UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A NEW DESIGN CONCEPT OF LIGHTWEIGHT REAR AXLE FOR B-SEGMENT PASSENGER CAR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

by

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Tajuk: A new design concept of lightweight rear axle for b-segment passenger car

Sesi Pengajian: 2019

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UteM as a partial fulfilment of the degree of Bachelor of Mechanical and Manufacturing Engineering Technology (Automotive) with Honours. The member of the supervisor is as follow :

.....

Mr Mohd Hafizi bin Abdul Rahman

(Project Supervisor)

ABSTRAK

Ringkasan yang boleh dibuat dari projek ini ialah Gandar Belakang yang di ikat di bawah kenderaan yang menyerap getaran untuk meningkatkan keadaan keselesaan di dalam kabin kenderaan telah di optimumkan beratnya. Sebab utama mengapa projek ini dijalankan untuk mengurangkan penggunaan bahan mentah dalam pembuatan gandar belakang kenderaan. Dalam era globalisasi, dalam dunia bahan mentah menurun setiap tahun, hal ini kerana bahan mentah itu mesti disimpan dan mengitar semula bahan tersebut. Jadi, gandar belakang ini dibuat untuk mengatasi masalah yang dihadapi oleh kenderaan dengan mengoptimumkan berat gandar belakang ini tanpa mengubah kekuatan produk. Selepas itu, produk prototaip telah dibuat untuk kegunaan percetakan 3D untuk paparan.

ABSTRACT

The summary that can be made from this project is a Rear Axle Twist Beam that attached below the vehicle that absorbs the vibration to increase the comfort condition in the cabin vehicle has been optimize. The main reason why this project is run to reduce the uses of raw material in manufacturing the rear axle twist beam of the vehicle. In the era of globalization, in the world raw material decrease every year, because of that the raw material must be saved and recycle the material. Thus, this rear axle twist beam was created to overcome the problem faced by the vehicle by optimizing the weight without changing the strength of the product. After that, the prototype product has been developed using the 3D printing for display.

ACKNOWLEDGEMENT

All praise belong to ALLAH (SWT). Without the health, strenght and perseverance he gave, i would not be able to complete this project. I have taken efforts in this project and spend time wisely to complete this project. However, it would have not been possible without kind of support and help from many individuals family and friend. In particular, i want to thank to anyone that contributed in my project. First, i would like to express the deepest appreciations to my supervisor Mr Mohd Hafizi Bin Abdul Rahman for this patient and endless support that continually teaching my throughout my project. He gave me a necessary suggestion and constant supervision as weel as for providing information regarding this project. Without his guidence and persistent help for this project and he gave me an inspiration idea about the project. In addition, i am very greatful for those giving me a chance to ask information from basic conceptual idea of the project. My big appreciation also to the people who are direct or indirectly help me in developing this project. Thank you so much for all my supporters.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.0 Background.

Twist beam suspension is commonly mounted in non-driven rear axles for its lightweight, sparing compartment space and efficient as a safety part to give comfort condition to traveller in the vehicle. Twist beam suspension system is attached on the rear vehicle to absorb any vibration effect from the condition of the road to give driving precision and stability. This assembly of rear axle delivers roll stiffness by connected to both rear wheel that twist ever so slightly under pressure, to give a degree of independence to each wheel's movement.(Zhao, Zheng, and Feng 2014)

There are many different types of suspension used in vehicle and most of them provide acceptable readability. It can split into two types of suspension based on their construction is dependent suspension and independent suspension. For solid beam axle suspension right and left wheels connected with the single axle and for the independent suspension which is the left and right wheels move indenpendently and not connected to both wheels. (David A. Crolla 2009)

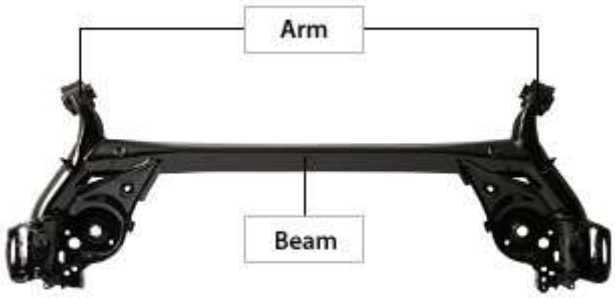

Figure 1 the part of twist beam suspension of rear axle.

For this rear axle suspension system has many parts such as Trailing Arm, Twist Beam, and coil spring housing. Each part was developed part by part and through the process of seam weld to combine and created Twist Beam Rear Axle suspension. Part of the trailing arm and the beam was created with many class of process, for example, using a foaming process or stamping process according to the category of car also depend on manufacturing company that demand from the customer.

