Failure Analysis and Performance Improvement of a Lower Wishbone using FEA - Design and Hand Calculations

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Abstract— The wishbone is a hinged suspension link between the chassis and the suspension hub that carries the wheel. The general purpose of suspension system is to reduce vertical and longitudinal wheel load variations like that bumps and vibrations of the vehicle body and to keep the wheels of a vehicle from the uncontrollably swerving when the road conditions are not smooth. During the working condition, the maximum load is transferred from upper wishbone arm to the lower arm which creates the possibility of failure of arm. Similarly, impact loading produces the bending which is not desirable. Hence, it is essential to focus on the stress and strain analysis study of lower wishbone arm to improve and modify the existing design. In order to study the existing arm the structural three-dimensional solid modeling of lower arm was developed using the Solid works computer-aided drawing software and hand calculations were performed.

Key words: Lower Wishbone, Hand Calculations

I. INTRODUCTION

Lower control arm is one of the most important suspension parts of vehicle body that enables the wheel to keep its position and provide upwards and downwards movement of the wheel in safety.

The important role of the suspension system is to compensate forces that occur as a result of the accelerations of the car. Also, it makes the vehicle more comfortable and safe. Forces that occur as a result of accelerations, breaking and rolling movement of the vehicle, are compensated by bearing, which is usually mounted on vehicle chassis. The forces generate due to the movement of lower control arm is absorbed by rubber bushes.

II. PROBLEM FORMULATION

A suspension arm is one of the main components in the suspension systems. It can be seen in various types of the suspensions such as wishbone or double wishbone suspensions. Most of the times it is called as A-type control arm. It joins the wheel hub to the vehicle frame for allowing a full range of motion while maintaining proper suspension alignment. Uneven wear in tyre, suspension noise or misalignment, steering wheel shimmy or vibrations are the main causes of the failure of lower suspension arm. Most of the cases the failures are catastrophic in nature. So the structural integrity of suspension arm is crucial from design point of view both in static and dynamic conditions. As the Finite Element Method (FEM) gives better visualization on this kind of the failures so, FEM analysis of the stress distributions around typical failure initiation sites is essential. Therefore in this it is proposed to carry out the crash analysis of lower suspension arm of light weight commercial vehicle using FEM.

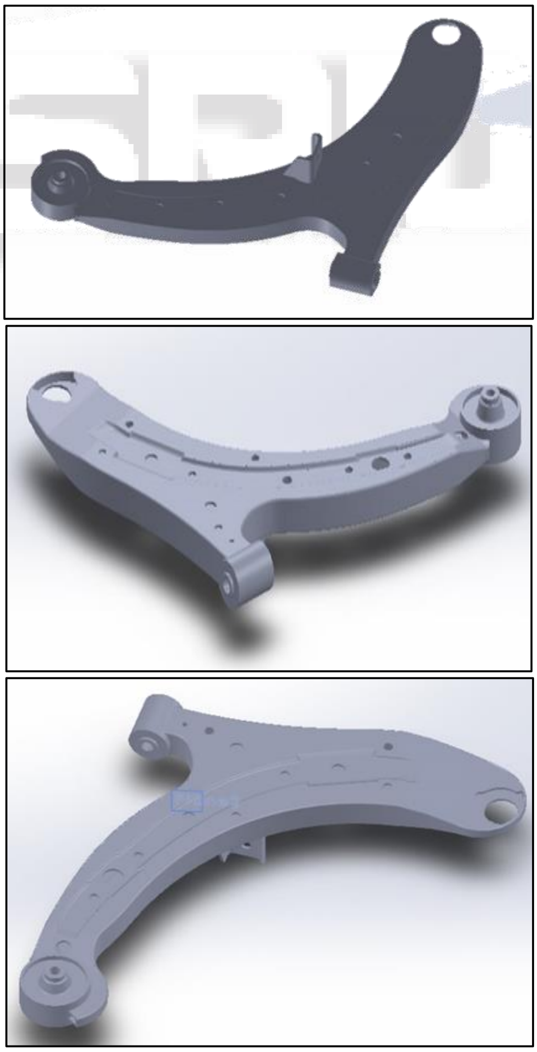
A. *Objectives of Project are*

- Study the existing model design and its function for identifying the potential areas of high stress.
- Upon finding results for structural analysis, use inputs for pursuing mass optimization to enhance the performance of the drive shaft assembly by modifying the design.
- To reduce failure of the lower wishbone

