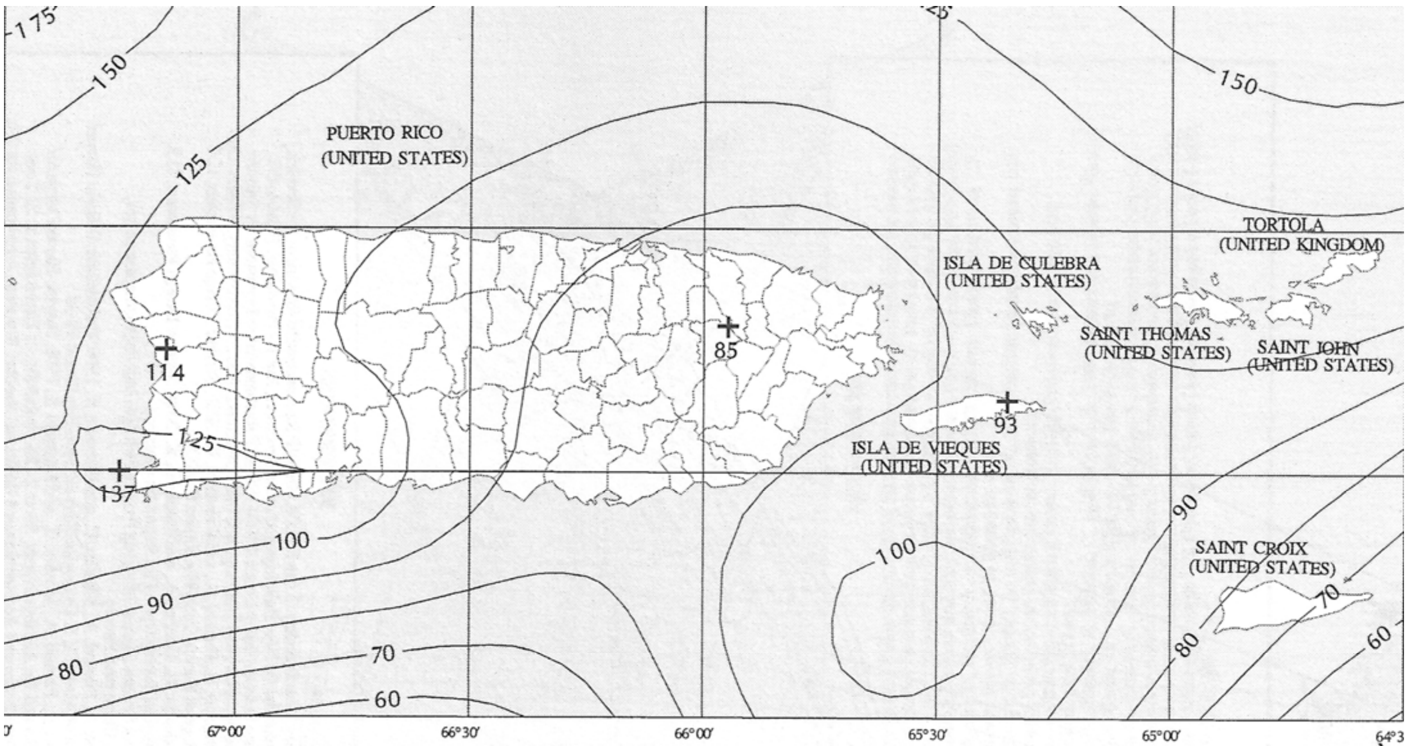
Table 11.4-1 Short-Period Site Coefficient, F_a

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at Short Period					
	$S_S \leq 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S = 1.25$	$S_S \geq 1.5$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.3	1.2	1.2	1.2	1.2
D	1.6	1.4	1.2	1.1	1.0	1.0
E	2.4	1.7	1.3	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8
F	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

