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

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Agenda

- UBC
- IBC
- ASCE7
- Calculations
- Compare/Contrast
Uniform Building Code - UBC

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

Uniform Building Code - UBC
continued

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

- UBC focused on earthquake design.

Uniform Building Code - UBC continued

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

\[
F_p = 4.0 \ C_a \ L_p \ W_p \quad (32-1)
\]

Alternatively, \( F_p \) may be calculated using the following formula:

\[
F_p = \frac{a_p \ C_a \ L_p}{R_p} \left( 1 + 3 \frac{h_{sl}}{h_t} \right) W_p \quad (32-2)
\]

Except that:

\( F_p \) shall not be less than \( 0.7C_aL_pW_p \) and need not be more than \( 4C_aL_pW_p \) \( (32-3) \)

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.
International Building Code - IBC
continued
- Updates are published every three years.
- IBC2003 referenced ASCE7-02 for seismic design loads.

International Building Code - IBC
continued
- IBC2015 is latest, most widely adopted version.
- IBC2018 is latest version, references ASCE7-16.
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 \( F_r \) 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:

\[
F_r = \frac{0.4qH_S S_{2D} W_p}{R_s \left( 1 + 2 \frac{H}{l} \right)}
\]

(13.3-1)

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

\[
F_p = 1.6S_{1D} W_p
\]

(13.3-2)

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

\[
F_p = 0.3S_{1D} W_p
\]

(13.3-3)
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

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
IBC2009/ASCE7-05 Calculations continued

**Fₚ using project design criteria, where:**

\[ W_p = 1,000 \text{ Kg} \]
\[ S_{DS} = 0.464 \text{ g} \]
\[ a_p = 2.5 \]
\[ I_p = 1.25 \]
\[ R_p = 6.0 \]
\[ z = 60\text{m} \]
\[ h = 60\text{m} \]

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**IBC2009/ASCE7-05 Calculations continued**

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<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Note</th>
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<td>Occupancy Category</td>
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<td>meters</td>
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<tr>
<td>Roof elevation</td>
<td>z</td>
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<td>meters</td>
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<td>Component operating weight</td>
<td>W₀</td>
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<td>Component amp. Factor</td>
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\[ F_{L,max} = 523 \text{ Kg} \]
\[ F_{max} = 290 \text{ Kg} \]
\[ F_{L} = 174 \text{ Kg} \]

Equation 13.3-2
Equation 13.3-1
Equation 13.3-3
**UBC1997 Calculations**

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

$$ F_p = 4.0 \ C_a \ I_p \ W_p $$

(32-1)

Alternatively, $F_p$ may be calculated using the following formula:

$$ F_p = \frac{a_p \ C_a \ I_p}{R_p} \left(1 + \frac{h_x}{h_r}\right) W_p $$

(32-2)

Except that:

- $F_p$ shall not be less than $0.7C_aI_pW_p$ and
- need not be more than $4C_aI_pW_p$

(32-3)

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**UBC1997 Calculations continued**

$F_p$ using project design criteria, where:

- $W_p = 1,000$ Kg
- $I_p = 1.25$
- $C_a = 0.28$
- $R_p = 3.0$
- $a_p = 1.0$
**UBC1997 Calculations continued**

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<td>Fp</td>
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<td>Fp,MIN</td>
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<td>Equation 13.3-3</td>
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**Compare Fp 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.**
Bibliography

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Questions?

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