7th National Conference on
"Role of Engineers in Nation Building" organized by VIVA Institute of Technology, Mumbai
(1st and 2nd March 2019)
International Journal of Engineering Research & Science (IJOER)
ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

Manufacturing and Testing of All Terrain Vehicle

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Abstract— *The main aim of this Technical Paper is to Design an All-Terrain Vehicle (ATV) which is safe from Drivers view complying with all the rules specified in BAJA SAE INDIA rule book 2019. Being familiar to the event, certain changes were made to enhance the overall design.*

The car's demand is majorly from off-road enthusiast, hence considering drivers ease was a huge design consideration. Driver Ergonomics and performance of the off-roader was one of the major changes incorporated this year. Making the vehicle lighter and durable was another important consideration.

The vehicle was so designed according to the design reports and was tested in different off roads to get the strength of the car and will be used a safe guarded vehicle where a normal car cannot even reach.

This paper highlights the points to analyse the safety of its chassis in case of impact or roll over.

Keywords— ATV –all terrain vehicle, CV–continuous joint, KPI – king pin inclination, MC –master cylinder, TMC –tandom master cylinder .

I. INTRODUCTION

The major motive of the design report is to have an overall view of the All-Terrain Vehicle complying with basic Driver Ergonomics, Vehicle Performance and Specifications etc. adhering to all the rules specified in the BAJA SAE International Rule Book2019. In accordance with last years' experience, the designs were optimized and the concept of 'design for manufacturing' was incorporated.

II. ROLLCAGE:

Design of a roll cage includes various factors like material selection, size selection and frame design and finite element analysis. These steps are elaborated further.

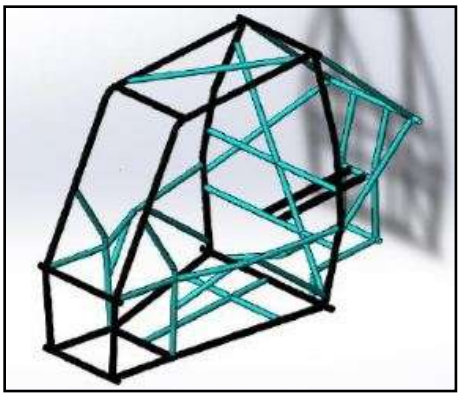

Fig 1: Roll Cage Model

2.1 Material Selection:

The material used for this year roll cage is AISI4130 (chrome-moly steel) i.e. chromium molybdenum alloy steel. This was selected on a comparative study on parameters like Availability, Cost, Weight and Strength. We compared this following parameter with other steel grades like AISI 1018 and AISI 1020. But AISI 4130 is quite best among them structure. The properties of this material are:

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Bending Stiffness =EI

Bending Strength = Sy*I/c

Table 1:
Equivalency

Parameter	AISI 1018	AISI 4130
Bending Stiffness	2.76*109	3.45*109
Bending Strength	387.378*103	706.70*103

Table 2:
Pipe Dimensions

Pipe Sizing	Last year	Current year
Primary	29.2*1.65	29.2*1.65
Secondary	25.4*1.2	25.4*1

2.2 Frame :

The primary objective of the roll cage is to provide the driver safe driving conditions and a platform for all the various subsystems considering the harsh terrain and topography. The roll cage must have sufficient strength such that it can withstand driver weight, bump loads and engine and transmission load. Also providing minimum clearances while designing the chassis, great emphasis was put on the safety of the driver as well as on Driver Ergonomics. The main goals that were kept in mind while designing of the chassis were:

- Overall chassis weight = 26kg
- Least additional members for strength and support.
- Maximum roll cage stability considering loading of the various subsystems.

III. TRANSMISSION

The main objective of the transmission system is to achieve good velocity with high efficiency power.

In addition to CVT it contains two stage reduction gear box which is made up of Aluminum for a light weight housing of gears. The first reduction ratio is of 2.33 and second reduction ratio of 3.6 which provides the required velocity.

Fig 2: Gear Trail

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3.1 Gearbox casing:

The gearbox casing is required for optimum performance of the gear drives. It provide proper lubrication, protection from environmental element and proper orientation of gear. The material used for gearbox casing Aluminum 6061-T6considering it's light weight, machinability and heat dissipation property. It is machined using CNC machine for proper fitting and compactness.

3.2 Steering:

The design aim of the steering team was to ensure smooth maneuvering of vehicle during Corners. In order to achieve this ratio of vehicle wheelbase to track width is kept close to 1:1. Steering system hard points were first fixed by considering the clearance and ergonomics.

