

## Unit 1: WOOD

Wood, Wood Based Products: Cross section details of trees, their general properties, various types of defects in wood and timber, Methods of seasoning and their importance, common Indian trees and their uses. Wood based Products: Veneers, Plywood and its types.

### 1.5 TIMBER: (Ref: Basic Civil Engineering by S.S. Bhavikatti)

Timber refers to wood used for construction works. In fact the word timber is derived from an old English word 'Timbrian' which means 'to build'. A tree that yields good wood for construction is called 'Standing Timber.' After felling a tree, its branches are cut and its stem is roughly converted into pieces of suitable length, so that it can be transported to timber yard. This form of timber is known as rough timber. By sawing, rough timber is converted into various commercial sizes like planks, battens, posts, beams etc. Such form of timber is known as converted timber.

Timber was used as building material even by primitive man. Many ancient temples, palaces and bridges built with timber can be seen even today.

#### 1.5.1 Classification of Timber

Various bases are considered for the classification of timbers. The following are the important basis: (i) Mode of growth (ii) Modulus of elasticity (iii) Durability (iv) Grading (v) Availability

##### (i) Classification Based on Mode of Growth:

On the basis of mode of growth trees are classified as (a) Exogenous and (b) Endogenous

- (a) **Exogenous Trees:** These trees grow outward by adding distinct consecutive ring every year. These rings are known as annual rings. Hence it is possible to find the age of timber by counting these annual rings.

These trees may be further divided into (1) coniferous and (2) deciduous.

Coniferous trees are having cone shaped leaves and fruits. The leaves do not fall till new ones are grown. They yield soft wood.

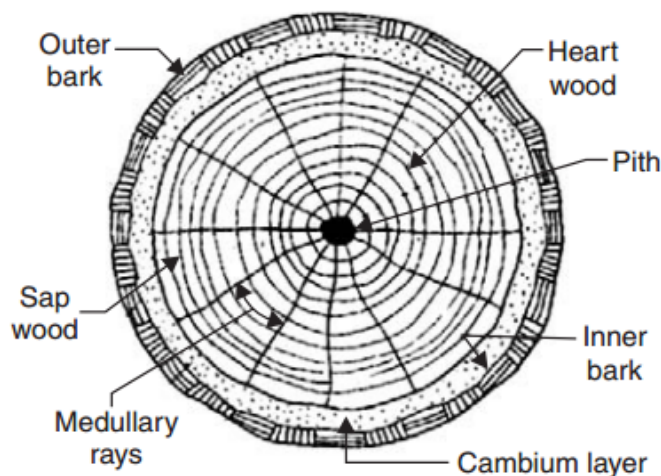
Deciduous trees are having broad leaves. These leaves fall in autumn and new ones appear in springs. They yield strong wood and hence they are commonly used in building construction. The classification as soft wood and hard wood has commercial importance. The difference between soft wood and hard wood is given below:

1. In soft wood annual rings are seen distinctly whereas in hard wood they are indistinct.
2. The colour of soft wood is light whereas the colour of hard wood is dark.
3. Soft woods have lesser strength in compression and shear compared to hard woods.

4. Soft woods are light and hard woods are heavy.
5. Fire resistance of soft wood is poor compared to that of hard wood.
6. The structure of soft wood is resinous while structure of hard wood is close grained.

The cross-section of a exogenous tree is as shown in the Fig. 1.7. The following components are visible to the naked eye:

1. Pith: It is the inner most part of the tree and hence the oldest part of exogenous tree when the plant becomes old, the pith dies and becomes fibrous and dark. It varies in size and shape.



**Fig. 1.7.** Cross-section of exogeneous tree

rings of sap wood are less sharply divided and are light in colour. The sap wood is also known as alburnum.

4. Cambium Layer: It is a thin layer of fresh sap lying between sap wood and the inner bark. It contains sap which is not yet converted into sap wood. If the bark is removed and cambium layer is exposed to atmosphere, cells cease to be active and tree dies.

5. Inner Bark: It is a inner skin of tree protecting the cambium layer. It gives protection to cambium layer.

6. Outer Bark: It is the outer skin of the tree and consists of wood fibres. Sometimes it contains fissures and cracks.

7. Medullary Rags: These are thin radial fibres extending from pith to cambium layer. They hold annular rings together. In some of trees they are broken and some other they may not be prominent.

