CHAPTER 05

Timber

The word timber is derived from an old English word *timberian* which means to build.

Three terms are to be noted in connection with the timber:

1. *Converted timber:* This indicates timber which is sawn and cut into suitable commercial sizes.
2. *Rough timber:* This indicates timber which is obtained after felling a tree.
3. *Standing timber:* This indicates timber contained in a living tree.

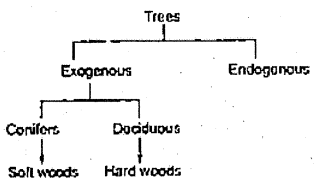
Do You Know ?

A single tree can cool the summer heat for an entire day and night and is found better than 20 air-conditioners running for 20 hours.

A hectare of trees will produce about 10 tonnes of oxygen which is enough for 45 persons to live for one year.

5.1 Classification of Trees

Trees are classified according to their mode of growth. Following is the 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 belong to this category.

   Exogenous trees are further subdivided into two groups.

   (i) Conifers: They show distinct annual rings.

   (ii) Deciduous: They do not show distinct annual rings.

Conifers are also known as evergreen trees and leaves of these do not fall till new ones are grown. As these trees bear cone-shaped fruits, they are given the name conifers. These trees yield soft woods.

Deciduous trees are also known as broadleaf trees and leaves of these trees fall in autumn and new ones appear in spring season. Timber for engineering purposes is mostly derived from deciduous trees. These trees yield hard woods.

Table: Comparison of Soft Wood and Hard Wood

S.No.	Item	Soft Wood	Hard Wood
1.	Annual rings	Distinct	Indistinct
2.	Colour	Light	Dark
3.	Fire resistance	Poor	Good
4.	Medullary rays	Indistinct	Distinct
5.	Strength	Strong for direct pull and weak for resisting thrust or shear	Equally strong for resisting tension, compression and shear
6.	Structure	Resinous and splits easily	Non-resinous and close-grained
7.	Weight	Light	Heavy

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

5.2 Structure of a Tree

From the visibility aspect, the structure of a tree can be divided into *two* categories:

(i) Macrostructure

(ii) Microstructure

(I) **Macrostructure:** The structure of wood visible to the naked eye or at a small magnification is called the macrostructure.

1. **Pith:** The innermost central portion or core of the tree is called the pith or medulla.
2. **Heart Wood:** The inner annual rings surrounding the pith is known as heart wood. It is usually dark in colour.

   It does not take active part in the growth of tree. But it imparts rigidity to tree and hence, it provides strong and durable timber for various engineering purposes.
3. **Sap Wood:** The outer annual rings between heart wood and cambium layer is known as sap wood. It is usually light in colour and weight. It indicates recent growth and it contains sap.

   It takes active part in the growth of tree and sap moves in an upward direction through it. Sap wood is also known as laburnum.
4. **Cambium Layer:** The thin layer of sap between sap wood and inner bark is known as cambium layer. It indicates sap which has yet not been converted into sap wood.
5. **Inner Bark:** It gives protection of cambium layer from any injury.
6. **Outer Bark:** It consists of cells of wood fibre and is also known as cortex.
7. **Medullary Rays:** The thin radial fibres extending from pith to cambium layer are known as *medullary rays*. The function of these rays is to hold together the annual rings of heart wood and sap wood.

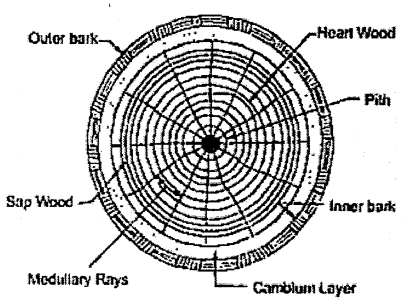


Fig. Cross-section of an exogeneous tree

(ii) **Microstructure:** The structure of wood apparent only at great magnifications is called the microstructure.

- Wood consists of living and dead cells of various sizes and shapes.
- A living cell consists of four parts, namely (i) membrane, (ii) protoplasm (iii) sap (iv) core. Cell membrane consists mainly of cellular tissue and cellulose. Protoplasm is a granular, transparent, viscous, vegetable protein composed of carbon, hydrogen, oxygen, nitrogen and sulphur. Core of cell differs from protoplasm merely by the presence of phosphorus and it is generally oval.

5.2.1 Felling of Trees

- To get timber, the trees are knocked down or cut down or caused to fall on the ground. This is known as the felling of trees. The important facts to be remembered in connection with felling of trees are as follows:
- **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.
  1. **Age of trees for felling:** The age of good trees for felling varies from 50 to 100 years.
  2. **Season for felling:** In autumn and spring, sap is in vigorous motion and hence, felling of trees in these seasons should be avoided. For hilly areas, mid-summer would be the proper season for felling as there is heavy rainfall in winter. For plain areas, mid-winter would be the proper season for felling as in summer, water contained in sap would be easily evaporated and it will lead to the formation of cracks.

5.3 Defects in Timber

Defects occurring in timber are grouped into the following five categories:

1. Defects due to conversion
2. Defects due to fungi
3. Defects due to insects
4. Defects due to natural forces
5. Defects due to seasoning

1. Defects due to Conversion

(i) **Chip mark:** Marks or signs placed by chips on the finished surface of timber.

(ii) **Diagonal grain:** This defect is formed due to improper sawing of timber.

(iii) **Torn grain:** This defect is caused when a small depression is formed on the finished surface of timber by falling of a tool or so.

(iv) **Wane:** This defect is denoted by the presence of original rounded surface on the manufactured piece of timber.

2. Defects due to Fungi

Fungi attack timber only when the following two conditions are satisfied simultaneously:

(i) The moisture content of timber is above 20 percent.

(ii) There is presence of air and warmth for the growth of fungi.

If any of the above condition is absent, decay of wood due to fungi would not occur. Hence, dry wood having moisture content less than 20 per cent will remain sound for centuries.

Following defects are caused in timber by fungi:

(i) **Blue Stain:** Sap of wood is stained to bluish colour by the action of certain types of fungi.

(ii) **Brown Rot:** The term rot is used to indicate decay or disease of timber. Certain types of fungi remove cellulose compounds from wood and hence, wood assumes the brown colour due to removal of cellulose.

(iii) **Dry Rot:** Dry rot occurs at places where there is no free circulation of air such as improperly ventilated basements, rooms, etc.

- Unseasoned soft woods and sap wood are easily attacked by dry rot.
- Dry rot is also caused by charring, painting and tarring the unseasoned timber.

Do You Know ?

- The most favourable conditions for the rapid growth of fungus responsible for dry rot are absence of sunlight, dampness, presence of sap, stagnant air and warmth.
- *When part of timber is seriously affected by dry rot, the damaged portion may be completely removed and the remaining unaffected portion should be painted with a solution of copper sulphate.*

(iv) **Heart rot:** This is formed when a branch has come out of a tree.

- The tree becomes weak and it gives out hollow sound when struck with a hammer.

(v) **Sap Stain:** Certain types of fungi do not bring about the complete decay of timber. But they feed on cell contents of sap wood. In doing so, sap wood loses it colour.

- It generally occurs when moisture content goes beyond 25 per cent or so.

(vi) **Wet Rot:** Fungi cause chemical decomposition of wood or the timber and in doing so, they convert timber into a greyish brown powder.

The important facts to be remembered in connection with wet rot are:

- Alternate dry and wet conditions favour the development of wet rot.
- If unseasoned or improperly seasoned timbers are exposed to rain and wind, they become easily liable for the attack of wet rot.

(vii) **White Rot:** In this case, certain types of fungi attack lignin of wood and wood assumes the appearance of a white mass consisting of cellulose compounds.

3. Defects due to Insects

Following are the insects which are usually responsible for the decay of timber:

(i) Beetles

- They form pin-holes of size about 2 mm diameter in wood. They attack the sap wood of all species of hard woods.
- The timber is converted into fine flour-like powder. They usually do not disturb the outer shell or cover. Hence, timber piece attacked by beetles may look sound till it completely fails.

(ii) Marine Borers

- These are generally found in salty water. Most of the varieties of marine borers do not feed on wood. But they make holes or bore tunnels in wood for taking shelter.
- The diameter and length of these holes may go as high as 25 mm and 60 mm respectively.
- No timber is completely immune from the attack of marine borers.

(lii) Termites

- These are popularly known as white ants and they are found in abundance in tropical and sub-tropical countries. These insects live in a colony and they are very fast in eating away the wood from core of the cross-section. They make tunnels inside the timber in different directions and usually do not disturb the outer shell or cover.
- Very few good timbers such as teak, sal, etc. can resist the attack of white ants.

4. Defects due to Natural Forces

(i) Burls	(ii) Callus	(iii) Chemical stain
(iv) Coarse grain	(v) Dead wood	(vi) Druxiness
(vii) Foxiness	(viii) Knots	(ix) Rind galls
(x) Shakes	(xi) Twisted fibres	(xii) Upsets
(xiii) Water stain	(xiv) Wind cracks	

(i) Burls: They are particularly formed when a tree has received shock or injury in its young age.

(ii) Shakes: These are cracks which partly or completely separate the fibres of wood. Following are the different varieties of shakes:

(a) Cup Shakes: These are caused by the rupture of tissue in a circular direction as shown in Fig. It is a curved crack and it separates partly one annual ring from the other. It develops due to non-uniform growth. It may not prove to be harmful, if it covers only a portion of ring.

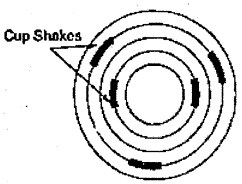


Fig. Cup Shakes

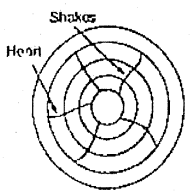


Fig. Heart Shakes

(b) Heart Shakes: These cracks occur in the centre of cross-section of tree and they extend from pith to sap wood in the direction of medullary rays as shown in Fig. These cracks occur due to shrinkage of interior part of tree which is approaching maturity. Heart shakes divide the tree cross-section into two to four parts.

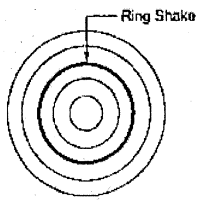


Fig. Ring Shakes

(c) Ring Shakes: When cup shakes cover the entire ring, they are known as ring shakes as shown in Fig.

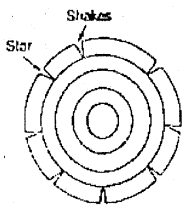


Fig.Star Shakes

(d) Star Shakes: These are cracks which extend from bark towards the sap wood. They are usually confined up to the plane of sap wood. They are usually formed due to extreme heat or frost.

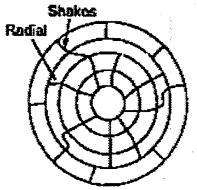


Fig. Radial Shakes

(e) Radial Shakes: These are similar to star shakes. But they are fine, irregular and numerous. They usually occur when tree is exposed to sun for seasoning after being felled down.

(iii) Twisted Fibres: These are also known as wandering hearts and they are caused by twisting of young trees by fast blowing wind. Timber with twisted fibres is unsuitable for sawing.

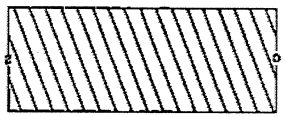


Fig. Twisted Fibres

Fig. Upset

(iv) Upsets: These are also known as ruptures and they indicate wood fibres which are injured by crushing or compression. Upsets are mainly due to improper felling of tree and exposure of tree in its young age to fast blowing wind.

(v) Knots: These are base of branches or limbs which are broken or cut off from the tree.

- The portion from which the branch is removed receives nourishment from the stem for a pretty long time and it ultimately results in the formation of dark hard rings which are known as the knots.
- These are caused by wood limb encased by wood of tree trunk.
- Caused when branch base embedded in timber by natural growth.

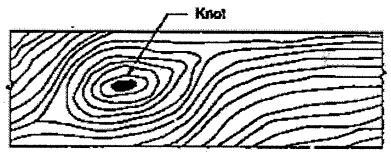


Fig. Knot

Table: Classification of Knots on Size Basis

S.No.	Type of knot	Size
1.	Pin knot	Diameter upto 6.50 mm
2.	Small knot	Diameter between 6.50 and 20 mm
3.	Medium knot	Diameter between 20 and 40 mm
4.	Large knot	Diameter greater than 40 mm

Table : Classification of Knots on Basis of Form and Quality

S.No.	Type of knot	Remarks
1.	Dead knot	The fibres of knot are properly interconnected with those of surrounding wood. Hence it can be easily separated out from the body of wood. It is not safe to use wood with such a knot for engineering purposes.
2.	Decayed knot	It is also known as an unsound knot and it is formed by the action of fungi on wood.
3.	Live knot	It is also known as a sound knot. It is free from decay and cracks. It is thoroughly fixed in wood and hence it cannot be separated out from the body of wood. The presence of such knots makes wood difficult to plane. However the wood containing such knots can be used for engineering purposes.
4.	Loose knot	It indicates preliminary stage of dead knot. The fibres of knot are not firmly held in the surrounding wood.
5.	Round knot	The cross-section of this type of knot is either round or oval. It is obtained by cutting the knot at right angles to its long axis.
6.	Tight knot	It indicates preliminary stage of live knot. The fibres of knot are firmly held in the surrounding wood.

(vi) Rind Galls: The rind means bark and gall indicates abnormal growth.

- Peculiar curved swellings found on the body of a tree are known as the rind galls.
- They develop at points from where branches are improperly cut off or removed.
- They are rarely found in a tree and the timber in this part is very weak and not durable.

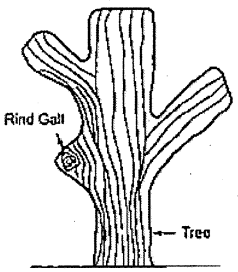


Fig. Rind gall

5. Defects due to Seasoning

Following defects occur in seasoning process of wood:

(i) Bow	(ii) Case-hardening
(iii) Check	(iv) Collapse
(v) Cup	(vi) Honey-combing
(vii) Radial shakes	(viii) Split
(ix) Twist	(x) Warp

(i) Bow : This defect is indicated by the curvature formed in the direction of length of timber.

Fig. Bow

(ii) Cup: This defect is indicated by the curvature formed in the transverse direction of timber. Unequal shrinkage in radial and tangential direction is cause of cup.

(iii) Case Hardening: The exposed surface of timber dries very rapidly. It therefore shrinks and is under compression. The interior surface which has not completely dried is under tension. This defect is known as the case - hardening and it usually occurs in timbers which are placed at the bottom during seasoning.

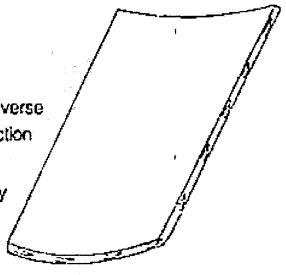


Fig. Cup

(iv) Check: A check is a crack which separates fibres of wood. It does not extend from one end to the other.

(v) Collapse: Due to uneven shrinkage, the wood sometimes flattens during drying. This is known as the collapse.