In the automotive industry, shape design and optimizing of any part are the greater part of the issues confronted are multicriteria as per part created. Reduced the weighting, developed cost, the material used, and doesn't change the material properties also the strength of a part. To overcome this issue benchmarking process need to followed to make design perfect and improve certain mechanical criteria design, power efficiency of vehicle and improve energy used. Solid thinking will be use to created design. (Tovey, Porter, and Newman 2003)

8.6 **Problem Statement.**

The automotive industry is slightly differently from other industries, it's known a remarkable increase in demand to fulfil people request and requirements. Beside, now automotive sector which is played with reducing fuel consumption moreover improving safety and keep the mechanical efficiency from reduced. According to defect structural components of the twist beam part mostly reasons from fatigue and weakening of the material when applied loads on the part.

From that, weight reduction improvement and protect environment also reduce raw material from wasted has been select to be the main purpose of the manufacturer. Causes of that since reduced weight will improve occupant safety, enhanced fuel economy, reduction in workplace emissions, and improvement of efficiency. (Cole and Sherman 2002)

These are the fundamental issue explanation in this research:

I. Exactly how to created and design the new concept of rear axle twist beam suspension?
II. By what method of fabrication progress to produce a lightweight twist beam suspension.
III. What of the type material will be used and faced to moderate weightiness without decrease the strength of the part.

8.6 **Objectives.**

Main purposes on behalf of this project are:

I. To design a new concept of the lightweight twist beam suspension of rear axle.

II. To decrease weight of twist beam suspension of rear axle by optimization and strength analysis techniques.

8.6 **Scope.**

The scopes of this project are followed below.

I. The Concept design is remains on benchmark product design that already at the market industry.

II. Design 3D prototype of twist beam suspension of rear axle using CATIA V5.

III. Strength analysis and optimization method are run using Hyperwork and Solid Thinking respectively.

IV. Developed the prototype of twist beam rear axle using selective laser sintering (SLS) 3D printer.

V. Actual material for fabrication development related to analysis process only.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction.

In this chapter, mechanism based on rear axle, application of software incorporate such as CATIA, Hyperworks, and Solidworks, developing process which is including material properties and part fabrication, design criteria comprise benchmark and Quality Function Deployment (QFD) will discuss in this part. In addition, the product's strength analysis will also be discussed in this section.

8.6 Mechanism.

In Automotive industry, the Twist Beam suspension is generally utilized a rear wheel suspension system for a front driven passenger vehicle, this component comprises a few parts such as bushings, swing arm and trailing arms. (Aalae, Abderrahmane, and Gael 2016) On other hands, Twist Beam stand framed substantially in a straight shape and associated at inverse closures to the separate left and right control arms to give the twist beam impervious to twisting however strong concerning torsional stress. Furthermore, coil spring attached at spring seat provided on control arm which is connected between the vehicle bodies (Tallman et al. 2006) .

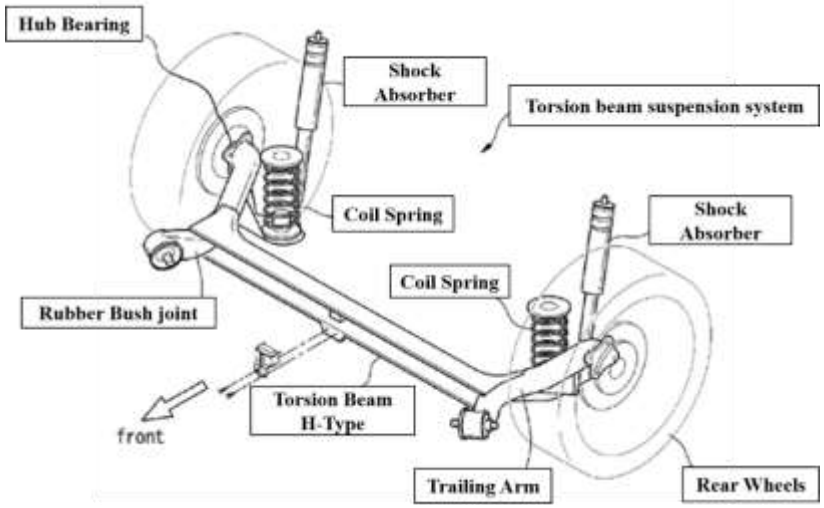

Figure 2 : Example of coupling type Twist Beam suspension of Rear Axle

Figure 1 above demonstrates an H-Type torsion beam suspension framework appended at rear wheels. The both Trailing Arm left and right are supported at vehicle body and attach with Rubber Bush Joint for a vertical swaying according of rear wheels movement. In addition, this trailing arm extending laterally across the vehicle and linked to each other by a torsion beam that will twist rendering rear wheel movement because of road and rear wheels condition. (Tallman, Santner, and Miller 2006) Spring coil and shock absorber are used to absorb any vibration and respond from road condition and wheel condition, if this kind of part the vehicle damaged will make the ride uncomfortable such as bounce, roll or dive excessively. Besides, the ride will be rough and bumps also will tend other part of vehicle damaged. The twist beam rear axle cause the vehicle oversteer during cornering by using toe-bushing. This part have symmetrical and pointed shape which is can opposite the direction of displacement when lateral cornering force applied. There are three types of twist beam that can be classified based on the longitudinal position of the cross member:

I. Torsion-type: this type of rear axle beam is close to the wheel centre and similar to rigid axle that defined as a horizontal axle body that rigidly connect

two wheels to one another and make the motion of one wheel dependent on a motion of the other.

