ANALYSIS OF MULTIAXIAL FORCE ACTING ON STERING KNUCKLE OF A VEHICLE ON UNEVEN SURFACES

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding degree of Bachelor of Mechanical Engineering (Design and Innovation)"

Signature : ……..

Supervisor's Name : ……..

Date : ……..

"I hereby declared that this report is a result of my own work except for the excepts that have been cited clearly in the references"

Signature : …….

Name : MOHD SHAZWAN BIN MOHD ZAKI

Date : April 2009

DEDICATION

For my beloved father, Haji Mohd Zaki Bin Taib
my mother,Hajah Ramlah Binti Endut,
my friends and my wonderful siblings.

ACKNOWLEDGEMENT

Assalamualaikum Warahmatullahi Wabarakatuh,

Praise to Allah S.W.T the Almighty, that gives me strength and His blessings to complete my report for the Bachelor Degree Project (PSM). Without His blessings and help, it is difficult for me to complete this report.

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ABSTRACT

The purpose of this work is to study, discuss analysis the acting force to a steering knuckle while in track or random load for a standard vehicle. Steering knuckle is a main automotive component that requires a lot of attention in taking care of it. That's because once it damage, it have to be replaced with the new one. Steering knuckles are heavy cast parts made of steel or aluminium. They are not repairable and should be replaced if damaged. Steering knuckle hold the wheel part, lower control arm, sub frame, and the strut, which is bolted to the body of the vehicle. In mechanical part, it will become wear or excessive in certain cyclic time due to load of force that has been carry in this pivot. This is due to random load from the uneven road surfaces. Each time the vehicle travel on the road, this part will receive certain amount of force.

ABSTRAK

Kajian ini bertjuan untuk mengkaji, dan membuat analisa terhadap knuckle steering berdasarkan ujian litar ataupun daya-daya rawak. Knuckle steering merupakan komponen automotif yang memerlukan penjagaan rapi dan cermat. Ini kerana ia perlu ditukar baru jikalau rosak dan tidak boleh dibaiki. Komponen seperti ini tidak boleh dibaiki kerana bahagian yang rosak mengandungi retakan. Knukle steering memegang bahagian bahagian tayar, lengan kawalan bawah, rangka, strut yang mana dibolt kan di bahagian kereta. Dalam konteks mekanikal, bahagian ini akan haus kerana digunakan banyak kali dlam keadaan maksimum akibat daya yan bertindak dari permukaan jalan yang tidak rata. Setiap kali kenderaan melalui permukaan itu, knuckle steering akan menerima daya-daya tersebu

TABLE OF CONTENTS

. LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Project Background

Steering Knuckle or hub carrier is one of automotive part on the vehicles and mostly been used in car suspension system. This part is mounted between the upper joints and has the wheel spindle. Type of vehicle using this part is known as front drive axle where the front will control the steer of the vehicle. Steering knuckle assembly for the drive wheels of automotives vehicles including a carrier component adapted to be secured to the wheel suspension and carrying a floating-caliper brake and a wheel axle bearing, and a rotatable mounted wheel axle having a constant-velocity joint for the drive and a flange for the attachment of a brake disc. This part is located next to the wheel as steering knuckle has the wheel spindle that holds the wheel. Each vehicles has two steering knuckles as it located at the both front-side and the control arm connected from the left side knuckle to other side of knuckle. Type of connection between steering knuckle and control arm is ball joint. This ball joint has certain advantages such as reduces the unsprung mass of the suspension system and thus contributes to improved road holding. In part that involving mechanism and movement, each pivot or joint will become wear or crack in certain time.

Knuckle steering is mostly the important part in the vehicle but not everyone knows what this use for. Steering knuckle is a forging that usually includes the spindle and steering arm, and allows the front wheel to pivot. The knuckle is mounted between the upper and lower ball joints on a SLA suspension, and between the strut and lower ball joint on a MacPherson strut suspension.

According to the present invention, the carrier component with the disc brake and the wheel axle bearing together with the wheel axle, the flange, the brake disc and a bowl shaped part of the constant-velocity joint are coupled to form a module which can be secured to the wheel suspension as a preassembled unit in the final assembly of the automotive vehicle.

The carrier component is preferably formed integrally with supporting arms for the disc brake, fastening sections for the wheel suspension and a lever for the steering, on the one hand, and a radially internal ring of the wheel axle bearing, a shell-shaped part of the constant-velocity joint and the flange for attaching the brake disc are formed integrally with the wheel axle, on the other hand.

1.2 Problem Statement

The assumption that loads tug in one direction is a simplication that works well, to a point. In the real world, however, loads are simultaneously applied in several directions, producing stresses with no bias to a particular direction. These stresses are called multiaxial. In order to accurately calculate fatigue damage, analyses must identify multiaxial stresses and use appropriate algorithms. Steering knuckle is one of automotive that frequently carries load from several directions. The

Steering knuckle has a strut mount at the top, ball joint at the bottom, and a steering arm on the side. The wheel spindle fits through a hole in the center. Each circumstances of the road give the different impact to the steering knuckle. If the user driving the vehicle over cobblestone slalom, the applied loads to the steering knuckle through the strut mount, lower ball joint, steering rod tie, and wheel axis will create a multiaxial load condition. Multiaxial fatigue analysis is important to analyze all the pivot point in this part. This research will be based on this multiaxial stresses that act on steering knuckle part during the unstable road. In that situation, random load are applied to these pivot.

