

Introduction to Structural Systems

Introduction to Structural Systems

Key concepts, classifications, and design considerations

1. What Is a Structural System?

Aspect	Description
Definition	An arrangement of interconnected members that transfers loads from the point of application to the supports, ensuring stability, strength, and serviceability.
Purpose	- Safely carry dead, live, environmental, and accidental loads. - Provide rigidity (resistance to deformation). - Allow controlled movement (thermal expansion, seismic drift). - Primary structural elements (beams, columns, walls, slabs, foundations).
Components	- Secondary elements (bracing, ties, connections). - Load path (the route loads travel from application to ground).

2. Fundamental Load Types

Load	Typical Sources	Effect on Structure
Dead load	Self-weight of structural members, permanent finishes, fixed equipment	Constant, predictable; governs size of members.
Live load	Occupants, furniture, movable equipment	Variable; design based on occupancy category.
Environmental loads	Wind, snow, rain, temperature, humidity	May cause lateral forces, uplift, or differential movement.
Seismic load	Ground motion during earthquakes	Inertial forces; requires ductility and energy dissipation mechanisms.
Other	Impact, blast, fire, settlement	Special design provisions (e.g., impact factors, fire resistance).

3. Classification of Structural Systems

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System	Typical Materials	Main Load-Carrying Mechanism	Common Applications
Frame (Beam-Column) System	Steel, reinforced concrete, timber	Bending of beams and axial/compression in columns	Office buildings, warehouses, residential high-rise
Shear-Wall System	Reinforced concrete, masonry, steel plate	In-plane shear resistance, vertical load transfer	High-rise residential, schools, hospitals
Braced Frame	Steel, timber	Diagonal bracing carries shear; columns resist axial loads	Industrial facilities, warehouses
Moment-Resisting Frame	Steel, reinforced concrete	Rigid connections develop bending moments at joints	Seismic-resistant buildings, high-rise towers
Truss System	Steel, timber, aluminum	Axial tension/compression in members; negligible bending	Roofs, bridges, long-span arenas
Space Frame	Steel, aluminum, composite	3D network of members; distributes loads in multiple directions	Airports, exhibition halls, stadiums
Load-Bearing Wall System	Masonry, concrete block, timber	Walls directly support vertical loads	Low-rise residential, small commercial
Hybrid Systems	Combination of above	Tailored to performance, cost, and architectural needs	Modern high-rise, mixed-use towers

4. Primary Structural Elements

Element	Role	Typical Shapes / Sections
Beam	Transfers loads horizontally to columns or walls; resists bending and shear.	I-section, rectangular, T-beam, box, flanged, T-shaped.
Column	Carries axial compression (and sometimes bending) from upper elements to foundations.	Square, rectangular, circular, I-shaped, tapered.
Slab	Provides floor/roof surface; distributes loads to beams/walls.	One-way, two-way, flat plate, ribbed, waffle.