**(b) Endogenous Trees:** These trees grow inwards. Fresh fibrous mass is in the inner most portion. Examples of endogenous trees are bamboo and cane. They are not useful for structural works.

### 1.5.2 Properties of Timber Properties of good timbers are:

Colour: It should be uniform.

Odour: It should be pleasant when cut freshly.

Soundness: A clear ringing sound when struck indicates the timber is good.

Texture: Texture of good timber is fine and even.

Grains: In good timber grains are close.

Density: Higher the density stronger is the timber.

Hardness: Harder timbers are strong and durable.

Warping: Good timber does not warp under changing environmental conditions.

Toughness: Timber should be capable of resisting shock loads.

Abrasion: Good timber does not deteriorate due to wear. This property should be looked into, if timber is to be used for flooring.

Strength: Timber should have high strength in bending, shear and direct compression.

Modulus of Elasticity: Timber with higher modulus of elasticity are preferred in construction.

Fire resistance: A good timber should have high resistance to fire.

Permeability: Good timber has low water permeability.

Workability: Timber should be easily workable. It should not clog the saw.

Durability: Good timber is one which is capable of resisting the action of fungi and insects attack

Defects: Good timber is free from defects like dead knots, shakes and cracks.

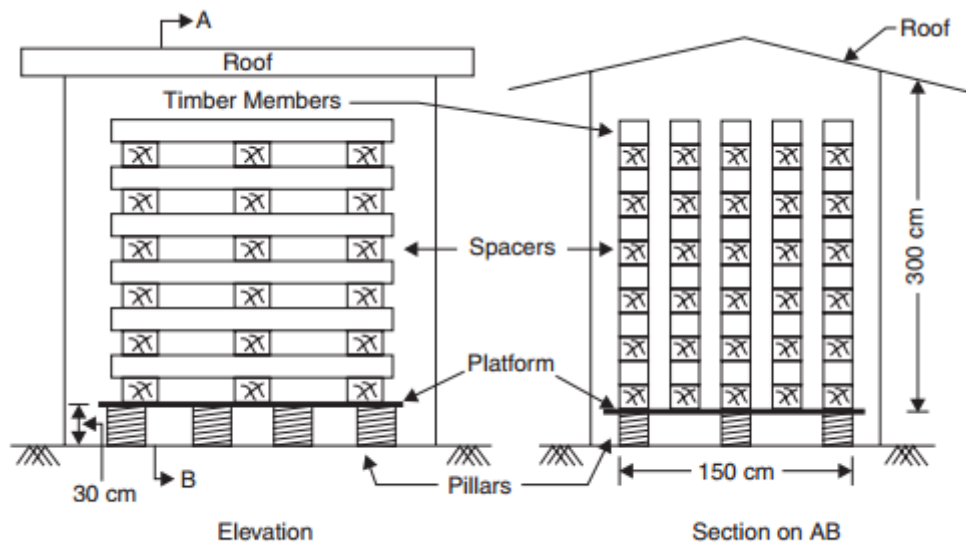
### 1.5.3 Seasoning of Timber

This is a process by which moisture content in a freshly cut tree is reduced to a suitable level. By doing so the durability of timber is increased. The various methods of seasoning used may be classified into: (i) Natural seasoning (ii) Artificial seasoning.

- (i) **Natural Seasoning:** It may be air seasoning or water seasoning. Air seasoning is carried out in a shed with a platform. On about 300 mm high platform timber barks are stacked as shown in Fig. 1.8. Care is taken to see that there is proper air circulation around each timber bark. Over a period, in a natural process moisture

content reduces. A well seasoned timber contains only 15% moisture. This is a slow but a good process of seasoning.

Water seasoning is carried out on the banks of rivers. The thicker end of the timber is kept pointing upstream side. After a period of 2 to 4 weeks the timber is taken out. During this period sap contained in the timber is washed out to a great extent. Then timber is stalked in a shed with free air circulation.



**Fig. 1.8. Air seasoning**

(ii) **Artificial Seasoning:** In this method timber is seasoned in a chamber with regulated heat, controlled humidity and proper air circulation. Seasoning can be completed in 4 to 5 days only. The different methods of seasoning are: (a) Boiling (b) Kiln seasoning (c) Chemical seasoning (d) Electrical seasoning.

(a) **Boiling:** In this method timber is immersed in water and then water is boiled for 3 to 4 hours. Then it is dried slowly. Instead of boiling water hot steam may be circulated on timber. The process of seasoning is fast, but costly.

(b) **Kiln Seasoning:** Kiln is an airtight chamber. Timber to be seasoned is placed inside it. Then fully saturated air with a temperature  $35^{\circ}\text{C}$  to  $38^{\circ}\text{C}$  is forced in the kiln. The heat gradually reaches inside timber. Then relative humidity is gradually reduced and temperature is increased, and maintained till desired degree of moisture content is achieved. The kiln used may be stationary or progressive. In progressive kiln the carriages carrying timber travel from one end of kiln to other end gradually. The hot air is supplied from the discharging end so that temperature increase is gradual from charging end to discharging end. This method is used for seasoning on a larger scale.

(c) **Chemical Seasoning:** In this method, the timber is immersed in a solution of suitable salt. Then the timber is dried in a kiln. The preliminary treatment by chemical seasoning ensures uniform seasoning of outer and inner parts of timber.

(d) **Electrical Seasoning:** In this method high frequency alternate electric current is passed through timber. Resistance to electric current is low when moisture content in timber is high. As moisture content reduces the resistance reduces. Measure of resistance can be used to stop seasoning at appropriate level.

However it is costly process. This technique has been tried in some plywood industries but not in seasoning of timber on mass scale.

#### 1.5.4 Defects in Timber:

Various defects which are likely to occur in timber may be grouped into the following three: (i) Due to natural forces (ii) Due to defective seasoning and conversions. (iii) Due to attack by fungi and insects.

##### (i) Defects due to Natural Forces:

The following defects are caused by natural forces: (a) Knots (b) Shakes (c) Wind cracks (d) Upsets.

- (a) **Knots:** When a tree grows, many of its branches fall and the stump of these branches in the trunk is covered. In the sawn pieces of timber the stumps of fallen branches appear as knots. Knots are dark and hard pieces. Grains are distorted in this portion.

Figure 1.9 shows some varieties of knots. If the knot is intact with surrounding wood, it is called live knot. If it is not held firmly it is dead knot.

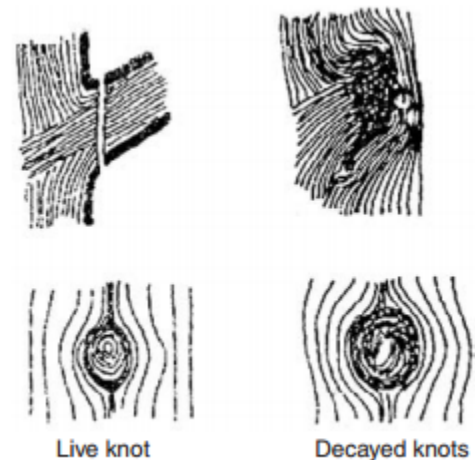


Fig. 1.9. Knots

- (b) **Shakes:** The shakes are cracks in the timber which appear due to excessive heat, frost or twisting due to wind during the growth of a tree. Depending upon the shape and the positions shakes can be classified as star shake, cup shake, ring shakes and heart shakes [Ref. Fig. 1.10]

