Design, Analysis and Experimental Investigation of Double Wishbone Independent Suspension System for Agriculture Trolley

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Abstract: *Suspension system is the critical part in the assembly of the any auto mobile to design. Design of the suspension system should take of several aspects like holding space, space for movement, mounting location, specified load carrying capacity, rigidity, flexibility etc. This paper deals with the design of suspension system, static load calculations to be performed so that initial loads and load conditions should be known to us. Using these loads and load conditions multibody dynamics simulation can be carried out in the MSC ADAMS. Then 3D model is created by using NX cad software. Different types of analysis are carried out by using Ansys 15.0.After getting the result from the MSC ADAMS, Ansys and Load calculations and comparing it we can move towards for making actual prototype. Also the actual prototype will be tested for the different road conditions. And the results of the actual testing will be compared with the simulation results.*

***Key words*:** Suspension system, load calculation, finite element analysis, multibody dynamic analysis.

I. INTRODUCTION

In the beginning of 19th century lot of cars & automobiles were being produced by many countries. Suspension system plays an important role for the comfortable ride for passengers besides protecting chassis & other working parts from getting damaged due to the road shocks. If in a vehicle front & rear axles are rigidly fixed to the frame. While vehicle is moving on the road, the wheels will be thrown up & down due to the irregularities of road, as such there will be much strain in the components as well as the journey for the passengers in the vehicle will also be very uncomfortable.

The primary function of the suspension system of the vehicle should fulfil pretentious requirements about stability, safety and maneuverability. The suspension of the vehicle performs multiple tasks such as maintaining the contact between tires and road surface and also providing vehicle stability, protecting the vehicle chassis of the shocks excited from the unevenness terrain, etc. The suspension system works together with the tires, wheels, frame, suspension linkages, wheel hubs, brake system as well as steering system to provide driving comfort, stability, etc.

The suspension system is the mechanism which physically separates the vehicle body from the wheels of the vehicle. The performance of the suspension system has been greatly increased due to the continued advancements in automobiles in the recently years. The suspension system will consider ideal if the vehicle body isolated from uneven road and inertial disturbances associated during situation like cornering, braking and acceleration. The design of the vehicle suspension system may be different for front and rear axis (independent or dependent suspension)

In order to provide a comfortable ride to the passengers and avoid additional stresses in motor car frame, the car should neither bounce or roll or sway the passengers when cornering nor pitch when accelerating. For this purpose the virtual prototype of suspension systems were built in software MSC ADAMS/CAR and suspensions for agriculture trolley were analyzed keeping in mind the optimization of suspension parameters. Using ADAMS, analysis of existing model is carried out to determine the forces acting on components of suspension system. With the aim of minimizing the forces acting on the components of the suspension system such as mounting points, track width and mass were modified and incorporated into the new model. It is considered that these modifications significantly improve the performance of simulating impacts with off road side.

Problem Statement:

1) **As per manufacturers of highway as well as off-highway equipment & Farmer.**
   - Free and independent incorporation of the kingpin offset, disturbing force and torque developed by the radial load.
   - Considerable opportunities for balancing the pitching movements of the vehicles at the time of braking and acceleration.
   - Advantageous wheel control with refer to toe-in, camber and track width behavior from the point of view of type force build-up, and type wear as a function of jerk with almost free term

of the roll center and hence a very good possibility of balancing the self-steering properties.

- Avoid the damaging of Export quality material while transporting or carrying through road.
- Looking For the lightest and most durable suspension with the smoothest ride.
- Increased load carrying capacity of the vehicle.

2) **Design for future ambulances national patient safety agency.**

- Modified suspension to reduce noise vibration and improve ride while maintaining vehicle stability handling and road handling.

Objectives:

- Study the conventional suspension system used in automobile.
- Analytical design of component like double wishbone suspension system for Front wheel
- Multi body dynamic simulation for Double wishbone suspension system.
- Load calculation.
- Put the different road condition on the prototype model (Use Adams setup).
- Calculate the suspension parameter behavior with experiment setup (Prototype model).

II. LITERATURE REVIEW:

Ashish V. Amrute, Edward Nikhil Karlus, R. K. Rathore. In this paper describes the Leaf spring are one of the oldest suspension components they are steel frequently used, especially in heavy load vehicles. The automobile industry has shown increased interest in the replacement of steel spring with fiber glass composite leaf spring because of its high strength to weight ratio. The objective is to compare the load carrying capacity, stresses and weight reduction of composite leaf spring compared to that of steel leaf spring. The finite element modeling and analysis of a leaf spring has been carried out. The CAE analysis of the multilink leaf spring is performed for the deflection and stresses. The theoretical and CAE results are compared for validation.

G. Harinath Gowd, E. Venugopal Goad. This paper described the Coil spring is special kind of springs used in automobile suspension system. The main function of Coil spring has not only to support vertical load but also to isolate road induced vibrations. Static analysis determines the safe stress and pay load of the Coil spring to learn the behavior of structures under practical conditions.

Jadhav Mahesh V, ZomanDigambar B, Y. R. Kharde . R. R. Kharde. In this paper we look on the stability of the composite Double wish bone on vehicles and their advantages. Efforts have been made to reduce the cost of Double wishbone. The achievement of weight reduction with adequate improvement of mechanical properties has made composite a replacement material for conventional steel. After prolonged use strength of conventional metal Coil Spring reduces and vehicle starts running back side down and hits on the bump stoppers (i.e. chassis).

Malaga. Anil Kumar, T. N. Charyulu, Ch. Ramesh. The automobile industry has shown increased interest in the replacement of leaf spring with independent suspension due to high strength to weight ratio. This work deals with the replacement of leaf spring with Double wishbone. Suspension system in an automobile also determines the riding comfort of passengers and the amount of damage to the vehicle. The main function of Double wishbone assembly as suspension element has not only to endorse vertical load, but also to isolate road –induced vibrations. The design constraints were limiting stresses and displacement.

III. ANALYTICAL & EXPERIMENTAL CALCULATIONS:

Input:

Reaction on front axle = 2907 kg

Reaction at one wheel = $\frac{2907}{2}$ = 1453.5 kg = 14258.84 N

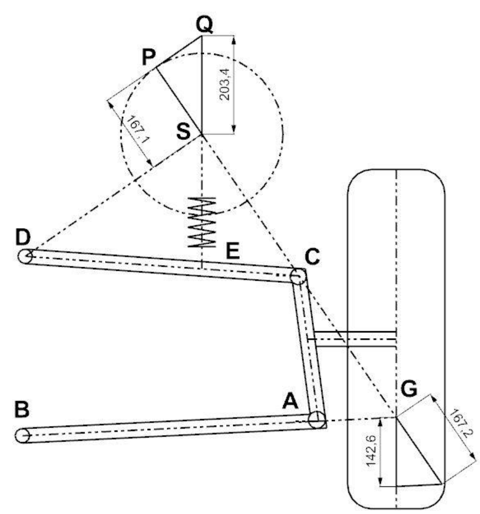

Fig5. 6: *Force analysis of wishbone structure*

- **Procedure for Static Force Analysis**

Step 1. A force scale of 100 N = 1mm was established. A vertical line is drawn at wheel centerline.

Step 2. For equilibrium the lines of action of the forces at the upper and lower ball joints at the wheel centerline must all cross the point G. This is equivalent to analytical condition, å M = 0

Step 3. A line is drawn from point B to point A and it intersects the centerline at point G. The force acting at the wheel centerline (i.e. 14260 N = 142.6 mm) is drawn at point R from point G.

Step 4. A line is drawn from point G to point C. This line is extended so that it intersects the line parallel to line GB at point H.

Step 5. From this, the force at point C (upper ball joint) from line GH is obtained, i.e., 16720 N.

Step 6. The line GC is extended so that it intersects the line of action of spring force at point S and an arc of 167.2 mm is drawn.

Step 7. A line is drawn from point D to point S and a line PQ parallel to DS is drawn at P which intersects the line of action of spring force at point Q.

Step 8. Thus, spring force is obtained from the diagram (QS) and is found to be 20340 N. Spring was designed for this force.

IV. SOFTWARE ANALYSIS:

For the modeling purpose here NX is used. For analysis purpose here Ansys is used.

Parameters	Values
Material selected as MS	AISI 1018
Tensile strength	440 MPA
Yield strength	370 MPA
Poisson ratio	0.3
Density	7850 kg/mm ^{3}

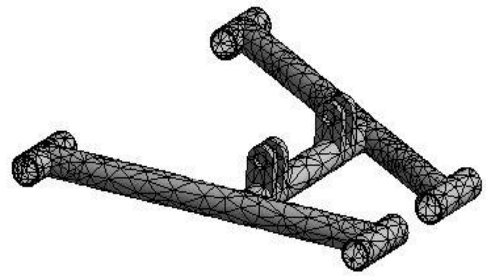

Fig 4.3.2: Meshed Model of Suspension arm

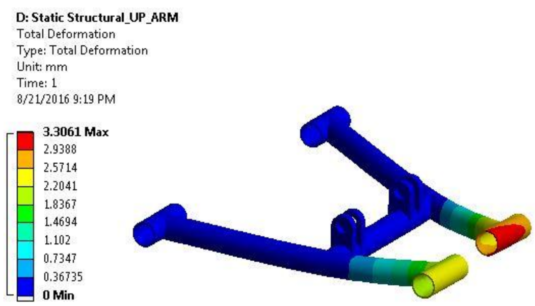

Fig 4.3.3: Total Deflection of Suspension arm

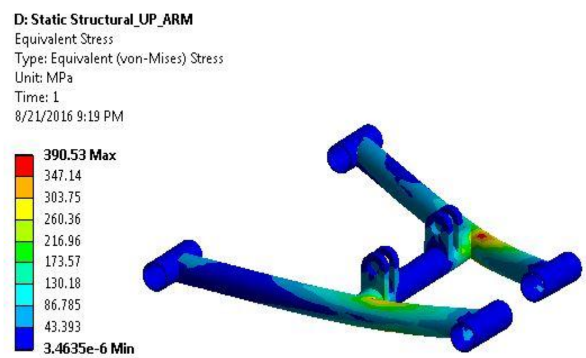

Fig 4.3.4: Stress of Suspension arm

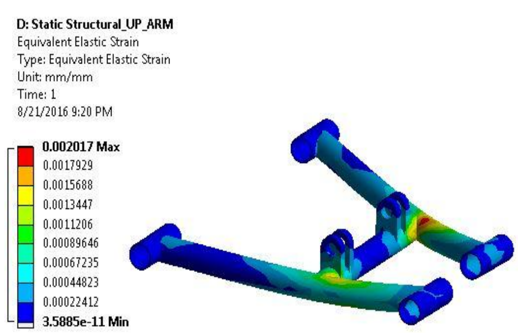

Fig 4.3.5: Strain of Suspension arm

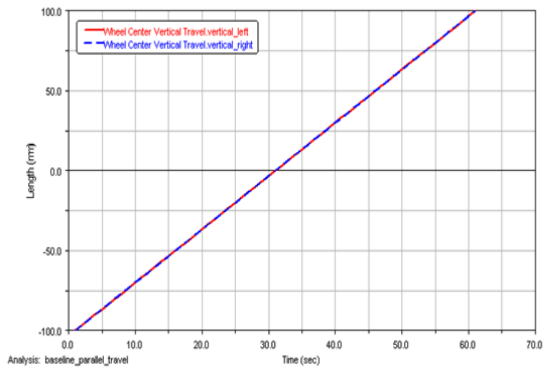

Fig. 6.39: Wheel Travel V/S Time (parallel wheel travel)

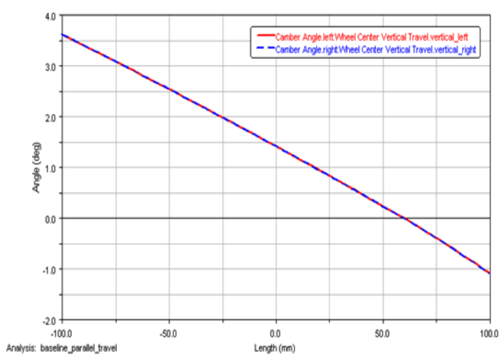

Fig. 6.40: Camber Angle V/S Wheel Travel (parallel wheel travel)

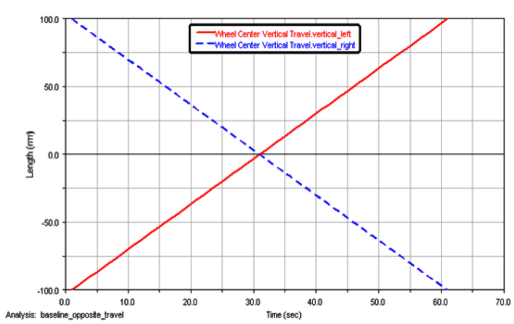

Fig6.41: Wheel Travel V/S Time (Opposite wheel travel)

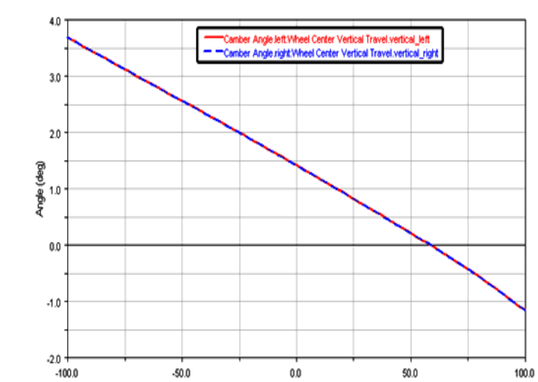

Fig 6.42: Camber Angle v/s Wheel Travel (Opposite wheel travel)

CONCLUSION

- High mobility is the prime requirement in cross country terrain for any off road vehicle. The technical parameter considered for improving the mobility of vehicle was wheel travel. **MBD results shows that pitching movements are balanced**
- MBD results for different situation shows that double wishbone system **avoid damage to export quality material while transporting through road**
- It **also increases load carrying capacity** from 1200 kg to 3000 kg approx.
- It is **light weight and durable** though it is designed for 3000 kg
- FEA result shows that system can **withstand to actual road conditions**
- It can be **used for future ambulances for transporting patients**

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