

Company

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JOB TITLE Example 6 & 11 - 2000 IBC

JOB NO.	_____	SHEET NO.	_____
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www.struware.com

STRUCTURAL CALCULATIONS

FOR

Example 6 - Wind

Example 11 - Seismic

2000 IBC Handbook - Structural Provisions

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Code Search

I. Code: International Building Code 2000

II. Occupancy:

Occupancy Group = B Business

III. Type of Construction:

Fire Rating:
Roof = 2.0 hr
Floor = 2.0 hr

IV. Live Loads:

Roof angle (θ) 0.00 / 12 0.0 deg
Roof
0 to 200 sf: 20 psf
200 to 600 sf: 24 - 0.02Area, but not less than 12 psf
over 600 sf: 12 psf

Floor 50 psf
Stairs & Exitways 100 psf
Balcony 100 psf
Mechanical N/A
Partitions 20 psf

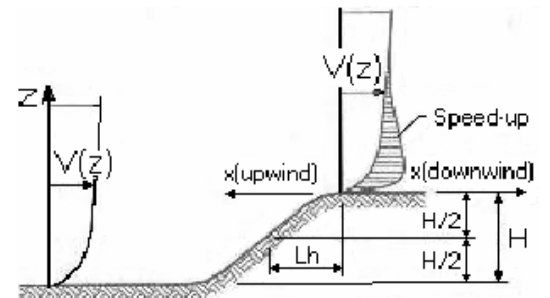
V. Wind Loads : ASCE 7 - 98

Importance Factor 1.00
Basic Wind speed 85 mph
Directionality (Kd) 0.85
Mean Roof Ht (h) 255.0 ft
Parapet ht above grd 258.0 ft
Exposure Category B
Enclosure Classif. Partially Enclosed
Internal pressure +/-0.55
Building length (L) 130.0 ft
Least width (B) 130.0 ft
Kh case 1 1.291
Kh case 2 1.291

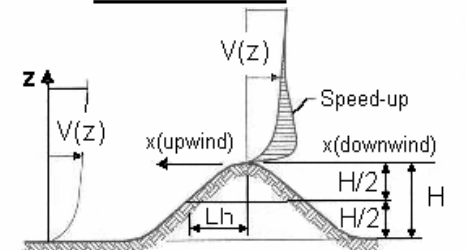
Topographic Factor (Kzt)

Topography Flat
Hill Height (H) 80.0 ft
Half Hill Length (Lh) 100.0 ft
Actual H/Lh = 0.80
Use H/Lh = 0.50
Modified Lh = 160.0 ft
From top of crest: x= 50.0 ft
Bldg up/down wind? downwind

H/Lh= 0.50 K₁ = 0.000
x/Lh = 0.31 K₂ = 0.792
z/Lh = 1.59 K₃ = 1.000
At Mean Roof Ht:
Kzt = (1+K₁K₂K₃)² = 1.000



ESCARPMENT



2D RIDGE or 3D AXISYMMETRICAL HILL

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V. Wind Loads - cont.:**Gust Effect Factor**

h = 255.0 ft
 use this h : 255.0 ft
 B = 130.0 ft
 Calculated /z = 153.0 ft
 Use this /z : 153.0 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).

However, rule of thumb is if h/B < 4 then rigid structure.

h/B = 1.96 Therefore, probably rigid structure

G = 0.88

Rigid Structure

/ε = 0.33
 l = 320 ft
 Z_{min} = 30 ft
 c = 0.30
 g_Q, g_v = 3.4
 L_z = 533.6 ft
 Q = 0.81
 I_z = 0.23
 G = 0.83

Flexible or Dynamically Sensitive Structure

Natural Frequency (n₁) = 0.5 Hz
 Damping ratio (β) = 0.01
 /b = 0.45
 /α = 0.25
 V_Z = 82.3
 N₁ = 3.24
 R_n = 0.067
 R_h = 0.131
 R_B = 0.237
 R_L = 0.079
 g_R = 4.021
 R = 0.342
 G = 0.876

η = 7.125
 η = 3.632
 η = 12.160
 h = 255.0 ft

Enclosure Classification

Test for Enclosed Building: A building that does not qualify as open or partially enclosed.

Test for Open Building: All walls are at least 80% open.
 A_o ≥ 0.8A_g

Test for Partially Enclosed Building:

Input	Test
A _o ≥ 1.1A _{oi}	YES
A _o > 4' / 0.01A _g	NO
A _{oi} / A _{gi} ≤ 0.20	NO

Building is NOT Partially Enclosed.

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:

- A_o ≥ 1.1A_{oi}
- A_o > smaller of 4' or 0.01 A_g
- A_{oi} / A_{gi} ≤ 0.20

Where:

- A_o = the total area of openings in a wall that receives positive external pressure.
- A_g = the gross area of that wall in which A_o is identified.
- A_{oi} = the sum of the areas of openings in the building envelope (walls and roof) not including A_o.
- A_{gi} = the sum of the gross surface areas of the building envelope (walls and roof) not including A_g.