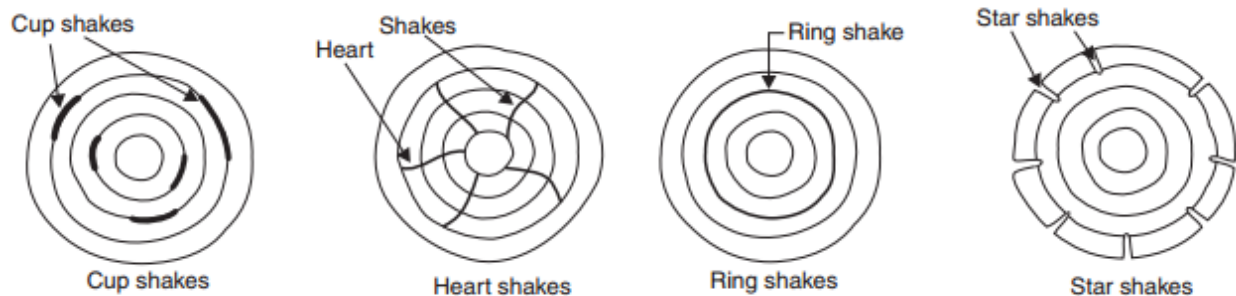
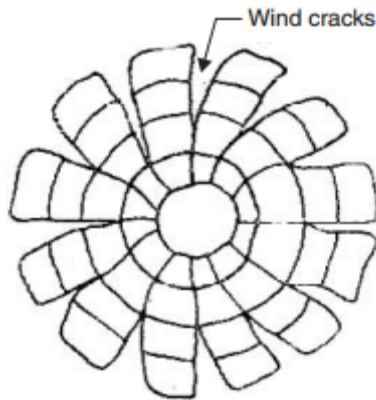


Fig. 1.10. Shakes

- (c) **Wind Cracks:** These are the cracks on the outside of a log due to the shrinkage of the exterior surface. They appear as shown in Fig. 1.11.



**Fig. 1.11. Wind cracks**



**Fig. 1.12. Upset**

- (d) **Upsets:** Figure 1.12 shows a typical upset in a timber. This type of defect is due to excessive compression in the tree when it was young. Upset is an injury by crushing. This is also known as rupture.

## **(ii) Defects due to Defective Seasoning and Conversion:**

If seasoning is not uniform, the converted timber may warp and twist in various directions. Sometimes honey combining and even cracks appear. These types of defects are more susceptible in case of kiln seasoning. In the process of converting timber to commercial sizes and shapes the following types of defects are likely to arise: chip marks, torn grain etc.

## **(iii) Defects due to Fungi and Insects Attack:**

Fungi are minute microscopic plant organism. They grow in wood if moisture content is more than 20°C and exposed to air. Due to fungi attack rotting of wood, takes place. Wood becomes weak and stains appear on it. Beetles, marine borers and termites (white ants) are the insects which eat wood and weaken the timber. Some woods like teak have chemicals in their compositions and resist such attacks. Other woods are to be protected by chemical treatment.

## **1.5.6 Uses of Timber:**

Timber is used for the following works:

1. For heavy construction works like columns, trusses, piles.
2. For light construction works like doors, windows, flooring and roofing.
3. For other permanent works like for railway sleepers, fencing poles, electric poles and gates.



4. For temporary works in construction like scaffolding, centering, shoring and strutting, packing of materials.
5. For decorative works like showcases and furniture.
6. For body works of buses, lorries, trains and boats
7. For industrial uses like pulps (used in making papers), card boards, wall papers
8. For making sports goods and musical instruments.

## 1.6 Veneers:

1. It is very thin piece of wood which is attached to board or wood. It is made of thin sheet of plywood on which textured paper is pasted.
2. Manufacturing of veneers
  - Slicing-after felling of a tree then it is transported to a veneer mill.
  - This cut the logs using one of the different cutting method into sheets that we know as a veneer.
  - These sheets are then clipped along their edges and bundled into manageable parcel.
  - Grading or sorting : when the veneer arrives at the warehouse it is carefully graded and sorted on the basic of quality and colour, length and grain pattern
  - Trimming : the first process must be to create a straight joinable edge on the outside of each bundle of veneer
  - Joining : then the bundle is ready for jointing and will pass through one of two types.
  - Stitching : the lay on is then given one final check and any repairs carried out, before being packaged up and sent out to the customer.
3. Types of veneers
  - Oak veneer
  - Teak veneer
  - Walnut Veneer
  - Birch veneer
  - Maple Veneer



Teak Veneer



Wood Veneer Sheets

4. Uses
  - Generally used in interior of residential and commercial areas for furniture including table, chair, walls and ceilings
  - Decorative design on the musical instruments.
5. Advantages
  - It looks like natural wood.
  - Low cost material. • Flexibility in design.
  - Each sheet different as tree would be different.
  - Increases strength and durability.
  - Eco-friendly and non toxic.
6. Disadvantages • water damage. • Installation required skilled workers. • More maintenance required for this.
7. Cost & Size • Cost depends on quality • Cost – 50rs to 2000rs. • More cost – 20000rs.
  - It has high profit margin as compared to laminates • It is imported by seaways

## 1.7 Plywood:

1. A type of strong thin wooden board consisting of two or more layer placed one above the other pressed with the direction of grain alternating.
2. Manufacturing Process
  - Selecting the Log
  - Stripping the Bark
  - Peeling the Log
  - Making a Continuous Ribbon of Wood
  - Cutting and Stacking
  - Gluing the Wood, Pressing the Wood
  - Trimming, Sanding and Finishing
3. Types of Plywood
  - a) Hardwood Plywood • Hardwood plywood is made up of wood and angiosperm trees and used for demanding end uses. • Hardwood plywood is characterized by its excellent strength, stiffness and resistance.
  - b) Softwood Plywood • Softwood plywood is usually made either of Cedar tree or Pine tree and Fir or Redwood is typically used for construction and industrial purpose.
  - c) Marine Plywood • Marine plywood is manufactured from durable face and core veneer, with few defects so it performs longer in both humid and wet condition and resist delaminating and fungal attack.
  - d) Tropical Plywood
    - Tropical plywood is made of mixed species of tropical timber.



- Originally from Asian region, it is now also manufactured in African and south American countries
- It is superior to softwood plywood due to its density, strength, evenness of layers and high quality.

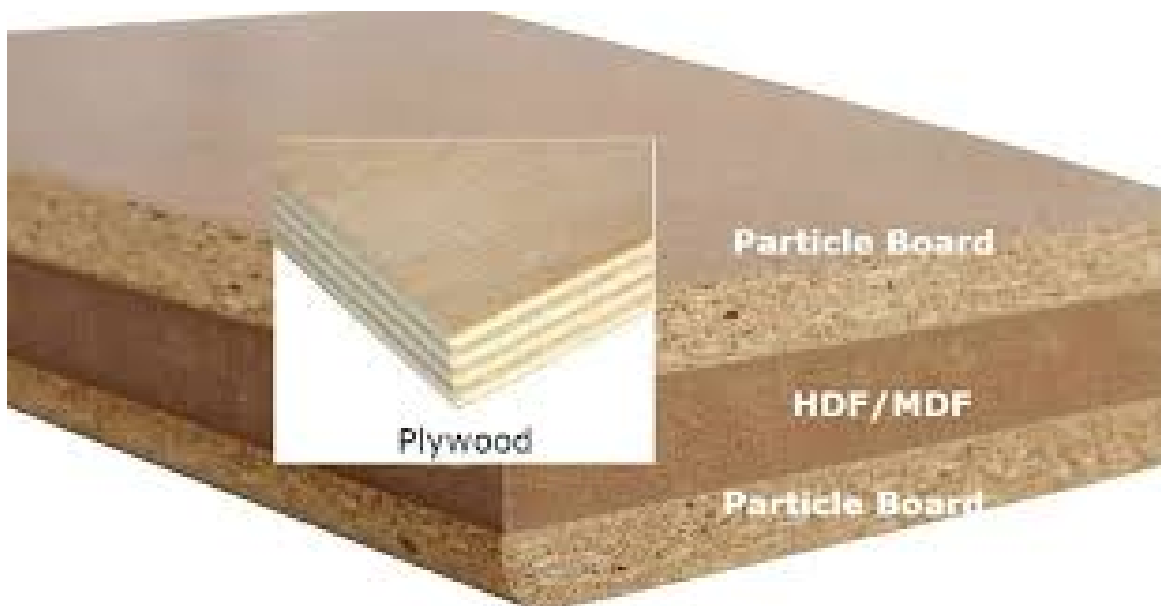
e) Fibreboard

i. Medium Density Fibreboard :

MDF is an engineered wood product made by breaking down hardwood or softwood residual into wood fibres. MDF is generally denser than plywood

ii. High Density Fibreboard :

HDF is an engineered wood product similar to particle and MDF board. It is much stronger and harder because it is made out of wood fibre that have been highly compressed.



4. Uses

- Exterior Wall Sheathing.
- Interior Walls.
- Roofing and Flooring.
- Furniture & Cabinets.
- Industrial and commercial.
- 18mm plywood is mostly used.

5. Advantages

- It has strength and durability compared to MDF.
- It makes the wood resistant to warping, cracking.

- It makes the wood porous and water damage.
- It is available in different thicknesses ranges from 6mm to 32mm.
- It can be cut into any shapes.

6. Disadvantages

- It makes the wood porous and water damage.
- It is quite difficult to cut.
- It is more expensive than Medium Density Fiberboard (MDF).
- Water may damage the plywood.

7. Cost & Size

- The most commonly manufactured plywood size is 4'x 8'. Other sizes are also available in market.
- Cost of plywood depend on the size & Thickness.
- Most Costly – 4000/sheet
- Least costly – 1500/sheet
- It is available in thickness of 4, 6, 9, 12, 18 mm.

SOME COMMON INDIAN TREES (Only for reference)

S.No.	Common name	Density	Location	Characteristics, usage and status
1	Teak	639 kg/m <sup>3</sup>	Central India and Southern India	Moderately hard, teak is durable and fire-resistant. It can be easily seasoned and worked. It takes up a good polish and is not attacked by white ants and dry rot. It does not corrode iron fastenings and it shrinks little. It is among the most valuable timber trees of the world and its use is limited to superior work only.
2	Sal	880–1,050 kg/m <sup>3</sup>	Karnataka, Andhra Pradesh, Maharashtra, Uttar Pradesh, Bihar, Madhya Pradesh, Orissa	It is hard, fibrous and close-grained. It does not take up a good polish. It requires slow and careful seasoning. It is durable underground and water. It is used for railway sleepers, shipbuilding, and bridges.

3	Deodar	560 kg/m <sup>3</sup>	Jammu and Kashmir, Himachal Pradesh and Uttarakhand.	Deodar is the most important timber tree providing soft wood. It can be easily worked and it is moderately strong. It possesses distinct annual rings. It is used for making cheap furniture, railway carriages, railway sleepers, packing boxes, and structural work.
4	Mango	560–720 kg/m <sup>3</sup>	Throughout India	The mango tree is well known for its fruits. It is easy to work and it maintains its shape well. It is moderately strong. It is most often used for cheap furniture, toys, packing boxes, cabinet work, panels for doors and for windows.
5	Sissoo	770 kg/m <sup>3</sup>	Mysore, Maharashtra, Assam, Bengal, Uttar Pradesh, Orissa	Also known as shisham or tali, this wood is strong and tough. It is durable and handsome and it maintains its shape well. It can be easily seasoned. It is difficult to work but it takes a fine polish. It is used for high quality furniture, plywoods, bridge piles, sport goods, and railway sleepers. It is a very good material for decorative works and carvings.
6	Rosewood	850 kg/m <sup>3</sup>	Kerala, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Orissa	It is strong, tough and close-grained. It is a handsome wood that takes up a high polish. It maintains its shape well and is available in large sizes. It is used for furniture of superior quality, cabinet work, and ornamental carvings.
7	Kathal, Keledang, Jackfruit	800 kg/m <sup>3</sup>	Karnataka, Andhra Pradesh, Kerala, Maharashtra, Tamil Nadu	It is heavy and hard. It is durable under water and in damp conditions, however, it cracks if exposed to direct sun. White ants do not attack it. It is used for piles,

				platforms of wooden bridges, door and window panels.
8	Arjun	870 kg/m <sup>3</sup>	Central India	It is heavy and strong. It has such uses as beams, rafters, and posts.
9	Himalayan Elm, Indian Elm	960 kg/m <sup>3</sup>	Throughout India	It is moderately hard and strong. It is used for door and window frames, and carts.
10	Jarul	640 kg/m <sup>3</sup>	Assam, Bengal, Maharashtra	Hard and durable, it can be easily worked. It takes a good finish and is used for house construction, boat building, railway carriages, cart making and scaffolding.