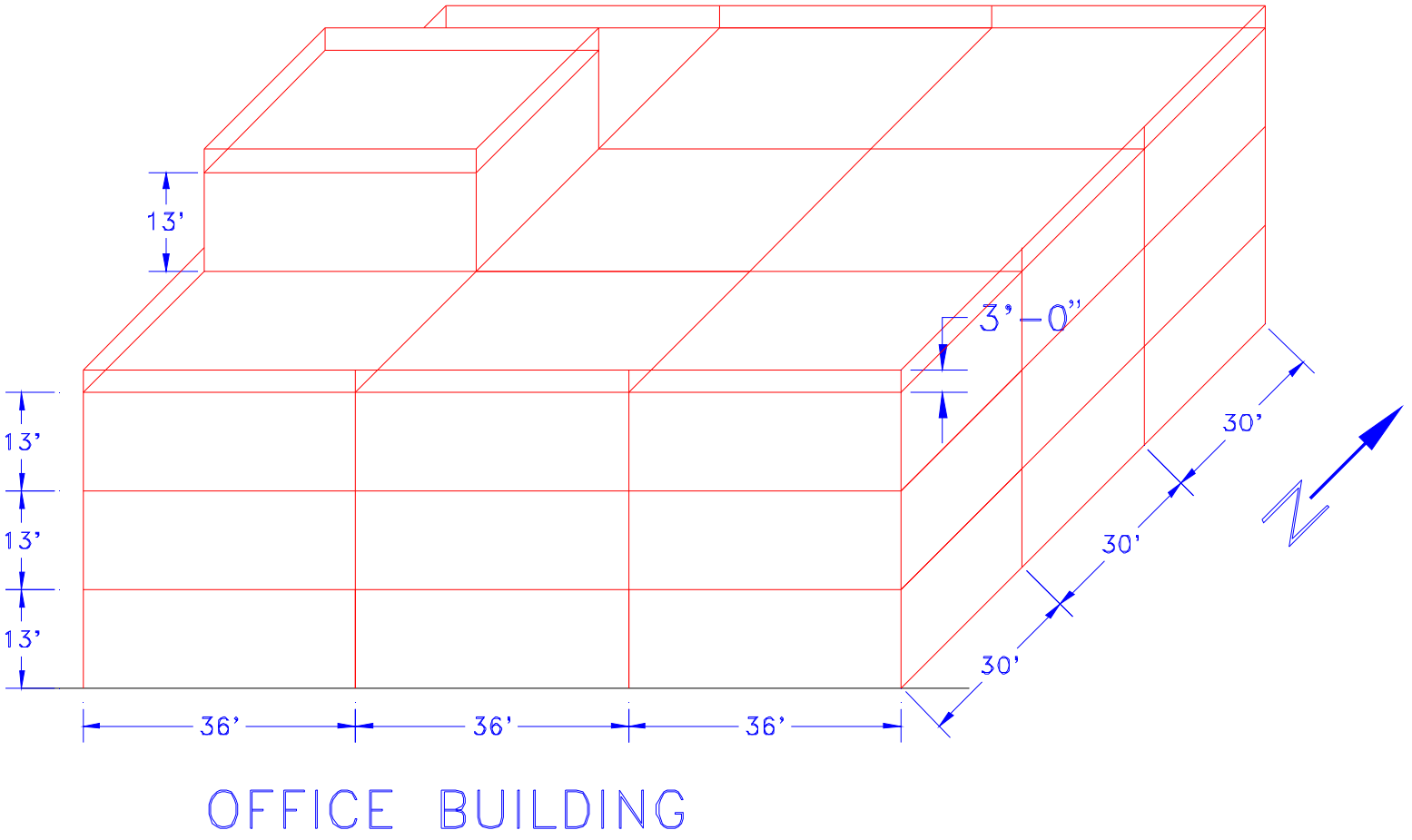
Summary

- Design loads used by engineers represent rational estimates of loads that we should consider in our design.
  - Experience has shown if we design for these loads, the building should survive for a reasonable amount of time (50 years or more).

Summary (cont.)

- The models try to consider situations that will have a significant effect on the design load.
  - Max wind speed, building height and shape, etc.
- The maximum loads estimated by the design codes are then factored to add a safety margin to our calculations.

Example Building

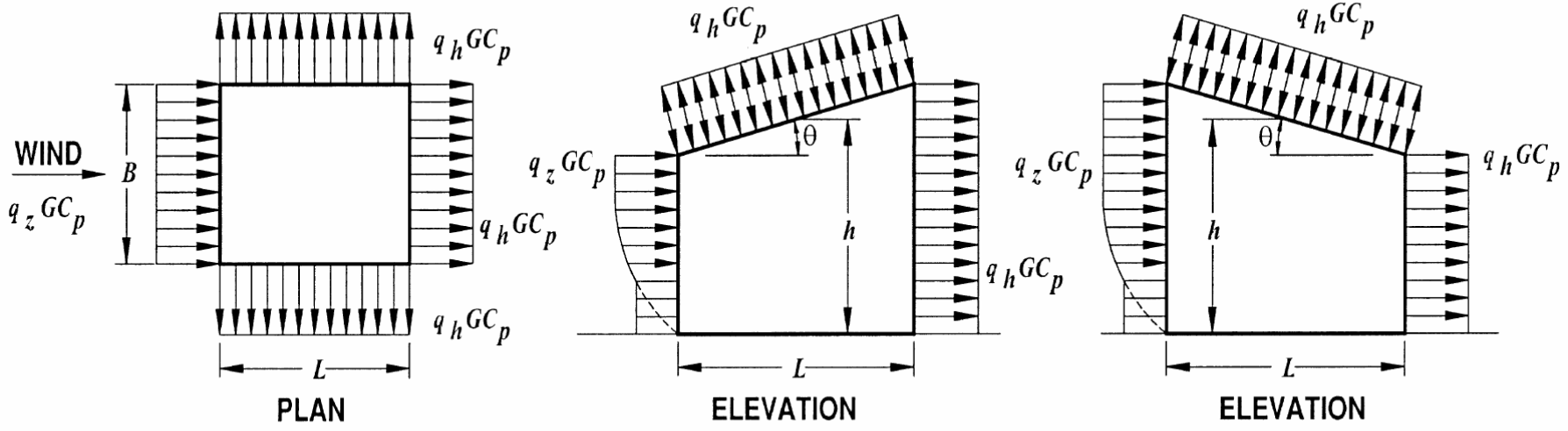


OFFICE BUILDING

Design Methods

- Method 1 – Simplified Procedure:
  - Simple diaphragm building,
  - Low-rise,
  - Enclosed,
  - Regular geometry, symmetric,
  - Not flexible, prone to flutter/vortex shedding, torsion etc.
- Method 2 – Analytic Procedure.
- Method 3 – Wind Tunnel Procedure.

Wind Loads on Structures



MONOSLOPE ROOF (NOTE 4)

Gust Factor, G

- G = 0.85 for rigid, low rise buildings

Wall Pressure Coefficients, C_p

Wall Pressure Coefficients, C_p			
Surface	**L/B**	**C_p**	**Use With**
Windward Wall	All values	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥4	-0.2	
Side Wall	All values	-0.7	q_h

Wind Velocity Pressure

6.5.10 Velocity Pressure

Velocity pressure, q_z, evaluated at height z shall be calculated by the following equation:

$$q_z = 0.00256 K_z K_{zt} K_d V^2 I \text{ (lb/ft}^2\text{)} \qquad \text{(Eq. 6-13)}$$

[in SI: $q_z = 0.613 K_z K_{zt} K_d V^2 I$ (N/m^2)]

Importance Factor

Category	Non-Hurricane Prone Regions and Hurricane Prone Regions with V = 85-100 mph and Alaska	Hurricane Prone Regions with V > 100 mph
I	0.87	0.77
II	1.00	1.00
III	1.15	1.15
IV	1.15	1.15

- Agriculture Buildings Category I
- “Typical” Buildings Category II
- Hazardous Buildings Category III
- Essential Facilities Category IV

Wind Load Map: Western US

Wind speeds in MPH (kph)

Velocity Pressure Exposure Coefficients

Velocity Pressure Exposure Coefficients, K_h and K_z

Table 6-3

Height above ground level, z		Exposure (Note 1)			
		B		C	D
ft	(m)	Case 1	Case 2	Cases 1 & 2	Cases 1 & 2
0-15	(0-4.6)	0.70	0.57	0.85	1.03
20	(6.1)	0.70	0.62	0.90	1.08
25	(7.6)	0.70	0.66	0.94	1.12
30	(9.1)	0.70	0.70	0.98	1.16
40	(12.2)	0.76	0.76	1.04	1.22
50	(15.2)	0.81	0.81	1.09	1.27
60	(18)	0.85	0.85	1.13	1.31
70	(21.3)	0.89	0.89	1.17	1.34
80	(24.4)	0.93	0.93	1.21	1.38
90	(27.4)	0.96	0.96	1.24	1.40
100	(30.5)	0.99	0.99	1.26	1.43
120	(36.6)	1.04	1.04	1.31	1.48
140	(42.7)	1.09	1.09	1.36	1.52
160	(48.8)	1.13	1.13	1.39	1.55
180	(54.9)	1.17	1.17	1.43	1.58
200	(61.0)	1.20	1.20	1.46	1.61
250	(76.2)	1.28	1.28	1.53	1.68
300	(91.4)	1.35	1.35	1.59	1.73
350	(106.7)	1.41	1.41	1.64	1.78
400	(121.9)	1.47	1.47	1.69	1.82
450	(137.2)	1.52	1.52	1.73	1.86
500	(152.4)	1.56	1.56	1.77	1.89

Notes:

Exposure B, Case 2

Velocity Pressure Exposure Coefficients Notes

- Case 1
  - a. All components and cladding.
  - b. Main wind force resisting system in low-rise structure designed using Figure 6-10 [Method 2].
- Case 2
  - a. All main force wind resisting systems in buildings except those in low-rise buildings designed using Figure 6-10 (gable buildings).
  - b. All main wind force resisting systems in other structures.
- We will use Case 2.

Velocity Pressure Exposure Coefficients (cont.)

2. The velocity pressure exposure coefficient K_z may be determined from the following formula:

   For 15 ft. $\leq z \leq z_g$ — $K_z = 2.01\ (z/z_g)^{2/\alpha}$

   For $z < 15$ ft. — $K_z = 2.01\ (15/z_g)^{2/\alpha}$

   Note: z shall not be taken less than 30 feet for Case 1 in exposure B.

3. α and z_g are tabulated in Table 6-2.

Exposure	α	z_g (ft)
B	7.0	1200
C	9.5	900
D	11.5	700

Exposure Categories

- Exposure B:
  - Urban and suburban areas, wooded areas… Exposure B shall be assumed unless the site meets the definition of another type of exposure.
- Exposure C
  - Open terrain with scattered obstructions…
- Exposure D
  - Flat unobstructed areas exposed to wind flowing over open water for a distance of at least one mile…

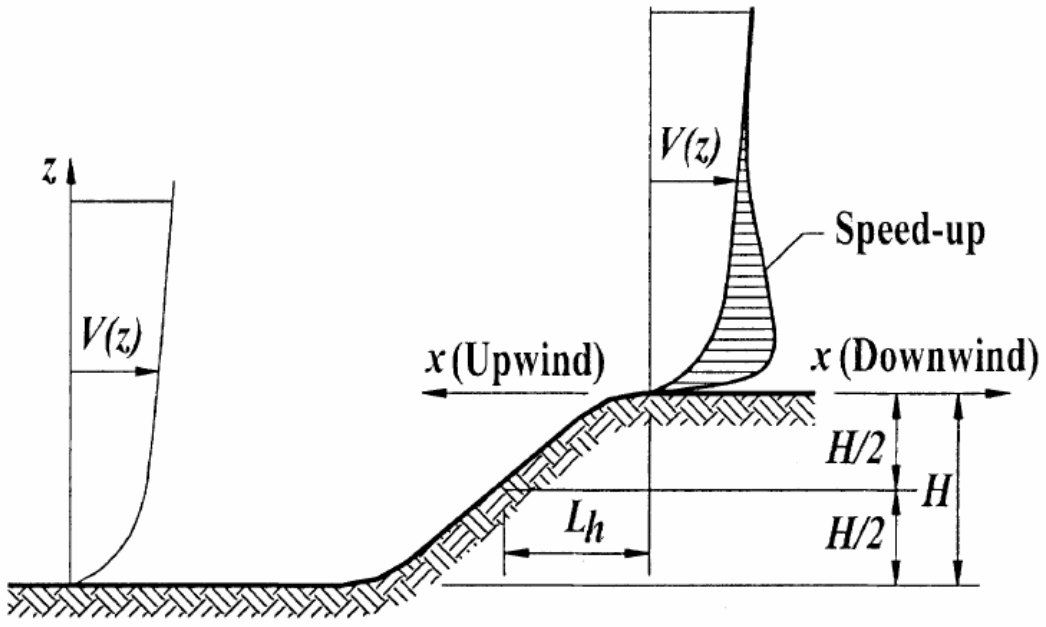
Directionality Factor K_d

Structure Type	Directionality Factor K_d*
Buildings	
Main Wind Force Resisting System	0.85
Components and Cladding	0.85
Arched Roofs	0.85
Chimneys, Tanks, and Similar Structures	
Square	0.90
Hexagonal	0.95
Round	0.95
Solid Signs	0.85

