UNIVERSITI TEKNOLOGI MARA

THE FRACTURE MECHANISM OF PRESTRESSED CONCRETE SLEEPERS SUBJECTED TO LINEAR AND VARIABLE HARMONIC FUNCTIONS

MOHD IKMAL FAZLAN BIN ROZLI@ROSLI

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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.

Name of Student	:	Mohd Ikmal Fazlan bin Rozli@Rosli
Student I.D. No.	:	2016426158
Programme	:	Doctor of Philosophy – EC950
Faculty	:	Civil Engineering
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Signature of Student	:	………………………………………………………..
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ABSTRACT

Railway has been one of the oldest modes of transportation in Malaysia. It has an important role not only in connecting people and transferring goods, but also a preferred mobility mode in defending the country during war. This research studies on one of the most important structure of a railway track known as prestressed concrete sleeper. Prestressed concrete sleepers (PCS) are laid in between the rail and the ballast. It is to firmly hold the rail together at its intended width. In Malaysia, the width between rails is set at 1m apart. Another important function of PCS is to transfer the load from the train onto the ballast. The sleeper will experience a high loading when the wheel of the train is exactly on top of the sleeper. Thus, the sleepers with any defects or are unstable, will affect the rail. The train will be a little wobbly when passing through a problematic railway section. The PCS has also been reportedly seen dancing when a train pass through. Dancing is the term used by railway engineers when the sleeper moves or vibrate aggressively as the train passes. These phenomena prompted the researchers to think, what exactly is the structural behaviour experienced by the sleeper when the train pass through. This research idea was motivated by previous researcher and then further discussed with Malaysian rail authorities and industries. Upon sitting and discussing, the objective and methodology were strategized to achieve the objective of this research. The Malaysian rail authorities, Keretapi Tanah Melayu Berhad (KTMB) has agreed to allow the researcher to go into their active railway line and record the much-needed data. A total of seven sites had been identified to facilitate this research. During on-site investigation, the researcher has gathered the strain, vibration, and speed values of each type of train especially the six-coach commuter and freight train. The researcher has determined that the speed of trains varies from 60kmph to 110kmph. The displacement of the sleepers varies between sites, some site recorded a 39mm, whereas another site recorded a 1.5mm. As KTMB operates a double track railway line, it is also found that the deflection readings taken from one side differs from the readings taken on the other side of the rail. As for the strain reading, it was found that the values while the train pass through during the morning, afternoon and evening were different. It was observed that the strain values were the highest in the afternoon. For testing, 10 samples of prestressed concrete sleeper were supplied by a Malaysian rail industry player; Eastern Pretech (M) Sdn. Bhd. Tests were set to mimic the Australian Standard AS 1085. This standard is also the KTMB standard approval test for the sleepers before laying on track. The test methods are static and fatigue loading. For static test, it has been recorded that the PCS maximum force were recorded at 400kN at the first crack were detected at an average when the load reaching 110kN. After that, the actual loading of six coach and freight train has been determined earlier using Rainflow method. The actual loading of the trains has been successfully determined. The actual maximum load were found at 100kN whereas the minimum load is at 30kN. For sleeper testing in laboratory, the actual load determine earlier were applied. It is found that the displacement for ballast fatigue configuration were almost similar with the site. The maximum displacement recorded in the laboratory was 2.0mm and minimum was 0.1mm. Lastly, a finite element was done to replicate and validate the results obtained. A triangulation of results was used during onsite investigation, laboratory investigation and finite element investigation. The finite element modelling shows a promising displacement results of a maximum of 4.0mm which is not far off from the results obtained from site and laboratory investigation.

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