Wind Loads

Exposure Category: C
Topographic Factor, $K_{zt}$: 1.0
Enclosure Classification: Enclosed
Velocity Pressure Coefficient, $K_v$: 0.94 (height of 25 ft, Table 26.10-1)
Wind Directionality Factor, $K_d$: 0.85
Ground Elevation Factor, $K_e = e^{-0.000362z_g}$, $z_g$ = ground elevation in ft

$$q_h = 0.00256K_vK_{zt}K_dK_eV^2$$

$q_h$ in psf; $V$ in mph

Note: Design wind speed went from 115 mph to 105 mph from ASCE 7-10 to ASCE 7-16. This is a 17% decrease in design wind pressure. The addition of $K_e$ caused another 2% decrease in design wind pressure.

Out-of-Plane Loading: Wind Load

Parapet

Components and Cladding (C & C) Parapet Wind Load, ASCE 7-16
Figure 30.8-1

Out-of-Plane Loading: Wind Loading

Parapet Design Force (ASCE 7-16)

ASCE 7-16 30.8

Flat roof ($\theta \leq 7^\circ$), $h \leq 60$ ft

Effective Wind Area:
- $h^{2/3}$ (Section 26.2)
- $h \times$ (control joint spacing)
- Use 10 ft$^2$

No internal pressure

Case A:
Positive pressure: +0.9
(reduced by 10% for flat roof)
Negative pressure: -2.3
(zone 2 since flat roof and parapet)

Case B
Positive pressure: +0.9
(reduced by 10% for flat roof)
Negative pressure:
-1.1(0.9) = -0.99 typical
-1.4(0.9) = -1.26 corner zone
May be reasonable to use typical if parapet braced at corner by perpendicular wall

<table>
<thead>
<tr>
<th>Parapet</th>
<th>$GC_p$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Case A</td>
<td>0.9</td>
<td>-2.3</td>
</tr>
<tr>
<td>Case B</td>
<td>0.9</td>
<td>-1.26</td>
</tr>
</tbody>
</table>

$$p = q_h (GC_p)_{total}$$

Out-of-Plane Loading: Wind Load

Wall-to-diaphragm connection

$$R = \frac{ph}{2} + \frac{p_1h_1(h + \frac{h_1}{2})}{h}$$

Out-of-plane wind loads
- Determined from Components and Cladding (C & C) wind loads
- Effective Wind Area: tributary area to anchor
Out-of-Plane Loading: Wind Load

Mid-height moment

Parapet pressure to use for designing wall? Parapet wind load reduces mid-height wall moment
- Very conservative: parapet load is 0
- Aggressive: full parapet C&C pressure
- Moderate: extend wall pressure to parapet

**EFFECTIVE WIND AREA, A**: For component and cladding elements, the effective wind area is the span length multiplied by an effective width that need not be less than one-third the span length.

Wind uplift load from roof determined from MWFRS

ASCE 7-16 Figure 30.3-1

Values of GCp for walls shall be reduced by 10% when $\theta \leq 10^\circ$.
- $a$: 10% of least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of least horizontal dimension or 3 ft.

$$p = q_h (G C_p - G C_{pi})$$

Interior Pressure: $G C_{pi} = \pm 0.18$
Out-of-Plane Loading: Wind Load

**MWFRS Roof Uplift**

Flat roof: $C_p \sim -1.0 \quad G = 0.85$

Interior Pressure $GC_{pi} = \pm 0.18$

---

Seismic Loads

Site Class: C (used for ESF building design)

Note: $S_{DS}$ went from 0.332 to 0.526 from ASCE 7-10 to ASCE 7-16. This is a 58% increase in seismic design force. This also puts Knoxville in Seismic Design Category D.
Out-of-Plane Loading: Seismic Loading

Parapet Design Force

ASCE 7-16 13.3.1

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

<table>
<thead>
<tr>
<th>Parapet</th>
<th>( a_p )</th>
<th>( R_p )</th>
<th>( F_p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braced below center of mass</td>
<td>2.5</td>
<td>2.5</td>
<td>( F_p = 1.2S_{DS} W_p )</td>
</tr>
<tr>
<td>Braced above center of mass</td>
<td>1.0</td>
<td>2.5</td>
<td>( F_p = 0.48S_{DS} W_p )</td>
</tr>
</tbody>
</table>

\( S_{DS} \) = spectral acceleration
\( a_p \) = component amplification factor
\( I_p \) = component importance factor
\( W_p \) = component weight
\( R_p \) = component response modification factor
\( z \) = height of point of attachment
\( h \) = roof height

13.1.4 Exemptions

Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls.

Out-of-Plane Loading: Seismic Loading

Wall Anchorage Force ASCE 7-16, 12.11.2

\[ F_p = 0.8S_{DS} k_a I_e W_p \]
\[ F_p \geq 0.2 k_a I_e W_p \]
\[ k_a = 1.0 + \frac{I_e}{100} \leq 2 \]

\( S_{DS} \) = spectral acceleration
\( I_e \) = importance factor
\( 1.0 \) Category I, II
\( 1.25 \) Category III
\( 1.5 \) Category IV
\( k_a \) = amplification factor for diaphragm flexibility
\( I_f \) = span in ft for flexible diaphragm; 0 for rigid diaphragm
\( W_p \) = weight of wall tributary to anchor

Structural walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4 ft.
Out-of-Plane Loading: Seismic Loading

Wall Design Force ASCE 7-16 12.11.1

\[ F_p = 0.4S_{DS}l_e W_p \]
\[ F_p \geq 0.1W_p \]

Parapet force to use for designing wall. In first mode, wall and parapet loads are in opposite directions

- Conservative: parapet load in opposite direction of wall
- Aggressive: wall and parapet load in same direction
- Moderate: no parapet load

Non-Bearing Wall Design

Design the walls on the east and west side that are away from girder reactions and the end of the wall (non-bearing wall).

- Your can ignore the 3 ft of tributary roof load from the roof.
- The corner zones (about 8 ft from the corner in this building), have higher wind pressures. If there is a supporting intersecting wall, nothing probably needs to be done. If you are worried, add an extra bar.

Design the 6'-3" section to the south of the opening on column line 1 between columns lines A and B. The wind load on this segment is approximately doubled due to the tributary area from the door.

Results of a survey of masons

<table>
<thead>
<tr>
<th>which options do masons prefer?</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot; thick CMU, 22ft tall, 24ft long wall?</td>
</tr>
<tr>
<td>(1)6@40in</td>
</tr>
<tr>
<td>12&quot; thick CMU, 32ft tall, 24ft long?</td>
</tr>
<tr>
<td>A- 11R@96in</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>preferred bar options</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot; thick CMU, 22ft tall, 24ft long wall</td>
</tr>
<tr>
<td>(11)2R@48in</td>
</tr>
<tr>
<td>(1)1R@48in</td>
</tr>
</tbody>
</table>

Results of a survey of masons