Seismic Restraints – IBC vs. UBC for Non-structural Components

Paul Selman | **Kinetics Noise Control, Inc.**
Senior Mechanical Engineer, PE
pselman@kineticsnoise.com
kineticsnoise.com
6300 Irelan Place, Dublin, Ohio 43017-0655
(614) 889-0480 Ext. 302

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Agenda

- UBC
- IBC
- ASCE7
- Calculations
- Compare/Contrast

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Uniform Building Code - UBC

- History
  - First published in 1927 by the International Conference of Building Officials (ICBO)
  - Intended to promote public safety, provided standardized requirements for safe construction which would not vary from city to city.

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Uniform Building Code - UBC

continued

- Updates were published approximately every three years until 1997, which was the final version of the UBC.
- ICBO merged with Building Officials and Codes Administrators (BOCA) and the Southern Building Code Congress (SBCC)

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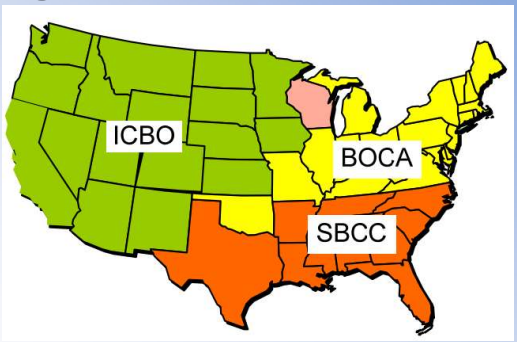
Uniform Building Code - UBC

continued

- **UBC focused on earthquake design.**



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Uniform Building Code - UBC

continued

- **Seismic Restraint**
  - **Section 1632 – Lateral Force on Elements of Structures, Nonstructural Components and Equipment Supported by Structures**

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Uniform Building Code - UBC

continued

- **1632.2 Design for Total Lateral Force.** The total design lateral seismic force, F_p, shall be determined from the following formula:

$$F_p = 4.0\, C_a\, I_p\, W_p \qquad (32\text{-}1)$$

Alternatively, F_p may be calculated using the following formula:

$$F_p = \frac{a_p\, C_a\, I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right) W_p \qquad (32\text{-}2)$$

Except that:

F_p shall not be less than $0.7 C_a I_p W_p$ and need not be more than $4 C_a I_p W_p$ (32-3)

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International Building Code - IBC

- **History**
  - **International Code Council (ICC) was established by joining of ICBO, BOCA and SBCC.**
  - **IBC was first published in 2000 by the ICC.**

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International Building Code - IBC

continued

- **Updates are published every three years.**
- **IBC2003 referenced ASCE7-02 for seismic design loads.**

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International Building Code - IBC

continued

- **IBC2015 is latest, most widely adopted version.**
- **IBC2018 is latest version, references ASCE7-16.**

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American Society of Civil Engineers – ASCE7

- **Minimum Design Loads and Associated Criteria for Buildings and Other Structures**

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American Society of Civil Engineers – ASCE7

- **Minimum Design Loads and Associated Criteria for Buildings and Other Structures**

13.3 SEISMIC DEMANDS ON NONSTRUCTURAL COMPONENTS

13.3.1 Seismic Design 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:

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

F_p is not required to be taken as greater than

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

and F_p shall not be taken as less than

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

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IBC2009/ASCE7-05 Calculations

Determine F_P using project design criteria, where:

- **F_p = seismic design force**
- **S_{DS} = spectral acceleration, short period**
- **a_p = component amplification factor**
- **I_p = component importance factor**

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IBC2009/ASCE7-05 Calculations

continued

Determine F_P using project design criteria, where:

- **W_p = component operating weight**
- **R_p = component response modification factor**
- **z = height in structure of point of attachment of component**
- **h = average roof height of structure**

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IBC2009/ASCE7-05 Calculations

continued

F_P using project design criteria, where:

W_p = 1,000 Kg

S_{DS} = .464 g R_p = 6.0

a_p = 2.5 z = 60m

I_p = 1.25 h = 60m

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IBC2009/ASCE7-05 Calculations

continued

Description	Symbol	Value	Note
Occupancy Category	IV	Essential facilities	Table 1-1
Component Importance Factor	I_p	1.25	Section 13.1.3
Site Class	C	Very Dense Soil	Table 20.3-1
Mapped short period MCE	S_s	0.6	g, Section 1613.3.1
Short-period site coefficient	F_a	1.16	Table 11.4-1
Spectral acceleration	S_{DS}	0.464	g, Section 1613.3.1
Height of attachment	h	60	meters
Roof elevation	z	60	meters
Component operating weight	W_p	1,000	Kg
Component amp. Factor	a_p	2.5	Table 13.6-1, Air-side HVAC
Component Response Factor	R_p	6.0	Table 13.6-1, Air-side HVAC
Seismic Design Category	SDC	D	
	$F_{P,max}$	928 Kg	Equation 13.3-2
Seismic Design Lateral Force	F_P	290 Kg	Equation 13.3-1
	$F_{P,min}$	174 Kg	Equation 13.3-3

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UBC1997 Calculations

1632.2 Design for Total Lateral Force. The total design lateral seismic force, F_p, shall be determined from the following formula:

$$F_p = 4.0\, C_a\, I_p\, W_p \qquad (32\text{-}1)$$

Alternatively, F_p may be calculated using the following formula:

$$F_p = \frac{a_p\, C_a\, I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right) W_p \qquad (32\text{-}2)$$

Except that:

F_p shall not be less than $0.7 C_a I_p W_p$ and need not be more than $4 C_a I_p W_p$ (32-3)

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UBC1997 Calculations

continued

F_P using project design criteria, where:

W_p = 1,000 Kg **I_p = 1.25**

C_a = 0.28 **R_p = 3.0**

a_p = 1.0

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UBC1997 Calculations

continued

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Compare F_P using UBC1997 and IBC2009

- $F_{P, UBC97} < F_{P, IBC09}$
- UBC is fixed, unchanging
- IBC is changing, evolving every 3 years, benefits from continued advancements in seismic research.

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Questions?

Paul Selman
pselman@kineticsnoise.com

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