DESIGN AND FABRICATION OF AN UPRIGHT WITH BRAKE CALIPER MOUNTING FOR FORMULA VARSITY RACE CAR

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DECLARATION

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

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Name of Author : .....

Date : .....

Especially for my father, Suhaimi Bin Othman and my mother,

Norhayati Bt Mohd. Azmir

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ABSTRACT

The objective of this project is to design and fabricate an upright with brake caliper mounting for Formula Varsity race Car. The aim of the project is to reduce the upright weight, reduce number of parts and maintain or gain structural strength. This project undergoes stages such as designing, analysis, fabrication and fitting. During the design stage, CATIA software was used to generate the upright model. Then, the selected design was put through finite element analysis also using CATIA software. After the design passed the analysis stage, the design was the brought to the fabrication stage where 5-axis CNC machine was used to fabricate the upright. Finally after fabrication stage was finished, the upright was then fitted to the Formula Varsity 2010 race car. The new upright able to meets project aims and objective as it was able to withstand the load applied as the factor of safety of the upright is 12.1 after analysis. 55.82 percent of weight reduction achieved and it also able to perform part reduction as it only uses 1 part from 2 parts before.

ABSTRAK

Projek ini adalah mengenai perekaan dan fabrikasi satu upright Beserta Brek mount untuk kereta Lumba Formula Varsiti. Projek ini di jalankan di dalam beberapa peringkat seperti peringkat rekaan, analisis, fabrikasi dan pemasangan. Semasa peringkat rekaan, perisian CATIA telah digunakan. Selepas itu rekaan yang terpilih telah melalui proses analisis. Rekaan yang terpilih yang melepasi peringkat analisis di bawa ke peringkat fabrikasi. Mesin kawalan pernomboran berkomputer 5 paksi telah pun digunakan di peringkat ini. Setelah selesai peringkat fabrikasi. Upright tersebut telah pun dipasang di kerete lumba Formula Varsity 2010. Rumusannya, upright tersebut berjaya mencapai objektif da sasaran projek kerana upright tersebut berjaya dikurangkan beratnya sebanyak 55.82 peratus daripada berat asal, ianya juga berjaya menahan beban yang diberikan ketika ujian analisis berkomputer dan memperoleh faktor keselamatan sebaanyak 12.2.Upright tersebut juga telah berjaya mengurangkan penggunaan komponen sebanyak satu daripad sebelumnya yang menggunakan 2 component.

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LIST OF SYMBOLS

Θ1= angle (degree)

Θ2= angle (degree)

Θ3= angle (degree)

Σ = Sigma

Π= 3.45

τ = Torsional shear (MPa)

LIST OF ABBREVATIONS

RC= Remote Control

F1= Formula One

FSAE= Formula Society Automotive Engineering

CNC = Computer Numerical Control

SAE= Society Automotive Engineering

UTeM= Universiti Teknikal Malaysia Melaka

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CHAPTER 1

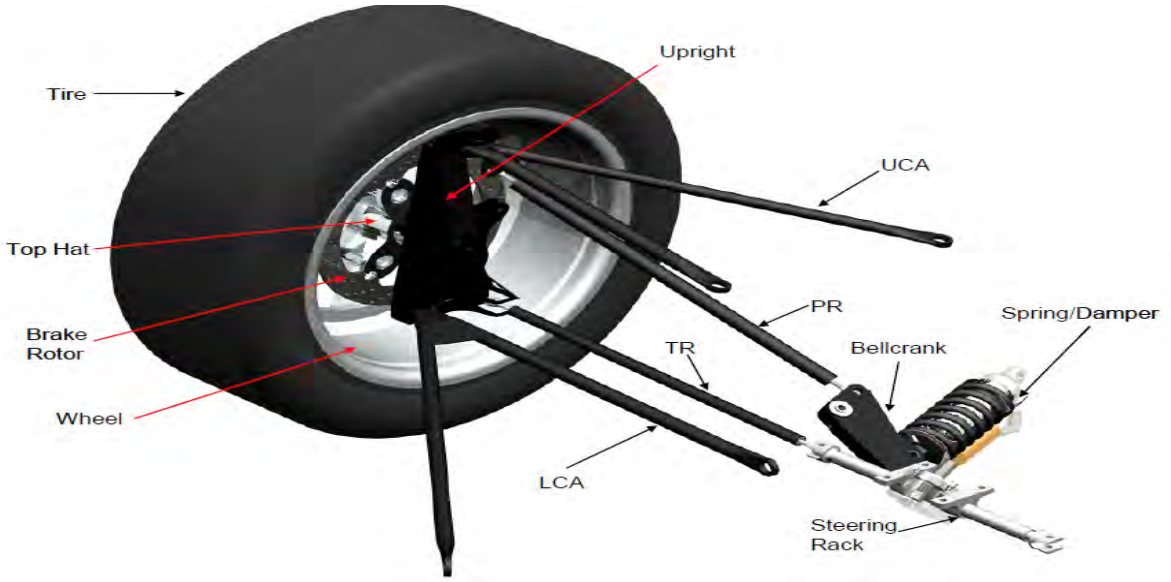
INTRODUCTION

1.0 FORMULA VARSITY

Universiti Teknikal Malaysia Melaka (UTeM) Formula Varsity is an international student racing competition that challenges students to design, manufacture and race their single seat open-wheel formula style racing car in real track condition. This event is inspired by similar student racing event such as formula student and formula SAE. The events have provided a platform for Malaysian student to practice their knowledge in engineering through motorsport event. The event hope to foster the tie and collaboration between all Malaysian and international higher education institutions especially among the students as well as

to help create the needed competent human capitals for our country automotive industries.(http://formulavarsity.utem.edu.my)

The UTeM Formula Varsity 2010 team consists of 11 member crews that are appointed for the car fabrication. After completion, several problems were founded that affected the performance of the car, one of it was the weight of the car. This project has been dedicated to reducing the upright component weight as it helps to improve the performance of the car. Upright is stated as a linkage or a bracket to the parts of suspension arms, transmission parts and brake parts.



Where:

UCA : Upper control arm

LCA : Lower control arm

TR : Tie Rod

PR : Push Rod

Figure 1.1: Suspension Assembly (Lane, 2009)

Vehicle upright assembly serves as a provider for physical connections between wheel and suspension link, and to provide mounting for brake caliper (Wong, 2007).

1.1 OBJECTIVE

To design and fabricate a wheel upright with brake caliper mounting for UTeM Formula Varsity 2010 Race Car.

1.2 PROBLEM STATEMENT

1.2.1 Upright Weight

The mass of the vehicle body is called sprung mass and the mass of the running gear together with associated components are called unsprung mass (Wong, 2001). The upright is an unsprung mass, thus the shock absorber must control this load in bumps. It is important to minimize the weight as it can reduce the force acting on the shock absorber (David, 1999).

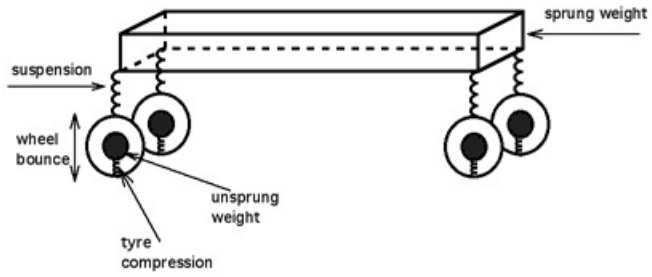
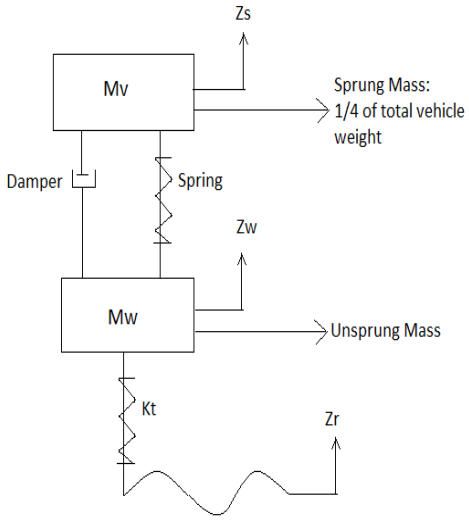


Figure 1.2: Component of Sprung and Unsprung Mass

(http://www.citizendia.org/Unsprung_weight)



Where:

Mv: Sprung mass

Zs: Body vertical acceleration

Mw: Unsprung mass

Zw: Wheel vertical acceleration

Kt: Tire spring coefficient

Zr: Road profile

Figure 1.3: Quarter Car Suspension Model (Hudha, 2010)

1.2.2 Upright Parts

The current upright design uses a caliper bracket in order to mount the brake caliper. With a new upright design, the use of caliper bracket can be eliminate and it contribute to reducing number of parts. The advantages of reducing part is that it contribute to weight reduction, improve reliability, enhancing performance simplified maintenance and lower lifecycle cost (Frey et. al, 2006)

Figure 1.4: Current Upright Design

1.3 SCOPES

i. To produce detail and 3 dimension design of the wheel upright component using CAD software based on 2010 UTeM Formula Varsity specification and regulation.

ii. To perform material selection and load analysis on the component

iii. To fabricate the upright component

iv. To measure the overall weight of the upright

CHAPTER 2

LITERATURE REVIEW

2.0 DESIGN REVIEW

2.0.1 Total Design Method

Before producing a detail drawing of the upright, we must first look for sources from previous example of upright that was build for race car. This is called market investigation. In order to produce the best possible design for the upright, a method name “Total Design Method” has been followed (Pugh, 1991). The flow chart in Figure 2.1 below shows the steps in the method: