TIMBER

DEFINITION

Wood suitable for building or other engineering purposes is called 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.

CLASSIFICATION OF TREES

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

(a) Endogenous, and (b) Exogenous

(a) 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.

(b) Exogenous trees: 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 as:

- **Conifers or evergreens:** These are trees with pointed leaves yielding soft wood. Deodar, Pine, Chir and Kaii belong to this class.
- **Deciduous:** These are trees with broad leaf, yielding hard wood. Teak; sal, shisham belong to this class.

GROWTH OF TREE

In spring season roots of the tree suck a solution of salts from the soil—salts that are food for the tree and transmit the same through the trunk of tree to its branches and leaves. This solution of salts loses some of the moisture because of evaporation and absorbs carbon dioxide from the air. This action in the presence of sun makes the solution a bit viscous. This transformed viscous solution is known as *sap*.

In autumn viscous sap descends below the bark and leaves a thick layer. Layer of sap left below the bark gets transformed to wood and is known as *cambium layer*. It goes on gaining strength with the passage of time. A fresh layer is thus added on the outside of the tree every year forming

a new annual ring. The new ring represents a year's growth of tree. Medullary rays carry the sap from below the bark to the interior thereby nourishing the tree.

STRUCTURE OF TREE

On examining the cross section of the trunk of an exogenous tree, we see the different parts as shown in Fig. A brief description of each part is discussed separately.

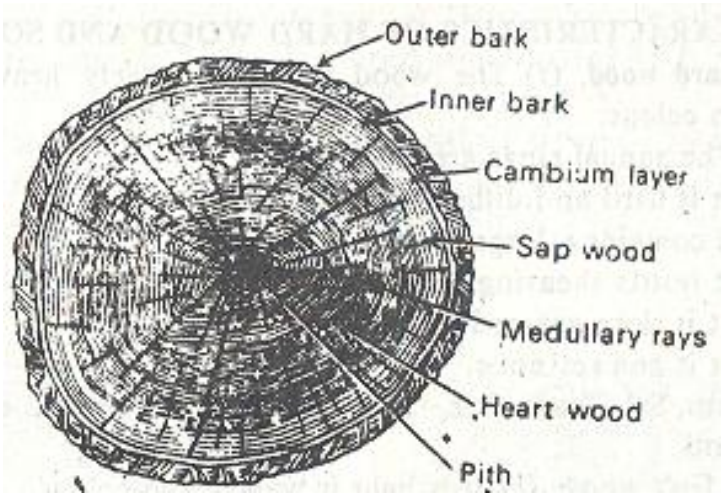


Figure: Structure of an exogenous tree

- **Pith or Medulla:**

  It is the first formed portion of the stem of tree. It consists entirely of cellular tissues. The pith, which when the plant is young, contains a large amount of fluid and nourishes the plant. It dies up and decays when the plant becomes old. Sap is then transmitted by the woody fibers that deposit about the pith. Pith of branches is a mere prolongation of the pith of stem.

- **Annual Rings:**

  The rings of woody fiber arranged in concentric circle around the pith are known as annual rings because one such ring is added every year.

- **Heart Wood:**

  Innermost rings surrounding the pith constitute the heart wood. This wood is darker in colour, stronger, more compact and durable.

- **Sap Wood:**

  Outer annual rings of the tree constitute the sap wood which transmits the sap from roots to branches. Compared with heart wood, sap wood is lighter in colour, weaker and more liable to decay.

- **Cambium Layer:**

  Outermost one ring between the bark and sap wood which is not yet converted into wood is known as the cambium layer. In due course, cambium layer changes to sapwood. If the cambium layer is exposed by removing the bark, the cells cease-to be active and results in death of tree.

- **Medullary Rays:**

These are thin horizontal veins radiating from the pith towards the bark. They carry sap from outside to the inner parts of tree and nourish it. They keep the annual rings tightly gripped together. In some trees they might be found broken or may not even be clearly visible.

