Design and Development of Multi-Link Suspension Suspension System

[1]Piyush Parida, [2]Vaibhav Itkikar, [3]Harshal Patil, [4]Sandip Patil

[1,2,3,4]UG Students
Mechanical Engineering Department
G.H. Raisoni College of Engineering and Management, Chas, Ahmednagar, India

***Abstract*: 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 military truck were analyzed keeping in mind the optimization of suspension parameters. As there is tremendous development in Suspension Technology, Multi-Link suspension system are considered better independent suspension system among all other independent suspension system. Its simple design and construction makes it way more convenient to install and serve its purpose. As there is vast growth in Agriculture, farming becoming more and more advanced in terms of technology and in that transport vehicles play important role in making agriculture more productive. We saw different scenario where agriculture transport vehicles collapsing because of their conventional suspension system fails to stabalize the loaded vehicle on different road conditions. We tried to see the improvement in performance of vehicle in stabalizing itself by using Multi-Link suspension system.**

***Keywords*: Suspension, links, vibrations, Multi body dynamic analysis (MBD)**

1. INTRODUCTION

In heavy transport vehicle field existing dependent suspension system unit is used. If some have that is leaf spring suspension. In all cases Leaf spring design for full load condition. Because of that leaf spring not gives the suspension effect. The rattling effect due to shock and vibration coming in the vehicle should be minimizing as per that point of view design new suspension unit for enhancing the performances of suspension system Also change the camber angle due to change camber angle vehicle tilt and chance accident So keep in mind the transportation of marital in trailer and comfortless of patient while travelling in ambulance. Designed the Suspension system loading suspension, it is based on independent suspension phenomenon. The addition feature of this suspension unit is by replacing existing setup and operates independently. As industrial point of view Suspension system has been use in commercial as agriculture trailer & and transport vehicle. Also in case of emergency vehicle this Suspension system suspension unit used without compromising speed and comfortless.

As cost point of view this Suspension system suspension unit can be available with affordable prize as compare to existing suspension system. This Suspension system suspension unit provides great performance in terms of smooth, quiet, safe ride by proper utilization of material properties. This Suspension system suspension unit have been manufacture and used commercially because of it has less complexity, easily availability of material and economical so it significantly contributes demand by user for keeps vehicle safety and comfortable.

This paper discusses about multi-link suspension systems main components i.e. links design, material selection based upon strength required to handle tremendous amount of various forces acting on links from vehicle and road conditions to allow safe, stable and comfortable ride of passenger.

2. LITERATURE REVIEW

V.V. Jagirdar: Wishbone structure for double wishbone front-independent Suspension for a military truck application is presented. At present, the vehicle is equipped with rigid axle with leaf springs. There are two aspects that dictate the design of wishbone structure, viz. the path of relative motion between the constituents of the suspension system and the forces transmitted between them. Also, enhancement of mobility was made possible by maintaining the live axle in the system. A double wishbone, double coil spring with twin damper configuration was employed for this application. MBD Analysis was carried out using MSC ADAMS. A double wishbone independent suspension has been designed for the front axle and has been successfully integrated with the vehicle.

Ashish V. Amrute: in this paper he worked on design and assignment of multi leaf spring. This work deals with replacement of conventional steel leaf spring of a light commercial vehicle with composite leaf spring using E-glass/Epoxy. The objective is to compare the load carrying capacity, stress and weight savings of composite leaf spring with that of steel leaf springs.

Shpetim LAJQI: in his paper a terrain Vehicle with four wheels drive and four wheels steer intended to use for recreational purpose is presented. The main purpose is to design the suspension mechanism that fulfills requirements about stability, safety and maneuverability.

Jadhav Mahesh: in this paper he worked on the stability of composite multi-link on vehicles and their advantages. Efforts have been made to reduce the cost of multilink. The achievement of weight reduction with adequate improvement of mechanical properties has made composite a very replacement material for conventional steel.

Fırat Barlas: Design of a Mars Rover Suspension Mechanism Several mechanisms have been suggested in recent years for suspensions of rovers on rough terrain. Although their different mechanisms have found a widespread usage in mobile robotics, their low operation speed is still a challenging problem. In this research, a new suspension mechanism has been designed and its kinematic analysis results were discussed.

Sairam Kotari: This paper deals with the analysis of chassis frame for improving its payload by adding stiffner and c channel at maximum stress region of chassis frame. The FEM analysis has been carried out with various alternatives. The results illuminate the new creative ways for optimum frame design which makes it more sustainable for structural concerns.

3. DESIGNING MULTI LINK SUSPENSION SYSTEM

A four-link suspension uses links to locate the axle from moving, side to side and front to back, while allowing it to travel up and down . The well designed and tested four-link will provide a superior translation of power to the ground and higher ride quality than a leaf-spring suspension. Four links are required to provide longitudinal and lateral control of the wheels and reacting brake torque. The use of linkages provides flexibility for the designer to achieve the wheel motions desired.

Material Selection:

There are various tubing materials like A-53 pipe, Chromium- molybdenum steel and aluminum.

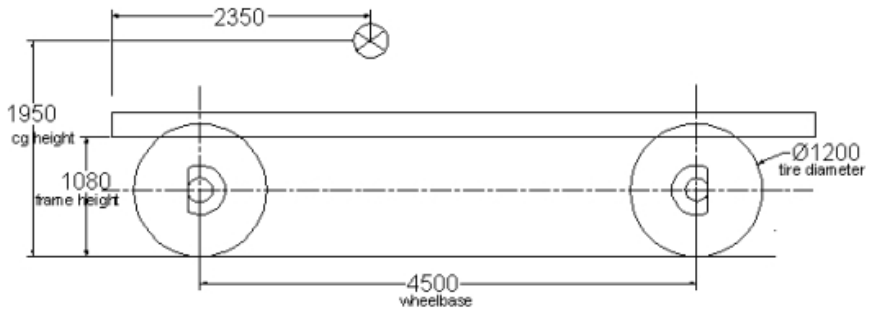
Material List

	Carbon Steels
10xx	Plain Carbon (Mn 1.00% max)
11xx	Resulfurized
12xx	Resulfurized and Rephosphorized
15xx	Plain Carbon (Mn 1.00% to 1.65%)
	Manganese Steels
13xx	Mn 1.75%
	NickelSteels
23xx	Ni 3.50%
25xx	Ni 5.00%
	Nickel-Chromium Steels
31xx	Ni 1.25%, Cr 0.65% or 0.80%
32xx	Ni 1.25%, Cr 1.07%
33xx	Ni 3.50%, Cr 1.50% or 1.57%
34xx	Ni 3.00%, Cr 0.77%
	Molybdenum Steels
40xx	Mo 0.20% or 0.25%
44xx	Mo 0.40% or 0.52%
	Chromium-Molybdenum (Chromoly) Steels
41xx	Cr 0.50% or 0.80% or 0.95%, Mo 0.12% or 0.20% or 0.25 % or 0.30%
	Nickel-Chromium-Molybdenum Steels
43xx	Ni 1.82%, Cr 0.50% or 0.80%, Mo 0.25%

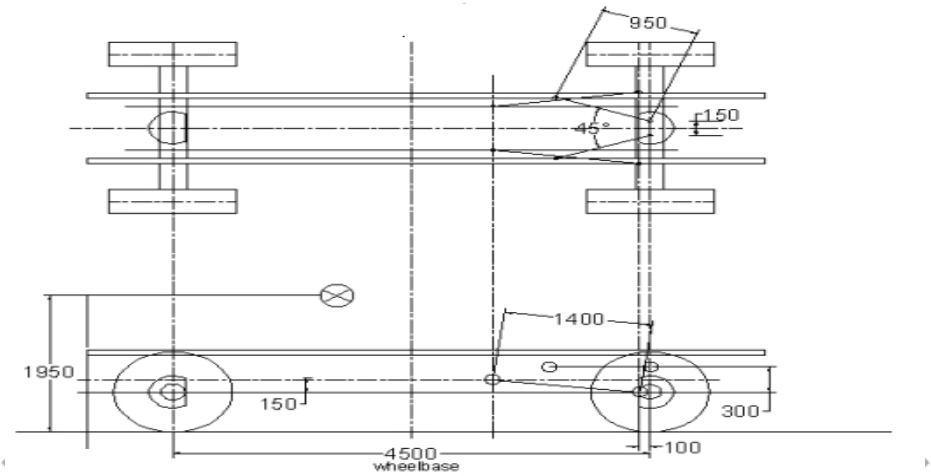
From the above material list the Chromium-Molybdenum steel is selected. Because, it is high tensile strength 620-650 MPa. In the normalized condition and malleability. It is also easily welded and is considerably stronger and more durable than standard steel.

Locating Multi-links

Locating links in between chassis and axle was complicated part due to its high degree of freedoms and complicated independent movements of links with respect to chassis and axle, but this issue was solved by referring previous work of experts on multi-link suspension system on locating links and it saved our time helped us to focus on strength and structure of links to sustain tremendous amount of various forces acting on links to ensure safe, stable and comfortable ride.



The first step in building a four-link consist of taking dimensions from Workshop Maintenance manual and constructing diagram in AutoCAD. By using this figured out, the axle centerline points on the bottom half were located, where the frame should sit above the axle. The center of gravity of the sprung weight was located.



Locations of lower and upper links in between rear axle and chassis in multi-link suspension system as per research available on locating links without compromising its mobility and excellent vehicle stabelizing features of multi-link suspension.

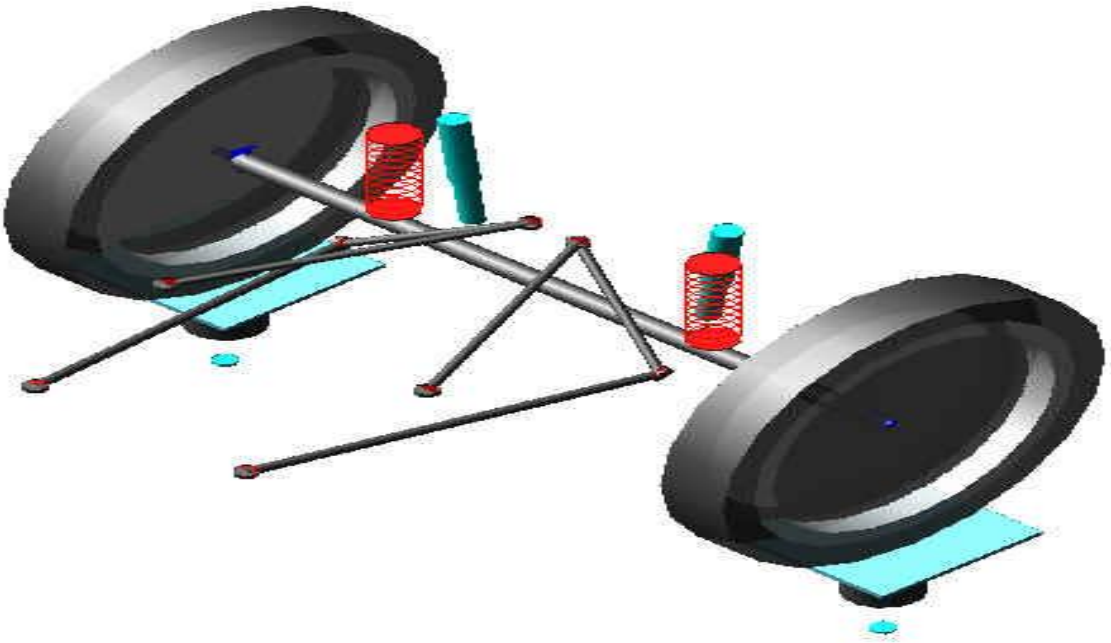
Input Dimensions

Sr.No.	Description	Symbol	Value
1	Rear axle weight	W	3102.5 Kg
2	Length of link	L	1150mm
3	Outside diameter	OD	63.5mm
4	Thickness	Th	12.7mm
5	Inside Diameter	ID	38.1mm

Note: All inputs are taken from workshop maintenance manual.

4. SIMULATION AND SOFTWARE VALIDATION RESULTS:

Multi body simulation for front and rear suspension system was carried out using MSC ADAMS /CAR software. A virtual prototype was built simulation for camber angle inclination and wheel travel analysis viz. single (right, left), parallel, opposite was carried out and we get following results.



Multi body simulation of Multi-link rear suspension system using MSC ADAMS/CAR

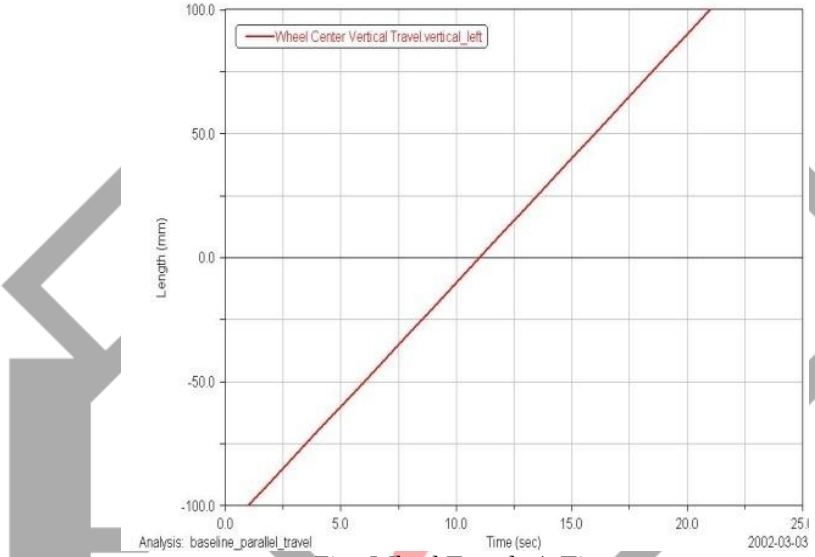


Fig.: Wheel Travel v/s Time

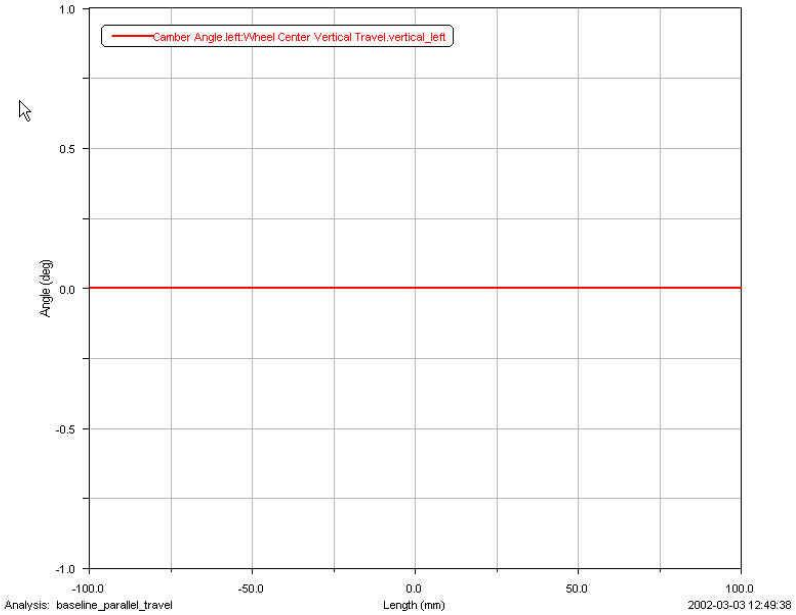


Fig.: Camber Angle v/s Wheel Travel

First graph gives relation between wheel travel v/s time which shows wheel moves constantly from its mean position for different road conditions.
Second graph gives relation between camber angle v/s wheel travel which shows camber angle not get changed for different values wheel travel.

The Links are main components of our Multi Link Suspension System are designed as per input data available. Then this available dimensions of Links are drafted into CAD Software where we specified the Locations of links and Springs with respect to chassis and axle of vehicle.
Then this CAD data available of Multi Link Suspension System we used to Analyse this Suspension system in CAE Software. Here we preferred Adams Car Software which is Suspension System Analysis dedicated Software, Due to its easier and convenient interface. We analysed the performance of our links for Suspension System for different road conditions, to see how much the vehicle remains Stable even after going through road conditions using our Multi Link suspension.
After many tests performed on ADAMS Car, the suspension System showed that it has potential to be used as better replacement old conventional suspension system to enhance vehicle performance.

5. SUMMARY

We discovered the problem behind the collapsing of farming transport vehicles like trailers, which was its convetional suspension system which wasn't delivering enough suspension effect while vehicle running off road conditions and we were convinced that replacement of old suspension system might minimise this destabalization, vibling and collapsing of trailers. So we took into consideration the general trailers chssis and axle dimensions and its loaded and unloaded conditions and designed the 4 links required for new suspension system in CAD software and seeking to see any chance of these links to stand against the travel conditions faced by trailer suspension to keep it stable by analysing them at Labs so we can finaly conclude that they are safe to be used as key component in trailer multi link suspension system and thus our project vision will satisfy.

6. 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. Four link suspensions for rear axle of the truck were designed. The leaf spring were removed and instead the nested coil spring were designed. Since the leaf spring was to be removed the axle was provided with longitudinal and lateral support with the help of four links. Calculation for estimation of length and cross section was also undertaken as part of this project.
Multi body simulation for front and rear suspension system was carried out using MSC ADAMS /CAR software. A virtual prototype was built simulation for wheel travel analysis viz. single (right, left), parallel, opposite was carried out. The analysis of the suspension was carried out for the possible combination of wheel travel. Wheel travel orientation between extreme wheel travel positions were predicted and were compared to the objectives.

ACKNOWLEDGMENT

Inspiration and guidance are invaluable in every aspects of life especially in the field of academics, which we have received from our Company Guide **Mr.Thombare** who has shown us right throw in various stages of project. A word of thanks is also placed for our parents for their moral support and last but not the least; we acknowledge a depth of gratitude to all our friends for their constant encouragement and suggestions.

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