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DESIGN AND ANALYSIS OF GO KART

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ABSTRACT: *The prime objective of this report is to present the final design of our go-kart vehicle design. Our ultimate aim is to design and manufacture a safe, functional and economical go-kart from scratch. Efforts have been made to make the frame rigid and torsion free and to increase the performance of the vehicle. The secondary objective is to optimize the vehicle to the best of our abilities.*

Keywords: Go-Kart, Design, Analysis, Manufacture, Performance.

INTRODUCTION

The Go-Kart has been designed by a team consisting of undergraduate students. We approached our design making process by determining the requirements from the rule book followed by a basic sketch and cad modelling. The modelling of components is designed by using cad software's like CATIA, SOLID WORKS and is subjected to analysis using FEA Software, ANSYS. This model is further modified by making necessary changes to optimize and enhance the performance of the vehicle. Based on the above results a final design has been decided. The design process was influenced by the following factors:

1. Driver Ergonomics
2. Cost of components
3. Safe engineering practices
4. Durability and light weight

By Setting up a few parameters for our work, with a goal in mind, we divided the team into the following subsystems:

- Chassis design
- Engine, Power train and Wheels
- Steering
- Braking
- Super structure

1. CHASSIS

1.1 OBJECTIVE:

The primary objective of the team is to design a frame which is durable, rigid and which is light in weight, while adhering strictly to the rule book. Also, to determine the maximum stress concentration areas. The chassis is designed keeping in mind the driver's safety.

Chassis Weight	8kg
Total Weight	145kg
Kerb Weight	75kg

Table 1.1: Weight Distribution

Vehicle Dimension	Measurement
Overall Length	62"
Overall Width	26"
Wheel Base	43"
Track Width Front	35"
Track Width Rear	36.5"
Height	21.25"
Ground Clearance	2"

Table 1.2: Dimension Table

1.2 MATERIAL USED

AISI4130

AISI 4130 has structural properties that provide a low weight to strength ratio and it has higher yield strength. It has a good manufacturability. It is a versatile alloy with good atmospheric corrosion resistance. It shows good overall combinations of strength, toughness and fatigue strength.

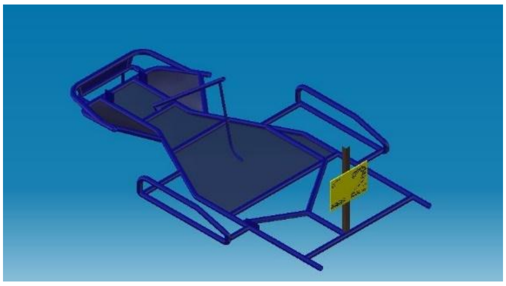

Fig 1: Chassis

1.3 CAE ANALYSIS:

Following analysis were conducted on the chassis (i) Impact analysis a) Front Impact b) Side impact c) Rear impact (ii) Torsion analysis (iii) Modal analysis

