Bule Hora University



Faculty of Engineering and Technology

Dep'T Of Construction Technology and Management

Timber

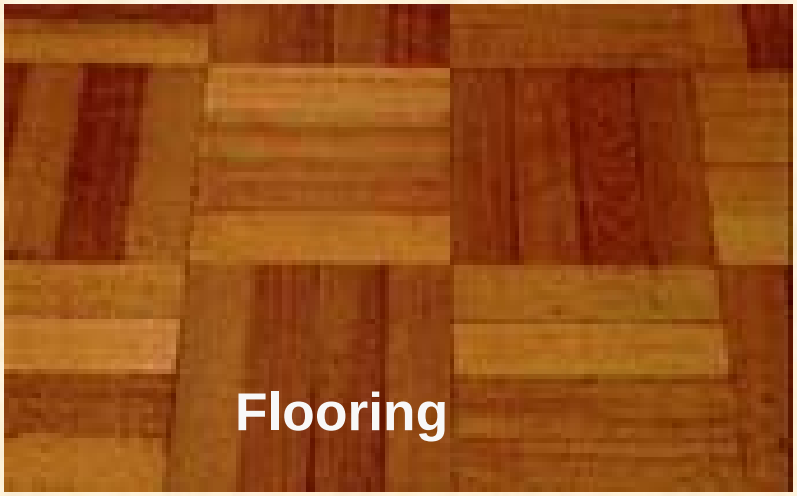
Wood suitable for building or engineering purpose

Uses of timber

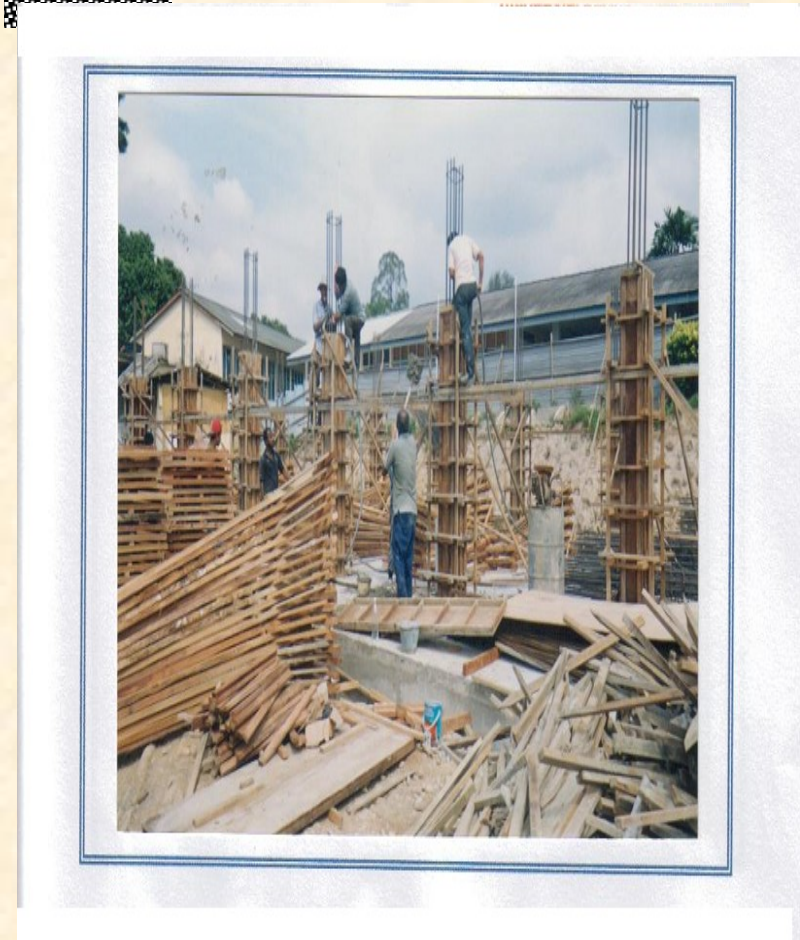




Cladding



Uses of timber



Formwork

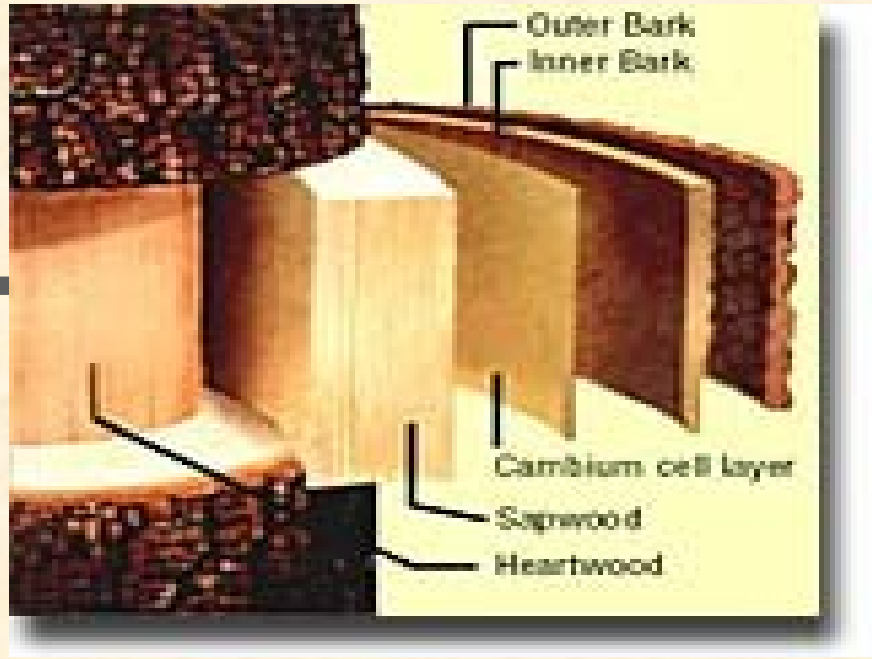


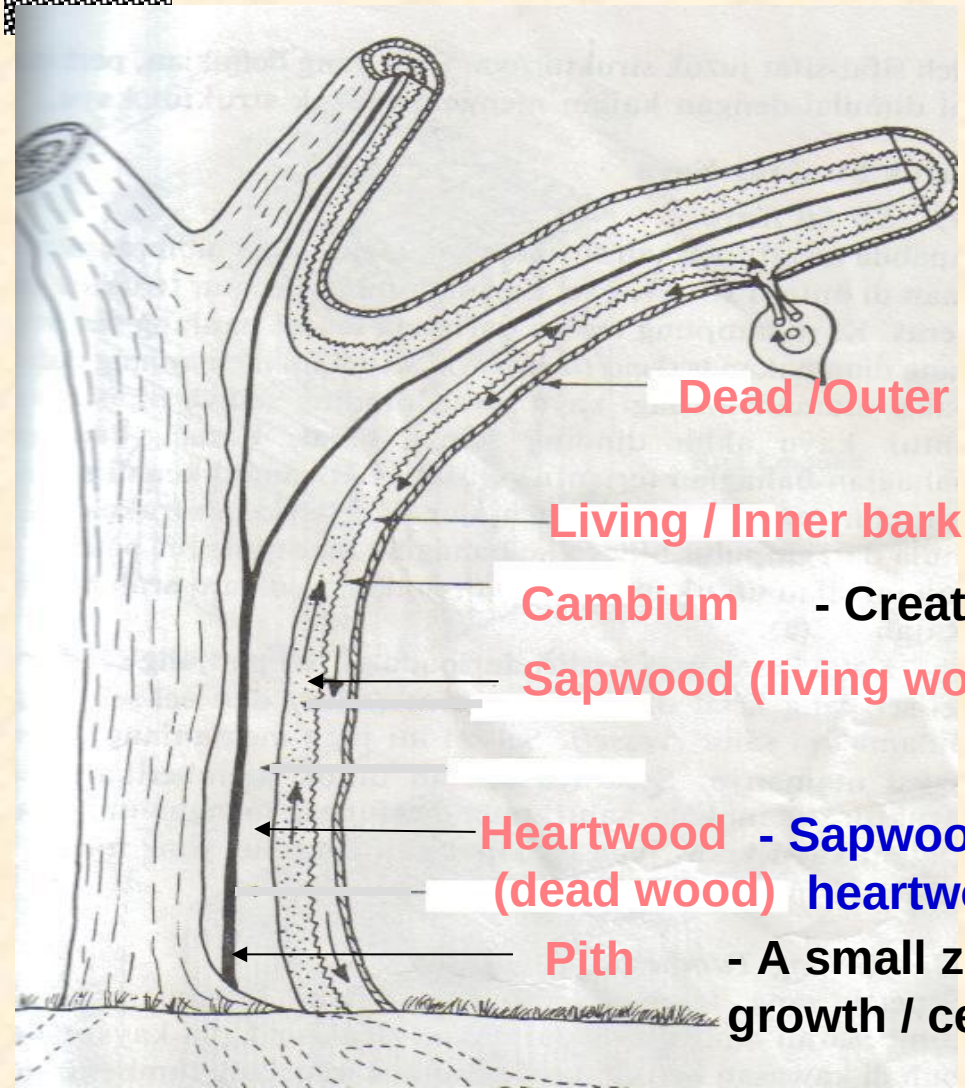
Panel



Pergola

Tree Components





Dead /Outer Bark - Protective outer layer

Living / Inner bark - Carry nutrients from the leaves to the r

Cambium - Creates new bark cells and wood cells

Sapwood (living wood) - Nutrients are stored and sap (sugar & starch) is pumped upward from roots to leaves.

Heartwood (dead wood) - Sapwood dies progressively and becomes heartwood – contribute strength to tree

Pith - A small zone of weak wood cells from first year growth / central core of the tree.

Tree Components



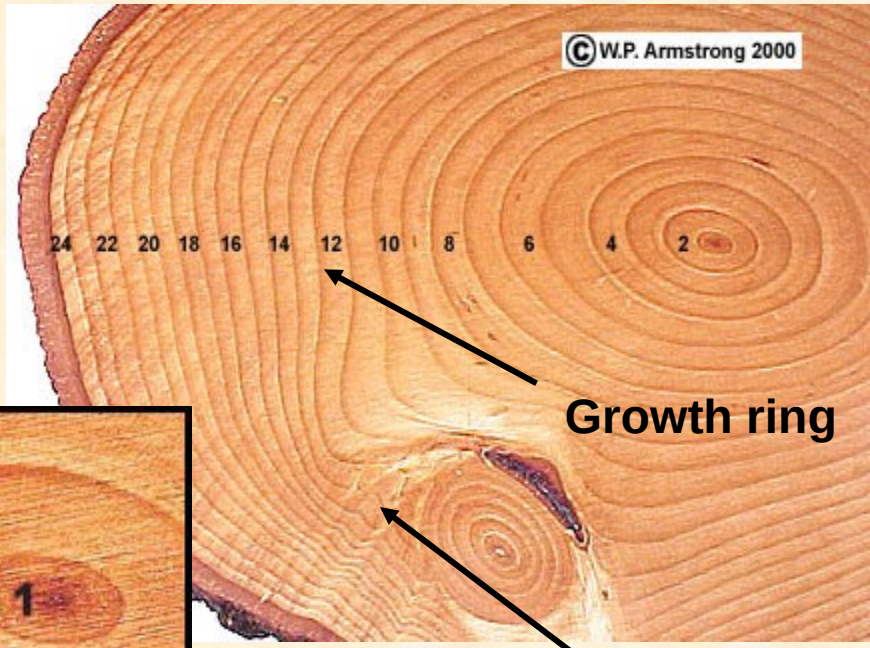


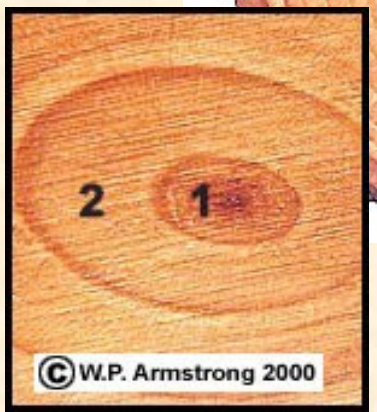
Growth rings

In temperate climates, during early growing season (spring/early summer), the wood has vigorous growth. Cells are larger with thinner walls; lighter colour.

- In later growing season (sunlight or water less plentiful), wood has slower growth. Cells are smaller, with thicker walls: darker colour.

- Tropical regions, growth ring is not obvious.





Commercial Classification

Hardwood



- Broad leafed trees
- Heavy
- Dark coloured
- Do not show distinct annual ring
- Generally stronger
- Beautiful grained
- Thicker cell walls, close cell structure

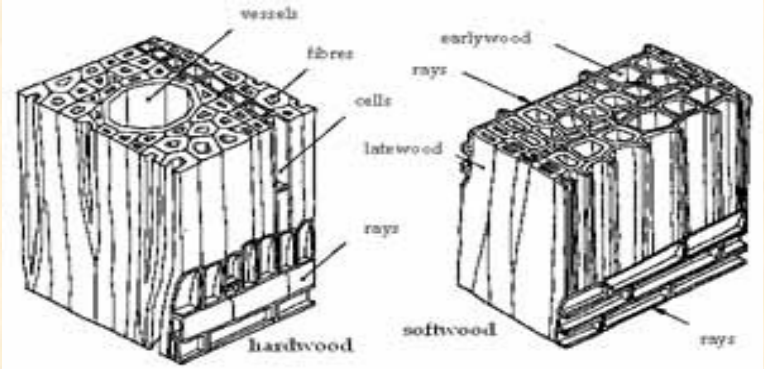


Softwood

- Coniferous trees (needle- like leaves)
- Light in weight
- Light coloured
- Show distinct annual ring
- Weak, liable to split easily
- Uninteresting grain
- Thin cell walls, open cell structure







hardwood

Heavy hardwood
(Density > 880 kg/m$^{3)}$
e.g. Balau , Cengal, Resak, Tembusu

Medium heavy Hardwood
(Density : 720 kg/m^3 - 880 kg/m$^{3)}$
e.g. Kapur, Keruing, Kempas

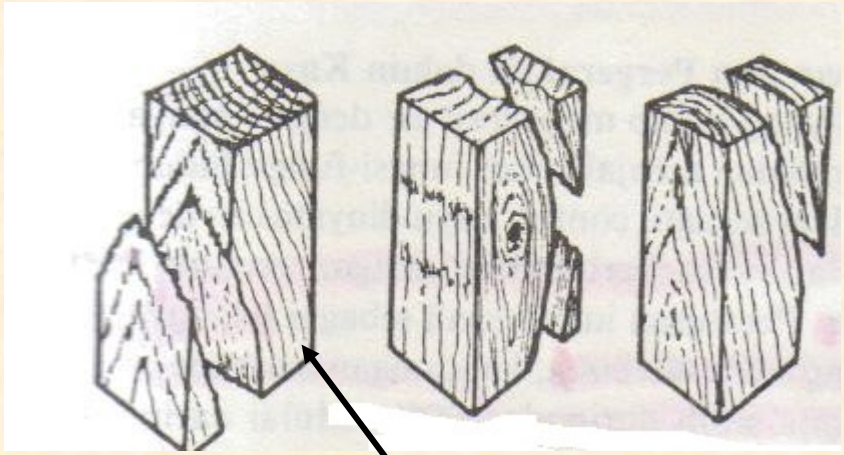
Light hardwood
(Density < 720 kg/m$^{3)}$
e.g. Meranti, Jelutong