Topographic Factor K_{zt}

Topographic Factor, K_{zt}

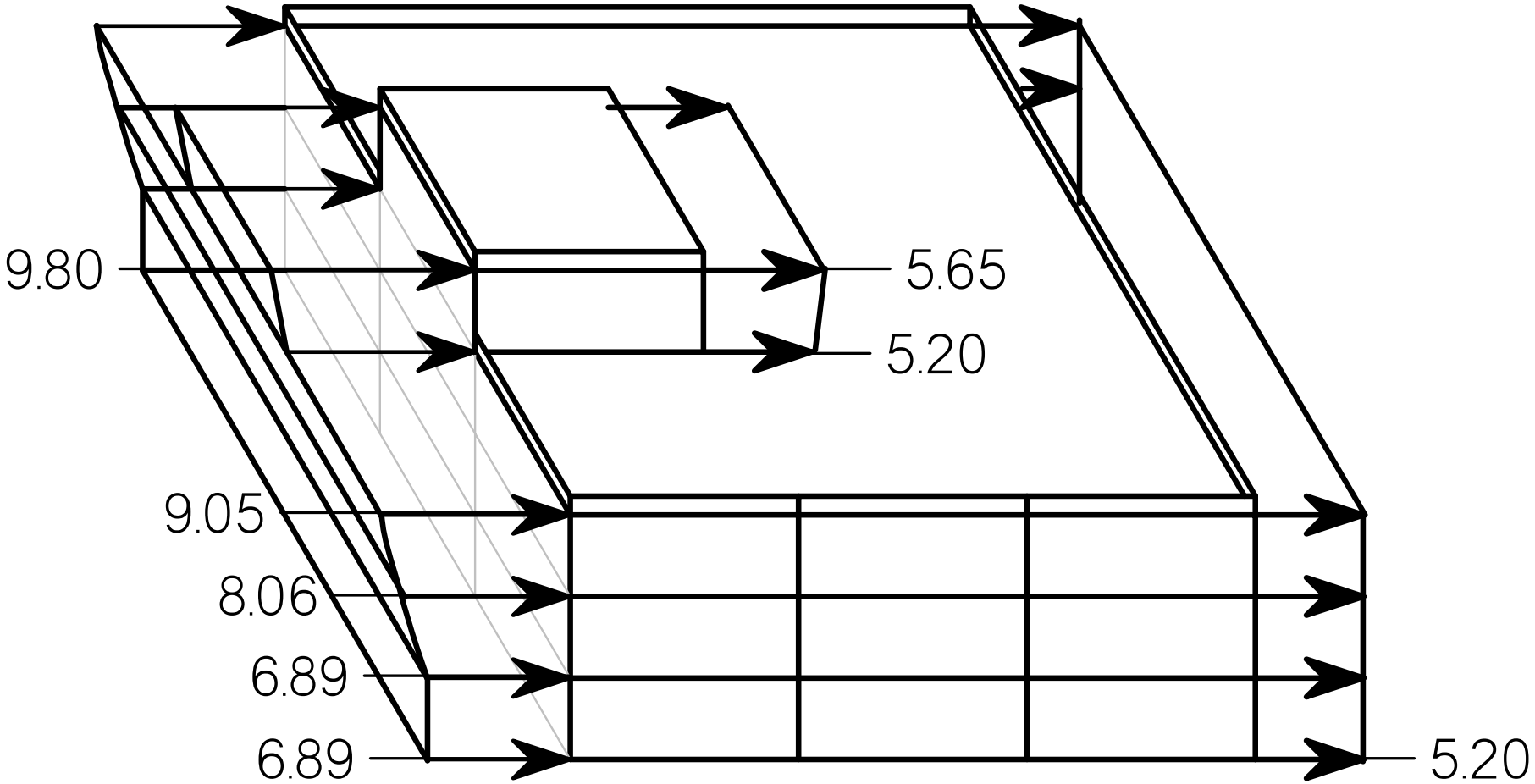
Figure 6-2

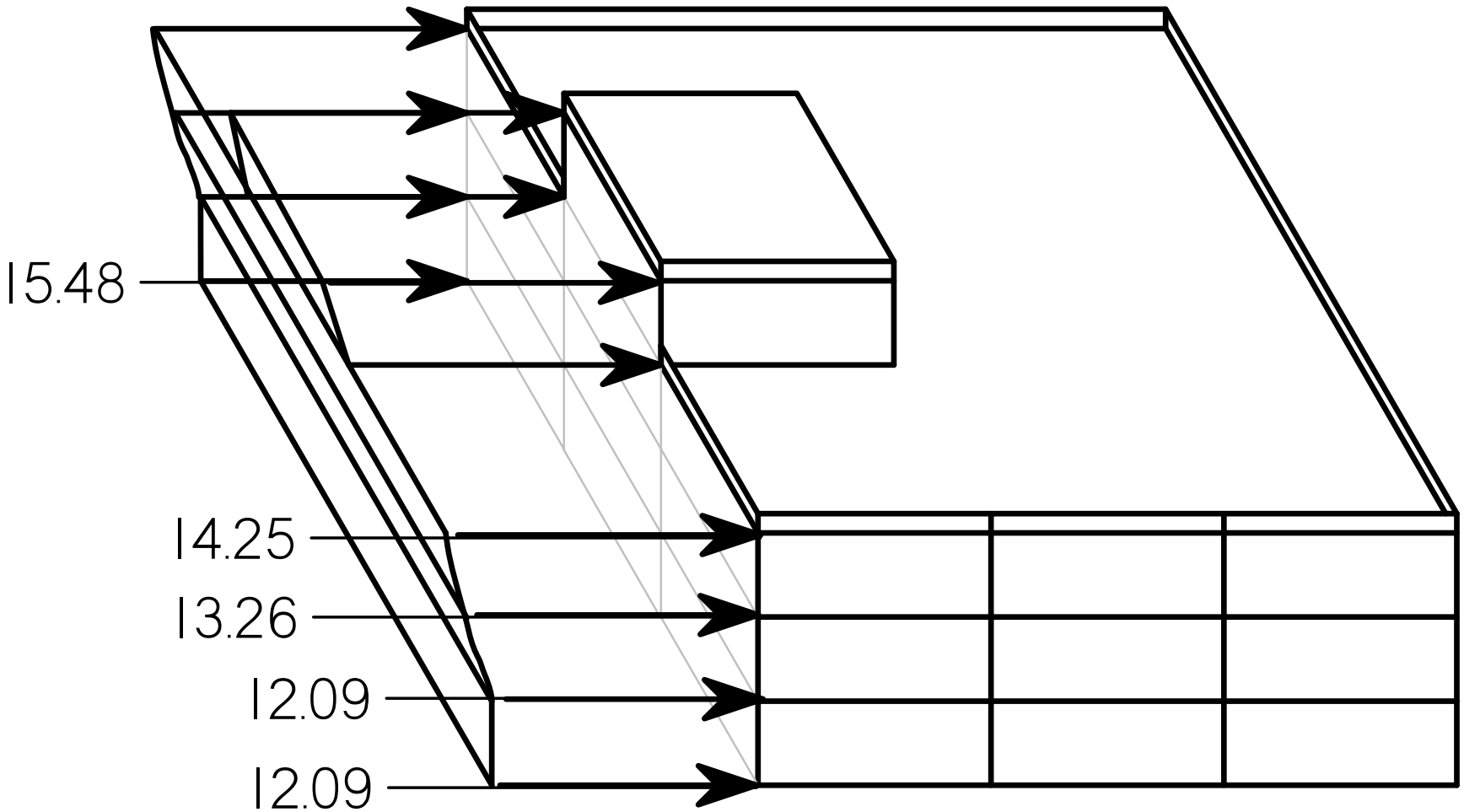


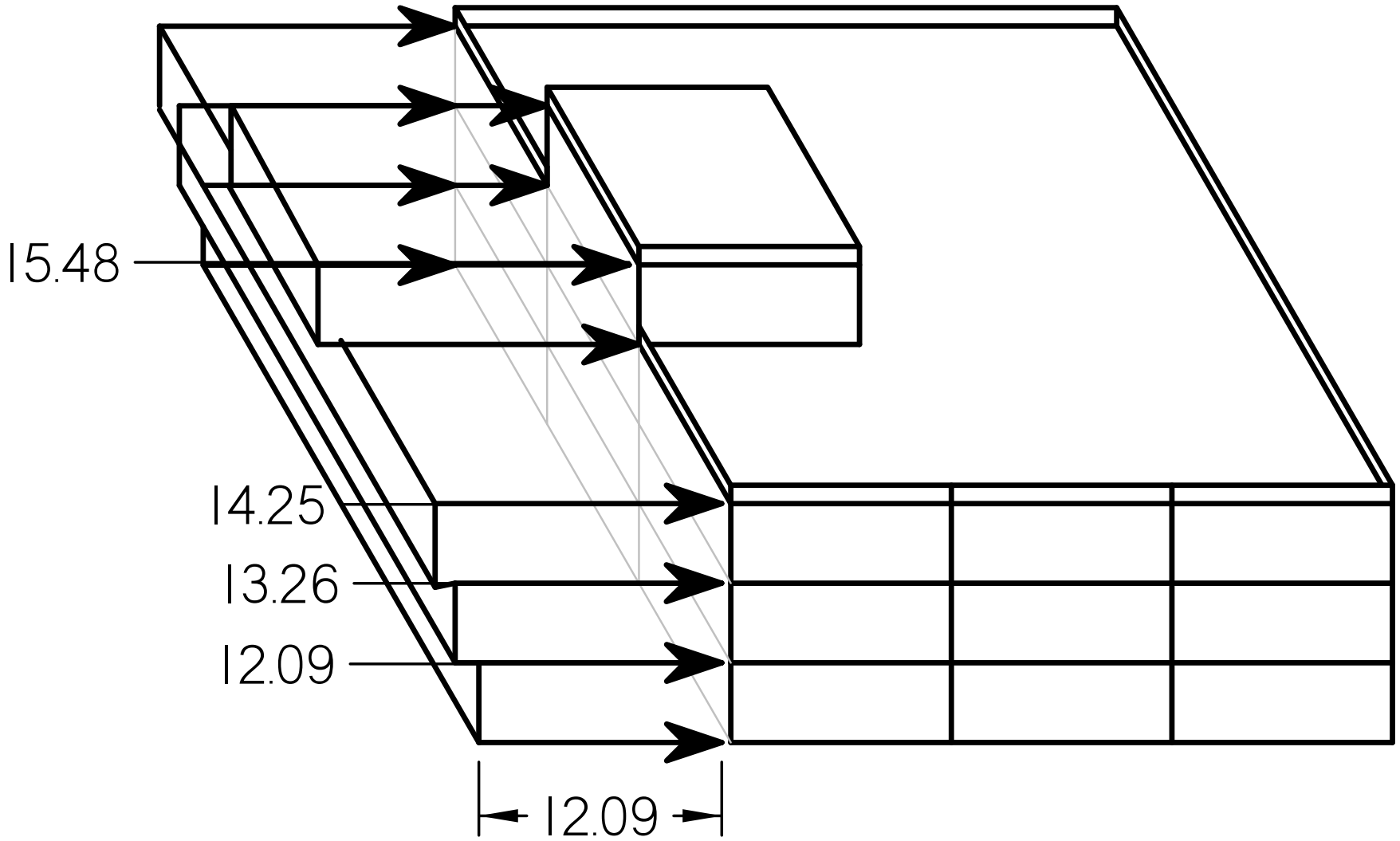
If flat terrain $K_{zt} = 1$

Wind Loads

- Calculate Wind Loads
  - Wind From East
  - Wind From West


9.80
5.65
5.20
9.05
8.06
6.89
6.89
5.20


15.48
14.25
13.26
12.09
12.09


15.48
14.25
13.26
12.09
12.09