Table 5-2
Value of Dynamic Pressure Coefficient, C_p

Building Category	C_p
I	1.6
II	2.8
III	3.2
IV	3.5

Table 5-3
Minimum Elevation of Lowest Floor, A Zones

Building Category	Minimum Elevation of Lowest Habitable Floor
I	DFE
II	DFE
III	DFE
IV	BFE + 1.0 ft (0.30m), or DFE, whichever is higher

Table 5-4
Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor, V Zones

	Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor	
	—Member Orientation Relative to the Direction of Wave Approach	
Building Category	Parallel*	Perpendicular*
I	DFE	DFE
II	DFE	BFE + 1.0 ft (0.30m) or DFE, whichever is higher
III	BFE + 1.0 ft (0.30m) or DFE, whichever is higher	BFE + 2.0 ft (0.60m) or DFE, whichever is higher
IV	BFE + 1.0 ft (0.30 m) or DFE, whichever is higher	BFE + 2.0 ft (0.60m) or DFE, whichever is higher

* Orientation of lowest horizontal structural member relative to the general direction of wave approach; parallel shall mean less than or equal to 20 degrees from the direction of wave approach; perpendicular shall mean greater than 20 degrees from the direction of approach

6. Wind Loads

6.1 General

6 1.1 Scope. Buildings and other structures, including the main wind force resisting system and all components and cladding thereof, shall be designed and constructed to resist wind loads as specified herein

6.1.2 Allowed Procedures. The design wind loads for buildings and other structures, including the main wind force resisting system and component and cladding elements thereof, shall be determined using one of the following procedures: (1) Method 1 - Simplified Procedure as specified in 6 4 for buildings meeting the requirements specified therein; (2) Method 2 - Analytical Procedure as specified in 6.5 for buildings meeting the requirements specified therein, (3) Method 3 - Wind Tunnel Procedure as specified in 6 6

6.1.3 Wind Pressures Acting on Opposite Faces of Each Building Surface. In the calculation of design wind loads for the main wind force resisting system and for components and cladding for buildings, the algebraic sum of the pressures acting on opposite faces of each building surface shall be taken into account.

6.1.4 Minimum Design Wind Loading. The design wind load, determined by any one of the procedures specified in 6 1 2, shall be not less than specified in this section.

6.1.4.1 Main Wind Force Resisting System. The wind load to be used in the design of the main wind force resisting system for an enclosed or partially enclosed building or other structure shall not be less than 10 lb/ft^2 (0.48 kN/m^2) multiplied by the area of the building or structure projected onto a vertical plane normal to the assumed wind direction The design wind force for open buildings and other structures shall be not less than 10 lb/ft^2 (0 48 kN/m^2) multiplied by the area A_f

6.1.4.2 Components and Cladding. The design wind pressure for components and cladding of buildings shall be not less than a net pressure of 10 lb/ft^2 (0.48 kN/m^2) acting in either direction normal to the surface

6.2 Definitions. The following definitions apply only to the provisions of Section 6:

Approved: Acceptable to the authority having jurisdiction.

Basic wind speed, V: 3-second gust speed at 33 feet (10 meters) above the ground in Exposure C (see 6.5.6.1) as determined in accordance with 6 5.4

Building, enclosed: a building that does not comply with the requirements for open or partially enclosed buildings

Building envelope: cladding, roofing, exterior walls, glazing, door assemblies, window assemblies, skylight assemblies, and other components enclosing the building

Building and other structure, flexible: Slender buildings and other structures that have a fundamental natural frequency less than 1 Hz

Building, low-rise: enclosed or partially enclosed buildings which comply with the following conditions

6. mean roof height h less than or equal to 60 ft (18 m),
7. mean roof height h does not exceed least horizontal dimension.

Building, open: a building having each wall at least 80% open This condition is expressed for each wall by the equation $A_o \geq 0\,8\,A_g$ where.

A_o = total area of openings in a wall that receives positive external pressure, in sq ft (m^2)

A_g = the gross area of that wall in which A_o is identified, in sq ft (m^2)

Building, partially enclosed: a building which complies with both of the following conditions

1 the total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10%, and

2. the total area of openings in a wall that receives positive external pressure exceeds 4 sq ft (0 37 m^2) or 1% of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20%.

These conditions are expressed by the following equations

1 $A_o > 1.10A_{oi}$
2 $A_o > 4$ sq ft (0 37 m^2) or $> 0\,01A_g$, whichever is smaller, and $A_{oi}/A_{gi} \leq 0\,20$ where:

A_o, A_g are as defined for Open Building
A_{oi} = the sum of the areas of openings in the building envelope (walls and roof) not including A_o, in sq ft (m^2)
A_{gi} = the sum of the gross surface areas of the building envelope (walls and roof) not including A_g, in sq ft (m^2)

Building or other structure, regular shaped: a building or other structure having no unusual geometrical irregularity in spatial form.

Building or other structures, rigid: a building or other structure whose fundamental frequency is greater than or equal to 1 hz.

Building, simple diaphragm: an enclosed or partially enclosed building in which wind loads are transmitted through floor and roof diaphrams to the vertical main wind force resisting system.

Components and cladding: elements of the building envelope that do not qualify as part of the main wind-force resisting system

Design force, F: equivalent static force to be used in the determination of wind loads for open buildings and other structures.

Design pressure, p: equivalent static pressure to be used in the determination of wind loads for buildings

Effective wind area: the area used to determine GC_p For component and cladding elements, the effective wind area in Figures 6-5 through 6-8 is the span length multiplied by an effective width that need not be less than one-third the span length For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.

Escarpment: Also known as scarp, with respect to topographic effects in 6.5.7, a cliff or steep slope generally separating two levels or gently sloping areas

Glazing: glass or transparent or translucent plastic sheet used in windows, doors, or skylights.

Glazing, impact resistant: glazing which has been shown by an approved test method to withstand the impact of wind borne missiles likely to be generated in wind borne debris regions during design winds.

Hill: with respect to topographic effects in 6 5.7, a land surface characterized by strong relief in any horizontal direction. See Figure 6 2.

Hurricane prone regions: areas vulnerable to hurricanes; in the United States and its territories defined as:

1. the U.S Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph, and

2. Hawaii, Puerto Rico, Guam, Virgin Islands, and American Samoa.

Impact resistant covering: a covering designed to protect glazing, which has been shown by an approved test method to withstand the impact of wind borne missiles likely to be generated in wind borne debris regions during design winds.

Importance factor, I: a factor that accounts for the degree of hazard to human life and damage to property.

Main wind-force resisting system: an assemblage of structural elements assigned to provide support and stability for the overall structure The system generally receives wind loading from more than one surface

Mean roof height, h: The average of the roof eave height and the height to the highest point on the roof surface, except that, for roof angles of less than or equal to 10°, the mean roof height shall be the roof heave height

Openings: apertures or holes in the building envelope which allow air to flow through the building envelope and which are designed as "open" during design winds as defined by these provisions

Recognized literature: published research findings and technical papers that are approved

Ridge: with respect to topographic effects in 6 5 7 an elongated crest of a hill characterized by strong relief in two directions. See Figure 6 2

Wind borne debris regions: areas within hurricane prone regions located

1. within one mile of the coastal mean high water line where the basic wind speed is equal to or greater than 110 mph and in Hawaii, or

2. in areas where the basic wind speed is equal to or greater than 120 mph.

6.3 Symbols and Notations. The following symbols and notation apply only to the provisions of Section 6

A = effective wind area, in sq ft (m^2)
A_g = the gross area of that wall in which A_o is identified. in sq ft (m^2)
A_{gi} = the sum of the gross surface areas of the building envelope (walls and roof) not including A_g, in sq ft (m^2)
A_o = total area of openings in a wall that receives positive external pressure, in sq ft (m^2)
A_{oi} = the sum of the areas of openings in the building envelope (walls and roof) not including A_o, in sq ft (m^2)
A_{og} = total area of openings in the building envelope sq ft (sq meters)
a = width of pressure coefficient zone, in feet (meters)
A_f = area of open buildings and other structures either normal to the wind direction or projected on a plane normal to the wind direction, in square feet (sq meters)
B = horizontal dimension of building measured normal to wind direction, in feet (meters)
$\bar{b}$ = mean hourly wind speed factor in Eq 6-12 from Table 6-4
$\hat{b}$ = 3 second gust speed factor from Table 6-4
C_f = force coefficient to be used in determination of wind loads for other structures

C_p = external pressure coefficient to be used in determination of wind loads for buildings

c = turbulence intensity factor in Eq 6-3 from Table 6-4

D = diameter of a circular structure or member in feet (meters)

D' = depth of protruding elements such as ribs and spoilers, in feet (m)

G = gust effect factor

G_f = gust effect factor for main wind-force resisting systems of flexible buildings and other structures

GC_p = product of external pressure coefficient and gust effect factor to be used in determination of wind loads for buildings

GC_{pf} = product of the equivalent external pressure coefficient and gust effect factor to be used in determination of wind loads for main wind-force resisting system of low-rise buildings

GC_{pi} = product of internal pressure coefficient and gust effect factor to be used in determination of wind loads for buildings

g_Q = peak factor for background response in Eq. 6-2 and Eq. 6-6

g_R = peak factor for resonant response in Eq 6-6

g_v = peak factor for wind response in Eq. 6-2 and Eq 6-6

H = height of hill or escarpment in Figure 6-2, in feet (meters)

h = mean roof height of a building or height of other structure, except that eave height shall be used for roof angle θ of less than or equal to 10°, in feet (meters)

