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Design, Analysis and Fabrication of Hybrid Human Powered Tricycle

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Abstract: ***In this modern era, the technology becomes very big and everyone has the knowledge to use the technologies in a fruitful manner. But there some technological inventions that are harmful to society such as automobile which is the cause for pollution. Since it was an intelligent invention and it had some harmful effects too because of the emission NOx, SOx gas .Even though there are many innovations that are implemented to reduce pollution, since no one has found complete solution. Hence we have to move on to hybrid vehicle for our well-being and safety measures. Leading to the formation of a team named RACING ROIS (participants of SAE-INDIA EFFICYCLE - 2019). The vehicle is designed in a manner which supports handicapped people. The can be driven in both ways (i.e.,) mechanical as well as electrical drives. For short range transportation this vehicle can be opted in future. This paper encompasses the methods and techniques we had used for designing the vehicle and made it as a real time model.***

Keywords: Efficycle, Electric vehicle, design, analysis, fabrication.

I. INTRODUCTION

We believe that a vehicle should be meticulously planned beforehand. It gives us a detailed idea and analysis for designing our vehicle. The subsystems of our vehicle and its parameters were carefully analyzed and calculated using necessary softwares. Our vehicle has gone through all possible tests and the results gave us a vivid mindset before we started to work on the fabrication part. CAD is the use of computer system to aid in the creation, modification, analysis or optimization of a design. The factors that are considered while designing the vehicles are drive's safety, frame strength and durability. The design calculation and analysis for different materials with different cross sections were made. The design of frame and other components are done by "FUSION 360" and analysis is done using "ANSYS 15.0".The best material and cross section is found out for each parts and analysis is carried based on it.

II. FABRICATION OF VEHICLE

A. Frame Material Options

On the basis of the optimization of our vehicle design, we were inclined to select different materials with different cross section according to the necessity of our vehicle. The following are the materials selected.

1) Chromoly steel (AISI 4130)
2) Mild steel (AISI 1018)
3) Aluminum (AISI 6063)

The three materials mentioned above were chosen on a simple basis. These three materials have several similar properties and very less dissimilar properties. Even the combination of these three materials will only lead to a very good welding prospect. (Except Chromoly AISI 4130 and Mild Steel AISI 1018). Since these materials have very superior applications in the modern-day industries, we have chosen these three materials to carry out the experiment and identify the best one out of it, provided with the conclusions regarding which one of them suits all the criteria. Each material is compared with the reference material and a clear conclusion has been made at the end, regarding which material suits the frame in all possible ways.

B. Ergonomics & Comfort Features

As a part of the ergonomics, we have placed foam on top of our seats. It has the property of mending into the shape of the driver's back, providing the driver extra comfort while drivingg and also to make the Vehicle ergonomic for all average aged people.

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C. Steering

Our steering geometry is based on ackerman steering geometry which is capable of
Steering easily on both right and left and also mainly designed for the making the driver feel comfort. It looks like a normal bike steering. The steering arm is connected to the pitman arm and in turn that arm is connected to tie rod which helps to turn the vehicle.

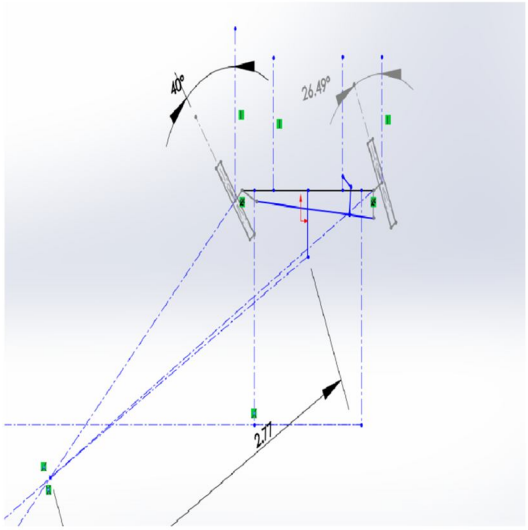

Figure 1: Steering Geometry

D. Brakes & Suspension

The brakes have been mounted on all the three wheels and front wheels are having a dual brake lever connected together and rear brake is a power brake setup and all works perfectly. Suspension are mounted to chassis to withstand shock load acting on it and there are two suspensions placed parallel to each other.

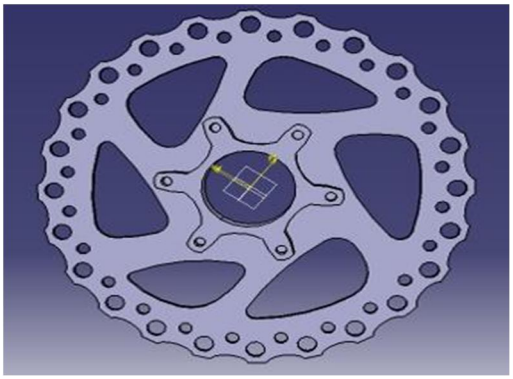

Figure 2: Disc Brake

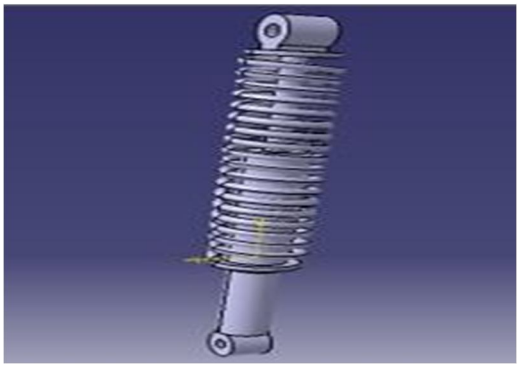

Figure 3: Suspension

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E. Electric Drive and Specifications

Our electrical drive consists of the following specifications:

1) *Energy Storage:* Battery having a capacity of 48V and 12Ah and it is able to run continuously for more than 3 hours.
2) *Driving Motor:* Bush less DC motor of 400 watts, 48 V, 450rpm.
3) *Kill Switch:* The kill switch is used for switching on the vehicle and it is connected to the battery which cuts the power to the motor. It is also used for safety purposes of the vehicle.

III. DESIGN OF ROLL CAGE USING CAD

The vehicle is designed with the latest software known as auto desk fusion 360 and it is a new software and comprises of many features and the phase takes about three weeks to design the complete roll cage. It is shown in Figure 1. We choose the cross section as per the maximum static load applied on the roll cage and also considered as a factor for maintaining safety.

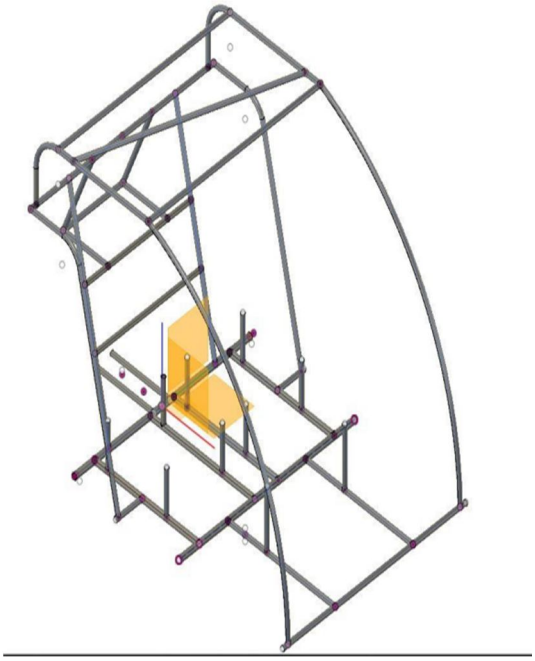

Figure 4: Isometric view of vehicle

Figure 5: Fabricated Roll Cage

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IV. ANALYSIS OF VEHICLE USING FINITE ELEMENT ANALYSIS

The vehicle chassis have been analysed through the software called ANSYS-15.The analysis carried out is nodal analysis and we are calculating how much the vehicle have been deformed and with that we had made several analysis as follows.

