RAILWAY WHEEL WEAR ANALYSIS

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A report submitted

in fulfilment of the requirements for the degree of

Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

APPROVAL

I hereby declare that I have read thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

Signature : ……..

Supervisor : ……..

Date : ……..

DECLARATION

"I declare this thesis is on my own work except for summary and quotes that I have mentioned its sources"

Signature : ……..

Name of Author : ……..

Date : ……..

DEDICATION

For my beloved mum, Pn. Anizon binti A. Rahman and my caring dad,

Mr. Solahudin bin Daud.

ACKNOWLEDGEMENT

First thing first, I would like to express my gratefulness to the great Creator, Allah S.W.T. on completing this undergraduate project successfully.

This project would not have been possible without the support of many people. I am deeply grateful to my supervisor Profesor Madya Dr. Mohd Azman bin Abdullah for his patience, support, encouragement, supervision, kind advice and interesting follow up which gave me confidence and made the completion of this work possible. I benefited from his adviced and valuable discussion when exploring new ideas during this research project. I wish to express my love and gratitude to my beloved family especially to my father and my mother for their understanding and endless support in completing my study. Not forgetting my best friends for their encouragement, assistance, support and love.

ABSTRACT

Wear due to wheel-rail critically influences railway operations. Wear of the wheel alters its profile which compromises the vehicle stability and increases the derailment risk. Past researches have focused on wear prediction due to wheel-rail interaction that crucial for different aspects such as running Stability, passenger safety, comfort, life cycle optimization and maintenance scheduling. This research aims to provide an analysis on comparison wear of the wheel and to analyse and compare the axle against wear rate. The data of wheel wear were measured by using Calipri device. It is a wheel measurement device that is highly precise measurement for predictive maintenance. The data obtained were analysed deeply in order to see the pattern of wear rate of the wheel. The analysis shows that the wear rate increase in smaller radius of track curve due to the curve effect that happen because of friction between the wheels and the track. Lubrication system offers a potentially cost effective means to reduce the wear rate of the wheels thus enhance rail wheels life.

ABSTRAK

Kehausan pada roda kereta api banyak mempengaruhi operasi kereta api secara kritikal. Kehausan roda juga boleh mengubah profil roda itu sendiri yang mana boleh menjejaskan kestabilan kenderaan dan meningkatkan risikonya berlaku penggelinciran rel kereta api. Kajian terdahulu lebih memfokuskan kepada ramalan kehausan roda kerana interaksi roda kereta api penting bagi aspek yang berbeza seperti menjalankan ujian kestabilan, keselamatan penumpang, keselesaan, kitaran hayat dan penjadualan penyelenggaraan.Kajian ini bertujuan untuk melakukan analisis atas perbandingan kehausan roda dan menganalisis serta membandingkan hubungan antara gandar dan roda. Kadar kehausan pada roda diukur dengan menggunakan peranti Calipri. Calipri adalah alat ukur kehausan pada roda yang sangat tepat untuk melakukan penyelenggaraan. Data yang diperoleh dianalisis secara mendalam untuk melihat kadar kehausan roda. Analisis menunjukkan kadar kehausan meningkat pada lengkungan yang lebih kecil disebabkan oleh kesan lengkungan yang mana berlakunya geseran antara roda dan trek. Sistem pelinciran menawarkan cara yang efektif dan mengurangkan kadar kehausan roda sekali gus boleh meningkatkanjangka hayat roda kereta api.

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LIST OF SYMBOLS

$\bar{X}$	=	Mean
H	=	Flange height
T	=	Flange thickness
H'	=	Flange height after wear depth increase
T'	=	Flange thickness after wear depth increase
M_H	=	Gradient of flange height (wear rate)
M_T	=	Gradient of flange thickness (wear rate)

LIST OF ABBREVIATIONS

ERL	Express Rail Link
KLIA	Kuala Lumpur International Airport
KL	Kuala Lumpur
FYP	Final Year Project
MBS	Multibody Software
MATLAB	Matrix Laboratory
PC	Personal Computer
RCF	Rolling Contact Fatigue
3D	3 Dimension
DC	Direct Current
TORFM	Top of Rail Friction Management
UK	United Kingdom
MGT	Million Gross Tones
USB	Universal Serial Bus
E-MAS	ERL Maintenance Support

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CHAPTER 1

INTRODUCTION

1.1.1 Background

The wear at the wheel interface is an important problem in railway field. The evolution of the profile shape due to wear has a deep effect on the vehicle dynamics and on its running stability, leading to performance variations both in negotiating curves and in straight track. Therefore the original profiles have to be periodically re-established by means of turning. The correct prediction of the wear rate in a particular context may be very important in the planning of the wheel set maintenance interventions. These fundamental operations which are periodically necessary, are quite onerous both in economic sense and in terms of vehicle's availability. Hence, it is certainly advantageous to reduce their frequency [1].

