STRUCTURAL CALCULATIONS

FOR

Example 4 - 157' Building, on escarpment

Guide to Wind Load Procedures of ASCE 7-02

Code Search

Code: ASCE 7 - 02

Occupancy:

Occupancy Group = B Business

Occupancy Category & Importance Factors:

Occupancy Category =	II
Wind factor =	1.00
Snow factor =	1.00
Seismic factor =	1.00

Type of Construction:

Fire Rating:

Roof =	0.0 hr
Floor =	0.0 hr

Building Geometry:

Roof angle (θ)	0.00 / 12	0.0 deg
Building length (L)	200.0 ft	
Least width (B)	100.0 ft	
Mean Roof Ht (h)	157.0 ft	
Parapet ht above grd	160.0 ft	
Minimum parapet ht	3.0 ft	

Live Loads:

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

Typical Floor	50 psf
Lobbies & first floor corridors	100 psf
Corridors above first floor	80 psf
Mechanical	100 psf
Stairs & Exitways	100 psf
Balcony / Deck	50 psf
Partitions	20 psf

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Address
City, State
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other

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JOB NO. **SHEET NO.**
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Wind Loads :

Importance Factor	1.00
Basic Wind speed	120 mph
Directionality (Kd)	0.85
Exposure Category	B
Enclosure Classif.	Partially Enclosed
Internal pressure	+/-0.55
Kh case 1	1.124
Kh case 2	1.124
Type of roof	Monoslope

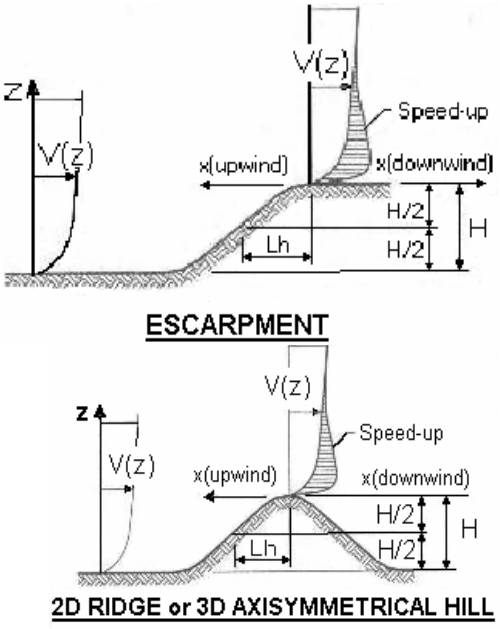
Topographic Factor (Kzt)

Topography		2D Escarpment
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	K_1 =	0.375
x/Lh = 0.31	K_2 =	0.922
z/Lh = 0.98	K_3 =	0.086

At Mean Roof Ht:

$Kzt = (1+K_1K_2K_3)^2$ = 1.06



Gust Effect Factor

h =	157.0 ft
B =	100.0 ft
/z (0.6h) =	94.2 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).
However, if building h/B < 4 then probably rigid structure (rule of thumb).
h/B = 1.57 Therefore, probably rigid structure

G = 0.83 Using rigid structure formula

Rigid Structure

/ε =	0.33
l =	320 ft
z_{min} =	30 ft
c =	0.30
g_Q, g_v =	3.4
L_z =	453.9 ft
Q =	0.83
I_z =	0.25
G =	0.83

Flexible or Dynamically Sensitive Structure

Natural Frequency (n_1) =	0.0 Hz				
Damping ratio (β) =	0				
/b =	0.45				
/α =	0.25				
Vz =	102.9				
N_1 =	0.00				
R_n =	0.000				
R_h =	28.282	η =	0.000	h =	157.0 ft
R_B =	28.282	η =	0.000		
R_L =	28.282	η =	0.000		
g_R =	0.000				
R =	0.000				
G =	0.000				

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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.
$Ao \geq 0.8Ag$

Test for Partially Enclosed Building:

	Input		Test	
Ao	0.0 sf	Ao ≥ 1.1Aoi	YES	
Ag	0.0 sf	Ao > 4' / 0.01Ag	NO	
Aoi	0.0 sf	Aoi / Agi ≤ 0.20	NO	Building is NOT Partially Enclosed.
Agi	0.0 sf			

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:
Ao >= 1.1Aoi
Ao > smaller of 4' or 0.01 Ag
Aoi / Agi <= 0.20
Where:
Ao = the total area of openings in a wall that receives positive external pressure.
Ag = the gross area of that wall in which Ao is identified.
Aoi = the sum of the areas of openings in the building envelope (walls and roof) not including Ao.
Agi = the sum of the gross surface areas of the building envelope (walls and roof) not including Ag.

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

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

Total area of all wall & roof openings (Aog): 0 sf
Unpartitioned internal volume (Vi) : 0 cf
Ri = 1.00

Altitude adjustment to constant 0.00256 :

Altitude = 0 feet
Constant = 0.00256
Average Air Density = 0.0765 lbm/ft^3

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

Kh (case 2) =	1.12	h =	157.0 ft	GCpi =	+/-0.55
Base pressure (q_h) =	**37.4 psf**	ridge ht =	157.0 ft	G =	0.83
Roof Angle =	0.0 deg	L =	200.0 ft	z for qi :	157.0 ft use 90.00
Roof tributary area - (h/2)*L:	15700 sf	B =	100.0 ft	qi =	31.9 psf for positive internal pressures
(h/2)*B:	7850 sf				

Surface Pressures (psf) / Surface	Wind Normal to Ridge (psf) B/L = 0.50		h/L = 1.57		Wind Parallel to Ridge (psf) L/B = 2.00		h/L = 0.79	
	Cp	q_hGC_p	w/+q_iGC_{pi}	w/-q_hGC_{pi}	Dist.*	Cp	q_hGC_p	w/ +q_iGC_{pi}	w/ -q_hGC_{pi}
Windward Wall (WW)	0.80	24.9	see table below			0.80	24.9	see table below	
Leeward Wall (LW)	-0.50	-15.6	-33.1	5.0		-0.30	-9.3	-26.9	11.2
Side Wall (SW)	-0.70	-21.8	-39.3	-1.3		-0.70	-21.8	-39.3	-1.3
Leeward Roof (LR)		**				Included in windward roof			
Windward Roof: 0 to h/2*	-1.04	-32.4	-49.9	-11.8	0 to h/2*	-0.98	-30.5	-48.0	-10.0
> h/2*	-0.70	-21.8	-39.3	-1.3	h/2 to h*	-0.79	-24.5	-42.0	-3.9
					h to 2h*	-0.61	-19.1	-36.6	1.4

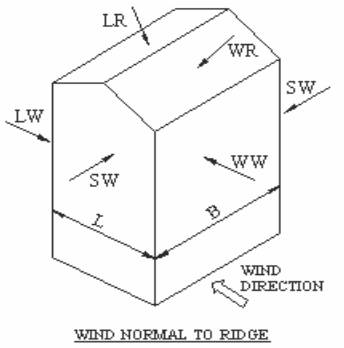
**Roof angle < 10 degrees. Therefore, leeward roof is included in windward roof pressure zones.

*Horizontal distance from windward edge

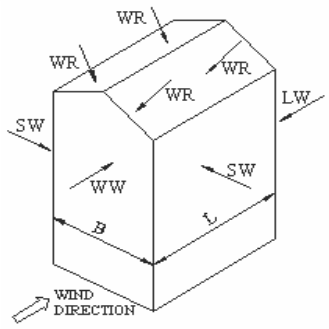
For monoslope roofs, entire roof surface is either windward or leeward surface.

Windward Wall Pressures at "z" (psf)

	z	Kz	Kzt	Windward Wall q_zGC_p	Windward Wall w/+q_iGC_{pi}	Windward Wall w/-q_hGC_{pi}	Combined WW + LW Normal to Ridge	Combined WW + LW Parallel to Ridge
	0 to 15'	0.57	1.71	20.5 psf	3.0 psf	41.1 psf	36.1 psf	29.9 psf
	30.0 ft	0.70	1.55	22.6	5.1	43.2	38.2	32.0
	50.0 ft	0.81	1.40	23.8	6.3	44.3	39.4	33.1
	80.0 ft	0.93	1.27	24.5	7.0	45.1	40.1	33.9
	120.0 ft	1.04	1.15	25.0	7.5	45.6	40.6	34.4
h=	157.0 ft	1.12	1.08	25.4	7.9	45.9	41.0	34.7



WIND NORMAL TO RIDGE



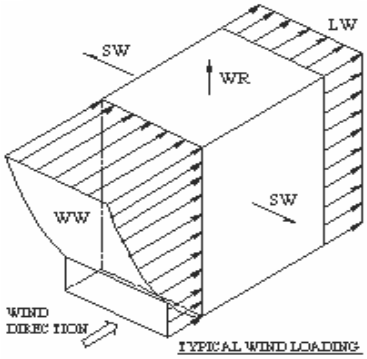
WIND PARALLEL TO RIDGE

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)
160.0 ft	1.13	1.06	37.5

Windward parapet: 67.4 psf (GCpn = +1.8)
Leeward parapet: -41.2 psf (GCpn = -1.1)



TYPICAL WIND LOADING

Company
Address
City, State
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Wind Loads - Components & Cladding : h > 60'

Kh (case 1) =	1.12	h =	157.0 ft
Base pressure (qh) =	**37.4 psf**	a =	10.0 ft
Minimum parapet ht =	3.0 ft	GCpi =	+/-0.55
Roof Angle =	0.0 deg	qi =	31.9 psf for positive internal pressures

Roof

	GCp			Surface Pressure (psf)			**User input**	
Area	10 sf	100 sf	500 sf	10 sf	100 sf	500 sf	50 sf	250 sf
Negative Zone 1	-1.40	-1.11	-0.90	-69.8 psf	-58.8 psf	-51.1 psf	-62.1 psf	-54.4 psf
Negative Zone 2	-2.30	-1.89	-1.60	-103.4 psf	-88.0 psf	-77.3 psf	-92.7 psf	-81.9 psf
Negative Zone 3	-2.30	-1.89	-1.60	-103.4 psf	-88.0 psf	-77.3 psf	-92.7 psf	-81.9 psf
Positive Zones 1-3	-	-	-	10.0 psf	10.0 psf	10.0 psf	10.0 psf	10.0 psf

Negative zone 3 = zone 2, since parapet >= 3ft.

Parapet

qp = 37.5 psf

CASE A = pressure towards building
CASE B = pressure away from building

	Surface Pressure (psf)			**User input**
Solid Parapet Pressure	10 sf	100 sf	500 sf	40 sf
CASE A : Interior zone:	119.9 psf	98.8 psf	82.4 psf	108.1 psf
Corner zone:	119.9 psf	98.8 psf	82.4 psf	108.1 psf
CASE B : Interior zone:	-67.4 psf	-58.1 psf	-48.7 psf	-63.4 psf
Corner zone:	-101.1 psf	-80.5 psf	-59.9 psf	-92.3 psf

Walls

	GCp			Surface Pressure at "h"			**User input**	
Area	20 sf	100 sf	500 sf	20 sf	100 sf	500 sf	28 sf	55 sf
Negative Zone 4	-0.90	-0.80	-0.70	-51.1 psf	-47.4 psf	-43.7 psf	-50.4 psf	-48.8 psf
Negative Zone 5	-1.80	-1.40	-1.00	-84.8 psf	-69.8 psf	-54.9 psf	-81.8 psf	-75.4 psf
Positive Zone 4 & 5	0.90	0.75	0.60	54.2 psf	48.6 psf	43.0 psf	53.1 psf	50.6 psf

NOTE: Negative zones 4 & 5 pressures apply to all heights. Positive pressures vary with height, see below.

Wall surface pressure at 'z'				Positive zone 4 & 5 (psf)			**User input**	
z	Kz	Kzt	qz (psf)	20	100	500	28 sf	55 sf
0 to 15'	0.70	1.71	37.5	54.3	48.7	43.1	53.2	50.8
30.0 ft	0.70	1.55	33.9	51.1	46.0	40.9	50.1	47.9
50.0 ft	0.81	1.40	35.7	52.6	47.3	41.9	51.6	49.3
80.0 ft	0.93	1.27	36.8	53.6	48.1	42.6	52.6	50.2
120.0 ft	1.04	1.15	37.5	54.3	48.7	43.1	53.2	50.8
h = 157.0 ft	1.12	1.08	38.1	54.8	49.1	43.4	53.7	51.2

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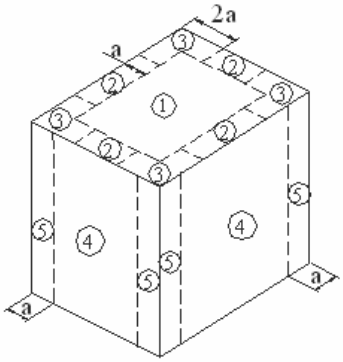
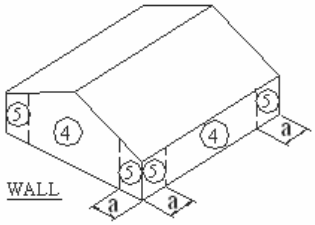
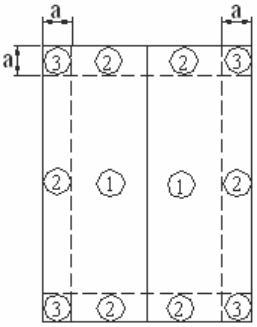
Location of Wind Pressure Zones



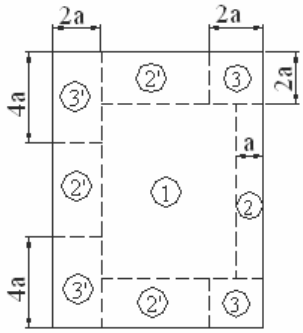
Roofs w/ $\theta \leq 10°$
and all walls
h > 60'



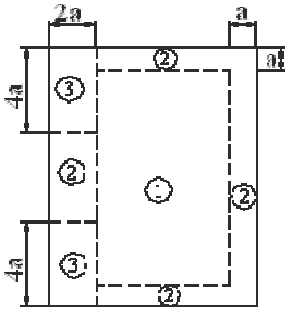
Walls h ≤ 60'
& alt design h<90'



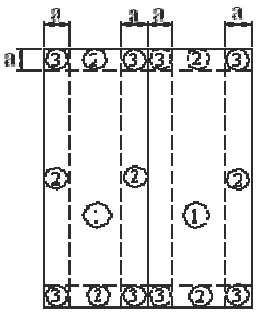
Gable, Sawtooth and
Multispan Gable $\theta \leq 7$ degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'



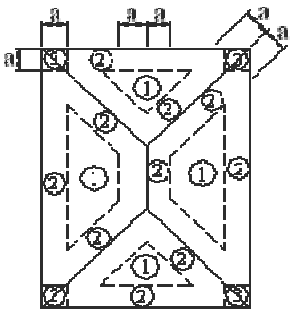
Monoslope roofs
$3° < \theta \leq 10°$
h ≤ 60' & alt design h<90'



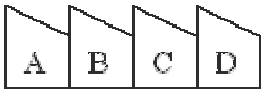
Monoslope roofs
$10° < \theta \leq 30°$
h ≤ 60' & alt design h<90'

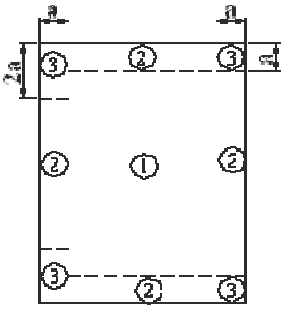


Multispan Gable &
Gable $7° < \theta \leq 45°$

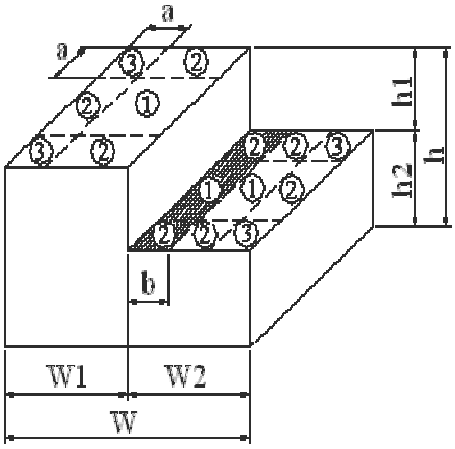


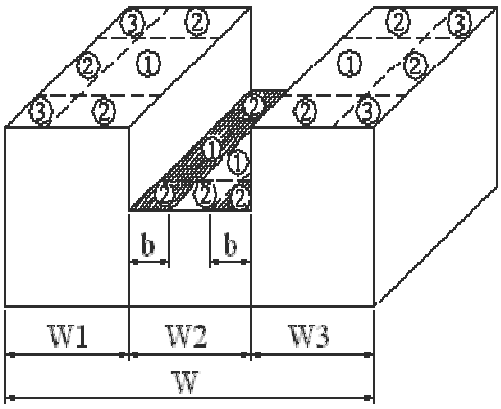
Hip $7° < \theta \leq 27°$





Sawtooth $10° < \theta \leq 45°$
h ≤ 60' & alt design h<90'





Stepped roofs $\theta \leq 3°$
h ≤ 60' & alt design h<90'