IMPACT ANALYSIS

1.1 FRONT IMPACT:

Deformation	1.9894mm
Maximum stress	237.05MPa
Factor of safety	1.9

Table 1.3: FEA Results for Front Impact

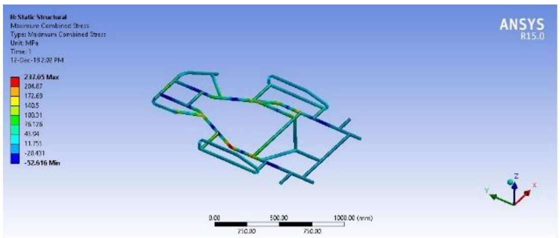

Fig 2: Front Impact- Max equivalent Stress

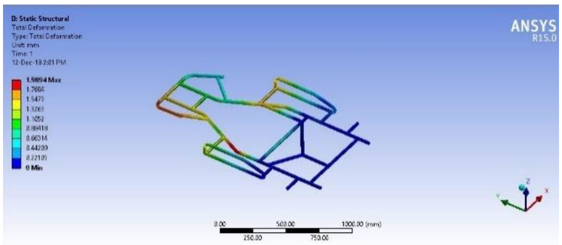

Fig 3: Front Impact-Total Deformation

1.2 REAR IMPACT:

Deformation	1.895mm
Maximum stress	219.84MPa
Factor of safety	2.0

Table 1.4: FEA Results for Rear Impact

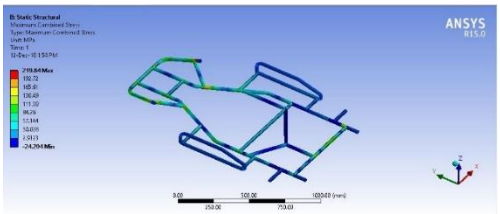

Fig 4: Rear Impact-Max equivalent Stresses

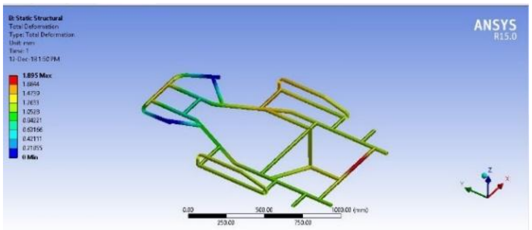

Fig 5: Rear Impact-Total Deformation

1.3 SIDE IMPACT:

Deformation	3.6301mm
Maximum stress	257.7MPa
Factor of safety	1.7

Table 1.5: FEA Results for side impact

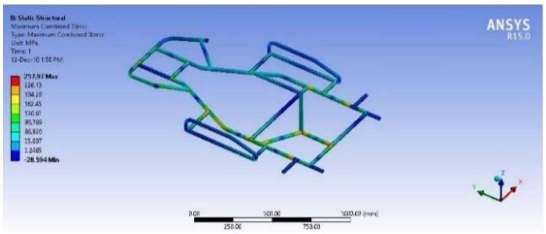

Fig 6: Side Impact-Equivalent Stresses

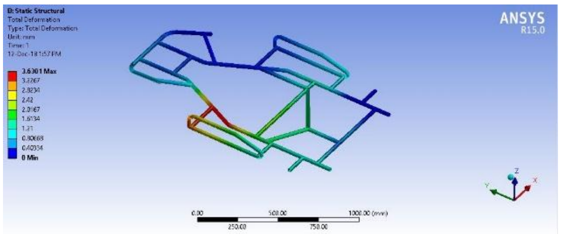

Fig 7: Side Impact-Total Deformation

TORSIONAL ANAYLSIS:

Total Deformation	27.233mm
Equivalent stress	352.54MPa
Factor of safety	1.3

Table 1.6: FEA Results for Torsional Analysis

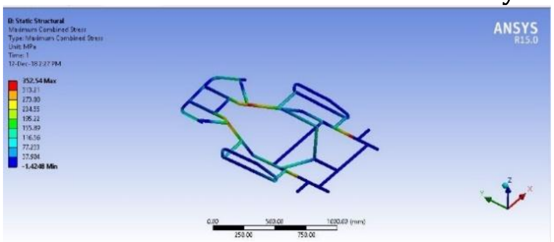

Fig 8: Torsional Analysis- Max Equivalent Stress

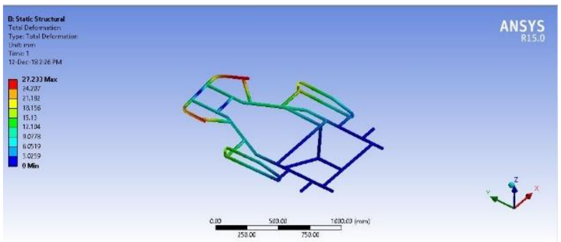

Fig 9: Torsional Analysis-Total Deformation

MODAL ANALYSIS:

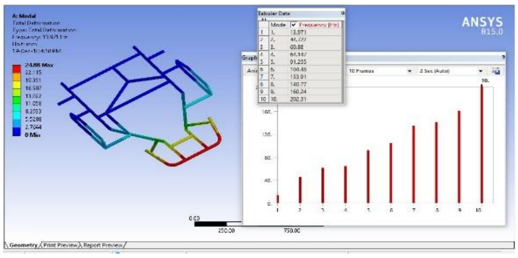

Fig 10: Modal Analysis

2. STEERING SYSTEM

2.1 OBJECTIVE

The design of steering ensures control over direction of travel, good maneuverability and smooth recovery from turns thereby minimizing transmission of shocks. The optimum turning radius is 1.8m. After a study of several steering systems, bell crank mechanism of steering has been selected. And for geometry, Ackermann steering geometry since it does not slip during the turning of tyre and it reduces the steering efforts.

Wheel Base	43"
Rear Track Width	36.5"
Front Track Width	35"
Outer Angle	38^0
Inner Angle	25.8^0
Ackermann Angle	37.9^0
Steering Ratio	1:1
Turning Radius	1.84meters
Friction b/w Tyre and	0.8

Table 2.1: Steering Parameters

2.2 BELL CRANK MECHANISM

A bell crank is a crank that diverts motion along an angle. This angle can be of any from 0^0 to 360^0 but 90^0 and 180^0 are most common.

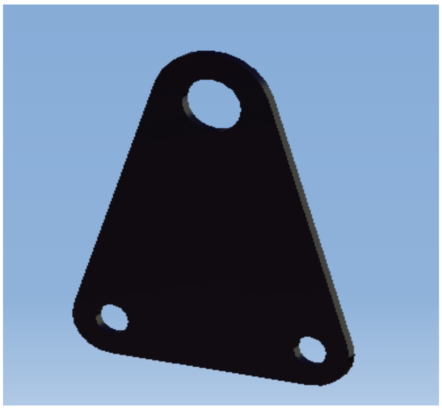

Fig 11: Bell Crank

2.3 WHY BELL CRANK

Since it is light in weight as compared to rack and pinion
Occupies less space.
Requires less effort
Rack and pinion are non-adjustable when it does wear and develops breakage, the only cure is replacement.

2.4 STUB AXLE

The mild steel has been selected for design of stub axle.

Fig 12: Stub Axle

2.5 KNUCKLE AND TIE-RODS

The material used for knuckle is mild steel, whereas for tie rods is stainless steel.

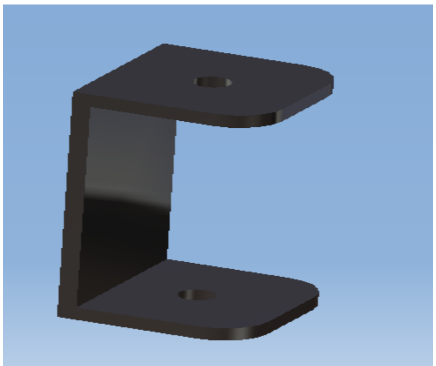

Fig 13: Knuckle

2.6 CAE ANALYSIS:

- 2.1 STUBAXLE:

Total Deformation	0.22499mm
Equivalent stress	117.44MPa
Factor of safety	3.07

Table 2.2: FEA results on stub axle

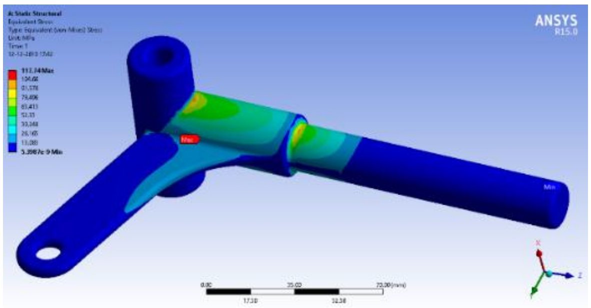

Fig 14: Stub Axle- Equivalent Stresses

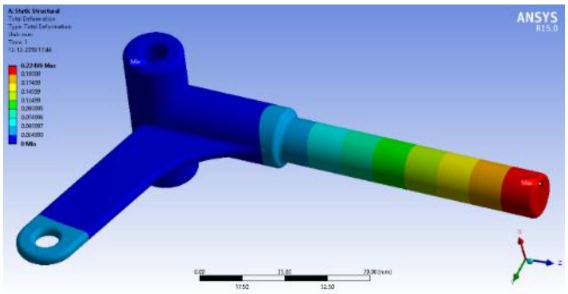

Fig 15: Stub Axle- Total Deformation

2.2 KNUCKLE:

Deformation	0.56995mm
Equivalent stress	335.97MPa
Factor of safety	1.1

Table 2.3: FEA results on Knuckle

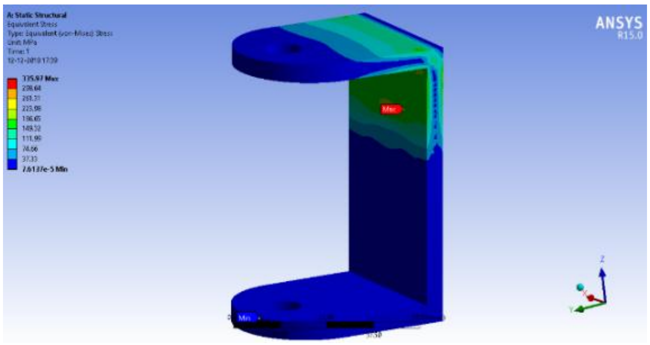

Fig 16: Knuckle – Equivalent Stress

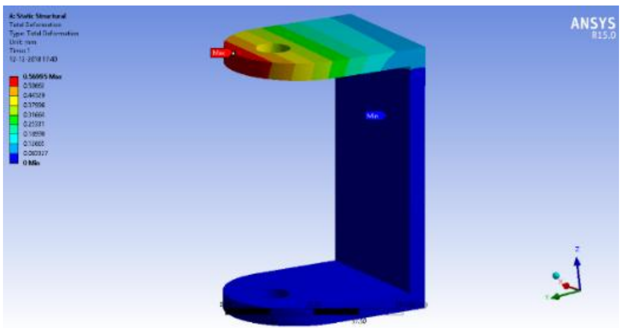

Fig 17: Knuckle- Total Deformation

2.3 BELL CRANK:

Deformation	0.001mm
Equivalent stress	19.361MPa

Table 2.4: FEA results of Bell crank

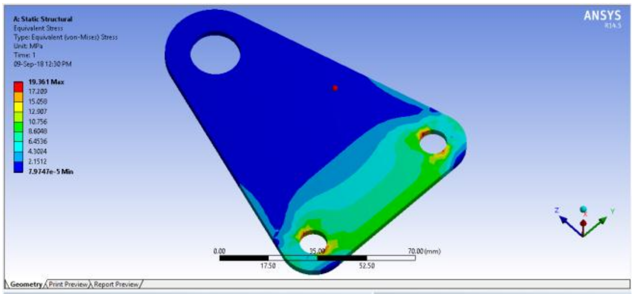

Fig 18: Bell Crank- Equivalent Stress

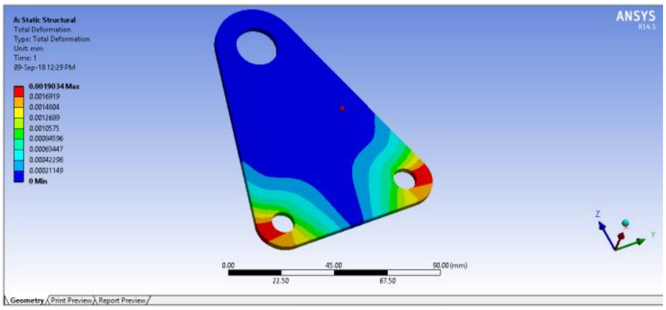

Fig 19: Bell Crank- Total Deformation

3. BRAKING SYSTEM

3.1 OBJECTIVE

The main objective of braking is to bring the vehicle to stop, safely and effectively. To achieve the most performance out of the braking system, the brakes were designed to lock the rear wheels, while minimizing the cost and weight.

