



DESIGN AND ANALYSIS OF AL 7075 STEERING KNUCKLE COMPONENTS

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Abstract

The Steering Knuckle component is the most important part of vehicle which is connected to front wheel with the help of suspension system, wheel hub and these are also connected to steering system and brake to the chassis. The Steering Knuckle component provides motion to desired directions with the help of steering system. It undergoes various types of varying load under different conditions. In Automobile industry low fuel consumption and light weight are the two main demands for the vehicle because the lighter steering knuckle resulting greater power and less vibration because of inertia is less. In this Paper we have done static analysis of steering knuckle component. The design of Steering Knuckle component is done with the help of Computer Aided Engineering. Steering Knuckle model is prepared in solid works and the static analysis is done in ANSYS 15.0 by constraining the steering knuckle and applying load on steering knuckle due to calliper mounting, longitudinal reaction, vertical reaction, vehicle weight and steering reaction. In this we have focused on the material for the steering

knuckle component made from AL 7075 which is suggested material.

Keywords Steering knuckle component, Static Analysis, and ANSYS 15.0.

1 Introduction

Steering knuckle is the critical component of the vehicle which is linked with suspension system. It allows steering arm to turn the front wheel and it also supports the vertical weight of the vehicle. The steering knuckle is the connection between stub axle, tie rod and axle housing with the help of using king pin, and these are also connected to the suspension system [6]. In this, wheel hub is fixed with steering knuckle with the help of bearing. The main function of steering knuckle is to convert linear motion of the tie rod into the angular motion of the stub axle [5]. In the automobile industry, the requirement of properties of steering knuckle is that it must be strong, inflexible and light as well as possible. When steering is turned by drivers, half portion of the steering knuckle component is subjected to tensile load and another half portion of steering knuckle component is subjected to compressive load and due to this rotation of wheel, steering knuckle is subjected to torsional load.

The part of steering knuckle component are given below:

1. Suspension Mounting Upper Arm/Strut Mount
2. Tie Rod Mounting / Steering Arm
3. Lower Ball Joint / Suspension Mounting Lower Arm
4. Ball Bearing Location / Stub Hole
5. Brake Caliper Mounting

The shape and size of steering knuckle component depends upon the vehicle weight because vertical load of the vehicle is directly act on it and hence the steering knuckle component subjected to power thrust from tie rod to the stub axle and hence it must be strong and inflexible in nature. The steering knuckle in the automobile industry

can be made either by forging or from casting. However, castings have blow-holes which are injurious from fatigue and durability points of view. The fact that forgings produce blow-hole free and good parts give them an advantage over cast parts. Due to large volume production of steering knuckle component, it is only logical that optimization of the steering knuckle for its volume or weight should be result in large-scale saving. The reduction of inertia load, torsional load, vehicle weight will improve the vehicle performance and fuel economy.

2 METHODOLOGY

This study has been followed in two parts. First part of this study includes modelling of steering knuckle component and analysis of stresses under actual load conditions. CAD models of steering knuckle were developed in 3D modelling software, such as Solid works. While the second part is of the models were then obtained and compared using finite element analysis (FEA) via ANSYS software.

3 DESIGN MODELING

CAD model of steering knuckle component was made in 3D modelling software Solid works. It consists of Stub Hole Brake Calliper mounting points, steering tie-rod mounting, Suspension upper arm mounting and Suspension lower arm mounting. Steering knuckle component design mainly depends on suspension system geometry and steering geometry. The design processes were started with preliminary study on the current steering knuckle component used for the previous including investigating the existing knuckle design especially from the published design of Formula Society of Automotive Engineering (SAE) [4]. The design also needs to follow the criteria and regulations, which the size should be mainly depends on suspension system. The steering knuckle was made by AL 7075 (yield strength 250 MPa) and the mass is about 3.7 kg. In general, a steering knuckle has three connections on the body part; connection to the tie rod, suspension upper arm and suspension lower arm. There-

fore, the design needs to be stressed on these three connections, as well as one side of connectors where brake calliper mounting is attached.

