Table G7-5. Design Pressures for MWFRS for Wind Parallel to Roof Slope, Normal to Ridge Line

Wind direction	Surface	Z (ft)	q_z (psf)	Gust effect	External C_p	Design pressure (psf)[a] (+GC_{pi})	(−GC_{pi})
Windward wall (15 ft)	Windward wall	0 to 15	17.8	0.85	0.80	8.9	15.3
	Leeward wall	0 to 25	19.4	0.85	−0.50	−11.7	−4.8
	Side wall	All	19.4	0.85	−0.70	−15.0	−8.1
	Roof	—	19.4	0.85	−0.74	−15.7	−8.7
	Overhang top	—	19.4	0.85	−0.74	−12.2[b]	−12.2[b]
	Overhang bottom	—	17.8	0.85	0.80	8.9[b]	15.3[b]
Windward wall (25 ft)	Windward wall	0 to 15	17.8	0.85	0.80	8.9	15.3
		15 to 20	19.4	0.85	0.80	9.7	16.7
		20 to 25	20.7	0.85	0.80	10.4	17.8
	Leeward wall	All	19.4	0.85	−0.50	−11.7	−4.8
	Side wall	All	19.4	0.85	−0.70	−15.0	−8.1
	Roof	—	19.4	0.85	−0.50	−11.7	−4.8
	Overhang top	—	19.4	0.85	−0.50	−8.2[b]	−8.2[b]
	Overhang bottom	—	—	—	—	0.0[b]	0.0[b]

[a] External pressure calculations include $G = 0.85$.

[b] Overhang pressures are not affected by internal pressures. ASCE 7-16 does not address bottom surface pressures for leeward overhang. It could be argued that leeward wall pressure coefficients can be applied, but neglecting the bottom overhang pressures would be conservative in this application.

$$(GC_{pi}) = +0.18 \text{ and}$$

$$(GC_{pi}) = -0.18$$

Typical Calculations of Design Pressures for MWFRS: For cases with wind parallel to the slope with a 15 ft windward wall (**Table G7-5**):

Pressure on leeward wall:

$$\begin{aligned} p &= q_h G C_p - q_h(\pm GC_{pi}) \\ &= 19.4(0.85)(-0.5) - (19.4)(+0.18) \\ &= -11.7\,\text{psf with positive internal pressure} \\ \text{and} &= 19.4(0.85)(-0.5) - (19.4)(-0.18) \\ &= -4.7\,\text{psf with negative internal pressure} \end{aligned}$$

Pressure on overhang top surface:

$$p = q_h G C_p = 19.4(0.85)(-0.74) = -12.2\,\text{psf}$$

Pressure on overhang bottom surface: This is the same as windward wall external pressure.

$$p = q_z G C_p = 17.8(0.85)(0.8) = 12.1 \text{ psf}$$

Note that q_z was evaluated for $z = 15$ ft for the bottom surface of the overhang because the C_p coefficient is based on induced pressures at the top of the wall.

Figures G7-2 and G7-3 illustrate the external, internal, and combined pressure for wind directed normal to the 15 ft wall. **Figures G7-4 and G7-5** illustrate combined pressure for wind directed normal to the 25 ft wall and perpendicular to the slope (parallel to ridge line), respectively (**Table G7-6**).

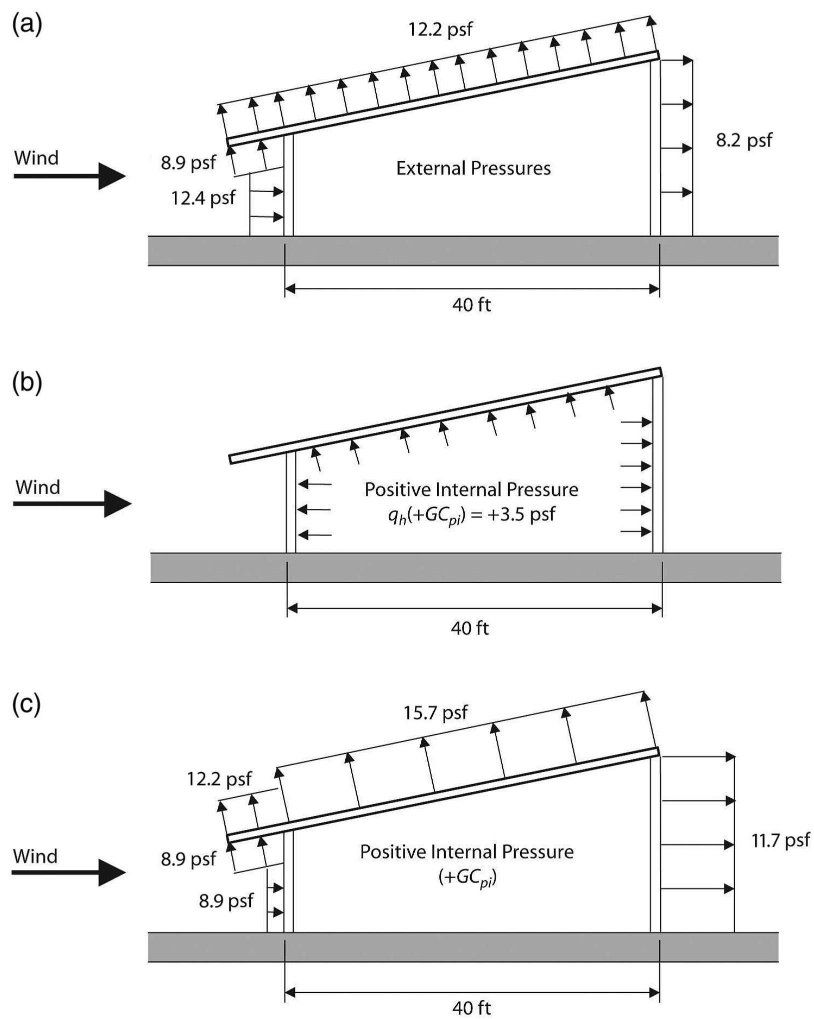

Figure G7-2. **Design pressures for MWFRS for wind parallel to the roof slope, normal to a 15 ft wall, and positive internal pressure: (a) external pressures, (b) positive internal pressure, and (c) combined external and positive internal pressure.**

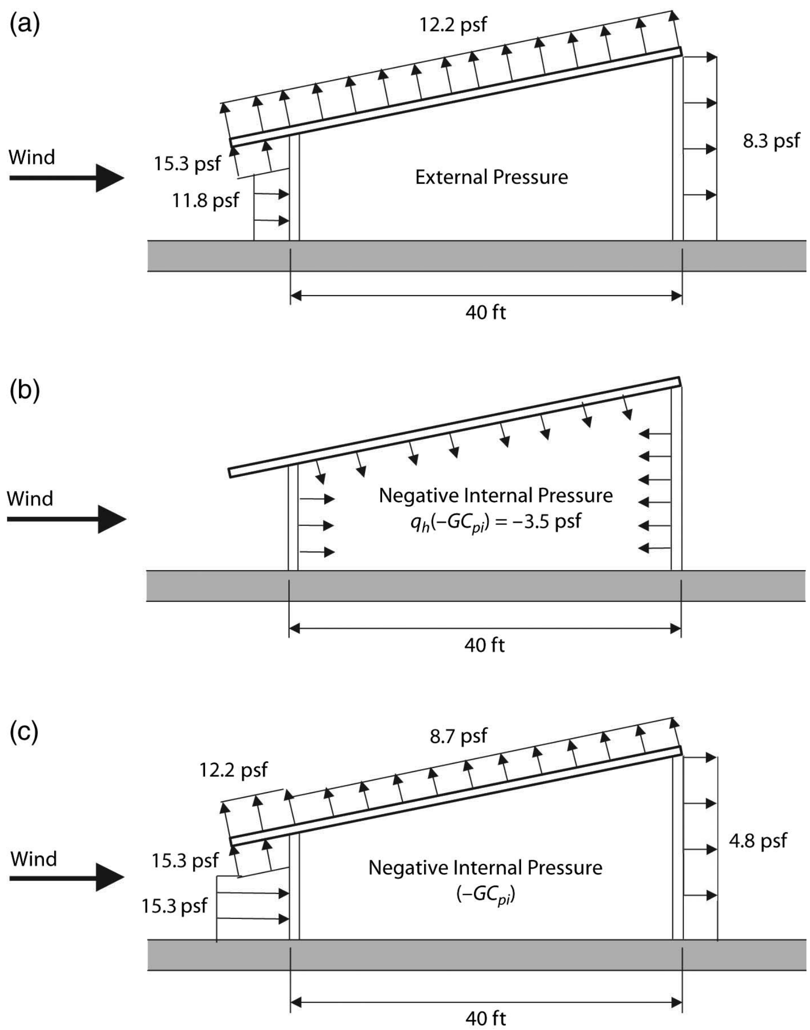

***Figure G7-3*. Design pressures for MWFRS for wind parallel to the roof slope, normal to a 15 ft wall, and negative internal pressure: (a) external pressures, (b) negative internal pressure, and (c) combined external and negative internal pressure.**

