

Introduction to Structural Design in

Introduction to Structural Design in Architecture

Architecture

Key concepts, principles, and workflow for creating safe, functional, and expressive buildings.

1. What Is Structural Design?

Aspect	Description
Definition	The process of determining how a building will support loads and resist forces while meeting architectural intent.
Goal	Provide safety, durability, and serviceability while enabling the desired spatial and aesthetic outcomes.
Stakeholders	Architects, structural engineers, contractors, owners, code officials, and consultants (e.g., geotechnical, façade).
Outcome	A set of coordinated drawings, calculations, and specifications that define the structural system (foundations, columns, beams, slabs, walls, roof, etc.).

2. Core Principles

Principle	Why It Matters	Typical Application
Load Path Continuity	Forces must travel from the point of application to the ground without interruption.	Align columns with supporting walls; use continuity beams.
Equilibrium	Sum of forces and moments = 0 at every point.	Verify with static analysis (e.g., moment distribution, FEM).
Compatibility	Deformations of connected members must be compatible (fit together).	Design connection detailing; account for differential settlement.
Redundancy & Robustness	Alternate load paths prevent collapse if one element fails.	Provide secondary frames, shear walls, or bracing.
Material Efficiency	Use each material where its strengths are best exploited.	Steel for tension, concrete for compression, timber for lightweight spans.
Serviceability	Limits on deflection, vibration, cracking for occupant comfort.	Deflection limits (L/360 for floors), vibration criteria for long spans.

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Principle	Why It Matters	Typical Application
Sustainability	Minimize embodied energy, use recyclable materials, reduce waste.	Optimize member sizes, employ high-performance concrete, use timber.

3. Types of Loads

Load Category	Description	Typical Design Values (US)
Dead Loads (DL)	Permanent self-weight of structural elements, fixed equipment, finishes.	10–30 psf for floors; 150–200 lb/ft ³ for concrete.
Live Loads (LL)	Variable occupier loads, furniture, movable equipment.	40–100 psf (office, residential); 150 psf (assembly).
Snow Loads (SL)	Accumulated snow pressure, climate-dependent.	Based on ground snow load * shape factor.
Wind Loads (WL)	Pressure from wind on building envelope.	Determined by ASCE 7 wind speed, exposure, height.
Seismic Loads (EL)	Inertial forces from ground motion.	Calculated via response spectra, importance factor.
Thermal & Shrinkage	Expansion/contraction of materials.	Considered in connection detailing, joint design.
Construction Loads	Temporary loads during erection (e.g., formwork, crane loads).	Usually specified by contractor & engineer.

Load combinations (e.g., LRFD, ASD) are prescribed by code to ensure safety under simultaneous actions.

4. Common Structural Systems

System	Typical Uses	Advantages	Limitations
Load-Bearing Masonry	Low-rise residential, schools.	Simple, low cost, fire-resistant.	Limited span, heavy, seismic vulnerability.
Concrete Frame (RC)	Mid-rise office, hospitals.		