1.3 Objective

a) To make a research and analyse multiaxial load that acting on steering knuckle of a vehicles that‟s travel on the uneven surface.
b) To make a research and analyse multiaxial load that acting on steering knuckle of a vehicles that‟s travel on the bumpy road.

1.4 Scope

a) to study what most suitable material in manufacturing of steering knuckle
b) to use COSMOSWorks as a method and software to find the multiaxial stresses in steering knuckle
c) to analyze the effect of acting force on strut mount, lower ball joint, steering rod tie, and wheel axis using Finite Element Analysis.

CHAPTER 2

LITERATURE REVIEW

This chapter will explains all the details of the research and reviews of steering knuckle from the material, the benefits and also its functions. This information or research will be used as guidance for selection method of analyzing. Based on the fact and theory, the final method will be decided.

2.1 Introduction of Steering Knuckle

Steering knuckle or hub carrier is a forging that usually includes the spindle and steering arm, and allows the front wheel to pivot. The knuckle is mounted between the upper and lower ball joints on a Short Lower Arm (SLA) suspension, and between the strut and lower ball joint on a Macpherson strut suspension.

Steering knuckle is the part of front axle assembly which fastens to the spindle and is held in place by the kingpin. (drive and live by Fitzgerald, James Augustine, page 277). This part is located at the front axle of a vehicle. It holds the wheel as it also hold the lower control arm, upper control arm, upper ball joint, and also the lower ball joint. If vehicles past through a bad surface or cobblestone slalom, the road forces are then transferred into the knuckle. Due to this condition, some cases, these pivot have occurs fatigue effect.

Figure 2.1: Toyota Camry Steering knuckle

(Source: www.intat.com/Products.html)

This figure above show the Toyota Camry steering knuckle. The knuckle determine the position of the upper ball joint, lower ball joint, and the steering ball joint in relation to the wheel and tire. Criteria of the ball joint heights is based on the loads from the wheel and tire must be fed into chassis and control arms through the upper and lower ball joints and it is explain why the bal joints as far as possible.

The table below shows the ball joint pivot locations. These pivot locations is important as this has a great deal of influence on the total effectiveness of a suspension design. (Chassis Engineering)

Chart 7-1

BALL JOINT PIVOT LOCATIONS

	Height from Axle Center (inches)	Offset from Wheel Surface (inches)
Lower Ball Joint	5.75 below	3.75 inboard
Upper Ball Joint	5.75 above	5.50 inboard
Steering Ball Joint	5.25 below	3.50 inboard

Note: Figure 7-2 shows these dimensions added to the layout.

Table 2.1: Ball Joint Pivot Locations

(Source: Adams H., (1993))

2.2 Application of Steering Knuckle

Steering knuckle are components that been used in the vehicles whether in the front or rear axle. These are some of the applications involving the steering knuckle:

2.2.1 Steering Mechanism

This steering knuckle is one of the most important parts in vehicle but not many people know about it. Apart from the steering system, this part also involved in the steer of the car. The two steering system are standard mechanical and rack and pinion steering. The standard mechanical steering can be either assisted or non-power. Meanwhile rack & pinion always assisted although there are race cases where it is not.

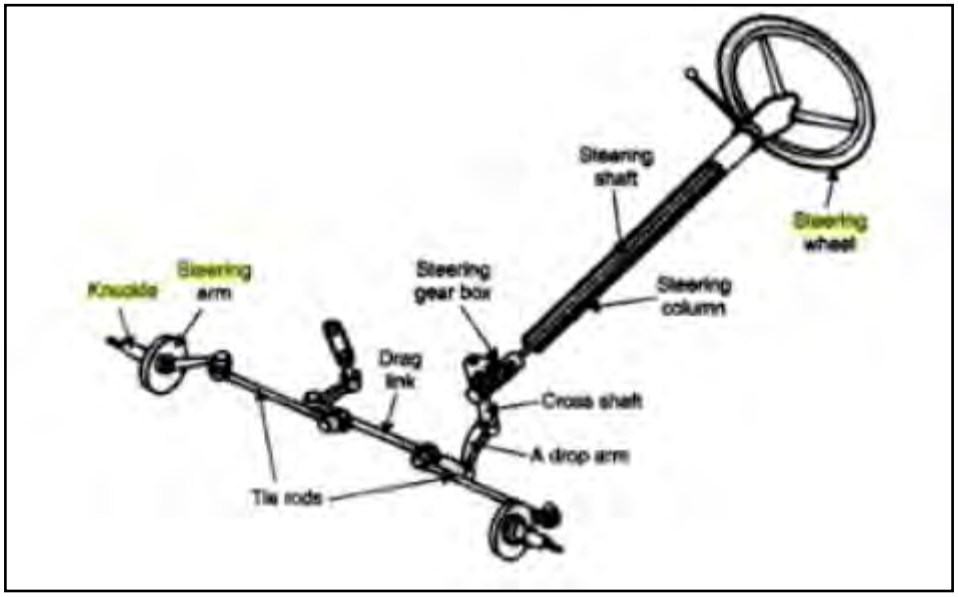

Figure 2.2: General arrangement of a steering system
(Source: Rajput R.K.(2007))

For standard mechanical steering system, it uses a series of link and arms to insure both wheels turn in the same direction at the same time. The steering wheel rotates the steering column. At the end of this column a steering gear is fitted and therefore, when the wheel rotated, the cross shaft in the gear box oscillates. The cross shaft is connected to the drop arm and linked by means of a drag link to the steering