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Design and Analysis of Go Kart Chassis

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Abstract—*Go-kart is a small four wheeled vehicle, specifically designed for track based purpose. It has got no suspension and no differential as well. It is mainly used to learn driving in a completely safe driving environment. It is one of the basic milestones that has to be achieved by any racer before venturing into the world of professional racing. It is used for racing and recreational purpose. Professional racers use this kind of karting in their leisure time. This helps them to safely learn and adapt new driving techniques. In the current market scenario the safety of driver is our utmost priority. Since the first thing that increases the safety of the driver is the design of chassis. So in our design of go kart chassis we have tried to use the maximum factor of safety, with weight as the limiting factor. Factor of safety is a term of load carrying capacity of the system beyond the expected or actual load. In our design consideration we have applied the highest possible force on all the four direction of the vehicle namely front, rear, side and torsion. In our design consideration, we have tried to consider as much practicality as possible in our analysis software.*

1. INTRODUCTION

Go-kart is termed as a four-wheeled, small racing car used mainly in the United States of America. They were first developed in the 1950s. Art Ingels is considered as the father of karting. He built his first kart in Southern California in 1956. From there only it was brought forward in Europe followed by other parts in the world.

A Go-kart practically has no suspension and no differential. Go Kart is usually a track focused vehicle. Go-Kart is almost exact replica of Formula One racing but in a much lower scaled down fashion. If you want to be in the formula one race, karting is the first milestone you need to make sure of. Karting is the most economically available form of racing. Since karting is the safest form of race, it can be driven by age 8 onwards in almost all the countries. A Go Kart comprises of different parts like chassis, steering, brake, tire, engine & transmission. Since the chassis plays the major role in the safety of the driver, our main focus is on the chassis which is also called as roll cage. There are various tests that can be done on the roll cage before it is manufactured. There are few parameters that need to be taken care of like displacement, stress and the factor of safety to name a few. We are not going to test the frequency test as it is not required for a go kart chassis. The roll cage that we have used is completely based on our design constraints and according to our own driver's weight.

2. DESIGN OF ROLL CAGE

The material in this chassis is AISI 4130 also known as Chromoly. This material is used in the chassis as it is more strong, durable and extremely light in weight than its nearest competitor AISI 1018. The pipe's outer diameter is of 1 inch (25.4mm) while having a thickness of 1.65mm. The physical properties and their comparison are given below.

Table 1: Physical comparison between AISI 1018 and AISI 4130.

Serial Number	Properties	AISI 1018	AISI 4130
1.	Tensile St.	440 MPa	670 MPa
2.	Yield Strength	370 MPa	435 MPa
3.	Bulk Modulus	140 GPa	140 GPa
4.	Shear Modulus	80 GPa	80 GPa
5.	Young's Modulus	205 GPa	205 GPa
6.	Poisson's Ratio	0.290	0.290

Now that we have seen the clear choice between the two materials, which is AISI 4130, we are now going to show the chemical composition of AISI 4130.

Table 2: Chemical composition of AISI 4130.

Materials	Percentage (%)
Iron	97.33-98.22
Chromium	0.8-1.10
Manganese	0.4-0.6
Carbon	0.280-0.330
Silicon	0.15-0.30
Molybdenum	0.15-0.25
Sulphur	0.040
Phosphorous	0.035

The total weight of the vehicle is considered to be 160 kg along with the weight of the driver. Please note, since we have assumed the average weight of 22 years old 6 feet male is 70Kgs, we have considered this to be the driver's weight. The vehicle is considered to be 90Kgs. We will now study the analysis like displacement, factor of safety and stress on each direction of the chassis like front, rear, side or torsional. We will analyze the given data on SolidWorks and check if the value is within our defined limit. If the value is not within our given limit, then it implies that our design has failed in that particular test.

3. FRONT IMPACT ANALYSIS

We have applied a front impact with 10000 N force which is roughly 6.3g force. The maximum displacement, maximum stress and the minimum factor of safety is well within the recommended value.

