AR 251
BUILDING TECHNOLOGY-1

Winter - 2014

DR. HAITHAM SAMIR

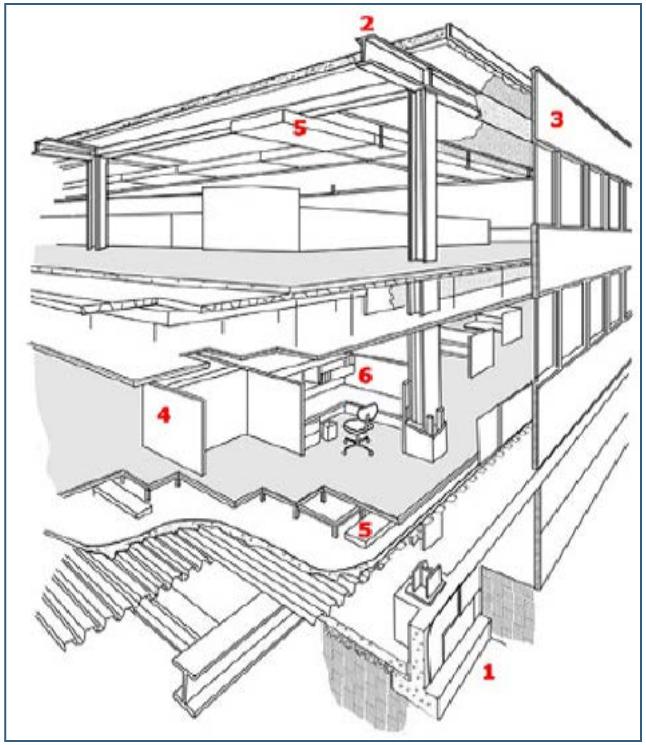
DR. AHMED M. SALEH

Lecture 2 ...

Building systems

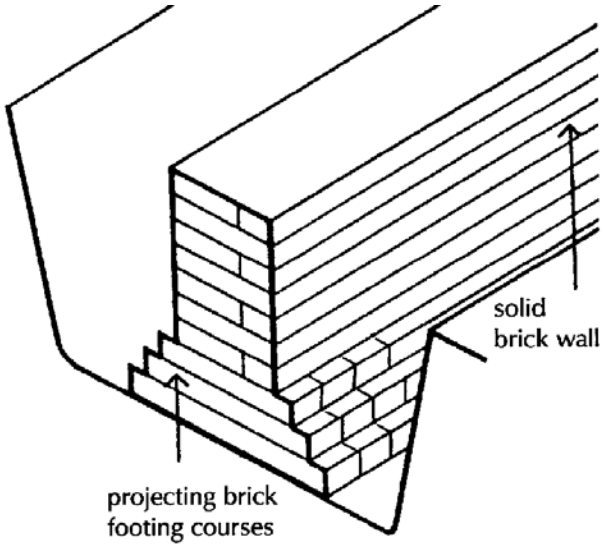
Building Systems

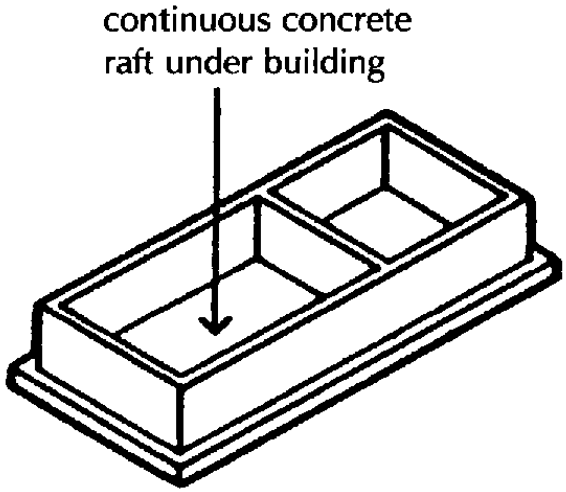
1. Substructure *(Foundation)*
2. Superstructure *(STRUCTURE)*
3. Exterior Envelope *(SKIN)*
4. Interior Partitions *(SPACE PLAN)*
5. Mechanical Systems *(SERVICES)*

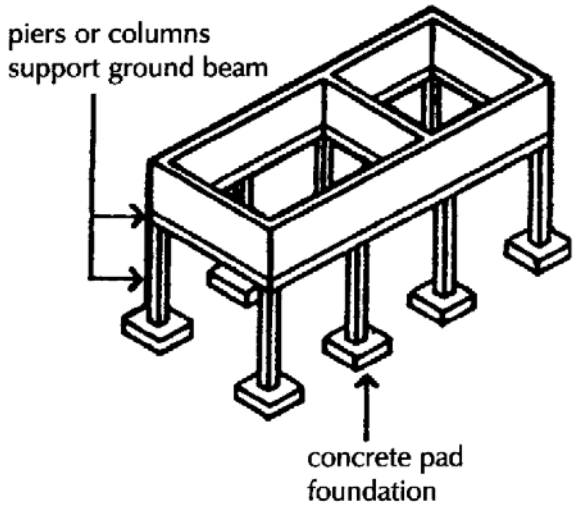


1.Sub structure (Foundation)

1. Transfer superstructure loads to subgrade condition
2. Act as subgrade exterior envelope
3. Resist lateral loading from below and above







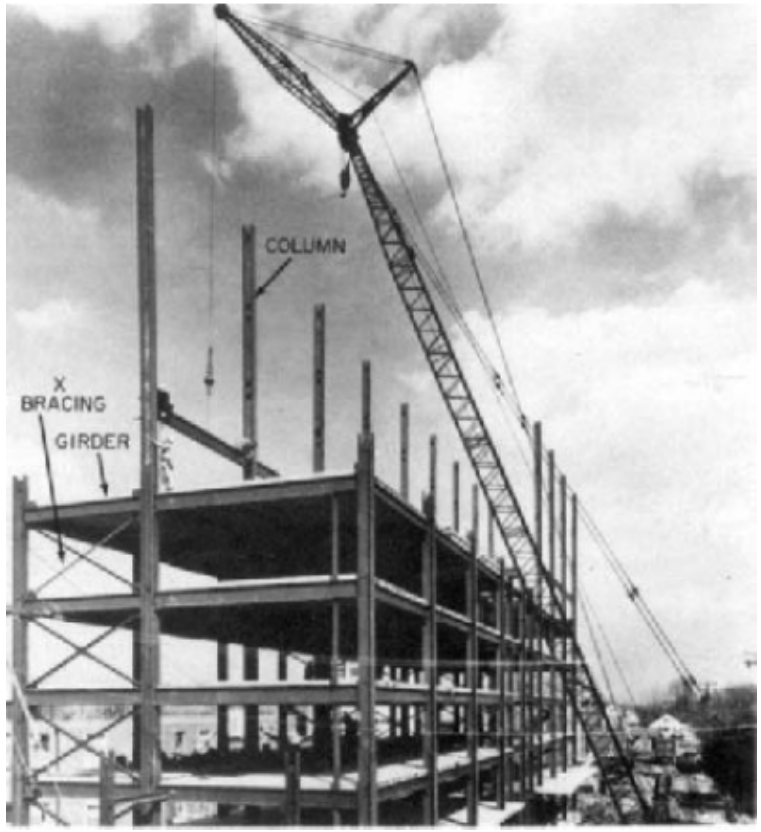
2.Superstructure *(STRUCTURE)*

1.Transfer vertical dead and live loads

2.Transfer lateral loading on exterior surfaces of building

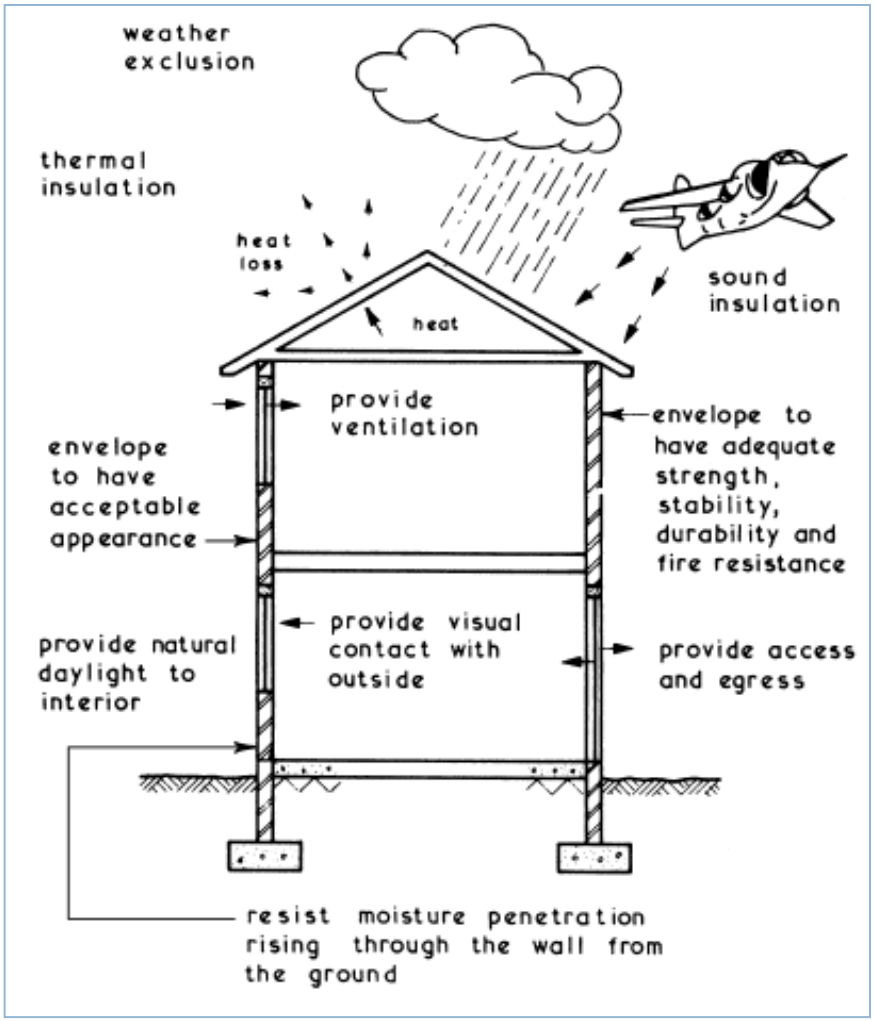
3.Provide rigidity and limit deflection

4.Provide armature for the suspension and support of secondary structure and other building systems such as the exterior envelope, mechanical systems, interior partitions etc.



3.Exterior Envelope *(SKIN)*

1. Mediate between interior and exterior environments means:
2. Control of thermal flux
3. Control of light energy
4. Transfer of loads (primarily self weight and lateral)
5. Control of acoustic flux
6. Provide delineation of interior space for programmatic activities
7. Define character of building on urban and architectural scales



5.Mechanical Systems *(SERVICES)*

Maintain interior environment through service to the space with:

- **Air distribution systems (ventilation)**
- **Water distribution systems (plumbing)**
- **Heating and cooling systems**
- **Electrical distribution systems**
- **Artificial lighting**
- **Data distribution systems**
- **Fire detection, and alarm systems**
- **Vertical circulation systems (elevators)**

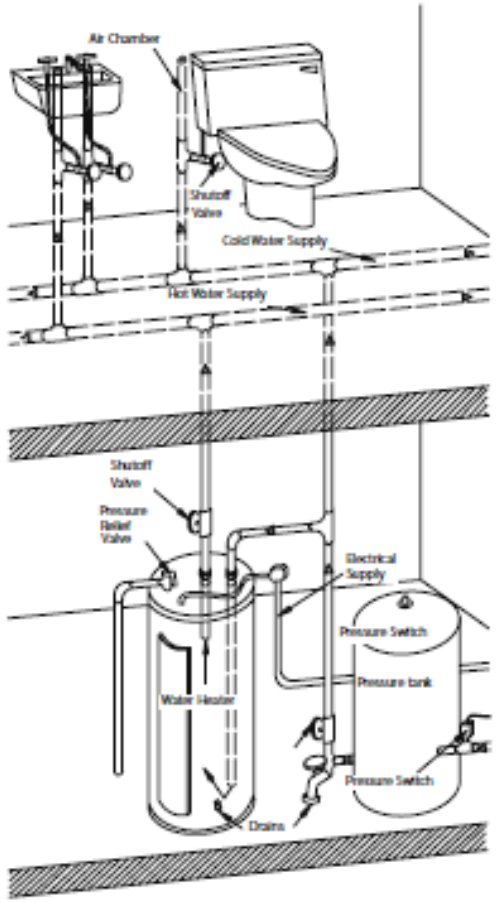
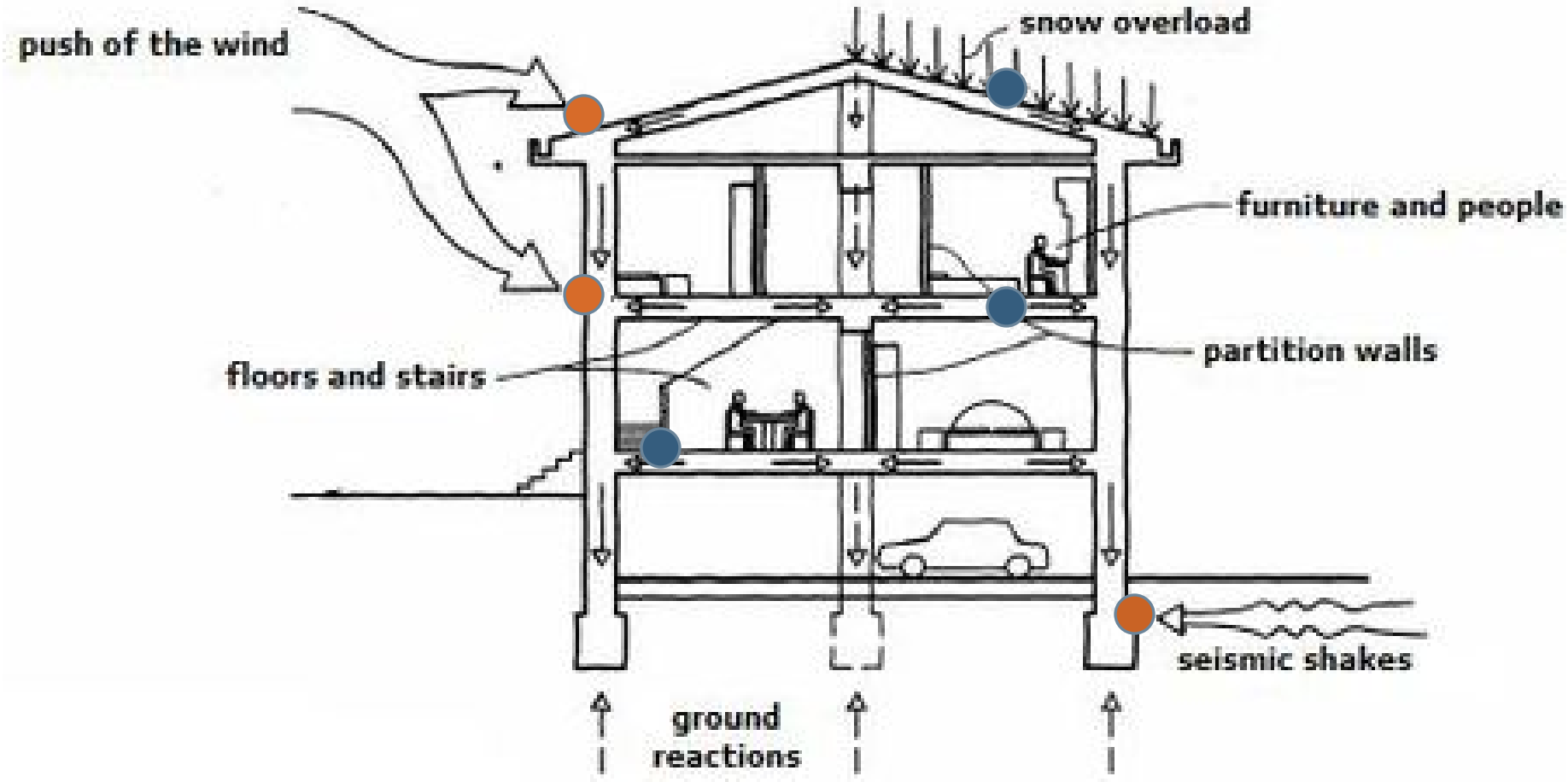
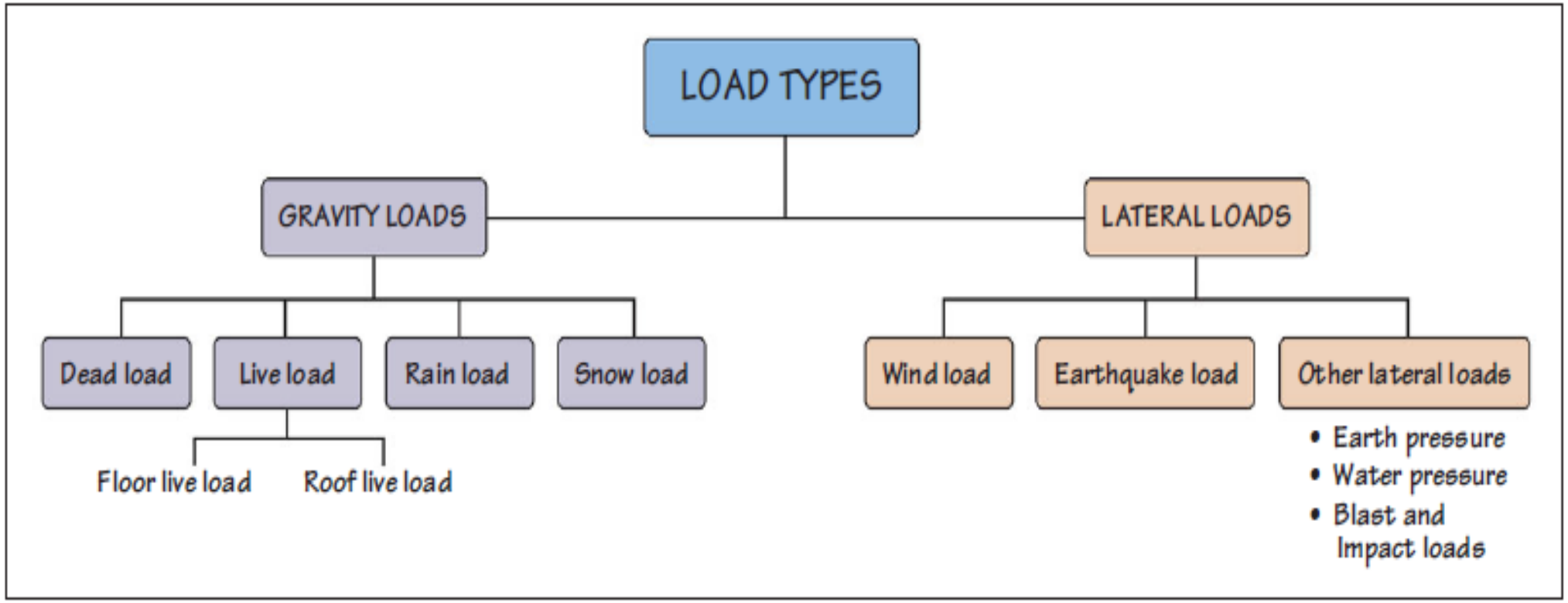


Figure 8-2 Supply plumbing.

Loads in Buildings



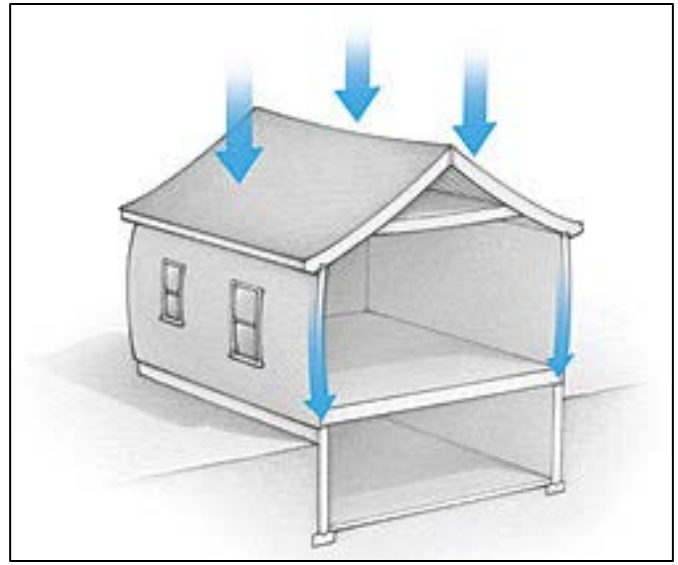
Important Loads in Buildings



Dead Loads

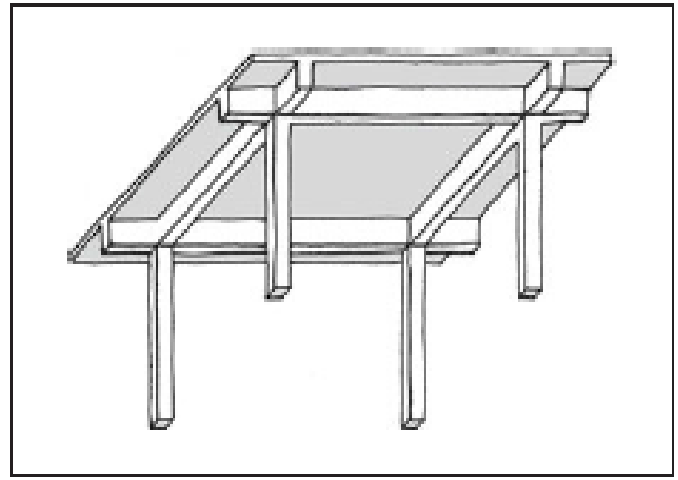
What it means:

Dead loads are the loads incurred due to the weight of all the materials used in the construction of a building. Dead loads can vary greatly depending on the type of construction and the interior finishes.



What it affects:

Dead loads have an effect on all structural members of a house. The loads are a constant over the life of the structure, and they have a big impact on the long-term.



Live Loads

What it means:

Live loads are produced by the users of a building. These loads include the weight of people, their furniture, their storage items, and movable equipments. A live load is most applicable to floors, but it can apply to roofs during repair projects due to the weight of workers and their materials.



What it affects:

Live loads exert force on almost all of a building's structural components. The goal is to design floor systems that limit deflection and vibration. Safety considerations require that the worst expected situation be considered

Live Loads

Occupancy	Description	Load (psf)
Access floor system	Office use	50
	Computer use	100
Auditoriums	Fixed seating areas	60
	Movable seating areas	100
	Stage areas and enclosed platforms	125
Garages	Passenger cars	40
Hospitals	Wards and rooms	40
	Operating theaters	60
Libraries	Reading rooms	60
	Stack rooms	150
Manufacturing	Light	125
	Heavy	250
Offices	General office	50
	Corridors	80
	Lobbies	100
Residential dwellings	Dwellings and hotel guest rooms	40
	Habitable attics	30
	Corridors, public spaces, and balconies	100
Schools	Classrooms	40
	Corridors and lobbies	80
Stores	Light	125
	Heavy	250

Rain Load

What it means:

Rain load is the weight of rainwater that accumulates on a roof. This type of load is typically an issue only on very low-slope roofs. Water accumulation occurs on roofs that are provided with parapet



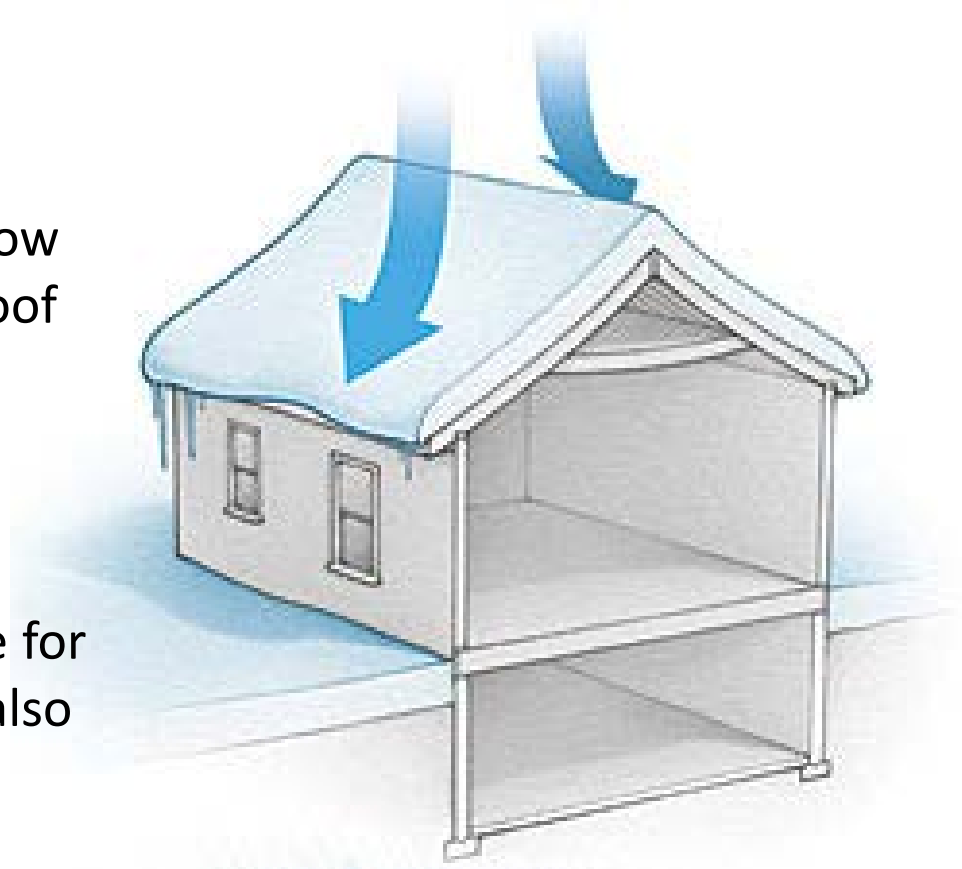
What it affects:

Roofs may deflect under the weight of water. This deflection leads more accumulated water, causing additional deflection.

Snow Load

What it means:

Snow load is the weight of snow uniformly distributed on the roof or piled into drifts. Snow that slides from an upper roof onto a lower roof also can add significantly to snow load.



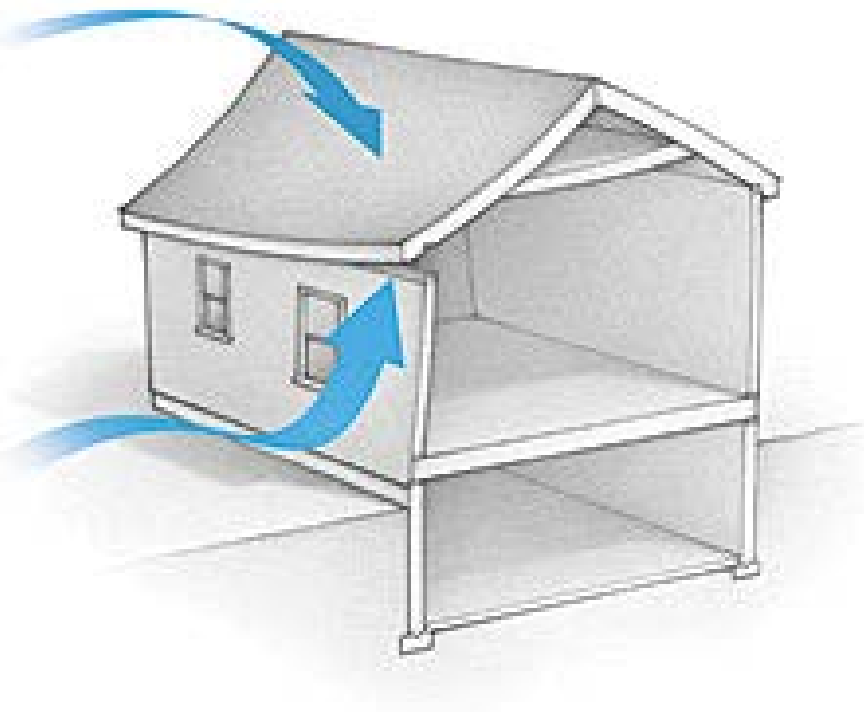
What it affects:

Roof and wall framing is generally responsible for resisting snow loads. Floor joists and girders also may be affected depending on the framing configuration.

Wind Load

What it means:

Wind loads are the positive or negative pressures exerted on a house when it obstructs the flow of moving air. Wind loads generally act perpendicular to the surfaces of the house.



What it affects:

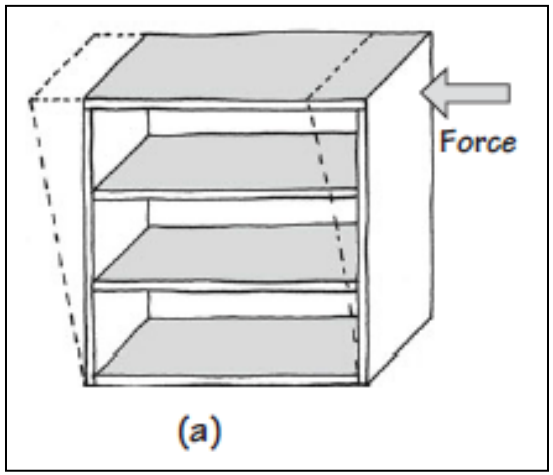
The significance of the load varies depending on the geographic location of the house, its height, and its roof pitch.

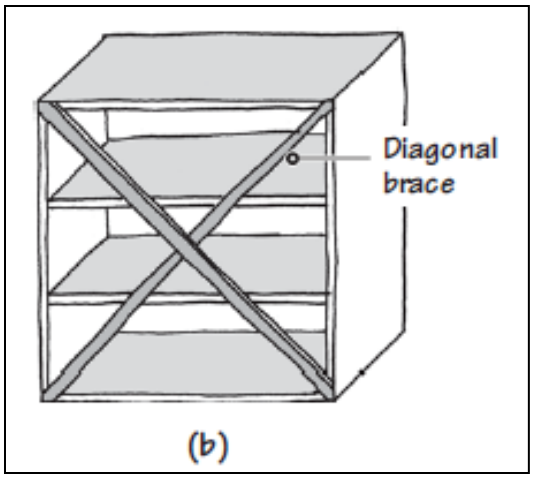
Wind loads have the most significant impact on roof, and large openings, especially those near building corners.

Wind Load Basics

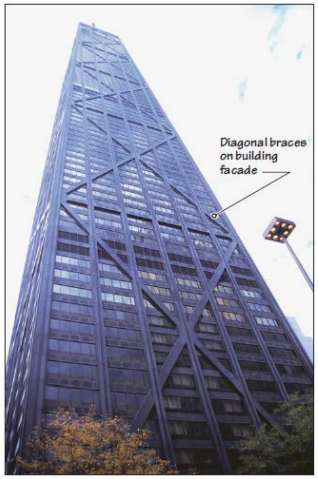
Wind Loads are primarily **horizontal**, they also exert and **upward force** on horizontal elements such as flat and low-slop roofs.

- Resistance against upward wind force is provided by anchoring the building to its foundation
- Resistance against horizontal loads requires anchorage and the use of wind bracing elements.









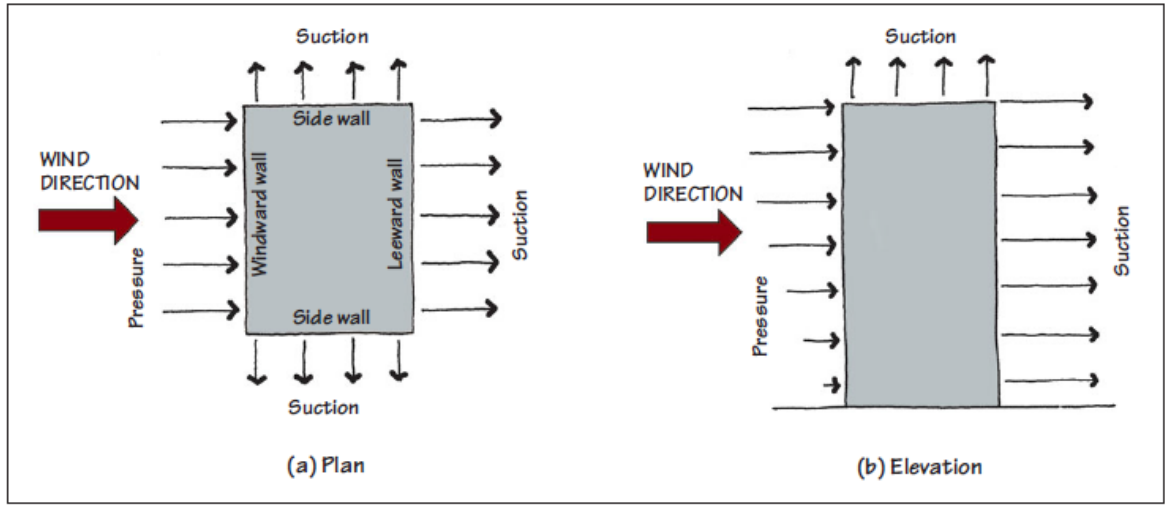
Lateral Load resistance could be provided by diagonal braces on the building exterior facade

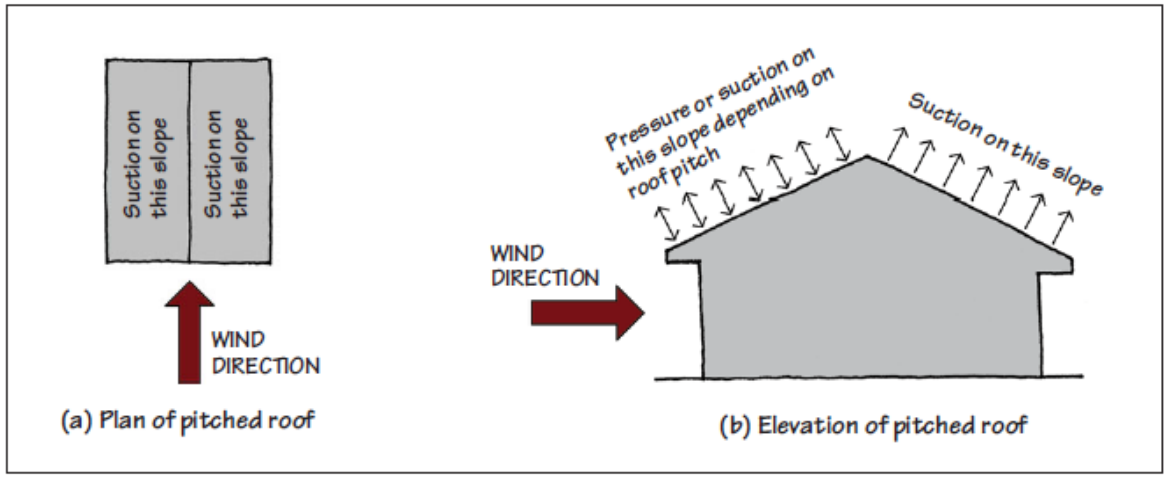
Wind Induced pressure and suction

The direction of wind pressure is always perpendicular to the building surface.

On flat roof, wind pressure is vertical. On a vertical wall is horizontal.

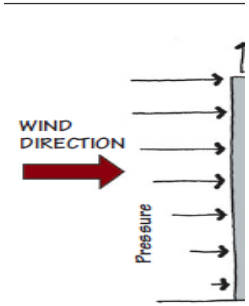
It acts either toward the surface or away from the surface (suction).



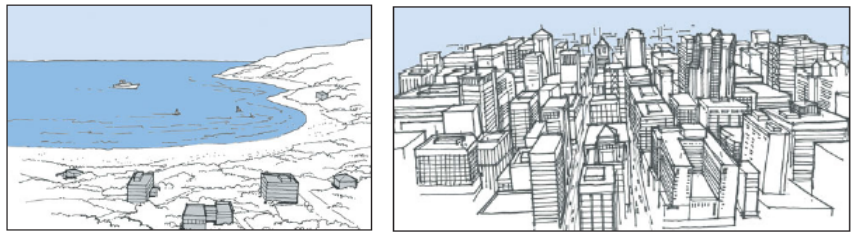


Factors Affecting Wind Load

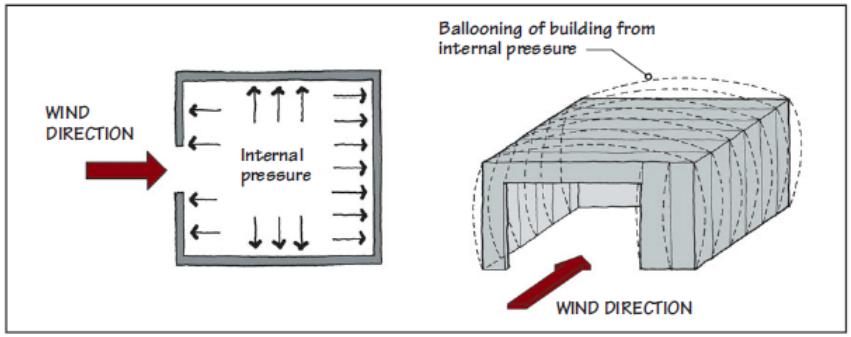
- **Height** above the ground



- **Exposure** classification of the site



- **Enclosure** classification of the building



Seismic Load

What it means:

Seismic loads are the inertial forces acting on a building due to earthquake-induced ground motions. These forces generally act horizontally on each element of the structure and are proportional to their mass. As such, heavier buildings are more susceptible to seismic loads.



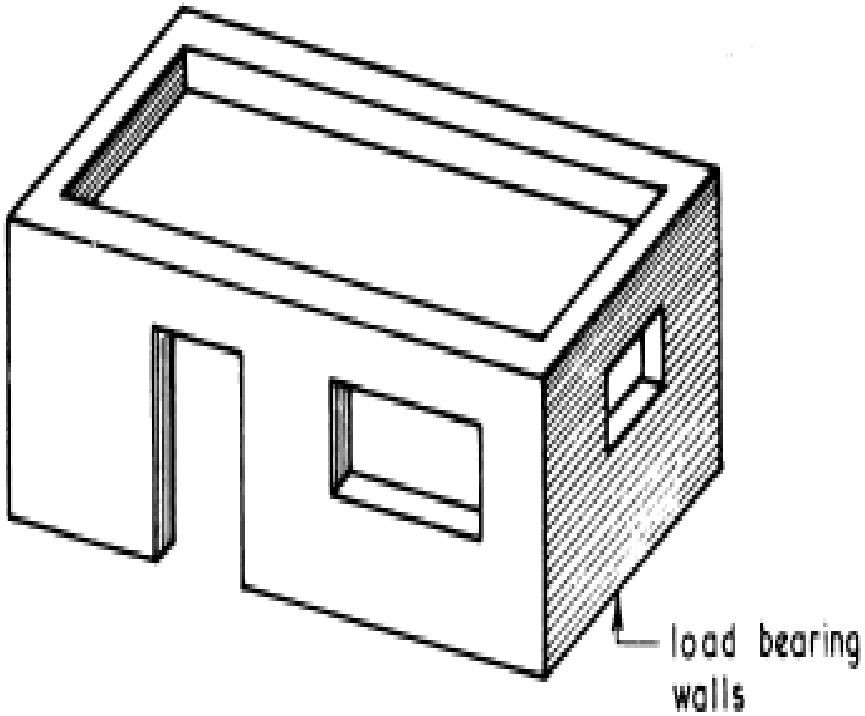
What it affects:

While the ground is displaced horizontally. The building has inertia, and it takes a period of time for horizontal displacement to travel to the upper parts of the building causing deformations.

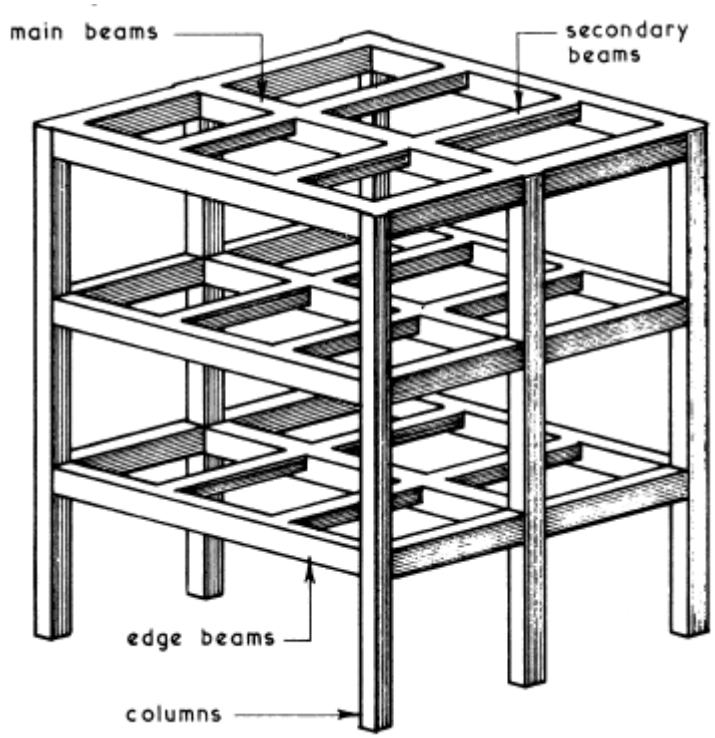
Factors Affecting Earthquake Loads

- Ground Motion
- Buildings mass and flexibility of the structure
- Type of soil
- Building occupancy risk category

Building basic forms

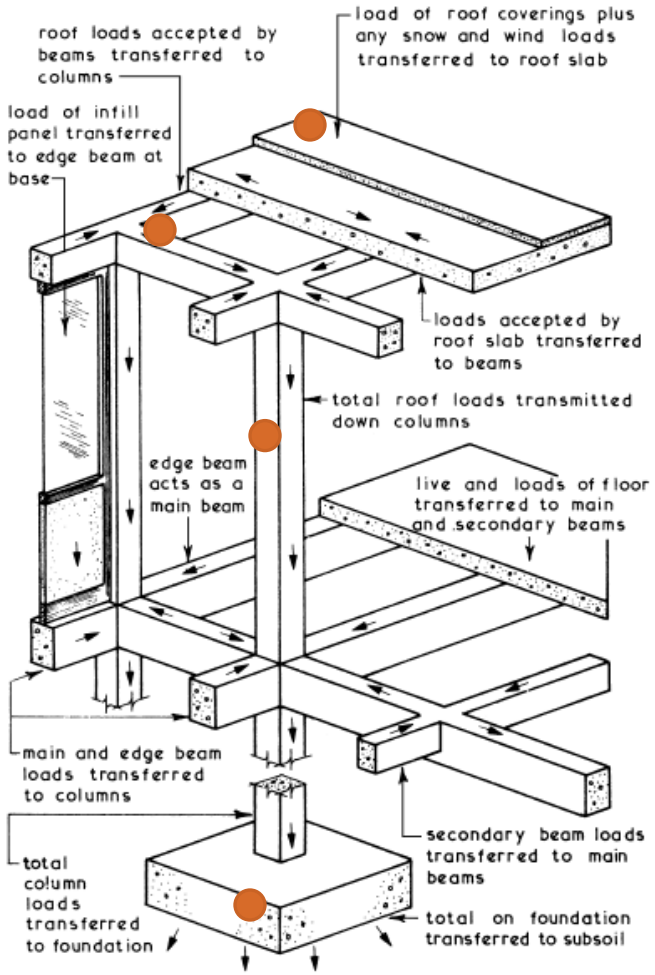


Solid construction

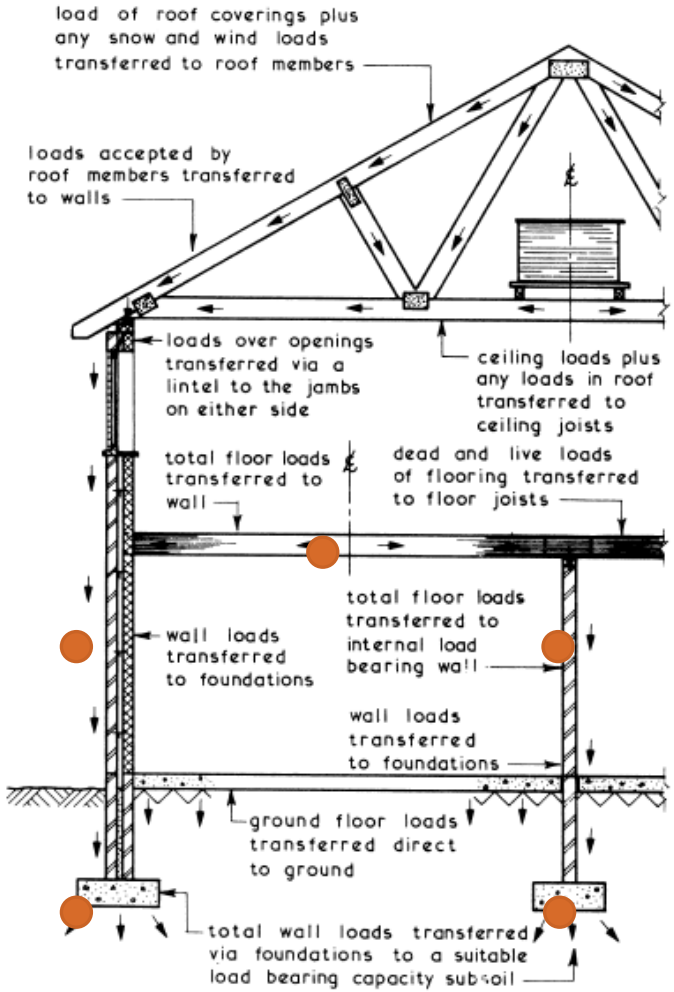


Framed or skeletal construction

Load transfer to building elements



Skeletal structures



Wall bearing structures

Loads and forces

Loads on Buildings

Gravity Loads

- Live loads
- Dead loads

Lateral Loads

- Wind loads
- Earthquake loads

generate

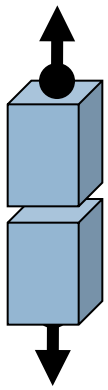
Forces in the structural system

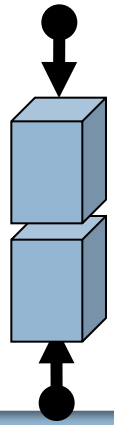
Axial

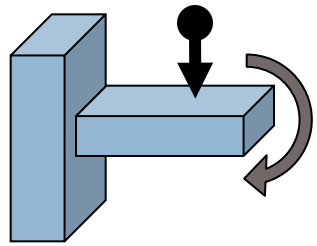
- Tension
- Compression

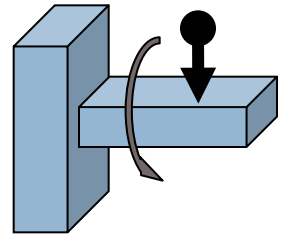
Perpendicular

- Shear
- Torsion









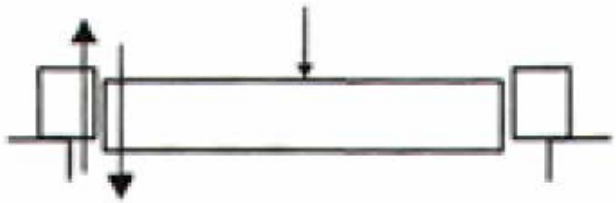
Loads and forces



Bending stresses



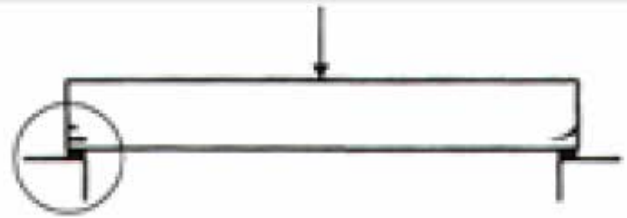
Bending failure



Vertical shear stress failure



Horizontal shear stress failure



Bearing stress failure



Torsion



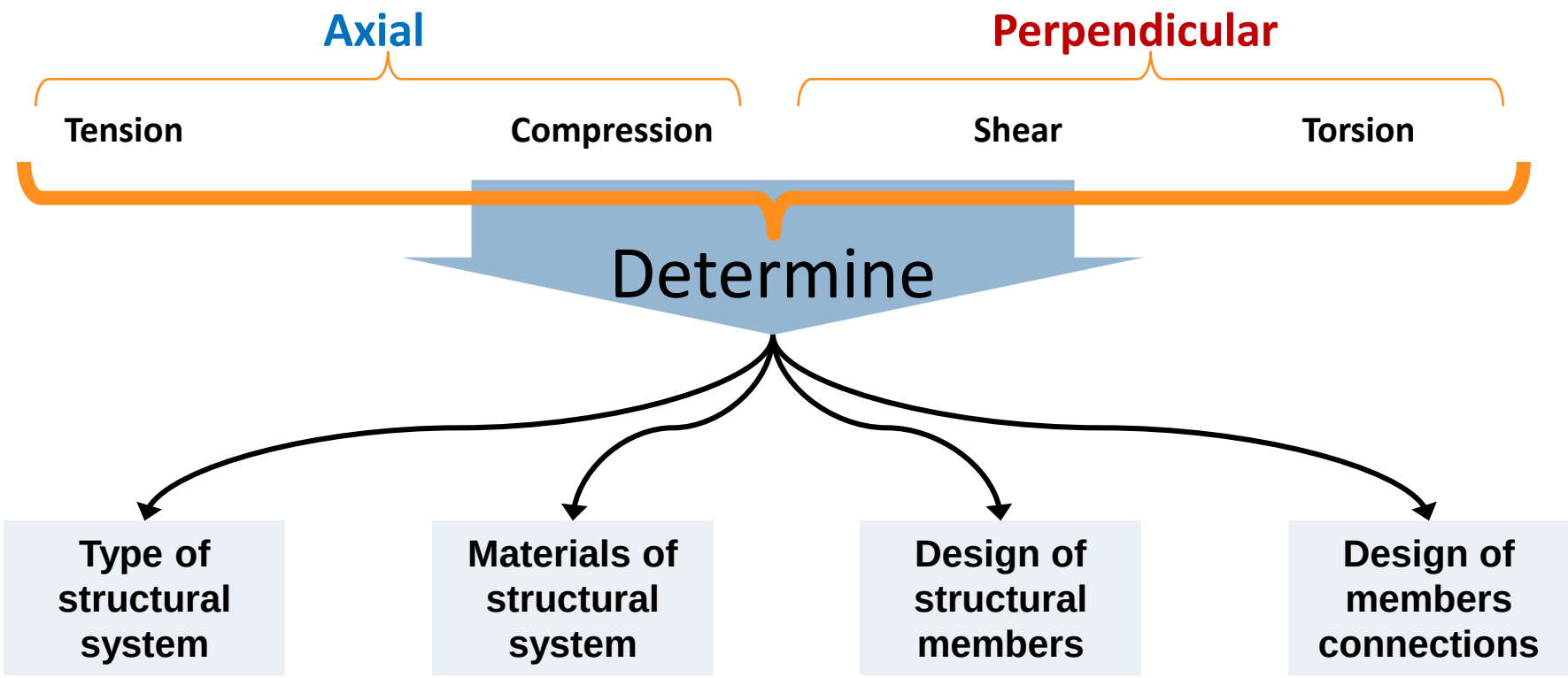
Deflections (Excessive de-formations)



Top region of beam is in compression. A beam not rigid in the lateral direction can buckle laterally because of the compressive force present.

Loads and forces

Forces in the structural system



According To building Materials

1) Stone & Brick

2) Reinforced concrete

3) Wood

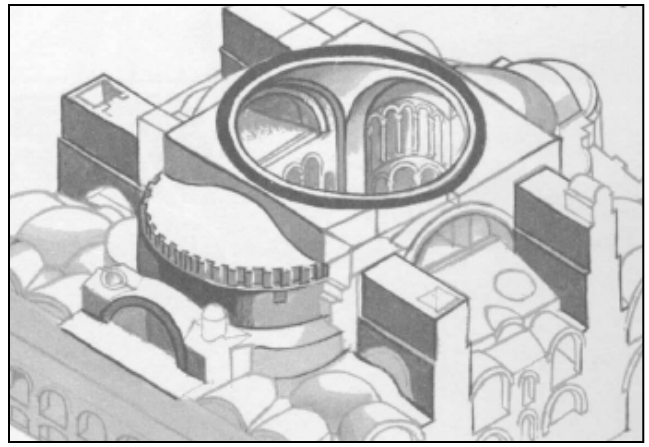
4) Steel

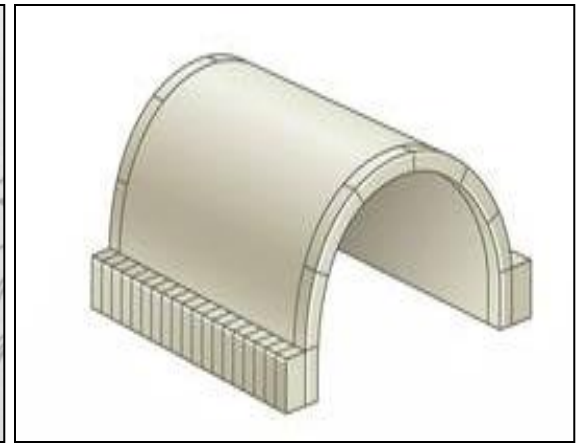
Lecture (2)

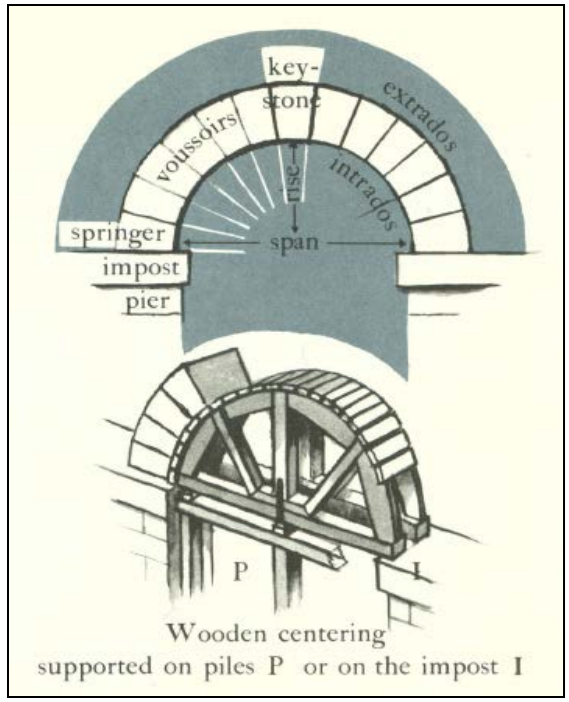
Classifications of construction systems

Stone & Bricks









Wooden centering
supported on piles P or on the impost I



Parts of an **arch**.

Lecture (2)

Types of construction

Timber



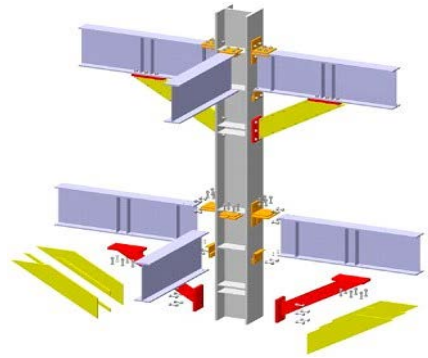




Steel







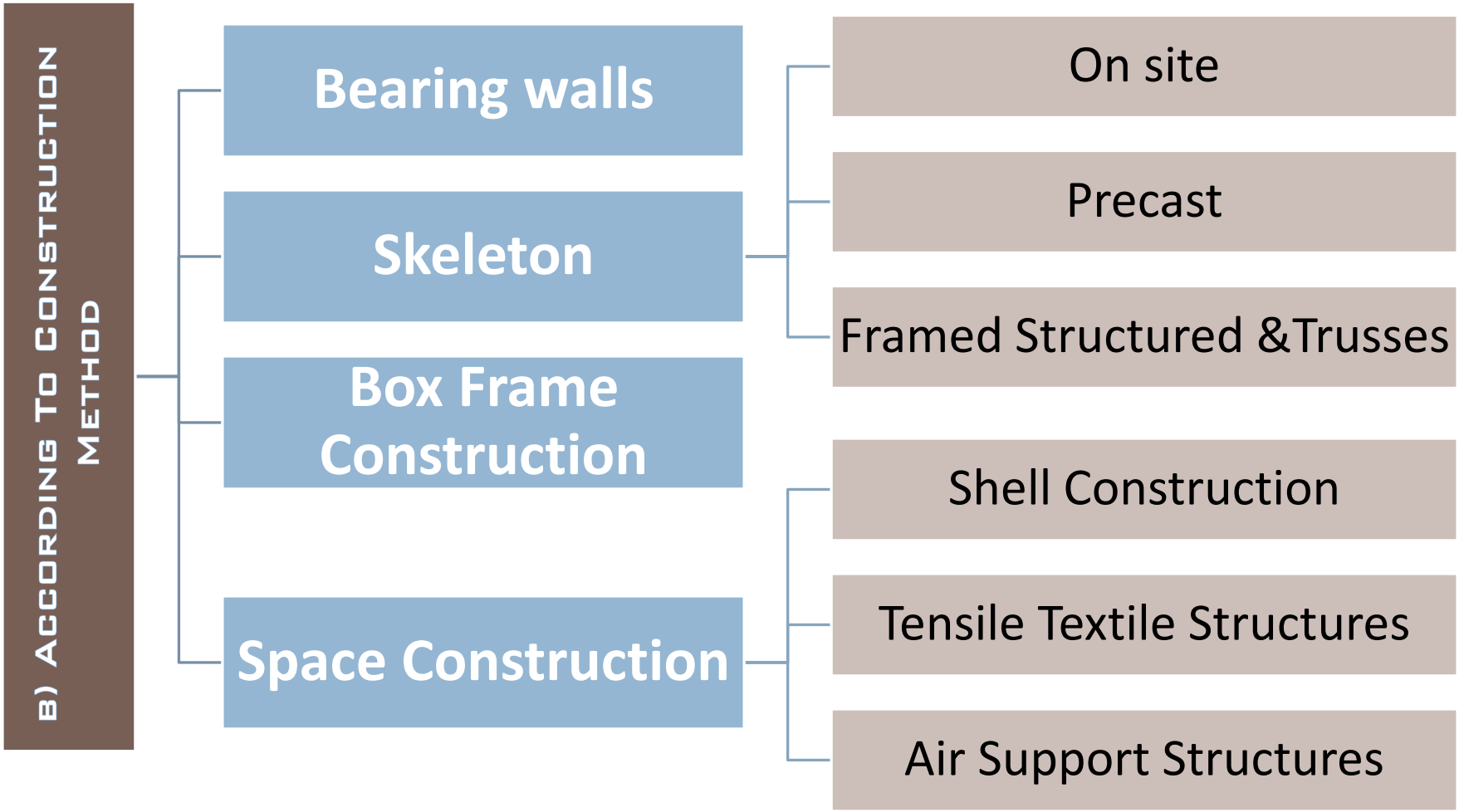
Concrete







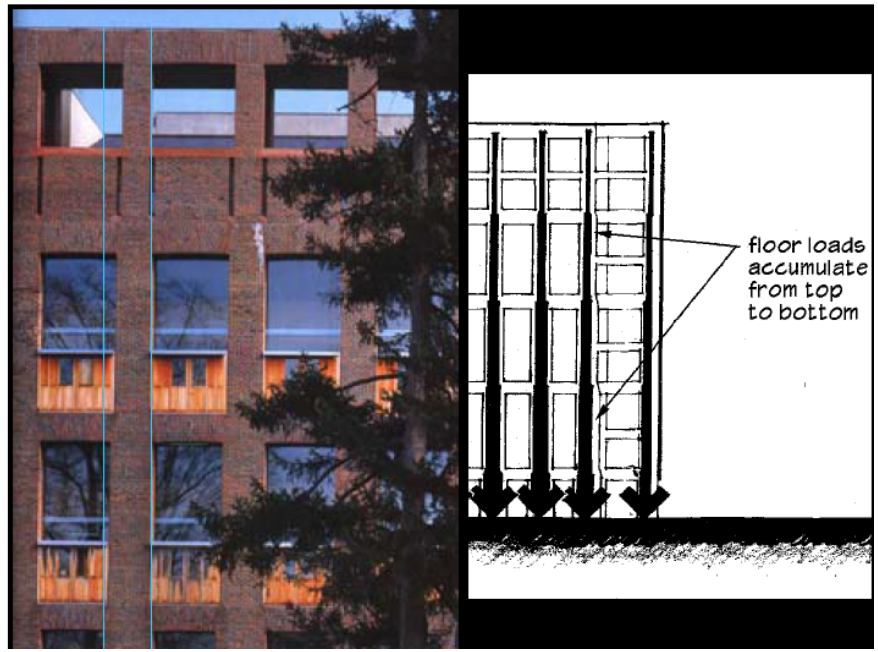
According To Construction Method



According To Construction Method

Bearing Walls





According To Construction Method

Skeleton

On site Concrete





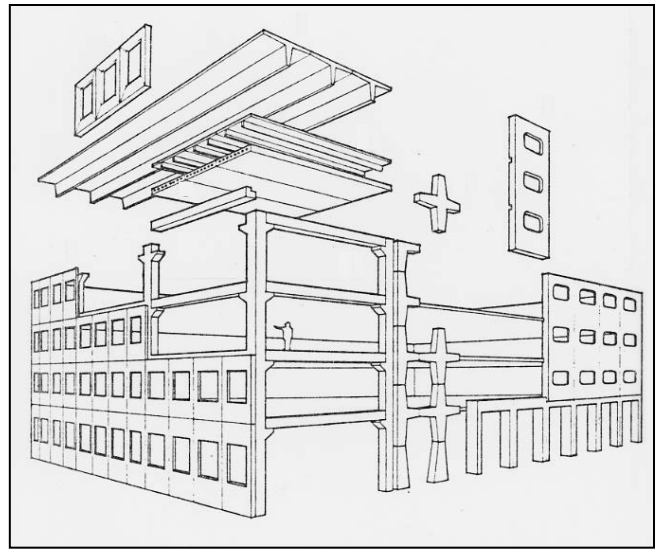
According To Construction Method

Skeleton

Pre Cast Concrete









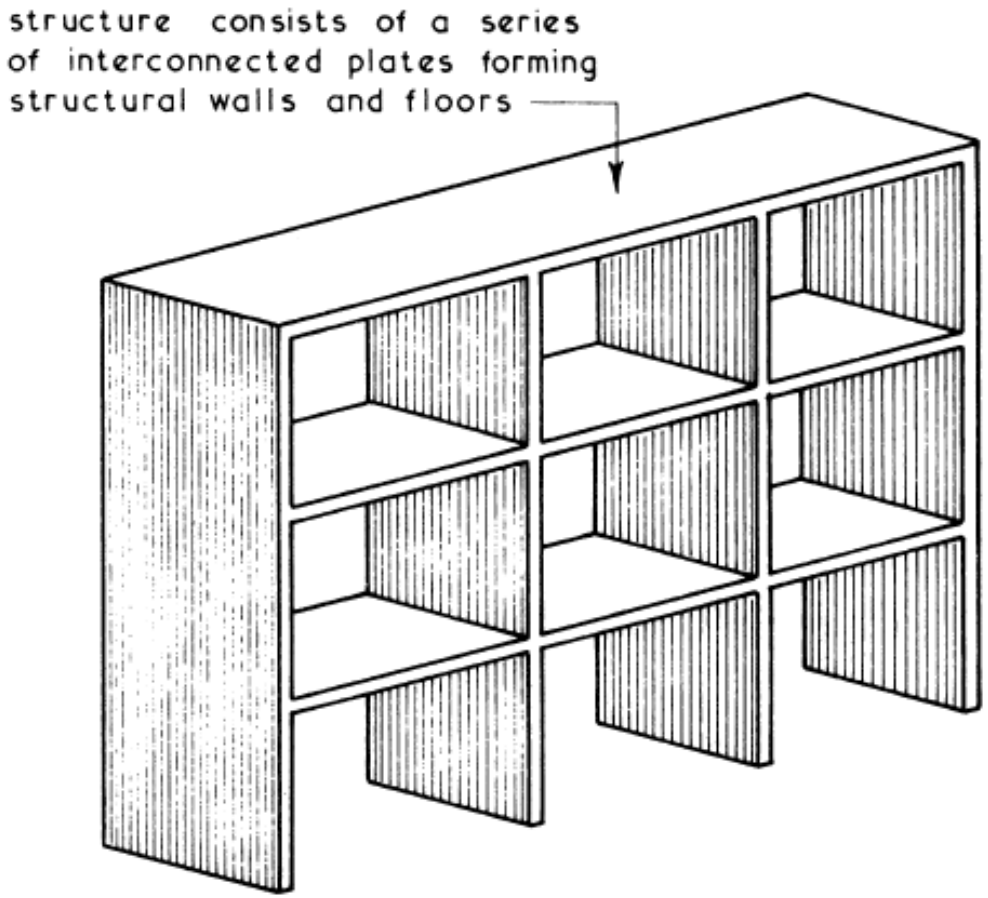




According To Construction Method

Box frame structure

method of building with concrete in which individual cells, are set horizontally and vertically together to create an overall structural frame. Because the main weight of the building is carried through the cross walls, they must be sufficiently thick to carry their own weight as well as loads from above, and so the potential height of a structure built in this manner is limited.



PANEL OR BOX CONSTRUCTION

According To Construction Method

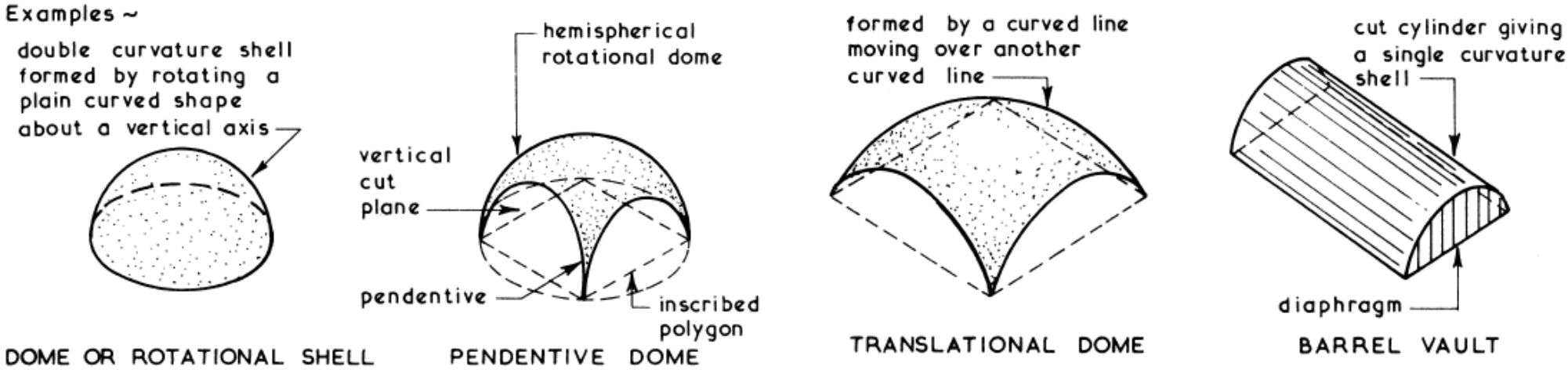
Space construction

Shell Construction



structure composed of a relatively thin shell of concrete, usually with no interior columns or exterior buttresses. The shells are most commonly flat plates and domes, but may also take the form of ellipsoids or cylindrical sections.

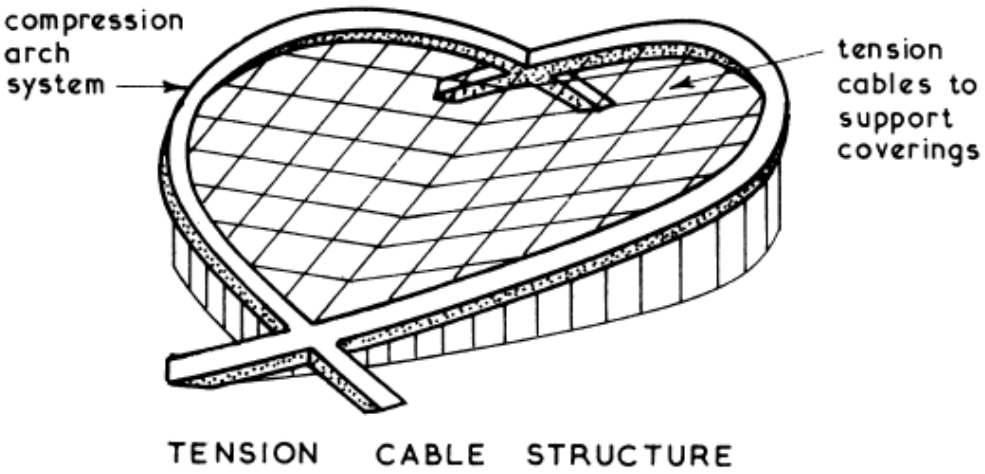
Examples ~



According To Construction Method

Tensile structure

A **tensile structure** is a construction of elements carrying only tension and no compression or bending



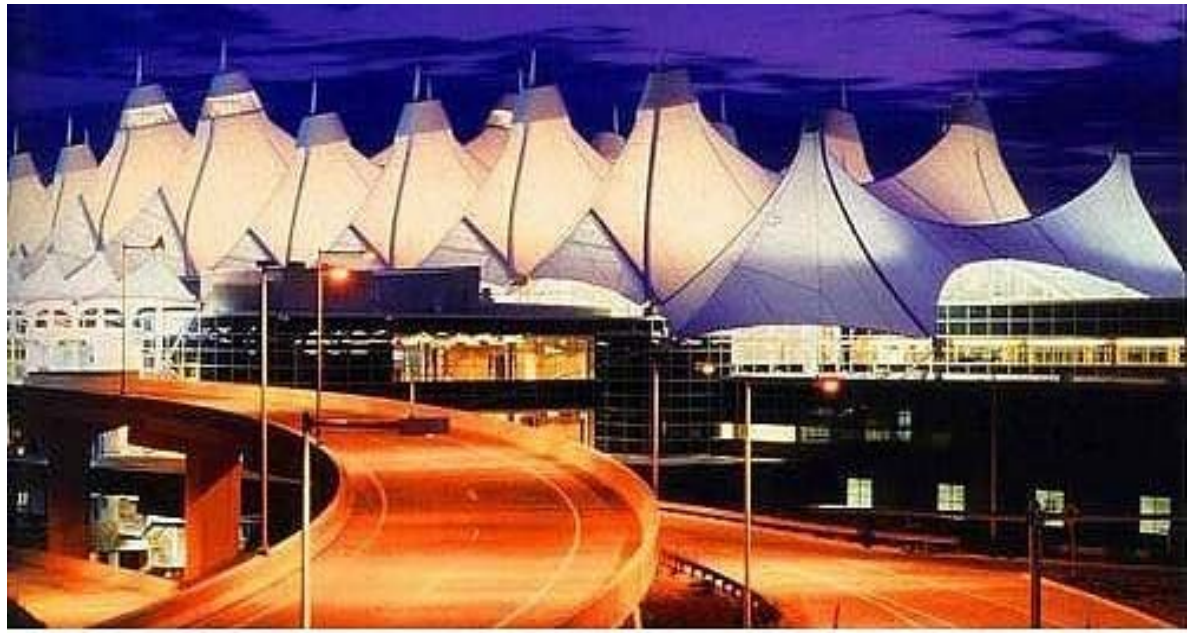
TENSION CABLE STRUCTURE

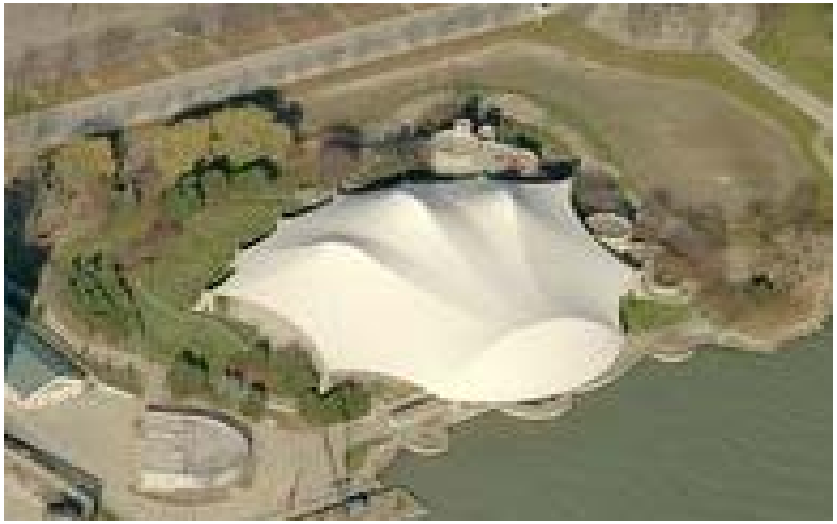


TENSION MEMBRANE STRUCTURE

According To Construction Method

Tensile structure





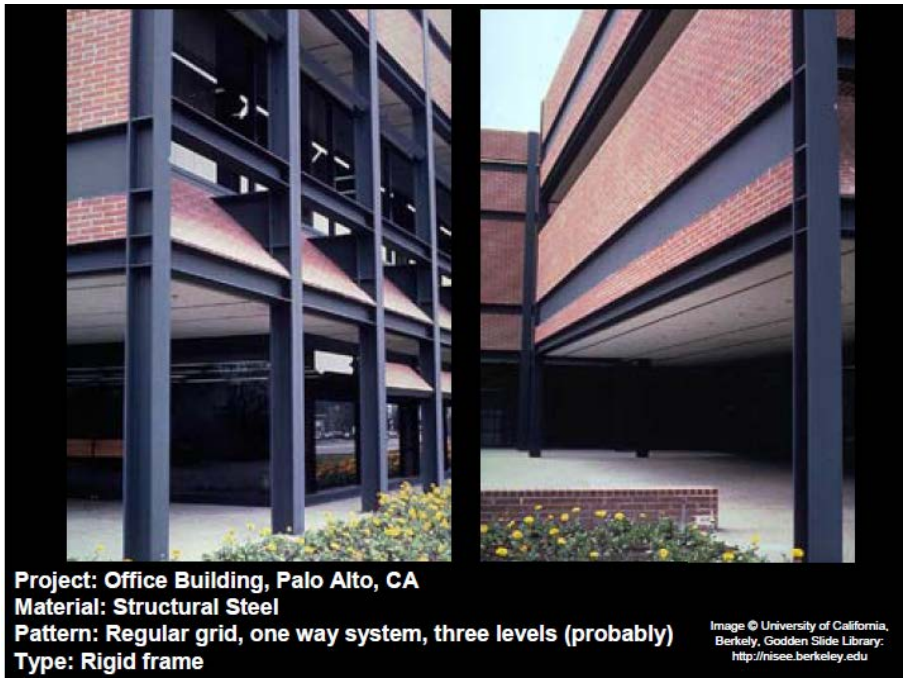


According To Construction Method

Framed Structures







Project: Office Building, Palo Alto, CA
Material: Structural Steel
Pattern: Regular grid, one way system, three levels (probably)
Type: Rigid frame

Image © University of California, Berkely, Godden Slide Library: http://nisee.berkeley.edu

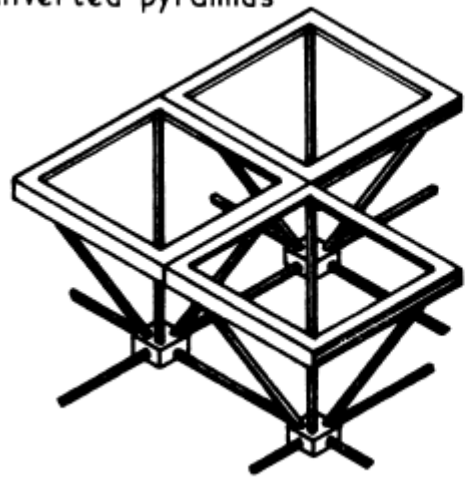


Project: Riola Church, Riola Italy (Alvar Aalto, architect)
Material: Reinforced concrete
Pattern: One-way structure, regular linear grid, three levels
Type: Rigid frame

According To Construction Method

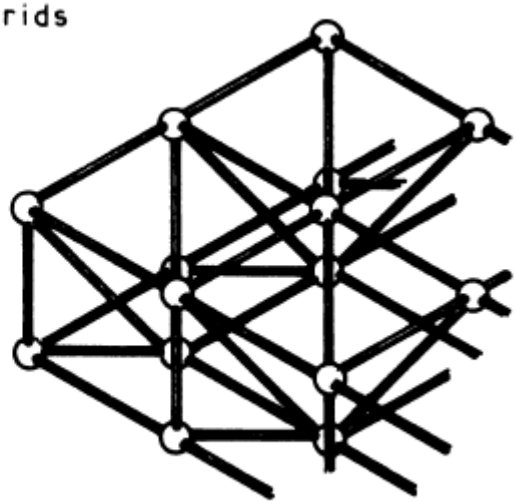
Trusses

a series of interconnected inverted pyramids

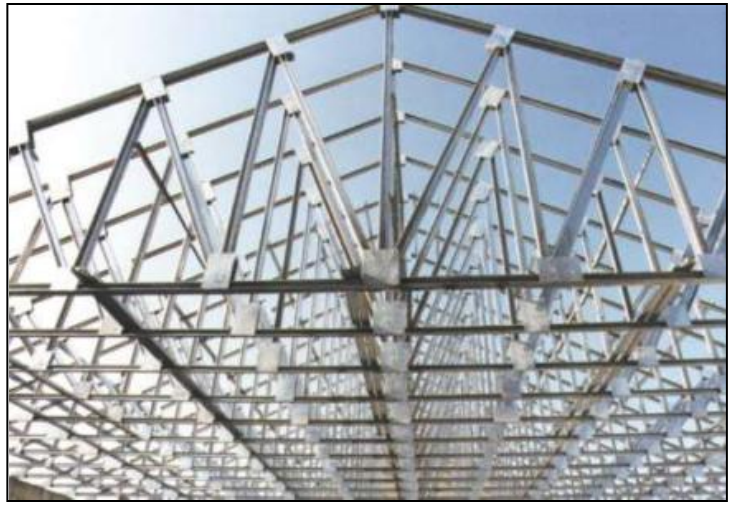


SPACE DECK

a series of interconnected grids



SPACE FRAME





According To Construction Method

Space construction

Air Supported Structures

An air- (or air-inflated) structure is any building that derives its structural integrity from the use of internal pressurized air to inflate a pliable material (i.e. structural fabric) envelope, so that air is the main support of the structure