The selection of the components of Braking System is as follows:

MAKE	*BOSCH 19.05*
Diameter (mm)	*19.05mm*

Table 3.1: Master Cylinder

Type	DOT 4
Dry boiling point	446°F

Table 3.2: Brake Fluid

BRAKE LINES: *Steel*
BRAKE DISC: *Stainless Steel*

Diameter	*180mm*
Approx. weight	*500gm*

Table 3.3: Brake Disc

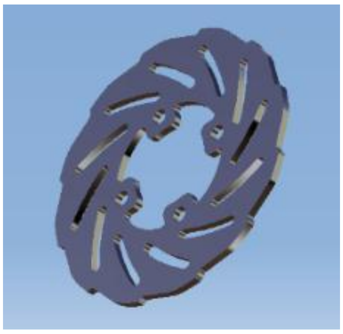

Fig 20: Brake Disc

Diameter of slave	25.4mm
Coefficient of friction	0.4

Table 3.4: Brake Callipers

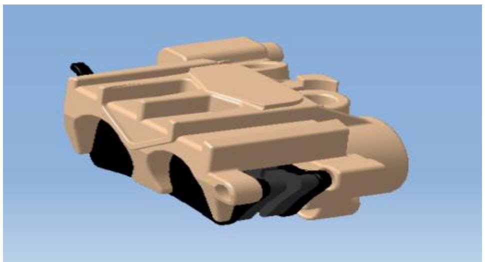

Fig 21: Brake calliper

3.2 CAE ANALYSIS:

3.1 BRAKE PEDAL:

Equivalent Stress	195.85Mpa
Total deformation	1.4602mm
Minimum factor of safety	1.88

