Given:

1P: Determine wind loads for the Main Wind Force Resisting System (load at edge of roof diaphragm) and Components and Cladding (siding, studs, decking, joists, beams) using ASCE 7-10:

a) Using the directional procedure for the MWRFS (i.e., Chapter 27 Part 1)
b) Using Chapter 30 Part 1 for C & C.

Solution:

a) Using the directional procedure for the MWFRS (i.e., Chapter 27 Part 1):

Main Wind Force Resisting System (MWFRS):

- The directional procedure of Chapter 27 for buildings of all heights may be used
- The envelope procedure of Chapter 28 for low-rise buildings may be used since the mean roof height is less than 60 ft and does not exceed the least horizontal dimension

Determine values for factors that will be used in other chapters to determine wind pressures:

- §26.5.1 Basic Wind Speed (V): The retail warehouse is a Risk Category II building so Fig. 26.5-1A is applicable. For Pensacola:

  $V := 150 \ \text{mph}$

- §26.6 Directionality Factor (K_d): From Table 26.6-1:

  $K_d := 0.85$

- §26.7 Exposure: Exposure D given.
- §26.8 Topographic Effects:

  $K_{zt} := 1.0$

- §26.9 Gust Effect Factor (G): The building is less than 60 ft therefore per §26.9.1 it may be considered rigid.

  $G := 0.85$

- §26.10 Enclosure Classification: The building will be enclosed. Doors and windows will be designed to resist wind loads. (V = 150 MPH)
- §26.11 Internal Pressure Coefficient (GCpi): From Table 26.11-1:

  $GC_{pi} := 0.18$

- §27.3.1 - Velocity Pressure Exposure Coefficients (K_h and K_z), From Table 27.3-1:

  $K_{z0\_15} := 1.03$ $\qquad$ $K_{z16} := 1.03 + (1.08 - 1.03)\cdot\frac{(16 - 15)}{(20 - 15)} = 1.04$

Part 1: Buildings of All Heights

Determine velocity based pressures (§27.3):

$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2$ Eq. (27.3-1)

where:

K_z = from Table 27.3-1 Table 27.3-1
K_{zt} = 1.00 (no isolated hills) §26.8
K_d = 0.85 (wind directionality factor) Table 26.6-1
V = 125 mph Fig. 26.6-1A

therefore:

$q_{z0\_15} := 0.00256 \cdot K_{z0\_15} \cdot K_{zt} \cdot K_d \cdot V^2 = 50.429$ psf

$q_{z16} := 0.00256 \cdot K_{z16} \cdot K_{zt} \cdot K_d \cdot V^2 = 50.918$ psf

Wind pressures on walls: §27.4.1

$p = qGC_p - q_i(GC_{pi})$ (combined external and internal pressure) Eq. (27.4.1)

where:

$q = q_z$ on windward walls evaluated at height z above ground
$q = q_h$ on leeward walls, side walls, and roofs evaluated at mean roof height h (16 ft)
$q_i = q_h$ on windward walls, side walls, leeward walls and roof

therefore:

$q_z := q_{z0\_15} = 50.429$ psf $q_h := q_{z16} = 50.918$ psf

Coefficients for transverse wind loads. Fig. 27.4-1

$L := 160$ ft $B := 60$ ft $\frac{L}{B} = 2.667$

therefore:

$C_{pWWTransverse} := 0.8$

$C_{pLWTransverse} := 0.3 + (0.2 - 0.3) \cdot \frac{(2.667 - 2)}{(4 - 2)} = 0.267$

$C_{pSWTransverse} := 0.7$

Coefficients for longitudinal wind loads. Fig. 27.4-1

$L := 60$ ft $B := 160$ ft $\frac{L}{B} = 0.375$

therefore:

$C_{pWWLongitudinal} := 0.8$

$C_{pLWLongitudinal} := 0.5$

$C_{pSWLongitudinal} := 0.7$

This is a simple diaphragm building (i.e., vertically spanning walls). For design of the diaphragm and shear walls (i.e., the MWFRS) the loads on the windward and leeward walls may be added and assumed to act on the windward wall only. The internal pressure terms (GCpi) will cancel out (the internal pressure terms are either all positive or all negative never mixed). The roof uplift loads for a flat roof and sidewall loads have no effect on the loading for diaphragm/shearwall design.

therefore:

$p = [q_z GC_p]_{windward} + [q_h GC_p]_{leeward}$

Transverse Wind:

for 0 to 15 ft: $p := q_z \cdot G \cdot C_{pWWTransverse} + q_h \cdot G \cdot C_{pLWTransverse} = 45.832$ psf

at 16 ft: $p := q_h \cdot G \cdot C_{pWWTransverse} + q_h \cdot G \cdot C_{pLWTransverse} = 46.165$ psf

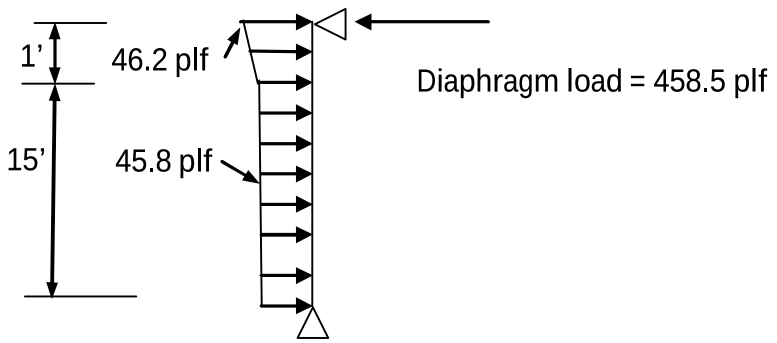
Longitudinal Wind:

for 0 to 15 ft: $p := q_z \cdot G \cdot C_{pWWLongitudinal} + q_h \cdot G \cdot C_{pLWLongitudinal} = 55.932$ psf

at 16 ft: $p := q_h \cdot G \cdot C_{pWWLongitudinal} + q_h \cdot G \cdot C_{pLWLongitudinal} = 56.265$ psf

Wind load on diaphragm:

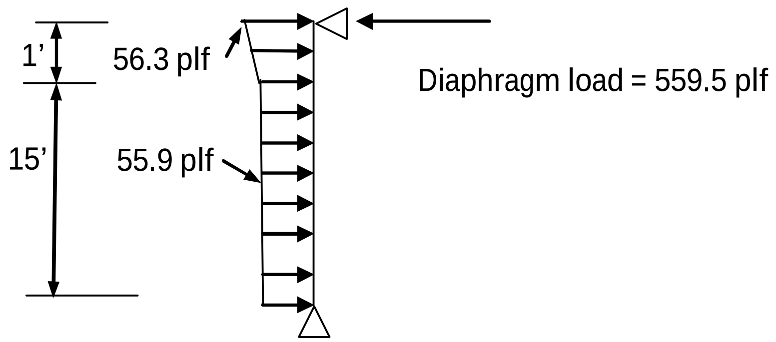
For transverse wind:



$\Sigma M_{base} := 0$

$$Diaphragm_{Load} := \frac{45.832 \cdot 16 \cdot 10 + \frac{1}{2} \cdot (46.165 - 45.832) \cdot 1 \cdot \left(16 - \frac{1}{3}\right)}{16} = 458.483 \quad plf$$

For longitudinal wind:



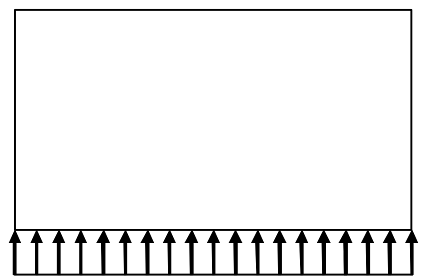
$\Sigma M_{base} := 0$

$$Diaphragm_{Load} := \frac{55.932 \cdot 16 \cdot 10 + \frac{1}{2} \cdot (56.265 - 55.932) \cdot 1 \cdot \left(16 - \frac{1}{3}\right)}{16} = 559.483 \quad plf$$

