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Physical and Mechanical Properties of Finger-jointed Keruing and Meranti Board using Phenol-Resorcinol-Formaldehyde and Polyurethane-Reactive Adhesives as Truck Deck

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ABSTRACT

Finger-jointed (FJ) boards are widely used for truck decking applications that require high mechanical strength and dimensional stability. Keruing (*Dipterocarpus* spp.) and Meranti (*Shorea* spp.) are common tropical woods, yet comparative performance data using different adhesives remain limited. This study evaluated the physical and mechanical properties of Keruing and Meranti FJ boards bonded with phenol-resorcinol-formaldehyde (PRF) and polyurethane-reactive (PUR) adhesives. Boards were manufactured using a 2 cm finger profile, adhesive spread of 260–300 g/m², and pressing pressure of 50 kg/cm². Physical properties assessed included moisture content, density, water absorption, thickness swelling, and delamination, while mechanical properties comprised modulus of rupture (MOR), modulus of elasticity (MOE), and Janka hardness. The experiment followed a factorial completely randomized design with two factors: wood species and adhesive type. All specimens achieved moisture contents of 9–10%. Keruing exhibited higher density (0.88–0.99 g/cm³) than Meranti (0.67 g/cm³). PUR adhesive significantly enhanced mechanical performance, increasing MOR to 128.81 N/mm² in Keruing and 122.70 N/mm² in Meranti, corresponding to improvements of 29.1% and 47.9%, respectively, and increasing MOE to 101.98 N/mm² and 96.88 N/mm², representing gains of 51.1% and 74.0%. These values exceeded the minimum requirements of ASTM D5572:1999. In contrast, PRF adhesive improved dimensional stability, reducing thickness swelling to 2.82% in Keruing and 3.57% in Meranti and producing low delamination values of 0.88% and 0.25%, fully complying with JAS 1152:2007 (<5%). The adhesive type and wood species had no significant effect on hardness. The results indicate that PRF is more suitable for applications requiring durability and moisture resistance, whereas PUR is preferable for maximizing mechanical strength in truck deck materials.

Keyword: Adhesive, Finger-jointed board, Keruing, Mechanical properties, Meranti

1. Introduction

The production of processed wood in Indonesia has continued to increase in response to the growing demand for wood-based products. Sawn timber production in Indonesia rose from 1.52 million m³ in 2020 to 1.69 million m³ in 2021[1]. It was recorded that approximately US$1.08 billion was generated from the sawn timber sector in 2020, and this value is expected to increase in the future [2].

One common application of wood boards is truck decking, which serves as a structural component supporting the mechanical function of a truck's steel frame. In general, trucks are categorized into several types based on load capacity: light-duty truck, medium-duty truck, and heavy-duty truck, so the wood material used for the deck can be adjusted accordingly [3]. A type of tropical wood often used for heavy-duty truck decking is Keruing (*Dipterocarpus* spp.), due to its favorable mechanical properties and durability. Keruing is classified in strength class I–II and durability class III, making it suitable for heavy load applications [4]. Meanwhile, Meranti (*Shorea* spp.), which falls under strength class II–IV [5] and durability class III–IV [6] is a potential material for light-duty truck decking. Based on these characteristics, Meranti is suitable for supporting lighter loads according to its intended truck application. The high potential for using wood materials in truck decking must be supported by appropriate dimensional engineering techniques to achieve sizes that meet market demand, particularly the required board length. The finger-joint technique allows the extension of board length to the desired dimensions and reduces wood defects. This is achieved by eliminating defective sections so that defect-free pieces can be joined into finger-jointed boards [7]. The finger-joint technique is widely used in structural applications [8]. Finger-joint strength is essential because the joint can be the weakest point when bearing loads. The strength of finger joints depends on several factors, including adhesive stiffness, production quality, finger-joint geometry, adhesive quality, and the bonding process [9].

The quality of the adhesive and bonding process can be influenced by the type of adhesive used. Several types of adhesives commonly used in structural wood applications include formaldehyde-based adhesives and reactive polyurethane adhesives [10]. Phenol-resorcinol-formaldehyde (PRF) adhesive is a polymerized product of phenol-formaldehyde and resorcinol-formaldehyde, known for its strong bonding performance in exterior applications and good fire resistance, making it suitable for wooden buildings and the automotive industry [11][12]. Meanwhile, polyurethane-reactive (PUR) adhesives cure rapidly at room temperature, are convenient to use as a single-component system, and are formaldehyde-free [13]. Previous studies comparing PRF and PUR using cross-laminated timber (CLT) made from Mangium wood showed that PRF produced higher mechanical, physical, and thermal properties than PUR [13][14][15]. In the other study by Yusof et al. [16], bamboo laminated boards with PRF exhibited higher shear strength, although PUR samples showed lower delamination values. Research by Njungab et al. [10] also demonstrated the advantages of PUR adhesive, which produced higher shear strength in laminated ayous (*Triplochiton scleroxylon*) and frake (*Terminalia superba*) compared to PRF. However, information on the characteristics of other wood products, such as finger-joint boards made from tropical woods like Keruing and Meranti, when using these two adhesives, remains lacking. Therefore, further information is needed on the characteristics of finger-joint boards with phenol-resorcinol-formaldehyde and reactive polyurethane adhesives, particularly for truck deck applications.

Therefore, this research aims to investigate the physical and mechanical properties of Keruing and Meranti finger-jointed boards with phenol-resorcinol-formaldehyde and reactive polyurethane adhesives and to analyze the effects of different wood species and the types of adhesive on their properties for truck deck applications. The physical properties measured were moisture content (MC), density, thickness swelling, water absorption, and delamination rate. Meanwhile, the mechanical properties measured were modulus of rupture (MOR), modulus of elasticity (MOE), and Janka hardness.

2. Materials and Methods

Preparation of Raw Materials

Finger-jointed boards were manufactured at PT Buana Triarta using a Mirai semi-automatic machine from sawn wood pieces with 12–14% moisture content. Wood segments (60–70 cm long, 2.2 cm thick, 12 cm wide) were shaped into 2 cm finger profiles, followed by adhesive application. Phenol-resorcinol-formaldehyde (PRF) adhesive was prepared using a 100:10 resin-to-hardener ratio, while polyurethane-reactive (PUR) was applied as a single-component adhesive. The adhesive spread for board assembly in this research was 260–

300 g/m². Boards were assembled, cut to a length of 5 m, and pressed at 50 kg/cm² for 15 seconds. Three boards were produced for each treatment and conditioned for five days. After conditioning, the boards were then planed and ripped to final dimensions of 1.6 × 1.6 cm, and samples were cut to a length of 70 cm as shown in Figure 1 and Figure 2.

Figure 1. Keruing FJ board samples**.**

Figure 2. Meranti FJ board samples**.**

Physical Properties Testing

Moisture content

Moisture content was measured using the gravimetric method based on JAS 1152:2007 [17] standard. Samples were weighed to obtain the initial weight (W_1), then oven-dried at 103 ± 2 °C for 48 hours until reaching a constant weight (W_2). Moisture content was calculated using the following formula:

$$MC\ (\%) = \frac{W_1 - W_2}{W_2} \times 100 \quad (1)$$

Where W_1 is the weight of the sample in air-dry condition (g), and W2 is the weight of the sample in oven-dry condition (g).

Density

Samples were conditioned to an air-dry state, after which their dimensions and weight were measured. This measurement referred to JAS 1152:2007. Density was then determined using the following formula:

$$Density\ (g/cm^3) = \frac{W_1}{V_1} \quad (2)$$

Where W_1 is the weight of the sample in air-dry condition (g), and V_1 is the volume of the sample in air-dry condition (cm^3).

Water absorption

Air-dry samples were weighed to obtain the initial weight (W_1) and then immersed in water at 25 °C for 24 hours. After immersion, the samples were weighed in the wet condition (W_2). This measurement referred to JAS 1152:2007. Water absorption was calculated using the following formula:

$$WA\ (\%) = \frac{W_2 - W_1}{W_1} \times 100 \quad (3)$$

Where W_1 is the weight of the sample in air-dry condition (g), and W_2 is the weight of the sample in wet condition after immersion (g).

Thickness swelling

The thickness of air-dry samples was measured on all sides (TKU), followed by immersion in water at 25 °C for 24 hours. After immersion, the thickness in the wet condition (TB) was measured. This measurement referred to JAS 1152:2007. Thickness swelling was calculated using the following formula:

$$TS\ (\%) = \frac{T_2 - T_1}{T_1} \times 100 \quad (4)$$

Where T_1 is the thickness of the sample in air-dry condition (cm) and T_2 is the thickness of the sample in wet condition after immersion (cm).

Delamination rate

Delamination testing followed JAS 1152:2007. Initial sample dimensions (length, width, and thickness) were recorded. Samples were then placed in boiling water at 100 °C for 4 hours, followed by cold-water immersion for 1 hour. Afterward, samples were oven-dried at 70 °C for 18 hours until reaching constant weight. The boiling–drying cycle was repeated twice. The total delamination length was measured, and delamination was calculated using the following formula:

$$\text{Delamination Rate } (\%) = \frac{\sum \text{the peeling adhesives line}}{\sum \text{the adhesives line}} \times 100 \quad (5)$$

Mechanical Properties Testing

Flexural test

Bending tests were conducted using a Baldwin UTM under two-point loading with a span of 40 cm. According to ASTM 5572-95[18], the finger-joint was positioned at the mid-span. Loading was applied at a rate of 12.7 mm/min until failure. Failure modes were recorded. MOE and MOR values were calculated using the following formulas:

$$MOE\ (N/mm^2) = \frac{\Delta PL^3}{4\Delta ybh^3} \quad (6)$$

Where ΔP represents the difference in load below the proportional limit (N), Δy refers to the change in deflection under the same limit (mm), L refers to the span of the test (cm), b refers to sample width (cm), and h refers to the sample thickness (mm).

$$MOR\ (N/mm^2) = \frac{3PL}{2bh^2} \quad (7)$$

Where P refers to the maximum load applied during testing (N), L refers to the span of the test (mm), b refers to sample width (mm), and h refers to sample thickness (mm).

Janka hardness

Janka hardness was tested by applying a hemispherical steel ball onto each side of the wood using a Shimadzu UH-100A UTM. According to ASTM D143-94[19], the load required for the steel ball to embed halfway into the sample surface at the finger-joint location was recorded.

$$\sigma^{//}\,(\mathrm{kg/cm^2}) = \frac{PL}{bh^2} \quad (8)$$

Where P refers to the maximum load applied during testing, L refers to the span of the test (cm), b refers to sample width (cm), and h refers to sample thickness (cm).

Data Analysis

A factorial completely randomized design was used, consisting of two factors: wood species (two levels) and adhesive type (two levels). Each treatment used five replicates. Treatment effects were analyzed using ANOVA based on the F-test. When significant differences were identified, Duncan's multiple range test was applied for mean separation. The statistical model followed the formulation described by Mattjik and Sumertajaya [20].

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \epsilon_{ijk} \quad (9)$$

3. Results and Discussion

Moisture Content

The moisture content of wood represents the amount of water present within the material, expressed as a percentage of its oven-dry weight [21]. In the present study, the moisture content of the finger-jointed samples ranged from 9 – 10% across all treatments, indicating that the samples were below the fiber saturation point. Commercially, structural wood products for truck decking are generally conditioned to a moisture content of approximately 9 – 12% to maintain dimensional stability, although the acceptable limit may vary according to buyer specifications, with a maximum moisture content of 15% commonly applied. Therefore, the 9 – 10% moisture content obtained in this study meets typical industrial requirements. Under this condition, wood dimensions become stable, which is critical for applications such as truck flooring where long-term dimensional reliability is required [22]. The Duncan multiple range test revealed significant differences in moisture content among treatments (indicated by subset labels a, b, and c). PRF specimens exhibited higher moisture content than their PUR counterparts for both Keruing and Meranti. This higher moisture content in PRF specimens could be due to the lower solid content of PRF (69.06%) than PUR (97.94%), meaning that PRF adhesive has higher water content than that of PUR, contributing to the higher MC of the PRF-based FJ boards. Lower moisture content can enhance wood strength and adhesive performance [23]. This is consistent with the present findings, in which PUR samples showed higher MOE and MOR values compared with PRF, as shown in Figure 3.

