UNIVERSITI TEKNOLOGI MARA

BENDING BEHAVIOUR OF TIMBER BEAMS STRENGTHENED USING BONDED-IN PLATES

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AUTHOR'S DECLARATION

I declare that the work submitted 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 investigation, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The structural of timber is usually limited by the relatively low bending stiffness and strength of the material in relation to other products like concrete and steel. Solid timber beams with bigger size are difficult to be obtained. Therefore, the timber beams at factory or existing timber beams that have been built can be strengthened and give equivalent load carrying capacity similar to beams with bigger size. One potential solution to increase the stiffness and strength of the timber is by reinforcing them with plates or rods. In order to attach the reinforcement to timber, the use of structural adhesive has been widely accepted with condition that the bond formed should be strong enough to transfer shear from one substrate to another. Adhesives can be used to form load-bearing joints in timber structures, both in repair and in new-build applications. An adhesive is expected to hold materials together and transfer design loads from one adherend to other within a given service environment for the life of the structure. The behavior of the joints depends on many parameters such as glue-line thickness, types of rods, types of adherends etc. Due to these factors, this research was conducted to investigate the the viability of using mild steel and carbon fiber reinforced polymer (CFRP) as reinforcements in Malaysian Tropical timber beams (Kempas and Keruing). This study focuses on the investigation of beams with different configurations (compression side reinforcements, tension side reinforcements and reinforcements at both sides) to come up with an optimum reinforcement arrangement which maximises the stiffness/strength properties. Fifty four beams with the dimension of 100 mm × 100 mm × 2000 mm were tested where six of the beams were used as control beam (unstrengthened), thirty six of total beams were used for strengthening and remaining beams were used for repairing. Since strengthening at tension side present the greater strength value among these different configurations, repairing work for timber beam just conducted at tension side. To characterize the performance of the bond integrity, a series of test were conducted such as block shear test, pull-out test and contact angle test. The mechanical properties of the materials involved were also determined by conducting tensile test. This study found that, the strengthening of timber beams using CFRP plate show better performance of strength compared to strengthening using steel plate due to better bonding between the timber to adhesive and adhesive to CFRP plates by the evidance of pull-out test, block shear test and contact angle test as well as SEM micrographs. The same results also occured in repaired work for both timber species where repaired with CFRP have higher strength value than repaired with steel. However, when comparing between species, Kempas usually performed higher value than Keruing in all test types.

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