Design wind load cases for MWFRS: §27.4.6

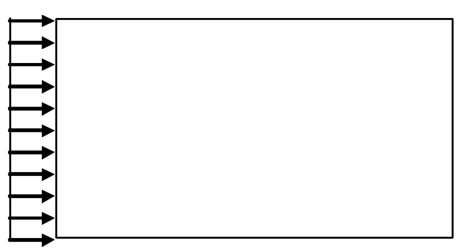
Figure 27.4-8 provides the MWFRS load cases that must be considered. Only Load Cases 1 and 3 need to be considered since the torsional exception of Section D1.1 exempts buildings with *h* le than 30 ft from torsional Load Cases 2 and 4.

Case 1 load for transverse wind:



458.5 lb/ft on roof diaphragm

Case 1 load for longitudinal wind:



559.5 lb/ft on roof diaphragm

Case 3 will not control since the N-S and E-W shearwalls will act independently for the maximu transverse and longitudinal loads.

b) Using Chapter 30 Part 1 for C & C.

Scope and general:

- Per §30.1, Part 1 is applicable to walls and roofs in an enclosed building with a height less than or equal to 60 ft.
- Minimum design wind pressures are 16 psf.

Determine values for factors that will be used in other chapters to determine wind pressures:

- §26.5.1 Basic Wind Speed (V): The retail warehouse is a Risk Category II building so Fig. 26.5-1A is applicable. For Pensacola:

$$V := 150 \text{ mph}$$

- §26.6 Directionality Factor (K_d): From Table 26.6-1:

$$K_d := 0.85$$

- §26.7 Exposure: Exposure D given.
- §26.8 Topographic Effects:

$$K_{zt} := 1.0$$

- §26.9 Gust Effect Factor (G): The building is less than 60 ft therefore per §26.9.1 it may be considered rigid.

$$G := 0.85$$

- §26.10 Enclosure Classification: The building will be enclosed. Doors and windows will be designed to resist wind loads. (V = 150 MPH)
- §26.11 Internal Pressure Coefficient (GCpi): From Table 26.11-1:

$$GC_{pi} := 0.18$$

- §30.3.1 - Velocity Pressure Exposure Coefficients (K_h and K_z): From Table 30.3-1:

$$K_{z16} := 1.03 + (1.08 - 1.03) \cdot \frac{(16 - 15)}{(20 - 15)} = 1.04 \qquad K_h := K_{z16}$$

Determine velocity based pressures (§30.3):

$$q_h := 0.00256 \cdot K_h \cdot K_{zt} \cdot K_d \cdot V^2$$ Eq. (30.3.1)

where:

K_h = from Table 30.3-1 — Table 30.3-1
K_{zt} = 1.00 (no isolated hills) — §26.8
K_d = 0.85 (wind directionality factor) — Table 26.6-1
V = 125 mph — Fig. 26.6-1A

therefore:

$$q_h := 0.00256 \cdot K_h \cdot K_{zt} \cdot K_d \cdot V^2 = 50.918 \quad \text{psf}$$

Wind pressures on C&C: §30.4.2

$p = q_h[(GC_p) - (GC_{pi})]$ (combined external and internal pressure) Eq. (30.4-1)

where:

GC_p = values from figures for zones on walls (Fig. 30.4-1) and roof (Fig. 30.4-2A).

therefore:

$$p := q_h \cdot \left[\left(GC_p\right) + GC_{pi}\right]$$

NOTE: All figures for GCp are divided into zones. Fig. 30.4-1 for walls has an interior zone 4 and an end zone 5. Fig. 30.4-2A for roofs has an interior zone 1, and edge strip zone 2, and a corner zone 3. In all cases, the distance *a* providing the breakpoint between the zones is defined the same:

