VERIFICATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of degree of Bachelor Mechanical Engineering (Structure & Material)"

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Supervisor's Name	:……
Date	: ……...

DECLARATION

I hereby declare that this project report entitled
STRENGTH AND SAFETY EVALUATION OF AUTOMATIVE'S COMPONENT WHICH STEERING KNUCKLE AND MATERIAL THAT HAVE BEEN USED
is written by me and is my own effort except the ideas and summaries which I have clarified their sources.

Signature :……
Author :……
Date : ……...

TO PARENT, LATE GRANDFATHER AND BELOVE FAMILY
LECTURERS AND FRIENDS

ACKNOWLEDGEMENT

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ABSTRACT

The steering knuckle is a part of the suspension system. It is one of the critical component as it carry varies type of load (vertical, longitudinal, lateral and torque load). Due to this, it is important to produce a great strength of steering knuckle in order to make sure that it can sustain the loads and can functioning well and safe. Generally the type of material and manufacturing process affects the strength of the steering knuckle. Based on literature review, the steering knuckle was designed according to several aspects, for example, the geometry of the steering knuckle. Material selection is also the other factor when design steering knuckle. Currently, there are several type of materials that have been used to produced the steering knuckle for example steel and for the process, usually forging and casting were used. The fatigue and bent of steering knuckle are the main problems, when it's in service. Regarding this, it is important to choose a great steering knuckle that has good strength. Cast steel, cast iron and ductile iron was selected as the main material in this chapter that will be assigned to the different type of steering knuckle. The effect of geometry and material contribute different analysis result.

ABSTRAK

Knuckle Steering merupakan salah satu komponen suspensi. Ia merupakan salah satu komponen yang kritikal disebabkan ia menahan beberapa jenis daya (daya tegak, melintang, sisi, dan memusing). Disebabkan oleh itu, ianya sangat penting untuk menghasilkan *knuckle steering* yang mempunyai kekuatan yang kuat untuk memastikan ianya dapat menampung daya dan berfungsi dengan baik dan selamat. Umumnya, jenis bahan dan proses untuk mempengaruhi kekuatan *knuckle steering*. Berdasarkan ulasan kajian ilmiah, *knuckle steering* direka berdasarkan beberapa aspek sebagai contohnya geometrinya. Pemilihan jenis bahan juga antara factor lain dalam membuat *knuckle steering.* Terdapat beberapa jenis bahan dan proses yang digunakan untuk menghasilkan *knuckle steering*, sebagai contoh, bahan keluli dan untuk proses, tempa dan acuan biasa digunakan. Kelesuan dan bengkok adalah masalah utama yg dihadapi oleh *knuckle steering* apabila ianya digunakan. Sehubungan itu, pemilihan *knuckle steering* yang mempunyai kekuatan yang bagus adalah penting. *Cast steel, cast iron* dan *ductile iron* digunakan sebagai bahan utama untuk dimasukkan ke dalam *knuckle steering*. Kesan geometri dan bahan menyumbang beberapa jenis keputusan.

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CHAPTER 1

INTRODUCTION

1.1 General

The steering knuckle can be classified as the part of the suspension system, steering system, brake system and as a part of the wheel's assembly. In general the steering knuckle helps to steer, brake and support the automobile. It is also allows the front wheel to pivot and to attach rotating components to suspension components beside distribute load from road to body.

In suspension system, there are several parts that work together with steering knuckle such as spring, shock absorbers, control arms, ball joints and spindle. The steering knuckle can be classified according to the type of suspension. Their shape also differs between types of suspension. Figure shows different types of knuckle that applied in several types of suspension system.

