# BCE
# (CVE 102B)

## Module 4 – Modern construction techniques and Materials


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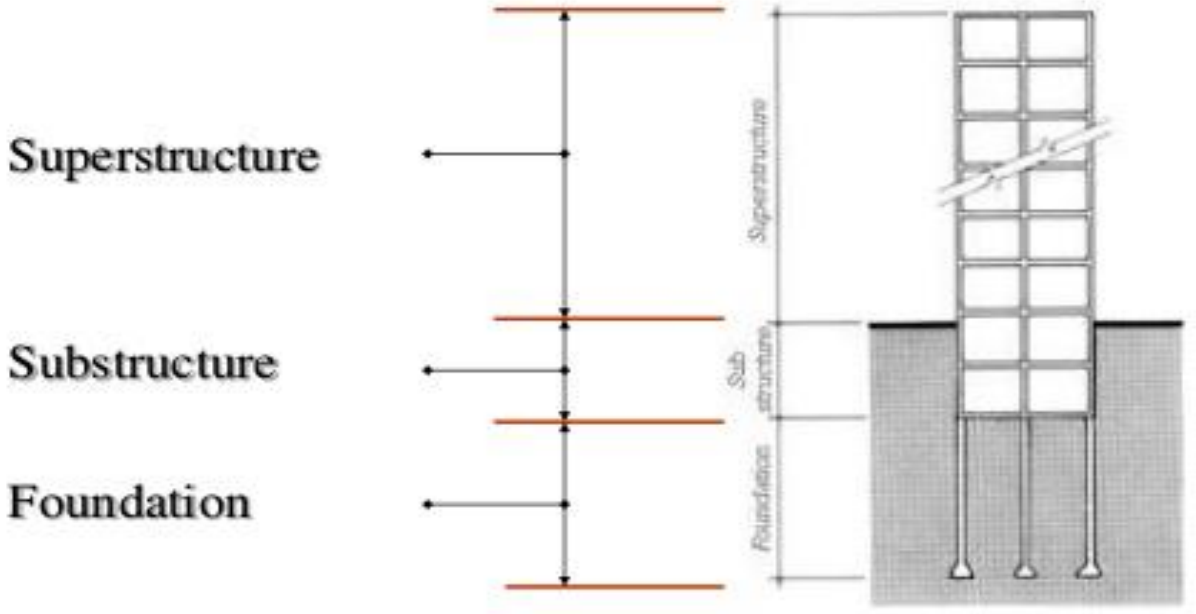
# Topics

- Basics of construction
- Construction techniques
- Conventional materials used in construction
- Ecofriendly materials
- Smart material
- Automation in construction

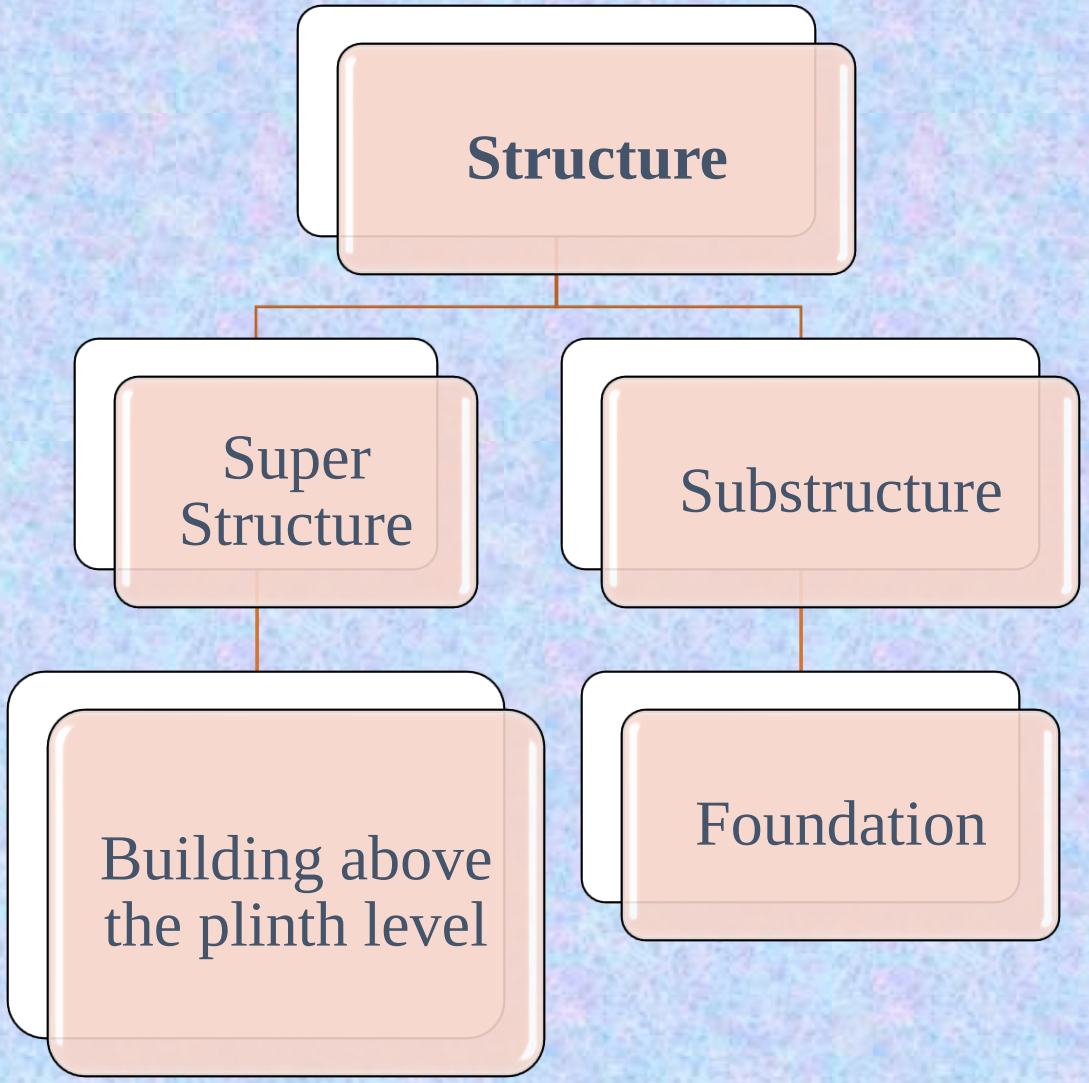
# Basics Of Construction

# Components of structures

## Major Building Parts

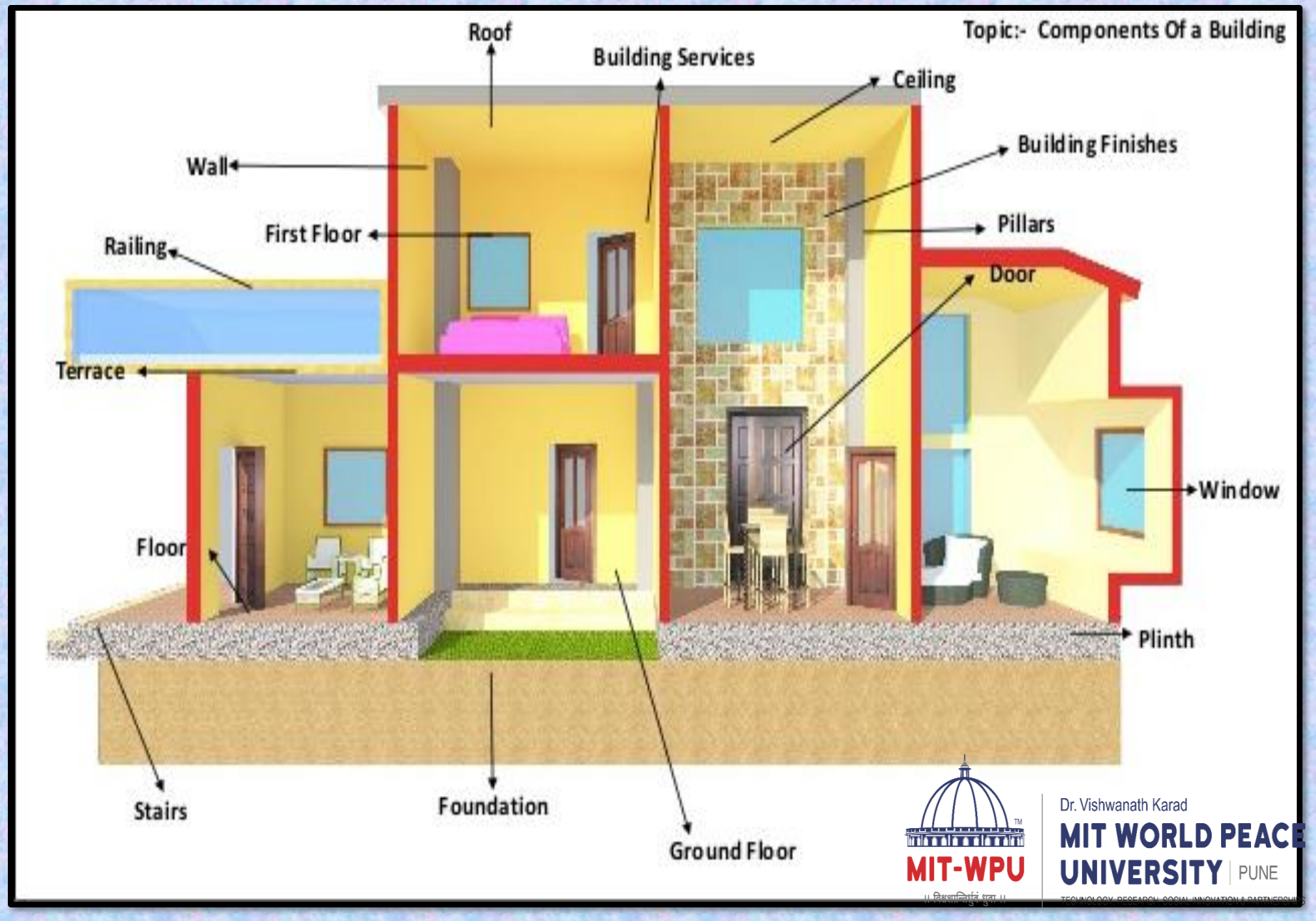


# Components of structure



# Components of structures

- **Substructure**
- **Plinth**
- **Super structure**
- **Substructure** :Substructure is the part of structure lying below the ground surface such as footing, piles.
- **Plinth** : Plinth is part of structure lying above the GL and below Superstructure
- **Super structure**: Super structure is the part of structure lying above the ground surface such as wall, doors, windows, slab.


Topic:- Components Of a Building
Roof
Building Services
Ceiling
Wall
Building Finishes
First Floor
Pillars
Railing
Door
Terrace
Window
Floor
Plinth
Stairs
Foundation
Ground Floor
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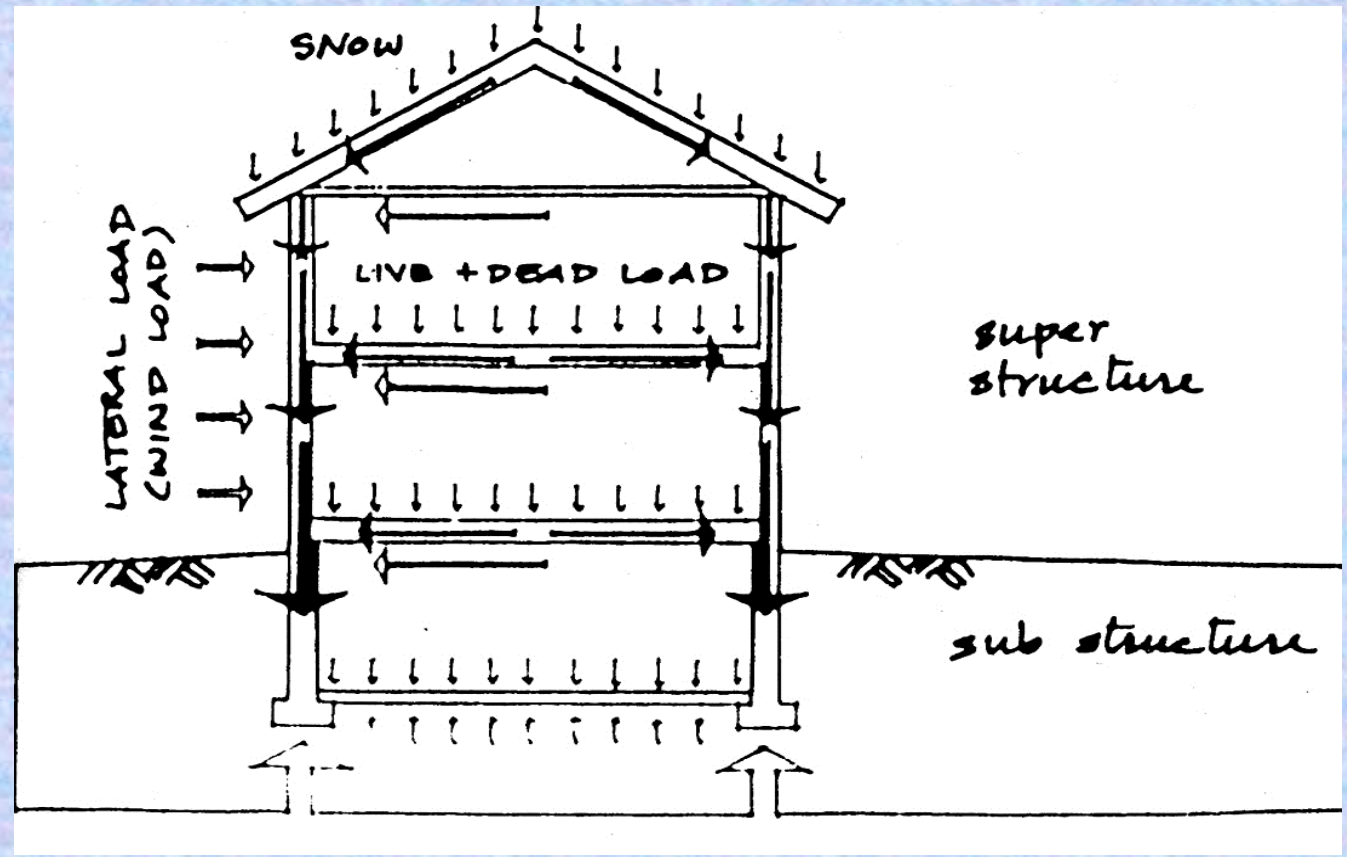
# Types of Structure

