

# UNIT – 3

## Timber, Glass, Ceramics, Plastics & Metals

BY  
P Swathi  
Asst. Professor  
Department of Civil Engineering

# Timber



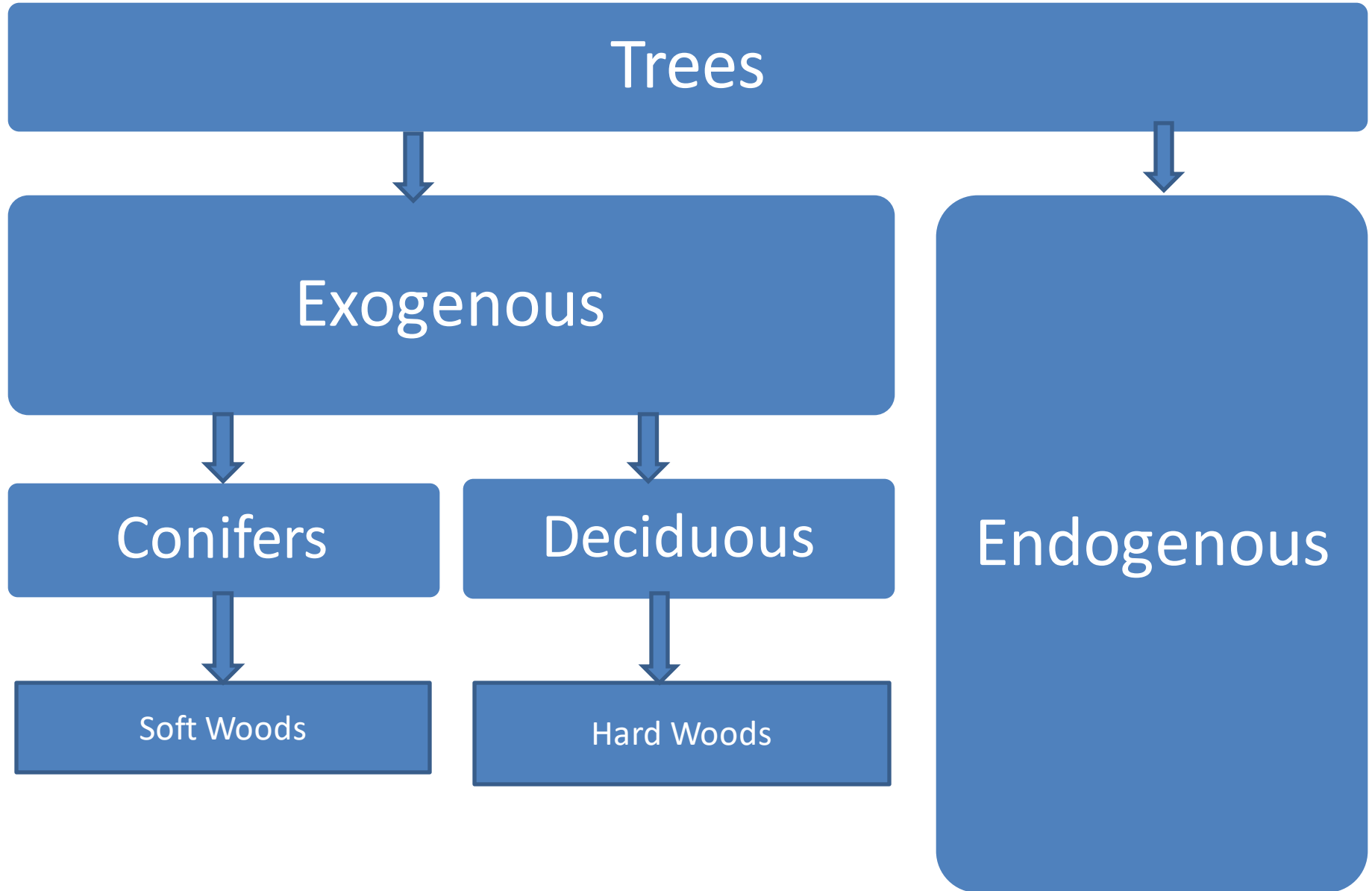
# **INTRODUCTION**

- The timber or wood, as a building material, possesses a number of valuable properties such as low heat conductivity, amenability to mechanical working, small bulk density, relatively high strength, etc.,
- However it has also its own drawbacks such as susceptibility to decay and inflammability, fluctuations in properties due to changes in moisture content, variations in strength in length and across fibres, etc.,
- These shortcomings of timber can greatly be reduced by the application of some of the modern wood processing techniques.
- At present, it has become possible to have effective utilization of wood waste e.g. Saw dust and shavings are used with admixture.





# Classification of Trees



(1) **Exogenous Trees** : These trees increase in bulk by growing outwards and distinct consecutive rings are formed in the horizontal section of such a tree. These rings are known as the annual rings because one such ring is added every year and these rings are useful in predicting the age of tree. The timber which is mostly used for engineering purposes belongs to this category.

The exogenous trees are further subdivided into two groups :

Conifers	Deciduous
<ul style="list-style-type: none"><li>✓ The conifers are also known as the <i>ever-green trees</i> and leaves of these trees do not fall till new ones are grown.</li><li>✓ As these trees bear cone – shaped fruits, they are given the name conifer.</li><li>✓ These trees yield soft woods which are generally light coloured, resinous, light in weight and weak.</li><li>✓ They show distinct annual rings.</li></ul>	<ul style="list-style-type: none"><li>✓ The deciduous trees are also known as the <i>broad – leaf trees</i> and leaves of these trees fall in autumn and new ones appear in spring season.</li><li>✓ The timber for engineering purposes is mostly derived from deciduous trees.</li><li>✓ These trees yield hard woods which are usually close – grained, strong, heavy, dark coloured, durable and non – resinous.</li><li>✓ They do not show distinct annual rings.</li></ul>



