

Timber Construction as a Systemic Pathway Towards Sustainable Built Environments

Manuel Carpio ^{1,2,3} 

¹ Department of Construction Engineering and Project Management, University of Granada, 18071 Granada, Spain; carpio@ugr.es

² Department of Construction Engineering and Management, School of Engineering, Pontificia Universidad Católica de Chile, Santiago 7820436, Chile

³ Centro Nacional de Excelencia para la Industria de la Madera (CENAMAD), Pontificia Universidad Católica de Chile, Santiago 7820436, Chile

The construction sector is at a critical crossroads [1]. Achieving sustainable built environments now requires systemic solutions that integrate materials, processes, and territorial conditions, rather than isolated technological improvements [2,3]. Material choice has therefore become a strategic decision rather than a purely technical one [4,5].

Within this context, timber has re-emerged as a key material for sustainable construction. Its renewability, capacity for biogenic carbon storage, and compatibility with industrialised and prefabricated processes position it as a central component of low-carbon construction strategies [6,7]. However, the sustainability of timber construction cannot be assessed at the level of individual products or buildings alone; it must be examined across the full value chain, from territorial and forest-related conditions to material processing, structural performance, and urban-scale impacts [8,9].

This Special Issue, “Timber Construction as a Systemic Pathway Towards Sustainable Built Environments”, was conceived to address timber construction as a continuous and interconnected system. The eleven contributions approach this system from complementary perspectives, covering upstream environmental baselines, material and process innovation, construction-scale performance, and city-level implications.

At the upstream end of the value chain, two contributions focus on the environmental conditions that underpin any credible timber-based construction strategy. One study, on *Pinus radiata* plantations, analyses the relationship between carbon stock and cumulative production at harvesting age, demonstrating how soil conditions influence both productivity and carbon storage potential (a). In parallel, the assessment of agricultural land expansion and groundwater sustainability in north-central Chile highlights how land-use change and water scarcity can constrain long-term territorial sustainability (b). Together, these works emphasise that the environmental performance of timber construction is inseparable from resilient land, forest, and water management.

Material innovation and value recovery are subsequently explored through bio-based and circular approaches. The applicability of pulp and paper industry waste in manufacturing mycelium-based thermoacoustic insulation materials illustrates how industrial by-products can be transformed into functional construction solutions (c). Complementarily, the development of cement pastes incorporating wheat straw ash and silica fume contributes to a reduction in embodied carbon through agricultural residue valorisation and hybrid material systems (d). Although not timber-based, this contribution reinforces the transversal nature of sustainable construction and the importance of low-impact material portfolios.



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At the product and process scale, engineered wood performance and manufacturing quality are addressed. An investigation into green-glued finger joints examines the influence of wood ring orientation on adhesion performance, providing practical knowledge to improve reliability, material efficiency, and the use of underutilised timber resources (e). Such process-level insights are essential, as connection behaviour often governs the structural performance and robustness of modern timber systems.

Several contributions adopt a broader perspective, analysing how timber construction knowledge evolves and is translated into practice. A bibliometric review of prefabricated and modular timber construction maps research development from 1990 to 2023, identifying dominant themes, emerging trends, and persistent challenges related to industrialisation and circular economy principles (f). A science mapping study focused on mid-rise and tall timber buildings highlights the growing relevance of timber in urban construction while underlining the need to align environmental ambition with structural feasibility and regulatory acceptance (g). In addition, a bibliometric analysis centred on urban coastal development situates timber housing within climate-resilient planning strategies, reinforcing the link between timber construction and adaptation-orientated urban policies (h).

Downstream, whole-building and urban-scale performance are examined. A life cycle assessment and cost analysis comparing mid-rise mass timber and concrete buildings in Australia demonstrate that timber solutions can provide both environmental and economic advantages when assessed across the building life cycle (i). At the city scale, the concept of urban timber buildings as a “second forest” reframes timber structures as long-term biogenic carbon stocks, positioning cities as active components in carbon management strategies (j).

Finally, this Special Issue addresses the transformation of the existing building stock. The proposed use of laminated timber elements to enhance the seismic performance of reinforced concrete buildings illustrates how timber can contribute to retrofit and strengthening strategies, extending its role beyond new construction while supporting sustainability objectives (k).

Together, the contributions to this Special Issue demonstrate that timber construction represents a systemic pathway towards sustainable built environments rather than a singular material substitution. Progress depends on linking robust territorial and environmental baselines, innovative and efficient material processing, reliable engineered products, and credible performance at the building and urban scales. By addressing timber construction as an integrated system, this Special Issue contributes to a deeper understanding of how timber can support climate-resilient, resource-efficient, and scalable construction strategies in the decades ahead.

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