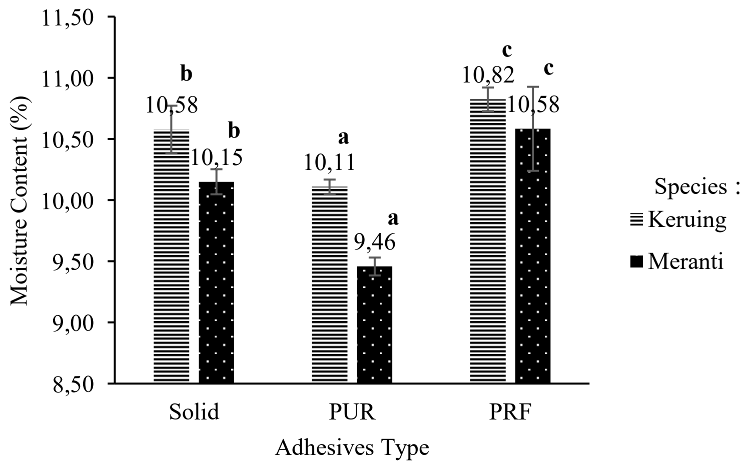

Figure 3. Influence of wood species and adhesive type on the moisture content.

Density

Wood density represents the mass of material contained within a given volume. In this study, Keruing exhibited higher density values than Meranti, with Keruing classified as a high-density wood ranging from 0.88 to 0.99 g/cm³. Wood species with density values exceeding 0.5 g/cm³ are generally categorized as high-density hardwoods [24]. This is consistent with the present findings, in which PUR samples showed higher MOE and MOR values compared with PRF, as shown in Figure 4. Although density is generally reported to correlate positively with thickness swelling in finger-jointed boards, the present study found the opposite trend, with the denser Keruing consistently showing lower thickness swelling than the less dense Meranti (see Section 3.4); this is discussed further in relation to Keruing's thicker cell walls and smaller lumens.

Statistical analysis indicated that wood species had a significant effect on density ($p < 0.05$), whereas adhesive treatments and the interaction between wood species and adhesive type did not have a statistically significant effect ($p > 0.05$). This outcome is expected, as density is primarily governed by the inherent characteristics of each species. Species with higher density typically produce plywood or laminated wood products with superior density and mechanical performance [26]. Density is also closely associated with wood strength. Higher density in laminated wood products can improve mechanical properties such as MOE and MOR obtained for the denser Keruing compared with Meranti in this study (Section 3.6), although the magnitude of this effect is also influenced by additional factors, including manufacturing processes, adhesive type, and product dimensions [27].

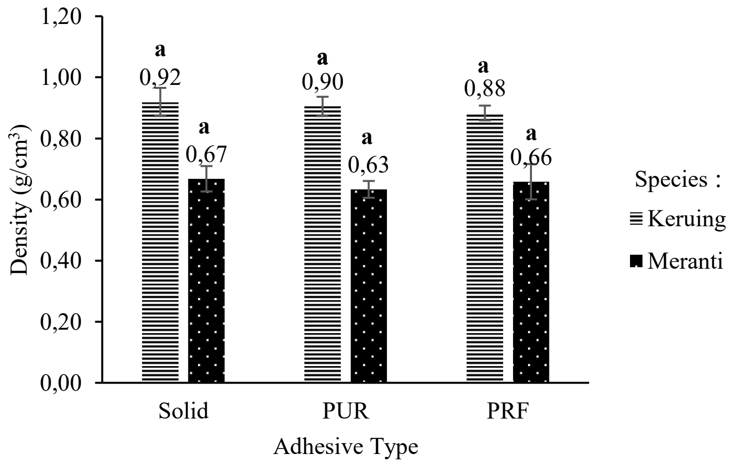

Figure 4. Influence of wood species and adhesive type on density.

Water Absorption

Water absorption represents the ability of a board to absorb water after being immersed for 24 hours [28]. A lower water absorption value indicates better dimensional stability of the material. The Duncan statistical test showed that wood species had a significant effect on water absorption. In this study, Keruing exhibited a higher solid-wood density (0.92 g/cm³) compared with Meranti (0.67 g/cm³) as shown in Figure 5. Materials with lower density tend to absorb more water, which corresponds to the higher water absorption observed in the PUR and PRF finger-jointed samples made from Meranti [29]. Low-density wood generally contains larger cell lumens and more interconnected void spaces, facilitating greater water penetration than high-density wood.

Water absorption reflects the potential of a material to uptake moisture from its surrounding environment [30]. This characteristic is a critical consideration when selecting wood species for truck flooring, as performance must be evaluated not only in terms of maximum load-bearing capacity but also in terms of resistance to extreme fluctuations in environmental humidity during service. Statistical results also indicated that adhesive type did not significantly affect water absorption ($p > 0.05$), however, the interaction between wood species and adhesive type significantly affected water absorption ($p < 0.05$), indicating that the influence of adhesive type varied depending on the wood species.