A. Front impact Analysis

Material-1 Chromoly AISI 4130 (1 inch Diameter and 2mm thickness)

1) Assumption & Considerations

a) Nodes : 309055

b) Elements: 155275

c) Force : 8700 N

2) Calculation of Impact Forces

General formula: $f \times t = m\ (vi - vf)$

$m = 250kg,\ t = 0.2$

$f \times 0.2 = 250((25 \times 1000/3600) - 0)$

$f = 8680.55 \cong 8700\ N$

3) Analysis Results

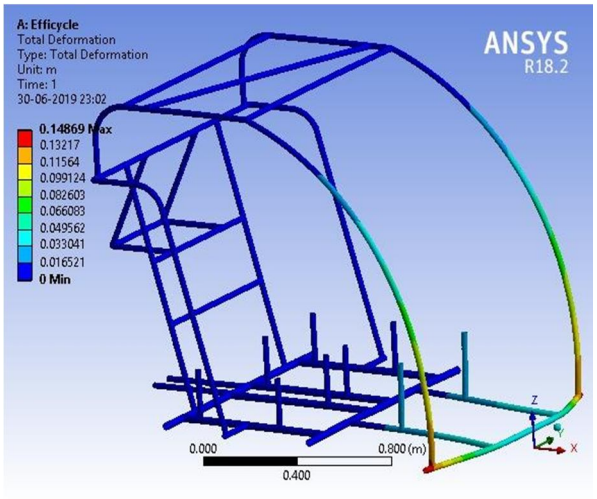

Figure 6: Image Report for Equivalent Stress

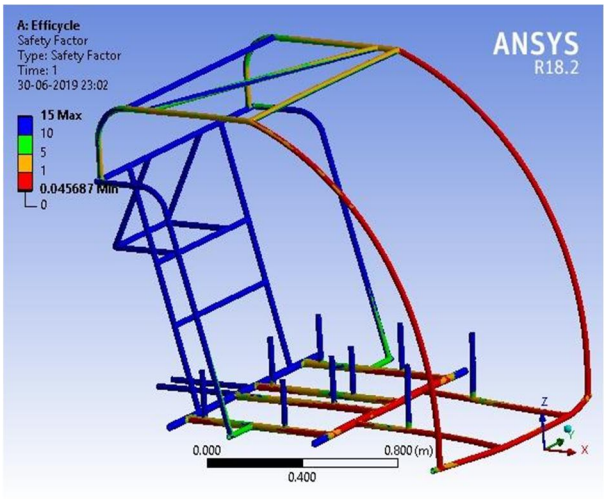

Figure 7: Image report for Deformation

Maximum Equivalent stress: 5.472e9 Maximum Deformation: 0.14869

B. Side Impact Analysis

Material 1 Mild Steel AISI 1018 (1-inch diameter and 2 mm wall thickness)

1) Assumption & Considerations

a) Nodes : 305885

b) Elements: 165450

c) Force : 5208 N

2) Calculation of Impact Forces

General formula: f × t = m (vi – vf)

m = 250kg, t = 0.2

f × 0.2 = 250((15×1000/3600)− 0)

