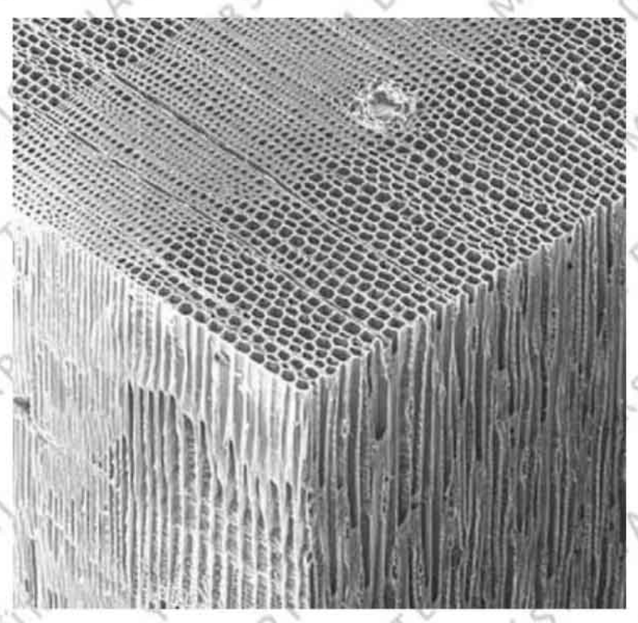
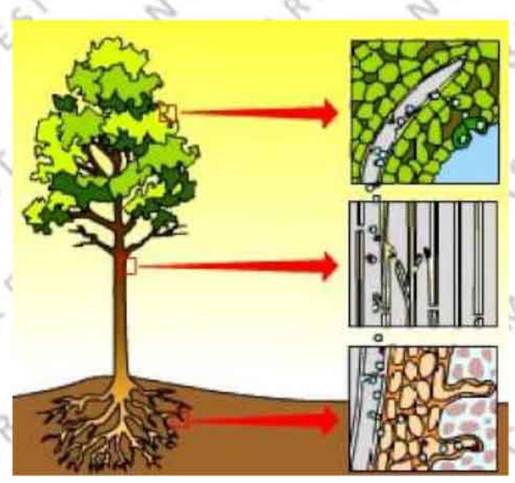
YILDIZ TECHNICAL UNIVERSITY – DEPARTMENT OF ARCHITECTURE
2017 -2018 ACADEMIC YEAR – SPRING SEMESTER
BUILDING MATERIALS LECTURE NOTES / Dr. Polat DARÇIN

BASIC MATERIALS – 4

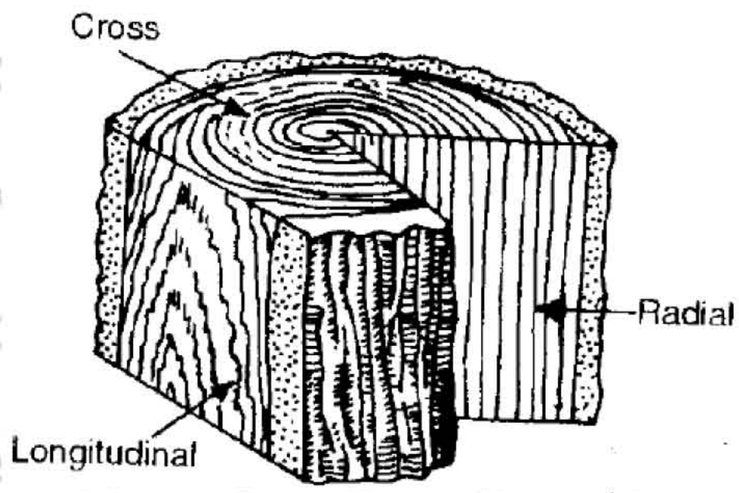
WOOD

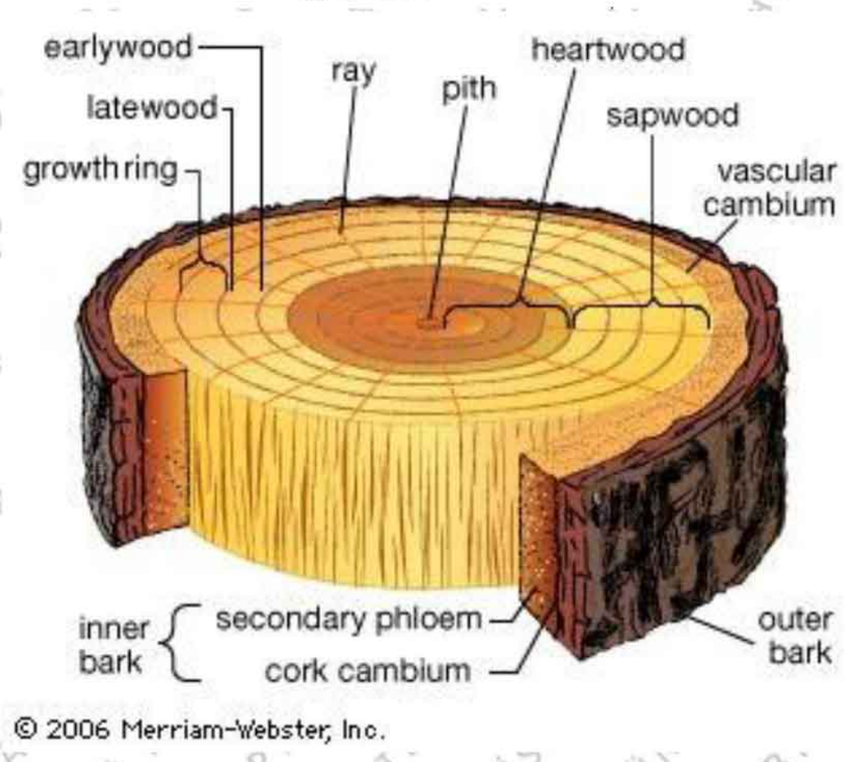


Wood is a **hard** and **fibrous** substance which forms a major part of the **trunk** and **branches** of a tree. It can also be defined as a natural polymeric material. It can be available for many parts of the world and easy to transport and handle, has more thermal insulation, sound absorption and electrical resistance as compared to steel and concrete. The terms timber and wood are often used synonymously, but they have distinct meanings in the building industry. **Wood** is the hard, fibrous material that makes up the tree under the bark, whereas **timber** may be defined as a wood which retains its natural physical structure and chemical composition and is suitable for various engineering works.



A tree can be divided into three portions, crown—composed of branches and leaves, trunk, and roots. The trunk accounts for about 80% of the total bulk of wood. 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.





The cells formed in the cambium layer are primarily **cellulose** and are commonly referred to as fibers because of their needle-like shape. They are cemented into groups by **lignin**, which gives the strength to wood. The comparative width of annual rings, the direction and the arrangement of the cells and fibers are the causes of the grains of the wood. Rapidly growing trees having wide annual rings produce coarse grained wood, while those of slower growth produce wood with narrow rings or fine grain. The wood is said to be straight-grained when the wood elements are straight and run parallel to the pith and cross-grained when the elements do not run parallel to the axis.

The structure of timber visible to naked eye or at a small magnification is called macro structure and that apparent only at great magnifications, the micro structure. Macro structure of the timber can be studied by cutting the trunk in **three directions (cross/transverse, longitudinal/tangential, radial)**. In the cross-sectional and radial ducts, the following main parts of a tree, e.g. **bark**, **cambium**, **sap wood**, **heart wood** and **pith**, become readily apparent. Each of the components has a specific function. The bark protects the wood against mechanical damage. Its inner layer, called bast conveys the nutrients from the crown downwards and stores them. The function of cambium is to grow wood cells on the inside and yeniden herkese merhaba smaller bast cells on the outside. The sapwood assists in the life process of tree by storing up starch and conducting sap. The cells in the sap wood are active. The heart wood gives a strong and firm support to the tree. With the growth of tree, the cells in the inner older portion of trunk gradually become inactive and lifeless, but do not decay. This portion of the trunk is called heart wood. At the centre of the cross-section is the pith, a small area occupied by friable tissues consisting of thin walled, loosely connected cells called pith. In a felled tree, it easily crumbles and rots. In the cross-sectional direction, nutrients pass from bast to the heart through groups of cells running at right angles to the cambium layers and are referred to as medullary rays.

Timber should be felled as soon as it is matured. The best time is midsummer or midwinter, when the sap is at rest. If it is felled, when the sap is vigorous in movement, the timber decays. If the tree is cut young, it yields soft wood and if it stands too long, the decay starts.