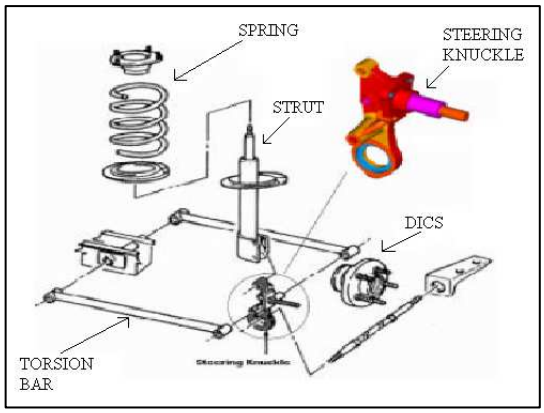
Figure 1.1: Knuckle for SLA Suspension

Figure 1.2: knuckle for Multilink Suspension

Figure 1.3: Knuckle for McPherson Suspension

(Sources: Jim Ziech, Western Michigan University)

As it's used with independent suspension, on most cases the steering knuckle and wheel spindle are forged to form a single piece, for example in a conventional dead axle set-up as shown in figure 1.1. The steering knuckle that carries wheel and wheel bearing connected each wheel independently to the frame, by ball joint, that attached narrow ends of both control arms.



` Figure 1.4: Suspension Components

(Source: Mehrad Zoroufi and Ali Fatemi)

On cars with McPherson strut suspension systems, the steering knuckle has an opening to allow the connection of the CV axle shaft to the wheel hub and bearing assembly, spindle is not required in steering knuckle geometry. Refer to figure, there are several components that connect to the steering knuckle, such as strut; consist of spring that assemble with shock absorber connect in vertical position. Strut carries the vehicle weight. The other component is the lower control arm that is connects by using a ball joint. The tie rod connects to the horizontal geometry of the steering knuckle.

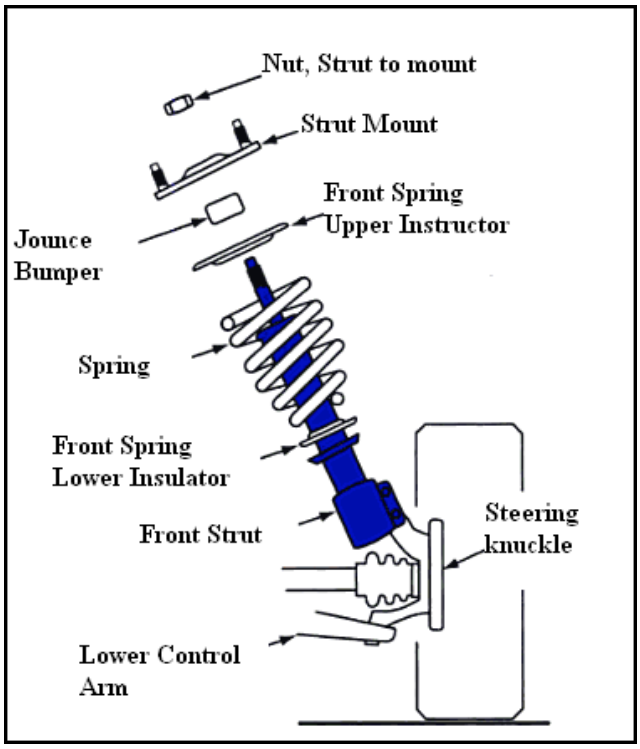


Figure 1.5: Related Components
(Source: Don Knowles; 2002)

In SLA (short long arm) suspension, the upper and lower control arms were attached to the steering knuckle. In order to provide a correct tracking and wheelbase between front and rear wheels, the upper and lower control arms must be positioned properly.

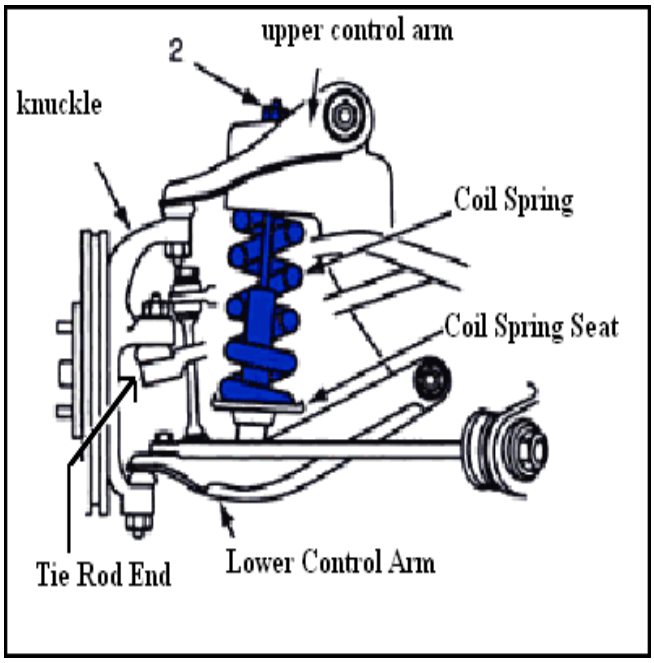


Figure 1.6: Knuckle in SLA suspension
(Source: Don Knowles; 2002)

In brake system, the knuckle supports the brakes that transmit braking forces to the wheel. And in steering system, the steering knuckle pivots on the upper and lower ball joints, when it's turned by the steering gear and linkage, as the steering wheel was turning.

Today, there are many type of steering knuckle that have been produced that depend on the application (types of suspension). Its can be classified according to the shapes, materials and process required to produce it. As previously mentioned, the shape basically designed by referring to the type of the suspension and also the frame. For the material and process, there are several types of material that presently used as well as for the process. Steel and aluminum are the type of materials that have been used and for the process; forging and casting are usually familiar in this industry.

Through this project, a several aspect of the steering knuckle which is very important to consider in manufacturing process for example, a safety and strength will be studied and evaluated. There are several factors that affect the safety and strength of the steering knuckle, for example the type of the materials that have been choosing. The study in choosing a right material here is very important. A great safety and strength of the steering knuckle will result in high durability and also has long life.

1.2 OBJECTIVE

The objective if the study is to evaluate the strength and stress of the steering knuckle that can be achieve from the differences of the materials that have been recommended for a chosen design.

1.3 PROBLEM STATEMENT

The steering knuckle is such an important component for the automobile because it is relate with many system and it carry varies of load. A good durability of steering knuckle is required to make sure it well functioning. Many problems that appear today are about the bent or damaged of the steering knuckle. This will affect proper wheel alignment. And this will cause in high maintenance's cost, and can cause an accident that will lose of life. An efficiency solution should be finding and improve in order to prevent this problem.

Through this project, a study about the durability of the steering knuckle can help in choosing a better material, and analysis which design is better that will have a great strength and can sustain multi-axial loading when it is in service.

1.4 SCOPE

The scopes of this project are:

1.4.1 To choose a suitable design for steering knuckle.

1.4.2 To analyze the present materials to fulfill the criteria's in producing the steering knuckle.

1.4.3 To apply a simulation using MSC Nasran/Patran in order to evaluate the strength and safety of the proposed design of steering knuckle.

CHAPTER II

LITERATURE REVIEW

2.1 General

Literature review is collective of data gather from reading, references and also information from the professionals relating to the project which will be review in this chapter. From here, we will understand the purpose of the project and how we are going to achieve the result. So it is important to review the information gain to make sure it will be useful for this project

2.2 Steering Knuckle

Steering knuckle is one part of the critical component, which connects to other suspension part. Due to the many connections, its must sustain variable loads that result from the connection. Thus, steering knuckle must have a good strength and durability to overcome the loads and prevent from exhibit any damages, for example bent in geometry when it is working. There are several studied that have been done in several aspect such as design, material, process in producing a better steering knuckle.