- **Bark:**

It is outermost protective covering of cells and woody fibers on a tree. In course of time older layers split and scale off.

CHARACTERISTICS OF GOOD TIMBER

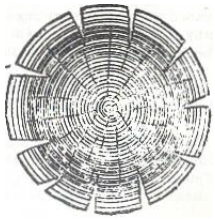
1) It should be from the heart, of a sound tree and be free from sap.
2) It should have straight and close fibers.
3) It should be of uniform color.
4) It should give a clear ringing sound when struck. Dull heavy sound is a sign of internal decay.
5) It should have regular annual rings.
6) Timbers with narrow annual rings are generally the strongest.
7) Freshly cut surface should give sweet smell.
8) Teeth of saw should not get clogged while sawing.
9) It should have bright and smooth surface when planed. Dull appearance is a sign of defective timber.
10) Out of same variety of timber, darker and heavier pieces are stronger.
11) 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: (a) Those developed during the growth of tree and (b) Those developed after the tree has been felled.

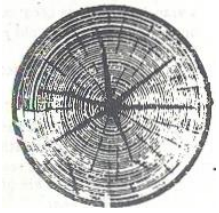
DEFECTS DEVELOPED DURING THE GROWTH OF TREE:

(i) Star Shakes:



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

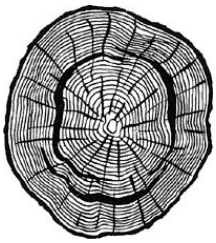
(ii) Heart Shakes:



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 interior parts or by decay because of

accumulated mixture.

(iii) Cup Shakes / Ring Shakes:

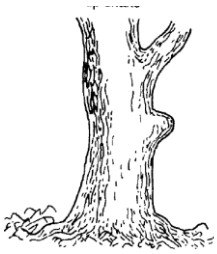


These are curved splits separating one annual ring from the adjacent one either wholly or partly. These are caused by strong winds swaying the tree and by excessive frost action on the moisture present in the tree, especially while it is still young.

(iv) Twisted Fibers:

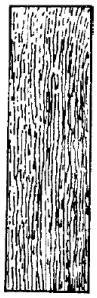
Fibers are twisted by strong winds turning the tree constantly in one direction. Trees in exposed positions or on hill tops are the most affected

(v) Rind Galls:



These are 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.

(vi) Upsets:



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

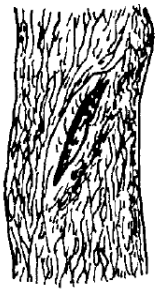
(vii) Knots:

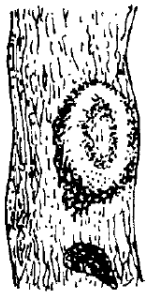
A knot is either the root of a branch that is embedded in the stem with the formation of annual rings at right angle to those of the stem or the tissues set in elliptical or concentric circles. These knots are of two classes:

(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 planing. 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.

(viii) Foxiness:

Presence of reddish or yellowish stains shows the beginning of decay in timber because of bad ventilation during storage.

(ix) Coarse Grains:

Timber having very wide annual rings because of rapid growth of trees are said to have coarse grains. The wood is not durable and is deficient in strength.

DEFECTS DEVELOPED AFTER THE TREE HAS BEEN FELLED OR DISEASES OF TIMBER.

(i) 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.

(ii) 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.

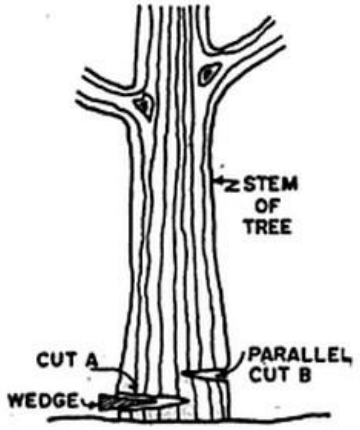
As such a tree should always be felled only after it has fully matured but before the heart wood starts deteriorating.