(vi) Honey combing: Due to stresses developed during drying, the various radial and circular cracks develop in the interior portion of timber. The timber thus assumes the honey-comb texture and the defect so developed is known as the honey-combing.

(vii) Radial shakes: These are radial cracks. They are explained earlier and are shown in Fig.

(viii) Split: When a check extends from one end to the other, it is known as a split.

(ix) Twist: When a piece of timber has spirally distorted along its length, it is known as a twist. It is shown in figure.

(x) Warp: When a piece of timber has twisted out of shape, it is said to have warped.

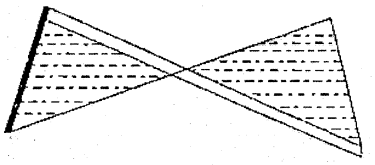


Fig. Twist

5.4 Preservation of Timber

Preservation of timber is carried out to achieve the following three objects:

(i) To increase the life of timber structures.

(ii) To make the timber structures durable, and

(iii) To protect the timber structures from the attack of destroying agencies such as fungi, insects, etc.

5.4.1 Requirements of a Good Preservative

(i) It should allow decorative treatment on timber after being applied over timber surface.

(ii) It should be capable of covering a large area with small quantity.

(iii) It should be cheap and easily available.

(iv) It should be free from unpleasant smell.

(v) Its penetrating power into wood fibres should be high. It is necessary for the preservative to be effective to penetrate at least for a depth of 6 mm to 25 mm.

(vi) It should be durable and should not be affected by light, heat, etc.

(vii) It should be non-inflammable.

(viii) It should be quite efficient in killing fungi, insects, etc.

(ix) It should be safe and harmless for humans and animals.

(x) It should give pleasant appearance to the timber after being applied over it.

(xi) It should not affect the strength characteristics of timber.

(xii) It should not be easily washed away by water.

(xiii) It should not corrode the metals with which it comes into contact.

5.4.2 Types of Preservatives

Following preservatives are commonly used for the preservation of timber:

1. AsCu treatment	2. Chemical salts	3. Coal tar
4. Creosote oil	5. Oil paints	6. Solignum paints

1. AsCu Treatment
   - AsCu is special preservative which was developed at the Forest Research Institute, Dehradun. Its composition is as follows:
   - 1-Part by weight of hydrated arsenic pentoxide, ($As_2O_5.2H_2O$).
   - 3-Part by weight of blue vitriol or copper sulphate, ($CuSO_4.5H_2O$).
   - 4-Part by weight of potassium dichromate ($K_2Cr_2O_7$) or sodium dichromate ($Na_2Cr_2O_7.2H_2O$)
   - This material is available in powder form. To prepare a solution of this material, six parts by weight of AsCu are mixed in 100 parts by weight of water.

Do you know? AsCu preservative gives timber protection against the attack of white ants. The surface treated with this preservative can be painted, polished, varnished or waxed.

2. Chemical Salts
   - These are water-borne preservatives and they are mostly salts dissolved in water. The usual salts used are copper sulphate, mercury chloride, sodium fluoride and zinc chloride.
   - These preservatives are odourless and non-inflammable.

3. Coal Tar
   - The timber surface is coated with hot coal tar with the help of brush. The coal tar becomes workable when heated. The process is known as the tarring. The coal tar has unpleasant smell and appearance. It makes timber unsuitable for painting. It is cheap and fire resistant.

4. Creosote Oil

In this case, timber surface is coated with creosote oil. The process is known as creosoting. Creosote oil is obtained by the distillation of tar. Creosoting is carried out as follows:

(i) Timber is thoroughly seasoned and dried.

(ii) It is then placed in an air tight chamber

(iii) Air is pumped out from the chamber.

(iv) Creosote oil is then pumped under a high pressure of about 7 to 10 kg/cm^2 and at temperature of about 50°C.

(v) After a period of about 1 to 2 hours, when timber has sufficiently absorbed creosote oil, it is taken out of chamber.

- Creosote oil is one of the best antiseptic. It is a black or brown liquid, weakly affected by water, neither volatile nor hygroscopic, harmless to wood or metal, inflammable, with an unpleasant odour and having low wood-penetrating ability to the extent of 1 mm to 2 mm only.
- Creosote oil should not be used for interior surfaces of dwelling houses, foodstuff-storage premises, in underground installations and near inflammable surfaces.

The creosoting practically doubles the life of timber and it is generally adopted for piles, railway sleepers, etc. Depending upon the net retention and type of timber, the creosote treated timber will normally increase in weight by 800 to 3200 N per m^3.

5. Oil Paints
   - The timber surface is coated with 2 or 3 coats of oil paint.
   - The wood should be seasoned, otherwise sap will be confined and it will lead to the decay of timber.
   - The oil paints preserve timber from moisture and makes it durable.

6. Solignum Paints
   - These paints preserve timber from white ants as they are highly toxic in nature.
   - They can be mixed with colour pigment and applied in hot state with the help of brush.
   - The timber surface may therefore be given the desired colour or appearance.

5.4.3 Methods for Preservation

Following are the six methods adopted for preservation of timber:

1. Brushing
2. Charring
3. Dipping and steeping
4. Hot and cold open tank treatment
5. Injecting under pressure
6. Spraying

1. Brushing
   - The solution prepared from preservative is applied on timber surface by good quality of brushes.
   - This is the simplest method and it is generally adopted for seasoned timber.
   - The cracks should be filled up before the application of preservative.
   - For better penetration, the oil type preservative may be applied hot and the preservative should be liberally used on the surface.

2. Charring
   - The method of charring is rather very old and as such, no preservative is used in this method.
   - The surface to be charred is kept wet for about half an hour and it is then burnt up to a depth of about 15 mm over a wood fire.
   - The charred portion is then cooled with water.
   - Due to burning, a layer of coal is formed on the surface.
   - This layer is not affected by moisture and it is not attacked by white ants, fungi etc.
   - The disadvantages of this method are:

     (i)The charred surface becomes black in appearance and hence it cannot be used for exterior work.

     (ii)There is some loss of strength of timber as the cross-section is reduced due to charring. The process of charring is generally adopted for lower ends of post for fencing, telephone etc. which are to be embedded in the ground or to be inserted in moist soil.

3. Dipping and Steeping
   - In this method, the timber to be given preservative treatment is dipped or soaked for a short period in the solution of preservative.
   - This method gives slightly better penetration of preservative than in case of brushing or spraying.
   - Instead of dipping, the striping or wetting of timber with preservative may be carried out for a period varying from a few hours to days or weeks.

4. **Hot and Cold Open Tank Treatment**
   - In this method, the timber is submerged in a tank containing solution of preservative which is heated for a few hours at temperature of 85°C - 95°C.
   - Tank is then allowed to cool down gradually while the timber is still submerged in the tank.
   - This method is effective in giving protection to the sap wood.

5. **Injecting Under Pressure**
   - In this method, the preservative is injected under pressure into the timber.
   - This method is usually adopted in creosoting.
   - This is the most effective method of treating timber with the preservative.
   - It requires special treatment plant.
   - This method proves to be essential for treating non-durable timbers which are to be used at places where there is a danger of attack by fungi and insects.

6. **Spraying**
   - In this method, the solution of preservative filled in a spraying pistol and it is then applied on timber surface under pressure.
   - This piston works under compressed air.
   - This method is also quite effective and it is superior than brushing.

5.5 Fire Resistance of Timber

With respect to the fire-resistance, the timber is classified as refractory timber and non-refractory timber. The refractory timber is non-resinous and it does not catch fire easily. The examples of refractory timbers are sal, teak, etc. The non-refractory timber is resinous and it catches fire easily. The examples of non-refractory timbers are chir, decoder, fir, etc.

To make timber more fire-resistant, the following methods are adopted:

1. **Application of Special Chemicals**
   - It is found that two coats of solution of borax or sodium arsenate with strength of 2 per cent are quite effective in rendering the timber fire-resistant.
   - When the temperature rises, they either melt or give off gases which hinder or forbid combustion. When the wood is treated with antipyrine, it does not inflame even at high temperature, but it merely moulders, i.e., burns slowly without flame. The antipyrines containing salts of ammonium or boric and phosphoric acids are considered to be the best in making the timber fire-resistant.

2. **Sir Abel's Process**
   - In this process, timber surface is cleaned and it is coated with a dilute solution of sodium silicate. A cream-like paste of slaked fat lime is then applied and finally, a concentrated solution of silicate of soda is applied on the timber surface. This process is quite satisfactory in making the timber fire-resistant.

5.6 Seasoning of Timber

By the process of seasoning, the excess water of timber is extracted in such a way that the moisture content of seasoned timber corresponds to the required moisture content in timber for the environments in which it is to be used.

5.6.1 Objects of Seasoning

(i) To allow timber to burn readily, if used as fuel.
(ii) To decrease the weight of timber and thereby to lower the cost of transportation and handling.
(iii) To make timber safe from the attack of fungi and insects.
(iv) To reduce the tendency of timber to crack, shrink and warp.
(v) To make timber fit for receiving treatment of paints, preservatives, varnishes etc.
(vi) To impart hardness, stiffness, strength and better electrical resistance to timber.

5.6.2 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.

Advantages:

(i) Depending on the climatic conditions, the moisture content of wood can be brought down to about 10-20%.
(ii) It does not require skilled supervision.
(iii) This method of seasoning timber is cheap and simple.
(iv) It is uneconomical to provide artificial seasoning to timber sections thicker than 100 mm as such sections dry very slowly. Hence such thicker timber sections are usually seasoned by the process of air seasoning.

Disadvantages:

(i) As the process depends on the natural air, it sometimes becomes difficult to control it
(ii) The drying of different surfaces may not be even and uniform.
(iii) If ends of thick sections of timber are not projected by suitable moisture proof coating, there are chances for end splitting because the end of such timber dry rapidly in comparison to the central portion.

2. **Artificial Seasoning**

Following are the reasons for adopting the artificial seasoning to the natural seasoning.

(a) The defects such as shrinkage, cracking and warping are minimized.
(b) The drying is controlled and there are practically no chances for the attack of fungi and insects.
(c) The drying of different surface is even and uniform.
(d) It considerably reduces the period of seasoning.
(e) There is better control on circulation of air, humidity and temperature.
(f) The wood becomes more suitable for painting and gluing.

Various methods of artificial seasoning are as follows:

(i) Boiling
   - In this method of artificial seasoning, timber is immersed in water and water is then boiled. But it affects the elasticity and strength of wood

(II) Chemical seasoning

- This is also known as salt seasoning. In this method, timber is immersed in a solution of suitable salt. It is then taken out and seasoned in the ordinary way. The interior surface of timber dries in advance of exterior one and chances of formation of external cracks are reduced.

(III) Electrical seasoning

- In this method, use is made of high frequency alternating currents.
- This is the most rapid method of seasoning.
- Initial and maintenance costs are so high that it becomes uneconomical to season timber on commercial basis by this method

(iv) Kiln Seasoning

- In this method, drying of timber is carried out inside an airtight chamber or oven.
- Air which is fully saturated with moisture and which is heated to a temperature of about 35°C to 38°C is then forced inside the chamber by suitable arrangement.

(v) Water Seasoning

- Timber pieces are immersed wholly in water, preferably in running water of a stream. Care should be taken to see that timber is not partly immersed.
- The thicker or larger end of timber is kept pointing on the upstream side.
- Timber is taken out after a period of about 2 to 4 weeks. During this period, sap contained in timber gets washed away by water.

Table : Comparison between Natural Seasoning and Kiln Seasoning

S.No.	Item	Natural Seasoning	Kiln Seasoning
1.	Moisture content	It is difficult to reduce the moisture content below 15-18%.	The moisture content can be reduced to any desired level
2.	Nature	It is simple and economical.	It is expensive and quite technical.
3.	Quality of timber	The air seasoned timber is more liable to the attacks of insects and fungi.	The kiln seasoned timber is less liable to the attacks of insects and fungi.
4.	Space	It requires more space for stacking	It requires less space for stacking.
5.	Speed	It is a slow process.	It is a quick process.
6.	Strength	It gives stronger timber.	It gives a little weaker timber.

5.6.3 Conversion of Timber

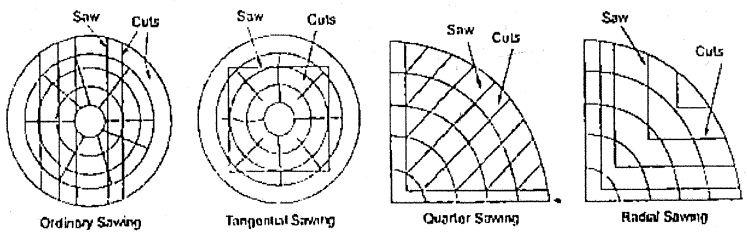


Fig. Different Methods of Sawing

The process by which timber is cut and sawn into suitable sections is known as the conversion.

Following important facts in connection with the conversion of timber are to be remembered:

(i) The allowance should be made for shrinkage, squaring and planning. It is about 3 mm to 6 mm.

(ii) 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.

(iii) 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.

(iv) The conversion may be achieved either by ordinary sawing, quarter sawing, tangential sawing or radial sawing.

Ordinary Sawing: Bastard sawing or flat sawing or slab sawing:

- The saw cuts are tangential to the annual rings and right through the cross-section of timber piece.
- The log is moved forward and backward on the plat form of a sawing mill.
- This is a very easy and quick method of sawing and it is widely adopted in our country.
- It is also most economical method and wastage of useful timber is the minimum.
- However the planks obtained by this method are liable to warp and twist as a result of unequal shrinkage.

Quarter Sawing:

- The saw cuts are tangential to the annual rings and they meet each other at right angles.
- It may produce fine figure wood when adopted in case of timber having no distinct medullary rays.

Tangential Sawing: Plain or flat grained sawing:

- The saw cuts are tangential to the annual rings and they meet each other at right angles.
- This method is adopted when the annual rings are very distinct and the medullary rays are not clearly defined.
- The plank obtained by this sawing warp too much because the section are weak as the medullary rays which impart strength to the longitudinal fibres are cut.

Radial Sawing or Rift Sawing:

- The saw cuts are made radially in a parallel direction to the medullary rays.
- This method is used for conversion of hard timber.
- The timber obtained by this method shrinks and warps to a less degree and it is distorted to the minimum.
- Strength of sawing in radial > quarter > ordinary > tangential. Plywoods are available in different commercial forms such as battenboard, laminboard, metal faced plywood, multiply, three-ply, veneered plywood.

5.7 Market forms of Timber

1. Batten: This is a timber piece whose breadth and thickness do not exceed 50 mm.
2. Baulk: It is a roughly squared timber piece and it is obtained by removing bark and sap wood. One of the cross-sectional dimension exceeds 50 mm, while the other exceeds 200 mm.

3. **Board :** It is a plank, i.e. a timber piece with parallel sides. Its thickness is loss than 50 mm and width exceeds 150 mm.
4. **Deal:** It is a piece of soft wood with parallel sides. Its thickness varies from 50 mm to 100 mm and its width does not exceed 230 mm.
5. **End:** This is a short piece of batten, deal, scantling, etc.
6. **Log:** It is the trunk of tree obtained after removal of branches.
7. **Plank:** It is a timber piece with parallel sides. Its thickness is less than 50 mm and its width exceeds 50 mm.
8. **Pole:** It is a sound long log of wood. Its diameter does not exceed 200 mm. It is also known as a spar.
9. **Quartering:** It is a square piece of timber, the length of side being 50 mm to 150 mm
10. **Scantling:** This is a timber piece whose breadth and thickness exceed 50 mm, but are less than 200 mm in length.

5.7.1 Industrial Timber

Following are the varieties of industrial timber:

1. **Veneers**

These are thin sheets or slices of wood of superior quality. The thickness of veneers varies from 0.40 mm to 6 mm or more. They are obtained by rotating a log of wood against a sharp knife of rotary cutter. Veneers after being removed are dried in kilns to remove moisture.

Following facts should be noted:

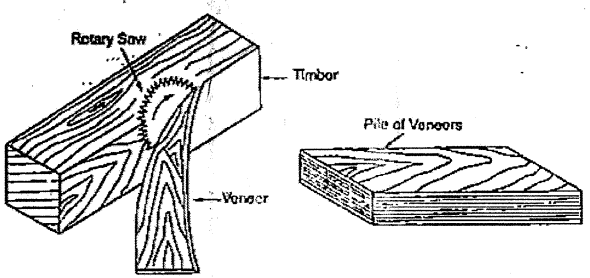


Fig. Veneers

- Edges of veneers are joined and sheets of decorative designs are prepared.
- Indian timbers which are suitable for veneers are mahogany, oak, rosewood, sissoo, teak, etc.
- The process of preparing a sheet of veneer is known as veneering.
- Veneers are used to produce plywoods, battenboards and laminboards.

2. **Plywoods**

- Three or more veneers in odd numbers are placed one above the other with the direction of grains of successive layers at right angles to each other. They are held in position by application of suitable adhesives. The placing of veneers normal to each other increases the longitudinal and transverse strengths of plywood.
- The pressure applied on plywood varies from 7 to 14 kg/cm^2.
- Plywoods, however, are not suitable in situations subjected to direct shocks or impacts.

Advantages of Plywoods:

- As plies are placed at right angles to each other, expansion and shrinkage are comparatively very low.
- They are elastic and hence they are not liable to split.
- They do not split in an axial direction.
- They possess uniform tensile strength in all directions.

3. Fiberboards

These are rigid boards and they are also known as pressed wood or reconstructed wood. The thickness varies from 3 mm to 12 mm.

4. Impreg Timbers

Timber which is fully or partly covered with resin is known as impreg timber. The usual resin employed is phenol formaldehyde which is soluble in water. Veneers or thin strips of woods are taken and they are immersed in resin. The resin fills the space between wood cells and by chemical reaction, a consolidated mass develops. It is then cured at a temperature of about 150°C to 160°C. Impreg timber is available under trade names such as Formica, Sunglass, Sunmica, etc.

Advantages of Impreg Timber:

- It is not affected by moisture and weather conditions.
- It is strong and durable.
- It possesses more electrical insulation.
- It presents a descent appearance.
- It resists acidic effects.
- The contraction and expansion of impreg timbers are about 25 to 40 per cent less than ordinary timber.

5. Compreg Timbers

- The process of preparing compreg timbers is same as that of impreg timbers except that curing is carried out under pressure.
- The strength and durability of compreg timbers are more as compared to the impreg timbers. The specific gravity of compreg timbers is about 1.30 to 1.35.

6. Battenboard

- It is a solid block with core of sawn thin wood.
- The thickness of core is about 20 mm 25 mm and total thickness of board is about 50 mm.
- The direction of the grains of core battens is at right angles to that of the adjacent outer ply sheets.
- These boards are light and strong.
- They do not crack or split easily.
- They are widely used for making partition walls, packing cash, shaffers of doors and windows.

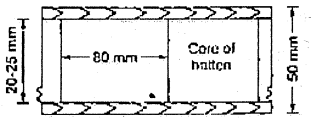


Fig. Battenboard

7. **Lamin Board**
   - It is similar to the batten board except that the core is made of multiple veneers.
   - The thickness of each veneer does not exceed 6 mm and total thickness of board is about 50 mm.
   - The external plies are of thick veneers and they are firmly glued with core to form a solid block.
   - These boards have the same uses as those of battenboards.

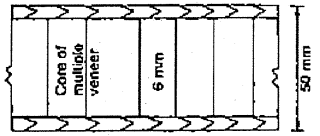


Fig. Laminboard

5.8 Qualities of Good Timber

1. **Appearance:** A freshly cut surface of timber should exhibit hard and shining appearance.
2. **Colour:** The colour of timber should preferably be dark. The light colour usually indicates timber with low strength.
3. **Defects:** A good timber should be free from serious defects such as dead knots, flaws, shakes etc.
4. **Durability:** A good timber should be durable.
   - It should be capable of resisting the action of fungi insets, dunlscals, physical agencies and mechanical agencies.
   - If wood is exposed to the action of aids and alkali for a prolonged period, it is seriously damaged.
5. **Elasticity:** This is the property by which timber returns to its original shape when load causing its deformation is removed.
   - This property of timber would be essential when it is to be used for bows, carriage shafts, sport good etc.
   - Elasticity of timber is $1.0 \times 10^3 - 1.5 \times 10^4$ N/mm^2.
6. **Fibres:** The timber should have straight fibres.
7. **Fire resistance:** The timber is a bad conductor of heat.
   - A dense wood offers good resistance to the fire and it requires sufficient heat to cause a flow.
8. **Hardness:** A good timber should be hard i.e. it should offer resistance when it is being penetrated by another body
   - The chemicals present in hard wood and density of wood impart hardness to the timber.
9. **Mechanical wear:** A good timber should not deteriorate easily due to mechanical wear or abrasion.
   - This property of timber would be essential for places where timber would be subject to traffic.
10. **Shape:** A good timber should be capable of retaining its shape during conversion or seasoning.
    - It should not bow or warp or split.
11. **Smell:** A good timber should have sweet smell.
    - An unpleasant smell indicates decayed timber.
12. **Sound:** A good timber should give out a clear ringing sound when struck.
    - An dull heavy sound, when struck, indicates decayed timber.
13. **Strength:** A good timber should be strong for working as structural member such as joist beam, rafter
    - It should be capable of taking loads slowly or suddenly.
14. **Structure:** It should be uniform, the fibres should be firmly added.
    - The medullary rays should be hard and compact.
15. **Toughness:** A good timber should be tough i.e. it should be capable of offering resistance to the shocks due to vibration.
    - This property of timber would be essential when it is to be used for tool handles, parts of motor cars and aeroplanes.
16. **Water permeability:** A good timber should low water permeability which is measured by the quantity of water filtered through a unit surface area of specimen of wood.
17. **Weight:** The timber with heavy weight is considered to be sound and strong.

5.9 Important Indian Timber Trees

1. **Babul:** It is used for bodies and wheels of bullock carts, agricultural instruments, tool handles, well kerbs, etc.

   It is used for making cabinets.
2. **Banyan:** It is used for aerial roots for tent poles, well curbs, etc.
3. **Benteak:** It is used for building construction, boat construction, furniture, etc.
4. **Deodar:** It is used for making cheap furniture, railway carriages, railway sleepers, packing boxes, structural work, etc.
5. **Guava:** It is used for making toys, handles of instruments, engraving work, etc.
6. **Hopea:** It is used for ordinary house construction, railway sleepers, piles, boat building, etc.
7. **Kathal:** It is not attacked by white ants.

   It is used for piles, platforms of wooden bridges, door and window panels, etc.
8. **Mulberry:** It is strong, tough and elastic. It takes up a clean finish. It can be well seasoned. It is turned and carved easily. Its weight after seasoning is about 650 kg/m^3. It is found in Punjab.

   It is used for baskets and sport goods like hockey sticks, tennis rackets, cricket bats, etc.
9. **Oak:** It is used for preparing sport goods.
10. **Rosewood or Blackwood:** It is used for furniture of superior quality, cabinet work ornamental carvings, etc.
11. **Sal:** It is used for railway sleepers, ship building, bridges, structural work, etc. Sal poles are used as foundation piles.
12. **Sissoo:** It is used for high class furniture, plywoods, bridge piles, sport goods, railway sleepers, etc. It is a very good material for decorative works and carvings.
13. **Toon:** It is used for furniture, packing boxes, cabinet making, door panels, etc.

Objective Brain Teasers

Q.1 Sapwood consists of
(a) innermost annular rings around the pith
(b) portion of timber between heartwood and cambium layer
(c) thin layers below the bark
(d) thin fibre which extends from the pith outwards and holds the annular rings together

Q.2 Which of the following trees yields hard wood?
(a) Deodar (b) Chir
(c) Shishum (d) Pine

Q.3 In which of the following pairs both trees yield soft wood?
(a) Deodar and Shishum
(b) Chir and Sal
(c) Sal and Teak
(d) Chir and Deodar

Q.4 Which of the following timber is suitable for making sports goods?
(a) Mulberry (b) Mahogany
(c) Sal (d) Deodar

Q.5 The moisture content in a well seasoned timber is
(a) 4% to 6% (b) 10% to 12%
(c) 15% to 20% (d) 100%

Q.6 In which of the following directions, the strength of timber is maximum?
(a) parallel to grains
(b) 45° to grains
(c) perpendicular to grains
(d) same in all directions

Q.7 Plywood has the advantage of
(a) greater tensile strength in longer direction
(b) greater tensile strength in shorter direction
(c) same tensile strength in all directions
(d) none of these

Q.8 The age of a tree can be known by examining
(a) cambium layer (b) annular rings
(c) medullary rays (d) heart wood

Q.9 Plywood is made by bonding together thin layers of wood in such a way that the angle between grains of any layer to grains of adjacent layers is
(a) 0° (b) 30°
(c) 45° (d) 90°

Q.10 The practical limit of moisture content achieved in air drying of timber is
(a) 5% (b) 15%
(c) 25% (d) 35%

Answers

1. (b) 2. (c) 3. (d) 4. (a) 5. (b)
6. (a) 7. (c) 8. (b) 9. (d) 10. (b)