## Coniferous trees



- small, needle-like leaves

## Deciduous trees



- broad, flat leaves

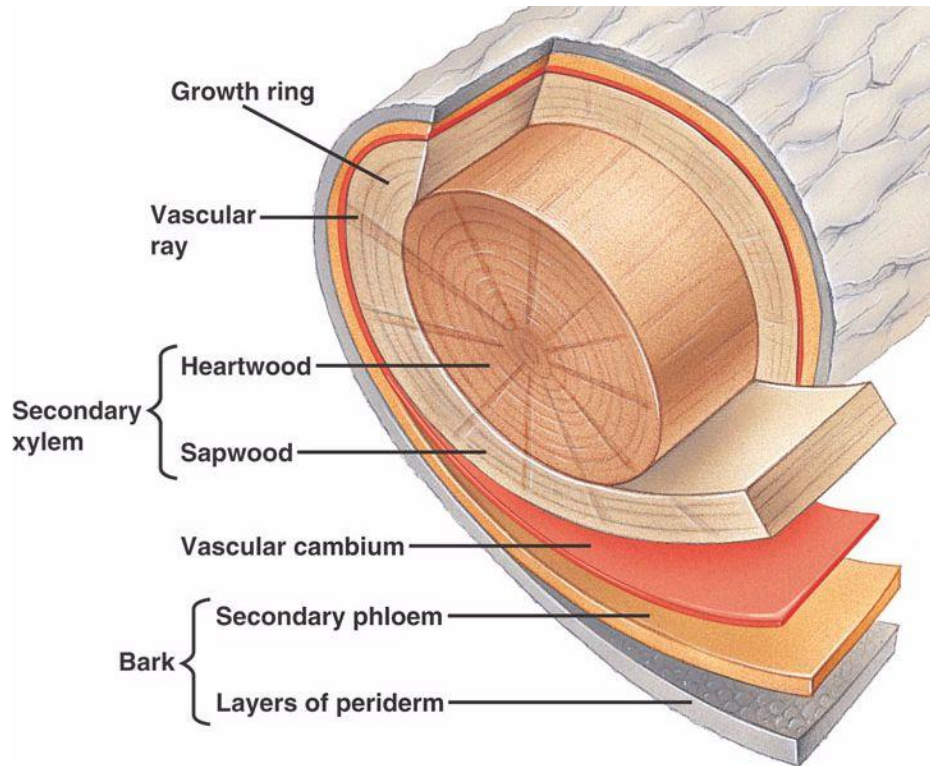
**Soft woods and hard woods :** The soft woods form a group of ever – green trees. The hard woods form a group of broad – leaf trees. It is to be noted that the terms soft woods and hard woods have commercial importance only.

The examples of Soft woods are chir, deodar, fir, kail, pine, spruce, etc., and those of hard woods are babul, mahogany, oak, sal, teak, etc.,

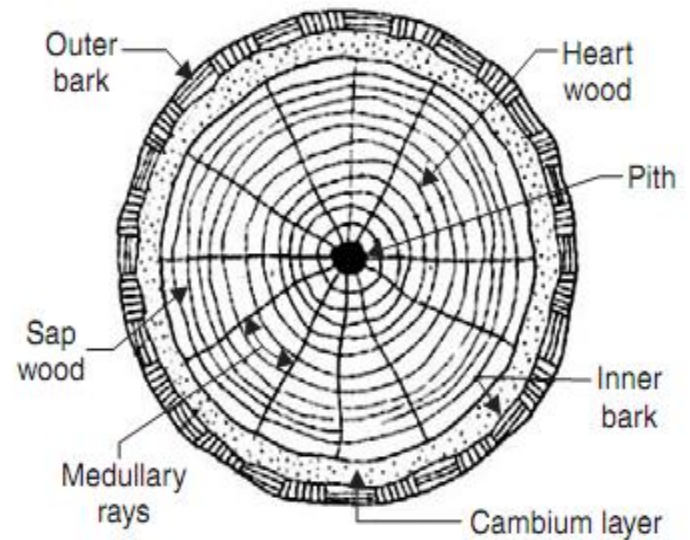
<b>HARDWOOD</b>	<b>SOFTWOOD</b>
<ul style="list-style-type: none"><li>▪ Darker colour</li><li>▪ Heavy</li><li>▪ More expensive</li><li>▪ Lasts for several decades</li><li>▪ Natural weather resistance</li><li>▪ More environmental impact</li></ul>	<ul style="list-style-type: none"><li>▪ Lighter colour</li><li>▪ Lighter weight</li><li>▪ Less expensive</li><li>▪ Lasts for over a decade</li><li>▪ Weather resistant when treated</li><li>▪ Less environmental impact</li></ul>



**(2) Endogenous trees :** These trees grow inwards and fibrous mass is seen in their longitudinal sections. The timber from these trees has very limited engineering applications. The examples of endogenous trees are bamboo, cane, palm, etc.,



**Endogenous Tree**



**Exogenous Tree**

# **COMPONENTS OF TREE**

- (1) **Pith/Medulla** : The innermost central portion or core of the tree is called the pith or medulla. It varies in size and shape for different types of trees. It consists entirely of cellular tissues and it nourished the plant in its young age.
- (2) **Heart wood** : The inner annual rings surrounding the pith constitute the heart wood. It is usually dark in colour. It indicates dead portion of tree and as such, it does not take part in the growth of tree. But it impart rigidity hence provides strong and durable timber.
- (3) **Sap wood/alburnum** : The outer annual rings between heart wood and cambium layer is known as the sap wood. It is usually light in colour and weight. It indicates recent growth and it contains sap(fluid). It takes active part in the growth of tree and the sap moves in an upward direction through it.
- (4) **Cambium layer** : The thin layer of sap between sap wood and inner bark is known as the cambium layer. It indicates sap which has yet not been converted into sap wood. If the bark is removed for any reason, the cambium layer gets exposed and the cells cease to be active resulting in the death of tree.

**(5) Inner bark :** The inner skin or layer covering the cambium layer is known as the inner bark. It gives protection to the cambium layer from any injury.

**(6) Outer bark :** The outer skin or cover of the tree is known as the outer bark. It is the outermost protective layer and it sometimes contains cracks and fissures. It consists of cells of wood fibre and is also known as the cortex.

**(7) Medullary rays :** The thin radial fibres extending from pith to cambium layer are known as the medullary rays. The function of these rays is to hold together the annual rings of heart wood and sap wood. These rays are sometimes broken and in some varieties of trees, they are not very prominent.

# **USES OF TIMBER**

- There is hardly any material other than timber which can be used as an all round substitute in construction work and its various uses can be summarized as follows :
  - 1) It is used for door and window frames, shutters of doors and windows, roofing materials etc.,
  - 2) It is used for formwork of cement concrete, centering of an arch, scaffolding etc.,
  - 3) It is used for making furniture, agricultural instruments, sport goods, musical instruments etc.,
  - 4) It is used for making railway coach wagons.
  - 5) It is used for making toys, engraving work, matches, etc.,
  - 6) It is used for railway sleepers, packing cases, etc.,
  - 7) It is used for temporary bridges and boat construction.



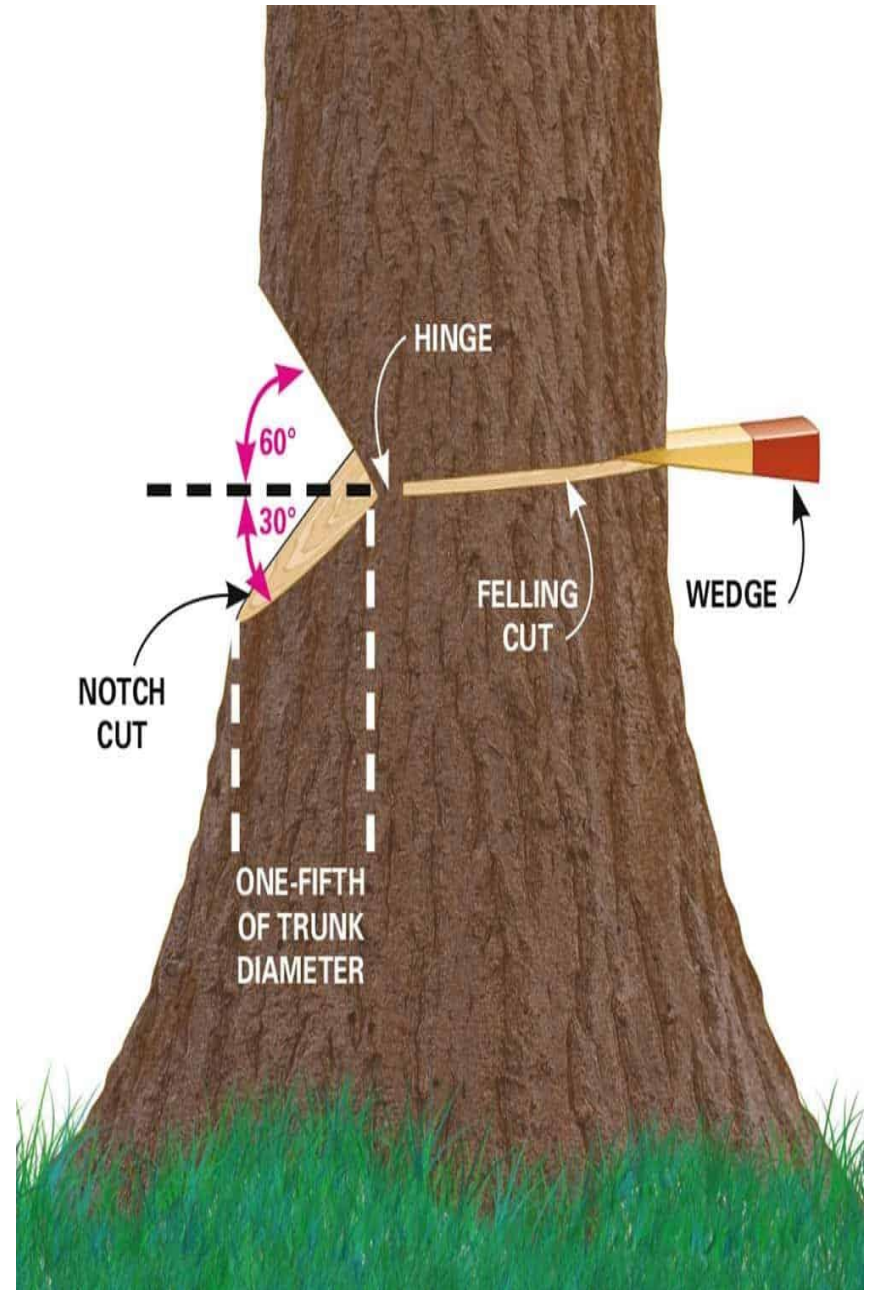
# **PROCESSING OF TIMBER**

- Four stages for the processing of timber are :

- (1) Felling of trees
- (2) Seasoning of timber
- (3) Conversion of timber
- (4) Preservation of timber

(1) **Felling of Trees** : To get the timber, the trees are knocked down or cut down or caused to fall to the ground. This is known as *felling of trees*. Felling can be done based on the facts as

- A. **Age of trees for Felling** : The trees should be felled when they have just matured or when they are very near to maturity **but** neither before maturity nor after fully matured. If before maturity, the sap wood would be in excess so the trees would not be durable. After fully matured heart wood of the tree starts decaying. The age of good trees for felling varies from 50 to 100 years.
- B. **Method of felling** : The trees should be felled by experienced persons. The tree should be cut from a place a little above its roots and very near to the ground level. Such practice would help in getting more timber from the trunk of tree. The various appliances required in the process of felling of trees include axes, ropes, saws, wedges, wire cables, etc.,



**(3) Season for Felling :** The trees should be felled when sap is at rest. The season should be carefully determined by climatic conditions of the locality and types of trees.

**For hilly areas:** mid – summer would be the proper season for felling as there is heavy rainfall in winter.

**For plain areas :** The mid – winter would be the proper season for felling as in summer, the water contained in sap would be easily evaporated and it will lead to the formation of cracks.

**(2) SEASONING OF TIMBER :** When a tree is newly felled, it contains about 50% or more of its own weight as water. This water is in the form of sap and moisture. The water is to be removed before the timber can be used for any engineering purpose. This process of drying of timber is known as the *seasoning of timber*.

- ✓ Moisture should be extracted during seasoning under controlled conditions as early as possible at a uniform rate from all parts of the timber.
- ✓ If the drying is irregular, the shrinkage of timber will also be irregular and it will set up internal stresses between the fibres.

✓ *The seasoning of timber is carried out to achieve the following objects :*

- 1) To allow timber to burn readily, if used as fuel.
- 2) To decrease the weight of timber and thereby to lower the cost of transport and handling.
- 3) To impart hardness, stiffness, strength and better electrical resistance to timber.
- 4) To increase the resisting power of timber, as most of the causes of decay of timber are more or less related to the moisture.
- 5) To make timber easily workable and to facilitate operations during conversion.
- 6) To make timber fit for receiving treatment of paints, preservatives, varnished etc.,
- 7) To make timber safe from the attack of fungi and insects.
- 8) To make timber suitable for gluing, i.e., effectively joining two members of timber with the aid of glue.



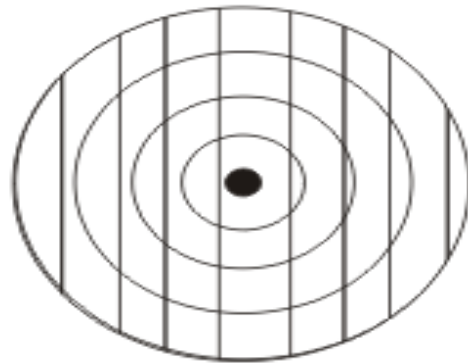
- There are two methods of seasoning.
- 1. **Natural Seasoning :** In this method, the seasoning of timber is carried out by natural air and hence it is also sometimes referred to as air seasoning.
- 2. **Artificial seasoning:** To rectify some of the defects caused due to natural seasoning, artificial seasoning is adopted to the natural seasoning. This can be done by Boiling, Chemical seasoning, Electrical, Kiln and Water seasoning.
- Comparison between Natural Seasoning and Artificial seasoning is

S. NO	Item	Natural Seasoning	Artificial(Kiln) Seasoning
1	Moisture content	It is difficult to reduce the moisture content below 15 to 18%	Can be reduced by any desired level
2	Nature	Simple and economical	Expensive and quite technical
3	Quality	More liable to the attacks of insects and fungi	Less liable to the attacks of insects and fungi
4	Space	Requires more space for stacking	Requires less space for stacking
5	Speed	Slow process	Quick process

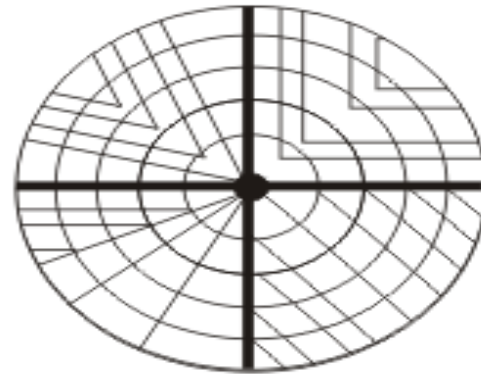
**(3) CONVERSION OF TIMBER :** The process by which timber is cut and sawn into suitable sections is known as the conversion. For this purpose, the power machines may be employed at different stages of process.

Important facts to be remembered in connection with conversion of timber :

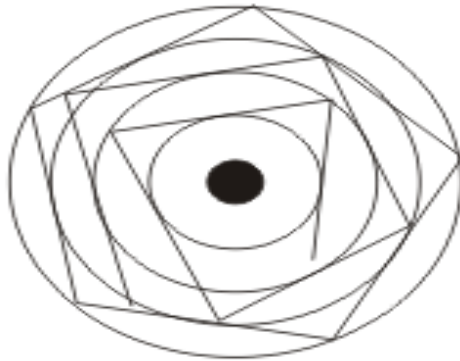
- 1) The conversion is a skilled art and it should be carried out in such a way that there is minimum wastage of useful timber.
- 2) The wooden beams should be sawn in such a way that they do not contain pith in their cross – section. To achieve this, the timber is first sawn through pith into two halves.
- 3) To obtain strong timber pieces, the saw cuts should be made tangential to the annual rings and practically parallel to the direction of medullary rays.
- 4) The conversion may be achieved either by ordinary sawing, quarter sawing, tangential sawing or radial sawing.



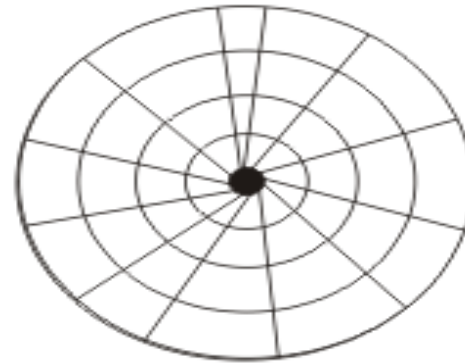
Ordinary Sawing



Quarter Sawing



Tangential Sawing



Rift or Radial Sawing

types of sawing  
(iamcivilengineer.com)

**(4) PRESERVATION OF TIMBER** : The preservation of timber is carried out to achieve the following three objects :

- 1) To increase the life of timber structures,
  - 2) To make the timber structures durable, and
  - 3) To protect the timber structures from the attack of destroying agencies such as fungi, insects, etc.,
- ✓ The preservative should be cheap, durable, easily available, free from unpleasant smell, non – inflammable, quite efficient in killing fungi, insects, etc., safe, harmless for persons and animals, not affect the strength of the timber, not easily washed away by water and allow decorative treatment after being applied over the surface of the timber.
  - ✓ Ascu treatment, chemical salts, Coal tar, Creosote oil, Oil paints and Solignum paints are used as preservatives for timber.
  - ✓ Various methods of preservation of timber are Brushing, Charring, Dipping and Steeping, Hot and cold open tank treatment, Injecting under pressure and Spraying.



