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DEVELOPMENT OF CHARACTERISTIC VALUE OF BENDING STRENGTH PROPERTIES FOR SELECTED MALAYSIAN TROPICAL HARDWOOD TIMBER IN ACCORDANCE WITH EUROCODE 5

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Timber structural design in Malaysia is still making reference to Malaysia Standard MS 544: Part 2 and MS 544: Part 3, which are based on permissible (working) stress and the strength data such as bending, compression and tensile strength in those standards were derived from data obtained from testing small clear specimens. However, there is some weaknesses arise as the data derived from the small clear specimen is not represents the true strength properties and imposed to inaccuracies when it comes to design the structural size timber that are surely contain some defects. This issues lead to the insecurity of the engineers to widely use the timber material safely in construction industries. The introduction of the limit states code principles of Eurocode 5: Design of Timber Structures presents opportunities for engineers to optimize the design of timber structures and get the best out of the material. However the reference strength data expressed as characteristic values which provided in EN 338: 2016 are based on European softwood and a few of hardwood species with none from Malaysian hardwood timber. Those values were derived from the strength data of structural size specimens. Therefore, there is a need to establish the strength data from structural size specimens from Malaysian Tropical Hardwood timber if the design needs to be changed into limit state design as in Eurocode 5. The aims of this study are to determine the bending strength properties, to evaluate the characteristic value for bending strength properties to form strength class for selected Malaysian hardwood timber based on the EN 384:2016 and BS EN 338:2016 and to develop correlation based on small clear specimens and structural size specimen. In this study, there are 10 timber species were selected namely Balau, Kempas, Kelat, Resak, Kapur, Keruing, Mengkulang, Light red meranti, Geronggang and Acacia. All of these species were tested in structural size and small clear specimen according to EN 408: 2010 and BS 373:1957 respectively. There were in total 3225 specimens tested. The outcome of this study reveals that the bending strength characteristic value results is in the order of Balau (55.2 N/mm^2), Kempas (49.7 N/mm^2), Resak (49.5 N/mm^2), Mengkulang (47.6 N/mm^2), Kapur (46.8 N/mm^2), Keruing (44.9 N/mm^2), Kelat (44.7 N/mm^2), Light red meranti (26.1 N/mm^2) and Geronggang (21.9 N/mm^2). In order to fit the strength classes system there are a lot of sacrifices needed in term of reducing the strength, modulus of elasticity and density. The strength are reduces compared to the actual strength such as Mengkuang and Light red meranti from strength 47.6 N/mm^2 and 26.1 N/mm^2 to 40 N/mm^2 and 20 N/mm^2 respectively. The highest strength class are placed in DM55 which is Balau and the lowest are placed in C20 which is Light Red Meranti. The strength class shows upgrades for Balau and downgrades for Kempas, Kapur and Keruing compared to the strength classes published in EN338:2016. From the derivation of strength class a new equation to determine characteristic MOE, $E_k = 0.70E_{mean}$ and mean density, $\rho_{mean} = 1.0899\rho_k + 104.41$ were establish. Through the correlation of mean bending strength small clear and characteristic value of structural size specimens, the equation to determine characteristic value for density ranging between 900 kg/m^3 to 1000 kg/m^3 is $f_k = 0.48x \times 0.8$.

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