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Design And Optimization Of Chassis Of All Terrain Vehicle

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Abstract - *All terrain vehicle is famously used for various purposes. The design of the chassis frame for the use of all-terrain vehicles (ATV) is presented. In designing the chassis frame, a correct design method was employed. Finite Element Analysis (FEA) was utilized to determine the maximum stress and displacement of the frame when a particular load is applied to it. The chassis is the component in charge of supporting all other vehicle subsystems with the plus of taking care of the driver's safety. It must be strong and durable taking always into account the weight distribution for better performance. The fabrication of the frame is done by us and the fabricated frame will be used as the main part of a project in which a complete ATV will be developed.*

***Key Words*: Chassis Frame1, All-Terrain Vehicle2, Finite Element Analysis3, Safety4**

1. INTRODUCTION

As per the name, ATV is intended to run and maneuver on totally different terrains, or in alternative words, we are able to say that associate ATV is intended for the off-roading purpose. In off-roading, we have a tendency to encounter varied load that is finally transmitted to the frame. The frame is the most vital part of the auto as all the mountings and assemblies are done on the frame itself, therefore it becomes necessary for the associate ATV frame to sustain each static and dynamic masses. during this study, we've got to argue a correct methodology for planning and analyzing the frame before the ATV is tested on vigorous terrains and conditions.

Various sorts of frames are used are relying upon the kind of loading that they're going to bear, for instance, a ladder frame is employed in significant industrial vehicles wherever the load should be transferred from one place to a different, equally there are alternative varieties like monocoque chassis, ULSAB, cannular area frame, etc. Among this cannular area, the frame is one that we've got thought-about for planning our ATV as a result it provides multi-directional impact safety furthermore and is simpler in fabrication.

2. Literature Review

D.Nagarjuna et al. [1]- have mentioned the various vogue problems taken into consideration for building a perfect ATV. The loading analysis has been done considering the various parameters. Overall this report has prohibited varied load analysis on chassis and optimization has been achieved by reducing the load of the chassis frame. The usage of finite part analysis was valuable to the planning and analysis of the frame for all items of a ground vehicle. Bobbing up with analysis may be hard 0.5 to carry on to as masses of tests square measure needed to be conducted with heaps of constraints. The chassis was designed so that the vehicle can set about all kinds of tons and is capable of moving on terrains like rough areas.

Hirak Patel et al. [2]- has designed the truck chassis analytically and also the weight improvement is completed by sensitivity analysis. In sensitivity analysis, completely different cross section area units are used for stress analysis and we realize a weight reduction within the truck chassis the strain and deformation are compared for the various cross sections.

William B. Riley et al. [3]- have mentioned a spread of problems associated with frame and chassis style, an easy mathematical model was developed for examination the structural stiffness to realize insight into the correct style target for the vehicle structure. The model was made on ANSYS and a few experimental strategies were conferred the best capture the load elements and suspension contributors. The various road masses and deformation modes were thought about further as generic style targets supported expertise and strain gauged suspension links. An easy mathematical model was developed for examination the structural stiffness to the suspension stiffness to realize insight into correct style targets for the vehicle structure. These charts additionally aid in visualizing the trade-off between stiffness and weight the designer should create. With these stiffness targets in mind, a finite component model was made.

Upendra S. Gupta et al. [4]- elaborate description of the planning concerns, static and dynamic analysis associated mathematical information concerned within the style of an ATV vehicle. The main focus has been arranged on the simplicity of style, high performance, straight forward maintenance, and, safety at affordable cost. The planning and development comprise material choice, chassis, frame style, cross section determination, deciding strength needs of roll cage stress analysis, and, simultaneous checking the ATV against failure.

3. Methodology

This section discusses how to build a chassis and how to model the chassis as well as the factors considered during the design process. In the field of safety and esthetics, we built the roll cage. They are the two variables that matter most to us, and they are therefore of great importance. CAD modeling design of any component comprises three major principles, Optimization, Safety, and Comfort. The main features of chassis are Nodal geometry utilization, Less Weight, Driver Comfort Appropriate Triangulation The major factors considered in designing an ergonomically suited roll cage were, Seat location, Seat inclination, Steering, wheel location, Steering Column location, Design of the foot box area. Mesh size is calculated by checking the mesh independency. It means that there will be negligible changes in the accuracy of results on further reduction in mesh size. The analysis will be carried out using progressively reducing elemental sizes. The elemental size having a consecutive stress error of less than 5% is considered the optimum size of the mesh. It means that any further decrease in size will only negligibly increase the accuracy of the results.

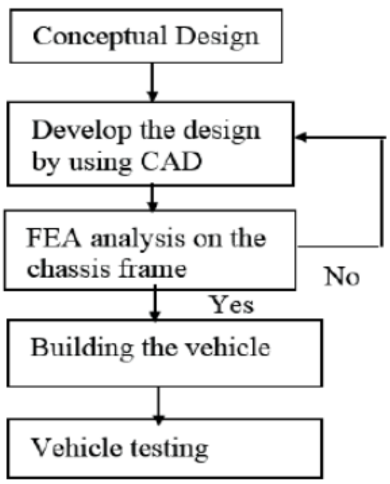


Fig. 1 Design process flow chart

3.1 Selection of Material

Parameters	Chromoly 4130	AISI 1020	Carbon-fiber epoxy composite
Density (g/Cm3)	7.860	7.870	1.5
Modulus of elasticity (Gpa)	205	186	134
Yield Strength (MPa)	670	420	572
Price	850/m	160/m	650/kg

4. Pre-Manufacturing Conditions

- **Preheating**
- **Effects of Residual Stress**

1. Deformation
2. Static strength
3. Dynamic strength
4. Chemical resistance
5. Magnetization

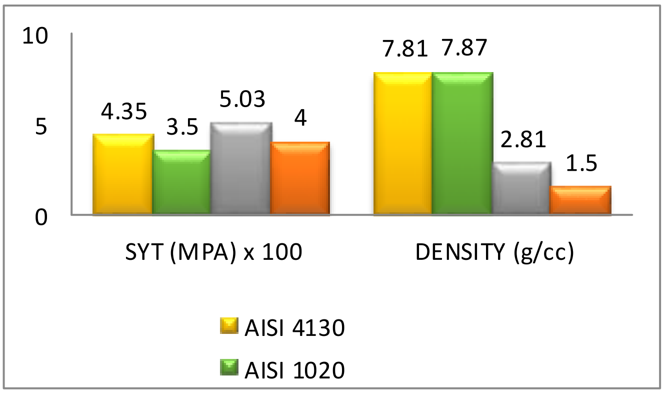
Preheating of the specimen i.e. tubes of Chromoly steel 4130 was done before bending operation so that the component would be free from residual stresses & deformation would be avoided.

The preheating temperature was taken to be 201̊ C for 2.4 minutes.

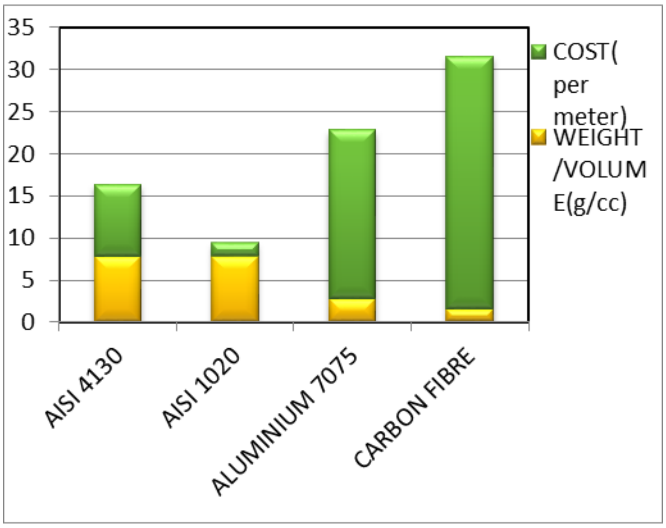
FORMULA USED:

$$Tp = \sqrt{CE} - 0.42^{\circ} C$$

4.1 COMPARISON OF STRENGTH & DENSITY OF MATERIALS:

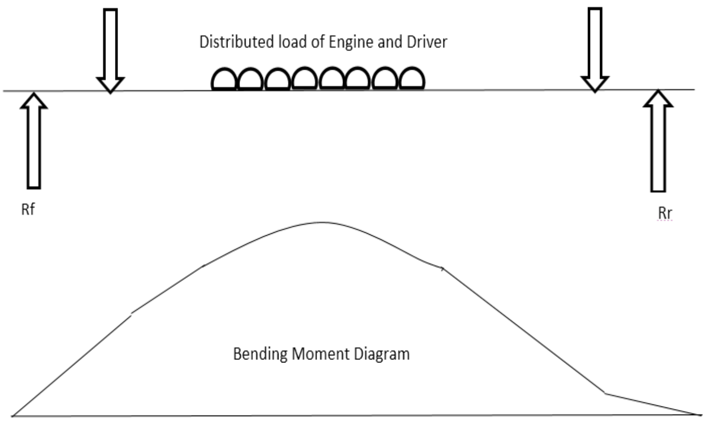


4.2 COMPARISON OF COST & WEIGHT OF DIFFERENT MATERIALS:



Thus from the above studies, we selected choromoly4130 as our chassis material as it has various plus points over others such as reasonable cost, wide availability, easily weldable, low cost, and can handle all the stresses as per analysis conducted on it.

5. MAXIMUM BENDING MOMENT CALCULATIONS



For a maximum bending moment, all the loads at different points were considered. Loads on the chassis at different locations include 1. Steering housing, column, bearings, etc. of 8kg at 200mm from chassis front. 2. Engine, driver weight, seat, fuel tank, mounts, etc. of 120kg at 524mm (524 to 955mm) from chassis front. 3. Transmission, suspension assemblies, etc. about 12kg at 1350 from chassis front. By calculating the maximum bending moment of about 535.40Nm at 801.0mm from the chassis front. This calculated moment will be sustained by two members so each member will carry 267.7Nm which is less than 487.5Nm (bending moment for chromoyl 4130). So our design is safe.

5.1 FORCE CALCULATION FOR ANALYSIS:-

F=W/D

W= ½ MV^2

= ½ * 200 *16.66^2

= 27755.55 N-M

D=1.66 M,

F= 27755.55/1.66

= 16720.2 N

5.2 WELD THICKNESS CALCULATION:-

1. $F_{MAX=}$ 16720.2 N
2. Permissible shear stress for MIG welding is 0.3 syt = 0.3*460=138MP
3. Weld thickness id given as,

Per. Shear stress = F/tl ,

Where,

t = weld thickness

l = length of weld = 80mm,

Now,

138= 16720/t*80

t = 1.52 mm

6. TORSIONAL RIGIDITY TEST

Procedure

Step 1: The rear hubs were constrained in all degrees of freedom by mounting them tightly to the adapter plate via the block to the I-beam section. The adapter plate had been welded firmly to the block.

Step 2: Front mounting points were constrained in all degrees of freedom except one rotational degree of freedom along the X-axis. For that, a roller had been made in the front system.

Step 3: The front torsion stands attach the front hubs of the chassis to an I-beam. The axis of rotation of the beam is parallel to the longitudinal axis of the chassis.

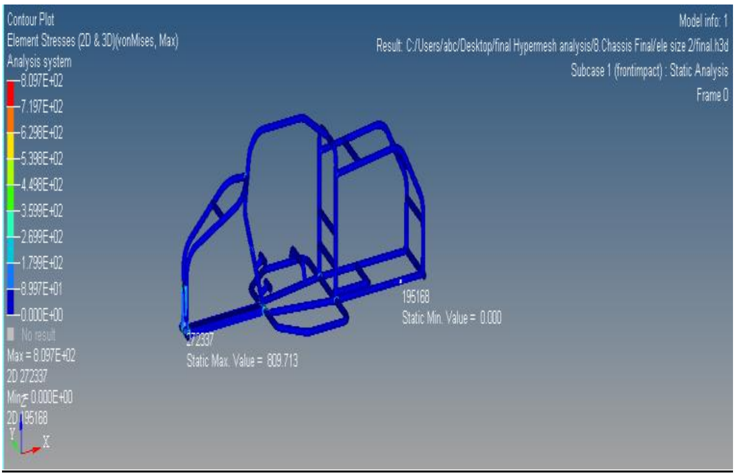
Step 4: Weights are now placed on the ends of the pivoting beam alternatively, causing it to pivot. These raise one stand and lower the other by an equal amount while keeping the rear stands fixed. The moment or torque applied is the amount of weight multiplied by its distance from the center of rotation.

Step 5: The twist of the frame is found by measuring the vertical displacement of the pivoting I-beam.

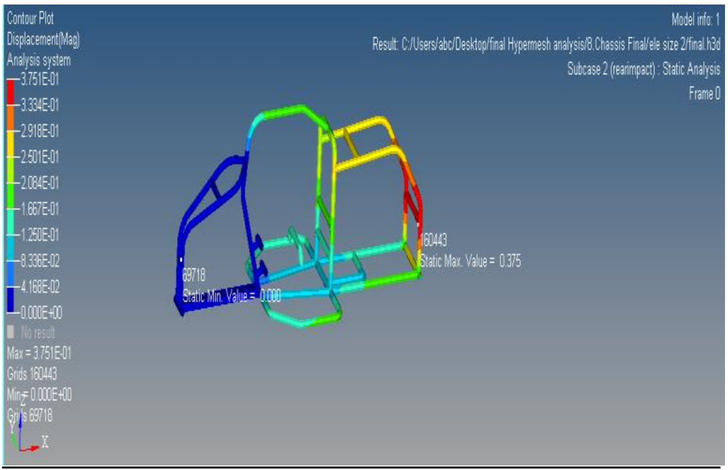
Step 6: In this experiment, a dial indicator was used since proof of concept and not accuracy was the goal. Three dial indicators were used in the suspension mounting points and one dial indicator was used in the engine compartment.

(Note: At first readings were taken with the engine mounted on the chassis and later the engine was removed and the readings were taken again. Mobiles were mounted at the rear and front sections to calculate the angle of twist.)

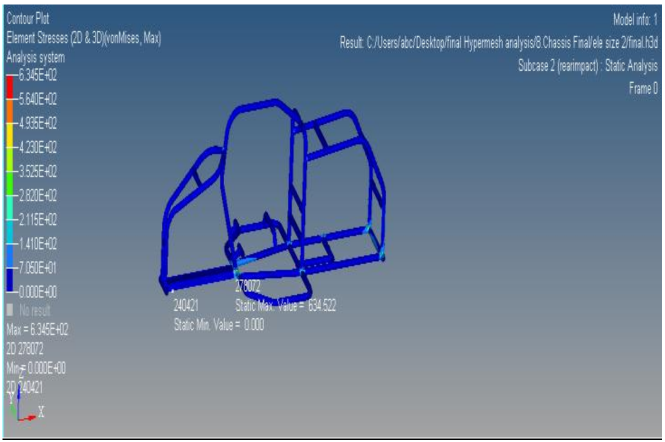
FRONT STRESS



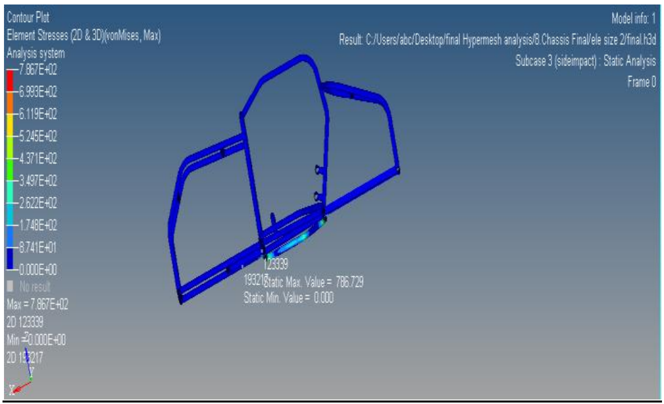
FRONT DISPLACEMENT



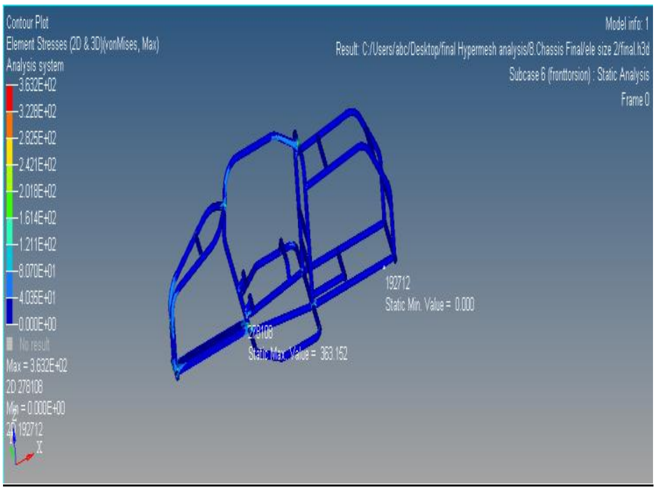
REAR STRESS



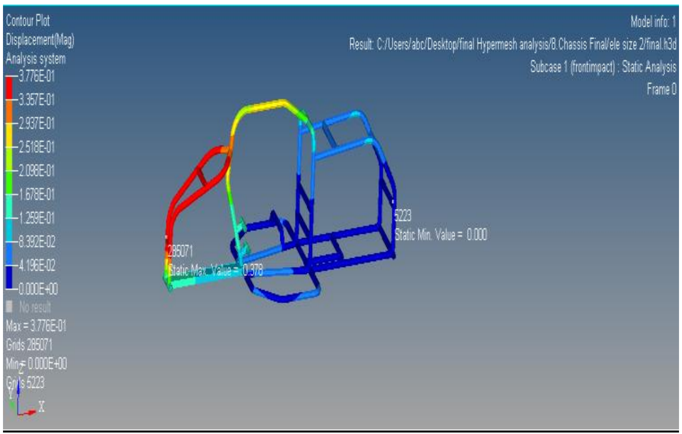
SIDE STRESS



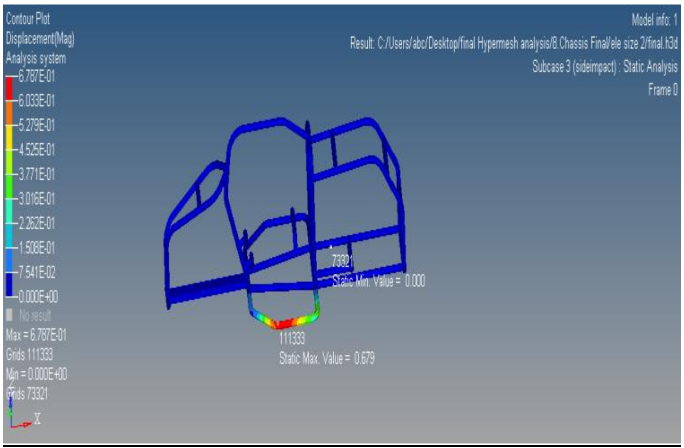
TORSIONAL STRESS



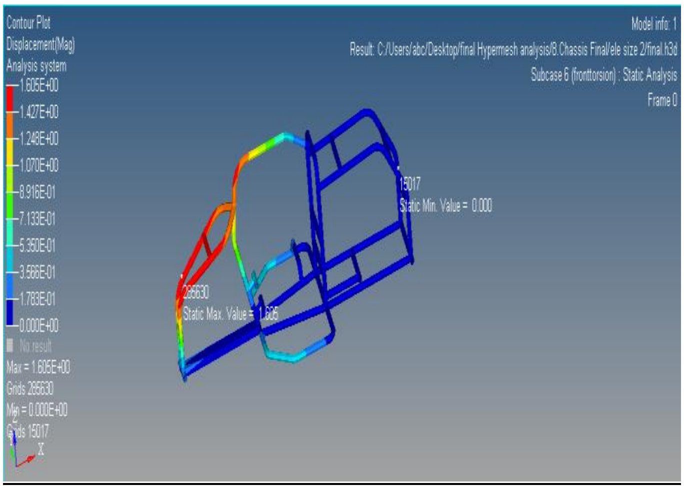
REAR DISPLACEMENT



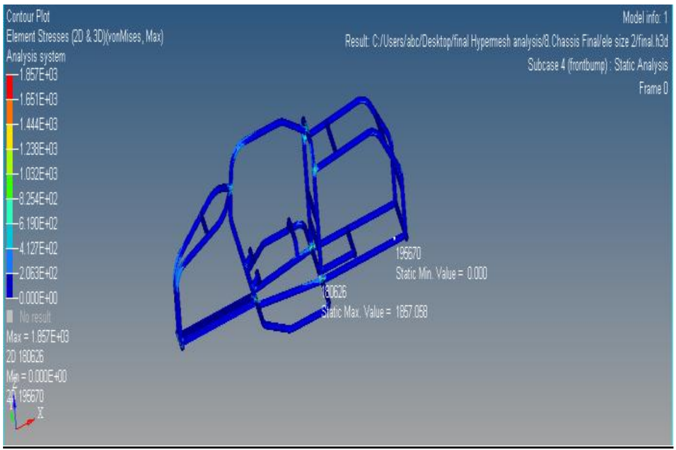
SIDE DISPLACEMENT



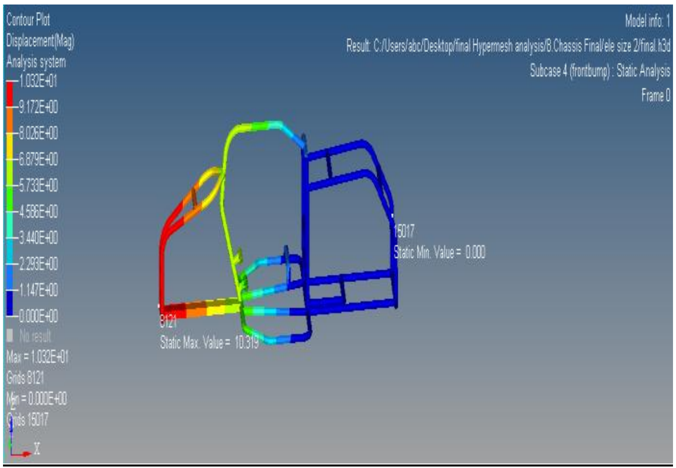
TORSIONAL DISPLACEMENT



BUMP STRESS



BUMP DISPLACEMENT



Conclusion

This document successfully demonstrates the chassis frame construction method for ATV use. The finite element analysis (FEA) results show that the designed chassis can handle the given realized load. Since the evaluation results are within the usual range, the chassis is manufactured. This chassis will later be used as the main part of the ATV designed for academic purposes.

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