UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION ON CORRUGATION EFFECTS AND GROWTH IN HIGH SPEED RAILWAY BY USING CAE SOFTWARE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

by

CHARLIE A/L VISAL

B071510046

930128-02-5065

FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: INVESTIGATION ON CORRUGATION EFFECTS AND GROWTH IN HIGH SPEED RAILWAY BY USING CAE SOFTWARE

Sesi Pengajian: 2018

Saya **CHARLIE A/L VISAL** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

CHARLIE A/L VISAL

Alamat Tetap:

LOT 2298 KAMPUNG BARU TASEK,

33100 PENGKALAN HULU,

PERAK.

Tarikh: 04.12.2018

Disahkan oleh penyelia:

.....

KHAIRUL AZRI BIN AZLAN

Cop Rasmi Penyelia

Tarikh: 04.12.2018

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled INVESTIGATION ON CORRUGATION EFFECTS AND GROWTH IN HIGH SPEED RAILWAY BY USING CAE SOFTWARE is the results of my own research except as cited in references.

Signature: ……

Author : CHARLIE A/L VISAL

Date: 04.12.2018

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

Signature: …….

Supervisor : KHAIRUL AZRI BIN AZLAN

Signature: …….

Co-supervisor: AHMAD ZUL HUSNI BIN CHE MAMAT

ABSTRAK

Tajuk projek ini ialah 'Penyiasatan Kesan dan Pertumbuhan kecacatan (Corrugation) pada landasan Kereta Api Berkelajuan Tinggi dengan Menggunakan Software CAE. Getaran dan bunyi bising adalah kesan daripada pertumbuhan kecacatan pada permukaan jalan keretapi. Kecacatan ini akan menghasilkan bunyi bising yang menyebabkan ke tidak keselesaan kepada penumpang di dalam kereta api. Semakin panjang gelombongan kecacatan pada permukaan jalan kereta api,semakin kuat bunyi yang dihasilkan oleh jalan keretapi. Kajian ini akan memberi tumpuan lebih kepada kadar pertumbuhan kecacatan pada permukaan jalan keretapi berkelajuan tinggi. Pertumbuhan kecacatan pada permukaan jalan akan dikaji dengan membuat simulasi pergerakan roda keretapi yang berulang-alik dengan menggunakan perisian CAD dan CAE yang sesuai Hyperworks (HyperMesh, MotionView, HyperView) yang disediakan oleh Altair dan akan bandingkan hasil percubaan dengan kajian sebelumnya. Simulasi yang dibentuk adalah berdasarkan kajian “Simulation of the evolution of rail corrugation using a rotating flexible wheelset model” iaitu kajian terdahulu. Peningkatan hasil kajian yang di bandingkan dengan kajian yang sebelumnya akan menjadikan hasil kajian projek ini lebih sempurna. Akhirnya, prototaip rig ujian akan direkabentuk untuk tujuan kajian yang sebenar dan digunakan pada kajian yang akan datang. Dengan mempunyai hasil kajian yang sebenar dan hasil ‘simulation’, perbandingan akan dapat dibuat untuk mendapatkan hasil yang lebih sempurna.

ABSTRACT

The title of this project is 'Investigation on Corrugation Effects and Growth in High Speed Railway by Using CAE Software'. Vibration and noise is the effect of corrugation on the railway surface. This abnormalities defect will produce the uncomfortable noise to passenger in the train. The bigger of wavelength of corrugation, the louder noise will produce by railway. This study will be more focus on the corrugation growth rate on the high speed railway. The corrugation growth will be study by create the simulation of whellset passage by using CAD and CAE software suite HyperWorks (HyperMesh, MotionView, HyperView) and compare the result of experiment with the previous study. The simulation will be based on the parameters of study "Simulation of the evolution of rail corrugation using a rotating flexible wheelset model" of the previous study. The improvement of the simulation result compare to the previous result will be the result of this project. Finally, the test rig prototype will be design for actual experiment in further improvement. By having the test rig, the result of the simulation can be compare with the actual result for perfect and accurate result.

DEDICATION

This dissertation is decided to all my family members and friends. To my parents Mr Visal a/l Ai Reang and Mdm Sa Khon a/p Tom Too who take care of me with moral support whenever any challenges gets tougher. All my fellow friends are deserved to be partnership in my success of the project especially my housemates. They have provided me a lot of motivational and support. I also want to dedicate this dissertation to my supervisor Mr.Khairul Azri bin Azlan who taught and assisted me. Last but not least, thank you very much to Mr Saiful Naim bin Sulaiman and Mr Mohd Hafizi bin Abdul Rahman who expert in HyperWorks software and teach me how to use HyperWork software. Without them, my project result maybe will be not accurate and success.

ACKNOWLEDGEMENTS

Thanks god for His blessings and guidance, I have finally completed this project within my expectation even though there are many challenge and obstacle along the way. Though, I still managed to finish my part and I am very happy about it.

First of all, I would like to express my appreciation and deep respect to my supervisor, Mr.Khairul Azri bin Azlan for his guidance and support during the time phase of this project. His constant guidance and support during my thesis writing is invaluable to me and continuous direction and opinion regarding the flow of the project has contribute a lot in achieving the objectives of the project.

Thanks to my family, who has been the constant advisor for giving me continuous support and inspiration throughout my campus life. Their supports meant so much for me to finish this report.

Last but not least, I would like to thank everyone who involved directly and indirectly in this project. The sacrifice and commitment given towards me earning my Bachelor's Degree are indescribable and without them, this PSM report will never be able to be completed in time.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOLS

m	-	Meter
mm	-	Millimetre
cm	-	Centimetre
Km	-	Kilometre
h	-	Hour

LIST OF ABBREVIATIONS

LRT	Light Rail Transit
SSP	Sungai Buloh – Serdang – Putrajaya
CAE	Computer Aided Engineering
RCF	Rolling contact Fatigue
TRD	Tuned Rail Damper
ISO	International Organization for Standardization
CAD	Computer Aided Design

CHAPTER 1

INTRODUCTION

1.1 Background

The purpose of this study is to investigate on corrugation effect and growth in high speed railway. High speed rail is rapidly expending as new transport mode of the future in most of develop countries throughout the world. Rail corrugation encourages extreme vibration in trains as they pass over them, causing unwanted noise, limiting the vehicle speed. This abnormalities defect will cause uncomfortable to passenger when inside the train. The growth of these abnormalities will change the rail surface and produce more vibration and noise when the train passes the track.

1.2 Background of Study

Nowadays, high speed railways become famous around the most of developed countries throughout the world. Usually the structure of railway consists of rail, sleeper entrenched in the ballast layer, attachment pieces that join the rails to sleepers, rail and fastenings, ballast layer supporting and laterally confining the sleeper and the sub-ballast layer below the ballast layer. At the moment, to many railway transportations needs ballast railways tracks to solve the economic problems.

The railway system in Malaysia becomes important as a public transport in the main city around Kuala Lumpur. The rail transportation in Malaysia consist of heavy rail (including high-speed rail), light rail transit (LRT) and monorail line (Masirin et al, 2017). The latest project of Mass Rapid Transit Corporation Sdn Bhd has officially launched by

Prime Minister on 15 September 2016 as a twelfth rail transit line and will be fully operational in July 2022. The line will stretch from Sungai Buloh-Serdang-Putrajaya (SSP) with total length 52.2km which 13.5km is underground line.

However, this research to study on corrugation effect and growth that occur on the rail surface by run the simulation using CAE software. There are many causes of corrugation occur on the railway surface. Material selection for design the rail is one of the reason defection occur on the railway. The result from this study can be used as improvement method to minimize corrugation phenomena on the rail surface in further study.

1.3 Problem Statement

Vibration and noise is the effect of corrugation on the railway surface. This abnormalities defect will produce the uncomfortable noise to passengers in the train. The bigger of wavelength of corrugation the louder noise will produce by railway which can cause passengers distress or annoyance. After that, if the trains reach to the nearby buildings with abnormalities on the rail surface can cause the wall and floors of the building shake (Connolly et al., 2015).

Railway system is environmentally friendly types of public transportation because of their characteristic such as require less energy. After that, rail transport also produces less hazardous substance. Unfortunately, the rail transport also contributes to the environment pollution. The abnormalities defect which occurs on rail surface will produce a vibration and noise lead to the environment pollution. Rail corrugation is one of the phenomenon that produce noise when train passes through it. Poor maintenance system will cause the railway to become getting worse.

1.4 Objective of Study

The specific objectives of this case study are listed as below:

I. To investigation on corrugation effect in high speed railway.

II. To investigation on corrugation growth in high speed railway.

III. To design tests rig for run the simulation.

1.5 Work Scope

The scopes of this study are:

i. Design the railway by using CAE software.

ii. To study the corrugation effect and growth using Hyperworks software then analyze and validate the result.

iii. Focus on optimization of corrugation growth on railway with difference load of train and simulate by using Hperworks software.

iv. Studied the previous experiment and collect the data and parameter of railway system to design the test rig.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

High speed rail is rapidly expending as new transport mode of the future in most of develop countries throughout the world. It's made a faraway trip becomes more maintainable, easier and secure than others transport can provide to us. High speed railway operation is identifying as beneficial to economy in large population centre. There is few ways to ensure high speed rails are economically feasible. Firstly, is to upgrade existing track by introducing tilting trains that can be accommodate with curves at higher speed at the same time maintaining passenger comfort. Second, is to pay special attention to vertical at dynamics, corrugation and RCF phenomena in the wheel-rail interface.