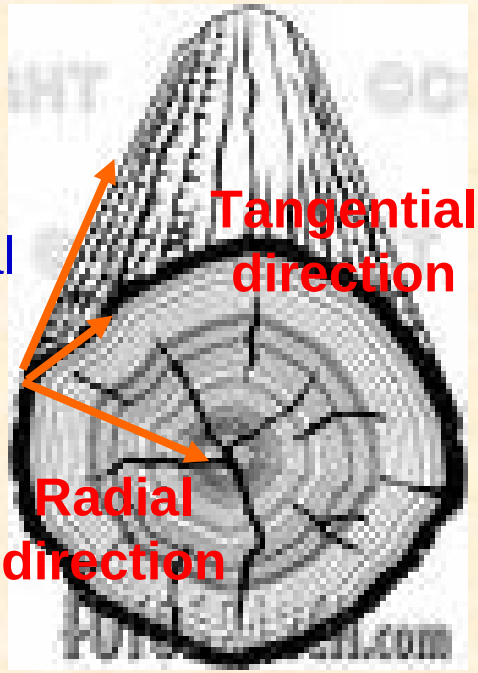






- Grain refers to the direction, size, arrangement, appearance or quality of the fiber. Grain direction is important to the strength of wood.





Moisture content of wood

- Wood is hygroscopic material **i.e., it will absorb water vapor from the atmosphere or shrink when it is dry.** (Moisture content will change varying on moisture content of the surrounding area)

- Water content in growing wood
  ~ 30% to 300% of its oven dry weight of wood.

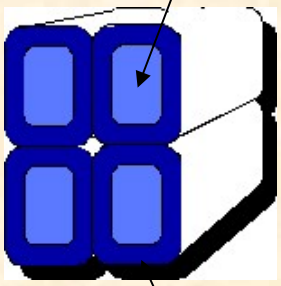
- Moisture content = $\frac{\text{weight of water}}{\text{oven dry weight}} \times 100$

- Moisture content affects properties such as weight, shrinkage and strength.

- Water stored in wood in two main forms:

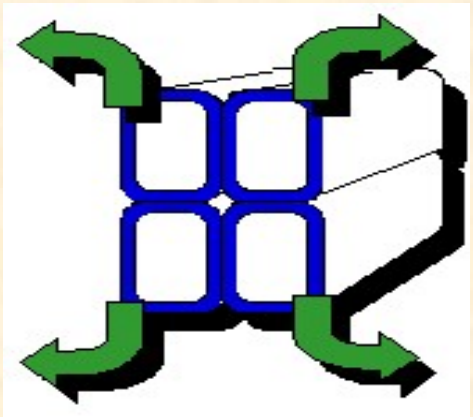
  - As free water in the vessels or cell cavities.

  - As cell water (or bound water) in cell wall.



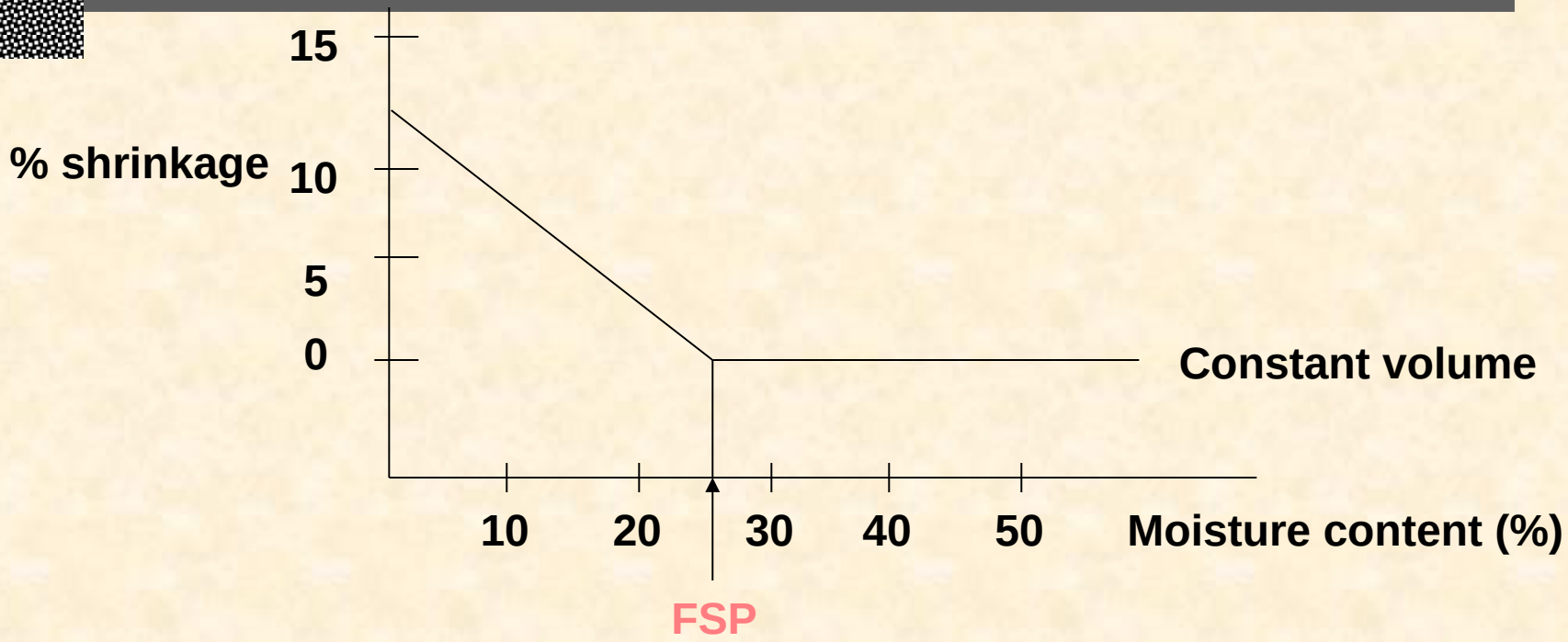


Free water starts to leave as soon as the tree is cut.



If the bound water is lost, wood starts to shrink; strength & stiffness increase.

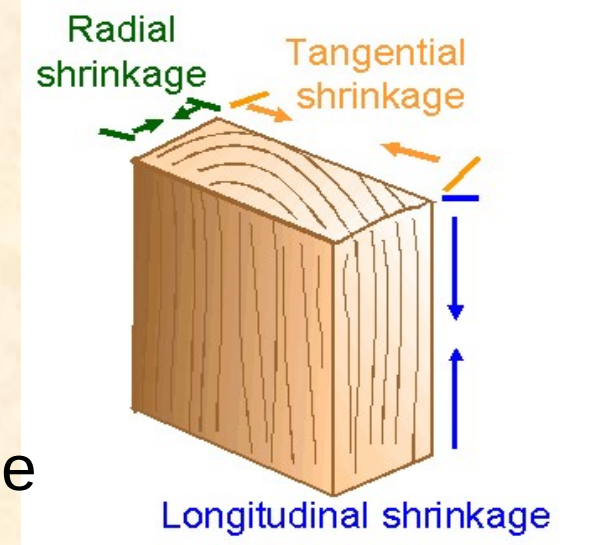
Changes in % of shrinkage vs changes in moisture content



Fiber saturation point (FSP) – The moisture content of wood at which the cell walls are saturated with bound water and no free water is present. Usually around 25-30 %. The addition or removal of water below FSP has a large effect on the properties of wood.

Shrinkage and Swelling

- Timber loses or gains moisture to be in equilibrium with the atmospheric moisture in its immediate environment.

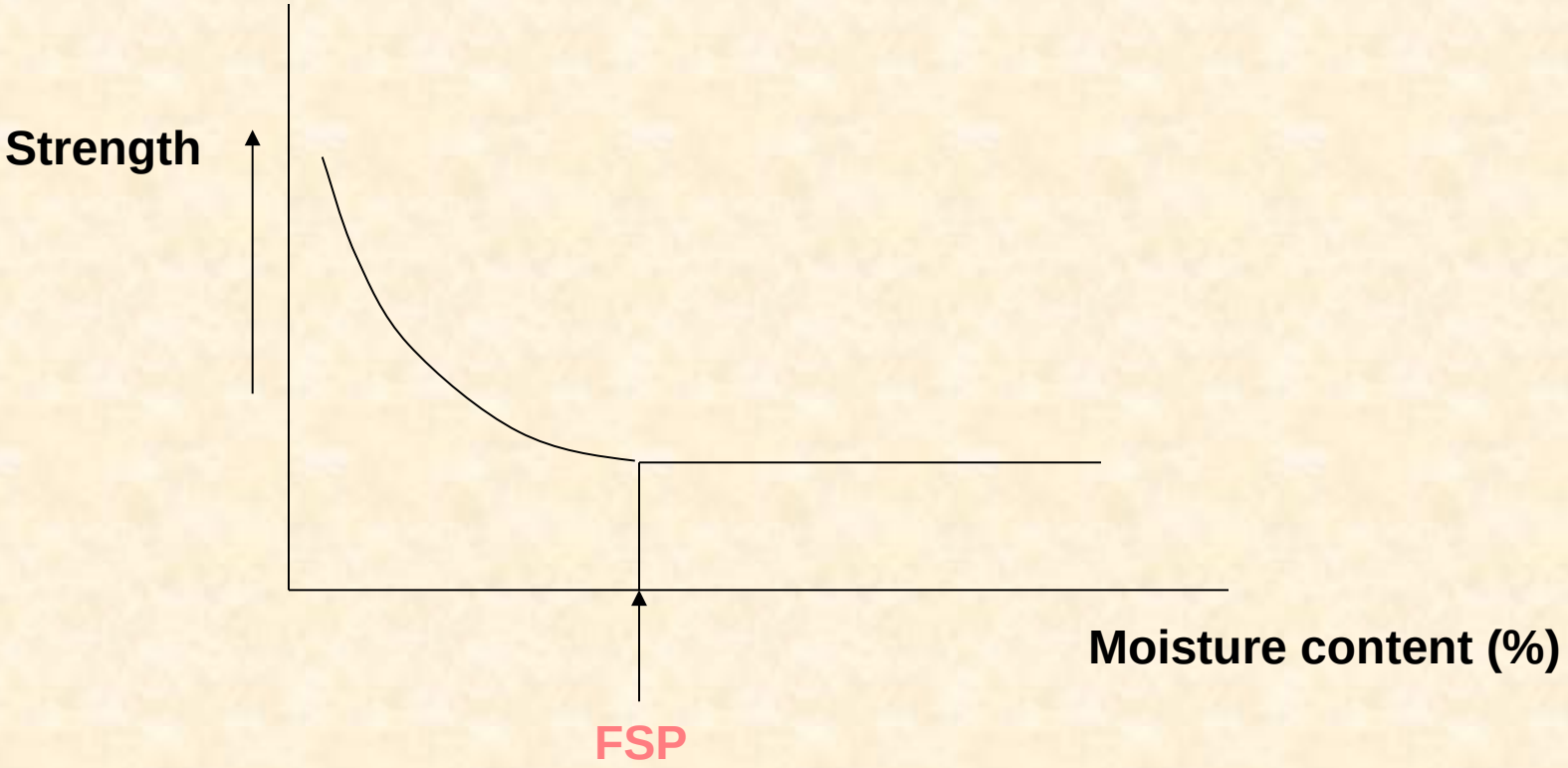


- Swelling (gain of moisture in the cell wall) and shrinking (loss of moisture from cell wall) are dependent on moisture in the air and temperature.

- Shrinkage is the highest in the tangential direction and least in longitudinal axes.

This dimensional changes causes, splitting and structural performance problem.

Changes in strength vs changes in moisture content



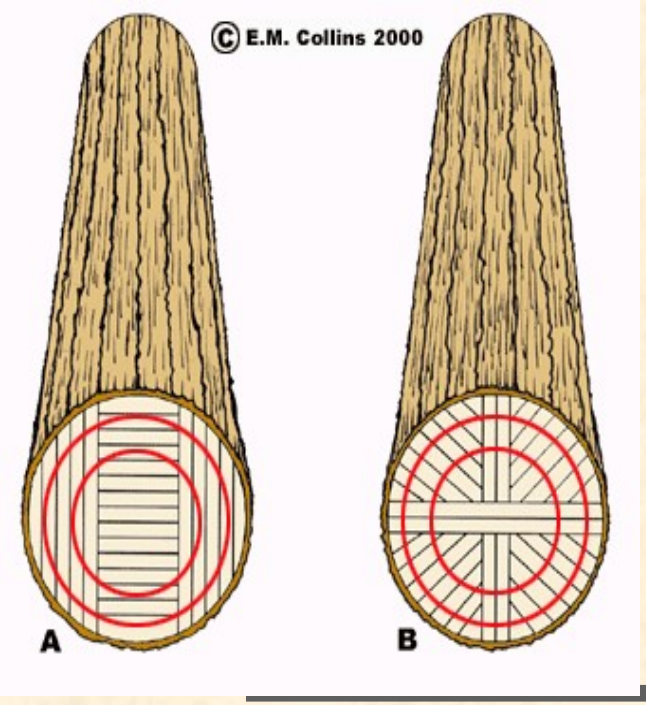
Lumber production

Lumber

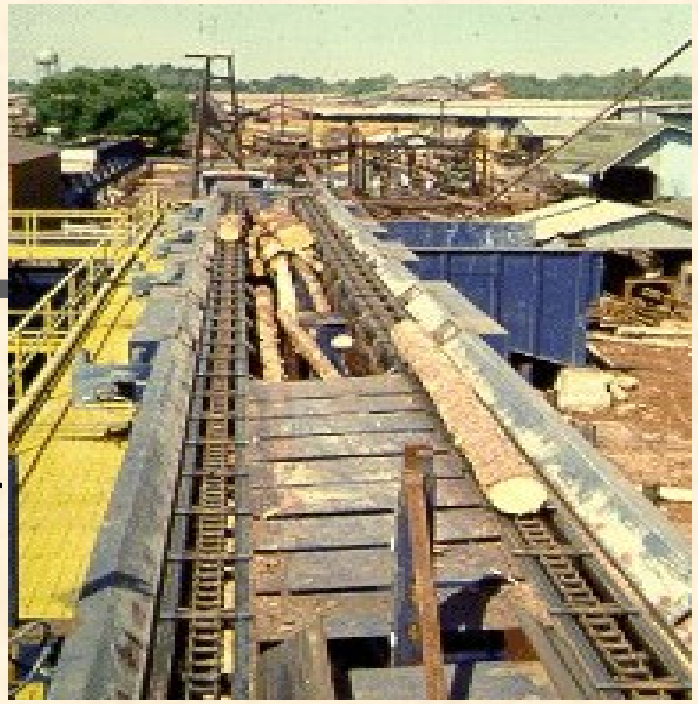
Lumber - timber that has been cut into boards, planks or other structural members of standard length for use as a building material.

