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FLEXURAL STATIC AND FATIGUE PERFORMANCE OF GLUED LAMINATED TIMBER RAILWAY SLEEPERS FROM SELECTED MALAYSIAN TROPICAL HEAVY HARDWOOD

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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.

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 availability of good quality timber logs for sleepers are limited. The other problems with timber are the inconsistencies in the mechanical properties of timber as well as numerous problems arise due to susceptibility on biological degradation which leading to unfavourable use of timber sleepers. Hence, most of Malaysian mainline railway tracks are installed with pre-stressed concrete sleepers (PSC). However, the utilisation of PSC in railway track have disadvantageous such as crack problems due to dynamic irregularities of the train and fatigue loads generated from the axle wheels through rails particularly at location of station area, yard and industrial line, bridges, tunnels and at the area contributing extreme shock and excessive force to the locomotive and sleepers. Materials with the characteristic of good dynamic absorption, timber is still considered the best. In the absent of good timber, an engineered timber product such as glued laminated timber (glulam) is seen possible as an alternative material to the existing solid timber sleeper. Glulam can be designed to provide the required dimension and performance quality as railway sleeper. At present, few glulam sleepers have been used but limited to hardwood and softwood from European and Brazil. Thus, there is a need to explore the capability of glulam from Malaysian Tropical timber as sleeper. One major difference between Malaysian tropical hardwood and European hardwood is the density. Malaysian tropical timber has high density which may interfere in the bonding under high dynamic load. Therefore, this research work investigate the flexural strength and fatigue performance of glulam sleepers made from Malaysian Tropical Heavy Hardwood namely Kekatong (*Cynometra spp.*) and Melagangai (*Potoxylon melagangai*) which categorised as natural durable timber. These species were chosen to comply with the requirement by local railway authority, *Keretapi Tanah Melayu Berhad* (KTMB). The first phase of the study was preliminary material study which involved in characterisation of the flexural properties of solid and glulam timber. Kekatong timber is grouped as D50 while Melagangai is grouped as D40 based on their characteristic strength. Since these two species are proved suitable to use as structural component, these glulam timber are then verified as railway sleepers through compliance tests (second phase). Kekatong (*Cynometra spp.*) was selected for further investigation due to its performance and design requirement specified by the American Railway Engineering and Maintenance-of-Way (AREMA). In the third phase, the assessment on static and fatigue performance at the rail seat of Kekatong glulam sleepers were carried out and the behaviour of this sleepers were monitored and comparison with Kekatong solid timber sleeper have been made. In static performance, Kekatong glulam sleepers achieved the higher first crack load compared to the Kekatong solid timber sleeper with the percentage difference of 27% and have a maximum strength capacity of 5% higher than Kekatong solid timber sleepers. In fatigue performance, there were no formation or propagations of cracks in the Kekatong glulam sleepers under two million constant amplitude load cycles which indicated that the sleeper can survive more than this applied cycles. The residual strength at the post-fatigue load ratio showed the optimum stress level is at 0.7 which the load obtained is 60% from the average maximum strength. The results obtained provide positive indication for using glulam timber sleepers as an alternative to solid timber sleepers. Enhanced understanding of the behaviour of glulam timber sleepers become the outcome of this study.

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