

A Student's Guide to

# **BUILDING CONSTRUCTIONS & MATERIALS**



MAHANIM ABDULLAH SADALI . NORNAWAR LAILI NORDIN

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**BUILDING CONSTRUCTIONS  
&  
MATERIALS**

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NORNAWAR LAILI NORDIN



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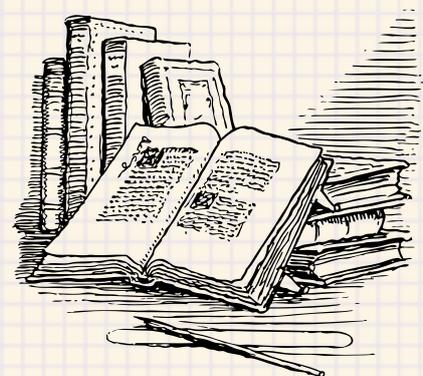
## ***Acknowledgments***

All praises be to Allah, the Most Gracious and the Most Merciful, on Whom we depend for sustenance and guidance, it is because of His blessing that it is possible for us to finish this e-book.

In particular, we would like to offer our heartfelt gratitude to Politeknik Port Dickson, Jabatan Pengajian Politeknik, and Kolej Komuniti for providing us with the opportunity to be a part of this e-book project as well as valuable assistance and guidance in finishing this e-book. They have aided our comprehension and cognitive processes.

Our heartfelt gratitude also extends to all of our colleagues and those who have assisted us on various occasions. Their perspectives and advice are really beneficial. Unfortunately, given the limited space, it is not feasible to mention all of them.

Finally, and most significantly, we dedicate this e-book to our dear students in the hopes that it will inspire and enable you to understand more about building construction & materials in general.



*"The more that you read, the more things you will know, the more that you learn, the more places you'll go." — Dr. Seuss*

## ***Preface***

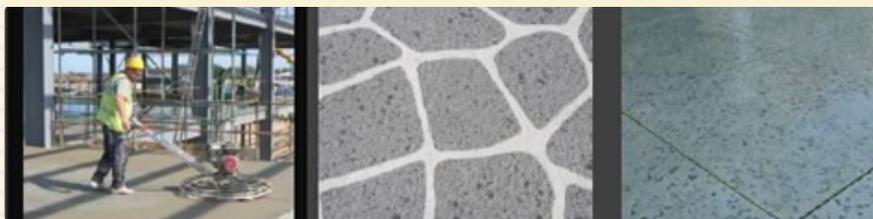
The purpose of this e-book is to provide a collection of resources and further knowledge on building construction and materials for a diploma in architecture in Malaysia and other institutions.

The content is meant to fit into the Malaysian Polytechnics' syllabus and covers the topics of building materials in construction and the fundamentals of building construction. This e-book includes useful graphs, colourful illustrations, and various interesting information.

This e-book is divided into two major segments. The first chapter discusses construction materials that adhere to the Malaysian Standards (MS) and their application to various architectural building typologies. The second chapter explains the notion of building form and envelope, as well as numerous sorts of structures lined with the most recent technology available.



**SHELL STRUCTURE**



**CONCRETE FINISH**



**MATERIALS**

Source : [unsplash.com](https://unsplash.com)

## Topic 01: Material

### CONCRETE

#### HISTORY

The remarkable attributes of today's concrete are the consequence of its illustrious history, which includes decades of technological advancement.

While concrete has a long history dating back to the Roman Empire, the material as we know it today first appeared in 1867 in France, when a gardener named Josef Monier invented a reinforced concrete system for his flowerpots.

It was not even long before the world discovered the durability of this new material and applications expanded fast over the world.

#### DEFINITION

Concrete is a man-made stone-like substance that is utilized for a variety of structural applications. It's formed by combining cement with water and various aggregates including sand pebbles, gravel, shale, and so on, then allowing the mixture to harden through hydration.



Source : [unsplash.com](https://unsplash.com)

## CHARACTER

### Basic Characteristics of Concrete

In terms of:

#### Workability

Concrete workability can be improved by increasing the water content or adding chemical admixtures.

#### Creep

Permanent deformation/movement of a material to release stress within the material.

#### Resistance to Absorption

Depends on the strength of concrete.

#### Strength

The water cement ratio, design ingredients, and mixing, installation, and curing processes all affect the ultimate strength of concrete.

#### Curing

Curing concrete properly results in greater strength and lower permeability, as well as the prevention of breaking when the surface dries out prematurely.

#### Cracking

Tension cracking and shrinkage cracking are possible.



Source : [unsplash.com](https://unsplash.com)

## CHARACTER

### Basic Characteristics of Concrete

In terms of:

#### Expansion & Shrinkage

It is necessary to make provisions to withstand the stresses of repeated expansion and contraction cycles.

#### Elasticity

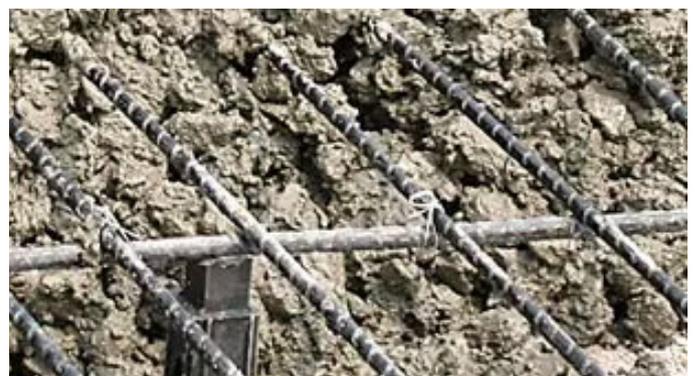
Depends on the proportions of cement and aggregate.

#### Resistance to freezing & thawing

The resistance to predicted exposure circumstances is influenced by the paste quality.

#### Watertight

Depends on the amount of cement and water and the length of the moist-curing period.



Source : [unsplash.com](https://unsplash.com)

## APPLICATION OF CONCRETE



Did you know what concrete can do?  
*It is not only just for a building, but it can also be for..*



Source : unsplash.com



Source : unsplash.com

- Driveways
- Basements
- Sidewalks
- Patios
- Homes
- Curbs
- Streets
- Barn Floors
- Bridges
- Dams
- Skyscrapers
- Swimming Pools

## CONCRETE MIX RATIO



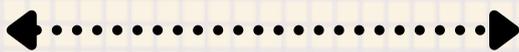
The standard chart table illustrates various concrete mix design grades as well as the appropriate cement, sand, and aggregate ratios.

Concrete	Ratios of Concrete Mix (Cement: Sand: Aggregate)	Cement
M5	1: 5: 10	
M7.5	1: 4: 8	
M10	1: 3: 6	
M15	1: 2: 4	
M20	1: 1.5: 3	
M25	1: 1 : 2	
M30	1: 0.75 : 1.5	
M35	1: 0.5 : 1	
M40	1: 0.25 : 0.5	

Source : unsplash.com

## TYPES OF AGGREGATE

### FINE AGGREGATE



The goal is to serve as a workability agent and to fill voids in the coarse aggregate.

The use of coarse aggregate with the biggest allowable maximum size allows for a reduction in water requirement.



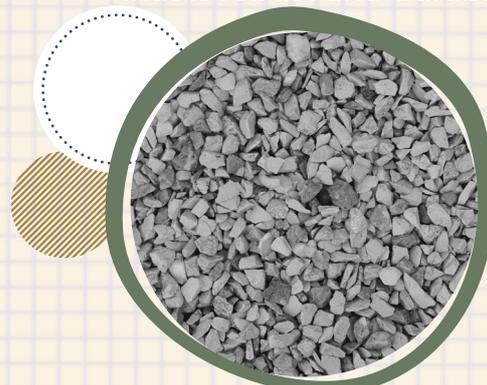
### COARSE AGGREGATE



It is for the economy's greater workability.

The shape should be circular.

These two groups, when correctly balanced or mixed with cement, produce a nearly voidless stone that is robust and durable.



Source : unsplash.com

## TYPES OF CONCRETE

### In-situ concrete

- Pre-cast concrete
- Prestressed concrete
- Reinforce concrete

### DEFINITION

On-site concrete is mixed and then poured into molds where the construction is being done.

Hand, machine, or plant can all be used to make the mixture.

Used as walkways, driveway, parking areas.



Source : theconstructor.org

## TYPES OF CONCRETE

In-situ concrete

### Pre-cast concrete

- Prestressed concrete
- Reinforce concrete

### DEFINITION

On construction sites or in factories, concrete is poured into moulds and hardened.

It will be taken to the building where the units are needed after it has attained the requisite strength.

It's also known as the Integrated Building System (IBS).



Source : theconstructor.org

## TYPES OF CONCRETE

In-situ concrete

Pre-cast concrete

**Prestressed concrete**

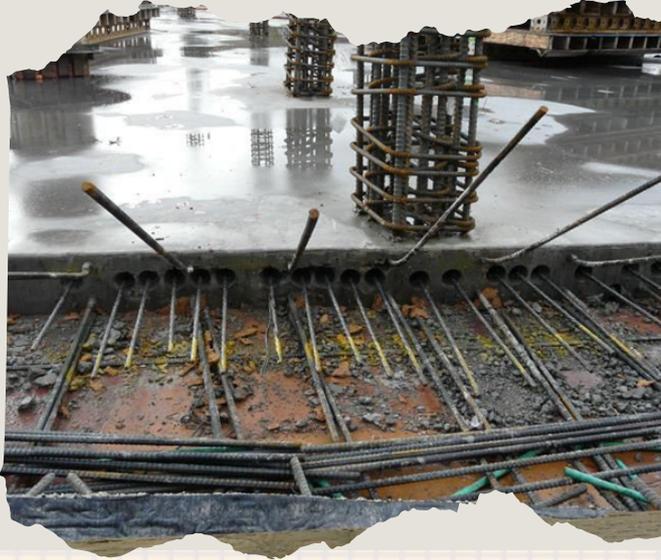
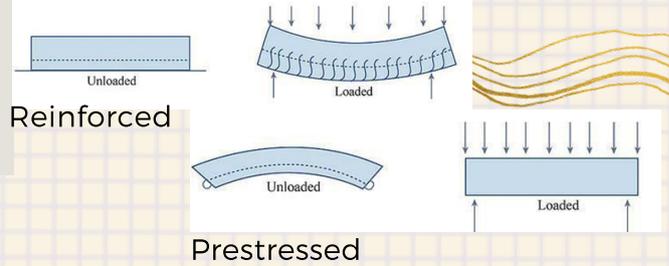
Reinforce concrete



### DEFINITION

To withstand tensile strains caused by the load carried, create compressive stresses in the concrete.

Using a hydraulic jack, tighten wires, high-tensile steel wire, and steel reinforcement are properly attracted before the concrete is poured. This is particularly true for megastructures like bridges.



