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Effect of Thermal Modification on the Density, Durability, Dimensional Stability, and Mechanical Properties of *Pinus caribaea*

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Abstract

Pinus caribaea (Pine) is an underutilized timber species in Sri Lanka due to its low density, durability, dimensional stability, and undesirable colour. This research aims to examine the enhancements in the physical and mechanical properties of Pinewood through thermal modification (TM) and compare the properties of the TM wood with kiln-dried and untreated wood and with the properties of high-graded timbers of *Tectona grandis* (teak) and *Koompassia malaccensi* (kempas). TM is a process that involves heating wood to high temperatures (200⁰ C) in the absence of oxygen, which removes the moisture and creates changes in the wood at the cellular level. The effectiveness of the thermal modification on density, modulus of rupture (MOR), modulus of elasticity (MOE), moisture content, dimensional stability, durability, and colour was studied. Specific gravity of thermally modified wood was 6% higher than untreated wood, but lower than teak and kempas. MOR and MOE values were 35.75% and 46.46% respectively higher than untreated wood. Equilibrium moisture content was reduced after TM and volumetric shrinkage of TM was reduced to 2.16% and swelling under liquid water contact was reduced to 2.37%. Thermally modified timber was classified as not durable (DC 5) based on field test (EN 252, 2014) results. However, TM timber was slightly durable (DC 4) according to laboratory tests and showed better fungal resistance. The wood underwent a darkening effect as a result of thermal modification, resembling the colour of teak. The cost of TM was 13.1% higher than kiln drying. Improved dimensional stability, enhanced bending strength, and attractive appearance demonstrate the potential of thermal modification as a promising alternative for transforming *P. caribaea* wood into high-value raw material. TM timber finds suitable applications in indoor furniture and joinery projects. However, due to its lack of termite resistance, preservative treatment is recommended for outdoor ground contact usage.

Keywords: Thermally modified timber, Mechanical properties, Dimensional stability, Durability, *Pinus caribaea*