STRUCTURAL CALCULATIONS

FOR

Company
Address
City, State
Phone

JOB TITLE _____

JOB NO. _____ SHEET NO. _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

Code Search

Code: International Building Code 2021

Occupancy:

Occupancy Group = B Business

Risk Category & Importance Factors:

Risk Category =	II
Wind Factor =	1.00
Importance Factor	1.00
Seismic Importance factor =	1.00

Type of Construction:

Fire Rating:

Roof =	0.0 hr
Floor =	0.0 hr

Building Geometry:

Roof angle (θ)	0.25 / 12	1.2 deg
Building length	300.0 ft	
Least width	175.0 ft	
Mean Roof Ht (h)	62.0 ft	
Parapet ht above grd	64.0 ft	
Minimum parapet ht	2.0 ft	
hb for Elevated bldg	0.0 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

Roofs used for roof gardens 100 psf

Floor:

Typical Floor	50 psf
Partitions	15 psf
Corridors above first floor	80 psf
Lobbies & first floor corridors	100 psf
Stairs and exit ways	100 psf

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Wind Loads : ASCE 7- 16

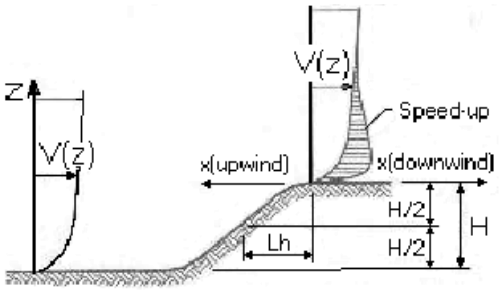
Ultimate Wind Speed	120 mph
Nominal Wind Speed	93 mph
Risk Category	II
Exposure Category	C
Enclosure Classif.	Enclosed Building
Internal pressure	+/-0.18
Bldg Directionality (Kd)	0.85
Kh MWFRS<=60	1.144
Kh all other	1.144
Type of roof	Monoslope

Topographic Factor (Kzt)

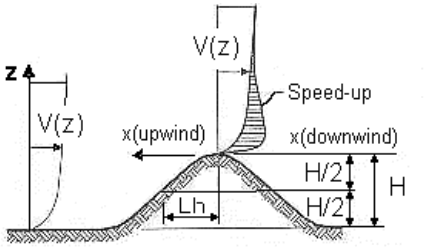
Topography		Flat
Hill Height	(H)	80.0 ft
Half Hill Length (Lh)		100.0 ft
Actual H/Lh	=	0.80
Use H/Lh	=	0.50
Modified Lh	=	160.0 ft
From top of crest: x =		50.0 ft
Bldg up/down wind?		downwind

H/Lh= 0.50 K_1 = 0.000
x/Lh = 0.31 K_2 = 0.792
z/Lh = 0.39 K_3 = 1.000

At Mean Roof Ht:
Kzt = $(1+K_1K_2K_3)^2$ = 1.00



ESCARPMENT



2D RIDGE or 3D AXISYMMETRICAL HILL

Gust Effect Factor

h = 62.0 ft
B = 175.0 ft
/z (0.6h) = 37.2 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).
If building h/B>4 then may be flexible and should be investigated.
h/B = 0.35

G = 0.85 Using rigid structure default

Rigid Structure

$\bar{e}$ =	0.20
ℓ =	500 ft
z_{min} =	15 ft
c =	0.20
g_Q, g_v =	3.4
L_z =	512.1 ft
Q =	0.85
I_z =	0.20
G =	**0.85** use G = 0.85

Flexible or Dynamically Sensitive Structure

Natural Frequency (η_1) =	0.7 Hz		
Damping ratio (β) =	0.01		
/b =	0.650		
/α =	0.154		
Vz =	116.5		
N_1 =	3.08		
R_n =	0.069		
R_h =	0.419	η = 1.713	h = 62.0 ft
R_B =	0.185	η = 4.836	
R_L =	0.035	η = 27.753	
g_R =	4.104		
R =	0.540		
Gf =	0.960		

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Ground Elevation Factor (Ke)

Grd level above sea level =	0 ft	Ke =	1.0000
Constant =	0.00256		
0.00256Ke =	0.00256		

Enclosure Classification

Test for Enclosed Building: Ao < 0.01Ag or 4 sf, whichever is smaller

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

Test for Partially Enclosed Building: Predominately open on one side only

	Input			Test	
Ao	500.0	sf	Ao ≥ 1.1Aoi	NO	
Ag	600.0	sf	Ao > 4sf or 0.01Ag	YES	
Aoi	1000.0	sf	Aoi / Agi ≤ 0.20	YES	Building is NOT
Agi	10000.0	sf			Partially Enclosed

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:
- Ao ≥ 1.1Aoi
- Ao > smaller of 4sf 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.

Test for Partially Open Building: A building that does not qualify as open, enclosed or partially enclosed.
(This type building will have same wind pressures as an enclosed building.)

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):	-	SF
Unpartitioned internal volume (Vi) :	-	CF
Ri =	1.00	

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Wind Loads - MWFRS all h (Except for Open Buildings)

		Kh =	1.144	GCpi =	+/-0.18
Base pressure (qh) =	**35.9 psf**	Bldg dim parallel to ridge =	300.0 ft	G =	0.85
Roof Angle (θ) =	1.2 deg	Bldg dim normal to ridge =	175.0 ft	qi = qh	
Roof tributary area:		h =	62.0 ft		
Wind normal to ridge =(h/2)*L:	9300 sf	ridge ht =	63.8 ft		
Wind parallel to ridge =(h/2)*L:	5425 sf				

Ultimate Wind Surface Pressures (psf)

	Wind Normal to Ridge				Wind Parallel to Ridge				
	L/B = 0.58		h/L = 0.35			L/B = 1.71		h/L = 0.21	
Surface	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	24.4	see table below			0.80	24.4	see table below	
Leeward Wall (LW)	-0.50	-15.2	-21.7	-8.8		-0.36	-10.9	-17.3	-4.4
Side Wall (SW)	-0.70	-21.3	-27.8	-14.9		-0.70	-21.3	-27.8	-14.9
Leeward Roof (LR)		**				Included in windward roof			
Neg Windward Roof: 0 to h/2*	-0.90	-27.4	-33.9	-21.0	0 to h/2*	-0.90	-27.4	-33.9	-21.0
h/2 to h*	-0.90	-27.4	-33.9	-21.0	h/2 to h*	-0.90	-27.4	-33.9	-21.0
h to 2h*	-0.50	-15.2	-21.7	-8.8	h to 2h*	-0.50	-15.2	-21.7	-8.8
> 2h*	-0.30	-9.1	-15.6	-2.7	> 2h*	-0.30	-9.1	-15.6	-2.7
Pos/min windward roof press.	-0.18	-5.5	-11.9	1.0	Min press.	-0.18	-5.5	-11.9	1.0

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

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

Windward roof overhangs : 24.4 psf (upward : add to qhGCp windward roof pressure)

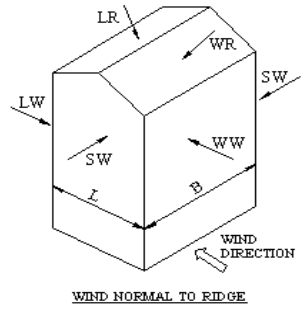
Parapet

z	Kz	Kzt	qp (psf)
64.0 ft	1.152	1.00	36.1

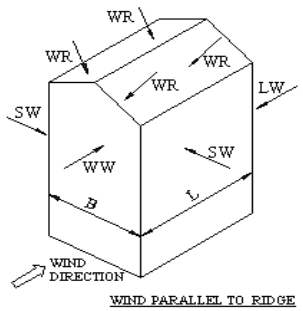
Windward parapet: 54.2 psf (GCpn = +1.5)
Leeward parapet: -36.1 psf (GCpn = -1.0)

Windward Wall Pressures at "z" (psf)

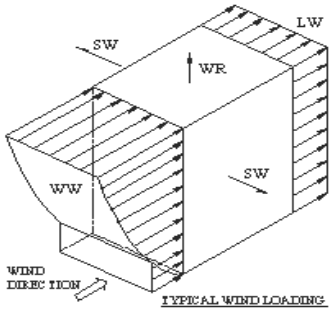
	z	Kz	Kzt	Windward Wall q_zGC_p	Windward Wall w/+q_iGC_{pi}	Windward Wall w/-q_hGC_{pi}	Combined WW + LW Wind Normal to Ridge	Combined WW + LW Wind Parallel to Ridge
	0 to 15'	0.85	1.00	18.1	11.6	24.5	33.3	29.0
	20.0 ft	0.90	1.00	19.2	12.8	25.7	34.5	30.1
	25.0 ft	0.95	1.00	20.1	13.7	26.6	35.4	31.0
	30.0 ft	0.98	1.00	20.9	14.5	27.4	36.2	31.8
	40.0 ft	1.04	1.00	22.2	15.8	28.7	37.5	33.1
	50.0 ft	1.09	1.00	23.3	16.9	29.8	38.5	34.2
	60.0 ft	1.14	1.00	24.2	17.8	30.7	39.5	35.1
h=	62.0 ft	1.14	1.00	24.4	17.9	30.8	39.6	35.3
ridge =	63.8 ft	1.15	1.00	24.5	18.1	31.0	39.8	35.4



WIND NORMAL TO RIDGE



WIND PARALLEL TO RIDGE



TYPICAL WIND LOADING

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Elevated Buildings

Elevated building procedure is from ASCE 7 -22

Horizontal MWFRS wind pressures on objects below hb

h = 62.0 ft
hb = 0.0 ft
z = 15.5 ft

Elevated Building Geometry limitation 1

Bldg Length = 300.0 ft
Bldg Width = 175.0 ft
Area of elevated building above = 52,500 sf

Area of below elements / Area of Bldg above = 0.2%

Cross setional area of all columns below bldg = 64.0 sf
Area of enclosed areas below bldg = 50.0 sf
Total cross sectional area below bldg = 114.0 sf

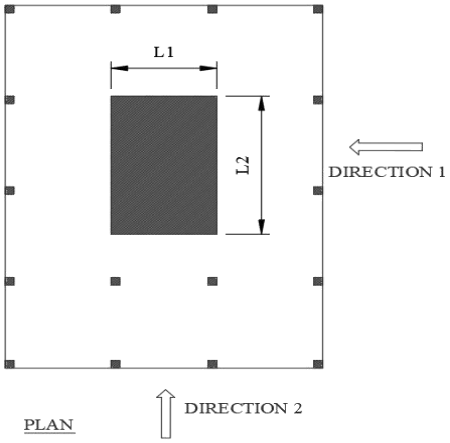
Direction 1 L/B = 0.58 Max L/B = 0.500 OK
Direction 2 L/B = 1.71 Max L/B = 0.500 OK
Meets geometry Limitation No 1 for both directions

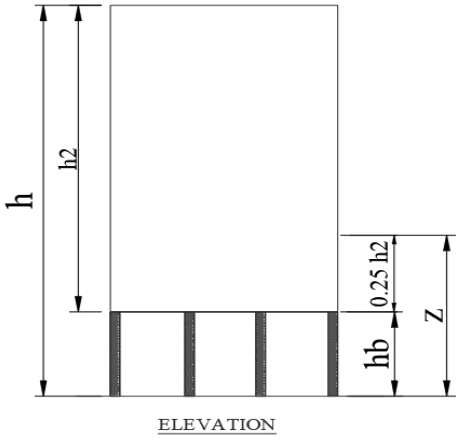
Elevated Building Geometry limitation 2

Direction 1		Direction 2	
Projected width of all columns facing direction 1 =	32.0 ft	Projected width of columns direction 2 =	30.0 ft
Projected L2 width of enclosed areas below bldg =	40.0 ft	Projected L1 width of enclosed areas =	42.0 ft
Total projected width below bldg (width) =	72.0 ft	Total projected width below bldg (width) =	72.0 ft
Projected area ratio =	24.0% OK	Projected area ratio =	41.1% OK

Meets geometry Limitation No 2 for both directions

hb = 0, therefore building is not an elevated building





Combined MWFRSwindward and leeward wind pressure on surfaces from 0 to hb (qzGCp) = **0.0** psf
MWFRS direction 1 force at height hb (width*hb/2) = 0.0 k
MWFRS direction 2 force at height hb (width*hb/2) = 0.0 k

Vertical MWFRS wind pressures on bottom surface of the elevated building

Base pressure (qz) = 0.0 psf

Ultimate Vertical MWFRS Wind Surface Pressures (psf) at horizontal bottom surface of elevated building

	Wind Normal to Ridge				Wind Parallel to Ridge				
	L/B = 0.58		hb/L = 0.00			L/B = 1.71		hb/L = 0.00	
	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}
Downward pressure: 0 to hb/2*	-0.90	0.0	0.0	0.0	0 to hb/2*	-0.90	0.0	0.0	0.0
hb/2 to hb*	-0.90	0.0	0.0	0.0	hb/2 to hb*	-0.90	0.0	0.0	0.0
hb to 2hb*	-0.50	0.0	0.0	0.0	hb to 2hb*	-0.50	0.0	0.0	0.0
> 2hb*	-0.30	0.0	0.0	0.0	> 2hb*	-0.30	0.0	0.0	0.0
Upward or min wind pressure	-0.18	0.0	0.0	0.0	Min press.	-0.18	0.0	0.0	0.0

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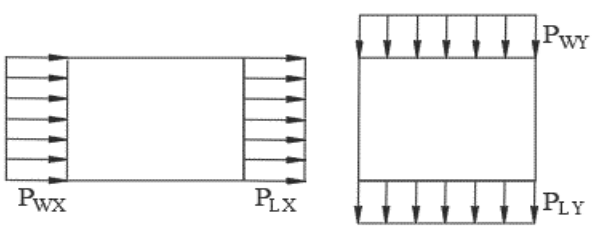
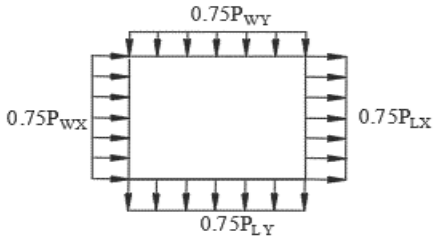
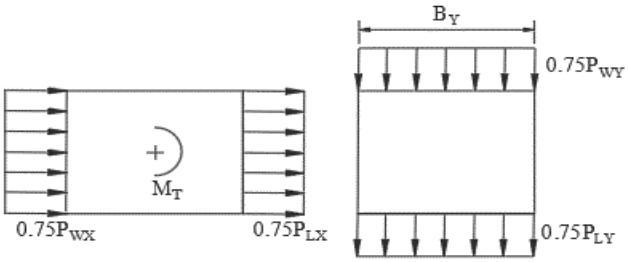
NOTE: ASCE 7 requires the application of full and partial loading of the wind pressures per the 4 cases below.



CASE 1



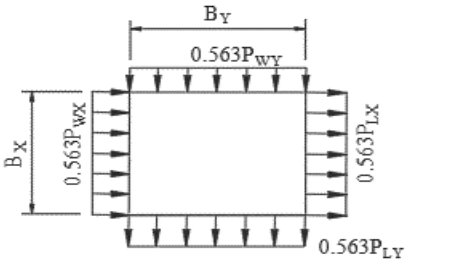
CASE 3



$M_T = 0.75(P_{WX}+P_{LX})B_X e_X$
$e_X = \pm 0.15\ B_X$

$M_T = 0.75(P_{WY}+P_{LY})B_Y e_Y$
$e_Y = \pm 0.15\ B_Y$

CASE 2



$M_T = 0.563(P_{WX}+P_{LX})B_X e_X + 0.563(P_{WY}+P_{LY})B_Y e_Y$
$e_X = \pm 0.15\ B_X$ $e_Y = \pm 0.15\ B_Y$

CASE 4

Wind Forces at Floors

Building dimension (parallel with ridge) = 300.0 ft e = 45.00 ft
Total Floors above grade = 2 Building dimension (normal to ridge) = 175.0 ft e = 26.25 ft
T/Fdn (dist below grade) = 2.0 ft L is the building dimension parallel to the wind direction

	Elevation Above	Height of Centroid	Wind Normal to Ridge						Wind Parallel to Ridge				
Level	Grade (ft)	to Fdn (ft)	L	B	Area (sf)	Applied Force (k)	Story Shear (k)	Overturning Moment ('k)	Area	Applied Force (k)	Story Shear (k)	Overturning Moment ('k)	
Equip,etc	66.00	68.00	wind on equip, screenwalls, etc =			2				0			
Parapet	64.00	65.00	175.0	300.0	600.0	54.2			350.0	31.6			
T/Ridge	67.20	66.60	175.0	300.0	1,560.0	0.0			455.0	16.2			
Roof	62.00	64.00	175.0	300.0	3,300.0	130.8	186.9	62.2	1,925.0	67.9	115.7	73.8	Roof
2	40.00	42.00	175.0	300.0	6,300.0	236.1	423.0	4,174.3	3,675.0	121.7	237.4	2,619.7	2
1	20.00	22.00	175.0	300.0	6,000.0	206.7	629.8	12,634.7	3,500.0	105.4	342.8	7,368.7	1
GRD		2.00						25,230.1				14,224.9	GRD
FDN		0.00						26,489.6				14,910.5	FDN

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Wind Loads - MWFRS h≤60' (Low-rise Buildings) except for open buildings

Kz = Kh = 1.144

Base pressure (qh) = **35.9 psf**
GCpi = +/-0.18

Edge Strip (a) = 17.5 ft
End Zone (2a) = 35.0 ft
Zone 2 length = 87.5 ft

h>60 - can't use low-rise method

Wind Pressure Coefficients

	CASE A				CASE B		
Surface	GCpf	θ = 1.2 deg w/-GCpi	w/+GCpi		GCpf	w/-GCpi	w/+GCpi
1	0.40	0.58	0.22		-0.45	-0.27	-0.63
2	-0.69	-0.51	-0.87		-0.69	-0.51	-0.87
3	-0.37	-0.19	-0.55		-0.37	-0.19	-0.55
4	-0.29	-0.11	-0.47		-0.45	-0.27	-0.63
5					0.40	0.58	0.22
6					-0.29	-0.11	-0.47
1E	0.61	0.79	0.43		-0.48	-0.30	-0.66
2E	-1.07	-0.89	-1.25		-1.07	-0.89	-1.25
3E	-0.53	-0.35	-0.71		-0.53	-0.35	-0.71
4E	-0.43	-0.25	-0.61		-0.48	-0.30	-0.66
5E					0.61	0.79	0.43
6E					-0.43	-0.25	-0.61

Ultimate Wind Surface Pressures (psf)

1		20.8	7.9		-9.7	-22.6
2		-18.3	-31.2		-18.3	-31.2
3		-6.8	-19.7		-6.8	-19.7
4		-3.9	-16.9		-9.7	-22.6
5					20.8	7.9
6					-3.9	-16.9
1E		28.3	15.4		-10.8	-23.7
2E		-31.9	-44.8		-31.9	-44.8
3E		-12.6	-25.5		-12.6	-25.5
4E		-9.0	-21.9		-10.8	-23.7
5E					28.3	15.4
6E					-9.0	-21.9

Parapet

Windward parapet = 54.2 psf (GCpn = +1.5)
Leeward parapet = -36.1 psf (GCpn = -1.0)

Windward roof overhangs = 25.1 psf (upward) add to windward roof pressure

Horizontal MWFRS Simple Diaphragm Pressures (psf)

Transverse direction (normal to L)

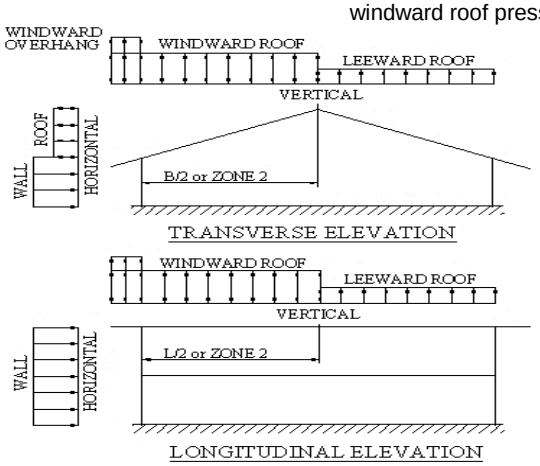
Interior Zone: Wall 24.7 psf
Roof -11.5 psf **
End Zone: Wall 37.3 psf
Roof -19.4 psf **

Longitudinal direction (parallel to L)

Interior Zone: Wall 24.7 psf
End Zone: Wall 37.3 psf

** NOTE: Total horiz force shall not be less than that determined by neglecting roof forces (except for MWFRS moment frames).

The code requires the MWFRS be designed for a min ultimate force of 16 psf multiplied by the wall area plus an 8 psf force applied to the vertical projection of the roof.



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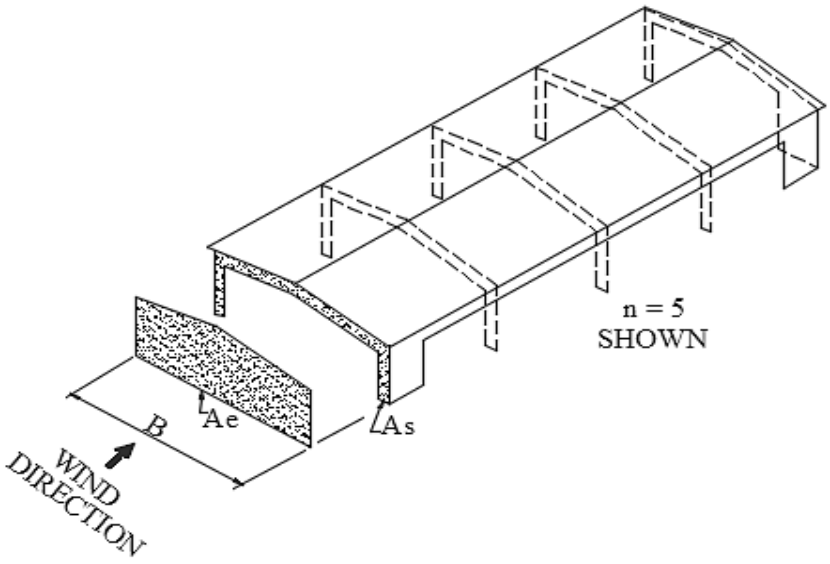
Wind Loads - h≤60' Longitudinal Direction MWFRS On Open or Partially Enclosed Buildings with Transverse Frames and Pitched Roofs

Base pressure (qh) = **35.9 psf** h>60 - can't use low-rise method **ASCE 7-16+ procedure**
GCpi = +/-0.18 Enclosed bldg, procdure doesn't apply
Roof Angle (θ) = 1.2 deg



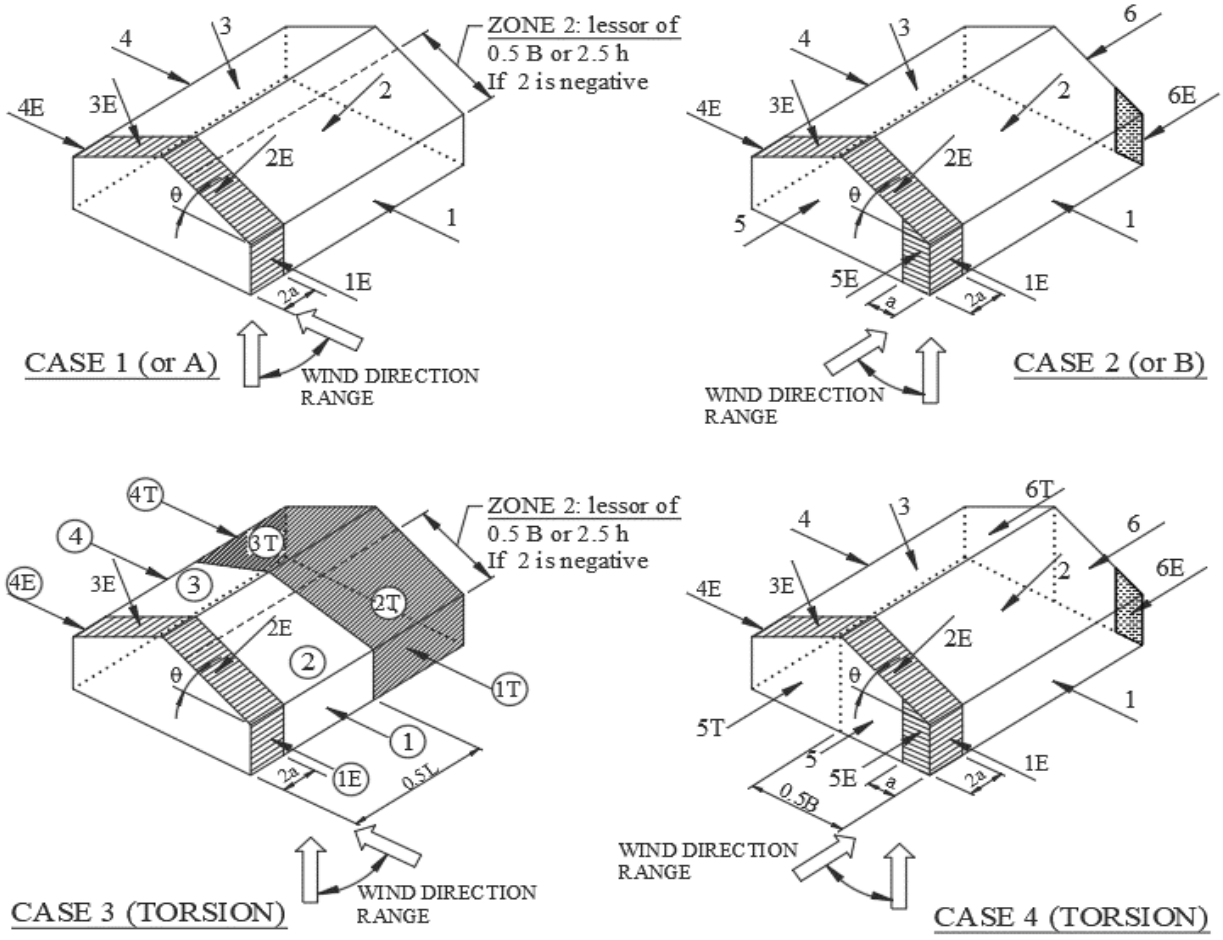
B=	175.0	ft
# of frames (n) =	4	
Solid are of end wall including fascia (As) =	26.0	sf
Roof ridge height =	63.8	ft
Roof eave height =	62.0	ft
Total end wall area if soild (Ae) =	11,009.5	sf

Longidinal Directional Force (F) = pAe
p= qh [(GCpf)windward -(GCpf)leeward] K_B K_S

Solidarity ratio (Φ) =	0.002	
n =	4	
KB =	0.8	
KS =	0.673	
Zones 5 & 6 area =	9,917	sf
5E & 6E area =	1,093	sf
(GCpf) windward - (GCpf) leeward] =	0.725	
p =	14.0	psf

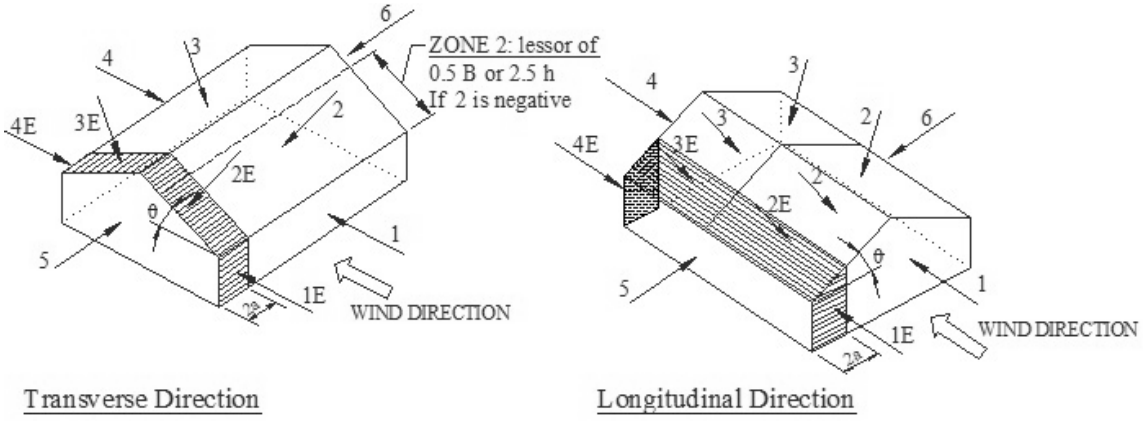
Total force to be resisted by MWFRS (F) = **154.1** **kips** applied at the centroid of the end wall area Ae

Note: The longidudinal force acts in combination with roof loads calculated elsewhere for an open or partially enclosed building.