Source : theconstructor.org

## TYPES OF CONCRETE

In-situ concrete

Pre-cast concrete

Prestressed concrete

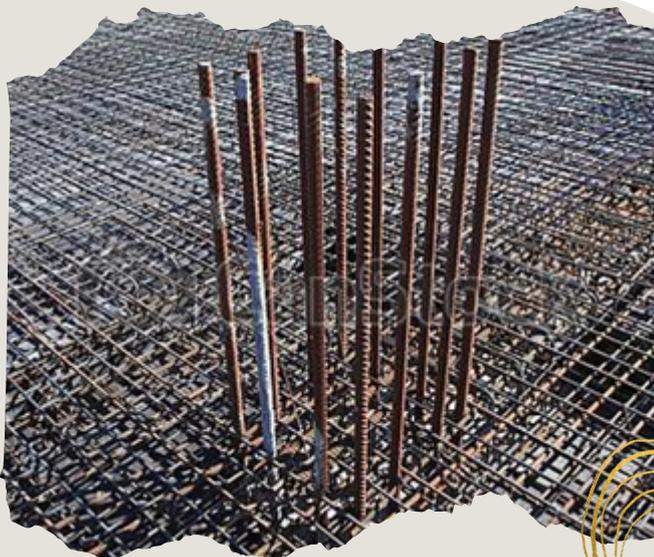
**Reinforce concrete**



### DEFINITION

Built on structural members with reinforcement that allows the structural members to sustain tensile and compressive pressures without deforming.

Foundations, beams, columns, stairwells, floors, slabs, and so forth.



Source : theconstructor.org

# ADVANTAGES AND DISADVANTAGES OF CONCRETE USED

## ADVANTAGES

## DISADVANTAGES

→ Concrete is **economical**.



Low tensile strength

Low ductility

Cracking

→ Concrete has the **ability to be molded** into any desired shape.

→ **Safe** in the event of a fire and able to tolerate **high temperatures** (built-in resistance to fire).

→ **Casting** can occur on the work-site which **reduces cost**.

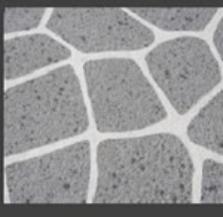
→ **Durability** (resistant to weather-wind, water, insects, and chemicals).

→ The **maintenance cost** of concrete is almost **negligible**.

→ Cinder concrete could be utilized as a **soundproofing** medium.

## TYPES OF CONCRETE FINISHES



					
Smooth finishes	Stamped concrete	Broom finishes	Float and trowel <i>Power floating is generally carried out later than hand floating as the concrete needs to take the weight of the machine</i>	Exterior stenciled <i>Stenciled is hand carved design, that is completely unique.</i>	Rock salt

Source : unsplash.com

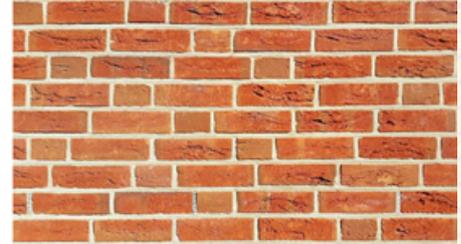
"What's nice about concrete is that it looks unfinished."

Zaha Hadid.

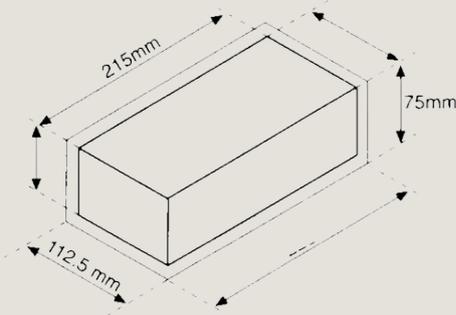
## MASONRY

### DEFINITION

Brick masonry is formed out of brick components that are mortared together.



Source : unsplash.com



### BRICKSIZE

The most widely utilized construction materials are bricks. Bricks are **made by moulding clay** into **rectangular blocks** of **uniform size**, drying them, and then burning them.

## TYPES OF MASONRY

-It **does not** have a **specific surface finish** and is commonly used in the **construction of partition walls** prior to the application of finishing plaster.

-The hues range from **yellow to brown**.

-When compared to face or engineering bricks, it has **lesser compressive strength** and is **less expensive**.

← Common Brick  
Facing Brick  
Engineering Brick



Source : unsplash.com

## TYPES OF MASONRY.....

Common Brick

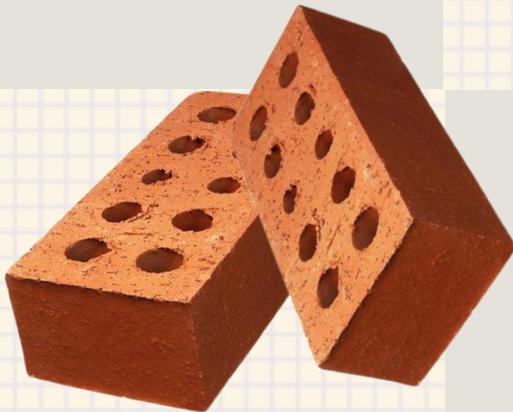
**Facing Brick** 

Engineering Brick



Source : unsplash.com

- Has a **textured, smooth, or sandy** surface finish that eliminates the need for finishing plaster.
- There are either **similar or colorful** color patterns.
- Used to **enhance** the attractiveness of **facades**.
- It can withstand the effects of cold, rain, wind, and chemical fumes without deteriorating.
- It is **strong** enough to sustain the **load distribution** that is applied to it.
- A **pressing method** is used to create this type of brick.



## TYPES OF MASONRY

Common Brick

Facing Brick

**Engineering Brick** 

A **robust** and **dense brick** made at a **high temperature** is used to prevent water penetration, absorption, and porosity. It is used as a **damp-proof course** with good acidity resistance.

It has **higher compressive strength** and a **lower water porosity** than other brick varieties. Lower porosity improves the weight-bearing capacity of bricks as well as their erosion resistance, making them **ideal as pavement and load-bearing** structural material.

Engineering bricks are used in projects that require a **high level of strength** and **resistance to water and frost**. Retaining walls, damp proof courses, manholes, sewers, and basic ground works are some examples of popular applications.

It has a **smooth finish with perforations** running from top to bottom and is easily recognized by its **consistent shape**.

# ADVANTAGES AND DISADVANTAGES OF MASONRY

## ADVANTAGES

### **Termite resistance**

Eliminating woods means that termites have nothing to consume.

### **Maintenance free**

Painting is not required, resulting in a structure with lower life cycle costs and little maintenance.

### **Weather resistant**

Hurricanes, heat, and tornadoes are less likely to damage masonry walls. It can withstand severe storms.

### **Fire resistance**

It is constructed of non-combustible materials.

### **Environmental friendly**

It is recognised as a green building material with a low environmental effect.

### **Sound proofing**

When compared to wood, it is more effective in blocking out noise.

## DISADVANTAGES

### **Moisture absorber**

When it rains, it absorbs moisture (moss).

### **Colour deterioration**

Masonry deteriorates as a result of extreme weather.

### **Heavy foundation**

Masonry walls are heavy, and a large base is required to minimize cracking.

### **More skill labor**

To construct a masonry wall, specialized labor was required.

### **Time constrain**

Building a masonry wall takes more time.



# MASONRY CONSTRUCTION

## ADVANTAGES

- Good fire resistance
- Noise resistance
- Weather and wind resistance
- Pest resistance
- Low maintenance

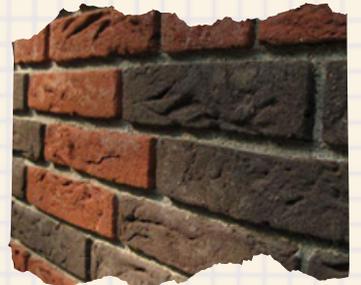
## DISADVANTAGES

- Dead load is very heavy
- Building usually up to 4-storey high only

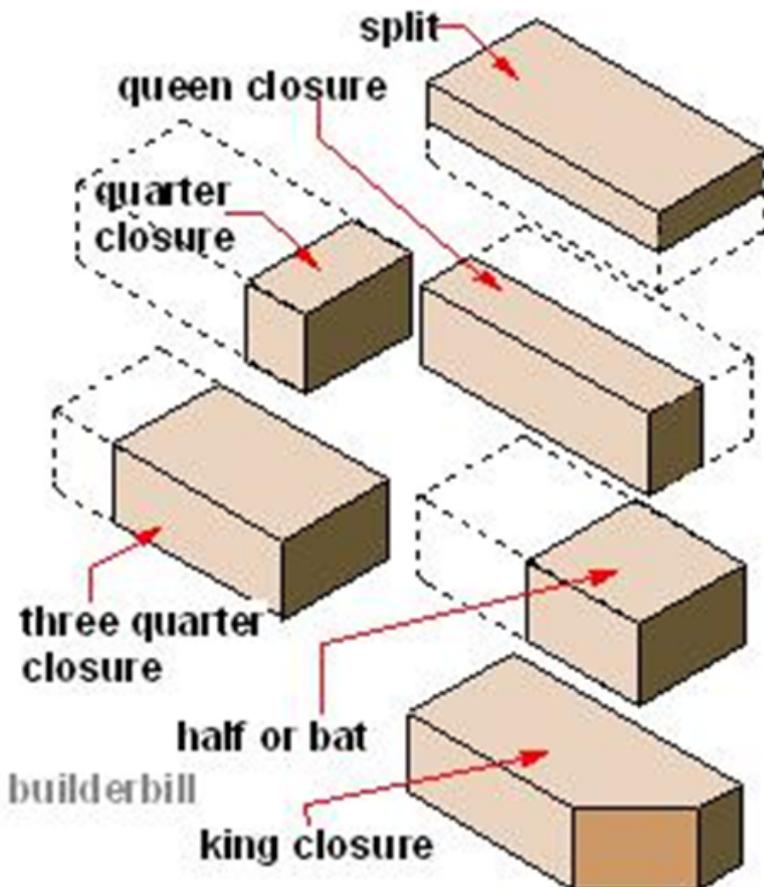
Individual unit of masonry material are put together and bonded together by mortar

## MATERIALS

- Brick
- Stone
- Concrete block
- Glass block



Source : unsplash.com



BRICK CLOSURE

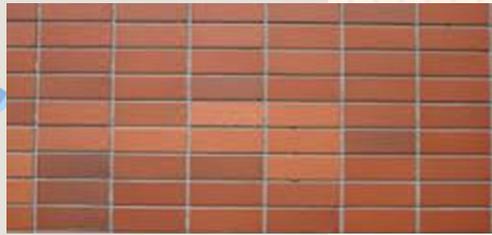
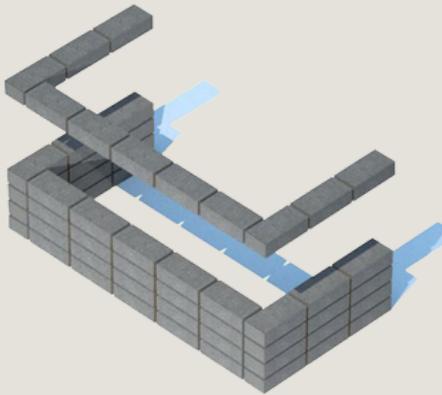


## TYPE OF MASONRY BOND

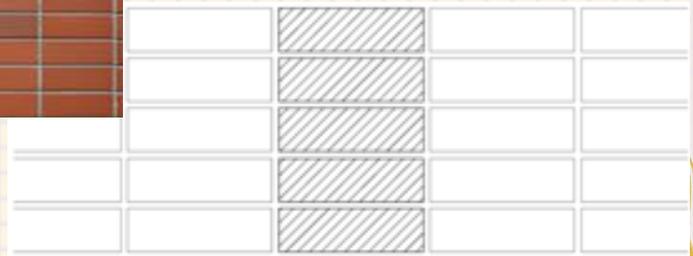
### Stack Bond

- Stretcher Bond
- Header Bond
- English Bond
- Flemish Bond

All members of a brick or masonry bond are **vertically aligned**. The arrangement is fundamentally weak because there is no staggered effect or overlapping. Stacked Bond is another name for this type of bond. This bond is only used for aesthetic purposes and for infill panels where structural strength is provided by other means. Even so, it's usually a good idea to utilize **extra bed reinforcement** while stack bonding.



