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AUSTRALIAN PLANTATION EUCALYPTUS NITENS AS AN ALTERNATIVE BUILDING MATERIAL

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ABSTRACT: Fast-growing plantation *Eucalyptus nitens* (*E. nitens*) presents a promising opportunity for the development of innovative building materials. This resource has traditionally been used for pulp production; however, research has uncovered their potential for high value engineered wood products (EWPs). This paper explores the progress in utilising plantation-grown *E. nitens* for structural EWPs, particularly in Tasmania, where extensive research and development efforts have been undertaken and a number of recent commercial buildings have used these products. The discussion highlights key findings, challenges, and advancements in processing *E. nitens* into engineered products such as cross-laminated timber (CLT) and glued-laminated timber (GLT). The paper also highlights research efforts on evaluating material and product performance, as well as the capacity to use plantation *E. nitens* in buildings.

KEYWORDS: Engineered Wood Products, Eucalyptus, Plantation, Australia, Tasmania

1- *E. nitens*: A Potential Feedstock for Engineered Wood Products (EWPs)

Eucalyptus species is cultivated in over 95 countries, with plantation areas exceeding 22.57 million hectares [1]. *E. nitens* and *E. globulus* (the other common fast growing Eucalypt species grown for pulp) are extensively cultivated in temperate regions worldwide, particularly in Australia, Portugal, Spain, Chile, and South Africa [2]. These species are predominantly grown in unthinned and unpruned stands and managed for pulpwood production [2].

E. nitens plantations are Australia's second most cultivated Eucalyptus species, making up approximately 84% of Tasmania's hardwood plantations [3-4]. Plantation *E. nitens*, is a dominant frost tolerant hardwood species with over 165,000 ha in Tasmania [4]. Mainly managed and used for pulp and paper, this fast-growing resource has been gaining interest due to its potential for innovative applications such as EWPs. The development of research on *E. nitens* in Australia has significantly evolved over the past decades, from its initial use in pulp production to sawn boards to higher value applications such as EWPs. This transformation has been driven by extensive research efforts, both locally and internationally, but particularly in regions like Tasmania, where a higher value use has been a long-term commitment. The reason being that the substantial plantation resource supply may provide solutions to the diminishing levels of native regrown resource. The plantation resource was originally grown for a new pulp mill for Tasmania, which never eventuated, meaning the wood chips are shipped to overseas markets. These markets are becoming more competitive and volatile. Hence, a growing body of research has resulted in demonstrating the versatility of plantation Eucalyptus, highlighting its potential role in the emerging field of

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EWPs. This shift not only aims to meet domestic EWPs demands but also to utilise the abundant plantation resources more effectively and reduce reliance on imports and native forest timber [5].

The types of high-value products developed over the last decade from this resource include GLT, CLT, plywood, and sawn boards for floors and furniture. Evidence of this continued research and increased confidence in *E. nitens* EWPs can be seen in several recent buildings at the University of Tasmania and and other local commercial buildings like the St Lukes Health Insurance headquarters.

2- Transition from Pulpwood to Structural Timber Products

Historically, plantation *E. nitens* has been overlooked as a structural material due to its rapid growth and the assumption that its wood lacks the strength/stiffness required for construction. However, research and the demand for local manufacturer resources has challenged these perceptions by showing that plantation grown *E. nitens* can perform comparably to other existing native regrown species used in construction when processed into EWPs.

A review of the literature suggests the link between *E. nitens* and potential structural products appeared in the late 1980s with an Australian journal article [6]. Subsequent research continued throughout the 1990s and early 2000s [7,8,9,10,11], with the first commercial sawmill processing *E. nitens* boards commencing in Tasmania in 2005 [12-13]. However, due to financial difficulties the company ceased operation, production stopped and the assets sold [14]. This resource was harvested between 8 and 15 years of age [12], whereas nowadays they are typically being harvested over 21 years.

Building on these early efforts, research continued to explore the opportunities to understand material quality and recovery, enhance processing efficiency, suitability of sawmilling, silvicultural practices, wood processing challenges, as well as developing methods to grade the material and predicting wood properties of plantation-grown *E. nitens* [15-18]. Parallel studies took place in New Zealand in the early 2000s which also explored the potential of young *E. nitens* for solid-wood products and veneer production [19-20]. Further research by McKenzie and associates (2006) later demonstrated the potential of *E. nitens* for LVL, opening new opportunities for its use in engineered wood products [21]. Similarly, in Australia, studies have demonstrated the suitability of plantation-grown *E. nitens* for structural products such as laminated veneer lumber (LVL), plywood, and veneer [22-24].

As research progressed, the studies explored non-destrutive technique (NDT) to improve LVL production from *E. nitens*, highlighting the importance of proper log selection [25]. Further investigations demonstrating that fibre-managed plantation logs, could be effectively used for sawn boards and structural products with appropriate segregation/selection and grading techniques [26]. Researchers explored the impact of *E. nitens* wood properties on product quality and incorporating predictive models to estimate key wood properties for manufacturing solid wood products [27-28]. This sustained work has generated information on *E. nitens* potential, challenges, and possibilities, contributing to a better understanding of its suitability for structural applications and have reshaped the perception from a species primarily grown for pulp into a viable option for EWPs.

3- The Impact of Silvicultural Practices on *E. nitens* Wood Quality

One factor that is a part of the ongoing discussion / research is whether thinning and pruning eucalyptus plantations can justifiably be used to enhance wood quality for solid wood production. Some studies suggest that these silvicultural practices play an important role in producing high-quality sawlogs [9, 11, 29]. For instance, Washusen et al. (2004) noted that thinning and pruning *E. globulus*—a species with some similar characteristics to *E. nitens* plays a significant role in improving the log and wood quality [10, 15]. However, other studies indicated that thinning has limited impact on processing performance of *E. nitens* except for its influence on some shrinkage characteristics [16]. Another recent study emphasised that wood properties are not only shaped by silviculture but also site environmental conditions (rainfall, elevation, etc) [30]. They found that thinning reduces stiffness but does not affect basic wood density [30]. The variability in findings in the literature reflect differing views on the impact of thinning on wood properties but also the number of variables that can influence the growth and management of trees. Although some studies have focused on enhancing the timber quality through practices such as thinning and pruning, other research underscores the need for a more thorough evaluation of its long-term viability, durability [31-33] and performance in structural and architectural applications.

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4- EWPs Potentials and Developments from *E. nitens* Sawn Boards

Potential EWPs from *E. nitens* sawn boards include adhesively bonded laminated products such as CLT and GLT as well as mechanically laminated products such as Nail-Laminated Timber and Dowel Laminated Timber [34-39]. EWP production from *E. nitens* requires a thorough understanding of its mechanical and physical properties. To optimise manufacturing and performance of *E. nitens* EWPs, studies have examined key factors such as lamination design, finger jointing, bonding, and grading techniques [34-40]. Studies have explored the timber properties and improving grading systems for *E. nitens* sawn timber and timber products [41-42]. Researchers have moved beyond traditional visual grading systems and focused on understanding the species' mechanical properties in more depth for structural applications [43-45]. NDT techniques, including AWV [43] and ultrasonic testing [46], have been used to evaluate mechanical properties of *E. nitens* sawn timber. Vibration-based techniques have also been used to provide a reliable measure of bending stiffness of *E. nitens* [47]. Building on research into manufacturing and optimisation of *E. nitens* EWPs, the production of GLT has also been explored, highlighting it's potential for structural applications [37].

Developing value-added products from *E. nitens* would require tools and techniques that could transform the timber into a material suited for built environment applications. In line with this, previous researchers emphasised that optimising machining techniques, tools, and technologies is essential to enhance the machinability of *E. nitens* for architectural applications [48]. Moreover, researchers investigated densification treatment, further adapting *E. nitens* into a more robust and structurally suitable material for building applications [49-50].

With developments in research and the growing interest in timber as a building material, researchers have progressed toward investigating the serviceability performance of EWPs in construction applications [51-53]. The findings across previous studies have led to further investigation into the long-term performance of *E. nitens* CLT in building applications [34-36, 54-55]. Researchers delved into assessing *E. nitens* CLT structural performance under different environmental conditions (temperature and humidity) revealing their crucial role in creep behaviour of timber [56]. In some instances, *E. nitens* CLT panels have shown better short-term and long-term serviceability performance compared to Spruce CLT [51,53].

The ongoing exploration of *E. nitens* over the years has contributed to a more comprehensive understanding of its capabilities, leading to its increasing use in structural and appearance applications commercially. With increasing interest in expanding the application of *E. nitens*, researchers have evaluated it's potential for engineered floor panels and plywood for lightweight interior applications [57-58]. Despite initial perceptions of *E. nitens* being unsuitable for appearance applications due to its lower densities, recent studies have shown promising results in terms of hardness and abrasion resistance in comparison to native regrowth *E. obliqua* for domestic flooring applications [59-60]. Subsequently, recent work has assessed the application of *E. nitens* in commercial long-span timber flooring systems, confirming their suitability for residential applications [61].

5 – Future Research And Development Efforts

Australia has witnessed a considerable shift in forestry and wood product applications, particularly the introduction of EWPs in mid-rise construction. Traditionally used for pulp, plantation *E. nitens* has been and continues to be explored as a potential valuable resource for EWPs. Research on *E. nitens* timber over the years has assessed several EWP production options, yet its application and acceptance in construction and engineering has not become widespread. This may be, in part, a result of companies needing to change their sawing technologies due to the tension in the fast grown logs and often smaller log diameters, the price and supply of the resource compared to other feedstock, and hesitancy to label and market products as plantation *E. nitens*, as observed in Australia. There is a growing number of timber processors in South-East Australia milling Eucalypt plantations (*E. nitens* and *E. globulus*) for engineered structural and appearance products, but they are being sold under a more generic timber product name.

Despite the opportunities revealed by research for EWPs with *E. nitens* more work is needed. Areas for more work include the challenges for hardwood processors to transition to new sawmilling technologies due to capital required and market acceptance before it can be adopted on a broader scale. Another area that makes it a challenge is the research itself on *E. nitens*, as each research project enviably has a different resource (age, site conditions and silviculture variables) meaning it cannot be directly equated to each other.

Future research should continue to focus on optimising processing techniques, improving material characterisation, and enhancing adhesive technologies to maximise *E. nitens'* structural potential. By expanding research efforts and promoting industry collaboration, plantation *E. nitens* can transition into a mainstream construction material, which will support innovative timber solutions for the built environment.

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7 – REFERENCES

[1] Hua, L., Chen, L., Antov, P., Krišťák, Ľ., & Tahir, P. (2022). Engineering wood products from Eucalyptus spp. Advances in Materials Science and Engineering. https://doi.org/10.1155/2022/8000780

[2] Hamilton, M. G., Blackburn, D. P., McGavin, R. L., Baillères, H., Vega, M., & Potts, B. M. (2015). Factors affecting log traits and green rotary-peeled veneer recovery from temperate eucalypt plantations. Annals of Forest Science, 72(3), 357-365.

[3] Downham, R., & Gavran, M. (2023). Australian plantation statistics 2023 update. ABARES.

[4] Forest & Wood Products Australia. (2024). *Private forestry guidance materials information sheet 20: Shining gum*. Forest & Wood Products Australia.

[5] Derikvand, M., Nolan, G., Jiao, H., & Kotlarewski, N. (2016). What to do with structurally low-grade wood from Australia's plantation Eucalyptus; Building application? Bioresources, 12(1), 4-7. https://doi.org/10.15376/BIORES.12.1.4-7

[6] McKimm, R. J., Waugh, G., & Northway, R. L. (1988). Utilisation potential of plantation-grown Eucalyptus nitens. Australian Forestry, 51(1), 63-71.

[7] Lausberg, M. J. F., Gilchrist, K. F., & Skipwith, J. H. (1995). Wood properties of Eucalyptus nitens grown in New Zealand. New Zealand Journal of Forestry Science, 25(2), 147-163.

[8] Yang, J. L., & Waugh, G. (1996). Potential of plantation-grown eucalypts for structural sawn products. II. Eucalyptus nitens (Dean & Maiden) Maiden and E. regnans F. Muell. Australian Forestry, 59(2), 99-107.

[9] Gerrand, A. M., Neilsen, W. A., & Medhurst, J. L. (1997). Thinning and pruning eucalypt plantations for sawlog production in Tasmania.

[10] Washusen, R., Reeves, K., Hingston, R., Davis, S., Menz, D., & Morrow, A. (2004). Processing pruned and unpruned Eucalyptus globulus managed for sawlog production to produce high value products. Forest and Wood Products Research and Development Corporation Report PN 03.1315.

[11] Nolan, G. B., Greaves, B. L., Washusen, R., Parsons, M., & Jennings, S. (2005). Eucalypt plantations for solid wood products in Australia—A review 'If you don't prune it, we can't use it'.

[12] Andrews, B. (2007, June 28). Against the grain. Australian Financial Review. https://www.afr.com/companies/against-the-grain-20070628-kag26

[13] Hopkins, P. (2007, November 22). 'Other' Tasmanian timber plant far from run-of-the-mill. The Sydney Morning Herald. https://www.smh.com.au/business/other-tasmanian-timber-plant-far-from-runofthemill-20071122-1c8d.html

[14] Examiner. (2010, April 14). FEA goes into voluntary administration. https://www.examiner.com.au/story/450608/fea-goes-into-voluntary-administration/

[15] Washusen, R., Harwood, C., Morrow, A., Northway, R., Valencia, J., Volker, P., & Bodjadzic, M. (2008). Eucalyptus nitens thinning trial: Solid wood quality and processing performance using conventional processing strategies. Forest and Wood Products Australia, Melbourne, Victoria, Australia. Project Number: PN07, 3019.

[16] Washusen, R., Harwood, C., Morrow, A., Northway, R., Valencia, J. C., Volker, P., ... & Farrell, R. (2009). Pruned plantation-grown Eucalyptus nitens: Effect of thinning and conventional processing practices on sawn board quality and recovery. New Zealand Journal of Forestry Science, 39(1), 39-55.

[17] Beadle, C., Volker, P., Bird, T., Mohammed, C., Barry, K., Pinkard, L., ... & Nolan, G. (2008). Solid-wood production from temperate eucalypt plantations: A Tasmanian case study. Southern Forests: A Journal of Forest Science, 70(1), 45-57.

[18] Farrell, R. R., Innes, T. C., & Nolan, G. (2008). Sorting plantation Eucalyptus nitens logs with acoustic wave velocity. Forest & Wood Products Australia.

https://doi.org/10.52202/080513-0580

[19] McKenzie, H. M., Turner, J. C. P., & Shelbourne, C. J. A. (2003). Processing young plantation-grown Eucalyptus nitens for solid-wood products. 1: Individual-tree variation in quality and recovery of appearance-grade lumber and veneer. New Zealand Journal of Forestry Science, 33(1), 62-78.

[20] McKenzie, H. M., Shelbourne, C. J. A., Kimberley, M. O., McKinley, R. S., & Britton, R. A. J. (2003). Processing young plantation-grown Eucalyptus nitens for solid-wood products. 2: Predicting product quality from tree, increment core, disc, and 1-m billet properties. New Zealand Journal of Forestry Science, 33(1), 79-113.

[21] McKenzie, H., Gea, L., & Gaunt, D. (2006). Eucalyptus nitens laminated veneer lumber. Boletín informativo CIDEU, (2), 51-55.

[22] Blackburn, D., Vega, M., Yong, R., Britton, D., & Nolan, G. (2018). Factors influencing the production of structural plywood in Tasmania, Australia from Eucalyptus nitens rotary peeled veneer. Southern Forests: A Journal of Forest Science, 80, 319-328. https://doi.org/10.2989/20702620.2017.1420730

[23] Blackburn, D., Vega, M., Van Overbergh, J., & Reich, L. (2016). Veneer product from fibre-managed plantation hardwood: Final report.

[24] McGavin, R. L., Bailleres, H., Lane, F., Blackburn, D. P., Vega, M., & Ozarka, B. (2014). Veneer recovery analysis of plantation eucalypt species using spindleless lathe technology. BioResources, 9(3), 421-437.

[25] Blackburn, D., Vega, M., & Nolan, G. (2019). Using acoustic wave velocity to select fibre-managed plantation Eucalyptus nitens logs for laminated veneer lumber products. Southern Forests: A Journal of Forest Science,81,223-234.
https://doi.org/10.2989/20702620.2018.1555945

[26] Balasso, M., Hunt, M., Jacobs, A., & O'Reilly-Wapstra, J. (2022). Development of a segregation method to sort fast-grown Eucalyptus nitens (H. Deane & Maiden) Maiden plantation trees and logs for higher quality structural timber products. Annals of Forest Science, 79(1), 9.

[27] Vega, M., Hamilton, M., Downes, G., Harrison, P. A., & Potts, B. (2020). Radial variation in modulus of elasticity, microfibril angle and wood density of veneer logs from plantation-grown Eucalyptus nitens. Annals of Forest Science, 77, 1-15.

[28] Vega, M., Harrison, P., Hamilton, M., Musk, R., Adams, P., & Potts, B. (2021). Modelling wood property variation among Tasmanian Eucalyptus nitens plantations. Forest Ecology and Management, 491, 119203.https://doi.org/10.1016/J.FORECO.2021.11923

[29] Forrester, D. I., & Medhurst, J. L. (2013). The effect of solid-wood silviculture on growth, form and wood properties in Eucalyptus plantations: An Australian perspective. Forest & Wood Products Australia, Project no. PNB291-1112B.

[30] Gendvilas, V., Downes, G. M., Neyland, M., Hunt, M., Harrison, P. A., Jacobs, A., ... & O'Reilly-Wapstra, J. (2021). Thinning influences wood properties of plantation-grown Eucalyptus nitens at three sites in Tasmania. *Forests*, *12*(10), 1304.

[31] Wood, K., Morrell, J., & Leggate, W. (2020). Enhancing the durability of low durability Eucalyptus plantation species: A review of strategies. *International Research Group on Wood Protection*.

[32] Wood, K., Kjellow, A. W., Konkler, M. J., Presley, G., & Morrell, J. J. (2024). Preservative treatment of Tasmanian plantation Eucalyptus nitens using supercritical fluids. Wood and Fiber Science, 55(1).

[33] Ghani, R., & Lee, M. (2021). Challenges of wood modification process for plantation Eucalyptus: A review of Australian setting. *Journal of the Korean Wood ScienceandTechnology*. https://doi.org/10.5658/wood.2021.49.2.191

[34] Pangh, H., Hosseinabadi, H., Kotlarewski, N., Moradpour, P., Lee, M., & Nolan, G. (2019). Flexural performance of cross-laminated timber constructed from fibre-managed plantation eucalyptus. *Construction and BuildingMaterials*. https://doi.org/10.1016/J.CONBUILDMAT.2019.03.010

[35] Ettelaei, A., Taoum, A., Shanks, J., & Nolan, G. (2022). Evaluation of the bending properties of novel cross-laminated timber with different configurations made of Australian plantation Eucalyptus nitens using experimental and theoretical methods. In Structures (Vol. 42, pp. 80-90). Elsevier.

[36] Gutierrez, M., Ettelaei, A., Kotlarewski, N., & Lee, M. (2023). Structural properties of commercial Australian plantation hardwood CLT. Buildings, 13(1), Article 208. https://doi.org/10.3390/buildings13010208

[37] Hou, J., Taoum, A., Kotlarewski, N., & Nolan, G. (2024). Evaluation and prediction of bending properties of glulam beams made from young plantation-grown Eucalyptus nitens. Australian Forestry, 87(3), 114-124.

[38] Derikvand, M., Kotlarewski, N., Lee, M., Jiao, H., Chan, A., & Nolan, G. (2019). Short-term and long-term bending properties of nail-laminated timber constructed of fast-grown plantation eucalypt. Construction and Building Materials, 211, 952-964.

[39] Derikvand, M., Jiao, H., Kotlarewski, N., Lee, M., Chan, A., & Nolan, G. (2019). Bending performance of nail-laminated timber constructed of fast-grown plantation eucalypt. European Journal of Wood and WoodProducts,77,421-437. https://doi.org/10.1007/s00107-019-01408-9

[40] Hou, J., Taoum, A., Kotlarewski, N., & Nolan, G. (2023). Study on the effect of finger-joints on the strengths of laminations from fiber-managed Eucalyptus nitens. *Forests, 14*(6), 1192.

[41] Balasso, M., Hunt, M., Jacobs, A., & O'Reilly-Wapstra, J. (2022). Quality traits of plantation Eucalyptus nitens logs impacting volume and value recovery of structural sawn boards. *European Journal of Wood and Wood Products, 80*(3), 657-668.

[42] Derikvand, M., Kotlarewski, N., Lee, M., Jiao, H., Chan, A., & Nolan, G. (2018). Visual stress grading of fibre-managed plantation Eucalypt timber for structural building applications. *Construction and Building Materials,167*,688699. https://doi.org/10.1016/J.CONBUILDMAT.2018.02.090

[43] Balasso, M., Hunt, M., Jacobs, A., & O'Reilly-Wapstra, J. (2021). Development of non-destructive-testing based selection and grading strategies for plantation Eucalyptus nitens sawn boards. Forests, 12(3), Article 343. https://doi.org/10.3390/F12030343

[44] Hou, J., Taoum, A., Nolan, G., & Kotlarewski, N. (2022). Study of the relationship between flatwise and edgewise modulus of elasticity of plantation fibre-managed E. nitens sawn boards. *Construction and Building Materials, 349*, 128774.

[45] Derikvand, M., Kotlarewski, N., Lee, M., Jiao, H., & Nolan, G. (2019). Characterisation of physical and mechanical properties of unthinned and unpruned plantation-grown Eucalyptus nitens H. Deane & Maiden lumber. *Forests*. https://doi.org/10.3390/F10020194

[46] Taskhiri, M., Hafezi, M., Harle, R., Williams, D., Kundu, T., & Turner, P. (2020). Ultrasonic and thermal testing to non-destructively identify internal defects in plantation eucalypts. *Computers and Electronics in Agriculture,173*,105396. https://doi.org/10.1016/j.compag.2020.105396.

