Chapter 31: Wood and Wood Products – Seasoning, Diseases, Defects, Decay

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1. Introduction

Wood has been one of the most versatile and sustainable building materials used since ancient times. In modern civil engineering, wood and its derivatives continue to play a significant role in construction, formwork, furniture, paneling, and interior design. Understanding the nature of wood, its behavior under environmental and biological conditions, and methods to preserve its strength and durability are essential for safe and long-lasting construction.

This chapter discusses the in-depth processes and engineering importance of **seasoning of wood**, **diseases affecting wood**, **defects** arising during or after growth and felling, and **decay** due to biological or environmental agents.

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2. Seasoning of Wood

2.1 Definition

Seasoning is the controlled process of reducing the moisture content in wood to make it suitable for use in construction or furniture-making. Unseasoned or green wood tends to shrink, warp, or decay easily when exposed to the atmosphere.

2.2 Objectives of Seasoning

- To reduce moisture content to an acceptable level (typically 8–15%)
- To improve dimensional stability
- To increase strength and durability
- To reduce weight
- To prepare wood for further treatment (painting, polishing)
- To minimize decay, warping, or fungal attack

2.3 Types of Seasoning

2.3.1 Natural Seasoning (Air Seasoning)

- Wood is stacked in a well-ventilated area protected from direct sun and rain.
- Wood pieces are spaced for free air circulation.
- Takes several months to over a year depending on wood species and local climate.
- Economical but slow and less uniform.

2.3.2 Artificial Seasoning Faster and more controlled method using external means.

a. Kiln Seasoning

- Wood is placed in a kiln chamber with regulated temperature and humidity.
- Involves drying schedules depending on species and thickness.
- Yields well-seasoned wood in days or weeks.

b. Boiling or Water Seasoning

- Logs are immersed in hot water or steamed to remove sap.
- Followed by air drying.
- Effective for certain hardwoods.

c. Chemical Seasoning

- Salts or chemicals like urea, sodium chloride, or boric acid used.
- Speeds up moisture removal.
- Reduces fungal and insect attacks.

d. Electrical or Microwave Seasoning

- High-frequency electric or microwave waves used to heat the moisture internally.
- Rapid but expensive; used for valuable timber.

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3. Wood Diseases

Wood diseases are caused by biological agents such as fungi, insects, and bacteria that deteriorate the quality, appearance, or strength of the wood.

3.1 Fungal Diseases

Fungi grow in wood when it is moist and has inadequate air circulation.

a. Stain Fungus

- Discoloration (bluish or black patches)
- No effect on strength but reduces commercial value

b. Decay or Rot Fungus

- Reduces structural integrity
- Types:
  - **White rot**: Cellulose and lignin destroyed, white spongy texture

  - **Brown rot**: Mainly cellulose destroyed, brown powdery residue
  - **Soft rot**: Occurs in moist, warm environments

3.2 Insect Infestation

a. Termites (White Ants)

- Attack both dry and moist wood
- Hollow out wood from inside, leaving thin shells

b. Beetles (Powder-post beetles)

- Lay eggs in wood; larvae bore tunnels
- Fine powder (frass) seen as symptom

c. Marine Borers

- Affect wood in water environments (harbors, piers)
- Examples: *Teredo*, *Limnoria*

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4. Defects in Wood

Wood may develop defects due to natural growth abnormalities, environmental exposure, improper seasoning, or mechanical damage.

4.1 Natural Defects

a. Knots

- Remnants of branches embedded in tree trunk
- Reduce strength and appearance
- Types: Tight (firmly held), Loose (can fall out)

b. Shakes

- Cracks or splits along annual rings
- Types:
  - **Star Shake**: Radiates outward from pith
  - **Heart Shake**: Starts at pith, along radial direction
  - **Ring Shake**: Along growth rings (circular)

c. Twisted Fibres

- Spiral grain growth
- Causes warping and uneven shrinkage

4.2 Defects from Improper Seasoning

a. Warping

- Uneven drying leads to distortion
- Types: bowing, cupping, twisting

b. Checks and Cracks

- Surface splits due to rapid drying
- Reduces strength and aesthetics

c. Honeycombing

- Internal cracks, usually not visible
- Dangerous for load-bearing timber

d. Case Hardening

- Outer layer dries too fast, traps moisture inside
- Causes stress and internal cracking

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5. Decay of Wood

Decay refers to the degradation of wood due to prolonged exposure to unfavorable conditions, especially high moisture, warmth, and poor ventilation.

5.1 Conditions for Decay

- Moisture content above 20%
- Warm temperatures (20–35°C)
- Lack of sunlight
- Poor ventilation

5.2 Types of Decay

a. Dry Rot

- Caused by *Serpula lacrymans* fungus
- Misleading name: requires moisture to initiate
- Rapid destruction of cellulose and lignin

b. Wet Rot

- Caused by continuous wetting (leaky roofs, soil contact)
- Leads to soft, spongy wood with discoloration

c. Brown Rot

- Common in coniferous woods
- Wood darkens and breaks into cube-like cracks

d. White Rot

- Breaks down both lignin and cellulose
- Leaves white fibrous texture

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6. Prevention of Wood Defects and Decay

6.1 Proper Seasoning and Storage

- Use kiln or chemical seasoning methods
- Store in dry, ventilated areas with elevated platforms

6.2 Chemical Treatments

- Preservatives: Creosote oil, copper-chrome-arsenate (CCA), zinc chloride
- Pressure treatment for deep penetration

6.3 Design Considerations

- Avoid wood in direct soil contact
- Use moisture barriers and proper drainage
- Choose decay-resistant species (e.g., teak, sal, cedar)

6.4 Periodic Maintenance

- Inspection for termites or fungal signs
- Surface treatments with antifungal or insecticidal coatings
- Prompt repair of leaks and cracks

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7. Testing of Wood and Timber in Civil Engineering

Wood must be tested to ensure its mechanical, physical, and biological properties meet the required standards for structural and non-structural applications.

