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Strength Performance and Microstructure Characteristics of Natural Bonded Fiber Composites from Malaysian Bamboo

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Abstract : Formaldehyde release from wood-based panel composites can be very toxicity and may increase the risk of human health as well as environmental problems. A new bio-composites product without synthetic adhesive or resin is possible to be developed in order to reduce these problems. Apart from formaldehyde release, adhesive is also considered to be expensive, especially in the manufacturing of composite products. Natural bonded composites can be termed as a panel product composed with any type of cellulosic materials without the addition of synthetic resins. It is composed with chemical content activation in the cellulosic materials. Pulp and paper making method (chemical pulping) was used as a general guide in the composites manufacturing. This method will also generally reduce the manufacturing cost and the risk of formaldehyde emission and has potential to be used as an alternative technology in fiber composites industries. In this study, the natural bonded bamboo fiber composite was produced from virgin Malaysian bamboo fiber (Bambusa vulgaris). The bamboo culms were chipped and digested into fiber using this pulping method. The black liquor collected from the pulping process was used as a natural binding agent in the composition. Then the fibers were mixed and blended with black liquor without any resin addition. The amount of black liquor used per composite board was 20%, with approximately 37% solid content. The composites were fabricated using a hot press machine at two different board densities, 850 and 950 kg/m^3, with two sets of hot pressing time, 25 and 35 minutes. Samples of the composites from different densities and hot pressing times were tested in flexural strength and internal bonding (IB) for strength performance according to British Standard. Modulus of elasticity (MOE) and modulus of rupture (MOR) was determined in flexural test, while tensile force perpendicular to the surface was recorded in IB test. Results show that the strength performance of the composites with 850 kg/m^3 density were significantly higher than 950 kg/m^3 density, especially for samples from 25 minutes hot pressing time. Strength performance of composites from 25 minutes hot pressing time were generally greater than 35 minutes. Results show that the maximum mean values of strength performance were recorded from composites with 850 kg/m^3 density and 25 minutes pressing time. The maximum mean values for MOE, MOR and IB were 3251.84, 16.88 and 0.27 MPa, respectively. Only MOE result has conformed to high density fiberboard (HDF) standard (2700 MPa) in British Standard for Fiberboard Specification, BS EN 622-5: 2006. Microstructure characteristics of composites can also be related to the strength performance of the composites, in which, the observed fiber damage in composites from 950 kg/m^3 density and overheat of black liquor led to the low strength properties, especially in IB test.

Keywords : bamboo fiber, natural bonded, black liquor, mechanical tests, microstructure observations
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