1–1. The floor of a light storage warehouse is made of 6-in.-thick cinder concrete. If the floor is a slab having a length of 10 ft and width of 8 ft, determine the resultant force caused by the dead load and that caused by the live load.

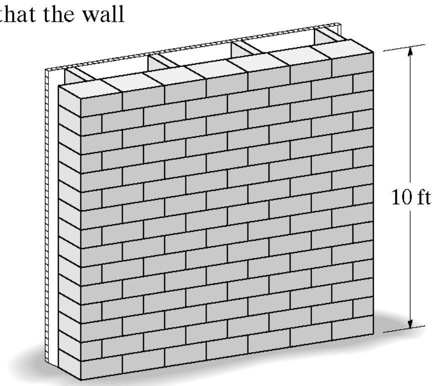
From Table 1 – 3,

$DL = (6\text{in.})(9\ \text{lb/ft}^2 \cdot \text{in.})(8\ \text{ft})(10\ \text{ft}) = 4.32\ \text{k}$ **Ans**

From Table 1 – 4,

$LL = (125\ \text{lb/ft}^2)(8\ \text{ft})(10\ \text{ft}) = 10.0\ \text{k}$ **Ans**

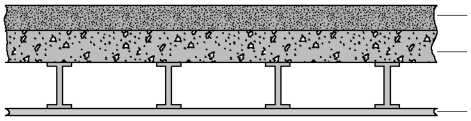
1–2. The building wall consists of 8-in. clay brick. In the interior, the wall is made from 2 × 4 wood studs, plastered on one side. If the wall is 10 ft high, determine the load in pounds per foot of length of wall that the wall exerts on the floor.



From Table 1 – 3,

$DL = (79\ \text{lb/ft}^2)(10\ \text{ft}) + (12\ \text{lb/ft}^2)(10\ \text{ft}) = 910\ \text{lb/ft}$ **Ans**

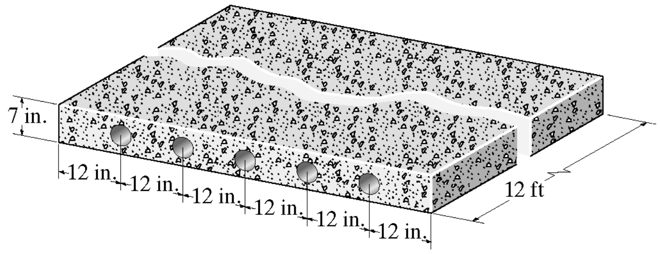
1–3. The second floor of a light manufacturing building is constructed from a 4-in.-thick stone concrete slab with an added 3-in. cinder concrete fill as shown. If the suspended ceiling of the first floor consists of metal lath and gypsum plaster, determine the dead load for design in pounds per square foot of floor area.



From Table 1 – 3,

4 in. – reinforced – stone slab	= 4(12)	= 48 lb/ft^2
3 in. – cinder concrete	= 3(9)	= 27 lb/ft^2
Plaster and lath		= 10 lb/ft^2
Total		$p = 85\ \text{lb/ft}^2$ **Ans**

***1–4.** The hollow core panel is made from plain stone concrete. Determine the dead weight of the panel. The holes each have a diameter of 4 in.



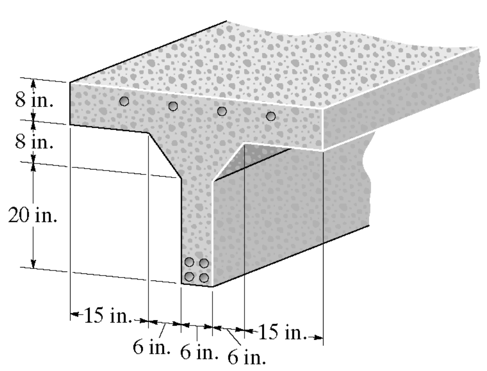
$$W = (144\ \text{lb/ft}^3)[(12\ \text{ft})(6\ \text{ft})(\frac{7}{12}\ \text{ft}) - 5(12\ \text{ft})(\pi)(\frac{2}{12}\ \text{ft})^2] = 5.29\ \text{k} \qquad \textbf{Ans}$$

1–5. The floor of a classroom is made of 125-mm thick lightweight plain concrete. If the floor is a slab having a length of 8 m and width of 6 m, determine the resultant force caused by the dead load and the live load.

$$F_D = 0.015\ \text{kN/m}^2/\text{mm})(125\ \text{mm})(8\text{m})(6\text{m})$$
$$= 90\ \text{kN} \qquad \textbf{Ans}$$

$$F_L = (1.92\ \text{kN/m}^2)(6\ \text{m})(8\ \text{m})$$
$$F_L = 92.16\ \text{kN} = 92.2\ \text{kN} \qquad \textbf{Ans}$$
$$F = F_D + F_L = 90\ \text{kN} + 92.16\ \text{kN} = 182.16\ \text{kN} = 182.\text{kN} \qquad \textbf{Ans}$$

1–6. The pre-cast T-beam has the cross-section shown. Determine its weight per foot of length if it is made from reinforced stone concrete and eight $\frac{3}{4}$-in. cold-formed steel reinforcing rods.



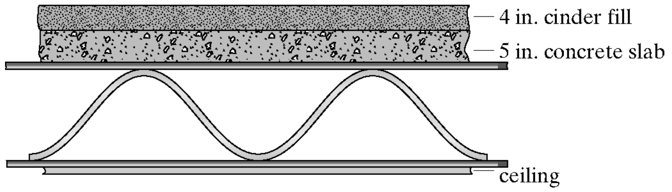
$$A = (28\ \text{in.})(6\ \text{in.}) + (8\ \text{in.})(48\ \text{in.}) + 2(\frac{1}{2})(6\ \text{in.})(8\ \text{in.}) = 600\ \text{in}^2 = 4.167\ \text{ft}^2$$

$$A_{steel} = 8(\frac{\pi(0.75\ \text{in.})^2}{4}) = 3.534\ \text{in}^2 = 0.02454\ \text{ft}^2$$

$$A_{conc} = 4.167\ \text{ft}^2 - 0.02454\ \text{ft}^2 = 4.142\ \text{ft}^2$$

$$W_c = 4.142\ \text{ft}^2(150\ \text{lb/ft}^3) + 0.02454\ \text{ft}^2(492\ \text{lb/ft}^3) = 633\ \text{lb/ft} \qquad \textbf{Ans}$$

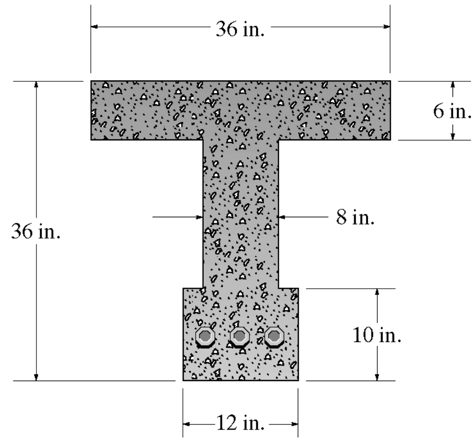
1–7. The second floor of a light manufacturing building is constructed from a 5-in.-thick stone concrete slab with an added 4-in. cinder concrete fill as shown. If the suspended ceiling of the first floor consists of metal lath and gypsum plaster, determine the dead load for design in pounds per square foot of floor area.



From Table 1 – 3,

5 – in. concrete slab	= (12)(5)	= 60	
4 – in. cinder fill	= (9)(4)	= 36.0	
metal lath & plaster		= 10.0	
Total dead load		= 106 lb/ft^2	**Ans**

***1–8.** The T-beam used in a heavy storage warehouse is made of concrete having a specific weight of 125 lb/ft^3. Determine the dead load per foot length of beam, and the load on the top of the beam per foot length of beam. Neglect the weight of the steel reinforcement.



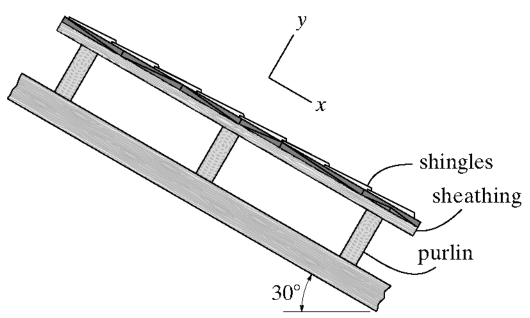
$A = 36(6) + 8(20) + 12(10) = 496\ \text{in}^2$

$DL = (496\ \text{in}^2)(1\ \text{ft}^2/144\ \text{in}^2)(125\ \text{lb/ft}^3) = 431\ \text{lb/ft}$ **Ans**

From Table 1-4,

$LL = (250\ \text{lb/ft}^2)\left(\dfrac{36\ \text{in.}}{12\ \text{in./ft}}\right) = 750\ \text{lb/ft}$ **Ans**

1–9. The beam supports the roof made from asphalt shingles and wood sheathing boards. If the boards have a thickness of $1\frac{1}{2}$ in. and a specific weight of 50 lb/ft^3, and the roof's angle of slope is 30°, determine the dead load of the roofing—per square foot—that is supported in the x and y directions by the purlins.

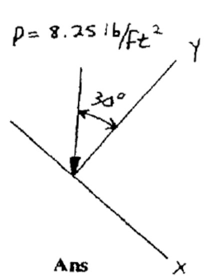


Weight per square foot $= (50\ \text{lb/ft}^3)\left(\dfrac{1.5\ \text{in.}}{12\ \text{in./ft}}\right) = 6.25\ \text{lb/ft}^2$

From Table 1-3

Shingles $= 2\ \text{lb/ft}^2$

Total $p = 8.25\ \text{lb/ft}^2$



$p_x = (8.25)\sin 30^\circ = 4.12$ psf **Ans**

$p_y = (8.25)\cos 30^\circ = 7.14$ psf **Ans**

1–10. A two-story school has interior columns that are spaced 15 ft apart in two perpendicular directions. If the loading on the flat roof is estimated to be 20 lb/ft^2, determine the reduced live load supported by a typical interior column at (a) the ground-floor level, and (b) the second-floor level.

Tributary area $A_t = (15)(15) = 225\ \text{ft}^2$

$F_R = 20(225) = 4.50\ \text{k}$

Since $K_{LL}A_T = 4(225) > 400$

Live load for second floor can be reduced.

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_t}}\right)$$

$$L = 40\left(0.25 + \frac{15}{\sqrt{(4)(225)}}\right) = 30\ \text{psf}$$

(a) For ground floor column:

$L = 30 > 0.5\,L_o = 20$

$F_F = 30(225) = 6.75\ \text{k}$

$F_g = F_F + F_R = 6.75 + 4.50 = 11.25\ \text{k}$ **Ans**

(b) For second floor column:

$F = F_R = 4.50\ \text{k}$ **Ans**

1–11. A four-story office building has interior columns spaced 30 ft apart in two perpendicular directions. If the flat-roof loading is estimated to be 30 lb/ft^2, determine the reduced live load supported by a typical interior column located at ground level.

Floor load:

$L_o = 50\ \text{psf}$

$A_t = (30)(30) = 900\ \text{ft}^2$

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_t}}\right)$$

$$= 50\left(0.25 + \frac{15}{\sqrt{4(900)}}\right) = 25\ \text{psf}$$

$\%\ \text{reduction} = \frac{25}{50} = 50\% > 40\%$ **(OK)**

$F_g = 3[(25\ \text{psf})(30\ \text{ft})(30\ \text{ft})] + 30\ \text{psf}(30\ \text{ft})(30\ \text{ft}) = 94.5\ \text{k}$ **Ans**

***1–12.** A three-story hotel has interior columns that are spaced 20 ft apart in two perpendicular directions. If the loading on the flat roof is estimated to be 30 lb/ft^2, determine the live load supported by a typical interior column at (a) the ground-floor level, and (b) the second-floor level.

$A_t = (20)(20) = 400\ \text{ft}^2$

$L_o = 40\ \text{psf}$

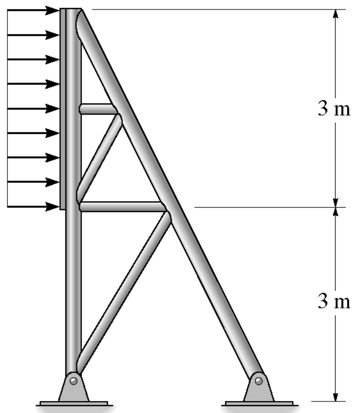
$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_t}}\right)$$

$$= 40\left(0.25 + \frac{15}{\sqrt{4(400)}}\right) = 25\ \text{psf}$$

(a) $F_g = 2[(400\ \text{ft}^2)(25\ \text{psf})] + (400\ \text{ft}^2)(30\ \text{psf}) = 32.0\ \text{k}$ **Ans**

(b) $F_{2F} = (400\ \text{ft}^2)(25\ \text{psf}) + (400\ \text{ft}^2)(30\ \text{psf}) = 22.0\ \text{k}$ **Ans**

1–13. Determine the resultant force acting on the face of the truss-supported sign if it is located near Los Angeles, California on open flat terrain. The sign has a width of 6 m and a height of 3 m as indicated. Use an importance factor of $I = 0.87$.



From the wind map $V = 38$ m/s

$K_z = 0.85$

$K_{zt} = 1$

$K_d = 1$

$q_z = 0.613 K_z K_{zt} K_d V^2 I$

$q_z = 0.613(0.85)(1)(1)(38)^2(0.87) = 654.58 \text{ N/m}^2$

$F = q_z G C_f A_f$

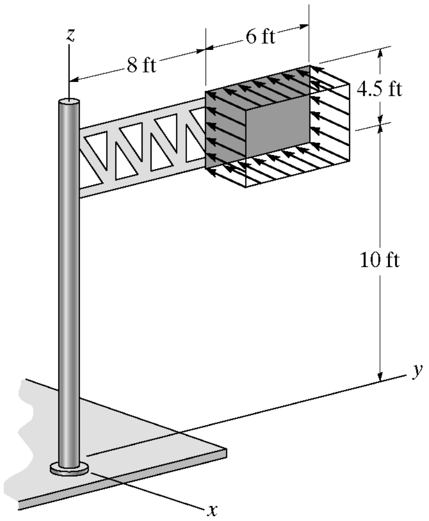
$G = 0.85$

$M/N = 6/3 = 2 < 6, \quad C_f = 1.2$

$A_f = 3(6) = 18 \text{ m}^2$

$F = 654.58(0.85)(1.2)(18) = 12.0 \text{ kN}$ **Ans.**

1–14. The sign is located in Minnesota on open flat terrain. Determine the resultant force of the wind acting on its face. Use an importance factor of $I = 0.87$.



$q_z = 0.00256 K_z K_{zt} K_d V^2 I$

From wind map $V = 90$ mi/hr

$K_z = 0.85$

$K_{zt} = 1$

$K_d = 1$

$q_z = 0.00256(0.85)(1)(1)(90)^2(0.87) = 15.33 \text{ lb/ft}^2$

$F = q_z G C_f A_f$

$G = 0.85$

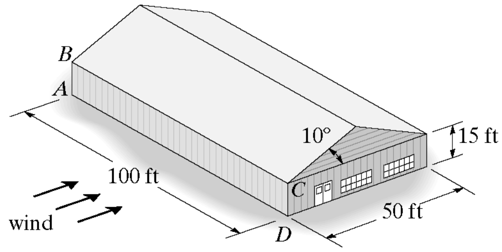
$\frac{M}{N} = \frac{6}{4.5} = 1.33 < 6 \qquad C_f = 1.2$

$A_f = 6(4.5) = 27 \text{ ft}^2$

$F = 15.33(0.85)(1.2)(27) = 422 \text{ lb}$ **Ans**

$y = 8 + 3 + 0.2(6) = 12.2 \text{ ft}$ **Ans**

1–15. Wind blows on the side of the fully enclosed agriculture building located on open flat terrain in Oklahoma. Determine the external pressure acting on the roof. Also, what is the internal pressure in the building which acts on the roof? Use linear interpolation to determine q_h and C_p in Figure 1–13.



$$q_z = 0.00256 K_z K_{zt} K_d V^2 I$$
$$= 0.00256 K_z (1)(1)(90)^2(0.87)$$

$$q_{15} = 0.00256(0.85)(1)(1)(90)^2(0.87) = 15.334 \text{ psf}$$

$$q_{20} = 0.00256(0.90)(1)(1)(90)^2(0.87) = 16.236 \text{ psf}$$

$$h = 15 + \frac{1}{2}(25 \tan 10°) = 17.204 \text{ ft}$$

$$\frac{q_h - 15.334}{17.204 - 15} = \frac{16.236 - 15.334}{20 - 15}$$

$$q_h = 15.732 \text{ psf}$$

External pressure on windward side of roof

$$p = q_h G C_p$$

$$\frac{h}{L} = \frac{17.204}{50} = 0.3441$$

$$\frac{[-0.9 - (-0.7)]}{(0.5 - 0.25)} = \frac{(-0.9 - C_p)}{(0.5 - 0.3441)}$$

$$C_p = -0.7753$$

$$p = 15.732(0.85)(-0.7753) = -10.4 \text{ psf} \qquad \textbf{Ans}$$

External pressure on leeward side of roof

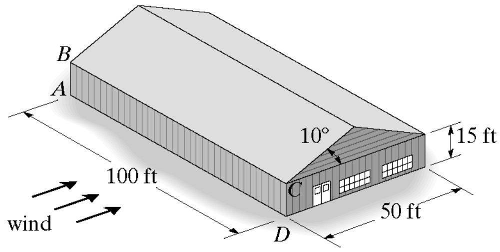
$$\frac{[-0.5 - (-0.3)]}{(0.5 - 0.25)} = \frac{(-0.5 - C_p)}{(0.5 - 0.3441)}$$
$$C_p = -0.3753$$

$$p = q_h G C_p$$
$$= 15.732(0.85)(-0.3753) = -5.02 \text{ psf} \qquad \textbf{Ans}$$

Internal pressure

$$p = -q_h(G C_{pi}) = -15.732(\pm 0.18) = \mp 2.83 \text{ psf} \qquad \textbf{Ans}$$

***1–16.** Wind blows on the side of the fully enclosed agriculture building located on open flat terrain in Oklahoma. Determine the external pressure acting over the windward wall, the leeward wall, and the side walls. Also, what is the internal pressure in the building which acts on the walls? Use linear interpolation to determine q_h.



$$q_z = 0.00256 K_z K_{zt} K_d V^2 I$$

$$q_z = 0.00256 K_z (1)(1)(90)^2(0.87)$$

$$q_{15} = 0.00256(0.85)(1)(1)(90)^2(0.87) = 15.334 \text{ psf}$$

$$q_{20} = 0.00256(0.90)(1)(1)(90)^2(0.87) = 16.236 \text{ psf}$$

$$h = 15 + \frac{1}{2}(25 \tan 10°) = 17.204 \text{ ft}$$

$$\frac{q_h - 15.334}{17.204 - 15} = \frac{16.236 - 15.334}{20 - 15}$$

$$q_h = 15.732 \text{ psf}$$

External pressure on windward wall

$$p = q_z\, G\, C_p = 15.334(0.85)(0.8) = 10.4 \text{ psf} \qquad \textbf{Ans}$$

External pressure on leeward wall $\quad \frac{L}{B} = \frac{50}{100} = 0.5$

$$p = q_h\, G\, C_p = 15.732(0.85)(-0.5) = -6.69 \text{ psf} \qquad \textbf{Ans}$$

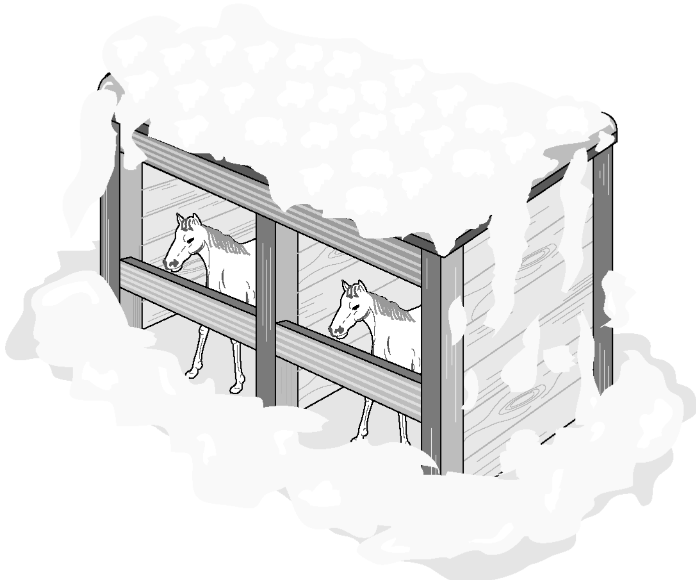
External pressure on side walls

$$p = q_h\, G\, C_p = 15.732(0.85)(-0.7) = -9.36 \text{ psf} \qquad \textbf{Ans}$$

Internal pressure

$$p = -q_h (G\, C_{pi}) = -15.732(\pm 0.18) = \mp 2.83 \text{ psf} \qquad \textbf{Ans}$$

1–17. The horse stall has a flat roof with a slope of 80 mm/m. It is located in an open field where the ground snow load is 1.20 kN/m^2. Determine the snow load that is required to design the roof of the stall.



$\theta = \tan^{-1}\dfrac{80 \text{ mm}}{1000 \text{ mm}} = 4.57° < 5°$ Flat roof

$C_e = 0.8$

$C_t = 1.2$

$I = 0.8$

$p_f = 0.7C_eC_tIp_g$

$p_f = 0.7(0.8)(1.2)(0.8)(1.20) = 0.645 \text{ kN/m}^2$

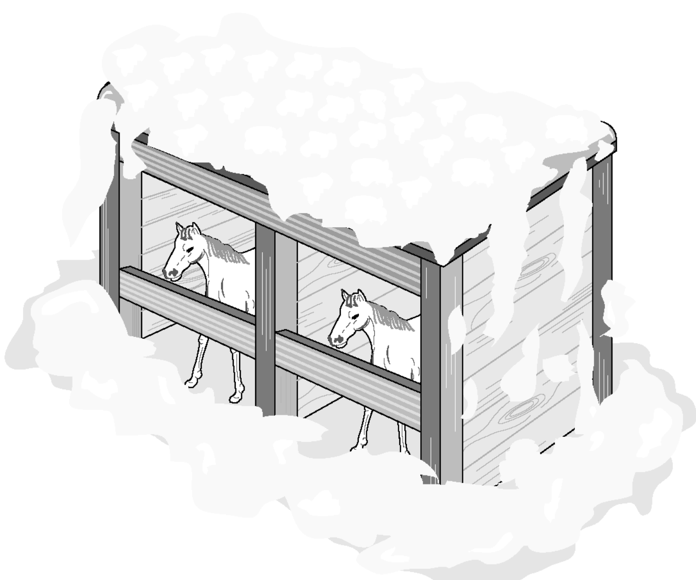
Since $p_g \le 0.96 \text{ kN/m}^2$, then also

$p_f = Ip_g = 0.8(1.20) = 0.960 \text{ kN/m}^2$

Use

$p_f = 0.960 \text{ kN/m}^2$ **Ans.**

1–18. The horse stall has a flat roof with a slope of 80 mm/m. It is located in an open field where the ground snow load is 0.72 kN/m^2. Determine the snow load that is required to design the roof of the stall.



$\theta = \tan^{-1}\dfrac{80 \text{ mm}}{1000 \text{ mm}} = 4.57° < 5°$ Flat roof

$C_e = 0.8$

$C_t = 1.2$

$I = 0.8$

$p_f = 0.7C_eC_tIp_g$

$p_f = 0.7(0.8)(1.2)(0.8)(0.72) = 0.387 \text{ kN/m}^2$

Since $p_g \le 0.96 \text{ kN/m}^2$, then also

$p_f = Ip_g = 0.8(0.72) = 0.576 \text{ kN/m}^2$

Use

$p_f = 0.576 \text{ kN/m}^2$ **Ans.**

1–19. A hospital located in Chicago, Illinois, has a flat roof, where the ground snow load is 25 lb/ft^2. Determine the design snow load on the roof of the hospital.

$C_e = 1.3$

$C_t = 1.0$

$I = 1.2$

$p_f = 0.7C_eC_tIp_g$

$p_f = 0.7(1.3)(1.0)(1.2)(25) = 27.3 \text{ lbft}^2$

Since $p_g > 20 \text{ lb/ft}^2$, then use

$p_f = I(20 \text{ lb/ft}^2) = 1.2(20 \text{ lb/ft}^2) = 24 \text{ lb/ft}^2$ **Ans.**