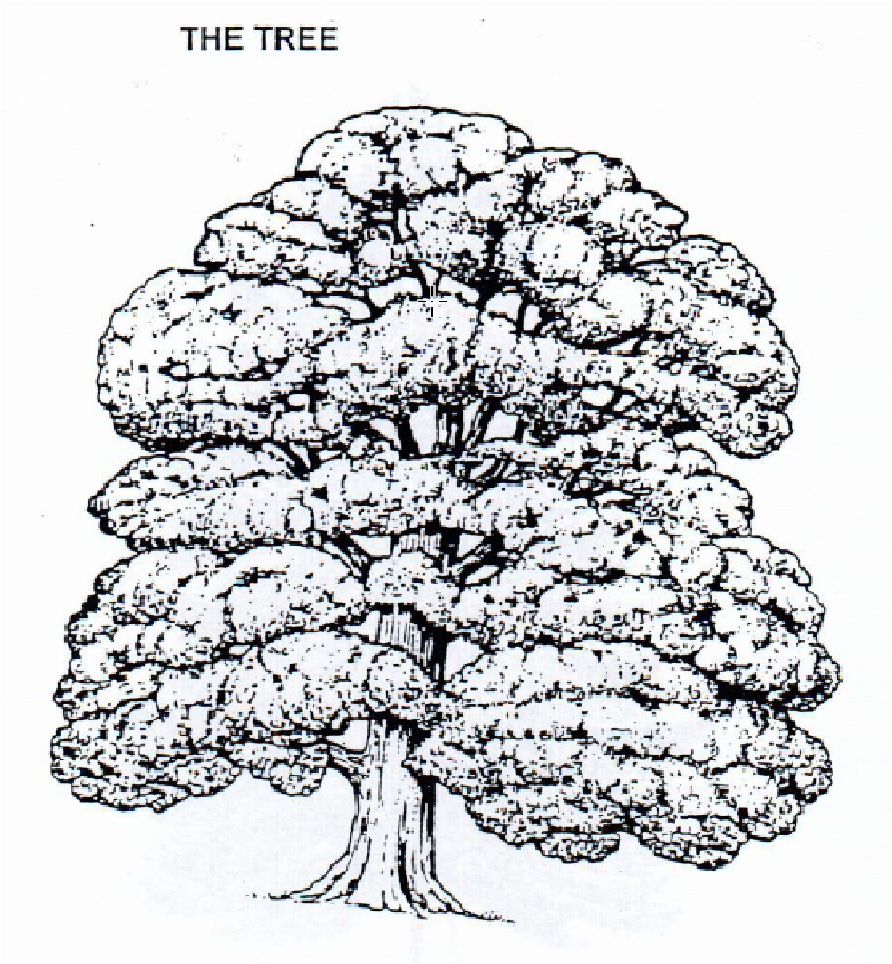
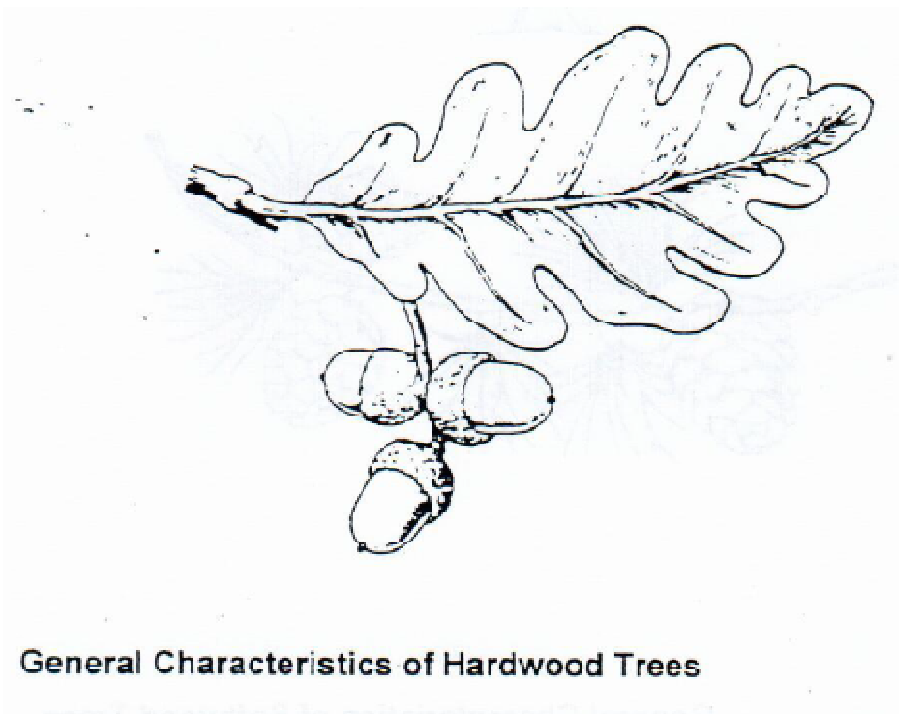
Wood - Characteristics and Uses

These notes introduce a variety of materials used in the construction industry.

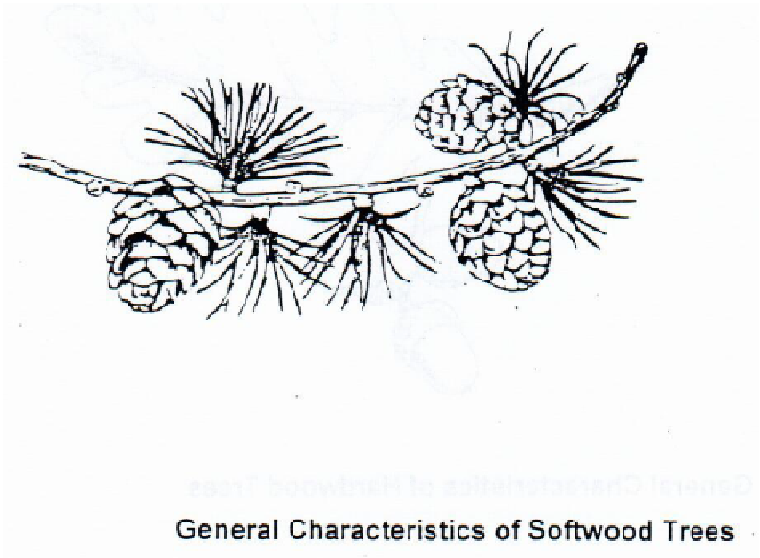
1. Outline the method of production use of construction materials and products.
2. Describe how the properties of construction materials and products affect their use.
3. Describe the causes and remedies of defects in construction materials and products.

Contents





General Characteristics of Hardwood Trees



General Characteristics of Softwood Trees

The Growth of a Tree

A tree consists of different parts eg. Roots, trunk, branches, twigs, leaves etc. these different parts can be grouped into three main parts each with a role to play in the growth of a tree. The three parts are:

1. Roots
2. Trunk
3. Crown

1. **The roots** perform two main functions. One function is to gather food material, as rain passes through the soil it dissolves various mineral salts, these salts are taken in by the roots and passed up the tree in the form of sap to be used in the manufacture of food. The other function of the roots is to anchor the tree to the ground.
2. **The trunk** performs several functions. It transports the sap up to the crown, it passes the manufactured food to places where it can be used and where it can be stored for future use. It also provides the tree with strength enabling it to withstand high winds and support an ample crown.
3. **The crown** is the part of the tree which manufactures food, the leaves in particular. The sap brought up from the roots passes, to the leaves where it combines with carbon dioxide from the air and the green colouring matter in the leaves called chlorophyll, then with the aid of sunlight is converted into food in the form of sugar and starches. The process of manufacturing food is called photosynthesis.

THE GROWTH OF A TREE

Trees grow by adding a new layer of wood cells below the bark each growing season (usually each year). Figure 93 shows the process involved to produce these new cells. Water and minerals (raw sap) are absorbed from the soil by the roots and travel up through the sapwood to the leaves. There, a process called photosynthesis occurs, using sunlight which is absorbed by the green substance in the leaves (chlorophyll). During this process carbon dioxide is absorbed and oxygen is given off, and as a result, sugar is formed. The sugar Is then added to the water and minerals. This enriched sap passes down the tree through the inner bark of the cambium layer. This layer consists of a ring of cells which divide to form the new layer of growth. Surplus foods are sorted in cells which radiate from the centre of the tree, which are called medullary rays.

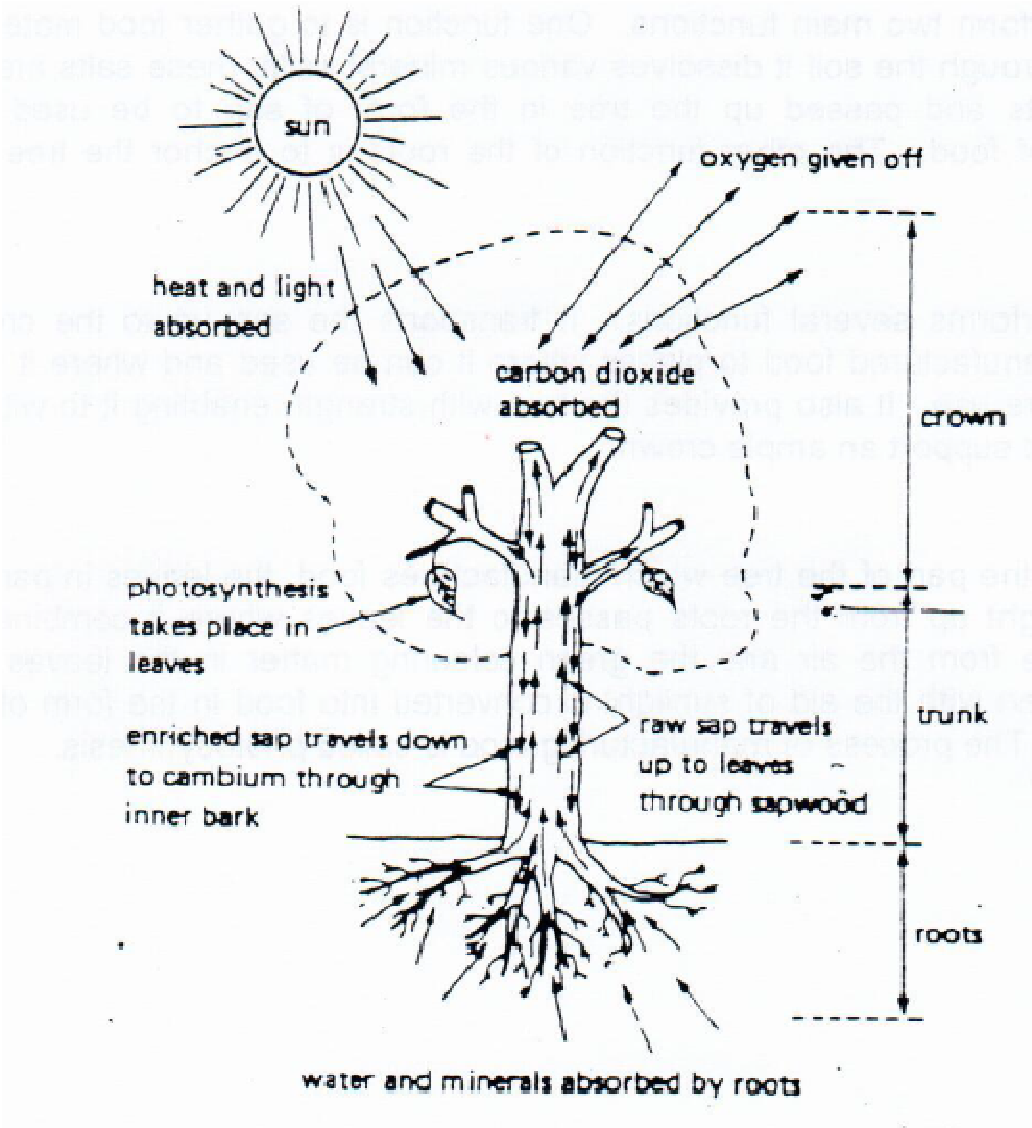
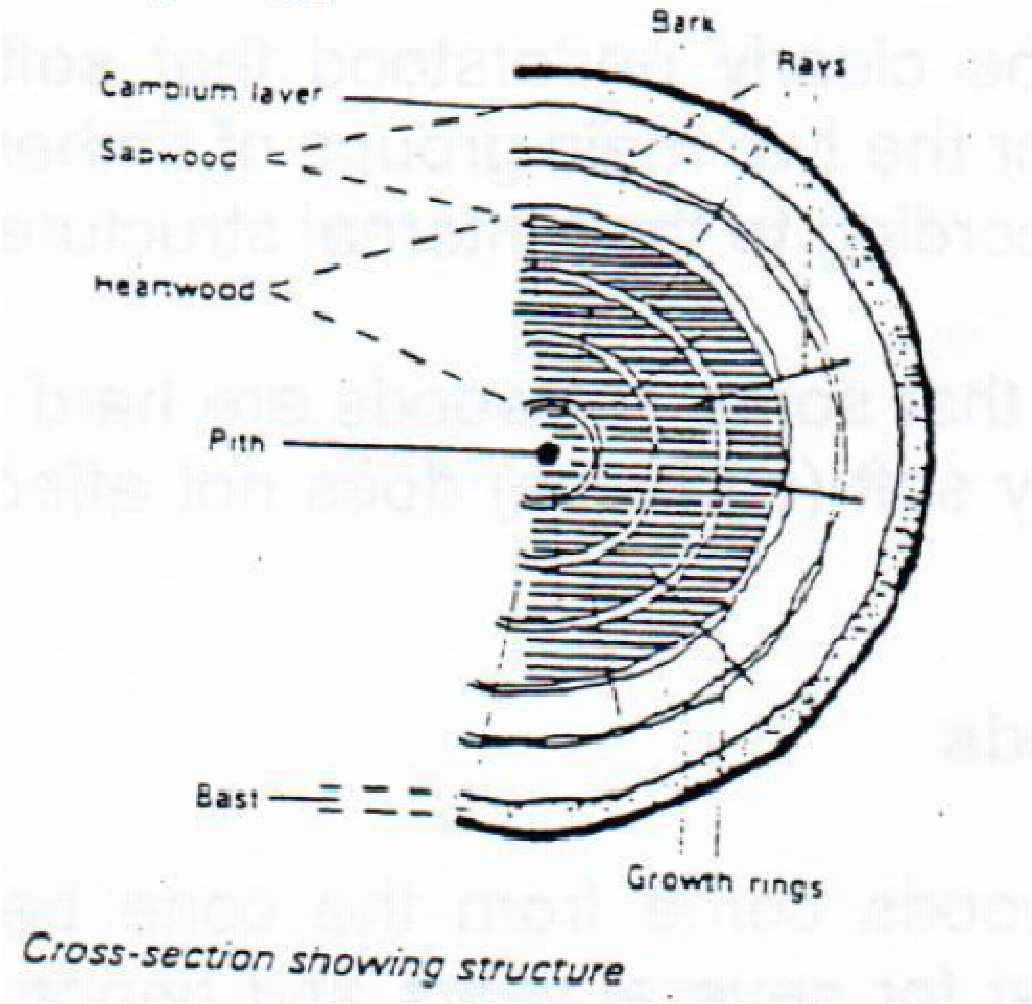


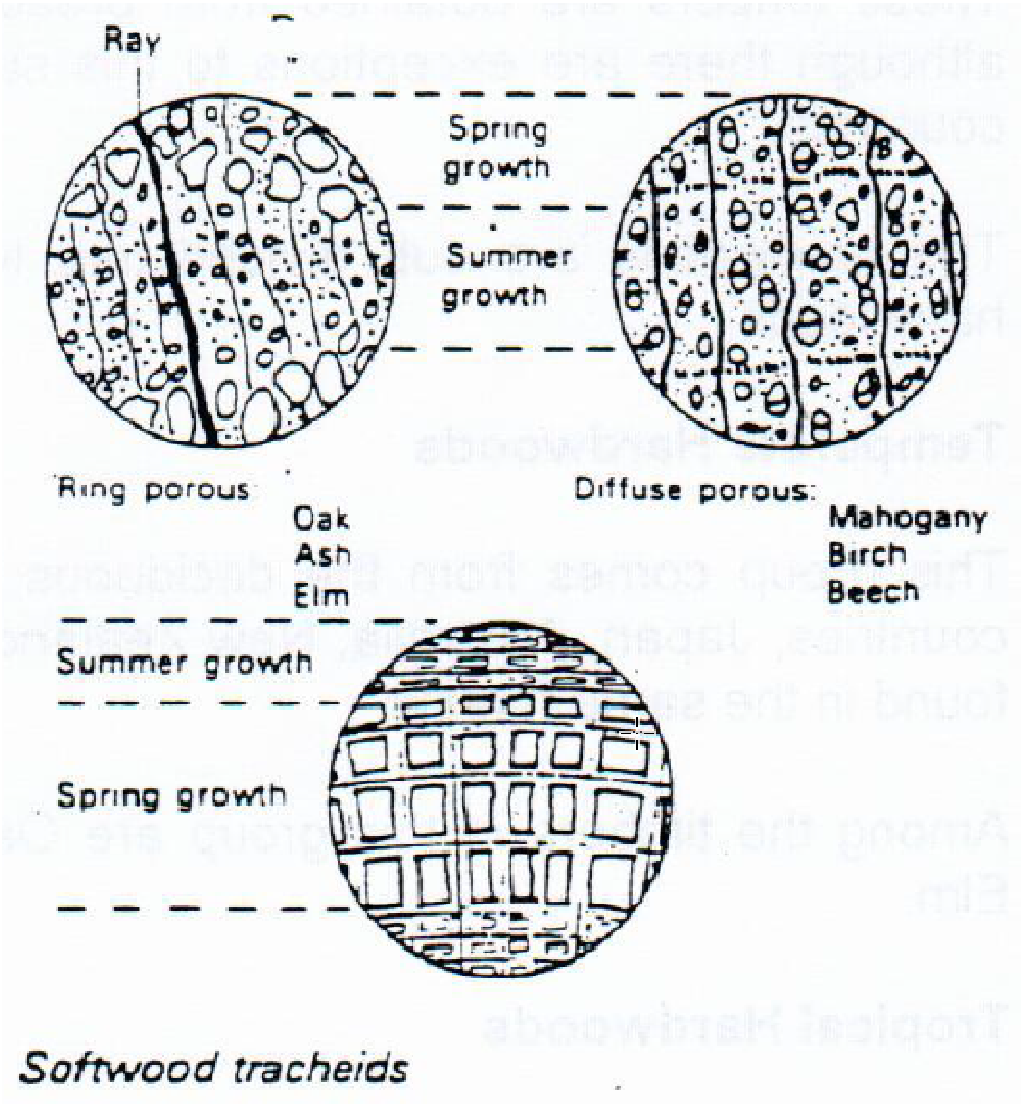
Figure 93 *The growth of a tree*

A ***cross section*** showing structure is illustrated and clearly shows what can be seen when a tree is felled and viewed from it's cross cut section. The pith, which is at the very centre, is of no use after the tree has grown beyond the sapling stage. Pith is easily recognised by its dark brown colour and spongy texture. The use of timber containing pith should be avoided.



Cross-section showing structure

Commercial timbers are classified into softwoods and hardwoods. Probably the most common method of identifying them is by their leaf. Softwoods, which include pines, firs and spruce have a narrow needle like leaf, whereas hardwoods (oaks, beech and ash etc) have a broad leaf. The difference is more pronounced, however, when the structure of both woods is seen under a microscope. This close examination reveals that softwoods are made up of a series of rectangular cells called tracheids, separated by walls through which the moisture is passed. In the case of hardwoods nature has devised a slightly different arrangement to convey food to the various parts during the trees' growth. This consists of a series of tube like ducts which are called vessels or pores. In hardwoods, such as oak and ash, the vessels are reasonably regular and give a clear indication of the growth ring. These are called ling porous, but in many other hardwoods the vessels are scattered and irregular and for this reason are called diffuse porous.



CLASSIFICATION OF TIMBER

Commercial timbers fall into two main classes, namely softwoods and hardwoods.

It must be clearly understood that softwood and hardwood are universally accepted names for the two main groups of timber, and that these are names given to the various trees according to their internal structure.

The fact that some softwoods are hard (eg pitch pine) and some of the hardwoods are extremely soft (eg balsa) does not affect the use of the terms in their special technical sense.

Softwoods

These woods come from the cone bearing trees (coniferous) having needle leaves which last for several years and hence do not all fall in one season. These trees are generally evergreens, but there are exceptions, such as the Larch, which sheds all its needles in the autumn.

The coniferous trees are found in the colder zones of the world, and much of the timber used in Britain is obtained in the forests of Northern Canada, Scandinavia and Northern Russia. Softwoods are also widely grown in the hill forests of Scotland.

The commonly used timbers obtained from these areas include Pines (Redwood), Spruces (Whitewood), Larch, Douglas Fir, Hemlock and Parana Pine from South America.

Hardwoods

These timbers are obtained from broad leaved trees which are normally deciduous, although there are exceptions to this such as holly and many of the trees in tropical countries.

The hardwoods are sub divided into two groups known as temperate and tropical hardwoods.

Temperate Hardwoods

This group comes from the deciduous trees of countries such as Britain, European countries, Japan, Australia, New Zealand and Central USA. Very often conifers will be found in the same forests.

Among the timbers in this group are Oak, Beech, Ash, Walnut, Sycamore, Lime and Elm.

Tropical Hardwoods

These timbers come from the evergreen trees of the tropical and sub tropical forests of Africa, the Amazon Basin, Burma, East and West indies and South America.

The species obtained from this group include Gaboon, Mahogany, Makore, Iroko, Meranti, Walnut, Teak and Obeche.

