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Design and Development of All-Terrain Vehicle : Volume 2

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Abstract- *The main objective is to Design and analyse the Double wishbone suspension system and Trailing Arm suspension system for All terrain vehicles (ATV), as it allows the engineer to carefully control the motion of the wheel throughout suspension travel. A 3D CAD model of the Double wishbone and Trailing Arm suspension is prepared by using CatiaV5 (CAD Software) for analysing the system capable of handling All terrain vehicles (ATV) while maintaining the ride quality. The topic is focused on designing the above mentioned suspension system considering the dynamics of the vehicle along with minimizing the stresses and deformations on suspension systems.*

Key Words: *Suspension systems, Double Wishbone, Strut, Trailing arm, Ansys*

1. INTRODUCTION

Suspension is the defined as system of tires, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between them [1].suspension systems must support road holding/handling and ride quality.

Figure 1. 3D Rendered CAD model of Double wishbone suspension system

Design of the geometry of double wishbone suspension system along with design of spring plays a very important role in maintaining the stability of the vehicle [2].Double Wishbone Suspension System consists of two control arms (upper arm and lower arm) usually of unequal length along with a coil over spring and shock absorber. It is used as front suspension and mostly used in rear wheel drive vehicles.

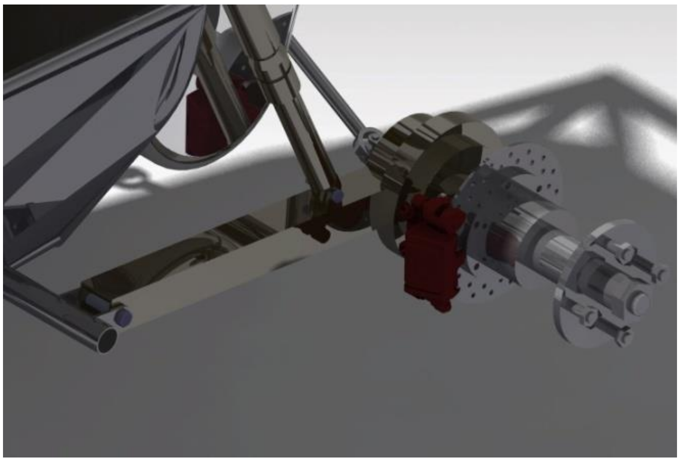

Figure 2. 3D Rendered CAD model of Trailing Arm suspension system

A trailing arm suspension sometimes referred as trailing-link is a vehicle suspension design in which one or more arms are connected between the axle and pivot point (located on the chassis of vehicle). Trailing arm suspension system is typically used on rear axle of a vehicle. Trailing arm suspension system designed can also be used in an independent suspension arrangement.

2. OBJECTIVE OF SUSPENSION DESIGN

1. Designing a suspension which will influence significantly on comfort, safety and ride quality.
2. To provide vehicle with good capabilities such as road holding/handling quality and driving pleasure.
3. Isolate the vehicle from excessive force of impact with Road obstacles (including minor obstacles, landing after jumping).
4. Good suspension system and better handling is the characteristic of a good All-Terrain Vehicle (ATV) [3].

3. DESIGN AND CALCULATIONS

I. Double wishbone calculations

Length of wishbone= 330mm

Point of attachment of strut = 180mm from chassis end …. (From point P)
Mass per wheel (tire +rim) = 30kg
Factor for static to dynamic conditions: 3

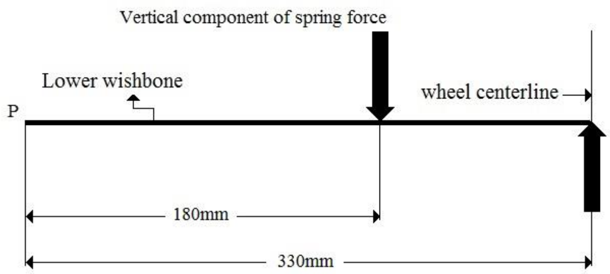

Figure 3. Forces on Front Wishbone

Reaction force acting from the ground on the wheel
= (Mass per wheel * 9.81) N
= (30kg * 9.81) N = 294.3 N
Considering the wishbone hinges (P) as the point about which moment is taken
Horizontal distance of reaction force from hinge point = 300mm …. (From point P)
Horizontal distance of strut attachment point from hinge point = 180mm
By taking moment about hinge points
294.3 * 300 = Spring Force * 180
Spring Force = 490.5 N
Considering the dynamic factor,
Dynamic force acting on the spring =
Spring force * Dynamic factor =
490.5*3 = 1471.5 N

II. Trailing Arm calculations

Length of Trailing Arm= 465mm
Point of attachment of strut = 315mm from chassis end …. (From point P)
Mass per wheel (tire +rim) = 30kg
Factor for static to dynamic conditions: 3

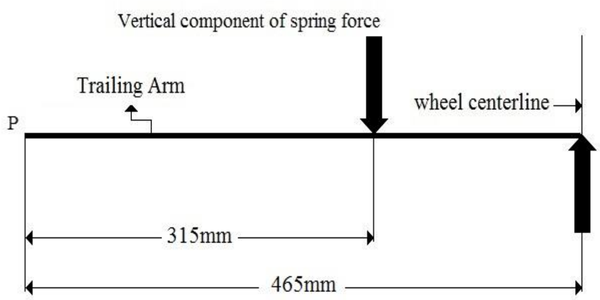

Figure 4. Forces on Trailing Arm

Reaction force acting from the ground on the wheel
= (Mass per wheel * 9.81) N
= (30kg * 9.81) N = 294.3 N
Considering the wishbone hinges (P) as the point about which moment is taken
Horizontal distance of reaction force from hinge point = 465mm …. (From point P)
Horizontal distance of strut attachment point from hinge point = 315mm
By taking moment about hinge points
294.3 * 465 = Spring Force * 315
Spring Force = 434.45N
Considering the dynamic factor,
Dynamic force acting on the spring =
Spring force * Dynamic factor =
434.45*3 = 1303.35 N

4. ANALYSIS

Analysis of wishbone and trailing arm is necessary in order to determine the induced maximum stress and maximum deflection in wishbone and trailing arm. For the analysis of systems we have used ANSYS 15 software.

I. Double wishbone Analysis

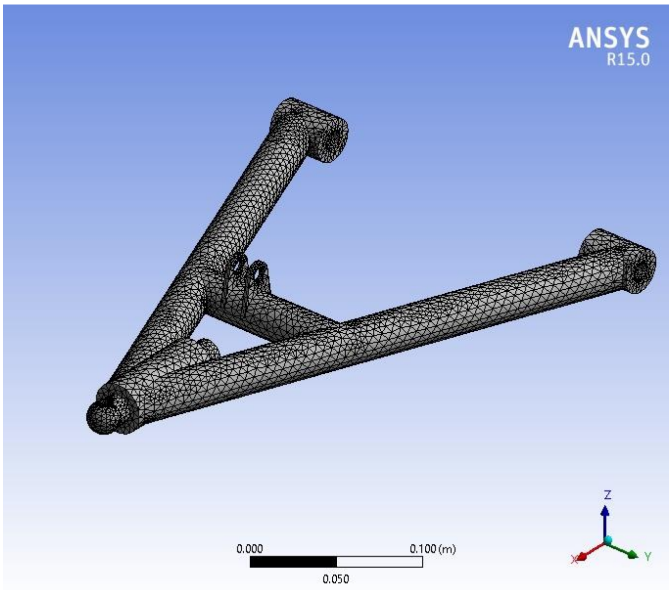

Figure 5: Meshing Of Wishbone

In Figure 5: Meshing Of Wishbone, initial settings are Physics Preference used is mechanical, Element Size is default, Smoothing is high, Transition is slow, Span Angle Center is fine , Transition Ratio is 0.272, Growth Rate is 1.2, total Nodes are 80958 and total Elements are 48598.

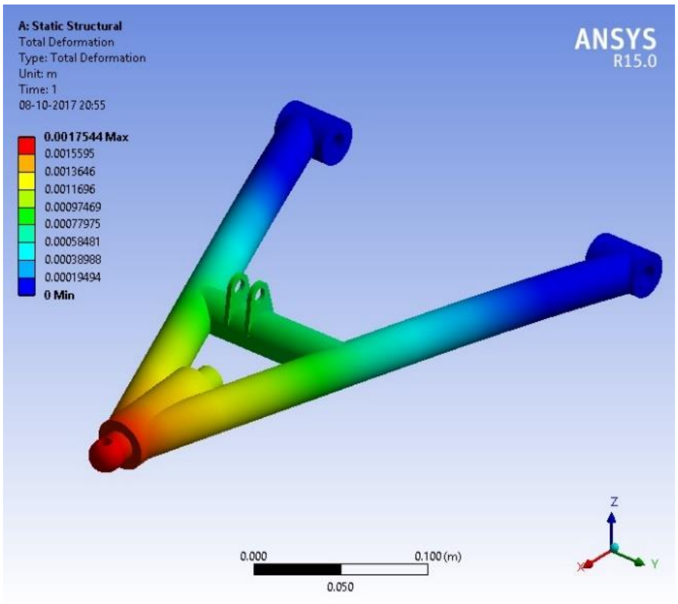

Figure 6: Total Deformation Of Wishbone

Figure 6: Total Deformation Of Wishbone, shows total deformation of wishbone when force of 1471.5 N is acted on it. From above figure it is observed that the maximum deflection is 2.08 mm.

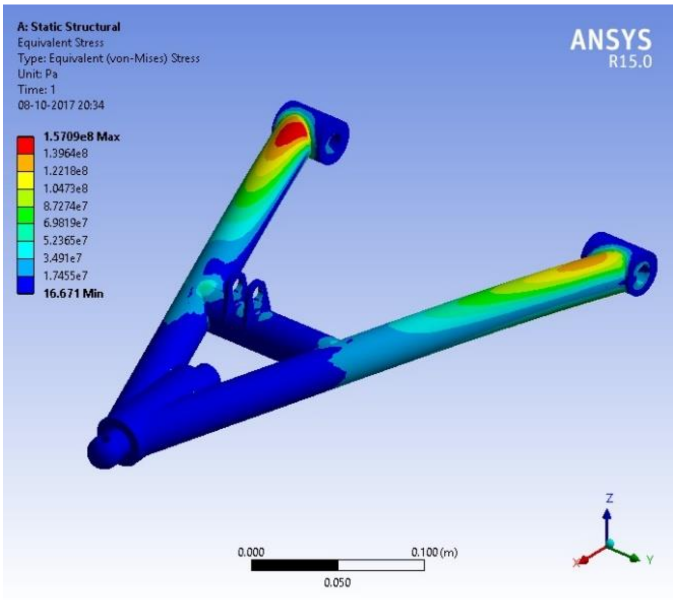

Figure 7: Maximum Stress in Wishbone

Figure 7: Maximum Stress in Wishbone, shows maximum stress occurred in wishbone when force of 1471.5 N is acted on it. From above figure it is observed that the maximum stress in body is 157.09 MPa .

II. Trailing Arm Analysis

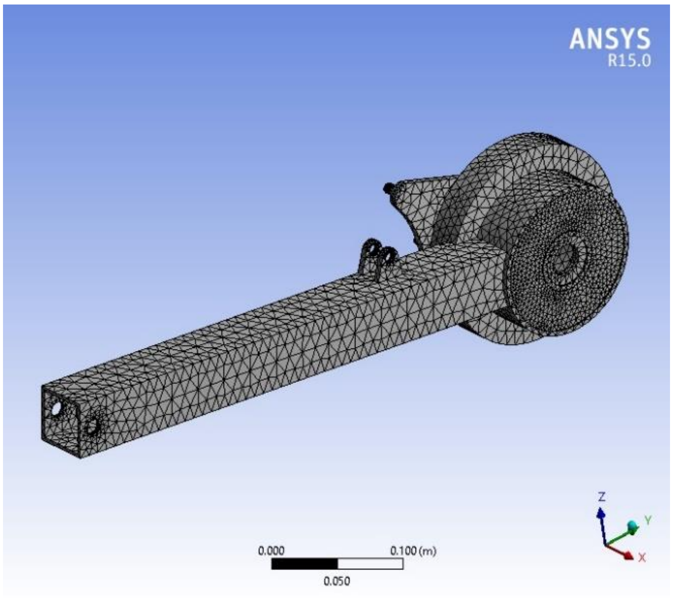

Figure 8: Meshing Of Trailing Arm

In Figure 8: Meshing Of Trailing Arm, initial settings are Physics Preference used is mechanical, Element Size is default, Smoothing is high, Transition is slow, Span Angle Center is fine , Transition Ratio is 0.272, Growth Rate is 1.2, total Nodes are 60180 and total Elements are 36098

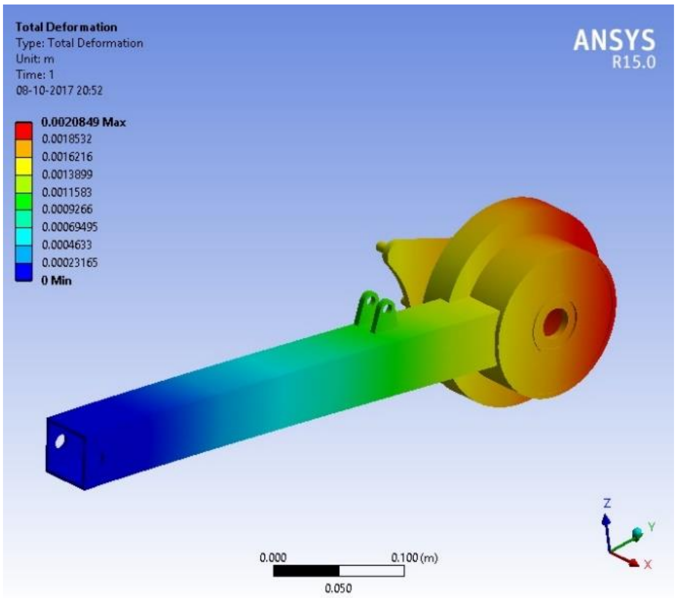

Figure 9: Total Deformation Of Trailing Arm

Figure 9: Total Deformation Of Trailing Arm, shows total deformation of Trailing Arm when force of 1303.35 N is acted on it. From above figure it is observed that the maximum deflection 1.75 mm.

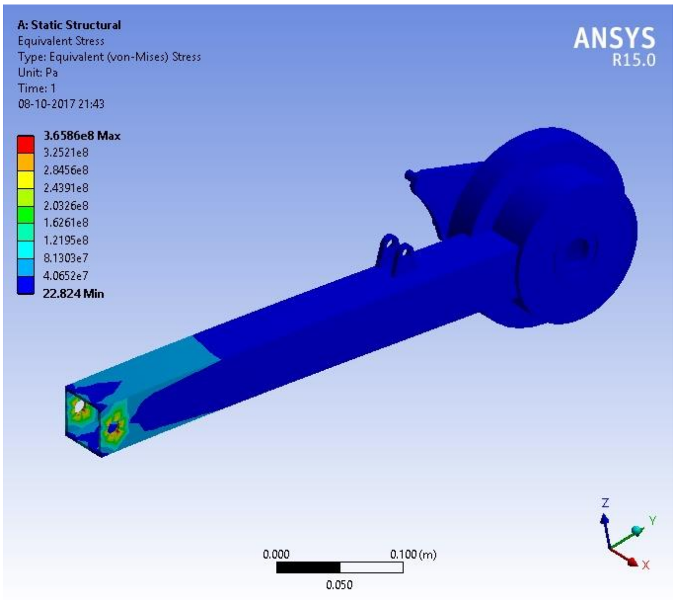

Figure 10: Maximum Stress in Trailing Arm

Figure 10: Maximum Stress in Trailing Arm, shows maximum stress occurred in Trailing Arm when force of 1471.5 N is acted on it. From above figure it is observed that the maximum stress in body is 365.86 MPa .

5. RESULTS

The analysis gave us the maximum stresses and deformed shape. As we know value of stresses on bodies, we can find the FOS with it, as we know that FOS is the ratio of Yield Strength of material to the Maximum stress occurring on body. Here we have used material AISI 4130 for both wishbone and trailing arm which has of Yield Strength of 435 Mpa .
Mathematically,

FOS = σy / (Max. Stress) ......[4]

The overall Results are tabulated as follows.

Type of Suspension System	**Double wishbone**	**Trailing arm**
Maximum stress (MPa)	**157.09**	**365.86**
Total Deformation (mm)	**2.08**	**1.75**
FOS (calculated)	**2.76**	**1.19**

Table 1: Results

6. CONCLUSION

We have designed the double wishbone suspension system and trailing arm suspension system considering dynamic factor which is 3 times greater than static force. From above results we conclude that FOS is greater than 1 in both static and dynamic conditions, so both (wishbone and trailing arm) components/bodies are safe. in both suspension systems the stresses occurring in bodies are less than the yield strength of material of body.

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