UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PERFORMANCE ANALYSIS OF FORMULA VARSITY CAR TYRE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Automotive Technology (Department of Mechanical Engineering Technology)(Hons.)

By,

DANIAL SOPHIAN BIN ONN
B071210028
901008055339

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Taman Angkasa Nuri, 76100,

Melaka .

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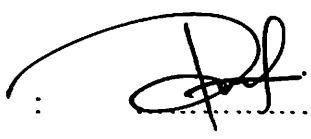
Signature : 

Author's Name : DANIAL SOPHIAN BIN ONN

Date : 2 JUNE 2015

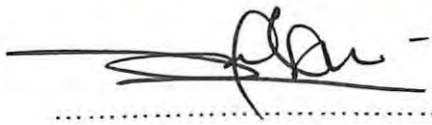
APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Automotive Technology (Department of Mechanical Engineering Technology) (Hons.). The member of the supervisory is as follow:

.....

(Project Supervisor)

DR. MUHAMMAD ZAHIR BIN HASSAN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Mekanikal
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka



.....

(Project Co- Supervisor)

AHMAD ZUL HUSNI BIN CHE MAMAT
Jurutera Pengajar
Jabatan Teknologi Kejuruteraan Mekanikal
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

ABSTRAK

Tayar pneumatik automotif memainkan peranan penting dalam sistem suspensi kenderaan.Pemilihan tayar yang digunakan adalah penting dalam meningkatkan pengendalian kenderaan dan prestasi. Formula Varsity adalah satu pertandingan lumba gaya formula berasaskan pelajar dan telah dianjurkan sejak tahun 2006 oleh Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka (UTeM). Pertandingan ini mencabar pelajar dari Malaysia IPTA / IPTS / Politeknik untuk merekabentuk, menganalisis, membina dan berlumba model kerja sebuah kereta lumba dalam keadaan trek sebenar. Pertandingan ini telah diilhamkan oleh pertandigan yang sama dinamakan sebagai Formula SAE® dianjurkan setiap tahun di negara-negara utama di seluruh dunia oleh Persatuan Jurutera Automotif. Pengalaman dan pengetahuan yang berharga dari peristiwa yang lepas telah memberi ruang dalam penambahbaikan untuk jentera lumba baru seperti meningkatkan kebolehan mengambil selekoh dan pengendalian yang baik bagi membolehkan nisbah kuasa enjin yang lebih tinggi dan mengurangkan 'oversteer' dan 'understeer' untuk membina jentera yang lebih cekap dan kompetitif. Menuju ke arah matlamat yang sama, projek ini telah dijalankan untuk mewujudkan kaedah eksperimen dipanggil ujian jalan raya untuk menentukan tayar terbaik untuk dipasang di dalam jentera perlumbaan baru dan pada masa yang sama mempunyai ciri-ciri pengendalian yang baik berbanding sebelumnya.

ABSTRACT

Automotive pneumatic tyre plays an important role in the vehicle suspension system. The selection of the tyre used is vital in improving the vehicle handling and performance. Formula Varsity is a student based formula style racing competition that was organized since 2006 by Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM). The competition challenges students from Malaysian IPTA/IPTS/Polytechnics to design, analyze, build and race the working model of a racing car in real track condition. The competition was inspired by similar event named as Formula SAE® organized yearly in major countries around the world by the Society of Automotive Engineers. Experience and valuable knowledge gathered from the previous event has brought up various rooms of improvements for the new race car such as improving cornering ability and handling properties to enable higher power-to-weight ratio and less oversteer and understeer to be achieved thus resulting in a more efficient and competitive race car. Responding towards similar goal, this project was conducted to create an experimental method called road test to determine the best tyre to be fitted in the new race car and at the same time has good handling properties compared to its predecessor.

DEDICATION

This thesis I dedicate to my both of my parents for their non-stop moral support, for giving all my needs during the completion of this thesis from the beginning to end. Also, not forgetting my friends for supporting me all the way.

I would also want to send this dedication to my soul mate who gives moral support during the hard times.

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First of all I would like to express my grateful to ALLAH s.w.t. for the blessing given to complete this study. In preparing this paper, I have engaged with many people in helping me completing this thesis. I wish to express my sincere appreciation to my supervisor Dr. Muhammad Zahir Hassan and co-supervisor Mr. Ahmad Zul Husni Bin Che Mamat for their encouragement, guidance, advice and motivation. Without thier continuous support and interest, this thesis would not have been the same as presented here.

I would like to express my gratitude to all my friends for their help and advice. I highly appreciate those who help in giving ideas and information needed in order to complete this thesis.

Last but not least, I would say that without the endless love and relentless support from my family, I would not have been here. The most sincere appreciation to my father, mother and sister who always support and encourage me along the road to success.

Thank you all.

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FV - Formula Varsity

NVH - Noise, Vibration, Harshness

DMA - Dynamic Mechanical Analysis

FEA - Finite Element Analysis

CHAPTER I

INTRODUCTION

In this chapter, an overview for performance analysis of Formula Varsity race car tire will be described. The main idea, problem statement, objectives and aim of the study will also be introduced. The organization of the report is stated below.

1.1 Overview

The first practical pneumatic tire was invented by John Boyd Dunlop, born in Scotland, while working as a veterinarian in May Street, Belfast, in 1887 for his son's bicycle, in an effort to prevent the headaches his son had while riding on rough roads. Pneumatic tires are made of a flexible elastomer material, such as rubber, with reinforcing materials such as fabric and wire. Tire companies were first started in the early 20th century, and grew in tandem with the auto industry.

The tires are one of the most important parts of the vehicle chassis, as they significantly influence aspects such as vehicle's directional stability, braking performance, ride comfort, NVH and fuel consumption. The tires are also a part whose size affects the vehicle's essential specifications such as wheelbase and track width. The size of the tires should therefore be determined in the initial stage of vehicle development, taking into account whether the size allows the vehicle to achieve the targeted overall performance (Kusaka, et al, 2015).

There are several types of tires have been invented nowadays for multiple purposes such as heavy lifting, road use and also performance tires used in racing. These tires vary in the construction types of the each tire. They include bias, belted bias and radial construction. This affects the handling, characteristic, behavior and uses of the tire.

Tread depth, inflation pressure, tire temperature, and road surface condition are among the most notable factors that have a noticeable effect on the tire force and moment characteristics. They can vary significantly during the operation of a tire and can effectively modify tire (and thus vehicle) performance (Sivaramakrishnan, 2015).

1.2 Problem statement

From the previous model of 2012 FV race car, it is known that the car is equipped with Bridgestone tire size 165/50/R13 which is a standard road use tire that is not suitable for racing and optimum handling characteristics. Due to its normal usage and construction, this study is made to determine the best type of tire to overcome the disadvantages from the previous chosen tire type.

The type of tire chosen is important to good cornering grip and traction and also able to withstand extreme racing conditions on the track. Knowledge of these characteristics and their effects on racecar performance can give the engineer insight into performance optimization. (Nicholas, 2013).

There are many factors that can contribute to the handling performance of an FV race car, they include tire thread pattern, tire material composition, tire type and also tire design. The width and size of tires can also be an important factor for its handling behavior. Tires are required to produce the forces necessary to control the vehicle. Given that the tire is the only means of contact between the road and the vehicle, they are at the heart of vehicle handling and performance. (Nicholas, 2013).

This analysis is being carried out to determine the best specification of the tire to be equipped to the next UTeM FV racecar by conducting road test to get accurate information in the tire selection.

1.3 Objective

Tire is the most important component that affects the vehicle dynamics. The tire cornering characteristic and gripping of the tire play a key role in determining the directional control and stability of the vehicle. Road tests are done to visualize the direct behavior and characteristic of the tire equipped to the vehicle to measure its performance on the track by implementing various tests.

The objective of the project is to study and analyze the road performance of the tire by conducting road test. The goals are as stated below:

I. To conduct road test of FV race car equipped with the tire to analyze.
II. To determine the thermal efficiency of the tire at maximum traction.
III. To determine the type of thread and material used on the tire.
IV. To determine the best type of tire to be used on the FV race car.

1.4 Scope

In line with the objective stated above, the scopes are:

1. Analyzing road test on UTeM FV race car equipped with Achilles ATR K-sport 165/55/R14 72V tire.
2. Determining the thermal efficiency, thread pattern, material and type of tire to be used.

