

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

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‘I/We* have read this thesis
And from my/our* opinion this thesis
Is sufficient in aspect of scope and quality for awarding
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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”

Signatures :

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 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 Varsity. 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 per nomboran 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 dan 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 sebanyak 12.2. Upright tersebut juga telah berjaya mengurangkan penggunaan komponen sebanyak satu daripada sebelumnya yang menggunakan 2 component.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	PREFACE	i
	DEDICATION	ii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENT	vii
	LIST OF TABLE	xi
	LIST OF FIGURE	xii
	LIST OF SYMBOLS	xiii
	LIST OF ABBREVIATION	xvi
	LIST OF APPENDIX	xvii

CHAPTER 1 INTRODUCTION	1
1.0 Formula Varsity	1
1.1 Objective	3
1.2 Problem Statement	3
1.2.1 Upright Weight	3
1.2.2 Upright Parts	5
1.3 Scopes	5
CHAPTER 2 LITERATURE REVIEW	6
2.0 Design Review	6
2.0.1 Total Design Method	6
2.0.2 Design Error	7
2.1 Material Review	10
2.2 Machining Review	13
2.3 Analysis Review	13
2.3.1 Forces Acting On Suspension	15
2.3.2 Brake Force Equation	16
2.3.3 Finite Elemnet Analysis	17
CHAPTER 3 METHODOLOGY	18
3.0 Introduction	18
3.1 Project Flow Chart	19
3.2 Designing The Upright	20
3.2.1 Market Investigation	20
3.2.2 Product Design Specification	20
3.2.3 Conceptual Design	21
3.2.4 Detail Design	21
3.2.5 Fabrication	21
3.3 Material Selection	21
3.4 Analysis	22

3.4.1	Static Case	22
3.4.2	Lateral Force	24
3.4.3	Forces Determination	24
3.4.4	Structure Analysis	25
3.5	Fabrication Process	26
3.5.1	Process Coding	27
3.5.2	Machining	28
3.6	Fitting Process	34
 CHAPTER 4 RESULT AND ANALYSIS		 35
4.0	Total Design Method	35
4.0.1	Market Investigation	35
4.0.2	Conceptual Design	37
4.0.3	Evaluation and Selection of Concept	40
4.0.4	Design Rating	43
4.1	Material Selection	44
4.1.1	Material Comparison	45
4.2	Load Analysis	46
4.2.1	Static Analysis	46
4.2.2	Brake Force Calculation	49
4.3	Structure Analysis And Results	52
4.3.1	Structure Analysis	52
4.3.2	Result	54
4.4	Design Modification	54
4.4.1	Modification	54
4.4.2	Modified Upright Design Draft	55
4.4.3	Structure Analysis (modified upright)	56
4.4.4	Result (modified upright)	57

CHAPTER 5 DISCUSSION	58
5.0 Upright After Fabrication Process	58
5.1 Weight Reduction	59
5.2 Component Reduced	60
5.2.1 Major Component	60
5.2.2 Subpart	60
5.3 Factor Of Safety	60
CHAPTER 6 CONCLUSION	62
5.0 Conclusion	62
5.1 Recommendation	63
REFERENCES	64
APPENDICES	69

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	AL6061-T6 properties	11
4.1	Weighting Factor	42
4.2	Design Rating	43
4.3	Material Properties	45
5.1	Upright Comparison	61

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Suspension Assembly	2
1.2	Componet of Sprung and Unsprung mass	3
1.3	Quarter Car Suspension Model	4
1.4	Current Upright Design	5
2.1	Design Core	7
2.2	Failed Upright	7
2.3	FSAE Team Upright	8
2.4	Unreliable Design	9
2.5	Analyzed Upright Design	9
2.6	Sample Calculation	15
2.7	Forces acting on Upright	15
2.8	Example of Finite Element Analysis	17
3.1	Process Flow Chart	19
3.2	Static Loads On Level Ground	22
3.3	Use Of Electronic Scale	23
3.4	Free Body Diagram of Rear Suspension	24
3.5	Failed Upright at top maounting	25
3.6	Fabrication Process Flow Chart	26
3.7	Touch Probe	28

3.8	After Drilling Process	29
3.9	After Roughing Process	29
3.10	After Pocketing And Pitting Process	30
3.11	After Contouring Process	30
3.12	Drilled Hole	31
3.13	Pocketed Area	31
3.14	After Third Process	32
3.15	T-slots Dimension	32
3.16	5mm Holes Drilled	32
3.17	Milled Area	33
3.18	Actual Hole Drilled	33
3.19	Glued T-slot	33
3.20	Fitted Upright	34
3.21	Full Assembly	34
4.1	F1 Upright	36
4.2	F1 Upright	36
4.3	Example Of Formula Student Uprights	36
4.4	Example of RC upright	36
4.5	Upright 1	38
4.6	Design Concept of Upright 1	38
4.7	Upright 2	38
4.8	Upright 3	38
4.9	Upright 4	39
4.10	Upright 5	39
4.11	Concept Generation Of Upright 5	40
4.12	Example of triangular pocket on an upright	41
4.13	Best example of triangular pocket	42
4.14	Rectangular Roughness Cornering	47
4.15	Rear Suspension Free Body Diagram	47
4.16	Realtions Between Master Pump and Caliper Piston	50
4.17	Forces Distribution On Upright	52
4.18	Torque Applied On The Caliper Mounting	52
4.19	Load and Constraint Setup before Analysis	53
4.20	Result Obtained After Analysis	53

4.21	Upright 5	55
4.22	Upright Modified	56
4.23	Upright Modified Technical Drawing	57
4.24	Load Distribution	56
4.25	Displacement Of The Upright	57
5.1	Weighing Both Upright	58
5.2	Caliper Mounts	60
5.3	Upright Body	60
5.4	New Upright	60
5.5	Location of Subpart Reduced	60
5.6	Elimination of The 4 Subparts	61

LIST OF SYMBOLS

Θ_1 = angle (degree)

Θ_2 = angle (degree)

Θ_3 = angle (degree)

Σ = Sigma

Π = 3.45

τ = Torsional shear (MPa)

LIST OF ABBREVIATIONS

RC= Remote Control

F1= Formula One

FSAE= Formula Society Automotive Engineering

CNC = Computer Numerical Control

SAE= Society Automotive Engineering

UTeM= Universiti Teknikal Malaysia Melaka

LIST OF APPENDICES

NO	TITLE	PAGE
A	Material Properties	69
B	Technical Drawing	74
C	Flow Chart And Gantt Chart	82

CHAPTER 1

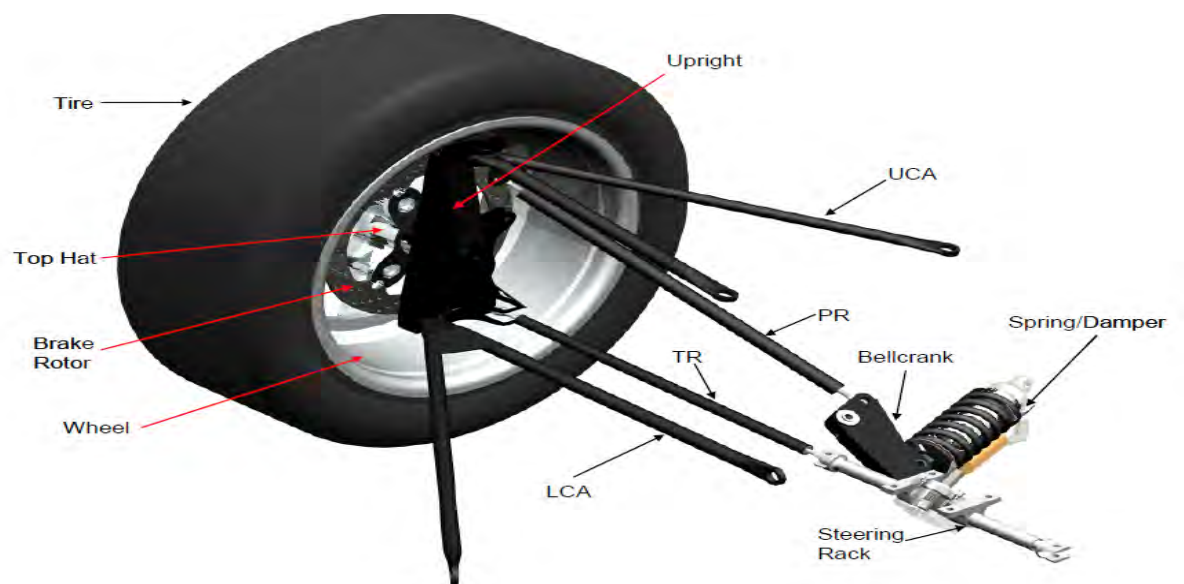
INTRODUCTION

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).

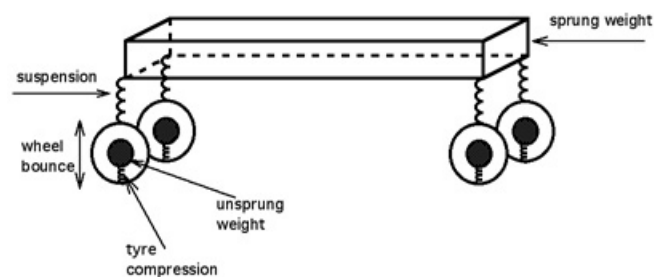
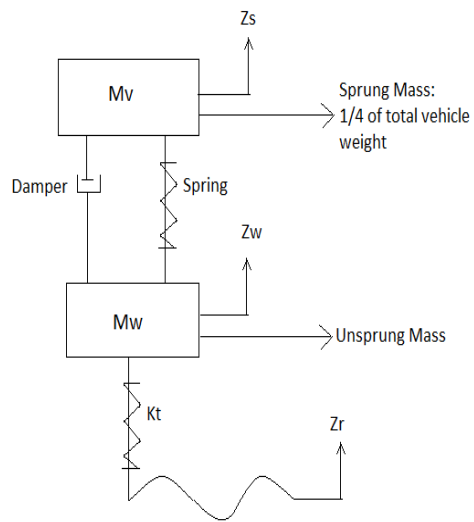


Figure 1.2: Component of Sprung and Unsprung Mass

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



Where:

M_v : Sprung mass

Z_s : Body vertical acceleration

M_w : Unsprung mass

Z_w : Wheel vertical acceleration

K_t : Tire spring coefficient

Z_r : 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 eliminated and it contributes to reducing the number of parts. The advantages of reducing parts is that it contributes to weight reduction, improved reliability, enhanced 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: