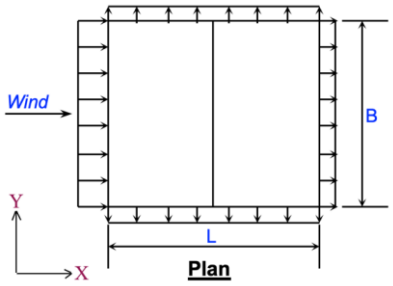
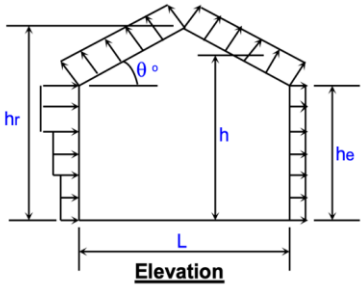
WIND LOADING ANALYSIS - MAIN WIND FORCE RESISTING SYSTEM (MWFRS)

Based on ASCE 7-16 Chapter 27 - Directional Procedure

Client:		**Designed By:**	*Ali Akbar Shaikhzadeh*	**Date:**	*20-Jan-20*
Job Name:		**Verified By:**		**Revision:**	*35%*



Plan



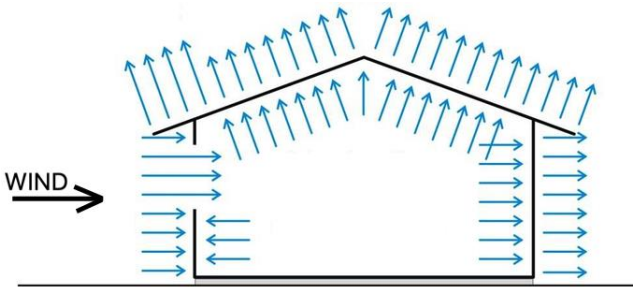
Elevation

DESIGN INPUT DATA

BASIC WIND SPEED, V		35	m/sec	
BUILDING WIDTH, L	(HORIZONTAL DIMENSION PARALLEL TO X DIRECTION)	19.30	m	(SEE NOTE 3)
BUILDING LENGTH, B	(HORIZONTAL DIMENSION PARALLEL TO Y DIRECTION)	30.00	m	(SEE NOTE 3)
ROOF TYPE		Gable		(RIDGE MUST BE PARALLEL TO Y DIRECTION)
ROOF EAVE HEIGHT, h_e		12.00	m	
ROOF RIDGE HEIGHT, h_r		13.50	m	
BUILDING RISK CATEGORY		II		TABLE 1.5-1
EXPOSURE CATEGORY		C		SECTION 26.7
ENCLOSURE CLASSIFICATION	PARTIALLY ENCLOSED BUILDING	2		TABLE 26.13-1
WIND DIRECTIONALITY FACTOR, K_d		0.85		TABLE 26.6-1
TOPOGRAPHIC FACTOR, K_{zt}		1.0		FIGURE 26.8-1
GROUND ELEVATION FACTOR, K_e		1.0		TABLE 26.9-1
GUEST-EFFECT FACTOR, G		0.85		SECTION 26.11
REFERENCE HEIGHT INCREMENT OF WINDWARD WALL		5.00	m	

RESULTING PARAMETERS & CONSTANT

θ		9	deg.	Roof angle		
$h = (h_r + h_e) / 2$		12.00	m	Mean roof height		
GC_{pi}	±	0.55		Internal pressure coefficient	SEE NOTES 6 & 9	TABLE 26.13-1
α		9.5		Terrain exposure constants		TABLE 26.11-1
z_g		274.32	m	Terrain exposure constants		TABLE 26.11-1



Simplified Representation of Wind Pressures

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PRESSURE ON WALL SURFACES

WINDWARD WALL

SEE NOTE 9

Same Pressures for Wind Parallel to Both X & Y Directions	Reference Height	Velocity Pressure Exposure Coefficient	Velocity Pressure	External Pressure Coefficient (FIGURE 27.3-1)	Internal Pressure Coefficient	External Wind Pressure	Internal Wind Pressure	Net Design Wind Pressure (with +Gcpi)	Net Design Wind Pressure (with -Gcpi)
	z (m)	K_z	q_z (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)
	5.00	0.87	552.1	0.8	0.55	0.38	0.37	0.01	0.74
	10.00	1.00	638.9	0.8	0.55	0.43	0.37	0.07	0.80
	12.00	1.04	663.9	0.8	0.55	0.45	0.37	0.09	0.82
K_h & q_h		1.04	663.9						

