Lecture 07:

Timber and Wood Products

Definition and Terms

Characteristics of Good Timber

Advantages and Disadvantages of Timber

Uses of Timber

Classification, Structure and Growth of Tree

Defects in Timber

Seasoning of Timber

Preservation of Timber

Mechanical Properties of Timber

Testing of Timber

Timbers in Bangladesh

Wood-based Products

Definition and Terms

Timber is the wood suitable for building or engineering purposes and it is applied to trees measuring not less than 600 mm in girth.



When in the living tree, **standing timber**, when felled, **rough timber**, when bark is removed and hewned (chop, cut) roughly, it is **log**, when the log is sawn into various market forms such as posts, beams, planks and battens, it is **converted timber.**

Characteristics of Good Timber: A good timber should,

- Have a uniform colour, sweet smell when freshly cut
- Have regular annular rings, straight and close fibres
- Be heavy in weight, sonorous when struck
- Be free from shakes, flaws, dead knots or blemishes (spot) of any kind
- Be firm adhesion of fibers and hard, compact medullary rays
- Have a surface to present a firm bright appearance with a silky luster
- Have fibrous tissues adhere firmly together an should not clog the teeth of the saw

- Be durable and capable of resisting the actions of fungi insects, chemicals, physical agencies and mechanical agencies
- Possess the property of elasticity i.e. it should regain its original shape and size when the load is removed
- Be hard, strong and fire resistant

Advantages and Disadvantages of Timber:

Advantages:

- Easy to handle, saw and join; easily available and quickly transportable
- Light in weight yet strong, may be cut readily and fastened firmly together with nails
- Is durable and good insulator of heat and sound
- Stands shocks and bumps, is preferred for building works in earthquake region
- Easy to repair, add or alter
- Ideal material of construction in sea water or marine works as it can resist corrosion

Disadvantages:

- The greatest is its ready combustibility
- Timber is destroyed by decay induced by fungi and by insects
- Timber swells and undergoes shrinkage with changing atmospheric humidity

Uses of Timber: Timber is used,

- Generally in the form of piles, posts, beams, lintels, door-window frames and leaves, roof members e.g. rafters, purlins, trusses etc.
- In flooring, ceiling, paneling and construction of partition walls
- For formwork of concrete, for he timbering of trenches, centering for arch work, scaffolding, transmission pole and fencing
- In wagon and coach building, marine installations and bridges
- In making furniture, agricultural implements, sports goods, musical instruments, well curbs, motor bodies arts and carriages, railway sleepers, packing cases etc.

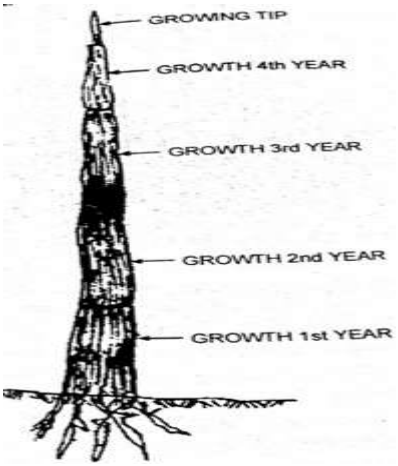
Classification, Structure and Growth of Trees

According to manner of growth, trees are

- **Exogenous**: grow outwards, increase in bulk, used for building and engineering purposes, Deodar, chir, sal, teak are of this variety
    - **Conifers**: evergreen trees with needlelike leaves, deodar, chir, Christmas tree, pine etc. light in color, resinous and light weight
    - **Deciduous**: trees having flat broad leaves, oak, teak, shishum, poplar, maple, they yield hard wood, non-resinous, dark color and heavy weight

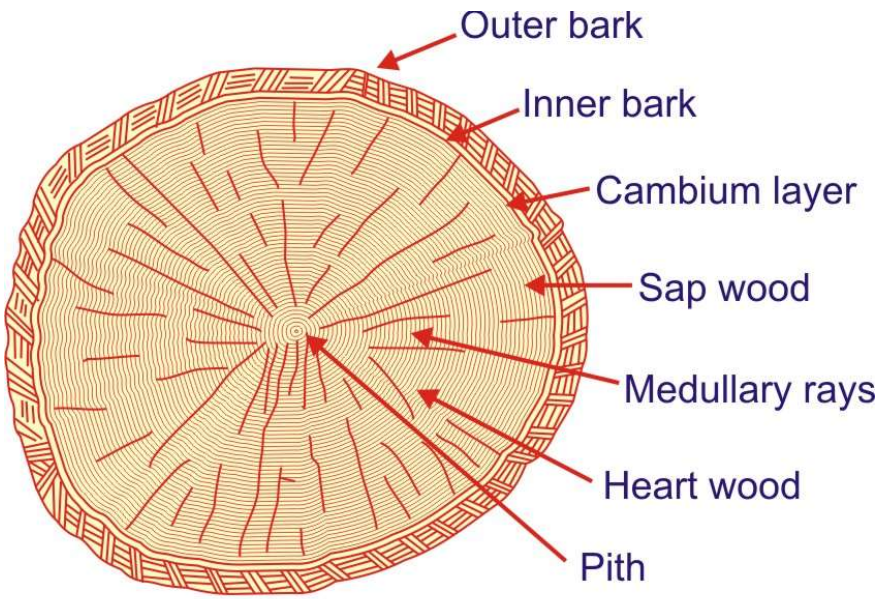
- **Endogenous**: grow inwards or endwards, stems are flexible, limited applications for temporary construction. Canes, bamboos, palms are of this variety

Basically, a tree consists of the following three parts,
i) Trunk ii) crown and iii) Roots



The structure of an exogenous tree consists of

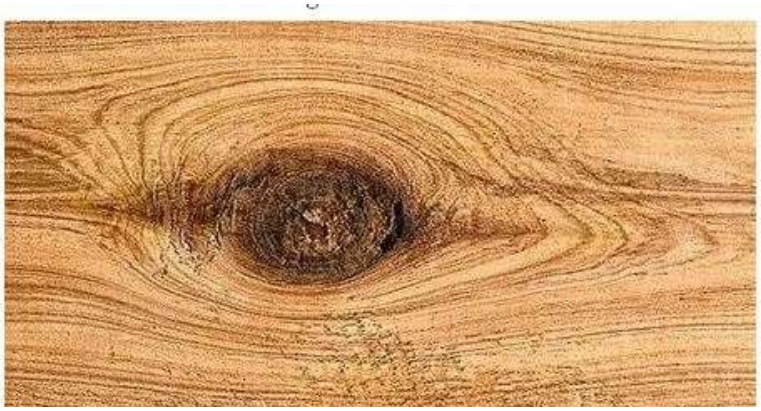
- **Pith**: is the innermost central portion or core of the tree
- **Heartwood**: consists of the inner annual rings round the pith, compact, strong, durable and darker in colour, provides the best timber for engineering works
- **Sapwood**: outer annual rings between heartwood and cambium layer, light in colour and weight, indicates recent growth and contains sap, an active layer, is moist, less durable
- **Cambium layer**: thin layer below bark, not converted to sapwood as yet
- **Inner bark or bast**: inner skin or layer covering the cambium layer, protects the cambium layer from injury
- **Outer bark or cortex**: consists of wood fibre and is the outermost cover or skin of stem



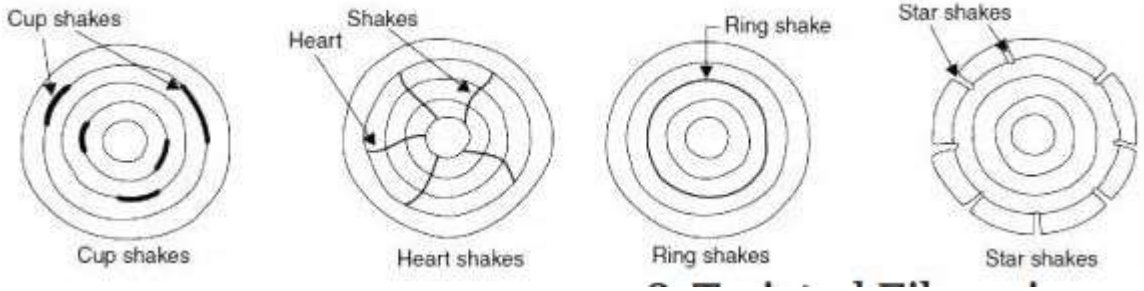
Defects in Timber:
https://theconstructor.org/building/types-of-defects-in-timber/21521/