Design Wind Load Cases

Section 27.4.6 of ASCE 7-16 requires that any building whose wind loads have been determined under the provisions of Chapter 27 shall be designed for wind load cases as defined in Figure 27.4-8 of ASCE 7-16. Case 1 includes the loadings shown in **Figure G7-2 through Figure G7-5**. The exception in Section 27.4.6 of ASCE 7-16 indicates that buildings meeting the requirements of Section D1.1 of Appendix D need only be designed for Cases 1 and 3 of Figure 27.4-8.

Design Pressures for Components and Cladding

The design pressure equation for C&C for a building with mean roof height $h \leq 60$ ft is given in Section 30.4.2 of ASCE 7-16 as follows:

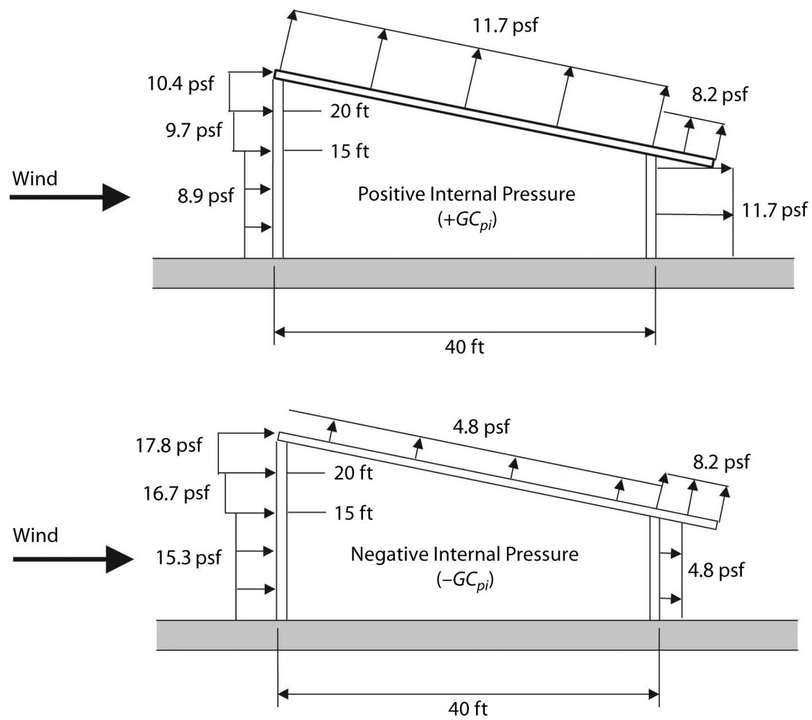

Figure G7-4. **Combined design pressures for MWFRS for wind parallel to the roof slope and normal to a 25 ft wall.**

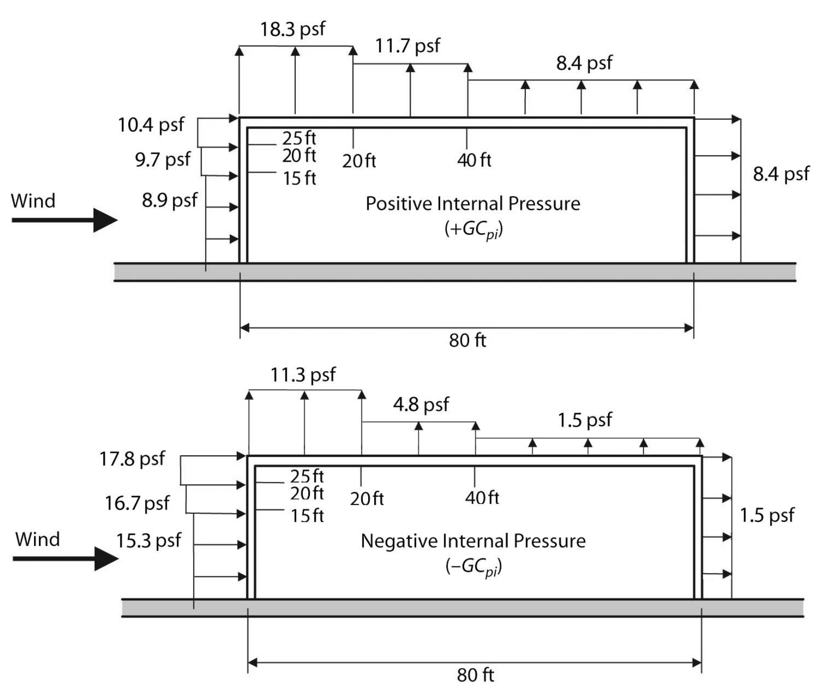

Figure G7-5. **Combined design pressures for MWFRS for wind perpendicular to the roof slope and parallel to the ridge line.**

***Table G7-6.* Design Pressures for MWFRS for Wind Normal to Roof Slope, Parallel to Ridge Line**

Surface	z *or distance (ft)*	q_z *(psf)*	*Gust effect* G	C_p	*Design pressure (psf)* +(GC_{pi})	−(GC_{pi})
Windward wall	0 to 15	17.8	0.85	0.8	8.9	15.3
	15 to 20	19.4	0.85	0.8	9.7	16.7
	20 to 25	20.7	0.85	0.8	10.4	17.8
Leeward wall	All	19.4	0.85	−0.3	−8.4	−1.5
Side wall	All	19.4	0.85	−0.7	−15.0	−8.1
Roof	0 to 20	19.4	0.85	−0.9	−18.3	−11.3
	20 to 40	19.4	0.85	−0.5	−11.7	−4.8
	40 to 80	19.4	0.85	−0.3	−8.4	−1.5

Note: For design pressure, external pressure calculations include $G = 0.85$. Internal pressure, (GC_{pi}), is associated with $q_h = 19.4$ psf. For z, distance along the roof is from the leading windward edge. For the roof, pressure on the overhang is only external pressure (contribution on the underside is conservatively neglected).

$$P = q_h[(GC_p) - (GC_{pi})] \tag{30.3-1}$$

where

q_h = Velocity pressure at mean roof height associated with Exposure B ($q_h = 19.4$ psf, previously determined),
(GC_p) = External pressure coefficients (Figure 30.4-2 of ASCE 7-16), and
(GC_{pi}) = +0.18 and −0.18 (previously determined from Table 26.11-1 of ASCE 7-16).

Wall Design Pressures: Wall external pressure coefficients are presented in **Table G7-7**. Because the CMU walls are supported at the top and bottom, the effective wind area will depend on the span length.

Effective wind area:
For a span of 15 ft, $A = 15(15/3) = 75$ ft^2
For a span of 20 ft, $A = 20(20/3) = 133$ ft^2
For a span of 25 ft, $A = 25(25/3) = 208$ ft^2

***Table G7-7.* Wall External Pressure Coefficients by Zone**

A *(ft^2)*	*Pressure coefficients* — *Zones 4 and 5* (+GC_p)	*Zone 4* (−GC_p)	*Zone 5* (−GC_p)
75	0.85	−0.95	−1.09
133	0.80	−0.90	−1.00
208	0.77	−0.87	−0.93

Width of Zone 5 (Figure 30.4-1):

Smaller of	$a = 0.1(40) = 4$ ft (controls)
or	$a = 0.4(20) = 8$ ft
but not less than	$a = 0.4(40) = 1.6$ ft
or	$a = 3$ ft

Design pressures are the critical combinations when the algebraic sum of the external and internal pressures is a maximum.

Typical calculations for design pressures for a 15 ft wall, Zone 4: Wall design pressures are presented in **Table G7-8**.

$$p = q_h[(GC_p) - (\pm GC_{pi})]$$
$$= 19.4[(0.85) - (-0.18)] = 20.0\,\text{psf}$$
$$\text{and} \quad = 19.4[(-0.95) - (0.18)] = -21.9\,\text{psf}$$

The CMU walls are designed for pressures determined for Zones 4 and 5 using appropriate tributary areas.

The design pressures for doors and glazing can be assessed by using appropriate pressure coefficients associated with their effective wind areas.

Roof Design Pressures: Roof external pressure coefficients are presented in **Table G7-9**; roof design pressures are presented in **Table G7-10**.

Effective wind area:
Roof joist

$$A = (41.2)(5) = 206\,\text{ft}^2$$

$$\text{or} \quad = (41.2)(41.2/3) = 566\,\text{ft}^2 \text{ (controls)}$$

Roof panel

$$A = (5)(2) = 10\,\text{ft}^2 \text{ (controls)}$$

$$\text{or} \quad = (5)(5/3) = 8.3\,\text{ft}^2$$

***Table G7-8.* Wall C&C Design Pressures by Zone**

	Design pressures (psf)		
Wall height (ft)	*Zones 4 and 5 positive*	*Zone 4 negative*	*Zone 5 negative*
15	13.0	−14.9	−17.7
20	12.0	−14.0	−15.9
25	11.4	−13.4	−14.6

Note: $q_h = 19.4$ psf.

Table G7-9. Roof External Pressure Coefficients for $\theta = 14°$ by Zone

Component	A (*ft*^{2})	*Zones 1, 2, and 3* ($+GC_p$)	*Zone 1* ($-GC_p$)	*Zone 2* ($-GC_p$)	*Zone 3* ($-GC_p$)
		Pressure coefficients, Figure 30.3-5B			
Joist	566	0.3	−1.1	−1.2	−2.0
Panel	10	0.4	−1.3	−1.6	−2.9
		Pressure coefficients, Figure 30.3-2B*			
Joist	566	0.3	−1.5	−1.5	−1.5
Panel	10	0.7	−2.5	−2.5	−4.1

* Values are from the overhang chart in Figure 30.3-2B.

Table G7-10. Roof Design Pressures by Zone (psf)

Component	*Zones 1, 2, and 3 positive (psf)*	*Zone 1 negative (psf)*	*Zone 2 negative (psf)*	*Zone 3 negative (psf)*
Joist	9.3	−24.8	−26.8	−42.3
Joist overhang	9.3	−32.6	−32.6	−32.6
Panel	11.3	−28.7	−34.5	−59.8
Panel in overhang	14.0	−52.0	−52.0	−83.0

Note: $q_h = 19.4$ psf. Zones for overhang are in accordance with Figure 30.3-2B of ASCE 7-16. Section 30.2-2 of ASCE 7-16 requires a minimum of 16 psf.

Section 30.9 of ASCE 7-16 requires that pressure coefficients for components and cladding of roof overhangs be obtained from Figures 30.3-2A to 30.3-2I. Note that the zones for roof overhangs in Figure 30.3-2B are different from the zones for a monoslope roof in Figure 30.3-5B.

Width of zone distance:

Smaller of	$a = 0.1(40) = 4$ ft (controls)
or	$a = 0.4(20) = 8$ ft
but not less than	$a = 0.4(40) = 1.6$ ft
or	$a = 3$ ft

The widths and lengths of Zones 2 and 3 for a monoslope roof are shown in Figure 30.3-5B of ASCE 7-16 (they vary from a to $4a$); for overhangs, widths and lengths are shown in Figure 30.3-2B.

Similar to the determination of design pressures for walls, the critical design pressures for roofs are the algebraic sum of the external and internal pressures. The design pressures for overhang areas are based on pressure coefficients obtained from Figure 30.3-2B of ASCE 7-16.