- Load Bearing Structure
- Framed structure
- Composite Structure

# Load Bearing Structure Construction

- A **load-bearing** wall or **bearing** wall is a wall that bears a **load** resting upon it by conducting its weight to a foundation **structure**.
- The materials most often used to construct **load-bearing** walls in large buildings are concrete, block, or brick.
- Load bearing structure, the loads are directly transferred to the soil through the walls that are designed to specifically carry the loads.
- Economical upto 2 storeys
- Less important Buildings

# Load Transfer Mechanism for Load Bearing Structure

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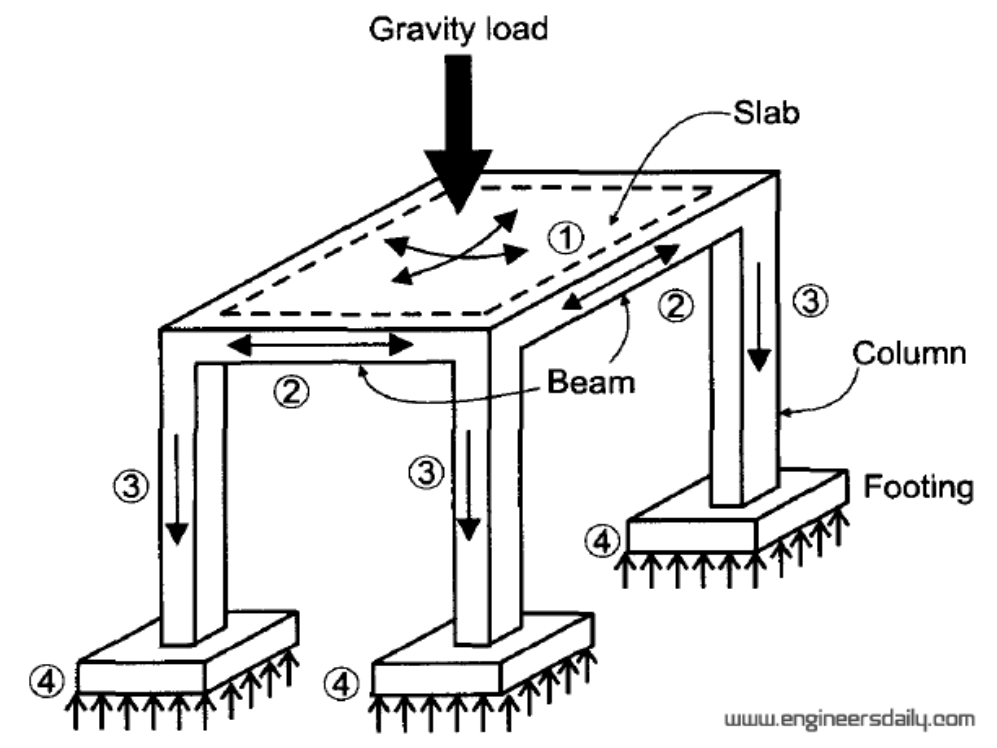
# Framed Structures

- Frame structures are the structures having the combination of beam, column and slab to resist the lateral and gravity load.

**Advantages**

- The floor area of a R.C.C framed structure building is 10 to 12 percent more than that of a load bearing walled building.
- Construction can be done upto multi storeyed building.
- Speedy construction

# Load Transfer Mechanism for Framed Structure




- It consist of frame work of columns, beams and floor.
- The loads are taken by slab, beam, column and then transfer to the foundation

# DIFFERENCE

| LOAD BEARING STRUCTURE | FRAMED STRUCTURE |
| --- | --- |
| • Cost is less<br>• Suitable up to three stories.<br>• Walls are thicker , hence floor area is reduced.<br>• Slow construction<br>• Not possible to alter position of walls after construction.<br>• Resistance to earthquake is poor | • Cost is more.<br>• Suitable for any numbers of stories.<br>• Walls are thinner hence more floor area available for use.<br>• Speedy construction.<br>• Position of walls may be changed , whenever necessary.<br>• Resistance to earthquake forces is good. |

# Composite Structure

- Combination of Load Bearing and Frame Structure
- The outer walls can be load bearing type where as column and beam structure can be provided internally
- Thus floors and roofs are supported by walls as well as frames
- Used in Industrial sheds or warehouses where spans are large.

# Foundation

# Foundation

## Definition

- Foundation  is the lower most part of the structure which provides the base for the superstructure and transmits the load of  superstructure to the subsoil without any failure.

# Functions of Foundation

**The foundation is provided for following purpose.**

- To distribute the total load coming on structure on a larger area.
- To support the structures.
- To give enough stability to the structure against various disturbing forces such as wind and rain.
- To prepare a level surface for concreting and masonry work.
- To minimize the chances of unequal settlement by distributing the load over wide area.

# Factors affecting Design of Foundation

- Load from building.
- Soil type  and ground water condition.
- Structural requirement and Foundation.
- Construction Requirement.
- Site condition and Environmental Factors.
- Economy.

# Bearing capacity



- The shear failure may result in sinking or tilting of the loaded mass
- Entire structure may collapse due to unequal settlement
- The maximum load per unit area which the soil or rock can carry without displacement is termed as the **bearing capacity of soils.**
- To know maximum load carrying capacity of the underlying soil
- Load = intensity of pressure x area
- Safe bearing capacity of soil may be defined as ultimate bearing capacity of soil divided by factor of safety.
- The ultimate bearing capacity is defined as the maximum gross pressure intensity at the base of the foundation at which the soil does not fail in shear.

  Safe bearing capacity = ultimate bearing capacity / factor of safety
- Safe bearing capacity, black cotton soil- 150kN/$m^2$ , gravel – 450 kN/$m^2$

# Settlement of Foundation

It is the vertical downward movement of loaded base.

**TYPES OF SETTELEMENT:**

- **Uniform Settlement**
- **Differential Settlement**

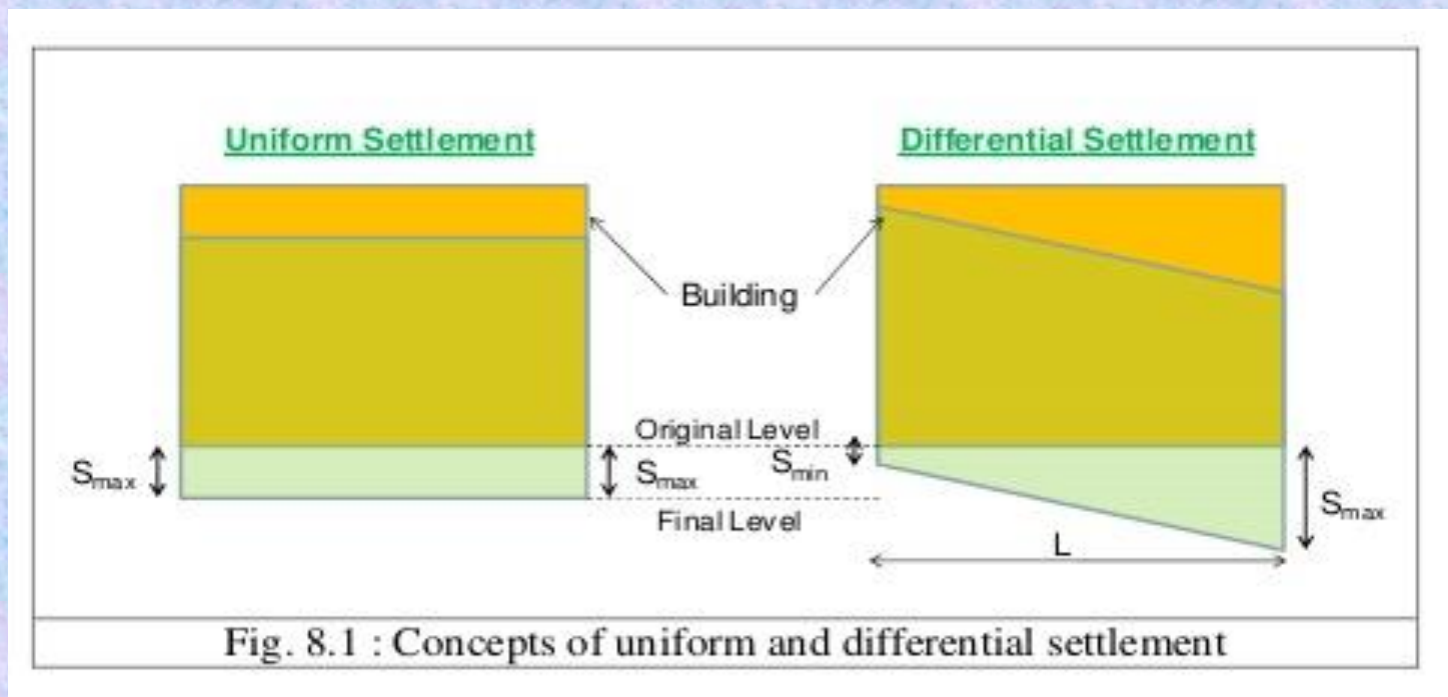



Fig. 8.1 : Concepts of uniform and differential settlement

# Uniform Settlement and Differential Settlement

➢**Uniform Settlement:**

- If the downward vertical movement of total base of structure is equal, the settlement is Uniform.
- Uniform settlement will not cause any damage to the structure. But excessive uniform settlement will damage the underground utility services like water supply line, drainage line, telephone cable, electric cable.

➢**Differential Settlement**

- If the downward vertical movement of total base of structure is unequal, the settlement is Differential.
- Differential Settlement will occurs when one part of structure settles more than the other part.

# Types of settlement

# Differential Settlement

The ratio of differential settlement to the distance between the point under consideration is called as angular distortion (θ).

$$\Theta = (S_{max} - S_{min}) / (L)$$

Where

θ = Angular distortion.

$S_{max}$ = Maximum Settelement.

$S_{min}$ = Minimum Settelement.

L = Distance between the points under considerations

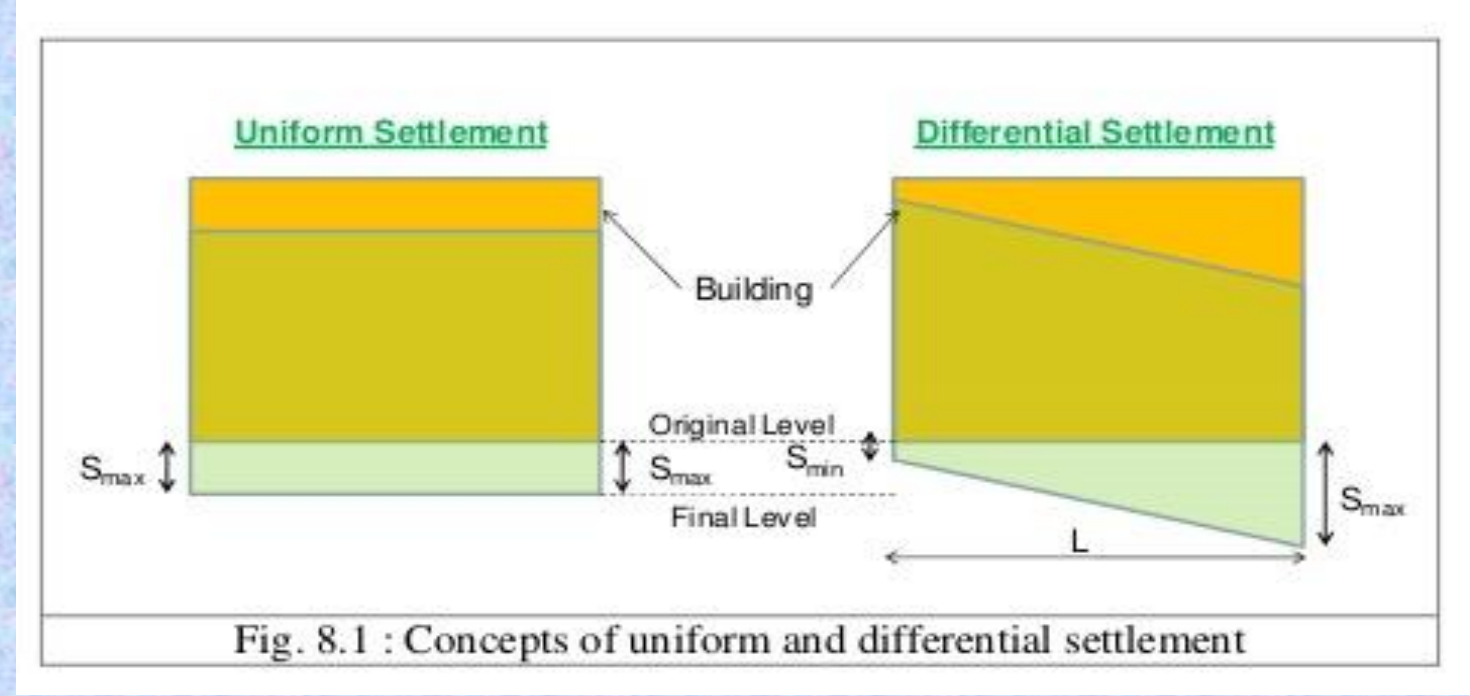
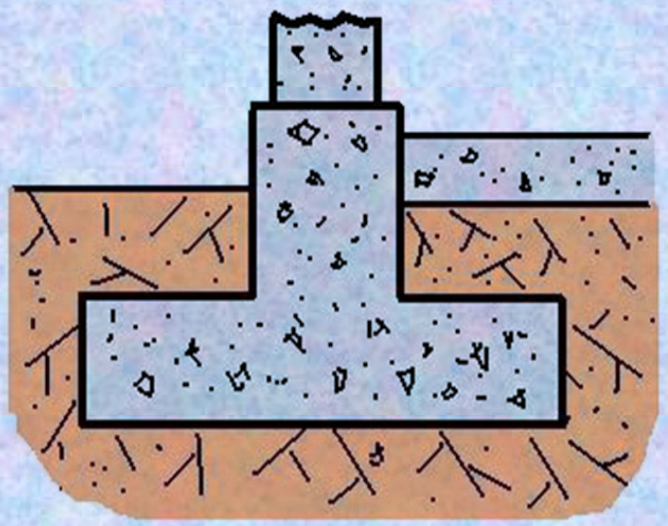



Fig. 8.1 : Concepts of uniform and differential settlement

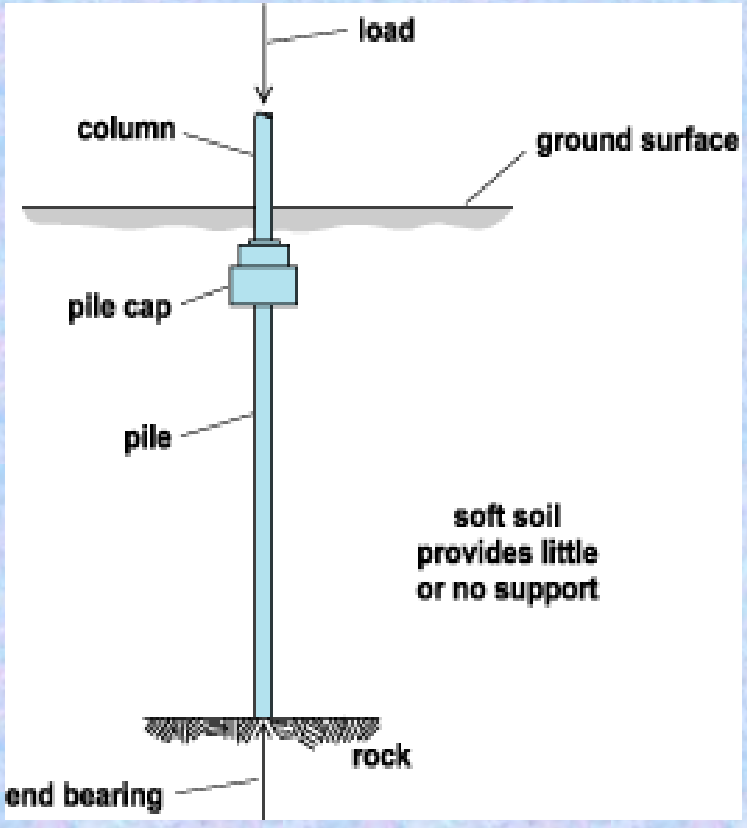
# Types of foundation



## 1. Shallow foundation (D≤B)

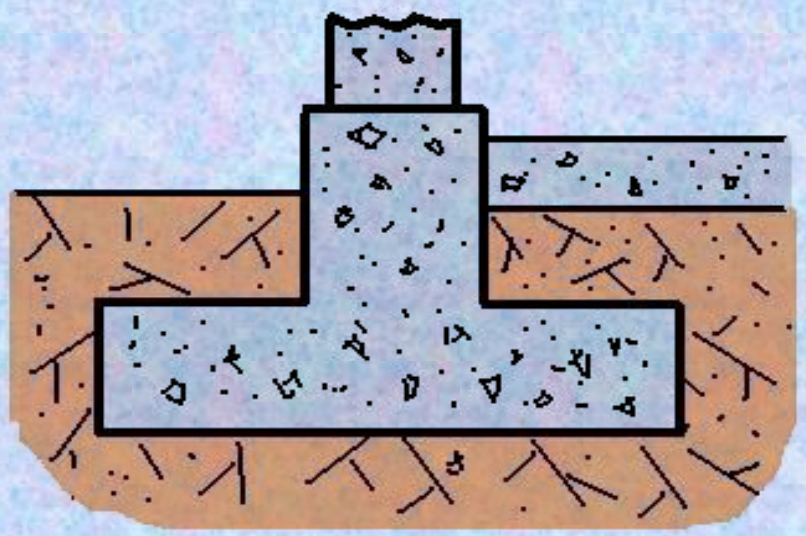


## 2. Deep foundation(D>B)



# Shallow foundation(D≤B)

- When the depth  of foundation is less than or at the most equal  to its width, the foundation is called shallow foundation



# Shallow foundation

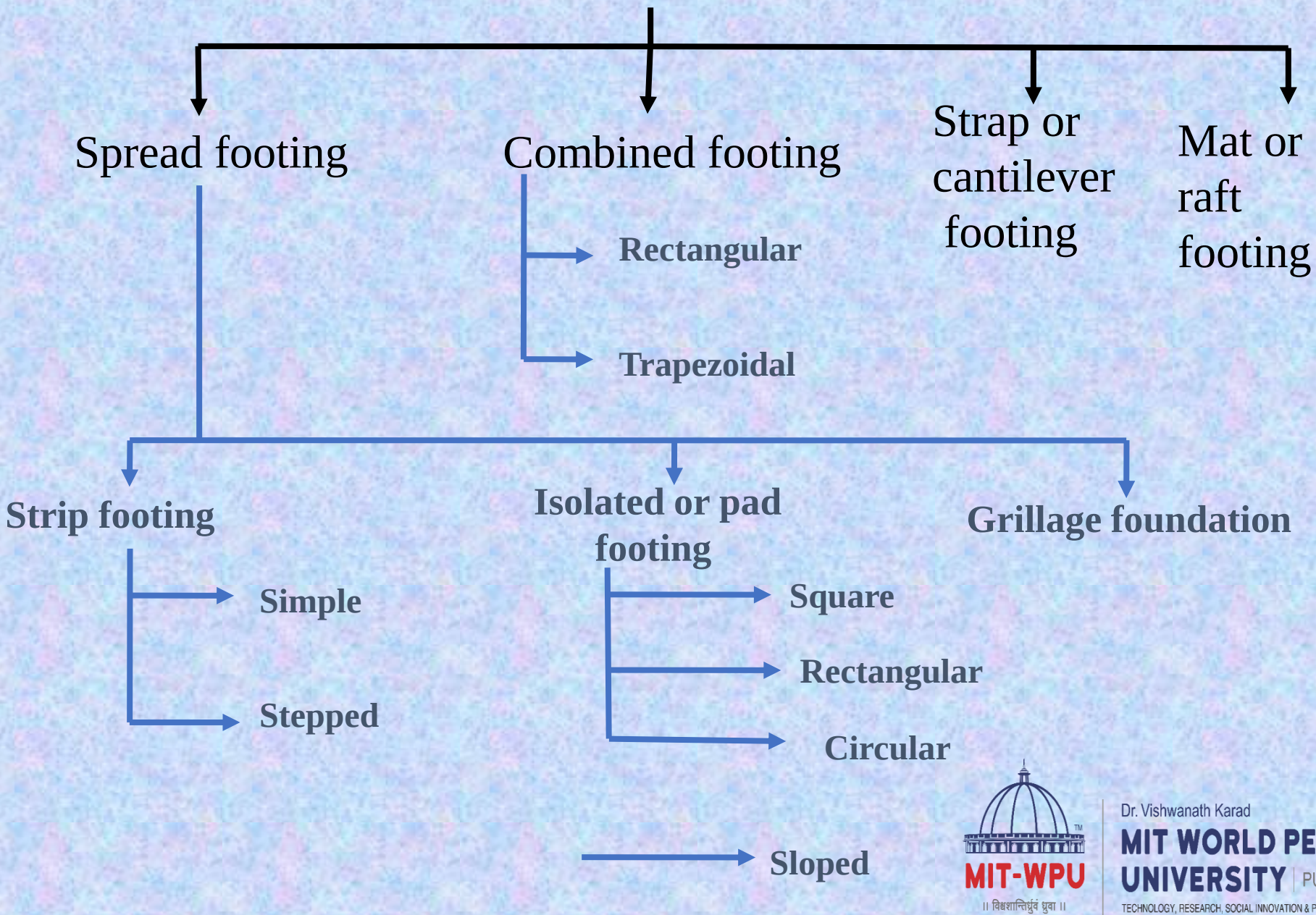
Provided in following cases

- When hard strata available at shallow depth.
- When bearing capacity of soil is good.

## Limitation of shallow foundation:

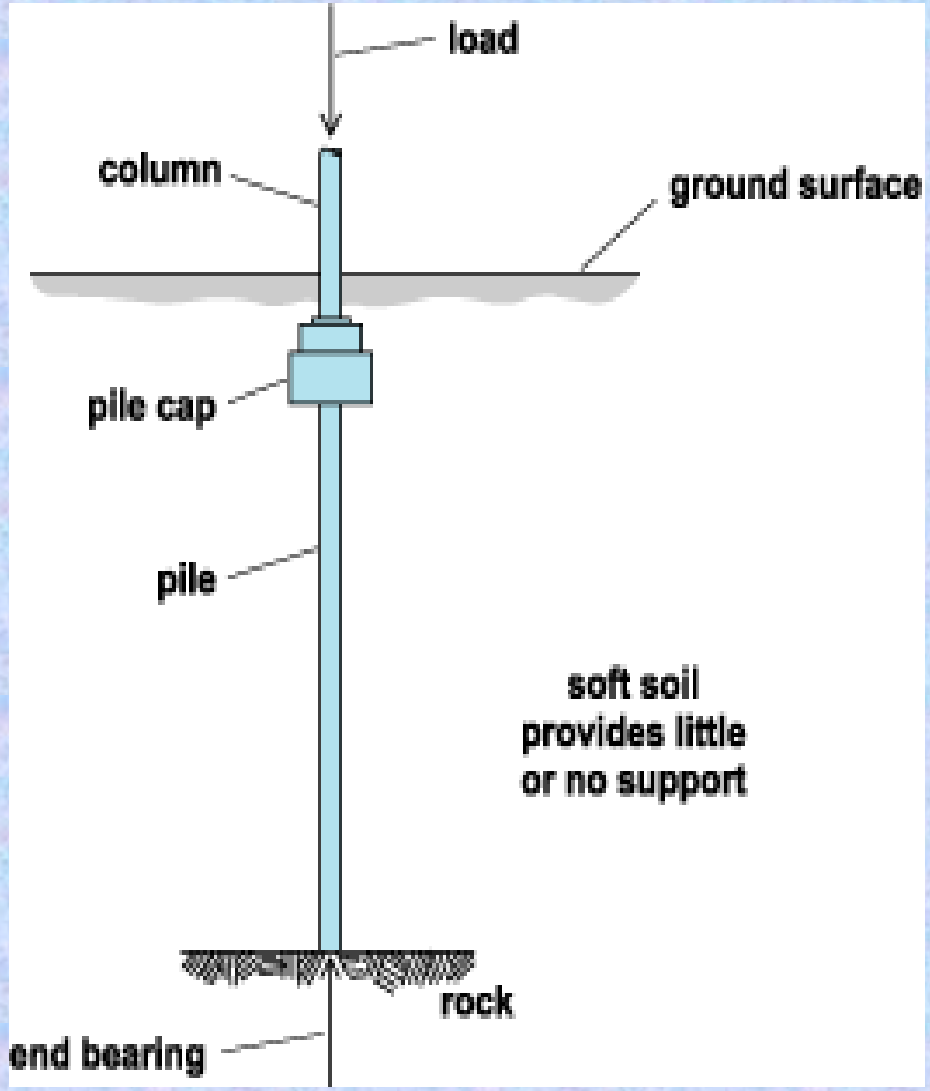
- It cannot be used under a Marshy land and water logged area. The load carrying capacity is less as compared to deep foundations.