Source : unsplash.com



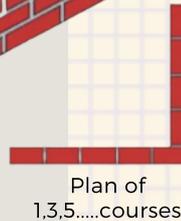
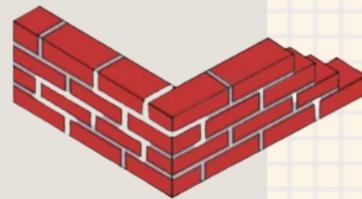
Because the bricks in the stack bond do not overlap, the reinforcement is essentially weak. Stainless steel ladder reinforcement is often placed into every third bed joint to compensate for the lack of bonding.

### Stack Bond

### Stretcher Bond

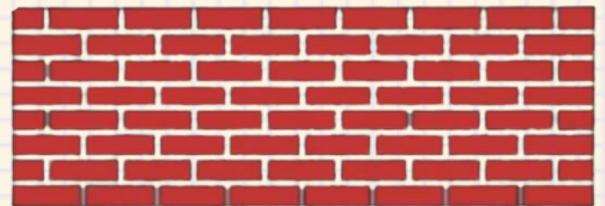
- Header Bond
- English Bond
- Flemish Bond

All stretchers are used in this approach, which is the **simplest way to lay bricks**. It's frequently utilised in cavity and facing tile wall constructions. Originally used for **single brick walls** since it needed the least amount of cutting. As a result, it is the most **cost-effective bond pattern**, and it is widely utilised in modern structures.



Plan of 2,4,6.....courses

Plan of 1,3,5.....courses

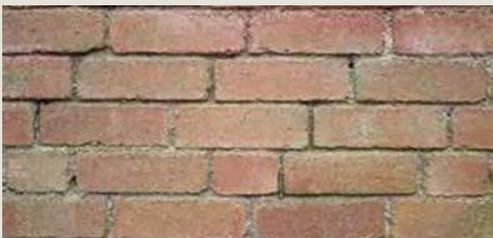


Front Elevation

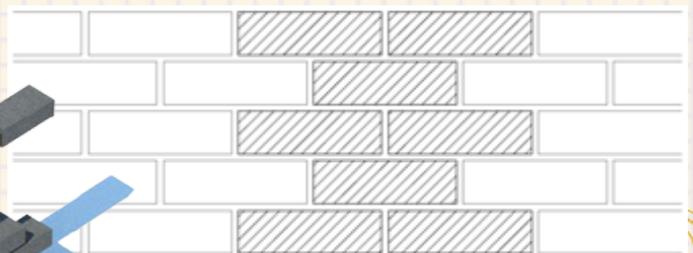
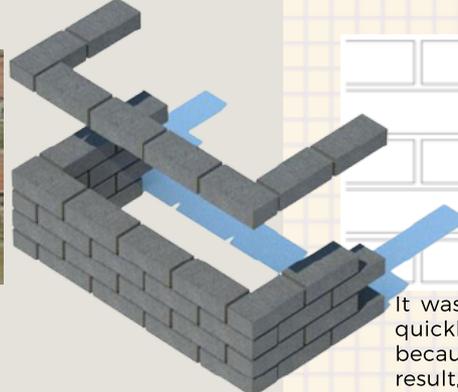


Plan of Course 1

Plan of Course 2



Source : unsplash.com



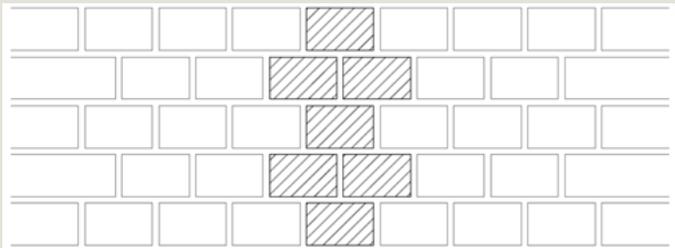
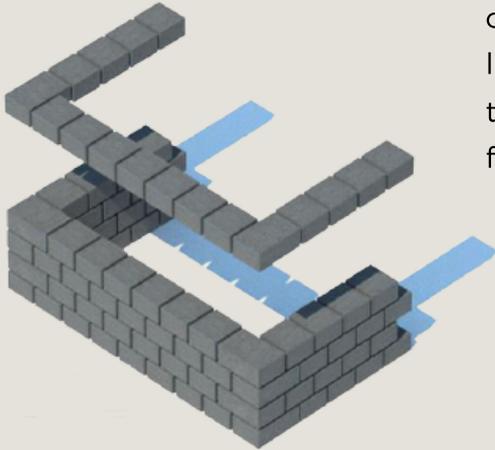
It was originally designed for single brick walls, but it quickly became the natural choice for cavity walls because it required the least amount of cutting. As a result, it is the most cost-effective bond pattern, and it is widely utilised in modern construction.

## TYPE OF MASONRY BOND

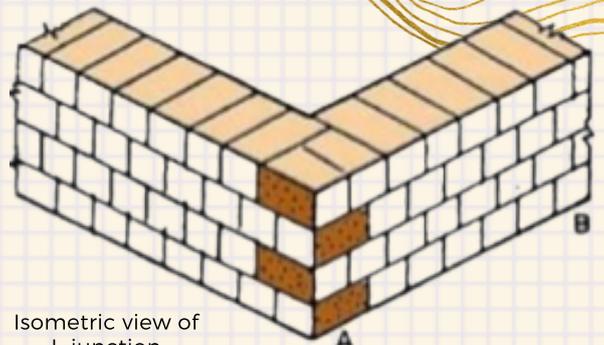
- Stack Bond
- Stretcher Bond
- Header Bond**
- English Bond
- Flemish Bond



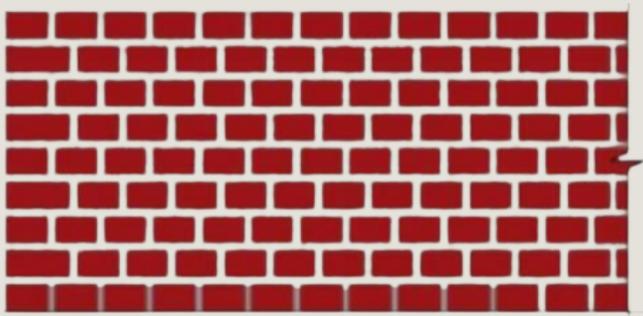
A brick or masonry bond in which all members are **vertically aligned** and the **head faces the outside**. There is an overlapping effect. Because the width of the wall is the entire length of a brick, this method is **exceptionally sturdy**. It was traditionally utilized for high-end structures, and it was frequently employed for curved brickwork.



A brick course with the short end of the brick exposed, set flat. Because the width of the wall is the entire length of a brick, this method is exceptionally sturdy. It was traditionally utilized for high-end structures, and it was frequently employed for curve brickwork.



Isometric view of L-junction



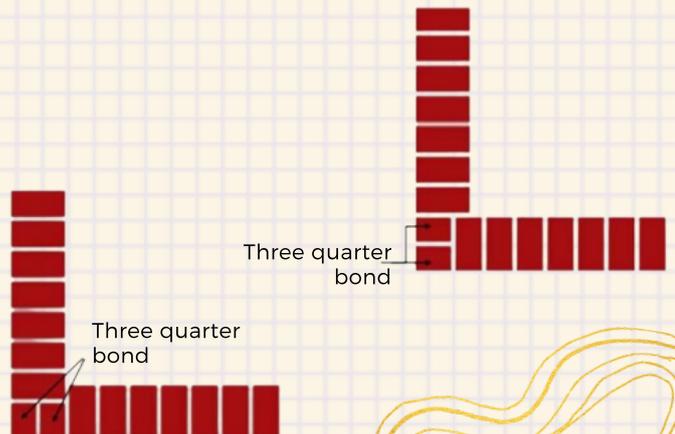
Front Elevation



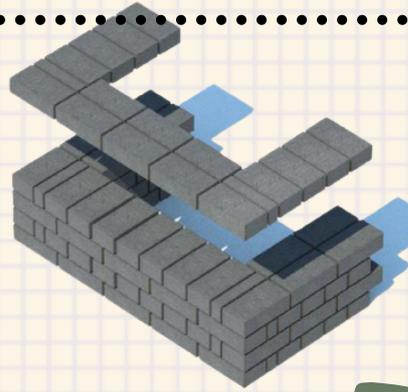
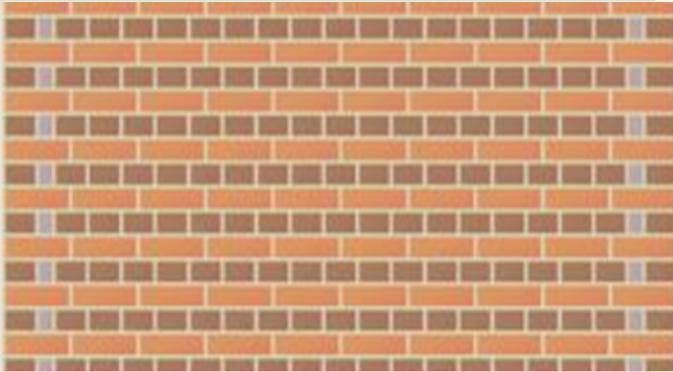
Plan of 1,3,5.....courses



Plan of 2,4,6.....courses



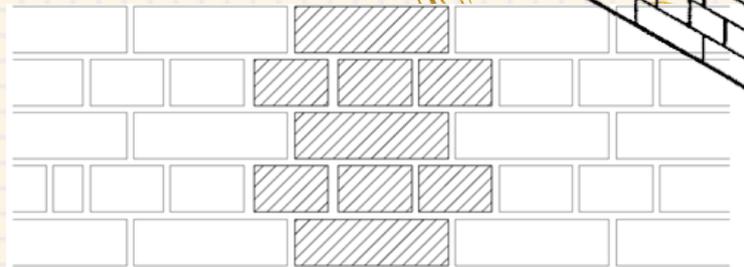
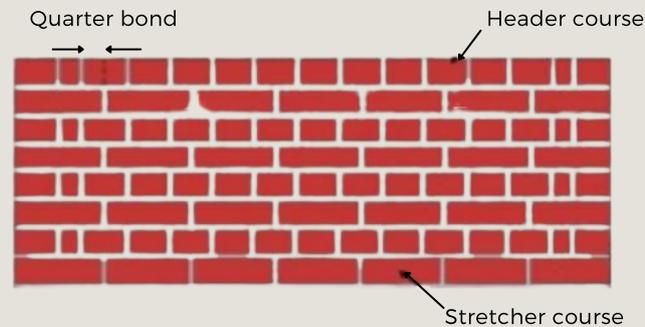
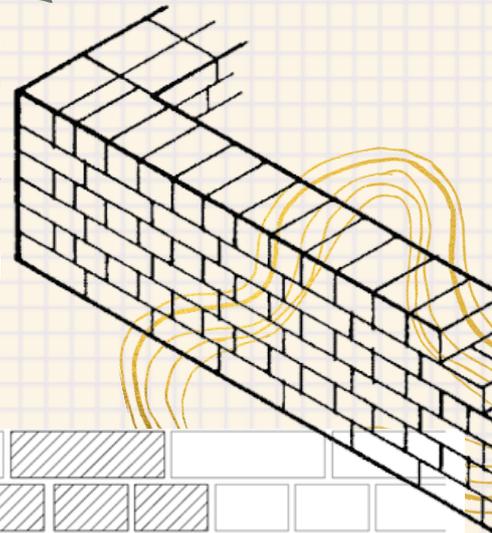
## TYPE OF MASONRY BOND



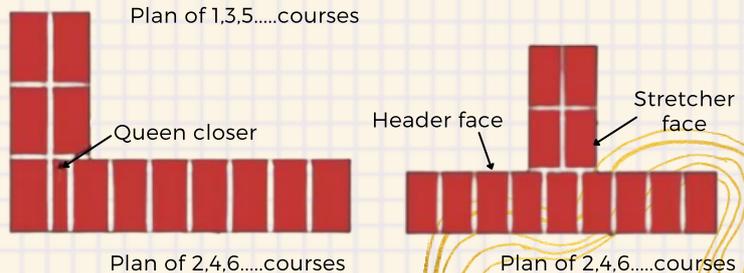
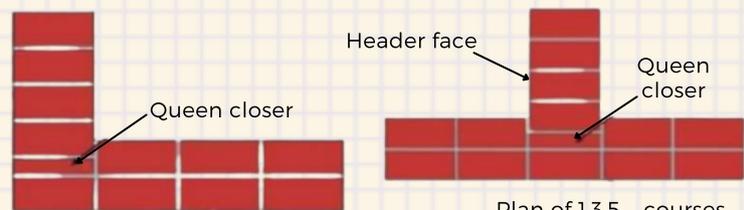
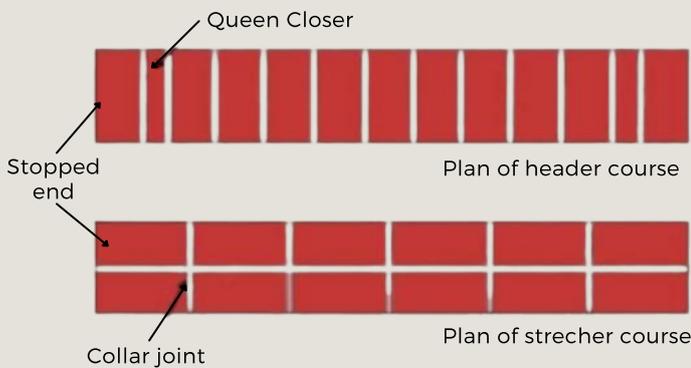
- Stack Bond
- Stretcher Bond
- Header Bond
- English Bond**
- Flemish Bond

A brick or masonry bond in which all members are vertically aligned with the head and side facing the outside in one layer. There is an overlapping effect. The layouts are arranged in a clockwise direction.

It is made up of different courses of **headers and stretchers**. When the wall is **one brick thick**, it forms a **solid link**. **Bridges, viaducts, embankment walls, and other civil engineering structures** use this bonding pattern.



It is made up of different types of headers and stretchers. When the wall is one brick thick, it forms a solid link. Bridges, viaducts, embankment walls, and other civil engineering structures use this bonding pattern.

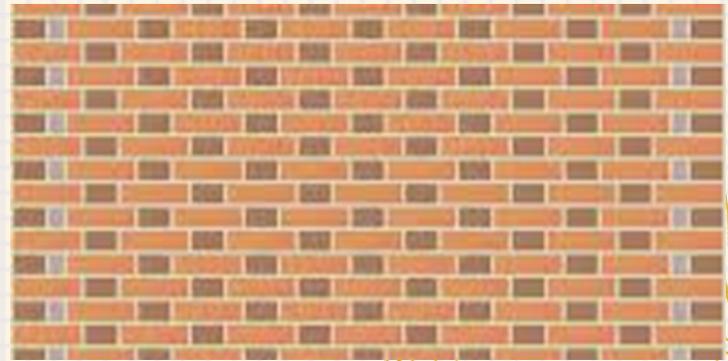
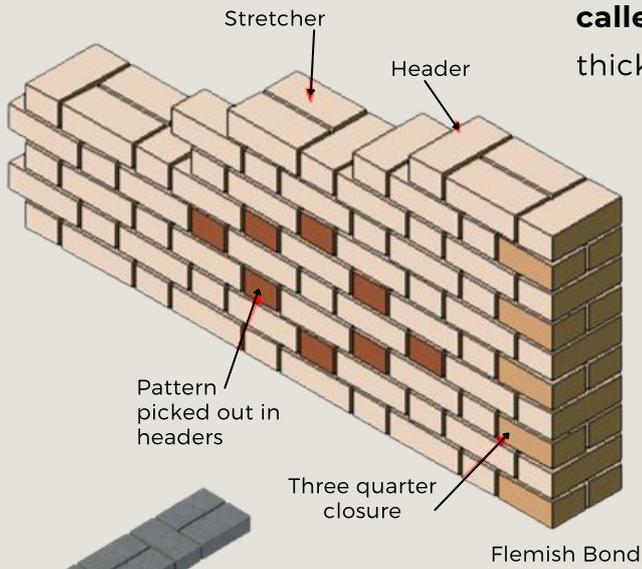


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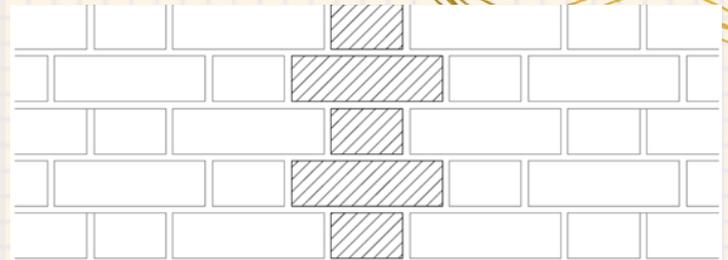
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- English Bond
- Flemish Bond**



A brick or masonry bond in which all members are **vertically aligned with the head and side facing the outside**. There is an overlapping effect. The layouts are arranged in a clockwise direction. Flemish bonds can be duplicated in a **cavity wall's half-brick outer leaf by utilising entire bricks as stretchers and half bricks called bats or snap-headers as headers**. At one brick thick, it is not as sturdy as English bond.

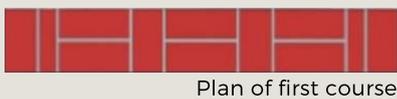
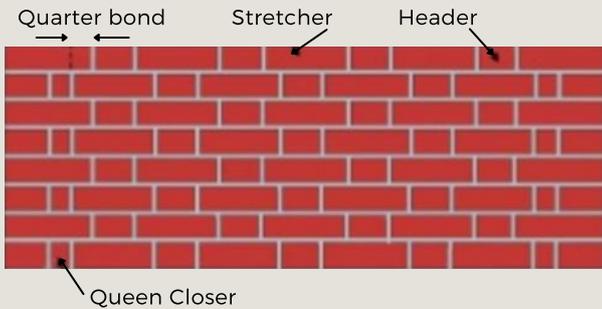


Source : civilsnapshot.com



Flemish bonds can be duplicated in a cavity wall's half-brick outer leaf by utilizing entire bricks as stretchers and half bricks called bats or snap-headers as headers. At one brick thick, it is not as sturdy as English bond.

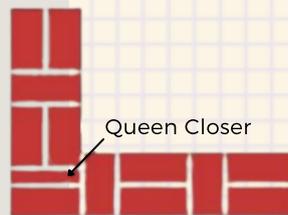
Source : civilsnapshot.com



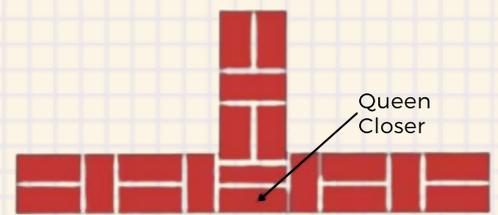
Plan of first course



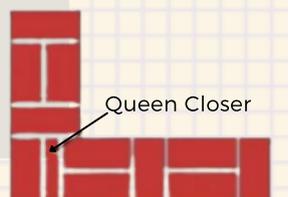
Plan of second course



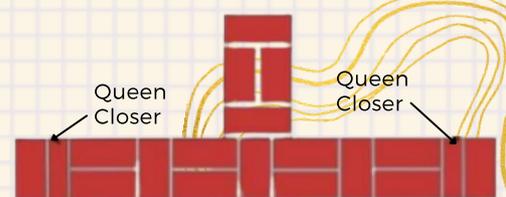
Plan of first course



Plan of first course



Plan of second course

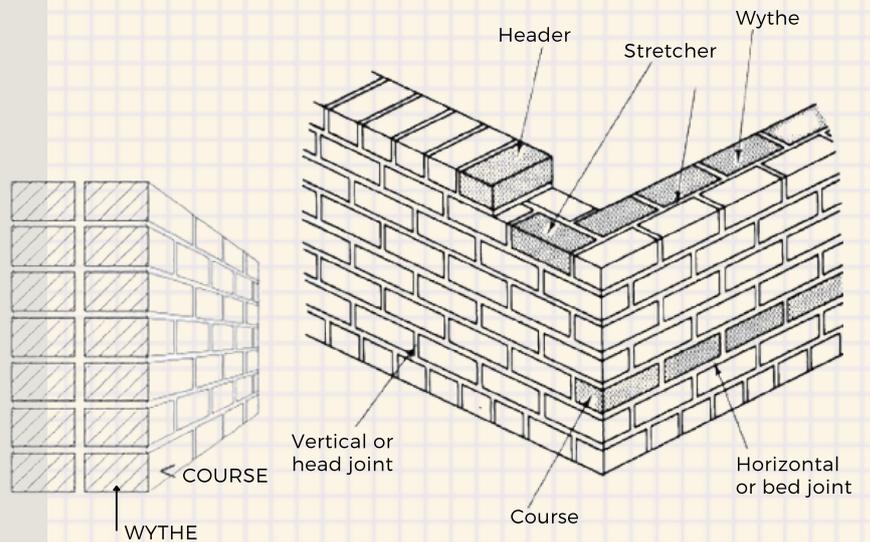


Plan of second course

# TYPES OF MASONRY JOINT.....

## Course

- Lapped Joint
- Vertical Joint
- Lateral or Horizontal Joint
- End Joint
- Toothing
- Racking Back
- Jointing and pointing



**Course**: Continuous layer  
**Wythe**: Continuous vertical section

Source : civilsnapshot.com

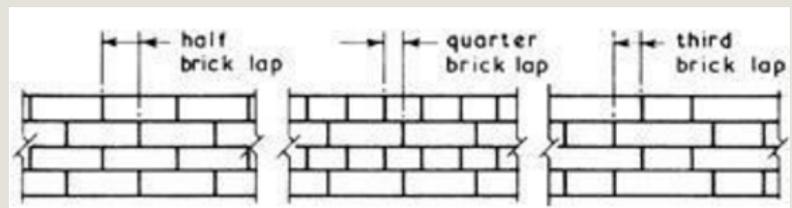
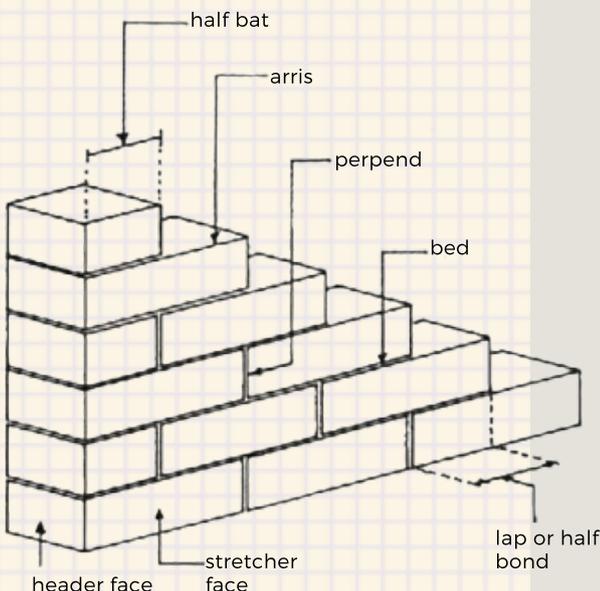
## Course

A **lap joint**, also known as an overlap **joint**, is one where the **members overlap**. Masonry, wood, plastic, and metal can all be joined with lap joints. A **full lap, half lap, or quarter lap** joint can be used.



