Concrete and Structures for Interior Design Engineering

Lecture -6-

Structural Elements: Horizontal Systems

Lecturer- Asmaa Abdulmajeed

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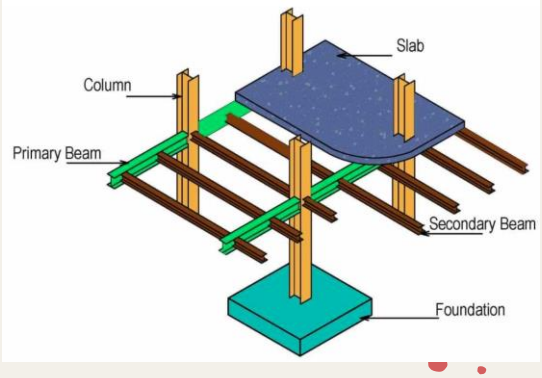
1. Introduction to Horizontal Structural Systems

- ✓ Horizontal structural elements are the flat or slightly inclined parts of the building that carry loads across spaces.
- ✓ Their main job:
  - Carry weight of people, furniture, walls
  - Transfer loads to beams → columns → foundation
  - Create usable interior spaces



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2. Types of Horizontal Systems

- 1. Slabs
- 2. Beams
- 3. Floor
- 4. Roofs
- 5. Ceilings

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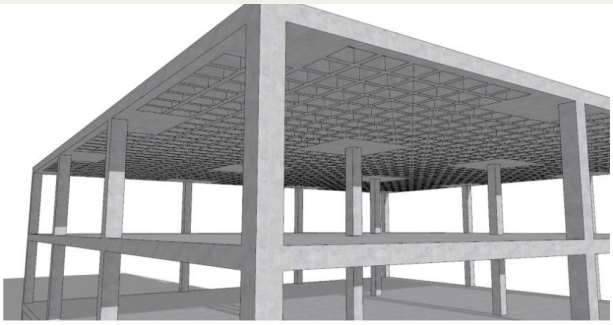
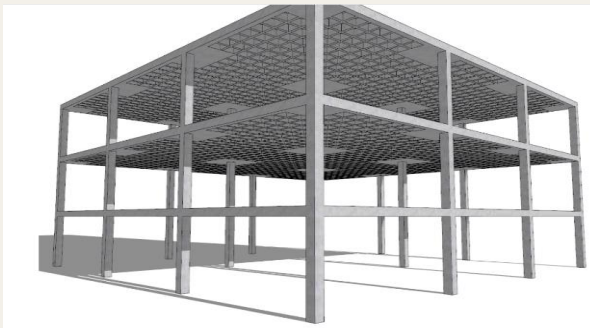
1. Slabs

- A slab is a flat concrete plate forming floors and ceilings.





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Types of Slabs

1. One - Way Slabs
- -Two opposite sides supported.
- -Load travels in one direction.
- -Common in small rooms (bedrooms, small office rooms).

2. Two - Way Slabs
- -Supported on all four sides
- -Load travels in two directions
- -Used in square or large rooms (living rooms, studios)

3. Flat Slabs
- -No beams, slab rests directly on columns
- -Smooth ceiling → perfect for interior design flexibility

4. Ribbed / Waffle Slabs
- -Underside has patterns (ribs, grids)
- -Lighter and stronger
- -Often used in parking floors, commercial buildings

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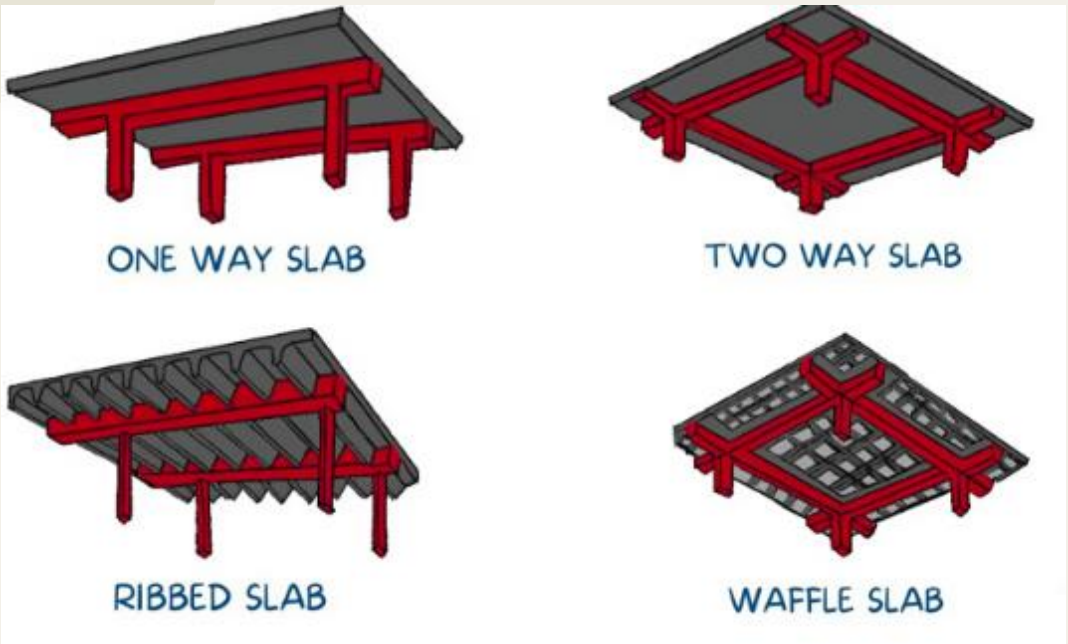

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2. Beams

- A **beam** is a horizontal structural member that supports slabs.

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2. Beams

- ✓ Carry loads from slabs
- ✓ Reduce slab spans
- ✓ Transfer load to columns
- ✓ Provide stiffness to floors

Types;

- ✓ Primary beam (main support)
- ✓ Secondary beam (supports slab and transfers to primary beam)
- ✓ Lintel beam (above doors/windows)

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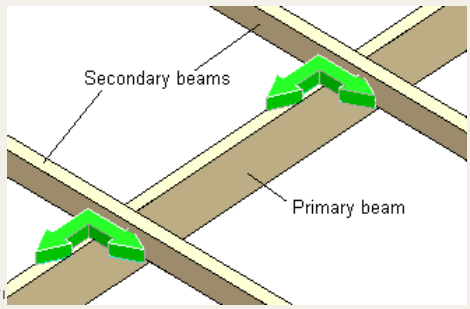

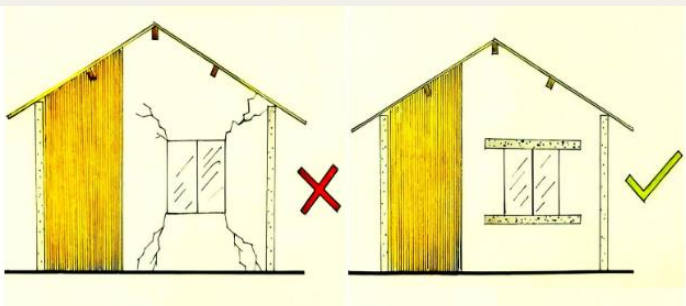

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3. Floors

A floor system includes:

- ✓ Structural slab
- ✓ Screed
- ✓ Waterproofing
- ✓ Floor finish (tile, wood, carpet, vinyl, marble)

Classification;

- ✓ **Structural floor:** concrete slab + beams
- ✓ **Raised floor:** space for wires and AC ducts
- ✓ **Composite floor:** steel + concrete

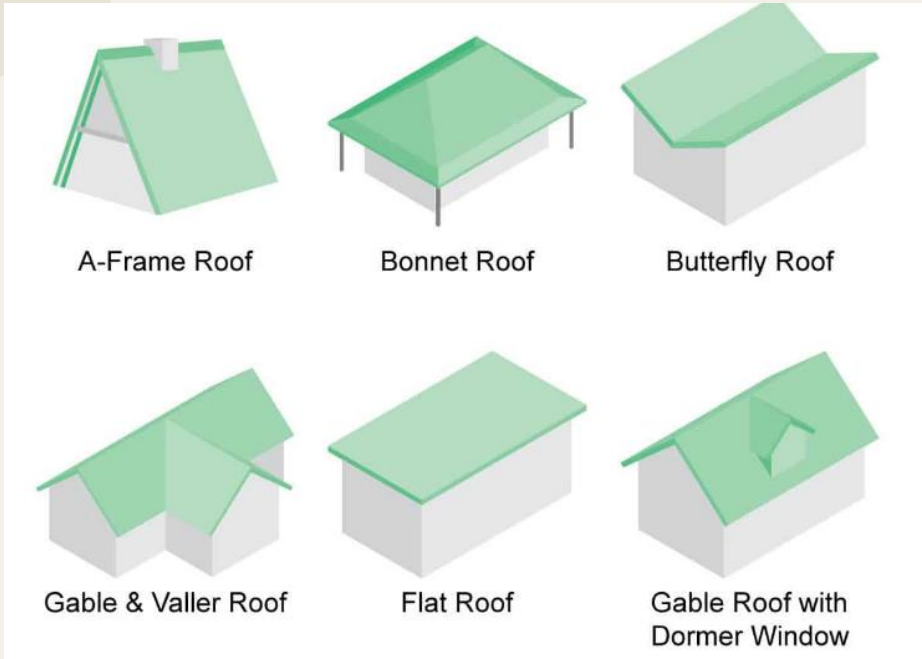
4. Roofs

Types;

- ✓ **Flat roof:** usable for AC units, tanks, solar panels
- ✓ **Sloped roof:** better for rain drainage
- ✓ **Truss roof:** strong, lightweight for wide spans

Roof Loads; Roofs must carry:

- ✓ Self-weight
- ✓ Rainwater
- ✓ Snow (in some regions)
- ✓ Wind pressure



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5. Ceilings

- A **ceiling** is the **upper interior surface** of a room. It is the **visible underside of a structural slab** or **roof** and often includes applied materials and finishes used for:
  - ✓Aesthetics
  - ✓Lighting
  - ✓Acoustics
- In most buildings, the structural ceiling is concrete, and interior designers create a false ceiling or dropped ceiling below it to improve design and function.

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Parts of a Ceiling System

1. Structural Layer (top)
- ✓ Reinforced concrete slab or roof system
- ✓ Supports loads above

2. Services Layer (middle)
- ✓ Electrical cables
- ✓ AC ducts
- ✓ Sprinkler pipes
- ✓ Internet and data networks
- ✓ Plumbing for bathrooms above

3. Finish Layer (bottom)
- ✓ Gypsum boards
- ✓ Wooden panels
- ✓ Stretch fabric ceilings
- ✓ Acoustic tiles

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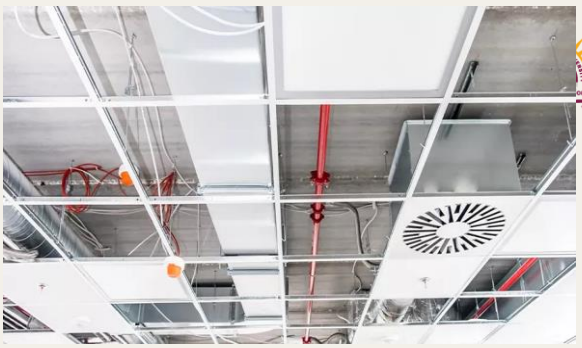

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3. Load Transfer Path

Understanding load path helps interior designers avoid unsafe modifications.

How loads travel:

1. People/furniture/equipment → **Slab**
2. Slab transfers load → **Beams**
3. Beams transfer load → **Columns**
4. Columns transfer load → **Foundation**
5. Foundation transfers load → **Soil**

Simple visualization:

Slab = sheet
Beam = support under sheet
Column = legs
Foundation = feet

4. Why Horizontal Structural Systems Matter in Interior Design

A. They Affect Ceiling Designs and Lighting

- ✓ Slabs and beams determine the maximum height of the ceiling.
- ✓ Beams create **drops** (lower sections) that can block lighting or ventilation ducts.

Solutions;

- ✓ Designers need to plan **false ceilings** to hide beams, pipes, and wires.
- ✓ Lighting fixtures (such as spotlights, LED strips, chandeliers) must be positioned **between beams**, not under structural obstructions.
- ✓ Rooms with deeper beams may require different **ceiling design styles**, such as:
  - Coffered ceilings
  - Cove lighting
  - Layered ceilings

B. They Limit Placement of Heavy Elements

What is a heavy element in interiors?

- Stone-clad walls
- Granite countertops
- Library shelves full of books
- Large aquariums
- Piano or musical equipment
- Water tanks
- Gym equipment

Why is this important?

Slabs are designed to carry a **limited load (kN/m²)**.

Placing very heavy items without checking load capacity can cause:

- Cracks
- Sagging floors
- Structural failure

C. They Control Acoustics, Insulation, and Finishes

Structural relation to sound and temperature:

- ✓ Concrete slabs block sound well but may transmit impact noise (footsteps, moving chairs).
- ✓ Lightweight floors (wood) need extra insulation.
- ✓ Roof slabs affect heat gain (especially in hot climates).

Interior design considerations:

- ✓ Sound insulation materials may be added:
  - Acoustic mats under flooring
  - Suspended ceilings with mineral wool
- ✓ Thermal insulation is important for:
  - Top floors
  - Rooms under roofs

Finishes affected:

- ❑ Ceramic tiles → cold, strong, heavy
- ❑ Carpets → warm, lightweight, sound-absorbing
- ❑ Wood flooring → comfortable, requires dry slab
- ❑ Marble → very heavy, requires slab capacity check

Example:

An interior designer might choose acoustic ceiling tiles in office spaces to reduce echo caused by flat concrete slabs.

D. They Restrict Cutting and Drilling (to Keep the Building Safe)

Why cutting is dangerous:
Slabs and beams contain **steel reinforcement bars (rebar)**.
Cutting or drilling too deep can:

- ➢ Break rebar
- ➢ Reduce strength of slab
- ➢ Cause cracks and collapse

What interior designers must avoid:

- ❌ Cutting openings in slabs for skylights
- ❌ Making large ducts through beams
- ❌ Drilling deep holes for AC, electrical, or plumbing

What is allowed:

- ✓ Shallow drilling (2–3 cm) for screws and anchors
- ✓ Cutting only after **structural engineer approval**

Simple Summary for Students

Horizontal systems:

- ❖ Control the look of ceilings and lighting
- ❖ Determine where heavy items can be safely placed
- ❖ Affect acoustic and thermal comfort
- ❖ Must not be cut or drilled without permission

5. Simple Examples & Calculations

Example 1: Load on a Floor Area

A small room has a slab area of 4 m × 3 m. The design load is 2 kN/m².

Required:

Find the total load the slab must carry.

Solution:

Load=Area×Load per m²

Load=(4×3)×2= 12×2= 24 kN

👉 The slab carries **24 kN**.

Example 2: Beam Load from Slab

A 4m × 4m slab is supported by two beams. Total slab load = 40 kN.

Required:

How much load does each beam carry?

Solution:

Slab load is shared equally:

Load per beam= 40/2 =20 kN

👉 Each beam carries **20 kN**.

Example 3: Checking Floor Capacity for Interior Items

Floor capacity = 3 kN/m²A marble bathtub weighs 1.8 kN/m². Interior finishes add 0.8 kN/m².

Required:

Is the floor safe?

Solution:

$$1.8+0.8=2.6\ kN/m^2$$

Floor capacity = 3.0 →

2.6 < 3.0 → Safe

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3. K. Janamian and J. Aguiar, *Concrete Materials Technology: A Practical Guide*, Abingdon, UK: Routledge / Taylor & Francis, 2023.