SESSION 4

WOOD TECHNOLOGY AND APPLICATION

INVITED SPEAKER

Innovation in Wood Treatment for Quality Enhancement

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The timber industry in Malaysia needs to innovate and re-invent itself in order to stay competitive. It is expected that the future growth of the industry will be through higher productivity, innovation and technological breakthroughs. Innovation refers to the successful exploitation of new ideas and designs that result in tangible products and services, while, technology involves the application of knowledge, equipment, machines and processes in translating innovations into newer and more sophisticated products for commercial gains. To remain relevant, the industry has to adopt new and state-of-the-art technologies to overcome production bottlenecks and produce newer and more sophisticated products. The wood-based products industry is expected to face the problem of adequate supply of raw materials to sustain the growth of the industry in the future. The supply of raw materials from natural and plantation forests may not be suffice and the industries have to seek for alternative raw materials to augment the diminishing supply of traditional commercial timbers. Through innovation and R&D activities, the inferior properties of lignocellulosic materials such as low density wood, OPW and bamboo, which are normally used for traditional purposes, can be alternative raw materials for wood-based industries, if their properties are enhanced. This paper aims to highlight the research works carried out at the Faculty of Forestry, Universiti Putra Malaysia, on enhancing the properties of low density wood or underutilised timber species, oil palm wood and bamboo so that they can be further utilised and made into higher value-added products. Various treatments to enhance the property of these raw materials are discussed in this paper. One of the potential treatments is through phenolic resin treatment. Phenol formaldehyde with molecular weight of 600 can bulk the cell wall structure of woody materials, and upon heating, will polymerise and render them insoluble in the wood and will not leach if the treated wood is in contact with water. The resultant products, impreg or compreg, have dimensional stability, strength, hardness superior than the untreated materials. One of the potential products which has superior physical, mechanical and biological properties and is expected to have commercial gains is laminated compreg wood. This product is fabricated by assembling PF resin-impregnated strips parallel or perpendicular to each other to form three layers of laminae, followed by compression in a hot press. Results of our findings from several intense research works can be of useful information on diversifying the utilisation of inferior quality wood, agriculture waste and bamboo for higher value-added products such as heavy-duty parquet flooring, panelling, furniture components or moulding products.

Keywords: quality enhancement, phenol formaldehyde, bulking impreg, laminated compreg wood

ID: O11

Cross Laminated Timber

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This is the 2nd Wood and Biofibre International Conference (WOBIC2019) with the theme Wood and Biofibre Innovation towards IR 4.0: From Forests to Shelves, a continuation from the previous one on 2017. WOBIC was previously named as the International Conference on Kenaf and Allied Fibres (ICKAF), which is held every 4 years and will carry on the tradition of the international conferences begun in 2009. INTROP is recognising the value of a holistic approach to sustainable wood and biofibre production, so that the final product meets the needs of all. A strategic decision has been made to change the name of the conference to expand its scope by covering other fibres and ascertains the evolution and significance of the wood and biofibre sector in the global economy. WOBIC seeks to bring together industry and academia to discuss the latest developments in wood and biofibre, from upstream agricultural-related topic to downstream fibre processing and product advancement as well as the socio-economic impact of these commodities. For more than 10 years, it has been serving as the meeting point for wood and biofibre experts from research, development and the industry. With presentations addressing the latest technologies, the policy framework, and the medium and long-term strategies and potentials, WOBIC is the interface between science, industry and policy makers. The conference will be an immediate assistance to those involved in the growing of the wood and biofibre products research and industry including researchers, investor, educators, supplier, and engineers.

Keywords: WOBIC2019, Kota Kinabalu, 3-5 Dec 2019, INTROP

ID: O12

Pull-Out Strength and Fracture Behaviour of Epoxy Bonded Structural Timber Connection

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This study investigated the performance of bonded-in rods in timber as structural timber connections by exploring the effect of two types of epoxy filler sizes on five different species of tropical timber. Comparison of bonded-in strength was made between nano particle-sized epoxy (Epoxy A) and micro-sized particle filled epoxy system (Epoxy B). The result showed that the pull-out shear strength was significantly affected by the types of filler, in which it influences the rheology and bonding properties of the bonded-in blocks. It was proven that epoxy containing nano-particles exhibited higher pull-out shear strength with a means of 15.10 MPa (τta) and 10.07 MPa (τra) respectively. In terms of failure mode, for Epoxy A, most of the failure occurred at mode IV, Mode III and II while for Epoxy B most of the failure occurred at mode II, III, and IV. In term of wood types, Kempas demonstrated the highest value for Epoxy A with means of 30 MPa (τta) and 20 MPa (τra). Balau species shows the highest value at 17 MPa (τta) and 11 MPa (τra) for Epoxy B. Correlation study on both epoxy adhesives has indicated a positive and significant correlation between wood density and pull-out shear strength.

Keywords: Pull-out strength, fracture behaviour, epoxy, structural timber

ID: O13

Effect of Surface Treatment by Using Sodium Hydroxide and Methanol on the Wettability and Finishing Properties of *Acacia mangium* Wood

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Surface treatment on the *Acacia mangium* wood by using sodium hydroxide (NaOH) and methanol (MeOH) to increase its surface wettability and improve finishing properties were conducted. It was reported that many furniture manufacturers who are using A. *mangium* wood often experienced difficulties in getting high glossy and attractive appearance and therefore often rejected by buyers. The first phase in this study is to identify the optimum solvent concentration (%) for both sapwood and heartwood of A. *mangium.* The treated samples were evaluated for surface roughness and contact angle according to ISO 4287 and ASTM D7334-08 respectively. The results show that both NaOH and MeOH solvent has significantly increased the roughness of the sapwood surface compared to the heartwood surface. For the result of surface roughness, NaOH treated samples has relatively lower contact angle than MeOH treated samples and experienced a complete wetting within 4.2 s for sapwood and 6.8 s for heartwood. However, it changed the appearance of A. *mangium* surface as it becomes darker and the grain is less visible. Meanwhile, MeOH treated surface took 6.4 s for sapwood and 15.1 s for heartwood to completely wet the wood surface by retained its original colour and enhance the grain clearness. Thus, the best result obtains from surface roughness, wettability, and appearance were given by MeOH having 8% concentration. That result was carried out for different commercial coating systems i.e. nitrocellulose (NC), acid catalyst (AC) and polyurethane (PU) to study the compatibility. The coated surface was evaluated for adhesion testcross cut, scratch resistance test, abrasion test, impact resistance test, surface roughness, and gloss measurements test according to the relevant standards. The results revealed that A. *mangium* wood surface treated with 8% methanol resulted in superior finished surface compared to untreated panels except for gloss. Among the coating systems, AC and PU appear to be more compatible with treatment compared to NC. All the quality of finished. All the quality of finished A. *mangium* met the minimum requirement stipulated in the standards.

Keywords: *Acacia mangium*, surface treatment, wettability, surface roughness, wood

ID: O14

Mechanical Properties of Cross-Laminated Timber Manufactured from *Acacia mangium* Willd. Wood

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Cross Laminated Timber (CLT) using mass timber has becoming more popular due to various sustainability advantages and benefits, notably the speed and ease with which CLT buildings can be constructed. This study evaluates the bond integrity and strength properties of CLT made from tropical *Acacia mangium* Willd. wood. In the preliminary study (Part 1), the bonding integrity of the CLT were assessed by determining the surface wettability, percent delamination and shear strength upon block shear test of CLT. The evaluation of bonding characteristics was done on two types of adhesive: one-component polyurethane (PUR) and phenol resorcinol formaldehyde (PRF), three pressing pressure (0.9 N/mm^2, 1.2 N/mm^2, 1.5 N/mm^2), and three adhesive spread rates (150 g/m^2, 200g/m^2, 250 g/m^2). Two types of two-layer block shear samples were prepared with grain orientation parallel and perpendicular to each other. The shear performance was conducted on two loading directions: parallel and perpendicular to the grain of the first layer. Additionally, delamination tests were performed on three-layer CLT to assess the durability of bonds. The ANOVA shows that among the parameters studied only adhesive types have significant effect on both the extent of delamination and shear bond strength of the blocks. PRF was found to be a more superior adhesive than PUR irrespective of clamping pressure and loading direction. The superior performance of PRF can be attributed to strong chemical bonding, stable and better gap-filling properties. Based on the optimum parameters (Part 1), the larger sized (Part 2) were produced with (1000 (l) × 280 (w) × 54 (t) mm), three-layer CLT were fabricated and its physico-mechanical properties were evaluated. Two types of adhesive were used: PUR and PRF with spreading rate of 250g/m^2, the CLT was pressed at 1.5 N/mm^2 for 1 hour 30 minutes. Based on physical mechanical properties, *Acacia mangium* can be converted to structural grade CLT provided that the maximum bending load is improved. CLT panels with PRF adhesive is more resistant in water compared to those bonded with PUR. The MOE and MOR of PRF-bonded CLT is superior than the PUR-bonded CLT higher in four-point bending, shear in bending and compression parallel to the grain and different failure modes were observed.

Keywords: *Acacia mangium,* cross laminated timber, phenol resorcinol formaldehyde