2.3 Comparison between findings

2.3.1 Design

D. J. Milbourn et al (1999) based on the study, in its simplest form; the front steering knuckle provides a mount for the wheel bearing, upper and lower ball joints and brake caliper. Due to this, it is a multifunctional component, in highly constrained package that is subject to complex loading. Table below state load applied that result the maximum stress in component

Table 2.1: Suspension Knuckle Load Cases and Stress Results
(Source: Milbourn et al, 2001)

Load Case	Load Type	Minimum Cycles	Component Max Stress (N/mm^2)
Pothole Braking	Proof	*	995
Reverse Shock		10	736
Overturning		1	895
Kerb Strike		1	876
0.5g Traction		*	227
2g at 30 degrees		*	451
3g Bump		*	348
1g Braking	Fatigue	100,000	434
-0.35g Reverse Braking		100,000	350
3g at 30 degrees		175,000	532
0.75g cornering, inner wheel		30,000	178
0.75g cornering, outer wheel		30,000	551
-2g rebound			271

* Not prescribed

Based on this, H section was taken as a proposed design for strut connection to the main body and ribbed caliper mounting bosses and while T section was taken as proposed design for its steering arm. The thickness of a component was selected 7mm in thickness as a minimum thickness. The proposed design is shown in figure below.

This design was using a material type air cooled micro-alloyed steel that aim in produce a lightweight steering knuckle as well as reducing a cost beside in increase fatigue qualities.

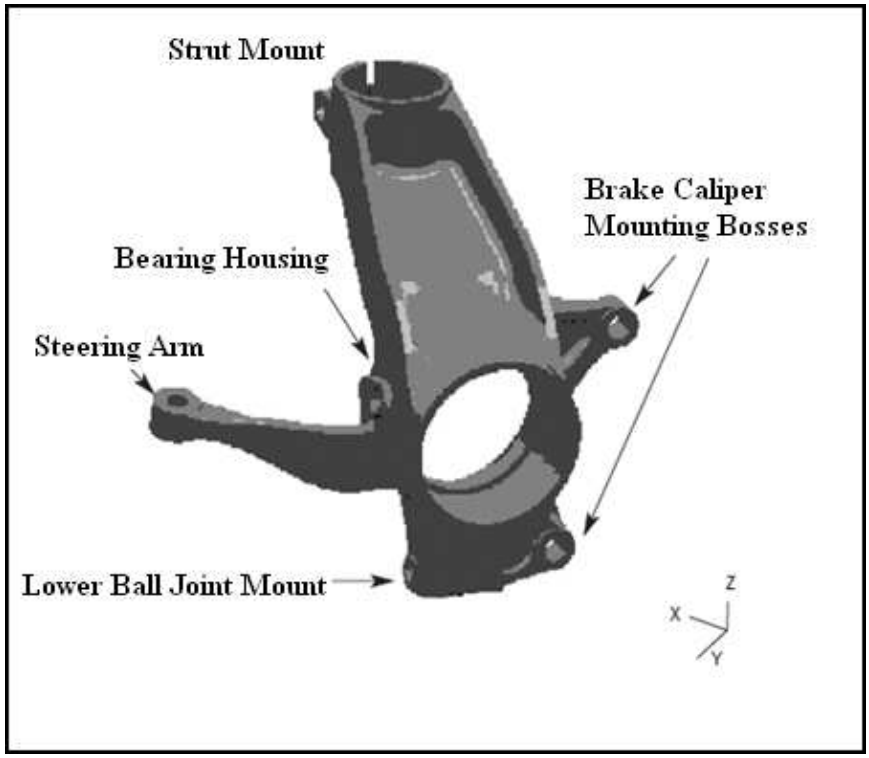


Figure 2.1: The proposed design of steering knuckle

(Source: Milbourn et al, 2001)

Krisna, Murali (1998) state that, it is very difficult to use traditional loads and displacements method to generate shape vector since a steering knuckle is not uniform in shape. Due to this, for every different regions of steering knuckle, it was subject to thermal loading independently that result in displacement which is use as a shape vector.

Through this study, a steering knuckle was redesigned in order to reduce its weight. Its weight was reduced through design direction. Shape optimization of a steering knuckle was done from application of thermal displacement.