WOOD / TIMBER

Definition of Timber

Wood suitable for building or other engineering purposes like for door, windows, beams, battens, roofs, partition walls is known as timber
When it forms part of a living tree it is called *standing timber.* When the tree has been felled it is called *rough timber*. When it has been sawn to various market forms such as beams, battens and planks etc. it is called *converted timber.*
Preferred due to reasonable cost, ease of working, attractive appearance, and adequate life if protected against moisture and insects

Classification of trees

- Depending on the mode of growth trees are classified into two catagories as:

  (a) Endogenous, and (b) Exogenous

- **Endogenous trees**: are the ones that grow inwards in a longitudinal fibrous mass such as banana, bamboo, palm and cane. Even though the "stem" of trees of this class is light and tough

yet it is too flexible and slender to furnish material suitable for engineering works, with the exception of bamboo.

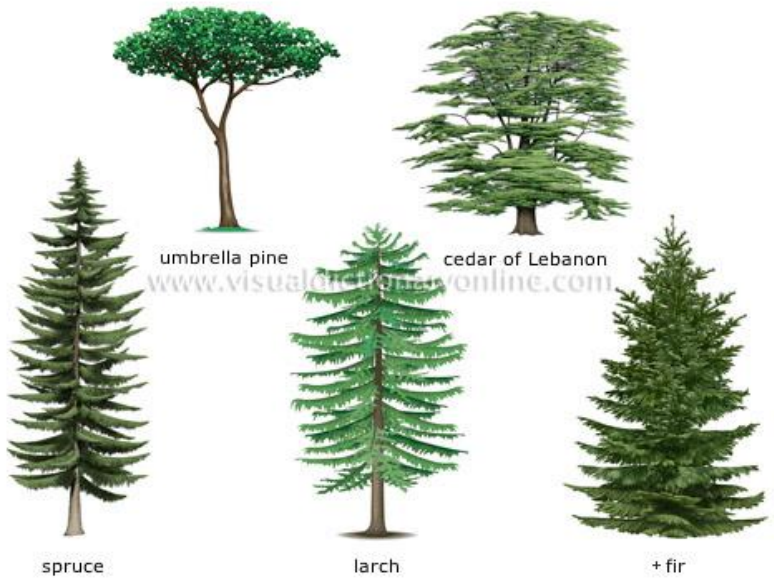
Classification of trees

- **Exogenous trees:**

- These are those that grow outwards by the addition of one concentric ring every year. These rings are known as annual rings. Since one ring is added to the tree every year so the number of annual rings in the stem of a tree indicates its age in years. Timber obtained from this class of trees is extensively used in engineering works.
- Timber available from exogenous trees is further classified into two catagories;

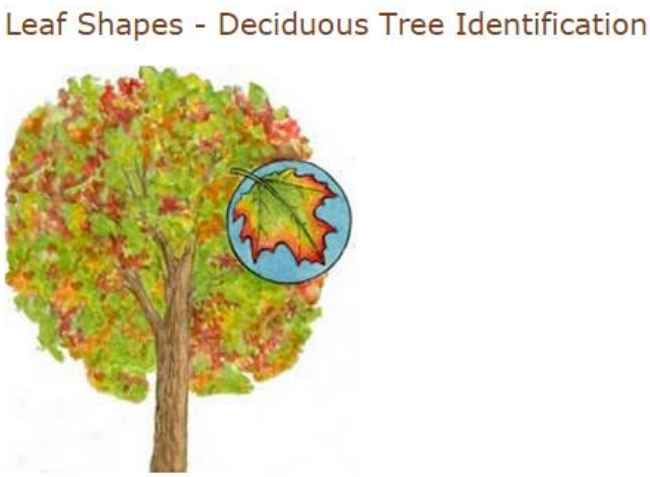
Classification of trees

- **Conifers or evergreens:** These are trees with pointed leaves yielding soft wood. Deodar, Pine, Chir belong to this class. They are well adapted to harsh climates, they often form the tree line on mountains and in subpolar (below the pole) regions.



Classification of trees

- **Deciduous:** These are trees with broad leaf, yielding hard wood. Teak(sagwan), shisham belong to this class.
- Broadleaved trees have mainly large flat leaves; in temperate zones, leaves usually fall as winter approaches.

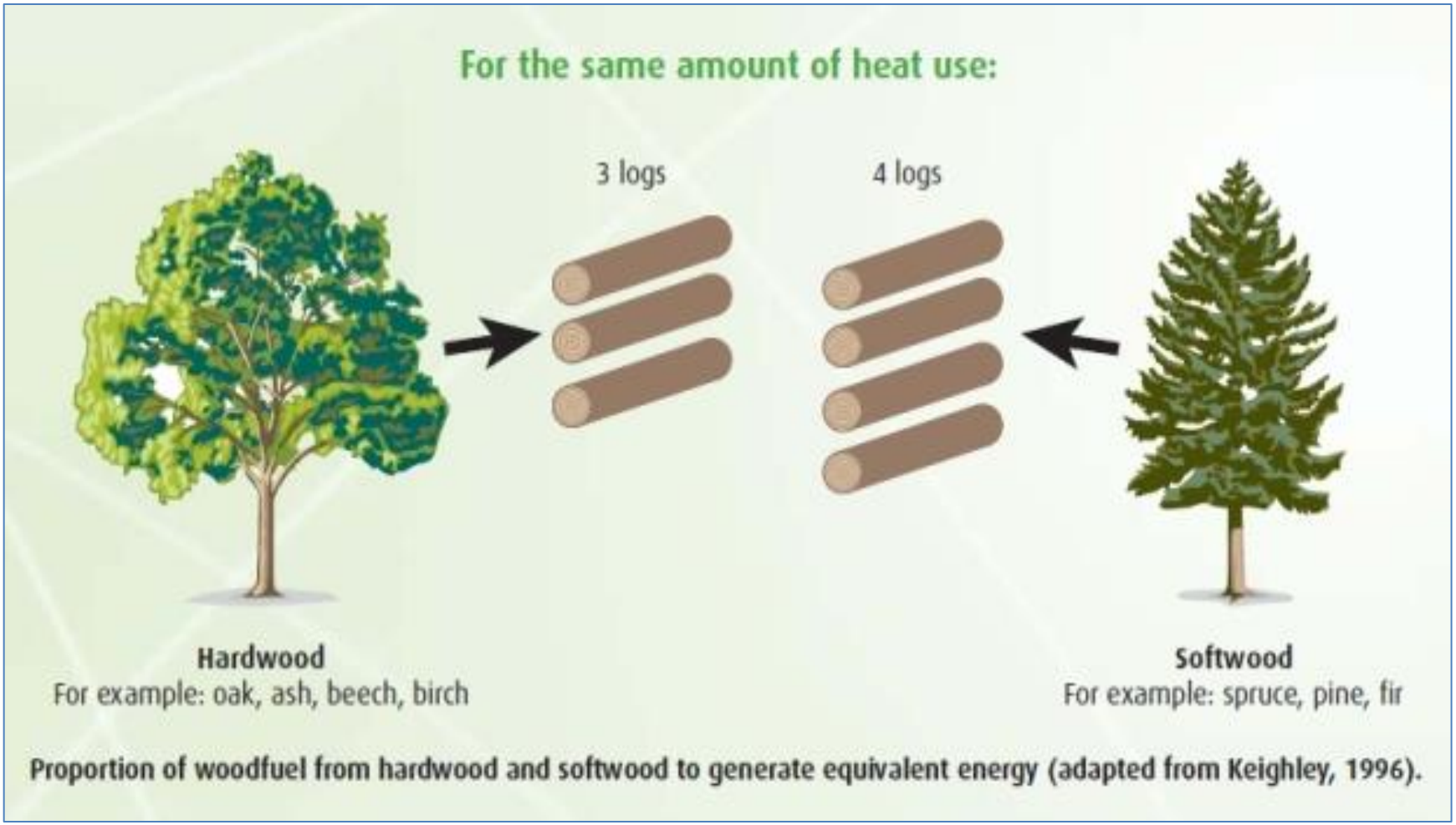


Types of wood

Softwood is wood obtained from Conifers. Soft wood is the source of about 80% of the world's production of timber like Pine, Ash, Beech etc

Hardwood is wood from deciduous and broad-leaf evergreen trees. Hardwoods all have enclosed nuts or seeds. Hardwood is in contrast to softwood which come from conifers and cone bearing seed plants. Hardwoods are not always harder than softwoods. Hardwoods have a more complex internal structure than softwoods. It is mostly solid wood fibers like hollow tubes (vessels) used to supply water to the tree. Softwoods have a structure that looks like many drinking straws bound together all of which are used to supply water to the tree. This give high heat compared to that by soft wood.

Basic difference: Soft and hard wood



Proportion of woodfuel from hardwood and softwood to generate equivalent energy (adapted from Keighley, 1996).

Difference between soft and hard wood

S.No.	*Property*	*Soft wood*	*Hard wood*
1.	Colour	Lighter	Darker
2.	Growth	Faster	Slower
3.	Weight	Lighter	Heavier
4.	Density	Low	High
5.	Annual rings	Distinct	Indistinct
6.	Heart wood and sap wood	Cannot be distinguished	Can be distinguished
7.	Strength	Strong along the grains	Strong along and across the grains
8.	Conversion	Easy	Difficult
9.	Resinous material	Exists in pores	Does not exist
10.	Examples	Chir, fir and others conifers	Teak, sal, sheesham, and other deciduous trees

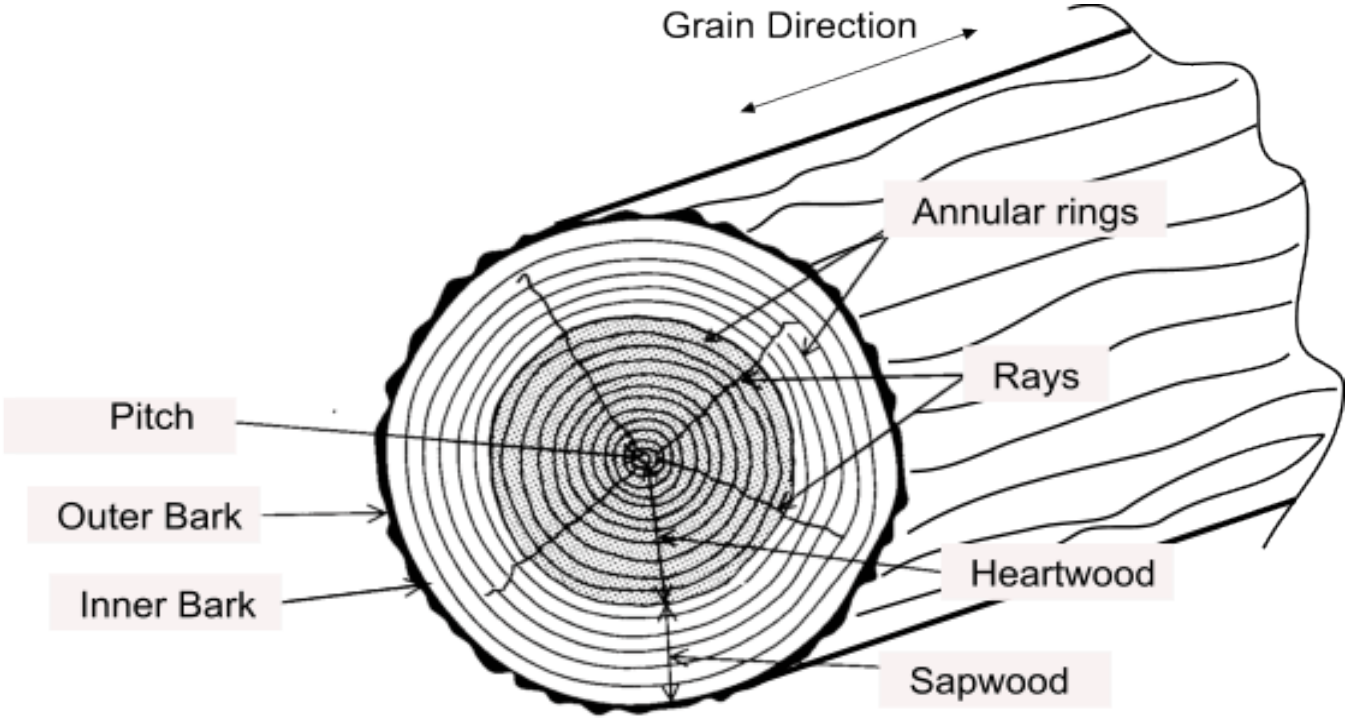
Usage of wood

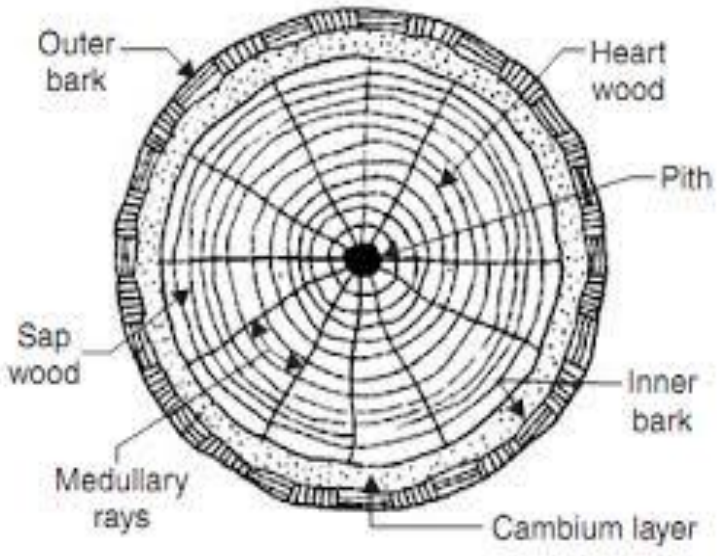
- In the form of piles, posts, beams, lintels, door/window frames etc
- For flooring, ceiling, paneling and construction of partition walls
- For form work for concrete, for the timbering of trenches, scaffolding, poles and fencing
- In building, and bridges
- In making furniture of agriculture implements, sports goods, musical instruments, well curbs, carts and carriages, railway sleepers, packing cases etc

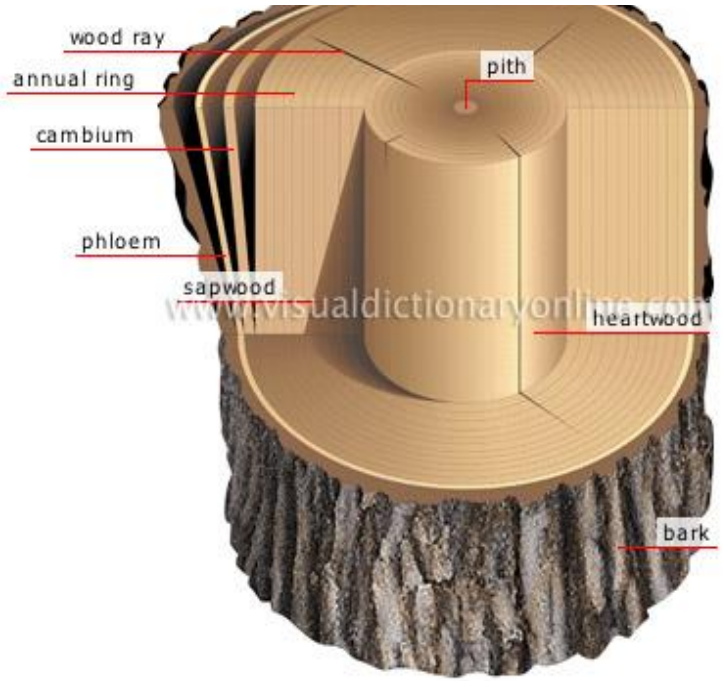
Growth of a tree

- In *spring* the roots of the tree suck sap as food from the soil which reaches the branches and the leaves. Sap contains moisture which gets evaporated. It absorbs carbon from air in presence of sunlight and becomes denser.
- In *autumn*, the sap descends and deposits in the form of a layer below the bark. This layer, referred to as the cambium layer, hardens and adds a layer of wood to the outside of tree every year in the form of concentric rings. These annual rings furnish valuable information regarding the age of the log, the rapidity and the uniformity of its growth. Medullary rays carry the sap from below the bark to the interior thereby nourishing the tree.

Structure of an exogenous tree







Description of different parts of the x-section

1. Pith: The inner most part of the tree. Varies in shape and size. It consists of cellular tissues and contains fluid to nourish the plant. The pith is the oldest part of exogenous tree and when the plant becomes old, the pith dies and becomes dark and woody fibers deposit about the pith.

2. Annual rings: Rings of woody fibers arranged in concentric circle around the pith

3. Heart Wood: The portion surrounding pith. Strong, compact, durable and dark in color. Heart wood is useful for several engineering purpose. The dead part of wood and consists of various annular rings.

4. Sap Wood: Next to heart wood is sap wood. Sap wood is instrumental in the growth of trees through permitting sap to move upward. Annual rings in sap wood are less sharply divided and light in color. Sap wood may also be referred to as “alburnum”.

Description of different parts of the x-section

5. Cambium Layer: This is the thin layer of fresh sap between the sap wood and the inner bark. The Cambium layer has sap which is not still converted into sap wood. If the bark is removed and Cambium layer exposed to atmosphere, the cells cease to be active and the tree dies.

6. Inner Bark: An inner skin of tree defending the cambium layer. It provides protection for the delicate and very important cambium layer.

7. Outer Bark: The outer skin of the tree made up of wood fibers. Sometimes it contains cracks and gaps.

8. Vascular (Medullary) Rays: Thin radial fibers extending from pith to cambium layer. They work together to hold the annular rings. In some of trees they are broken and some others are simply not prominent.

Characteristics of good timber

- It should be from the heart of a sound tree and be free from sap.
- It should have straight and close fibers.
- It should be of uniform color.
- It should give a clear ringing sound when struck. Dull heavy sound is a sign of internal decay.
- It should have regular annual rings.
- Timbers with narrow annual rings are generally the strongest.

Characteristics of good timber

- Freshly cut surface should give sweet smell.
- Teeth of saw should not get clogged while sawing.
- It should have bright and smooth surface when planed. Dull appearance is a sign of defective timber.
- Out of same variety of timber, darker and heavier pieces are stronger.
- It should be free from dead knots, from too many knots, shakes or other defects. It should have firm adhesion of fibers and compact medullary rays.

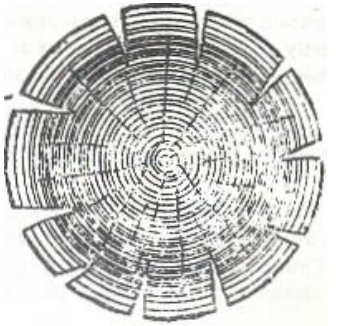
Defects in timber

These defects are mostly of two types:

- Those developed during the growth of tree and
- Those developed after the tree has been felled (diseases of tree)

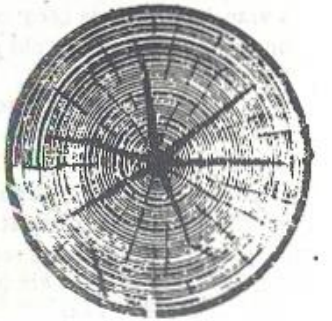
DEFECTS DEVELOPED DURING THE GROWTH OF TREE:

Star Shakes:



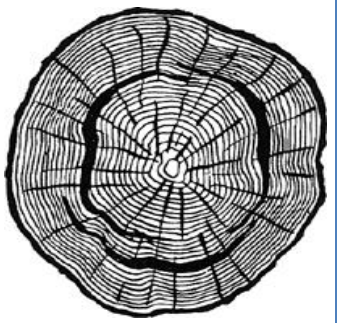
These are radial splits wider on the surface of the tree and becoming narrower as they move towards the center. They are caused by severe frost or by severe heat of the sun.

Heart Shakes:



These are wide splits running right through the heart wood of the tree. These splits radiate from the pith running towards the sapwood. These are caused by the shrinkage of parts or by decay because of accumulated mixture.

Cup Shakes / Ring Shakes:



These are curved splits separating one annual ring from the adjacent one either wholly or partly. These are caused by strong winds swaying the tree and by excessive frost action on the moisture present in the tree, especially while it is still young.

DEFECTS DEVELOPED DURING THE GROWTH OF TREE:

Twisted Fibers:

Fibers are twisted by strong winds turning the tree constantly in one direction. Trees in exposed positions or on hill tops are the most affected

Rind Galls:

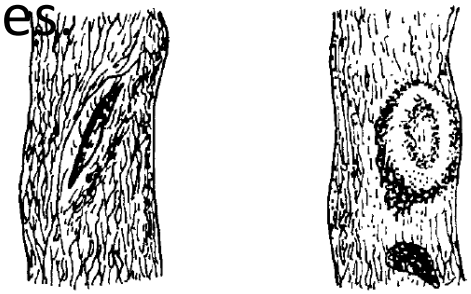
Peculiar swellings caused generally by the growth of layers of sapwood over wounds remaining after a branch of tree have been imperfectly cut off. These new layers do not unite properly with the old root thereby leaving cavities wherein the decay starts.

Upsets:

In this defect, during the growth of tree, fibers are sometimes injured due to crushing resulting in the breakage of continuity of fibers.

DEFECTS DEVELOPED DURING THE GROWTH OF TREE:

- **Knots:** A knot is either the root of a branch that is embedded in the stem with the formation of annual rings at right angle to those of the stem or the tissues set in elliptical or concentric circles.



These knots are of two classes:

(a) Dead or loose knot, (b) Live or sound knot

When the knot can be separated from the body of the wood it is known as **dead knot**. Because of the burning up or decay of outer tissues this type of knot becomes loose and falls out.

Live knots are firmly attached to timber and cannot be separate. It is hard to work upon a knot and it remains rough even after plaining. A live knot is not a serious defect. Only it reduces the strength of timber a little. It is hard to plane. Timber with too many knots or with loose knots should not be used for structural purposes

Defects developed after the tree has been felled or diseases of timber:

Dry Rot:

It is an attack of the timber by a fungus. The fungus reduces the timbers to a dry powder. Unseasoned timbers become an easy prey to the fungus. To prevent dry rot only well seasoned timber should be used. Also it should be ensured that the timber is used in such a manner that there is free access to fresh air to all parts of the timber.

Wet Rot.

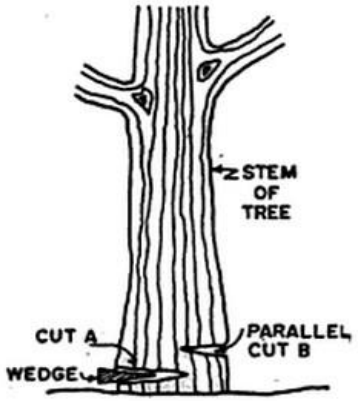
It is decay of timber due to alternate wetting and drying. In it there is no attack of any fungus. To prevent wet rot timber should be protected against alternate wetting and drying. It should be so used that either it is wholly submerged under water or it is always dry. For the latter condition timber should be fully seasoned and as a protection against moisture it should be painted.

Felling of tree

Only a fully grown tree should be felled because it then yields maximum and strongest timber. If felling is delayed then decay would set in the heart wood which is the best and the most important part of a tree. Early felling would give lesser quantity of timber which has not yet developed full strength.

As such a tree should always be felled only after it has fully matured but before the heart wood starts deteriorating.
The lower we go the more is the timber that the trunk of tree yields as such it would be wise to cut the tree from a place a little below the ground level but higher up than the roots.
Seasoning would be a problem if the tree is felled when the sap is moving. The tree should be felled when the sap has not started going up. Usually this condition is in summer season.

Process of felling of tree



- Determine the direction of felling.
- Make a cut at the lowest possible point of the trunk an extend it beyond the center of gravity of the x-section of tree, as shown at location A in Fig. This cut should be made on the side opposite to that on which it is desired to fell the tree.
- Make another parallel cut B, above the first cut, in the opposite direction of that cut.
- Tie the top of tree with ropes on all the four diametrically opposite sides.
- Pull the rope on the side the tree is to be felled loosening slowly the rope on the opposite side.
- The trunk of the tree will break at the level of cuts. Allow the tree to fall gently on the ground; otherwise it is likely to get damaged.
- After felling, chop off the branches and cut the log to the required sizes. Remove the bark and send the log for sawing as early as possible. Till then, care should be taken against any attack of fungi.

Seasoning of Timber

Timber cut from freshly felled trees is too wet for normal use and is dimensionally unsuitable. The strength, stiffness and dimensional stability of wood are related to its moisture content. Hence, if wood is dried (seasoned) before use, not only can higher strength values be used in a design, but a more durable structure will result.

Seasoning is the process of reducing the moisture content (drying) of timber in order to prevent the timber from possible fermentation and making it suitable for use. It can also be defined as the process of drying the wood to a moisture content approximately equal to the average humidity of the surroundings, where it is to be permanently fixed. Very rapid seasoning after removal of bark should be avoided since it causes case hardening and thus increases resistance to penetration of preservatives.

Seasoning of Timber

Timber must be stacked, supported and sometimes restrained so as to minimize distortion during seasoning. If drying is too rapid, the outer parts, in particular the unprotected ends, shrink before the interior does, and this leads to surface checking and splitting, as well as the possible extension of ring and heart shakes. Some timber species are more difficult to season satisfactorily than others.

Some of the **objects of seasoning** wood are as follows:

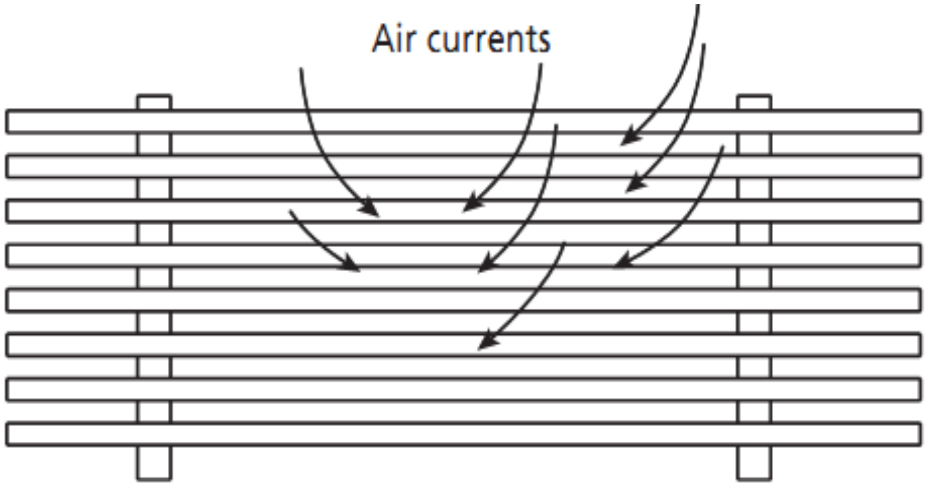
1. Reduce the shrinkage and warping after placement in structure.
2. Increase strength, durability and workability.
3. Reduce its tendency to split and decay.
4. Make it suitable for painting.
5. Reduce its weight.

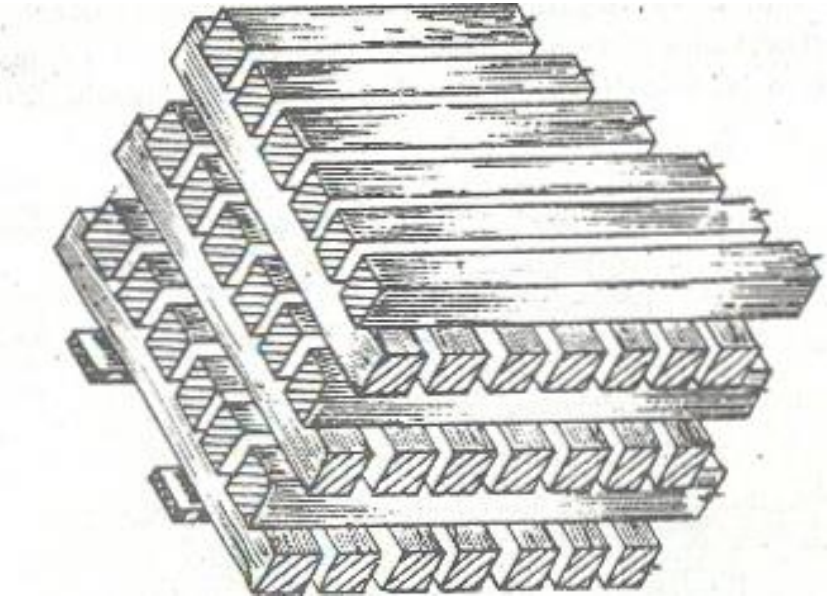
Air or Natural seasoning

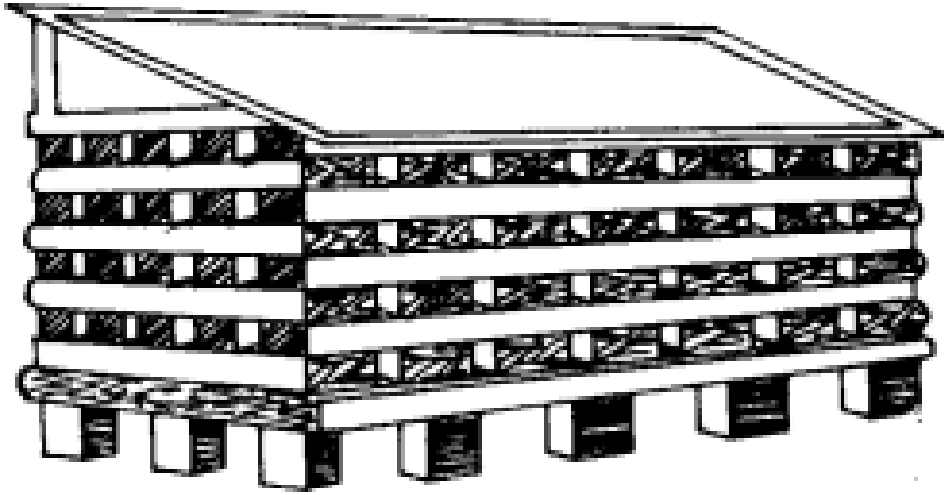
As soon as possible after felling, the log is converted by sawing it into battens and planks etc. These are then stacked on a well drained place in the shade. While stacking care should be taken to ensure free circulation of fresh air all around each piece. The stacking should be done on masonry or concrete supports a few centimeters above the ground.

Care should be taken not to expose the freshly converted timber stacked for seasoning to severe winds or to sun. This process of seasoning timber is the best as it gives very strong and durable timber, but it is extremely slow. It takes more than six months for timber to season in moderate climates.

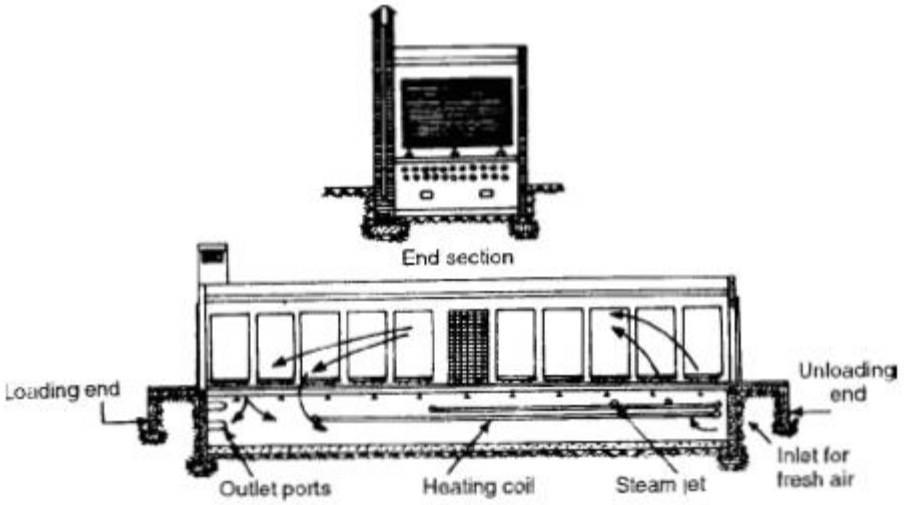
Different arrangements for air seasoning







Shed for Air Seasoning of Timber



Progressive Kiln

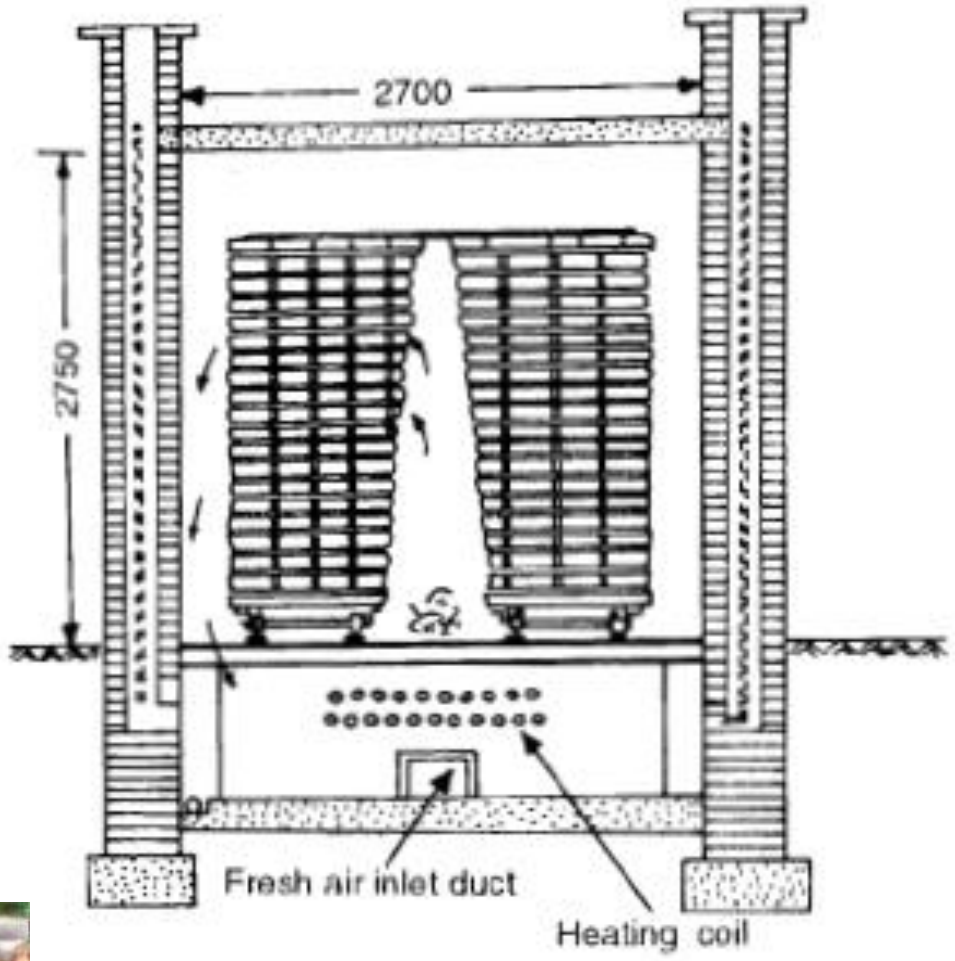
Kiln or Artificial seasoning

Artificial method of seasoning or kiln seasoning speeds up the seasoning process. For large scale production of seasoned timber kiln seasoning is a must.

Kiln seasoning is done in a chamber equipped with arrangements for heating and humidifying the air to required conditions of relative humidity and temperature and for its circulation across the timber stacked in the chamber for seasoning. Usually, it is steam that is used for heating and humidifying the air in the kiln. The seasoning of the timber is started at a comparatively lower temperature and high humidity. As the timber dries these conditions are gradually altered until at the end of the seasoning. The temperature of the air inside the chamber is fairly high and the humidity is low. The kiln charge is allowed to cool inside the kiln to within 15 to 20°C of the outside temperature before removal. Seasoning of timber by this method takes about four to five days under normal conditions.

Kiln seasoning

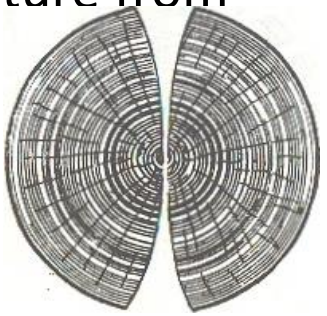
Compartment kiln



Seasoned and Unseasoned Timber

NATURAL WOOD SEASONING

Sawing of timber



After felling if the logs are not cut then because of drying of moisture from outer ring, outer rings shrink without an proportionate corresponding shrinkage of the central portion. As in an uncut log shrinkage takes place in circumferential direction so it results in star shakes (cracks on the surface of log narrowing as they move inwards). Such logs should be converted as soon as possible after felling as greater area of timber gets exposed to air for drying.