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.

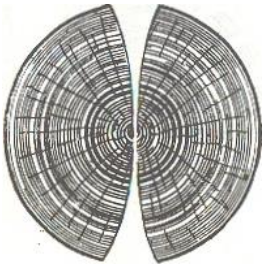
PROCESS OF FELLING

1. Determine the direction of felling.
2. Make a cut at the lowest possible point of the trunk and extend it beyond the center of gravity of the cross-section of the 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.



3. Make another parallel cut B, above the first cut, in the opposite direction of that cut.
4. Tie the top of tree with ropes on all the four diametrically opposite sides.
5. Pull the rope on the side the tree is to be felled loosening slowly the rope on the opposite side.
6. 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.
7. 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.

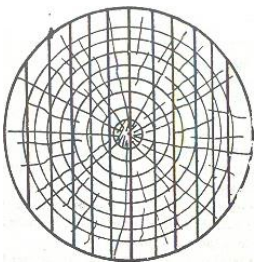
SAWING OF TIMBER



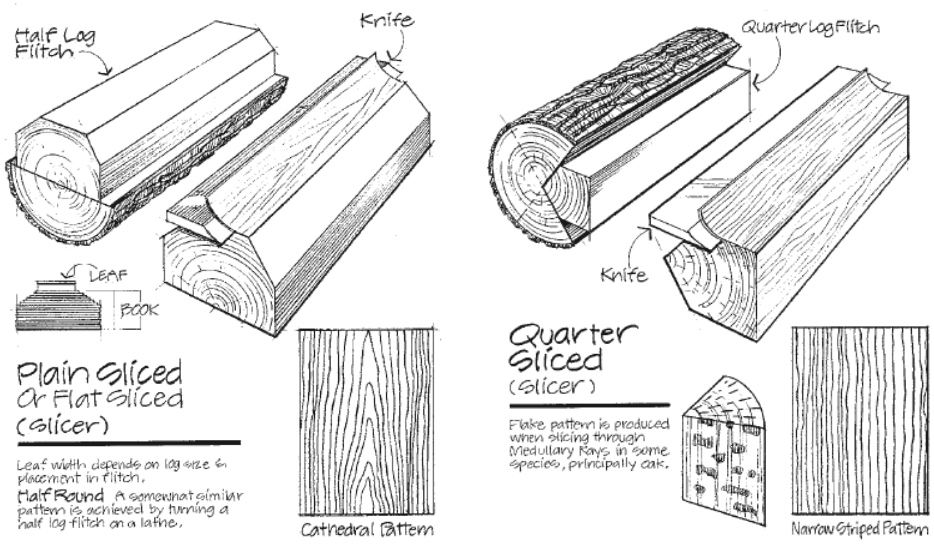
After felling if the logs are not cut then because of drying of moisture from outer ring, outer rings shrink without a proportionate corresponding shrinkage of the central portion. As in an uncut log shrinkage takes place in circumferential direction so it results in star shakes (cracks on the surface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

Methods commonly adopted for the conversion of timber are:

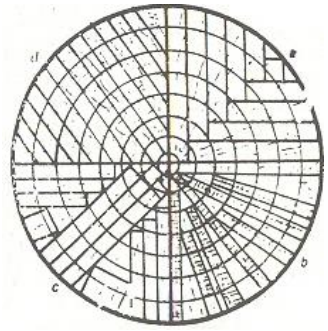
(i) Ordinary or Flat Sawing:



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 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.