Determine *a* using Note 6 Fig. 30.4-1 and Note 7 Fig. 30.4-2A:

- smaller of: 10% of least horizontal dimension
  40% of height at eave
- but not less than: 4% of least horizontal dimension
  3 ft

For the Pensacola Retail Warehouse:

- smaller of: 60(.10) = 6 ft controls
  16(.40) = 6.4 ft
- but not less than: 60(.04) = 2 ft
  3 ft

therefore:

$$a := 3 \quad \text{ft}$$

Design wind load for walls:

- Obtain GCp from Fig. 30.4-1 based on EWA of wall element.
- Per Note 5, GCp shall be reduced 10% for a flat roof.

For the plywood and nails of the Pensacola Retail Warehouse:

EWA for plywood and nails < 10 ft^2

therefore:

GC_p = -1.1, +1.0 for interior zones (zone 4)
GC_p = -1.4, +1.0 for end zones (zone 5)

$p_v = q_h[GC_p-(GC_{pi})]$
= 50.92[1.1(0.9)+0.18] = 59.6 psf outward on interior zone walls
= 50.92[1.4(0.9)+0.18] = 73.3 psf outward on end zone walls
= 50.92[1.0(0.9)+0.18] = 55 psf inward on all walls

Conservatively, design wall plywood and nails for pressures equal to end zone 5 negative pressure:

p_v = +/- 73.3 psf

For the vertical framing of the Pensacola Retail Warehouse:

EWA for vertical framing = 16*(16/3) = 85.333 ft^2

therefore:

GC_p = -0.95, +0.85 for interior zones (zone 4)
GC_p = -1.1, +0.85 for end zones (zone 5)

$p_v = q_h[GC_p-(GC_{pi})]$
= 50.92[0.95(0.9)+0.18] = 50.7 psf outward on interior zones
= 50.92[1.1(0.9)+0.18] = 59.6 psf outward on end zones
= 50.92[0.85(0.9)+0.18] = 48.12 psf inward on all walls

Conservatively, design vertical framing for pressures equal to negative pressure on end zones:

p_v = +/- 59.6 psf

Design wind load for roof:

- Obtain GCp from Fig. 30.4-2A based on EWA of roof element.

For the roof decking and nails in roof decking of the Pensacola Retail Warehouse:

EWA for roof decking and nails < 10 ft^2

therefore:

GC_p = -1.0, +0.3 for interior zones (zone 1)
GC_p = -1.8, +0.3 for edge zones (zone 2)
GC_p = -2.8, +0.3 for corners (zone 3)

$p_v = q_h[GC_p-(GC_{pi})]$
= 50.92[1.0(0.9)+0.18] = 55 psf outward on interior zones
= 50.92[1.8(0.9)+0.18] = 91.7 psf outward on edge zones
= 50.92[2.8(0.9)+0.18] = 137.5 psf outward on corners
= 50.92[0.3(0.9)+0.18] = 22.9 psf inward on all zones

Conservatively, design roof decking and nails for pressures equal to negative pressure on corner zones:

p_v = +/- 137.5 psf

For the roof joists and beams of the Pensacola Retail Warehouse:

EWA for the roof joists and beams 16*(16/3) = 85.333 ft^2

therefore:

GC_p = -0.95, +0.25 for interior zones (zone 1)
GC_p = -1.15, +0.25 for edge zones (zone 2)
GC_p = -1.15, +0.25 for corners (zone 3)

$p_v = q_h[GC_p-(GC_{pi})]$
= 50.92[0.95(0.9)+0.18] = 52.7 psf outward on interior zones
= 50.92[1.15(0.9)+0.18] = 61.9 psf outward on edge and corner zones
= 50.92[0.25(0.9)+0.18] = 20.62 psf inward on all zones

Wind loads on bearing walls:

The bearing walls well be designed for a +/- 59.6 psf uniform load over the 16 ft height. This pressure was reflected in both the MWFRS and the C&C calculations. The joists will be designed for the C&C loads.