Design and Modification of Double Wishbone Suspension System in an ATV

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Abstract: This paper focuses and summarizes the project summary of Design and modification of double wishbone suspension system for an all-terrain vehicle which includes selection of necessary design parameters for the vehicle keeping in mind the track conditions that are typically faced. Focus was to make the front suspension of the vehicle lighter than the double wishbone setup yet it retains the characteristics of unequal double wishbone setup which may not be possible through MacPherson strut type of suspension setup. The overall carbon footprint for the vehicle is lower hence keeping it eco-friendlier. This vehicle has lesser components than a typical ATV implying that manufacturing and production costs are reduced. Therefore, the vehicle is cheaper than any other all-terrain vehicle.

Keywords- suspension modeling , double wishbone, design optimization.

1) Introduction

This paper in particular concentrates on the design of the suspension for an ATV, modifying the mounting factors, analysing of the forces that are to be damped with the aid of the suspension. Suspension gadget plays a vital role within the coping with of the vehicle. It allows the driver to manoeuvre the vehicle. The main feature of suspension is to ensure that the driver feels snug while riding the auto and the forces are damped to save you chassis from getting damaged. Suspension enables to hold the tires in touch with floor when they come upon any bump on their way. Thus, suspension is used in automobiles. Suspension in itself is a essential sub system of the auto. It is the term given to the gadget of springs, dampers, linkages that isolates the chassis and driver form shock precipitated through the terrain. It determines how un-sprung mass is hooked up to the sprung mass and how they have interaction with each other. Constant remarks was collected from chassis and transmission subsystem to determine on the tough points for suspension. Various geometric and non-geometric parameters like camber, castor, toe, roll Centre variation, Ackermann geometry, song width, wheelbase is taken into consideration in detail.

2) Literature Review:

There are broadly two types of suspension systems:

A. Dependent suspension system: In this type of suspension system, an axle is connected to both the wheels directly. High un-sprung mass: high un-sprung mass is undesired for any vehicle which is designed for oversteer [2]. High inertia of the beam axle reduces the handling. Independent front suspension is considered better than a beam-axle front suspension, because the forces affecting one wheel do not affect the other wheel [1].

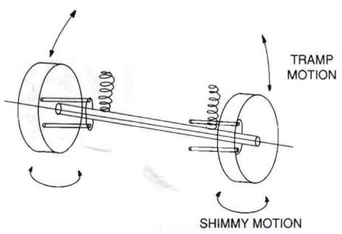


Fig. Beam axle [1]

B. Independent suspension system

i. Swing axle: Swing axle is an independent type of suspension which have certain disadvantages. The basic problem is called jacking and it results from the cornering forces acting through the wheel and axle to raise the car [1].

ii. Macpherson strut: one major drawback of a strut is the is has no room for wheel assembles and scrub of the tyres get sacrificed. Also strut provides less camber gain during jounce and droop conditions which is undesirable [6].

iii. Unequal double wishbone: Unequal double wishbone has a longer lower control arm and a shorter control arm which provides camber loss during compression [1]. The main reason we have selected to modify a double wishbone setup is that it eliminates all the drawbacks of other independent setups. These arms prevent deflections during hard cornering, which ensures that the steering and the wheel alignment stay constant [7].

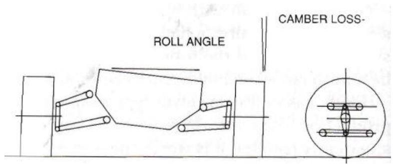


Fig. double wishbone suspension system [1]

Problem statement: Double wishbone suspension system used two arms for holding the steering knuckle which makes it heavy. Instead of two arms, we are proposing to use only one upper control arm and a live axle as a link which will satisfy four link bar mechanism on the vehicle.

3) Proposed design and calculations.

Double wishbone system has two control arms, one upper and other lower control arm which locks the DOF of the wheel. The ultimate aim of a suspension is to satisfy the required DOF for a wheel. To lock the DOF of the wheels, we have decided to remove the lower control arm and for lower link the live axle can be used which will also act as a lower control arm. We are basically optimising the current double wishbone system to obtain its characteristics through a lighter assembly

Front view of the Proposed design is shown below

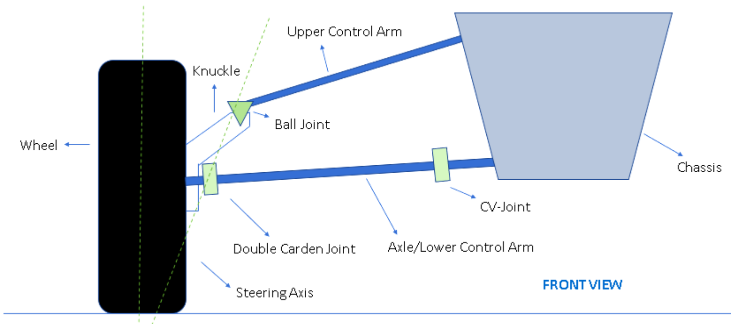


Fig. Layout of proposed design

3.1) Material Selection

The most crucial part in designing of any component is the selection of the material. After the designing of the suspension system geometry, the material selection is done [4]. Few factors that are to be considered in the selection of material are as follows: 1. Availability 2. Cost of the material 3. Density of the material 4. Yield strength of the material 5. Bending strength of the material 6. Weight of the material etc [8]. Hence chromoly can be selected as the best material for use. Each and every part of the suspension system is made up of different materials. The following gives the details of the material used in different components of the suspension system:

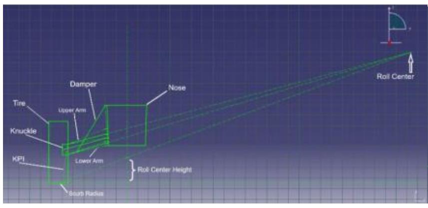
Parameters	Chromoly 4130	AISI 3415 steel	Aluminium 6061 T6
Density	7.8 g/cm^3	7.8 g/cm^3	2.7 g/cm^3
Tensile yield strength	460 MPa	996 MPa	207 MPa
Young's modulus	200000 MPa	210000 MPa	69000 MPa
Cost	150 Rs/ft	125 Rs/kg	280 Rs/kg

3.2) Front Suspension Geometry.

The basic objectives for design of suspension geometry are:

1. Maximum wheel travel.
2. Moderate camber and castor gain while the wheel travels.
3. Optimum scrub radius to have less steering effort.
4. Anti-dive for reduction of pitching during braking.
5. To have oversteer characteristics.

Constrains	Value
Height of C. G	24”
Ground Clearance	14”
Motion Ratio	0.72
Off-set of rim	2”
Damper inclination	41°



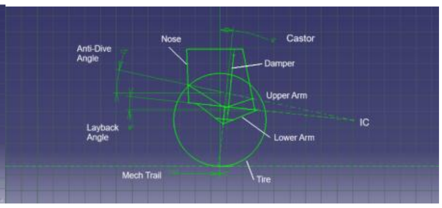


Fig. Front View Fig. Side View

3.3) Force Calculations

i) Lateral Weight Transfer

Weight transfer that happens while the vehicle is taking a turn.

The weight is transferred from the inner wheel to the outer wheel.

Here we calculate the maximum weight transfer that occurs during a turn and on what wheel it happens [5].

Lateral Weight Transfer = [(W*g's*H) /(Gravity*T)]

Parameters	Value
Vehicle weight	203 kg
CG height	24 inches
Front track width	50 inches
Rear track width	47 inches
Maximum load transfer	712 N
Maximum load on the wheel during cornering	997 N

ii) Longitudinal Load Transfer

Due to acceleration –

Taking moment about point "O", we have [ΔWx = (h/l)*W*Ax]

Vehicle acceleration = 1.81 m/s^2

Load acting on rear is 66.4 kg.

Due to braking –

Braking force 0.9g. Load acting on front is 96 kg

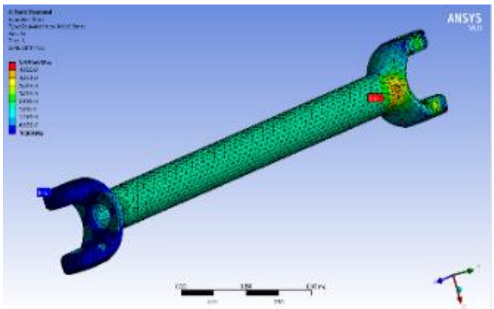
As the maximum load that is acting on the came to be around 96 kg for 1g cornering, braking and cornering load.

So, for further calculations as assuming maximum force acting on the vehicle is 3g force.

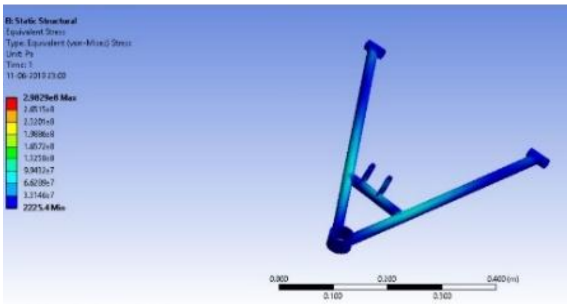
Maximum load = (3*Load*9.81) = 2898 N ≈ 3000 N

4) **Analysis of the designed components:** Below are the design assembly and analysis of each part using analysis software ANSYS Workbench.

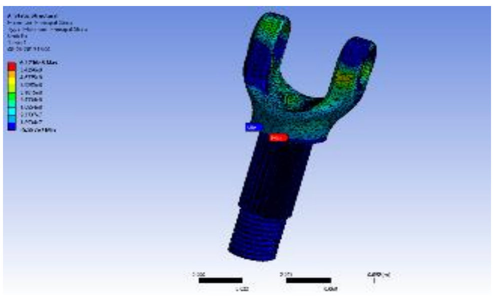
Fig. Assembly of modified system



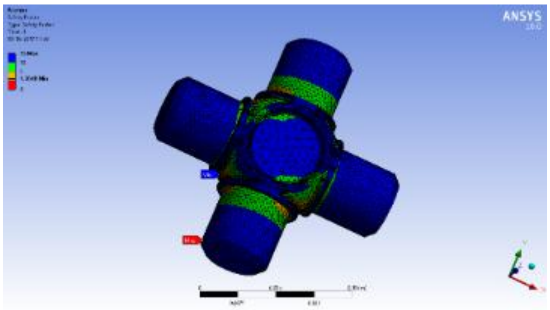
Half Axle-Stress-540.06MPa, FOS-1.802

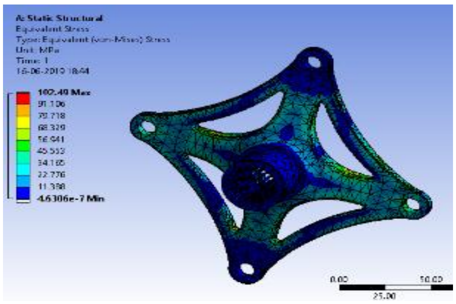


Upper control arm- Stress -298 MPa, FOS 1.4



Yoke-Stress-617.36MPa FOS-1.667





Cross pin-Stress- 606MPa, FOS- 1.7648 Wheel Hub-Stress- 102.49 MPa, FOS-2.02

5) Results and Discussion

After of completion of the designing and evaluation of the components, the next element is to restore the mounting factors for all of the components. As cited earlier, the whole layout is done based totally on few policies and regulations. It will need a terrific quantity of man paintings if we maintain on converting the mounting factors until the required factor is received and the received factor must be in line with the rule. To avoid this, we use LOTUS SHARK SUSPENSION ANALYSIS, which gives us the precise dimensions in which the mounting points should be installed. By the usage of LOTUS, a good deal iteration can be done. If there's any failure of the system, then we can be able to study that and trade the mounting points.

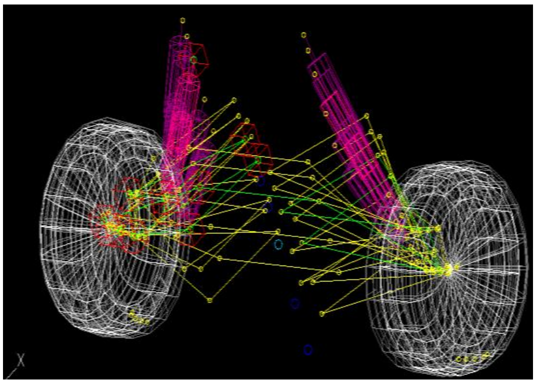


Fig. Analysis of suspension in LOTUS

6) Conclusion

Thus, by the usage of above double wishbone suspension system, we are able to obtain less weight, much less complexity, much less cost and required car characteristics. Our foremost goal turned into to modify double wishbone suspension even as retaining all of the traits of it. This helped our car to have an awful lot lesser carbon foot-print than conventional design.

7) References

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