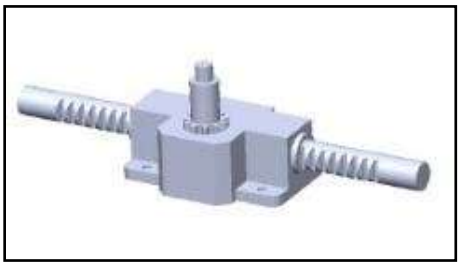

Fig 3: Rack and Pinion

IV. SUSPENSION

The main aim of providing suspension system is to provide comfort to the passengers from the shocks transmitted through regular ground surface, maintain traction on all terrains and also to increase the ride quality of vehicle. It must also keep the tires in contact with the road, regardless of road surface. The suspension system comprises of two components wise linkage and sand shock absorber.

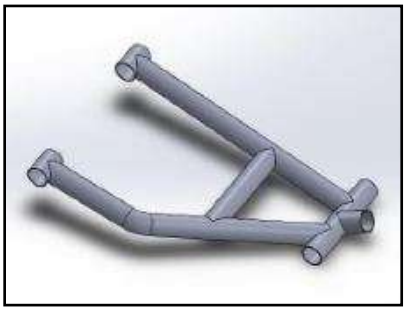

Fig 4: Control Arm

4.1 Specification:

Fox Float 3 series shocks were used as they are light in weight and incorporate variable stiffness Parameters. They provide a travel of 5.6 inches and have an extended length of 19 inches. In front, unequal double wishbone type suspension is incorporated which provides flexibility in design for required roll center height, camber gain, for efficient cornering and low unsprang weight.

4.2 Methodology:

4.3.1 Front Suspension:

While designing double wishbone suspension infront, main goals were as follows:

- Track width of 56 inches
- Kingpin inclination for optimum scrubradius

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- Ground clearance of 14 inches
- The material selected was Chromoly 4130because it helps in weight reduction and provides high strength and high bending stresses.

4.3.2 Rear Suspension

In rear H-arm and camber link is used keeping following factors in mind:

- Track width of 56 inches
- Less camber change and zero toe change
- Mounting on vehicle considering weight Reduction by elimination of additional Members required.

V. UPRIGHTS AND HUBS

Custom made uprights and hubs were used for Strength and durability of wheel assembly .Uprights were provided with a kingpin inclination of 6° to get the tire scrub radius of 50.80mm.PCD of rim.

- Mounting of brake disc
- Minimization of rotational inertia

Design of upright was based on following factors:

- UCA mounting point
- LCA mounting point
- Steering Arm mounting point
- Brake mounting point.

The hard points for upright design was obtained through Lotus suspension analysis software .This helped us to analyze our vehicle under dynamic conditions and also helped in determining the force developed in various vehicle behavior such as cornering, bump and Steering.

Fig 5: Uprights and Hub

5.1 Brakes

5.1.1 Methodology:

Tandem master cylinder with integrated dammedtyle reservoir is used to serve the purpose of having two independent braking systems. Brake calipers of two different bikes are used in order to obtain effective braking of the vehicle. Thickness of brake rotor is decided by considering convection and radiation of heat energy generated during braking and piston travel of calipers.

5.1.2 Brake Rotor:

Slotted design of Rotor was selected in order to reduce weight. According to those calculations effective radius of Rotor was decided. The two different effective radius are obtained for rear and front they are 95mm and 67.5mm respectively.

Material Selection of Rotor:

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The parameters considered while selecting material for brake rotor are machinability, frictional

property, hardness and resistance against rustingand wear etc. Accordingly, SS304 is selected complying with market availability and cost.

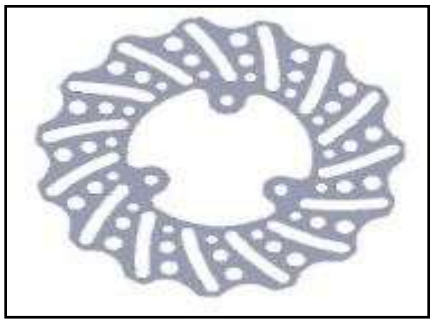

Fig 6: Brake Rotor

5.2 7. Pedal

Over hanging assembly was selected considering driver comfort and position of steering system. Pedal was designed with pedal ratio of 6:1 to reduce driver efforts. Piston travel of master cylinder was also taken in consideration. While calculating the heat flux n convection coefficient the vehicle stopping time considered is 1.25 seconds and Maximum Temperature Rise was during braking was examined.\

Fig 7: Brake Pedal

VI. CONCLUSION

Testing is a important method that plays a vital role in the project's resources, schedule, budget and facilities. Like the many constructive activities of engineering, testing is unique because it is inherently destructive. Its main role is to make the system and its components fail during the test and that can be again recover after fixing. In addition to defect Analysis, testing is also performed to provide sufficient evidence to justify strength in the system's quality, fitness for purpose, and readiness for being accepted and placed into operation. So now the vehicle is pass from the test and good to go.

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