

KP GATE CLASSES, NEW DELHI – INDIA'S No. 1 GATE AR COACHING

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CHAPTER 1. BUILDING MATERIALS

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WEIGHTAGE & TIPS (BUILDING MATERIALS)

Please refer to the weightage of this topic (Chapter 1: Building Materials of Book 3) from GATE 2011 to GATE 2023 tabulated below:

GATE YEAR	WEIGHTAGE (Marks)
2023	2
2022	3
2021	4
2020	0
2019	3
2018	5
2017	6
2016	2
2015	6
2014	3
2013	2
2012	5
2011	4
Average	3.5 Marks

Students are advised to remember the following points, before you start studying this Chapter:

- Building Materials is a subject which is a part of **Section B1.2** in Architecture Part of Official Syllabus.
- In building materials, the most important material from which maximum number of questions have been asked in GATE is 'CONCRETE'. Students are advised to focus on the numerical part also for this topic.
- Questions in building materials are based on types, defects, and uses. This is the theory area one should focus on.



*Scan the QR Code to Watch the Video:
Introduction to Chapter 1 - Building Materials*

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1.1 TIMBER

Wood derived from trees is processed into planks for use in construction. Such wood prepared for use in construction and carpentry is termed as “timber”.

1.1.1 CLASSIFICATION OF TIMBER

Timber can be classified into categories based on many criteria. Few such parameters are; growth characteristics, wood characteristics, and grading.

Based on growth characteristics, timber is classified into exogenous and endogenous. Exogenous trees grow outward by adding distinct consecutive rings known as growth rings or annual rings. In such trees it is possible to estimate the age of timber by counting the number of rings. Endogenous trees grow inwards. In these trees, fresh fibrous mass is in the inner most portion. Examples of endogenous trees are bamboo and cane.

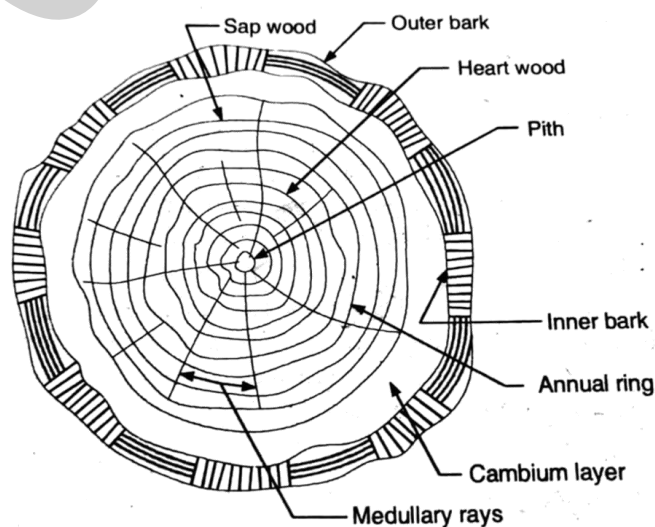
Based on wood characteristics, timber is classified into hardwood and softwood. Hardwood is generally derived from deciduous trees (characterized by broad leaves). Hardwood is generally dark and heavy with good strength and fire resistance. Softwood is generally derived from coniferous trees (characterized by cone shaped fruits). Softwood is generally light in colour and weight with lower strength and fire resistance compared to hardwood.

Based on grading as per IS 883:1994, timber is classified into three groups. The classification is based on strength properties, namely, modulus of elasticity (E) and extreme fiber stress in bending and tension (f). The classification is tabulated below:

Group A	E above $12.6 \times 10^3 \text{ N/mm}^2$; f above 18.0 N/mm^2
Group B	E above $9.8 \times 10^3 \text{ N/mm}^2$ and up to $12.6 \times 10^3 \text{ N/mm}^2$; f above 12.0 N/mm^2 and up to 18.0 N/mm^2
Group C	E above $5.6 \times 10^3 \text{ N/mm}^2$ and up to $9.8 \times 10^3 \text{ N/mm}^2$; f above 8.5 N/mm^2 and up to 12.0 N/mm^2

1.1.2 CROSS-SECTION OF TIMBER

Cross-section of timber for a typical exogenous tree is characterized by concentric growth rings. The dead inner rings are called ‘heartwood’ which is relatively dry and living outer rings are called ‘sap wood’ which is relatively moist. Other important parts are marked in the figure below:



1 Cross-section of Timber

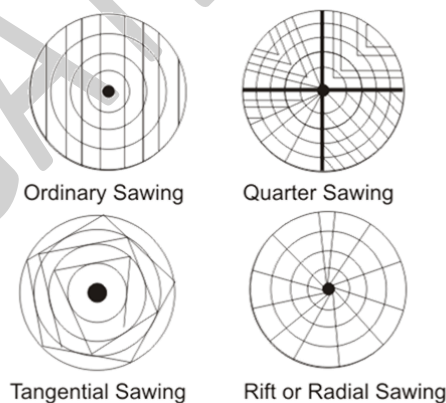
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- a. Pith: It is the inner most part of the tree and hence the oldest part of exogeneous tree when the plant becomes old, the pith dies and becomes fibrous and dark. It varies in size and shape.
- b. Heart Wood: This is the portion surrounding pith. It is dark in colour and strong. This portion is useful for various engineering purpose. This is the dead part of wood. It consists of multiple growth rings.
- c. Sap Wood: It is the layer next to heart wood. It is composed of newer growth and contains sap. It takes active part in the growth of trees by allowing sap to move in upward direction. The growth rings of sap wood are light in colour. Sap wood is also termed as alburnum.
- d. Cambium Layer: It is a thin layer of fresh sap lying between sap wood and the inner bark. It contains sap which is not yet converted into sap wood.
- e. Inner Bark: It is an inner skin of tree protecting the cambium layer.
- f. Outer Bark: It is the outer skin of the tree and consists of wood fibers. Sometimes it contains fissures and cracks.
- g. Medullary Rays: These are thin radial fibers extending from pith to cambium layer. They hold annular rings together. In some of trees they are broken and sometimes may not be visually prominent.

1.1.3 SAWING OF TIMBER

Tree logs (trees after felled) if not cut/sawn for a long duration, would result in circumferential shrinkage due to moisture drying from the outer part (sapwood). The outer most rings shrink more as compared to inner rings. As a result, star shakes or cracks (discussed under defects) would appear on the surface of log and deteriorate the timber quality.

There are four main methods of sawing. They are; Ordinary sawing, Quarter sawing, Tangential sawing and Radial sawing.



2 Sawing of Timber

- a. Ordinary Sawing: This is the most economical and widely used method of sawing. Here, long parallel planks are cut from the tree log. As the inner portion (heart wood) is hard and outer portion (sap wood) is soft, after drying there can be unequal shrinkage. So, the planks are liable to warp and twist.
- b. Quarter Sawing: In Quarter sawing the logs are cut or sawn in quarter and each quarter is then cut in such a way that the sawn members bend in transverse direction. This method is generally adopted when no distinct medullary rays are present.

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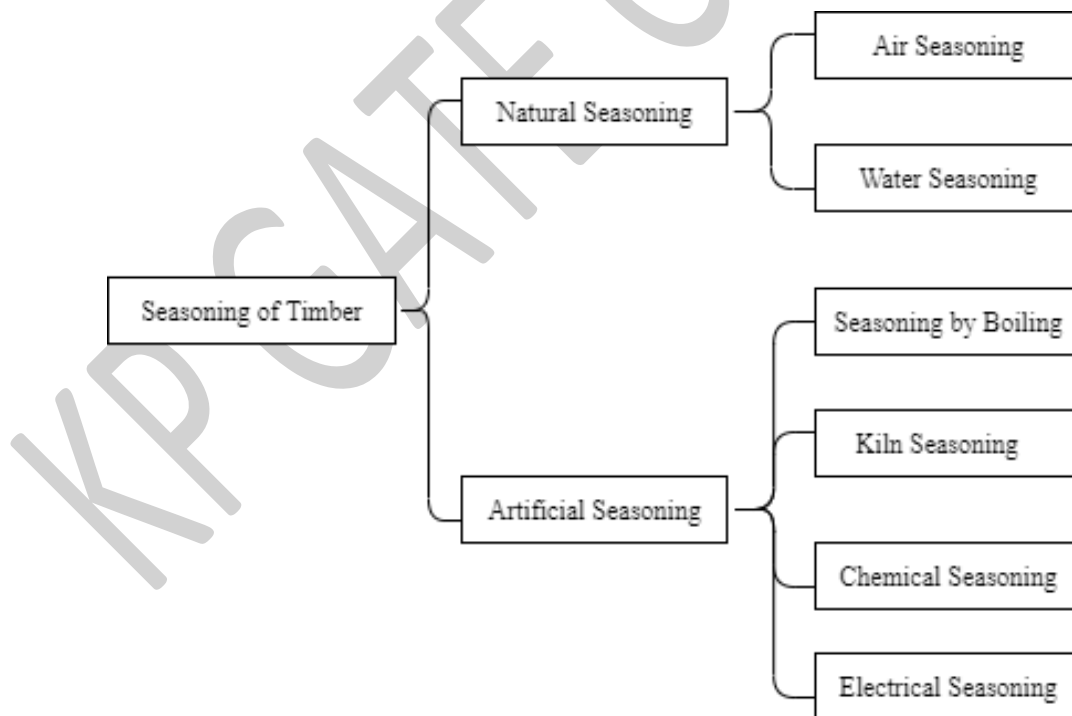
- c. **Tangential Sawing:** Tangential sawing is generally used if annual rings are well formed and medullary rays are not well formed. In this method, cuts are made tangent to the annual rings. Planks obtained by this method warp too much and must not be used for costly structural works or for flooring.
- d. **Radial Sawing:** In this method logs are sawn parallel to medullary rays and perpendicular to annual rings. This method gives least shrinkage but has highest wastage. This method gives most decorative grain patterns in which medullary rays are marked. This method yields timber planks with least shrinkage because of the property of medullary rays to resist shrinkage. This method is also known as Rift Sawing.

1.1.4 SEASONING OF TIMBER

Controlled reduction of moisture content from timber is termed as “Seasoning”. Moisture content of trees may sometimes be as high as 60 percent. Proper seasoning of timber brings down this moisture content to as low as 10 percent.

Seasoning of timber is necessary to reduce the moisture content and thereby increase the strength of timber. Seasoning of timber also reduces development of shrinkage defects and results in longer life of the timber.

Methods for seasoning of timber can be classified into two types: Natural seasoning and Artificial seasoning. Natural seasoning is of two main types; Water seasoning and Air seasoning. Artificial seasoning is of four main types; Seasoning by boiling, Kiln seasoning, Chemical seasoning and Electrical seasoning. The flowchart below summarizes the classification of methods for seasoning timber:

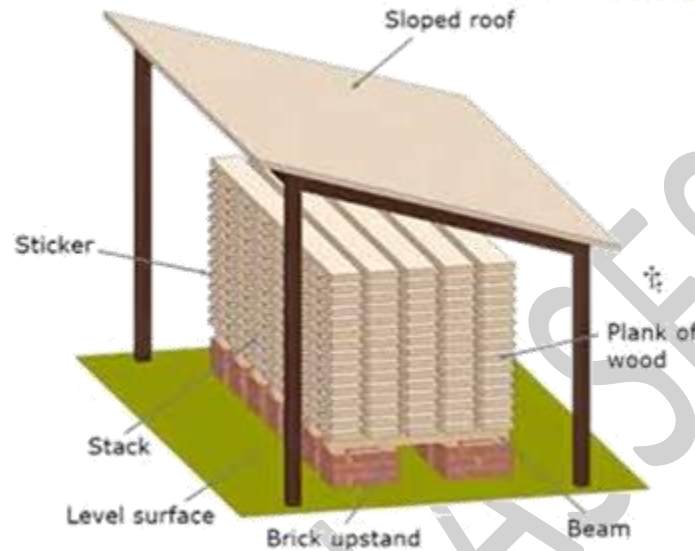


3 Classification of Timber Seasoning

- A. **Natural Seasoning:** Seasoning of timber using natural elements like air and water is called ‘Natural Seasoning’. This type of seasoning does not make use of external energy sources like fuel, electricity or chemicals. Natural seasoning is of two main types as explained below;

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- Air Seasoning: This process involves exposing timber to air flow for seasoning. At first, a platform or block piers are built on the ground to about 300mm height from ground level. Then the arrangement of timber in layers is prepared above the platform. Air circulation is maintained between timber planks to help reduce the moisture content. Even though this is a slow process, it is an economical method suitable for large scale seasoning.



4 Air Seasoning

- Water Seasoning: This process is carried along river banks or streams where removal of wood sap is achieved by immersing logs into water flow. This helps in replacement of wood sap of wood cells by water. The water-saturated wood dries quicker as compared to sap-saturated wood. This is a time-consuming process but an economical method.
- B. Artificial Seasoning: Artificial seasoning is a faster alternative process for seasoning timber but is costlier compared to natural processes. Types of artificial seasoning processes are discussed below:
- Seasoning by Boiling: Seasoning of timber is achieved by boiling it in water for 3 to 4 hours. After boiling, timber is allowed to dry. For large quantity of timber where boiling can be difficult, hot steam is passed through timber logs in an enclosed space. The boiling or steaming process develops the strength and elasticity of timber but it is costlier process.
 - Kiln Seasoning: In this method timber is subjected to hot air in an air tight chamber. The hot air circulates between the timber logs and reduces the moisture content. The temperature inside the chamber is raised with the help of heating coils. When the required temperature is obtained moisture content and relative humidity gets reduced and timber gets seasoned. Even though it is a costly process it gives good results with respect to strength.
 - Chemical Seasoning: In chemical seasoning, timber is stored in suitable salt solution for some time. The salt solution used has the tendency to absorb water from the timber. So, the moisture content is reduced, and then timber surface is allowed to dry. Even though this a quick process, it may sometimes affect the strength of timber.
 - Electrical Seasoning: Dry wood is non-conductor of electricity while moist timber is a conductor and can allow alternating current to pass through it. So, in this method alternating current is used for drying the cells of timber by creating heat. As electricity is used, this process is not economical.