Chapter 4

Timber

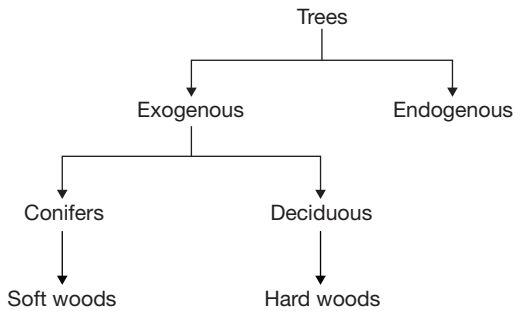
CHAPTER HIGHLIGHTS

- *Timber*
- *Structure of a tree*
- *Processing of timber*
- *Difference between natural seasoning and artificial seasoning*
- *Defects in timber*
- *Qualities of good timber*

Timber

The timber denotes wood which is suitable for building or carpentry or various engineering purposes. It is applied to the trees measuring not less than 650 mm in girth or circumference of the trunk.

Classification of Trees



1. **Exogenous trees:** These trees increase in bulk by growing outward and distinct consecutive rings are formed in horizontal section of such a tree. These trees are further divided into two groups:
   (a) **Conifers:** The leaves of the conferous trees do not fall till new ones are grown. They yield soft wood which is generally light coloured, resinous, light in weight and weak. These are also known as evergreen trees.
   (b) **Deciduous:** The deciduous trees are also known as broad-leaf trees. The leaves of these trees fall in autumn and new ones appear in the spring season. These trees yield hard woods which are usually close grained, strong, heavy dark coloured and non-resinous.
2. **Endogenous trees:** These trees grow inwards and fibrous mass is seen in their longitudinal sections. The timber obtained from these trees has very limited engineering applications.

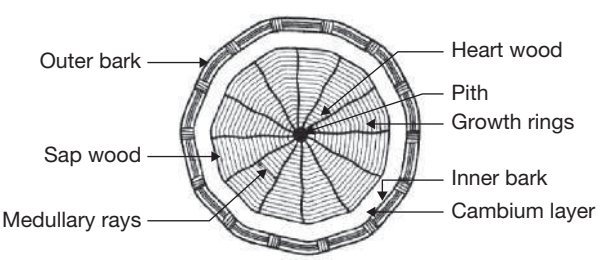
Structure of a Tree

Structure of a tree is divided into two categories. These are as:

1. Macrostructure
2. Microstructure

Let us know more about the structure of a tree.

1. **Macrostructure:**



Cross-section of an exogenous tree

Pith: The innermost central portion of tree is called 'pith' or 'medulla'.

It varies in size and shape for different types of trees.

Heart wood: The inner annular rings surrounding the pith constitute the heart wood. It is usually dark in colour. It imparts rigidity of the tree and hence, provides strong and durable timber for various engineering purposes.

Sap wood: Outer annual rings between heart wood and cambium layer is known as sap wood. It takes active part in growth of tree and sap moves in an upward direction through it.

Cambium layer: The thin layer of sap between sap wood and inner bark is known as cambium layer. It indicates sap which has been converted into sap wood.

Inner bark: Inner skin or layer covering the cambium layer is known as inner bark. It gives protection to cambium layer from injury.

Outer bark: Outer skin (or) cover of the tree is known as outer bark. It is the outermost layer and contains cracks and fissures.

Medullary rays: The thin radial fibres extending from pith to cambium layer are known as medullary rays. The function of these rays is to hold together the annual rings of heart wood and sap wood.

Microstructure: The structure of wood at great magnifications is called 'microstructure'.

Based on functions, cells are classified into the following three categories.

1. **Conductive cells:** These cells serve mainly to transport nutrients from roots to the branches and leaves.
2. **Mechanical cells:** The cells are elongated, thick-walled and have tightly interconnected narrow interior cavities. These cells impart strength to the wood.
3. **Storage cells:** These cells serve to store and transport nutrients to the living cells in the horizontal direction. These are usually found in the medullaray rays.

Processing of Timber

Timber processing from trees includes the following stages:

1. Felling of trees
2. Seasoning of timber
3. Conversion of timber
4. Preservation of timber

Let us learn more about the stages of timber processing.

1. **Felling of trees:** The trees are knocked down (or) cut down to the ground. This is known as falling of trees.
2. **Seasoning of timber:** The process of drying of timber is known as seasoning of timber.

Under controlled environment, as early as possible, moisture is extracted at uniform rate from all parts of timber during seasoning.

Seasoning is done in two ways:

1. Natural seasoning
2. Artificial seasoning

Natural seasoning: In this method, the seasoning of timber is carried out by natural air and hence, it is sometimes referred as air seasoning.

Artificial seasoning: This seasoning can be done in various methods like boiling, kiln seasoning, chemical seasoning, water seasoning and electrical seasoning.

Differences between Natural Seasoning and Artificial Seasoning

Natural Seasoning	Artificial Seasoning
It is difficult to reduce the moisture content below 15–18%.	The moisture content can be reduced to any desired level.
It is simple and economical.	It is expensive and highly technical.
It is more liable to attack of insects and fungi.	It is less liable to attack of fungi.
It requires more space for stacking.	It requires less space for stacking.
It is a slow process.	It is a quick process.
It gives stronger timber.	It gives weaker timber.

Defects in Timber

The defects in timber can be classified into five categories. These are:

1. **Defects due to conversion:** During the process of converting timbers to commercial form, the following types of defects may occur:
   - (a) **Chip mark:** Marks or signs placed by chips on finished surface of timber.
   - (b) **Diagonal grain:** Diagonal mark on straight grained surface of timber.
   - (c) **Torn grain:** Small depression is formed on finished surface of timber by falling of a tool.
   - (d) **Wane:** Presence of original rounded surface on manufactured piece of timber.
2. **Defects caused by fungi:**
   - (a) **Blue stain:** Wood is stained to bluish colour by the acts of certain type of fungi.

(b) **Brown rot:** Fungi remove cellulose compounds from wood. It results in brown colour.

(c) **Dry rot:** Fungi attack wood and convert it into powder form.

(d) **Heart rot:** A branch comes out of a tree, and the heart wood is exposed to the attack of atmospheric agents.

(e) **Wet rot:** Fungi cause chemical decomposition of wood. It converts timber into greyish brown powder.

3. **Defects due to insects**

(a) **Beeties:** These are small insects which cause rapid decay of timber. They form holes of 2 mm diameter in wood.

(b) **Marine borers:** These are found in marine waters. These can drill holes as high as 25 mm diameter and 60 mm length.

(c) **Termites:** Termites are also known as white ants. These insects are fast in eating wood from the core of cross-section.

4. **Defects due to natural forces:** The two main natural forces responsible for causing defect in timber are, namely, abnormal growth and rupture of tissues. Some defects caused due to these natural forces are burls, druxiness, foxiness, wind cracks, shakes, etc.

(a) **Burls:** These are also known as the excrescences and they are particularly formed when a tree has received shock or injury in its young age. Due to this, the growth of the tree is completely upset and irregular projections appear on the body of timber.

(b) **Callus:** It indicates soft tissue or skin which covers the wound of a tree.

(c) **Chemical stain:** The wood is sometimes discoloured by the chemical action caused with it by some external agency. This is known as the chemical stain.

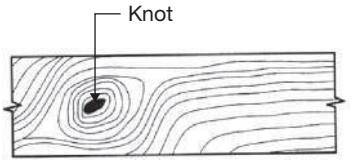
(d) **Coarse grain:** If a tree grows rapidly, the annual rings are widened. It is known as the coarse grained timber and such timber possesses less strength.

(e) **Dead wood:** The timber which is obtained from dead standing trees contains dead wood. It is indicated by light weight and reddish colour.

(f) **Druxiness:** This defect is indicated by white decayed spots which are concealed by healthy wood. Druxiness is probably formed by acts of fungi.

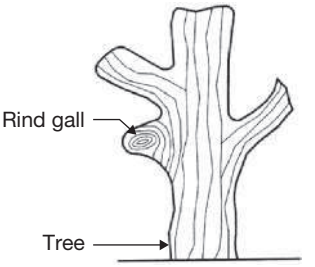
(g) **Foxiness:** This defect is indicated by red or yellow tinge in wood or reddish brown stains or spots round the pith of a tree discolouring the timber.

(h) **Knots:** These are the bases of branches or limbs which are broken or cut off from the tree. The following figure shows a typical knot.



Knot

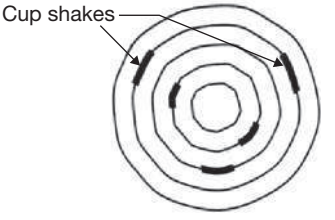
(i) **Rind galls:** The rind means bark and gall indicates abnormal growth. Hence, peculiar curved swellings found on the body of a tree are known as the rind galls as shown in the following figure.



Rind gall

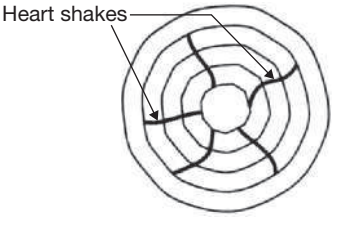
(j) **Shakes:** These are cracks which partly or completely separate the fibre of wood. Following are the different varieties of shakes.

(i) **Cup shakes:** These are caused by the rupture of tissue in a circular direction.



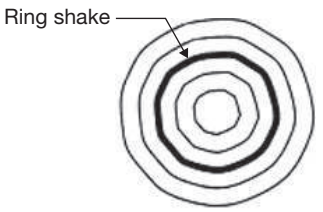
Cup shakes

(ii) **Heart shakes:** These cracks occur in the centre of cross-section of tree. Heart shakes extend from pith to sap wood in the direction of medullary rays.



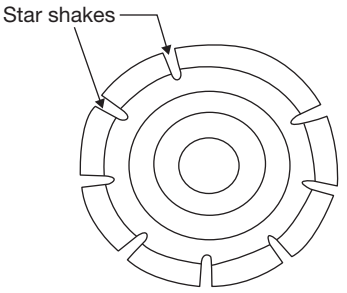
Heart shakes

(iii) Ring shakes: When cup shakes cover the entire ring, they are known as the ring shakes.



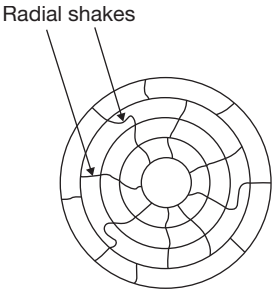
Ring shakes

(iv) Star shakes: These are cracks which extend from bark towards the sap wood. They are usually confined up to the plane of sap wood.



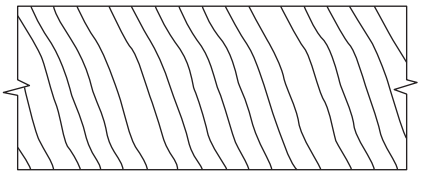
Star shakes

(v) Radial Shakes: These are similar to star shakes. But they are fine, irregular and numerous. They usually occur when a tree is exposed to sun for seasoning after it felled down.



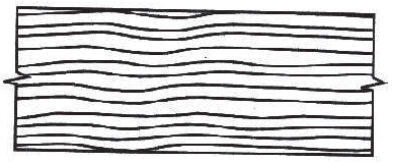
Radial shakes

(k) Twisted fibres: These are also known as the wandering hearts and caused by twisting of young trees by fast blowing wind.



Twisted fibres

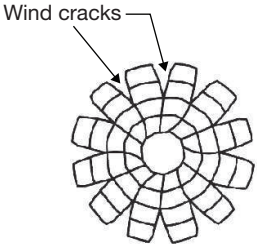
(l) Upsets: These are also known as the ruptures and they indicate the wood fibres which are injured by crushing or compression. The following figure shows a timber piece with this defect.



Upset

(m) Water stain: Woods sometime becomes discoloured when it comes into contact with water. This is known as water stain. This defect is usually found in converted timbers.

(n) Wind cracks: If wood is exposed to atmospheric agencies, its exterior surface shrinks. Such a shrinkage results into cracks.

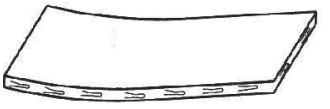


Wind cracks

5. Defects due to seasoning: The following defects occur in the seasoning process of wood:

(a) Bow
(b) Case-hardening
(c) Check
(d) Collapse
(e) Cup
(f) Honey-combing
(g) Radial shakes
(h) Spilt
(i) Twist
(j) Warp

Bow: This defect is indicated by the curvature formed in the direction of length of timber.



Bow

Case-hardening: The exposed surface of timber dries rapidly. It, therefore, shrinks and comes under compression. The interior surface which has not completely dried comes under tension. This defect is known as case-hardening. Usually it occurs in timbers which are placed at the bottom during seasoning.

Check: A check is a crack which separates fibres of wood. It does not extend from one end to the other.

Collapse: Due to uneven shrinkage, the wood sometimes flattens during drying. This is known as collapse.

Cup: This defect is indicated by the curvature formed in the transverse direction of timber as shown in the following figure.

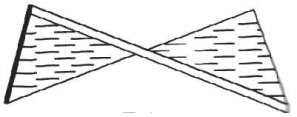
Cup

Honey-combing: Due to stresses developed during drying, the various radial and circular cracks develop in the interior portion of timber is known as honey-combing.

Radial shakes: These are radial cracks.

Split: When a check extends from one end to the other, it is known as a split.

Twist: When a piece of timber has spirally distorted along its length, it is known as twist.



Twist

Warp: When a piece of timber has twisted out of shape, it is said to have warped.

Qualities of Good Timber

Following are the characteristics or qualities of a good timber:

1. **Appearance:** A freshly cut surface of timber should exhibit hard and shining appearance.
2. **Colour:** The colour of timber should preferably be dark. The light colour usually indicates timber with low strength.
3. **Defects:** A good timber should be free from serious defects, e.g., dead knots, flaws, shakes, etc.
4. **Durability:** A good timber should be durable. It should be capable of resisting the actions of fungi insects, chemicals, physical agencies and mechanical agencies.
5. **Elasticity:** This is the property by which timber returns to its original shape when load causing its deformation is removed.

This is a sought after property of timber when it is used for making bow, carriage shafts, sport goods, etc.

6. **Fibres:** The timber should have straight fibres.
7. **Fire resistance:** The timber is a bad conductor of heat. A dense wood offers good resistance to the fire and it requires sufficient heat to cause a flame.
8. **Hardness:** A good timber should be hard, i.e., it should offer resistance when penetrated by another body.
9. **Mechanical wear:** A good timber should not deteriorate easily due to mechanical wear or abrasion.
10. **Shape:** A good timber should be capable of retaining its shape during conversion or seasoning. It should not bow or warp or split.
11. **Smell:** A good timber should have sweet smell. An unpleasant smell indicates a decayed timber.
12. **Sound:** A good timber should give out a clear ringing sound when struck. A dull heavy sound, when struck, indicates a decayed timber. The velocity of sound in wood varies between 2–17 times greater than that in air and hence, the wood may be considered high in sound transmission.
13. **Strength:** A good timber should be strong for working as structural member, such as joist, beam, rafter, etc.
14. **Structure:** It should be uniform. The fibres should be firmly added. The medullary rays should be hard and compact.
15. **Toughness:** A good timber should be tough, i.e., it should be capable of offering resistance to the shocks caused due to vibrations.
16. **Water permeability:** A good timber should have low water permeability which is measured by the quantity of water filtered through a unit surface area of specimen of wood.
17. **Weathering effects:** A good timber should be able to reasonably withstand the weathering effects. When timber is exposed to weather, its colour normally fades and slowly turns grey.

Exercises

1. According to the relevant IS code, the weight of the timber is to be reckoned at a moisture content of
(A) zero (B) 4%
(C) 8% (D) 12%

2. The strength of timber is maximum when load applied is
(A) parallel to grain.
(B) perpendicular to grain.
(C) inclined at 45° to grain.
(D) inclined at 60° to grain.

3. Seasoning of timber is required to
(A) soften the timber.
(B) harden the timber.
(C) straighten the timber.
(D) remove sap from the timber.

4. The moisture content in structural timber should be
(A) less than 5% (B) 5 to 10%
(C) 10 to 20% (D) 15 to 25%

5. Match List I with List II and select the correct answer using the codes given below the lists:

	List I		List II
a.	The innermost part or core of the stem of a tree	1.	Transverse septa (medullary rays)
b.	The vascular tissue which encloses the pith	2.	Annual rings
c.	A cellular tissue and woody fibre arranged in distinct concentric circles	3.	The cambium layer
d.	The thin layer below the bark not converted into sapwood as yet	4.	The outermost cover or skin of the stem
		5.	Medulla (pith)

Codes:

	a	b	c	d		a	b	c	d
(A)	2	5	3	4	(B)	5	1	2	3
(C)	4	3	2	1	(D)	5	1	4	3

6. Radial splits in timber originating from 'bark' and narrowing towards the 'pith' are known as
(A) heart shakes (B) star shakes
(C) cup shakes (D) knots

7. Timber can be made reasonably fire-resistant by
(A) soaking it in ammonium sulphate.
(B) coating with tar paint.
(C) pumping creosote oil into timber under high pressure.
(D) seasoning process.

8. Consider the following methods of preservation of timber:
I. Pressure application
II. Brush application
III. Dipping
IV. Open tank application

The correct sequence of these methods in the increasing order of their effectiveness is
(A) I, III, IV, II
(B) III, IV, II, I
(C) II, III, IV, I
(D) IV, II, I, III

9. Dry rot in timber is caused by
(A) lack of ventilation.
(B) lack of light.
(C) immersion in water.
(D) alternate wet and dry atmosphere.

10. Match List I (Term) with List II (Brief description) and select the correct answer using the codes given below the lists:

	List I		List II
a.	Heart shakes	1.	Disintegration caused by fungi
b.	Knot	2.	Outer layers of a log of wood
c.	Rot	3.	A branch base embedded in timber by natural growth
d.	Sap wood	4.	Cracks widest at centre and diminishing towards the outer circumference

Codes:

	a	b	c	d		a	b	c	d
(A)	1	3	4	2	(B)	4	2	1	3
(C)	1	2	4	3	(D)	4	3	1	2

11. What is the treatment for making timber fire-resistant?
(A) ASCU treatment
(B) Abel's process
(C) Creosoting
(D) Tarring

12. The age of a log of timber can be estimated by
(A) diameter of pith.
(B) thickness of bark.
(C) number of annular rings.
(D) number of medullary rays.

13. Which IS code is used for classification of timber for seasoning purposes?
(A) IS: 4970–1973
(B) IS: 1708–1969
(C) IS: 1141–1958
(D) IS: 399–1963

14. The plies in plywood are so placed that the grains of each ply are:

(A) Parallel to each other.
(B) At right angle to one another.
(C) 45° oblique to adjacent grain.
(D) Not constrained by any consideration.

15. Match List I (Wood elements) With List II (Description)

	List I		List II
a.	Pith	**1.**	Inner most portion of the tree
b.	Sap wood	**2.**	Inner annual rings Surrounding the pith
c.	Heart wood	**3.**	Outer most annual rings
d.	Cambium layer	**4.**	Thin layer of Sap between Sapwood and inner bark

Codes:

	a	b	c	d		a	b	c	d
(A)	1	3	2	4	(B)	2	4	1	3
(C)	1	4	2	3	(D)	2	3	1	4

16. Radial splits in timber origination from 'bark' and narrowing towards the 'pith' are known as _____.
(A) heart shakes (B) star shakes
(C) cup shakes (D) knots

17. 'Red Shortness' is the defect, related to _____.
(A) timber (B) brick
(C) lime stone (D) steel

18. Alternate wetting and drying of timber
I. Results in shrinkage and swelling
II. Brings about wet rot on set
III. Increases the durability
IV. Causes transmission of spores from germination

Identify the correct statements?
(A) I, II, III and IV (B) I, II and III
(C) II, III and IV (D) I, II and IV

19. On application of external stress on timbers, it behaves like
(A) an elastic material
(B) non-elastic material
(C) Visco elastic material
(D) Non-visco elastic material

20. Kiln seasoning of timber results in _____.
I. reduced density
II. reduced life
III. dimensional stability

Which of these statement is/are correct?
(A) I, II and III (B) I only
(C) II only (D) I and III

21. Identify the incorrect statements from the below:
I. Natural seasoning of timber results in strong timber compared to artificial seasoning.
II. Artificial seasoning results in strong timber compared to natural seasoning of timber.
III. Case-hardening and cup are the defects observed in timber due to seasoning.
IV. Seasoning reduces the weight of the timber and imparts dimensional stability.
(A) I and IV only
(B) II only
(C) I and III only
(D) I only

Answer Keys

Exercises

1. D	**2.** A	**3.** D	**4.** C	**5.** B	**6.** B	**7.** A	**8.** C	**9.** A	**10.** D
11. B	**12.** C	**13.** C	**14.** B	**15.** A	**16.** B	**17.** D	**18.** D	**19.** A	**20.** D
21. B									