WOOD SCIENCE FORESTRY

The Science of Lesser Known Timbers: A Technical Handbook for Sustainable Wood Utilization

Published: February 20, 2025 | Index ID: #611

The global timber industry has historically relied on a narrow selection of primary species, such as Teak (*Tectona grandis*), Mahogany (*Swietenia macrophylla*), and Rosewood (*Dalbergia latifolia*). However, as natural forests face increasing pressure and biodiversity conservation becomes a priority, the spotlight has shifted toward **Lesser Known Timbers (LKTs)**. These species, often overlooked due to a lack of technical data or established market presence, represent a vast untapped resource that can meet industrial demands while promoting ecological balance. This handbook explores the technical properties, mechanical performance, and industrial potential of LKTs, drawing on foundational research from the Kerala Forest Research Institute (KFRI) and the Plant Resources of South East Asia (PROSEA).

The Theoretical Framework of Lesser Known Timbers

In the context of wood science, **Lesser Known Timbers** are defined not by their biological rarity, but by their secondary status in the commercial market. While primary timbers have well-documented drying schedules, strength classes, and preservation requirements, LKTs often require rigorous characterization to ensure they meet engineering standards. The transition from utilizing primary species to LKTs requires a deep understanding of **wood anatomy**, **physical-mechanical properties**, and **durability cycles**.

Wood Anatomy and Identification

Technical identification of LKTs is the first step in their industrial integration. This involves microscopic and macroscopic analysis of the following features:

- Vessel Elements: Distribution (ring-porous vs. diffuse-porous), frequency, and the presence of inclusions such as tyloses or gums.
- Axial Parenchyma: Patterns such as paratracheal (associated with vessels) or apotracheal (independent of vessels), which influence the wood's density and permeability.
- Fiber Characteristics: Wall thickness and fiber length, which directly correlate with the wood's Modulus of Rupture (MOR) and Modulus of Elasticity (MOE).
- Ray Parenchyma: Width and height of rays, affecting the radial shrinkage and seasoning behavior.

Physical and Mechanical Properties

The utility of any timber is dictated by its behavior under stress and its interaction with moisture. For LKTs, the following metrics are essential:

1. Specific Gravity (SG): Often the most reliable predictor of strength. Most LKTs range from 0.40 to 0.85 SG.
2. Equilibrium Moisture Content (EMC): Understanding how LKTs reach a stable moisture state in different climatic conditions is critical to preventing warping and checking.
3. Fiber Saturation Point (FSP): Typically around 25-30% moisture content. Changes below this point result in dimensional instability.

Technical Analysis of Core Species

Drawing from the *KFRI Research Report 304* and *PROSEA Handbook 5(3)*, we can analyze several key species that exemplify the potential of LKTs.

1. Bombax ceiba (Semul / Silk Cotton Tree)

Commonly found across South and Southeast Asia, *Bombax ceiba*is a fast-growing species often categorized under the PROSEA framework for timber trees. While historically used for matches and plywood, its technical potential extends further when treated correctly.

- Density: Low (approx. 350-450 kg/m³ at 12% MC).
- Mechanical Strength: Low bending strength but high shock resistance relative to its weight.
- Permeability: Highly permeable, making it an excellent candidate for pressure impregnation with preservatives.

2. Acacia auriculiformis

Extensively researched in West Africa (Benin) and Asia, this species demonstrates how LKTs can serve as high-quality substitutes for construction timber. Research indicates that its mechanical properties, particularly **compression strength parallel to grain**, rival many traditional hardwoods.

3. Acmena acuminatissima

Highlighted in the PROSEA series, this species represents the dense, durable LKTs suitable for heavy construction and flooring. Its high silica content, while challenging for sawblades, provides natural resistance to marine borers.

Comparative Performance Matrix

The following table provides a comparative analysis of primary timbers versus prominent LKTs based on standardized technical data.

Species Type	Common Name	Density (kg/m³)	MOR (N/mm²)	MOE (kN/mm²)	Durability Class
Primary	Tectona grandis (Teak)	650	95	12.5	I (Very Durable)
LKT	Acacia auriculiformis	720	110	13.2	II (Durable)
LKT	Bombax ceiba	380	45	5.8	IV (Perishable)
LKT	Acmena acuminatissima	850	125	15.5	I (Very Durable)
Primary	Dalbergia latifolia	800	115	14.0	I (Very Durable)

Mathematical Modeling of Wood Strength in LKTs

To predict the performance of LKTs without exhaustive destructive testing, wood scientists use mathematical relationships between **Specific Gravity (G)**and various mechanical properties. The following power functions are standard in timber engineering:

Modulus of Rupture (MOR) Calculation

The relationship is often expressed as:

MOR = K * Gn

Where:**K** = constant (approx. 110-120 for air-dry wood)**G** = Specific Gravity at 12% moisture content**n**= exponent (typically 1.25 for hardwoods)

Modulus of Elasticity (MOE) Calculation

MOE = K * G

For many LKTs, the MOE scales linearly with density, allowing engineers to estimate stiffness based on simple gravimetric measurements. This is vital for using LKTs in structural load-bearing applications like trusses and joists.

Processing and Industrial Implementation Guide

One of the primary barriers to the adoption of LKTs is their seasoning and machining behavior. This section provides a field guide for industrial integration.

Seasoning Schedules

LKTs are often prone to severe seasoning defects such as **honeycombing**, **surface checking**, and **collapse**. A controlled kiln-drying schedule is mandatory.

- Refractory Species: Dense LKTs (e.g., Acmena) require a very mild schedule with high initial humidity to prevent case-hardening.
- Non-Refractory Species: Light LKTs (e.g., Bombax) can be dried rapidly but are susceptible to fungal staining (blue stain) if not processed immediately after felling.

Preservative Treatment Procedures

Because many LKTs lack natural durability (extractives like tannins and oils), chemical preservation is essential for exterior use. The **Full-Cell (Bethell) Process** is recommended for LKTs intended for ground contact:

1. Initial Vacuum: Remove air from wood cells (approx. -85 kPa for 30 minutes).
2. Pressure Period: Inject preservative solution (CCA or ACQ) at 1000-1400 kPa until refusal.
3. Final Vacuum: Remove excess solution from the surface.

Machining Considerations

High-density LKTs often contain **interlocked grain**, which causes "picking up" during planing. To mitigate this:

- Use a cutting angle of 15° to 20° rather than the standard 30°.
- Increase the number of knives on the cutter head to improve the finish on interlocked surfaces.
- Use tungsten-carbide-tipped tools for species with high silica content.

Case Study: KFRI Research on Sustainable LKT Trade

The Kerala Forest Research Institute (KFRI) conducted an extensive study (Report 304) to bridge the gap between timber researchers and the domestic market. The study identified 30 LKT species that could immediately enter the furniture market.

Operational Challenge: Species Grouping

A significant hurdle identified was the **taxonomic diversity**. Markets cannot handle hundreds of individual species names. KFRI proposed a **Property-Based Grouping System**.

The Solution: Grouping by End-Use

Instead of marketing wood by botanical name, timbers were grouped into categories:

- Group A (Structural): High density, high MOR (e.g., Hopea species).
- Group B (Joinery/Furniture): Medium density, good stability, attractive grain.
- Group C (Utility): Low density, easy to treat (e.g., Bombax).

This grouping allows architects and contractors to specify a "Performance Class" rather than a specific species, ensuring a steady supply even if one species becomes temporarily unavailable.

Troubleshooting Common Defects in LKTs

When working with non-traditional timbers, technical teams frequently encounter specific failure modes. Understanding the root causes is key to successful implementation.

1. Brittleheart (Center Rot)

Common in large-diameter tropical LKTs. It results in very low impact strength. **Solution:**Mandatory stress-grading and exclusion of the pith (center) during conversion.

2. Growth Stress

Common in fast-growing LKTs like Eucalypts or certain Acacias. The logs may split immediately upon felling or during sawing.**Solution:** Use of **S-hooks**on log ends, radial sawing patterns (quarter sawing), and log conditioning (steaming) before conversion.

3. Tension Wood

Reaction wood formed in leaning trees. It leads to fuzzy grain during machining and longitudinal shrinkage. **Solution:**Identify via visual inspection (it often appears darker and lustrous); separate these boards for non-structural utility use.

The Broader Implications for Global Forestry

The integration of Lesser Known Timbers is not merely a technical challenge but a strategic necessity for sustainable development. By diversifying the species used in global trade, we reduce the "high-grading" of natural forests—the practice of removing only the most valuable trees, which degrades the remaining ecosystem. The research provided by K.M. Bhat and the PROSEA project establishes a scientific foundation that transforms LKTs from "weed trees" into valuable industrial assets.

As carbon sequestration becomes a tradable commodity, fast-growing LKTs offer a dual benefit: they provide a renewable source of structural material while sequestering carbon at rates far exceeding those of old-growth primary species. The future of the timber industry lies in the precision engineering of these diverse species, supported by rigorous anatomical data, standardized mechanical testing, and innovative processing technologies. Through the adoption of these handbooks and technical reports, the timber trade can transition toward a more resilient, bio-based economy.

Tags: #Lesser Known Timbers #KFRI #PROSEA #Timber Engineering #Wood Anatomy #Sustainable Forestry