Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND ANALYSIS OF ANTI-ROLL BAR USING COMPUTER AIDED ENGINEERING TOOLS

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DEDICATION

Special dedication to my family members, my friends, my fellow colleague and all faculty members. For all your care, support and believe in me.

ABSTRACT

Anti-roll bar is a suspension element used at the front, rear, or at both ends of a car. It will reduce body roll by resisting any unequal vertical motion between the pair of wheels to which it is connected. The function is to keep tires in contact with the surface of the road, support the weight of a vehicle and absorb the forces generated by the movement and motion of the vehicle. From the previous study, most of the design are locate at the bushing near the bend location that it cause the stress of anti-roll bar higher and fracture will occur. Types of the cross section is also the cause to the problem. By using hollow bar, it will reduce the weight of the anti-roll bar compared to solid bar, but hollow bar will produce higher stress than solid bar. Some of the bars have a simpler shape depending on the car and some have irregular shape and some have weight issue. This project entitled Design and Analysis of Anti-roll bar using Computer-aided Engineering tools is focusing to analyse the anti-roll bar design by using computer-aided engineering tool and to improve the design regarding the analysis of computer-aided engineering tools. A stress analysis was carried out by using the finite element technique for the determination of highly stressed areas on the bar. Design consideration of the car anti-roll bar is studied from past researchers with the summarized of current invention of car anti-roll bar. In development of the car anti-roll bar, interplay among design elements such as material, function analysis, failure analysis and product design specifications are needed to be taken into consideration in development of it without affecting its conventional function and achieve the performance goal. The ability of the composite material is possible to be the next future generation of automotive anti-roll bar. Regarding to the analysis, it shows that the improvement design of the anti-roll bar have higher roll stiffness compare to previous design. It also have lower weight because of using hollow anti-roll bar and changing the material of the anti-roll bar, but in term of stress, it have higher stress compare to previous design. This is because of type of material, type of cross-section, location of bushing and parameter of the improvement in the improvement design was change compare to previous design.

ABSTRAK

Bar anti-roll adalah elemen penggantungan yang digunakan di bahagian depan, belakang, atau di kedua-dua hujung kereta. Ia akan mengurangkan roll badan dengan menentang mana-mana gerakan menegak yang tidak sama rata antara sepasang roda yang bersambung. Fungsi ini adalah untuk menjaga tayar bersentuhan dengan permukaan jalan, menyokong berat kenderaan dan menyerap daya yang dihasilkan oleh pergerakan dan gerakan kenderaan. Dari kajian terdahulu, kebanyakan reka bentuk meletakkan sesendal pada bahagian lengkuk yang menyebabkan tekanan bar anti-roll lebih tinggi dan ia akan menyebabkan bar patah. Jenis-jenis keratan rentas juga menyebabkan masalah. Dengan menggunakan bar kosong, ia akan mengurangkan berat bar anti-roll berbanding bar pepejal, tetapi bar kosong akan menghasilkan tekanan yang lebih tinggi daripada bar pepejal. Sesetengah bar mempunyai bentuk yang lebih mudah bergantung kepada kereta dan ada yang mempunyai bentuk yang tidak teratur dan ada yang mempunyai masalah berat badan. Projek ini yang bertajuk Reka Bentuk dan Analisis bar Anti-roll yang menggunakan alat Kejuruteraan Berbantu Komputer memberi tumpuan untuk menganalisis reka bentuk bar anti-roll dengan menggunakan alat kejuruteraan dibantu komputer dan untuk memperbaiki reka bentuk mengenai analisis peralatan kejuruteraan berbantu komputer.Analisis tekanan dilakukan dengan menggunakan teknik elemen terhingga untuk menentukan kawasan yang sangat tertekan di bar. Pertimbangan reka bentuk kereta anti-roll bar dikaji dari penyelidik masa lalu dengan diringkaskan ciptaan bar kereta anti-roll semasa. Dalam pembangunan bar anti-roll kereta, interaksi antara unsur-unsur reka bentuk seperti bahan, analisis fungsi, analisis kegagalan dan spesifikasi reka bentuk produk perlu diambil kira dalam perkembangannya tanpa menjejaskan fungsi konvensional dan mencapai matlamat. Keupayaan bahan komposit mungkin menjadi generasi masa depan untuk bar anti-roll automotif. Mengenai analisis, ia menunjukkan bahawa reka bentuk penambahbaikan bar anti-roll mempunyai ketegaran roll yang lebih tinggi berbanding reka bentuk terdahulu. Ia juga mempunyai berat yang lebih rendah kerana menggunakan bar anti-roll berongga dan mengubah bahan bar anti-roll, tetapi dari segi tekanan, ia mempunyai tekanan yang lebih tinggi berbanding dengan reka bentuk sebelumnya. Ini kerana jenis bahan, jenis keratan rentas, lokasi sesendal dan parameter penambahbaikan dalam reka bentuk pembaikan adalah perubahan berbanding dengan reka bentuk terdahulu.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Automobile industry focus on producing element which gives managing and performance of the vehicle better than nowadays car, however, such element should no longer produce the extra cost and also it must improve the comfort level of the automobile that is to the passenger. The anti-roll bar is one of the innovations in the automobile industry which is also known as a sway bar or stabilizer bar. Anti-roll bar will connect two wheels that are left and right wheel and bar are fixed to the chassis of the automobile through the bush. Anti-roll bar may be a solid or hollow tube. The main function of the anti-roll bar is to reduce the body roll. Body roll condition occurs because of the weight transfer and changes take place inside the chamber of the car which directly has an effect on the steering behavior of the car and car losses its balance, therefore, to remove the rolling impact in case of below steer and over-steer anti-roll bar is used. Anti-roll bar provides comfort in riding condition and protection for the driver.

1.1 Project Background

Anti-roll bar, considered as one of the components of the car that enables to prevent the car from rollover which causes harm to the car. It additionally saves severe accidents to each passengers and crew members. It additionally helps vehicle from maneuver. One more advantage of that, it improves traction by way of controlling the camber angle changes as a result of body roll. The anti-roll bar might not have the precise model to get round chassis component or can be much easier relying on the automobile. There are available specifics to examined approximately the anti-roll bars within the supplied and second, the geometry of the bar is under the shape of else chassis components. (Kemal Caliskan, 2003)

The most important of anti-roll bar is to reduce body roll. Body roll appears as soon as a car actions faraway from within the course of movement. The road connection the roll centers of wheels suspensions forms the roll axis of a body. Centre of gravity of a car is frequently higher than this roll axis. Therefore, while turning the centrifugal force creates a roll moment connecting roll axis that is okay to develop a force with the gap between the roll axis. Anti-roll bars serve 2 or extra key functions. First, the role of the body was cut back, as defined better than, and the second one offer a few manner to once more spreading cornering hundreds between each wheel, that in turns, given the aptitude of modifying handling characteristics of the vehicle. (Kemal Caliskan, 2003)

In automotive suspensions of car, anti-roll bar is one of the forces elements that can limit vibration and maintain the tires in contact with the road. There are three types anti-roll bar that are many times set up in cars which are active anti-roll bar, semi-active anti-roll bar, and passive anti-roll bar system (Taha, Sapuan, Mansor, and Aziz, 2017). The passive anti-roll bar system is operated when the anti-roll bar interacts with the suspension system passively to minimize automobile roll at a constant position. Basically, passive anti roll bar has the lowest cost rather than active and semi-active anti-roll bar but in contact with safety,

active anti-roll bar more minimized the body roll compared the passive anti-roll bar. It can be concluded that the active ARB system could enhance the handling of off-road automobiles without sacrificing ride comfort.

Anti-roll bar are one of the suspension components that used in vehicle for limiting the body roll angle. In vehicle production, changes the design of the anti-roll bar is common at various step but design analysis should be done for every change of the design. For the analysis of the design of anti-roll bar, Finite Element Analysis (FEA) are one of the effectively way. For this study, Hypermesh software was chosen to analyses the design of the anti-roll bar. This software can use to analysis for a wide range of the design of the anti-roll bars. The centre line of the anti-roll bar can be 3D shape in any shape, the location of the bushing can be located at any position on the anti-roll bar with a user defined bushing length, for the both end connection can be pin joint or spherical joint and lastly for cross section, it can be in a solid or hollow type of cross section.

1.2 Problem Statement

Anti-roll bar also called stabilizer bar or sway bar may be in a solid or hollow tube, normally made of from steel which connected between the right and left suspension members together. It is to resist roll or swaying of the automobile which occurs at some stage in cornering or because of road irregularities. The bar's torsional stiffness (resistance to twist) determines its ability to lessen body roll, and is known as "Roll Stiffness". Nowadays, there are many cases that state about the fracture of anti-roll bar after 100,000 km of journey. It always happen at the bend location. From the previous study, most of the design are locate the bushing at the bend location so it make the stress of anti-roll bar higher and the fracture will occur. Type of the cross section also cause the problem. If using hollow bar, it will reduce the weight of the anti-roll bar compare to solid bar. But hollow bar will produce higher stress than solid bar. Some of the bars have a simpler shape depending on the car and some have irregular shapes. Some of the anti-roll bars also have weight issue. If the design of the bar is much simpler than the design of other chassis components, it is going to be a problem in managing the car, so that, the first thing to be done is by changing the design of the anti-roll bar.

