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Design and Analysis of Stub Axle with Bracket of Go-Kart Vehicle

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Abstract—*Go-Kart is a small four wheeled vehicle that has neither differential nor suspension. It is one of the basics form vehicle that is designed specifically for small scaled racing. It is a full-fledged aerodynamic vehicle which can reach speed with more than 200 Km/Hr. Since handling of go-kart is our main issue, we are going to focus on the design and analysis of stub axle and bracket of the vehicle. We have analyzed different tests like bump steer and tensile stress with the required value of forces and bracket and the stub axle. We have achieved desirable factor of safety and other parameters for our vehicle. This spindle is an important part of the vehicle as it is used to turn the vehicle in high speed cornering and also to support the bump. However, if the stub axle or the bracket fails at high speed cornering then it could lead to a catastrophic disaster for the safety of the driver. So keeping in mind the safety of the driver, we have analyzed the stub axle and bracket with weight as a constraint. The innovative feature of our stub axle is that with such a low weight it is producing an optimum factor of safety, displacement and stress.*

1. INTRODUCTION

A go-kart is a four wheeled vehicle whose sole purpose is to hit the track and race. Since it is a track based vehicle, suspension is not required. Similarly, differential is also missing since it is very small vehicle. It is one of the basic form racing which has been strictly derived from Formula One racing. It was first originated in United States of America, followed by Europe and now this go-kart racing is popular all over the world. Art Ingels first developed go-kart in the year 1956 at Southern California in United States of America. It is economic to afford and it can easily be disassembled. It generally uses engine capacity up to 200cc. However, for recreational purpose, lower engine capacities are generally maintained. [4]

Since handling of go-kart is our prior objective [1], we are mainly going to focus on stub axle and the bracket. The reason we are generally focused on the steering part is because during high speed cornering [2] if the bracket or the stub axle fails, then it would be a catastrophic disaster for the safety of the driver. We have tried to design the stub axle and the bracket to get the optimum result with as low weight as possible [6]. We have assumed the force applied by the driver on the steering wheel is 100N.

2. THE MATERIAL OF THE STUB AXLE AND BRACKET

The material we have used is Steel Alloy, which is also known as EN24, for manufacturing the Stub Axle and the Bracket. The physical properties of the material EN24 is given in Table 1 below.

Table 1: Physical Composition of EN24.

Properties	Value
Elastic Modulus	210 GPa
Poisson's Ratio	0.28
Shear Modulus	79 GPa
Tensile Strength	723.8256 MPa
Yield Strength	620.422 MPa
Specific Heat	460 J/(Kg-K)
Thermal Conductivity	50 W/(m-K)

The chemical composition of the material EN24 is given in Table 2 below.

Table 2: Chemical Composition of EN24

Element	Percentage
Carbon	0.36-0.44
Silicon	0.10-0.35
Manganese	0.45-0.70
Phosphorus	0.0-0.035
Sulphur	0.0-0.04
Molybdenum	0.20-0.35
Chromium	1.00-1.40
Nickel	1.30-1.70

The main reason of selecting the material EN24 over other engineering materials is its advantages. It is very high strength steel alloy. It is supplied hardened and tempered. It has got good very well maintained combination of ductility, strength and very good resistance to wear. It is readily machinable and easily available in the market.

3. DESIGN OF STUB AXLE

The stub axle is designed in such a way, to keep the weight as low as possible and other parameters in its optimum level [3] [5]. The image of the stub axle are given below.

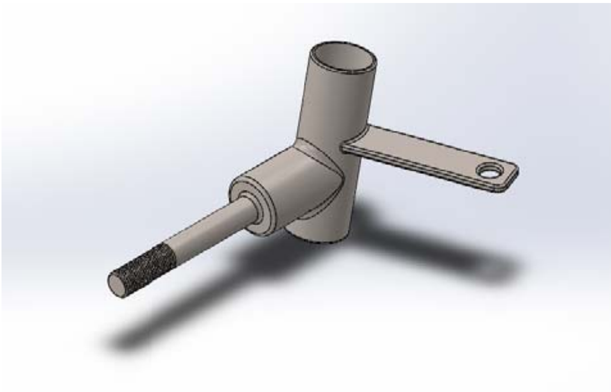

Figure 1: The Stub Axle of our Go-Kart Vehicle in SolidWorks.

We have analyzed our stub axle under different conditions and we have achieved satisfactory result.

3.1 Static Analysis of Stub Axle

We have analyzed our stub axle during static condition. The force we have applied is 1750N and we have achieved satisfactory displacement, stress and factor of safety. [11]

The maximum displacement of stub axle is shown below.

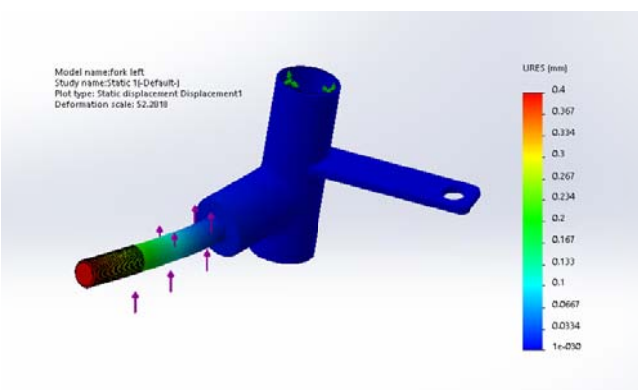

Figure 2: Maximum Displacement on Stub Axle.

Maximum Displacement- 0.4mm

The maximum stress of stub axle is given below.

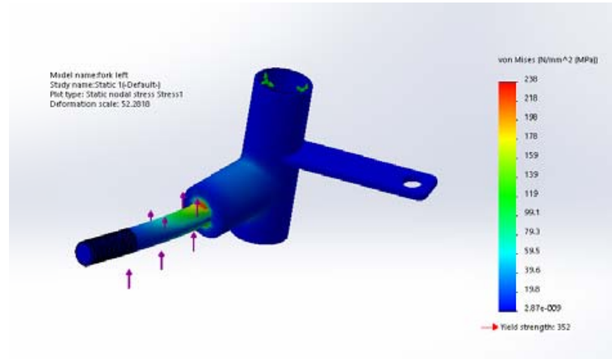

Figure 3: Maximum Stress on Stub Axle.

Maximum Stress- 238 MPa

The minimum factor of safety for the stub axle is given below.

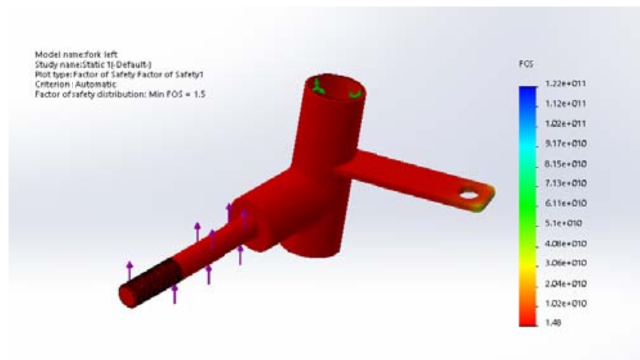

Figure 4: Minimum Factor of Safety on Stub Axle.

Minimum Factor of Safety- 1.5

3.2 Bump Steer Analysis of Stub Axle

We have analyzed the bump steer of stub axle with a force of 882.5N. The analysis images of displacement, stress and factor of safety are given below.

The maximum displacement is given below.

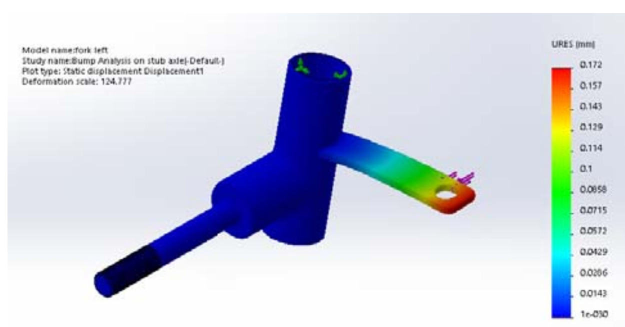

Figure 5. Maximum Displacement on Stub Axle.

