1–1. The floor of a heavy storage warehouse building is made of 6-in.-thick stone concrete. If the floor is a slab having a length of 15 ft and width of 10 ft, determine the resultant force caused by the dead load and the live load.

From Table 1–3

$DL = [12\text{ lb/ft}^2\cdot\text{in.}(6\text{ in.})]\,(15\text{ ft})(10\text{ ft}) = 10{,}800\text{ lb}$

From Table 1–4

$LL = (250\text{ lb/ft}^2)(15\text{ ft})(10\text{ ft}) = 37{,}500\text{ lb}$

Total Load

$F = 48{,}300\text{ lb} = 48.3\text{ k}$ **Ans.**

1–2. The floor of the office building is made of 4-in.-thick lightweight concrete. If the office floor is a slab having a length of 20 ft and width of 15 ft, determine the resultant force caused by the dead load and the live load.

From Table 1–3

$DL = [8\text{ lb/ft}^2\cdot\text{in.}\,(4\text{ in.})]\,(20\text{ ft})(15\text{ ft}) = 9600\text{ lb}$

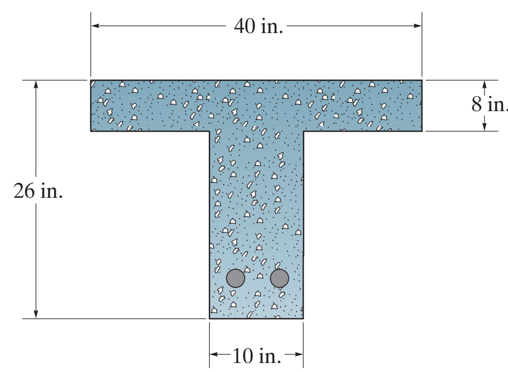
From Table 1–4

$LL = (50\text{ lb/ft}^2)(20\text{ ft})(15\text{ ft}) = 15{,}000\text{ lb}$

Total Load

$F = 24{,}600\text{ lb} = 24.6\text{ k}$ **Ans.**

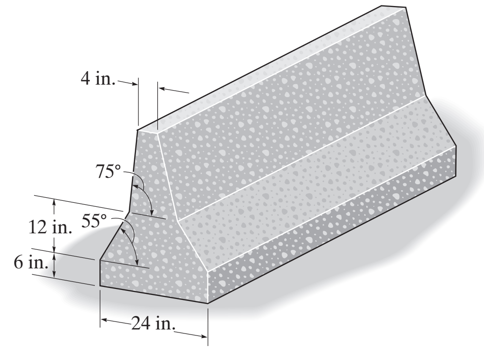
1–3. The T-beam is made from concrete having a specific weight of 150 lb/ft^3. Determine the dead load per foot length of beam. Neglect the weight of the steel reinforcement.



$$w = (150\text{ lb/ft}^3)\,[(40\text{ in.})(8\text{ in.}) + (18\text{ in.})\,(10\text{ in.})]\left(\frac{1\text{ ft}^2}{144\text{ in}^2}\right)$$

$w = 521\text{ lb/ft}$ **Ans.**

***1–4.** The "New Jersey" barrier is commonly used during highway construction. Determine its weight per foot of length if it is made from plain stone concrete.

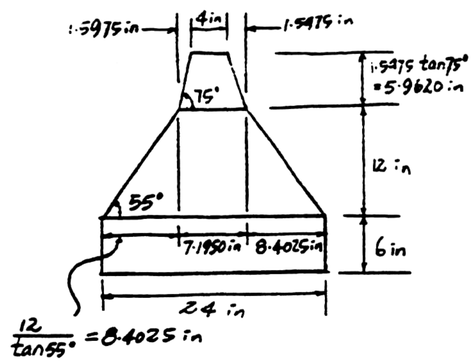


$$\text{Cross-sectional area} = 6(24) + \left(\frac{1}{2}\right)(24 + 7.1950)(12) + \left(\frac{1}{2}\right)(4 + 7.1950)(5.9620)$$

$$= 364.54 \text{ in}^2$$

Use Table 1–2.

$$w = 144 \text{ lb/ft}^3 \, (364.54 \text{ in}^2)\left(\frac{1 \text{ ft}^2}{144 \text{ in}^2}\right) = 365 \text{ lb/ft}$$ **Ans.**



1–5. The floor of a light storage warehouse is made of 150-mm-thick lightweight plain concrete. If the floor is a slab having a length of 7 m and width of 3 m, determine the resultant force caused by the dead load and the live load.

From Table 1–3

$$DL = [0.015 \text{ kN/m}^2 \cdot \text{mm} \, (150 \text{ mm})] \, (7 \text{ m}) \, (3 \text{ m}) = 47.25 \text{ kN}$$

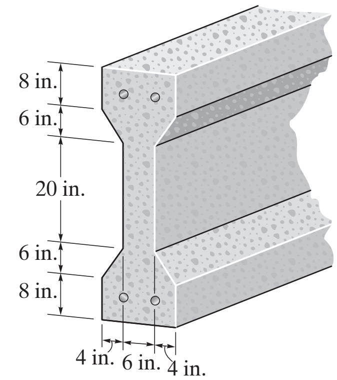
From Table 1–4

$$LL = (6.00 \text{ kN/m}^2) \, (7 \text{ m}) \, (3 \text{ m}) = 126 \text{ kN}$$

Total Load

$$F = 126 \text{ kN} + 47.25 \text{ kN} = 173 \text{ kN}$$ **Ans.**

1–6. The prestressed concrete girder is made from plain stone concrete and four $\frac{3}{4}$-in. cold form steel reinforcing rods. Determine the dead weight of the girder per foot of its length.



$$\text{Area of concrete} = 48(6) + 4\left[\frac{1}{2}(14 + 8)(4)\right] - 4(\pi)\left(\frac{3}{8}\right)^2 = 462.23\ \text{in}^2$$

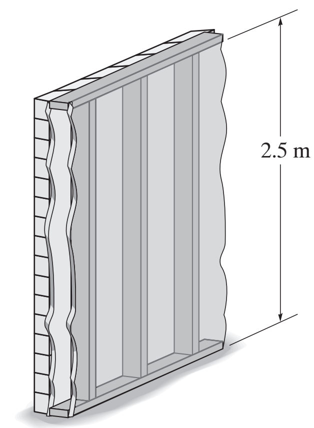
$$\text{Area of steel} = 4(\pi)\left(\frac{3}{8}\right)^2 = 1.767\ \text{in}^2$$

From Table 1–2,

$$w = (144\ \text{lb/ft}^3)(462.23\ \text{in}^2)\left(\frac{1\ \text{ft}^2}{144\ \text{in}^2}\right) + 492\ \text{lb/ft}^3(1.767\ \text{in}^2)\left(\frac{1\ \text{ft}^2}{144\ \text{in}^2}\right)$$

$$= 468\ \text{lb/ft}$$ **Ans.**

1–7. The wall is 2.5 m high and consists of 51 mm × 102 mm studs plastered on one side. On the other side is 13 mm fiberboard, and 102 mm clay brick. Determine the average load in kN/m of length of wall that the wall exerts on the floor.



Use Table 1–3.

For studs

Weight $= 0.57\ \text{kN/m}^2\ (2.5\ \text{m}) = 1.425\ \text{kN/m}$

For fiberboard

Weight $= 0.04\ \text{kN/m}^2\ (2.5\ \text{m}) = 0.1\ \text{kN/m}$

For clay brick

Weight $= 1.87\ \text{kN/m}^2\ (2.5\ \text{m}) = 4.675\ \text{kN/m}$

Total weight $= 6.20\ \text{kN/m}$ **Ans.**

***1–8.** A building wall consists of exterior stud walls with brick veneer and 13 mm fiberboard on one side. If the wall is 4 m high, determine the load in kN/m that it exerts on the floor.

For stud wall with brick veneer.

$w = (2.30\ \text{kN/m}^2)(4\ \text{m}) = 9.20\ \text{kN/m}$

For Fiber board

$w = (0.04\ \text{kN/m}^2)(4\ \text{m}) = 0.16\ \text{kN/m}$

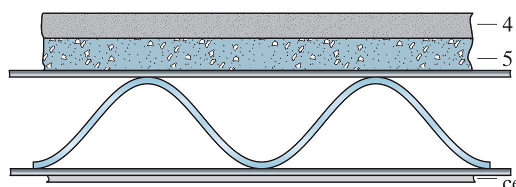
Total weight $= 9.2 + 0.16 = 9.36\ \text{kN/m}$ **Ans.**

1–9. The interior wall of a building is made from 2 × 4 wood studs, plastered on two sides. If the wall is 12 ft high, determine the load in lb/ft of length of wall that it exerts on the floor.

From Table 1–3

$w = (20\ \text{lb/ft}^2)(12\ \text{ft}) = 240\ \text{lb/ft}$ **Ans.**

1–10. 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)	= 60.0
4-in. cinder fill	= (9)(4)	= 36.0
metal lath & plaster		= 10.0
Total dead load		= 106.0 lb/ft² **Ans.**

1–11. A four-story office building has interior columns spaced 30 ft apart in two perpendicular directions. If the flat-roof live 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:

$L_o = 50$ psf

$A_t = (30)(30) = 900 \text{ ft}^2 > 400 \text{ ft}^2$

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

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

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

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

***1–12.** A two-story light storage warehouse has interior columns that are spaced 12 ft apart in two perpendicular directions. If the live loading on the roof is estimated to be 25 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.

$A_t = (12)(12) = 144 \text{ ft}^2$

$F_R = (25)(144) = 3600 \text{ lb} = 3.6 \text{ k}$

Since $A_t = 4(144) \text{ ft}^2 > 400 \text{ ft}^2$

$$L = 12.5\left(0.25 + \frac{15}{\sqrt{(4)(144)}}\right) = 109.375 \text{ lb/ft}^2$$

(a) For ground floor column

$L = 109 \text{ psf} > 0.5\, L_o = 62.5$ psf OK

$F_F = (109.375)(144) = 15.75$ k

$F = F_F + F_R = 15.75 \text{ k} + 3.6 \text{ k} = 19.4$ k **Ans.**

(b) For second floor column

$F = F_R = 3.60$ k **Ans.**

1–13. The office building has interior columns spaced 5 m apart in perpendicular directions. Determine the reduced live load supported by a typical interior column located on the first floor under the offices.

From Table 1–4

$L_o = 2.40\ \text{kN/m}^2$

$A_T = (5\ \text{m})(5\ \text{m}) = 25\ \text{m}^2$

$K_{LL} = 4$

$$L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}}\right)$$

$$L = 2.40\left(0.25 + \frac{4.57}{\sqrt{4(25)}}\right)$$

$L = 1.70\ \text{kN/m}^2$ **Ans.**

$1.70\ \text{kN/m}^2 > 0.4\,L_o = 0.96\ \text{kN/m}^2$ OK

1–14. A two-story hotel has interior columns for the rooms that are spaced 6 m apart in two perpendicular directions. Determine the reduced live load supported by a typical interior column on the first floor under the public rooms.

Table 1–4

$L_o = 4.79\ \text{kN/m}^2$

$A_T = (6\ \text{m})(6\ \text{m}) = 36\ \text{m}^2$

$K_{LL} = 4$

$$L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}}\right)$$

$$L = 4.79\left(0.25 + \frac{4.57}{\sqrt{4(36)}}\right)$$

$L = 3.02\ \text{kN/m}^2$ **Ans.**

$3.02\ \text{kN/m}^2 > 0.4\,L_o = 1.916\ \text{kN/m}^2$ OK

1–15. Wind blows on the side of a fully enclosed hospital located on open flat terrain in Arizona. Determine the external pressure acting over the windward wall, which has a height of 30 ft. The roof is flat.

$V = 120$ mi/h

$K_{zt} = 1.0$

$K_d = 1.0$

$$q_z = 0.00256\, K_z K_{zt} K_d V^2$$
$$= 0.00256\, K_z\,(1.0)(1.0)(120)^2$$
$$= 36.86\, K_z$$

From Table 1–5,

z	K_z	q_z
0–15	0.85	31.33
20	0.90	33.18
25	0.94	34.65
30	0.98	36.13

Thus,

$$p = q\,G\,C_p - q_h\,(G\,C_{p_i})$$
$$= q\,(0.85)(0.8) - 36.13\,(\pm 0.18)$$
$$= 0.68q \mp 6.503$$

$p_{0\text{–}15} = 0.68(31.33) \mp 6.503 = 14.8$ psf or 27.8 psf **Ans.**

$p_{20} = 0.68(33.18) \mp 6.503 = 16.1$ psf or 29.1 psf **Ans.**

$p_{25} = 0.68(34.65) \mp 6.503 = 17.1$ psf or 30.1 psf **Ans.**

$p_{30} = 0.68(36.13) \mp 6.503 = 18.1$ psf or 31.1 psf **Ans.**

***1–16.** Wind blows on the side of the fully enclosed hospital located on open flat terrain in Arizona. Determine the external pressure acting on the leeward wall, which has a length of 200 ft and a height of 30 ft.

$V = 120$ mi/h

$K_{zt} = 1.0$

$K_d = 1.0$

$$q_h = 0.00256\, K_z K_{zt} K_d V^2$$
$$= 0.00256\, K_z(1.0)(1.0)(120)^2$$
$$= 36.86\, K_z$$

1–16. Continued

From Table 1–5, for $z = h = 30$ ft, $K_z = 0.98$

$$q_h = 36.86(0.98) = 36.13$$

From the text

$$\frac{L_o}{B} = \frac{200}{200} = 1 \text{ so that } C_p = -0.5$$

$$p = q\,GC_p - q_h(GC_{p_2})$$

$$p = 36.13(0.85)(-0.5) - 36.13(\pm 0.18)$$

$$p = -21.9 \text{ psf or } -8.85 \text{ psf}$$ **Ans.**

1–17. A closed storage building is located on open flat terrain in central Ohio. If the side wall of the building is 20 ft high, determine the external wind pressure acting on the windward and leeward walls. Each wall is 60 ft long. Assume the roof is essentially flat.

$$V = 105 \text{ mi/h}$$

$$K_{zt} = 1.0$$

$$K_d = 1.0$$

$$q = 0.00256\, K_z K_{zt} K_d V^2$$

$$= 0.00256\, K_z(1.0)(1.0)\,(105)^2$$

$$= 28.22\, K_z$$

From Table 1–5

z	K_z	q_z
0–15	0.85	23.99
20	0.90	25.40

Thus, for windward wall

$$p = qGC_p - q_h(GC_{p_i})$$

$$= q(0.85)(0.8) - 25.40(\pm 0.18)$$

$$= 0.68\,q \mp 4.572$$

$$p_{0-15} = 0.68\,(23.99) \mp 4.572 = 11.7 \text{ psf or } 20.9 \text{ psf}$$ **Ans.**

$$p_{20} = 0.68\,(25.40) \mp 4.572 = 12.7 \text{ psf or } 21.8 \text{ psf}$$ **Ans.**

Leeward wall

$$\frac{L}{B} = \frac{60}{60} = 1 \text{ so that } C_p = -0.5$$

$$p = q\,GC_p - q_h(GC_{p_i})$$

$$p = 25.40(0.85)(-0.5) - 25.40\,(\pm 0.18)$$

$$p = -15.4 \text{ psf or } -6.22 \text{ psf}$$ **Ans.**

1–18. The light metal storage building is on open flat terrain in central Oklahoma. If the side wall of the building is 14 ft high, what are the two values of the external wind pressure acting on this wall when the wind blows on the back of the building? The roof is essentially flat and the building is fully enclosed.

$V = 105$ mi/h

$K_{zt} = 1.0$

$K_d = 1.0$

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

$= 0.00256\, K_z\, (1.0)(1.0)(105)^2$

$= 28.22\, K_z$

From Table 1–5

For $0 \leq z \leq 15$ ft$K_z = 0.85$

Thus,

$q_z = 28.22(0.85) = 23.99$

$p = q\, GC_p - q_h(GC_{p_i})$

$p = (23.99)(0.85)(0.7) - (23.99)(\pm 0.18)$

$p = -9.96$ psf or $p = -18.6$ psf **Ans.**

1–19. Determine the resultant force acting perpendicular to the face of the billboard and through its center if it is located in Michigan on open flat terrain. The sign is rigid and has a width of 12 m and a height of 3 m. Its top side is 15 m from the ground.

$q_h = 0.613\, K_z K_{zt} K_d V^2$

Since $z = h = 15$ m $K_z = 1.09$

$K_{zt} = 1.0$

$K_d = 1.0$

$V = 47$ m/s

$q_h = 0.613(1.09)(1.0)(1.0)(47)^2$

$= 1476.0$ N/m^2

$B/s = \dfrac{12\text{ m}}{3\text{ m}} = 4, s/h = \dfrac{3}{15} = 0.2$

From Table 1–6

$C_f = 1.80$

$F = q_h\, GC_f A_s$

$= (1476.0)(0.85)(1.80)(12)(3) = 81.3$ kN **Ans.**

***1–20.** A hospital located in central Illinois has a flat roof. Determine the snow load in kN/m^2 that is required to design the roof.

$$p_f = 0.7\, C_c C_t I_s p_g$$

$$p_f = 0.7(0.8)(1.0)(1.20)(0.96)$$

$$= 0.6451 \text{ kN/m}^2$$

Also

$$p_f = I_s p_g = (1.20)(0.96) = 1.152 \text{ kN/m}^2$$

use

$$p_f = 1.15 \text{ kN/m}^2$$ **Ans.**

1–21. The school building has a flat roof. It is located in an open area where the ground snow load is 0.68 kN/m^2. Determine the snow load that is required to design the roof.

$$p_f = 0.7\, C_c C_t I_s p_g$$

$$p_f = 0.7(0.8)(1.0)(1.20)(0.68)$$

$$= 0.457 \text{ kN/m}^2$$

Also

$$p_f = p_f = I_s p_g = (1.20)(0.68) = 0.816 \text{ kN/m}^2$$

use

$$p_f = 0.816 \text{ kN/m}^2$$ **Ans.**

1–22. The hospital is located in an open area and has a flat roof and the ground snow load is 30 lb/ft^2. Determine the design snow load for the roof.

Since $p_q = 30 \text{ lb/ft}^2 > 20 \text{ lb/ft}^2$ then

$$p_f = I_s\, p_g = 1.20(30) = 36 \text{ lb/ft}^2$$ **Ans.**