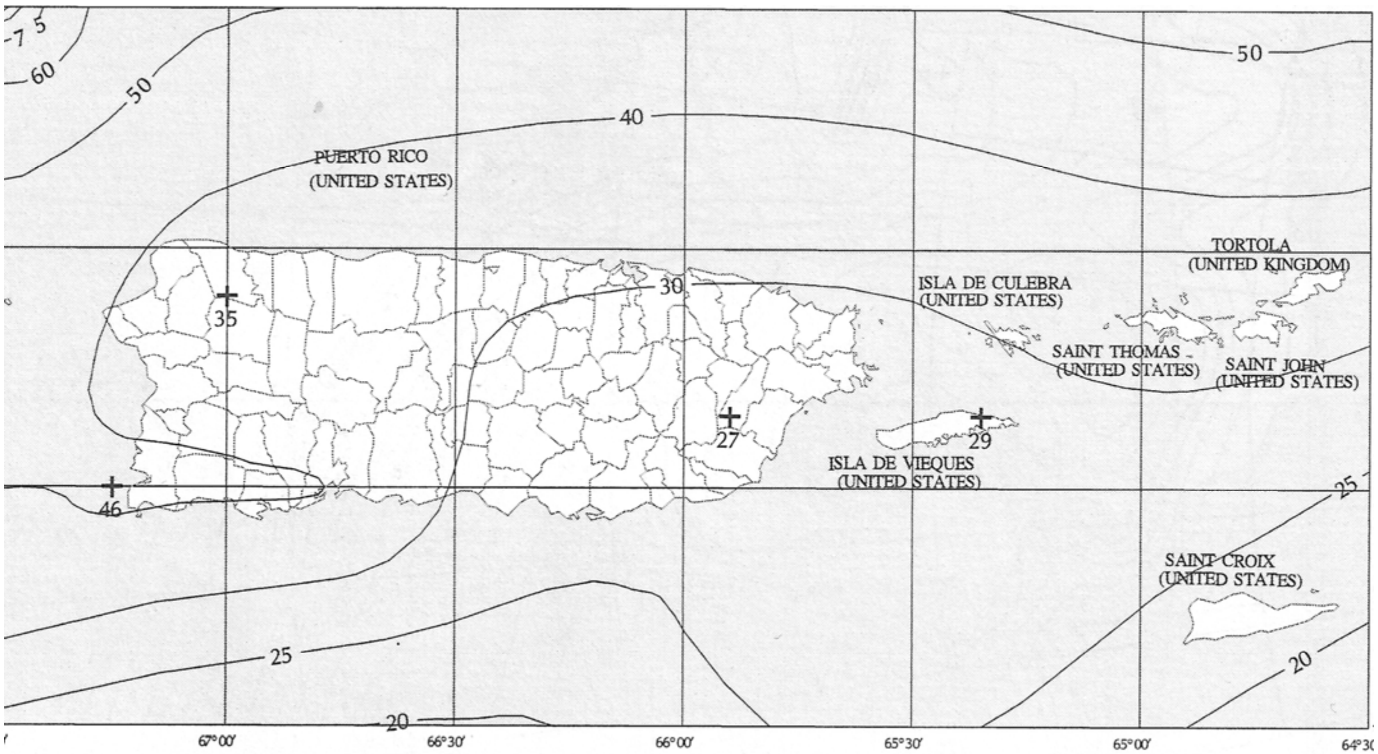
IBC Seismic Activity Maps
ASCE 7

- **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)



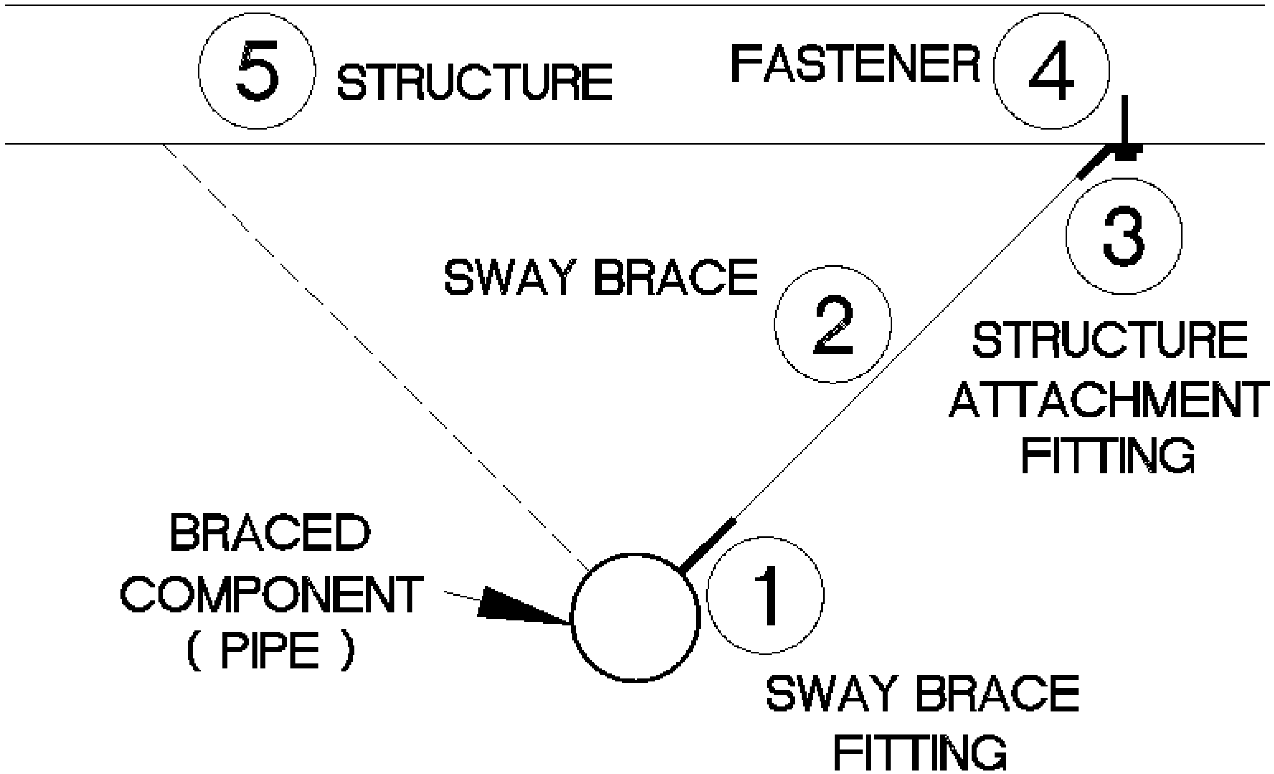
1.0 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)

Table 13.6-1 Seismic Coefficients for Mechanical and Electrical Components

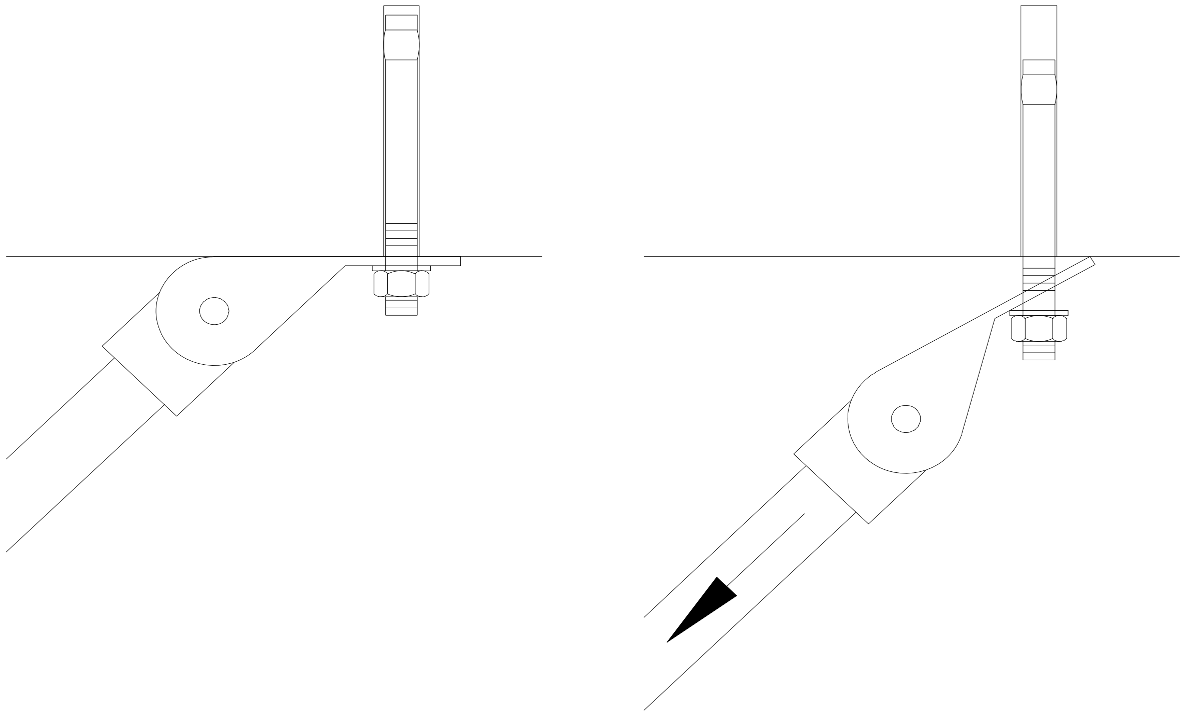
Components	a_p[a]	R_p[b]	Ω_0[c]
Communication equipment, computers, instrumentation, and controls	1	2½	2
Roof-mounted stacks, cooling and electrical towers laterally braced below their center of mass	2½	3	2
Roof-mounted stacks, cooling and electrical towers laterally braced above their center of mass	1	2½	2
Lighting fixtures	1	1½	2
Other mechanical or electrical components	1	1½	2
Electrical conduit and cable trays	2½	6	2