LEEWARD WALL

	z (m)	L/B	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)
Wind Parallel to X Direction	12.00	0.64	663.9	-0.50	0.55	-0.28	0.37	-0.65	0.08
Wind Parallel to Y Direction	12.00	1.55	663.9	-0.39	0.55	-0.22	0.37	-0.58	0.15

SIDE WALL

Same Pressures for Wind Parallel to Both X & Y Directions	z (m)	L/B	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)
	12.00	All	663.9	-0.70	0.55	-0.40	0.37	-0.76	-0.03

PRESSURE ON ROOF SURFACES

FLAT ROOF

Wind Parallel to X Direction

Hor. Distance From Windward Edge (m)	z (m)	h/L	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)
0.00 *to* 6.00	12.00	0.62	663.9	-1.00	0.55	-0.56	0.37	-0.93	-0.1977

6.00	*to*	12.00	12.00	0.62	663.9	-0.85	0.55	-0.48	0.37	-0.85	-0.1153
12.00	*to*	19.30	12.00	0.62	663.9	-0.55	0.55	-0.31	0.37	-0.67	0.0555

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Wind Parallel to Y Direction

Hor. Distance From Windward Edge (m)			z (m)	h/B	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)
0.00	*to*	6.00	12.00	0.40	663.9	-0.90	0.55	-0.51	0.37	-0.87	-0.1427
6.00	*to*	12.00	12.00	0.40	663.9	-0.90	0.55	-0.51	0.37	-0.87	-0.1427
12.00	*to*	24.00	12.00	0.40	663.9	-0.50	0.55	-0.28	0.37	-0.65	0.08299
	>	24.00	12.00	0.40	663.9	-0.30	0.55	-0.17	0.37	-0.53	0.19584

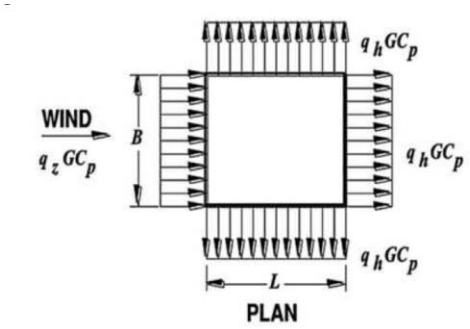
GABLE & MONOSLOPE ROOF ===> *NOT APPLICABLE HERE*

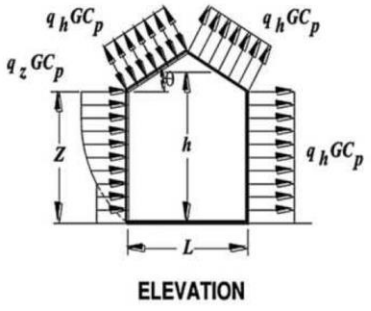
Wind Parallel to X Direction (Normal to Ridge)

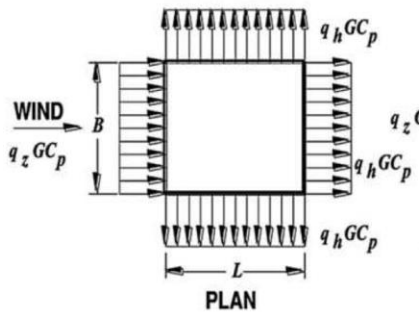
Surface	z (m)	h/L	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)

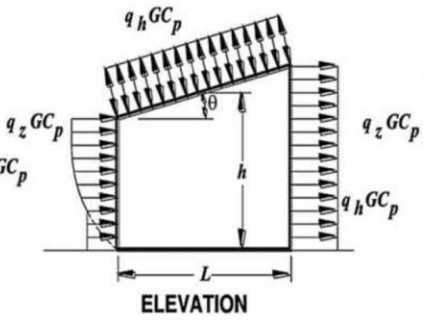
Wind Parallel to Y Direction (Parallel to Ridge)

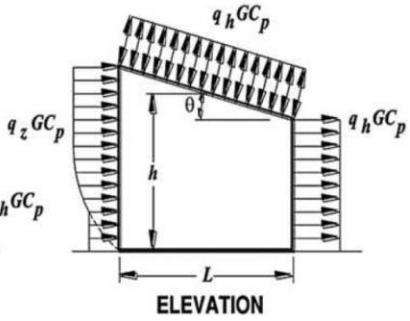
Hor. Distance From Windward Edge (m)	z (m)	h/B	q_h (Pa)	C_p	(GC_{pi})	p_e (kPa)	p_i (kPa)	p_{+in} (kPa)	p_{-in} (kPa)











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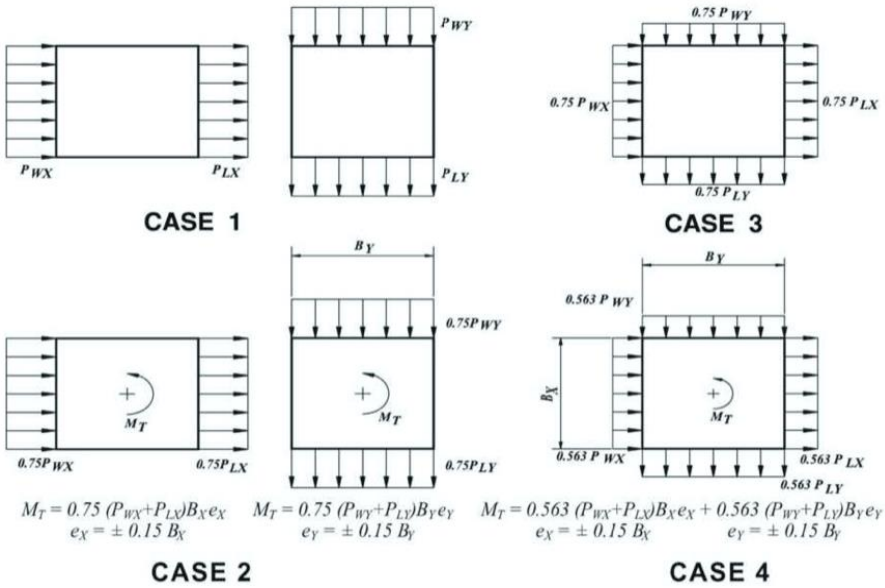
DESIGN WIND LOAD CASES SEE NOTES 7 & 8

Diagrams



Notation

P_{WX}, P_{WY} = Windward face design pressure acting in the x, y principal axis, respectively.
P_{LX}, P_{LY} = Leeward face design pressure acting in the x, y principal axis, respectively.
$e(e_X, e_Y)$ = Eccentricity for the x, y principal axis of the structure, respectively.
M_T = Torsional moment per unit height acting about a vertical axis of the building.

Case 1. Full design wind pressure acting on the projected area perpendicular to each principal axis of the structure, considered separately along each principal axis.
Case 2. Three-quarters of the design wind pressure acting on the projected area perpendicular to each principal axis of the structure in conjunction with a torsional moment as shown, considered separately for each principal axis.
Case 3. Wind loading as defined in Case 1, but considered to act simultaneously at 75% of the specified value.
Case 4. Wind loading as defined in Case 2, but considered to act simultaneously at 75% of the specified value.

Notes

1. Design wind pressures for windward and leeward faces shall be determined in accordance with the provisions of Sections 27.3.1 and 27.3.2 as applicable for buildings of all heights.
2. Diagrams show plan views of buildings.

FIGURE 27.3-8 Main Wind Force Resisting System, Part 1 (All Heights): Design Wind Load Cases

NOTES:

1- Plus and minus signs signify pressures acting toward and away from surfaces, respectively.

2- N/A = Not Applicable

3- The definition of ASCE 7-16 of L and B is as follows:

L = Horizontal dimension of building parallel to wind direction B = Horizontal dimension of building normal to wind direction

This definition has been minorly changed in this spreadsheet for more clarification:

L = Horizontal dimension of building parallel to X direction B = Horizontal dimension of building parallel to Y direction

4- Where two values of C_p are listed, this indicates that the windward roof slope is subjected to either positive or negative pressures and the roof structure shall be designed for both conditions.

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

6- Two cases shall be considered to determine the critical load requirements for the appropriate condition (Notes 3 on Table 26.13-1):

a. A positive value of (GCpi) applied to all internal surfaces, or b. A negative value of (GCpi) applied to all internal surfaces.

Both cases are calculated and shown in this spreadsheet.

7- Section 27.3.5 of the Standard requires that any building whose wind loads have been determined under the provisions of Chapter 27 shall be designed for wind cases as defined in Fig. 27.3-8 of the Standard.

8- If considereing all four ASCE design load cases, there will be 12 combination sets of wind loading of the structure. Meanwhile, each of the 12 combination sets w two values, one with postitive internal pressure and next with negative internal pressure. Thus, 24 structural wind loading conditions will be created in general.

9- Internal pressures would only be used if designing individual components whose effective tributary area is equal to or greater than 65 square meters based on ASCE 7-16 Section 30.2.3. When determining loads on the global structure (i.e., shear walls or foundation design), the internal pressure components will act i equal and opposite directions on the roof / floor and the leeward / windward walls, thereby algebraically canceling each other.