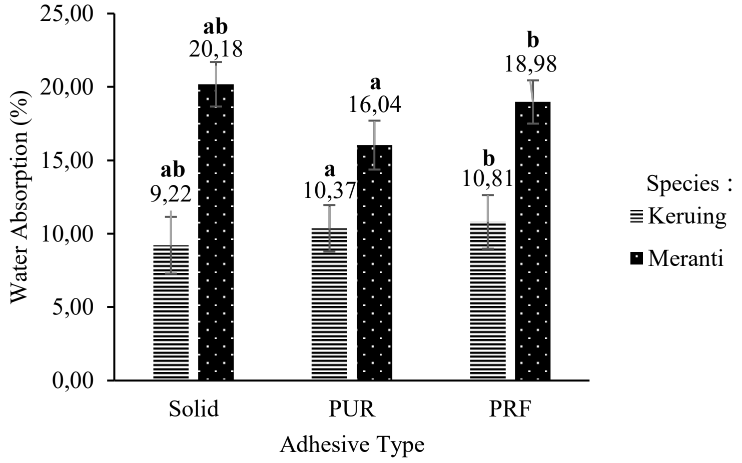

Figure 5. Influence of wood species and adhesive type on water absorption.

Thickness Swelling

Thickness swelling refers to the increase in board thickness caused by water penetrating and filling the internal voids of the material after 24 hours of immersion [28]. This parameter indicates the dimensional stability of FJ boards when exposed to moisture. In this study, the thickness swelling values of PRF-FJ boards were lower than those of PUR-FJ for both Keruing (2.82%) and Meranti (3.57%), as shown in Figure 6. Lower thickness swelling reflects improved dimensional stability [31].

Across all treatments, including solid wood, FJ PUR, and FJ PRF, the Keruing samples consistently exhibited lower thickness swelling than Meranti. This finding may seem counterintuitive from a bound-water perspective, since wood with a greater proportion of cell-wall material (i.e., higher density) is generally expected to show greater swelling, as more hygroscopic sites are available for bound-water uptake. However, Keruing's thicker cell walls and smaller lumens also restrict the pathways available for free-water penetration into the wood structure, which can slow moisture ingress within the 24-hour immersion period used in this test; the lower thickness swelling recorded for Keruing may therefore reflect this reduced rate of water penetration rather than a lower intrinsic hygroscopic capacity of its cell walls. The generally higher extractive content of denser tropical hardwoods, which can also reduce moisture uptake, may have contributed to this result. The resistance to water-induced deformation in wood products is influenced by adhesive type, panel density, and production technology [32]. Additionally, drastic or cyclic changes in moisture content can increase the likelihood of defects developing in wooden structural components and finished products. Therefore, the lower thickness swelling observed in FJ boards, particularly those with PUR, demonstrates enhanced durability for truck flooring applications, where materials must withstand long-term exposure to extreme weather conditions and extended transportation distances.

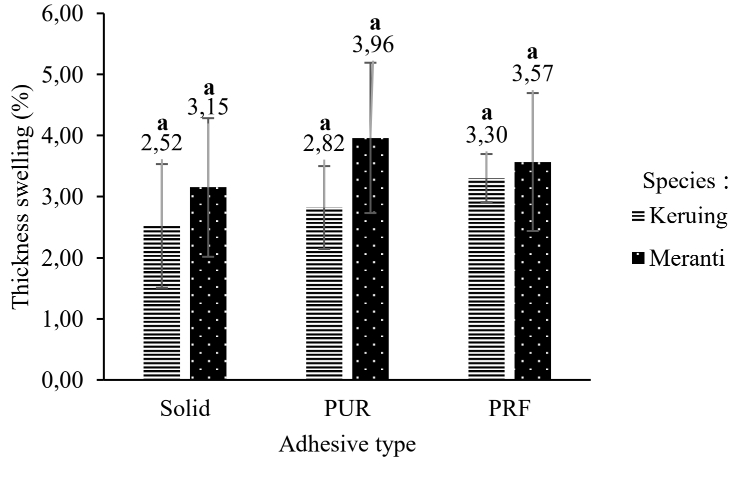

Figure 6. Influence of wood species and adhesive type on thickness swelling.

Delamination Rate

Delamination refers to the separation between wood laminae along the glue line, caused by the failure of the adhesive to form a sufficiently strong bond, either between adhesive layers or between the adhesive and the wood substrate [33]. Delamination performance is a critical indicator of the suitability of FJ boards for truck flooring, where materials must withstand extreme environmental conditions during service. Wood products used in outdoor applications are frequently exposed to severe weather fluctuations [34].

In the present study, the delamination values of both adhesives were below 5%, indicating that the Keruing and Meranti FJ boards with PUR and PRF met the requirements of JAS 1152:2007 after completing two boiling–drying delamination test cycles. This result demonstrates that both adhesives provide satisfactory bond durability under harsh conditions. PRF adhesives tend to exhibit lower delamination values than PUR due to their superior penetration and their contribution to dimensional stability within the wood structure [35]. PRF is also known for its high water resistance [36]. Although PRF-bonded boards showed slightly higher moisture content, this does not necessarily indicate lower water resistance. The excellent delamination performance of PRF is mainly attributed to its highly cross-linked adhesive network, which provides superior bond durability under wet conditions. These findings are consistent with the thickness swelling results in this study, where PRF- Keruing and Meranti boards showed lower swelling values, indicating better dimensional stability. These findings are consistent with the thickness swelling results in this study for Meranti, where PRF boards showed lower thickness swelling than PUR (3.57% vs 3.96%), indicating better dimensional stability. For Keruing, however, PRF boards showed slightly higher thickness swelling than PUR (3.30% vs 2.82%), indicating that the relationship between delamination resistance and thickness swelling is not uniform across species and may be influenced by additional species-specific factors such as extractive content and cell-wall structure.

Meranti FJ boards exhibited lower delamination values compared with Keruing, with measured values of 1.18% (PUR) and 0.25% (PRF) as shown in Figure 7. This trend suggests that adhesives penetrate more effectively into low-density wood species, which contain larger anatomical voids that facilitate deeper resin diffusion. Statistical analysis further revealed a significant interaction between wood species and adhesive type ($p < 0.05$), indicating that each wood–adhesive combination produced distinct delamination behaviors.

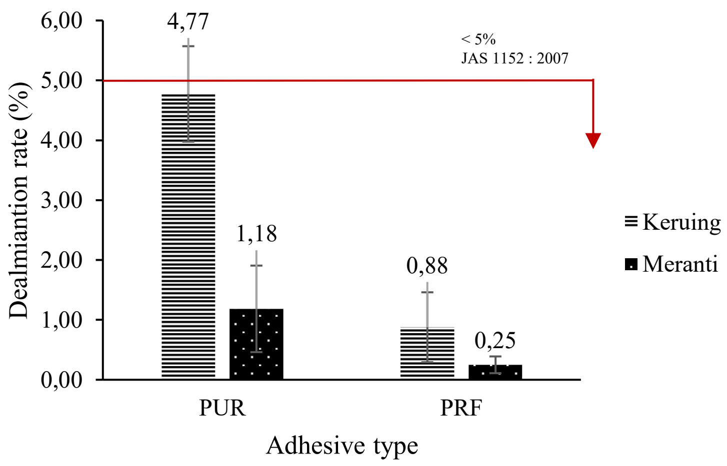

Figure 7. Influence of wood species and adhesive type on delamination rate.

Flexural Strength

The modulus of elasticity (MOE) represents the stiffness of wood, or its ability to resist deformation under applied load [37]. MOE values vary depending on wood species and the direction of loading. Among all treatments, the highest MOE was observed in Keruing bonded with PUR adhesive (23920.89 N/mm²), whereas the lowest MOE was recorded in Meranti bonded with PRF adhesive (13043.52 N/mm²) as shown in Figure 8. In this study, the MOE values of Keruing FJ boards with PUR and PRF were higher than those of Meranti. The Duncan test confirmed that wood species had a significant effect on MOE. With its higher stiffness, the

Keruing FJ board is suitable for heavy-duty applications such as large container truck flooring with more variable loads, whereas Meranti FJ boards are more appropriate for smaller trucks used to transport agricultural products. This aligns with the findings of Pinna et al. [38] who reported that density is positively correlated with wood MOR (strength), consistent with the higher MOR of Keruing compared with Meranti observed in this study; the relationship between density and MOE (stiffness) tends to be weaker and more variable, since MOE is also influenced by additional factors such as grain angle and microfibril angle.