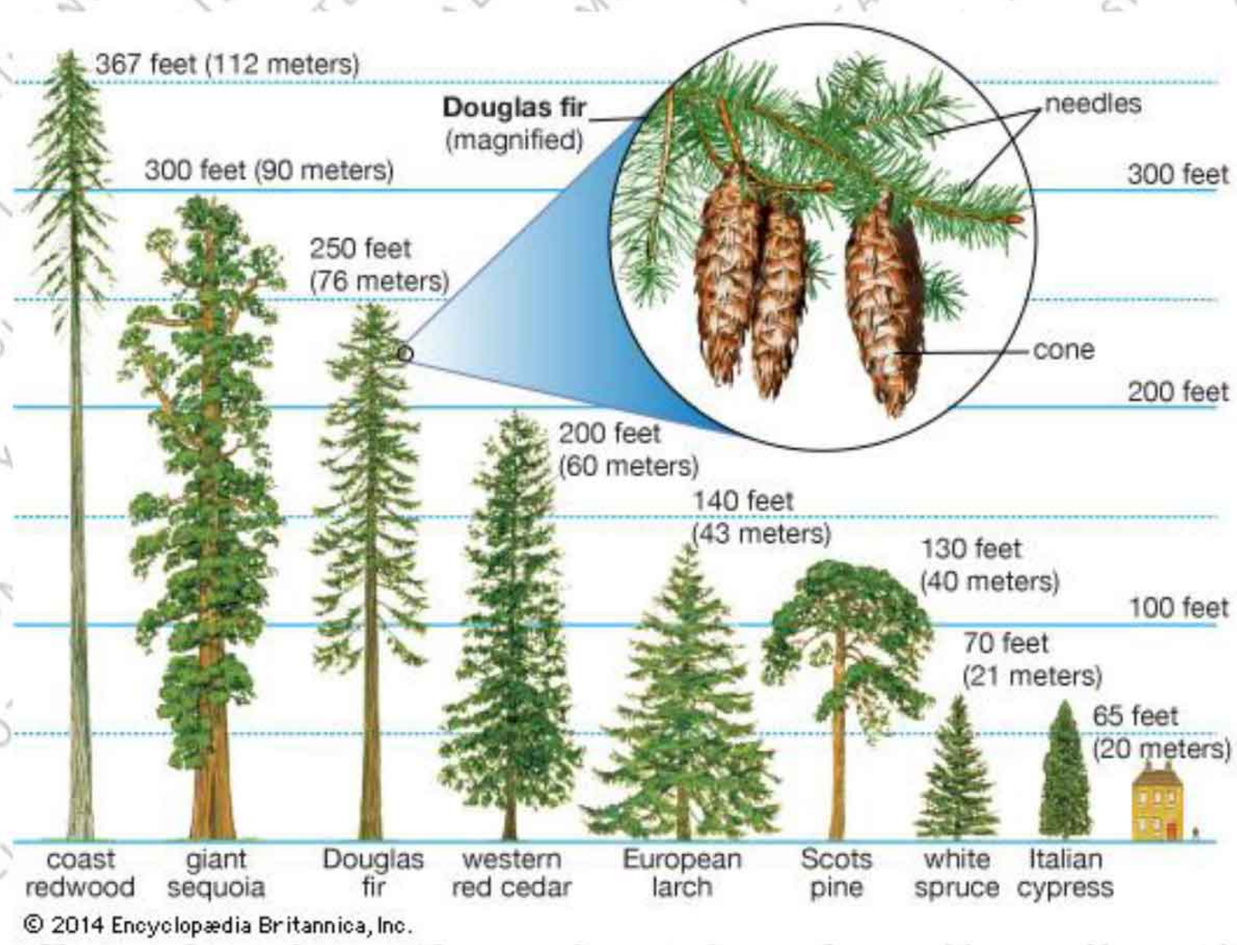
Classification of Trees

Trees are classified as endogenous and exogenous according to the mode of growth.

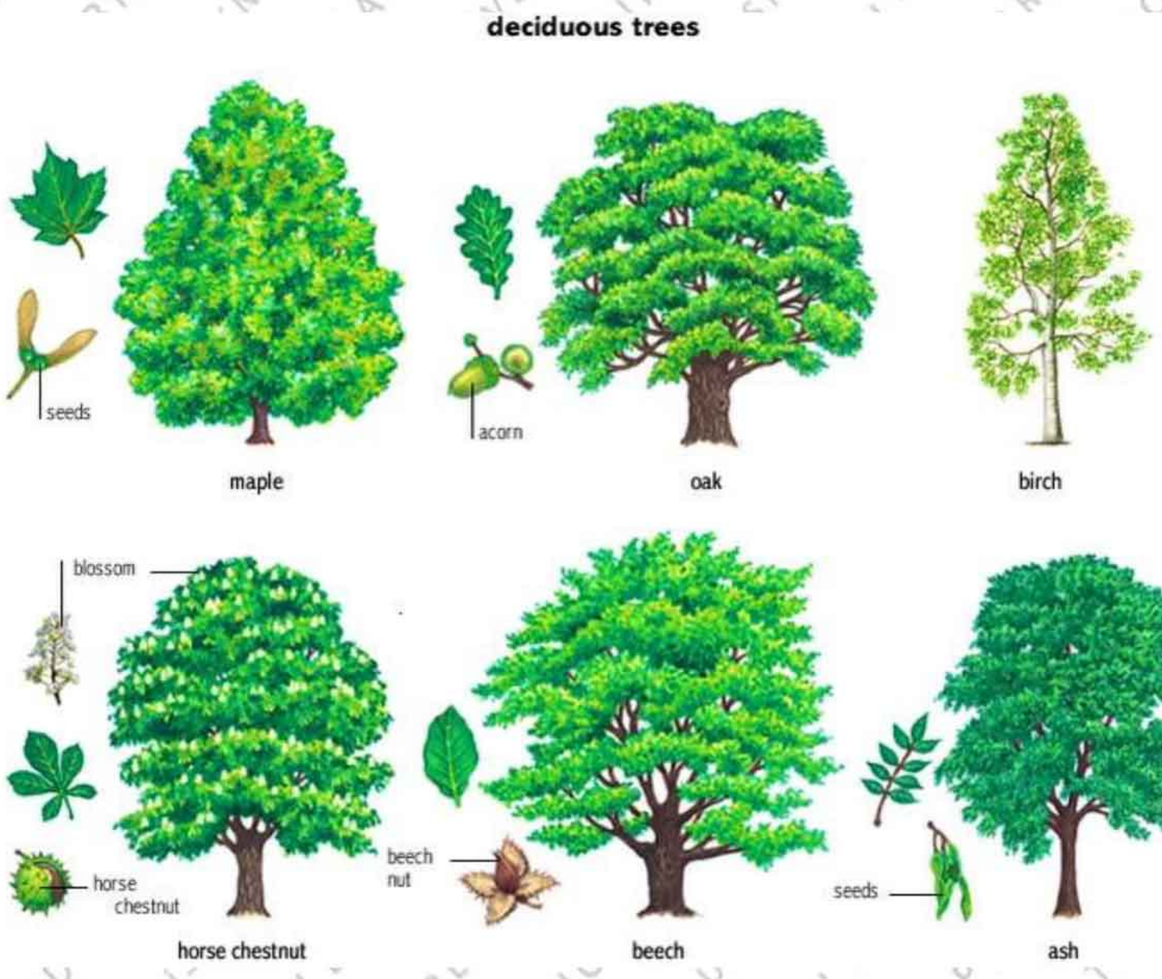
endogenous trees: Trees grow endwards, e.g. palm, bamboo, etc.

exogenous trees: Trees grow outwards and are used for making structural elements. They are further subdivided as

conifers: are evergreen trees having pointed needle like leaves, e.g. deodar, chirr, fir, kail, pine and larch. They show distinct annual rings, have straight fibers and are soft with pine as an exception, light in color, resinous and light weight.



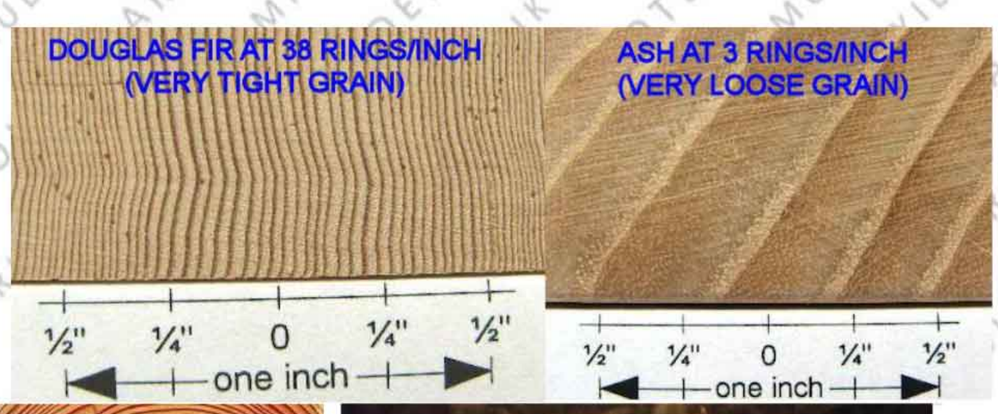
deciduous trees: have flat board leaves, e.g. oak, teak, shishum, poplar and maple. The annual rings are indistinct with exception of poplar and bass wood; they yield hard wood and are non-resinous, dark in color and heavy weight.



Characteristics of Good Timber

The principal characteristics of timber of concern are strength, durability and finished appearance.

1. Narrow annual rings, closer the rings greater is the strength.



2. Compact medullary rays, dark color, free from defects and uniform texture.

3. Sweet smell, a shining fresh cut surface without woolliness.

4. Heavy weight and when struck, sonorous sound is produced.

Seasoning of Timber

Timber cut from freshly felled trees is too wet for normal use and is dimensionally unsuitable. 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 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. 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.

Timber can be seasoned naturally or artificially.

natural or air seasoning: The log of wood is sawn into planks of convenient sizes and stacked under a covered shed in cross-wise direction in alternate layers so as to permit free circulation of air. The duration for drying depends upon the type of wood and the size of planks. The rate of drying is however very slow. Air seasoning reduces the moisture content of the wood to 12–15 per cent. It is used very extensively in drying ties and the large size structural timbers.

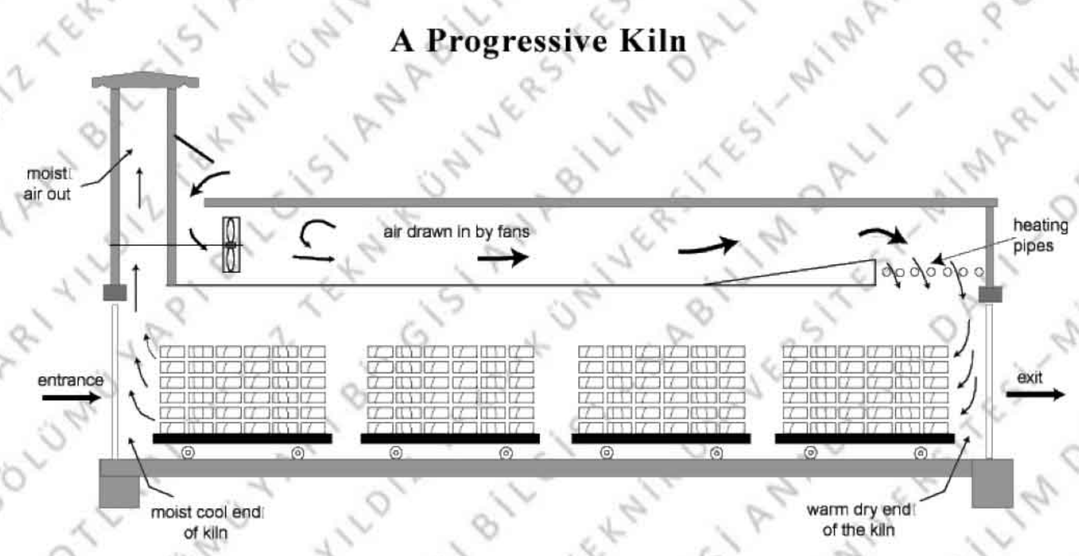
artificial seasoning: The prevalent methods of artificial seasoning are as follows:

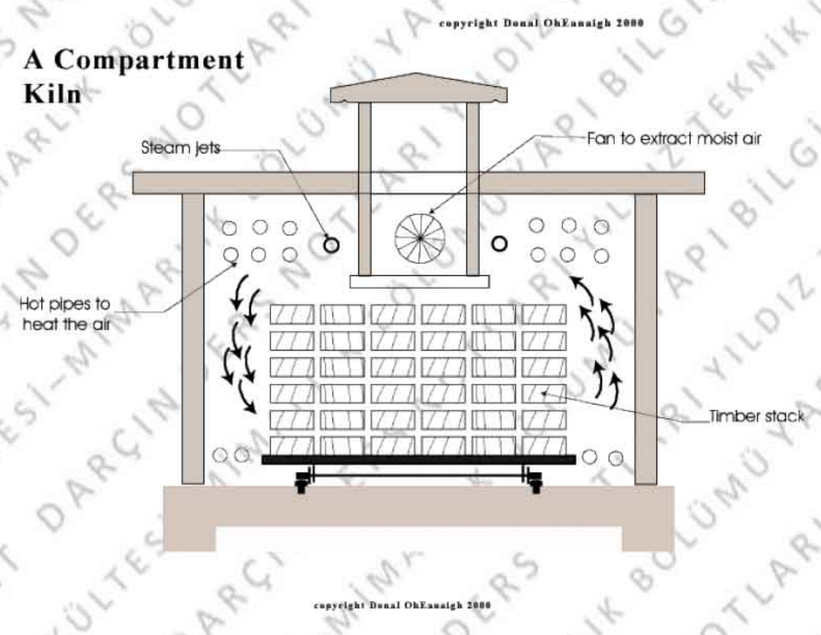
water seasoning: The logs of wood are kept completely immersed in running stream of water, with their larger ends pointing upstream. Consequently the sap, sugar, and gum are leached out and are replaced by water. The logs are then kept out in air to dry. It is a quick process but the elastic properties and strength of the wood are reduced.

boiling in water or exposing the wood to the action of steam spray is a very quick but expensive process of seasoning.

kiln seasoning is adopted for rapid seasoning of timber on large scale to any moisture content.

The scantlings are arranged for free circulation of heated air with some moisture or superheated steam. The circulating air takes up moisture required from wood and seasons it. Two types of kilns, the progressive and the compartment are in use. For most successful kiln-seasoning the timber should be brought to as high a temperature as it will stand without injury before drying is begun; otherwise the moisture in the hot outer fibers of the wood will tend to flow towards the cooler interior. With kiln drying there is a little loss in strength of timber, usually less than 10 per cent. Also, the wood is more thoroughly and evenly dried, thus reducing the hygroscopicity of the wood.





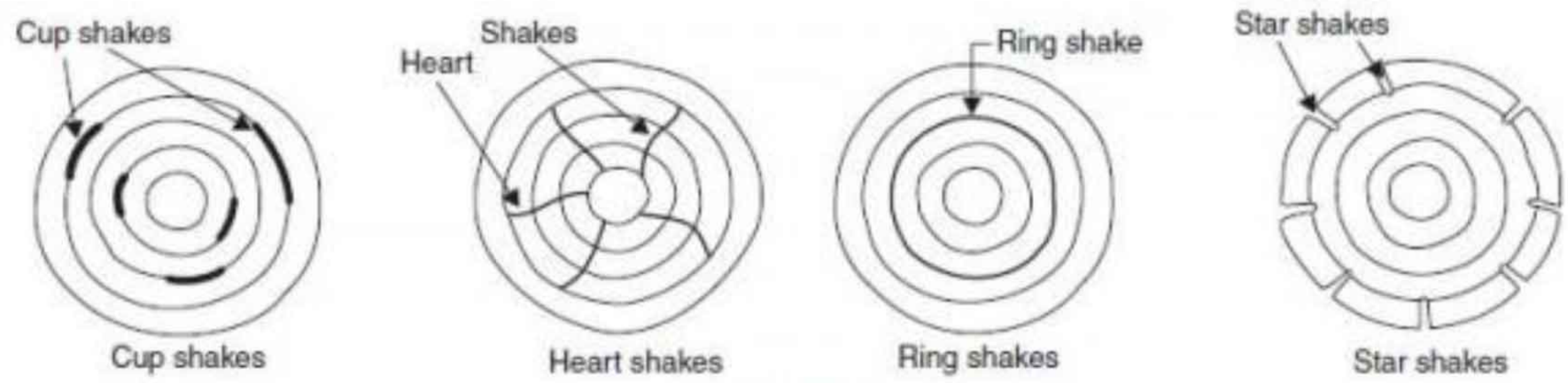
Defects in Timber

Defects can occur in timber at various stages, principally during the growing period and during the conversion and seasoning process. Defects affect the quality, reduce the quantity of useful wood, reduce the strength, spoil the appearance and favor its decay.

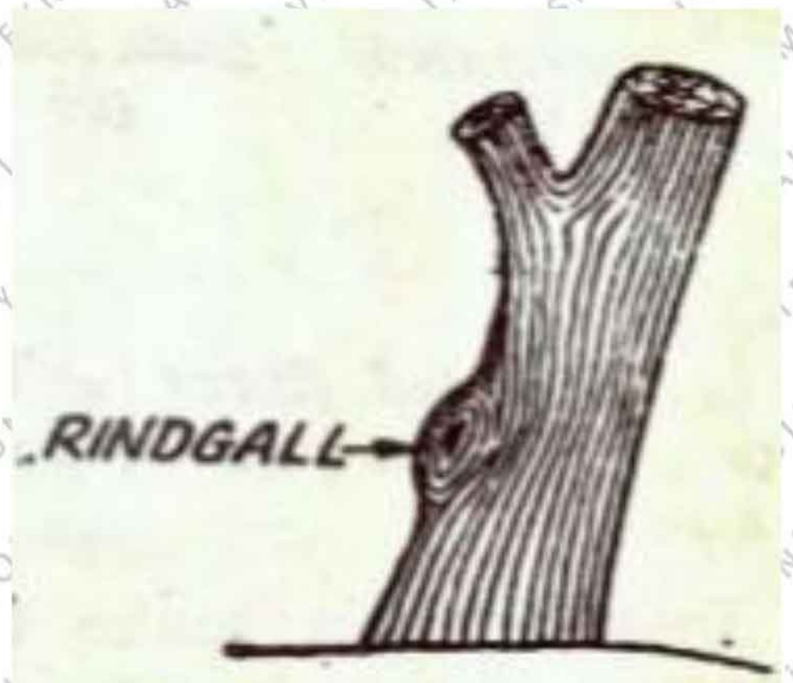
1. defects due to abnormal growth: Following are some of the important defects commonly found in wood due to abnormal growth or rupture of tissues due to natural forces.

a. checks are a longitudinal cracks which are usually normal to the annual rings. These adversely affect the durability of timber because they readily admit moisture and air.

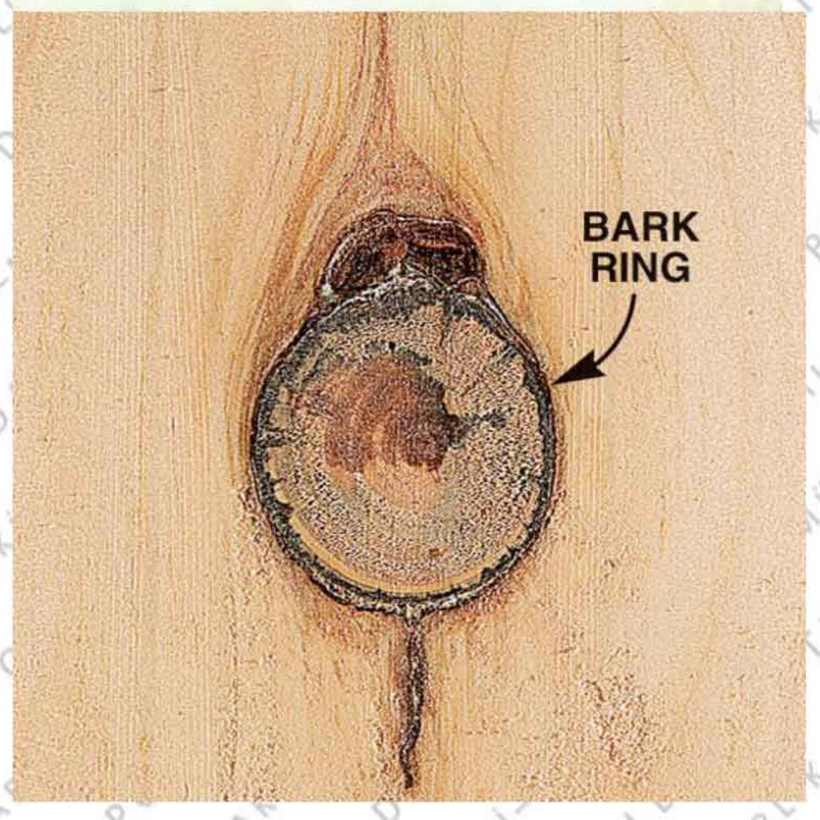
b. shakes are longitudinal separations in the wood between the annual rings. These lengthwise separations reduce the allowable shear strength without much effect on compressive and tensile values. The separations make the wood undesirable when appearance is important.



c. rindgall is characterized by swelling caused by the growth of layers of sapwood over wounds after the branch has been cut off in an irregular manner. The newly developed layers do not unite properly with the old rot, thereby leaving cavities, from where decay starts.



d. knots are bases of twigs or branches buried by cambial activity of the mother branch. The root of the branch is embedded in the stem, with the formation of annual rings at right angles to those of the stem. The knots interrupt the basic grain direction of the wood, resulting in a reduction of its strength. In addition these affect the appearance of the wood. A dead knot can be separated from the body of the wood, whereas live knot cannot be. Knots reduce the strength of the timber and affect workability and cleavability as fibers get curved. Knots are classified on the basis of size, form, quality and occurrence.