## Lapped Joint

- Vertical Joint
- Lateral or Horizontal Joint
- End Joint
- Toothing
- Racking Back
- Jointing and pointing



**HALF BONDING** used in half brick thick walls built in stretcher bond.

**QUARTER BONDING** used in most bonds built, with standard bricks.

**THIRD BONDING** used in bonds built, with metric bricks.

Source : civilsnapshot.com

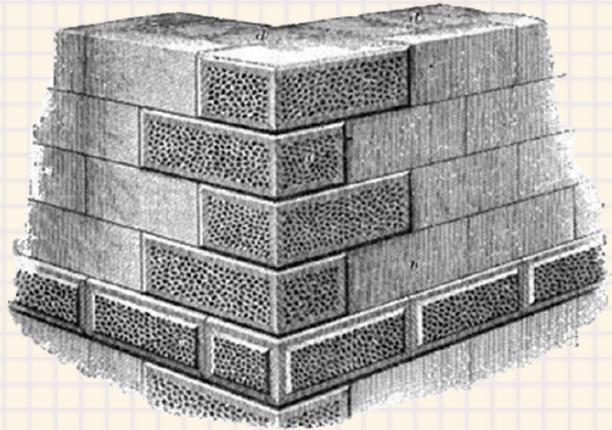
# TYPES OF MASONRY JOINT.....

Course  
Lapped Joint

## Vertical Joint

Lateral or Horizontal Joint  
End Joint  
Toothing  
Racking Back  
Jointing and pointing

The **vertical seams between blocks or bricks that have been set in a horizontal course to build a wall** are referred to as 'perpend.' The bed joint is the term used to describe the horizontal mortar joint in a wall construction.



Source : unsplash.com

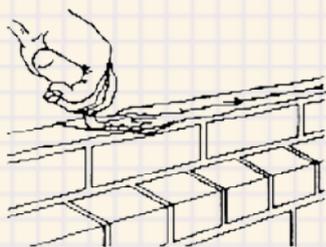


Course  
Lapped Joint  
Vertical Joint

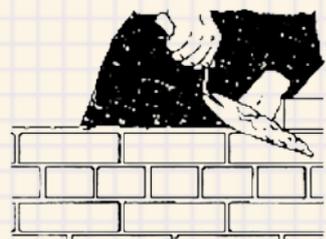
Over pinning to save cost on underpinning and ring beams to increase lateral load resistance:

## Lateral or Horizontal Joint

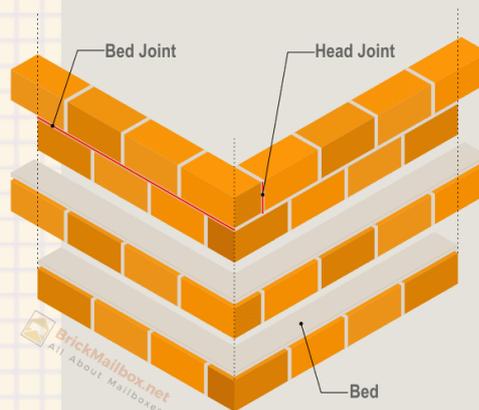
End Joint  
Toothing  
Racking Back  
Jointing and pointing



VIEW 1: making a furrow



VIEW 2: cutting of excess mortar



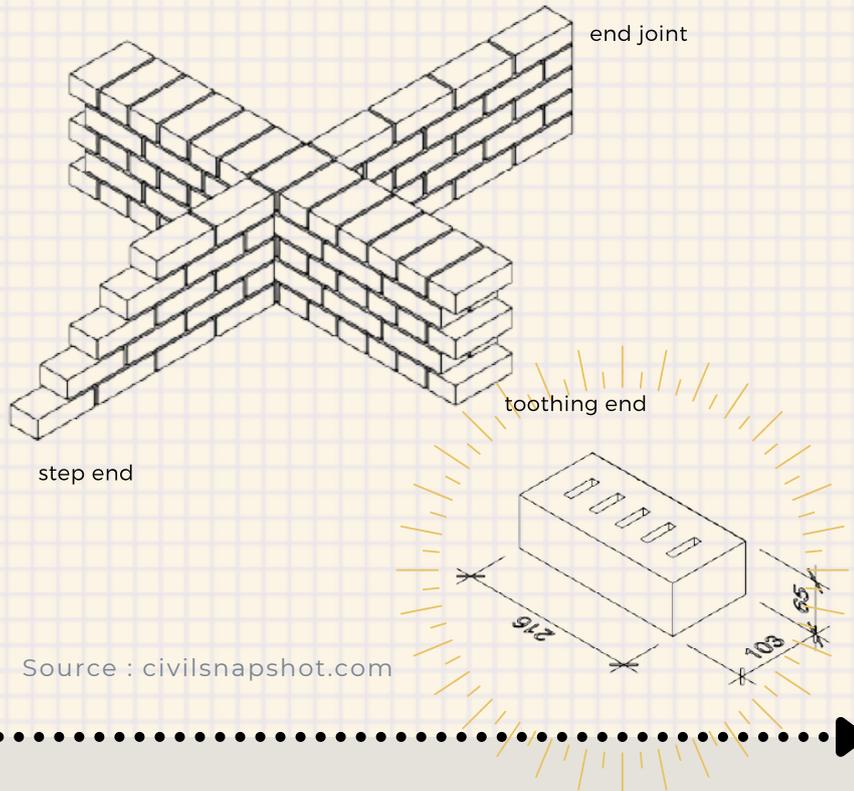
Source : civilsnapshot.com

# TYPES OF MASONRY JOINT.....

- Course
- Lapped Joint
- Vertical Joint
- Lateral or Horizontal Joint

## End Joint

- Toothing
- Racking Back
- Jointing and pointing



- Course
- Lapped Joint
- Vertical Joint
- Lateral or Horizontal Joint
- End Joint

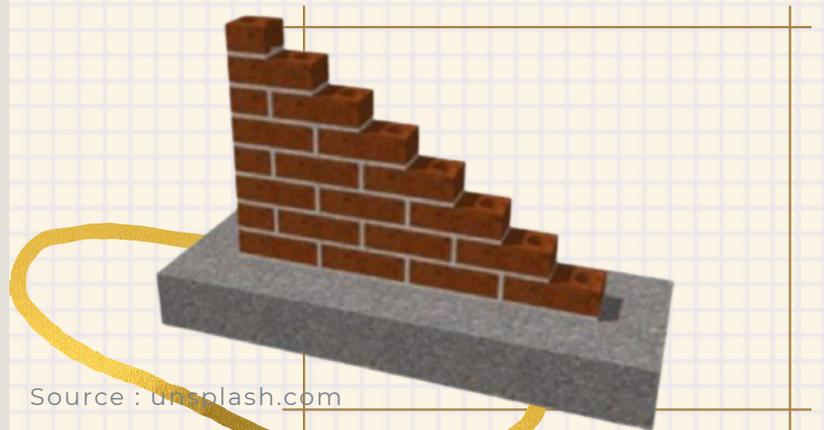
## Toothing

- Racking Back
- Jointing and pointing

The illustration depicts a **toothed** half brick wall with a stop end. The goal of toothing the brickwork is to allow plumbing to go higher than a racking would typically allow.

# TYPES OF MASONRY JOINT.....

- Course
- Lapped Joint
- Vertical Joint
- Lateral or Horizontal Joint
- End Joint
- Toothing



Source : unsplash.com

## Racking Back

Jointing and pointing

A half-brick wall with a stop end and **racking back** is depicted in the illustration. Bricklayers typically utilize this type of building to build plumbings that allow them to plumb either end of the wall and build to a line in the middle. This method is far more efficient than constructing the wall one course at a time.



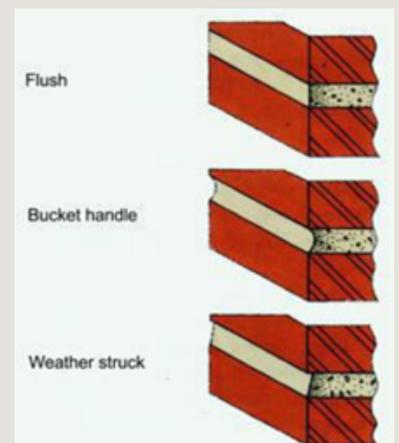
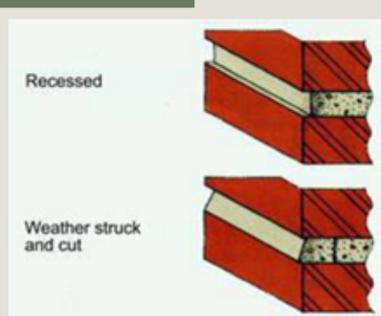
Source : unsplash.com

Profile	Rain Resistance
Concave*	Good
V-Shape	Fair
Weathered	Fair
Flush	Poor
Struck	Very Poor
Raked	Very Poor

\*Preferred Profile

- Course
- Lapped Joint
- Vertical Joint
- Lateral or Horizontal Joint
- End Joint
- Toothing
- Racking Back

## Jointing and pointing



## NON METAL AS BUILDING MATERIAL

### Glass

Plastic  
Ceramic  
Terrazzo  
Gypsum  
Fiber

Glass is one of the most versatile materials on Earth, with a vast range of applications and shapes ranging from simple clear glass to tempered and colored variants, and so on. Glass is formed naturally when silicate-rich rocks melt at high temperatures and cool before forming a crystalline structure.

### Uses:-

- Eyeglasses, bottles, windows, and even some types of furniture are all examples.
- Living rooms are typically decorated with glass.
- For use in residential, commercial, and decorative settings.

# GLASS



SODIUM SILICATE, which is SOLUBLE in water, is formed when these ingredients are melted together.

The solubility is lowered when lime is introduced.

When enough lime is added, a tough glass is formed that can withstand the elements and all strong acids except hydrofluoric acid.



Glass plate facade edge  
Madrid, Spain  
By: Joel Filipe



Frankfurt am Main, Deutschland  
By: Kai Rohweder

## BASIC CHARACTERISTICS OF GLASS .....

Transparent

Can be kept in liquid condition

Bend when heated

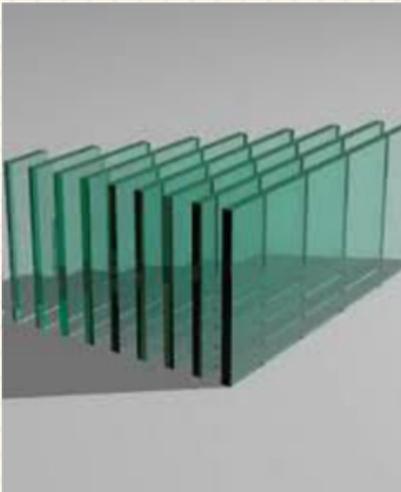
Fragile

Reflectable

Hard & Durable



## CHARACTERISTICS OF GLASS



Transparent glass

Source : unsplash.com



Translucent glass



Special glass



## TYPES OF GLASS

- Flat Glass

Plate Glass



- Is made by rolling molten glass into a plate, then grinding and polishing it as it cools.
- Plate glass allows for virtually distortion-free viewing.

Sheet Glass



- Sheet glass is made by either pulling molten glass from a furnace (drawn glass) or making a cylinder, dividing it lengthwise, and flattening it (flattening glass) (cylinder glass). Because the fire polished surfaces are not precisely parallel, some visual distortion occurs.

Float Glass



- Made by carefully pouring molten glass onto a molten tin surface and allowing it to cool.
- Flat, parallel surfaces are produced, which reduce distortion and remove the need for grinding and polishing.
- Flat glass is the most extensively used type of glass.

- Laminated Glass

- A robust protective interlayer made of polyvinyl butyryl (PVB) is bonded together between two panes of glass under heat and pressure to form laminated glass.
- Once sealed, the glass "sandwich" functions as a single unit and appears to be ordinary glass.
- Laminated glass is often used in airports, museums, recording studios, and schools to block out undesirable noise from airplanes, heavy machinery, and traffic, to name a few examples.



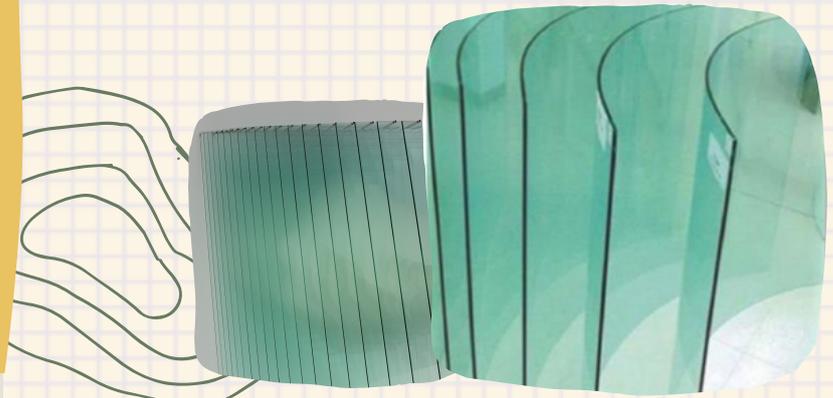
- Tempered Glass

Uses:-

Oven windows, computer displays, skylights, door windows, tub enclosures, and shower doors are all made of this material.

Automobiles: tempered glass for the back and side windows and safety glass for the windshield.

- Tempered glass is one of two types of safety glass that are commonly used in settings where ordinary glass could be dangerous.
- When it breaks, it is four to five times stronger than regular glass and does not shatter into jagged fragments.
- It's made through a process of high heating and quick cooling, which makes it much tougher than regular glass.
- Tempered glass is heat resistant due to the thermal process that cures it.



Source : unsplash.com

- Wired Glass

- Wire mesh is inserted between the two faces of sheet glass to avoid shattering in the case of a break.
- Wired glass is a type of glass in which a wire mesh has been introduced during the manufacturing process.
- It has a similar impact resistance to regular glass, but in the event of shattering, the mesh traps the glass fragments.



- Across the country, wired glass can be found in schools, companies, and hotels.
- It is primarily made as a fire retardant, with wire mesh inlaid in the glass to prevent it from fracturing and breaking when subjected to high temperatures or stress.
- The glass keeps the fire at bay when the window is intact, shielding individuals on the opposite side from the destructive effects of smoke and flame.

- Patterned Glass

- Has a linear or geometric surface pattern generated during the rolling process that obstructs vision or diffuses light.



Source : unsplash.com

- Block Glass



Source : unsplash.com

- Glass blocks are the most widely utilised alternative to basement windows in residential applications.
- Glass blocks are available in a range of shapes and sizes.
- They can be opalescent or clear, and they can also be stained with a variety of colors.
- Non-load bearing walls, partitions, and windows are constructed with this material. Because natural sunlight may be filtered in, glass blocks are regarded as both an architectural element and a practical aspect of design.

# NON METAL AS BUILDING MATERIAL

Glass

**Plastic** → The term "plastic" refers to a class of synthetic or natural organic materials that may be moulded softly and then solidified.

Ceramic

Terrazzo

Gypsum

Fiber

Plastics are primarily high-molecular-mass polymers that may contain additives to increase performance and/or save costs.

Petroleum or natural gas are used as raw materials in the production of plastics.

## 2 CLASSIFICATIONS OF PLASTIC

Thermoplastics

Thermosetting plastics



THERMOPLASTICS

Source : unsplash.com

- When heated, it softens and melts gradually, and it can be sculpted while still warm.
- When heated or cooled, linear molecular chains move in respect to one another.
- Polyethylene, polypropylene, polystyrene, and polyvinyl chloride are the most popular thermoplastics.

- Reheating thermosetting resins does not result in lasting changes; they soften and melt when heated then solidify when cooled, much like butter.
- When the mould is cooled, the moulded shapes are preserved.
- Any thermoplastic object can be remoulded into a different shape.

# NON METAL AS BUILDING MATERIAL

## THERMOPLASTICS

Method	Product
Extrusion (penyemperitan)	Pipes, tubes, rods
Molding (acuan)	Polyethylene, polystyrene, nylon

Material	Properties	Uses
Polystyrene	<ul style="list-style-type: none"> <li>modulus elasticity is low</li> <li>-has good water resistance</li> <li>-poor heat resistance</li> <li>-brittle and lacks toughness</li> </ul>	<ul style="list-style-type: none"> <li>-storage containers and cups</li> <li>-tiles, packing</li> <li>-insulation boards</li> </ul>
Polyvinyl Chloride (PVC)	<ul style="list-style-type: none"> <li>-excellent insulator</li> </ul>	<ul style="list-style-type: none"> <li>-raincoats, shower curtain</li> <li>-electric cable</li> <li>-flexible sheeting</li> <li>-hoses, pipes</li> </ul>
Polyethylene	<ul style="list-style-type: none"> <li>-Weather resisting plastic</li> <li>-Durable</li> <li>-Excellent electrical properties</li> <li>-Favorable chemical resistance</li> <li>-Tensile strength very low</li> </ul>	<ul style="list-style-type: none"> <li>-manufacture of films</li> <li>-piping</li> <li>-electrical conduits</li> <li>-tanks</li> <li>-bottle</li> </ul>
polypropylene	<ul style="list-style-type: none"> <li>- Low specific gravity</li> <li>- The lightest of all thermoplastics</li> <li>- Good heat resistance and hardness</li> </ul>	<ul style="list-style-type: none"> <li>-pipes</li> <li>-molding</li> <li>-geomembranes</li> </ul>

# NON METAL AS BUILDING MATERIAL

## THERMOSETTING PLASTICS

- Is a polymer that can't be reshaped once it's been made. The molecular structure of thermosets is similar to that of thermoplastics prior to moulding, but these chains are cross-linked during the hardening process to form an interconnected network of chains that are not free to move.

- They do not soften when warmed and cannot be remoulded.

Material	Uses
polyester	-fiberglass product -composite material
Phenol-formaldehyde	-manufacture of lavatory seats -electrical fittings and equipment -decorative laminates



Source : unsplash.com



**QUIZ TOPIC 01: MATERIAL**

## NON METAL AS BUILDING MATERIAL

- Glass
- Plastic
- Ceramic**
- Terrazzo
- Gypsum
- Fiber

Inorganic and nonmetallic materials are both classified as ceramics.

Ceramics are often manufactured by moulding clay, earthy materials, powders, and water mixes into desired shapes. After the ceramic has been moulded, it is burnt in a kiln, which is a high-temperature oven. Glazes are ornamental, waterproof, paint-like substances that are applied to ceramics.



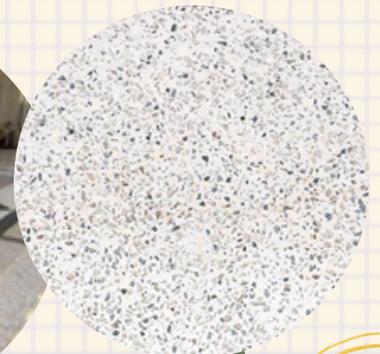
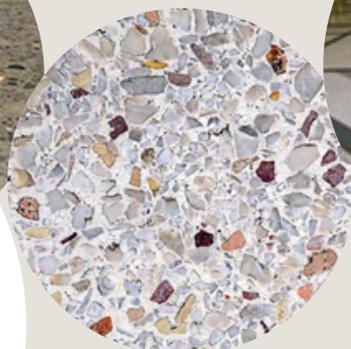
This category of materials includes things like tile, bricks, plates, glass, and toilets flooring.



source : unsplash.com

A precast or poured-in-place composite material is used for floor and wall treatments. It's made out of marble, quartz, granite, glass, or other suitable chips, sprinkled or not, and poured with a cementitious (for chemical binding), polymeric (for physical binding), or a combination of the two binder types. Terrazzo is cured, then ground and polished or otherwise treated to provide a consistently textured surface.

- Glass
- Plastic
- Ceramic
- Terrazzo**
- Gypsum
- Fiber



Source : unsplash.com

# NON METAL AS BUILDING MATERIAL

- Glass
- Plastic
- Ceramic
- Terrazzo
- Gypsum**
- Fiber

Gypsum is a calcium sulphate dihydrate-based soft sulphate mineral.



It is frequently mined and can be used as a fertilizer. It is also a key ingredient in many types of plaster and blackboard chalk.



A gypsum board is a gypsum plaster panel sandwiched between two thick sheets of paper. It's employed in the construction of interior walls and ceilings.



Source : unsplash.com

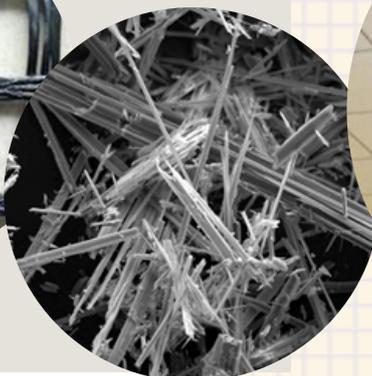


Fibre-reinforced plastic (also known as fibre-reinforced polymer) is a composite material made up of a polymer matrix and fibres.

It's a pressed board panel made up of tiny composite materials. It's used to construct ceilings, partitions, automobile bumpers, and a variety of other things.



- Glass
- Plastic
- Ceramic
- Terrazzo
- Gypsum
- Fiber**



## Topic 02: Form & Structure

### INTRODUCTION

THE MAIN COMPONENTS OF A SHELTER OR BUILDING ARE **STRUCTURE** AND **ENVELOPE**.

A structure is something that is created or made from various interconnected pieces and has a fixed place on the ground.

This includes buildings.

However, the term **STRUCTURE** may also apply to any linked body of components that is built to carry **LOADS**, even if it is not intended to be populated by humans.



