



# Thermally modified wood: assessing the impact of weathering on mechanical strength and exposure to subterranean termites

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## Abstract

The main objective of this study was to evaluate the mechanical properties of three thermal-modified wood species when exposed to weathering in urban and maritime/industrial environments and their durability against subterranean termites. The wood species studied were Maritime pine, ash, and blackwood acacia. All wood samples were exposed to two different environments (urban and maritime/industrial) for 24 months. Then, its physical and mechanical properties were evaluated (modulus of elasticity (MOE), modulus of rupture (MOR), compression strength (CS), and modulus of compression (MOC). Thermally modified woods revealed a lower density, which could explain the loss of MOE and MOR. In compression, no significant changes were verified. The weathered samples showed changes in mechanical properties, mostly verified in MOE and MOR, where some decreases were reported in both locations. Tests were performed to evaluate biodegradation and the resistance of all wood samples to subterranean termites. The grade of attack ( $\approx 4$ ) and termite survival rate were similar in all wood species (above 75% and lower than 80%), except for modified acacia (59%), which could indicate that thermal modification increased toxic substances. The cellulose degradation was reflected in FTIR-ATR and Py-GC/MS in natural and thermally modified woods. Py-GC/MS showed a decrease in levoglucosan, while lignin suffered some modifications with slight changes in monomeric composition reflected by the reduction of the S/G ratio. No changes were found between the two environments, and thermal modification did not give extra protection against termites and weathering.

## 1 Introduction

Wood is one of the most ancient materials used by humans in construction. Its flexibility, strength, elasticity, and workability make it an extremely versatile material. Today, wood is used in numerous applications, from indoor furniture to outdoor uses in building construction. However, when applied outdoors, wood is exposed to various conditions, such as weathering and biodegradation. Thermal treatment can increase wood durability and overcome weathering and

biodegradation. Over the years, different wood protection technologies have been developed to protect wood against these environmental aggressions. One type of wood protection technology is wood modification, which changes wood chemically and helps protect wood against degradation (Ormondroyd et al. 2015). One of the most common wood modification technologies worldwide is thermal modification (Esteves and Pereira 2009; Jones et al. 2019; Godinho et al. 2021; Hill et al. 2021).

Wood weathering is a slower degradation caused by sun radiation, rain, humidity, and wind, among other climatic factors (Nuopponen et al. 2004; Williams 2005; Godinho et al. 2021, 2024). Usually, it causes wood surface alterations, namely color, chemical, physical, mechanical, and morphological changes (Tomak et al. 2018; Cui and Matsumura 2019; Humar et al. 2019; Godinho et al. 2024). This slow degradation could promote some changes in wood's physical and mechanical properties. For example, Tomak et al. 2014 exposed some thermally modified wood species, such as softwood and hardwood, for 24 months and showed

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