DESIGN AND ANALYSIS OF CHASSIS, ENGINE AND STEERING SYSTEM OF AN ATV – A DESIGN REPORT

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Abstract - *This design report explaining Engineering design process and analysis of All Terrain Vehicle (ATV) which has been developed for the Rally Car Design Challenge 2019. The main idea of our project is to get practical knowledge in the field of both mechanical and automobile trying to grasp finest concepts in the design, manufacturing and marketing sectors. Our project is to build an ATV that is capable to run on roughest and one of the most uneven roads present. The prerequisite of this specific design is that it should be rigid enough to withstand the forces created by different impact without making the vehicle financially impossible to access. Senior design project enables student to gain real world experience in the design, Analysis and Manufacture the vehicular product. Solidworks 2016 has been conducted on all important parameters of ATV to ensure the safety. This report is details of procedure and methodology used for the Design Of ATV.. The main criteria considered in the design included High performance, reliability, Manufacturability, serviceability, weight and cost.*

Key Words: Engineering management, Performance, All Terrain Vehicle, Safety. Chassis, Steering

1. INTRODUCTION

The design process of this single-person vehicle is iterative and based on several engineering and reverse engineering processes. Following are the major points which were considered for designing the off road vehicle:

- Endurance
- Safety and Ergonomics
- Market availability
- Cost of the components
- Standardization and Serviceability
- Manoeuvrability
- Safe engineering practices.

Team Triumphant Racers began the task of designing by conducting extensive research for main parts of the vehicle. We contacted numerous auto part dealers in different parts of the country to know the availability of required parts. Then keeping the voluminous list of available parts in mind, the designing team initiated their work to achieve the best standardised as well as optimised design possible. Solidworks 2016 software was used for designing and analyse the Impact test and all. We used Lotus Software for suspension simulations and Transmission simulations. Specifications laid down by the rulebook were the foremost concern while designing and selection of the parts. Besides performance, consumer needs of serviceability and affordability were also kept in concern which we got to know through the internet research and reviews for all terrain vehicles.

2. Engine :

With many sessions of discussions as well as analysing torque speed characteristics we decided to use Maruti 796 cc Three cylinder water cooled engine. The reason we selected this engine was the due to its easy availability and its great capability to produce required Torque.

Table 1 : Specifications of engine

Parameter	Value
No. of cylinder	Three cylinder
Displacement vol.	796cc
Compression ratio	8.7:1
Rated power	37bhp@6000rpm
Maximum Torque	59 Nm @ 2500rpm
Top Speed	90 Kph
Ground Clearance	170mm
Kerb Weight	665kg
Fuel Tank Capacity	22 Litres
Cooling System	Water Cooled.

3. CHASIS:

Material selection of the chassis plays crucial part in providing the desired strength, endurance, safety and reliability to the vehicle. To choose the optimal material we did an extensive study on the properties of different carbon steel. We first considered SA106 and AISI 4130 chromoly. The strategy behind selecting the material for roll cage was to achieve maximum welding area, good bending stiffness, and maximum strength for the pipes. So, after market analysis on cost, availability and properties of these two alloys, we finalized SA106 GRADE B of the following dimensions

	OD(mm)	ID(mm)	MI(mm)
Primary	48.3	40.94	1365151.26
Secondary	42.2	35.08	81337.74

Reason to select SA106 :

- SA106 is abundantly available and is less expensive than chromoly.
- Yield Strength : 320 mpa
- Tensile Strength : 450 mpa

3.1 Roll Cage :

We have designed the roll cage keeping in view the safety and aesthetics. These are the two factors that are given utmost consideration. The design complies with the rules mentioned in the RCDC 2019 RULE BOOK. The chassis was designed in Solidworks 2016 edition. All the triangulated structures have been created such that the forces can be reacted well into space frame. The chassis was tested for front collision, sideways collision, rollover safety and torsional rigidity. The displacement and stress induced were within the desired limits. The Analysis for collisions/impact was done in Solidworks 2016.