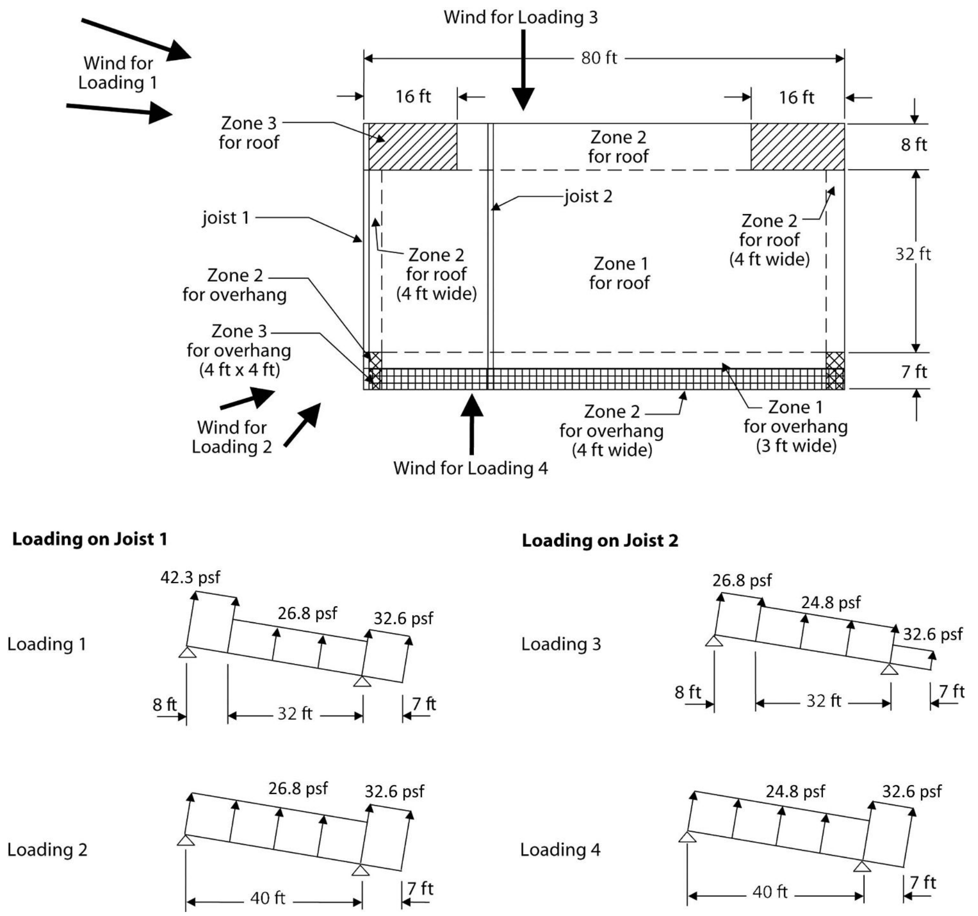

***Figure G7-6*. Design pressures for typical joists and pressure zones for roof components and cladding.**

Typical Calculations for Joist Pressures: Zone 2

$$p = q_h[(GC_p) - (\pm GC_{pi})]$$
$$= 19.4[(0.3) - (-0.18)] = 9.3\,\text{psf}$$
$$\text{and} \quad = 19.4[(-1.2) - (0.18)] = -26.8\,\text{psf}$$

Zones for the monoslope roof and for overhangs are shown in **Figure G7-6**. The panels are designed for the pressures indicated.

Roof joist design pressures need careful interpretation. The high pressures in corner or eave areas do not occur simultaneously at both ends. Two loading cases—Wind Loadings 1 and 2 for Joist 1 and Wind Loadings 3 and 4 for Joist 2—are shown in **Figure G7-6** based on the following zones:

- Joist 1, Loading 1: Zones 2 and 3 for roof and Zone 2 for overhang,
- Joist 1, Loading 2: Zone 2 for roof and Zones 2 and 3 for overhang,
- Joist 2, Loading 3: Zones 1 and 2 for roof and Zone 1 for overhang, and
- Joist 2, Loading 4: Zone 1 for roof and Zones 1 and 2 for overhang.

For simplicity, only one zone is used for overhang pressures in **Figure G7-6**.

Comment: The pressures determined are limit state design pressures for strength design. Section 2.3 of ASCE 7-16 indicates the load factor for wind load to be 1.0 for loads determined in this example. If allowable stress design is to be used, the load factor for the wind load is 0.6 as shown in Section 2.4 of ASCE 7-16.

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8

L-Shaped House with Gable/Hip Roof

Design wind pressures for a typical one-story house are to be determined. Various views of the house are provided in **Figure G8-1**. The physical data are presented in **Table G8-1**.

Glazing is uniformly distributed (pressures on C&C will depend on effective area and location; for brevity, all items are not included).

8.1 Procedures

For MWFRS, the analytical directional procedure for a building of any height given in Chapter 27, Part 1, is used to determine design wind pressure. For C&C, analytical envelope procedure for the low-rise (h < 60 ft) building given in Chapter 30, Part 1, is used to determine design wind pressure.

Building Classification: The residential building can be in Risk Category II according to Table 1.5-1 of ASCE 7-16. The wind speed map associated with this risk category is Figure 26.5-1B of ASCE 7-16.

Wind Load Parameters:

Wind speed $V = 105$ mph (Figure 26.5-1B of ASCE 7-16)
Topography factor $K_{zt} = 1.0$ (Section 26.8 of ASCE 7-16)
Directionality factor $K_d = 0.85$ (for buildings) (Table 26.6-1 of ASCE 7-16)
Ground elevation factor $K_e = 1.0$ (Section 26.9 of ASCE 7-16)

The building is located in a suburban area; according to Sections 26.7.2 and 26.7.3 of ASCE 7-16, Exposure B is used.