Chapter 1

Types of Structures & Loads
Introduction

- *Structure refers* to a system of connected parts used to support load, such as Buildings, Bridges, towers, ............... 

- Engineers should account for structures safety, esthetics and serviceability, economic and environmental issues.
Structural Elements

Any structure comprises a number of elements

• Tie Rods
Beams

- Type of Beams

  - Simply supported beam
  - Cantilevered beam
  - Fixed-supported beam
  - Continuous beam
Columns

- Columns
Type of Structure

- Trusses

Loading causes bending of truss, which develops compression in top members, tension in bottom members.
Cables and Arches

cables support their loads in tension

(a)
Cables and Arches

arches support their loads in compression (b)
Frames

- Frames members are subjected to axial, shear and moment
Surface Structures
Loads

➢ Codes

General Building Codes

Specify the requirement of minimum design load on structures

1. ASCE
2. UBC
3. IBC
Loads

➢ Codes

Design Code
Used to establish the requirement for the actual structural design
1. ACI
2. AISC
3. AASHTO
Dead Load

Consist of the weight of the various structural members and weight of any object that permanently attached to the structure
The floor beam in Fig. 1–8 is used to support the 6-ft width of a lightweight plain concrete slab having a thickness of 4 in. The slab serves as a portion of the ceiling for the floor below, and therefore its bottom is coated with plaster. Furthermore, an 8-ft-high, 12-in.-thick lightweight solid concrete block wall is directly over the top flange of the beam. Determine the loading on the beam measured per foot of length of the beam.

**Solution**
Using the data in Tables 1–2 and 1–3, we have

Concrete slab: \[8 \text{ lb/(ft}^2 \cdot \text{in.})](4 \text{ in.})(6 \text{ ft}) = 192 \text{ lb/ft}\]

Plaster ceiling: \[(5 \text{ lb/ft}^2)(6 \text{ ft}) = 30 \text{ lb/ft}\]

Block wall: \[(105 \text{ lb/ft}^3)(8 \text{ ft})(1 \text{ ft}) = 840 \text{ lb/ft}\]

Total load \[1062 \text{ lb/ft} = 1.06 \text{ k/ft} \textbf{Ans.}\]

Here the unit k stands for “kip,” which symbolizes kilopounds. Hence, 
\[1 \text{ k} = 1000 \text{ lb}.\]
Live Load

Can vary both in their magnitude and location

- Building Loads
- Bridge Load
Wind Load

Wind pressure

\[ q_z = 0.613 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I \] (N/m²)

\( V \)  The velocity of the wind measured 10 m above the ground

\( I \)  Importance factor depends upon nature of the building

\( K_z \)  The velocity pressure coefficient which is function of height

\( K_{zt} \)  a factor that account for wind speed increases due to hills and escarpments for flat ground \( K_{zt}=1.0 \)

\( K_d \)  a factor account for direction of wind when subjected to load combination
Wind Load

Wind pressure for Enclosed Building

\[ p = qG C_p - q_h (G C_{p_i}) \quad \text{(N/m}^2\text{)} \]
Wind Load

Design wind pressure for Signs

\[ F = q_h GC_p A_f \]
Snow Load

\[ F = 0.7 C_e C_t L p_g \]
Earthquake Load

lumped mass of roof

lumped mass of columns
Hydrostatic and Soil Pressure

Other natural Loads
Structural Design

• LRFD (Load and resistance factor design)

Load combination example:

1.4 Dead Load
1.2 Dead Load + 1.6 Live Load
1.2 Dead Load + 1.6 Live Load + 0.5 Snow Load
1.2 Dead Load + 1.5 Eq. Load + 0.5 Live Load