[47] Opazo-Vega, A., Rosales-Garcés, V., & Oyarzo-Vera, C. (2021). Non-destructive assessment of the dynamic elasticity modulus of eucalyptus nitens timber boards. *Materials, 14*(2), 269.

[48] Kotlarewski, N. J., Derikvand, M., Lee, M., & Whiteroad, I. (2019). Machinability study of Australia's dominate plantation timber resources. *Forests, 10*(9), 805.

[49] Kotlarewski, N., Lee, M., Schwartzkopf, M., Pecnik, J., & Mikuljan, M. (2020). Thermo-hydro-mechanical treatment of Australian sawlog and pulplog hardwood resources. In InnoRenew CoE International Conference 2020 Book of Abstracts. https://figshare.utas.edu.au/articles/conference_contribution/Thermo-Hydro Mechanical_Treatment_of_Australian_Sawlog_and_Pulplog_Hardwood_Resources/23154863

[50] Balasso, M., Kutnar, A., Niemelä, E., Mikuljan, M., Nolan, G., Kotlarewski, N., Hunt, M., Jacobs, A., & O'Reilly-Wapstra, J. (2020). Wood properties characterisation of thermo-hydro mechanical treated plantation and native Tasmanian timber species. Forests, 11(11), Article 1189. https://doi.org/10.3390/f11111189

[51] Liang, Y., Taoum, A., Kotlarewski, N., Chan, A., & Holloway, D. (2023). Behavior of cross-laminated timber panels made from fibre-managed Eucalyptus nitens under short-term serviceability loads. Buildings, 13(1), Article 245. https://doi.org/10.3390/buildings13010245.

[52] Liang, Y., Taoum, A., Kotlarewski, N., Chan, A., & Holloway, D. (2024). Investigating vibration characteristics of cross-laminated timber panels made from fast-grown plantation Eucalyptus nitens under different support conditions. Buildings, 14(3), Article 831. https://doi.org/10.3390/buildings14030831

[53] Liang, Y., Taoum, A., Kotlarewski, N., & Chan, A. (2024). Bending performance of cross-laminated timber constructed from fibre-managed Eucalyptus nitens under short-term and long-term serviceability loads. *European Journal of Wood and Wood Products*, 1-14.

 https://doi.org/10.52202/080513-0580

[54] Ettelaei, A., Taoum, A., Shanks, J., & Nolan, G. (2022). Rolling shear properties of cross-laminated timber made from Australian plantation Eucalyptus nitens under planar shear test. Forests, 13(1), 84.

[55] Ettelaei, A., Taoum, A., & Nolan, G. (2022). Rolling shear properties of cross-laminated timber made of fibre-managed plantation eucalyptus under short-span bending. Wood Material Science & Engineering, 17(6), 744-751.

[56] Liang, Y., Taoum, A., Kotlarewski, N., & Chan, A. (2025). Long-term creep behaviour of cross-laminated timber made from fibre-managed Eucalyptus nitens under uncontrolled environmental conditions. Construction and Building Materials, 459, 139802.

[57] Jiao, H., Nolan, G., Lee, M., Kotlarewski, N., & Derikvand, M. (2019). Developing high-mass laminated flooring products from fibre-managed plantation hardwood. Forest & Wood Products Australia.

[58] Muñoz, F. (2012). Determinación del módulo elástico de Young en tableros contrachapados de madera de Eucalyptus nitens (Deane & Maiden). Revista Forestal Mesoamericana Kurú, 9(23), 29-34.

[59] Millaniyage, K., Kotlarewski, N., Taoum, A., & Wallis, L. (2023). The role of abrasion resistance in determining suitability of low-density plantation timber for engineered flooring. Forests, 14(7), 1309.

[60] Millaniyage, K., Kotlarewski, N., Wallis, L., Taoum, A., & Nolan, G. (2022). Janka hardness evaluation of plantation-grown Eucalyptus nitens for engineered flooring applications. Buildings, 12(11), 1862.

[61] Nero, R., Christopher, P., & Ngo, T. (2024). Residential long-span timber floor typologies: a comprehensive performance assessment and opportunities for value adding to plantation hardwood. Wood Material Science & Engineering, 1-12.