Types of Loads

Once the dimensional requirements for a structure have been defined, it becomes necessary to determine the loads the structure must support.

Transmission loads

floor slab would be designed first, followed by the supporting beams, columns, and last, the foundation footings

two types of codes:

general building codes and design codes. *General building codes* specify the requirements of governmental bodies for minimum design loads on structures and minimum standards for construction. *Design codes* provide detailed technical standards and are used to establish the requirements for the actual structural design.

Dead Loads

_consist of the weights of the various structural members and the weights of any objects that are permanently attached to the structure

TABLE 1–2 Minimum Densities for Design Loads from Materials*

	lb/ft^3	kN/m^3
Aluminum	170	26.7
Concrete, plain cinder	108	17.0
Concrete, plain stone	144	22.6
Concrete, reinforced cinder	111	17.4
Concrete, reinforced stone	150	23.6
Clay, dry	63	9.9
Clay, damp	110	17.3
Sand and gravel, dry, loose	100	15.7
Sand and gravel, wet	120	18.9
Masonry, lightweight solid concrete	105	16.5
Masonry, normal weight	135	21.2
Plywood	36	5.7
Steel, cold-drawn	492	77.3
Wood, Douglas Fir	34	5.3
Wood, Southern Pine	37	5.8
Wood, spruce	29	4.5

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TABLE 1–3 Minimum Design Dead Loads*

Walls	psf	kN/m^2
4-in. (102 mm) clay brick	39	1.87
8-in. (203 mm) clay brick	79	3.78
12-in. (305 mm) clay brick	115	5.51
Frame Partitions and Walls		
Exterior stud walls with brick veneer	48	2.30
Windows, glass, frame and sash	8	0.38
Wood studs 2 × 4 in., (51 × 102 mm) unplastered	4	0.19
Wood studs 2 × 4 in., (51 × 102 mm) plastered one side	12	0.57
Wood studs 2 × 4 in., (51 × 102 mm) plastered two sides	20	0.96
Floor Fill		
Cinder concrete, per inch (mm)	9	0.017
Lightweight concrete, plain, per inch (mm)	8	0.015
Stone concrete, per inch (mm)	12	0.023
Ceilings		
Acoustical fiberboard	1	0.05
Plaster on tile or concrete	5	0.24
Suspended metal lath and gypsum plaster	10	0.48
Asphalt shingles	2	0.10
Fiberboard, $\frac{1}{2}$-in. (13 mm)	0.75	0.04

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Live Loads

can vary both in their magnitude and location. They may be caused by the weights of objects temporarily placed on a structure, moving vehicles, or natural forces.

TABLE 1–4 Minimum Live Loads*

Occupancy or Use	Live Load psf	Live Load kN/m^2	Occupancy or Use	Live Load psf	Live Load kN/m^2
Assembly areas and theaters			Residential		
Fixed seats	60	2.87	Dwellings (one- and two-family)	40	1.92
Movable seats	100	4.79	Hotels and multifamily houses		
Garages (passenger cars only)	50	2.40	Private rooms and corridors	40	1.92
Office buildings			Public rooms and corridors	100	4.79
Lobbies	100	4.79	Schools		
Offices	50	2.40	Classrooms	40	1.92
Storage warehouse			Corridors above first floor	80	3.83
Light	125	6.00			
Heavy	250	11.97			

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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.

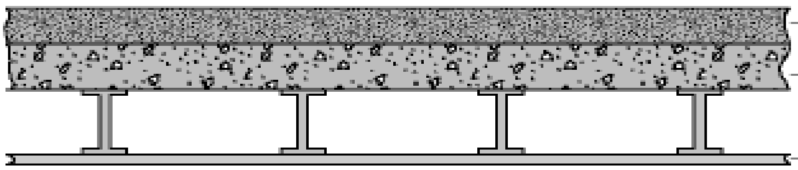
From Table 1 – 3,

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

From Table 1 – 4,

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

1–3. 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.

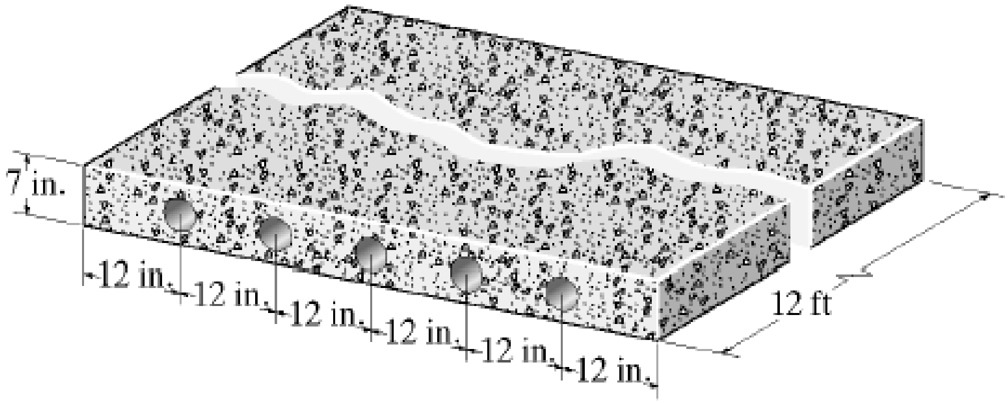


From Table 1 – 3,

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.



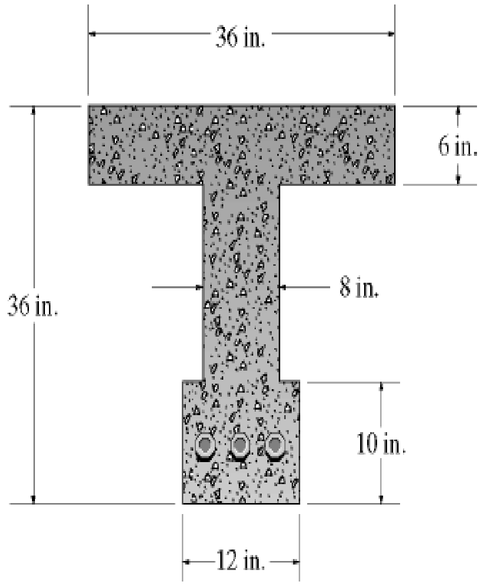
$$W = (144\ \text{lb/ft}^3)[(12\ \text{ft})(6\ \text{ft})(\frac{7}{12}\ \text{ft}) - 5(12\ \text{ft})(\pi)(\frac{2}{12}\ \text{ft})^2] = 5.29\ \text{k} \qquad \textbf{Ans}$$

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.

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

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

*1–8. The T-beam used in a heavy storage warehouse is made of concrete having a specific weight of 125 lb/ft³. 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**

1–10. 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/ft², 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.

$$L = L_0\left(0.25 + \frac{15}{\sqrt{K_{LL}A_t}}\right)$$

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

(a) For ground floor column :

$L = 30 > 0.5\, L_0 = 20$

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

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

(b) For second floor column :

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