I = importance factor

$I_{\bar{z}}$ = intensity of turbulence from Eq 6-3

K_1, K_2, K_3 = multipliers in Figure 6-2 to obtain K_{zt}

K_d = wind directionality factor in Table 6-6

K_h = velocity pressure exposure coefficient evaluated at height z = h

K_z = velocity pressure exposure coefficient evaluated at height z

K_{zt} = topographic factor

L = horizontal dimension of a building measured parallel to the wind direction, in feet (meters)

L_h = distance upwind of crest of hill or escarpment in Figure 6-2 to where the difference in ground elevation is half the height of hill or escarpment, in feet (meters)

$L_{\bar{z}}$ = integral length scale of turbulence, in ft (m)

ℓ = integral length scale factor from Table 6-4, ft (m)

M = larger dimension of sign, in feet (meters)

N = smaller dimension of sign, in feet (meters)

N_1 = reduced frequency from Eq 6-10

n_1 = building natural frequency, hz

p = design pressure to be used in determination of wind loads for buildings, in pounds per square foot (N/m^2)

p_L = wind pressure acting on leeward face in Figure 6-9

p_W = wind pressure acting on windward face in Figure 6-9

Q = background response from Eq 6-4

q = velocity pressure in pounds per square foot (N/m^2)

q_i = velocity pressure for internal pressure determination

q_h = velocity pressure evaluated at height z = h, in pounds per square foot (N/m^2)

q_z = velocity pressure evaluated at height z above ground, in pounds per square foot (N/m^2)

R = resonant response factor from Eq 6-8

R_B, R_h, R_L = values from Eq 6-11

R_n = reduction factor from Eq 6-14

R_n = value from Eq 6-9

r = rise-to-span ratio for arched roofs

V = basic wind speed obtained from Fig 6-1, in miles per hour (meters per second). The basic wind speed corresponds to a 3-second gust speed at 33 ft (10 m) above ground in exposure category C

V_i = unpartitioned internal volume in cubic feet (cubic meters)

$\bar{V}_{\bar{z}}$ = mean hourly wind speed at height $\bar{z}$, ft/sec (m/s)

W = width of building in Figures 6-5C and 6-7A, and width of span in Figures 6-6 and 6-7B, in feet (meters)

X = distance to center of pressure from windward edge in Table 6-6, in feet (meters)

x = distance upwind or downwind of crest in Figure 6-2, in feet (meters)

z = height above ground level, in feet (meters)

$\bar{z}$ = equivalent height of structure, in ft (m)

z_g = nominal height of the atmospheric boundary layer used in this standard. Values appear in Table 6-4

z_{min} = exposure constant from Table 6-4

α = 3 second gust speed power law exponent from Table 6-4

$\hat{\alpha}$ = reciprocal of α from Table 6-4

$\bar{\alpha}$ = mean hourly wind speed power law exponent in Eq 6-12 from Table 6-4

β = damping ratio, percent critical for buildings or other structures

$\bar{\epsilon}$ = integral length scale power law exponent in Eq 6-5 from Table 6-4

ϵ = ratio of solid area to gross area for open sign, face of a trussed tower, or lattice structure

η = value used in Eq 6-11 (see 6.5.8.2)

θ = angle of plane of roof from horizontal, in degrees

ν = height-to-width ratio for solid sign

6.4 Method 1 - Simplified Procedure

6.4.1 Scope. An enclosed or partially enclosed building whose design wind loads are determined in accordance with this section shall meet all the following conditions

1. the building is a simple diaphragm building as defined in 6.2, and
2. the building has roof slopes less than 10°, and
3. the mean roof height of the building is less than or equal to 30 feet (9m), and
4. the building is a regular shaped building or structure as defined in 6.2, and
5. the building is not classified as a flexible building as defined in 6 2, and
6. the building structure has no expansion joints or separations, and
7. the building is not subject to the topographic effects of 6 5.7 (i.e. K_{zt}=1.0)

6.4.2 Design Procedure:

1. The *basic wind speed V* shall be determined in accordance with 6 5 4. The wind shall be assumed to come from any horizontal direction.
2. An *importance factor I* shall be determined in accordance with 6 5.5.
3. An *exposure category or categories* shall be determined in accordance with 6.5.6.
4. An *enclosure classification* shall be determined in accordance with 6.5 9.
5. The design *wind loads for the main wind force resisting system* shall be determined from Table 6-2 The design wind loads shall be applied normal to the surface The design wind loads shall be applied simultaneously, with the net combined wall pressure applied on all windward wall surfaces and the net roof pressure applied on all roof surfaces.
6. *The design wind load for component and cladding elements* shall be determined from Table 6-3. These net design pressures shall be applied to each exterior surface

6.4.3 Air Permeable Cladding. Design wind loads determined from Table 6-3 shall be used for all air permeable cladding unless approved test data or recognized literature demonstrate lower loads for the type of air permeable cladding being considered.