B. *Methodology*

- Data accumulation
- CAD modeling of the existing lower wishbone
- Analysis of design in FEA of existing lower wishbone
- Modification of the design
- Analysis of modified design in FEA
- Result discussion

III. CAD MODEL



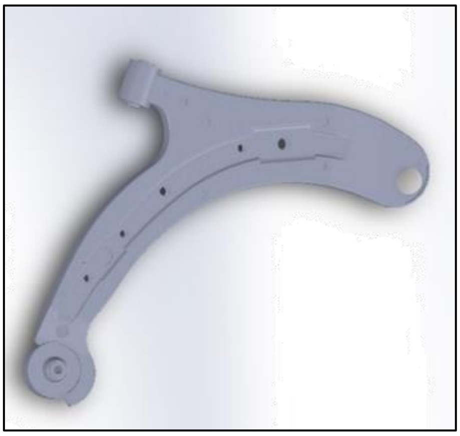


Fig. 1: Car Model

A. *Hand Calculations*

M = mass of vehicle in kg = 1760kg
A = front axle track width = 1.67m
H = height of center of gravity = 0.9m
L = wheel base = 2.4m
C = distance from front axle to center of gravity = 1.06m
B = distance from back axle to center of gravity = 1.36m

B. *Assumption Made for Calculation*

R = radius of curvature = 100
β = angle of banking = 12^0
θ = slope = 11^0
μ = coefficient of friction between tires and road = 0.6
f = retardation by braking (m/s^2) = 6
V = velocity of vehicle = 120
w = 1.91

C. *Vertical Load Acting on Wheel*

1) *Vehicle at the instant of braking on downhill grade*

$(wf_o)_{brake}$= (1/2L) [w (H sinθ + C cosθ) + m×a×H] =

$$\left(\frac{1}{2}\times 2.4\right)[1.91\,(0.9\sin 11 + 1.06\cos 11) + 1760 \times 1.67 \times 0.9]$$

$= 1.2\,[1.91\,(0.171 + 1.0388) + 2645.28]$
= 6065.75N

2) *Vehicle at the instant cornering:*

$$(wf_o)_{com} = (w/2a)\left[\left(\frac{v^2}{2g}\right)(\alpha\sin\beta + 2H\cos\beta) + (\alpha\cos\beta + 2H\sin\beta)\right]$$

$$= (1.91/2\times 1.67)\left[\left(\frac{120^2}{2\times 9.81}\right)(1.67\sin 12 + 2\times 0.9\cos 12) + (1.67\cos 12 - 2\times 0.9\sin 12)\right]$$

$= 0.571\,[733.944 \times (0.347 + 1.760) + (1.633 - 0.37)]$
= 1412.3N

D. *Lateral Load Acting*

$(L)fo = \mu \times w_{total}$
$w_{total} = (wf_o)_{brake} + (wf_o)_{corner}$
w_{total}= 6065.75 + 1412.30
w_{total}= 7475.05N
(L)fo = 0.6 x 7475.05
(L)fo = 4486.83

IV. RESULTS & DISCUSSION

In this paper a CAD model of wishbone modelled as per the design specification and proper evaluation of the design will be performed and will be created even better design in next paper. Finally we conclude that newly design of wishbone will be better than other existing machines and the analysis will be the part of next paper.

V. CONCLUSION

The objective is to reduce failure of wishbone. Considering problem we have designed a CAD model of the existing wishbone. To modify the design we will perform analysis that will be the part of our next paper.

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