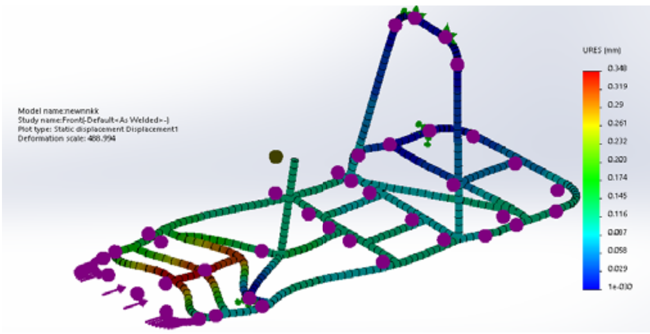

Figure 1. Displacement on Front Impact.

Maximum deformation- 0.348mm

Deformation Scale- 488.994

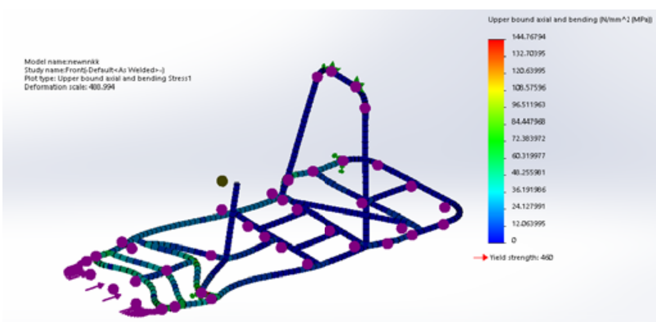

Figure 2. Stress on Front Impact.

Maximum Stress- 144.76794 MPa

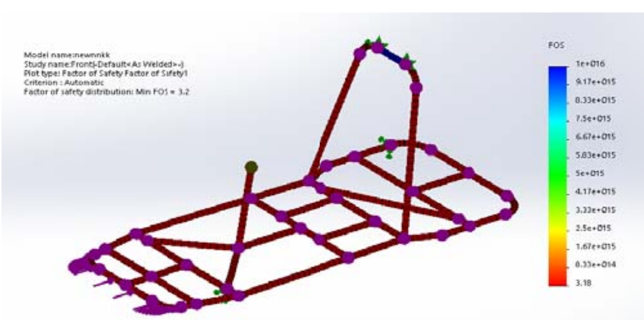

Figure 3. Factor of Safety on Front Impact.

Minimum Factor of Safety- 3.2

4. REAR IMPACT ANALYSIS

We have applied a front impact with 6000 N force which is roughly 3.8g force. The maximum displacement, maximum stress and the minimum factor of safety is well within the recommended value.

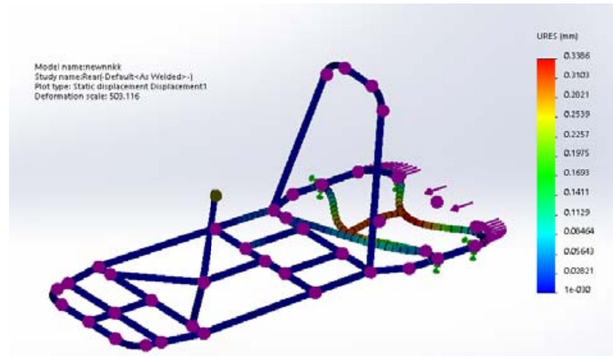

Figure 4. Displacement on Rear Impact.

Maximum Deformation- 0.3386mm

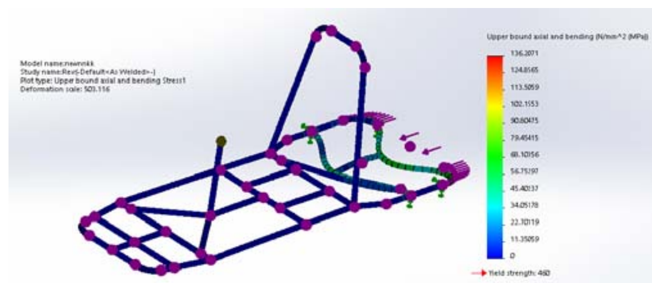

Figure 5. Stress on Rear Impact.

Maximum Stress- 136.2071 MPa

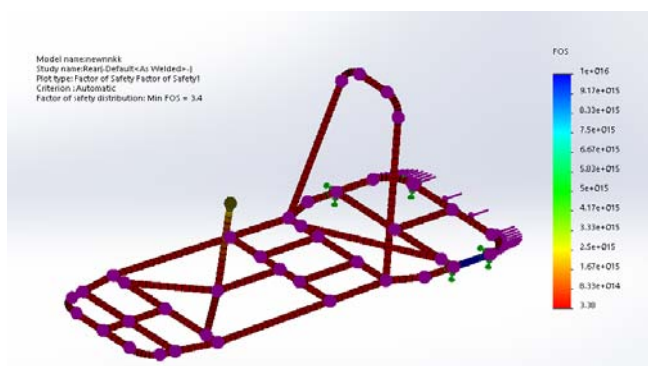

Figure 6. Factor of Safety on Rear Impact.

Minimum Factor of Safety- 3.4

5. SIDE IMPACT ANALYSIS

We have applied a front impact with 5000 N force which is roughly 3.2g force. The maximum displacement, maximum stress and the minimum factor of safety is well within the recommended value.

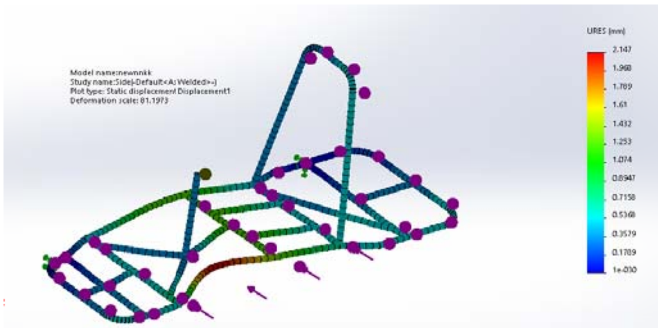

Figure 7. Displacement on Side Impact.

Maximum Stress- 216.065MPa

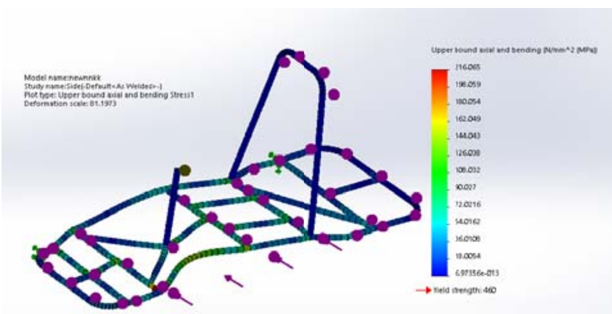

Figure 8. Stress on Side Impact.

Maximum Displacement- 2.147mm

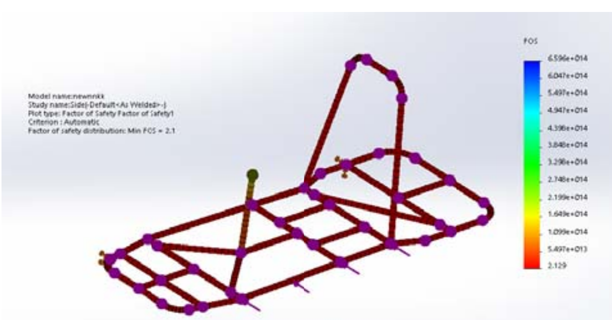

Figure 9. Factor of Safety on Side Impact.

Minimum Factor of Safety- 2.1

6. TORSIONAL IMPACT ANALYSIS

We have applied a front impact with 1500 N force which is roughly 1g force. The maximum displacement, maximum stress and the minimum factor of safety is well within the recommended value.

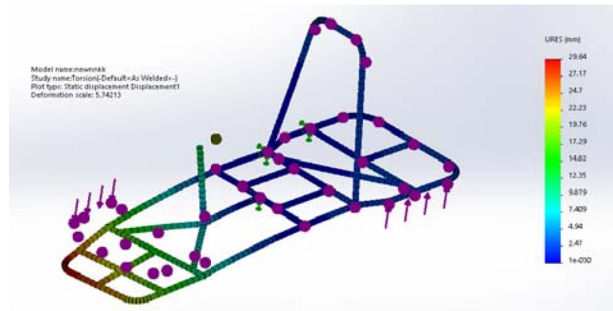

Figure 10. Displacement on Torsional Impact.