Greater speed will affect the breakup of the vertical loads which result in increasing in high contact forces. This also may develop a new structure for corrugation which leads to contact forces and expended wheel and rail RCF that may cause risky splinter of wheel rim material. Hence, high speed wheel must be handling carefully in term of material and regular check-up must be done for crack in the wheel rims. To design the rail, the basic principle must be including in the designing the rail such as the optimum weight of steel, their dependable with maximum potential stiffness, durability and strength to give constant level surface and sufficient lateral guidance for wheels to pass over on it.

2.2 Railway Infrastructure

Rail transport also recognized as a train transport. It is a means of transport on vehicle which run on the track, rails or tracks. Based on Taylor and Francis Group (2015, p9) state that locomotive has been divided into four categories that is steam locomotive, diesel locomotive, gas turbine and electric locomotive. Since this system drives on metal

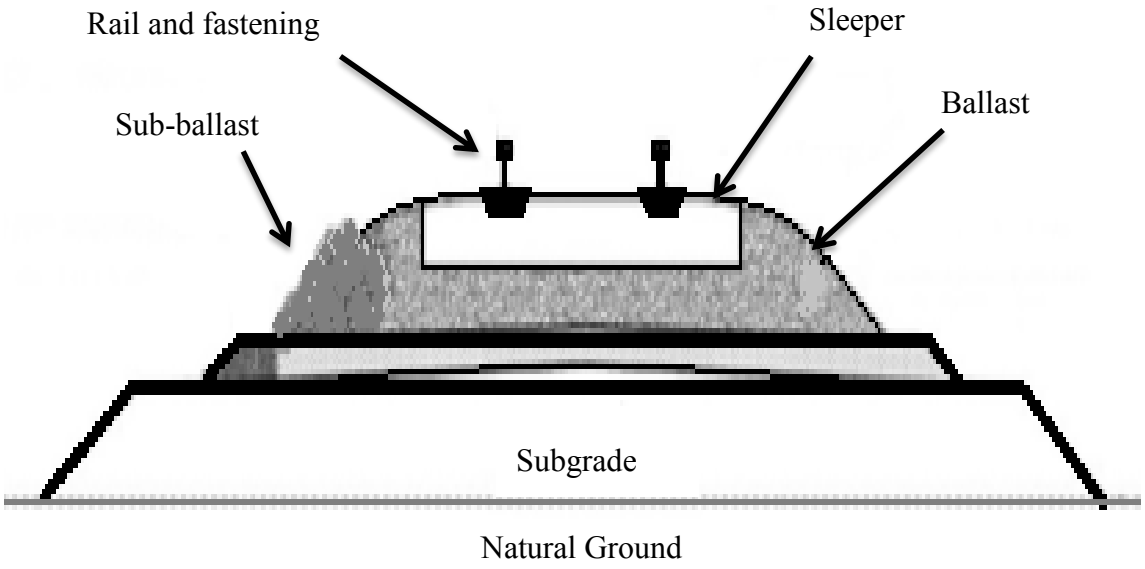

Figure 2.1: Cross-section of a single ballasted track on a fill (Bezgin, 2017)

rails and wheels, it has an inherent advantage of lesser frictional resistance which supports attach more loads in terms of wagons or carriages. This system is known as a train. Nowadays, to many railway transportations needs ballast railways tracks to solve the economic problems. Figure 1 show the cross-section of a single ballast track on a fill.

In studied of Bezgin (2017) defines the superstructure of ballast railway consist of rail, sleeper entrenched in the ballast layer, attachment pieces that join the rails to sleepers, rail and fastenings, ballast layer supporting and laterally confining the sleeper and the sub-ballast layer below the ballast layer. Timber sleeper have been used since the creation of the first railway construction. The characteristic of sleeper design must be provided resistance to the estimated stresses. Nowadays, ballasted railway tracks typically assembled with monobloc concrete sleeper such as twin-bloc concrete sleeper. Because of the characteristics of concrete sleeper are batters than wooden sleeper such as higher density and weight, modern high-speed railway tracks are require using the prefabricated high performance concrete sleepers. The concrete sleepers are heavy which can give stability to the track and inflammable then can prevent from the corrosion happen (Mundrey, 2003).

Furthermore, concrete provides an important significant basis with higher durability become first choice of the concrete as the construction material for railway track sleeper compare to wood sleeper. In their study, Bezgin also study various types of the concrete sleepers such as B58, B70 and B90 which use in Germany. The letter B means "beton" and the last two digits signifies their year production. After that, Bezgin has been introduce the technique of prestressing force into the sleeper has important implications in term of the design requirements and manufacture of the sleeper.

According to the using wooden sleepers, various possible regimes of corrugation may occur in the rail. In case to keep the track quality to specified usage level and confirm a safe track operation, damage and deteriorated sleeper are being replaced with better