Chapter 33: Wood and Wood Products – Plywood, Veneers, Particle Boards and Their Uses

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Introduction

Wood has been one of the oldest materials used in construction due to its availability, ease of use, renewability, and favorable strength-to-weight ratio. With the advancement of engineering and technology, various wood products have been developed to overcome the limitations of solid wood such as dimensional instability, knots, warping, and cost. These engineered wood products include **plywood**, **veneers**, **particle boards**, and others, each tailored for specific structural and non-structural applications in civil engineering.

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1. Plywood

1.1 Definition and Composition

Plywood is an engineered wood product made by gluing together multiple thin layers (plies) of wood veneer. Each adjacent layer is rotated relative to the one below it, usually at 90° (cross-laminated).

1.2 Manufacturing Process

- **Log Selection**: High-quality logs (usually softwood or hardwood) are selected and conditioned (steam or soak).
- **Veneer Cutting**: Logs are rotated against a knife to peel veneers.
- **Drying**: Veneers are dried in kilns to the required moisture content.
- **Adhesive Application**: Phenol-formaldehyde (for exterior) or urea-formaldehyde (for interior) adhesives are applied.
- **Layering**: Veneers are stacked with alternating grain directions.
- **Pressing**: The stack is pressed under high temperature and pressure.
- **Trimming and Sanding**: The board is cut to size and surface finished.

1.3 Types of Plywood

- **Softwood Plywood**: Made from pine, fir, etc. – commonly used in construction.
- **Hardwood Plywood**: Made from teak, birch, etc. – for furniture and flooring.
- **Marine Plywood**: High-quality water-resistant glue and hardwood veneers – for boat and moisture-prone applications.
- **Flexible Plywood**: Thin, bendable – used for curved surfaces.

1.4 Properties of Plywood

- Dimensional stability
- High strength-to-weight ratio
- Resistance to warping and cracking
- Good nail and screw holding capacity
- Resistance to moisture (varies with adhesive used)

1.5 Uses of Plywood

- Formwork and shuttering in concrete construction
- Flooring and wall sheathing
- Furniture and cabinetry
- Roofing and subflooring
- Doors and partition panels

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2. Veneers

2.1 Definition

A veneer is a thin slice of wood (usually less than 3 mm thick) that is typically glued onto core panels (like plywood, particle board, or MDF) to produce flat panels such as doors, tops, and panels for cabinets and parquet floors.

2.2 Types of Veneers

- **Raw Veneer**: Natural veneer without backing; flexible.
- **Backed Veneer**: Veneer glued to a backing (paper, cloth) for strength.
- **Reconstituted Veneer**: Made from fast-growing species, dyed, and glued to mimic premium woods.
- **Laminated Veneer**: Layers of veneer glued under heat and pressure to form laminated veneer lumber (LVL).

2.3 Manufacturing Process

- **Log Preparation**: Logs are steamed or soaked.
- **Slicing or Rotary Cutting**: The log is sliced into sheets.
- **Drying**: Veneers are dried to a moisture content of 6–10%.
- **Trimming and Grading**: Based on appearance, grain, and defects.

2.4 Characteristics of Veneers

- Retains natural wood appearance
- Lightweight and flexible
- Allows use of rare wood finishes economically
- Subject to peeling or delamination if not properly adhered

2.5 Applications of Veneers

- Decorative finishes on furniture
- Wall panels and ceilings
- Wooden flooring and cabinetry
- Doors, office partitions
- Vehicle interiors and dashboards

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3. Particle Boards

3.1 Definition

Particle board is a low-density engineered wood product made from wood chips, sawdust, or shavings that are bound together using synthetic resin or binder under heat and pressure.

3.2 Manufacturing Process

- **Raw Material Preparation**: Waste wood is cleaned and broken down into particles.
- **Drying**: Moisture is reduced to desired levels.
- **Mixing with Binder**: Particles are mixed with urea-formaldehyde or phenol-formaldehyde resin.
- **Mat Formation**: The mixture is layered in mats with fine particles at the surface and coarse inside.
- **Pressing**: Pressed under high heat and pressure to cure the binder.
- **Trimming and Finishing**: Boards are cut to size and surface-sanded.

3.3 Types of Particle Boards

- **Single Layer Particle Board**: Uniform particles throughout.
- **Three-Layer Particle Board**: Fine particles on the surfaces, coarse inside.
- **Graded-Density Particle Board**: Continuously varying density through the thickness.
- **Cement-Bonded Particle Board**: Wood particles bonded with cement – used in fire-resistant and moisture-proof applications.

3.4 Properties

- Low cost and easy to manufacture
- Smooth surface suitable for painting and laminating
- Low strength compared to plywood and solid wood
- Vulnerable to moisture unless treated
- Brittle under impact loads

3.5 Applications

- Modular furniture and cabinetry
- False ceilings and wall partitions
- Underlayment for countertops
- Flooring and shelving
- Office furniture and doors (non-load bearing)

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4. Comparison Table of Engineered Wood Products

Property	Plywood	Veneer	Particle Board
Structure	Cross-laminated	Thin wood slice	Random particle bonded
Strength	High	Dependent on core	Low to moderate
Moisture Resistance	High (marine)	Low	Low unless treated
Aesthetic Value	Moderate to high	Very high	Low to moderate
Applications	Structural & furniture	Decorative only	Non-structural furniture
Cost	Moderate	High (for rare woods)	Low

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5. Advantages of Engineered Wood Products

- **Resource efficiency**: Utilization of wood waste and fast-growing species.
- **Design flexibility**: Available in large sizes and curved forms.
- **Stability**: Less susceptible to warping or shrinking than solid wood.
- **Economic**: Cost-effective compared to natural hardwoods.

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6. Limitations and Concerns

- **Environmental impact**: Use of formaldehyde-based adhesives can emit VOCs (volatile organic compounds).
- **Durability**: Some products are not suitable for load-bearing or moisture-prone areas.
- **Maintenance**: Surface finishes may deteriorate over time.

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7. Indian Standards and Specifications (ISI Codes)

In India, wood and wood-based products are governed by standards issued by **Bureau of Indian Standards (BIS)**. These ensure uniformity in quality, safety, and performance. Some relevant IS codes include:

Material/Product	Relevant IS Code	Description
Plywood	IS 303	General-purpose plywood
	IS 710	Marine plywood (waterproof)
Veneer Sheets	IS 1328	Veneer decorative plywood
Particle Board	IS 3087	Specification for wood particle boards
Cement-Bonded Particle Bd.	IS 14276	Specification for cement bonded particle boards
Adhesives	IS 848	Synthetic resin adhesives for plywood and panel use

Note: Adherence to these IS codes is mandatory for public projects and quality certification.

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8. Testing of Wood-Based Products

Proper **testing** is essential to determine mechanical and physical properties, especially when used in structural components.

8.1 Common Tests for Plywood and Veneers

- **Modulus of Rupture (MOR)** and **Modulus of Elasticity (MOE)**: Evaluated using a three-point bending test.
- **Tensile and Shear Strength Tests**: To assess bonding strength of plies.
- **Moisture Content Test**: Oven-dry method or moisture meter.
- **Delamination Test**: Assesses bonding durability under boiling water or vacuum-pressure treatment.
- **Adhesive Test**: Pull-off strength and glue line shear strength.

8.2 Particle Board Testing

- **Internal Bond Strength**: Assesses cohesion between particles.
- **Swelling in Thickness**: After immersion in water for 24 hours.
- **Surface Soundness**: Resistance to delamination of surface layer.

- **Screw Holding Capacity**: Both face and edge.
- **Density and Moisture Content**: Using standard oven-drying techniques.

Testing Standards Used:

- IS 1734 (for plywood)
- IS 2380 (for particle board testing)
- ASTM D1037 (international particleboard test methods)

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9. Workability and Joinery

Wood-based products offer distinct **workability characteristics** that affect cutting, machining, fixing, and joining.

9.1 Plywood

- **Machining**: Easy to cut, plane, and drill.
- **Fastening**: Nails and screws hold well; pre-drilling reduces splitting.
- **Finishing**: Accepts paints, laminates, and veneers smoothly.
- **Cutting**: Fine-toothed saw blades prevent tear-out on face veneers.

9.2 Veneers

- Usually used as overlays; workability depends on the substrate.
- Require careful pressing to avoid bubbling or wrinkling.

9.3 Particle Boards

- **Low nail/screw holding capacity** – must use inserts or surface-mounted fasteners.
- **Chipping**: Common while cutting unless carbide tools are used.
- **Laminates**: Often covered with laminate or veneer to enhance aesthetics and wear resistance.

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10. Sustainability and Environmental Considerations

10.1 Environmental Impact

- Many wood products use **formaldehyde-based adhesives** which may emit VOCs.
- Unsustainable logging can lead to deforestation and biodiversity loss.

10.2 Solutions and Trends

- **E0 and E1 Grade boards**: Ultra-low formaldehyde emission.
- **FSC® and PEFC™ Certifications**: Ensure responsible forest management.
- **Eco-friendly binders**: Soy-based or MDI adhesives replacing urea-formaldehyde.
- **Recyclability**: Most boards can be reused or recycled as fuel or filler.

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11. Common Defects in Wood-Based Products

11.1 Plywood Defects

- **Delamination**: Poor bonding between plies.
- **Core gaps**: Voids in the inner plies weaken the board.
- **Warping and bowing**: Due to uneven drying or imbalance in layering.
- **Face veneer splits or patches**: Reduces aesthetic value.

11.2 Veneer Defects

- **Checking and cracking**: Especially in thin or improperly dried veneers.
- **Discoloration**: Staining due to sap or improper adhesive.
- **Overlapping**: Inconsistent gluing leads to visible seams.

11.3 Particle Board Defects

- **Blistering or bubbling**: Moisture trapped under laminates or during curing.
- **Edge crumbling**: Especially if exposed to moisture or mishandled.
- **Delamination**: Inadequate pressure during pressing or adhesive failure.

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12. Field Applications in Civil Engineering Projects

12.1 Concrete Formwork

- Plywood is extensively used for shuttering and centering because:
  - It provides a smooth finish to concrete.
  - It is reusable if properly maintained.
  - Phenolic-coated shuttering plywood enhances water resistance.

12.2 Modular and Pre-fab Construction

- Particle boards and veneered panels are widely used in modular cabin and partition systems.

12.3 Interior Architecture

- Decorative veneers enhance the finish of lobbies, ceilings, and furniture in commercial and residential spaces.

12.4 Industrial Buildings

- Cement-bonded particle boards are used as wall panels due to their fire and moisture resistance.

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13. Innovations in Engineered Wood Products

- **Cross Laminated Timber (CLT)**: Massive panels made by gluing layers of solid-sawn lumber; increasingly used in multi-storey buildings.
- **Oriented Strand Board (OSB)**: Alternative to plywood in structural sheathing; made of aligned wood strands.
- **Laminated Veneer Lumber (LVL)**: Used for structural beams and headers; high dimensional stability.

These innovations are pushing wood products beyond interior use to structural roles in modern construction.