The overstrength factor, Ω_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



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 Ω_0
    - Maximum Ω_0 = 2.0

Vertical Seismic Force

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

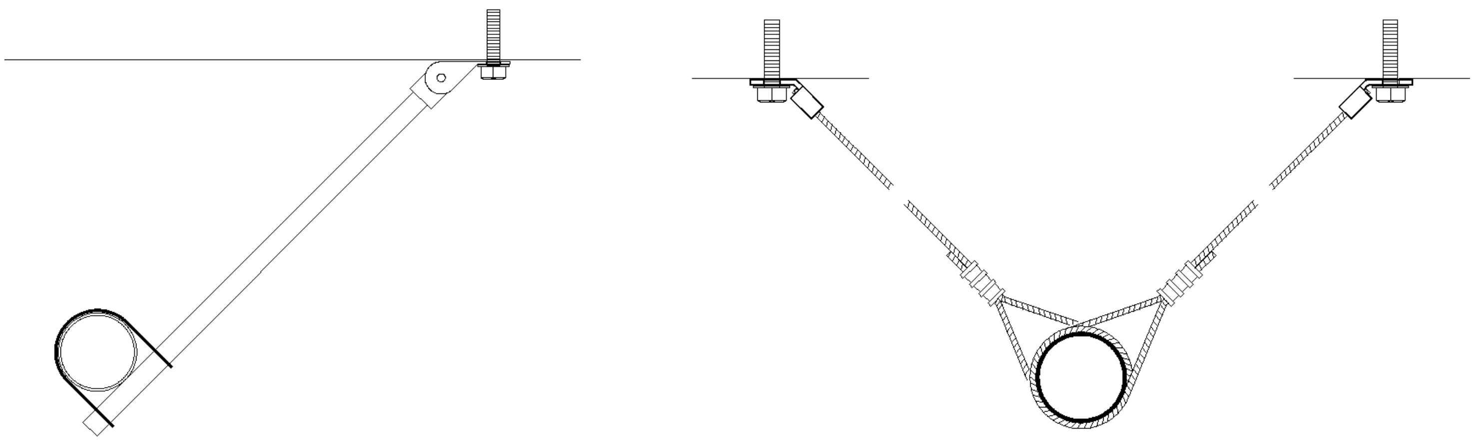
EXCEPTION: The concurrent vertical seismic force need not be considered for lay-in access floor panels and lay-in ceiling panels.

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

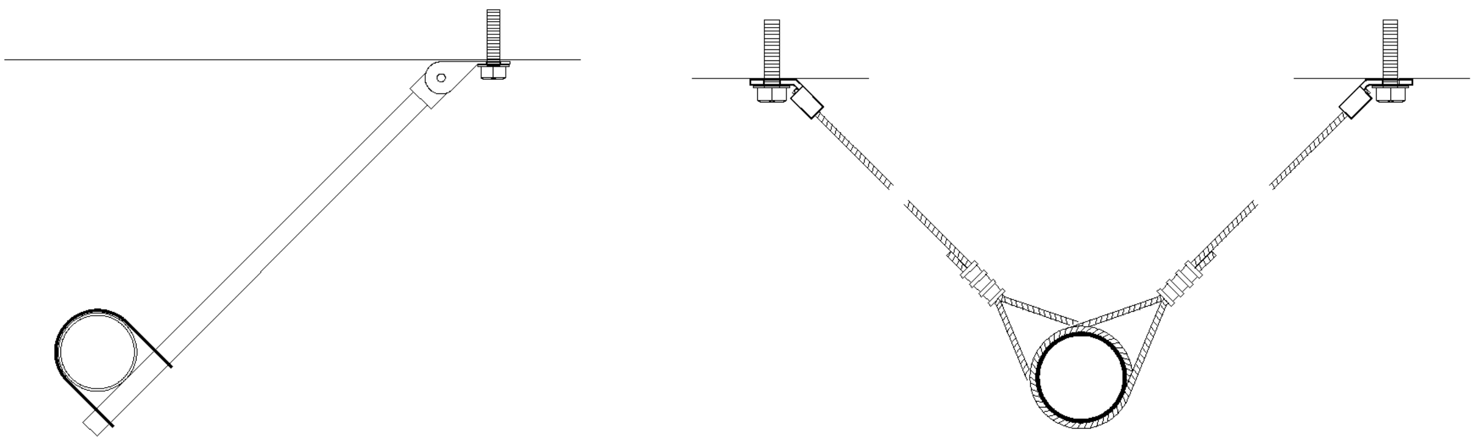


Upward Vertical Force (E_v)

- 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 = $0.2S_{DS}D$

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 ls (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