Table 3.5: FEA results for Brake pedal

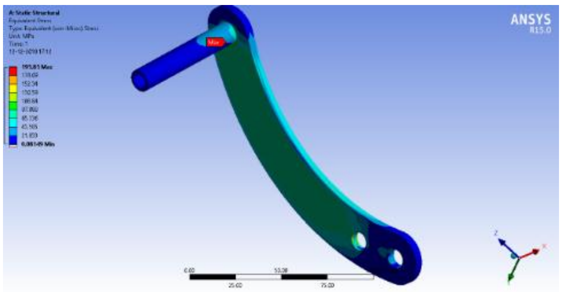

Fig 22: Brake Pedal- Equivalent Stress

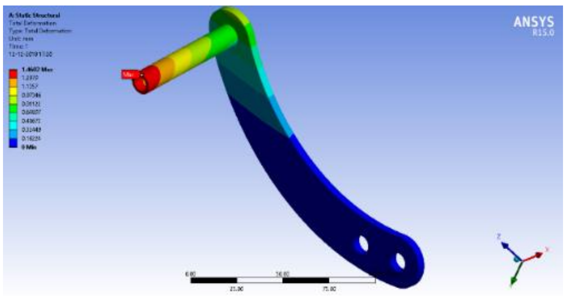

Fig 23: Brake Pedal- Total Deformation

3.2 BRAKE DISC:

Heat flux	2883W/m^2
Max. Temperature	55^{0}C

Table 3.6: FEA results for Brake Disc

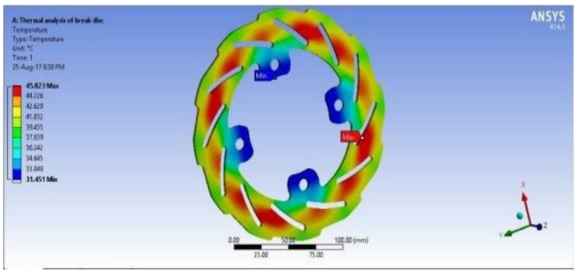

Fig 24: Thermal Analysis of Brake Disc-Temperature

3.3 BRAKE HUB:

Equivalent stress	135.42MPa
Deformation	0.022mm
Factor of safety	2.7

Table 3.7: FEA results on brake hub

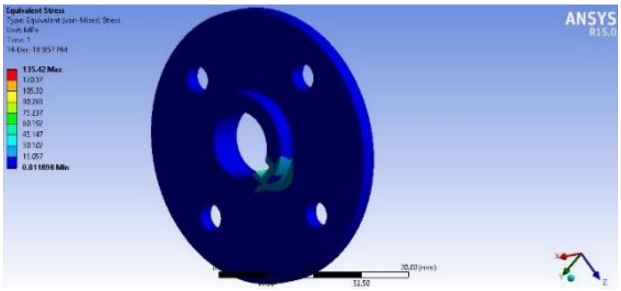

Fig 25: Brake Hub-Equivalent Stress

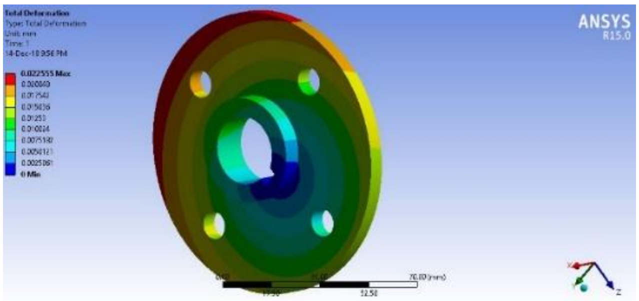

Fig 26: Brake Hub-Total Deformation

4. TRANSMISSION

4.1 OBJECTIVE

The main objective of transmission is to provide maximum driving torque at the wheels, to attain greater range of speed. Variation and resistance to the wheel motion at various speeds.

ENGINE	HONDA SHINE
Displacement	125cc
Max. Power	10.12bhp@7500rpm
Max. torque	10.54Nm@5500rpm
Fuel economy	55kmpl
Dry weight	30kgs
Overall dimensions	14" *12" *18"
Gear box	4

Table 4.1: Engine Specifications

Primary gear reduction	3.350
1st gear reduction	3.83
2nd gear reduction	2.2
3rd gear reduction	1.4
4th gear reduction	0.913

Table 4.2: Gear Reduction

4.2 ENGINE AND POWER TRAIN SHAFT DESIGN

It is solid shaft of diameter 0.98" and length of 36.5" according to design calculations. The material used is EN24.

4.3 WHY DO WE USE EN24 ONLY?

The specification and the properties of the material are given below:

Ultimate tensile	850-1000N/mm²
Yield stress	654N/mm²
Hardness	220-280BHN
Density	7840Kg/m²
Young's modulus	207-109N/m²

Table 4.3: Mechanical Properties

Maximum torque at the wheel	120Nm
Top Speed	60kmph
Chain Length (inches)	43.21
Chain Pitch	3/8"
Primary Gear Ratio	3.350
Diameter of Shaft	0.98"

Table 4.4: Specifications of Chain Drive

Fig 27: Sprocket

Chain pitch(inches)	0.375
Drive sprocket teeth	13
Driven sprocket teeth	40
Centre to centre distance(inches)	15
Links	115.42
Length(inches)	43.21"
Reduction ratio	3.1:1