Lumber production

1) Logging & Transporting to saw mill
2) Sawing / milling
3) Seasoning / Drying
4) Surfacing
5) Grading
6) Preservation (Optional)



Lumber production



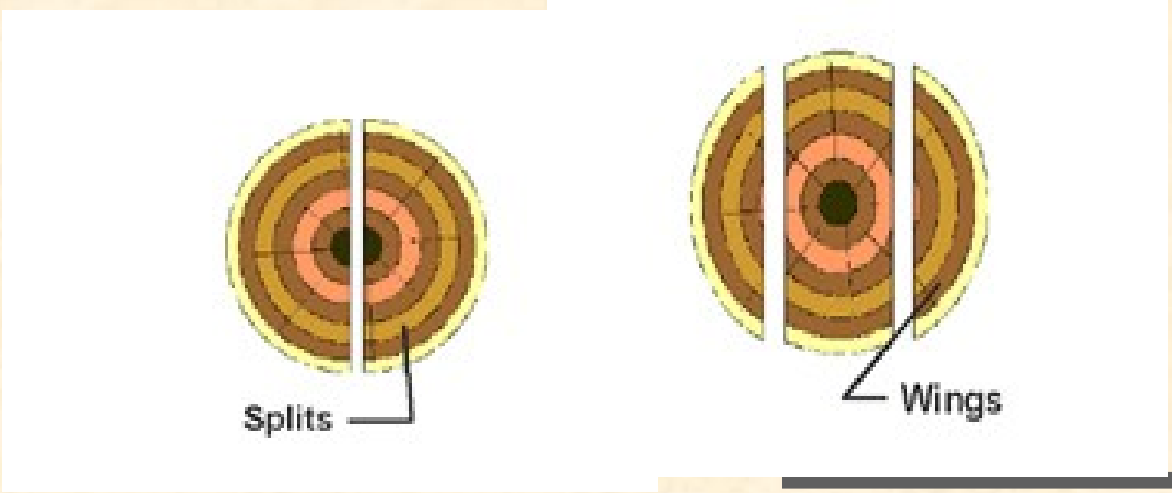
1) Logging

- The felling and preparation of timber for shipment to sawmills.

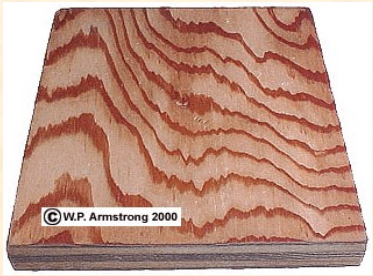
2) Sawing / Milling process

- Convert logs into boards in a manner that secure maximum product with minimum waste & labour.

- Log breakdown
(Cutting log to provide flat surface)

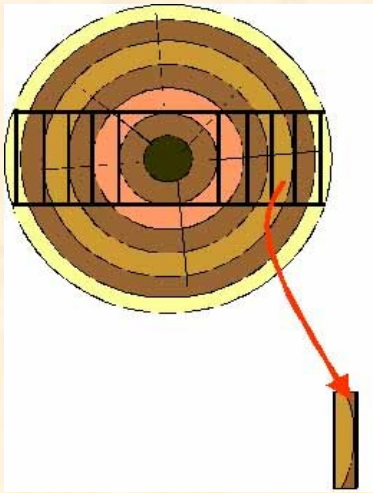


Methods of sawing / cutting techniques

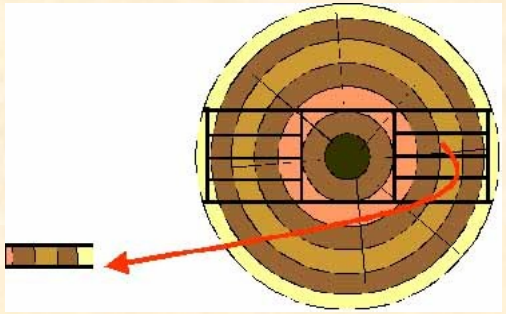




Plain sawn (slab-cut)

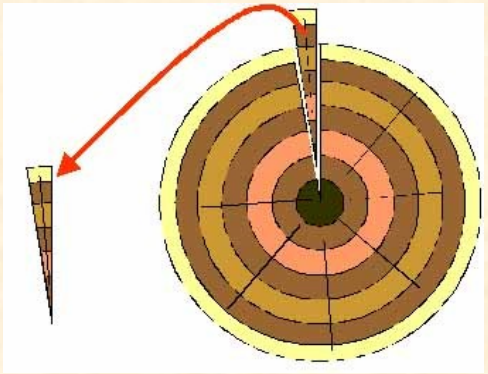


- Used for framing
- Very economical, less wastage, high shrinkage



Quarter sawn

- Used for flooring, interior trim and furniture
- Less shrinkage



Radial sawn

- Not common

3) Seasoning / Drying

- The process of drying timber to remove the bound moisture contained in wall cells in order to produce seasoned timber.

Lumber is considered seasoned when moisture content is less then 15 - 19%.

Purpose of seasoning

- Improved strength, reduce shrinkage
- Greater resistance to decay
- Reduced weight; easily handled & transported
- Paints applied will last longer

Methods of seasoning

A.Air dry (traditional method)

Lumber is stacked. Air circulate through & around the stacks. Takes months to reach moisture content 20 %.



B. Dried in kiln

The lumber is stacked as in air dry & placed in a special chamber. Takes days to one week. Most commonly used.



4) Surfacing

The surface of lumber is machined to give smooth surface and a more precise dimension, easier to work with & less damaging to hands.

5) Grading

All sawn timber are graded based on quality e.g. appearance and structural strength.

Characteristics of a good timber

- Strength
  - Tensile, compressive, shear, bending (depends on species and grade)
- Hardness
  – i.e. wood should not be hurt by an ordinary impact
- Free from defects - e.g. knots
- Heavy weight
- Durable
  – able to resist atmospheric effects, attacks of worms or fungi
- Workable – easily planed