6.5 Method 2 - Analytical Procedure

6.5.1 Scope. A building or other structure whose design wind loads are determined in accordance with this section shall meet all of the following conditions.

1. The building or other structure is a regular shaped building or structure as defined in 6 2, and
2. The building or other structure does not have response characteristics making it subject to across wind loading, vortex shedding instability due to galloping or flutter, or does not have a site location for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration

6.5.2 Limitations. The provisions of 6.5 take into consideration the load magnification effect caused by gusts in resonance with along-wind vibrations of flexible buildings or other structures Buildings or other structures not meeting the requirements of 6.5 1, or having unusual shapes or response characteristics shall be designed using recognized literature documenting such wind load effects or shall use the wind tunnel procedure specified in 6 6

6.5.2.1 Shielding. There shall be no reductions in velocity pressure due to apparent shielding afforded by buildings and other structures or terrain features

6.5.2.2 Air permeable cladding. Design wind loads determined from 6.5 shall be used for air permeable cladding unless approved test data or recognized literature demonstrate lower loads for the type of air permeable cladding being considered.

6.5.3 Design Procedure:

1. *The basic wind speed V* and *wind directionality factor* K_d shall be determined in accordance with 6.5.4.
2. An *importance factor I* shall be determined in accordance with 6.5 5.
3. An *exposure category or exposure categories* and *velocity pressure exposure coefficient* K_z *or* K_h, as applicable, shall be determined for each wind direction in accordance with 6.5 6.
4. A *topographic factor* K_{zt} shall be determined in accordance with 6.5 7.
5. A *gust effect factor G or* G_f, as applicable, shall be determined in accordance with 6.5 8.
6. An *enclosure classification* shall be determined in accordance with 6.5 9.
7. *Internal pressure coefficient* GC_{pi} shall be determined in accordance with 6.5.11.1
8. *External pressure coefficients* C_p *or* GC_{pf}, or *force coefficients* C_f, as applicable, shall be determined in accordance with 6.5.11 2 or 6.5.11.3, respectively.
9. *Velocity pressure* q_z *or* q_h, as applicable, shall be determined in accordance with 6.5.10
10. *Design wind load P or F* shall be determined in accordance with 6.5.12 and 6 5.13, as applicable.

6.5.4 Basic Wind Speed. The basic wind speed, V, used in the determination of design wind loads on buildings and other structures shall be as given in Fig. 6-1 except as provided in 6.5.4.1 and 6.5.4.2. The wind shall be assumed to come from any horizontal direction.

6.5.4.1 Special wind regions. The basic wind speed shall be increased where records or experience indicate that the wind speeds are higher than those reflected in Fig 6-1 Mountainous terrain, gorges, and special regions shown in Figure 6-1 shall be examined for unusual wind conditions The authority having jurisdiction shall, if necessary, adjust the values given in Figure 6-1 to account for higher local wind speeds Such adjustment shall be based on meteorological information and an estimate of the basic wind speed obtained in accordance with the provisions of 6 5 4.2

6.5.4.2 Estimation of basic wind speeds from regional climatic data. Regional climatic data shall only be used in lieu of the basic wind speeds given in Fig. 6-1 when (1) approved extreme-value statistical-analysis procedures have been employed in reducing the data; and (2) the length of record sampling error, averaging time, anemometer height, data quality, and terrain exposure of the anemometer have been taken into account

In hurricane prone regions, wind speeds derived from simulation techniques shall only be used in lieu of the basic wind speeds given in Figure 6-1 when (1) approved simulation or extreme value statistical analysis procedures are used (the use of regional wind speed data obtained from anemometers is not permitted to define the hurricane wind speed risk along the Gulf and Atlantic coasts, the Caribbean or Hawaii) and (2)the design wind speeds resulting from the study shall not be less than the resulting 500-year return period wind speed divided by $\sqrt{1.5}$.

6.5.4.3 Limitation. Tornadoes have not been considered in developing the basic wind-speed distributions.

6.5.4.4 Wind directionality factor. The wind directionality factor, K_d, shall be determined from Table 6-6 This factor shall only be applied when used in conjunction with load combinations specified in 2 3 and 2 4

6.5.5 Importance Factor. An importance factor, I, for the building or other structure shall be determined from Table 6-1 based on building and structure categories listed in Table 1-1

6.5.6 Exposure Categories

6.5.6.1 General. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories:

1 **Exposure A.** Large city centers with at least 50% of the buildings having a height in excess of 70 feet (21 3 m) Use of this exposure category shall be limited to those areas for which terrain representative of Exposure A prevails in the upwind direction for a distance of at least one-half mile (0 8 km) or 10 times the height of the building or other structure, whichever is greater Possible channeling effects or increased velocity pressures due to the building or structure being located in the wake of adjacent buildings shall be taken into account

2. **Exposure B.** Urban and suburban areas wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger Use of this *exposure* category shall be limited to those areas for which terrain representative of Exposure B prevails in the upwind direction for a distance of at least 1,500 ft (460 m) or 10 times the height of the building or other structure, whichever is greater

3 **Exposure C.** Open terrain with scattered obstructions having heights generally less than 30 ft (9 1 m) This category includes flat open country, grasslands and shorelines in hurricane prone regions

4 **Exposure D.** Flat, unobstructed areas exposed to wind flowing over open water (excluding shorelines in hurricane prone regions) for a distance of at least 1 mile (1 61 km) Shorelines in Exposure D include inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska. This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the water Exposure D extends inland from the shoreline a distance of 1500 feet (460 m) or 10 times the height of the building or structure, whichever is greater

6.5.6.2 Exposure category for main wind-force resisting systems

6.5.6.2.1 Buildings and other structures. For each wind direction considered, wind loads for the design of the main wind-force resisting system determined from Figure 6-3 shall be based on the exposure categories defined in 6.5.6.1.

6.5.6.2.2 Low-rise buildings. Wind loads for the design of the main wind-force resisting systems for low-rise buildings shall be determined using a velocity pressure q_h based on the exposure resulting in the highest wind loads for any wind direction at the site when external pressure coefficients GC_{pf} given in Fig. 6-4 are used.

6.5.6.3 Exposure category for components and cladding

6.5.6.3.1 Buildings with mean roof height h less than or equal to 60 ft (18 m). Components and cladding for buildings with a mean roof height h of 60 ft (18 m) or less shall be designed using a velocity pressure q_h based on the exposure resulting in the highest wind loads for any wind direction at the site.

6.5.6.3.2 Buildings with mean roof height h greater than 60 ft (18 m) and other structures. Components and cladding for buildings with a mean roof height h in excess of 60 ft (18 m) and for other structures shall be designed using the exposure resulting in the highest wind loads for any wind direction at the site.

6.5.6.4 Velocity pressure exposure coefficient. Based on the exposure category determined in 6 5.6.1, a velocity pressure exposure coefficient K_z or K_h, as applicable, shall be determined from Table 6-5.

6.5.7 Topographic Effects

6.5.7.1 Wind speed-up over hills, ridges, and escarpments. Wind speed-up effects at isolated hills, ridges, and escarpments constituting abrupt changes in the general topography, located in any exposure category, shall be included in the design when buildings and other site conditions and locations of structures meet all of the following conditions:

1. The hill, ridge, or escarpment is isolated and unobstructed upwind by other similar topographic features of comparable height for 100 times the height of the topographic feature (100H) or two miles (3.22 km) whichever is less. This distance shall be measured horizontally from the point at which the height H of the hill, ridge, or escarpment is determined; and
2. The hill, ridge, or escarpment protrudes above the height of upwind terrain features within a two mile (3.22 km) radius in any quadrant by a factor of two or more, and
3. The structure is located as shown in Figure 6-2 in the upper one-half of a hill or ridge or near the crest of an escarpment, and
4. $H/L_h \geq 0.2$, and
5. H is greater than or equal to 15 feet (4.5 m) for exposures C and D and 60 feet (18 m) for exposures A and B.

6.5.7.2 Topographic factor. The wind speed-up effect shall be included in the calculation of design wind loads by using the factor K_{zt}:

$$K_{zt} = (1 + K_1 K_2 K_3)^2 \qquad \text{Eq. 6-1}$$

where K_1, K_2, and K_3 are given in Figure 6-2.

6.5 8 Gust Effect Factor

6.5.8.1 Rigid structures. For rigid structures as defined in 6 2. the gust effect factor shall be taken as 0 85 or calculated by the formula

$$G = 0.925\left(\frac{(1+1.7 g_Q I_{\bar{z}} Q)}{1+1.7 g_v I_{\bar{z}}}\right) \qquad \text{Eq. 6-2}$$

$$I_{\bar{z}} = c\,(33/\bar{z})^{1/6} \qquad \text{Eq. 6-3}$$

where $I_{\bar{z}}$ = the intensity of turbulence at height $\bar{z}$ and where $\bar{z}$ = the equivalent height of the structure defined as 0 6 h but not less than z_{min} for all building heights h. z_{min} and c are listed for each exposure in Table 6-4. g_Q and g_v shall be taken as 3.4 The background response Q is given by

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{B + h}{L_{\bar{z}}}\right)^{0.63}}} \qquad \text{Eq. 6-4}$$

where B, h are defined in 6 3; and $L_{\bar{z}}$ = the integral length scale of turbulence at the equivalent height given by

$$L_{\bar{z}} = l(\bar{z}/33)^{\bar{\epsilon}} \qquad \text{Eq. 6-5}$$

in which l and $\bar{\epsilon}$ are constants listed in Table 6-4.

6.5.8.2 Flexible or dynamically sensitive structures. For flexible or dynamically sensitive structures as defined in 6 2. the gust effect factor shall be calculated by:

$$G = 0.925\left(\frac{1+1.7 I_{\bar{z}}\sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1+1.7 g_v I_{\bar{z}}}\right) \qquad \text{Eq. 6-6}$$

g_Q and g_v shall be taken as 3.4 and g_R is given by

$$g_R = \sqrt{2\ln(3600\, n_1)} + \frac{0.577}{\sqrt{2\ln(3600\, n_1)}} \qquad \text{Eq. 6-7}$$

R, the resonant response factor, is given by

$$R = \sqrt{\frac{1}{\beta} R_n R_h R_B (0.53 + 0.47\, R_L)} \qquad \text{Eq. 6-8}$$

$$R_n = \frac{7.47\, N_1}{(1 + 10.3\, N_1)^{5/3}} \qquad \text{Eq. 6-9}$$

$$N_1 = \frac{n_1 L_z}{\overline{V}_z} \qquad \text{Eq 6-10}$$

$$R_\ell = \frac{1}{\eta} - \frac{1}{2\eta^2}(1 - e^{-2\eta}) \text{ for } \eta > 0 \qquad \text{Eq 6-11a}$$

$$R_\ell = 1 \text{ for } \eta = 0 \qquad \text{Eq. 6-11b}$$

where the subscript ℓ in Eq 6-11 shall be taken as h, B, and L respectively:

R_ℓ = R_h setting $\eta = 4.6\, n_1 h / \overline{V}_{\bar{z}}$

R_ℓ = R_B setting $\eta = 4.6 n_1 B / \overline{V}_{\bar{z}}$

R_ℓ = R_L setting $\eta = 15.4 n_1 L / \overline{V}_{\bar{z}}$

n = building natural frequency

β = damping ratio, percent of critical

h, B, L are defined in 6.3

$\overline{V}_{\bar{z}}$ = mean hourly wind speed (ft/sec) at height $\bar{z}$ determined from Eq 6-12

$$\overline{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{33}\right)^{\bar{\alpha}} V\left(\frac{88}{60}\right) \qquad \text{Eq. 6-12}$$

where $\bar{b}$ and $\bar{\alpha}$ are constants listed in Table 6-4 and V is the basic wind speed in mph

6.5.8.3 Rational analysis. In lieu of the procedure defined in 6.5.8.1 and 6.5.8.2, determination of the gust effect factor by any rational analysis defined in the recognized literature is permitted.

6.5.8.4 Limitations. Where combined gust effect factors and pressure coefficients (GC_p, GC_{pi}, and GC_{pf}) are given in figures and tables the gust effect factor shall not be determined separately

6.5.9 Enclosure Classifications

6.5.9.1 General. For the purpose of determining internal pressure coefficients, all buildings shall be classified as enclosed, partially enclosed, or open as defined in 6.2.

6.5.9.2 Openings. A determination shall be made of the amount of openings in the building envelope in order to determine the enclosure classification as defined in 6.5.9.1.

6.5.9.3 Wind borne debris. Glazing in the lower 60 feet (18.3 m) of Category II, III, or IV buildings sited in wind borne debris regions shall be impact resistant glazing or protected with an impact resistant covering, or such glazing that receives positive external pressure shall be assumed to be openings.

6.5.9.4 Multiple classifications. If a building by definition complies with both the "open" and "partially enclosed" definitions, it shall be classified as an "open" building. A building that does not comply with either the "open" or "partially enclosed" definitions shall be classified as an "enclosed" building.

6.5.10 Velocity Pressure. Velocity pressure, q_z, evaluated at height z shall be calculated by the following equation

$$q_z = 0.00256\, K_z\, K_{zt}\, K_d\, V^2\, I \quad \text{(lb/sq ft)} \qquad \text{Eq. 6-13}$$

[In SI: $q_z = 0.613\, K_z\, K_{zt}\, K_d\, V^2\, I$ (N/m²)]

where K_d is the wind directionality factor defined in 6.5.4.4. K_z is the velocity pressure exposure coefficient defined in 6.5.6.4 and K_{zt} is the topographic factor defined in 6.5.7.2.

q_h is the velocity pressure calculated using Equation 6-13 at mean roof height h.

The numerical coefficient 0.00256 (0.613 in SI) shall be used except where sufficient climatic data are available to justify the selection of a different value of this factor for a design application

6.5.11 Pressure and Force Coefficients

6.5.11.1 Internal pressure coefficient. Internal pressure coefficients, GC_{pi}, shall be determined from Table 6-7 based on building enclosure classifications determined from 6.5.9.

6.5.11.1.1 Reduction Factor for Large Volume Buildings, R_i. For a partially enclosed building containing a single, unpartitioned large volume, the internal pressure coefficient, GC_{pi}, shall be multiplied by the following reduction factor, R_i

R_i = 1.0 or

$$R_i = 0.5\left(1 + \frac{1}{\sqrt{1 + \frac{V_i}{22{,}800\, A_{og}}}}\right) \le 1.0 \qquad \text{Eq. 6-14}$$

where

V_i = unpartitioned internal volume, in cubic feet

A_{og} = total area of openings in the building envelope (walls and roof, in sq ft)

6.5.11.2 External pressure coefficients.

6.5.11.2.1 Main Wind Force Resisting Systems. External pressure coefficients for main wind force resisting systems C_p are given in Figures 6-3 and Table 6-8.

Combined gust effect factor and external pressure coefficients, GC_{pf}, are given in Figure 6-4 for low-rise buildings. The pressure coefficient values and gust effect factor in Figure 6-4 shall not be separated.

6.5.11.2.2 Components and Cladding. Combined gust effect factor and external pressure coefficients for components and cladding GC_p are given in Figures 6-5 through 6-8. The pressure coefficient values and gust effect factor shall not be separated.

6.5.11.3 Force coefficients. Force coefficients C_f are given in Tables 6-9 through 6-13.

6.5.11.4 Roof overhangs

6.5.11.4.1 Main Wind-Force Resisting System. Roof overhangs shall be designed for a positive pressure on the bottom surface of windward roof overhangs corresponding to $C_p = 0.8$ in combination with the pressures determined from using Figures 6-3 and 6-4.

6.5.11.4.2 Components and Cladding. For all buildings, roof overhangs shall be designed for pressures determined from pressure coefficients given in Figure 6-5B.

6.5.12 Design Wind Loads on Enclosed and Partially Enclosed Buildings

6.5.12.1 General

6.5.12.1.1 Sign Convention. Positive pressure acts toward the surface and negative pressure acts away from the surface.

6.5.12.1.2 Critical Load Condition. Values of external and internal pressures shall be combined algebraically to determine the most critical load.

6.5.12.1.3 Tributary Areas Greater than 700 sq ft (65 sq m). Component and cladding elements with tributary areas greater than 700 sq ft (65 sq m) shall be permitted to be designed using the provisions for main wind force resisting systems.

6.5.12.2 Main force resisting systems

6.5.12.2.1 Rigid Buildings of All Heights. Design wind pressures for the main wind force resisting system of buildings of all heights shall be determined by the following equation:

$$p = qGC_p - q_i(GC_{pi}) \quad \text{(lb/sq ft)} \quad \text{Eq. 6-15}$$
$$\text{(N/m}^2\text{)}$$

where,

q = q_z for windward walls evaluated at height z above the ground

q = q_h for leeward walls, side walls and roofs, evaluated at height h

q_i = q_h for windward walls, side walls, leeward walls, and roofs of enclosed buildings and for negative internal pressure evaluation in partially enclosed buildings

q_i = q_z for positive internal pressure evaluation in partially enclosed buildings where height z is defined as the level of the highest opening in the building that could affect the positive internal pressure. For buildings sited in wind borne debris regions, glazing in the lower 60 ft (18.3 m) that is not impact resistant or protected with an impact resistant covering, the glazing shall be treated as an opening in accordance with 6.5.9.3. For positive internal pressure evaluation, q_i may conservatively be evaluated at height h ($q_i = q_h$)

G = gust effect factor from 6.5.8

C_p = external pressure coefficient from Figure 6-3 or Table 6-8

(GC_{pi}) = internal pressure coefficient from Table 6-7

q and q_i shall be evaluated using exposure defined in 6.5.6.2.1.

6.5.12.2.2 Low-Rise Buildings. Alternatively, design wind pressures for the main wind force resisting system of low-rise buildings shall be determined by the following equation:

$$p = q_h[(GC_{pf})-(GC_{pi})] \quad \text{(lb/sq ft)} \quad \text{Eq. 6-16}$$
$$\text{(N/m}^2\text{)}$$

where,

q_h = velocity pressure evaluated at mean roof height h using exposure defined in 6.5.6.2.2

(GC_{pf}) = external pressure coefficient from Figure 6-4

(GC_{pi}) = internal pressure coefficient from Table 6-7

6.5.12.2.3 Flexible Buildings. Design wind pressures for the main wind force resisting system of flexible buildings shall be determined from the following equation:

$$p = qGC_p - q_i(GC_{pi}) \quad \text{(lb/sq ft)} \quad \text{Eq. 6-17}$$
$$\text{(N/m}^2\text{)}$$

where a, q_i, C_p and (GC_{pi}) are as defined in 6 5 12 2 1 and

G_f = gust effect factor defined in 6 5 8 2

6.5.12 3 Full and partial loading The main wind-force resisting system of buildings with mean roof height h greater than 60 ft (18 m) shall be designed for the torsional moments resulting from design wind loads calculated from 6 5.12 acting in the combinations indicated in Figure 6-9.

6.5.12.4 Components and cladding

6.5.12.4.1 Low-rise buildings and buildings with h ≤ 60 ft (18.3 m). Design wind pressures on component and cladding elements of low-rise buildings and buildings with h≤60 ft (18 3 m) shall be determined from the following equation

$$p = q_h [(GC_p)-(GC_{pi})] \quad (lb/sq\ ft)\ (N/m^2) \qquad Eq\ 6\text{-}18$$

where

q_h = velocity pressure evaluated at mean roof height h using exposure defined in 6.5 6.3 1

(GC_p)= external pressure coefficients given in Figures 6-5 through 6-7

(GC_{pi}) = internal pressure coefficient given in Table 6-7

6.5.12.4.2 Buildings with h > 60 ft (18.3 m). Design wind pressures on components and cladding for all buildings with h > 60 ft (18 3 m) shall be determined from the following equation.

$$p = q\,(GC_p) - q_i\,(GC_{pi}) \quad (lb/sq\ ft)\ (N/m^2) \qquad Eq\ 6\text{-}19$$

where

q = q_z for windward walls calculated at height z above the ground

q = q_h for leeward walls, side walls, and roofs, evaluated at height h

q_i = q_h for windward walls, side walls, leeward walls, and roofs of enclosed buildings and for negative internal pressure evaluation in partially enclosed buildings

q_i = q_z for positive internal pressure evaluation in partially enclosed buildings where height z is defined as the level of the highest opening in the building that could affect the positive internal pressure For buildings sited in wind borne debris regions with glazing in the lower 60 ft (18 3 m) that is not impact resistant or protected with an impact resistant covering, the glazing shall be treated as an opening in accordance with 6.5 9 3 For positive internal pressure evaluation, q_i may conservatively be evaluated at height h ($q_i = q_h$)

(GC_p)= external pressure coefficient from Figure 6-8

(GC_{pi})= internal pressure coefficient given in Table 6-7

q and q_i shall be evaluated using exposure defined in 6 5 6 3 2.

6.5.12.4.3 Alternative design wind pressures for components and cladding in buildings with 60 ft (18.3 m) < h < 90 ft (27.4 m). Alternative to the requirements of 6.5 12.4 2, the design of components and cladding for buildings with a mean roof height greater than 60 feet (18 3) m) and less than 90 feet (27.4 m) values from Figures 6-5, 6-6, and 6-7 shall be used only if the height to width ratio is one or less (except as permitted by Note 6 of Figure 6-8) and Equation 6-18 is used

6.5.13 Design Wind Loads on Open Buildings and Other Structures. The design wind force for open buildings and other structures shall be determined by the following formula.

$$F = q_z\, G\, C_f\, A_f \quad (lb)\ (N) \qquad Eq.\ 6\text{-}20$$

where.

q_z = velocity pressure evaluated at height z of the centroid of area A_f using exposure defined in 6.5 6 3 2

G = gust effect factor from 6 5 8

C_f = net force coefficients from Table 6-9 through 6-12

A_f = projected area normal to the wind except where C_f is specified for the actual surface area, sq ft (m^2)

6.6 Method 3 - Wind Tunnel Procedure

6.6.1 Scope.. Wind tunnel tests shall be used where required by 6.5 2 Wind tunnel testing shall be permitted in lieu of Methods 1 and 2 for any building or structure

6.6.2 Test Conditions Wind tunnel tests, or similar tests employing fluids other than air, used for the determination

of design wind loads for any building or other structure shall be conducted in accordance with this section Tests for the determination of mean and fluctuating forces and pressures shall meet all of the following conditions

1 the natural atmospheric boundary layer has been modeled to account for the variation of wind speed with height, and
2 the relevant macro (integral) length and micro length scales of the longitudinal component of atmospheric turbulence are modeled to approximately the same scale as that used to model the building or structure, and
3 the modeled building or other structure and surrounding structures and topography are geometrically similar to their full-scale counterparts, except that, for low-rise buildings meeting the requirements of 6 5.1, tests shall be permitted for the modeled building in a single exposure site as defined in 6.5 6.1, and
4 the projected area of the modeled building or other structure and surroundings is less than 8 percent of the test section cross-sectional area unless correction is made for blockage, and
5 the longitudinal pressure gradient in the wind tunnel test section is accounted for;
6. Reynolds number effects on pressures and forces are minimized, and
7 response characteristics of the wind tunnel instrumentation are consistent with the required measurements.

6.6.3 Dynamic Response. Tests for the purpose of determining the dynamic response of a building or other structure shall be in accordance with 6.6 2. The structural model and associated analysis shall account for mass distribution, stiffness, and damping.

6.6.4 Limitations

6.6.4.1 Limitations on wind speeds. Variation of basic wind speeds with direction shall not be permitted unless the analysis for wind speeds conforms to the requirements of 6.5.4.2

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