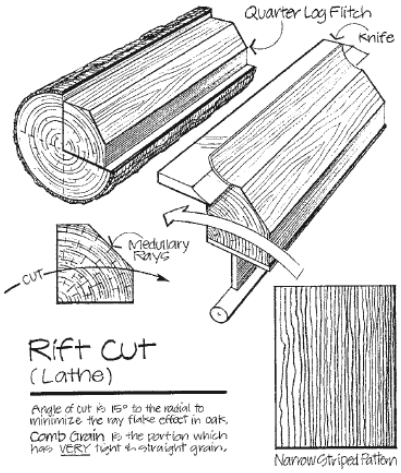


(ii) Quarter Sawing:



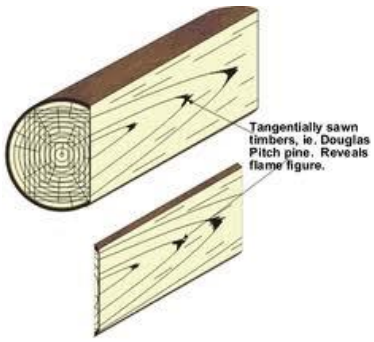
In this method, there is a tendency for the timber to cut off to bend in a transverse direction. This method of sawing gives very fine figure wood when adopted in case of timber having no distinct medullary rays. (a)

(iii) 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.

(iv) 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.

SEASONING OF TIMBER

Newly felled tree contains a considerable quantity of sap. If this sap is not removed the timber is likely to warp, crack and shrink. It may even decay. The art of seasoning is to extract the moisture under controlled conditions as nearly as possible at a uniform rate from all parts of timber and to leave the remaining, moisture, that cannot be extracted, uniformly distributed throughout the mass. Irregular drying will cause irregular shrinkage resulting in the setting up of internal stresses between the fibers. When these stresses become strong enough to overcome the cohesion of the fibers then the timber warps and shakes are formed.

OBJECTS OF SEASONING

(i) Wet timber is an easy prey to decay by fungi, borers, termites etc. Seasoning thus makes timber resistant to decay.

(ii) Seasoning makes timber lighter.

(iii) It becomes easier to paint and polish seasoned limber.

(iv) It is easier to treat seasoned timber with preservatives.

(v) Seasoned timber becomes stronger and more stable.

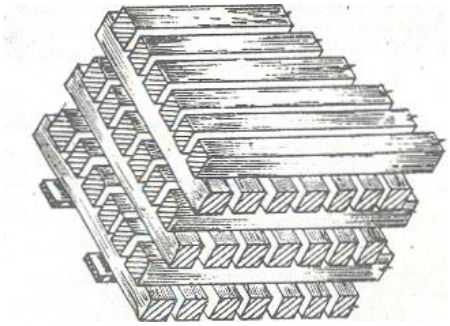
(vi) Seasoning stops shrinkage of timber on drying.

(vii) Seasoned timber has better electrical resistance.

METHODS OF SEASONING OF TIMBER

- **AIR SEASONING 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.



- **KILN SEASONING 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.

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. Following are some of the more common methods of preservation adopted:

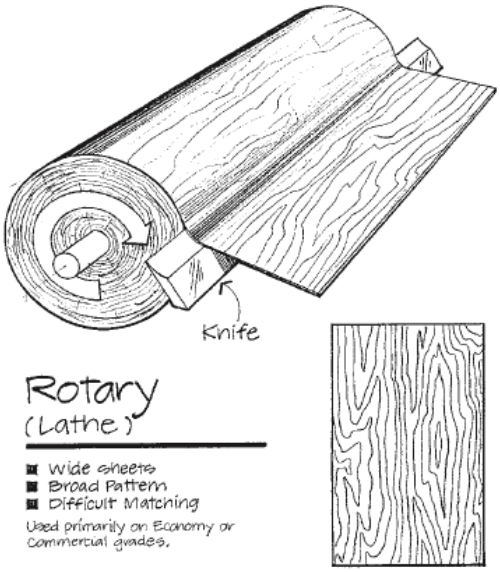
- **Charring;** Lower ends of the posts that are to be embedded in ground arc generally charred with a view to prevent dry rot and attack of worms. It is done by quenching the ends of posts in water after they are charred on wood fire to a depth of 1.5 cm.
- **Tarring;** It consists in coating with tar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

- **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 creamlike paste of slaked fat lime and in the end with a concentrated solution of silicate of soda.