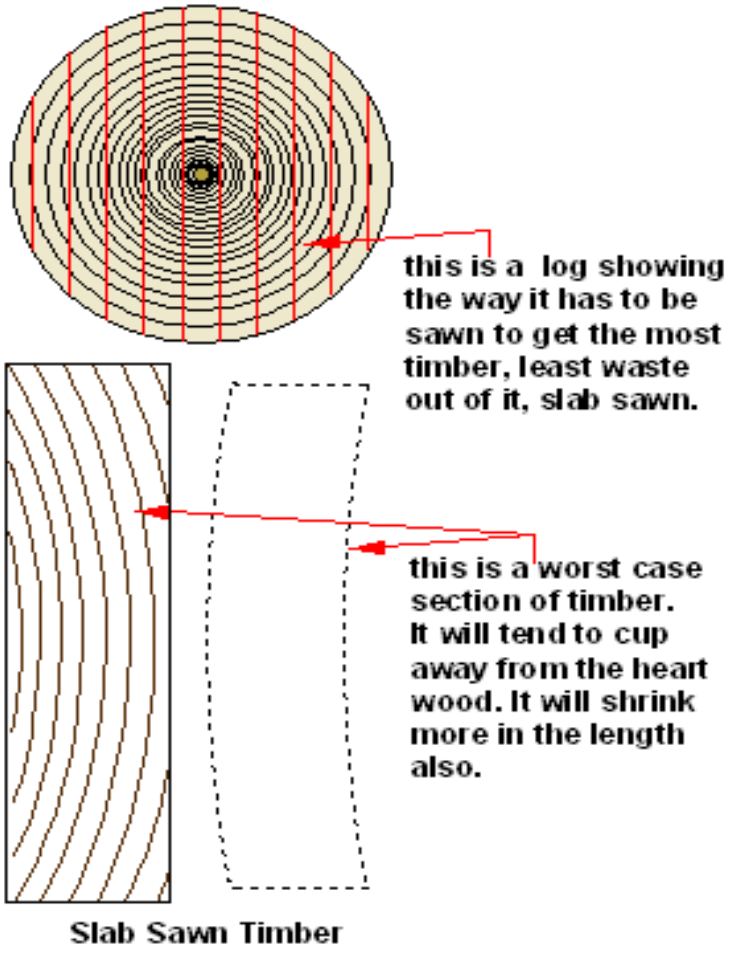
Ordinary or Flat Sawing:

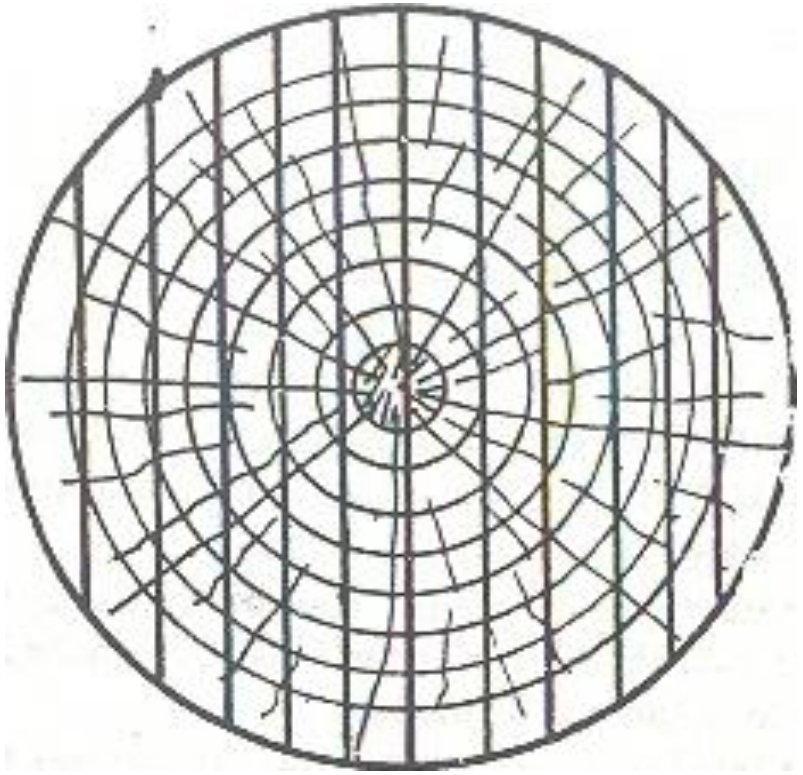
This is not only the easiest method of sawing timber but it is also the most economical one so far as the out turn is concerned. In it only parallel cuts are made-throughout the length of the log, thereby cutting parallel slices of planks. Circumferential shrinkage is the greatest and the sapwood shrinks more than the central heart wood portion. The thickness at the centre, therefore, remains almost unaltered while the sapwood shrinks causing warping and twisting of planks

MANUFACTURING PLYWOOD BOARDS

British Columbia, Canada, 1954

Ordinary, through and through sawing



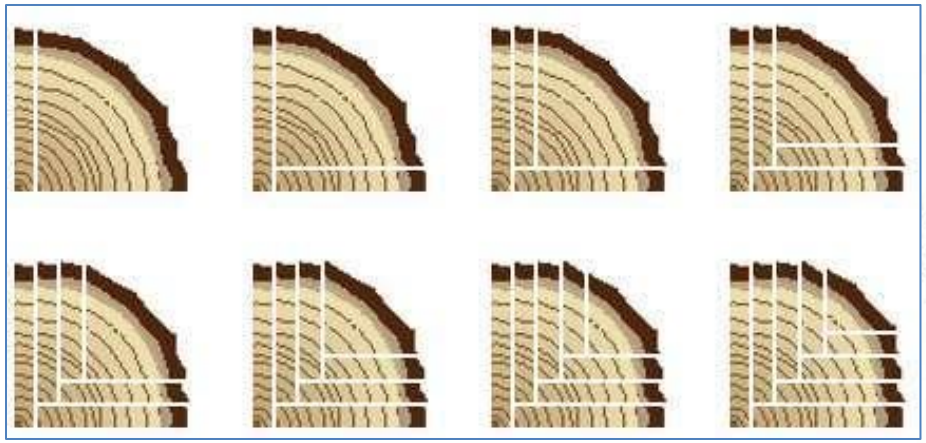


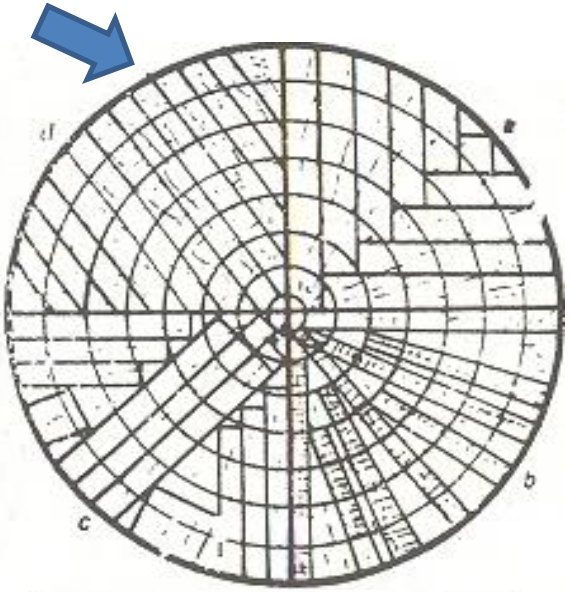
FRANK MILLER™

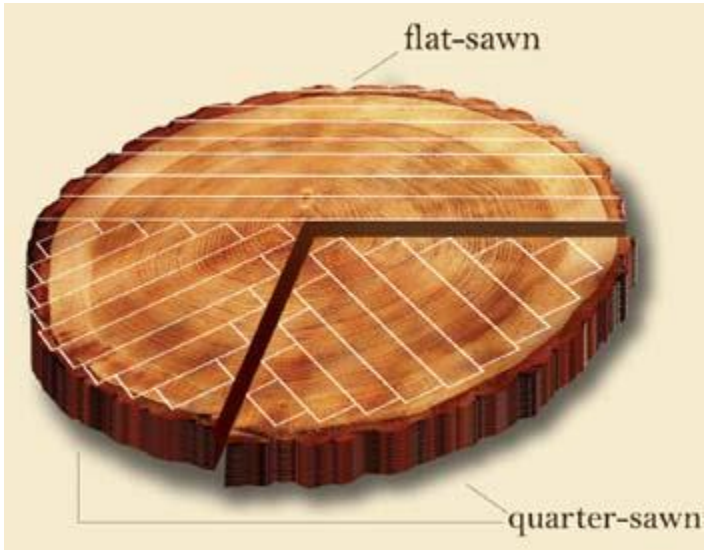
Quartersawn Hardwood

Quarter Sawing:

In this method, there is a tendency for the timber to cut off to bend in a transverse direction. This method of sawing gives very fine figure wood when adopted in case of timber having no distinct medullary rays (a)



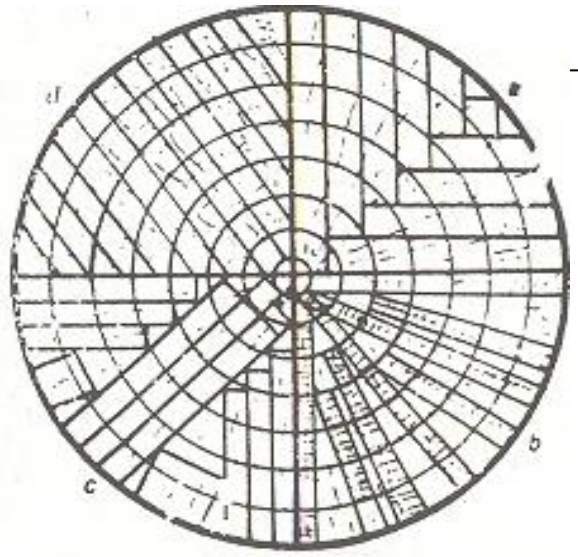




Rift or Radial sawing

Timber sawn according to this method is cut parallel to medullary rays and perpendicular to annual rings. This method gives least shrinkage but it is most wasteful (b). Hence, method known as **limited rift** is adopted (c).

