International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

STRUCTURAL OPTIMISATION OF UPPER CONTROL ARM FOR DOUBLE WISHBONE SUSPENSION SYSTEM

Umesh.S.Kaur[1], Mahesh. B. Dhawale[2], Sahil. H. Wanikar[3]

[1]Professor (Dept.of Mechanical Engineering, RMD Sinhgad college of Engineering, Pune,Maharastra,India)
[2,3]Student (Dept.of Mechanical Engineering, RMD Sinhgad college of Engineering, Pune,Maharastra,India)

Abstract – *Structural optimization could be a discipline handling optimal design of load-carrying mechanical structures. The suspension of a road vehicle is typically designed with two objectives namely to isolate the vehicle body from road irregularities and to take care of contact of the wheels with the roadway. Most well-liked combinations in modern passenger cars are the double wishbone suspension systems. The aim of this paper is to optimize the Structural look of the upper control arm of wishbone suspension to loading. This paper work is proposed to be designed using CATIA V5 and Finite Element Modal Analysis for wishbone suspension using ANSYS. Pre-Processing steps like updating of element type, application of loads and boundary conditions are done. Optimization of upper control arm in terms of structural design for wishbone suspension are done by reducing its weight and there by the fixed costs, operation cost are decreased. Thickness of the upper control arm together with its material is varied in numerous steps to optimize it and maintain factor of safety within limits.*

Key Words: Upper Control Arm, Structural Optimization, Lower Control Arm, FEA Analysis

1. INTRODUCTION

Control arm is one of the most important part of the suspension system which joins steering knuckle and the vehicle frame. Control arm is created from the materials like steel, iron or aluminum. Suspension arm is significant part for every vehicle on the road. Due to developing annoying vibrations and undesirable driving irregularities that would sometimes cause to road accidents like collision with another vehicle or obstacle on road if there's no suspension arm. Suspension arm is fitted in several sorts of suspensions like wishbone or double wishbone, Macpherson strut suspension. Control arm used for up and down movement of vehicle front suspension system or steering knuckle to tyre movement . Their need is crucial in automobile industry allover and can be differed according to its shape, size and material. Upper control arm can classified into forged metal, casted metal, sheet metal design and hollow metallic pipe type. Once upon a time, a double wishbone suspension was the norm on the front of most cars. They were also called A-Frames or A-Arms. This design remains common on many modern cars because it just works. To develop and modify the existing design of the control lever, it is necessary to focus on the study of stresses and deformations of the upper control lever. For the transition structural analysis, modal 8analysis, and optimization, the finite element method of the upper arm is used.

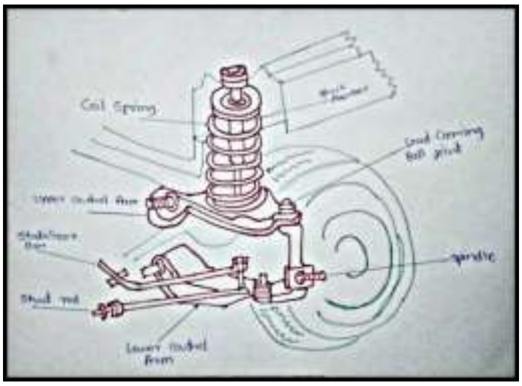

Fig 1: Double Wishbone Suspension System

1.1 Problem Statement

The need of market today is to produce light weight automobile parts. The main aim is to reduce weight of suspension system by structurally optimizing the upper control arm for double wishbone suspension system to reduce weight and increase strength. This will ultimately result in reduction of part cost.

1.2 Objective

The main objective of the study is to search out optimized model of upper control arm which can reduce its weight and there by fixed charge, operation cost are decreased. To achieve this objective, following steps must be considered

1. To scale back the general weight of the component up to 10 to 12%.

2. To scale back the value of the component.

3. To extend the strength of the component.

1.3 Scope

It is proposed try to structural analysis on upper control arm, as per the subsequent.

Theoretical analysis

• Loading calculations for upper control arm.

• Solving the UCA in ANSYS for Finite Element Method analysis design simulation.

FEA of Existing UCA

• Comparing the results with the project testing analysis.