Complete the list by indicating the country of origin:

Softwoods		**Temperate Hardwoods**		**Tropical Hardwoods**	
Pines		Oak		Gaboo	
Spruces		Beech		Mahogany	
Larch		Ash		Makore	
Douglas Fir		Walnut		Iroko	
Hemlock		Sycamore		Walnut	

Conversion

When a tree has matured it is cut down (felled) and sawn into timber sizes which are in common use in the industry. This process is called conversion. Fully mature trees should be felled in winter months for best results. The tree takes in least moisture during winter and therefore will begin to dry out at a slower late. The way in which the log is cut will depend on the use to which the timber is to be put.

Conversion methods include:

Through and through - this is the most economical method of conversion since the log is sawn into battens etc with the minimum of handling. This method is also known as slash, tangent and plain saw.

- ***Advantages*** - little waste, quicker and cheaper
- ***Disadvantages*** - timber is liable to warp, also the majority of the boards show little or now figure.

Quarter Sawn - in this method the log is usually first cut into quarters. The second stage may vary, but the principle behind the sawing remains the same. The surface of the boards follow the medullary rays.

- ***Advantages*** - timber is less liable to warp, timbers with pronounced rays will be figured
- ***Disadvantages*** - considerable amount of waste, takes longer and costs more.

Tangential Sawn - starting with a squared log. Tangential sawn boards are produced by working round the log by turning it, to produce boards all of which (except the centre), have their growth rings across the boards width.

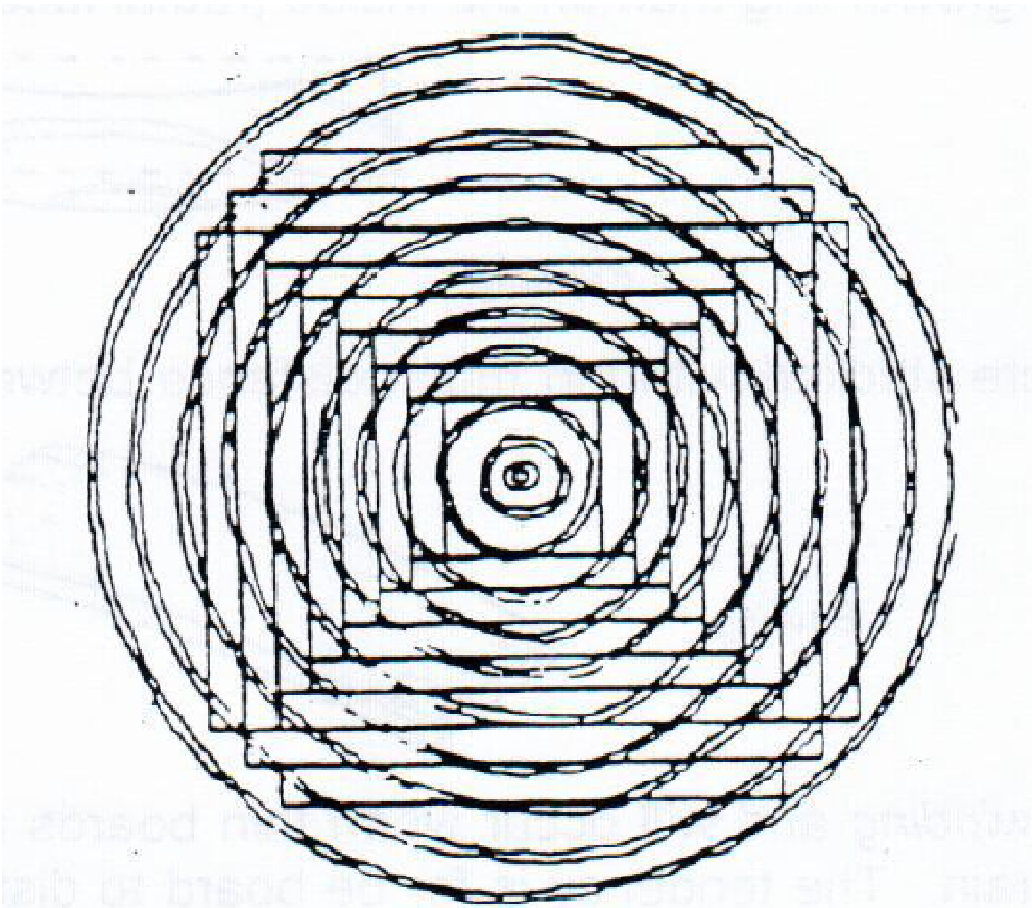
- ***Advantages*** - suitable for floor joists and beams because of greater strength in their depth

- ***Disadvantages*** - subject to cupping.

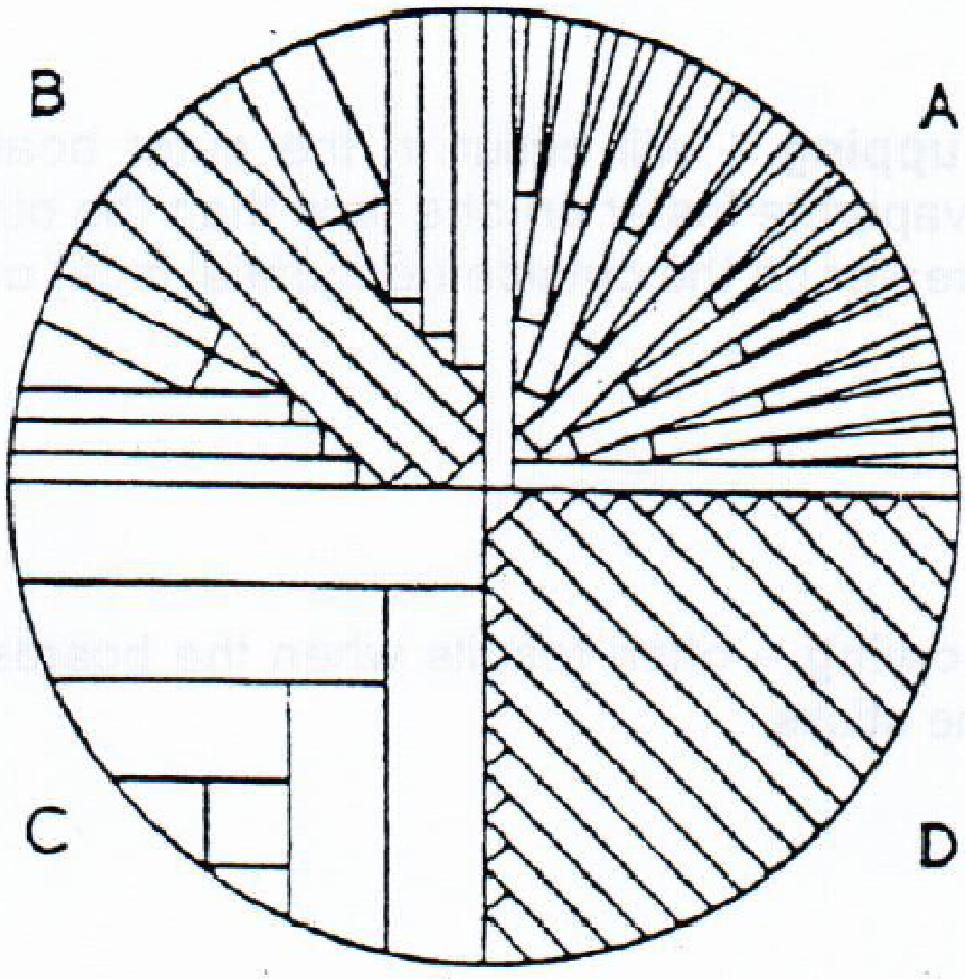
Flat, bastard or slash sawing. A common way of dealing with ordinary oak logs is first to halve the log and then saw it as shown. Sometimes it is sawn whole. The middle board will show considerable "flower," whilst less and less will appear as the outside boards are reached. Also the “flower” will be more pronounced on one half ot he board than the other. The outside portions being entirely sapwood are, of course, of little use as timber.

Figure pitch pine and walnut are two woods which depend on the annual rings for figure, which is displayed to the best advantage when the boards are cut tangential to the rings as shown.

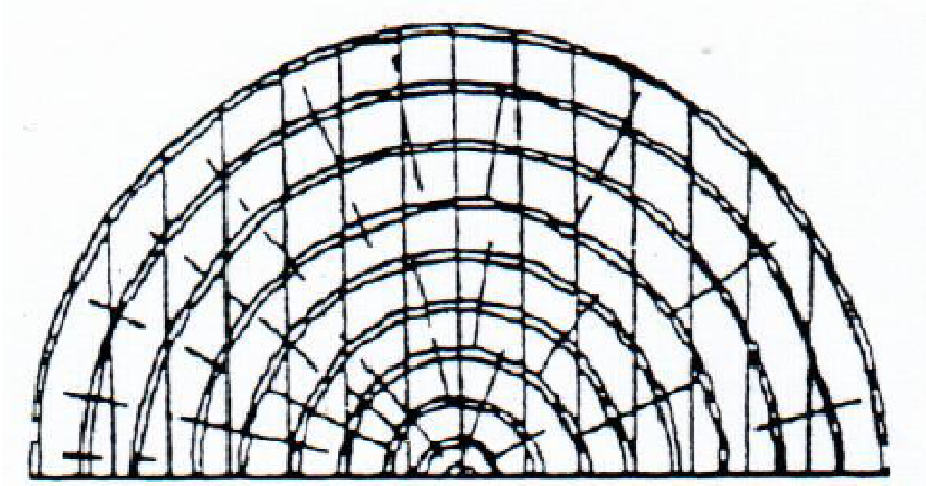
Strength and Special Features. In general, softwoods, in which the grain is of no special importance, are out up to obtain the greatest amount of timber with the minimum waste.



Converting pitch pine by tangential sawing

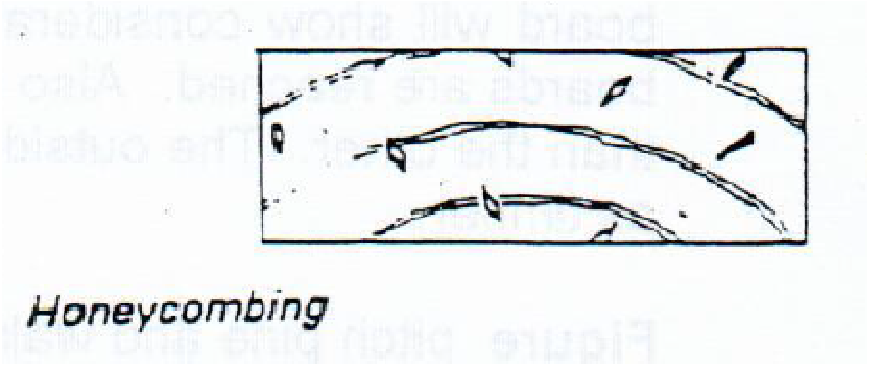


Various accepted methods of converting oak and other timbers with 'flower'.



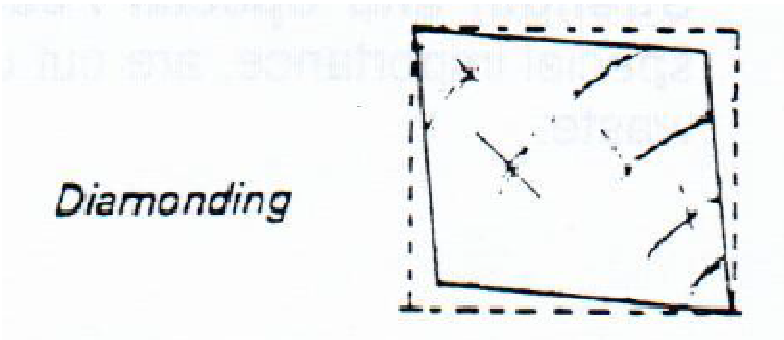
Flat, bastard, or slash-sawn oak log.

Honeycombing - occurs for the same reason as case hardening, except that the hardened outer fibres apply such pressure on the moisture soaked inner fibres that the numerous small holes can be seen on the end grain



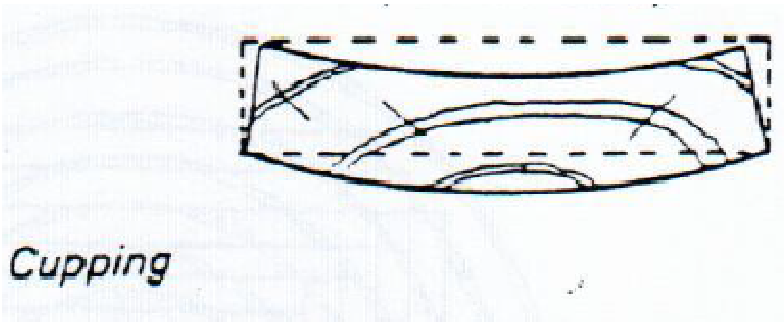
Honeycombing

Diamonding - this is the name given to the tendency of square cut pieces from certain areas of the log to become diamond shaped. It occurs when the piece has been cut with the growth rings running diagonally causing the unequal shrinkage between summer and spring growth to pull it out of shape.

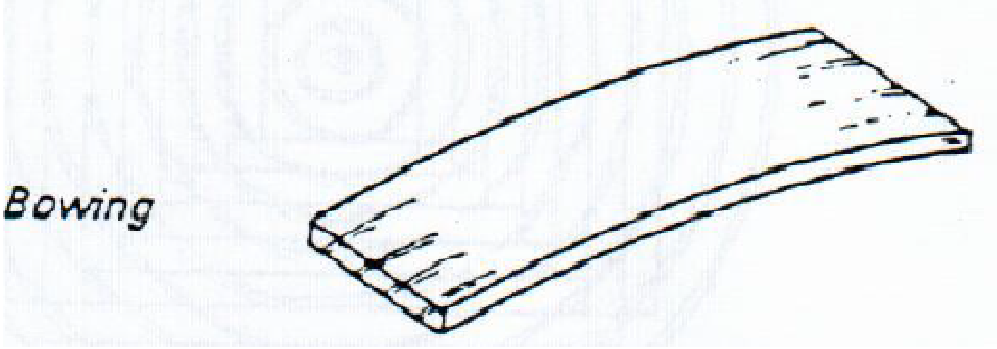


Diamonding

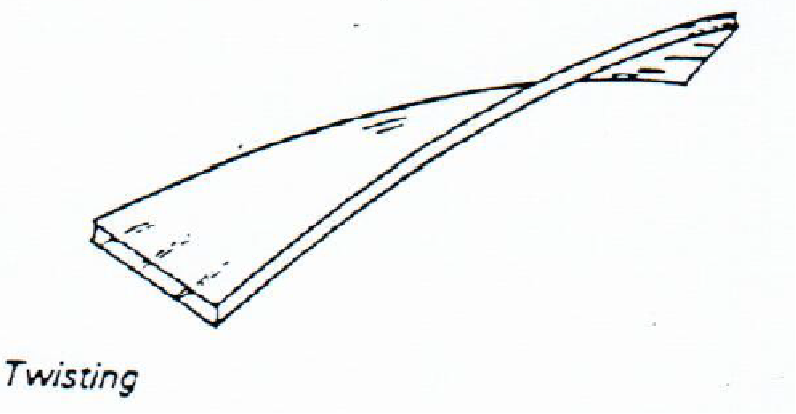
Cupping - will occur in the outer boards of a stack when moisture is permitted to evaporate faster on one face than the other. This is helped by the fact that shrinkage is greater on the outside (tangential face) of a growth ring than on the inside (radial face).



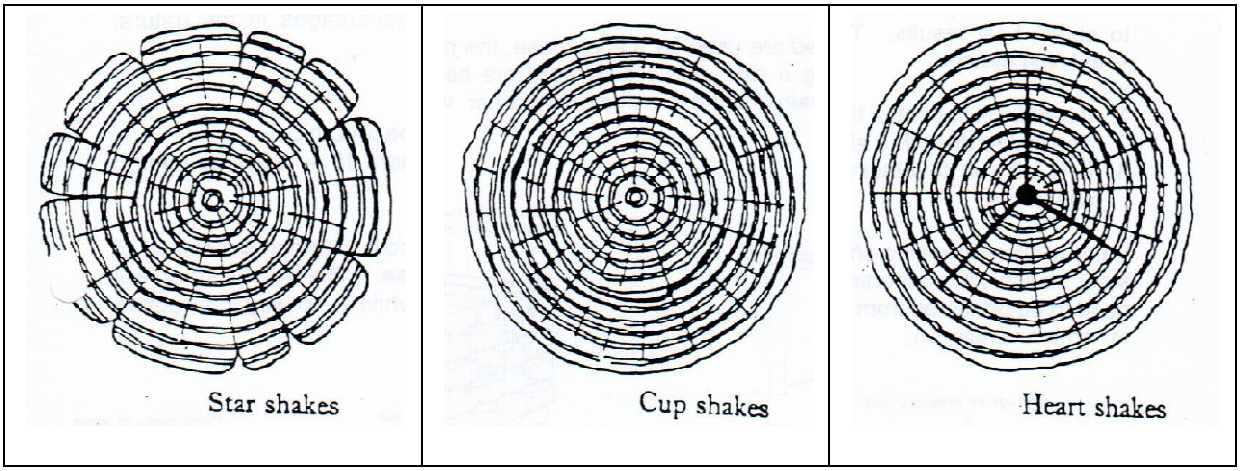
Bowing - often results when the boards are stacked with too much distance between the sticks.



Twisting - this defect is also knowing as winding and will occur when thin boards are cut from a log having curved longitudinal grain. The tendency is for be board to distort spirally.



STAR SHAKES / CUP SHAKES / HEART SHAKES

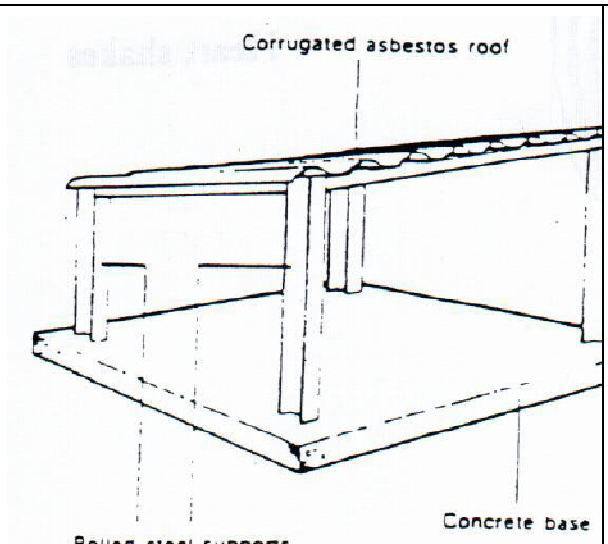


NATURAL OR AIR SEASONING

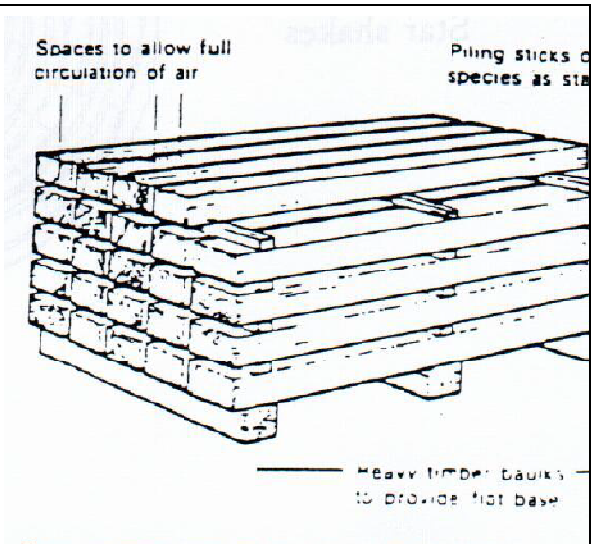
This process is the oldest method of drying timber and depends entirely upon a free flow of air to evaporate the moisture of the wood. The timber must be stacked correctly to obtain best results. There are three acknowledged disadvantages in the natural seasoning method:

1. It is difficult to control the rate of drying.
2. The timber dries at a slow rate, thus making the method uneconomical.
3. It is difficult to obtain a moisture content level less than 18 - 20% in natural conditions.

Various types of ***drying shed*** are used for this purpose, the most common consisting of steel stanchions supporting a roof over a solid concrete base. The timber stack will need to be protected from rain and other inclement weather, while in no way interrupting maximum ventilation.

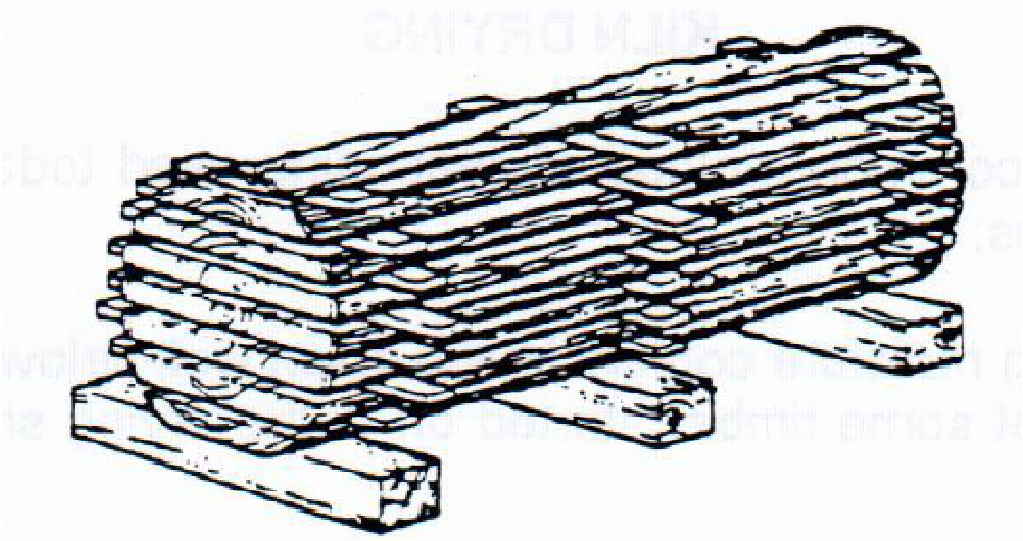


Typical construction of a natural drying shed



Correct stacking method for softwoods (kiln natural)

Stacking of the timber is of paramount importance. The boards should be stacked neatly with a gap of at least 25 mm between each. Piling sticks (sometimes called spacers) are placed between each layer of timber to enable air to get to all parts of the stack. These piling sticks vary in thickness in order to help control the drying rate. Sticks should also be of the same material as that being seasoned. For timbers where it is safe to dry fairly rapidly a piling stick of up to 38 mm in thickness can be used but for timbers which must be dried slowly the gap between layers is reduced to only 12 mm. Piling sticks should be in vertical alignment and approximately 600 mm apart, although with thicker boards which are less likely to warp this spacing could be increased. Softwood stacks for natural seasoning should be no more than 2.000 m wide and 3.000 rn high to allow a reasonable chance of uniform drying. ln larger stacks it is likely that the outer boards will dry much faster than those in the centre.



