UNIVERSITI TEKNOLOGI MARA

FRACTURE MECHANICS ANALYSIS OF PRESTRESSED CONCRETE RAILWAY SLEEPERS CONTAINING FIBRES

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CANDIDATE'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 result 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 other degree or qualification.

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ABSTRACT

The Malaysian rail industry has developed tremendously over the last decade in order to play a major role in providing better alternative for road users. Taking a cue to future developments, sleeper demand will also increase. However, these prestressed concrete sleepers are mostly prestressed concrete types designed with less emphasis on dynamic irregularities of the train or the rails that generate fatigue loads. Cracks could develop during a train passage which can be a threat to the overall stiffness properties as they can propagate further under repeated loads. By utilising fibres, namely polypropylene as crack arresters, the behaviour of the sleeper would definitely change. Thus the research work presented in this thesis is focused on the performance of fibred prestressed concrete sleeper (HSFRC) under static and fatigue loads. Preliminary material study was carried out to select a new mix design of high strength concrete containing fibres. A major part of the laboratory investigation covered on the preparation of the sleeper itself and compliance to design requirements. There were no formations of cracks or crack propagations in the sleepers under constant and variable amplitude loads, testifying that fibres were effective in crack resistance. The proposed fibred-sleeper was capable to resist 97% of the yield strength after the occurrence of first crack and has a maximum strength capacity of 36% higher than the non-fibred sleeper (HSC). The residual strengths at post-fatigue remained almost similar for both types of sleepers depending on the cyclic stress ratios, but failures of the non-fibred sleepers were severe. Analysis sought by Linear Elastic Fracture Mechanics (LEFM) was extended using static test results and found that equivalent fatigue characteristics and life of sleepers had all been improved significantly. These include fracture toughness properties, stress intensities and crack growth rate. The fibres were effective to control cracks and its life is predicted at 86% more than the non-fibred sleepers.

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Afidah binti Abu Bakar,
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