UNIVERSITI TEKNOLOGI MARA

DETERMINATION OF CHARRING RATES OF LAMINATED VENEER LUMBER MADE FROM SELECTED MALAYSIAN TROPICAL TIMBER EXPOSED UNDER STANDARD FIRE EXPOSURE

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of the requirements for the degree of
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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

EN 1995-1-2 (EC5) has been widely used for designing timber structures and the charring rate is used for protection against fire. The charring rate is an essential factor in the fire design of exposed structural timbers because it determines how rapidly the size of the original section decreases to a critical level. In EC5, the one-dimensional charring rate of LVL for density > 480kg/m^3 is 0.65 mm/min and for two-dimensional or notional charring is 0.70mm/min. Unlike the EC5, the charring rate values published in the Malaysian standard are only for solid timber and based on their strength grade (SG). The charring rate value for Laminated Veneer Lumber (LVL) is not available. Therefore, thesis reports the study on the charring rate performance of LVL from selected Malaysian tropical timber and to develop predicted charring rate model. The two (2) main parameters investigated are one-dimensional, βo and two-dimensional or notional charring rate, βn. The LVL used were manufactured from Malaysian tropical timber namely Kedondong, Eucalyptus, Mengkulang, Rubber wood and Kasai. The fire tests were conducted in accordance with BS476: Part 22 and the determination of the charring rate was based on prEN 13381-7:2014. A series of tests were conducted by varying the width of LVL (50mm and 100mm width), exposure time (30 and 45 minutes), types of fire exposure (one-dimensional and two-dimensional) and timber densities (440kg/m^3-740kg/m^3). The charring rates were developed from direct and indirect measurements. The results show that the charring rate of these species ranged between 0.39 mm/min – 1.05mm/min. The test results also show that the density of timber have significantly affects the charring rate values as well as the scale effect. It is shown that for timber density less than 480kg/m^3 and width $\leq$ 50mm were not suitable for strucural element. The values of zero strength layer in this study shows good agreement compared with the proposed values in EC5. Three (3) predicted models were developed from statistical software from each species and were tested to obtain the suitable predicted model for βo and βn. The established models were validated by the lab experimental values. The predicted model for one-dimensional shows good agreement with measured but was quite conservative compared with EC5 model. However, for notional charring rate shows good agreement between measured and predicted charring rates models. The models of charring rates were also established to predict the effect of density, time, thickness of specimen, moisture content, temperature and specimens' size established using Buckingham PI theorem. It is quite apparent that good agreement is obtained between measured and predicted charring rates models.

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