4 MATERIAL SELECTION

The steering knuckle is made by different type of materials such as Cast iron, Mild steel and Aluminium. AL 7075 have a good strength but it contributes more weight to the vehicle. Forged steels are the most demanding materials for the steering knuckle in future. Due to the low weight of the materials fuel consumption can be stretched to the optimum level [1]. In this paper Al 7075 is used as it offers a better strength and lightweight for the steering knuckle component. Al materials are generally used where high tensile strength and toughness is required thus the Al materials are suited for the steering knuckle component. Due to this low weight of materials, it can decrease the fuel consumption and it has low density and sufficient yield strength. The mechanical, physical and chemical properties of AL 7075 materials are given below:

MECHANICAL PROPERTIES

QUANTITY	VALUE	UNIT
Tensile strength, Ultimate	600	Pa
Tensile strength, Ultimate	370	Pa
Young's Modulus	220	GPa
Poisson Ratio	0.3	-

5 ANALYSIS

The analysis of steering knuckle component is done in ANSYS 15.0. There is various force acting on this such as braking force, moment, lateral force, steering force as well as loads on knuckle hub in X, Y and Z direction. The various analysis results are shown in figures which are given below:

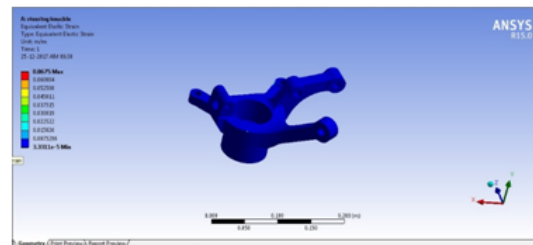


Figure 1: Elastic strain in steering knuckle using AL7075

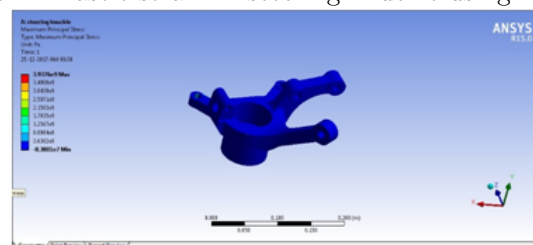


Figure 2: Maximum principal stress in steering knuckle using AL7075

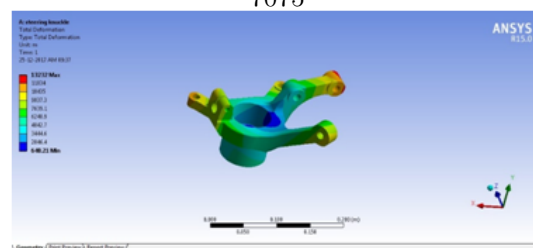


Figure 3: Total Deformation in steering knuckle using AL7075

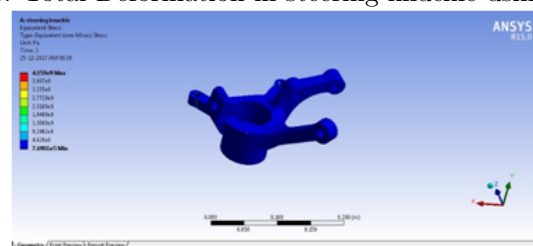


Figure 4: Von mises Stress in steering knuckle using AL7075

6 RESULT & CONCLUSION

The mass reduction for the steering knuckle component was found 5.64%. The steering knuckle component has been modelled using Solid works and analysed using ANSYS15.0. The various parameters such as total deformation, directional deformation, Maximum principal stress, And Maximum Shear Stress are completely analysed. This paper represents that the areas where the stress concentration is maximum due to the applied load. The study of steering knuckle component gives the small change in directional deformation and reduced the overall weight of vehicles due to decrease in weight of steering knuckle component as well as save the materials and cost and improved the vehicles performance and fuel economy.

Parameter	AL 7075
Elastic strain	0.067e-5
Principal stress	3.93e9
Total Deformation	13232mm
Von misses	4.159e9

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