Any irregularity or imperfection in or on wood which may lower its strength, durability and utility. Usually of two types,

- Natural defects due to abnormal growth and rupture of tissue
  - Knots
    - Pin, standard, large, pith, rotten, encased knot



- Twisted fibers
- Shakes
  - Cup, heart, ring, star, radial shakes



- Upsets
- Rind galls, burls or excrescence
- Foxiness
- Compression wood
- Pitch pocket

- Artificial defects arising from conversion and uses
  - Warping
  - Splitting and cracking
  - Defects due to fungal action
  - Defects due to insects

Seasoning of Timber:

Defn.: is the process of drying timber or removing moisture or sap, present in a freshly felled timber, under more or less controlled conditions.

Objects of Seasoning:

Main objectives of seasoning of timber are,

- To check/minimize the tendency of timber to shrink, warp or split
- To increase strength, durability and electrical resisting power of timber
- To maintain the shape and size
- To make timber safe from attack of fungi and insects
- To reduce the weight for transport purposes
- To make timber fit for receiving treatment of paints, preservatives, varnishes etc.
- To make timber easily workable and to facilitate operations during conversion
- To make timber suitable for gluing

Methods of Seasoning Timer:

- Natural Seasoning:

- Air drying/seasoning: simple, cheap, very slow and no rigid control
- Water seasoning: logs of wood are kept completely immersed under water, a quick process, tendency of wood to shrink or warp is reduced, reduces the elasticity and durability of the timber, timber is rendered brittle

- Artificial seasoning: are quick and m/c can be kept under control. Methods are,
  - Kiln seasoning: drying of timber is carried out inside an airtight chamber or oven. Depending on the mode of construction and operation kilns are,
    - Stationary of Compartment kiln: seasoning is carried out in a single compartment, close control of humidity and temp., gives better results
    - Progressive kiln: the carriage with timber sections travels slowly from one end of kiln to the other end starting with low temperature and high humidity to high temperature and low temperature.

- Chemical seasoning: also called salt seasoning, timber is first immersed in a solution of suitable salt (most common is urea), then seasoned by ordinary or in kilns, chances of formation of external cracks are reduced.

- Electrical seasoning: high frequency alternating currents are passed through timber, uniform evaporation of moisture is obtained, rapid method but not economical.

- Steaming or boiling: steam is passed or timber is immersed in water and water is boiled, very quick method but reduces elasticity and strength, not economical.

- Smoke seasoning: timber is dried in a smoke heat over a fire of straw, saw dust and wood savings, efficient method to make timber durable and resistant to decaying agents.

Preservation of Timber:

Defn.: refers to the art of treating the timber with some chemical so as to increase its life

Objectives of Preservation:

- To increase the life of timber structures
- To make the timber structure durable, and
- To protect timber from the attack of destroying agents such as fungi, insects, etc

A good preservative should be,

• Cheap • Easily available • durable

• non-inflammable • free from unpleasant smell

• allow decorative treatment • give pleasant appearance

• be safe and harmless to human • be quite efficient in killing fungi, insects

• offer high resistance to moisture and dampness

• not affect the strength characteristics of timber

• not be easily washed away by water

Types of Preservative:

- Oil type: coal tar creosote with or without admixture of soluble oils
- Organic solvent type: toxic chemicals in non-aqueous solvents, such as copper, zinc naphthalene, benzene hexa chloride and DDT

- Water borne type: toxic chemicals in water, such as zinc chloride, boric acid, copper chrome arsenic composition (Ascue)

Methods of Preservation:

- Tarring: applying a coat of tar, employed for rough types of works
- Charring: surface to be charred is kept wet and burnt into a depth of 15 mm over a wood fire, prevents dry rot and attacks of insects, adopted for lower ends of posts.
- Painting: carried out on the thoroughly seasoned wood, preserves wood from moisture and prolongs its life, solignum paints available in various shades can effectively bear white ants' attack
- Creosoting: creosote oil obtained by the distillation of coaltar or woodtar, its toxic ingredients are complex phenols, preserves timber from rots and attack by white ants, also imparts some water repellent properties to wood, employed for piles, poles, sleepers
- Ascue treatment: 1 part (by wt.) of hydrated arsenic pentoxide, 3 parts of copper sulphate and 4 parts of potassium dichromate available in powdered form. Six parts (by wt.) of ascue mixed with 100 parts of water are mixed to prepare ascue soln., applied or sprayed on timber surface, protects against white ants attack, the surface then can be painted, polished, varnished or waxed
- Fire proofing: attempts are made to make wood fire resistant by,
    - Application of special chemical: timber is coated by certain chemicals like borax or sodium arsenate, zinc chloride etc
    - Sir Abel's process: timber surface is cleaned and is coated with a dilute solution of sodium silicate, cream-like paste of slaked fat lime is then applied followed by the application of silicate of soda.

Mechanical Properties of Timber:

The mechanical properties of timber are extremely variable, not only between species and different trees of the same species but also specimens cut from different portions of the same tree. The principal mechanical properties of timber are,

- Durability: The resistance of timber to both fungal and insect attack is termed as natural durability and this can be increased by treating the wood with chemicals toxic to fungi and insects. In general, durability is staying in sound condition for longtime, for this timber should be free from defects, annual rings should be regular and uniform, well seasoned.

  Various causes or situations for early decay of timber are,

    - Moisture
    - Imperfect seasoning
    - Alteration of dry and wet states
    - Vegetable growth
    - Attacks of insects
    - Bad storage or stacking of timber
    - Using unseasoned timber with a coat of paint or tar
    - Using seasoned timber without applying suitable preservative

In order to increase durability, preservation of timber is necessary (discussed earlier)

- **Strength**: Since timber is an anisotropic material, it follows that the angle at which stress is applied relative to the longitudinal axis of the cells will determine the ultimate strength of the timber. Illustrates that tensile strength is much more sensitive to grain angle than is compression strength. At angle as high as 60° to the longitudinal both tension and compression strengths have fallen to only about 10% of their value in straight grained timber. Strength at any angle to the grain, σ_θ, can be obtained using the formula,

$$\sigma_\theta = (\sigma_p \times \sigma_q) / (\sigma_p \sin^n\theta + \sigma_q \cos^n\theta)$$

where, σ_p is the strength parallel to the grain
σ_q is the strength perpendicular to the grain
n is an empirical constant which is 1.5-2.0 for tension, 2-2.5 for compression and 2.0 for stiffness

The strength parameters are,

  - Tensile strength
  - Compressive strength
  - Flexural or transverse strength
  - Torsion strength

- **Moisture – strength relation**:

  The moisture content of green wood (newly felled) is high, usually varying from about 60% to nearly 200% depending on the location of the timber in the tree and the season of the year. The strength and stiffness of greenwood is considerably lower than for the same timber when dry. The marked increase in strength on drying from the fibre saturation point to oven dry conditions is illustrated in Figure page 3 (Fig.38.19, illston)

- Stiffness: largely depends upon the same factors as strength, proper seasoning is necessary

- Toughness: property to resist shocks and vibrations

- Hardness: depends on weight, uniformity in texture, closely spaced annual rings and freeness from defects.

- Cleavability: refers to the splitting strength of timber specimen in radial and tangential direction. High resistance to cleavage is important for nailing and screwing

- Brittleness: property of suffering little deformation before breaking,

- Workability: ability to work with

Testing of Timber:

Some important tests of timber to determine mechanical properties are,

- Tensile strength: load is applied either parallel or perpendicular to the grains of a 5x5 cm and 20 cm long specimen

- Compressive strength: load is applied to a 5x5x20 cm specimen parallel to the grains.

- Shear strength: important for beams and slabs. Determined only parallel to the grain, 5x5x6.25 cm specimen notched in a corner so as to produce a failure on 5x5 cm surface.

- Bending strength: modulus of rupture, elasticity is determined from static bending test on a 5x5x7.5 cm specimen. Impact bending is also done to determine shock resistance

- Moisture content: m/c as a percent of oven dry wt.

Timbers in Bangladesh:

- Teak or segun: very strong and durable timber with a beautiful golden yellow colour. Used in all sorts of house const. and structural works, is found in Ctg. Hills

- Sal: very strong, hard, durable and heavy timber, difficult to work with, used in rly sleepers, house const., boat building etc., is found in Ctg. and Sundarban

- Garjan: strong and durable, difficult to work with, does not take good polish, widely used in house building, rly sleepers, is found in Ctg., Sundarban

- Gazari: strong, hard and durable, extensively used as piles, posts and other structural member, is found in bhowal garr, modhupur, ctg.,

- Jarul: light, hard, durable, resist action of salt water, takes good polis, used in boat building, wheels of bullock carts

- Sundari: strong, tough, hard and heavy timber, difficult to season and work, used in house building, carts, wheel spokes, tool handles, boat building etc.

- Shisham or shisso, shiris, simul, babul, debdaru, gamhari, chambal, telsu, nageshwar, bailum, arjun, bakul, kathal, mango, neem, tetul, etc. etc.

Table 1: Structural Properties of Some Bangladeshi and Foreign Timber

Type of timber	Unit wt., lb/cft	Max. Comp. St.parallel to grain, psi	Max. Comp. St.perpen. to grain, psi	Max. Shear St. parallel to grain, psi	Modulus of Elasticity, x 10^3 psi
Broad Leaves					
Teak	45	9,000	1500	1480	1500
Sal	55	10,000	1800	1810	1800
Sundari	60	7,500	1400	1850	1600
Garjan	46	8,000	1500	1560	1600
Oak	64	7,000	1260	1830	1800
Wallnut	58	7,580	1250	1370	1600
conifers					
Pine	52	7,000	1000	1300	1700
Kail	52	5,500	720	1100	1600
Debdaru	36	5,800	550	850	1500
Fir	38	7,400	870	1160	2000

WOOD BASED PRODUCTS

- are the products manufactured from different types of wood, developed to economize the use of timber. These products are manufactured out of veneers, strips, fibres of wood.

- Veneers: are thin sheets or slices of wood of superior quality, having thickness varying from 0.4 mm to 0.6 mm or more. Veneers are sliced from logs of timber, by sharp knife or rotary saw, from teak, mahogany, wall nut etc. Veneers are glued or cemented together to use in the construction of aircraft and manufacture of plywood are other products which are,

- Plywood: is made by cementing together several layers of thin veneers in odd number. Water proof glue is applied to the sheets, assembled and compressed in a hot press to proper thickness. Plywood has good strength, low shrinkage and swell, better splitting resistance, good workability and great aesthetic variety. It is extensively used in partition and panel works, interior decorations and rail cars.

- Lamin board: is a board having a core of strips, each not exceeding 7 mm thickness, laid side by side with their grains reversed, glued and compressed. This core is covered with veneers at right angles to the core. These boards are light, strong and do not split or crack easily, are used for walls, ceilings, partitions and packing cases.

- Block board: is constructed in the same way as lamin board, but the core consists of smaller timber block up to 25 mm in width. Extensively used for construction of railway carriages, bus bodies, marine and river crafts and for furniture making, partitions, panelling

- Batten board: is a board having a core made up of strips of wood usually 80 mm wide, are light and strong, used for door panels, table tops etc.

Reconstructed Wood:

- Fibre boards: are rigid boards and also known as pressed wood or reconstructed wood. They are used internal finish, rire and sound insulation, suspended ceilings and finishing cover to furniture. They are made from a mass of felled wood or vegetable fibres, 3 – 12 mm thick, are as,

    - Insulating boards
    - Light and hard boards
    - Laminated fibre building board

- Hard boards: are hard pressed and hence are more compact, strong and durable

- Partex: is the trade name of the versatile chip boards manufactured from wood veneers, wood chips or jute sticks, a Bangladeshi product

- Cork and Cork boards: Cork is the thick spongy bark of Oak tree, light, porous, very elastic and easily compressible. Cork boards are manufactured by compressing cork chips with some cementing material and subjecting to high temperature. They are principally used insulating against heat, cold and sound.

Questions:

- What is timber? What are the characteristics of good timber?
- What are the uses, advantages and disadvantages of timber?
- Draw the cross section of the trunk of an exogenous tree leveling different items and discuss the structure of timber.
- What are the objectives and methods of seasoning timber?
- What are the objectives and methods of preservation of timber?
- What are the mechanical properties of timber? What are the tests for timber?
- What are the timbers available in Bangladesh?
- What are the characteristics and uses of wood based products?