Hardwood log sawn and stacked for natural drying

Hardwood stacking is rather different from the softwood method. It is more usual for the log to be converted through and through style and then stacked, again with sticks between, exactly as it would come off the saw. For best results, softwoods should be stacked in the spring whereas hardwoods should be stacked in the autumn to prevent the initial drying rate from being too rapid. Quite often, hardwoods are started off by natural methods and then finished off in the kiln, Softwood boards of 25 mm thickness reach 20 % moisture content in approximately 3 months, while 50 mm boards require 4 months and perhaps more by this method. Hardwoods of 25 mm thickness would take between 7 - 8 months to reach 20% moisture content and 50 mm boards at least a year. These drying times can only be approximate because differences between timbers and weather conditions play an important part in seasoning by this method.

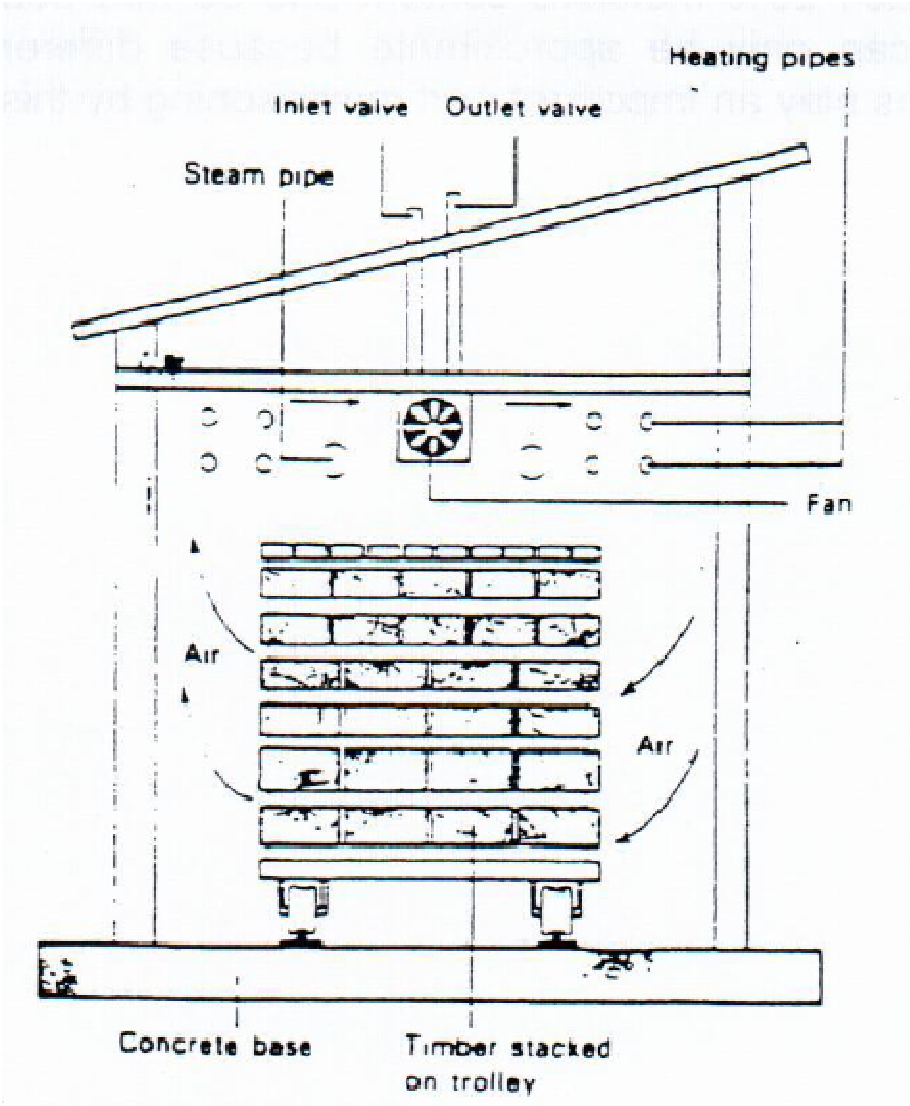
KILN DRYING

This is by far the most common method of seasoning used today, mainly because of two important advantages:

- It is capable of getting moisture content levels down well below that of natural drying. This often means that some timber started off in the drying shed is finished off in a kiln.
- The fact that these levels can be reached safely in a controlled manner and in less time meets the demand of industry much better.

Drying times in the kiln can be accurately estimated, but the instructions related to each species should be closely adhered to if degrades such as splits or warping are to be avoided.

There are various types of kiln, but most are built of brick. Inside the chamber there is a system of heating coils as well as steam jets. Most kilns will have fans to create circulation, but in a few cases natural draught kilns are used.



Forced draught type of kiln

CONVERSION

Waney edges. As shown in the sketch, wane is due to an effort to obtain the maximum amount of timber from the log. It will also be observed that the wane

indicates the presence of sapwood.

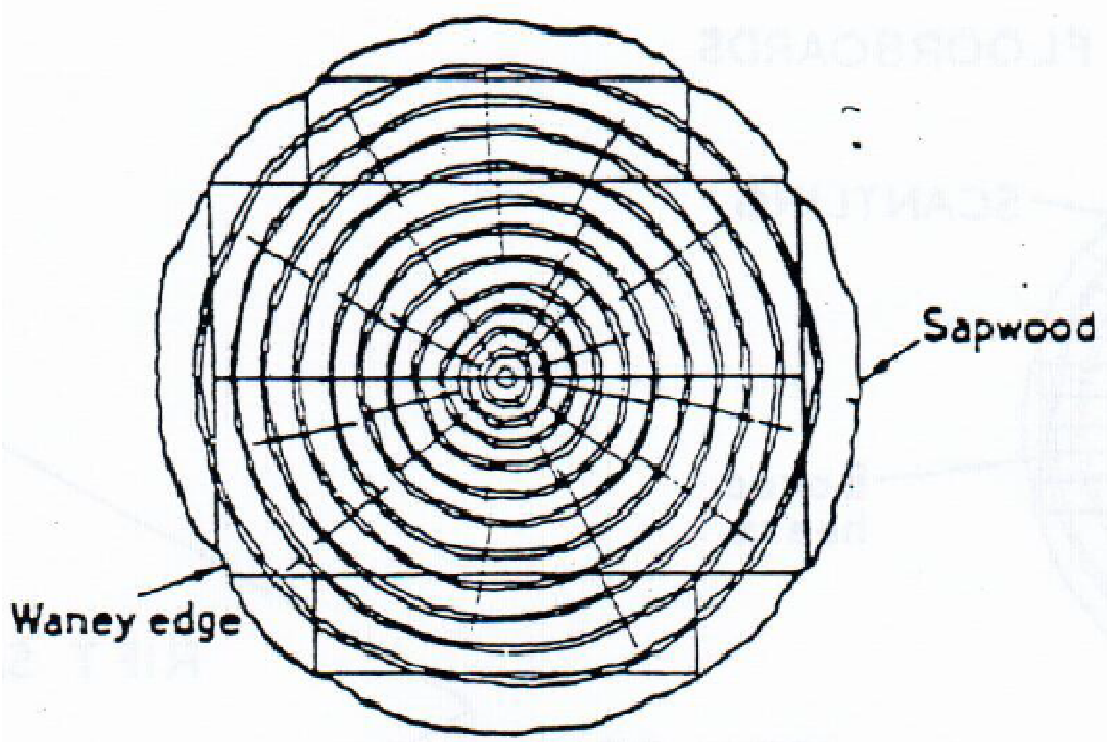
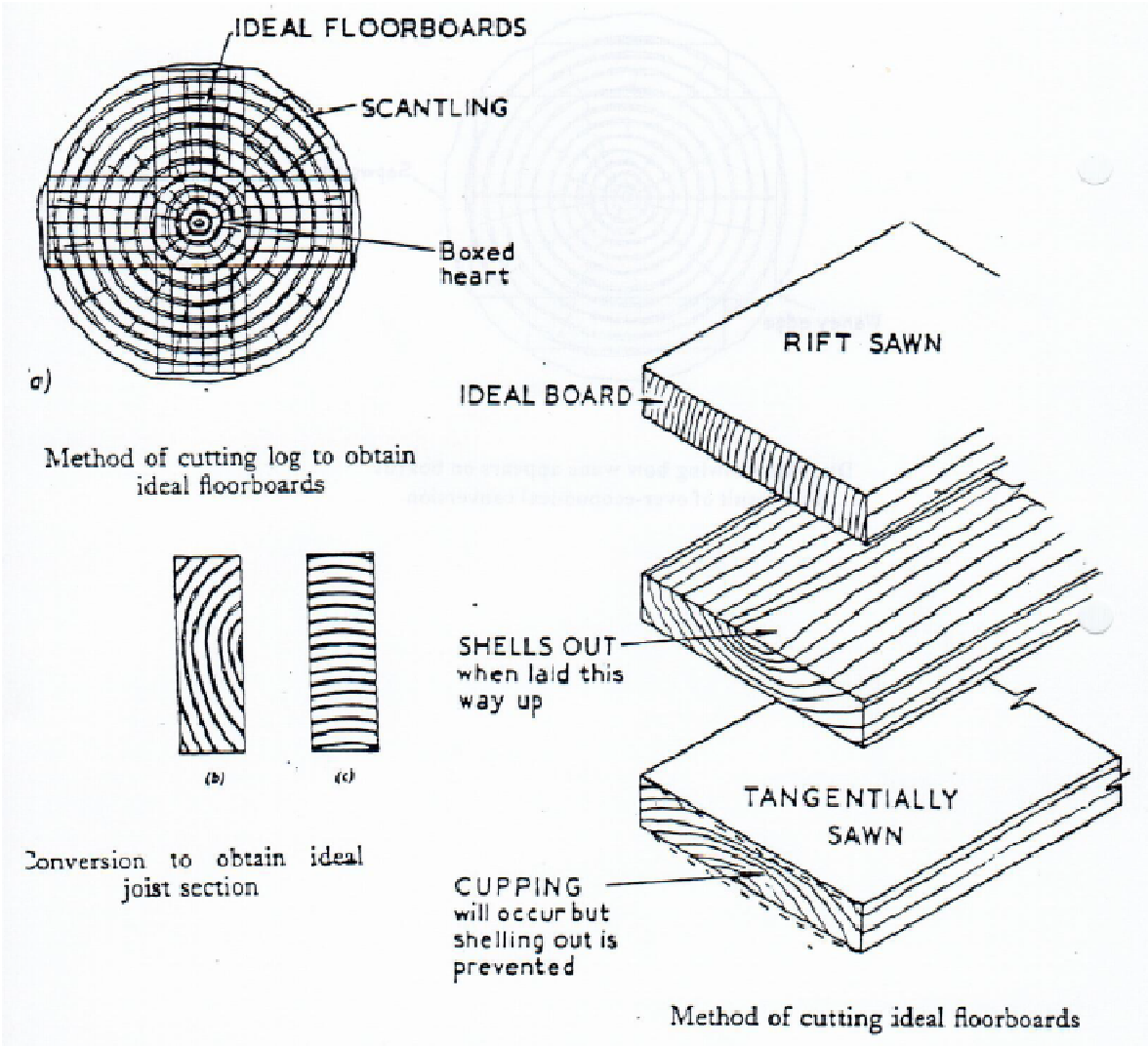


Diagram showing how wane appears on boards as a result of over-economical conversion

Sapwood. The presence of a large amount of sapwood in converted timber is undesirable, chiefly on account of it's considerable shrinkage and generally immature state. Moreover, as it contains a high proportion of the foods required by wood attacking fungi and insect enemies, it is likely to be attacked more readily than the heartwood. On the other hand, if the timber is to be subjected to one of the impregnating processes, the sapwood is more readily and more thoroughly treated than the heartwood. Some preservative methods claim to make the sapwood equal to, or better than the heartwood.



Manufactured Boards (Wood Based)

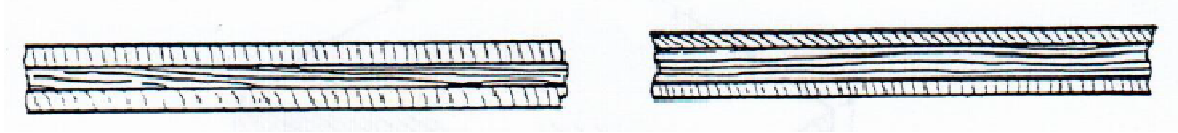
Plywood fibreboard (hardboard and insulation board), blockboard and wood chipboard are the main types of boarding used in building today. These provide a choice of relatively thin materials in large sheets having much more homogeneous properties than ordinary wood.

Each needs for its manufacture a complicated plan which must be fed continuously with raw materials.

Plywood

This board is made of layers of thin wood sheets, called veneers, which are glued together with the grain directions on adjacent sheets at right angles to each other, thus improving its strength properties and minimising moisture movement in the board.

When three veneers are bonded together, this is known as three ply (and may be equal layer or stout heart). Five layers is known as five ply, but anything above five is usually referred to as multi-ply.



Generally there is an odd number of veneers. Why should this be desirable?

_____

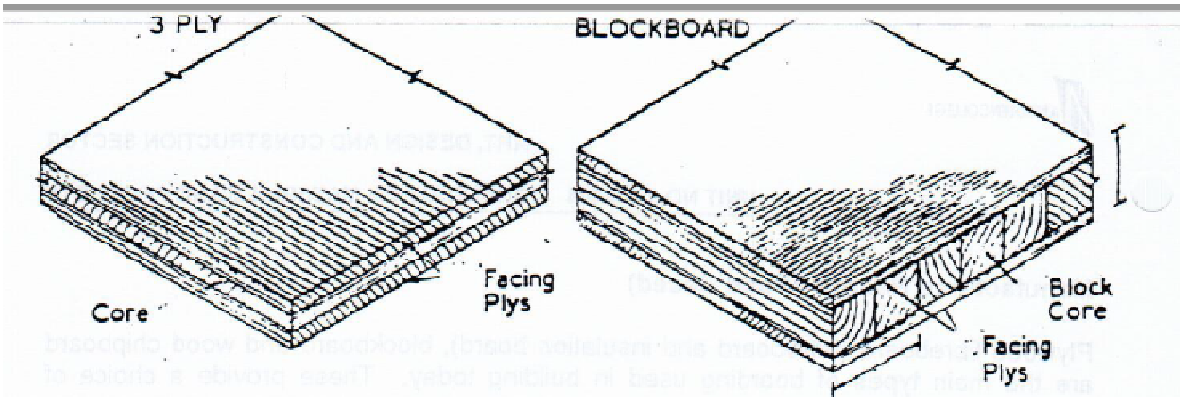
Manufacture

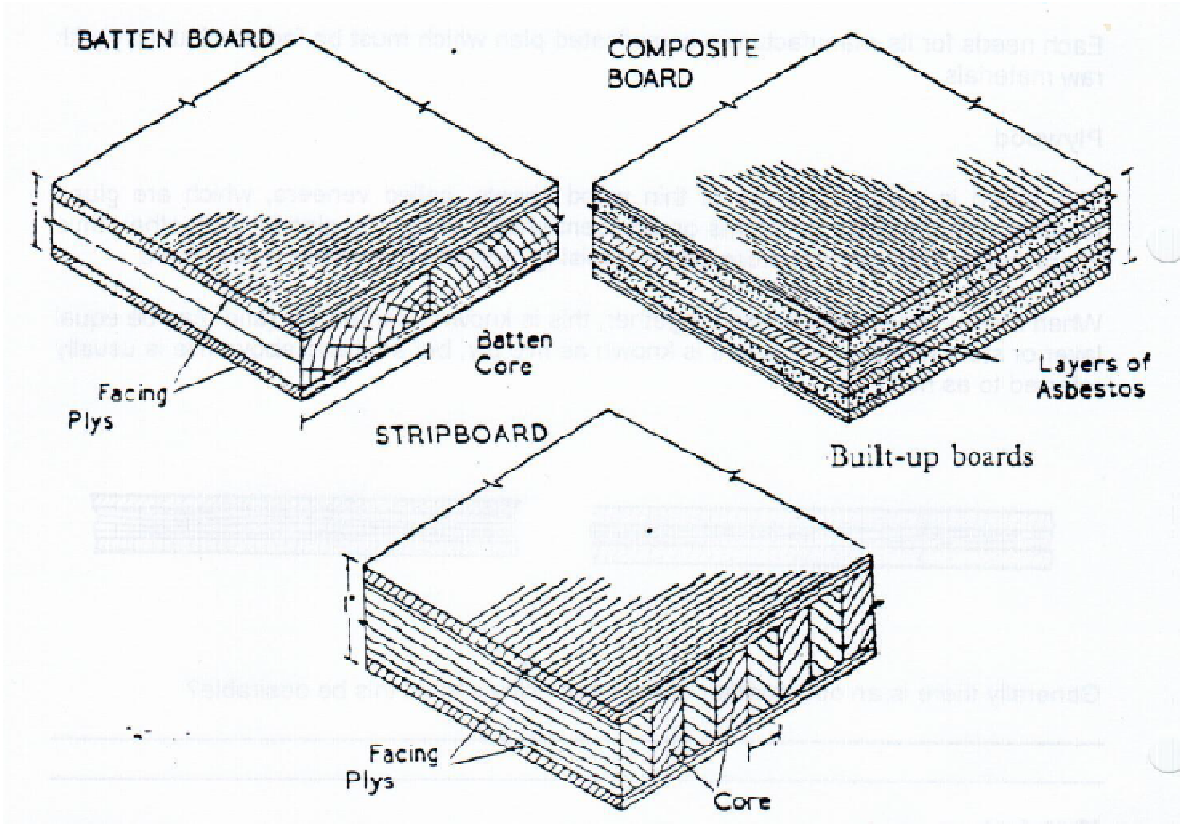
The logs are treated by boiling or steaming before processing in order to soften the timber, and enable a smooth veneer to be cut The veneers may be cut by a rotary method, known as peeling, or by slicing.

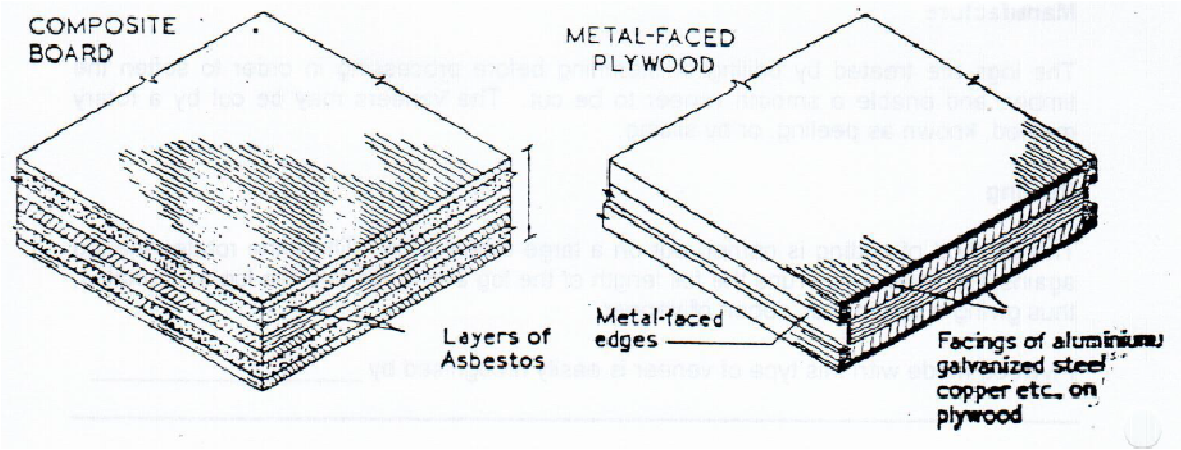
Peeling

This method of cutting is carried out on a large rotary lathe. The lathe rotates the log against the knife which runs the full length of the log and is fed into the log as it rotates, thus giving a continuous ribbon of veneer.

Plywood made with this type of veneer is easily recognised by _____.