VENEERS

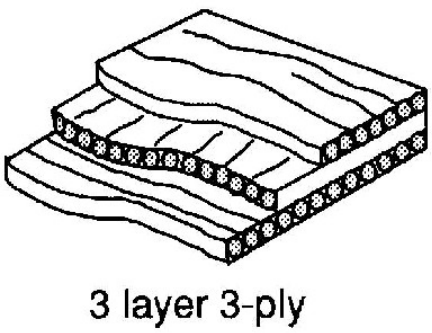
Veneers are those thin sheets of wood that are peeled off, sliced or sawn from a log of wood having attractive and artistic arrangement of grains. Logs of wood are converted into veneers by either *rotary veneer cutters* or by veneer slicing machines



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.

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.

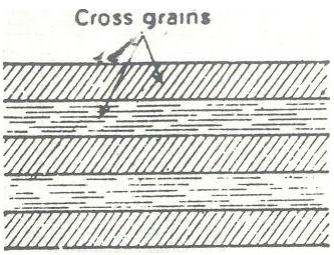


Outside plies are known as ***face plies or face.*** Plies are arranged so that the grain of one layer is at right angles to the grain of an adjacent layer.The thinner

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.

Advantages. Plywood has some advantages in structural usage as detailed below:

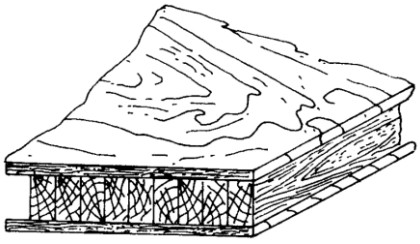
- It gives better appearance.
- It is stronger. A three-ply board is three times as strong as a solid board of same thickness.
- It can be easily bent to give any shape.
- It is an elastic material and is not very much affected by climatic changes.
- It gives uniform tensile strength in all directions.
- 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.

LAMIN BOARDS

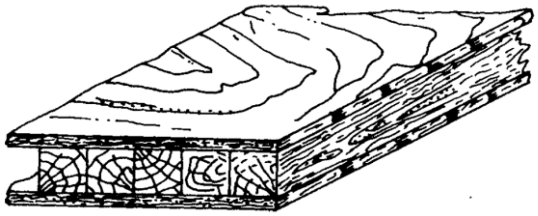
Lamin board consists of a core built up of laminae not more than 8 mm wide and glued between two or more plies. Grains of core laminae should be at right angles to those of outer plies. These are pressed into sheets 1 cm to 5 cm thick.These boards are available up to 1.5 metres in width and 2.5 to 3 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

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

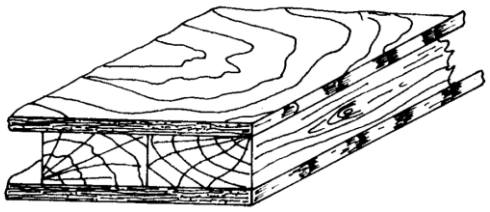


Block Board

widths from 0.9 m to 1.2 m.

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.



Batten Board

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 arc 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.

Tempered hard board 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.

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.

GLUING AND JOINING TECHNIQUES

1. Basic Butt Joint

There is no more basic wood joinery than the butt joint. A butt joint is nothing more than when one piece of wood butts into another (most often at a right angle, or square to the other board) and is fastened using mechanical fasteners. This type of joint is often used in wall framing on construction sites.

Fig 01 Butt Joint

2. Mitered Butt Joint

A mitered butt joint is nearly the same as a basic butt joint, except that the two boards are joined at an angle (instead of square to one another). The advantage is that the mitered butt joint will not show any end grain, and as such is a bit more aesthetically pleasing. However, the mitered butt joint isn't all that strong.

Fig 02 Mitered Butt Joint

3. Half-Lap Joint

The half-lap joint is where half of each of the two boards being joined is removed, so that the two boards join together flush with one another. This type of wood joinery can obviously weaken the strength of the two adjoining boards, but also is a stronger joint than butt joints. There are a number of projects where this type of wood joint is quite desirable, in spite of its drawbacks.

