Chapter 15

LOADS

15.1 Introduction

1 The main purpose of a structure is to transfer load from one point to another: bridge deck to pier; slab to beam; beam to girder; girder to column; column to foundation; foundation to soil.

2 There can also be secondary loads such as thermal (in restrained structures), differential settlement of foundations, P-Delta effects (additional moment caused by the product of the vertical force and the lateral displacement caused by lateral load in a high rise building).

3 Loads are generally subdivided into two categories

Vertical Loads or gravity load

1. **dead load** (DL)
2. **live load** (LL)

also included are snow loads.

Lateral Loads which act horizontally on the structure

1. **Wind load** (WL)
2. **Earthquake load** (EL)

this also includes hydrostatic and earth loads.

4 This distinction is helpful not only to compute a structure's load, but also to assign different factor of safety to each one.

5 For a detailed coverage of loads, refer to the Universal Building Code (UBC), (UBC 1995).

15.2 Vertical Loads

6 For closely spaced identical loads (such as joist loads), it is customary to treat them as a uniformly distributed load rather than as discrete loads, Fig. 15.1

Material	lb/ft^2
Ceilings	
Channel suspended system	1
Acoustical fiber tile	1
Floors	
Steel deck	2-10
Concrete-plain 1 in.	12
Linoleum 1/4 in.	1
Hardwood	4
Roofs	
Copper or tin	1-5
5 ply felt and gravel	6
Shingles asphalt	3
Clay tiles	9-14
Sheathing wood	3
Insulation 1 in. poured in place	2
Partitions	
Clay tile 3 in.	17
Clay tile 10 in.	40
Gypsum Block 5 in.	14
Wood studs 2x4 (12-16 in. o.c.)	2
Plaster 1 in. cement	10
Plaster 1 in. gypsum	5
Walls	
Bricks 4 in.	40
Bricks 12 in.	120
Hollow concrete block (heavy aggregate)	
4 in.	30
8 in.	55
12 in.	80
Hollow concrete block (light aggregate)	
4 in.	21
8 in.	38
12 in.	55

Table 15.2: Weights of Building Materials

Material	lb/ft^2
Timber	40-50
Steel	50-80
Reinforced concrete	100-150

Table 15.3: Average Gross Dead Load in Buildings

Floor	Roof	10	9	8	7	6	5	4	3	2	Total
Cumulative R (%)	8.48	16.96	25.44	33.92	42.4	51.32	59.8	60	60	60	
Cumulative LL	20	80	80	80	80	80	80	80	80	80	740
Cumulative R× LL	18.3	66.4	59.6	52.9	46.08	38.9	32.2	32	32	32	410

The resulting design live load for the bottom column has been reduced from 740 Kips to $\boxed{410 \text{ Kips}}$.

5. The total dead load is $DL = (10)(60) = 600$ Kips, thus the total reduction in load is $\frac{740-410}{740+600} \times 100 = \boxed{25\%}$.

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15.2.3 Snow

19 Roof snow load vary greatly depending on **geographic location and elevation**. They range from 20 to 45 psf, Fig. 15.2.

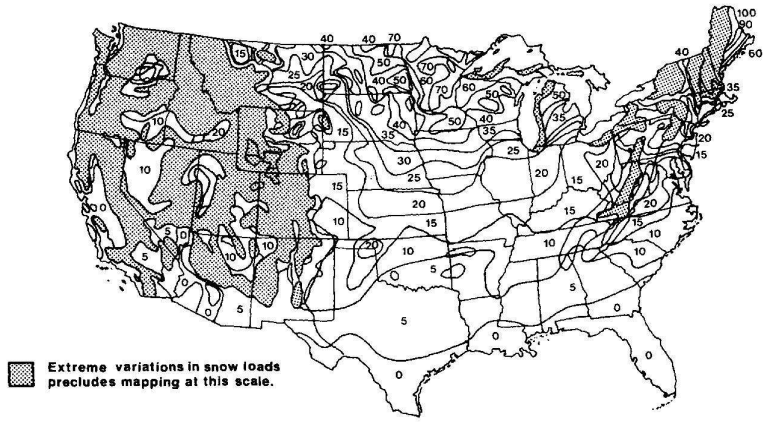

Figure 15.2: Snow Map of the United States, ubc

20 Snow loads are always given on the projected length or area on a slope, Fig. 15.3.

21 The steeper the roof, the lower the snow retention. For snow loads greater than 20 psf and roof pitches α more than 20° the snow load p may be reduced by

$$R = (\alpha - 20)\left(\frac{p}{40} - 0.5\right) \quad \text{(psf)} \tag{15.2}$$

22 Other examples of loads acting on inclined surfaces are shown in Fig. 15.4.

15.3 Lateral Loads

15.3.1 Wind

23 Wind load depend on: **velocity of the wind, shape of the building, height, geographical location, texture of the building surface and stiffness of the structure**.