*"I have always appreciated those who dare to experiment with materials and proportions." Zaha Hadid*

The building envelope is the physical barrier that separates the interior and exterior of a building.

The building envelope is the physical barrier that separates the interior and exterior of a structure.

Components of the envelope are typically: walls, floors, roofs, fenestrations and doors. Fenestrations are any openings in the structure: windows, skylights, clerestories, etc.

They must be designed and built to be suited for various sorts of structures, requirements, and construction methods.



Source : [unsplash.com](https://unsplash.com)

**STRUCTURE + ENVELOPE  
(FABRIC/MATERIALS)**



Every building is composed of some common elements

**(structure + envelope):** .....➔

- Foundations
- Columns
- Floors
- Walls
- Roof
- Windows and doors
- Stairs and ramps
- Surface finishes (walls and floor)
- Services



Source : unsplash.com



Did you know? humans do learn from nature...  
*a concept of biomimicry*

*"Biomimicry is basically taking a design challenge and then finding an ecosystem that's already solved that challenge, and literally trying to emulate what you learn"*

*- Janine Benyus*

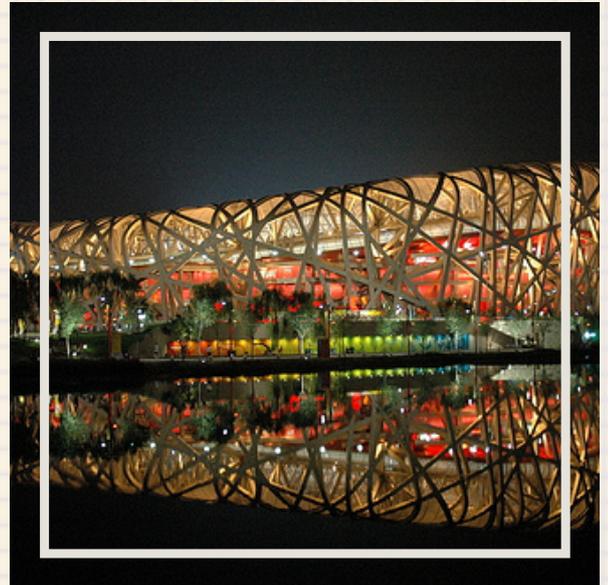


Source : unsplash.com

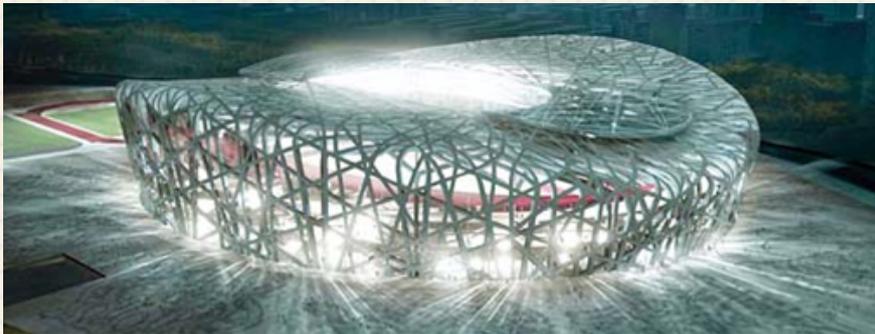
**BEIJING OLYMPIC NATIONAL STADIUM  
'BIRD'S NEST'**

*"Beijing National Stadium, or the Bird's Nest, as it has become known, is the world's largest steel structure and the most complex stadium ever constructed. It is one of the key engineering marvels in the world today."*

*ChinaHighlights*



Source : chinahighlights.com



Source : chinahighlights.com

**HEALTH SCIENCES EDUCATION BUILDING  
PHOENIX, ARIZONA, USA**

*Copper cladding –replicates the layering stratified earth of rock formation of Arizona Canyons and mountains*



Source : unsplash.com



**UNIVERSITY OF STUTTGART PAVILION  
sea urchin (landak laut)**

## BUILDING FUNCTIONS

### **To fulfil the basic human needs for shelter**

- To provide protection against various elements.

### **Building as a space enclosure**

- To achieve a suitable indoor environment.

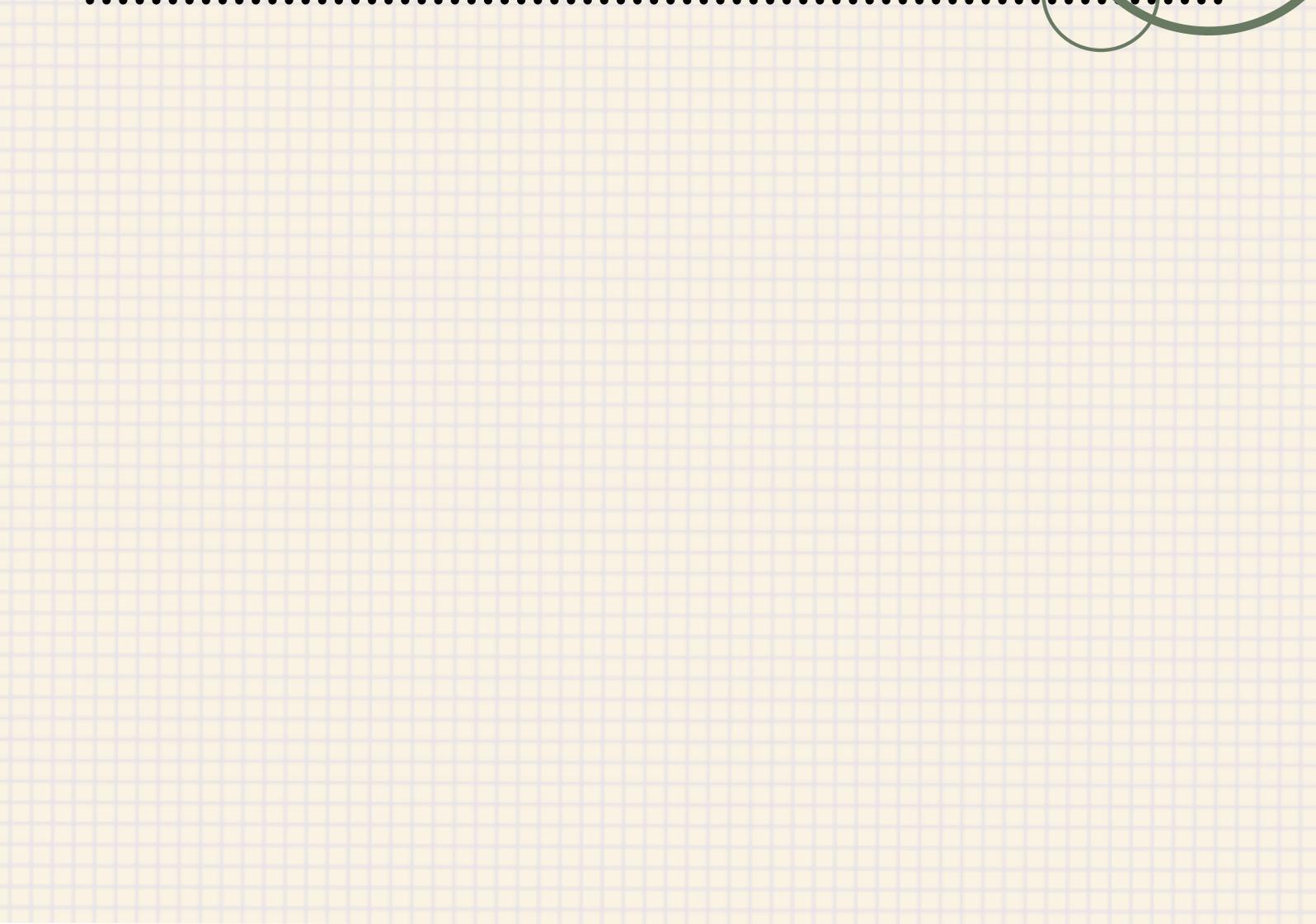
### **To provide desired thermal comfort level**

- Internal environment must be suitable for the various activities

### **Provide comfort and safety**



Source : [unsplash.com](https://unsplash.com)



## STRUCTURAL REQUIREMENTS

### FUNCTION:

#### To provide shelter

Structure must provide shelter, enclose spaces and control the internal environment.

#### As an enclosure

Buildings & structure are able to resist safely all the loads and forces imposed on it.

#### As a connection

Some structures function as a connection between two places such as bridges.

#### Resistance to natural forces

Some are designed to resist natural forces such as water and earth e.g. DAM AND RETAINING WALLS.

#### Energy efficient

Buildings must not be destructive to the natural environment or mother earth as a result of the energy crisis and global warming.



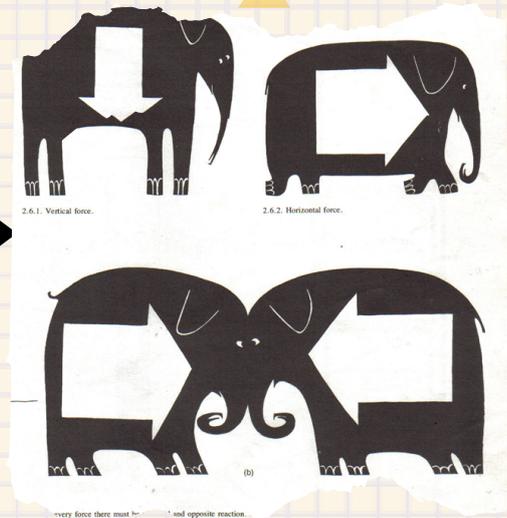
Source : [aviewoncities.com](http://aviewoncities.com)



## STRUCTURAL REQUIREMENTS

### EQUILIBRIUM

- A structure's most fundamental need.
- Structures must be designed in such a way that they do not shift or collapse.
- All forces must be in a state of balance.



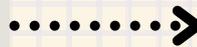
### SAFETY

Structures must be safe to use not just when inhabited, but also when under construction



### ECONOMICAL

Structure must be built within reasonable cost except for extravagant and monumental projects, designers must be accountable for minimizing structural costs (VALUE FOR MONEY)



### AESTHETIC

Structures must have aesthetics qualities. It is a science and study of quality of an object and how they are perceived by the human. It's human nature to appreciate beauty.



## BUILDING SYSTEM

### SUBSTRUCTURE



Building substructure is the lowest portion of a structural system that is built under the ground level and is concealed from view.

Building substructure transfers the load of the superstructure to the ground beneath.

It also supports and anchors the superstructure safely in the earth.

It should be designed with the proper technique because it assures the stability of the superstructure too.

### SUPERSTRUCTURE

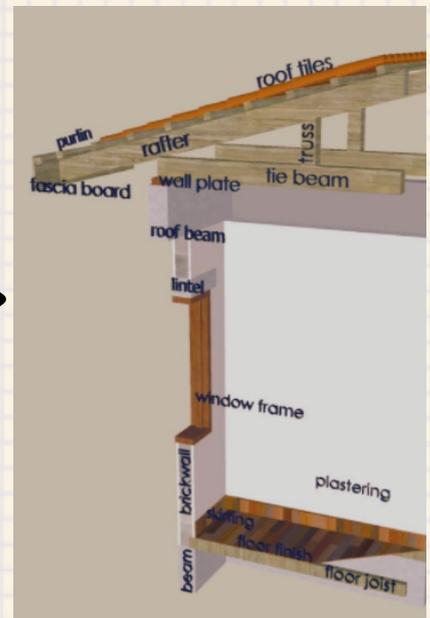


A superstructure is an upward extension of an existing structure above a baseline called Ground Level in general and it usually serves the purpose of the structure's intended use.