# GLASS



# **INTRODUCTION**

- The glass has been used as an engineering material since ancient times. But because of the rapid progress made in the glass industry in recent times, the glass has come out as the most versatile engineering material of the modern times.
- The first glass objects made by man were of natural glass such as obsidian and rock crystal.
- With the help of techniques developed in the glass industry, the glass of any type and quality can be produced to suit the requirements of different industries.

# Classification of Glass

- The glass is a mixture of a number of metallic silicates, one of which is usually that of an alkali metal. It is amorphous, transparent or translucent.
- The glass may be grouped in the following categories :
  1. Soda – lime glass or commercial glass
  2. Potash – lime glass
  3. Potash – lead glass
  4. Common glass
  5. Borosilicate glass
- The properties and uses of the above types of glasses will be discussed below.

Type of Glass	Properties	Uses
<p><b><u>1. Soda – Lime glass or commercial glass :</u></b> This is also known as the <i>soda – glass</i> or <i>soft – glass</i>. It is mainly a mixture of sodium silicate and calcium silicate.</p>	<ul style="list-style-type: none"> <li>✓ It is available in clean and clear state.</li> <li>✓ It is cheap.</li> <li>✓ It is easily fusible at comparatively low temperature.</li> <li>✓ It is possible to blow or to weld articles made from this glass with the help of simple sources of heat.</li> </ul>	<p>➤ It is used in the manufacture of glass tubes and other laboratory apparatus, plate glass, window glass, etc.,</p>
<p><b><u>2. Potash – Lime glass :</u></b> This is also known as the <i>Bohemian – glass</i> or <i>hard – glass</i>. It is mainly a mixture of potassium silicate and calcium silicate.</p>	<ul style="list-style-type: none"> <li>✓ It fuses at high temperature.</li> <li>✓ It is not easily affected by water and other solvents.</li> <li>✓ It does not melt so easily.</li> </ul>	<p>➤ This glass is used in the manufacture of glass articles which have to withstand high temperatures such as combustion tubes etc.,</p>
<p><b><u>3. Potash – lead glass:</u></b> This is also known as the <i>flint glass</i>. It is mainly a mixture of potassium silicate and lead silicate.</p>	<ul style="list-style-type: none"> <li>✓ It fuses very easily.</li> <li>✓ It is easily attacked by aqueous solutions.</li> <li>✓ It possesses bright lustre and great refractive power.</li> <li>✓ It turns black and opaque, if it comes into contact with reducing gases of the furnace during heating.</li> </ul>	<p>➤ It is used in the manufacture of artificial gems, electrical bulbs, lenses, prisms, etc.,</p>



**4. Common Glass :** This is also known as the *bottle glass*. It is prepared from cheap raw materials. It is mainly a mixture of sodium silicate, calcium silicate and iron silicate.

- ✓ It fuses with difficulty.
- ✓ It is brown, green or yellow in colour.
- ✓ It is easily attacked by acids.

➤ It is mainly used in the manufacture of medicine bottles.

**5. Borosilicate Glass :** Most of us are more familiar with this type of glass in the form of ovenware and other heat – resisting ware, better known under the trade name Pyrax. Borosilicate glass is made mainly of 70% to 80% silica and 7% to 13% boric oxide with smaller amounts of the alkalis (sodium and potassium oxides) and aluminium oxide.

- ✓ It has a relatively low alkali content and consequently has good chemical durability and thermal shock resistance.
- ✓ It has high softening point.
- ✓ It does not break when temperature changes quickly.

➤ This glass is widely used in the chemical industry, for laboratory apparatus, for ampoules and other pharmaceutical containers, for various high intensity lighting applications and as glass fibres used in the reinforced plastics to make protective helmets, boats, piping, car chassis, ropes, car exhausts and many other items and also in textile industry.

# Manufacture of Glass

- The procedure adopted in the manufacture of glass may broadly be divided into the five stages :
- **(1) Collection of raw materials** - Depending upon the type of glass to be manufactured, suitable raw material are collected. In addition to the raw materials, the cullet and decolourisers are also added for each type of glass. The cullet indicates waste glass or pieces of broken glass. They increase the fusibility of glass and prevent loss of alkali by volatisation during the reaction in forming new glass. They also reduce the cost.
- **(2) Preparation of Batch** - The raw materials, cullet and decolouriser are finely powdered in grinding machines. The mixing of these materials is carried out in mixing machines until a uniform mixture is obtained. Such a uniform mixture is known as the **batch or frit**.
- **(3) Melting in furnace** - The batch is melted either in a pot furnace or in a tank furnace. The heating is continued until the evolution of carbon dioxide, oxygen, sulphur dioxide and other gases stops.
- **(4) Fabrication** - The molten glass is given suitable shape or form in this stage. It can either be done by hand or by machine.
- **(5) Annealing** - The glass articles, after being manufactured, are to be cooled down slowly and gradually. This process of slow and homogeneous cooling of glass articles is known as annealing of glass.

## A large display of various decorative panels and tiles, including geometric patterns, floral designs, and textured surfaces, arranged in a grid-like fashion. The panels feature a wide range of colors and textures, from smooth and glossy to matte and textured. Some panels have intricate patterns, while others are solid colors. The display is organized into rows and columns, with some panels overlapping others. The overall appearance is that of a professional product showcase for interior design materials.

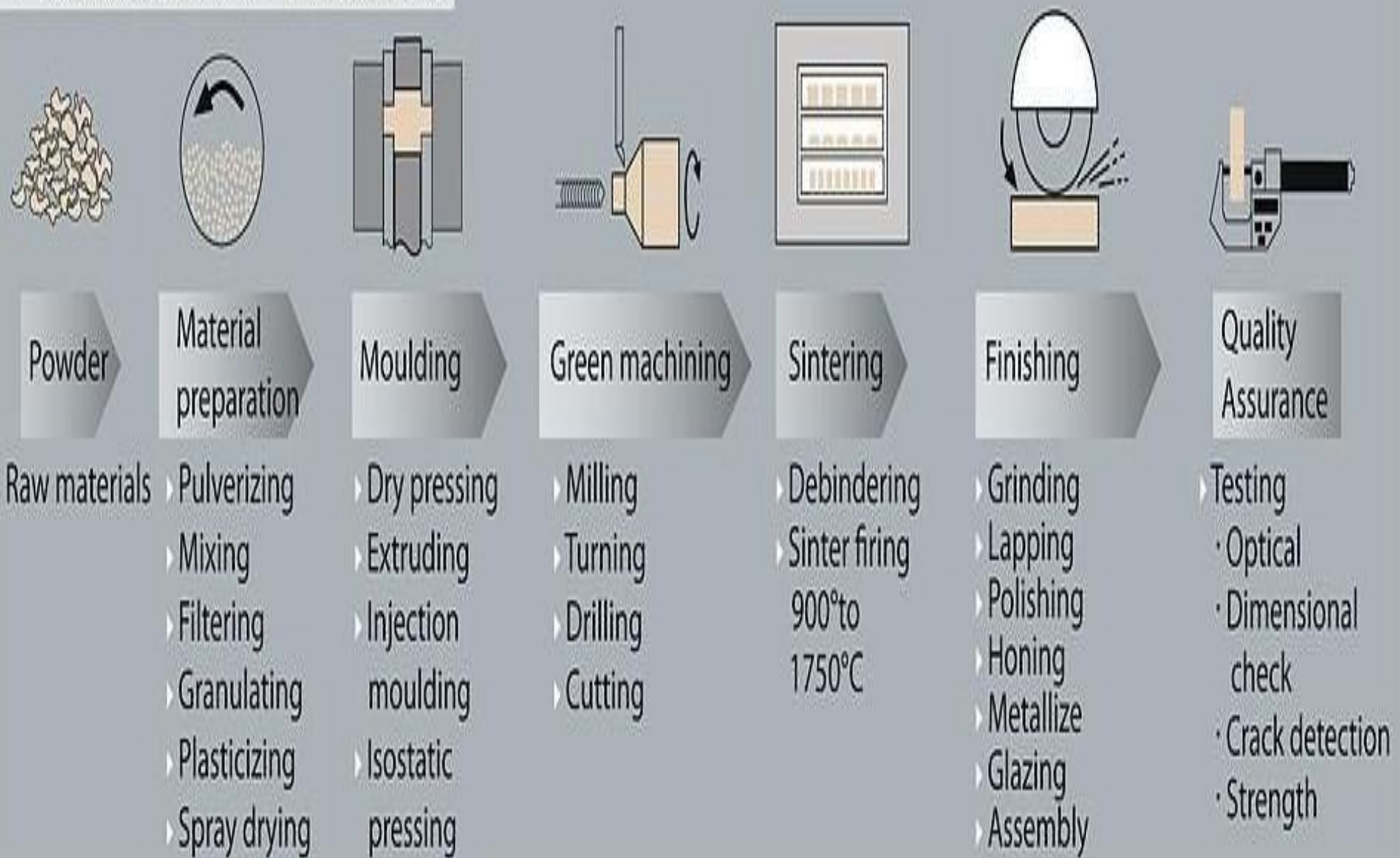
# Ceramics: Composition of Clay

Main compositions are feldspar group of minerals comprise around 60% of the earth's crust. They are aluminium silicates, also incorporating alkali and/or alkaline earth metals.

# Manufacturing Process of Ceramics



# PRODUCTION PROCESS



# Characteristics

- Bending Resistance
- High Hardness
- High degree resistance to moisture
- Resistance to impact and abrasion
- Excellent resistance to chemical attack

# Characteristics (cont')

- All floor tiles can be used on walls and others surface but not all wall tiles can be used on floors
- Installed in Portland cement setting bed
- Rarely accurate in shape and size
- Most advanced ceramic materials are combination of ceramics and others materials known as Ceramic Matrix Composites

# Daily Uses of Ceramics

- Bowls and plates
- Accessories or ornament for clothing
- Housing : floor tiles, bricks, roof tiles and so much more



# TYPES OF CERAMIC

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1. Terracotta
2. Stoneware
3. Fireclay
4. Earthenware
5. Roofing
6. Porcelain
7. Vitreous China



# METALS

## EXTRACTION OF METALS

METALS ARE OFTEN EXTACTED  
FROM THE EARTH BY MEANS OF MINING, RESULTING IN OR



An **ORE** is a type of rock that contains MINERALS with important elements including metals. Once mined, metals must be extracted usually by chemical or electrolytic reduction.





## PYROMETALLURGY

uses high temperatures to convert ore into raw materials

## HYDROMETALLURGY

employs aqueous chemistry for the same purpose.

# PROPERTIES OF METAL

## 1PHYSICAL 2MECHANICAL

HARDNESS STRONG&HARD

BRITTLENESS LUSTOER

MALLEABILITY HEAT CONDUCTORS

DUCTILITY ELECTRIC CONDUCTORS

ELASTICITY DENSE

TOUGHNESS SONOROUS SOUNF

FUSIBILITY HIGH MELTING POINTS

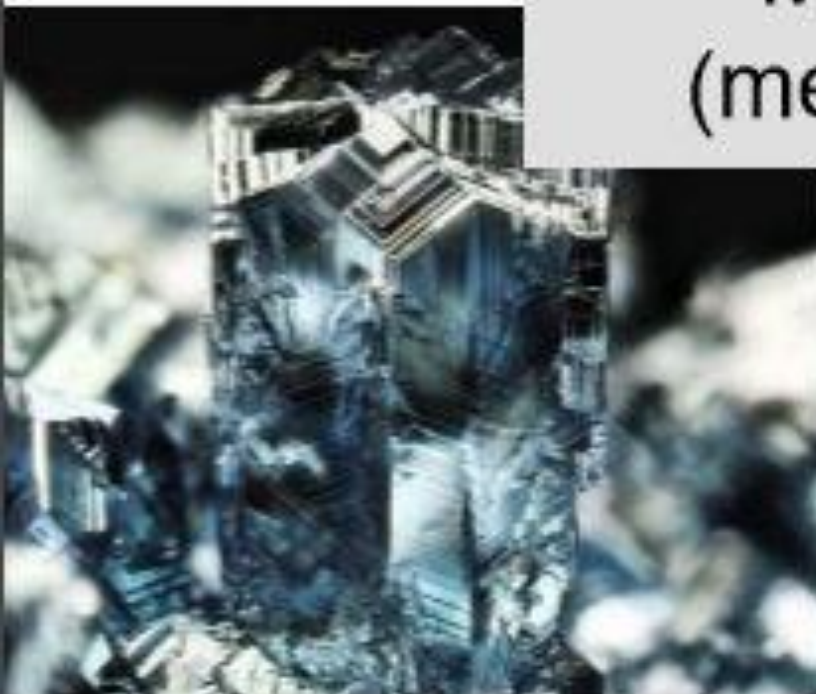
CONDUCTIVITY HIGH BOILING POINTS

DENSITY





# PROPERTIES OF METALS (mechanical)





## 1. HARDNESS

- ability of a metal to resist abrasion, penetration, cutting action, or **permanent distortion**. Hardness may be increased by working the metal and by heat treatment and cold working (in the case of steel and certain titanium and aluminum alloys)

## 2. BRITTLENESS

- property of metal that allows little bending or deformation without shattering.

## 3. MALLEABILITY

- ability of steel to be **hammered**, rolled or pressed into various shapes without cracking or breaking or other detrimental effects.



#### **4. DUCTILITY**

- a property that permits the metal to be permanently drawn, bent or twisted without breaking it.

#### **5. ELASTICITY**

- property that enables a metal to return to its original shape.

#### **6. TOUGHNESS**

- when a metal can withstand tearing or shearing and may be stretched or otherwise deformed without breaking.

#### **7. FUSIBILITY**

- ability of a metal to become liquid by the application of heat.

## **8. CONDUCTIVITY**

- property that enables a metal to carry heat or electricity.
- Governs the amount of heat that will be required for proper fusion.

## **9. DENSITY**

- weight of a unit volume of a material.

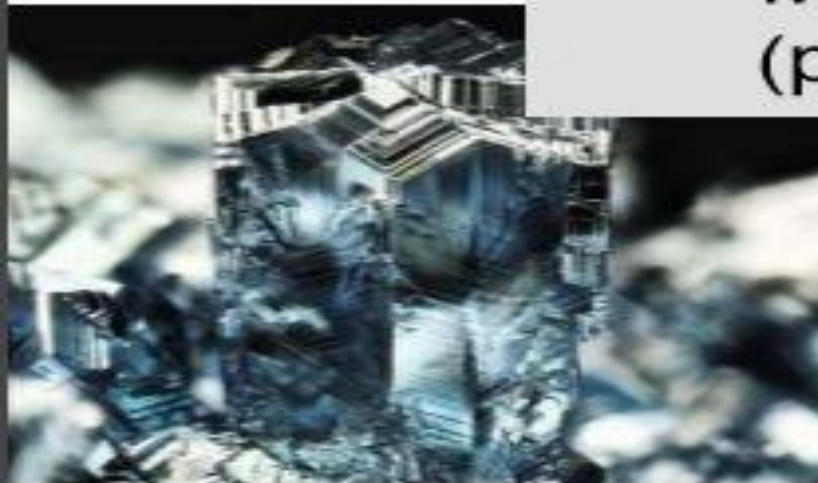




For All Your Metal Needs



## PROPERTIES OF METALS (physical)





## **1. STRONG & HARD**

## **2. LUSTER**

- metals shine because of its properties which is metallic bonding.

## **3. HEAT CONDUCTORS**

- able to conduct heat and take it from a high temperature place to a lower temperature. Heat transfer occurs due to the combination of vibrations from molecules.