CHAPTER 2

LITERATURE REVIEW

In this chapter, brief information of tires will be presented. Construction types, nomenclature of pneumatic tires will be explained. Review of previous tire performance analysis and road test will also be presented. The flow of the literature review is shown in **Figure 2-1**

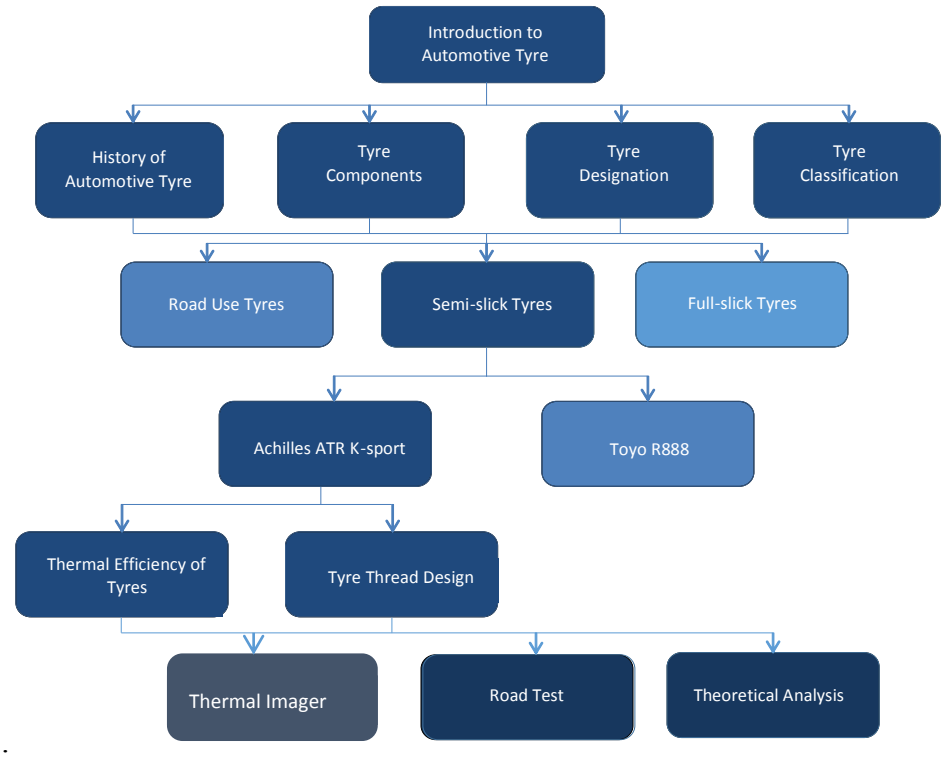

Figure 2-1: Flow Chart of Literature Review

2.1 Tyre

One of the main components of an automotive chassis system is the tyre. Most of the weight of a vehicle is supported by the components of the chassis system including wheels and tyres. Tyres act like springs by using air as cushions and absorb most of the shocks caused by road irregularities. The tire sidewalls flexes as they make contact with road irregularities. This action reduces the effect of road shocks on the vehicle, passengers and load. Tyres also function as a medium of contact with the road to provide traction and grip. With that, the vehicle would be able to accelerate, brake and make turns without skidding (NHTSA, 2012)

It can be concluded that the very motion of a vehicle is controlled entirely through the forces exerted by the tyre on the road surface. To support and control the movement of a vehicle, the tires needs to interact well with the road surface and provide needed forces in order to overcome skidding. The kinematic behavior of the vehicle is produced by the interaction between the tyre and road surface which is determined by the path of the tyre, which in other terms called as "footprint". For years engineers have been researching and taken serious attention to the study of tire footprint to develop the tire with adequate durability and performance.

2.2 History of Automotive Tyre

In earlier days, tyres were originally made of durable material that circles a fragile round wheel made of steel hoop on a wooden spoked wagon wheel. The pneumatic tires today are much more advanced and different compared to the tyres during those times. The tyres during olden days were just a material durable enough to withstand the elements and to protect and give a longer service life to the wheels.