f = 5208 N

3) Analysis Results

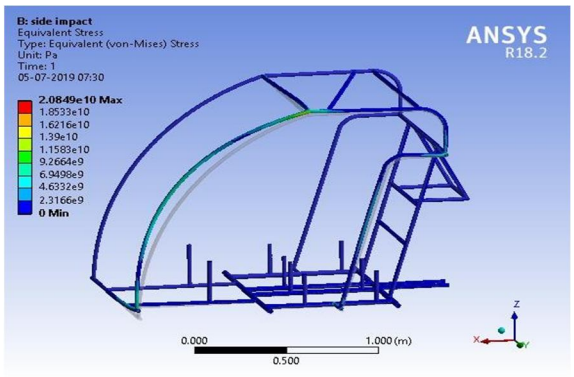

Figure 8: Image Report for Equivalent Stress

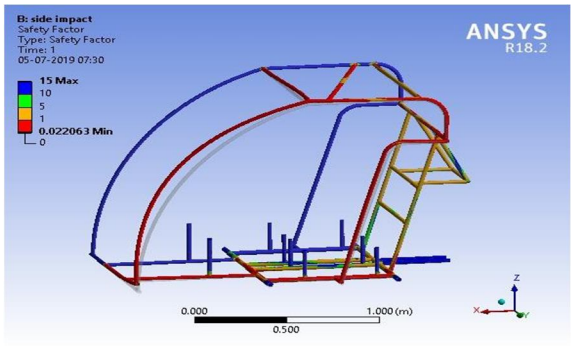

Figure 9: Image report for Deformation

Maximum Equivalent Stress: 2.0849e10 Maximum Deformation: 1.0483

C. Rear Impact Analysis

Material 1: Mild Steel AISI 1018 (1.25-inch and 2mm wall thickness)

1) Assumption & Considerations

a) Nodes : 285640

b) Elements: 138920

c) Force : 9723 N

2) Calculations For Impact For Forces

General formula: f × t = m (vi – vf)

m = 250kg, t = 0.2

f × 0.2 = 250((28×1000/3600)− 0)

f = 9722.22 ≅ 9723 N

3) Analysis Results

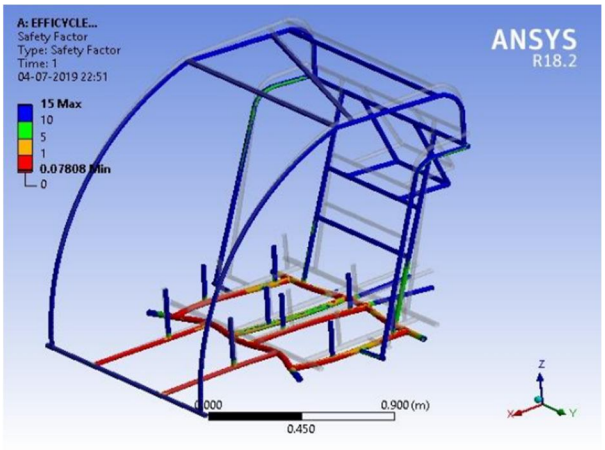

Figure 10: Image Report for Equivalent Stress

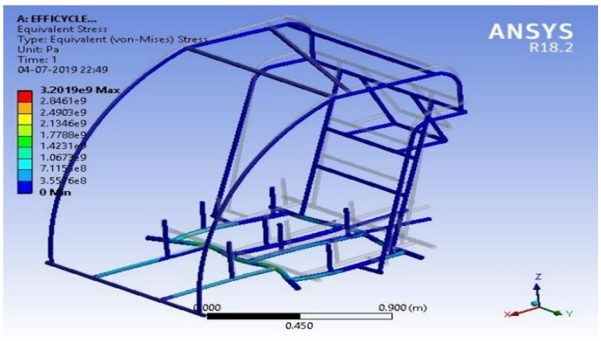

Figure 11: Image report for Deformation

Maximum Equivalent Stress: 3.2019e9 Maximum Deformation: 0.02805

D. Rollover Analysis

There was no roll over impact analysis in the frame.

V. SOURCES USED FOR FABRICATION

A. Workshop

1) Lathe shop
2) Bending shop
3) CNC Machining
4) Welding(TIG&MIG) shop

B. Machines

1) Drilling machine
2) Cutting machine
3) Grinding machine
4) Shearing machine

VI. FEATURES OF VEHICLE

A. Light weight
B. Unique design
C. Disk brakes
D. Strong suspension
E. Stylish look

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VII. CONCLUSION

The decreasing rate of fossil fuels and increasing of vehicle pollution makes this world very worse. So the electric vehicle will be the only choice to get out of this pollution. For that reason only we have fabricated this vehicle and it can be able to run continuously without any fault for more than 100km and it can be charged within two hours. Finally we have learnt a lot on design and fabrication work. The design and analysis becomes easy because of ANSYS and FUSION-360 soft wares.

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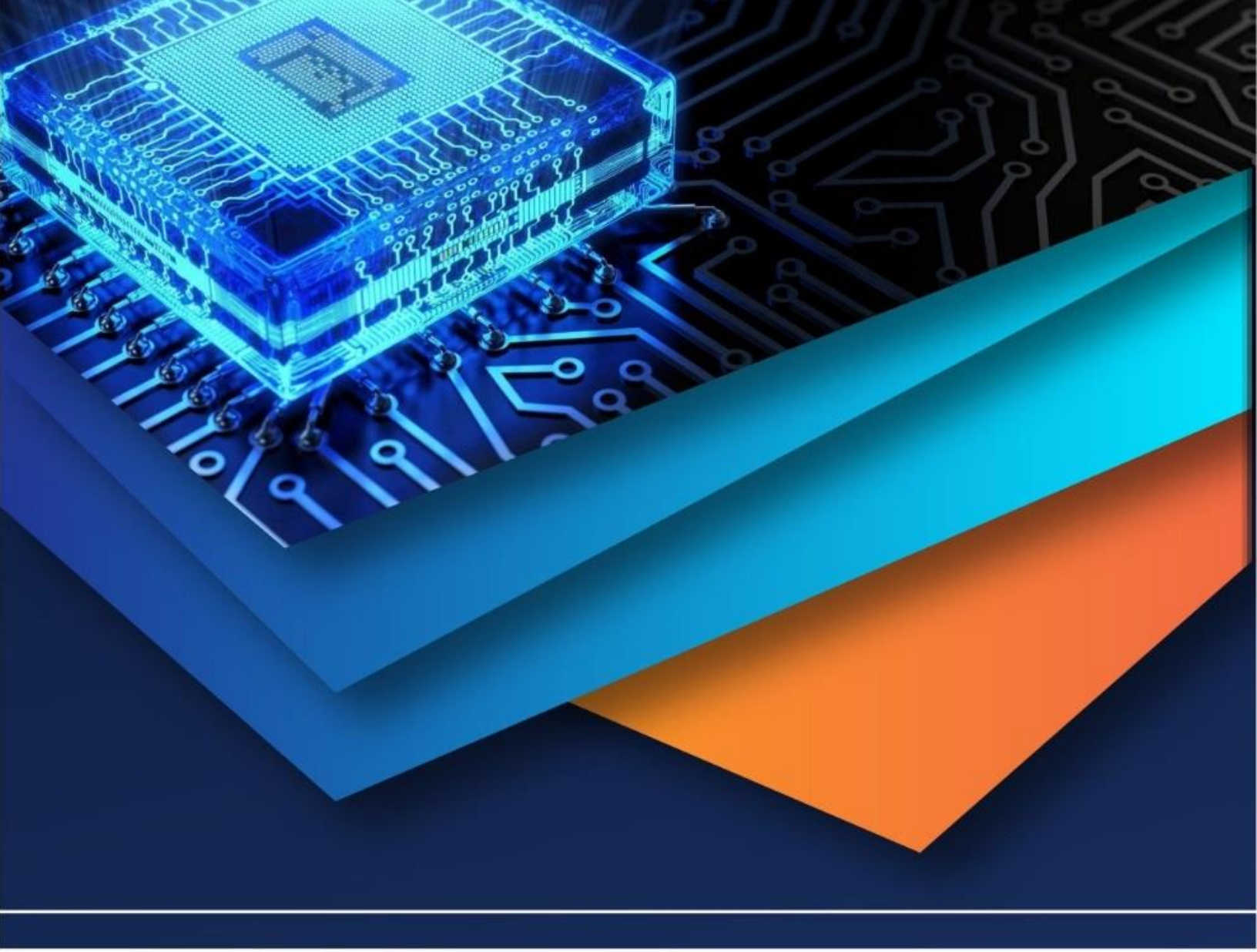

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