FEA of Existing UCA

• Testing of the upper control arm under actual conditions which is in a position to resist the particular loads

2. Theoretical Analysis

Total weight of vehicle W =25987.6 N

Front axle weight F1 =13513.5 N

Rear axle weight F2= 12474.05 N

Tire road coefficient M =1.5

Wheel base L= 3040 mm

Avg acceleration a= 2.5 m/s2

Vehicle mass M =1200 kg

Centre of gravity height HCG= 1950 mm

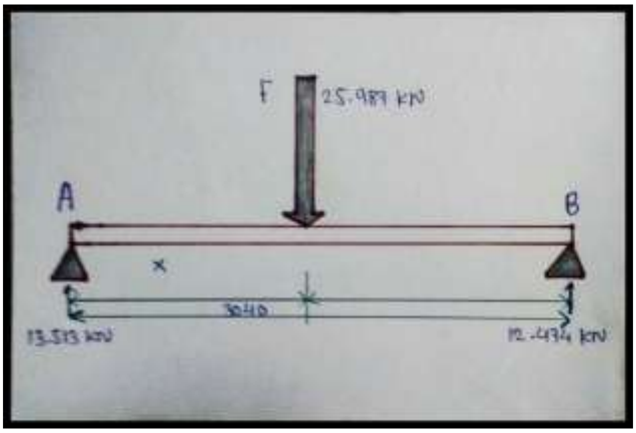

Figure 2.1: Force on Vehicle

Taking Moment at pt A:

$\Sigma mA = 25.987 * X - 12.47 * 3040 = 0$

X = 1459.23mm

Bcg = 3040 – X = 1580.77 mm

Front Axle Breaking Force

FB = 0.5 μ (Static + Dynamic)

= 0.5 μ ((W*bcg/l) + (m*a*hcg/l))

FB = 11.57KN

Vertical Force (FV)-

FV = 3/2 [Static+ dynamic load]

FV = 3/2 [W *bcg/l + m* a *hcg/l]

= 23.155 KN

Lateral Force (FL)

FL = W [Static+ dynamic load]

FL = W [bcg* g + a* hcg / gl]

= 17.75 KN

3. FEA of Existing UCA

The existing dimensions of the Mahindra Xylo arm were taken into consideration and by reverse engineering method the upper control arm was designed on CATIA V5. The initial weight of the arm was checked on CATIA. Further FEA analysis was done by meshing and various forces like vertical, lateral and longitudinal were applied to the UCA on Ansys 16.0 software. Stress and deformation carried by the arm was considered for Structural Optimization with safe limits and sustainable limits. Factor of safety is considered as 1.5 for Structural Optimization during material removal process so as the UCA can sustain during favorable conditions. The CAD model and the Ansys or FEA model is shown below:

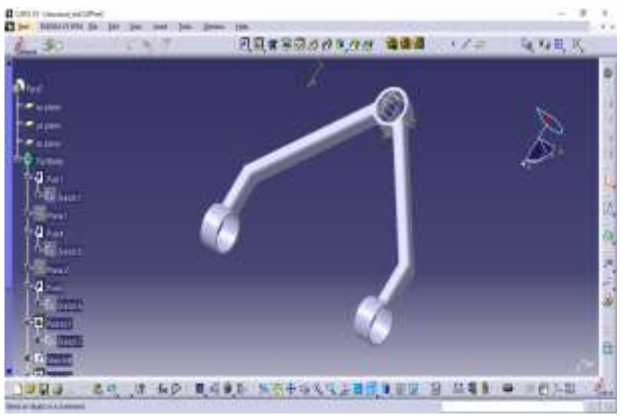

Fig 3.1: CAD Model of Existing arm

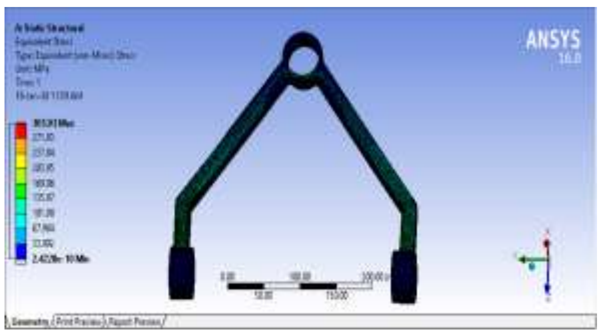

Fig 3.2: FEA Model of Existing Arm

Fig 3.3: CAD Model of Experimental Arm

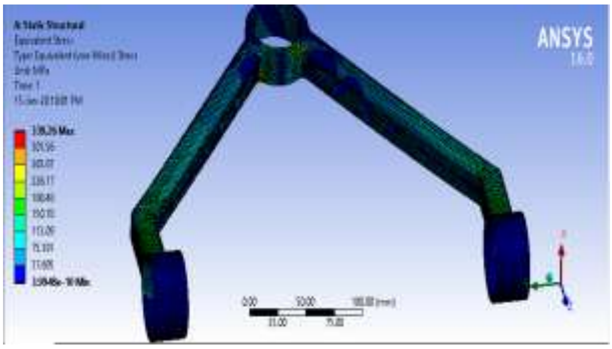

Fig 3.3: FEA Model of Experimental Arm

By using the iteration method we apply various condition for the prevailing component by making holes within the Arm one by one.