Maximum Displacement- 29.64mm

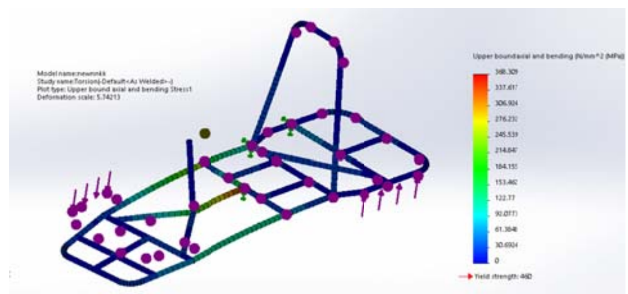

Figure 11. Stress on Torsional Analysis.

Maximum Stress- 368.309 MPa

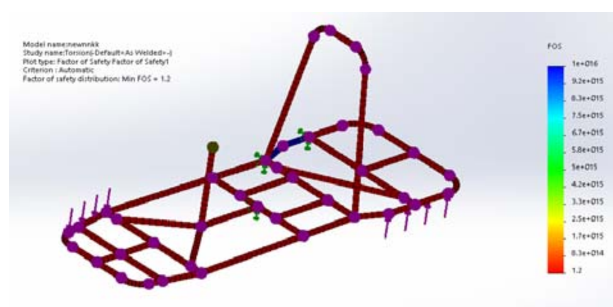

Figure 12. Factor of Safety on Torsional Impact.

Minimum Factor of Safety- 1.2

Here is an image of complete CAD model made on SolidWorks.

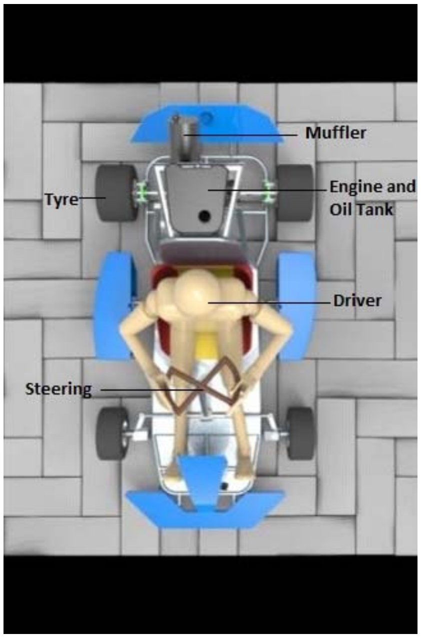

Figure 13. A Completed Kart in SolidWorks

7. MANUFACTURING

Now, we have produced a CAD model of our chassis, we will now produce a prototype with PVC (or Polyvinyl Chloride) model just to check the ergonomics and positions of gas or brake pedals.

Figure 14. A PVC model of chassis

When you're satisfied with the ergonomics, you can proceed to manufacture the chassis with AISI 4130. Here's an image side by side of our PVC model and the actual chassis of material AISI 4130.

Figure 15. A prototype PVC model and an actual chassis made by the material AISI 4130 kept side by side.

Now, that we have completed our manufacturing of our chassis, add other parts like the seat of the driver, brake and gas pedals, etc. on the actual chassis.

Here is the image of the completed vehicle of our go-kart.

Figure 15. Completed Go-Kart Vehicle.

8. CONCLUSION

The chassis or the roll cage is one of the most important parts of the vehicle as it not only supports the weight of the engine & transmission, steering, weight of the driver, braking system, but it also plays a significant role for overall vehicle and driver's safety. In our design consideration, as already mentioned before, we have considered the weight of the vehicle to be 90Kg while the weight of the driver is 70Kg. So in total the chassis or the roll cage of the vehicle will be able to withstand a total weight of 160Kg at high speed. The total weight of the chassis turns out to be 10.90Kgs, which is considerably much lower than the other chassis made up of other engineering materials.

As we have done multiple analysis on our chassis, which has qualified in all the possible tests as possible. The innovative feature of our chassis is its weight, which is comparatively lower with such a high factor of safety and other parameters.

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