Maximum Displacement- 0.172mm

The maximum stress on stub axle is given below.

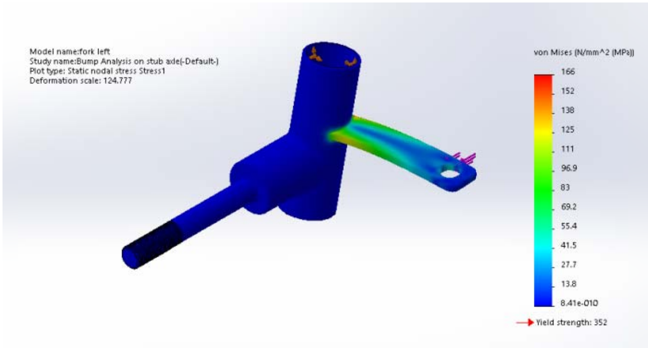

Figure 6: Maximum Stress on Stub Axle.

Maximum Stress- 166 MPa

The minimum factor of safety of the stub axle is given below.

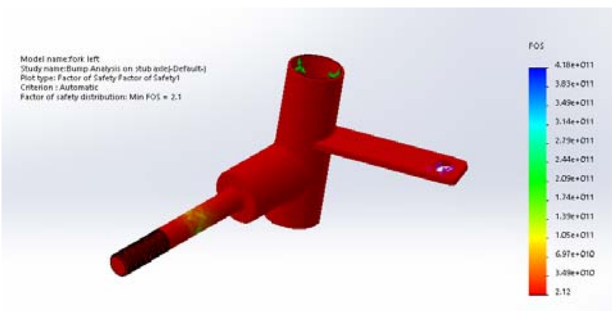

Figure 7: Minimum Factor of Safety for Stub Axle.

Minimum factor of safety- 2.12

Thus, as we can observe that all the analysis results are well within expected result.

Now that we have created a CAD model for stub axle, we are now going to create a bracket for our stub axle. [8]

4. DESIGN OF BRACKET FOR STUB AXLE

The bracket is designed to hold the stub axle in place while the go-kart vehicle is in motion [13]. The isometric view of the CAD model is given below.

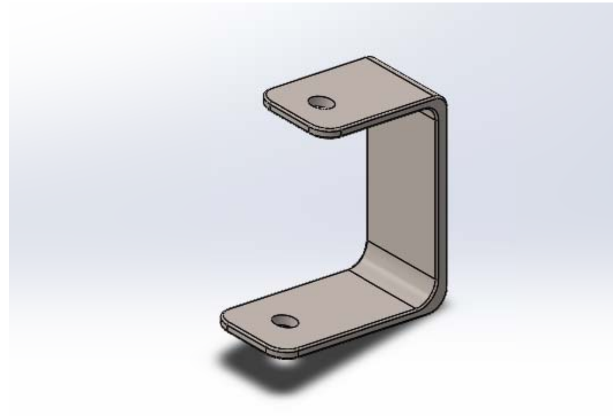

Figure 8: The Bracket of the Go-Kart Vehicle in SolidWorks.

The bracket has been analyzed to get the value of stress, displacement and the factor of safety.

We have applied a force of 1000N on the bracket and the result is well within our limit.

The maximum stress of the bracket is given below.

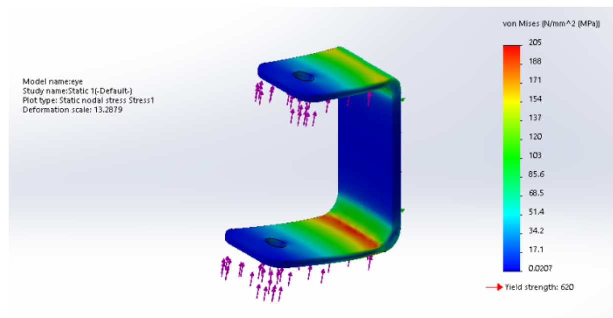

Figure 9: Maximum Stress on the Bracket.

Maximum Stress- 205 MPa

The maximum value of displacement is given below.

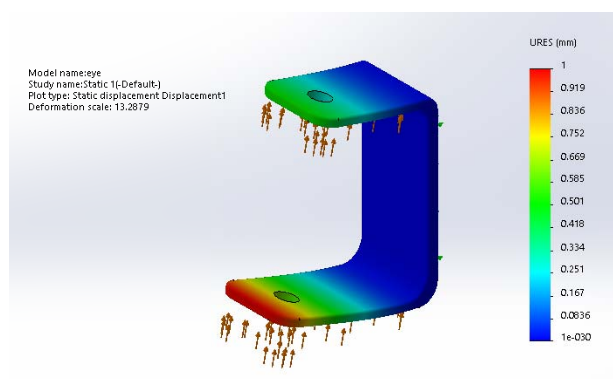

Figure 10. Maximum Displacement on Bracket.

Maximum Displacement- 1mm

The minimum value of factor of safety is given below.

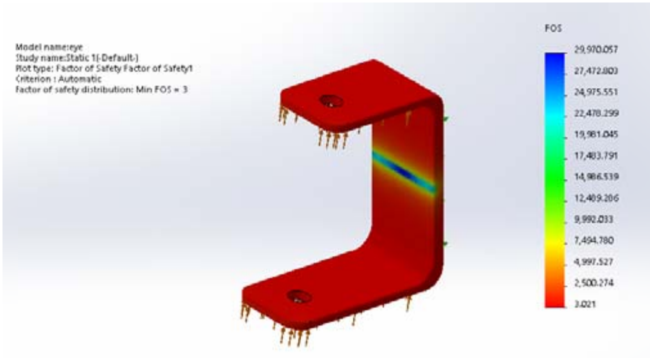

Figure 11. Minimum Value of Factor of Safety.

Minimum factor of safety- 3.0

As you can see, that all the values such as maximum stress, maximum displacement and the minimum factor of safety is well within safety range.

5. THE ASSEMBLED CAD MODEL

The image of assembled CAD Model of the bracket and the stub axle is shown. The model is first made in computer to get all the exact dimension of the manufacturing parts and then it is manufactured. [12][9]

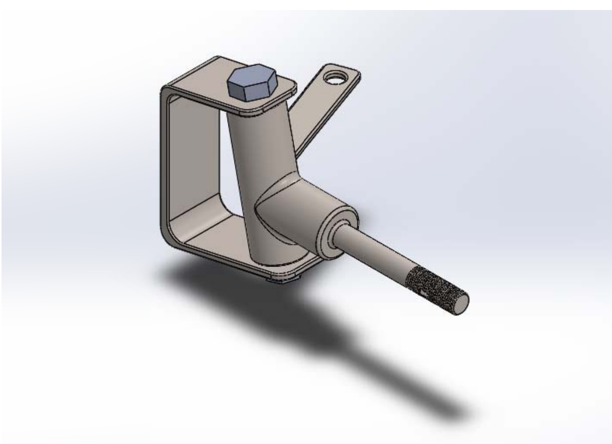

Figure 12: CAD Model of the Stub Axle and the Bracket in SolidWorks.

6. MANUFACTURING

This is where the exact dimensions from the design comes into play. The dimensions are carefully taken and then it is manufactured on EN24. Since the material is easily machinable, we have manufactured in our mechanical workshop.

After manufacturing, the bracket is welded with the frame of the go-kart vehicle [10]. At the end of the welding of the bracket, the stub axle is put inside the bracket with a nut and bolt, to keep the stub axle in place. [7]

Figure 13: Our Manufactured Stub Axle and Bracket in Go-Kart Vehicle.

7. CONCLUSION

The stub axle and the bracket is one of the main important part of the vehicle as it helps in controlling the vehicle in high speed cornering. If the bracket or the stub axle fails then this could lead to disastrous result for the safety of the driver. We have designed the stub axle and the bracket to keep weight as low as possible and to get required parameters within our safety consideration. The weight of the assembly which includes the bracket and the stub axle is 1.241Kgs, which turns out to be low considering such high other parameters. As already said we have designed the steering system in such a way that the driver has to apply a 100N force on the steering wheel.

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