

STRESS EFFECT STUDY ON 6 DIFFERENT PATTERN OF TYRES FOR SIZE
175/70 R13

SYAHRIL AZEEM ONG BIN HAJI MALIKI ONG

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Diploma of Mechanical Engineering

Signature :

Name of Supervisor : MOHD FAZLI BIN ISMAIL

Position :

Date :

STUDENT'S DECLARATION

I declare that this thesis entitled “Stress Effect Study on 6 Different Pattern of Tyres for Size 175/70 R13” is the result of my own research except as cited in the references. The thesis has not been accepted for any diploma concurrently submitted in candidature of any other diploma.

Signature :

Name : Syahril Azeem Ong bin Haji Maliki Ong

ID Number : MB 06002

Date : 11 NOVEMBER 2008

To my late father and beloved mother

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ABSTRACT

Generally stress is a measure of the average amount of force exerted per unit area. The main objective of this project is to study the stress effect generated on tyre while in static state scenario. Also one of the main objectives is to differentiate each tread pattern design through series of stress analysis result such as generated stress and deformation result. The procedure included achieving this project's objective starts from Contact Patch Capturing, Contact Patch dimensioning, converting them to CAD drawing by using SolidWorks, obtaining stress and deformation result through COSMOS-Express analysis, and graph was plotted from various tabulated data gained from COSMOS-Express result. From the processed data, the tyre DUNLOP SP SPORT LM703 with symmetric tread pattern shows the best result in terms of stress generated on contact patch and deformation of the tyre when a certain pressure exerted on the tyre compared to other tyre.

ABSTRAK

Secara umumnya, *stress* ialah pengiraan bagi nilai keseluruhan daya yang dikenakan terhadap luas permukaan. Objektif utama projek ini adalah untuk membuat kajian mengenai kesan stress yang dihasilkan di tayar semasa berada dalam keadaan statik. Juga salah satu daripada objektif utama adalah untuk membezakan setiap rekaan design melalui beberapa hasil analisis *stress* seperti *stress* yang terhasil dan hasil perubahan bentuk. Prosedur yang telah digunakan untuk mencapai objektif projek ini bermula dengan ‘*Contact Patch Capturing*’, pendimensian ‘*Contact Patch*’, menukarkan hasil pendimensian ‘*Contact Patch*’ kepada lukisan CAD dengan menggunakan SolidWorks, mendapatkan nilai *stress* dan hasil perubahan bentuk melalui analisis COSMOS-Express, dan graf diplotkan daripada beberapa data yang dijadualkan hasil daripada analisis COSMOS-Express. Daripada data yang diproses, tayar DUNLOP SP SPORT LM703 dengan corak bunga tayar yang simetri menunjukkan hasil yang terbaik dari segi stress yang terhasil di atas *contact patch* serta perubahan bentuk tayar apabila nilai tekanan yang berbeza dikenakan terhadap tayar berbanding dengan tayar tayar yang lain.

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LIST OF SYMBOLS

σ	-	Average stress
F	-	Force
A	-	Area
m	-	Metre
m ²	-	Metre per square
mm	-	Millimetre
cm	-	Centimetre
kg	-	Kilogram
kPa	-	Kilo Pascal
lbs	-	Pound per square inch
psi	-	Pressure per square inch

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Despite being a car's sole contact with the road surface, tyres remain neglected a lot. Motorists spend fortunes on car stereo systems and various car accessories but will scour the market to find the cheapest tyre and finally may even settle for part-worn or reconditioned rubber. This apathy shown by car owners, many of whom consider buying tyres a 'distress purchase', displays ignorance of the fact that the tyre is the most important component of a car on which their life depends. Tyres are the only contact between the car and the road surface yet they still remain the most neglected and abused part of a vehicle.

This project set off mainly from:

- a) The used by the newly produced Proton SAGA manufactured by one of the main automotive company in Malaysia; Proton

- b) As a reference for motorist to choose which tyre performs the best appropriate with the market price in Malaysia
- c) The lesser the stress effect on a particular tyre, the longer it may be used due to longer time for the tread to worn-out until it reaches the tread wear indicator mark

1.2 Objective

The objective of this project is:

- a) To study the stress effect on tyre while in static state scenario
- b) To differentiate each tread pattern design through series of stress analysis result such as stress generated and deformation result
- c) To find the lowest amount of stress on a tyre's contact patch

1.3 Problem Statement

- a) Finding the best geometry design for 175/70 R13 tyre that is commonly used for Proton SAGA manufactured by various manufacturer in Malaysia from 6 types of tread pattern
- b) Tyres are the only contact between the car and the road surface yet they still remain the most neglected and abused part of a vehicle. Thus this study may act as reference to user as they choose the appropriate tyre for their vehicle

1.4 Scope of Project

In order to reach the project's objective, the following scopes are identified:

- a) Literature review through an uncountable source which describe about stress effect on daily used tyre
- b) Develop CAD format for tyre with different pattern
- c) Analytical study on stress effect caused by vehicle on tyre with 6 different pattern for size 175/70 R13 using SolidWorks-COSMOS
- d) Stress result from each tyre design will be compared
- e) Displacement will be issued based on the tread deformation

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The title “Stress Effect Study on 6 Different Pattern of Tyres for Size 175/70 R13” requires an amount of good understanding of knowledge of this science. Therefore, executing a research is necessary to obtain all the information required and related to this topic. The information or literature reviews obtained are essentially valuable to assist in the construction and specification of this final year project. With this ground established, the project can proceed with guidance and assertiveness in achieving the target mark.

2.2 Pneumatic Tyre



Figure 2.1: a Pneumatic Tyre

Source: <http://en.wikipedia.org/wiki/Image:FirestoneTire.jpg>

Tyre is a ring-shaped parts, either pneumatic or solid (including rubber, metals, and plastic composites), that fit around wheels/rim to protect them and enhance their effect. Pneumatic tyres are used on many types of vehicles such as bicycles, motorcycles, cars, trucks, earthmovers, and aircraft. Tyres enable better vehicle performance by providing traction, braking, steering, and load support. Tyres form a flexible cushion between the vehicle and the road which smoothes out shock and makes for a comfortable ride^[1].

The first practical pneumatic tyre was made by John Boyd Dunlop in 1887 for his son's bicycle, in an effort to prevent the headaches his son had whilst riding on rough roads^[1]. Pneumatic tyres are made of a flexible elastomeric material, such as rubber, with reinforcing materials such as fabric and wire. Tyre companies were first started in the early 20th century, and grew in tandem with the automotive industry.

2.2.1 Stress Effect on Street Tyre for Size 175/70 R13

Street tyres are used for the purpose of daily usage either from home to workplace or for short distance travelling.

Tyre was chosen based on the size which is 175/70 R13 and all 6 tyres must have different types of tread pattern since this project is to find the best geometry design. The number 175 represents the tyre's width in millimetre while the number 70 which known as aspect ratio tells you the height of the tyre from the bead to the top of the tread. This is described as a percentage of the tyre width. To calculate the tyre's diameter, we multiply the tyre width by the aspect ratio to get the height of the tyre. Then we add twice the tyre height to the rim diameter (rim diameter is expressed in inches thus you may need to convert it to millimetre).

Geometry design of a tread pattern plays an important role for a tyre to optimise its performance and minimize the stress effect on a tyre. Stress is a measure of the average amount of force exerted per unit area. It is a measure of the intensity of the total internal forces acting within a body across imaginary internal surfaces, as a reaction to external applied forces and body forces. Stress is a concept that is based on the concept of continuum. In general, stress is expressed as

$$\sigma = \frac{F}{A}$$

Where,

σ is the average stress, also known as engineering and nominal stress, and

F is the force acting over the area, A

From the average stress equation above, average stress is inversely proportional with area (tyre contact patch) ^[2]. Thus, the bigger the force acting towards an area, the higher average stress rating on the contact patch of a tyre. However, the design of rain

groove on a thread pattern is important to avoid hydroplaning/aquaplaning which may result to accident or unable to steer the car at high speed or even at 80km/h. The risk of hydroplaning increases alongside with wider tyres.

The rain groove is a design element of the tread pattern specifically arranged to channel water away from the footprint but the more rain groove on a tread pattern, the less contact patch area which results to higher stress distribution.

Statically, the size, shape and pressure distribution are functions of many things, the most important of which are both the load on the tyre and the inflation pressure. There are some generalities that can be said about the contact patch of a tyre:

- i The larger the load on the tyre, the larger the size of the contact patch
- ii The higher the inflation pressure, the smaller the size of the contact patch

Unfortunately, both the load and the inflation pressure are not linearly proportional to the area of the contact. Put another way, a 10% increase of load (or a 10% decrease in inflation pressure) doesn't result in a 10% larger contact patch (except, of course, by coincidence.)^[3]

It is also true that calculating the size of the contact patch requires more than just the load and the inflation pressure.^[4]

2.3 Chosen Tyre

Below is a list of tyre chosen for this stress analysis study:

a) BRIDGESTONE – TURANZA ER60

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 300 kPa (44 psi)

b) BARUM – BRILLANTIS

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 300 kPa (44 psi)

c) MICHELIN – XM1

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 300 kPa (44 psi)

d) CORZA

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 300 kPa (44 psi)

e) YOKOHAMA – S306

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 300 kPa (44 psi)

f) DUNLOP – SP SPORT LM703

- Max Load : 475 kg (1047 lbs)
- Max Pressure : 350 kPa (51 psi)

CHAPTER 3

METHODOLOGY

3.1 Introduction

In succession of this stress effect study on 6 different pattern of tyres for size 175/50 R13, a flow of method has been used. This analysis project starts off with project planning by using a Flow chart and a Gantt chart. Regulating and analyzing these two charts are very important as each of it has its own criteria to be followed. Flow chart acts as a guide to successfully carry out this case study step by step while Gantt chart helps in order to accomplish the step by step method in time. Contact Patch capturing method is the backbone of this project, therefore using appropriate and precise steps is imperative in order to achieve the dimension of the tread pattern with the less error. Once this has been done, the process shall proceed with CAD drawing and followed by COSMOS-Express Analysis with different amount of pressure in tyre applied. Finally, the analysis of the whole project may be tabulated and concluded in the following chapter.