1.3 Objective

The main objectives of this project are deeply concentrated on the aspect below:

i) To analyse the anti-roll bar design by using computer-aided engineering tool.

ii) To improve the design regarding the analysis of computer-aided engineering tools.

1.4 Project Scope

The scope of this project is analyze the anti-roll bar by using computer-aided engineering tool to do the fatigue test simulation. The function of the fatigue test is to determine the relationship between stress range and the number of time that can be applied before causing failure.

Besides that, this project also will develop a new structural design for an automotive anti-roll bar that will act as a lightweight replacement to an existing steel bar. The anti-roll bar must be designed to have an ideal character to be applied in a vehicle that can improve stability and directional control, reduce roll further and also leads to better handling for the driver and make it the confidence of the driver increased.

1.5 Thesis Structure

Chapter 1:

The first chapter introduces the brief idea of the project. It focused on the overview of the project, detailing the objectives, the problems statement, scope and outcome of the project.

Chapter 2:

Project background is discussed in this chapter. It only concentrates on the literature review that will describe all the information that was referred as a reference in order to finish up the project. Basically, the literature review will contain the facts or other expectations that need that correspond to the project that will build. This chapter also defines terms used in this project and discussed the concept of the research and how it is related to the theory.

Chapter 3:

Chapter 3 describes the methodology used in this project. The schedule or steps that need to be completed and the detailed reports of studies that were done to achieve the aim of the project are presented. The methodology is the important aspect as it is the beginning process of planning. If the methodology is not organized only then will encounter the problem involved in the project.

Chapter 4:

This chapter is about the result and discussion. All the data collection and analysis obtained will be discussed in detail. The results will be compared with the objectives outlined in order to arrive at some hypothesis and conclusion.

Chapter 5:

Chapter 5 after through all the process and successful to achieve the objectives as stated in the earlier chapter. The project can be concluded and explain the detail in this chapter. Other than that, a future recommendation for this project also includes improving this project for the future improvement and upgrade.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides an introduction to anti-roll bar that follows with some background study such as function of anti-roll bar, types of anti-roll bar, materials of anti-roll bar, design of anti-roll bar and suggestion on the new design of anti-roll bar based on the previous study, product design specification and computer-aided engineering tools.

2.1 Anti-Roll Bar

Anti-roll bar referred to as stability bar, sway bar, rod, and tube, and usually made up from steel that connects the right and left suspension members collectively to oppose roll or swaying of the vehicle that happen during cornering or due to road irregularities (Laxminarayan, Kanna, Tare, and Kalje, 2014). The anti-roll bar is suspension component that used to keep away from the car from excessively rolling during sharp turns.

2.1.1 Function of Anti-Roll Bar

The function of the anti-roll bar is to attach the right and left suspension members together to oppose roll or swaying of the car that will occur during cornering or because of road irregularities. Car anti-roll bar is a part of a suspension system and most of the vehicles have front anti-roll bar. By using anti-roll-bar for the both of the front and rear wheels, it can lessen roll further. Good chosen (and installed), it will lessen body roll and make it better handling for the driver and make it the confidence of the driver higher. If the spring rate for the front anti-roll bar will increase, it will make under steer effect but for the rear bar, it will make over steer impact. Besides that, anti-roll bar also used to enhance balance and directional manipulate. Apart from that, it is going to enhance traction by limiting the camber angle change resulting from body roll (Bharane, Tanpure, Patil, and Kerkal, 2014). The anti-roll-bar is one of the forces elements in automotive suspensions of the car that can eliminate vibration and make the tires in contact with the road. The anti-roll bar is a component that installed in a vehicle to counteract the forces that provoke swaying of the vehicle during operation (Taha, Sapuan, Mansor, and Aziz, 2017)

Anti-roll bar became one invention utilized in stabilizing the vehicle. Anti-roll bar utilized in ground vehicles to dispose of body roll by using opposing any unequal vertical motion among the pairs of wheels suffers from fatigue failure. Essentially shape of the anti-roll bar is U-shaped. The end of the anti-roll bar become associated with the suspension device. Usually, an anti-roll bar is made in hollow in addition to the stable (Bhandiagare and Baskar, 2016). Anti-roll bars couple to the left and right wheels at one of them together and allow the semi-independent movement of every wheel. The bar will twist while cornering and form a torsion spring. The outside end will be pushed down and the inside end will be being lifted.