

Introduction to Structural Engineering

Introduction to Structural Engineering

Key concepts, roles, and fundamentals for beginners

1. What Is Structural Engineering?

Aspect	Description
Definition	The branch of civil engineering that focuses on the design, analysis, and construction of load-bearing structures (buildings, bridges, towers, etc.).
Goal	Ensure safety, serviceability, durability, and economic efficiency of structures throughout their life cycle.
Scope	- Buildings (residential, commercial, industrial) - Bridges & viaducts - Towers, masts, and chimneys - Retaining walls, dams, foundations - Special structures (stadiums, stadium roofs, seismic isolation systems)

2. Core Principles

- Equilibrium** – Sum of forces and moments = 0.
 - Compatibility** – Deformations of connected members must be compatible (no gaps or overlaps).
 - Material Behavior** – Stress-strain relationship (elastic, plastic, time-dependent).
 - Stability** – Resistance to buckling, overturning, and sliding.
 - Serviceability** – Limits on deflection, vibration, and cracking for comfort and functionality.
-

3. Typical Loads on Structures

Load Type	Description	Common Sources
Dead Load	Permanent, static weight of structural elements and fixed equipment.	Self-weight of concrete, steel, masonry, permanent fixtures.
Live Load	Variable, movable loads that can change over time.	Occupants, furniture, vehicles, temporary equipment.

Introduction to Structural Engineering

Load Type	Description	Common Sources
Environmental Loads	Forces from nature.	Wind, snow, rain, temperature changes, seismic activity.
Special Loads	Loads that occur rarely or under specific conditions.	Impact, blast, fire, construction loads.

Design codes (e.g., ASCE 7, Eurocode EN 1991) prescribe magnitude and combination rules for these loads.

4. Structural Materials – Properties at a Glance

Material	Typical Strength (MPa)	Modulus of Elasticity (GPa)	Key Advantages	Typical Uses
Concrete	20–50 (compressive)	25–35	Good compression, fire resistance, inexpensive	Foundations, slabs, columns, shear walls
Reinforced Concrete	Same as concrete (compression) + steel tension	Same as concrete	Combines tensile steel with compressive concrete	Beams, slabs, columns, bridges
Steel	250–550 (yield)	200	High tensile/compressive strength, ductility, fast erection	Frames, trusses, bridges, high-rise cores
Timber	30–80 (compressive/tensile)	10–13	Lightweight, renewable, good seismic performance	Residential framing, timber bridges
Masonry (brick, block)	5–15 (compressive)	5–15	Fire resistance, thermal mass	Low-rise walls, partitions

Material selection balances strength, stiffness, durability, cost, and constructability.

5. Structural Analysis Methods

Method	When Used	Main Idea
--------	-----------	-----------

Introduction to Structural Engineering

Hand Calculations (Statics)

Simple, low-rise structures

Resolve forces/moments using equilibrium equations.

Influence Line Method

Determining effects of moving loads (e.g., bridges)

Plot