Reduction Factor for large volume partially enclosed buildings (R_i):

If the partially enclosed building contains a single room that is unpartitioned, the internal pressure coefficient may be multiplied by the reduction factor R_i.

Total area of all wall & roof openings (A_{og}): 0 sf
 Unpartitioned internal volume (V_i): 0 cf
 R_i = 1.00

Altitude adjustment to constant 0.00256 :

Altitude = 0 feet Average Air Density = 0.0765 lbm/ft³
 Constant = 0.00256

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V. Wind Loads - MWFRS all h (Enclosed/partially enclosed only)

Kh (case 2) = 1.29 h = 255.0 ft GCpi = +/-0.55
Base pressure (qh) = **20.3 psf** ridge ht = 255.0 ft G = 0.88
Roof Angle = 0.0 deg L = 130.0 ft z for qi : 90.0 ft
Roof tributary area - (h/2)*L: 16575 sf B = 130.0 ft qi = 15.1 psf for positive internal pressures
(h/2)*B: 16575 sf

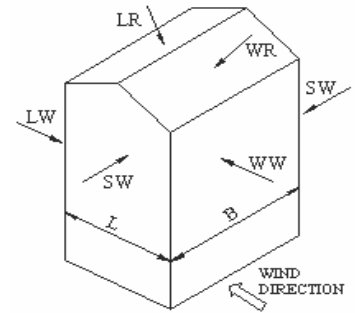
Surface Pressures (psf)	Wind Normal to Ridge (psf)				Wind Parallel to Ridge (psf)				
	B/L = 1.00		h/L = 1.96		L/B = 1.00		h/L = 1.96		
Surface	Cp	qhGCp	w/+qiGCpi	w/-qhGCpi	Dist.*	Cp	qhGCp	w/+qiGCpi	w/-qhGCpi
Windward Wall (WW)	0.80	14.2	see table below			0.80	14.2	see table below	
Leeward Wall (LW)	-0.50	-8.9	-17.2	2.3		-0.50	-8.9	-17.2	2.3
Side Wall (SW)	-0.70	-12.5	-20.7	-1.3		-0.70	-12.5	-20.7	-1.3
Leeward Roof (LR)		**				Included in windward roof			
Windward Roof: 0 to h/2*	-1.04	-18.5	-26.8	-7.3	0 to h/2*	-1.04	-18.5	-26.8	-7.3
> h/2*	-0.70	-12.5	-20.7	-1.3	> h/2*	-0.70	-12.5	-20.7	-1.3

*Horizontal distance from windward edge

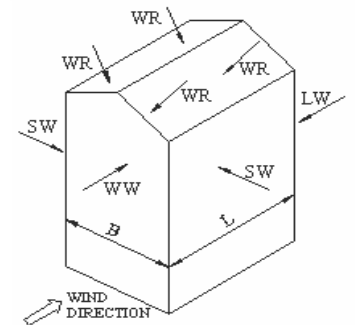
**Roof angle < 10 degrees. Therefore, leeward roof is included in windward roof pressure zones.

Windward Wall Pressures at "z" (psf)

z	Kz	Kzt	Windward Wall			Combined WW + LW	
			qzGCp	w/+qiGCpi	w/-qhGCpi	Normal to Ridge	Parallel to Ridge
0 to 15'	0.57	1.00	6.3 psf	-2.0 psf	17.5 psf	15.2 psf	15.2 psf
17.5 ft	0.60	1.00	6.6	-1.7	17.8	15.5	15.5
30.0 ft	0.70	1.00	7.7	-0.6	18.9	16.6	16.6
42.5 ft	0.77	1.00	8.5	0.2	19.7	17.4	17.4
55.0 ft	0.83	1.00	9.2	0.9	20.3	18.1	18.1
67.5 ft	0.88	1.00	9.7	1.4	20.9	18.6	18.6
80.0 ft	0.93	1.00	10.2	1.9	21.4	19.1	19.1
92.5 ft	0.97	1.00	10.7	2.4	21.8	19.5	19.5
105.0 ft	1.00	1.00	11.0	2.8	22.2	19.9	19.9
117.5 ft	1.03	1.00	11.4	3.1	22.6	20.3	20.3
130.0 ft	1.07	1.00	11.7	3.4	22.9	20.6	20.6
142.5 ft	1.09	1.00	12.1	3.8	23.2	20.9	20.9
155.0 ft	1.12	1.00	12.3	4.1	23.5	21.2	21.2
167.5 ft	1.15	1.00	12.6	4.3	23.8	21.5	21.5
180.0 ft	1.17	1.00	12.9	4.6	24.0	21.8	21.8
192.5 ft	1.19	1.00	13.1	4.8	24.3	22.0	22.0
205.0 ft	1.21	1.00	13.4	5.1	24.5	22.3	22.3
217.5 ft	1.23	1.00	13.6	5.3	24.8	22.5	22.5
230.0 ft	1.25	1.00	13.8	5.5	25.0	22.7	22.7
242.5 ft	1.27	1.00	14.0	5.7	25.2	22.9	22.9
h= 255.0 ft	1.29	1.00	14.2	5.9	25.4	23.1	23.1
258.0 ft	1.30	1.00	14.3	6.0	25.4	23.2	23.2



WIND NORMAL TO RIDGE



WIND PARALLEL TO RIDGE

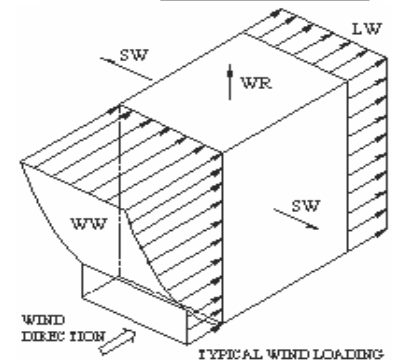
NOTE:

See figure 6-9 of ASCE7 for the application of full and partial loading of the above wind pressures. There are 4 different loading cases.

Parapet

z	Kz	Kzt	qp (psf)
258.0 ft	1.30	1.00	20.4

Windward parapet: 30.6 psf (GCpn = +1.5)
Leeward parapet: -20.4 psf (GCpn = -1.0)



TYPICAL WIND LOADING

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VI. Seismic Loads: IBC 2000

Seismic Use Group : I
 Importance Factor (I) : 1.00
 Site Class : D

Ss (0.2 sec) = 150.00 %g
 S1 (1.0 sec) = 60.00 %g

Zip Code Search for Ss & S1:
<http://eqint.cr.usgs.gov/eq-men/html/zipcode.html>

Fa = 1.000 Sms = 1.500 Sds = 1.000 Design Category = D
 Fv = 1.500 Sm1 = 0.900 Sd1 = 0.600 Design Category = D

Seismic Design Category = **D**

Number of Stories: 20

Structure Type: Not applicable

Plan Structural Irregularities: No plan Irregularity

Vertical Structural Irregularities: No vertical Irregularity

Flexible Diaphragms: No

Building System: **Dual Systems with special Moment Frames**Seismic resisting system: **Special reinforced concrete shear walls**System Building Height Limit: **Height not limited**

Actual Building Height (hn) = 255.0 ft

See Code section 1617.6.4 for exceptions and other system limitations

DESIGN COEFFICIENTS AND FACTORS

Response Modification Factor (R) = 8
 System Over-Strength Factor (Ω_o) = 2.5
 Deflection Amplification Factor (Cd) = 6.5
 Sds = 1.000
 Sd1 = 0.600

Code Reference Section for Detailing : 1910.2.4

Seismic Load Effect (E) = $\rho Q_E \pm 0.2S_{DS} D$ = $\rho Q_E \pm 0.200D$ Special Seismic Load Effect (Em) = $\Omega_o Q_E \pm 0.2S_{DS} D$ = $2.5 Q_E \pm 0.200D$

ρ = redundancy coefficient
 Q_E = horizontal seismic force
 D = dead load

PERMITTED ANALYTICAL PROCEDURES**Index Force Analysis (Seismic Category A only)** Method Not Permitted**Simplified Analysis** Method Not Permitted**Equivalent Lateral-Force Analysis** Method Not Permitted

Building period coef. (C_T) = 0.020 $C_u = 1.20$
 Approx fundamental period (T_a) = $C_{Th}^x = 1.276 \text{ sec}$ $x = 0.75$ $T_{max} = C_u T_a = 1.531$
 User calculated fundamental period (T) = 2.94 sec Use T = 1.531

Seismic response coef. (C_s) = $S_{ds}/R = 0.125$
 need not exceed $C_s = S_{d1} I / RT = 0.049$
 but not less than $C_s = 0.044 S_{ds} I = 0.044$
 USE $C_s = 0.049$

Design Base Shear V = Method Not Permitted

Model, Linear & Nonlinear Response Analysis - Permitted (see code for procedure)**ALLOWABLE STORY DRIFT**

Structure Type: All other structures

Allowable story drift = $0.020 h_{sx}$ where h_{sx} is the story height below level x

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VI. Seismic Loads - cont. :

Seismic Design Category (SDC)= D

CONNECTIONS**Force to connect smaller portions of structure to remainder of structure**

$$F_p = 0.133S_{DS}w_p = 0.13 w_p$$

$$\text{or } F_p = 0.5w_p = 0.05 w_p \quad \text{Use } F_p = 0.13 w_p \quad w_p = \text{weight of smaller portion}$$

Beam, girder or truss connection for resisting horizontal force parallel to member

F_p = no less than 0.05 times dead plus live load vertical reaction

Anchorage of Concrete or Masonry Walls to elements providing lateral support

$$F_p = 1.2I_eS_{Ds}W_w = 1.200 w_w$$

$$\text{or } F_p = 0.1w_w = 0.10 w_w \quad \text{Use } F_p = 1.20 w_w \quad \text{but not less than } 200.0 \text{ plf} = 400S_{Ds}I_e$$

Connection force given is for flexible diaphragms (use architectural components for rigid diaphragms)

MEMBER DESIGN**Bearing Walls and Shear Walls (out of plane force)**

$$F_p = 0.40I_eS_{DS}w_w = 0.400 w_w$$

$$\text{or } F_p = 0.1w_w = 0.10 w_w \quad \text{Use } F_p = 0.40 w_w$$

Diaphragms

$$F_p = (\text{Sum } F_i / \text{Sum } W_i)W_{px} + V_{px} = (\text{Sum } F_i / \text{Sum } W_i)W_{px} + V_{px}$$

need not exceed $0.3 S_{Ds}I_eW_{px} + V_{px} = 0.300 W_{px} + V_{px}$
 but not less than $0.15 S_{Ds}I_eW_{px} + V_{px} = 0.150 W_{px} + V_{px}$

ARCHITECTURAL COMPONENTS SEISMIC COEFFICIENTS

Architectural Component : Cantilever Elements (Unbraced or Braced to Structural Frame Below Its Center of Mass)

Importance Factor (I_p) : 1.0

Component Amplification Factor (a_p) = 2.5 $h = 255.0$ feet

Comp Response Modification Factor (R_p) = 2.5 $z = 50.0$ feet $z/h = 0.20$

$$F_p = 0.4a_pS_{Ds}I_pW_p(1+2z/h)/R_p = 0.557 W_p$$

not greater than $F_p = 1.6S_{Ds}I_pW_p = 1.600 W_p$
 but not less than $F_p = 0.3S_{Ds}I_pW_p = 0.300 W_p$ use $F_p = 0.557 W_p$

MECH AND ELEC COMPONENTS SEISMIC COEFFICIENTS

Seismic Design Category D & $I_p=1.0$, therefore see 2000IBC Section 1621.1.1 for exceptions

Mech or Electrical Component : General Electrical - Distribution systems (bus ducts, conduit, cable tray)

Importance Factor (I_p) : 1.0

Component Amplification Factor (a_p) = 1 $h = 255.0$ feet

Comp Response Modification Factor (R_p) = 3.5 $z = 50.0$ feet $z/h = 0.20$

$$F_p = 0.4a_pS_{Ds}I_pW_p(1+2z/h)/R_p = 0.159 W_p$$

not greater than $F_p = 1.6S_{Ds}I_pW_p = 1.600 W_p$
 but not less than $F_p = 0.3S_{Ds}I_pW_p = 0.300 W_p$ use $F_p = 0.300 W_p$

CODE SUMMARY- continued

Component and cladding wind pressures

Select method : C&C>60 feet

Roof	Area	Surface Pressure (psf)		
		10 sf	50 sf	100 sf
Negative Zone 1		-36.7	-30.7	-26.6
Negative Zone 2		-55.0	-46.6	-40.8
Negative Zone 3		-55.0	-46.6	-40.8

Wall	Area	Surface Pressure (psf)		
		20 sf	50 sf	100 sf
Negative Zone 4		-26.6	-24.5	-22.5
Negative Zone 5		-44.8	-36.7	-28.6
Positive Zone 4 & 5				
	0 to 15'	21.1	19.4	17.8
	18 ft	21.1	19.4	17.8
	30 ft	21.1	19.4	17.8
	43 ft	22.1	20.3	18.5
	55 ft	23.0	21.0	19.0
	68 ft	23.7	21.6	19.5
	80 ft	24.3	22.1	19.9
	93 ft	24.8	22.6	20.3
	105 ft	25.3	23.0	20.6
	118 ft	25.8	23.4	20.9
	130 ft	26.2	23.7	21.2
	143 ft	26.6	24.1	21.5
	155 ft	27.0	24.4	21.7
	168 ft	27.4	24.7	22.0
	180 ft	27.7	24.9	22.2
	193 ft	28.0	25.2	22.4
	205 ft	28.3	25.5	22.6
	218 ft	28.6	25.7	22.8
	230 ft	28.9	25.9	23.0
	243 ft	29.2	26.2	23.2
	255 ft	29.4	26.4	23.3
	258 ft	29.5	26.4	23.4