As a further application, a reliable wear model can also be used in the optimization of the wheel profile from the wear point of view. The research of an optimal shape of the wheel for a particular railway application may be useful to guarantee a uniform wear, which implies almost stable characteristics of the contact geometry. In this way, not only the wear rate may be reduced leading to an higher mean time between two maintenance interventions, but the performance of the wheel-rail contact may be kept nearly constant in the time [1].

The life of railway wheels is usually limited by wear. The wheel surface is subjected to high normal and tangential contact stress. Contact forces change magnitude and orientation as the wheel travels over the rail curves, crossings and local surface perturbations. This constantly changing contact patch moves over the wheel tread and to a certain extent the flange. The contact is nominally rolling but a small amount of local sliding takes place at the interface. The amount of sliding depends on the contact patch geometry, normal force, lateral force and friction coefficient. The removal of material from the surface by wear is a function of the sliding and contact stresses. These quantities depend on the railway vehicle dynamics that is affected by the change of wheel profile shape. Both stability and passenger comfort depend on wheel and rail wear. There are several advantages to be gained by the availability of a reliable predictive model of wheel wear. It would allow operators to effectively define maintenance schedules for wheel re-profiling. But it would also facilitate the design of vehicles and wheel sets that cause reduced wear to both wheel and rail surfaces [2].

1.1.2 Problem statement

Express Rail Link (ERL) is a company that owned and operated airport rail link that connects the Kuala Lumpur International Airport (KLIA) with the Kuala Lumpur Sentral (KL Sentral) with 57 km apart. The modelling and increasing of wear due to wheel–rail interaction is the main problem and fundamental aspect in the railway field. The safety and stability of passenger also the problem that need to be highlighted in this research. An analysis of wheel wear on train should be done in order to effectively evaluate maintenance intervals and to optimise wheel profiles with respect to wear. **Figure 1.1** below shows the train and the wheel [3].

(a) (b)

Figure 1.1: (a) Train (b) Train wheel

1.2 Objective

Firstly, the objective is to provide an analysis on comparison wear of the wheel. The second objective is to analyse and compare the axle against wear rate.

1.1.3 Scope of project

For this thesis, there are two scope in order to achieve the project objective. The first scope is to conduct the analysis only based on actual data given by the company. The second scope is the rate of wheel wear analysis only on train.

1.1.4 Thesis outline

This report contains five chapters which are chapter 1: Introduction, chapter 2: Literature review, chapter 3: Methodology, chapter 4: Results and discussion and chapter 5: Conclusion and recommendation. The gantt chart for FYP 1 and FYP 2 were recorded in the appendices.

1.5.1 Chapter 1

In the first chapter, this thesis cover the background, the problem statement, the objectives, the scope of the project and the thesis outline. All of these will be described briefly about the project.

1.5.2 Chapter 2

For the second chapter, the literature review of this report were explained. In this chapter, there are several past researches of wheel wear will be highlighted and also the lubrication performance of the wheel. A lot of journals, articles or any other issues relating to this project are reviewed deeply

1.5.3 Chapter 3

For this chapter, the project method were discussed. This chapter started with the general methodology. There is also a flowchart included telling the overview of general methodology. The method used for this project are by using Calipri. It is a highly precise measurement for predictive maintenance.

1.5.4 Chapter 4

In the fourth chapter, the results will be analysed deeply. There will have a graph for each wheel. From the graph, there will have a gradient and from that, a planning of the wheel set maintenance interventions can be done. The rate of wear for each wheel will be discussed deeply in this chapter.

1.5.5 Chapter 5

The last chapter of the thesis concluded the entire thesis briefly based on the objective of this project. In this chapter also included several recommendations to propose for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

When compared with road traffic, railway transportation is safer, more comfortable, less polluting and presents less energy consumption per passenger. When compared with the airplane, high speed trains are able to compete for short and medium distances with the advantage of having better energy efficiency and causing less pollution. However, to maintain the operational performance of railway vehicles, it is necessary that the quality of the wheel–rail contact is controlled, which requires among others a good understanding of the wear mechanisms of the wheels and the consequences of their changing profile on vehicle dynamics [4].

2.2 Prediction of wheel wear

The wheel wear prediction is a key-topic in the field of railway research as it has big impact on economical and safety aspects of train set design, operation and maintenance. The aim of this work was to implement a flexible and predictive railway wheel wear tool that starting from a specific vehicle mission, provides the wheel profile evolution as a function of the distance run. Special attention is also given to study how the wear evolution is affected by the friction conditions between the wheel and rail [5].