# Shallow foundation

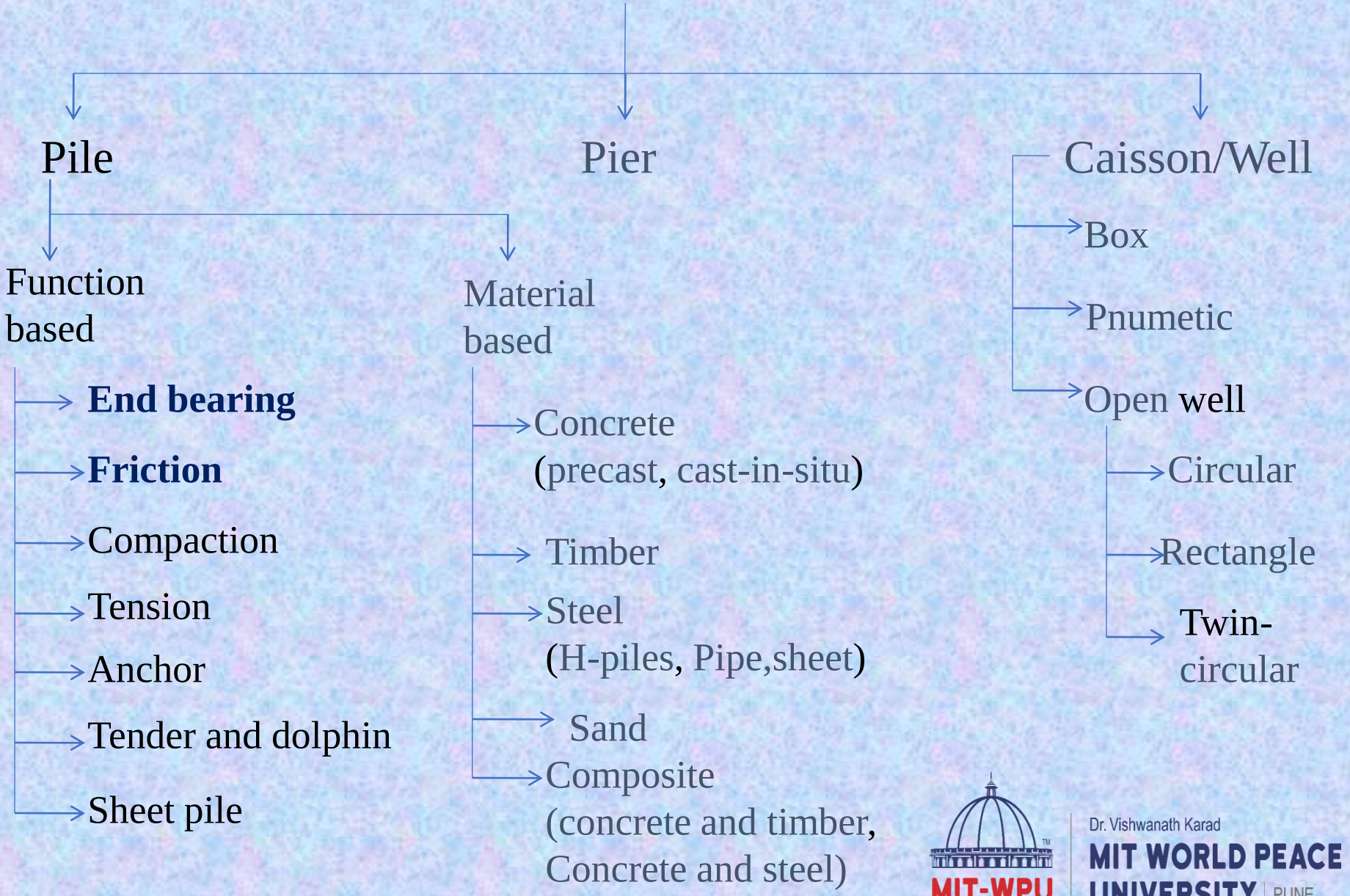


# Deep foundation(D>B)

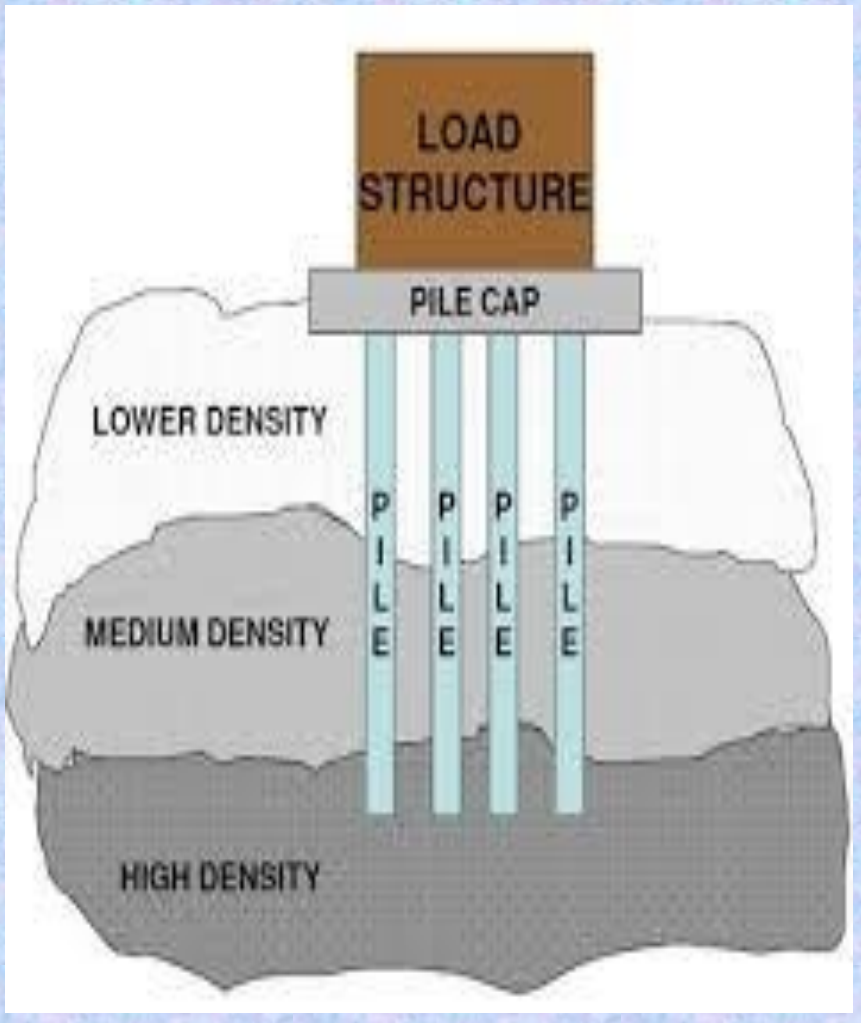
- When the depth of foundation is more than its width, the foundation is called Deep foundation.
- Deep foundation are provided when the soil immediately below the structure with a reasonable depth is not capable of supporting the building load safely. e.g. Black Cotton Soil

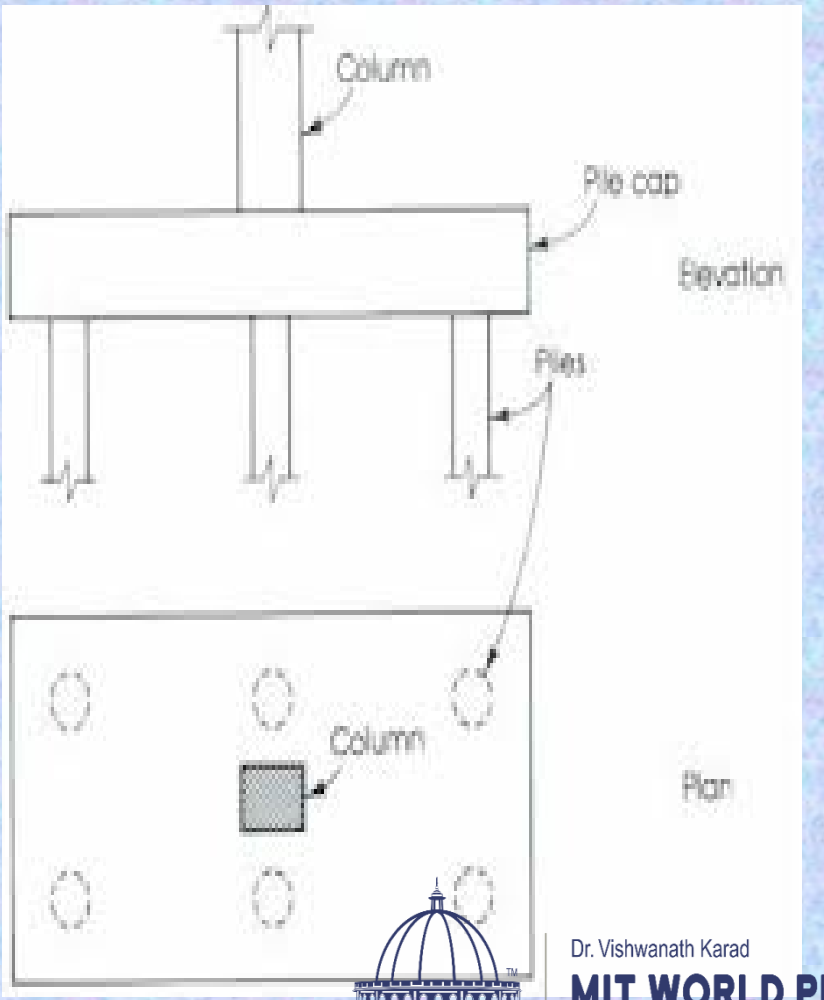


# Deep foundation



# Pile foundation

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# Pile Foundation

Pile is defined as a slender column capable of transferring the structural loads to deep underlying layers

**The Pile is a column like structure which is used in following circumstances.**

- When the hard strata is at higher depth.
- Higher loads to be transmitted.
- When bearing capacity of soil is very low like Black Cotton Soil and Marshy soil .
- When there is a standing water table.
- When there is intermediate compressible layer.

# Function Pile Foundation

- To transfer the load from the structure to the foundation at a greater depth where the bearing capacity of soil is efficient to withhold the structure loads.
- Pile controls the soil settlement which can be accompanied by surface foundations.
- Piles are used to increase the safety factor for high loaded structures.
- Piles enable the scope of construction in very low bearing capacity soils.

# Application of Pile Foundation

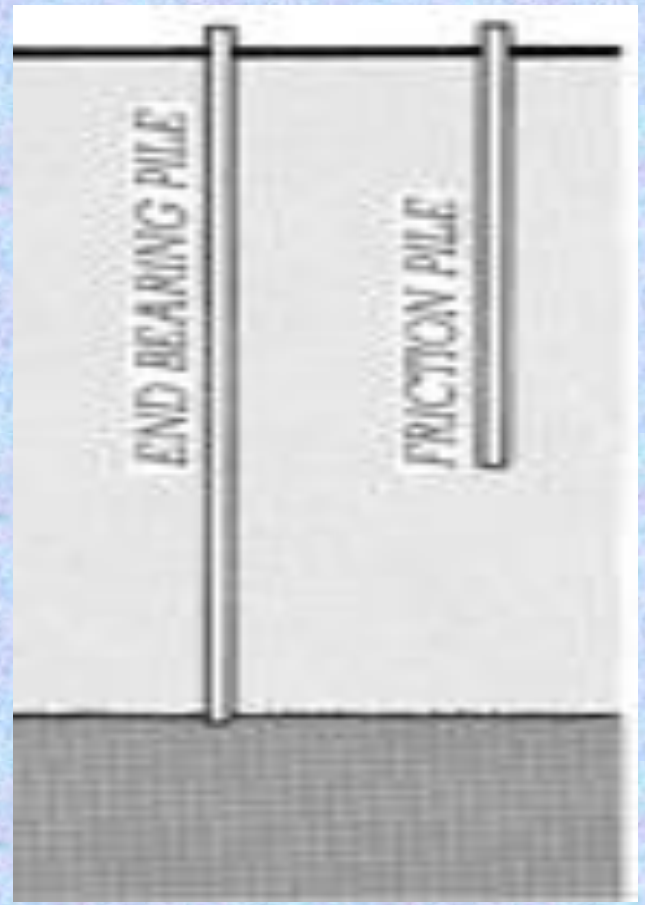
The Piles are applicable at the places where

- The load coming on the structure is very high and the distribution of load on soil is uneven.
- The subsoil water level is likely to rise or fall appreciably.
- The structure is situated in sea shore or river bed
- The Pumping of subsoil water is too costly for keeping the foundation trench in dry condition.
- The construction of raft foundation is likely to be very expensive

## Classification of pile Based on function vertical support :

**Two basic types of Piles**

- End bearing pile - point loading
- Friction pile - load transferred by friction resistance between the pile and the earth



# Basic material used in construction

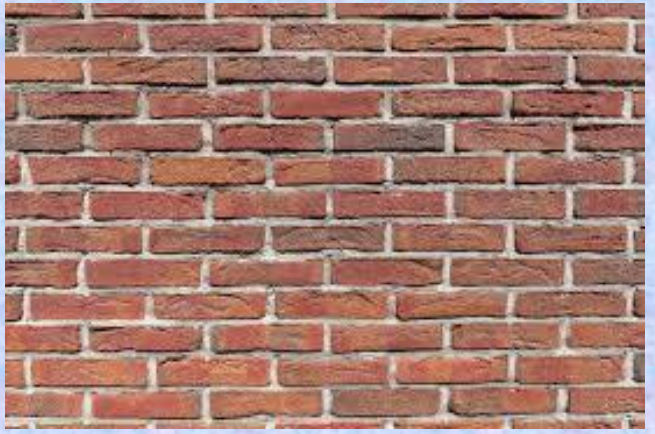
# Basic materials used in construction

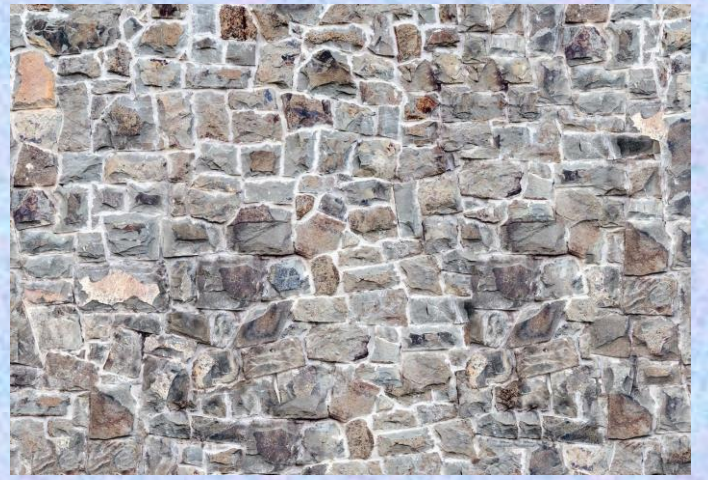
- Cement
- Sand (Fine Aggregate, Coarse Aggregate)
- Bricks
- Stone
- Steel
- Concrete
- Precast concrete

# Basic materials and its use



- Basic materials used in construction are cement, sand, bricks and stone.
- Cement is used as a binding material in the construction work.
- Sand is used for making mortar and concrete.
- Bricks and stone are used for the construction of masonary wall.