Table 4.5: Chain Drive

Fig 28: Chain

4.4 CAE ANALYSIS:

4.1 REAR AXLE:

Equivalent stress	178.23MPa
Total deformation	0.7119mm
Factor of safety	2

Table 4.7: FEA Results of Rear Axle

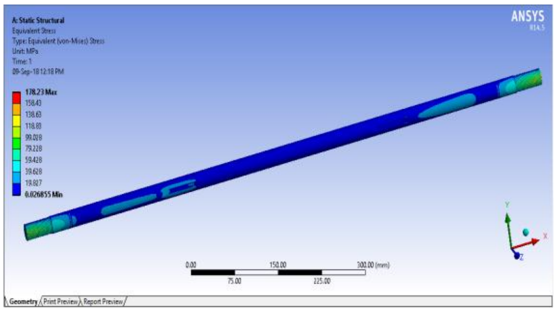

Fig 29: Rear Axle- Equivalent Stress

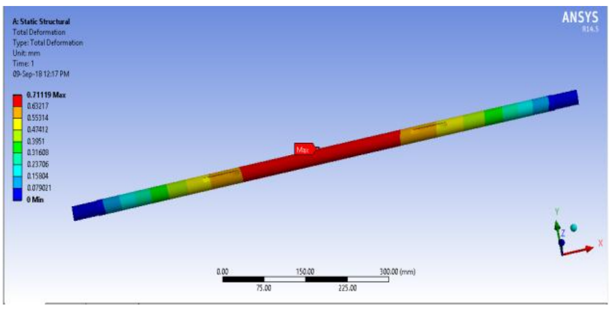

Fig 30: Rear Axle- Total Deformation

4.2 BEARING MOUNT AXLE:

Equivalent stress	17.978MPa
Total deformation	0.0047028mm

Table 4.8: FEA Results of Bearing Mount Axle

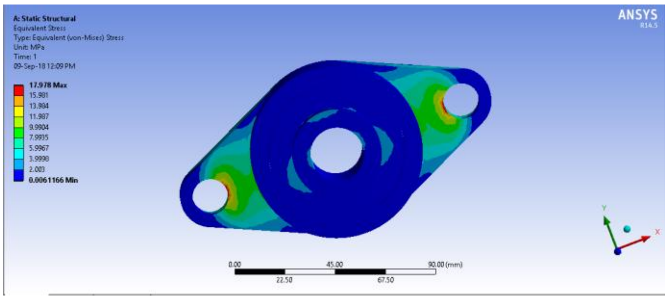

Fig 31: Bearing Mount Axle- Equivalent Stress

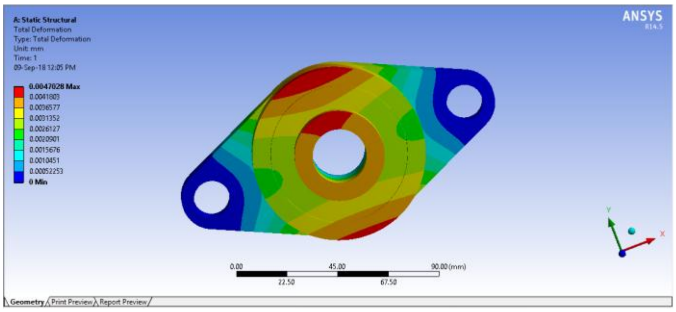

Fig 32: Bearing Mount Axle- Total Deformation

4.3 BIG SPROCKET:

Equivalent stress	154.73MPa
Total deformation	0.016154mm
Factor of safety	2.39

Table 4.9: FEA Results of Big Sprocket

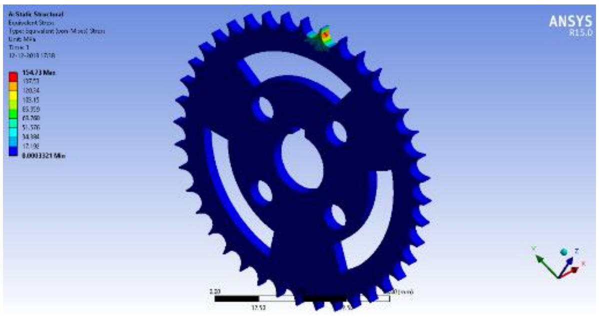

Fig 33: Big Sprocket- Equivalent Stress

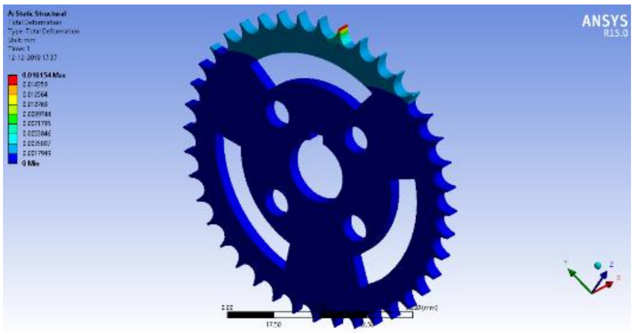

Fig 34: Big Sprocket- Total Deformation

4.4 SPROCKET HUB

Equivalent stress	35.851MPa
Total deformation	0.0019192mm
Factor of safety	10.32

Table 4.10: FEA Results of Sprocket Hub

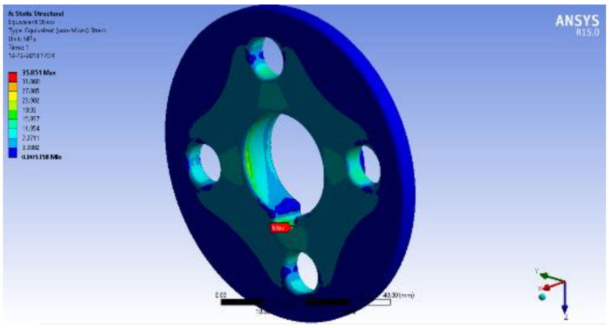

Fig 35: Sprocket Hub- Equivalent Stress

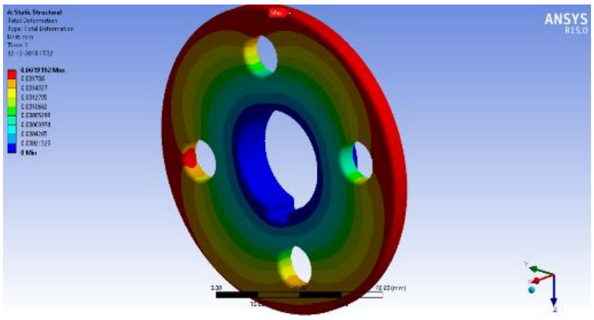

Fig 36: Sprocket Hub- Total Deformation

5. ERGONOMICS AND SAFETY:

The seat in this kart is designed to be very light and is made of plastic material. It is attached to the chassis by four points along with rubber bushes to reduce vibration to increase driver's comfort. The pedal position is ergonomically compatible with the driver's driving style. This kart has compact cockpit which is comfortable yet safe. The steering wheel is designed to occupy less space and easy to steer. The kill-switch which is mounted near the front side of seat is in ease of access to the driver in case of emergency.

Fig 37: Fire Extinguisher

Fig 38: Bucket Seat

6. CONCLUSION

The paper gives an elaborate idea on design guidelines about making of a Go-Kart. Thus, in all the cases the design, analysis, and style calculation. AISI 4130 is well known for its hardness, strength, and ease of machining. It is the best in terms of performance when compared to AISI 1018 or any other materials in the market. A very good team has performed all the required analysis on each part of the vehicle by using ANSYS software and the design team has been successful in optimizing the parts to the maximum extent. The performance of the vehicle is top notch and we are using the best part available in the market to make it number 1. Every subsystem member has worked hard to get the final desired outputs. Therefore, the final vehicle is manufactured without any compromise in either safety or in its performance.

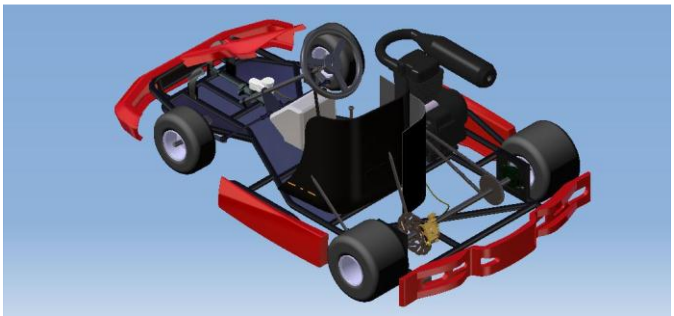

Fig 39: Final Assembly

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