UNIVERSITI TEKNOLOGI MARA

FRACTURE MECHANICS ANALYSIS OF PRESTRESSED CONCRETE RAILWAY SLEEPERS CONTAINING FIBRES

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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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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Malaysian roads have seen tremendous increase in the number of road-users, especially in the Klang Valley. Even with the new network of roads and highways, traffic congestions remained and this demands upgrades of the existing railway system as alternative for land transport. As a result, the rail industry has developed tremendously over the last decade with more electrified lines and new light rail transit (LRT) systems are also implemented, but the latter systems are concentrated only within the Klang Valley.

Keretapi Tanah Melayu Berhad (KTMB), a corporatised Government company, has been the nation's major established player in land transportation sector. Its rail network has services throughout the Malaysian peninsular and recognizing there are potentials for further economic growth, large capital investment has been made to develop its established rail infrastructure in order to provide safe, efficient and reliable services (KTMB Annual Report, 2001). Further, infrastructure rehabilitation and enhancement programs are well underway (Briginshaw, 2001). In view of these massive projects, expert technological solutions need to be readily available to check all track designs, products and any related materials; of which sleeper is the interest of this study.