# 1. Cement

- **Cement** is adhesive substances, the binding materials used in building and civil engineering construction.
- Cements of this kind are finely ground powders of limestone which contain argillaceous and calcareous matter.
- When it is mixed with water, set to a hard mass.
- Setting and hardening result from hydration, which is a chemical combination of the cement compounds with water that yields submicroscopic crystals or a gel-like material with a high surface area.
- Because of their hydrating properties, constructional cements, which will even set and harden under water, are often called hydraulic cements. The most Important of these is “Portland cement”.
- Cement is used in the form of mortar or concrete.
- Mortar – cement + sand + water (Mix in proportion)
- Concrete – Cement + fine aggregate+ coarse aggregate + water (Mix in proportion)

- Chemical composition

Cao (Lime)

$SIO_2$ (Silica)

$Al_2O_3$ (Alumina)

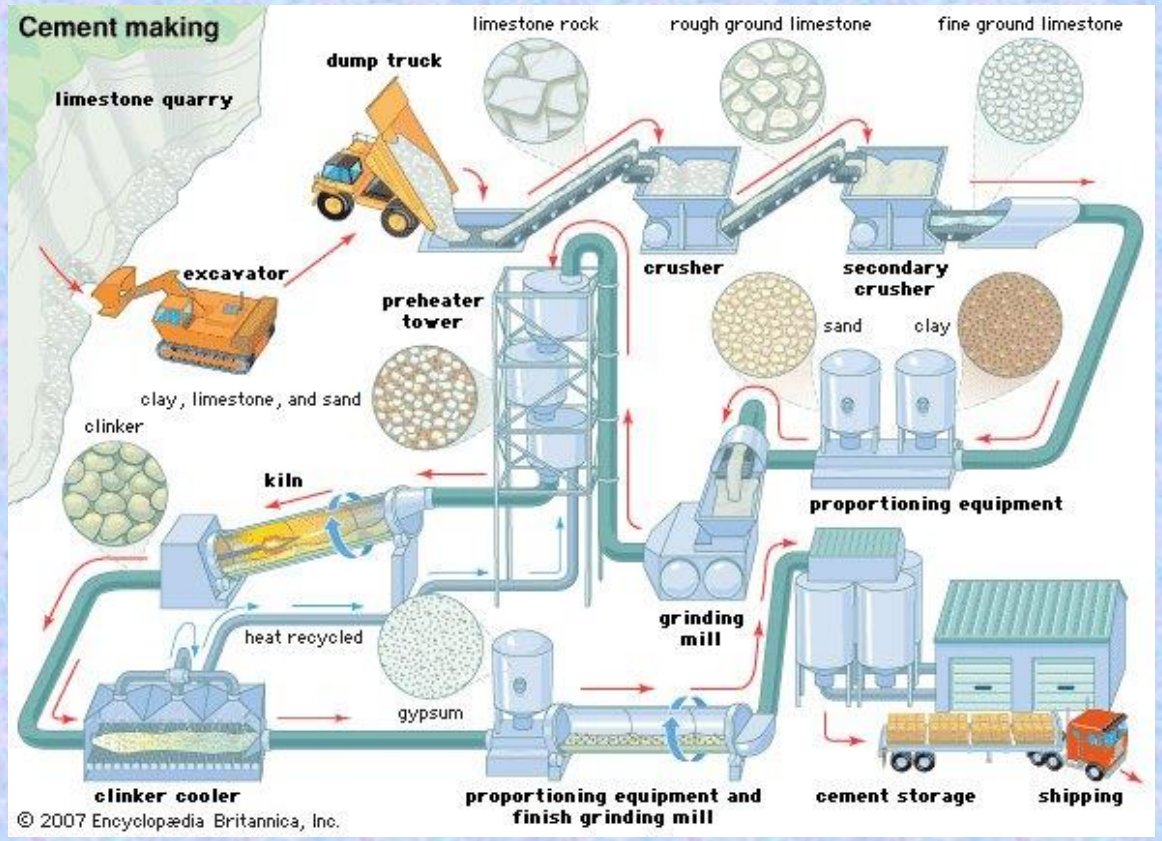
$Fe_2O_3$ (Iron Oxide)

MgO

Alkalines ($K_2O$, $Na_2O$)

$SO_3$

- Manufacturing process



# Types of Cement

The most commonly used cement is Ordinary Portland cement.

1. Rapid Hardening Cement
2. Low heat Cement
3. Sulphate resisting cement
4. Blast furnace slag cement
5. Air entraining cement
6. White and coloured cement
7. High alumina cemnt
8. Pozzolana cement
9. Quick setting cement

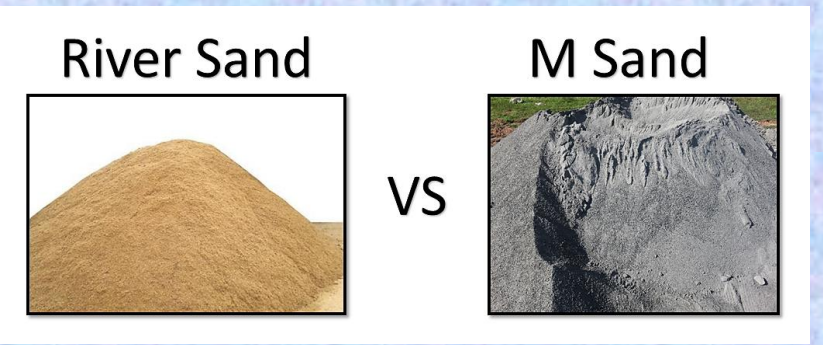
# Use of cement

- Cement is use in cement mortar and cement concrete.
- Construction of buildings: ordinary portland cement is generally used for making cement mortar and concrete.
- Construction of highway slabs: rapid hardening cement is used
- Construction of dams, retaining wall, bridge abutment (mass concrete): low heat cement is used
- Marine structures and other underground works: Blast furnace slag cement
- Canal lining culverts or structures where surface is exposed to severe sulphate action, sulphate resisting cement is used.
- Terrazo surface, face plasters, ornamental works white and coloured cement is used.
- cement is used for construction of buildings, road pavements bridges, underground and over head water reservoirs, chimneys, marine structures. Water pipes and sewers, runways, dams, tunnels, shells, domes etc.

# 2. Sand

- It is a form of silica, which may be siliceous, argillaceous according to composition. It is formed by decomposition of sandstones due to various weathering effects.
- Sand obtained from pits, shores, river beds, sea beds is known as Natural sand.
- Sand obtained from crushing of stones is known as artificial sand.
- Sand is used as inert material in mortar and concrete.
- Sand may be divided in to two categories depending upon its fineness

1. Coarse aggregate
2. Fine aggregate



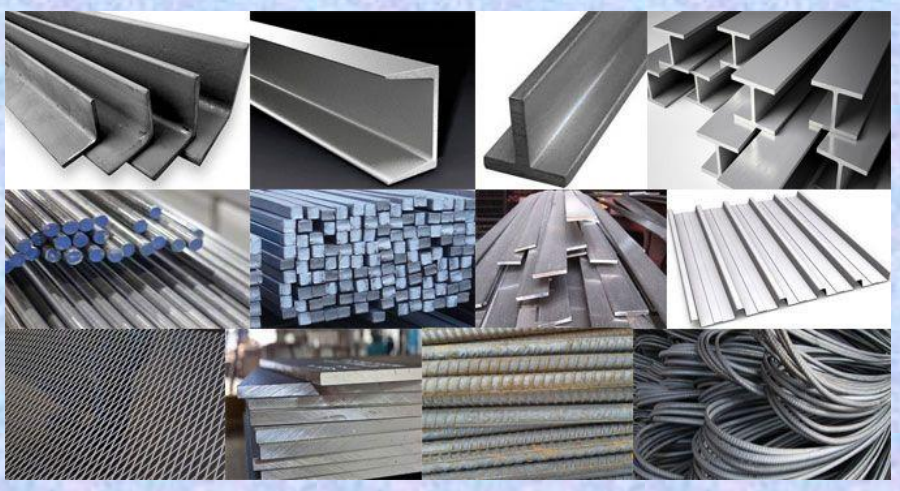

- Sand passing through an Indian Standard sieve of 4.75 mm is called as fine aggregate.
- Sand retaining on 4.75mm sieve is called as coarse aggregate.
- Sand increases the volume of mortar thereby making the mortar economical and also prevents excessive shrinkage of cement paste.
- It also prevents excessive shrinkage of mortar thereby avoiding cracks during setting. Fine sand occupies the voids in coarse aggregates.
- This help in making a concrete solid, waterproof material, very fine and coarse sands are objectionable in a sense that fine sand is uneconomical where as coarse sand gives harsh less workable mix.

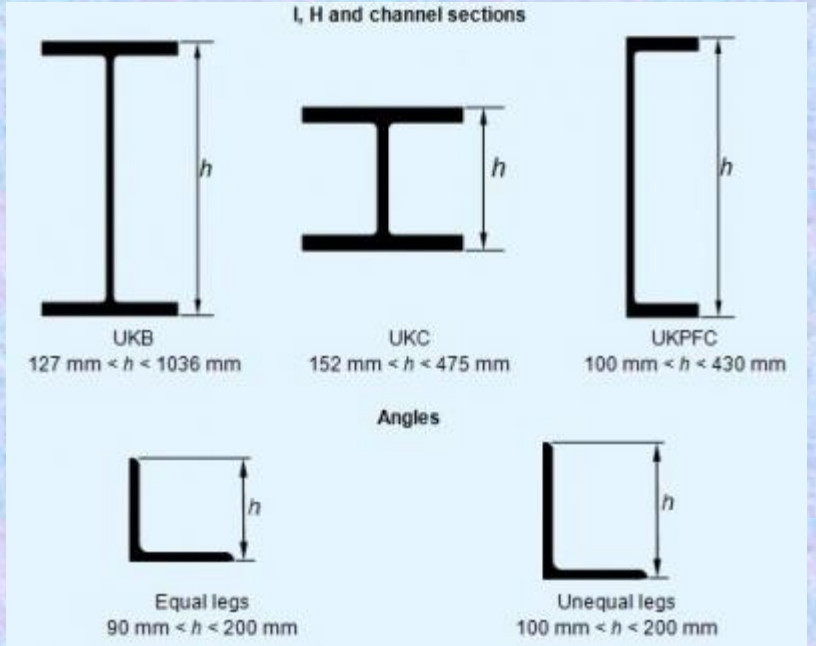
# Use of Sand

1. Used in cement mortar for stone masonary, brick masonary and plastering.
2. Used in plain cement concrete, reinforced cement concrete, prestressed concrete.
3. Coarse sand is applied in form of face plaster on external walls of the buildings.

# 3. Steel

- Steel is an intermediate form between cast iron and wrought iron.
- It is an alloy of iron and carbon containing carbon from 0.25% to 1.25%.
- Steel highly elastic, ductile, malleable, forgeable and weldable.
- Generally mild steel, tor steel and high tensile steel is used in various construction activities.
- Mild steel is used as structural and non structural steel in the form of various section like I section, channel, angle, flat and also in the form of round bars as reinforcement in concrete.
- Tor steel is extensively used as reinforcement in R.C.C works.





- Mild steel bars are designated as Fe 250 due to the yield strength of 250 $N/mm^2$.
- When mild steel plain bars are subjected to cold working by tensioning and twisting raises both yield and ultimate strength. These are known as High Yield Strength deformed (HYSD) bars or tor steel.
- Tor steel bars are available in two grades namely Fe 415 and Fe500 where 415 and 5oo denotes their yield strength in $N/mm^2$ and in variety of diameters ranging from 8mm to 40mm.
- Wires of high tensile strength (tendons) are used in prestressed concrete. These are available in the range of 1.5mm to 8mm diameter with their ultimate stress ranging from 1500 $N/mm^2$ to 2350 $N/mm^2$.
- Generally tendons are grouped in the form of cables containing 7 to 8 individual wires.

# Use of Steel

1. Structural material in trusses, stanchions, beams in the form of various sections.
2. Non structural component for grills, stairs, windows and doors
3. In fabrication of steel pipes, tubes, tanks, ducts etc.
4. Used as corrugated sheets which act as roof over the structures.
5. Mild steel is used as distribution steel in reinforced cement concrete members.
6. Tor steel is used as main steel in reinforced cement concrete members.
7. High tensile steel cables are used in prestressed concrete girders.

# 4. Concrete

- Cement concrete may be defined as a building material obtained by mixing cement, fine aggregates (usually sand), coarse aggregate (usually crushed stone) and water in definite proportion.
- Fresh concrete is a workable and mouldable plastic mixture which flows easily so that it can be transported, placed and compacted to attain the required shape.
- The product is then allowed to cure for gaining strength.
- The strength of concrete depends upon the properties of the ingredients.
- Classification of cement concrete

a. Plain Cement Concrete (P.C.C)

b. Reinforced Cement Concrete (R.C.C)

c. Precast Concrete

d. Prestressed Concrete

# a. Plain cement Concrete (PCC)

- It is a mixture of cement, fine aggregate and coarse aggregate and water.
- The proportion of these ingredients depends upon the grade of mix required for meeting the requirements of a particular job.
- The grades of PCC are generally designated as $M_{15}$, $M_{20}$, $M_{25}$, $M_{30}$ etc. where M stands for mix and the no stands for compressive strength of that mix after 28 days expressed in $N/mm^2$.
- The procedure for deciding the proportion of various ingredients for a particular mix is termed as concrete mix design.
- A mix of 1:2:4 i.e 1 part cement, 2 part fine aggregate, 4 part coarse aggregate along with water in proportion to **w/c ratio** makes a concrete of grade $M_{15}$.
- The concrete is manufactured either by hand mixing or machine mixing using volume batching or weight batching techniques for measuring the quantities of the ingredients.
- Plain cement concrete has very less tensile strength and therefore it is not used for flexural members.
- Its use is more common in levelling course over plinth or below footing and in lean concrete mixes used to fill columns in the terraces.

# b. Reinforced cement Concrete (RCC)

- As PCC has a little usable tensile strength (1/10$^{th}$ of strength in compression) it is reinforced with a tensile material usually steel.
- The reinforcement is in the form of mild steel or tor steel bars are used to make RCC.
- Due to bonding between steel and concrete, stresses are transferred from one material to another thus concrete caters for compressive stresses and steel for tensile stresses.
- Recently use of M15 concrete for any type of RCC work is prohibited by IS codes. The minimum grade of concrete to be used is M20.
- The concrete manufactured on site is termed as ‘in-situ concrete’.

# Use of PCC and RCC

1. Concrete is used in almost all types of construction either in the form of PCC or RCC.
2. PCC is used for levelling course below footing and over plinth.
3. PCC can be used for mass concrete work for heavy wall.
4. PCC can be used for levelling course below masonary.
5. PCC can be used in lean concrete mixes to fill the column in terrace.
6. RCC is used for concreting the general work like beams, columns, slabs, lintel, footing etc.
7. RCC can be used for machine foundation.

# c. Pre-cast concrete

- The term precast concrete is applied to individual concrete members of various types, which are cast in separate forms before they are placed in the structure.
- Precast members are cast either on building sites or in casting yards located at some distance from the site or in precast concrete factories.
- Precast members are then transported to the site and then placed in position by cranes or other devices if they are heavy like beam or slab units.
- Due to controlling measures employed in factory regarding quality and quantity of materials used, precast members offer the required strength, durability, attractive appearance better than in-situ concrete members.
- Due to use of precast members, building erection work can be done with greater speed.

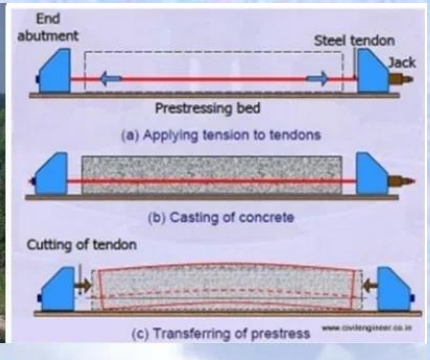
# Uses of precast concrete

1. For casting various building elements such as beams, columns, slabs, water tanks etc.
2. For manufacturing of compound poles, electricity poles, ornamental structures.
3. Fabrication of RCC pipes, bridge girders, bridge piers, concrete piles.

# c. Pre-stressed concrete

- This is a reinforced concrete in which concrete is subjected to compressive stressed, before the external loads are applied, by inducing tensile stresses in the reinforcement to counteract tensile stresses caused in the concrete by external loads.
- If the tensile reinforcement is subjected to tensile stresses before the external loads are applied compressive stresses are induced in the concrete of the beam which absorbs or counteracts the tensile stresses caused by external loads in concrete.
- Thus concrete can therefore be used effectively in resisting tensile stresses also steel cables of high tensile strength are used as reinforcements along with rich concrete mix (preferable above M30).

1. Pre-tensioning
2. Post-tensioning

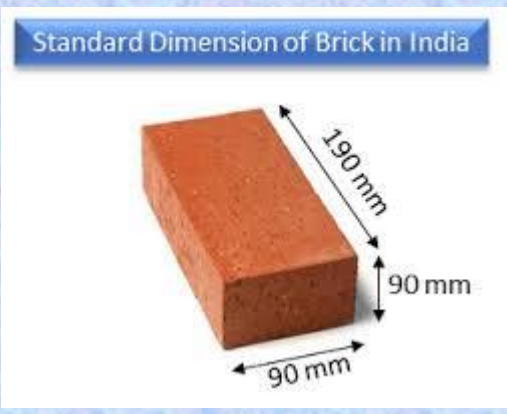



# Uses of prestressed concrete

1. Girders for bridges
2. Railway slippers
3. Beams for large spans
4. Electric poles
5. Precast blocks

# 5. Bricks

- Bricks are made of clay and chiefly employed in building construction and architectural compositions.
- Bricks are obtained by moulding plastic mass of suitably proportioned earth that mainly consists of silica and alumina in timber or steel moulds.
- Moulded bricks are first allowed to dry and then burnt in kilns to achieve strength.
- Bricks are generally rectangular in shape having size 19cm x 9cm x 9cm, so that 10 layers when laid in mortar will form one metre height of masonary.




# Classification of Bricks

- Clay bricks

1. Ordinary bricks
2. Fire bricks

Ordinary bricks are further classified as

1. 1st class bricks
2. 2nd class bricks
3. 3rd class bricks

# Classification of Bricks

- The 1st class bricks are well burnt and of proper rectangular shape and size with sharp edges. They do not absorb more than 1/6th of their weight of water after being soaked for 1 hr and give ringing sound.
- The 2nd class bricks are also fully burnt and giving a clear ringing sound when struck. They should not absorb more than 1/4th of their dry weight of water after one 1 hr soaking.
- The 3rd class bricks are not burnt so fully but are generally of uniform reddish yellow colour.
- Fire bricks are made of special fire clays. They are used for lining in fir-places, furnaces etc. They are slightly larger than the ordinary bricks.
- Zhama bricks are overburnt bricks having deformed shapes and sizes.

- Bricks are laid in various coursed with frog upward to form the brick wall.
- Cement mortar is placed below, sides of the brick and inside the frog.
- All bricks are soaked in water for 24 hrs. before using them in construction work.


**Importance of Frog:**

- Frog is indentation in the bricks provided to form  a key for holding the mortar.
- Bricks are laid in various layers with frog upward to form the brick wall.
- Various courses are strongly bonded with the provision of frog in brick.

# 5. Stones

- Stone is always obtained from rock, which is a solid portion of earth's crust.
- Quarried stones may be in the form of stone blocks, stone aggregate, stone slabs, stone lintels, stone flags etc.
- Stone has to be properly dressed and shaped before it is used at the place of work.

# Classification of Rocks

**a. Geological classification**

- Igneous rocks
- Sedimentary rocks
- Metamorphic rocks

**b. Physical classification**

- Stratified rocks
- Unstratified rocks
- Laminated rocks

**c. Chemical classification**

- Siliceous rocks
- Argillaceous rocks
- Calcareous rocks

**d. Classification based on hardness**

- Very hard rock
- Hard rock
- Medium rock
- Soft rock

# Classification of Stones

- The rocks which are formed due to cooling of exposed magma are called **Igneous rocks**. Examples- Basalt, Granite, Dolerite.
- **Sedimentary rocks** are formed by deposition of broken materials like sand, clay, disintegrated rocks, dead sea organism etc. Examples- sand stone, lime stone, slate, shale.


- Re- alignment of materials due to either temperature change or pressure change or both results in change in the texture of the rock. This is known as **metamorphic rocks.**
- Example – limestone and marl becomes marble, basalt and trap becomes schist.

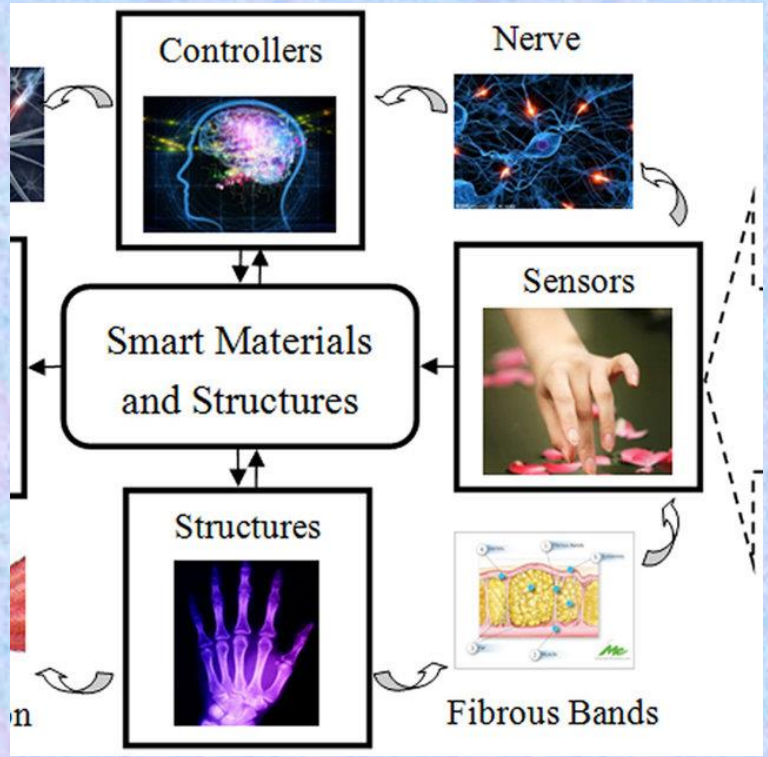
- The sedimentary rock possessing planes of stratification can be easily split along these planes, these are **stratified rocks**.
- Igneous rocks are compact granular in nature and do not show any stratification, are there for classified as **unstratified rocks**.
- All the stones are seasoned (dried) before they are used.


# Uses of Stones

1. Broken stones and stone chips are used in foundation, roofs of building and as road metal and railway ballast.
2. Stone blocks are mainly used in walls, foundations and ornamental facia work.
3. Quartzite is used for rubble masonary, road metaling and also as aggregate for concrete.
4. Lime stone slabs are used for flooring, paving and roofing.
5. Slates are used as roofing and flooring material.
6. Granite is used for important works like bridge abutments, piers etc. These days it is very common in kitchen ota.
7. Marble is extremely suitable for ornamental and superior type of building work e.g. Tajmahal.

# Smart material

Some materials have the ability to change shape or size simple by adding a little bit of heat or to change from a liquid to a solid almost instantly when near a magnetic field or electric field these materials are called smart materials



# SMART MATERIALS

- Smart materials are the materials that can significantly alter one or more of their inherent properties owing to the application of an external stimuli in a controlled fashion.
- The several external stimulus to which the SMART Materials are sensitive :
- Stress
- Temperature
- Moisture
- pH
- Electric Fields
- Magnetic Fields

# SMART MATERIAL TYPES

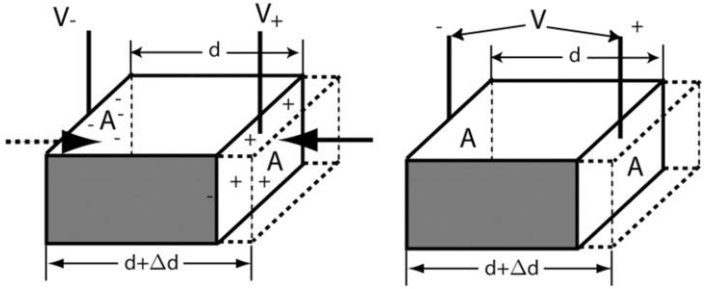
- Piezoelectric materials
- Electrostrictive materials
- Magnetostrictive materials
- Optical fibers
- Shape memory alloys (SMA)
- Electro active materials
- Smart concrete( Traffic sensing recorder)
- Strain sensitive concrete ( Detects earthquake)
- Thermochromic

# Classification of Smart material

| Type of SMART Material | Input | Output |
|---|---|---|
| Piezoelectric | Deformation | Potential Difference |
| Electrostrictive | Potential Difference | Deformation |
| Magnetostrictive | Magnetic Field | Deformation |
| Thermoelectric | Temperature | Potential Difference |
| Shape Memory Alloys | Temperature | Deformation |
| Photochromic | Radiation | Color Change |
| Thermochromics | Temperature | Color Change |

# PIEZOELECTRIC MATERIAL

- Piezoelectric materials have two unique properties which are interrelated.
- When a piezoelectric material is deformed, it gives off a small but measurable electrical discharge.
- Alternately, when an electrical current is passed through a piezoelectric material it experiences significant increase in size (upto 4% change in volume)
- They are used to measure fluid compositions, fluid density, fluid viscosity or the force of an impact.
- It possesses the property of converting mechanical energy into electrical energy and vice versa.
- Best known example is electric cigarette lighter
- Airbag sensor in car.



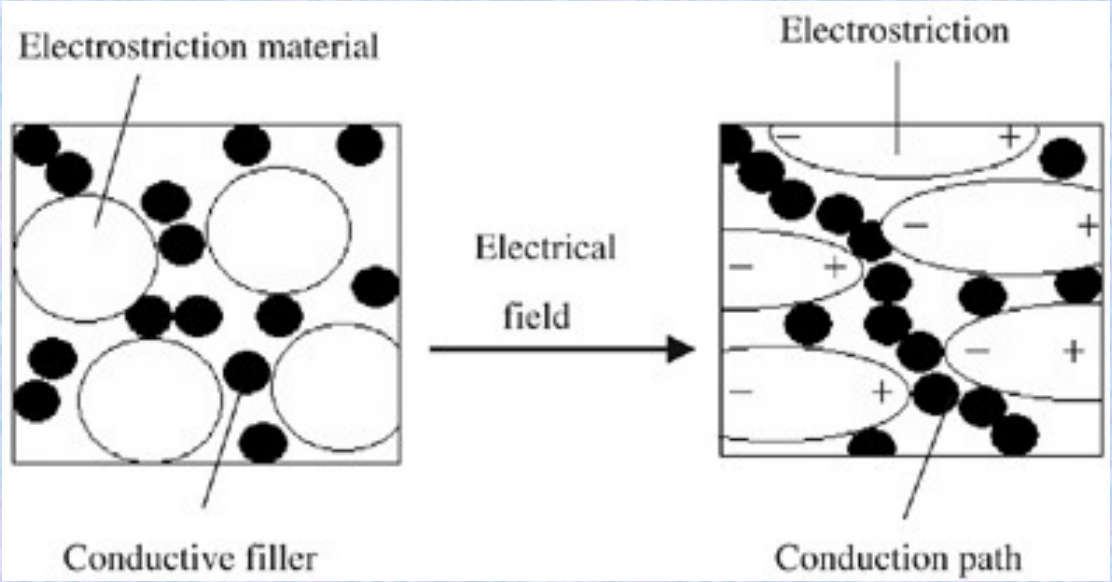

Forces change thickness and create charge

Applied voltage causes thickness changes

# Electrostrictive Material (Electro-rheostatic-ER)

- Electro rheostatic materials are fluids, which can experience a dramatic change in their viscosity.
- These fluids can change from a thick fluid to nearly a solid substance within the span of a millisecond when exposed to a **electric field**, the effect can be completely reversed just as quickly when the field is removed.
- **Electrostriction** is a property of all dielectric **materials**, and is caused by displacement of ions in the crystal lattice upon being exposed to an external electric field. Positive ions will be displaced in the direction of the field, while negative ions will be displaced in the opposite direction.

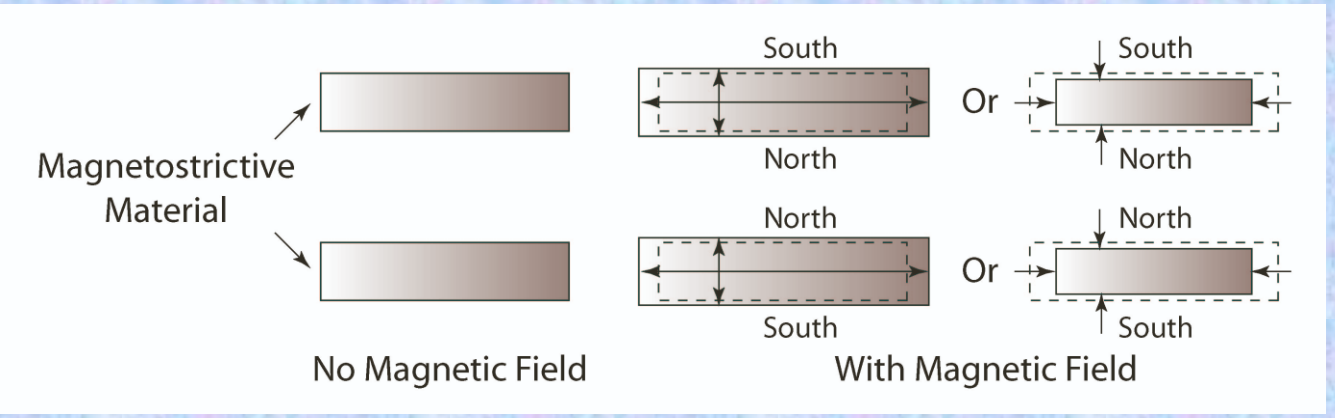
- ER fluids have mainly been developed for use in clutches and valves, as well as engine mounts designed noise and vibration in vehicles.



# Magnetostrictive Material (Magneto-rheostatic-MR)

- Magneto rheostatic materials are fluids, which can experience a dramatic change in their viscosity.
- These fluids can change from a thick fluid to nearly a solid substance within the span of a millisecond when exposed to a **magnetic field**, the effect can be completely reversed just as quickly when the field is removed.

- MR fluids are being developed for use in car shocks, damping washing machine vibration, prosthetic limbs, exercise equipment and surface polishing of machine parts.



# Optical Fibre

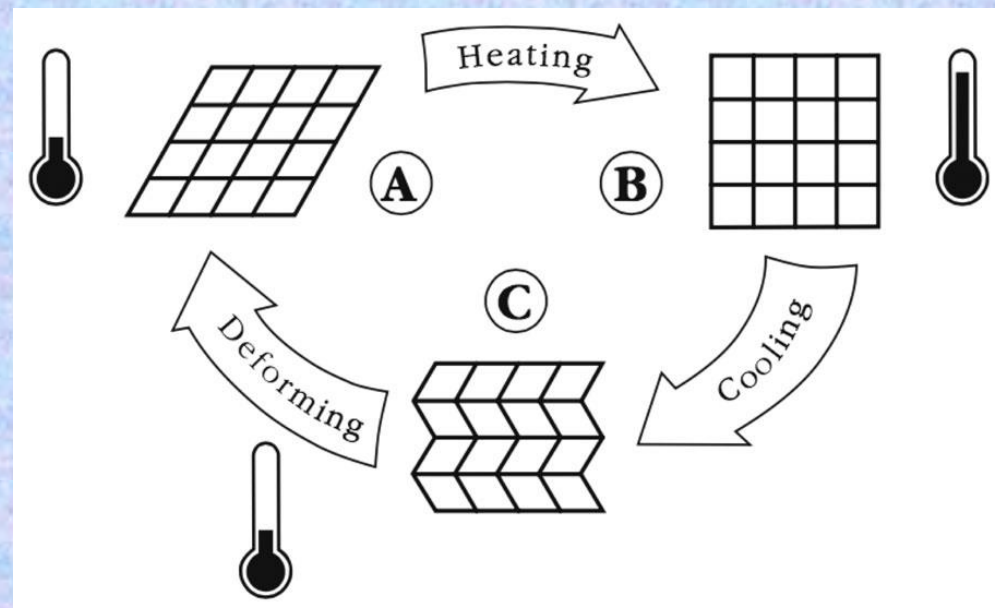
- **Fiber optics**, or **optical fiber**, refers to the medium and the technology associated with the **transmission of information as light pulses along a glass or plastic strand or fiber.**
- **Fiber optics** is used long-distance and high-performance data networking.

- Fiber optics transmit data in the form of light particles or photons that pulse through a fiber optic cable.
- The glass fiber core and the cladding each have a different refractive index that bends incoming light at a certain angle.
- When light signals are sent through the fiber optic cable, they reflect off the core and cladding in a series of zig-zag bounces, adhering to a process called total internal reflection.
- The light signals do not travel at the speed of light because of the denser glass layers, instead traveling about 30% slower than the speed of light.
- To renew, or boost, the signal throughout its journey, fiber optics transmission sometimes requires repeaters at distant intervals to regenerate the optical signal by converting it to an electrical signal, processing that electrical signal and retransmitting the optical signal.

# Shape Memory Alloys

- When subjected to a thermal field, this material will undergo phase transformation.
- It is made possible through a solid state phase change that is a molecular rearrangement, which occurs in the shape memory alloy.
- A solid state phase change is similar in that a molecular rearrangement is occurring, but the molecules remain closely packed so that the substance remains a solid.
- Shape-memory alloy is an alloy that can be deformed when cold but returns to its pre-deformed ("remembered") shape when heated. It may also be called memory metal, memory alloy, smart metal, smart alloy, or muscle wire.
- In shape memory alloy, a temperature change of only about 10° C is necessary to initiate this phase change.

- Shape Memory Alloys are metal alloys which can undergo solid- to-solid phase transformation and can recover completely when heated to a specific temperature.
- The two phases, which occur in shape memory alloys are “Martensite” and “Austenite”.
- It deforms to its “Martensite” condition with low temperature and regains its original shape in its “Austenite” conditions when heated .



## Thermochromic

- These materials changes colour in response to changes in temperature.
- They have been used in bath plugs that changes colour when the water is too hot.

## Photochromic

- These material changes colour in response to changes in light conditions.
- Uses includes security inks and dolls that tan in the sun.


# Applications

- Smart Fabric
- Smart Aircraft
- Sporting Goods
- Smart Dust
- Reducing vibration
- Helicopter blades
- Robotics
- Medical Surgeries
- Security
- And many others……

# Translucent concrete-LitraCon

- Translucent concrete is mixed with glass fiber optical strands, which create a solid but sheer block.

# Self-Repairing Concrete

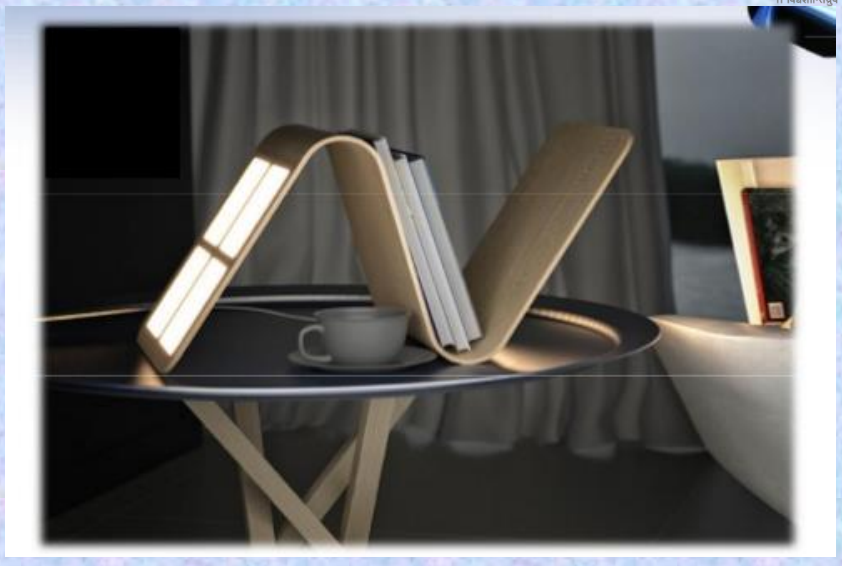
- A new self-healing cement is currently being developed which has the ability to repair its own cracks.
- This cement is mixed with microcapsules that release a glue-like epoxy resin that will automatically repair any cracks that form in the sidewalk or roadway.
- In addition, this cement will have the ability to regulate heat.

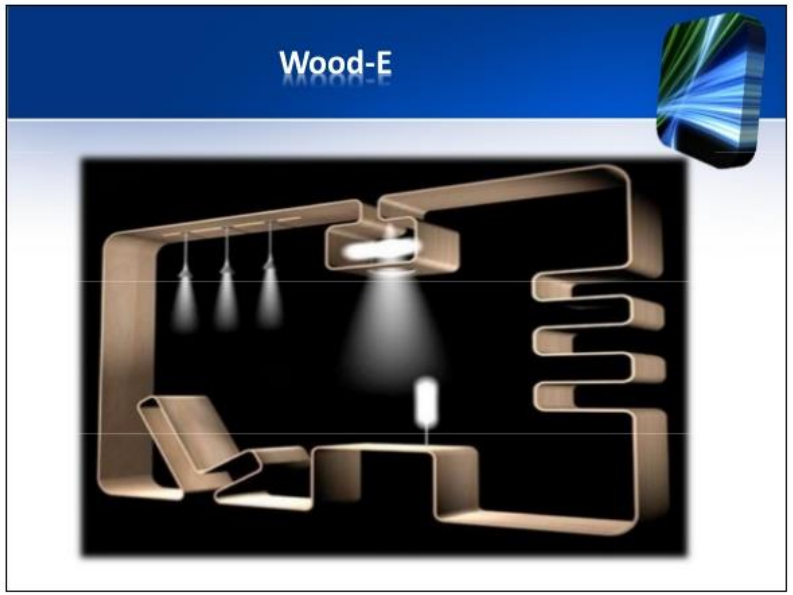
# Sensi Tile

- The concrete of the tiles is embedded with acrylic fiber-optic channels that transfer light from one point to another.
- As shadows move across Terrazzo's surface, the light channels flicker with a randomized, twinkling effect.
- Their tiles are available for use as flooring, in bathrooms and even ceilings, so you can have twinkling lights follow you all over the house.

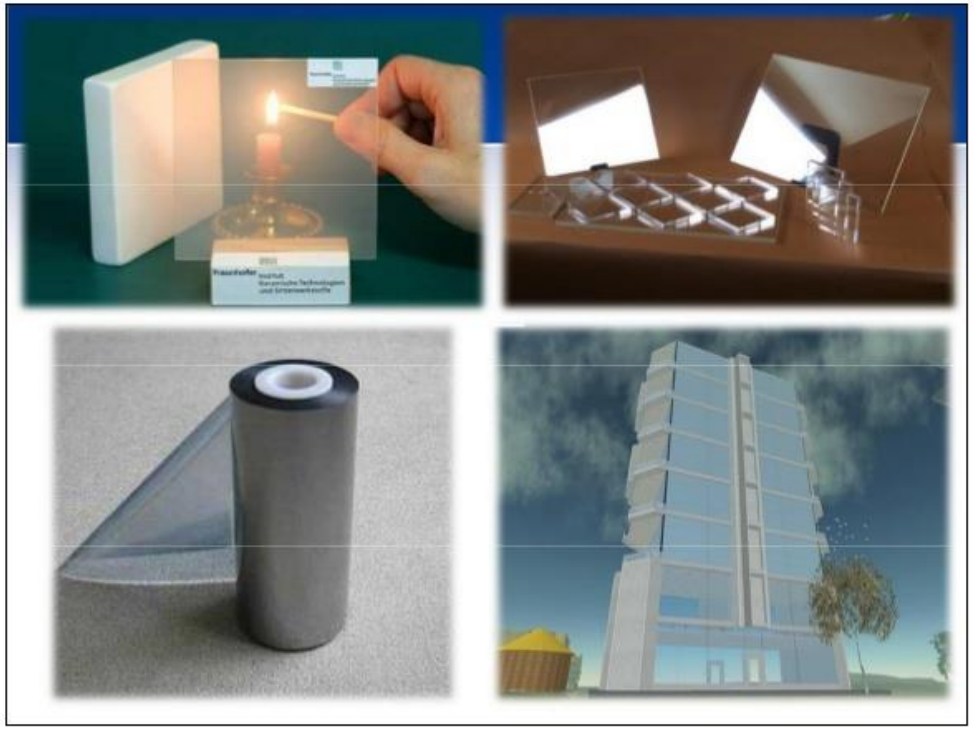
# Electrified Wood

- This European-designed material incorporates a source of electricity directly into tables and chairs.
- Two metal layers are pressed between the wood of the furniture, making it possible to pass an electrical current through the whole thing.

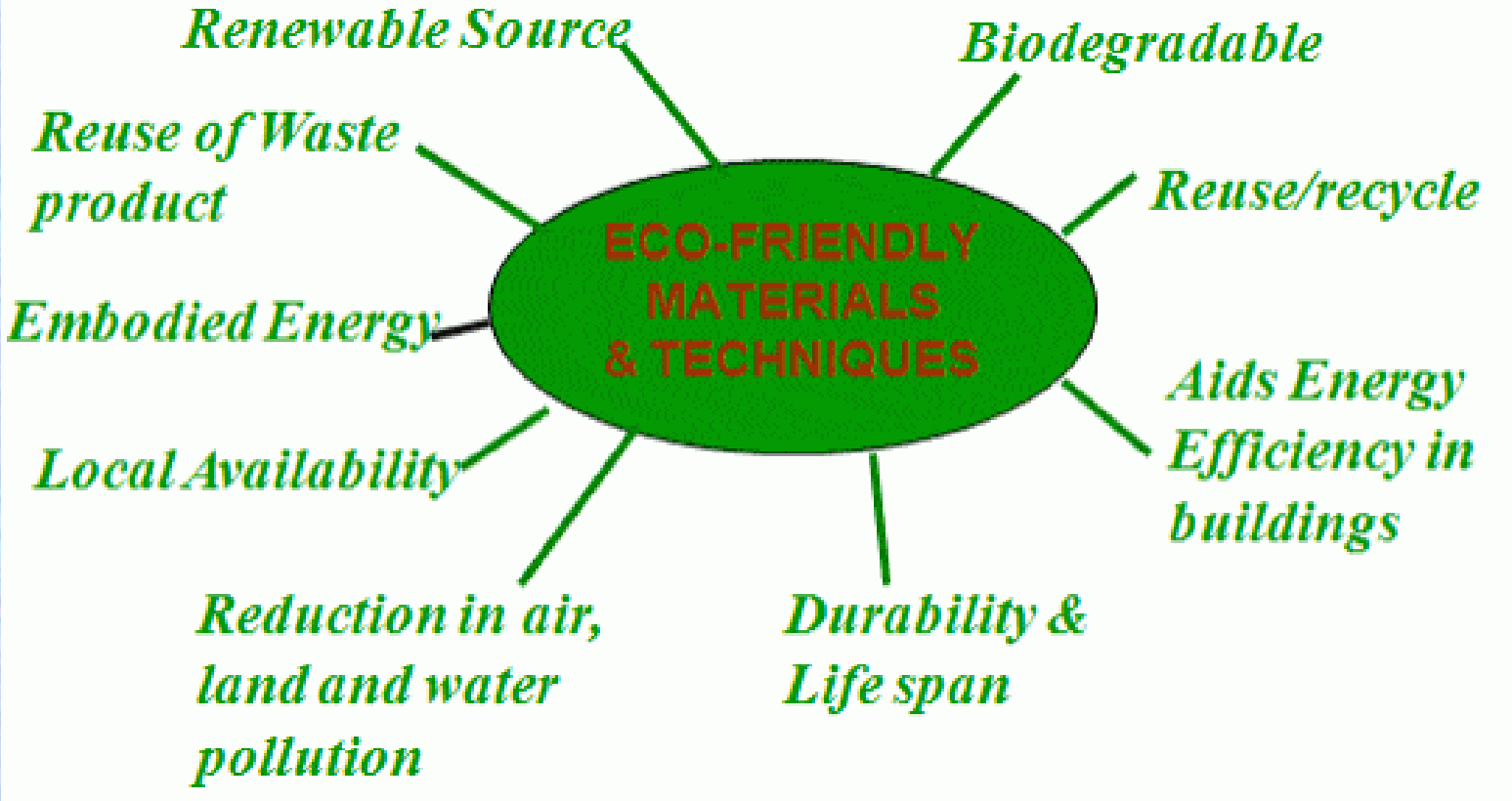




# Transparent Aluminum



# Eco – Friendly material


Renewable Source
Biodegradable
Reuse of Waste product
Reuse/recycle
ECO-FRIENDLY MATERIALS & TECHNIQUES
Embodied Energy
Aids Energy Efficiency in buildings
Local Availability
Reduction in air, land and water pollution
Durability & Life span

# Eco-friendly materials

Eco-Friendly is the act of living with intent. The intent is focused on not creating harm to environment through interactions.

➢What is mean by Eco – Friendly technology ?

•Eco-friendly technologies involved making use of alternative energy source which is abundant to generate renewable energy, reducing the amount of resource which is limited used through the conventional like fossil fuel.

•There are various technologies and materials developed by various research organizations, innovators and manufacturers in India that are beneficial in the housing construction.

# Why eco-friendly materials?

- Phenomenal growth in the construction industry that depends upon depletable resources.
- Production of building materials leads to irreversible environmental impacts.
- Using eco-friendly materials is the best way to build a eco-friendly building.
- Reduce pollution
- Energy conservation

# Eco-friendly Building materials

- The eco-friendly building materials represents a response from the building sector intended to reduce the environmental cost of making and using buildings.
- In the construction industry, selection of sustainable structural materials during the design phase leads to move towards more sustainable construction. Therefore, there is a need to select more eco-friendly building materials to be used in construction.

# Conventional Eco-friendly materials

1. Bamboo, Bamboo Based Particle Board & Ply Board, Bamboo Matting
2. Bricks sun dried
3. Pre-cast cement concrete blocks, lintels, slab. Structural and non-structural modular elements
4. Calcined Phospho-Gypsum Wall Panels
5. Calcium silicate boards and Tiles
6. Cellular Light Weight Concrete Blocks
7. Cement Paint
8. Clay roofing tiles
9. Ferro-cement boards for door and window shutters
10. Ferro-cement Roofing Channels
11. Fly-ash Sand Lime Bricks and Paver Blocks
12. Gypsum Board, Tiles, Plaster, Blocks, gypsum plaster fibre jute/sisal and glass fibre composites
13. Laminated Wood Plastic Components
14. Marble Mosaic Tiles
15. MDF Boards and Mouldings
16. Micro Concrete Roofing Tiles
17. Particle Boards

# Eco-friendly House

- **An eco-house  with a turf roof and solar panel**

Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

# Automation in Construction

# 1. Autonomous Machines on the Construction Site



- Perhaps the most common example of automation in construction is the use of autonomous machines. These are essentially self-driving machines that can be used to transport materials across the work site and to haul heavy items without posing a risk to workers.
- For example, machines can be fitted with robotic technology solutions and sensors that enable forklifts, diggers, trucks, and other similar equipment to operate without a driver in the cabin. By creating relevant paths, providing GPS capabilities, and programming movement of the machine itself, construction site workers can remotely operate machinery and enjoy more efficient processes.

# Examples of automation in Construction Industry



- **Roads**

  **Asphalt Mixers** and **Asphalt Pavers** are automatic machines.

  **Concrete pavers** are used for roadwork.

  Use of highly automated **hydraulic drill rig** for piling has become common, for all highways and flyovers.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HCC
HCC
SELI
Kishanganga Project
SHILA

# 2. Drones to Survey Working Areas and Employees

- Drones are another useful example of construction automation, allowing for the automated monitoring of worksites without the need for active supervision. Drones can be programmed to automatically scan the working area for any potential hazards, after which signals can be sent back to a centralised control system.
- Using drones allows construction companies to conduct pre-project inspections and other important site monitoring activities.

# 3. Robotics in Concrete Works

- Automation in construction has also found its way to concrete mixing. Control systems and robotics are being used to mix concrete, lay the cement, polish floors, and remove surface water. This also allows companies to prepare precast and ready-mixed concrete products that take a much shorter time to install. Automation reduces material consumption and eliminates the human error that would otherwise go into concrete works.
- Another area of concrete work that is enjoying the benefits of automation is concrete floor polishing. Programmable machines are being used to polish soft concrete in both commercial and residential structures. These machines can be programmed to pour and level concrete in the right portions while avoiding obstacles near the work zone.
- Demolition robots are also being used to bring down walls and to dismantle concrete slabs. This often results in lower operational costs and a safer working environment for employees.

# Examples of automation in Construction Industry

- **Ready Mix Concrete (RMC)**

Few years ago all concrete was prepared on project site. But today even small concrete plants, say 15 m3/hr. capacity , have integrated weigh batchers at small and medium size projects.

Concrete batching plants up to a capacity of 750 m3/hr. are used at large project sites.

The **tower crane** is an example of automation in material movement.

At large projects e.g. dams and tunnel construction automation has happened in the use of **earthmoving equipments, dumpers** etc. (10 tons, 25 tons or 30 tons)


R.K.ready MIX
Concrete Inc.
Ph.: 02622 - 324508

# 4. IoT Sensors to Collect and Process Data



- Sensors are the key devices that make automation possible. These devices can take real-time readings of location, temperature, pressure and other conditions. Sensors allow construction companies to automate many different machines and robots according to their preferences.
- Sensors can also transmit signals to machines to trigger a specific action. For example, automation is typically achieved in welding and fabrication machines through the use of sensors. These sensors collect important environmental data that can be used to trigger a relevant action in the welding machine.

# IOT IN CONSTRUCTION INDUSTRY

## SITE MONITORING

Construction managers can have real-time insights on employees and machines

## MACHINE CONTROL

IoT sensors can guide the machines with greater precision and minimal human involvement

## CONSTRUCTION SAFETY

Combining other technologies like AI with IoT, safety measures can be further enhanced, thereby assuring the safety and health of workers

## FLEET MANAGEMENT

IoT fleet management solutions can be used for optimizing transit routes and maintaining vehicles

## PROJECT MANAGEMENT

IoT devices can facilitate cost-cutting by using site monitoring techniques, keeping the project budget-friendly

# 5. Virtual Reality During Project Planning and Training

- Virtual reality systems are another example of automation in construction. These systems allow for construction companies to plan for a project even before they lay down a single brick.
- Virtual reality simulates a realistic environment that allows builders to interact with a particular structure using a series of scanned images. For example, builders can virtually crawl through pipes in the building to determine if they have enough room for repair and maintenance.
- Virtual reality is an important form of automation because it uses programmed 3D scans that are highly accurate and not prone to human error.

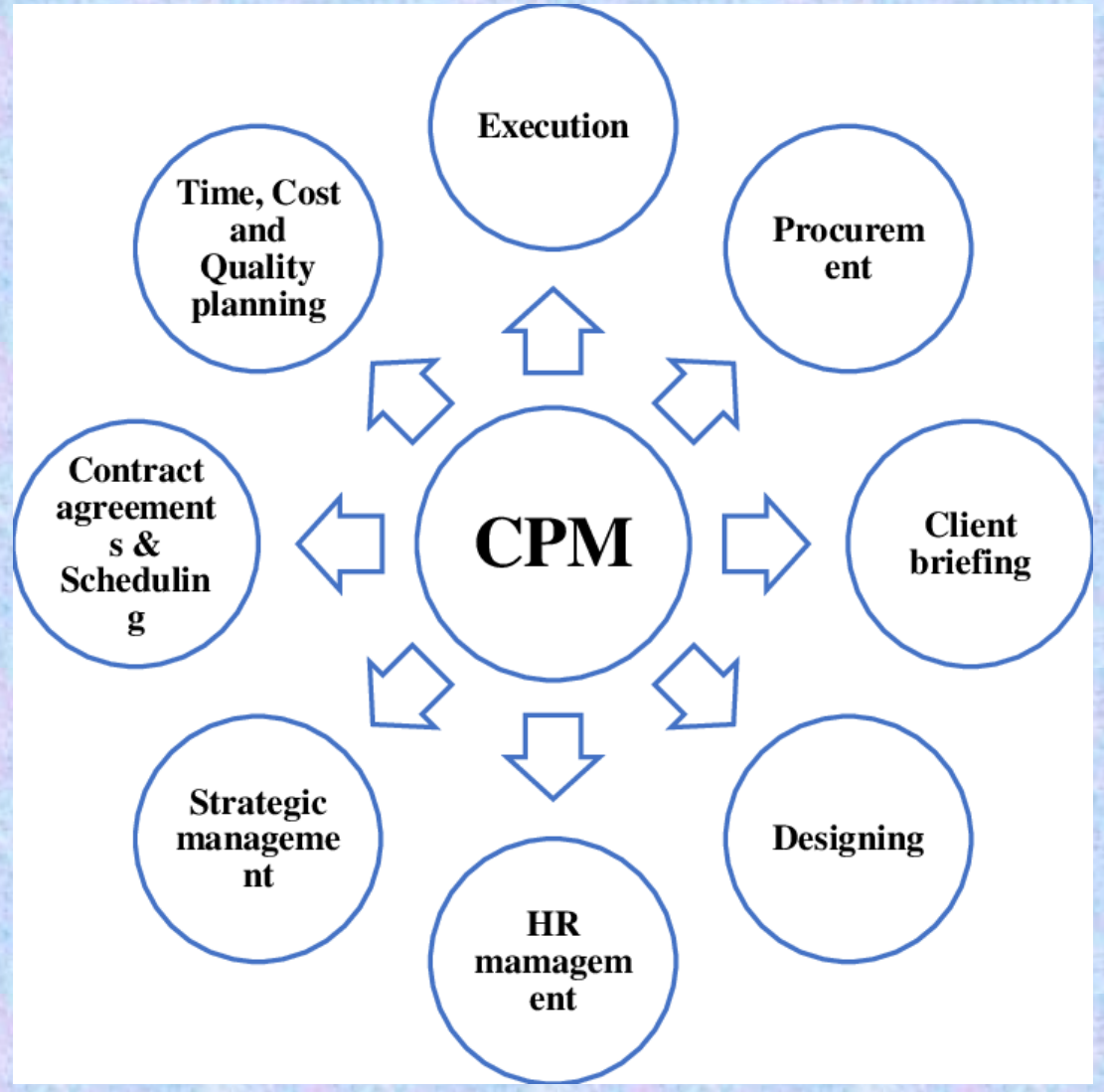
## Examples of automation in Construction Industry

- **Survey work** (total station software)
- **Measurement at site** (profile meter )
- **Automatic instruments**

## Future in automation

- Remote control operation
- Robots doing hazardous operations
- Sensors giving out signals for operation, say automated toll gate on highways
- Network communication of project site, suppliers, designers etc.


Construction Projects Management Software
Project Information
Tasks manager
Labor Billing
Payment & Expenses
Critical path management
Materials Requirement Management
Financial Information Management
Customer Information Management
Contract Document Management
Human resource
Work order
Employee information
Schedule management


CPM
Execution
Procurement
Client briefing
Designing
HR mamagement
Strategic management
Contract agreements & Scheduling
Time, Cost and Quality planning

# Thank You