NOTE: Torsional loads are 25% of zones 1 - 6.
Exception: One story buildings h<30' and 1 to 2 storybuildings framed with light-frame construction or with flexible diaphragms need not be designed for the torsional load case.

ASCE 7-98 & ASCE 7-10 (& later) - MWFRS wind pressure zones



NOTE: Torsional loads are 25% of zones 1 - 4. See code for loading diagram.
Exception: One story buildings h<30' and 1 to 2 storybuildings framed with light-frame construction or with flexible diaphragms need not be designed for the torsional load case.

ASCE 7-02 and ASCE 7-05 - MWFRS wind pressure zones

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Ultimate Wind Pressures

Wind Loads - Components & Cladding : Alternate design 60'<h<90'

		Kh =	1.144		~~100.0 ft~~	~~30.0 ft~~
Base pressure (qh) =	**35.9 psf**	h =	62.0 ft	0.2h = 12.4 ft	~~100.0 ft~~	
Minimum parapet ht =	2.0 ft	0.6h =	37.2 ft		~~100.0 ft~~	
Roof Angle (θ) =	1.2 deg	GCpi =	+/-0.18			
Type of roof =	Monoslope	qi = qh =	35.9 psf			

Roof

	Surface Pressure (psf)								User input	
Area	10 sf	20 sf	50 sf	100 sf	200 sf	350 sf	500 sf	1000 sf	80 sf	200 sf
Negative Zone 1	-67.40	-63.00	-57.10	-52.60	-48.2	-44.6	-42.3	-42.3	-54.1	-48.2
Negative Zone 1'	-38.70	-38.70	-38.70	-38.70	-33.3	-29.0	-26.2	-20.8	-38.7	-33.3
Negative Zone 2	-88.90	-83.20	-75.70	-69.90	-64.2	-59.6	-56.7	-56.7	-71.8	-64.2
Negative Zone 3	-121.20	-109.80	-94.70	-83.20	-71.8	-62.5	-56.7	-56.7	-86.9	-71.8
Positive All Zones	17.20	16.10	16.00	16.00	16.0	16.0	16.0	16.0	16.0	16.0
Overhang Zone 1&1'	-61.00	-59.90	-58.50	-57.40	-48.1	-40.6	-35.9	-35.9	-57.7	-48.1
Overhang Zone 2	-82.50	-74.90	-64.80	-57.20	-49.5	-43.4	-39.4	-39.4	-59.6	-49.5
Overhang Zone 3	-114.80	-101.40	-83.80	-70.40	-57.1	-46.3	-39.4	-39.4	-74.7	-57.1

Overhang pressures in the table above assume an internal pressure coefficient (Gcpi) of 0.0
Overhang soffit pressure equals adj wall pressure (which includes internal pressure of 6.5 psf)

Parapet

qp = 36.1 psf

		Surface Pressure (psf)						User input
Solid Parapet Pressure		10 sf	20 sf	50 sf	100 sf	200 sf	500 sf	50 sf
CASE A:	Zone 2 :	115.5	108.0	98.1	90.7	83.2	73.3	98.1
	Zone 3 :	148.0	134.8	117.3	104.0	90.8	73.3	117.3
CASE B:	Interior zone :	-68.2	-64.8	-60.2	-56.8	-53.3	-48.7	-60.2
	Corner zone :	-78.0	-72.8	-65.9	-60.8	-55.6	-48.7	-65.9

wall a = 17.5 ft

Walls

	GCp +/- GCpi				Surface Pressure at h				User input	
Area	10 sf	100 sf	200 sf	500 sf	10 sf	100 sf	200 sf	500 sf	100 sf	200 sf
Negative Zone 4	-1.17	-1.01	-0.96	-0.90	-42.0	-36.3	-34.5	-32.3	-36.3	-34.5
Negative Zone 5	-1.44	-1.12	-1.03	-0.90	-51.6	-40.2	-36.8	-32.3	-40.2	-36.8
Positive Zone 4 & 5	1.08	0.92	0.87	0.81	38.7	33.0	31.3	29.0	33.0	31.3

Note: GCp reduced by 10% due to roof angle <= 10 deg.

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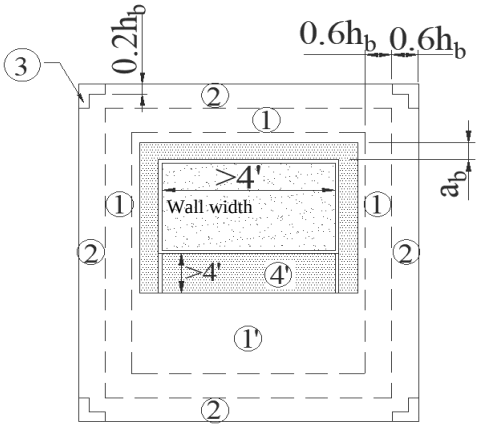
Elevated building procedure is from ASCE 7 -22

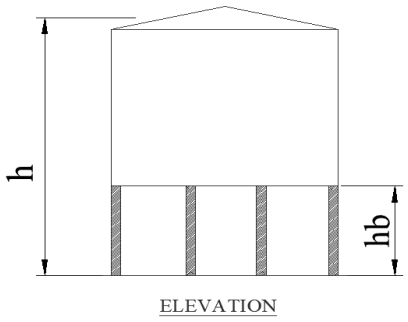
Bottom Horizontal Surface of Elevated Buildings

	1.14	h =	62.0 ft	0.2hb =	0.00
Base pressure (qh) =	**35.9 psf**	hb =	0.0 ft	0.6hb =	0.00
Wall width =	5.0 ft			ab =	0.00

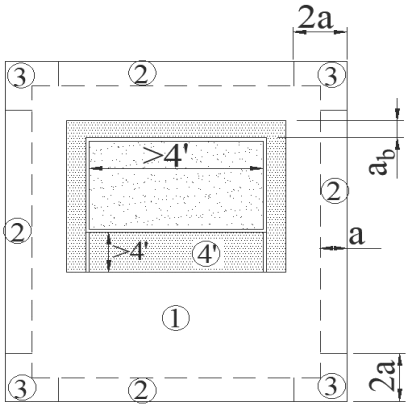
	GCp				Surface Pressure (psf)				User input	
Area	10 sf	100 sf	500 sf	1000 sf	10 sf	100 sf	500 sf	1000 sf	80 sf	200 sf
Negative Zone 1	-1.70	-1.29	-1.00	-1.00	-67.4	-52.6	-42.3	-42.3	-54.1	-48.2
Negative Zone 1'	-0.90	-0.90	-0.55	-0.40	-38.7	-38.7	-26.2	-20.8	-38.7	-33.3
Negative Zone 2	-2.30	-1.77	-1.40	-1.40	-88.9	-69.9	-56.7	-56.7	-71.8	-64.2
Negative Zone 3	-3.20	-2.14	-1.40	-1.40	-121.2	-83.2	-56.7	-56.7	-86.9	-71.8
Positive Zones 1-3	0.30	0.20	0.20	0.20	17.2	16.0	16.0	16.0	16.0	16.0
Negative Zone 4'	-0.99	-0.83	-0.72	-0.72	-42.0	-36.3	-32.3	-32.3	-36.8	-34.5
Positive Zone 4'	0.90	0.74	0.63	0.63	38.7	33.0	29.0	29.0	33.6	31.3

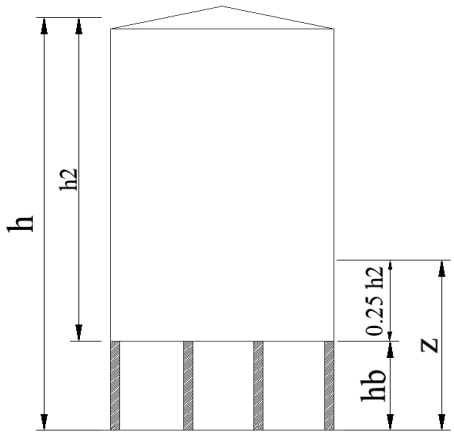
Negative pressures are downward





Building Bottom Plan: h ≤ 60' and alternate design 60'<h<90'





Building Bottom Plan: h> 60 feet

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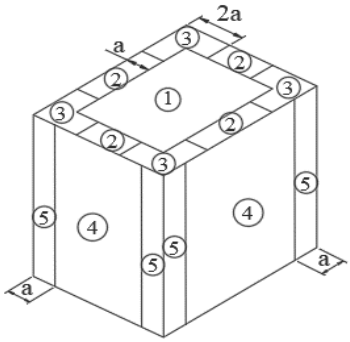
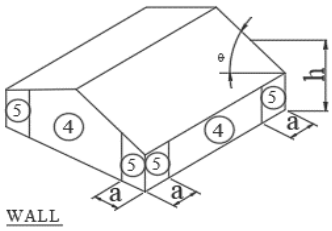
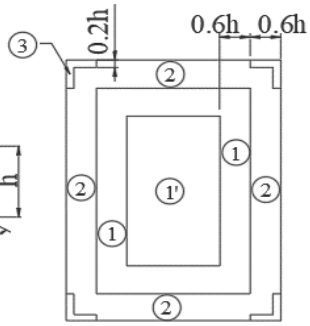
Location of C&C Wind Pressure Zones - ASCE 7-22



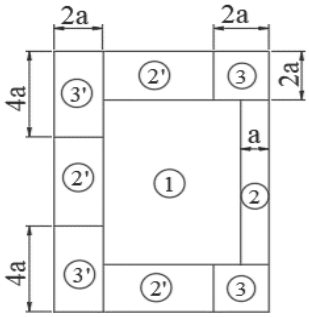
Roofs w/ θ ≤ 10°
and all walls
h > 60'



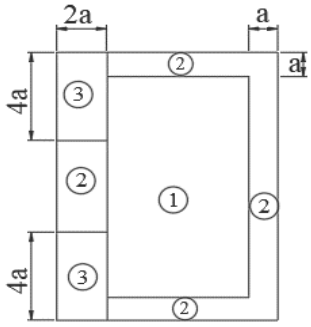
Walls h ≤ 60'
& alt design h<90'



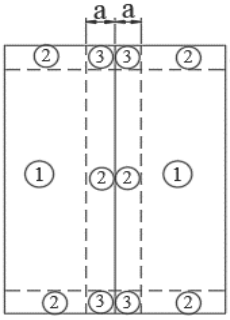
Multispan Gable & Sawtooth ≤ 10°
& Gable θ ≤ 7 degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'



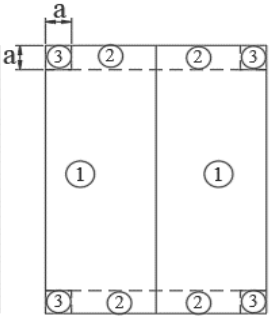
Monoslope roofs
3° < θ ≤ 10°
h ≤ 60' & alt design h<90'



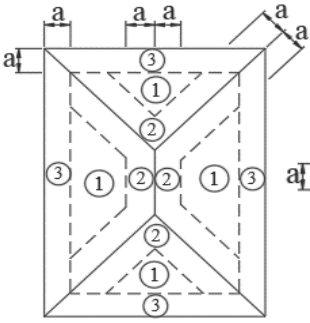
Monoslope roofs
10° < θ ≤ 30°
h ≤ 60' & alt design h<90'



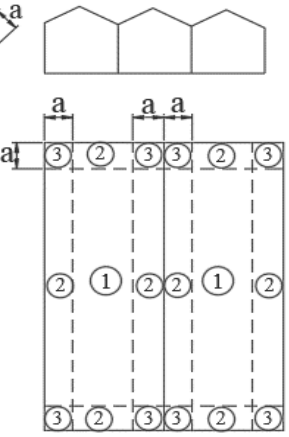
Gable 7° < θ ≤ 27°



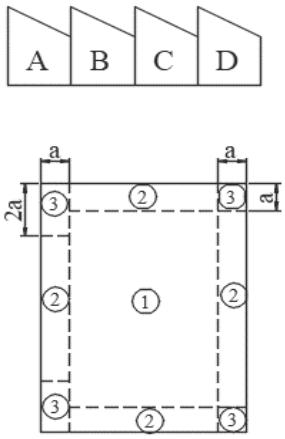
Gable 27° < θ ≤ 45°



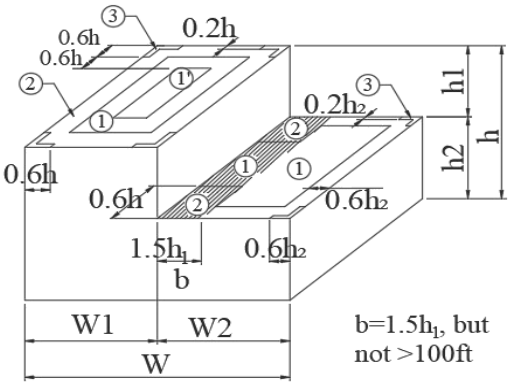
Hip 7° < θ ≤ 45°

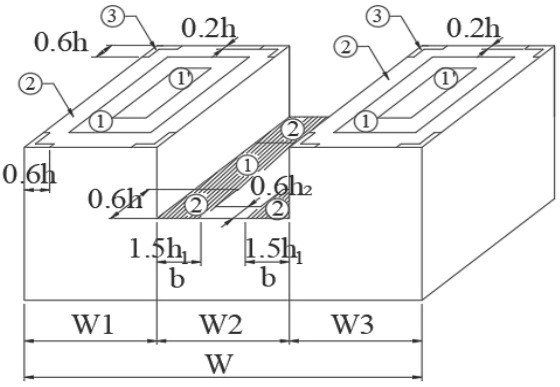


Multispan gable 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'



Sawtooth 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'





Stepped roofs θ ≤ 3°
h ≤ 60' & alt design h<90'

Note: The hatched area indicates where roof positive pressures are equal to the adjacent wall positive pressure.