## **4. ELECTRIC CONDUCTORS**

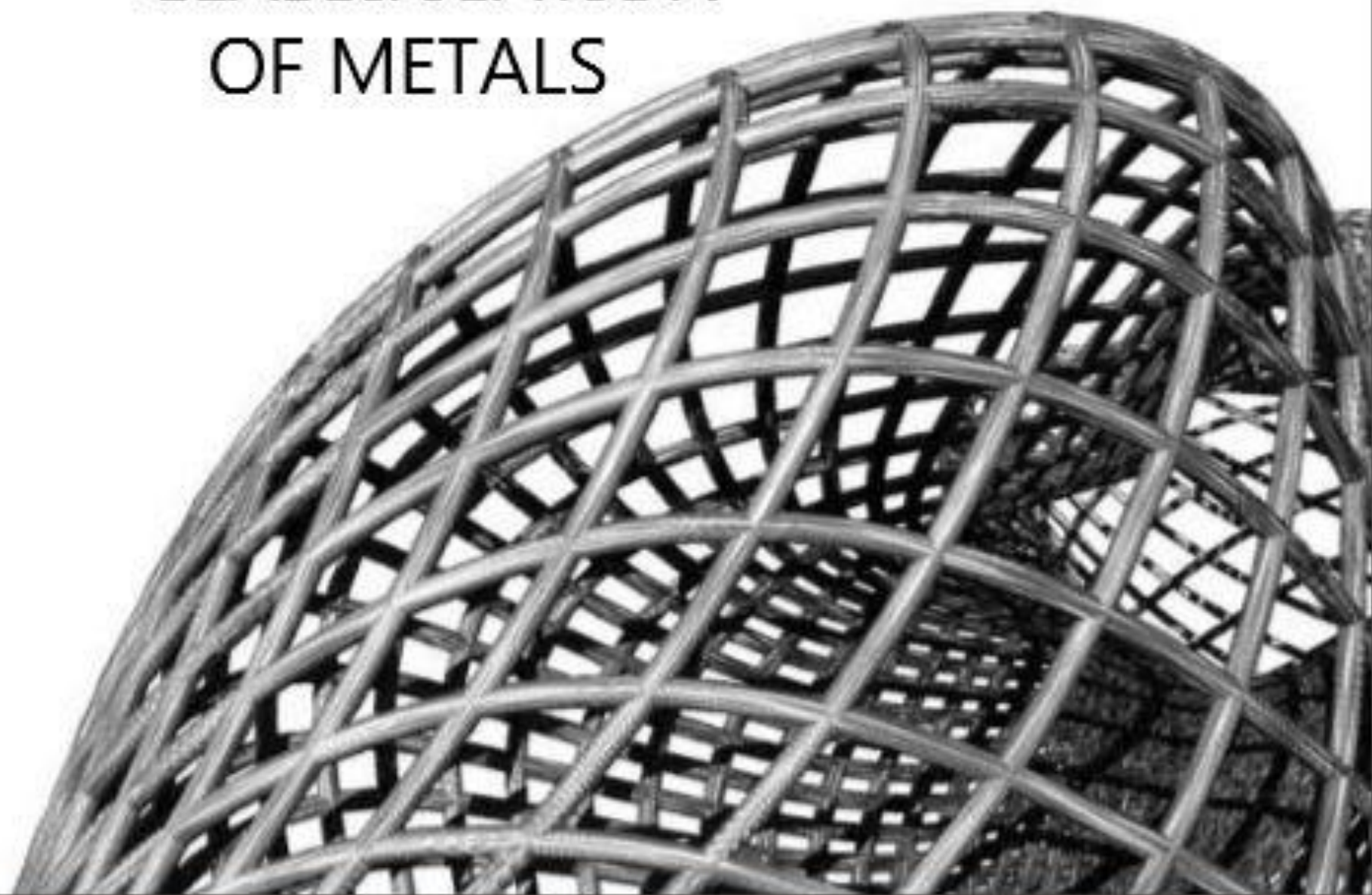
- metals consists FREE electrons which makes is a good electrical conductor.

## **5. DENSE**

- tightly balance, packed crystals in the metal structure.



# CLASSIFICATION OF METALS



# FERROUS

## METALS

- contain IRON
- MAGNETIC
- gives little resistance to corrosion.

# NON- FERROUS

## METALS

- Does not contain IRON
- not MAGNETIC
- gives more resistance to corrosion than ferrous metals.

# PLASTICS AS BUILDING MATERIAL

An abstract graphic consisting of several thin, white, parallel lines that originate from the bottom right corner and extend diagonally upwards towards the top right corner of the slide. The lines vary slightly in length and position, creating a sense of movement and depth against the solid blue background.



- ▶ Plastic is a synthetic material made from a wide range of organic polymers such as polythene , PVC , nylon etc that can be moulded into shape while soft and then set into a rigid or slightly elastic form
- ▶ Classification of plastics according to behaviour with respect to heating
  - thermoplastics
  - thermo setting

## INTRODUCTION

- ▶ Thermoplastics – softens by heat and hardens when cooled down . It is recyclable
- ▶ Example – insulation of electrical cables , electrical applications
- ▶ Thermosetting plastics -cannot be reused , require great pressure and momentary heating during moulding
- ▶ Example – structural components, laminated panels , handles , knobs , chairs . Waterproof materials , automobile bodies

## TYPES OF PLASTICS



## Advantages

- ▶ Corrosion resistance
- ▶ Light weight
- ▶ Water resistant and possess good adhesiveness
- ▶ Low electrical and thermal conductivity
- ▶ Easily formed into complex shapes
- ▶ Wide choice of appearance , colours and transparency

## Disadvantages

- ▶ Low strength and poor ductility
- ▶ Aging effect , hardens and become brittle over time
- ▶ Sensitive to environment , moisture and chemicals
- ▶ Deformation under load

ADVANTAGES & DISADVANTAGES



Bath and sink units



Electrical insulators and conduits



Lighting fixtures



Decorative laminates and wall tiles

# APPLICATIONS



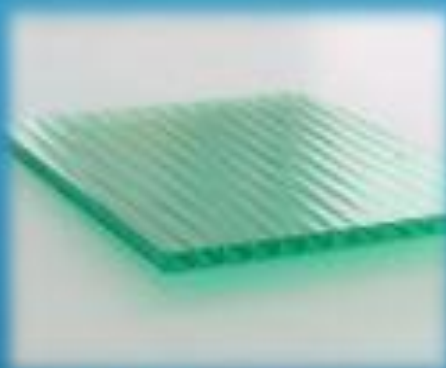
Over head water tanks



Roof lights



Damp proof films



Safety glass



Corrugated sheets and roof panels

# APPLICATIONS



- ▶ Pvc films are thermoplastic material that can be highly manipulated with the application of heat
- ▶ Properties
- ▶ Hard structure but can be made more flexible and soft by adding plasticizers
- ▶ Versatile , good stability , strength and excellent weathering properties

## PVC POLYMER FILMS

- ▶ Durable
- ▶ Cheap material
- ▶ Easily available
- ▶ Ease of installation
- ▶ Easy to clean
- ▶ Can be casted to any shape
- ▶ Variable thickness
- ▶ Water proof
- ▶ Flexible
- ▶ Recyclable
- ▶ Wide range of colours patterns
- ▶ Good electric shock proof

## ADVANTAGES OF PVC



# References

“Engineering Materials “ by RANGWALA

“Building Construction “ Dr. B.C. Punmia

[www.slideshare.net](http://www.slideshare.net)

Google references

**THANK YOU**