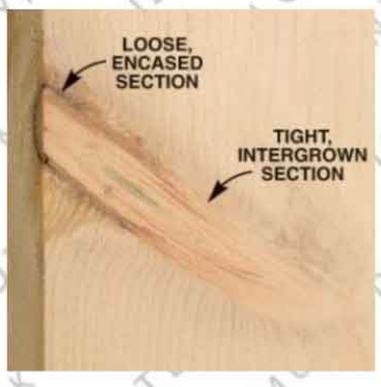


size of knots: pin knot (under 12 mm), small knot (12–20 mm), medium knot (20–40 mm) and large knot (over 40 mm).

form of knots:

round knot

spike knot: a round knot exposed by sawing lengthwise



quality of knots:

sound knot: as hard and solid as the surrounding wood

decayed knot: contains advanced decay and is softer than the surrounding wood

encased knot: the annual rings fail to grow into the fibers of the surrounding wood

occurrence of knots:

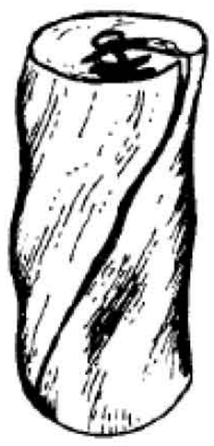
single knot: when wood fibers deflect around one knot

cluster knot: when wood fibers deflect about two or more knots as a unit and

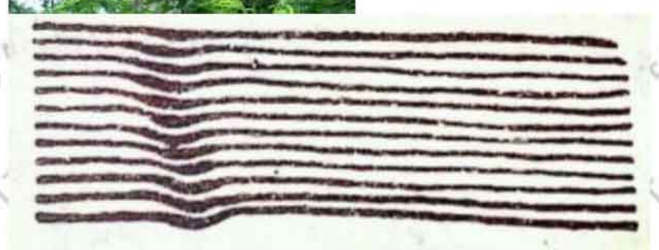
branch knot: two or more knots radiating from a common centre

e. end splits: are caused by greater evaporation of sap at the end grains of log and can be reduced by painting the exposed end grains with a water proof paint or capping the exposed end with hoop iron bandage.

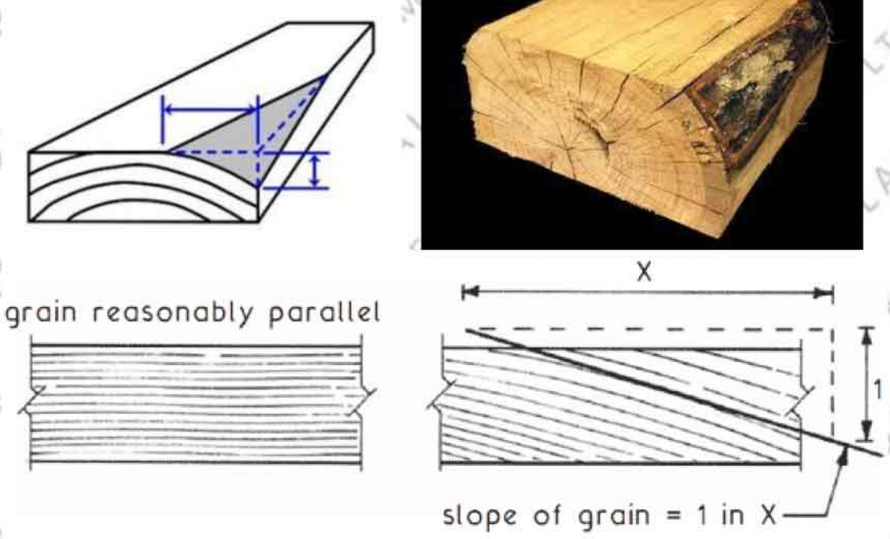
f. twisted fibers: are caused by wind constantly turning the trunk of young tree in one direction.



g. upsets: are caused by the crushing of fibers running transversely during the growth of the tree due to strong winds and unskilled felling consequently resulting in discontinuity of fibers.

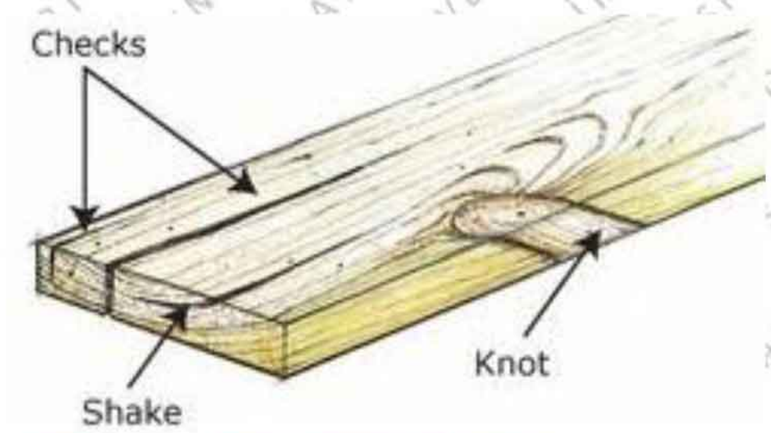


2. defects due to conversion: Conversion is the term used to describe the process whereby the felled tree is converted into marketable sizes of timber. Conversion defects are basically due to unsound practice in milling or attempts to economize during conversion of timber. A **wane** occurs in timber which contains, on one or more faces, part of bu hafta yeni şifreleri ilerleyen sayfalarda vereceğim the bark or the rounded periphery of the trunk. This reduces the cross sectional area, with consequent reduction in strength in the parts affected. **Excessive slope of grains** may also be classed as a conversion defect when conversion has not been done parallel to the axis of the trunk.



3. defects due to seasoning: These defects are directly caused by the movement which occurs in timber due to changes in moisture content. Excessive or uneven drying, exposure to wind and rain, and poor stacking during seasoning can all produce **distortions** in timber. These defects result in loosening of fixings or disruption of decoration, or both. The common types of seasoning defects are:

a. checks: longitudinal separation of fibers not extending throughout the cross-section of wood;



b. splitting: separation of fibers extending through a piece of timber from one face to another;

c. warpage: consists of cupping, twisting and bowing.

Diseases of Timber

dry rot: It is decomposition of felled timber caused by the action of various fungi. The fungus reduces fibers to fine powder and the timber loses its strength. This disease is highly infectious and causes tremendous destruction. It occurs when the timber is imperfectly seasoned and placed in a moist, warm and confined atmosphere having no free access of air. Fungus rapidly dies when exposed to air or sunlight. The best remedy is to cut away the affected part and paint the remaining part.

wet rot: When timber is subjected to alternate wet and dry conditions, decomposition of tissues takes place. This is not caused by fungal attack. In a living tree, it is set up by the access of water through wounds in the bark and causes the decomposition of sap and fibers of the tree. This may also occur when timber is seasoned by exposing it to moisture. To avoid wet rot, well seasoned timber is used with preservatives and paints.

Decay of Timber

Timber does not deteriorate by pure ageing. It is, however, affected by destructive elements, such as weathering, chemical attack, fungi, insects or rodents. The most crucial amongst these are fungi and insects, described as follows.

1. decay due to fungal and bacterial attack: Wood is essentially an organic substance, made up of a skeleton of cellulose impregnated with lignin. The organic substances are susceptible to attack by both bacteria and fungi. Bacteria are the smallest of living organism and do not cause any serious damage to timber, except for some discolorations. Fungi are a system of plant organism which live in and attack timber causing rot and decay.

The method by which bacteria decompose wood is probably similar in nature to a fungal attack. Fungi reproduce through minute particles called spores, millions of which are produced at the fruiting stage. These spores send out mycelia, which in turn destroy the wood tissue by secretions of solvent chemicals and enzymes. After a considerable proportion of the cell wall has been destroyed by mycelia, the wood becomes brittle and weak.

The basic requirements for the existence of fungi are moisture, suitable temperature and food supplies. The wood itself forms the food supply and optimum temperature conditions are in the range of 18°C to 30°C. Some fungi like *Merulius lacrymans* and *Poria incrassata* provide moisture by themselves and seem to thrive even in fairly dry wood leading to what is technically known as dry rot. The various symptoms of incipient decay are discoloration, abnormal mottled appearance, roughness of surface and presence of soft spots of intense discoloration.

One of the prime requirements in the control of fungal attack is the dryness of timber. The timber should not be subjected to alternate wet and dry conditions. When this is unavoidable, a proper preservative treatment should be made. Felled trees should be air-dried as rapidly as possible and sawn timber should be kiln-seasoned properly in accordance with good air-seasoning practice.

Thereafter, they should be protected from rain and other sources of moisture. It should be ensured that adequate ventilation is there around the timber to prevent fungal attack. Also, no timber used in a structure should contain sapwood which is more susceptible to fungal attack because of the food supplies stored in its parenchyma.

2. damage due to insects

termites: Termites, or white ants, are the most destructive of all insect agencies. They are small, social insects which form vast colonies and completely excavate the wood at the centre leaving the outer shell intact.

beetles: are small insects and they cause rapid decay of timber by converting them into fine powder. Usually, the outer shell of timber remains intact and hence the timber looks sound from outside until it fails completely.

powder post beetles *(Family Lycridae):* attack sapwood of hardwoods with large pores. The eggs are laid in the pores and the larva that comes out eats through the wood, leaving a very fine powder.

long-horn beetles *(Cerambycidae):* are 6 mm to 20 mm in size. They normally do not attack seasoned wood and mainly thrive on timber in the forest yard. Their bore holes are elliptical in cross-section.

ambrosia beetles (pin hole beetles): are very common. They are less than 6 mm in size
The larva bores tunnels through the wood which are filled with the characteristic oval-shape pellets.

death watch beetles *(Xestobium):* are somewhat larger and the tunnels made by these are also bigger and filled with bun-shaped pellets. They normally attack decayed timber.

carpenter ants: are usually black in color. Unlike termites, they do not eat wood but merely tunnel it out for habitation. Timbers are often riddled with galleries before the presence of ants is detected.

Control of insects is much simpler than eradicating fungi. The tunnels made by the insects help in the deep penetration of toxic elements that are used to destroy them. Large scale fumigation is carried out using powerful hydrocyanic acid gas, but this method is not recommended as this gas is highly poisonous and dangerous. The use of creosote is also not desirable because of its odor and undesirable color. A good insecticide which does not damage the paint or varnish and vaporizes easily is yet to be found. The vapors should also not be dangerous to human beings. It is found that no insecticide can fulfill all these requirements in one application and periodic applications are

required to be effective. The best alternative is common turpentine mixed with a small quantity of orthodichlorobenzene. This vapor is very deadly to insects and is not poisonous to human beings and animals.

Preservation of Timber

The durability of wood is decidedly variable property. If well-seasoned and kept in a dry place, if immersed in water, or if buried in ground, wood often lasts for centuries. When, however, unprotected wood can easily decay by swelling (when it gets wet), fungi, insects, fire, etc. The rapidly with which it decays depends on external conditions, the species of the wood, its preliminary conditioning, and its structure. One of the basic approaches to protect it is to create conditions unfavorable to fungi. Low humidity, heat and water insulation, etc. help to maintain the timber dry and thus make it insusceptible to damage by fungi. Water absorption, decay and other undesirable effects can be minimized by coating the surface of wood with polymer films or drying oils, oil base paints, varnishes and synthetic enamels. Preservative treatment of timber is not supposed to improve its basic properties like mechanical, electrical, or chemical properties.

oil type preservatives: applied over outside of exposed timber, give unpleasant smell and are not suitable when timber is to be painted. The types in use are creosote, carbolinium, solignum etc. with or without admixture with petroleum or suitable oils having a high boiling range.

organic solvent preservatives: consists of toxic chemical compounds, e.g. pentachlorophenol, benzene-hexa-chloride, dichlorodiphenyl trichloro-ethane (D.D.T). These are dissolved in suitable organic solvents or in petroleum products. The treated timber can be painted, waxed or polished.

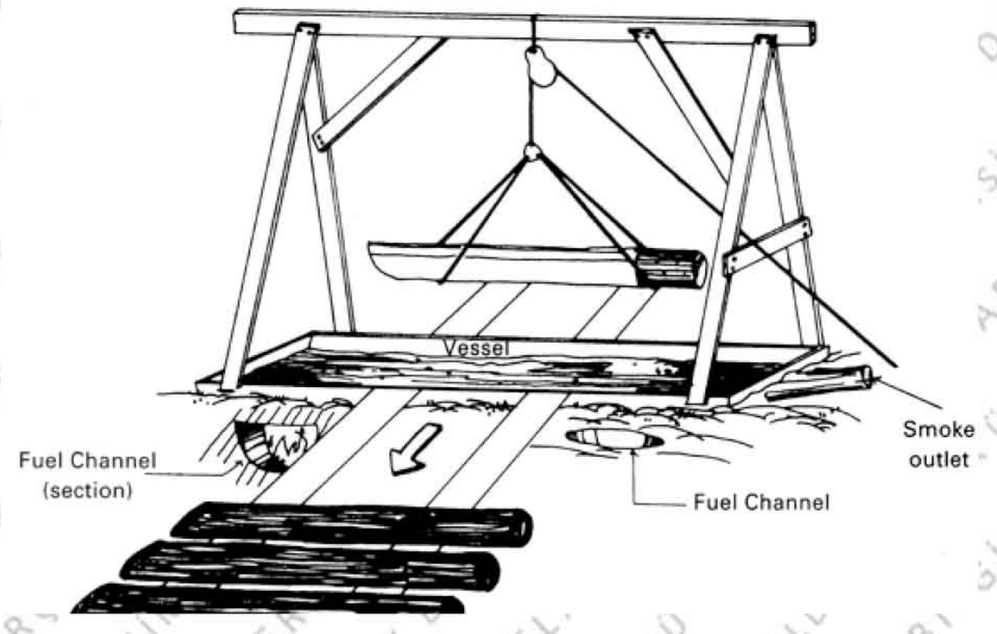
water soluble preservatives: are odorless organic or inorganic salts and are adopted for inside locations only. If applied over outside surfaces, the salts can be leached by rainwater. Examples of leachable (3A-water soluble) type of preservatives are zinc chloride, boric acid (borax), etc.

Treatment Processes:

surface applications: is done either by spraying, dipping or by brushing the preservative for a short period on thoroughly debarked timber. For the oil type preservatives, the moisture content in timber should not be more than 14 per cent. With water soluble preservatives, a moisture content of 20 to 30 per cent is permissible. At least two coats should be applied. The second and subsequent coats should not be applied until the first one

has dried or soaked into the wood. Where possible, the treatment is done hot. Surface treatment is used mostly for treating timber at site and for retreatment of cut surfaces.

hot and cold process ensures sterilization against fungi and insects. The timber is submerged in the preservative solution. This is then heated to about 90° to 95°C and maintained at this temperature for a suitable period depending on the charge. It is then allowed to cool until the required absorption is obtained. During the heating period, the air in the timber expands and is partially expelled. While cooling, the residual air in the timber contracts and creates a partial vacuum which causes the preservative to be sucked into the timber. Generally two baths are used, the first containing water where the hot treatment is given and the second the cold bath containing the preservatives into which the timber is transferred immediately after heating. This overcomes the danger of precipitation of chemicals at high temperatures. This arrangement also helps to make the process continuous in case the quantity of timber is large.

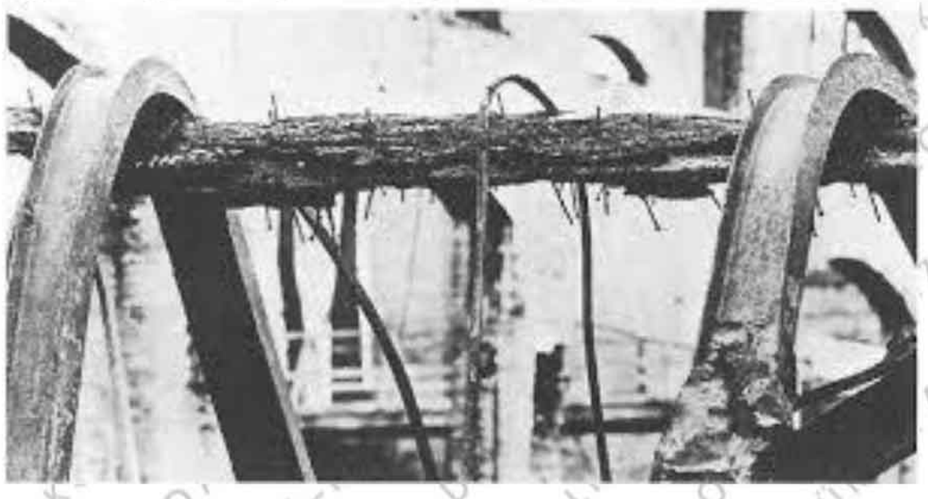


boucherie process: Sapwood of almost all green timbers with the bark on and of bamboos in green condition, soon after felling, can be treated using any of the inorganic water soluble preservatives by this process. The log of wood attached to the hose pipe and connected to the reservoir containing preservative. Due to hydrostatic pressure, the preservative displaces the sap in the wood.

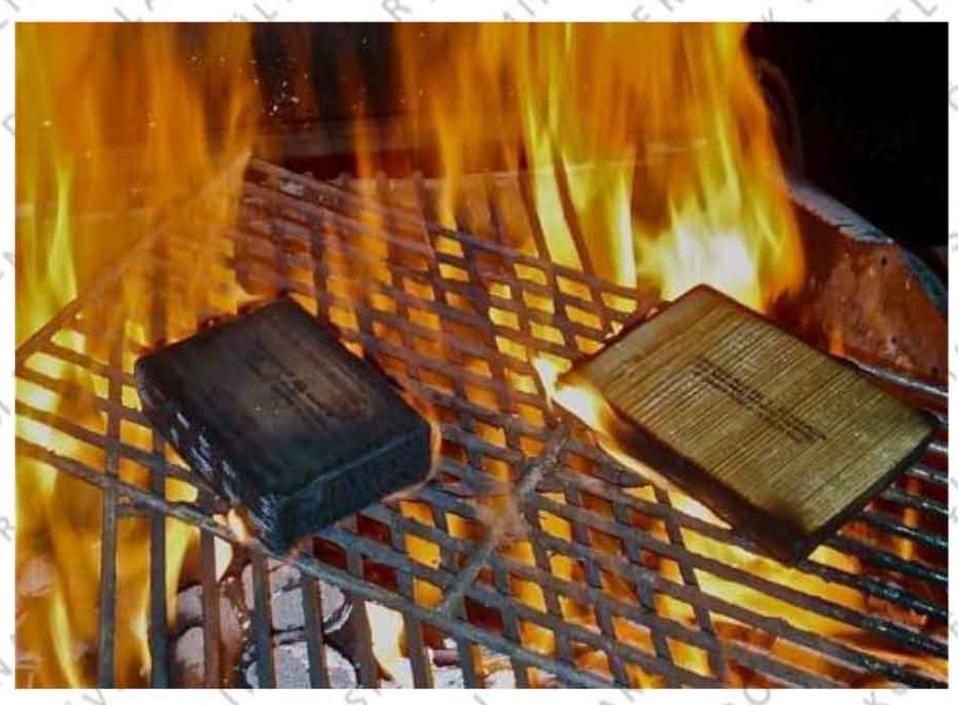
full cell or bethel process: is essentially a pressure process and is used when maximum absorption of the preservative is desired. The timber charge is introduced into the cylinder. The door is tightly closed and then a vacuum of at least 560 mm of mercury is created and maintained for half an hour to remove as much air as possible from the wood cells. At the end of the vacuum period, the preservative is introduced into the cylinder, with the vacuum pump working.

Fire Resistance and Fire Proofing of Timber

Timber is very inflammable. The fire hazard of timber structures is, however, often overemphasized. When wood burns, the first step is the vaporization of moisture (118°C) and the next is the volatilization of extraneous materials (110–165°C). As the temperature builds up, the evolution of gases is more rapid and the surface of the timber begins to char. Finally, the point is reached at which the wood itself begins to glow and to ignite (220–390°C). Until this point is reached, the woody portion does not support its own combustion. Quick ignition of inflammable gases and glowing of charcoal occur at about 390–530°C. Fire proofing makes timber resistant to fire to a degree that it is difficult to ignite and support its own combustion. The fire resistance of wood can be enhanced either by impregnating it with chemicals like phosphates of ammonia, mixture of ammonium phosphate and ammonium sulfate, borax and boric acid, sodium arsenate, sodium tetra-borate or by designing wood to provide slow burning construction.



impregnating with chemicals: As chemicals are water soluble, they are leached out due to rain when applied on exposed structures. Therefore, a second shallow impregnation with a fire retardant, water-repellent sealer or paints like flamex and bitulac fire-retardant paint is applied which substantially retards leaching. Fire-retardant salts are impregnated by pressure process. The surface of wood is painted by a weak solution of sodium silicate. Thereafter slaked lime solution of the consistency of a paste is applied followed by the application of concentrated solution of sodium silicate in two coats, the second being applied after 6 hours of the first coat.



surface coating: The most commonly used flame retardant coatings are cement grouts, clay-sulfate paste; paints such as silicate, chloride, phosphate paints and; emulsions like chloro paraffin. Some fire retardants (chemicals) form a film on the surface of wood and decompose under heat yielding non-inflammable gases that dilute the inflammable gases and consequently retard the ignition of the latter. Some of the other fire retardants have low melting point.

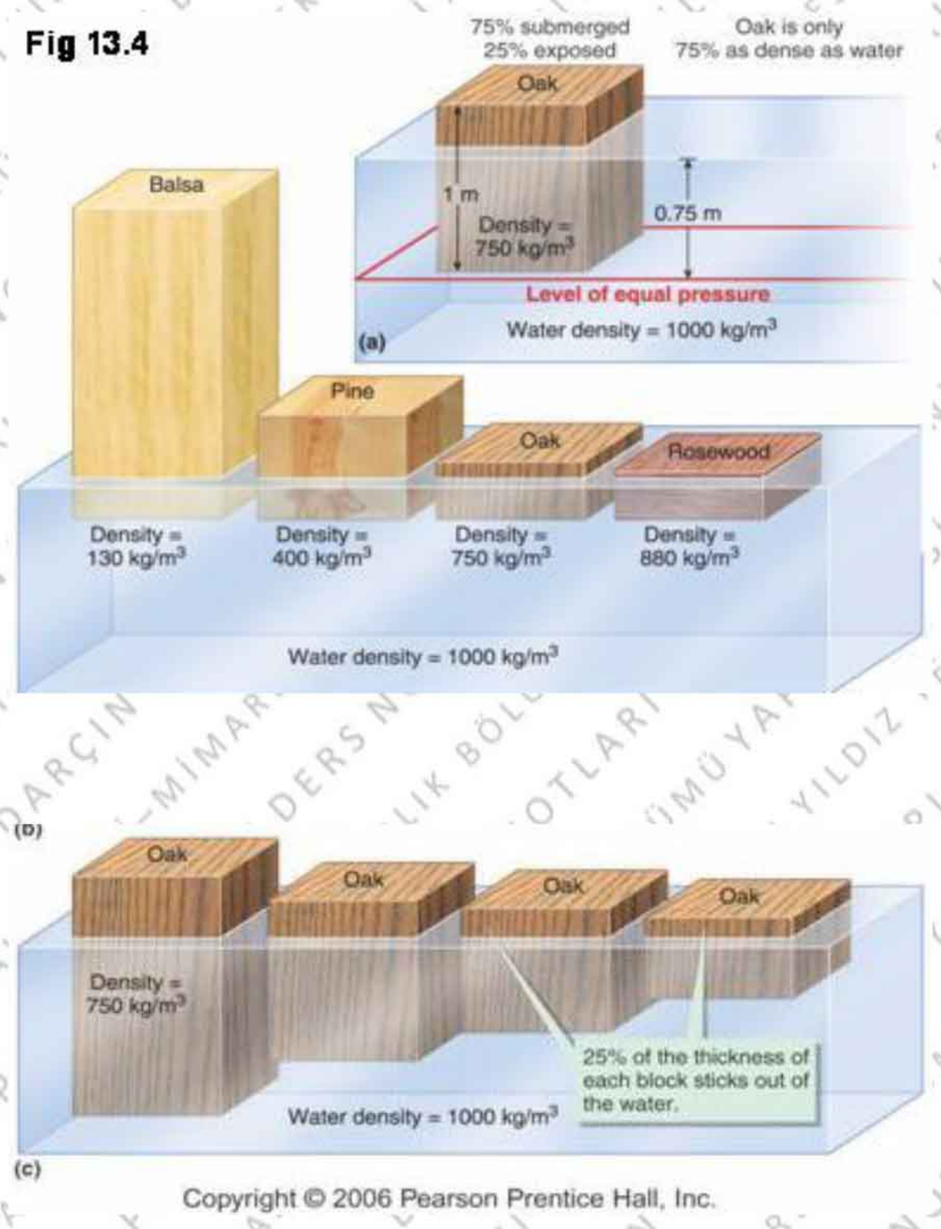
These melt under heat and form a barrier to the supply of oxygen to the inside.

Properties of Timber

Physical Properties:

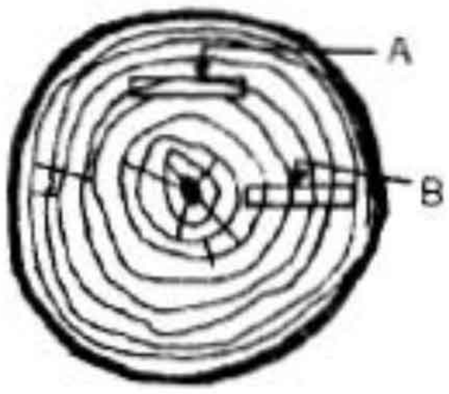
density and specific weight: All the mechanical properties of clear wood are related to its density, which varies directly with the apparent specific gravity. The true specific gravity of wood is approximately equal for all species and averages 1.54, whereas the specific weight and apparent specific gravity vary with density[1] of wood. The percentage of moisture in the wood has a very large effect upon the specific weight and hence true comparisons of this property can only be made on dry specimens.

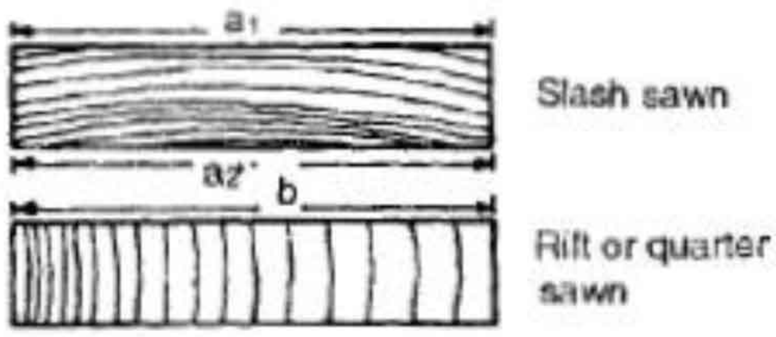
Fig 13.4



bulk density: depends on the volume of pores and moisture content of the wood. For most wood species, the bulk density is less than density. Bulk density value is used to determine the quality factor which is the ratio of compressive strength to the bulk density. It is 0.6 for pine and 0.57 for oak.

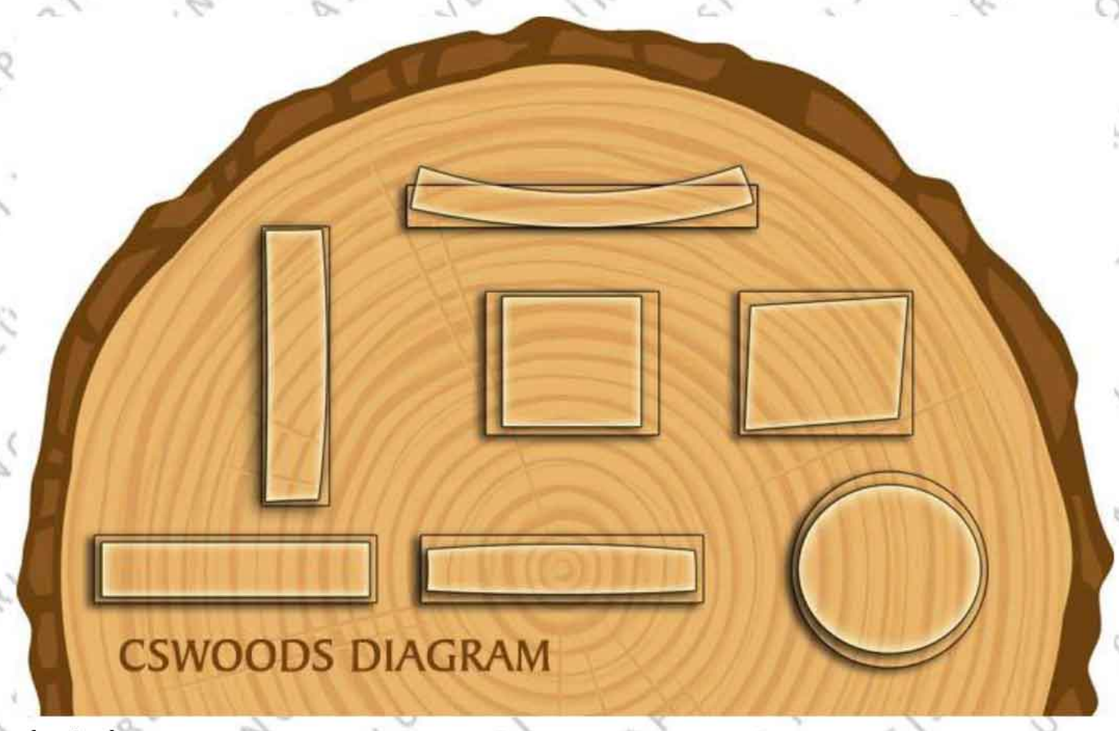
moisture movement: Timber is liable to shrink or swell with the movement of moisture. This movement is not the same in all the directions. The figure below shows two pieces A and B cut from a log. In piece A, the layers producing the annual rings run roughly parallel to the face of the timber, while in piece B, they run roughly at right angles to the face. **Movement of the wood due to variations in moisture content is greatest in the plane of the annual rings.** The movement a1 will be greater than movement b. Also, as a2 is nearer to the condition of b, it will move rather less than a1. It is clear, therefore, that if a piece of üçüncü ve dördüncü şifreler: “a part” timber is to be used as a board or panel, it will move less if cut like B than like A. It should also be obvious that the slightly varying tendency to movements on the faces of piece may lead to stresses which will cause it to warp. Recommended moisture content for structural elements is 12–20 per cent for doors and 10–16 per cent for windows.