7.1 Physical Tests

a. Moisture Content Test

- Oven drying method: A wood sample is weighed, dried in an oven at 105°C, and reweighed.

- Formula:

$$\text{Moisture Content (\%)} = \frac{\text{Initial weight - Oven dry weight}}{\text{Oven dry weight}} \times 100$$

b. Density Test

- Density = Mass/Volume
- Indicates strength and quality; hardwoods generally have higher density than softwoods.

c. Shrinkage and Swelling Tests

- Measures dimensional change with varying moisture.
- Important for flooring, joinery, and furniture.

7.2 Mechanical Tests

a. Compression Test (Parallel and Perpendicular to Grain)

- Determines load-bearing capacity.
- Parallel test for columns and posts.
- Perpendicular test for beams under compression.

b. Bending Test (Modulus of Rupture and Elasticity)

- Specimens are loaded as simply supported beams.
- Determines:
  - **Modulus of Rupture (MOR)**: Maximum stress before failure.
  - **Modulus of Elasticity (MOE)**: Stiffness of wood under load.

c. Hardness Test

- Janka test: Measures force required to embed a steel ball halfway into wood.
- Indicates resistance to denting and wear.

d. Shear Test

- Determines shear strength along the grain, important for beam design.

7.3 Durability and Biological Resistance Tests

a. Preservative Absorption Test

- Measures retention and penetration of wood preservatives.
- Done by slicing test specimens after pressure treatment.

b. Fungal and Insect Resistance Tests

- Wood samples exposed to known fungi or insects under lab conditions.
- Weight loss is measured after a set duration to assess deterioration.

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8. Indian Standard Codes Relevant to Timber

In civil engineering practice in India, Bureau of Indian Standards (BIS) provides guidance and specifications for timber use:

IS Code	Title
IS 1708	Methods of Testing Small Clear Specimens of Timber
IS 399	Classification of Commercial Timbers and Their Zoning
IS 401	Code of Practice for Preservation of Timber
IS 287	Recommendations for Maximum Permissible Moisture Content
IS 4970	Key for Identification of Commercial Timbers
IS 9096	Code of Practice for Preservation of Timber by Pressure Process
IS 10013	Method of Testing Timber for Resistance to Termites

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9. Preservation Techniques and Treatment Methods

Effective preservation significantly increases the service life of wood products, especially in hostile environments such as water, soil, or humid climates.

9.1 Preservative Types

a. Oil-based Preservatives

- *Creosote Oil*: Deep penetration; suitable for railways, poles, marine structures.

- *Tar Oils*: For fence posts and outdoor use.

b. Water-soluble Preservatives

- *Copper-Chrome-Arsenic (CCA)*: Widely used; toxic to fungi and insects.
- *Zinc Chloride, Sodium Fluoride*: Lower cost but leachable.

c. Organic Solvent-Based Preservatives

- Used where water or oil preservatives may not be suitable.
- Volatile carriers evaporate leaving active preservative inside.

9.2 Treatment Methods

a. Brushing and Spraying

- Simple method, only for temporary protection.
- Suitable for furniture or low-risk items.

b. Dipping and Soaking

- Timber is immersed in preservative solution for several hours.
- Better penetration than brushing.

c. Hot and Cold Open Tank Treatment

- Timber is heated in hot preservative, then cooled in a cold tank.
- Creates vacuum effect for deeper absorption.

d. Pressure Treatment (Vacuum/Pressure Impregnation)

- Timber placed in autoclaves and subjected to high pressure.
- Ensures uniform deep penetration.
- Common for utility poles, railway sleepers, and outdoor decking.

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10. Engineered Wood and Modern Wood Products

To overcome the natural limitations of solid wood, various engineered products are developed for structural and aesthetic purposes.

10.1 Plywood

- Thin layers (veneers) glued together with grains at right angles.
- High strength, stable, widely used in construction.

10.2 Particle Board

- Made from wood chips, sawdust mixed with resin and pressed.
- Economical and used for furniture and partitions.

10.3 Medium Density Fibreboard (MDF)

- Wood fibers bonded with resin under heat and pressure.
- Smooth surface, good machinability.

10.4 Laminated Veneer Lumber (LVL)

- Veneers laminated in same grain direction.
- Used for structural members (beams, joists).

10.5 Glue-Laminated Timber (Glulam)

- Layers of lumber glued together to form large, curved beams.
- Suitable for long-span and decorative applications.

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11. Eco-Friendly Wood Alternatives and Sustainability

As civil engineering moves toward sustainable practices, wood usage is being optimized for environmental impact.

11.1 Bamboo as a Timber Alternative

- Fast-growing, strong, and flexible.
- Used for scaffolding, flooring, and reinforcement.

11.2 Agro-Waste Boards

- Made from bagasse, rice husk, or wheat straw.
- Useful for low-cost panels and boards.

11.3 Certified Wood

- FSC (Forest Stewardship Council) and PEFC certified timber ensures sustainable harvesting.
- Encouraged for green building ratings (LEED, GRIHA).