Adhesive type also had a significant effect on MOE. PUR adhesives possess more flexible characteristics, making them more pliant under loading [39]. This indicates that both adhesives meet the mechanical performance criteria for structural finger-joint products. Furthermore, both Keruing and Meranti FJ boards achieved MOE values above the ASTM threshold, demonstrating that tropical Indonesian wood species are capable of meeting international quality standards for finger-jointed products.

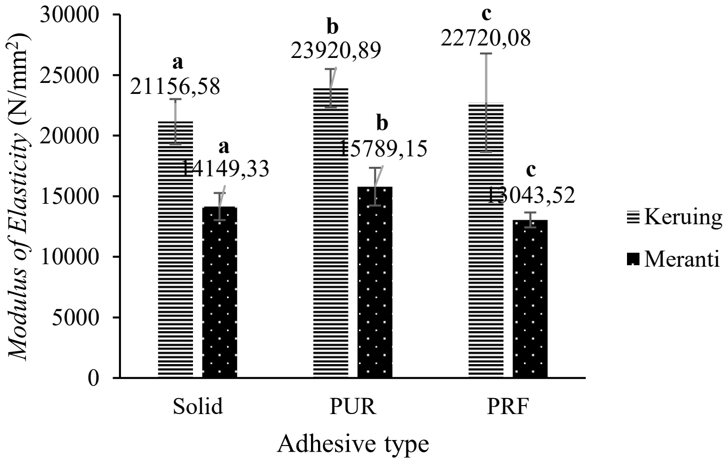

Figure 8. Influence of wood species and adhesive type on modulus of elasticity (MOE).

The modulus of rupture (MOR) represents the maximum load a piece of wood can withstand before failure [40]. According to Haygreen and Bowyer (1993), MOR is calculated based on the maximum bending load applied to the wood at the point of fracture during flexural testing. In this study, PUR-FJ boards exhibited higher MOR values, specifically 128.81 N/mm² for Keruing and 99.81 N/mm² for Meranti**.** The elevated MOR values in PUR FJ boards are associated with more uniform adhesive distribution, which increases the proportion of intact wood fibers remaining after testing [41]. It should be noted that solid (non-jointed) specimens exhibited the highest MOR for both species (151.88 N/mm² for Keruing and 104.92 N/mm² for Meranti), exceeding both the PUR- and PRF-bonded FJ boards. This is expected, since the finger joint itself constitutes the weakest section of the board regardless of adhesive type, as the joint geometry and adhesive interface locally interrupt the continuous wood grain that gives solid wood its full strength. The present statistical comparison focuses specifically on PUR versus PRF within the finger-jointed boards to isolate the effect of adhesive type on joint performance; solid specimens were included as a reference baseline in the figures but were not part of this factorial comparison. Statistical analysis confirmed that adhesive type had a significant effect on MOR, indicating that PUR improves both MOR and MOE, thereby enhancing the strength and stiffness of the finger-joint, typically the weakest point in FJ boards. Furthermore, no significant interaction between wood species and adhesive type was observed for MOR and MOE ($p > 0.05$), indicating that the combined effect of these factors did not significantly influence the mechanical properties of the FJ boards. Importantly, the MOR values of both PRF and PUR FJ boards exceeded the requirements of ASTM D5572:1999, which specifies a minimum MOE of 13.8 N/mm² (2000 psi) for finger-jointed lumber, as shown in Figure 9.

The Duncan test also showed that wood species had a significant effect on MOR. This reflects the influence of inherent density differences, as species with higher density generally exhibit greater MOR. The density variations among wood species strongly affect their MOR [42]. The laminated products made from high-density wood provide superior stiffness and maximum load capacity compared with low-density species, particularly under variable loading conditions [43]. These findings highlight the importance of selecting appropriate wood species for different truck types to ensure optimal performance of FJ flooring boards.

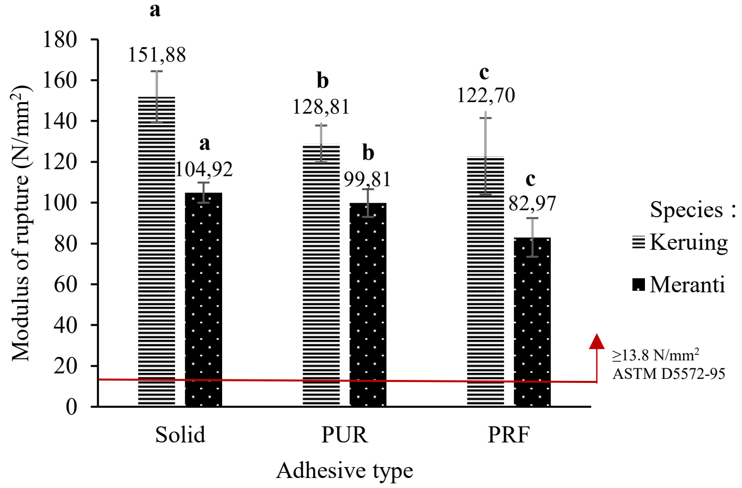

Figure 9. Effect of adhesives type on Keruing and Meranti FJ board on modulus of rupture (MOR).