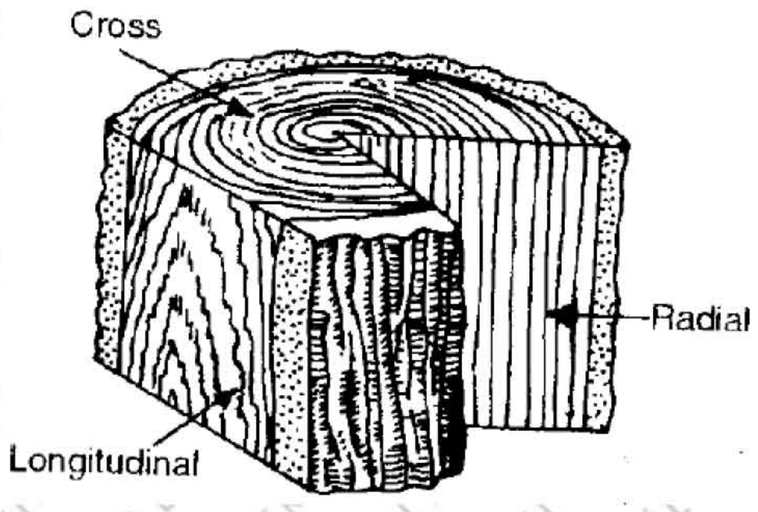


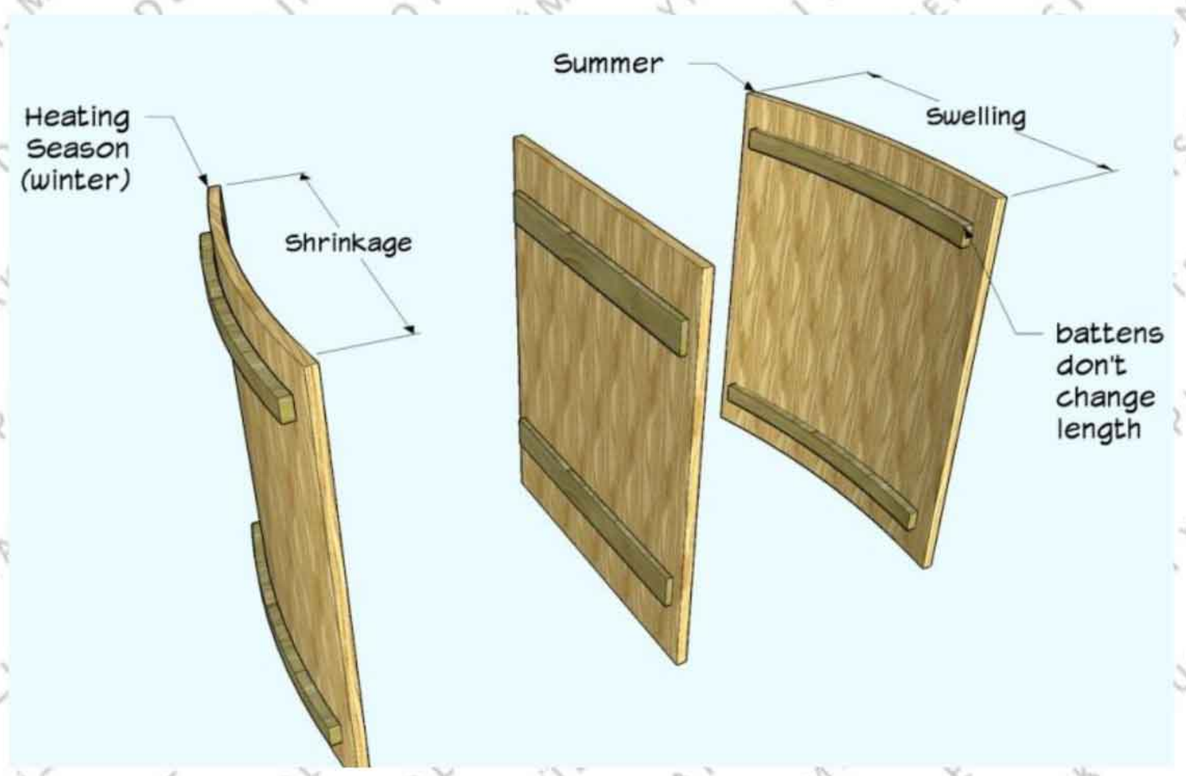
[1] Since wood in the lower part of the trunk of a tree is denser than that higher up and since the densest wood at any given height is situated between the pith and middle ring of the cross section, a small variation in the strength of wood due to the position of the tree will be found.

shrinkage is the reduction in linear and volumetric dimensions in drying of wood. Evaporation of capillary water is not accompanied by shrinkage, the latter taking place only when hygroscopic moisture evaporates. Because of structural non-uniformity, wood shrinks or swells irregularly in various directions. Linear shrinkage along the fibers lies between 0.1 and 0.3 %, in radial direction between 3 and 6 % and in longitudinal direction between 7 and 12 %. In general, the radial shrinkage of wood is 60 % of the longitudinal, and the cross shrinkage is negligible. Therefore, the volumetric shrinkage is practically 1.6 times the longitudinal shrinkage.



shrinkage





shrinkage and swelling

swelling: is the capacity of wood to increase both its linear and volumetric dimensions when it absorbs water. Swelling of wood along the length of fibers ranges from 0.1 to 0.8 %, 3 to 5 % in the radial direction and 6 to 12 % in the longitudinal direction.

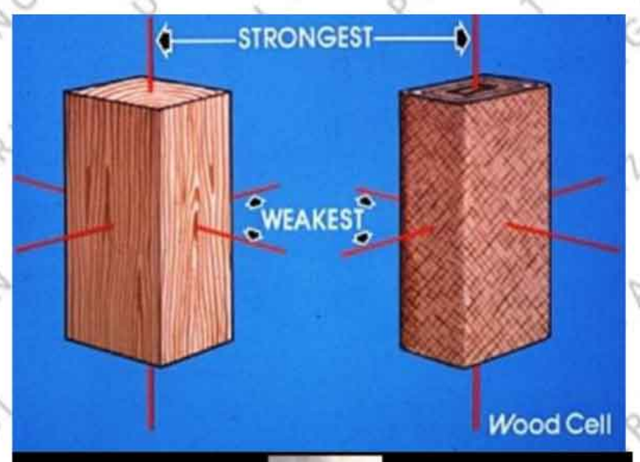
heat conductivity: is quite low. The coefficient of heat conductivity along the fibers is 1.8 times greater than that across the fibers and averages 0.15 to 0.27 K cal/mh°C. As the bulk density of wood increases and its moisture content decreases, the amount of air entrapped inside cavities decreases, the effect being greater heat conductivity of wood.

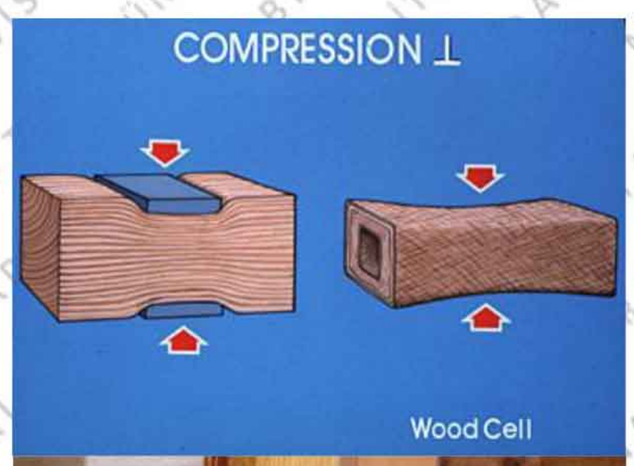
sound conductivity: The velocity of sound in wood is 2 to 17 times greater than that in air and as such wood may be considered to have high sound conductivity.

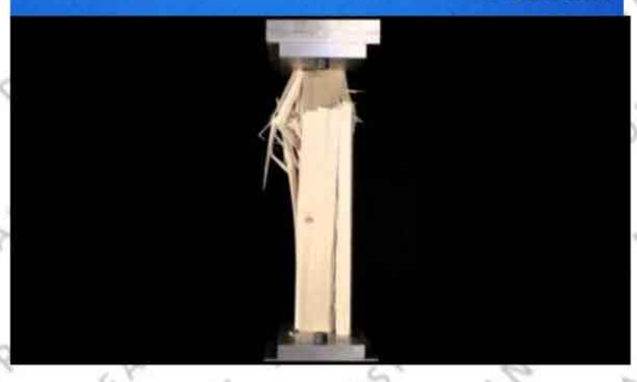
resistance to acids and alkalis: Wood is not affected by weak alkali solution but decays in an acid medium (pH< 4).

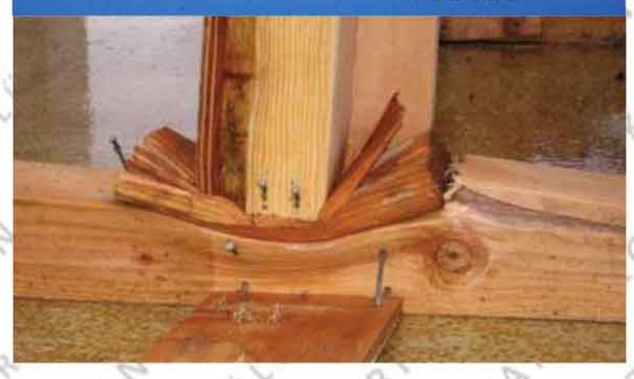
mechanical properties: Wood has three principal axes—longitudinal, radial and tangential— along which properties are fairly constant. Since wood is a non-isotropic material, it has three values of modulus of elasticity varying by as much as 150 to 1, three shear moduli varying by 20 to 1, and six Poisson's ratios varying by 40 to 1. There is no sharply defined elastic limit in wood but there is a proportional limit. It is a ductile material.

compression strength: When subjected to compressive force acting parallel to the axis of growth, wood is found to be one of the strongest structural material. Columns and posts are, therefore, often fashioned of it. However, compressive strength perpendicular to fibers of wood is much lower than that parallel to fibers of wood.









tensile strength: When a properly shaped wooden stick is subjected to tensile forces acting parallel to the grain it is found to have greater strength that can be developed under any other kind of stresses. Indeed, the tensile strength of wood parallel to the grain is so great that much difficulty is encountered in designing end connections so that the tensile strength of a piece can be developed. Therefore, wood tension members are rarely used.

bending strength: Wood well withstands static bending, owing to which it is widely employed for elements of buildings, e.g. beams, slabs, rafters, trusses, etc. The initial failure of long beams of uniform width is indicated by a wrinkling of the overstressed compression fibers, much like the failures which occur in compression prisms. Final failure of such beams is generally in tension. It is accompanied more or less by snapping as the individual fibers begin to break when the maximum load is reached.

cleavability: is the measure of the ease with which wood may split. Most hardwoods split more easily along radial planes than along longitudinal surfaces. Woods which must be fastened by nails and screws should have a high resistance to splitting. Among the conifers, with an exception of longleaf pine, the difference in cleavage strength in the two directions is not great.

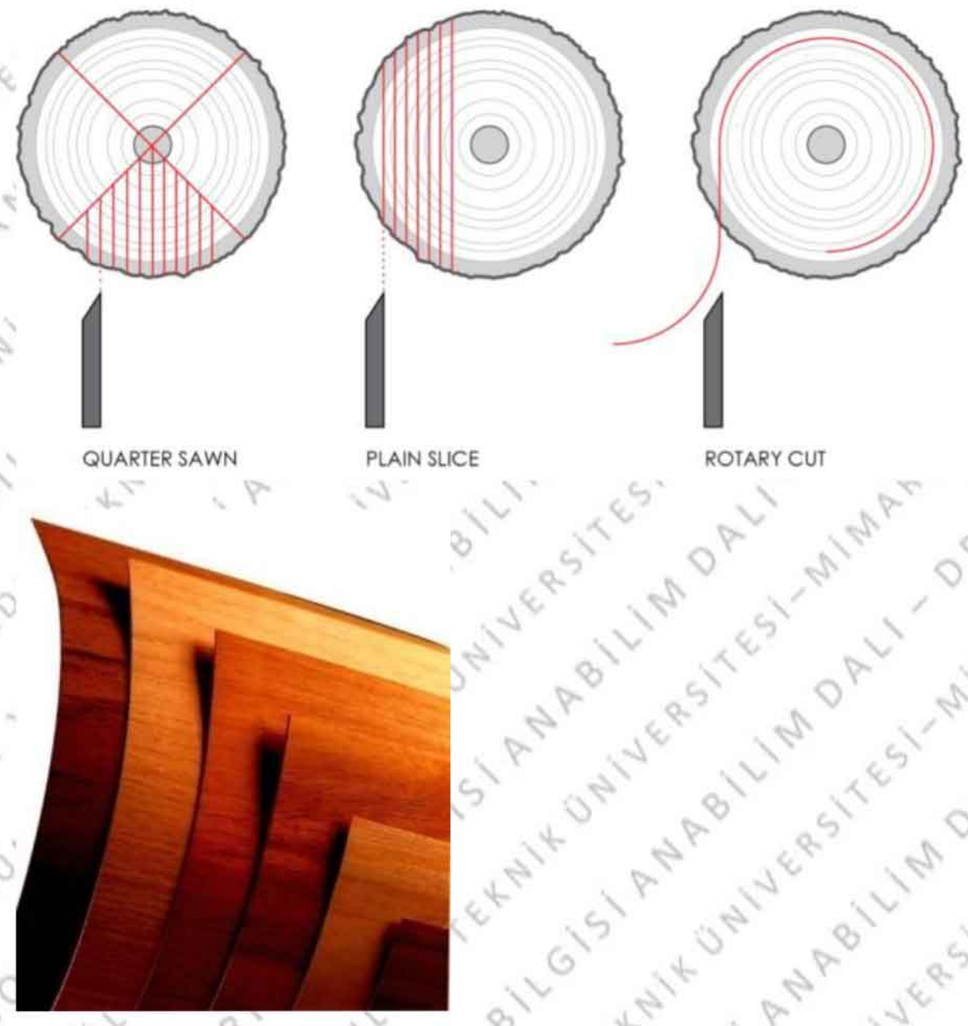
hardness: is defined and measured as resistance to indentation and resistance to scratching. Both are important properties in woods used for finishing and for furniture. These properties, together with the ability to wear without splintering, determine the wearing resistance of wood for floors and pavements.

the difference between soft wood and hard wood

property	soft wood	hard wood
color	lighter	darker
growth	faster	slower
weight	lighter	heavier
annual rings	distinct	indistinct
heartwood and sap wood	cannot be distinguished	can be distinguished
strength	strong along the grains	strong along and across the grains
conversion	easy	difficult
resinous material	exists in pores	does not exist

Wood Products (other than lumber)

veneer: The primary process in the manufacture of wood based products is veneering which produces thin sheets of wood known as veneers. The thickness of veneers varies from 0.4 to 0.6 mm. In no case it should exceed 1 mm. The most suitable wood for this purpose is walnut. However other species like teak, sissoo, rose wood, etc. are also used. The logs to be used for this purpose are kept in wet storage to avoid end splitting and are softened by heating with hot water or steam and the bark is removed. The log is then cut to veneers.



plywood (kontrplak): A wood panel glued under pressure from an odd number (usually 3 to 13) of layers/piles of veneers is known as plywood.

thickness: 18; 21 mm
width: 1250 mm
length: 2500 mm

fiberboard (lif levha): These boards built up of felting from wood or vegetable wastes are classified by the process of their molding. If the boards are molded by wet process, the main bond is by the felting of woody fibers and not by added glue. Fiberboards are manufactured in various densities like, medium and high (MDF, HDF).

thickness: 2,5; 3; 4; 6; 8; 10; 12; 14; 16; 18; 22; 25; 30 mm
width: 2440 mm
length: 2100; 2800 mm

particleboard / chipboard: They are manufactured from particles of wood or other ligno cellulose materials which are agglomerated, formed and pressed together by the use of an organic or cementitious binder together in the presence of heat, pressure or moisture. They are manufactured from small timber pieces and wood wastes. The moisture content of chips is reduced and then some gluing material, (usually phenol formaldehyde for organic binder – this is not water resistant, cement mortar for the other which makes it water resistant), is sprayed. The chips are then spread to form a mat and then pressed in a hydraulic press in presence of heat and moisture.

chipboard / particle board (with synthetic resin binder) (yonga levha / sunta)
thickness: 8; 10; 12; 16; 18; 22; 25; 30 mm
width: 2100; 1830 mm
length: 2800; 3660 mm

chipboard / particle board (with cement binder) (talaş levha)
thickness: 15; 25; 35 mm
width: 600; 625 mm
length: 1200; 1250 mm

oriented standard board (OSB) (yönlendirilmiş yonga levha) : is a type of engineered lumber similar to particle board, formed by adding adhesives and then compressing layers of wood strands (flakes) in specific orientations.

thickness: 9; 11; 15; 18; 22 mm
width: 1220 mm
length: 2440 mm

hard wood

name of the tree	image	defects	properties	uses
white beech / beyaz kayın		formation of checks and slakes	takes good polish	For furniture. Not suitable for outside uses.
red beech / kırmızı kayın		difficult to process, absorbs high amount of water, formation of checks and slakes,	heavy, hard and homogenous	For furniture. Not suitable for outside uses.
hornbeam / gürgen		high level of shrinkage and swelling, vulnerable against water	heavy, hard and homogenous	For indoor woodworking, structure and flooring. Not suitable for outside uses.
elm / karaağaç		difficult to process, vulnerable against beetles	takes good polish, durable.	For structure, furniture, handrails, stairs.
chestnut / kestane			durable against water, takes good polish	For furniture and veneers.
oak / meşe		difficult to process	durable against water, takes good polish	For furniture, woodworking, flooring and veneers.
walnut / ceviz			durable, can be sawn in all directions, takes good polish	For furniture and veneers.
ash / dişbudak		easily attacked by beetles	takes good polish, high bending strength	For furniture and handrails.

	name of the tree	image	defects	properties	uses
soft woods	poplar / kavak		not very durable, decays in humid environment	easily processed, lightweight.	For undercoat veneer.
	plane / çınar			easily processed	For veneer.
	lime / ıhlamur		not very durable	lightweight, soft, not susceptible against humidity, low bending strength, takes little polish	Fur furniture, carving works.
	willow / söğüt			takes little polish	For furniture.
delicate woods	boxwood / şimşir		heavy	takes polish	
	ebony / abanoz		heavy	takes good polish	For furniture.
	mahogany / maun		cannot be used as solid	gets darker in daylight	For furniture and veneer.
	teak / tik		heavy	takes polish	For furniture and veneer.

	name of the tree	image	defects	properties	uses
resinous woods	spruce / ladin (çıralı çam)		heavy and knotty	durable against humidity	For woodworking and veneers.
	cedar / sedir (Toros çamı)		cannot be polished or painted	durable against water, resinous	For veneers, suitable for outdoor environment.
	filyos (çırasız çam)		susceptible against humidity	Soft, lightweight, flexible and durable	For indoor woodworking, veneers.
	fir / köknar (beyaz çam)		susceptible against humidity and heat	lightweight and flexible	For making plywood and indoor veneers.
	white spruce / akçam		becomes ash colored in time	lightweight	For upholstery.
	larch (black pine) / karaçam (alaçam)			durable	For structure and furniture.
	calabrian pine (Turkish pine) / kızılçam		knotty	resinous	For structure
	cypress / selvi			lightweight, easily processed	For woodworking and veneers