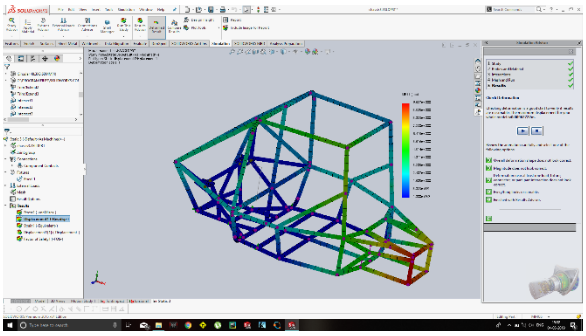

Fig -1 : Front Impact

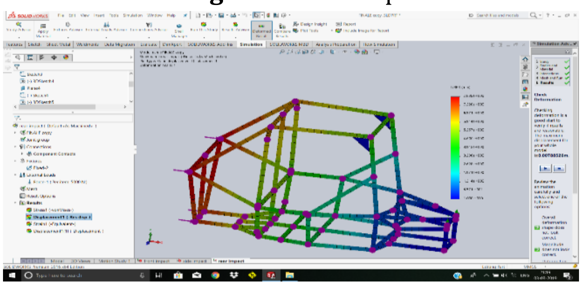

Fig - 2 : Rear Impact

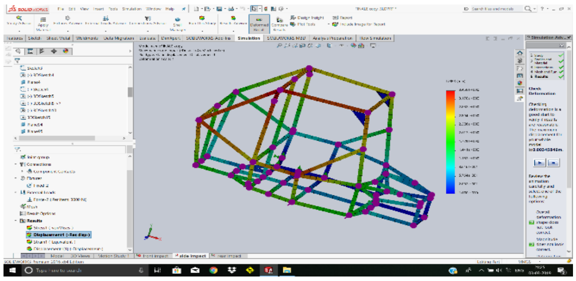

Fig - 3 : Side Impact

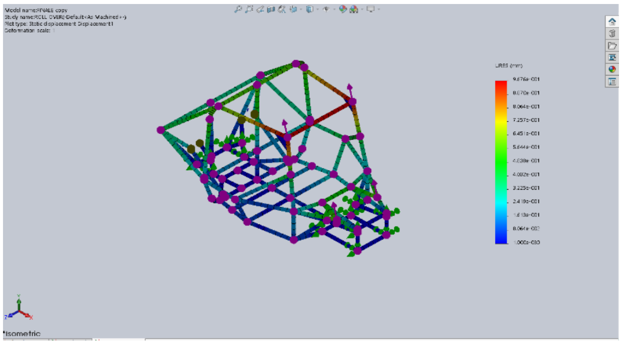

Fig - 4 : Torsional Analysis

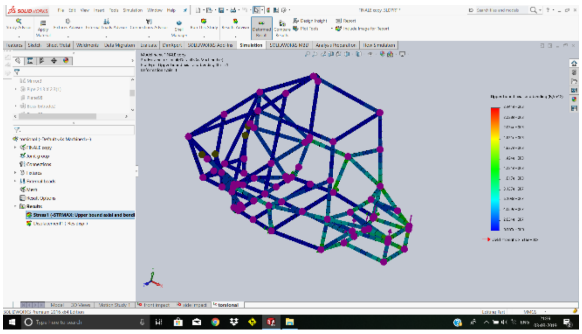

Fig - 5 : Roll Over Analysis for plot FOS

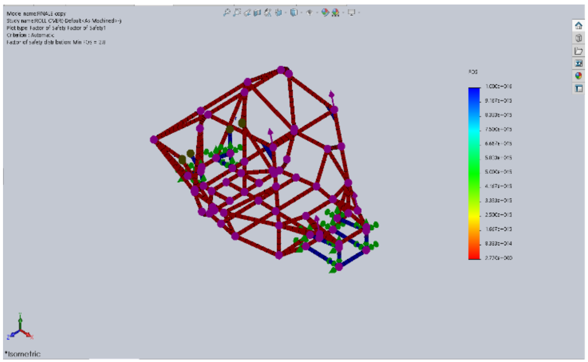

Fig - 6 : Roll Over Analysis for plot Static Displacement

4. Steering System:

The steering system is a vital component of the vehicle as well as the driver interface. The basic function of steering system has to provide maximum direction control and stability to the vehicle. The steering system is group of parts that transmit the movement of steering wheel to the front wheels. The **objective** of steering system is to provide directional control of the vehicle, to withstand high stress in off terrain conditions, to reduce steering effort and to provide good response from road to driver. Ackerman steering system is based on the four bar linkage mechanism in which different links move relative to each other and finally direct vehicle in particular direction. This system is beneficial during sharp turning and reduces steering efforts. This helps in maneuverability. Steering rack and pinion mechanism is suitable because of obvious advantages of reduced complexity, ease of construction and less space requirement compare to other steering mechanisms.

Steering Geometry:

Type – Rack and pinion
Inside wheel angle – 40.115
Outside wheel angle (α) – 27.77
Wheelbase – 75 inch
Wheel track – front – 55 inch
Ackerman angle – 40.623
Turning radius – 4.11m
Ackerman % - 101.26 (oversteer)
Steering ratio – 7:1
Dia of steering wheel – 14 inch
Length of tie rod – 289.07 mm
No. of turns of steering wheel – 3 (L to L)
Turning Radius
= (Track width/2) +
(Wheel base/ sin (avg steering angle)
= 4.11 m
Ackermann angle
= $\tan^{-1}$ (wheelbase/ (Wheelbase/tan α)- T_w)
= 40.623
Percentage Ackermann
= (Ackermann angle / Inner wheel angle)*100
= 101.26%
Steering effort = 105.107 N

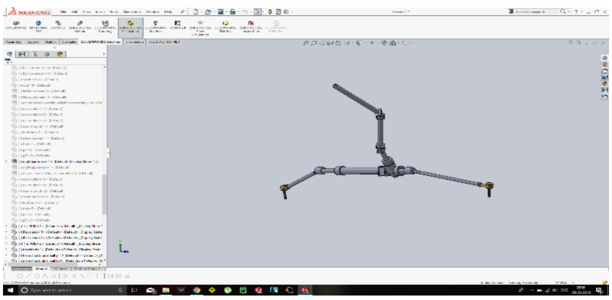

Fig - 7 : Wheel Assembly

5. Conclusion:

When undertaking any design project there are several factors to be considered that are common to all engineering projects. A project must have a proper scope with clearly defined goal. Our team is participating for the first time in this event, so a comparative study of various automotive systems is taken as our approach. With such an approach, engineers can come up with the best possible product for the society. We are also planning to conduct a customer needs survey to improve the vehicle further more. Anything being done for the first time, few difficulties are sure to come. Further improvements and a detail design of all other systems of the vehicle will lead to competitive vehicle. We hope to come with the best possible final product so that we will be one of the noticeable competitors in this year's competition

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