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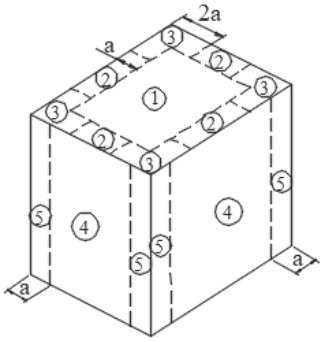
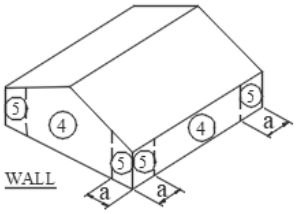
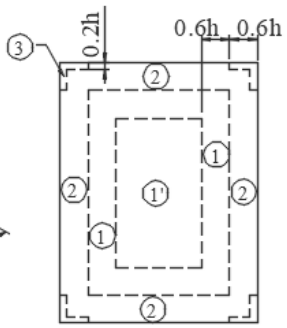
Location of C&C Wind Pressure Zones - ASCE 7-16

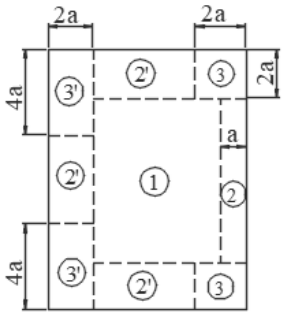


Roofs w/ θ ≤ 10°
and all walls
h > 60'



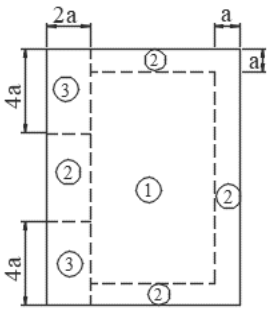
Walls h ≤ 60'
& alt design h<90'



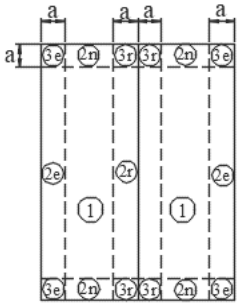


Multispan Gable & Sawtooth ≤ 10°
and Gable θ ≤ 7 degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'

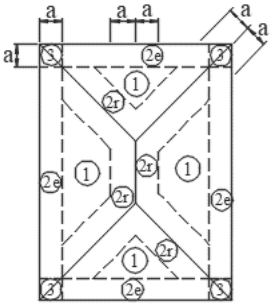
Monoslope roofs
3° < θ ≤ 10°
h ≤ 60' & alt design h<90'



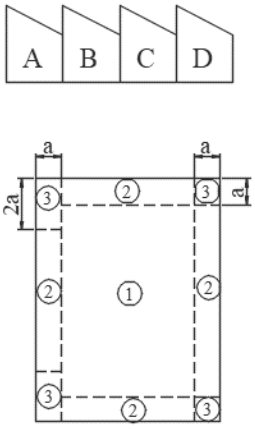
Monoslope roofs
10° < θ ≤ 30°
h ≤ 60' & alt design h<90'



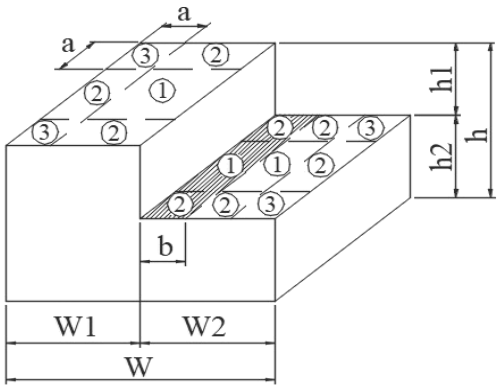
Multispan Gable > 10°
& Gable 7° < θ ≤ 45°



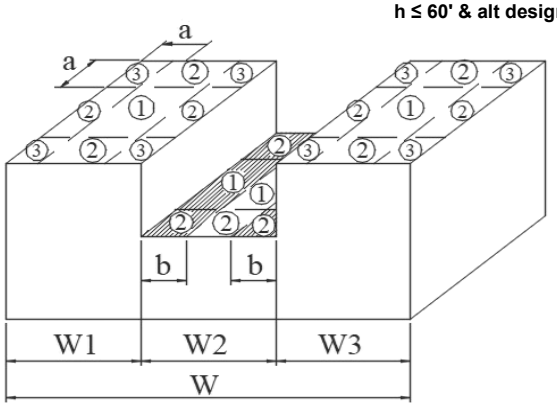
Hip 7° < θ ≤ 27°



Sawtooth 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'



Note: The hatched area indicates where roof positive pressures are equal to the adjacent wall positive pressure.



Stepped roofs θ ≤ 3°
h ≤ 60' & alt design h<90'

Note: The stepped roof zones above are as shown in ASCE 7-16 . Prior editions didn't show zones, but the notes sent you to the low slope gable figure. The note in ASCE 7-16 still sends you to the low slope gable figure, but for some reason the zones shown are per editions prior to ASCE 7-16. Therefore, the above zones may be a code mistake and the correct zone locations may be per the low slope gable roof shown at the top of this page.

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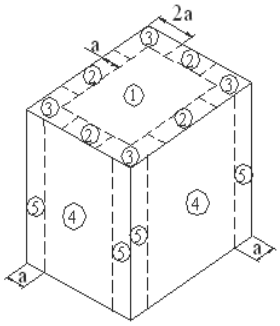
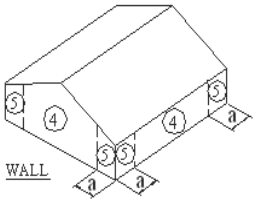
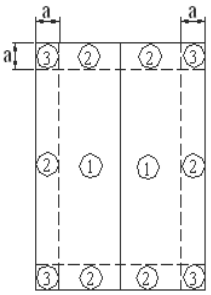
Location of C&C Wind Pressure Zones - ASCE 7-10 & earlier

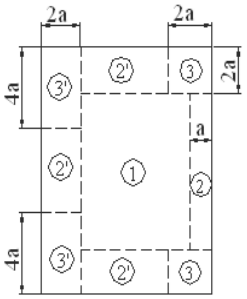


Roofs w/ θ ≤ 10°
and all walls
h > 60'



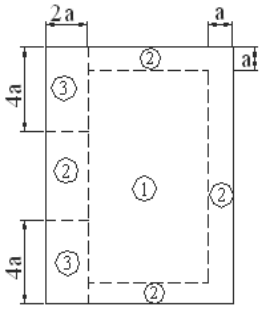
Walls h ≤ 60'
& alt design h<90'



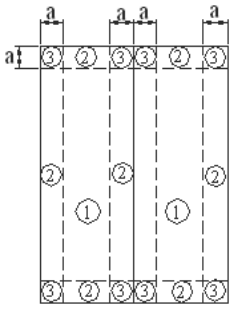


Gable & Sawtooth ≤ 10 degrees
& Gable θ ≤ 7 degrees &
Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'

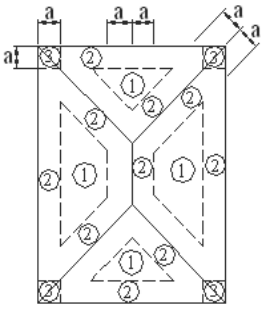
Monoslope roofs
3° < θ ≤ 10°
h ≤ 60' & alt design h<90'



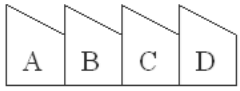
Monoslope roofs
10° < θ ≤ 30°
h ≤ 60' & alt design h<90'

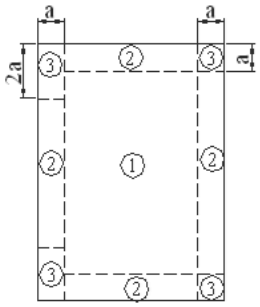


Multispan Gable > 10°
& Gable 7° < θ ≤ 45°

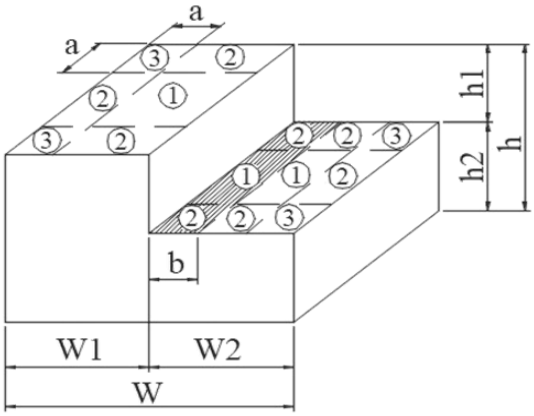


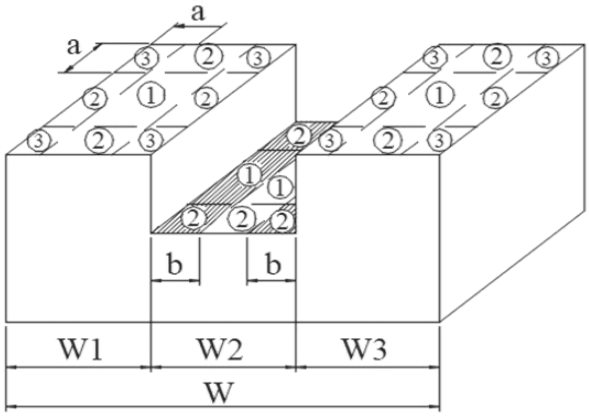
Hip 7° < θ ≤ 27°





Sawtooth 10° < θ ≤ 45°
h ≤ 60' & alt design h<90'





Stepped roofs θ ≤ 3°
h ≤ 60' & alt design h<90'

Note: The hatched area indicates where roof positive pressures are equal to the adjacent wall positive pressure.

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Wind Loads - Open Buildings

Ultimate Wind Pressures

Type of roof = Monoslope Free Roofs
Wind Flow = Clear

G = 0.85
Roof Angle = 1.2 deg

NOTE: The code requires the MWFRS be designed for a minimum pressure of 16 psf.

Main Wind Force Resisting System

Kz = Kh = 1.144

Base pressure (qh) = **35.9 psf**

Roof pressures - Wind Normal to Ridge

Wind Flow	Load Case		Wind Direction ɣ = 0 & 180 deg	
			Cnw	Cnl
Clear Wind Flow	A	Cn =	1.20	0.30
		p =	36.6 psf	9.1 psf
	B	Cn =	-1.10	-0.10
		p =	-33.5 psf	-3.0 psf

NOTE: 1). Cnw and Cnl denote combined pressures from top and bottom roof surfaces.
2). Cnw is pressure on windward half of roof. Cnl is pressure on leeward half of roof.
3). Positive pressures act toward the roof. Negative pressures act away from the roof.

Roof pressures - Wind Parallel to Ridge, ɣ = 90 deg

Wind Flow	Load Case		Horizontal Distance from Windward Edge		
			≤ h	>h ≤ 2h	> 2h
Clear Wind Flow	A	Cn =	-0.80	-0.60	-0.30
		p =	-24.4 psf	-18.3 psf	-9.1 psf
	B	Cn =	0.80	0.50	0.30
		p =	24.4 psf	15.2 psf	9.1 psf

h = 62.0 ft
2h = 124.0 ft

Fascia Panels -Horizontal pressures

qp = 35.9 psf

Windward fascia: 53.8 psf (GCpn = +1.5)
Leeward fascia: -35.9 psf (GCpn = -1.0)

Components & Cladding - roof pressures

Kz = Kh = 1.14
Base pressure (qh) = **35.9 psf**
G = 0.85

a = 17.5 ft

a^2 = 306.3 sf
$4a^2$ = 1225.0 sf

	Effective Wind Area	Clear Wind Flow					
		zone 3		zone 2		zone 1	
		positive	negative	positive	negative	positive	negative
C_N	≤ 306.3 sf	2.53	-3.44	1.90	-1.76	1.26	-1.15
	>306.3, ≤ 1225 sf	1.90	-1.76	1.90	-1.76	1.26	-1.15
	> 1225 sf	1.26	-1.15	1.26	-1.15	1.26	-1.15
Wind pressure	≤ 306.3 sf	77.0 psf	-105.0 psf	57.8 psf	-53.8 psf	38.5 psf	-35.0 psf
	>306.3, ≤ 1225 sf	57.8 psf	-53.8 psf	57.8 psf	-53.8 psf	38.5 psf	-35.0 psf
	> 1225 sf	38.5 psf	-35.0 psf	38.5 psf	-35.0 psf	38.5 psf	-35.0 psf

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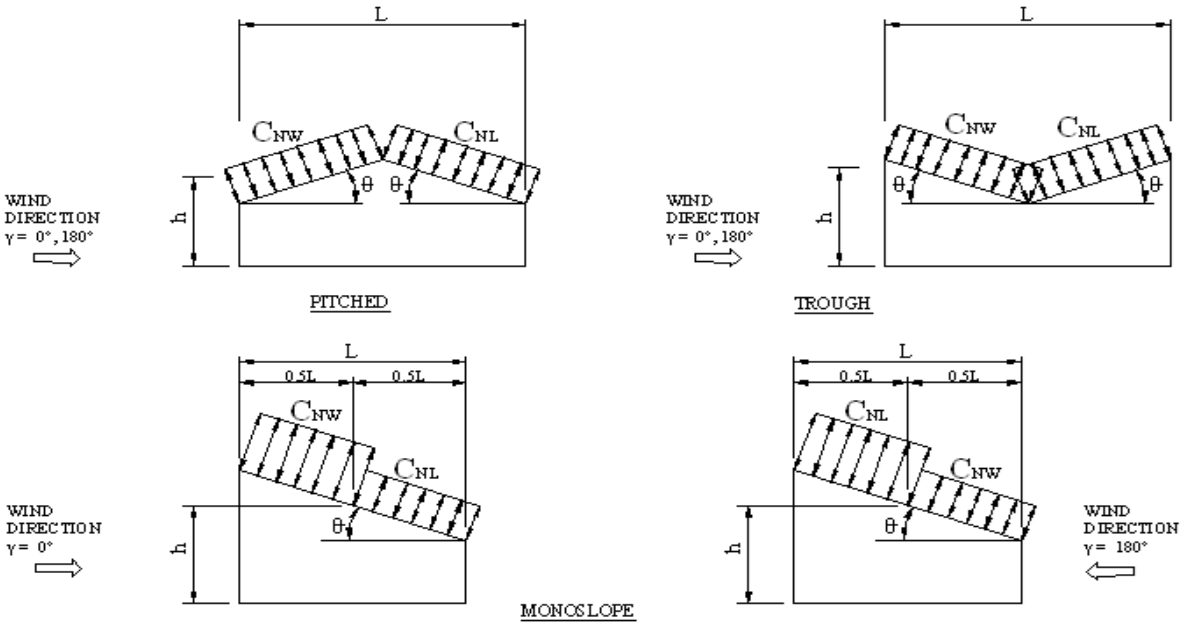
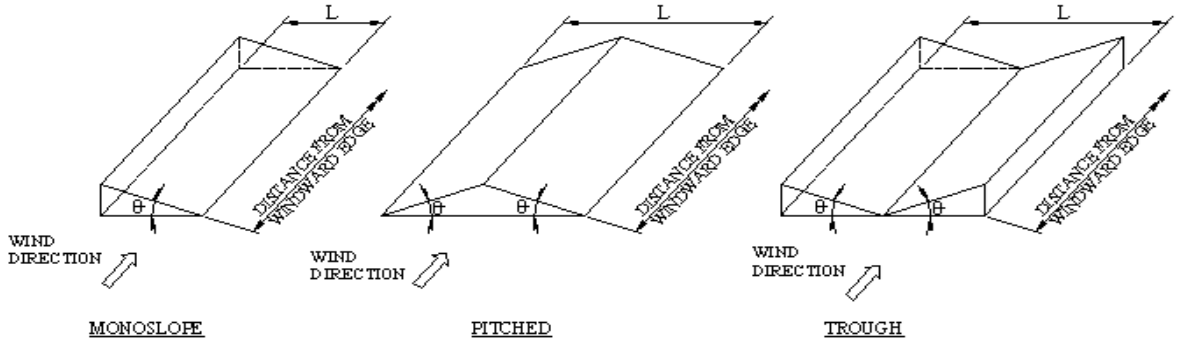
Location of Open Building Wind Pressure Zones

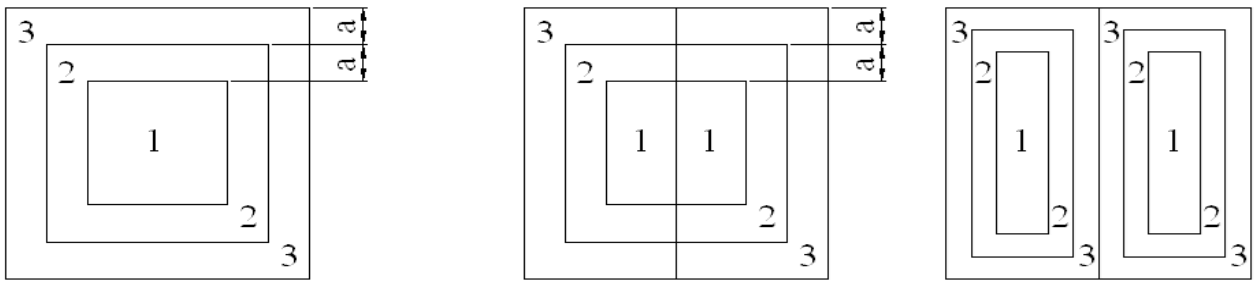


WIND DIRECTION $\gamma = 0°, 180°$



WIND DIRECTION $\gamma = 90°$

MAIN WIND FORCE RESISTING SYSTEM



COMPONENTS AND CLADDING

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Wind Loads - Rooftop Structures & Canopies

Ultimate Wind Pressures

Building (L) = 300.0 ft
Building (B) = 175.0 ft

Directionality (Kd) = 0.85

Rooftop Structures & Equipment #1

Equipment length parallel to L = 10.0 ft
Equipment length parallel to B = 5.0 ft
Height of equipment = 5.0 ft

Base pressure (qh) = **35.9 psf**

Vertical wind pressure		Wind normal to building B		Wind normal to building L	
Ar =	50.0 sf	Af =	25.0 sf	Af =	50.0 sf
GCr =	1.500	GCr =	1.90	GCr =	1.90
F = qhGCr Ar =	**53.8** Ar (psf)	F = qhGCr Af =	**68.1** Af (psf)	F = qhGCr Af =	**68.1** Af (psf)
Fv =	**2.7** kips	Fh =	**1.7** kips	Fh =	**3.4** kips

Rooftop Structures & Equipment #2

Equipment length parallel to L = 3.0 ft
Equipment length parallel to B = 3.0 ft
Height of equipment = 10.0 ft

Base pressure (qh) = **35.9 psf**

Vertical wind pressure		Wind normal to building B		Wind normal to building L	
Ar =	9.0 sf	Af =	30.0 sf	Af =	30.0 sf
GCr =	1.500	GCr =	1.90	GCr =	1.90
F = qhGCr Ar =	**53.8** Ar (psf)	F = qhGCr Af =	**68.1** Af (psf)	F = qhGCr Af =	**68.1** Af (psf)
Fv =	**0.5** kips	Fh =	**2.0** kips	Fh =	**2.0** kips

Attached Canopies on Buildings : Alternate design 60'<h<90'

ASCE 7-22 Procedure used since h>60'

Mean Roof Ht (h)= 62.0 ft
Mean eave height (he) = 60.0 ft
Mean Canopy height (hc) = 45.0 ft
hc/he = 0.75

Base pressure (qh) = **35.9 psf**

	C&C Surface Pressure (psf)				User input
Area	10 sf	50 sf	100 sf	1000 sf	75 sf
Separate Individual Surfaces:					
Upper surface negative pressure	-42.9	-33.3	-29.1	-27.3	-30.8
Lower surface negative pressure	-29.0	-25.2	-23.5	-22.8	-24.2
Upper or Lower surface pos pressure	28.5	23.5	21.4	21.4	22.2
Combined Upper & Lower Surfaces (net):					
Negative pressure	-33.1	-26.3	-23.4	-23.4	-24.6
Positive pressure	32.0	25.8	23.1	23.1	24.2

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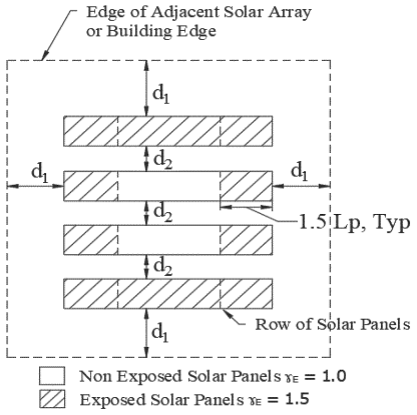
Wind Pressures on Solar Panels

Ultimate Wind Pressures

Roof angle θ =	1.2 deg
Mean Roof Ht h =	62.0 ft
Mean parapet height above roof hpt =	0.00 ft
Panel edge to adjacent array or bldg edge d1 =	18.40 ft
Panel edge to adjacent panel edge d2 =	1.00 ft
Panel chord length Lp =	6.00 ft
Dist from roof to lowest panel edge h1 =	0.80 ft
Dist from roof to highest panel edge h2 =	0.80 ft
Panel gap (must be 0.25 inches minimum) =	0.25 in
Solar panel angle to roof surface ω =	0.0 deg



SOLAR PANEL ROOF PLAN

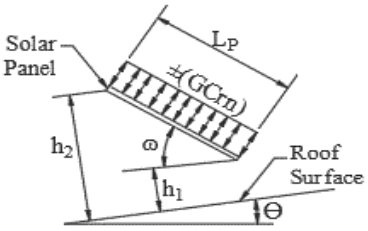
Panels parallel to roof (ω ≤ 2 deg) all heights & roof slope

Wind pressure = qh(GCp)(ɣE)(ɣa)

Calculate panel pressure by subtracting 6.45 psf (internal pressure) from the wind roof pressures and then multiply by the following factors (but minimum pressure shall be 16 psf)

Location	Adjustment Factor (γ_E)(γa) <10 sf	20 sf	50 sf	>100 sf	User Input 21 sf	
Exposed Panel Uplift	1.20	1.02	0.78	0.60	1.01	γ_E = 1.5
Non exposed Uplift	0.80	0.68	0.52	0.40	0.67	γ_E = 1.0
All panels downward	0.80	0.68	0.52	0.40	0.67	γ_E = 1.0

A panel is exposed if d1 to the roof edge is greater than 0.5h = 31.0 ft
and either 1) d1 to the adjancent array is greater than 4 ft
or 2) d2 to the next adjacent panel is greater than 4 ft



SOLAR PANEL ELEVATION

Panels not parallel to roof - all heights & roof slope < 7 deg

Procedure only applies if clear distance between the roof edge and the panels is at least 4 ft

Wind pressure = qh(GCrn) $(GCrn)=(\gamma_p)(\gamma_c)(\gamma_E)(GC_{rn})_{nom}$

γp = 0.900 γc = 0.960 qh = **35.86** psf

"A" is the effective wind area of the solar panel being considered

Normalized wind area An = A * 1,000 / (max Lb or 15)^2 = 0.336 A

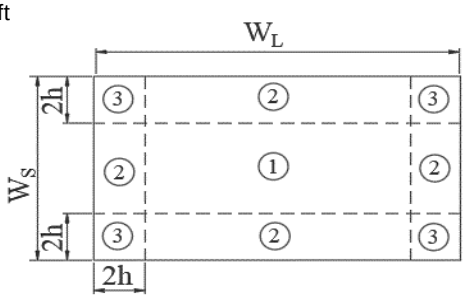
Lb = minimum of $0.4(hW_L)^{0.5}$ or h or Ws = 54.6 ft

Location		Wind pressure for normalized area An 0 sf	10 sf	100 sf	500 sf	1000 sf	5000 sf
Exposed Zones							
γ_E = 1.5	Zone 1	-69.7	-49.9	-30.1	-16.3	-16.0	-16.0
	Zone 2	-93.0	-66.3	-39.6	-20.9	-16.7	-16.0
	Zone 3	-106.9	-75.9	-44.9	-23.2	-18.3	-16.0
Non Exposed Zones							
γ_E = 1.0	Zone 1	-46.5	-33.3	-20.1	-16.0	-16.0	-16.0
	Zone 2	-62.0	-44.2	-26.4	-16.0	-16.0	-16.0
	Zone 3	-71.3	-50.6	-29.9	-16.0	-16.0	-16.0
All Zones							
γ_E = 1.0	Zone 1	46.5	33.3	20.1	16.0	16.0	16.0
	Zone 2	62.0	44.2	26.4	16.0	16.0	16.0
	Zone 3	71.3	50.6	29.9	16.0	16.0	16.0

User input		
A =	10 sf	1000 sf
An =	3 sf	336 sf
	-49.9	-16.0
	-66.3	-16.7
	-75.9	-18.3
	-33.3	-16.0
	-44.2	-16.0
	-50.6	-16.0
	33.3	16.0
	44.2	16.0
	50.6	16.0

A panel is exposed if d1 to the roof edge is greater than 0.5h = 31.0 ft
and either 1) d1 to the adjancent array is > the max of 4h2 or 4 ft = 4.0 ft
or 2) d2 to the adjancent panel is > the max of 4h2 or 4 ft

W_L = 300.0 ft
Ws = 175.0 ft
2h = 124.0 ft



WIND PRESSURE ZONES

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Wind Loads - Other Structures: ASCE 7- 16 Ultimate Wind Pressures

Wind Factor = 1.00
Gust Effect Factor (G) = 0.85 Ultimate Wind Speed = 120 mph
Kzt = 1.00 Exposure = C

A. Solid Freestanding Walls & Solid Signs (& open signs with less than 30% open)

		s/h =	0.25	**Case A & B**	
Dist to sign top (h)	80.0 ft	B/s =	2.50	C_f =	1.80
Height (s)	20.0 ft	Lr/s =	0.00	F = qh G Cf As =	**57.9 As**
Width (B)	50.0 ft	Kz =	1.208	As =	10.0 sf
Wall Return (Lr) =	0.0 ft	qh =	37.8 psf	F =	579 lbs
Directionality (Kd)	0.85				
Percent of open area		Open reduction		**CaseC**	
to gross area	0.0%	factor =	1.00	Horiz dist from windward edge	Cf F=qhGCfAs (psf)
		Case C reduction factors		0 to s	2.43 78.0 **As**
		Factor if s/h>0.8 =	1.00	s to 2s	1.60 51.5 **As**
		Wall return factor		2s to 3s	1.15 37.0 **As**
		for Cf at 0 to s =	1.00		

B. Open Signs & Single-Plane Open Frames (openings 30% or more of gross area)

Height to centroid of Af (z)	15.0 ft			Kz =	0.849
				Base pressure (qz) =	26.6 psf
Width (zero if round)	0.0 ft				
Diameter (zero if rect)	2.0 ft	D(qz)^.5 =	10.31	F = qz G Cf Af =	**24.9 Af**
Percent of open area		Ï =	0.65	Solid Area: A_f =	10.0 sf
to gross area	35.0%	C_f =	1.1	F =	249 lbs
Directionality (Kd)	0.85				

C. Chimneys, Tanks, & Similar Structures

Height to centroid of Af (z)	15.0 ft			Kz =	0.849
Cross-Section	Round			Base pressure (qz) =	29.7 psf
Directionality (Kd)	0.95				h/D = 15.00
Height (h)	15.0 ft				D(qz)^.5 = 5.45
Width (D)	1.0 ft				
Type of Surface	Rough (D'/D = 0.02)				
				Round	
				C_f =	0.84
				F = qz G Cf Af =	**21.3 Af**
				A_f =	10.0 sf
				F =	213 lbs

D. Trussed Towers

Height to centroid of Af (z)	15.0 ft			Kz =	0.849
∈ =	0.27			Base pressure (qz) =	26.6 psf
Tower Cross Section	square				
Member Shape	flat			Diagonal wind factor =	1.2
Directionality (Kd)	0.85			Round member factor =	1.000
		Square (wind along tower diagonal)		Square (wind normal to face)	
		Cf =	3.24	C_f =	2.70
		F = qz G Cf Af =	**73.2 Af**	F = qz G Cf Af =	**61.0 Af**
		Solid Area: Af =	10.0 sf	Solid Area: A_f =	10.0 sf
		F =	732 lbs	F =	610 lbs

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Snow Loads : ASCE 7- 16

Nominal Snow Forces

Roof slope		=	1.2 deg
Horiz. eave to ridge dist (W)		=	87.5 ft
Roof length parallel to ridge (L)		=	300.0 ft
Type of Roof			Hip and gable w/ trussed systems
Ground Snow Load	Pg	=	30.0 psf
Risk Category		=	II
Importance Factor	I	=	1.0
Roof R value	Rroof	=	30
Thermal Factor	Ct	=	1.000
Exposure Factor	Ce	=	1.0
Pf = 0.7*Ce*Ct*I*Pg		=	20.5 psf
Unobstructed Slippery Surface			no
Sloped-roof Factor	Cs	=	1.00
Balanced Snow Load		**=**	**20.5 psf**
Rain on Snow Surcharge Angle			1.75 deg
Code Maximum Rain Surcharge			5.0 psf
Rain on Snow Surcharge		=	0.0 psf
Ps plus rain surcharge		=	20.5 psf
Minimum Snow Load	Pm	=	20.0 psf
Uniform Roof Design Snow Load		=	**20.5 psf**

Near ground level surface balanced snow load = **30.0 psf**

NOTE: Alternate spans of continuous beams shall be loaded with half the design roof snow load so as to produce the greatest possible effect - see code for loading diagrams and exceptions for gable roofs

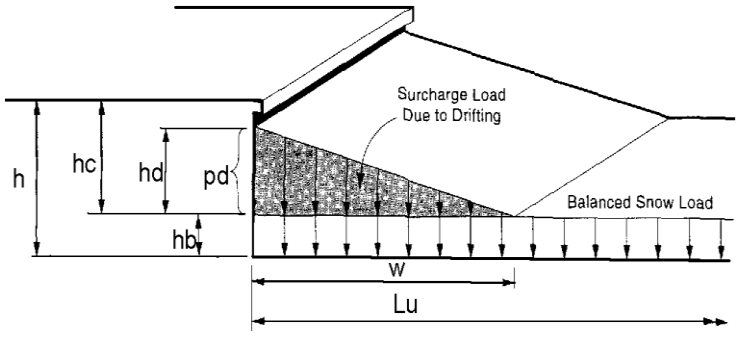
Unbalanced Snow Loads - for Hip & Gable roofs only

~~0.55~~

Required if slope is between 7 on 12 =	30.26 deg	
and 2.38 deg =	2.38 deg	**Unbalanced snow loads are not required**
Windward snow load =	20.5 psf	
Leeward snow load =	20.5 psf	

Snow Drift 1 - Against roof projections, parapets, etc

Up or downwind fetch	lu	=	220.0 ft
Projection height	h	=	5.2 ft
Projection width/length	lp	=	20.0 ft
Snow density	γ	=	17.9 pcf
Balanced snow height	hb	=	1.14 ft
	hd	=	3.77 ft
	hc	=	4.06 ft
hc/hb >0.2 = 3.5	**Therefore, design for drift**		
Drift height (hd)		=	3.77 ft
Drift width	w	=	15.08 ft
Surcharge load:	pd = γ*hd	=	**67.5 psf**
Balanced Snow load:		=	20.5 psf
			88.0 psf



Snow Drift 2- Against roof projections, parapets, etc

Up or downwind fetch	lu	=	50.0 ft
Projection height	h	=	4.0 ft
Projection width/length	lp	=	20.0 ft
Snow density	γ	=	17.9 pcf
Balanced snow height	hb	=	1.14 ft
	hd	=	1.86 ft
	hc	=	2.86 ft
hc/hb >0.2 = 2.5	**Therefore, design for drift**		
Drift height (hd)		=	1.86 ft
Drift width	w	=	7.45 ft
Surcharge load:	pd = γ*hd	=	**33.3 psf**
Balanced Snow load:		=	20.5 psf
			53.8 psf

Note: If bottom of projection is at least 2 feet above hb then snow drift is not required.

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Snow Loads - from adjacent building or roof:

ASCE 7- 16

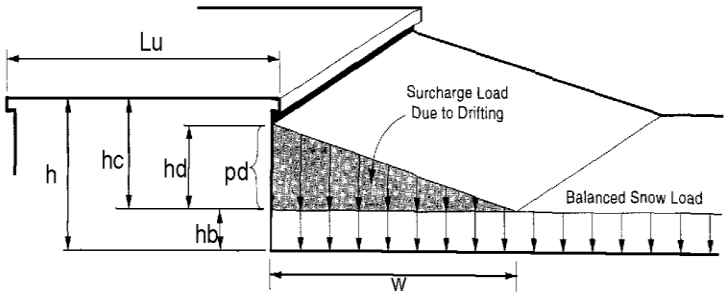
Nominal Snow Forces

		Higher Roof	Lower Roof	
Roof slope	=	1.2 deg	0.00 / 12 = 0.0 deg	
Horiz. eave to ridge dist (W)	=	87.5 ft	24.0 ft	
Roof length parallel to ridge (L)	=	300.0 ft	240.0 ft	0.55
Projection height (roof step) h	=		8.0 ft	
Building separation s	=		5.0 ft	
Type of Roof		Hip and gable w/ trussed systems	Monoslope	
Ground Snow Load	Pg =	20.0 psf	20.0 psf	
Risk Category	=	II	II	
Importance Factor	I =	1	1	
Roof R value	Rroof =	30	10	
Thermal Factor	Ct =	1.100	1.100	
Exposure Factor	Ce =	1.0	1.0	
Pf = 0.7*Ce*Ct*I*Pg	=	15.4 psf	15.4 psf	
Unobstructed Slippery Surface		no	no	
Sloped-roof Factor	Cs =	1.00	1.00	
Balanced Snow Load	**Ps =**	**15.4 psf**	**15.4 psf**	
Rain on Snow Surcharge Angle		1.75 deg	0.48 deg	
Code Maximum Rain Surcharge		5.0 psf	5.0 psf	
Rain on Snow Surcharge	=	5.0 psf	5.0 psf	
Ps plus rain surcharge	=	20.4 psf	20.4 psf	
Minimum Snow Load	Pm =	20.0 psf	20.0 psf	
Uniform Roof Design Snow Load	=	**20.4 psf**	**20.4 psf**	
Building Official Minimum	=			

NOTE: Alternate spans of continuous beams and other areas shall be loaded with half the design roof snow load so as to produce the greatest possible effect - see code.

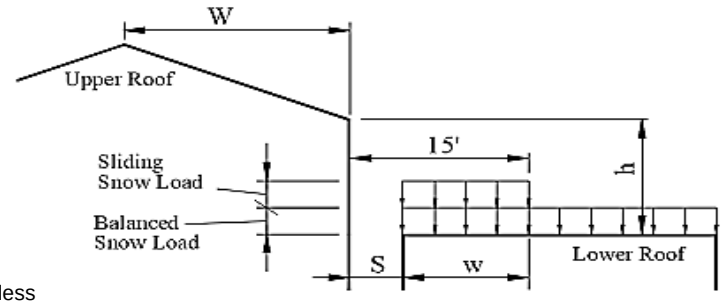
Leeward Snow Drifts - from adjacent higher roof

Upper roof length	lu =	250.0 ft
Snow density	γ =	16.6 pcf
Balanced snow height	hb =	0.93 ft
	hc =	7.07 ft
hc/hb >0.2 = 7.6	**Therefore, design for drift**	
(6h-s)/6	=	7.17 ft
Drift height	=	4.84 ft
Drift width	w =	29.04 ft
Surcharge load:	pd = γ*hd =	**80.3 psf**
Balanced Snow load:	=	15.4 psf
		95.7 psf **Leeward drift controls**



Windward Snow Drifts - from low roof against high roof

Lower roof length	lu =	80.0 ft
Adj structure factor	=	0.75
Drift height	=	0.88 ft
Drift width	w =	3.51 ft
Surcharge load:	pd = γ*hd =	**14.6 psf**
Balanced Snow load:	=	15.4 psf
		30.0 psf



Sliding Snow - onto lower roof

Sliding snow = 0.4 Pf W	=	0.0 plf
Distributed over 15 feet	=	0.0 psf
hd + hb	=	0.93 ft
hd + hb < =h therefore sliding snow	=	**0.0 psf**
Balanced snow load	=	15.4 psf
Uniform snow load	=	15.4 psf

Sliding snow not required since upper roof slope is 1/4 in 12 or less

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Seismic Loads: IBC 2021 Strength Level Forces

Risk Category : II
Importance Factor (Ie) : 1.00

Site Class : D

Ss (0.2 sec) = 0.60 g Fa = 1.320
S1 (1.0 sec) = 0.10 g Fv = 2.400

Site specific ground motion analysis performed:

Sms = 0.792 S_{DS} = 0.528 Design Category = D
Sm1 = 0.240 S_{D1} = 0.160 Design Category = C

Seismic Design Category = **D**
Redundancy Coefficient ρ = 1.30
Number of Stories: 3

Structure Type: All other building systems
Horizontal Struct Irregularities: No plan Irregularity
Vertical Structural Irregularities: No vertical Irregularity

Flexible Diaphragms: No
Building System: **Structural steel systems not specifically detailed for seismic resistance**
Seismic resisting system: **Structural steel systems not specifically detailed for seismic resistance**
System Structural Height Limit: **System not permitted for this seismic design category**
Actual Structural Height (hn) = 62.0 ft
See ASCE7 Section 12.2.5 for exceptions and other system limitations

DESIGN COEFFICIENTS AND FACTORS

Response Modification Coefficient (R) = 3
Over-Strength Factor (Ωo) = 3
Deflection Amplification Factor (Cd) = 3

To = 0.2(Sd1/Sds) = 0.061
Ts = Sd1/Sds = 0.303
Long Period Transition Period (TL) = **error, you need to enter TL (see link above right)**

S_{DS} = 0.528
S_{D1} = 0.160

Seismic Load Effect (E) = Eh +/-Ev = ρ Q_E +/- 0.2S_{DS} D = 1.3Qe +/ 0.106D Q_E = horizontal seismic force
Special Seismic Load Effect (Em) = Emh +/- Ev = Ωo Q_E +/- 0.2S_{DS} D = &G40&"(0.106D D = dead load

ALLOWABLE STORY DRIFT

Structure Type: All other structures

Allowable story drift Δa = 0.020hsx where hsx is the story height below level x

PERMITTED ANALYTICAL PROCEDURES

Index Force Analysis - Method Not Permitted (only applies to Seismic Category A)

Model & Seismic Response Analysis - Permitted (see code for procedure)

Equivalent Lateral-Force (ELF) Analysis - Permitted

Building period coef. (C_T) = 0.020 Cu = 1.58
Approx fundamental period (Ta) = $C_T h_n^x$ = 0.442 sec x= 0.75 Tmax = CuTa = 0.698 sec
User calculated fundamental period = T = 0.442 sec

Seismic response coef. (Cs) = SdsI/R = 0.176
need not exceed Cs = Sd1 I TL/RT^2 = 0.000
but not less than Cs = 0.044Sds*I = 0.023
USE Cs = 0.023

Design Base Shear V = 0.023W

SEISMIC FORCES AT FLOORS - ELF Procedure

Total Stories =	1	Floor Dead Load =	80.0 psf	Roof Snow Load =	0.0 psf
Building length L =	300.0 ft	Floor LL to include =	0.0 psf	Roof Equip wt =	0.0 kips
Building width W =	175.0 ft	Floor Equip wt =	0.0 kips	Parapet weight =	0.0 psf
hn =	62.0 ft	Partition weight =	10.0 psf	Parapet height =	0.0 ft
k =	1.000	Ext Wall Weight =	50.0 psf		
V =	enter TL (see link above right)	Roof Dead Load =	20.0 psf		

Bottom Floor (level 1) is a slab on grade

Diaphragm shall be designed for level force Fx, but not less than Fpx = (Σ Fi / Σ wi) wpx, but :

Fpx min = $0.2S_{DS}$ Ie wpx = 0.106 wpx

Fpx max = $0.4S_{DS}$ Ie wpx = 0.211 wpx

Seismic Forces (Including all exterior walls)

Level (x)	EL above Seismic Base hx (ft)	Level Weight Wx (kips)	Wx hx^k (ft-kips)	Cvx = Wx hx^k / Σ Wi hi^k	V = 32.7k Base Shear Distribution Fx=CvxV	Σ Fx (k)	Story M	Diaphragm Force Fpx Σ Wi (k)	Fpx	Design Fpx
Roof	15.00	1,406	21,094	1.000	32.67	32.7	0	1,406	32.7	148.5
1	0.00	0	0	0.000	0.00	0.0	0	0	0.0	0.0
Base		1,406		1.000		32.7	490			
							490 = Base M			

Diaphragm Forces excluding parallel exterior walls

Diaphragm Force Fpx Parallel to Bldg Length V= 27k						Diaphragm Force Fpx Normal to Bldg Length V= 30k						
Cvx =	Fx=CvxV	Σ Fx (k)	Σ Wi (k)	Fpx	Design Fpx	Level (x)	Cvx =	Fx=CvxV	Σ Fx (k)	Σ Wi (k)	Fpx	Design Fpx
1.000	27.44	27.4	1,181	27.4	124.7	Roof	1.000	29.6	29.6	1,275	29.6	134.6
0.000	0.00	0.0	0	0.0	0.0	1	0.000	0.0	0.0	0	0.0	0.0
1.000		27.4				Base	1.000		29.6			

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Seismic Loads - cont. :

Strength Level Forces

Seismic Design Category (SDC)= D

Ie = 1.00

Sds = 0.528

CONNECTIONS

Force to connect smaller portions of structure to remainder of structure

$Fp = 0.133 Sds w_p =$ 0.070 w_p

or $Fp = 0.05 w_p =$ 0.05 w_p Use Fp = 0.07 w_p w_p = 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 Structural Walls to elements providing lateral support

Fp = not less than 0.2KaIeWp Flexible diaphragm span Lf =

Enter Lf to calculate Fp for flexible diaphragm

Fp =0.4SdskaIeWp = 0.211 Wp, but not less than 0.2Wp (rigid diaphragm) ka= 1 Fp = 0.211 Wp

w/ anchor adjustment factor but Fp shall not be less than 5 psf

h= 62.0 Flexible Diaphragm: Fp= Wp

z= 62.0 Rigid Diaphragm: Fp= 0.211 Wp factor = 1.000

MEMBER DESIGN

Bearing Walls and Shear Walls (out of plane force)

$Fp = 0.4 Sds Ie Ww =$ 0.211 w_w

but not less than 0.10 w_w Use Fp = 0.211 w_w

Diaphragms

Fp = (Sum Fi / Sum Wi)Wpx + Vpx = (Sum Fi / Sum Wi)Wpx + Vpx

need not exceed 0.4 SdsIeWpx + Vpx = 0.211 Wpx + Vpx

but not less than 0.2 SdsIeWpx + Vpx = 0.106 Wpx + Vpx

ARCHITECTURAL COMPONENTS SEISMIC COEFFICIENTS

Architectural Component : Cantilever Elements (Unbraced or Braced to Structural Frame Below Its Center of Mass): Chimneys and stacks when laterally braced or supported by the structural frame

Importance Factor (Ip) : 1.0

Component Amplification Factor (ap) = 2.5 h= 62.0 feet

Comp Response Modification Factor (Rp) = 2.5 z= 20.0 feet z/h = 0.32

Over-Strength Factor (Ωo) = 2

Fp = 0.4apSdsIpWp(1+2z/h)/Rp = 0.347 Wp

not greater than Fp = 1.6SdsIpWp = 0.845 Wp

but not less than Fp = 0.3SdsIpWp = 0.158 Wp use Fp = 0.347 Wp

MECH AND ELEC COMPONENTS SEISMIC COEFFICIENTS

Seismic Design Category D & Ip=1.0, therefore see ASCE7 Section 13.1.4 for exceptions

Mech or Electrical Component : Suspended vibration isolated equipment including in-line duct devices and suspended internally isolated components.

Importance Factor (Ip) : 1.0

Component Amplification Factor (ap) = 2.5 h= 62.0 feet

Comp Response Modification Factor (Rp) = 2.5 z= 20.0 feet z/h = 0.32

Over-Strength Factor (Ωo) = 2

Fp = 0.4apSdsIpWp(1+2z/h)/Rp = 0.347 Wp

not greater than Fp = 1.6SdsIpWp = 0.845 Wp

but not less than Fp = 0.3SdsIpWp = 0.158 Wp use Fp = 0.347 Wp

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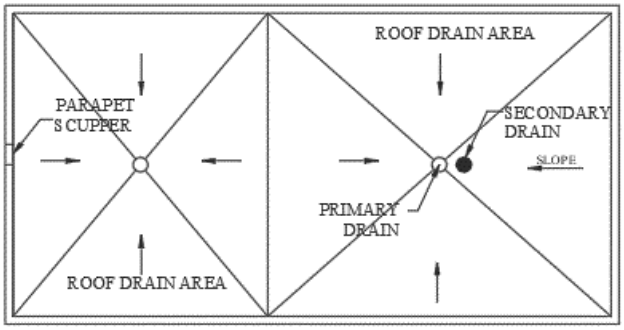
Rain Loads : ASCE 7- 16

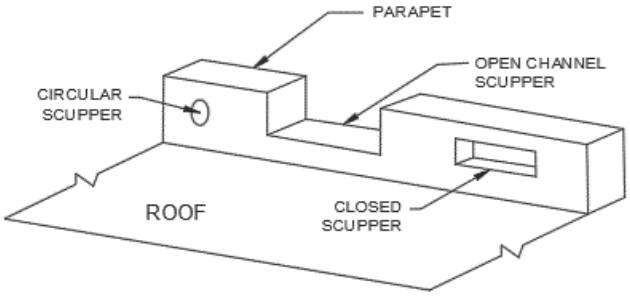
Rain Intensity	i =	7.23	in/hr
Static Head	ds =	2.00	inches
Tributary Roof Area	A =	2500	SF
Ponding Head	dp =	2.00	inches
Flow Rate	Q =	188.0	gal/min

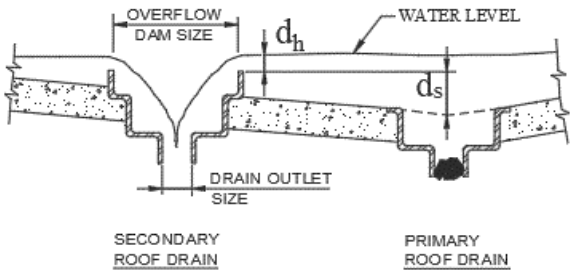
Type of overflow device: **Rectangular Closed Scupper 4" high** width = 16.0 in

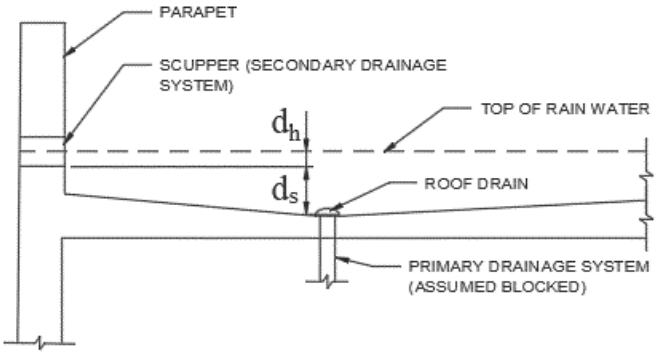
Hydraulic Head dh = 2.69 inches

Design Rain Load R = 5.2(ds + dh + dp) = 34.8 psf at primary drain









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Tornado Loads : Change Code to ASCE 7-22 or 2024 IBC to design for tornados

Risk Category	II		Tornado Design is not required for Risk Category I or II
Effective Plan Area (Ae)	50,000	SF	
Tornado Speed (V_T)	120.0	mph	
Ground EL Factor (Ke)	1.00		
Exposure Coeff (KhTor)	1.00		
Enclosure Classif.	Enclosed Building		
Internal pressure Coefficient:			
positive	0.55		
negative	-0.18		
Directionality Factor (KdT):			
MWFRS	0.80	use 1.00	
C&C Roof Zone 1'	1.00		Essential Facility
C&C for all others	1.00		
Rooftop equipment	1.00		
Other structures, use wind Kd			

$q_{hT} = .00256K_{hTor}\ K_e V_T^2 =$ 36.9 psf

Tornado Gust Effect Factor G_T

h =	62.0	ft
B =	175.0	ft
/z (0.6h) =	37.2	ft
ē =	0.20	
ℓ =	500	ft
z_{min} =	15	ft
c =	0.20	
g_Q, g_v =	3.4	
L_z =	512.1	ft
Q =	0.85	
I_z =	0.20	
G_T =	**0.85**	>0.85 use Gt = 0.85

G = 0.85 Using default Gt

Tornado Pressure Coefficient Adjustment Factor for Vertical Winds K_{vT}

Buildings

Negative (uplift) pressures on Roofs

Main Wind Force Resisting System	1.10
Components and Cladding:	
Roof Angle (θ) = 1.2 deg	
Roof Slope ≤ 7 degrees	
Zone 1	1.20
Zone 2	1.05
Zone 3	1.05

Positive (downward) pressures on Roofs 1.00

Wall Presures 1.00

All Other Cases 1.00

Other Structures

Negative (uplift) pressures on Rooftop Structures and Equipment and Rooftop Solar Panels Parallel to the Roof Surface

Main Wind Force Resisting System	1.10
Components and Cladding:	1.00

All other cases 1.00

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K_{dT} =	1.00			Enclosed Building		
Tornado Base pressure (q_{hT}) =	**36.9 psf**	Bldg dim parallel to ridge =	300.0 ft	GC_{piT} =	+ 0.55	-0.18
Roof Angle (θ) =	1.2 deg	Bldg dim normal to ridge =	175.0 ft	G_T =	0.85	
Roof tributary area:		h =	62.0 ft		qi = qhT	
Wind normal to ridge =(h/2)*L:	9300 sf	ridge ht =	63.8 ft			
Wind parallel to ridge =(h/2)*L:	5425 sf	Roof Uplift KvT =	1.10			
		Walls & Positive Roof KvT =	1.00			

Ultimate Tornado Surface Pressures (psf)

	Wind Normal to Ridge				Wind Parallel to Ridge				
	L/B = 0.58		h/L = 0.35			L/B = 1.71		h/L = 0.21	
Surface	Cp	+++	w/+q_iGC_{piT}	w/-q_hGC_{piT}	Dist.*	Cp	+++	w/ +q_iGC_{piT}	w/ -q_hGC_{piT}
Windward Wall (WW) @ h	0.80	25.1	4.8	31.7		0.80	25.1	4.8	31.7
Leeward Wall (LW) @ h	-0.50	-15.7	-35.9	-9.0		-0.36	-11.2	-31.5	-4.6
Side Wall (SW) @ h	-0.70	-21.9	-42.2	-15.3		-0.70	-21.9	-42.2	-15.3
Leeward Roof (LR)		**				Included in windward roof			
Neg Windward Roof: 0 to h/2*	-0.90	-31.0	-51.3	-24.4	0 to h/2*	-0.90	-31.0	-51.3	-24.4
h/2 to h*	-0.90	-31.0	-51.3	-24.4	h/2 to h*	-0.90	-31.0	-51.3	-24.4
h to 2h*	-0.50	-17.2	-37.5	-10.6	h to 2h*	-0.50	-17.2	-37.5	-10.6
> 2h*	-0.30	-10.3	-30.6	-17.0	> 2h*	-0.30	-10.3	-30.6	-3.7
Pos/min windward roof press.	-0.18	-6.2	-26.5	1.0	Min press.	-0.18	-6.2	-26.5	1.0

+++ is $q_{hT}K_{dT}K_{vT}GCp$

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

*Horizontal distance from windward edge

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

Windward roof overhangs : 25.1 psf (upward : add to +++ windward roof pressure)