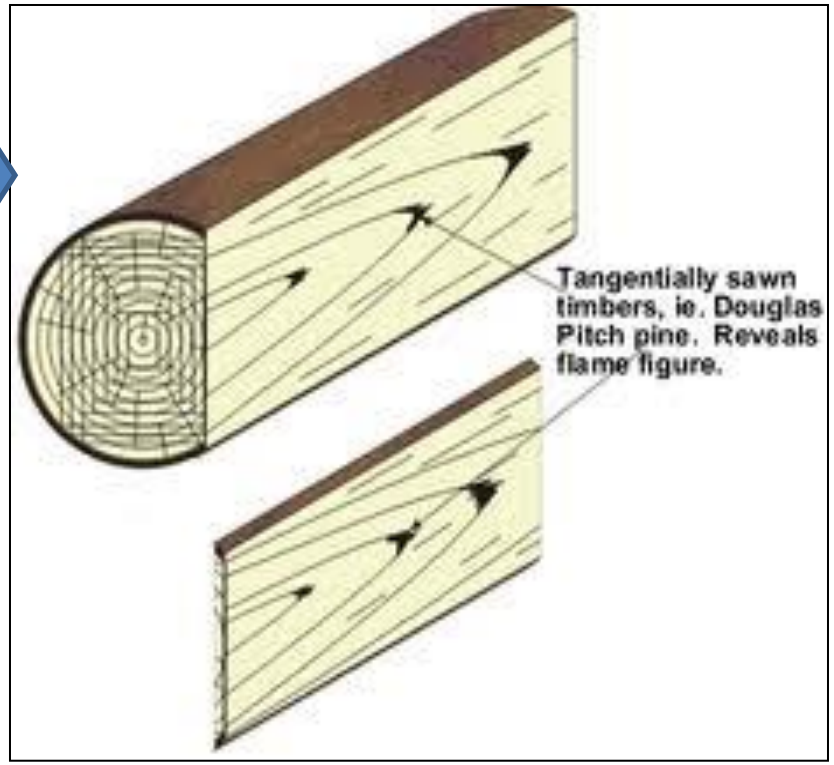
This method gives greater decorative effect of figuring in woods in which the medullary rays are most marked. This method is adopted when medullary rays are pronounced. Medullary rays have the property of resisting shrinkage. As such, rift sawn planks shrink by about one half of those cut tangentially due to the restraining action of the medullary rays, i.e. positions subject to abrasive action as in floors the rift sawn timber gives a harder wearing surface than the other ones. Timber sawn as in (d) reduces wastage but gives, a little inferior timber.

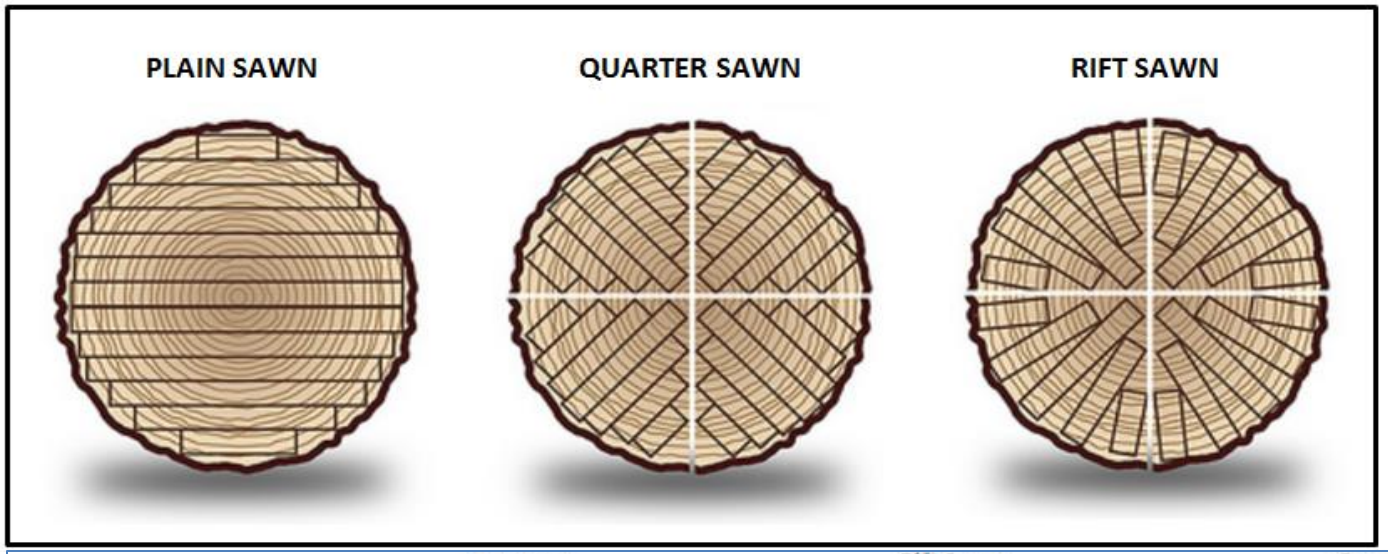


Sawing of timber

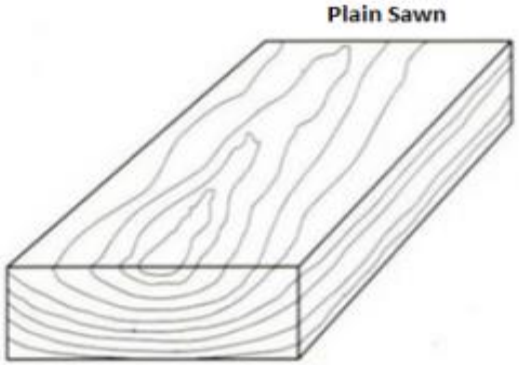
Tangential Sawing.

In this method boards or planks are sawn tangentially to annual rings but such boards are not very suitable for flooring. Planks obtained by this method of sawing warp too much. This method is adopted when the annual rings are very distinct and the medullary rays are ill defined.

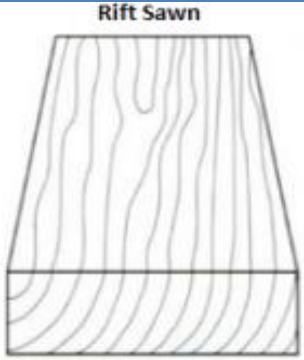




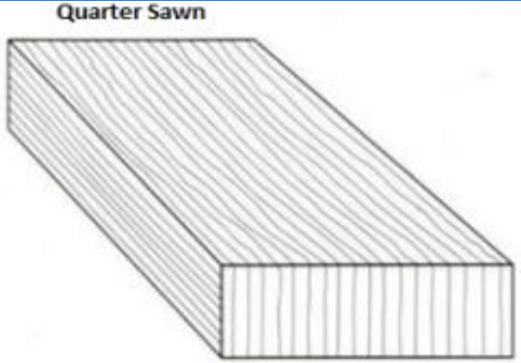
Different methods



Tangential Grain



60° Grain



Radial Grain (90°)

Plain Sawn Oak Timber Flooring

Rift Sawn Oak Timber Flooring

Quarter Sawn Oak Timber Flooring

PRESERVATION OF TIMBER

Timber has to be protected from the attack of insects *e.g.* white ants etc., and from internal decay due to dry and wet rots, Perfect seasoning is the most effective means of preservation. Timber should be so used that either it is wholly dry and well ventilated or is wholly under water. It will not decay when kept under water but it will become soft and weak. Proper damp proofing of the building and providing free circulation of air around the built-in portions of timber is essential for the preservation of the timber used. However, when these conditions cannot be obtained then preservatives have to be applied for preservation. Timber should be well seasoned before the application of preservatives as otherwise the preservatives would block the pores of timber thereby causing its decay due to the entrapped moisture. When used in masonry, direct contact with lime mortar should be avoided.

Methods of preservation of timber

Charring; Lower ends of the posts that are to be embedded in ground arc generally charred with a view to prevent dry rot and attack of worms. It is done by quenching the ends of posts in water after they are charred on wood fire to a depth of 1.5 cm.

Tarring; It consists in coating with tar or tar mixed with pitch. Embedded portions of timber fence posts, ends of door and window frames, battens and beams built in wall are usually tarred. Tarring is not done in case of those portions of structural members that are open to view, because of unsightly black colour.

