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Design and Analysis of Front and Rear Wheel Assembly of an ATV

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Abstract - *The objective of this paper is to define a path towards material selection, calculation and design of a wheel-assembly comprising of a knuckle; hub and a brake disc along with their respective design and analysis data for an ATV. The major goal is to achieve a system with least weight along with the maximum strength so as to obtain the desirable output. The decision and conclusion stages to this project are also discussed in the paper which include considering the suspension geometry parameters, identifying and evaluating the problems that were involved with previous designs and paving a path towards the final assembly of the system. From this solution we expect to generate a light weight system with minimum amount of mechanical drag and a substantial built to perform all the tasks without fail.*

***Key Words*: ATV, knuckle, hub, brake disc.**

1. INTRODUCTION

In an ATV the construction of hub, knuckle and their assembly plays one of the most crucial roles as this is the system which acts as a bridge in between the potential of the designed steering, suspension and powertrain system and the track. In this particular application; this wheel assembly not just has to provide fluidity to the operations but also has to be sturdy and well-built in order to last the harsh endurance run which goes on for four hours without a halt or break. The front assembly on either side comprises of a knuckle, hub, stub axle, spacers, bearings, dust seals, heim joints and an axle nut whereas the rear assembly on the outboard at either ends comprises of an upright, hub, bearings, dust seal, drive-shaft and an axle nut. Steering knuckle is the critical component of the vehicle which is linked with suspension system. It allows steering arm to turn the front wheel and it also supports the vertical weight of the vehicle. The steering knuckle is the connection between stub axle, tie rod and axle housing with the help of using king pin, and these are also connected to the suspension system. [2]

Figure 1 Front wheel assembly

2. Significance

This study opens a pathway towards a solution in the form of a system which acts as a focal point of two different Inputs provided by the driver, and vehicle namely the steering input and the transmission input and one reactive input due to the combined weight of driver and vehicle which is termed as suspension input. The assembly makes these inputs work in unison such that maximum performance is delivered at all fronts.

3. Design Specification

Table -1: Dimension of parts used

S. No.	Part	Dimension
1	Knuckle	Length (170mm) Width(97.5mm) Thickness(39mm)
2	Front Disc	Total Dia.(154mm) PCD(70mm)
3	Hub	PCD(144mm) Thickness(4mm)
4	Rear Upright	Length(162mm) Width(65mm) Thickness(33mm)

4. Design Procedure

High strength, less weight, economical, easy to manufacture are the four factors on which the design was made. While designing the wheel assembly, we first took certain parameters from the steering and suspension geometry. Steering parameters comprised of SAI (Steering axis inclination), steering travel from lock to lock, tie rod angle, and steering arm length. Suspension geometry included track width, caster angle, and angle of Independent suspension (Double Wishbone). The Length constraint for knuckle was also provided by size of the rim selected for the vehicle. As ultimately the wheel assembly has to fit in the rim. Rim also added constrain for PCD for hub. The Design was made such that we can use the same design for both front and rear. Aluminum 6061 is used as a material for both hub, knuckle and upright. This led to reduction in manufacturing cost. Stub axle is a crucial parameter for wheel assembly, after calculating vertical forces and moment we decided to go with (material) so as to increase strength. Brake disc is self manufactured with the aim of reducing the overall weight of the wheel assembly. A lot of research led to use SS320 as material for brake disc, as it has high thermal conductivity and was easily available for us.

5. Software Used

Creo is a CAD software developed by PTC which we used for designing and modeling of the front and rear wheel assembly. CAD software are used by industries as it saves a lot of time and money. Creo includes simulations, analysis, modeling, and manufacturing which make it a complete software but the modeling part is what Creo is most known for. It makes use of 2D drawings and extrudes them to make 3D objects. This is the most widely used elementary 3D design software by engineering students as it is so easy to use.

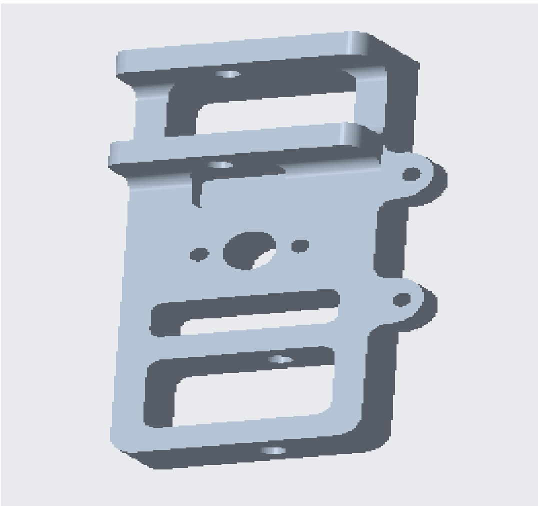

Figure 2- knuckle

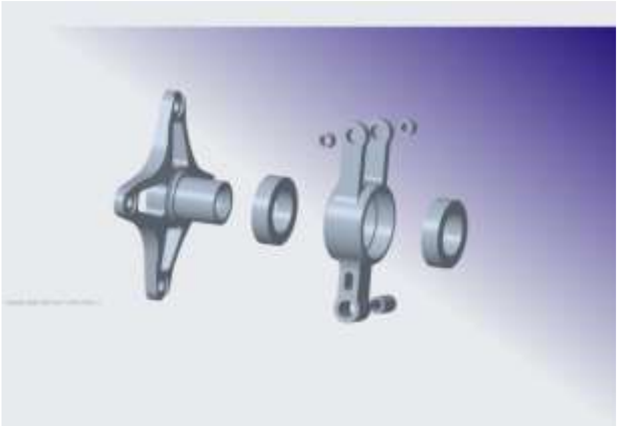

Figure 3 - Rear wheel assembly

Ansys- the ANSYS Mechanical software suite is trusted by organizations around the world to rapidly solve complex structural and thermal problems with ease. Structural mechanics solutions from ANSYS provide the ability to simulate every structural aspect of a product, including nonlinear static analysis that provides stresses & deformations, modal analysis that determines vibration characteristics, through to advanced transient nonlinear phenomena involving dynamic effects & complex material behavior[9].Using ANSYS Mechanical software solutions, you can import geometries of complex assemblies, optimally mesh them, and apply realistic boundary conditions. Following these pre-processing steps, you can perform analyses to assess the strength, vibration, motion and thermal response characteristics of the system. A variety of graphical tools allow you to easily visualize the

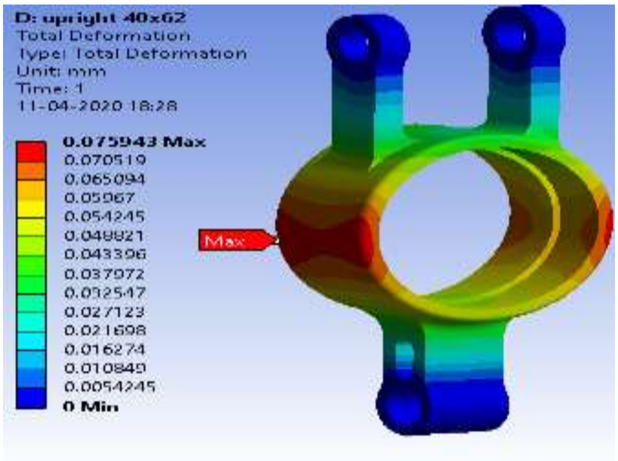

Figure 4 - Upright

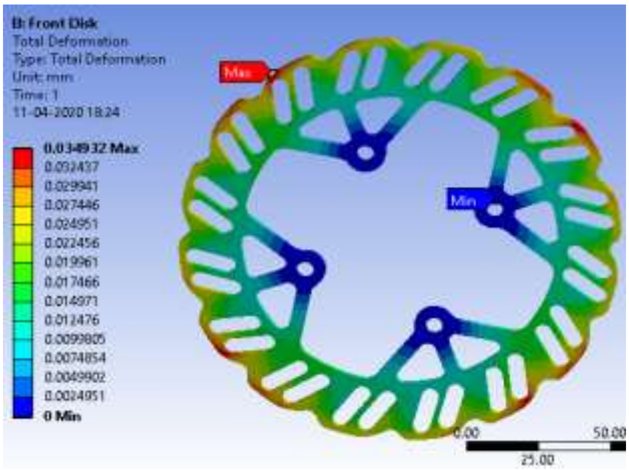

Figure 5 - Front brake disc

6. Result

Table -2: Analysis result

SNo.	Part	Total Deformation(m)	Equivalent Stress(MPa)
1	Knuckle	$6.6*10^{-5}$	38.436
2	Upright	$7.59*10^{-5}$	70.875
3	Front Hub	$8.026*10^{-6}$	71.495
4	Rear Hub	be $3.287*10^{-5}$	108.58
5	Front Brake Disc	$3.49*10^{-5}$	371.95

Figure 6 - Wheel Assembly

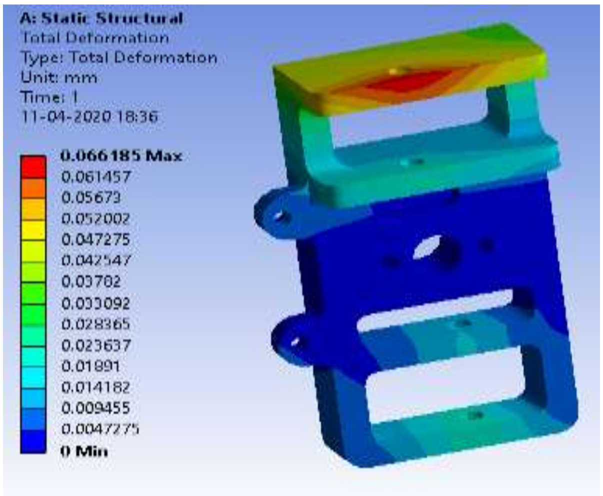

Figure 7 - Knuckle analysis (Total Deformation)

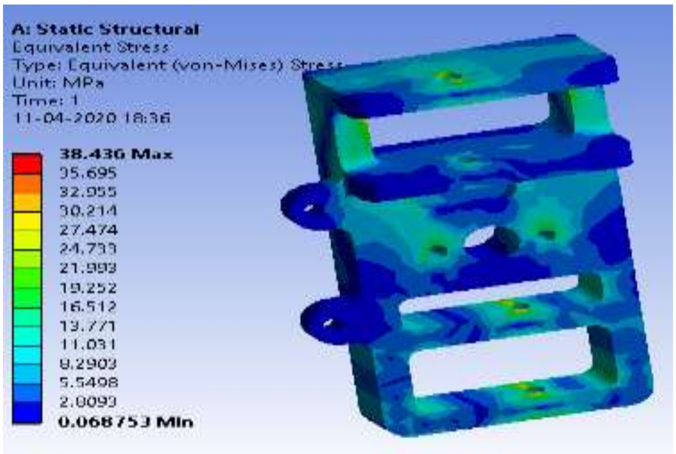

Figure 8 - Knuckle analysis (Equivalent Stress)

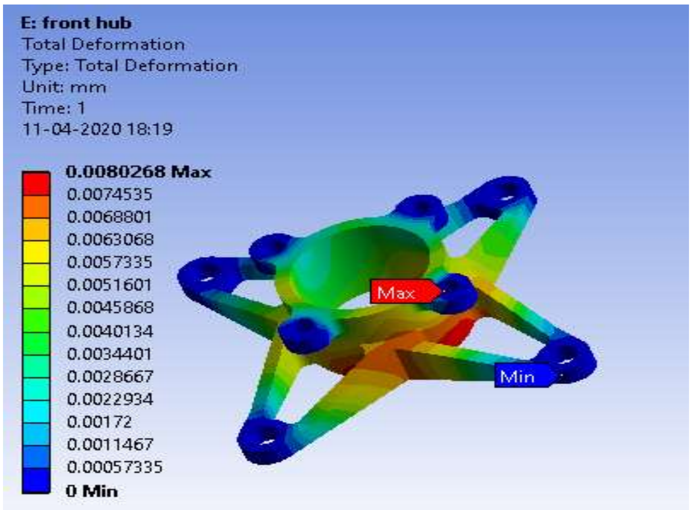

Figure 9 – Front hub analysis (Total Deformation)

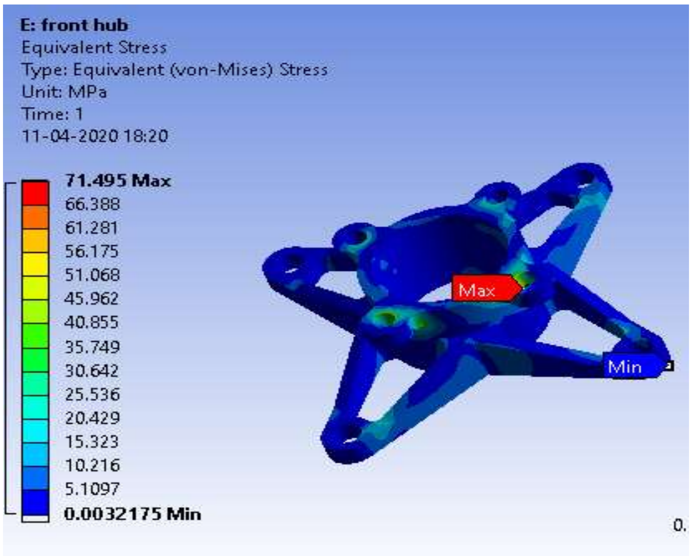

Figure 10 – Front hub analysis (Equivalent stress)

7. Conclusion

The ATV successfully completed the four hour long endurance run without a single breakdown. After disassembling this unit it was found that there were no deformations or major defects in this assembly and it was fit to be re-used again

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9. BIOGRAPHIES

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