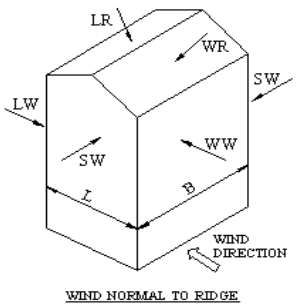
Parapet

z	KzTor	qpT (psf)
64.0 ft	1.000	36.9

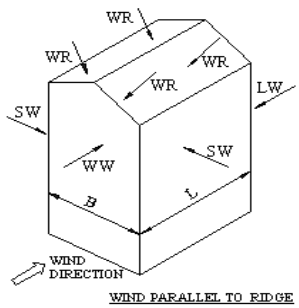
Windward parapet: 55.3 psf (GCpn = +1.5)
Leeward parapet: -36.9 psf (GCpn = -1.0)

Wall Pressures at "z" (psf)

				Windward Wall		Leeward Wall Normal	Leeward Wall Parallel	Side Walls		Combined WW + LW Wind Normal	Combined WW + LW Wind Parallel
z	KzTor	q_{zT}	$qKKGC_p$	w/+q_iGC_{pi}	w/-q_hGC_{pi}	w/+q_iGC_{pi}	w/+q_hGC_{pi}	w/+q_iGC_{pi}	w/-q_hGC_{pi}	to Ridge	to Ridge
0 to 200'	1.000	36.9	25.1	4.8	31.7	-35.9	-31.5	-42.2	-15.3	40.7	36.3



WIND NORMAL TO RIDGE



WIND PARALLEL TO RIDGE

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Tornado Base pressure (q_{hT}) =	**36.9 psf**	Min parapet ht =	2.0 ft	K_vT neg zone 1	= 1.20
Essential Facility K_{dT} =	1.00	h =	62.0 ft	K_vT neg zone 2	= 1.05
Roof Zone 1' K_{dT} =	1.00	a =	17.5 ft	K_vT neg zone 3	= 1.05
Roof Angle (θ) =	1.2 deg			K_vT pos roof	= 1.00
Type of roof =	Monoslope	GCpiT =	+ 0.55 -0.18	K_vT wall	= 1.00
Enclosed Building		qi = qhT =	36.9 psf		

Roof

	GCp				Ultimate Surface Pressure (psf)				User input	
Area	10 sf	50 sf	100 sf	500 sf	10 sf	50 sf	100 sf	500 sf	50 sf	250 sf
error	-1.40	-1.19	-1.11	-0.90	-82.2	-72.9	-69.4	-60.1	-73.1	-64.0
error	-2.30	-2.01	-1.89	-1.60	-109.3	-98.1	-93.4	-82.2	-98.2	-87.0
error	-3.20	-2.83	-2.67	-2.30	-144.1	-129.8	-123.6	-109.3	-129.8	-115.5
error	-	-	-	-	16.0	16.0	16.0	16.0	16.0	16.0
error	-2.30	-2.04	-1.91	-1.60	-95.1	-83.9	-78.4	-65.6	-83.9	-71.1
error	-3.20	-2.86	-2.69	-2.30	-122.2	-109.0	-102.6	-87.7	-109.0	-94.1
error	-4.10	-3.67	-3.47	-3.00	-157.0	-140.6	-132.8	-114.8	-140.6	-122.6
error	-5.00	-4.40	-4.07	-3.30	-190.2	-167.5	-155.0	-125.9	-167.5	-138.4
error										
error										

Overhang pressures are from ASCE 7-22 procedure and assume internal pressure coef of 0.0
Overhang soffit pressure equals adj wall pressure (which includes internal pressure of 20.3 psf)

Parapet

pT KdT= 36.9 psf

	Ultimate Surface Pressure (psf)						User input
Solid Parapet Pressure	10 sf	20 sf	50 sf	100 sf	200 sf	500 sf	200 sf
error	118.0	113.4	104.2	97.2	90.3	81.1	90.3
error	151.1	145.3	134.3	126.1	117.8	109.6	117.8
error							
error							
error	-66.4	-66.4	-61.1	-57.1	-53.2	-47.9	-53.2
error	-99.5	-99.5	-88.0	-79.3	-70.5	-59.0	-70.5

Walls

	GCp				Ultimate Surface Pressure at h				User input	
Area	20 sf	100 sf	200 sf	500 sf	20 sf	100 sf	200 sf	500 sf	100 sf	500 sf
Negative Zone 4	-0.90	-0.80	-0.76	-0.70	-53.5	-49.8	-48.2	-46.1	-49.8	-46.1
Negative Zone 5	-1.80	-1.40	-1.23	-1.00	-86.6	-71.9	-65.5	-57.1	-71.9	-57.1
Positive Zone 4 & 5	0.90	0.75	0.69	0.60	39.8	34.3	31.9	28.8	34.3	28.8

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	KzTor	KdT KvT	qz (psf)	20	100	200	500	100 sf	500 sf
0 to 200	1.00	1.00	36.9	39.8	34.3	31.9	28.8	34.3	28.8

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Roof Design Loads

Items	Description	Multiple	psf (max)	psf (min)
Roofing	3 ply felt & gravel		5.5	5.0
Decking	Metal Roof deck, 1.5, 22 ga.		1.7	1.2
Framing	Steel roof joists & girders		3.0	2.0
Insulation	Rigid insulation, per 1"	x 2.0	3.0	1.4
Ceiling	Suspended acoustical tile		1.8	1.0
Mech & Elec	Mech. & Elec.		2.0	0.0
Misc.	Misc.		0.5	0.0
			0.0	0.0
		Actual Dead Load	○ 17.5	○ 10.6
		Use this DL instead	◉ 20.0	◉ 9.0
		Live Load	20.0	0.0
		Snow Load	20.5	0.0
		Ultimate Wind (zone 2 - 100 sf)	16.0	-69.9
ASD Loading		D + S	40.5	-
		D + 0.75(0.6*W + S)	42.5	-
		0.6*D + 0.6*W	-	-36.5
LRFD Loading		1.2D + 1.6 S + 0.5W	64.7	-
		1.2D + 1.0W + 0.5S	50.2	-
		0.9D + 1.0W	-	-61.8

Roof Live Load Reduction Roof angle 0.25 / 12 1.2 deg

0 to 200 sf: 20.0 psf
200 to 600 sf: 24 - 0.02Area, but not less than 12 psf
over 600 sf: 12.0 psf

	300 sf	18.0 psf
	400 sf	16.0 psf
	500 sf	14.0 psf
User Input:	450 sf	15.0 psf

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Floor Design Loads

Items	Description	Multiple	psf (max)	psf (min)
Flooring	Carpet & pad		1.0	1.0
Topping	Concrete lightwt per 1"	x 4.5	45.0	38.3
Decking	Metal Floor deck - 2", 20ga		2.0	1.5
Framing	Steel floor bms/joists & girders		8.0	5.0
Topping	Deflection Concrete		12.5	2.0
Ceiling	Suspended acoustical tile		1.8	1.0
Sprinklers	Sprinklers		2.0	0.0
Mech & Elec	Mech. & Elec.		2.0	0.0
Misc.	Misc.		0.5	0.0
		Actual Dead Load	○ 74.8	◉ 48.8
		Use this DL instead	◉ 80.0	○ 65.0
		Partitions	15.0	0.0
		Live Load	50.0	0.0
		Total Live Load	65.0	0.0
		Total Load	145.0	48.8

FLOOR LIVE LOAD REDUCTION (not including partitions)

NOTE: Not allowed for assembly occupancy or LL>100psf or passenger car garages, except may reduce members supporting 2 or more floors & non-assembly 20%.

$L=Lo(0.25+15/\sqrt{K_{LL}A_T})$

Unreduced design live load: Lo = 50 psf

Floor member & 1 floor cols K_{LL} = 2

Tributary Area A_T = 300 sf

Reduced live load: L = 43.1 psf

Columns (2 or more floors) K_{LL} = 4

Tributary Area A_T = 500 sf

Reduced live load: L = 29.3 psf

IBC alternate procedure

Smallest of:

R= .08%(SF - 150)

R= 23.1(1+D/L) = 60.1%

R= 40% member supports 1 floor

R= 60% member supports ≥2 floors

R = 12.0%

Reduced live load: L = 44.0 psf

R = 28.0%

Reduced live load: L = 36.0 psf

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Wall Design Load #1

Items	Description	Multiple	psf (max)	psf (min)
Sheathing	7/16" plywood/OSB		1.6	1.4
Sheathing	5/8" gypsum		2.8	2.5
Framing	6" metal studs @16"		2.5	0.9
veneer	4" Clay Brick		40.0	38.0
Wall Covering	1" Wood Paneling	x 0.38	0.9	0.9
Insulation	R-11 Fiberglass insul.		0.4	0.4
Mech & Elec	Mech. & Elec.		1.0	0.0
Misc.	Misc.		0.5	0.0
		Actual Dead Load	○ 49.7	○ 44.0
		Use this DL instead	◉ 50.0	◉ 40.0

Wall Design Load #2

Items	Description	Multiple	psf (max)	psf (min)
Sheathing	7/16" plywood/OSB		1.6	1.4
Sheathing	5/8" gypsum		2.8	2.5
Framing	CMU wall		47.0	45.0
veneer	7/8" Stucco		10.0	10.0
			0.0	0.0
Insulation	R-11 Fiberglass insul.		0.4	0.4
Mech & Elec	Mech. & Elec.		1.0	0.0
Misc.	Misc.		0.5	0.0
		Actual Dead Load	○ 63.3	○ 59.3
		Use this DL instead	◉ 65.0	◉ 55.0

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CODE SUMMARY

Code: International Building Code 2021

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
Roofs used for roof gardens		100 psf
Typical Floor		50 psf
Partitions		15 psf
Corridors above first floor		80 psf
Lobbies & first floor corridors		100 psf
Stairs and exit ways		100 psf

Dead Loads:

Floor	80.0 psf
Roof	20.0 psf

Roof Snow Loads:

Design Uniform Roof Snow load		=	20.5 psf
Flat Roof Snow Load	Pf	=	20.5 psf
Risk Category		=	II
Balanced Snow Load	Ps	=	20.5 psf
Ground Snow Load	Pg	=	30.0 psf
Importance Factor	I	=	1.00
Snow Exposure Factor	Ce	=	0.97
Thermal Factor	Ct	=	1.00
Sloped-roof Factor	Cs	=	1.00
Drift Surcharge load	Pd	=	
Width of Snow Drift	w	=	

Earthquake Design Data:

Risk Category		=	II
Importance Factor	I	=	1.00
Mapped spectral response accelerat	Ss	=	0.60 g
	S1	=	0.10 g
Site Class		=	D
Spectral Response Coef.	Sds	=	0.528
	Sd1	=	0.160
Seismic Design Category		=	D
Basic Structural System		=	Structural steel systems not specifically detailed for seismic resistance
Seismic Resisting System		=	Structural steel systems not specifically detailed for seismic resistance
Design Base Shear	V	=	0.023W
Seismic Response Coef.	Cs	=	0.023
Response Modification Factor	R	=	3
Analysis Procedure		=	Equivalent Lateral-Force Analysis

Rain Design Data:

Rain intensity	*i* =	7.23 in/hr
Rain Load	R =	34.8 psf

Wind Design Data:

Ultimate Design Wind Speed	120 mph
Nominal Design Wind Speed	92.95 mph
Risk Category	II
Mean Roof Ht (h)	62.0 ft
Exposure Category	C
Enclosure Classif.	Enclosed Building
Internal pressure Coef.	+/-0.18
Directionality (Kd)	0.85

Company
Address
City, State
Phone

JOB TITLE _____
JOB NO. _____ SHEET NO. _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

Component and Cladding Ultimate Wind Pressures

Roof	Surface Pressure (psf)							
Area	10 sf	20 sf	50 sf	100 sf	200 sf	350 sf	500 sf	1000 sf
Negative Zone 1	-67.4	-63.0	-57.1	-52.6	-48.2	-44.6	-42.3	-42.3
Negative Zone 1'	-38.7	-38.7	-38.7	-38.7	-33.3	-29.0	-26.2	-20.8
Negative Zone 2	-88.9	-83.2	-75.7	-69.9	-64.2	-59.6	-56.7	-56.7
Negative Zone 3	-121.2	-109.8	-94.7	-83.2	-71.8	-62.5	-56.7	-56.7
Positive All Zones	17.2	16.1	16.0	16.0	16.0	16.0	16.0	16.0
Overhang Zone 1&1'	-61.0	-59.9	-58.5	-57.4	-48.1	-40.6	-35.9	-35.9
Overhang Zone 2	-82.5	-74.9	-64.8	-57.2	-49.5	-43.4	-39.4	-39.4
Overhang Zone 3	-114.8	-101.4	-83.8	-70.4	-57.1	-46.3	-39.4	-39.4

Overhang soffit pressure equals adj wall pressure (which includes internal pressure of 6.5 psf)

	Parapet	Solid Parapet Pressure (psf)					
	Area	10 sf	20 sf	50 sf	100 sf	200 sf	500 sf
CASE A:	Zone 2 :	115.5	108.0	98.1	90.7	83.2	73.3
	Zone 3 :	148.0	134.8	117.3	104.0	90.8	73.3
CASE B:	Interior zone :	-68.2	-64.8	-60.2	-56.8	-53.3	-48.7
	Corner zone :	-78.0	-72.8	-65.9	-60.8	-55.6	-48.7

Wall	Surface Pressure (psf)			
Area	10 sf	100 sf	200 sf	500 sf
Negative Zone 4	-42.0	-36.3	-34.5	-32.3
Negative Zone 5	-51.6	-40.2	-36.8	-32.3
Positive Zone 4 & 5	38.7	33.0	31.3	29.0