

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.

SOLUTION

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

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

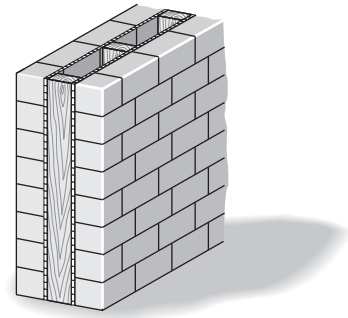
Total load

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

Ans.

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1-2. The wall is 12-ft high and consists of 2×4 studs. On each side is acoustical fiberboard and 4-in. clay brick. Determine the average load in lb/ft of length of wall that the wall exerts on the floor.



SOLUTION

$$2 \times 4 \text{ wood studs : } (4 \text{ lb/ft}^2)(12 \text{ ft}) = 48 \text{ lb/ft}$$

$$\text{fiberboard : } (2)(1 \text{ lb/ft}^2)(12 \text{ ft}) = 24 \text{ lb/ft}$$

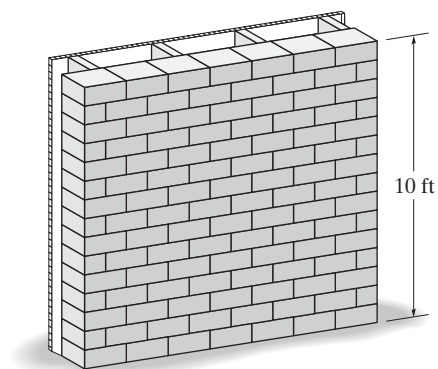
$$\text{Clay brick : } (2)(39 \text{ lb/ft}^2)(12 \text{ ft}) = 936 \text{ lb/ft}$$

$$\hline 1008 \text{ lb/ft}$$

Ans.

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1-3. A building wall consists of 12-in. clay brick and $\frac{1}{2}$ -in. fiberboard on one side. If the wall is 10 ft high, determine the load in pounds per foot that it exerts on the floor.



SOLUTION

From Table 1-3

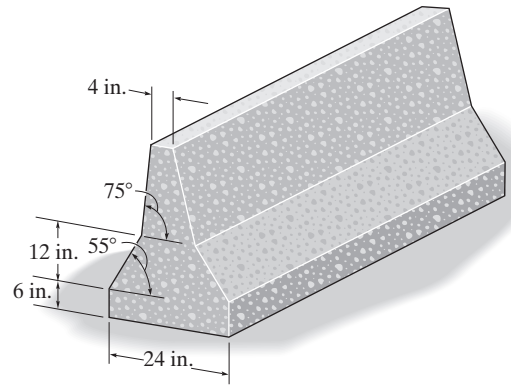
12 in. clay brick : $(115 \text{ lb/ft}^2)(10 \text{ ft}) = 1150 \text{ lb/ft}$

$\frac{1}{2}$ in. fiberboard : $(0.75 \text{ lb/ft}^2)(10 \text{ ft}) = 7.5 \text{ lb/ft}$

Total $\frac{1157.5 \text{ lb/ft}}{\quad} = 1.16 \text{ k/ft}$ **Ans.**

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*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.

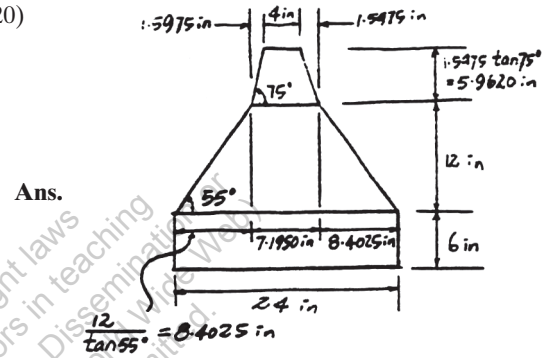


SOLUTION

$$\begin{aligned} \text{Cross-sectional area} &= 6(24) + \left(\frac{1}{2}\right)(24 + 7.1950)(12) + \left(\frac{1}{2}\right)(4 + 7.1950)(5.9620) \\ &= 364.54 \text{ in}^2 \end{aligned}$$

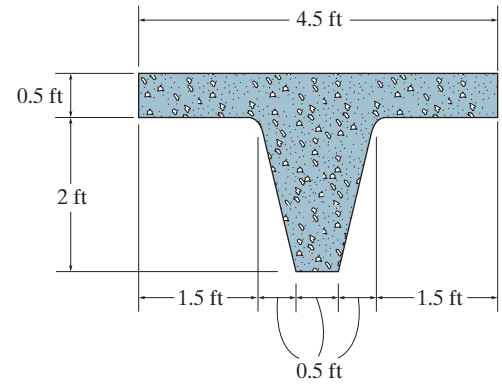
Use Table 1-2

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



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1-5. The precast floor beam is made from concrete having a specific weight of 150 lb/ft^3 . If it is to be used for a floor in an office of an office building, calculate its dead and live loadings per foot length of beam.



SOLUTION

Dead load:

$$DL = 150 \text{ lb/ft}^3 \left[4.5(0.5) + 2(1.5) - 2\left(\frac{1}{2}\right)(0.5)(2) \right] \text{ft}^2 = 638 \text{ lb/ft}$$

Ans.

Live load: From Table 1-4

$$LL = (50 \text{ lb/ft}^2)(4.5 \text{ ft}) = 225 \text{ lb/ft}$$

Ans.

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1–6. 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.

SOLUTION

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

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

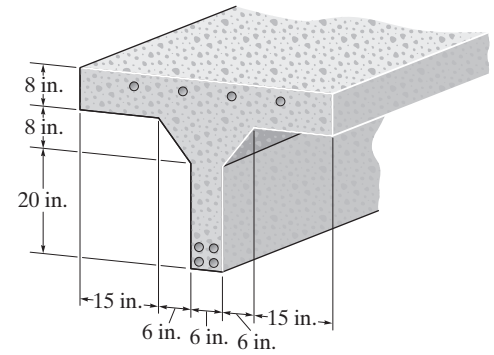
Total Load

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

Ans.

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1-7. 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.



SOLUTION

Concrete:

$$A_c = 8(48) + 6(28) + 2\left(\frac{1}{2}\right)(6)(8) - 8\pi\left(\frac{3}{8}\right)^2 = 596.5 \text{ in.}^2 = 4.142 \text{ ft}^2$$

$$\text{Wt. per foot} = 150(4.142) = 621.3 \text{ lb/ft}$$

Steel:

$$A_s = 8\pi\left(\frac{3}{8}\right)^2 = 3.534 \text{ in.}^2 = 0.02454 \text{ ft}^2$$

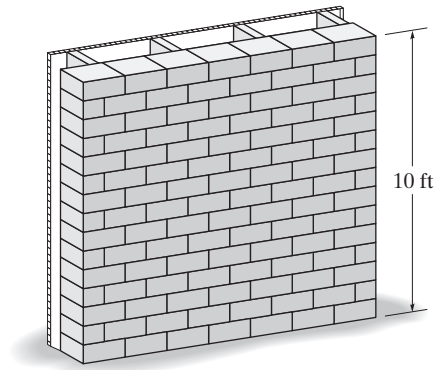
$$\text{Wt. per foot} = 492(0.02454) = 12.08 \text{ lb/ft}$$

$$\text{Total wt. per foot} = 621.3 + 12.08 = 633 \text{ lb/ft}$$

Ans.

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***1-8.** 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.



SOLUTION

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.

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1-9. 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.

SOLUTION

For stud wall with brick veneer

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

For fiberboard

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

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

Ans.

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1-10. 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.

SOLUTION

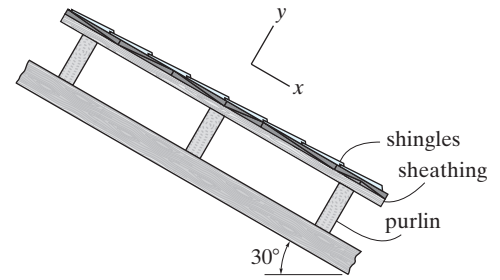
From Table 1-3

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

Ans.

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1-11. 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.



SOLUTION

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

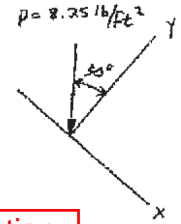
From Table 1-3

Shingles = 2 lb/ft²

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

$$p_x = (8.25) \sin 30^\circ = 4.12 \text{ psf}$$

$$p_y = (8.25) \cos 30^\circ = 7.14 \text{ psf}$$



Ans.

Ans.

<Au/Ed: this solution art was rendered but not marked to be replaced. We have placed it per the original manuscript drawing.>

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***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/ft², determine the live load supported by a typical interior column at (a) the ground-floor level, and (b) the second-floor level.

SOLUTION

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

$$L_o = 40 \text{ psf}$$

$$L = L_o \left(0.25 + \frac{15}{\sqrt{K_{Ll_0} A_t}} \right)$$
$$= 40 \left(0.25 + \frac{15}{\sqrt{4(400)}} \right) = 25 \text{ psf}$$

(a) $F_1 = 2[(400 \text{ ft}^2)(25 \text{ psf})] + (400 \text{ ft}^2)(30 \text{ psf}) = 32.0 \text{ k}$ **Ans.**

(b) $F_2 = (400 \text{ ft}^2)(25 \text{ psf}) + (400 \text{ ft}^2)(30 \text{ psf}) = 22.0 \text{ k}$ **Ans.**

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1-13. A hospital is to be built on open flat terrain in central Texas. If the building is 9.1 meters high, determine the internal pressure within the building if it is fully enclosed. Also, what is the external wind pressure acting on the side walls of the building? Each wall of the building is 25 meters long.

SOLUTION

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

$$= 0.613 K_z (1)(1)(54)^2 = 1787.5 K_z$$

$$\text{Use } z = h = 9.1 \text{ m}, \quad K_z = 0.98$$

$$q_h = 1787.5(0.98) = 1752 \text{ N/m}^2$$

Internal pressure, from Eq. 1-3

$$p = -q_h(GC_{pi}) = -(1752)(\pm 0.18) = \mp 315 \text{ N/m}^2$$

Ans.

Side wall external pressure

Use Fig. 1-11

$$p = q_h G C_p = 1752(0.85)(-0.7) = -1.04 \text{ kN/m}^2$$

Ans.

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1-14. 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.



SOLUTION

From Table 1-4

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

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

$$K_{LL} = 4$$

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

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

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

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

Ans.

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1-15. 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.

SOLUTION

$$C_e = 1.3$$

$$C_t = 1.0$$

$$I = 1.2$$

$$p_f = 0.7C_e C_t I p_z$$

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

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

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

Ans.

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***1-16.** 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.



SOLUTION

$$V = 120 \text{ mi/h}$$

$$K_{zt} = 1.0$$

$$K_d = 1.0$$

$$\begin{aligned} q_z &= 0.00256 K_z K_{zt} K_d V^2 \\ &= 0.00256 K_z (1.0)(1.0)(120)^2 \\ &= 36.86 K_z \end{aligned}$$

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,

$$\begin{aligned} p &= q G C_p - q_h (G C_{pi}) \\ &= q (0.85)(0.8) - 36.13 (\pm 0.18) \\ &= 0.68q \mp 6.503 \end{aligned}$$

$$p_{0-15} = 0.68(31.33) \mp 6.503 = 14.8 \text{ psf or } 27.8 \text{ psf}$$

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

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

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

Ans.

Ans.

Ans.

Ans.

1-17. 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.



SOLUTION

$$V = 120 \text{ mi/h}$$

$$K_{zt} = 1.0$$

$$K_d = 1.0$$

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

$$= 0.00256 K_z (1.0)(1.0)(120)^2$$

$$= 36.86 K_z$$

From Table 1-5, for $z = h = 30 \text{ ft}$, $K_z = 0.98$

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

From the text

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

$$p = q G C_p - q_h (G C_{p2})$$

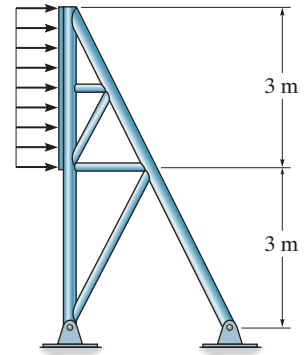
$$p = 36.13(0.85)(-0.5) - 36.13(\pm 0.18)$$

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

Ans.

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1-18. Determine the resultant force acting on the face of the sign if $q_h = 3.70$ kPa. The sign has a width of 12 m and a height of 3 m as indicated.



SOLUTION

$$F = q_h G C_f A_s$$

$$G = 0.85$$

$$s = 3 \text{ m}, h = 6 \text{ m},$$

$$\text{So } C_f = 1.70.$$

$$A_f = 3(12) = 36 \text{ m}^2$$

$$F = (3.70)(0.85)(1.70)(36) = 192 \text{ kN}$$

Ans.

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1-19. 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.



SOLUTION

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

$$K_{zt} = 1.0$$

$$K_d = 1.0$$

$$\begin{aligned} q_z &= 0.00256 K_z K_{zt} K_d V^2 \\ &= 0.00256 K_z (1.0)(1.0)(105)^2 \\ &= 28.22 K_z \end{aligned}$$

From Table 1-5

$$\text{For } 0 \leq z \leq 15 \text{ ft } K_z = 0.85$$

Thus,

$$q_z = 28.22(0.85) = 23.99$$

$$p = q GC_p - q_h(GC_{pi})$$

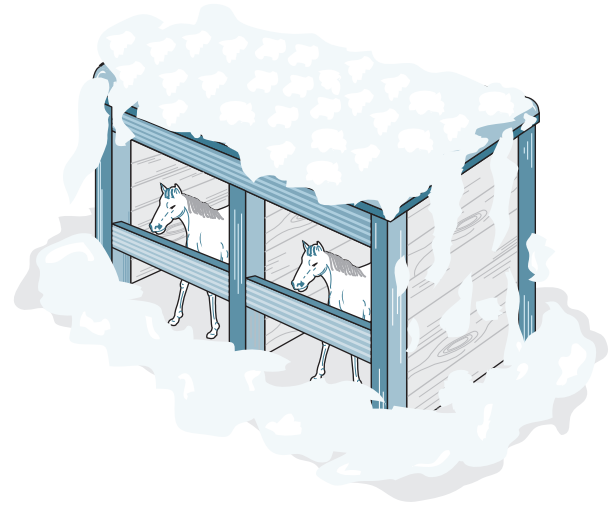
$$p = (23.99)(0.85)(0.7) - (23.99)(\pm 0.18)$$

$$p = -9.96 \text{ psf or } p = -18.6 \text{ psf}$$

Ans.

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***1-20.** 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/m². Determine the snow load that is required to design the roof of the stall.



SOLUTION

$$\theta = \tan^{-1} \frac{80 \text{ mm}}{1000 \text{ mm}} = 4.57^\circ < 5^\circ \quad \text{Flat roof}$$

$$C_e = 0.8$$

$$C_t = 1.2$$

$$I = 0.8$$

$$p_f = 0.7C_e C_t I p_g$$

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

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

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

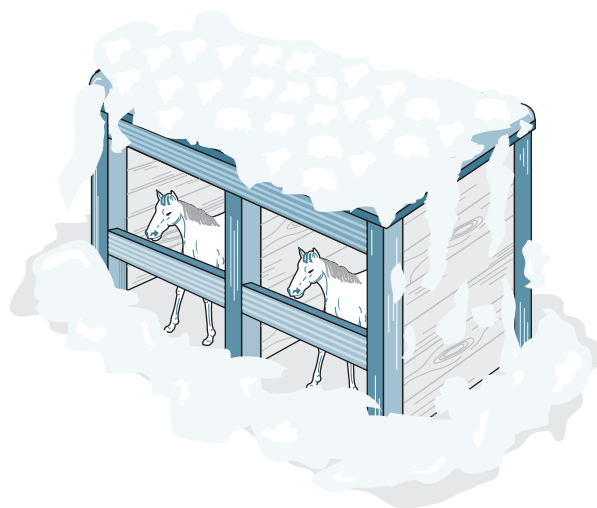
Use

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

Ans.

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1–21. 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/m². Determine the snow load that is required to design the roof of the stall.



SOLUTION

$$\theta = \tan^{-1} \frac{80 \text{ mm}}{1000 \text{ mm}} = 4.57^\circ < 5^\circ \quad \text{Flat roof}$$

$$C_e = 0.8$$

$$C_t = 1.2$$

$$I = 0.8$$

$$p_f = 0.7C_e C_t I p_g$$

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

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

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

Use

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

Ans.

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1-22. 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.

SOLUTION

$$p_f = 0.7 C_e C_t I_s p_g$$

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

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

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.

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1–23. 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.



SOLUTION

$$p_f = 0.7 C_e C_t I_s p_g$$

$$\begin{aligned} p_f &= 0.7(0.8)(1.0)(1.20)(0.68) \\ &= 0.457 \text{ kN/m}^2 \end{aligned}$$

Also

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

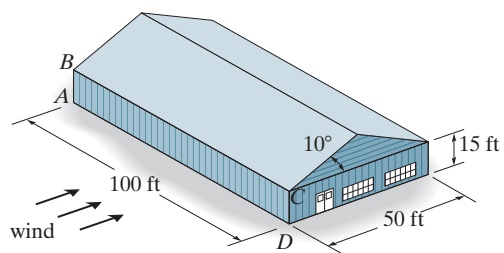
Use

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

Ans.

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***1-24.** 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 .



SOLUTION

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

$$q_z = 0.00256 K_p (1)(1)(105)^2 (0.87)$$

$$q_{15} = 0.00256 (0.85)(1)(1)(105)^2 (0.87) = 20.872 \text{ psf}$$

$$q_{20} = 0.00256 (0.90)(1)(1)(105)^2 (0.87) = 22.099 \text{ psf}$$

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

$$\frac{q_h - 20.872}{17.204 - 15} = \frac{22.099 - 20.872}{20 - 15}$$

$$q_h = 21.413 \text{ psf}$$

External pressure on windward wall

$$p_{\max} = q_z G C_p = 20.872 (0.85)(0.8) = 14.2 \text{ psf}$$

Ans.

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

$$p = q_h G C_p = 21.413 (0.85)(-0.5) = -9.10 \text{ psf}$$

Ans.

External pressure on side walls

$$p = q_h G C_p = 21.413 (0.85)(-0.7) = -12.7 \text{ psf}$$

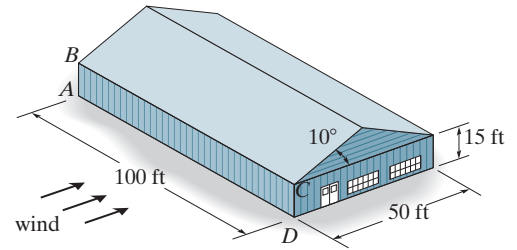
Ans.

Internal pressure

$$p = -q_h (G C_{pi}) = 21.413 (0.18) = \pm 3.85 \text{ psf}$$

Ans.

1-25. 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 Fig. 1-13.



SOLUTION

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

$$= 0.00256K_z (1)(1)(105)^2(0.87)$$

$$q_{15} = 0.00256(0.85)(1)(1)(105)^2(0.87) = 20.872 \text{ psf}$$

$$q_{20} = 0.00256(0.90)(1)(1)(105)^2(0.87) = 22.099 \text{ psf}$$

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

$$\frac{q_h - 20.872}{17.204 - 15} = \frac{22.099 - 20.872}{20 - 15}$$

$$q_h = 21.413 \text{ psf}$$

External pressure on windward side of roof

$$p = q_h G C_p$$

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

$$\frac{[1 - 0.9 - (-0.7)]}{(0.5 - 0.25)} = \frac{(-0.9 - C_p)}{(0.5 - 0.3441)}$$

$$C_p = -0.7753$$

$$p = 21.413(0.85)(-0.7753) = -14.1 \text{ psf}$$

Ans.

External pressure on leeward side of roof

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

$$C_p = -0.3753$$

$$p = q_h G C_p$$

$$= 21.413(0.85)(-0.3753) = -6.83 \text{ psf}$$

Ans.

Internal pressure

$$p = -q_h(G C_{pi}) = -21.413(\pm 0.18) = \pm 3.85 \text{ psf}$$

Ans.