

# Design and optimization of Double wishbone suspension system for ATVs

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**Abstract** - ATV means All Terrain vehicle. It is also known as quadricycle and quad bike. It is designed in such a way that it can handle wide variety of terrain. Suspension system is one of the most essential sub-system of an automobile its elementary function is to isolate driver from shocks and bumps and maintain the contact between road and the vehicle. As we know various forces are acting on suspension system of ATV. It carries out optimization computing for the suspension based system on the target of minimizing the weight and cost. MSC are is used ADAMS software is used for simulation of double wishbone suspension geometry. While simulation of suspension geometry the parameters considered for the result purpose are camber angle, caster angle, king pin inclination, scrub radius, roll steer, percent Ackerman. Objective is optimizing the front upper control. A-arm is converted into single member and the optimization result improves the suspension system performance in a certain extent. CATIA is used for modeling and after the modeling geometry is imported in ANSYS for structural analysis for finding out stress and deformation results of parts.

**Key Words:** camber angle, caster angle, roll steer, king pin inclination, scrub radius, ADAMS, ANSYS, FEA.

## 1. INTRODUCTION

All terrain vehicles is defined by American National standards Institute (ANSI) as a vehicle that travels on low pressure tires with a seat that is straddled by the operator along with handlebars for steering control. In some vehicles steering wheel similar to passenger cars is also used. As the name suggests it is designed to

- Study the static and dynamic parameters of chassis
- Workout the parameters by analysis, design and optimization of suspension system.
- Study of existing suspension system and parameters affecting its performance.
- Determination of design parameters for suspension system.

Suspension system of All terrain vehicle is one of the most critical system that need to be designed for better stability and comfort for the operator. Suspension system is generally designed with the relationship with steering

system. Suspension system is referred to the spring, shock absorber, and linkages that connect the vehicle to the wheels and allows the relative motion between the wheels and vehicle body. Also the most important role played by the suspension system is to keep the vehicle in contact with the road all the time. Good suspension system and better handling is the characteristic of a good All Terrain Vehicle (ATV).

## 2. Suspension system

Suspension system is the term given to the system of springs, shock absorbers and linkages that connect a vehicle to its wheels. When a tire hits an obstruction, there is a reaction force and the suspension system tries to reduce this force.

The functions of suspension system are to maintain the wheels in proper steer and camber attitudes to the road surface. It should react to the various forces that act in dynamic condition.

### 2.1 Double Wishbone Suspension

Double wishbones are the most ideal suspension. It can be used in front and rear wheels, it is independent and most important; it has near perfect camber control. For 40 years and even today, this is the first choice for racing cars, sports cars and demanding sedans. Basically, double wishbones suspension always maintains the wheel perpendicular to the road surface, irrespective of the wheel's movement.

## 3. Function

- 1) Provide vertical compliance so the wheel can follow the uneven road isolating the chassis from the roughness of the road.
- 2) Maintain the wheel in proper steer and camber attitudes to the road surface.
- 3) React to the control forces produced by the tires in longitudinal (acceleration and braking forces) and lateral (Cornering forces).
- 4) Keep the tires in contact with road with minimal road variations.

#### 4. Material Used

AISI 4130 Chromyl steel Used for member element.

#### 5. Suspension system analysis

5.1 Adams Simulation: After doing primary iteration we get three initial position of the upper wishbone which was about the optimized. Three positions are as follows:

- In Center
- Front Of Spring
- Behind The Spring

For center position we can't select this position because of the spring position. If we want to select this position we have change the spring position because of which stiffness can be change depending upon the angle of the spring mounting.

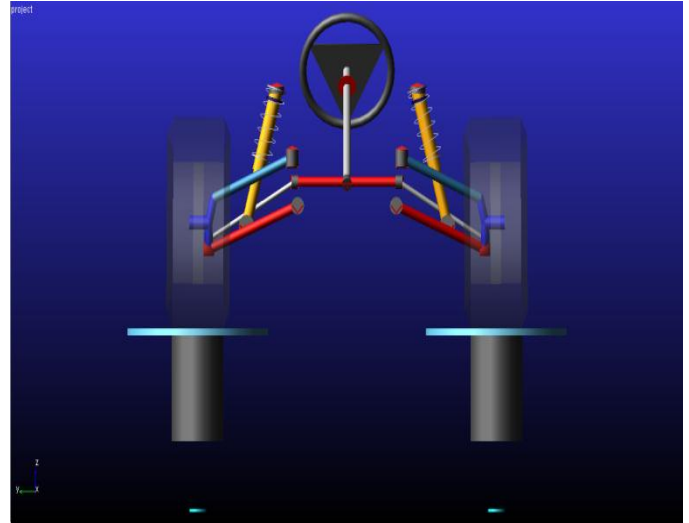


Figure :3 Front View of Geometry

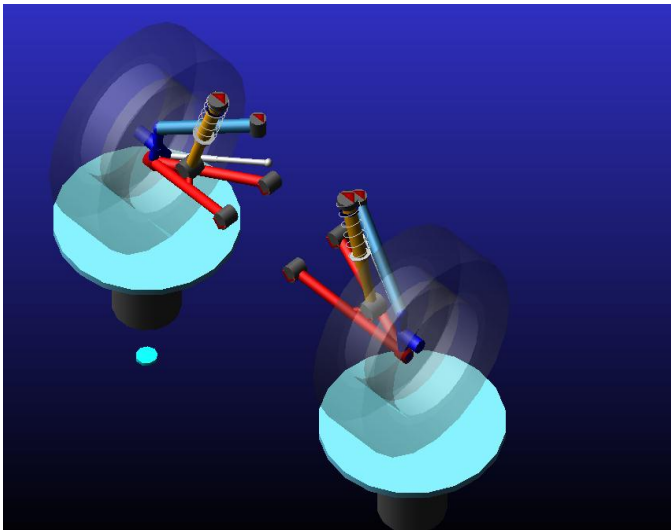


Figure :1 Behind the Spring

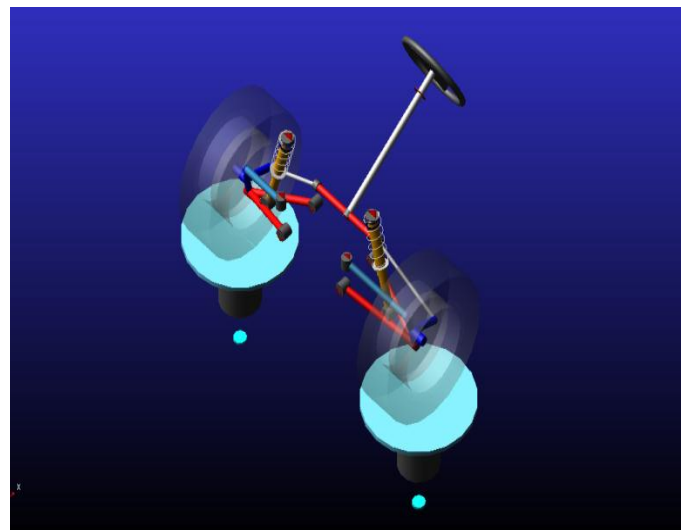


Figure:4 Isometric View of Geometry

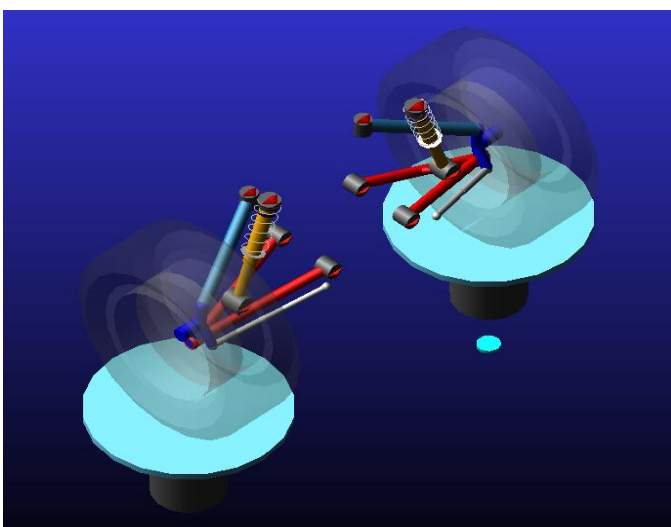


Figure : 2 In front of spring geometry

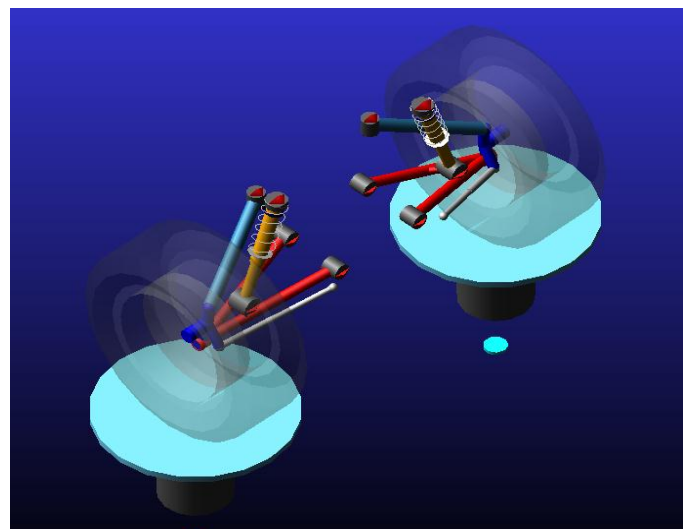


Figure :5 In front of spring geometry

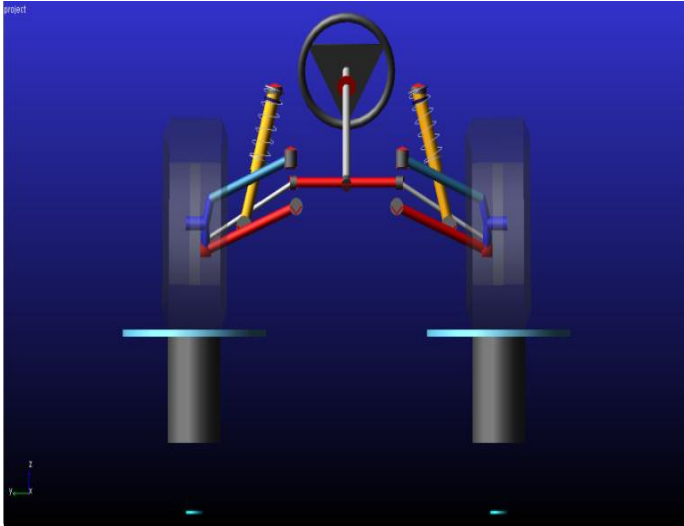


Figure : 6 Front View of Geometry

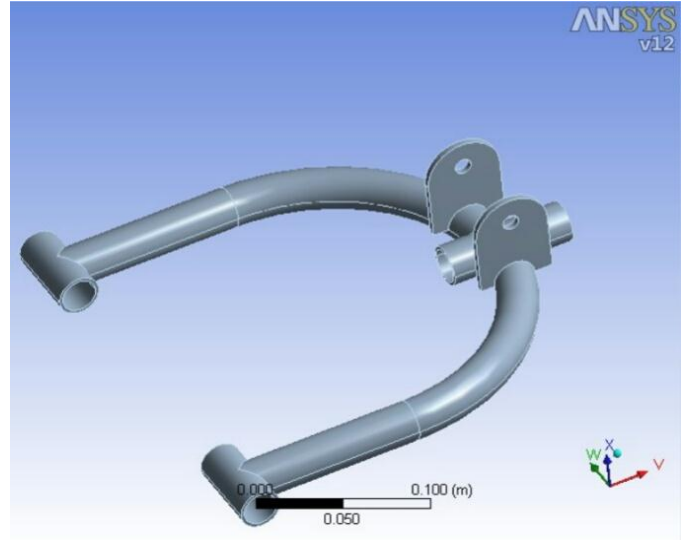


figure: 9 Cad model of wishbone

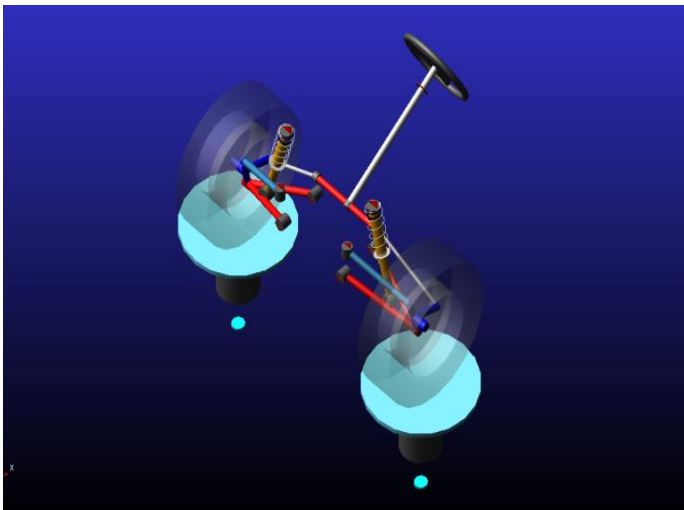


Figure:7 Isometric View of Geometry

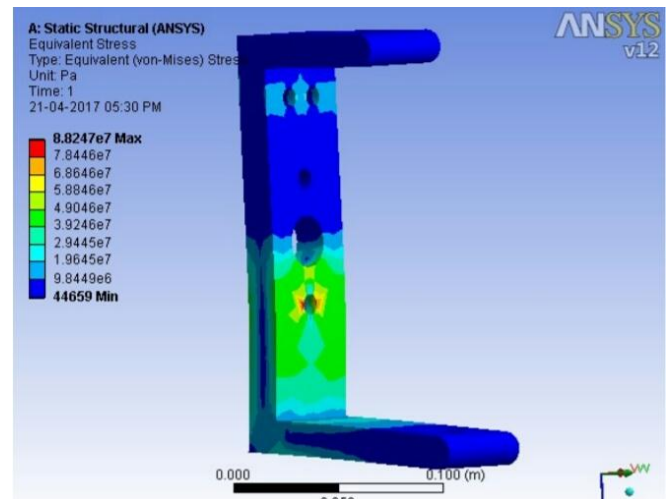


figure: 10 Ansys result of knuckle

### 5.2 Finite Element Analysis

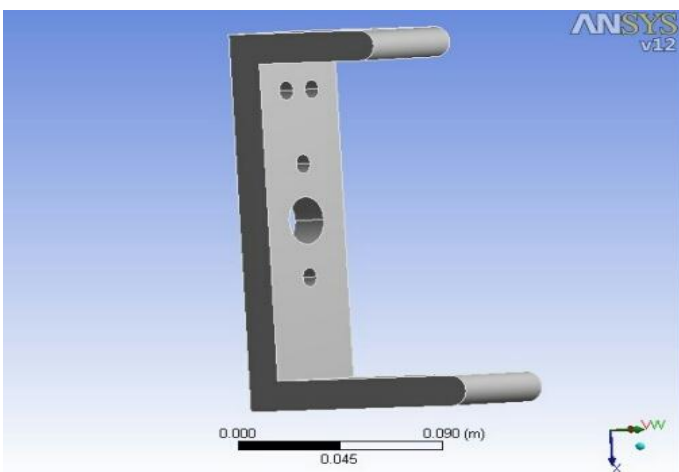


figure: 8 Cad model of knuckle

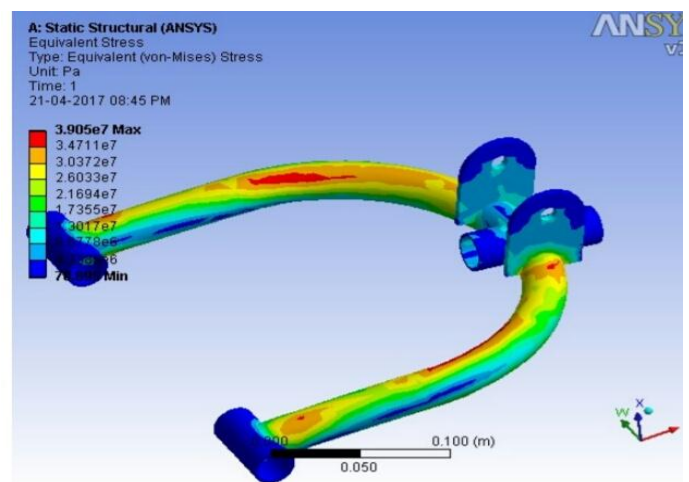
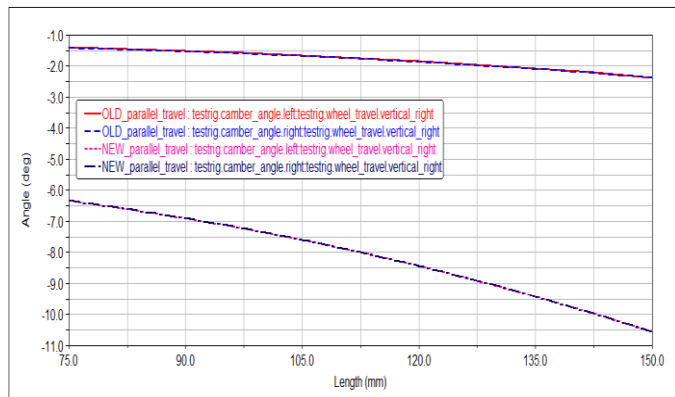


figure:11 Ansys result of wishbone

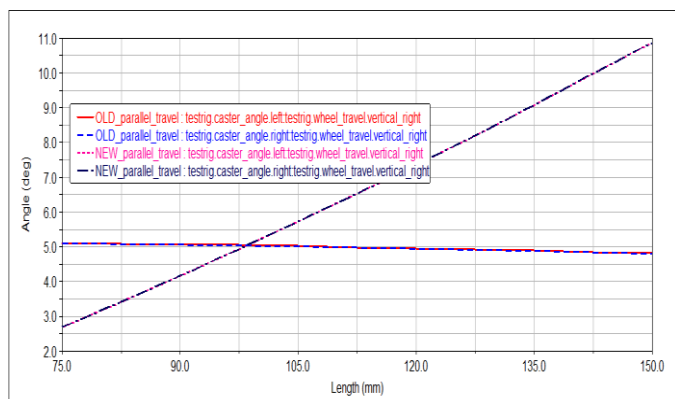
## 6. RESULTS AND DISCUSSION

Graph 1 is Length (mm) vs. Camber (degree) angle showing for both new and old geometry. Camber change for old geometry is from -1 to -3. Camber change for new geometry is from -6 to -9.5. Both values are in negative. Negative camber provides better cornering stability and traction while cornering. It will also reduce the life of the wheel. It will lead to more steering effort.



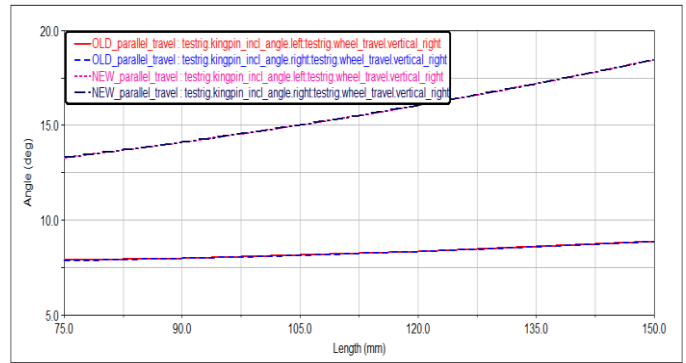
Graph 1: Camber Angle

Graph 2 is Length (mm) vs. Caster (degree) angle showing for both new and old geometry. Caster change for old geometry is from 4 to 5. Caster change for new geometry is from 3 to 10. Both values are in positive. More the caster angle value more will be the steering comfort. Caster angles over 7 degrees with radial tyres are common. As we have radial tyre so we have selected the range of 3 to 10 so that it will help the steering system.



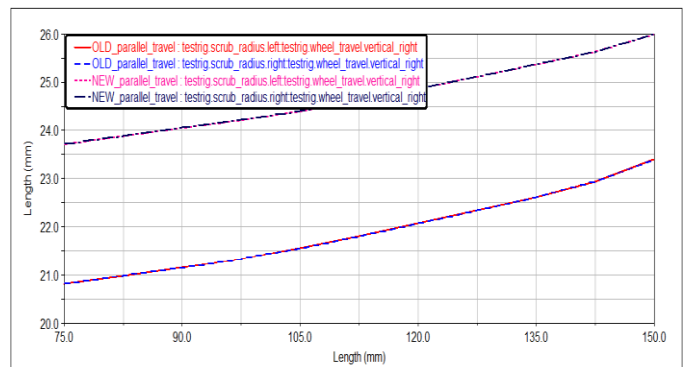
Graph 2: Caster Angle

Graph 3 is Length (mm) vs. Kingpin Inclination (degree) angle showing for both new and old geometry. Kingpin Inclination for old geometry is from 15 to 17. Kingpin Inclination for new geometry is from 7 to 8. Both values are in positive. Camber Caster and kingpin angle are very much related to each other. If there is no caster and no king pin angle there will be no change in camber while steering.



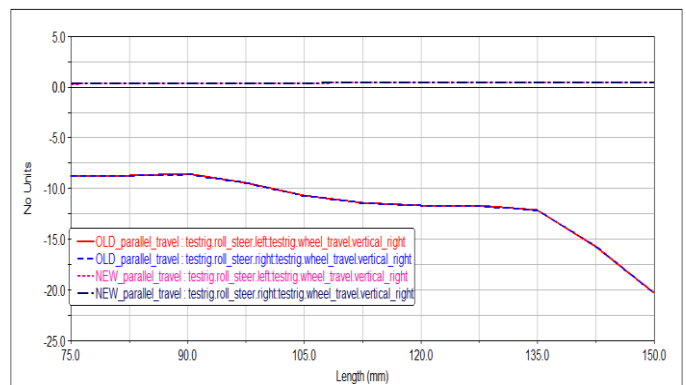
Graph 3: Kingpin Inclination

Graph 4 is Length (mm) vs. Length (degree) showing scrub radius for both new and old geometry. Scrub radius for old geometry is from 24 to 26. Scrub radius for new geometry is from 21 to 23. Positive scrub radius is defined as the steering axis intersecting the ground plane between the vehicle centerline and the contact patch. Value could be 20-30 for good result it is achieved by the both of the geometry.



Graph 4: Scrub Radius

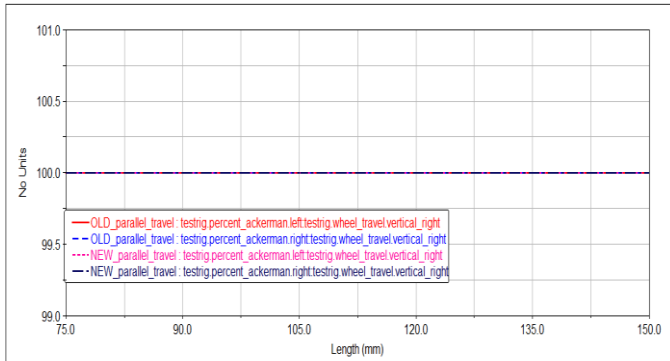
Graph 5 is Roll steer graph. By comparing old and new graph we can notice that the second geometry is more stable. Roll steer is usually measured in degrees of toe per degree of roll, but can also be measured in degrees of toe per metre of wheel travel.



Graph 5: Roll Steer

Graph 6 is Percentage Ackerman graph. For both old and new Geometry Percentage Ackerman is 100 % which indicates that both geometry are stable and steering geometry for this suspension geometry will give you good result.

- [5] 'Gillespie, T. D.', "Fundamentals of Vehicle Dynamics||" Society of Automotive Engineers – SAE, 1992.
- [6] "Rulebook BAJA SAE INDIA 2017"



Graph 6: Percent Ackerman

## 7. CONCLUSION

From the results, it is clear that the new optimized geometry is ready to be installing in the vehicle that is Baja's buggy. We used material as chromyl steel 4130.

All the primary factors of suspension kinematics and kinetics are achieved with the new optimized geometry. This makes it suitable for the ATV.

Other vehicle where this geometry can be install

- Auto rickshaw
- SUPRA competition car
- Electric cars

## REFERENCES

- [1] 'Sarvadnya Ajinkya Thakare', "Design and Analysis of Modified Front Double Wishbone Suspension for a Three Wheel Hybrid Vehicle"- Proceedings of the World Congress on Engineering 2015 VolII-2015.
- [2] 'Savan Thacker', "Design and analysis Double Wishbone Suspension system using Finite Element Analysis"- International Journal of Advance Research in Engineering, Science &Technology (IJAREST), ISSN (O):2393-9877, ISSN (P): 2394-2444, Volume 2, Issue 7, July – 2015, pp. 19-22.
- [3] 'Rajashakar Sardagi', "Design analysis of double wishbone suspension" - IJRET: International Journal of Research in Engineering and Technology ISSN: 2321-7308, 2014, pp.874-876.
- [4] Dixon, J.C. (1996)' . Tires, Suspension and Handling SECOND EDITION Warrendale:" Society of Automotive Engineers.