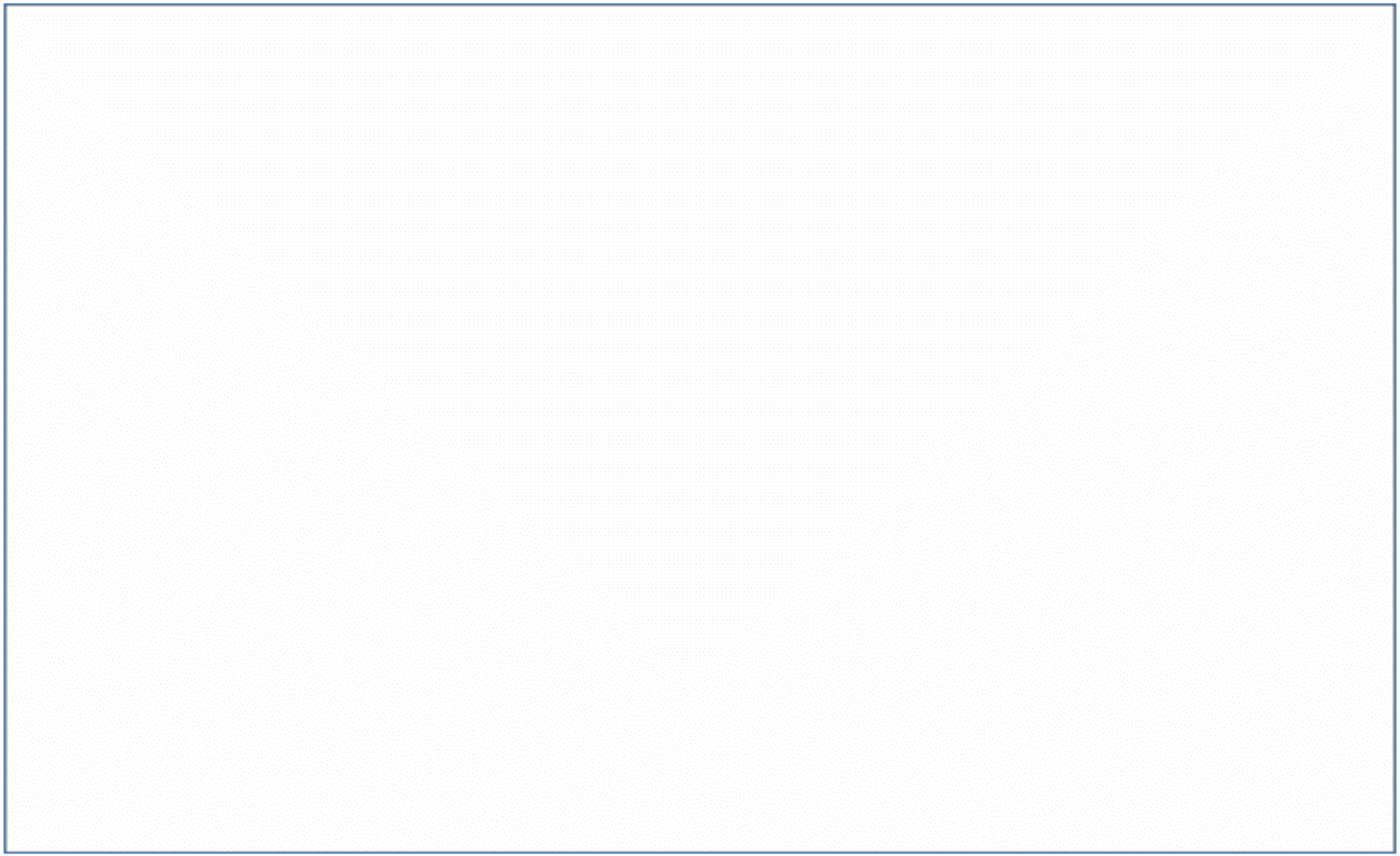
Painting; Paint when applied to timber acts not only as a good preservative but also it enhances the appearance of the surface so treated. Only well seasoned timber should be painted as otherwise the moisture entrapped in the timber, because of the closing of timber pores by paint, would cause decay. Paint, however, protects seasoned timber against moisture thereby prolonging its life.

Methods of preservation of timber

Creosoting; Creosote oil is a dark brown thick oily liquid. Thoroughly seasoned timber dried for 24 hours before its treatment is placed in an airtight chamber. After the air has been exhausted from this chamber the creosote oil is then pumped in at a pressure of 9 kg/cm^2 at a temperatup of 50°C so long as the timber is not fully saturated with oil. The oil preserves the timber from rot and from the attacks of white ant. It is used in case of railway sleepers, piles and transmission poles. Undesirable colour and smell, inability to take paint well and the tendency to stain plaster limit its use.

Wolman salt; This salt consists of creosote and sodium flouride and is soluble in water. It is odourless and leaves no stain on wood. After treatment timber could be painted or varnished. These salts destroy many kinds of fungi that cause timber to rot. This renders the timber extremely fire resistant too.Treatment of timber with zinc chloride, sodium flouride, magnesium, silico flouride or copper sulphate renders the timber immune from the attacks of fungi. The timber so treated is capable of being painted on drying.

Preservation of timber



Methods of preservation of timber

Fire proofing of timber;

Timber cannot be made completely fireproof; however, by treating as below it can be made fire resistant to a sufficient extent.

Soaking timber in amonium sulphate, amonium chloride, amonia phosphate, sodium arsenate, Zinc chloride, etc. or spraying on timber, a solution of sodium silicate, potasium silicate or amonia phosphate etc., imparts fire resisting properties.

Abel's methods of fire proofing timber is painting the surface firs with a dilute solution of sodium silicate **(Na_2 SiO_3)** then with a cream-like paste of slaked fat lime and in the end with a concentrated solution of silicate of soda.

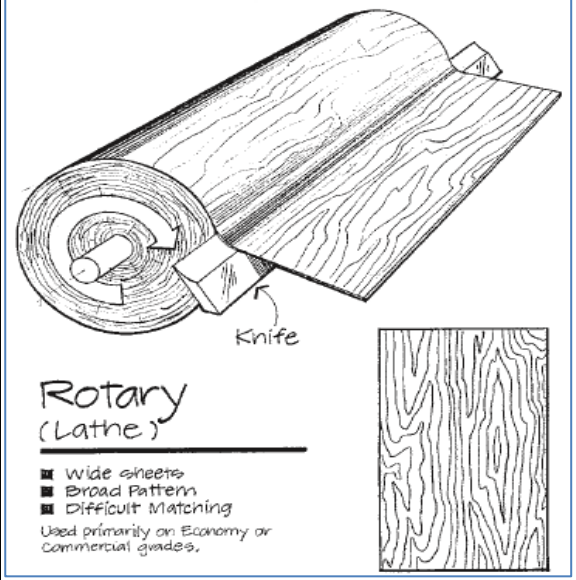
Wood based products

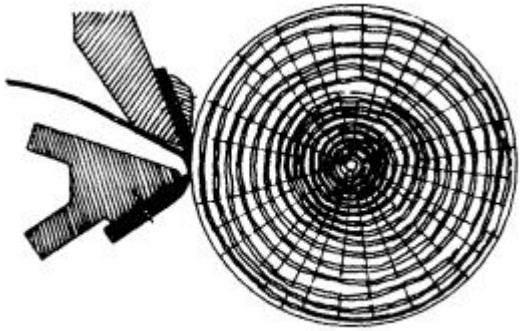
Veneers are those thin sheets of wood that are peeled off, sliced or sawn from a log of wood having attractive and artistic arrangement of grains. Logs of wood are converted into veneers by either *rotary veneer cutters* or by veneer slicing machines .

Thickness of these sheets varies from 0.4 mm to 6 mm. These veneers are then glued to inferior timber surfaces to improve the appearance and to form decorative and artistic designs.

Veneers should be dried carefully. Veneers are used in the manufacture of plywood, lamin boards and battern boards. Walnut, teak and rose wood are the timbers commonly used for conversion into veneers.

Veneers



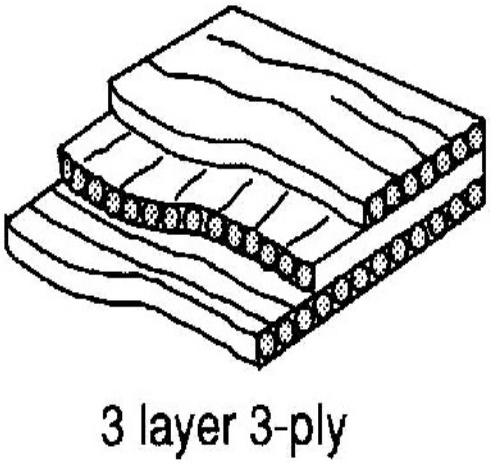


Rotary Cutting

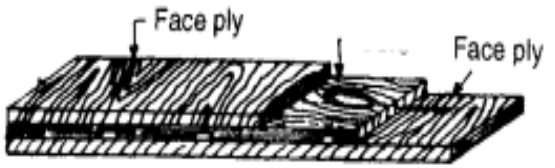
Wood based products

PLYWOOD

Veneers used for making plywoods are known as plies and plywoods are made by glueing together plies in *odd numbers.* Glueing is done under pressure. These are usually three ply, five ply or seven ply depending upon the number of plies used. Plywoods with more than three plies are known as multi-plies. Odd number of plies is used so that shrinkage stresses are symmetric about the middle ply and warping tendency is minimised. Outside plies are known as *face plies or face.* Plies are arranged so that the grain of one layer is at right angles to the grain of an adjacent layer.The thinner the plies the more homogeneous the- plywood shall be in its elastic properties. Use of better glue increases the strength of plywood. Plywoods are generally available up to 1.5 metre in width and 3.4 metre in length. They generally do not crack or split easily if not exposed to rain or to sun. Thickness of plywood varies from 3 mm to 6 mm.



3 layer 3-ply



Plywood

Ply manufacturing

Advantages of plywood

It gives better appearance.
It is stronger. A three-ply board is three times as strong as a solid board of same thickness.
It can be easily bent to give any shape.
It is an elastic material and is not very much affected by climatic changes.
It gives uniform tensile strength in all directions.
It is available in such large sizes that are not possible with solid boards.
Shrinkage and expansion of best grade plywood is almost negligible. *It is due to its cross grained nature.*
Because of its cross grained nature plywood does not split when nailed near edges.
Uses. It is used for covering or panelling walls, for doors, furniture and shuttering in R.C.C. The cheaper varieties are used for making packages.

Wood based products

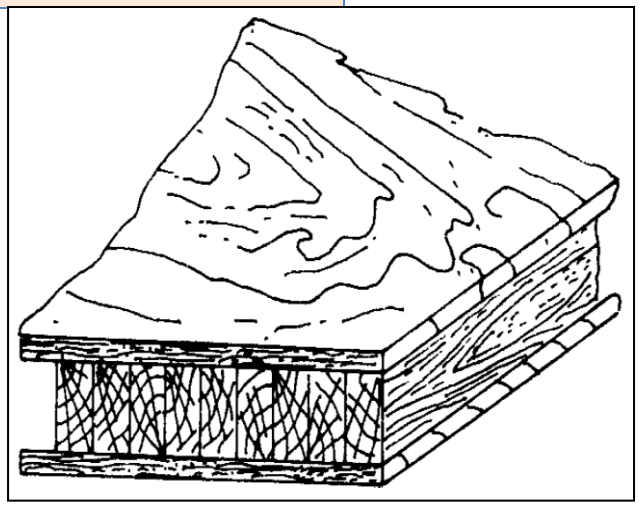
Lamin (lamina) board consists of a core built up of laminae not more than 8 mm wide and glued between two or more plies.

Grains of core laminae should be at right angles to those of outer plies. These are pressed into sheets 1 cm to 5 cm thick.

These boards are available up to 1.5 metres in width and 2.5 to 3 metres in length. These are light and strong and do not crack or split easily.

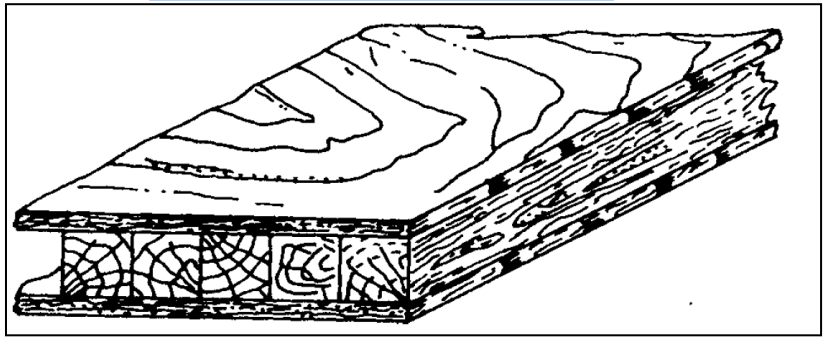
These are used for the construction of partition walls, packing cases, ceilings, furniture and doors etc.

Lamin board



Wood based products

BLOCK BOARDS



These are similar to lamin boards. The core is built up of blocks not exceeding 2.5 cm wide and glued between two or more outer plies.

Direction of grains of the core is at right angles to that of outer plies.

These are cheaper than lamin boards and are used for partition walls and doors etc. Usual thicknesses are 12 mm to 50 mm; lengths from 1.2 m to 2.4 m and widths from 0.9 m to 1.2 m.

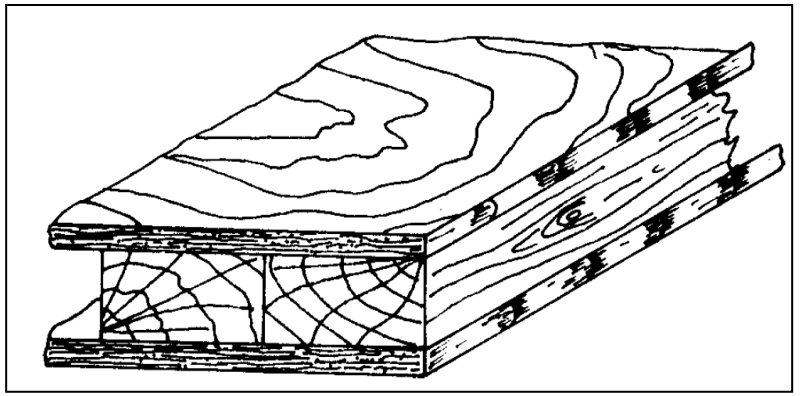
Wood based products

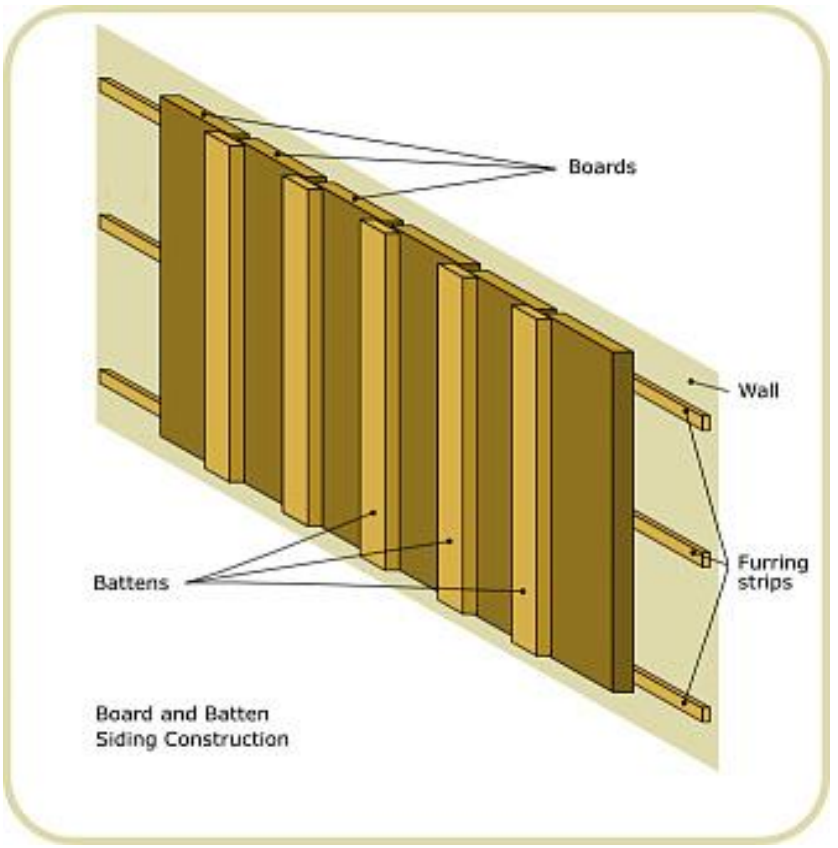
BATTEN BOARDS

Batten boards are similar to the block boards. In it the core consists of close grained battens not more than 8 cm in width, 2 to 3 cm thick and are edge-glued between two or more outer plies.

Direction of the grains of the core battens is at right angles to that of the adjacent outer ply sheets. These are light and strong and do not crack or split easily.

They are widely used for making partition walls, ceilings, packing cases and leaves of doors and windows etc.





Wood based products

HARD BOARDS

These are manufactured from wood wastes obtained from saw mills, inferior timber or short logs etc. With machines the raw material is converted into chips which are then softened with steam and converted into fibers. Water repellents and synthetic resins are added to increase the strength. These are then pressed into boards of uniform thickness in hydraulic presses.

Other materials may be added during manufacture to improve certain of its properties. Many species of wood are used, depending upon their availability.

HARD BOARDS

Wood based products

Tempered hard board

It is made from standard hard board by the addition of certain chemicals and further heat treatment to increase its strength, abrasion resistance and decrease its rate of water absorption.Hard boards are manufactured with both surfaces smooth or one surface smooth and the other with a screen back, or reverse impression of a screen. It is also available with special finishes such as grooved, embossed, or marked into tiles. The natural colour varies from blond to dark brown.Width of sheets is usually 1.25 metre but even 1.75 metre wide sheets too are available. The maximum length is 4.75 metres. The thickness varies from 2 mm to 20 mm.

Hard board is used for interior and exterior wall panels; ceilings, siding, table and counter tops and many other purposes.

Advantages of hard board

Hard Boards have the following advantages *vis-a-vis* sawn wood:

Unlike sawn wood these can be made of any sizes needed.
As these are homogeneous so their strength is uniform in all directions.

These are free from natural defects of timber like shakes and knots etc.

Based on the requirements these can be had with suitable finishes like embossed, pre-perforated, wood grained, plastic faced, veneer finished or enameled etc.

Tempered hard board