Testing of timber

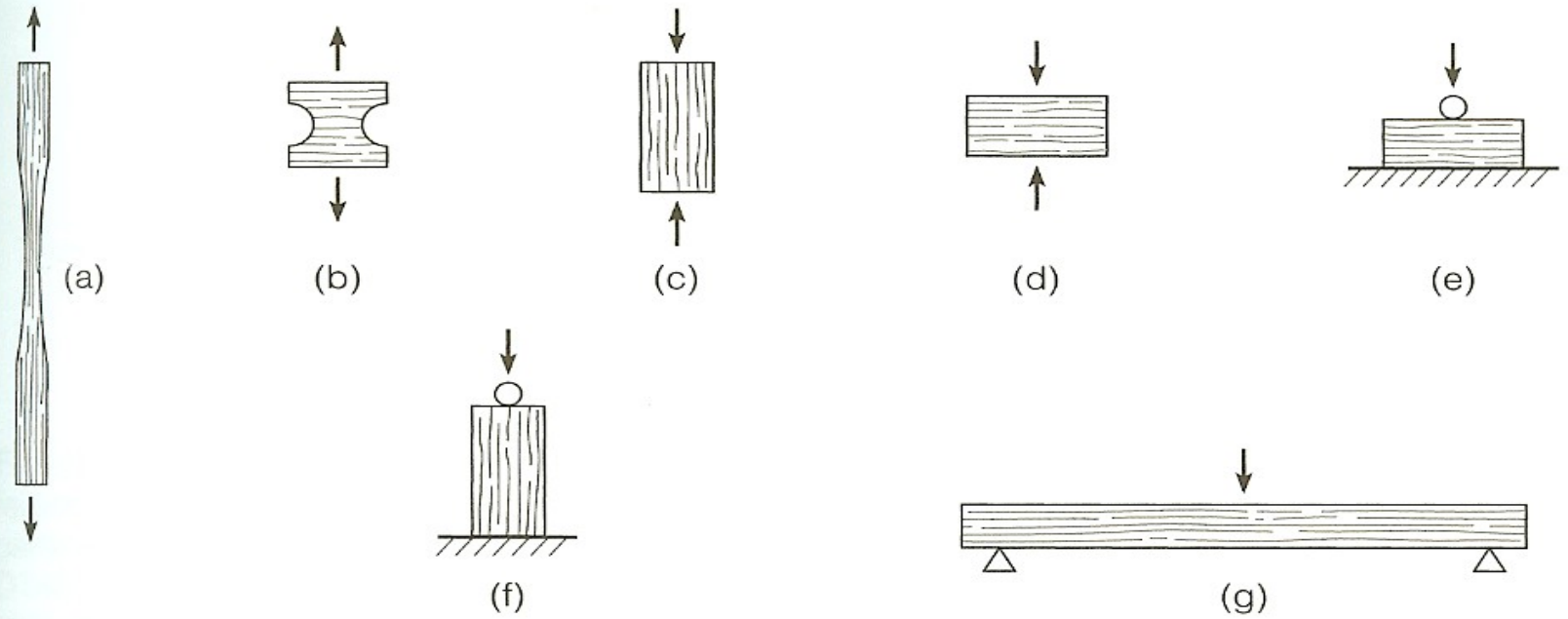


FIGURE 10.10 Test specimens of wood: (a) tension parallel to grains, (b) tension perpendicular to grains, (c) compression parallel to grains, (d) compression perpendicular to grains, (e) hardness perpendicular to grains, (f) hardness parallel to grains, and (g) bending. (© Pearson Education, Inc. Used by permission.)

- Tensile strength in (a) is 2 – 4 times larger than compressive strength in (c)

Factors affecting timber strength

- Moisture content

- Density – depends on cell size, cell wall thickness, number & types of cells. Strength and stiffness increases with density.

- Defects – e.g. Knots (disturb continuity of grain), decay, splits & checks

- Grain types - straight grain has higher strength.

- Seasoning / Drying

- Preservation / Treatment

Lumber defects

Any form of imperfection in or on surface of wood that lowers the strength, durability and economy of wood.

Types of defects

- Growth / Natural Defects – wind, abnormal growth
- Production defects - felling, sawing or drying process

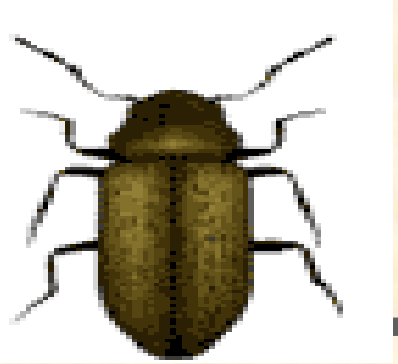
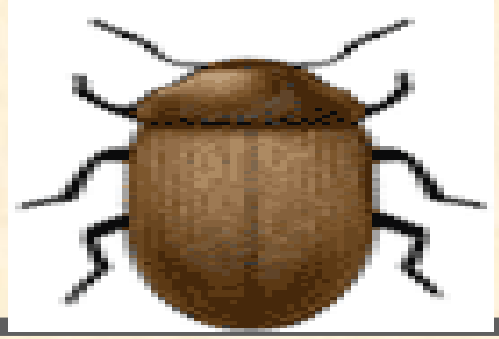
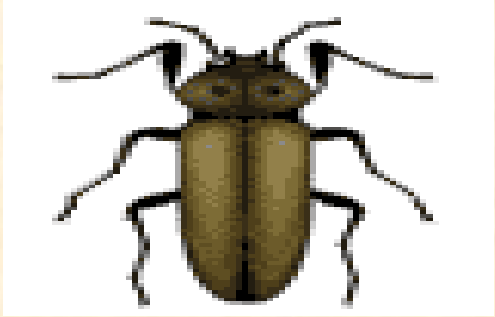
- **Growth Defects**

- Knots

✓ Portions of branch over which the tree has grown.

✓ Reduce wood strength, not desirable for appearance.



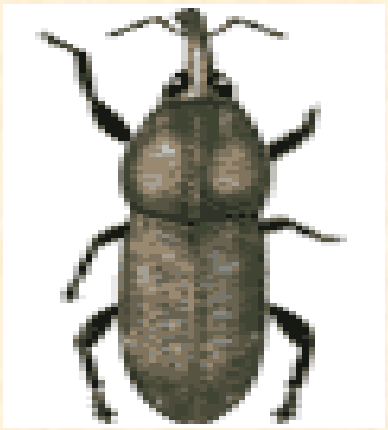




- **Decay**
  - ✓ Fungus (microscopic plant like organism) which feeds on wood fiber
  - ✓ Cause softening, loss of strength, weight and change of texture and color.



Damage

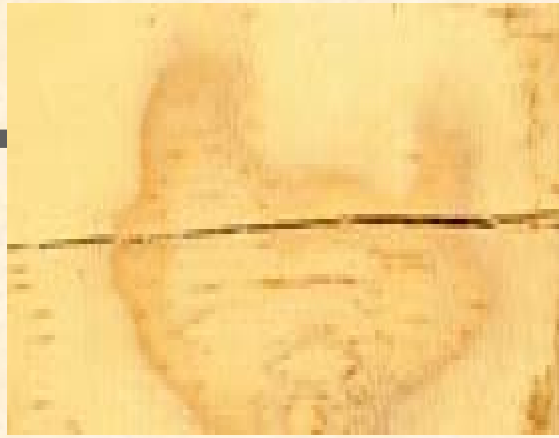
Due to insects such as beetle, termite & marine organisms

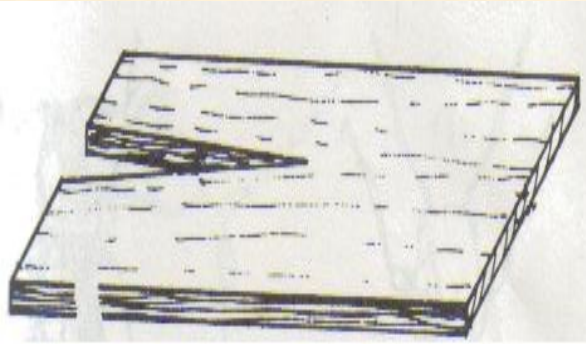


Production Defects

Cracks occur in various parts of trees



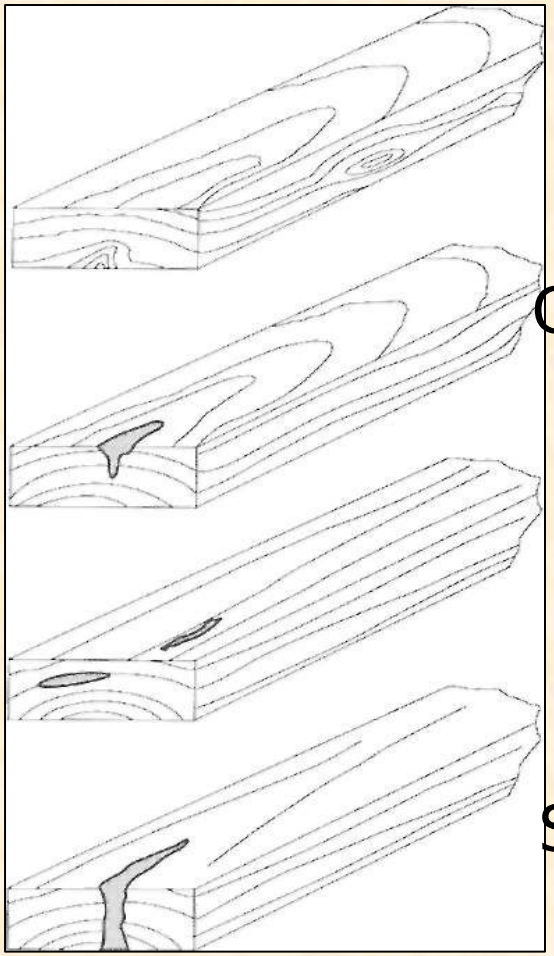
- Checks - radial cracks on surface of wood as a result of rapid drying. Effect on appearance and strength.



- Splits – deep crack that penetrate the entire depth of wood due to drying stresses or inappropriate handling. Effect on appearance & reduce shear strength.



- Shake - Defects that are caused due to stresses during growth (heavy wind), relief of stresses when tree is felled or impact on



Knots – growth defects

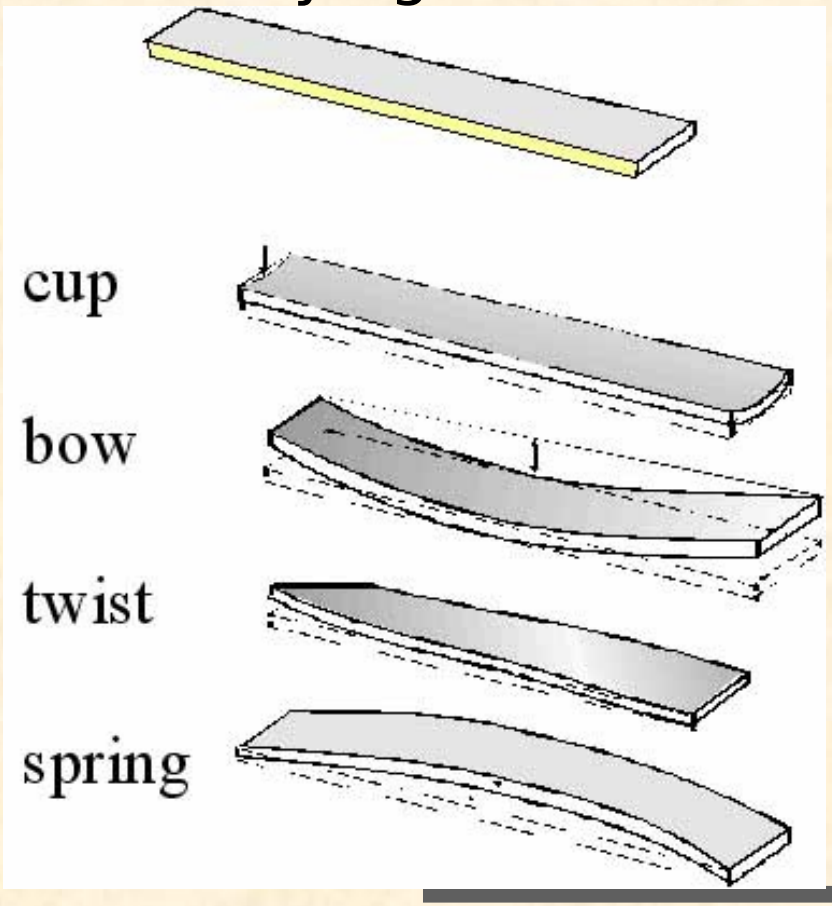
Checks - production defects

Shake – growth & production defects

Splits - production defects

Production Defects

Warping – distortion of wood from the desired plane. Results from differential drying and relief of internal stresses.



- Cup – Deformation of the cross section – edges move upward
- Bow – Deformation over the length of a board in the minor axis direction
- Spring – Deformation over the length of a board in the major axis direction
- Twist – lifting one corner of the plane

Timber Treatment / Preservation





- Treating wood with solutions to increase its durability

e. g. make it poisonous to fungi and inse
and to prevent it from absorbing more mo



Types of preservatives

- **Paints**
- **Oil type preservatives (petroleum b**

✓Creosote – brownish black oil made by distilling coal tar.

✓Pentachlorophenol (PCP), copper naphthenate – (Application – railroad ties, utility poles)

- Waterborne oxides (salts) preservatives – e.g.

Methods of preservation



- Brushing & spraying – Surface of timber is sprayed with preservatives.

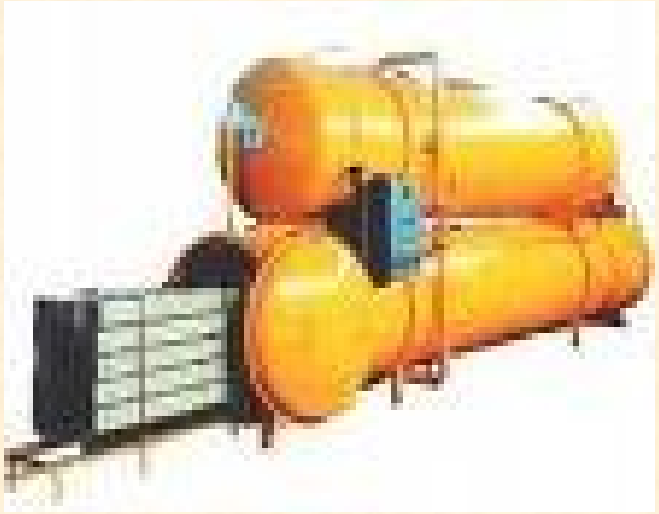
- Cold steeping (soaking) – Timber is soaked in a tank of preservative.

- Hot & cold open tank treatment – Timber placed in a tank of preservative.

- Pressure absorption – Timber is placed in vacuum cylinder. Air bubbles are removed from wood. Preservative is forced into the entire structure of wood.

Pressure absorption method





Logs loaded in a pressure chamber for impregnation with preservative.

Fire proofing of timber

- The rate of burning can be retarded or to make timber fire resistance to some extent.
- Lumber is placed in a pressure vessel.
- Impregnated with chemical salts e.g. ammonium sulfate, borax.
- Use fire retarding paint e.g. sodium silicate.



Advantages And Disadvantages Of Timber As A Construction Material

Advantages of wood

- High strength / weight ratio
- Easy to cut
- Good finishes and appearance
- Low heat and electrical conductivity
- High durability if properly treated

Disadvantages of wood

- Easy to catch fire (Combustibility)
- Susceptibility to attack by fungi and insects
- Shrinkage & swelling

Engineered Wood Products



- Engineered products are manufactured by bonding (gl
together with resin or adhesi
together wood veneers, strar
lumber, wood particles / chip
fibers to produce large and integral units.



- These products have specific and consistent engineering properties.





Classification of Engineered Wood Products

Wood Stock	Class Product	
	Structural Panel / Sheets (sheathing, flooring)	**Structural shapes (Beams, columns)**
Veneer (thin sheet of wood)	**Plywood (grains of veneer are alternated at 90 ^{0})**	**Laminated veneer lumber (grains are arranged parallel)**
Strands (length up to 150 mm, width < 25 mm)	**Waferboard – random orientation of strands. Oriented Strand Board - strands are oriented.**	**Laminated strand lumber**
Composite	Two parallel face veneers bonded to core of wood fiber.	-

❑ Structural panel



- **Plywood**

A glued wood panel made up of thin layers of veneer (thin layer of wood 1 to 6 mm thick) with the grain of adjacent layers at right angles.

- ❑ Major uses: wall paneling / partition and concrete formwork.
- ❑ Advantages: High strength stiff large sizes resistance to splitting



Veneer & Plywood Production



Logs are debarked.



Logs are soaked in hot water to soften wood.



Log mounted on lathe and being turned



Veneer being peeled from log

Veneer & Plywood Production



Dried and cut to required size



Applying glue and arranging veneer for pressing.



Finished product

❑ Structural shapes

- **Laminated veneer lumber (LVL)**

✓A structural lumber product manufactured from laminated veneers.

✓The grain of all veneers run parallel to the axis of a member. Thickness ~ 38 mm - 89 mm (1.5 - 3.5 inches).

Uses: scaffold planks.

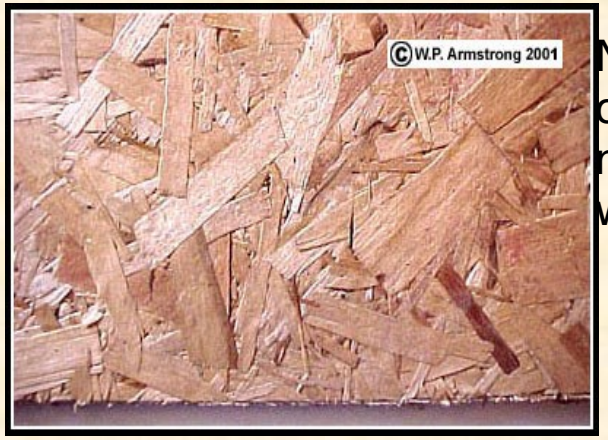


❑ Structural panel

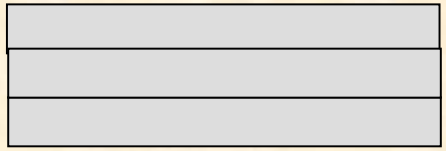


- **Wafer board**

A board made of wood strands randomly arranged and bonded together under heat and pressure using a binder.



Normally 3 to 5 layers of plies made of randomly arranged wood strands

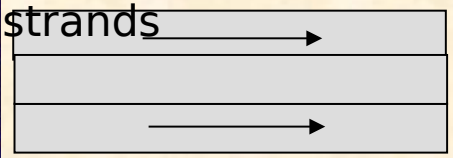


- **Oriented Strand board** (**OSB**)

Strands are oriented in one direction.



Panels are made of plies with alternating orientation of strands



Structural shapes



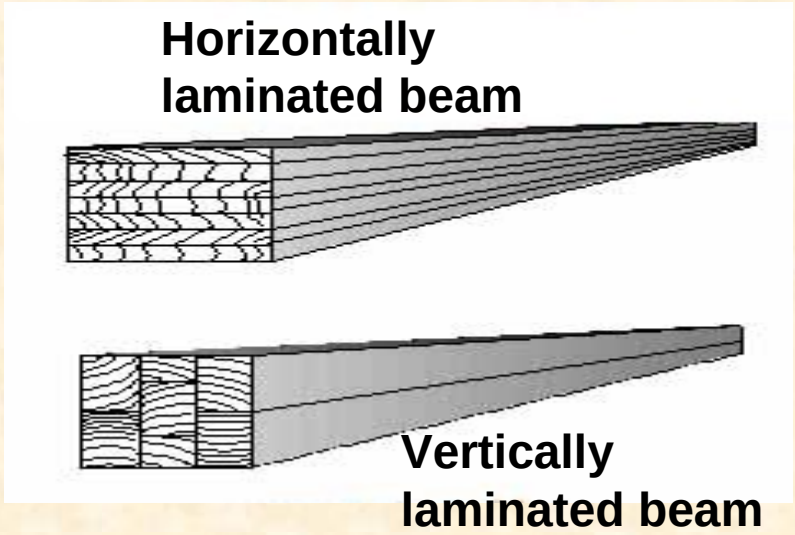
- **Laminated strand lumber (LSL)**

✓ Extensions of the technology used to produce OSB. Wood strands glued together with the grain of each strand oriented parallel to the length of the finished product.

✓ strands used (longer in LSL) and the density & strength are higher.

Laminated wood / Glu-lam (glue laminated wood)

- Small strips of wood (25 mm - 50 mm) are glued together to create larger section.
- The grain of all layers are laid parallel.
- Used in dry conditio
- Uses: Beam, colum roof truss.



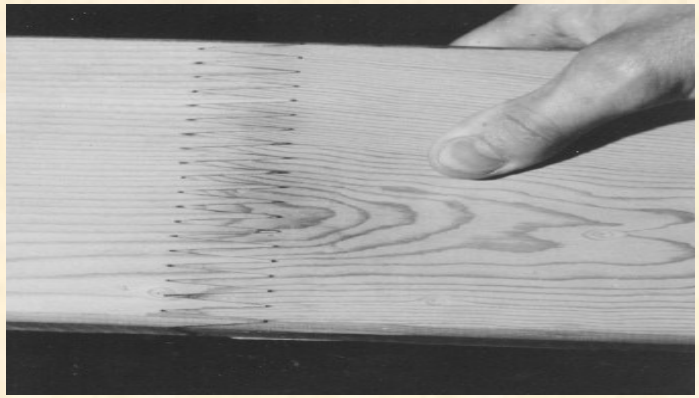




Advantages

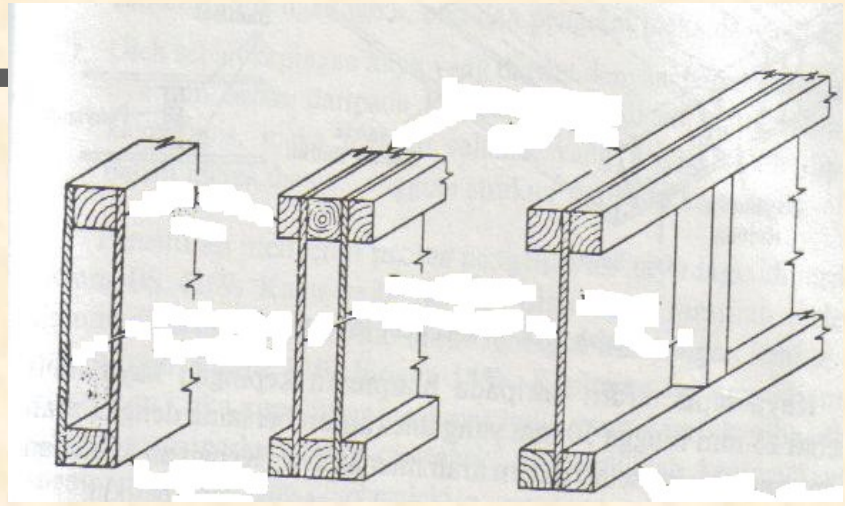


- Size - large section sizes, long lengths & various width
- Shape - straight, curved, tapered
- Quality - increased strength & stiffness, easier to dry
- Loss checking & other

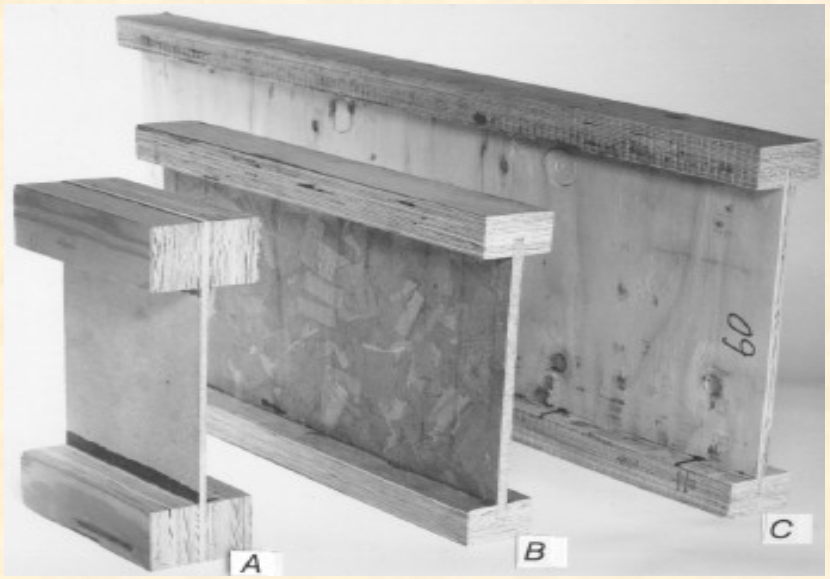


Finger joint used in the manufacture of glulam

Composite structural members



Sheet products and structural shapes product can be combined to produce composite structural members.



e.g. beams made of a combination of wood product : I- beam, box beam , T- sections.



End of chapter 3