II. Coupling-type: Cross member of this type rear axle is attached to the both trailing arms left and right rear axle, the combination give an advantage to trailing arms suspension system such as improve the lateral stiffness and reduce the chamber changes that reason of conflicting wheel travel.

III. Standard twist beam: the part of rear axle is close to the trailing arm front mounts and similar to a trailing arm suspension system.

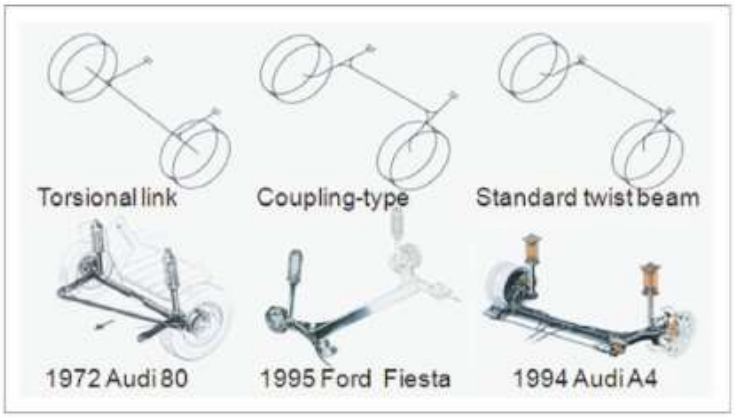

Figure 3 shows the three type of rear axle.

8.6 **Design.**

Designing of engineering items is a primarily human activity, a social and technical process operated human designer with their devices, coordinated towards and foreseen future objective, for the most part, an ideal item provided in great time and acceptable cost. Usually, the process of the system must be designed before or simultaneously with the object system. For instance, the manufacturing process need suitable manufacture machine to perform them. (W. Ernst Eder 2010).

In engineering design, a set of project design is not only by clients but increasingly particularly of original design planning in departments of companies. The planning product from designers proved to be most useful in the long term to maintain objective product design to convenient with the production department also with the product planning department. Before starting the design of the product, many requirements must be followed such as needs and requirements, market forecast, project sales, volume unit price, product development process, subassembly design, assembly analysis, quality requirement, selected process, material selection, economic analysis and cost of product also design feasibility investigation to redesign. (O'Driscoll 2002)

2.2.1 Software

2.2.1.1 CATIA

Dassault Systems created Computer Aided Three Dimensional Interactive Application (CATIA) in the mid-1980s and immediately developed as an industry head. This product modified to exploit the MS Windows capacity while keeping up the CATIA V5 is arranged into three platforms. The platform characterizes tech capacity. Inside every platform, there has Application Tool. These Application Tools contain workbenches that are sorted out into categories relying on their application supremacy and security of UNIX. (Richard Cozzens, 2009)

Since systems designing has advanced as a collective, integrated, and multidisciplinary model for product improvement to deal with the expanding intricacy of product and project. CATIA will empower to create the systems that fulfil customer needs and diminish chance just as the expense related to the advancement of the project. Besides, this product diminishes the complexity of creating different product development approaches inside a single platform.