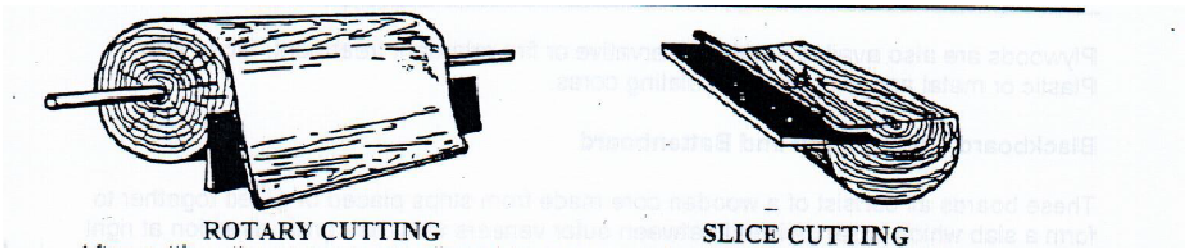






Slicing

In this means of cutting, one side of the flitch must be flat and either the flitch is moved past the knife or the timber is held steady and the knife moved through it. This method of cutting is normally used for the production of decorative veneers.' The plywoods are easily recognised by _____.



After cutting, the veneers are clipped to remove defects or automatically clipped to size and dried in preparation for assembly. The veneers are then graded into face, back and core qualities and in decorative plywoods, the face veneers are matched for grain and colour and jointed edge to edge.

Assembling

The veneers are passed through glue spreaders and laid with the grain at right angles to the grain in the adjacent veneer. The assembled veneers are then pressed in hydraulic presses which usually have heated platens. The assembled plywood is then conditioned to allow the moisture content to balance out through the board after which the sheets are cut to finished sizes and sanded. The panels are then inspected before packing for transport to the customers.

Adhesives

The correct grade of plywood must be used for any given situation otherwise the veneers will probably come apart (delaminate). Plywoods are graded as follows according to the glue used in their manufacture.

INT	Interior. These arehnot water resistant and so should be used where they are not to be subjected to damp conditions.
MR	Moisture Resistant. Used for most normal purposes, but will not withstand prolonged exposure.
BR	Boil Resistant. Durability is much better than MR but does not compare with the next grade.
WBP	Weather and Boil Proof. Can withstand the most severe conditions with deterioration.

NOTE this grading refers-only to the adhesive.

Uses of Plywood

Plywoods are also available with preservative or fire retardant treatment, faced with Plastic or metal and with fire or insulating cores.

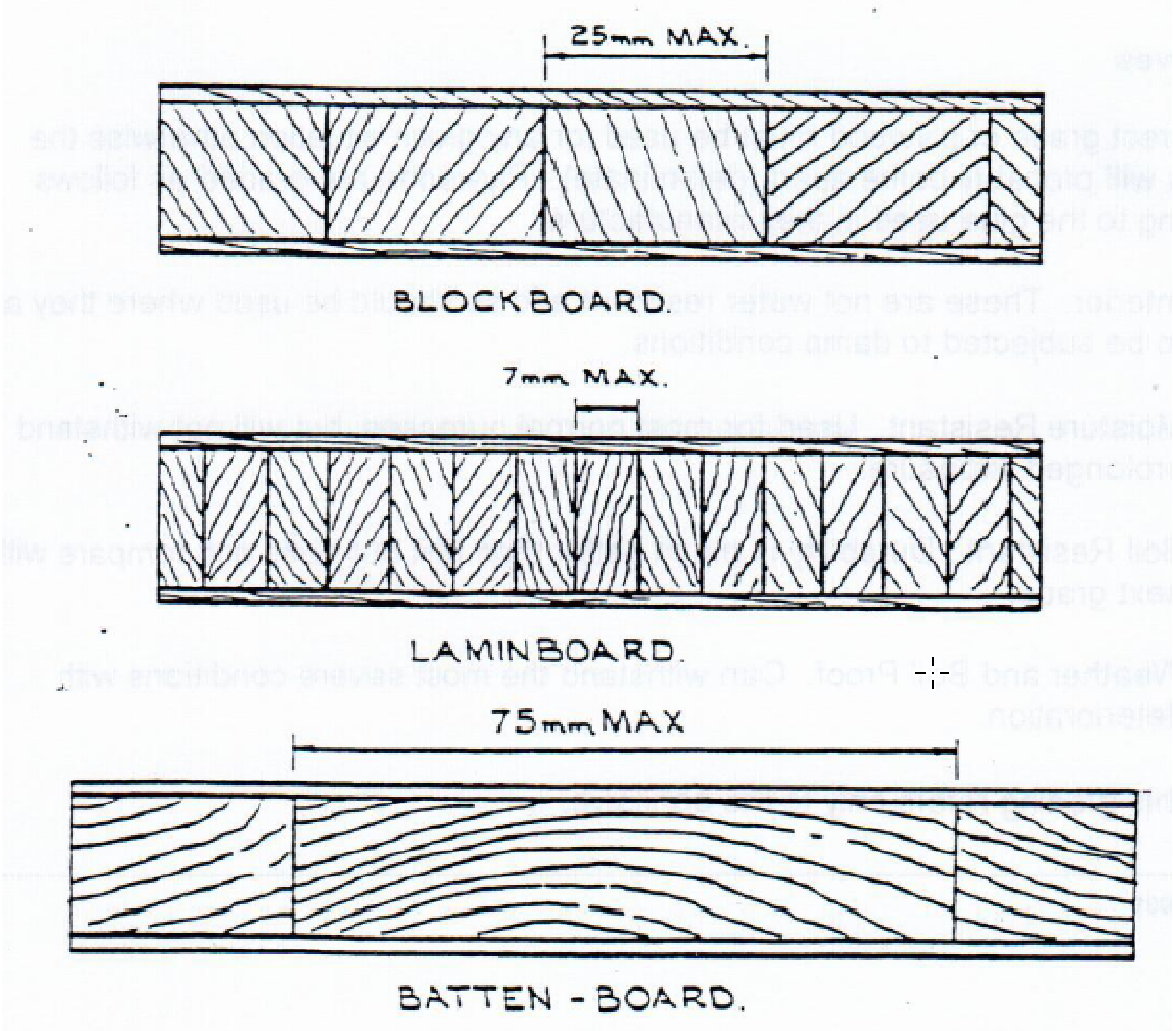
Blackboard, Laminboard and Battenboard

These boards all consist of a wooden core made from strips placed or glued together to form a slab which is sandwiched between outer veneers with their grain direction at right angles to the grain of the core.

In some cases a five ply blackboard is manufactured.

What is the advantage of this?

The three types of boards are all constructed in the same way, the only difference being in the width of the core strips - blockboard up to 25 mm wide, laminboard 1,5 to 7 mm wide and batten board not exceeding 75 mm wide. In all cases, the core strips are laid with the growth rings in opposite directions.


25mm MAX.
BLOCKBOARD.
7mm MAX.
LAMINBOARD.
75mm MAX
BATTEN - BOARD.

INSULATION MATERIALS

Insulate

To protect a room or building from sound or heat (or heat loss) usually by the use of special materials or methods of construction.
Insulation materials come in different forms ie. Flexible, loose, board, reflective.

Flexible

Supplied in rolls 600 mm/1200 mm wide x 10 m long and thickness from 50 mm to 150 mm and made from glass fibre or mineral fibre. Normally rolled out between joists or studs.

Loose

Expanded polystyrene granules in bags. Placed by pouring out between joists or framework.

Board

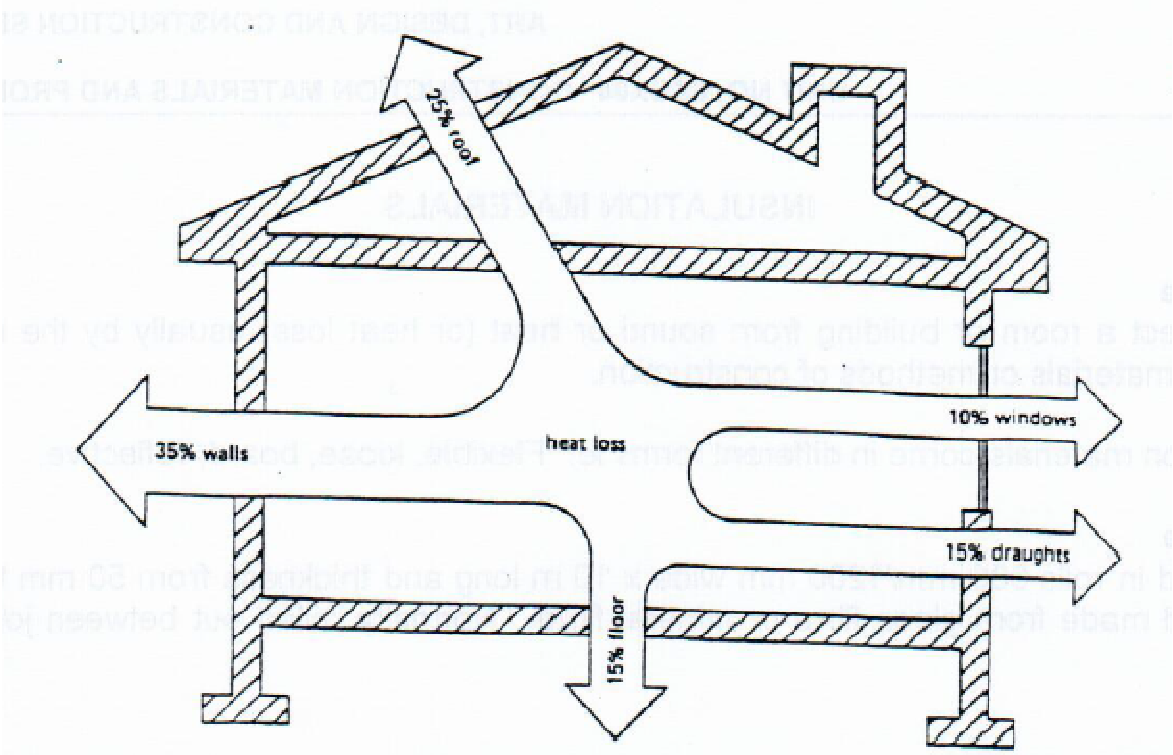
Rigid sheets made from fibreboard glass or mineral wool or expanded polystyrene. Cut between joists, framing or placed in cavity of building.

Reflective

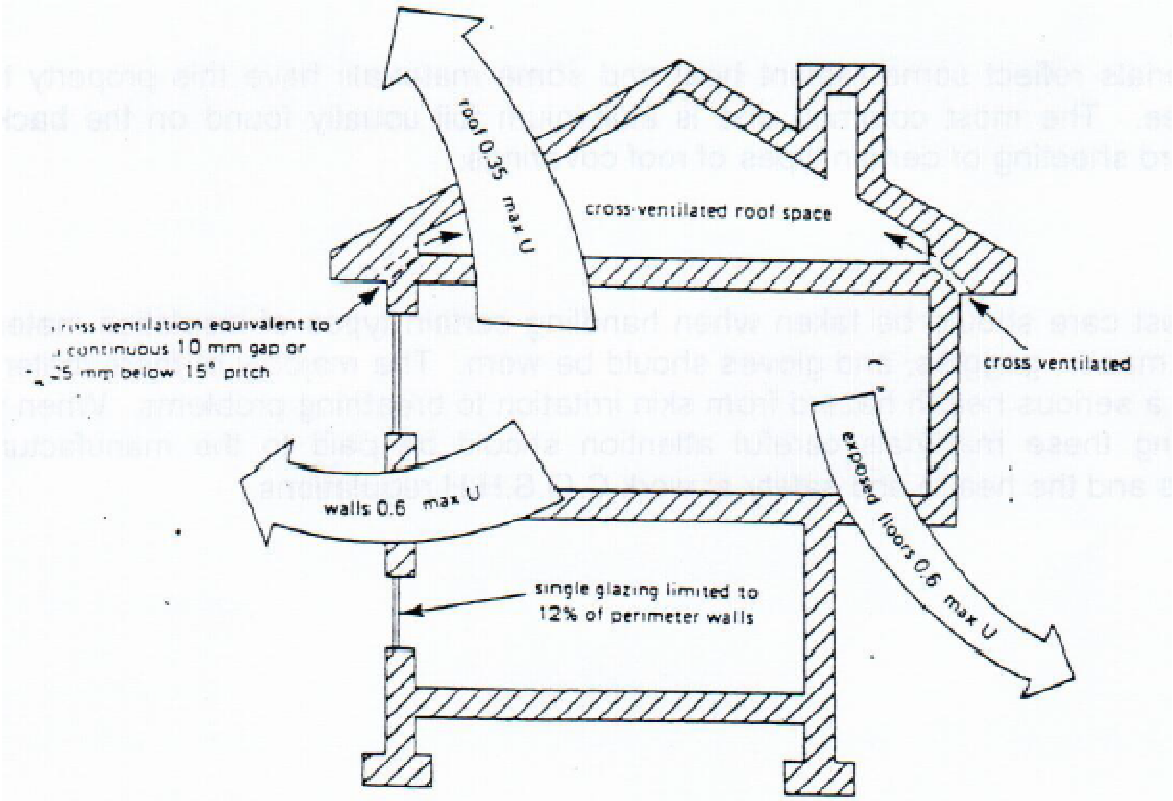
Most materials reflect some radiant heat and some materials have this property to a high degree. The most common one is aluminium foil usually found on the back of plasterboard sheeting or certain types of roof coverings.

NOTE

The greatest care should be taken when handling certain types of insulation material. Coveralls, masks, goggles, and gloves should be worn. The majority of there materials can cause a serious health hazard from skin irritation to breathing problems. When you are handling these materials careful attention should be paid to the manufacturers instructions and the health and safety at work C.O.S.H.H regulations.



Heat loss



Building Regulations requirements

Fibreboards - manufactured from wood fibres

Hardboard: Standard	Internal use: back to units
Hardboard: Oil tempered:	External use. Soffits to eaves
Laconite:	Melamine surface internal use. Bathrooms/kitchens.
Softboard:	Insulation board, pin or notice board, sound proofing. Internal use.
Bitumen impregnated softboard:	External use. Expansion strips. Sarking.
Medium density fibreboard (MDF):	Fitments, finishings, furniture production. Internal.
Also available in high density	Built up flooring

Standard sizes of these boards are usually 2.400 x 1.200 x 3 mm - 25 mm.

Sizes outwith these can be available from suppliers.

Depending on the use of hardboard or laconite might require the boards to be conditioned. This is dampening the back with water to stretch the material and allowing it to dry out. This will stop the material misshaping later.

This type of sheet material should where possible be stored flat and clear of the ground.

lf stored on edge, care should be taken to avoid edge damage.

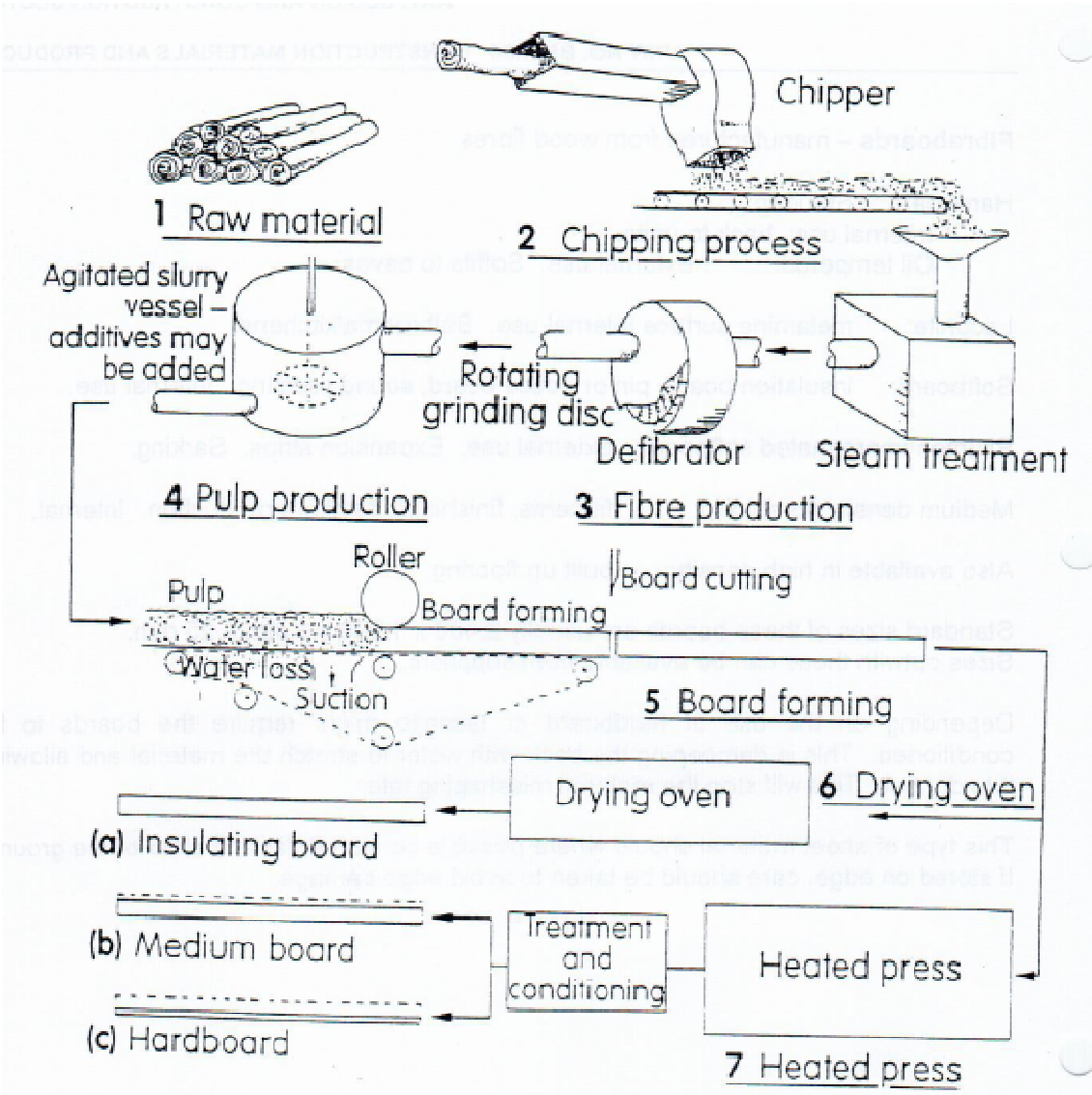


Figure 2.17 Guide to the manufacture of fibreboard using the wet process

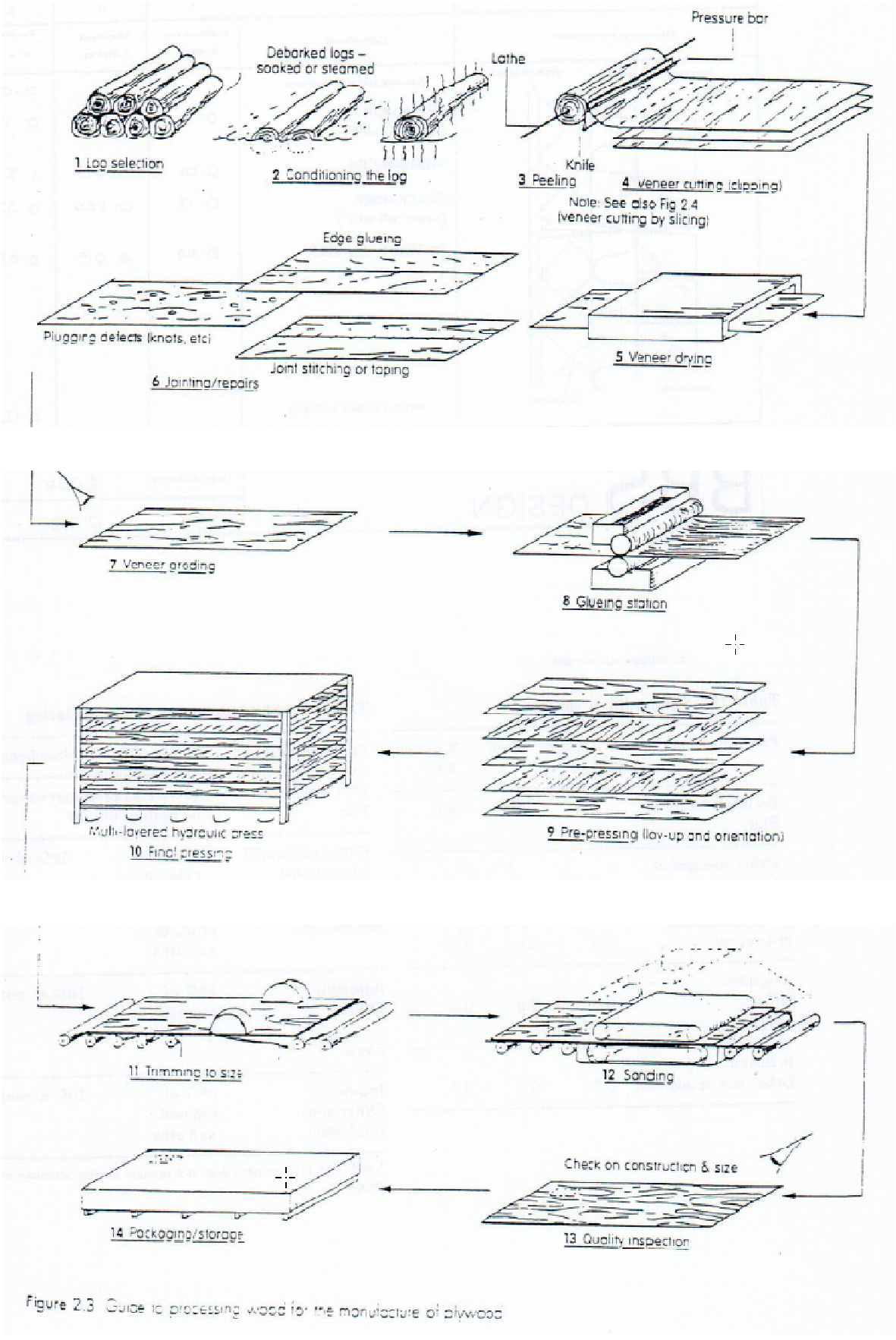


Figure 2.3 Guide to processing wood for the manufacture of plywood