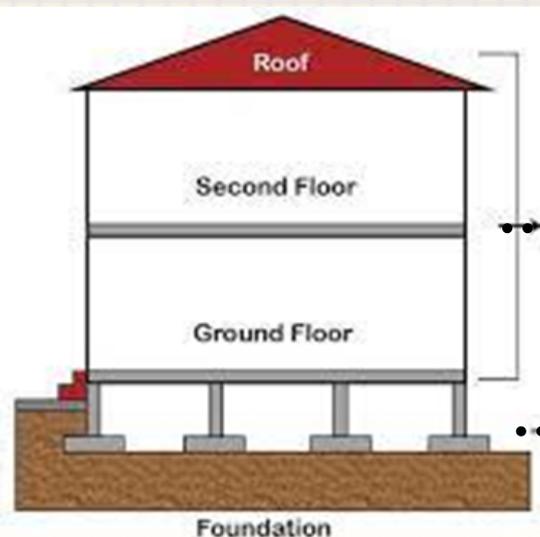
### FUNCTIONS OF BUILDING SUBSTRUCTURE:

- It ensures the overall stability of the building.
- It transfers loads from the superstructure to the ground below.
- It anchors the superstructure safely into the earth.

components of building system



Source : Writer



superstructure

substructure

Source : dreamcivil.com



# THE DIFFERENCE BETWEEN SUBSTRUCTURE AND SUPERSTRUCTURE SYSTEM

## SUB STRUCTURE

Part of a building that is constructed below ground level.

It transfers loads received from superstructure to supporting soil.

Elements of substructure includes of:

- foundation
- stump
- ground beam

## SUPER STRUCTURE

Part of a building that is constructed above ground level.

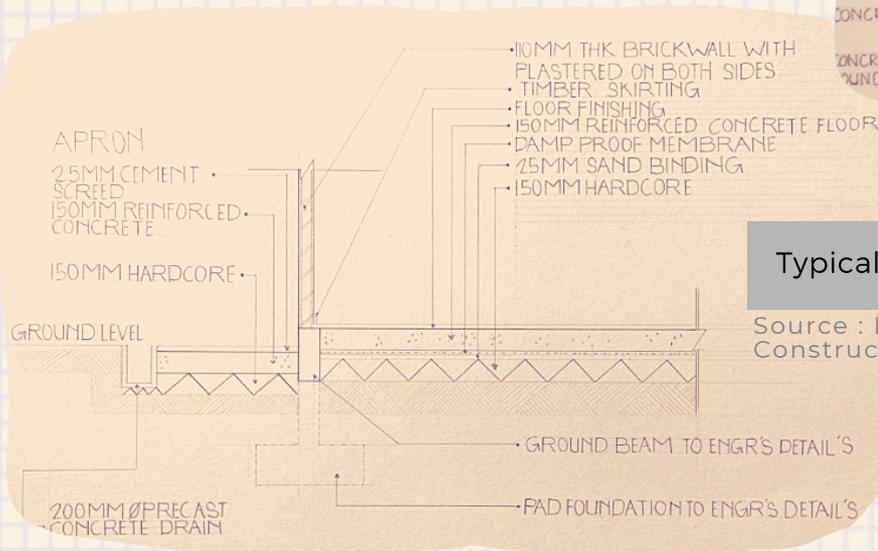
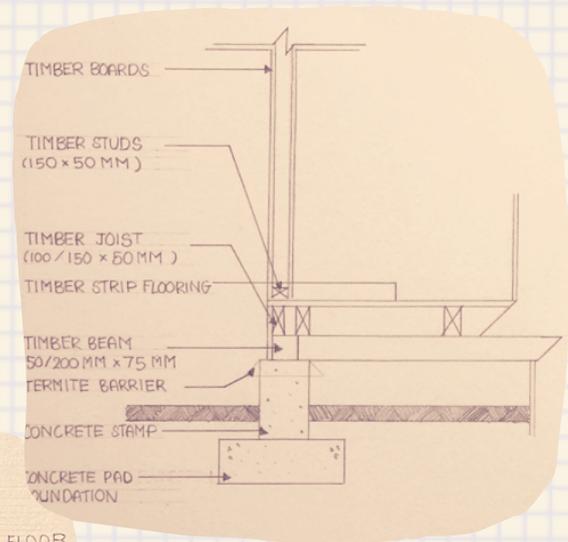
It serves the purpose of building's intended use.

Superstructure elements includes of:

- walls
- columns
- beams
- doors and windows, etc

### Typical detail - Suspended timber floor

Source : DCA10042 Building Constructions & materials



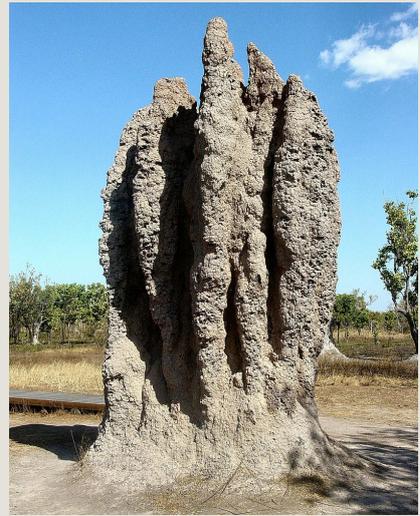
### Typical detail - Mass concrete ground floor

Source : DCA10042 Building Constructions & materials

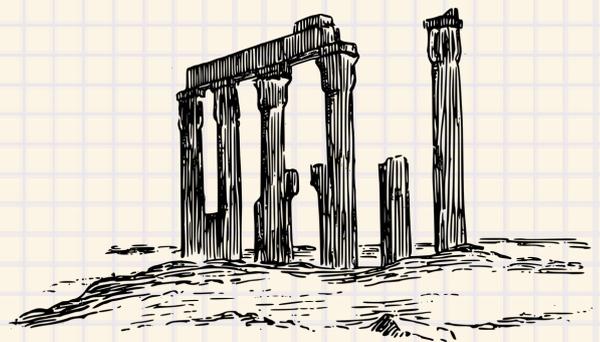
## BASIC STRUCTURAL CONCEPT

In general, structure can be divided into 3 types:

- Solid Structures (struktur pepejal)
- Frame/skeletal structures (struktur kerangka)
- Shell Structures (struktur permukaan)



Source : unsplash.com



*“As an architect you design for the present, with an awareness of the past, for a future which is essentially unknown.” – Norman Foster*

## 1. SOLID STRUCTURE

- Caves and igloos created by Eskimos are among the earliest and oldest structures.
- A solid structure uses solid construction materials to support loads.
- A solid structure often has a high mass. A well-constructed, strong structure will last a long time.
- Walls function not only as an enclosure but also as a way of distributing the loads of the structure. (load bearing structure)
- Walls must be thick to avoid fractures caused by differential settling.



Source : [studentsofheavenblogsite.wordpress.com](https://studentsofheavenblogsite.wordpress.com)



Source : [abriegrowsinbrooklyn.com](https://abriegrowsinbrooklyn.com)



Source : [areni.cave.com](https://areni.cave.com)



*In the early Stone Age, humans lived in caves  
Yes, they didn't have houses yet – caves were  
the best they could do.*

*Later on in the Stone Age, they did start to  
build huts made out of wood and animal skins.  
And then towards the end of the Stone Age,  
they started to build permanent places to live –  
with a roof!*



Did you know?

There were 4 different types of humans in the Stone Age

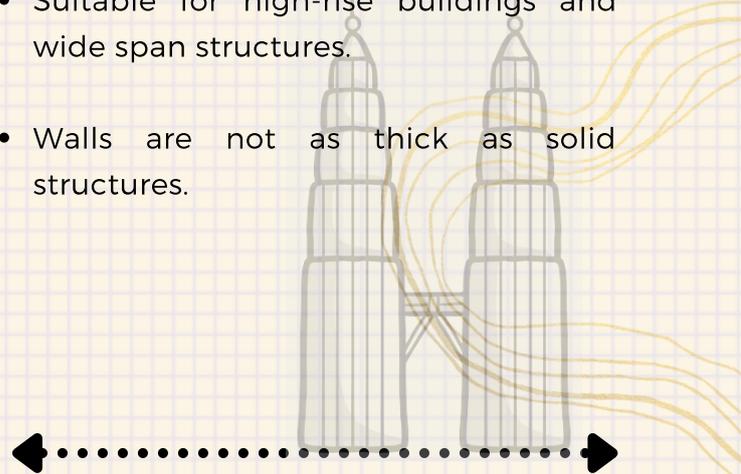
- Tool-makers (called homo habilis)
- Fire-makers (called homo erectus)
- Neanderthals (called homo neanderthalensis)
- Modern humans (called homo sapiens). *That's us!*



Source : [evanevanstours.com](https://evanevanstours.com)

## 2. FRAMED STRUCTURES

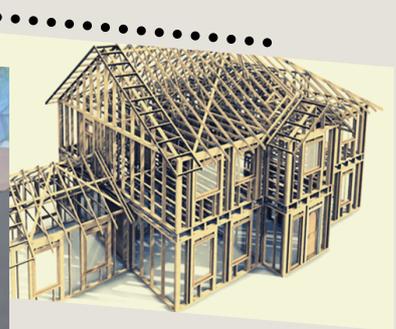
- The structure is simple: it consists of a column (post) and a beam. Malaysian/Malay traditional architecture makes extensive use of this material.
- A frame structure is made up of a network of interconnected materials. Frame structures have the potential to be extremely strong. A frame's components work together to withstand forces.
- Frame structures are also lighter than solid structures.
- The frame does not define spaces within the building but are defined by walls.
- Walls only carry their self weight.
- Suitable for high-rise buildings and wide span structures.
- Walls are not as thick as solid structures.



Source : youtube.com



Source : Malaysian Timber Council



Source : Malaysian Timber Council



Did you know? Malay traditional houses did not use any single bolt and nuts for its construction.

### 3. SHELL STRUCTURES

- A thin, curved plate structure shaped to transmit applied forces by compressive, tensile, and shear stresses that act in the plane of the surface.
- They are basically shaped like cylinders or folded plates and are known as thin plates or shells.
- Walls and roofs function as space enclosure and to support the loads of the building but they are designed in such a way to enable thin walls and roofs are used.
- Requires accurate scientific analysis, these types of structures are relatively new.
- The uses are limited due to problems of construction, architectural concepts and engineering analysis theories.



Source : wiclus.com



KLIA in Malaysia

Source : wiclus.com



Red Indian hut made from animal skin



Olympic Swimming Arena in Munich

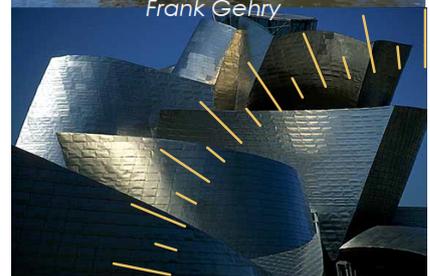
Source : structuremag.org



Haj Terminal, Saudi Arabia



The Guggenheim Museum Bilbao  
Frank Gehry



Source : structuremag.org

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*"Architecture starts when you carefully put two bricks together. There it begins."*

*– Ludwig Mies van der Rohe*



Thank you

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