Hardness

Hardness testing was conducted to evaluate the abrasion resistance of the wood, an important property for truck decking that is frequently subjected to scratching, friction, and wear during loading and unloading activities (Figure 10) [44]. Statistical analysis showed that hardness values did not differ significantly between wood species or adhesive types.

The hardness values of Keruing FJ boards with PUR and PRF were higher than those of Meranti, which corresponds to the higher density of Keruing. High-density wood typically possesses thicker cell walls and smaller lumens, resulting in a denser and harder surface texture. Wear resistance and hardness are influenced by wood density, service temperature, and moisture content [45]. Hardness is also an important practical indicator for machining and installation characteristics such as screw-and nail-holding capacity, sawing, and sanding [46]. These factors are particularly relevant for truck decking, where installation and maintenance require repeated woodworking processes to fit the boards onto the steel frame structure.

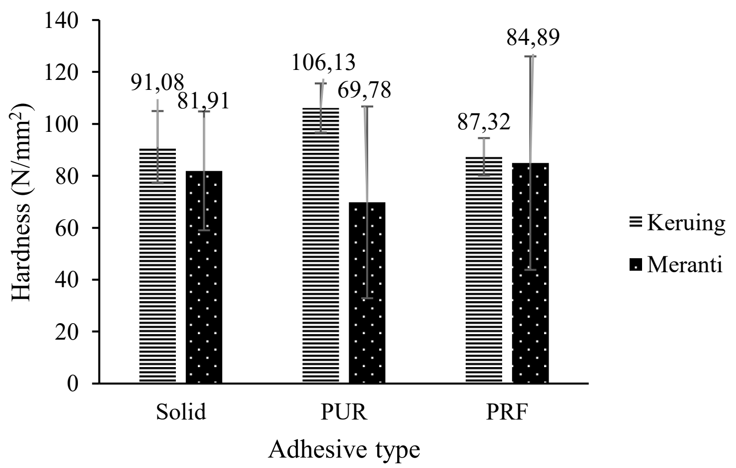

Figure 10. Effect of adhesive type on Keruing and Meranti FJ board hardness.

4. Conclusions

Wood species and adhesive type influenced the physical and mechanical properties of FJ boards, although their effects varied depending on the evaluated properties. PRF yielded lower thickness swelling values for both species, with FJ Keruing PRF showing 2.82% and FJ Meranti PRF 3.57%, indicating improved resistance to moisture-induced expansion. PRF also produced the lowest delamination values, particularly in Meranti (0.25%), confirming superior bond durability under boiling-drying cycles and meeting the JAS 1152:2007 requirement of <5%. Meanwhile, although PUR-bonded FJ boards exhibited slightly higher delamination values, all values remained below the standard limit. In contrast, PUR enhanced the mechanical properties; PUR-bonded Keruing reached an MOR of 128.81 N/mm² and Meranti 99.81 N/mm²; all bonded boards exceeded the minimum MOR requirement of ASTM D5572:1999. MOE values also increased with PUR for both species. Neither wood species nor adhesive type had a significant effect on hardness. A significant interaction between wood species and adhesive type was found for water absorption and delamination, indicating that adhesive performance depended on the wood species used, whereas MOE and MOR showed no significant interaction, indicating that the two factors acted independently on these properties. From this study, Keruing FJ boards are better suited to heavy-duty truck flooring requiring high strength and stiffness, while Meranti FJ boards are more appropriate for lighter-duty applications. PRF is the preferable adhesive where dimensional stability and moisture resistance are the priority, whereas PUR is preferable where higher mechanical strength is required. These findings provide practical guidance for selecting the optimal wood species–adhesive combination for FJ truck-deck board manufacturing according to structural demands.

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Conflicts of Interest

The authors declare no conflict of interest.

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