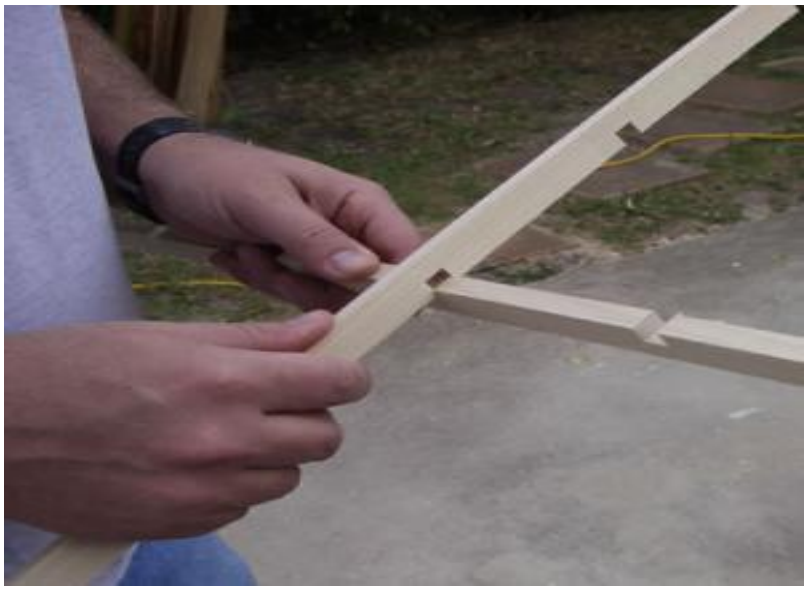


Fig 03 Half-Lap Joint

4. Tongue and Groove Joint

When joining two boards square to one another along a long edge, one can simply butt the joint together and hold it with fasteners. However, the tongue and groove joint is much stronger and provides more adjoining surface areas, which is particularly useful if you're going to glue the joint.

Fig 04 Tongue and Groove Joint

5. Mortise and Tenon Joint

The mortise and tenon is a classic wood joinery method. These joints have been used since the early times of woodworking, and are still among the strongest and most elegant methods for joining wood. Learn methods for creating tight, beautiful mortise and tenon joints.

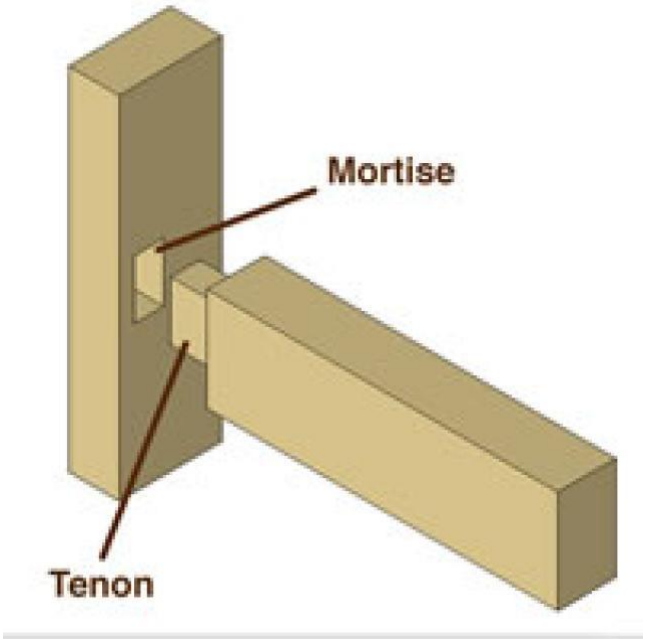


Fig 05 Mortise and Tenon Joint

6. Biscuit Joint

Another method for joining boards along the edges (like the tongue and groove joint) is to cut slots and use beech wood wafers (known as biscuits) to hold the boards in place. This is a very useful modern woodworking joint, particularly for creating table tops, relying on glue and the swelling of the beech wood biscuit to hold the boards in place.

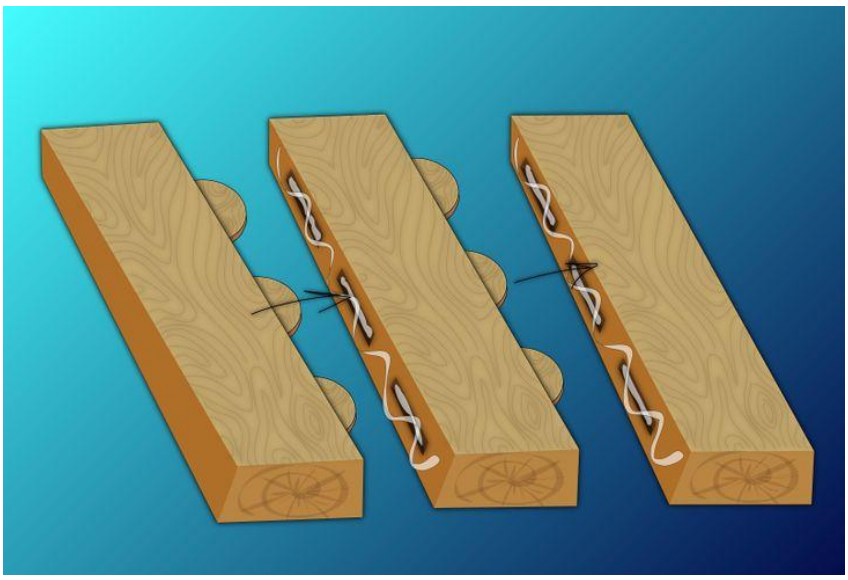


Fig 06 Biscuit Joint

7. Pocket Joint

The Pocket Joint is a type of wood joinery that involves cutting a slot and pre-drilling a pilot hole at an angle between two boards before connecting the two with a screw. This pre-drilling needs to be very accurate, so it is typically accomplished by use of a commercial jig. Pocket joints work great for cabinet face frames and other similar applications where a lot of strength is not needed.

Fig 07 Pocket Joint

8. Dado

A dado is nothing more than a square-grooved slot in one board where another board will fit. Similar to tongue and groove joinery, this is a commonly-used wood joint for connecting plywood, such as building cabinetry.

Fig 08 Dado Joint

9. Rabbet

Another common wood joint used in cabinetry is the rabbet. A rabbet is essentially a dado cut along the edge of a board. Rabbets are often used at the back of cabinets and other similar assemblies for attaching the back to the sides of the box, adding a considerable amount of strength to the assembly.

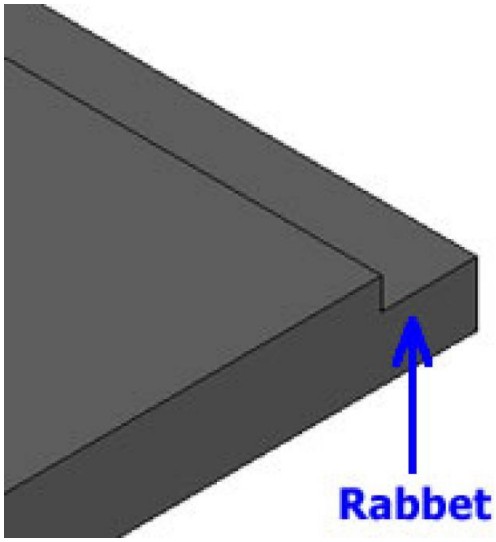


Fig 09 Rabbet Joint

10. Through Dovetail Joint

Of all wood joinery methods, the through dovetail may be the most revered. A classic through dovetail is beautiful and very strong, and adds a touch of class to any piece. There are a few methods for creating through dovetails, from hand cutting to machining with a jig.

Fig 10 Through Dovetail Joint