Mass of the prevailing component measured in CATIA which is 3.418 Kg for existing control arm and mass of optimized control arm is 3.18 Kg .Hence percentage reduction in mass is 6.9%

Table - 1: Observation table of Weight Calculated

Component	Weight (Kg)
Existing	3.418
Iteration 1	3.335
Iteration 2	3.265
Iteration 3	3.18

4. Applications

1. The minimum weight of the design of structures for cars and other types of mechanical loads.

2. Design of building engineering structures, such as framework foundations for bridges, towers, chimneys and dams for a minimal cost.

3. The optimal design of levers, cams, gears, machine tools and other mechanical components.

4. Designing handling equipment, such as a conveyor belt, trucks and a crane, at a minimal cost.

5. Conclusion:

FEA Analysis and optimization techniques is used for effective performance and weight reduction of upper control arm with good strength. Optimized model shows stress and deformation values within safe limit and the FOS is 1.5. By using Iteration Method, Optimization of arm shows 6.9% weight reduction than existing.

6. References:

[1] Aadesh.R.Shinde, Suyog.S.Wangi, Umesh.S.Kaur," Material Optimisation of Upper Control Arm for Double Wishbone Suspension System", International Research Journal of Engineering and Technology, Volume: 07 Issue: 03, March 2020 , pp-1923-1926.

[2] Mayur.S.Aware, W.S.Rathod,"Investigation Optimise Parameter Of Upper Control Arm For Mining Breaker ", International Journal of Research in Engineering and Technology, Volume:07 Issue:06, Jun-2018, pp-101-112.

[3] Bhushan S. Chakor, Y.B.Choudhary, "Analysis and optimization Of Upper Control Arm of Suspension System", International Journal of Research in Engineering and Technology, Volume:05 Issue:01, Sept-2017, pp-2808-2814.

[4] Nikhil R. Dhivare, Dr. Kishore P. Kolhe, "Vibration Analysis And Optimization Of Upper Control Arm Of Light Motor Vehicle Suspension System", International Journal for Innovation Research in Science and Technology, Volume:03 Issue:02, July-2016, pp-346-367.

[5] S. Mahaboob Khan, T.V.V.S.N.Murti, "Modelling And Structural Optimization Of Upper Control Arm Using FEA", International Journal of Research, Volume:02 Issue:11, November-2015, pp-789-793.

[6] Shantanu Garud, Pritam Nagare, Rohit Kusalkar, Vijaysingh Gadhave, Ajinkya Sawant, " Design And Optimization Of Double Wishbone Suspension System for ATVs", International Journal of Research in Engineering and Technology, Volume:04 Issue:12, Dec-2017, pp-847-851.

[7] Nikita Gawai, Deepak Yadav, Shewta Chavan, Apoorva lele, Shreyash Dalvi, "Design, Modelling and Analysis of Double Wishbone Suspension System", International Research and Development of India, Volume:04 Issue:1, 2016.

[8] Mr. Balasaheb Gadade, Dr. R. G. Todkar, "Design, Analysis of A-type Front Lower Suspension Arm in Commercial Vehicle", International Journal of Research in Engineering and Technology, Volume:02 Issue:07, Oct-2015, pp-759-766.

[9] Savan Thacker, Antriksh Bhatt, "Research Paper on Design and Analysis Double Wishbone Suspension System using Finite Element Analysis", International Journal of Advance Research in Engineering, Science and Technology , Volume:02 Issue:7, July-2015, pp-19-22.

[10] Jong-kyu Kim, Seung Ku Kim, Hwan-jung Son, Kwon-Hee Lee, Young-Chul Park, " The 9th WSEAS International Conference on Applied Computer And Applied Computational Science", Volume:04 Issue:14, Dec-2010, pp-811-817.

[11] V.V.Jagirdar, M.S.Dadar, V.P.Sulakhe, "Wishbone Structure For Front Independent Suspension of a Military Truck", Defence Science Journal, Volume 60, No. 2, March-2010, pp-178-183.