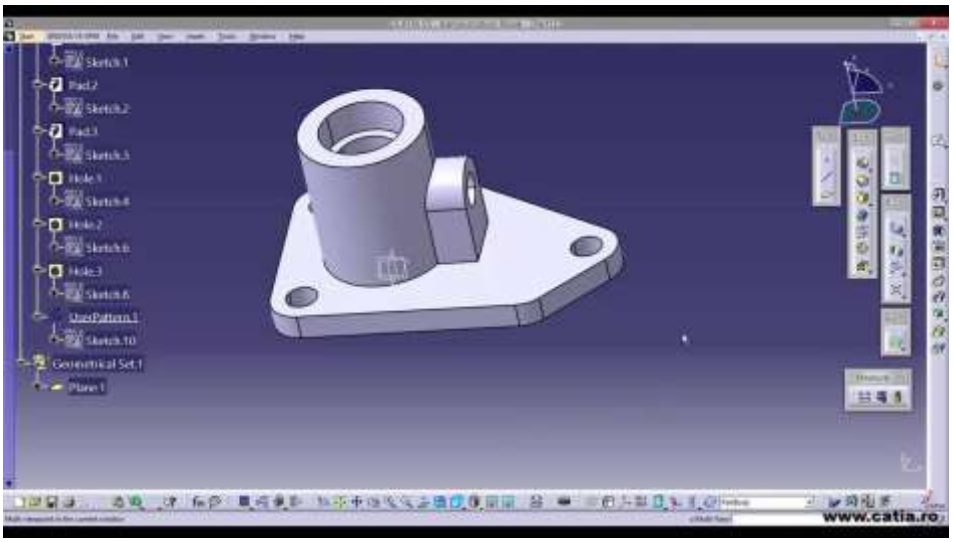

Figure 4 Show the example part design in mechanical design using CATIA V5

For figure above show the example of CAD part design in CATIA V5 that normally used in design development of any product. Commonly in this part design have many command will used by designer, the example of command is sketch, pad, pocket, rib, whole and many more command. In CATIA V5 also have a simple analysis for product design, but for more advance analysis designer must use other software to develop an exceptional result.

2.2.1.2 Solidwork.

Solidworks is CAD software that incorporates many efficient tools that enable a new and experienced user to finish a design short time. This software turns into a most favourite design tool for some engineers, mechanical designer, and industrial designers since it's easy to learn graphical user and an incredible arrangement of tools. The main purpose of Solidworks is to design automation and build parts also assemblies that takes advantages of familiar Microsoft Windows graphical user interface. Solidworks able create the intent design which is intelligent measures of topographies and

dimension of design. This process developed to accept future modification (David C. Planchard 2013). However for this software is similar to CATIA, but more advance and currently have various of features also command that make the user easy to design their product requirement depend on manufacturing industry demand.

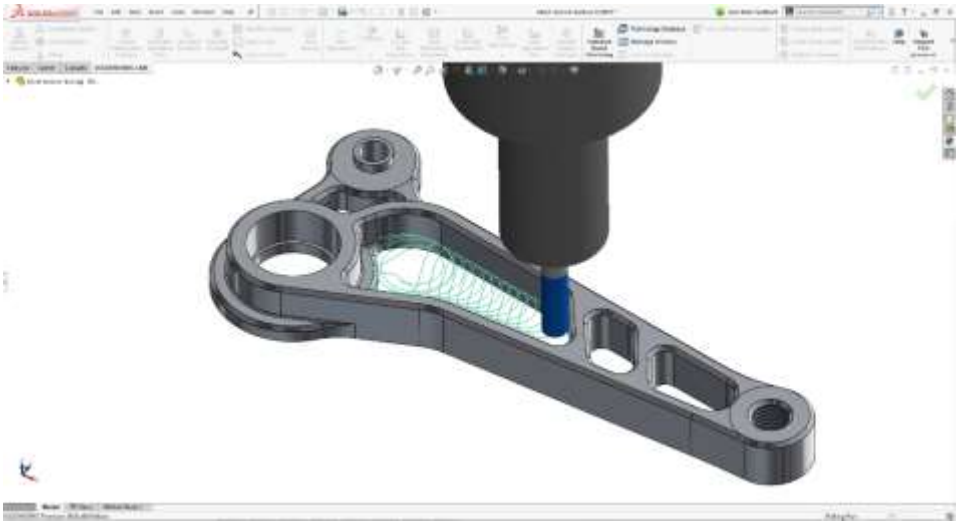

Figure 5 show the example process by using solidworks software.

2.2.2 Design Criteria.

2.2.2.1 Benchmark.

For environmental benchmarks depend on the user of the product. The designer can largely influence the characteristic of the product and through their decisions. Normally benchmarking themes include the measurement, comparison, identification of the best practices, implementation and improvement of the product that will design. Regularly benchmarking is the search for the best production practice which will lead to remarkable execution through the usage of these prescribed practices. (Anand and Kodali 2008). To improve the performance and quality of

anything type of product, designer must be followed the process of identifying, understanding and outstanding practices.

Figure 6 shows the step of Benchmarking process (Anand and Kodali 2008)

2.2.2.2 Quality Function Deployment (QFD).

Quality Function Deployment (QFD) was established in the late 1960s to early 1970s in Japan by Professor Yoji Akao (Cardoso, Casarotto Filho, and Cauchick Miguel 2015). QFD is a general impression delivers a means of explaining customer requirement into an appropriate technical requirement for each stage of product development and production. This concept include many things for example marketing strategies, product process development, sales, production, product design and engineering also develop the prototype evaluation. (Chan and Wu 2002)

The QFD mainly purpose for bring together and considering the customer opinion to developed high quality of anything products or systems. Beside, QFD also can reduce the development time and cost of start-up and manufacturing budget by followed the process below: