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Design Wind Pressure, p, Equation 6-19 (ASCE 7-05)

Design wind pressures and forces are determined per equations given in section 6.5.12

System Type	Structure Type	Equation
Main Wind-Force Resisting System	Flexible Buildings Buildings of all Heights	*p* : q·Gf·Cp - qi·GCpi q = qz : at height z above ground q = qh : for Leeward and Side Wall qi : qz for GCpi+, qh for GCpi- Gf : Obtained by rational analysis Cp : given in Figure 6-6 GCpi : given in Figure 6-5

Velocity Pressure Calculations, qz and qh

Velocity pressure qz and qh are calculated in accordance with section 6.5.10

qz = Velocity pressure @ height (z) (Eq. 6-15)
qz = Constant · Kz · Kzt · Kd · V ² ·I
qz = See wind pressure calculation table

qh = Velocity pressure @ height (h)
qh = Constant · Kh · Kzt · Kd · V ² ·I

Where : Constant	=	Numerical constant	(Section C6.5.10)
	=	½ · [(Air density lb/ cu ft) / (32.2 ft/s²)] · [(mi/h)(5280 ft/mi) · (1 hr/3600 s)] ²	
	=	0.00203	
Mean Sea Level	=	7,586.00 ft	
Air Density @MSL	=	0.0609 lb/cu ft	(Table C6-13)
Category	=	I	(Table 1-1)
Importance Factor	=	0.77	(Table 6-1)
Exposure Category	=	B (Urban areas)	
Alpha	=	7.00	(Table 6-2)
Zg	=	1,200.00 ft	(Table 6-2)
Basic Wind Speed	=	165.00 mph	(Figure 6-1)
Structure Height	=	45.00 ft	
Width	=	10.00 ft	
Depth	=	15.00 ft	
Natural Frequency	=	0.1000 Hz	
Damping Ratio, ß	=	3.5000 %	

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Velocity Pressure Calculations, qz (Cont.)

Where : Kz	=	Velocity pressure coefficient @ height z	
	=	2.01·(Z/Zg) ^ (2/Alpha) for 15 ft <= Z <= Zg	(Eq. C6-4a)
	=	2.01 · (15/Zg) ^ (2/Alpha) for Z < 15 ft	(Eq. C6-4b)
	=	See wind pressure calculation table	
Kh @ h	=	Velocity pressure coefficient @ height h	
	=	0.79	
Kz @ z	=	z = highest opening affecting pressure	
	=	0.70	
Kzt	=	Topographic factor obtained from Fig. 6-4	
	=	$(1 + K1 \cdot K2 \cdot K3)^2$	
	=	1.00	
Topography	=	None	
Kd	=	Wind directionality factor obtained from Table 6-4	
	=	1.00	

Internal Pressure Coefficient, GCpi, Figure 6-5

The internal pressure coefficients are given in Figure 6-5

Enlosure Classification	GCpi+	GCPi-	Ri	GCpi+	GCPi-
Partially enclosed buildings	0.55	-0.55	0.69	0.38	-0.38

Reduction Factor, Ri

Aog (sq. ft.)	=	50.00
Vi (cu. ft.)	=	7,000,000.00

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Gust Effect Factor, Gf, Obtained by Rational Analysis

The gust effect factor Gf for main wind-force resisting systems of flexible buildings and other structures shall be calculated by rational analysis, using dynamic properties of the system

Values Obtained from Table 6-2

Zmin	=	30.00 ft	
e	=	0.333	
l	=	320.0 ft	
c	=	0.300	
b (-)	=	0.450	
Alpha (-)	=	0.250	
b (^)	=	0.840	
Alpha (^)	=	0.143	

Calculated Values

Analysis	=	Category III : Flexible or Dynamically Sensitive Structures	
Damping Ratio, ß	=	3.50 %	
n1(Frequency)	=	0.100 Hz	
z (-)	=	30.00 ft	
Iz	=	$c \cdot (33/z)^{(1/6)}$	(Eq. 6-5)
	=	0.305	
Lz	=	$l \cdot (z/33)^{e}$	(Eq. 6-7)
	=	310.0 ft	
Q	=	$Sqr [1/ (1+ 0.63 \cdot [(b+h)/Lz]^{0.63})]$	(Eq. 6-6)
	=	0.908	
Vz (-)	=	$b(-) \cdot [z / 33]^{(alpha(-))} \cdot V \cdot (88/60)$	(Eq. 6-14)
	=	106.34 ft/s	
N1	=	$n1 \cdot Lz / Vz$	(Eq. 6-12)
	=	0.292	
Rn	=	$7.47 \cdot N1 / (1 + 10.3 \cdot N1)^{(5/3)}$	(Eq. 6-11)
	=	0.216	
Rl	=	$[1/n - 1/2 \cdot n^2 (1 - e^{(-2 \cdot n)})]$ for $n > 0$	(Eq. 6-13a)
	=	[1] for n = 0	(Eq. 6-13b)
nh = 4.6·n1·h / Vz	=	0.195	
nb = 4.6·n1·b / Vz	=	0.043	
nl = 15.4·n1·L / Vz	=	0.217	
Rh = Rl (n = nh)	=	0.882	
Rb = Rl (n = nb)	=	0.972	
RL = R (n = nl)	=	0.870	
R	=	$Sqr [(1 / ß) \cdot Rn \cdot Rh \cdot Rb (0.53 + 0.47 \cdot Rl)]$	(Eq. 6-10)
	=	2.227	
g (peak factor)	=	3.500	
gq	=	3.4	
gv	=	3.4	
gr	=	$Sqr(2 \cdot ln(3{,}600 \cdot n1)) + .577/Sqr(2 \cdot ln(3{,}600 \cdot n1))$	(Eq. 6-9)
	=	3.599	
Gust Factor (G)	=	$.925 \cdot [(1 + 1.7 \cdot Iz \cdot Sqr(gq^2 \cdot Q^2 + gr^2 \cdot R^2)) / (1 + 1.7 \cdot gv \cdot Iz)]$	(Eq. 6-8)
G	=	1.826	

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External Pressure Coefficient, Cp, Figure 6-6

The pressure force coefficient is given in Figure 6-6

Wall Pressure Coefficients, Cp

Surface	L/B	Cp	Use With
Windward	All Values	0.8	qz
Leeward	2.00	-0.3	qh
Side walls	All Values	-0.7	qh

Roof Pressure Coefficients, Cp, for use with qh

	Winward			Leeward	
Wind Direction	h/L	Angle (deg.)	Cp	Angle (deg .)	Cp
Normal to Ridge (Ang. >= 10)	1.00	33.00	-0.24 0.20	13.00	-0.64
Normal to Ridge (Ang. <10) and Parallel to Ridge for all angles	1.00	Horizontal distance from edge 0 to H/2 -1.30 (1)	 H/2 to H -0.70 (2)	 H to 2H -0.70 (3)	 > 2H -0.70 (4)

Design Wind Pressure, p. (psf), Equation 6-19

Design wind pressures and forces are determined per equations given in section 6.5.12

Surface	Cp	GCpi+	GCpi-	q = qh *(psf)*	qi+ = qz * *(psf)*	qi- = qh *(psf)*	G	p+ *(psf)*	p- *(psf)*
Wall Pressures									
Leeward wall	-0.30	0.38	-0.38	33.48	29.81	33.48	1.83	-29.60	-5.69
Side wall	-0.70	0.38	-0.38	33.48	29.81	33.48	1.83	-54.05	-30.13
Roof - Normal to Ridge for Angles > 10.0 deg.									
Windward NTR	-0.24	0.38	-0.38	33.48	29.81	33.48	1.83	-25.94	-2.02
Windward NTR	0.20	0.38	-0.38	33.48	29.81	33.48	1.83	0.96	24.88
Leeward NTR	-0.64	0.38	-0.38	33.48	29.81	33.48	1.83	-50.39	-26.47
Roof - Normal to Ridge (Ang. < 10.0 deg) and Parallel to Ridge All Angles									
(1) PTR or NTR	-1.30	0.38	-0.38	33.48	29.81	33.48	1.83	-90.73	-66.81
(2) PTR or NTR	-0.70	0.38	-0.38	33.48	29.81	33.48	1.83	-54.05	-30.13
(3) PTR or NTR	-0.70	0.38	-0.38	33.48	29.81	33.48	1.83	-54.05	-30.13
(4) PTR or NTR	-0.70	0.38	-0.38	33.48	29.81	33.48	1.83	-54.05	-30.13
Cp = -.18	-0.18	0.38	-0.38	33.48	29.81	33.48	1.83	-22.27	1.65

p+ uses GCpi+ *p- uses GCpi-*

* qz, where z = 30.00 ft

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Design Wind Pressure for Overhang, p, Equation 6-19

The design equation has been modified to qh · G · (Cp - Underside Cp) for overhang pressures
0.80 is used for Underside Cp instead of GCpi

Surface	Cp	Underside Cp	q = qh *(psf)*	G	p *(psf)*
Roof - Normal to Ridge for Angles > 10.0 deg.					
Windward NTR	-0.24	0.80	33.48	1.83	-63.57
Roof - Normal to Ridge for Angles < 10.0 deg. and Parallel to Ridge all Angles					
Leeward NTR	-0.64	0.80	33.48	1.83	-88.02
(1) PTR or NTR	-1.30	0.80	33.48	1.83	-128.36
(2) PTR or NTR	-0.70	0.80	33.48	1.83	-91.68
(3) PTR or NTR	-0.70	0.80	33.48	1.83	-91.68
(4) PTR or NTR	-0.70	0.80	33.48	1.83	-91.68
Cp = -0.18	-0.18	0.80	33.48	1.83	-59.90

p+ uses GCpi+ *p- uses GCpi-*

* qz, where z = 30.00 ft

Combined Net Pressure of Parapet, pp, Equation 6-20

kp = 2.01·(Parapet Height / Zg) ^ (2/Alpha)

kpt = (1 + K1 · K2 · K3) ², where z = parapet height in the k3 multiplier

qp = Constant · Kp · Kpt ·Kd · V ² ·I

pp = GCpn · qp

Side	GCpn	kp	kpt	qp *(psf)*	pp *(psf)*
Windward	1.50	0.69	1.00	29.23	43.85
Leeward	-1.00	0.69	1.00	29.23	-29.23

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Design Windward Wall Wind Pressures, p, Equation 6-19

Design wind pressures and forces are determined per equations given in section 6.5.12

p+ uses GCpi+ *p- uses GCpi-* * qz, where z = 30.00 ft

Heights *(feet)*	Kz	Kzt	Kd	q = qz *(psf)*	qi+ = qz * *(psf)*	qi- = qh *(psf)*	Cp	GCpi+	GCpi-	p+ *(psf)*	p- *(psf)*
40.01 - 45.00	0.79	1.00	1.00	33.48	29.81	33.48	0.80	0.38	-0.38	37.63	61.55
30.01 - 40.00	0.76	1.00	1.00	32.37	29.81	33.48	0.80	0.38	-0.38	36.01	59.93
25.01 - 30.00	0.70	1.00	1.00	29.81	29.81	33.48	0.80	0.38	-0.38	32.28	56.20
20.01 - 25.00	0.67	1.00	1.00	28.30	29.81	33.48	0.80	0.38	-0.38	30.07	53.99
15.01 - 20.00	0.62	1.00	1.00	26.55	29.81	33.48	0.80	0.38	-0.38	27.52	51.44
0.00 - 15.00	0.57	1.00	1.00	24.46	29.81	33.48	0.80	0.38	-0.38	24.46	48.38

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Design Wind Forces Windward Wall (Cp,+GCpi)

Design wind forces are calculated as follows :

Heights *(feet)*	Area *(sqr ft)*	p *(psf)*	Force *(lbs)*	Shear *(lbs)*	Moment *(lb-ft)*
40.01 - 45.00	28	37.63	1,045	1,045	2,607
30.01 - 40.00	222	36.01	8,002	9,047	53,027
25.01 - 30.00	194	32.28	6,277	15,324	113,923
20.01 - 25.00	243	30.07	7,309	22,633	208,779
15.01 - 20.00	250	27.52	6,880	29,512	339,108
0.00 - 15.00	750	24.46	18,343	47,856	919,663

Total Area	1,687	(sq. ft.)
Base Shear	47,856	(lbs)
Base Moment	919,663	(lb-ft)

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Design Wind Forces Windward Wall (Cp,-GCpi)

Design wind forces are calculated as follows:

Heights *(feet)*	Area *(sqr ft)*	p *(psf)*	Force *(lbs)*	Shear *(lbs)*	Moment *(lb-ft)*
40.01 - 45.00	28	61.55	1,709	1,709	4,264
30.01 - 40.00	222	59.93	13,317	15,026	87,873
25.01 - 30.00	194	56.20	10,928	25,953	190,266
20.01 - 25.00	243	53.99	13,122	39,076	352,773
15.01 - 20.00	250	51.44	12,859	51,935	580,235
0.00 - 15.00	750	48.38	36,282	88,217	1,631,890

Total Area	1,687	(sq. ft.)
Base Shear	88,217	(lbs)
Base Moment	1,631,890	(lb-ft)