STRUCTURAL OPTIMISATION OF UPPER CONTROL ARM FOR DOUBLE WISHBONE SUSPENSION SYSTEM

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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 based analysis, and optimization, the finite element method of the upper arm is used.

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.
- 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** \( W = 25987.6 \text{ N} \)

- **Front axle weight** \( F_1 = 13513.5 \text{ N} \)
- **Rear axle weight** \( F_2 = 12474.05 \text{ N} \)
- **Tire road coefficient** \( \mu = 1.5 \)
- **Wheel base** \( L = 3040 \text{ mm} \)
- **Avg acceleration** \( a = 2.5 \text{ m/s}^2 \)
- **Vehicle mass** \( M = 1200 \text{ kg} \)
- **Centre of gravity height** \( H_{CG} = 1950 \text{ mm} \)

**Figure 2.1**: Force on Vehicle

Taking Moment at pt A:

\[
\Sigma m = 25.987 \times X - 12.47 \times 3040 = 0
\]

\[
X = 1459.23 \text{ mm}
\]

\[
B_{CG} = 3040 - X = 1580.77 \text{ mm}
\]

**Front Axle Breaking Force**

\[
F_B = 0.5 \mu \left( W + \mu \left( W_{bcg/l} + m \times a \times h_{cg/l} \right) \right)
\]

\[
= 11.57 \text{ KN}
\]

**Vertical Force (FV)**

\[
F_V = \frac{3}{2} \left( W + \mu \left( W_{bcg/l} + m \times a \times h_{cg/l} \right) \right)
\]

\[
= 23.155 \text{ KN}
\]

**Lateral Force (FL)**

\[
F_L = W + \mu \left( W_{bcg/l} + m \times a \times h_{cg/l} \right)
\]

\[
= 17.75 \text{ KN}
\]

### 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:

**Figure 3.1**: CAD Model of Existing arm

**Figure 3.2**: FEA Model of Existing Arm
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:


