e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
( Peer-Reviewed, Open Access, Fully Refereed International Journal )
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

# DESIGN AND STRUCTURE ANALYSIS OF A GOKART

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## ABSTRACT

This paper aims to study and optimize the structural design for Go kart. We took three most available materials into consideration i.e., AISI 1018, AISI 1020 and AISI 4130, and calculated Bending Stiffness and Bending Strength. From the three materials selected AISI 1018 was found to the better material for making the chassis frame regarding the fact its cost effective and easily available. Traditional go-kart chases design process is used chassis configurations are designed as per standard followed by major go-kart events organized in India and abroad. Yet we considered to use AISI 4130 the calculations were better in AISI 1080. The basic sketching and three-dimensional CAD model are designed using CAD software SolidWorks Finite element analysis is done in Solid work Stimulation. Front, Side and Rear impact simulations are conducted to obtain Total deformations, Displacement, Stress, Strain and Factor of safety.

**Keywords:** Analysis, Modeling, Go Kart, Factor Of Safety, Deformation.

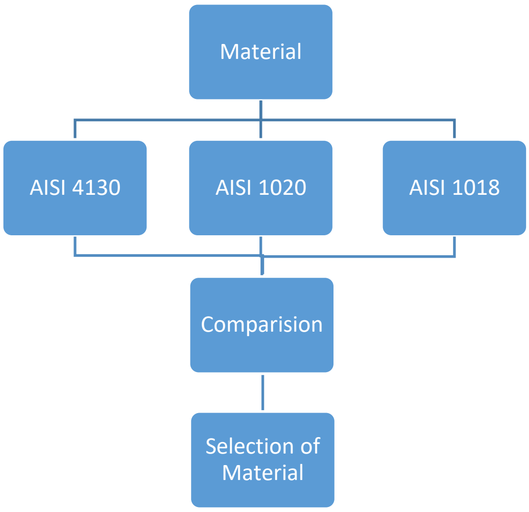
## I. INTRODUCTION

According to International Karting Commission Federation International Automobile, Go-Kart is a land vehicle with or without bodywork with four non-aligned wheels in contact with the ground, two which control the steering while the other transmits the power. Arts Ingles is known as the father of karting. Go-karts are usually powered by electric or petrol engines. The advantage of Go Kart is that it can absorb the road shocks and can drive directly as there is no need for suspension in it. Usually, the go-karts used for interschool competitions don't use suspension. [1]. Go-kart chassis is made up of steel pipes that are stiff and flexible to make up for the absence of suspension and provide some good vibrational support in case of any shock waves caused by obstacles. It should adjust itself for suspension function and be durable enough to absorb the impact of maneuvers. A chassis with high rigidity level will perform best on dry conditions whereas a flexible one in wet condition. Go-kart chassis can be classified into four types: (I) Open kart chassis with no roll cage (ii) Caged cart chassis, it has roll cage for additional support for which is preferred for dirt tracks (iii) Straight chassis is suitable for sprint racing (iv) Offset chassis is suitable for the left or right turn only [2]. The deformation and the displacement and factor safety's require simulation done is on front, side as well as rear in solid works stimulation software. The AISI 1018 contains almost 0.05 to 0.30% of carbon content due to which it is ductile and malleable in nature [3]. The chassis should be designed such that only a smaller number of materials and should be capable enough to withstand the loads when applied on it. AISI 1018 was found to be the suitable material for building the chassis due to its medium carbon content. The tensile strength of AISI 1018 was 440 Mpa for AISI 1020 it was 395 Mpa, AISI 4130 it was 560 Mpa [4]

## II. MATERIAL SELECTION

Based on the chemical and physical properties of materials, there are different materials by the AISI (American Iron and Steel Institute). AISI 4130, AISI 1018 and AISI 1020. The material AISI 4130 is having high tensile strength as compared to others, but it is expensive. Our motive is to build a budget friendly chassis. Among, AISI 1018 and AISI 1020, AISI 1018 has better yield strength and easily available

Thus, AISI 1018 is chosen as the material for our go-kart chassis having better weldability and provides a good balance of toughness, strength, ductility, cost and availability as compared to other materials viz. AISI 4130 and AISI 1020.




The circular cross section is 30.1mm x 26.9mm x 3.2mm.

Material 1: (AISI 1020) circular section, (30.1mm × 26.9mm× 3.2mm)

Material 2: (AISI 1018) circular section, (30.1mm × 26.9mm× 3.2mm)

Material 3: (AISI 4130) circular section, (30.1mm × 26.9mm× 3.2mm)

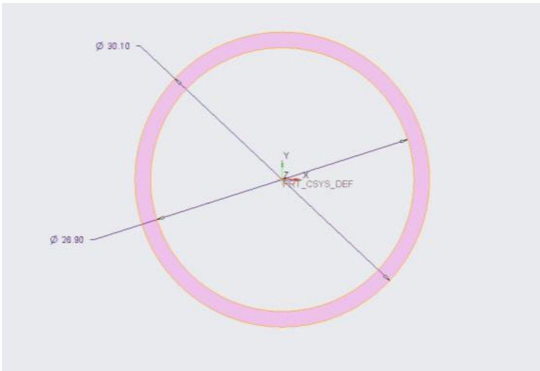


**Fig 1:** Pipe dimensions

**PROPRETIES OF MATERIAL**

| SNO | Properties | AISI 1018 | AISI 1020 | AISI 4130 |
|---|---|---|---|---|
| 1 | Tensile Strength (Mpa) | 440 | 395 | 560 |
| 2 | Yield Strength (Mpa) | 370 | 300 | 460 |
| 3 | Modulus of Elasticity (Gpa) | 205 | 200 | 210 |
| 4 | Youngs Modulus (Gpa) | 205 | 186 | 205 |
| 5 | Density (kg/m3) | 7.870 | 7.875 | 7.850 |
| 6 | Poisson's Ratio | 0.29 | 0.29 | 0.30 |

**CALCULATION OF MATERIALS**

Calculation of bending strength and bending stiffness:

Sy=Yield strength

I=Moment of inertia

C=distance between neutral axis

E= elasticity modulus

Bending strength = Sy*I/C

Bending Stiffness = E×I

a) **AISI 1018**

Circular Section, (30.1mm × 26.9mm× 3.2mm)

Sy=370MPa

E=205GPa

C=15mm

I=π× $(30.1^4-26.9^4)/64$

=14590.86$mm4$

=1.4590×$10^{-8}$ $m^4$

Hence, Bending Strength =370×1.4590×$10^{-8}$/0.015

=359.8 N-m

Bending Stiffness =205×1.4590×$10^{-8}$

=3062.7 N-$m^2$

b) **AISI 1020**

Circular Section, (30.1mm × 26.9mm× 3.2mm)

Sy=300MPa

E=200GPa

C=15mm

I=π× $(30.1^4-26.9^4)/64$

=14590.86$mm4$

=1.4590×$10^{-8}$ $m^4$

Hence, Bending Strength =300×1.4590×$10^{-8}$/0.015 =291.8 N-m

Bending Stiffness =200×1.4590×$10^{-8}$

=2918 N-$m^2$

c) **AISI 4130**

Circular Section, (30.1mm × 26.9mm× 3.2mm)

Sy=460MPa

E=210GPa

C=15mm

I=π× $(30.1^4-26.9^4)/64$

=14590.86$mm4$

=1.4590×$10^{-8}$ $m^4$

Hence, Bending Strength =460×1.4590×$10^{-8}$/0.015

=447.4 N-m

Bending Stiffness =210×1.4590×$10^{-8}$

=3064.7N-$m^2$

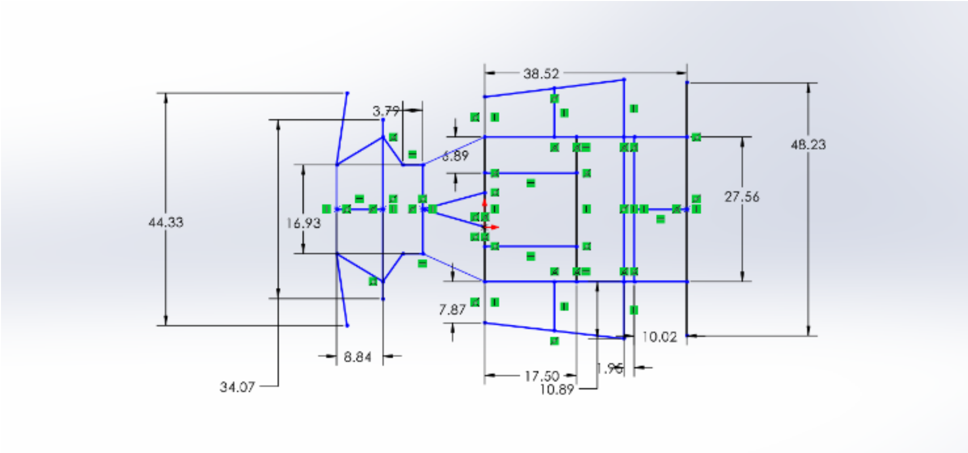
**SUMMARY**

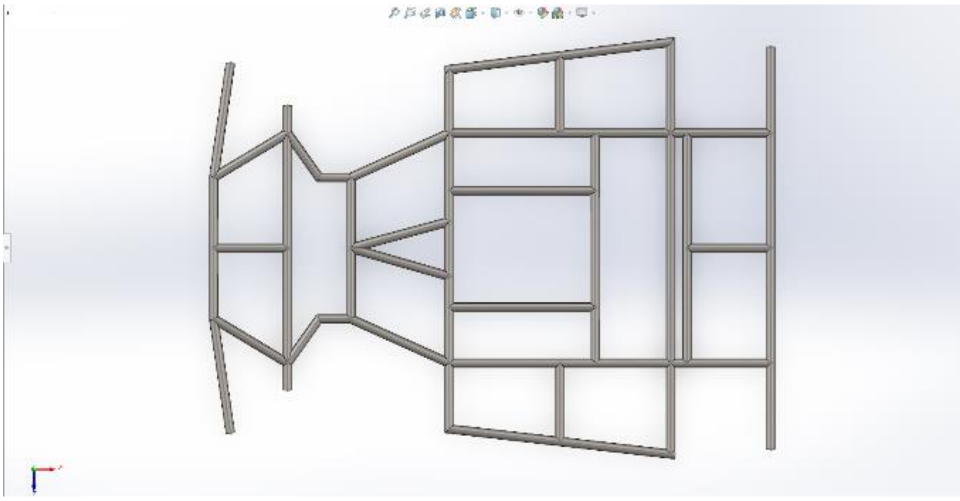
| Material | Bending Strength (N-m) | Bending Stiffness (N-$m^2$) |
|---|---|---|
| AISI 1018 | 359.8 | 3062.7 |
| AISI 1020 | 291.8 | 2918 |
| AISI 4130 | 447.4 | 3064 |

## III. MODELING AND ANALYSIS

**CHASSIS 2D AND 3D DESIGN**

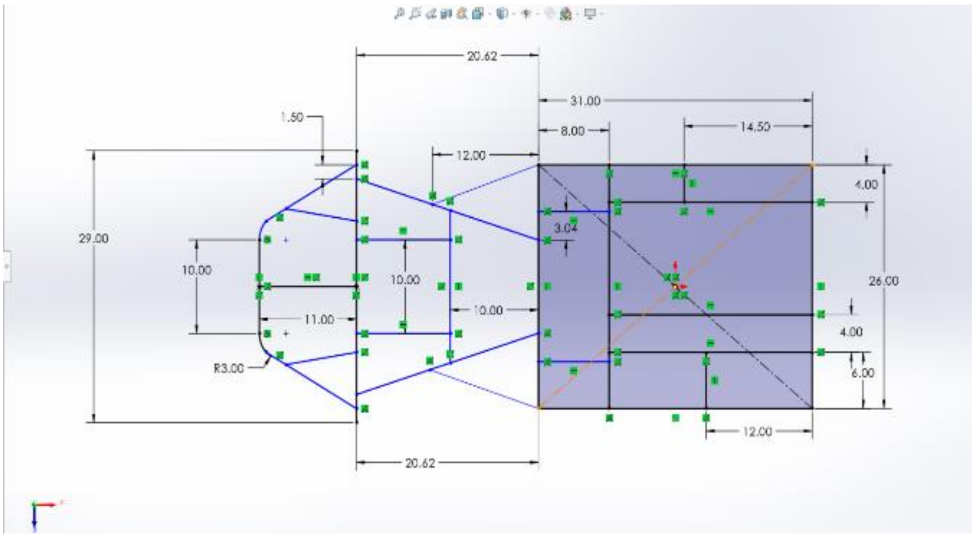
2D Sketch and Three- dimensional CAD geometry of Design – 1 (dimensions shown in figures are in inches).



Design reference (International Journal of Science, Engineering and Technology Research (IJSETR) Volume 7, Issue 1, January 2018, ISSN: 2278 -7798)

2D Sketch and Three- dimensional CAD geometry of Design – 2 (dimensions shown in figures are in inches).



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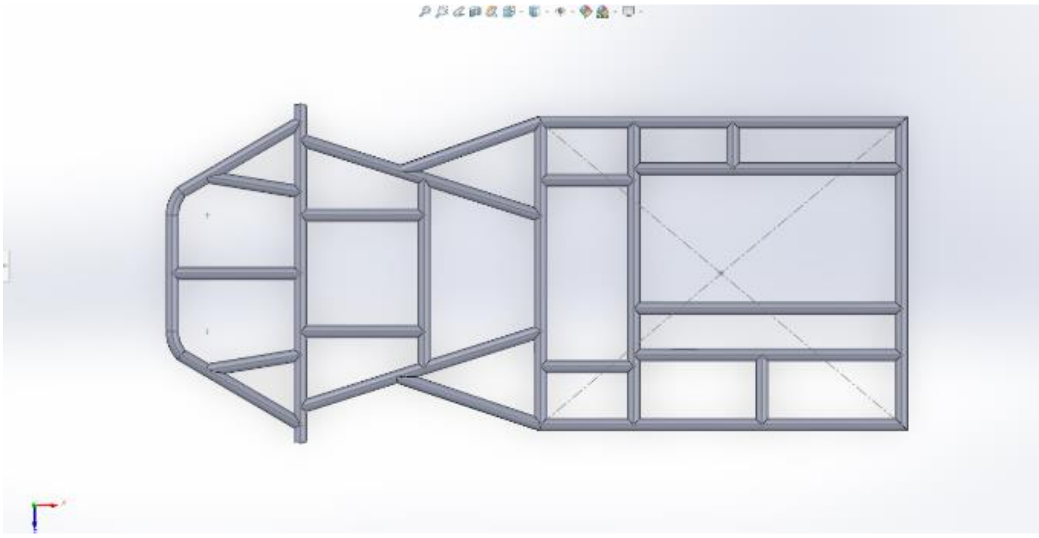


Design Reference (J. P. Srivastava, G. G. Reddy and K. S. Teja, Numerical investigation on vibration characteristics and structural behaviour of different go-kart chassis configuration, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.06.488)

**FRONT IMPACT ANALYSIS**

Mass of the vehicle is 140 Kg.

- Impact is taking place at the speed of 50Km in front, rear and side.
- Velocity is 13.89 m/s
- Time of the impact is calculated as 0.35 sec.
- Impact is calculated to take place with another vehicle that appears suddenly in front after a turn.
- G Load is 4 Nodes (node value is 4 because in finite element analysis chassis is fixed in 4 node points to be rigid)

Force = Mass of the vehicle * Acceleration

= 140*(4*9.81) = 5493.6 N = 5494 N (Rounded figure)

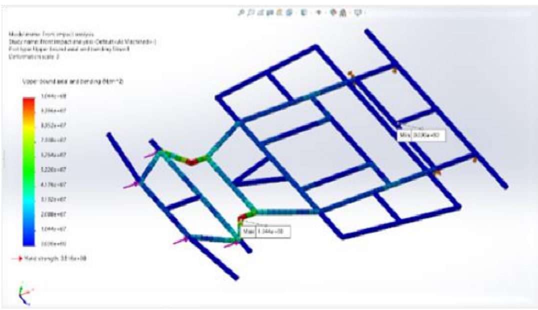
Impulse Time = W * (Velocity/Load)

= 140* (13.89/5494) = 0.35 sec

Force applied on each node = Total Load/ no of nodes = 5494/4 = 1373.5 N

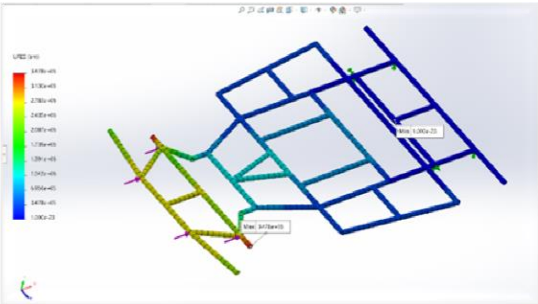
**Front Impact Analysis Design 1**

Deformation: -



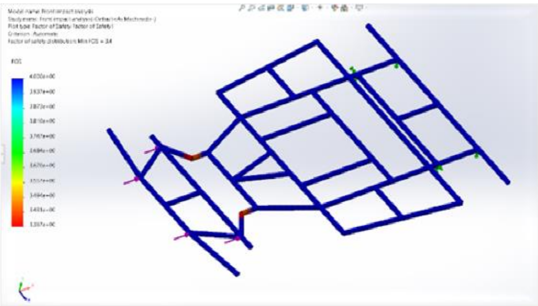
Maximum deformation = 1.044 mm

Displacement: -



Maximum Displacement = 3.47 mm

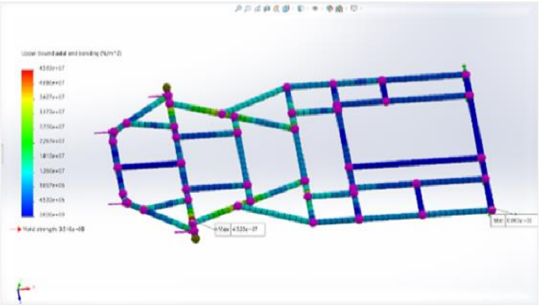
Factor of Safety: -



FOS = 3.4

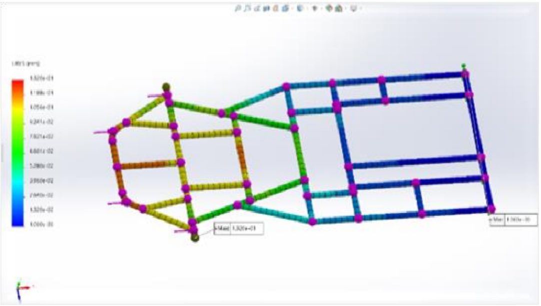
**Front Impact Analysis Design 2**

Deformation: -



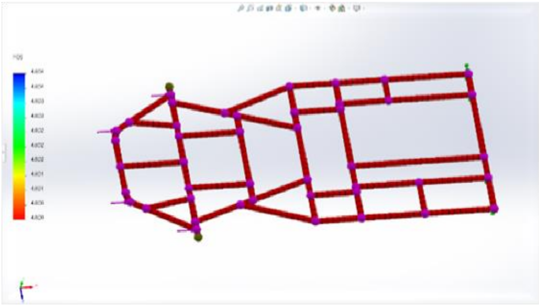
Maximum deformation = 4.553 mm

Displacement: -



Maximum Displacement = 1.320 mm

Factor of Safety: -



FOS = 4.04

**REAR IMPACT ANALYSIS**

Mass of the vehicle is 140 Kg.

- Impact is taking place at the speed of 50Km in front, rear and side.
- Velocity is 13.89 m/s
- Time of the impact is calculated as 0.35 sec.
- Impact is calculated to take place with another vehicle that appears suddenly in front after a turn.
- G Load is 4 Nodes (node value is 4 because in finite element analysis chassis is fixed in 4 node points to be rigid)

Force = Mass of the vehicle * Acceleration

= 140*(4*9.81) = 5493.6 N = 5494 N (Rounded figure)

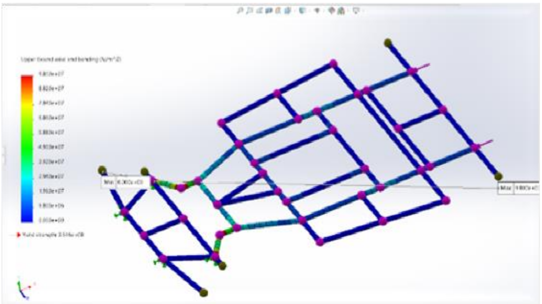
Impulse Time = W * (Velocity/Load)

= 140* (13.89/5494) = 0.35 sec

Force applied on each node = Total Load/ no of nodes = 5494/4 = 1373.5 N

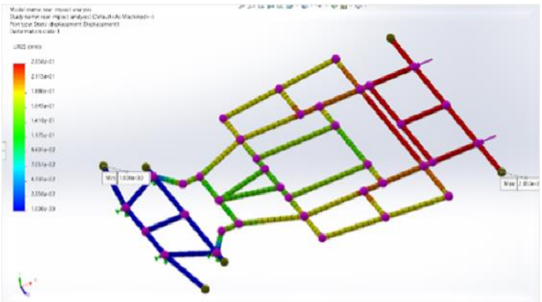
**Rear Impact Analysis Design 1**

Deformation: -



Maximum deformation = 9.8 mm

Displacement: -



Maximum Displacement = 2.35 mm

Factor of Safety: -

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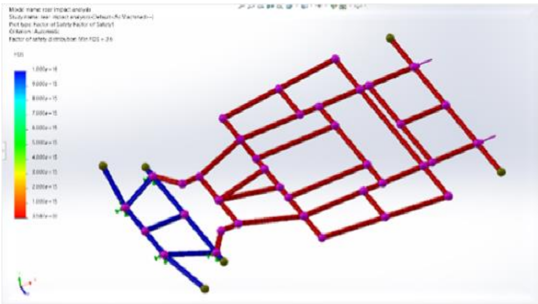
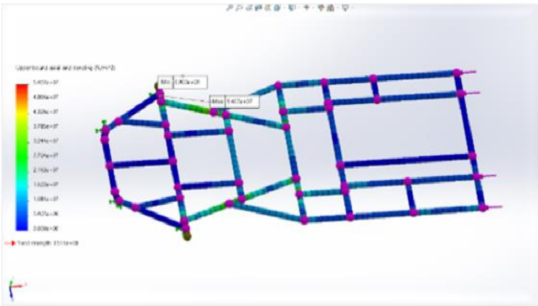


FOS = 3.6

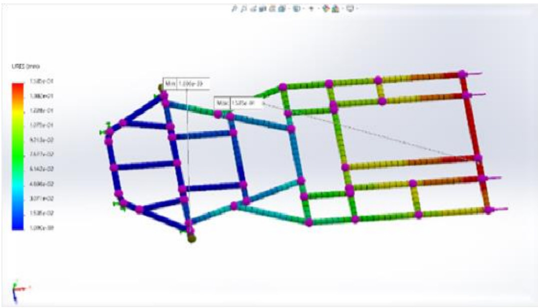
**Rear Impact Analysis Design 2**

Deformation: -



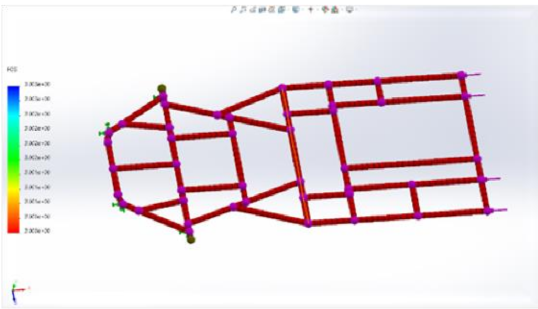
Maximum deformation = 5.40 mm

Displacement: -



Maximum Displacement = 1.53 mm

Factor of Safety: -



FOS = 3.03

**SIDE IMPACT ANALYSIS**

Mass of the vehicle is 140 Kg.

- Impact is taking place at the speed of 50Km in front, rear and side.
- Velocity is 13.89 m/s
- Time of the impact is calculated as 0.35 sec.

- Impact is calculated to take place with another vehicle that appears suddenly in front after a turn.
- G Load is 4 Nodes (node value is 4 because in finite element analysis chassis is fixed in 4 node points to be rigid)

Force = Mass of the vehicle * Acceleration

= 140*(4*9.81) = 5493.6 N = 5494 N (Rounded figure)

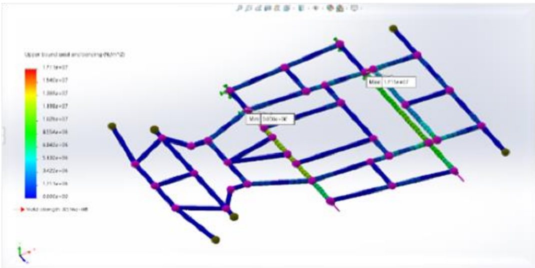
Impulse Time = W * (Velocity/Load)

= 140* (13.89/5494) = 0.35 sec

Force applied on each node = Total Load/ no of nodes = 5494/4 = 1373.5 N

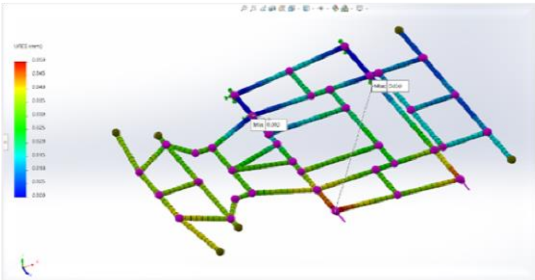
**Side Impact Analysis Design 1**

Deformation: -



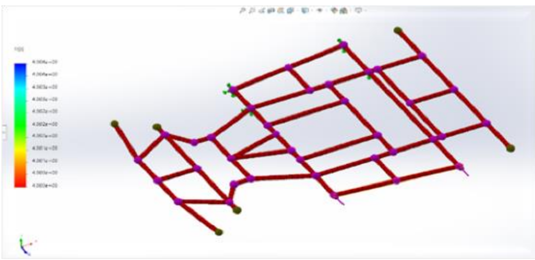
Maximum deformation = 1.71 mm

Displacement: -



Maximum Displacement = 0.05 mm

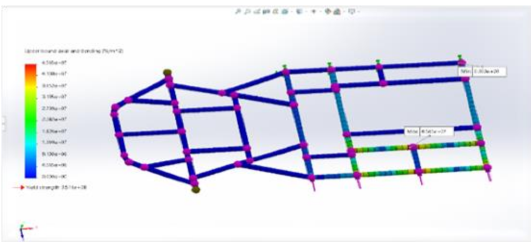
Factor of Safety: -



FOS = 4.04

**Side Impact Analysis Design 2**

Deformation: -



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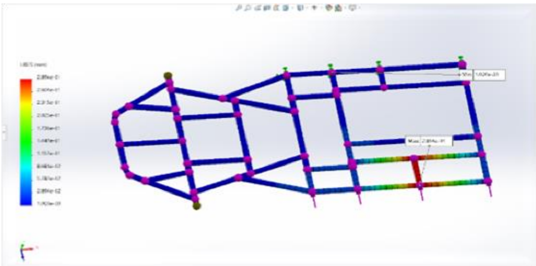
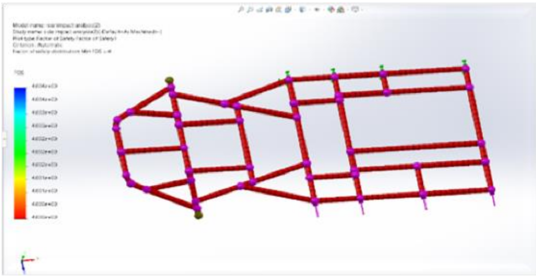
Maximum deformation = 4.565 mm

Displacement: -



Maximum Displacement = 2.89 mm

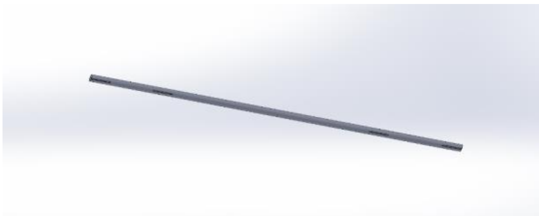
Factor of Safety: -



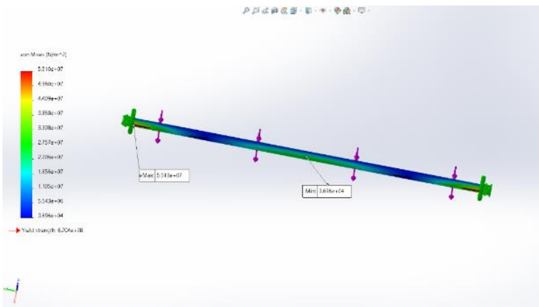
FOS = 4.04

**DRIVE SHAFT & WHEEL HUB ANALYTSIS**

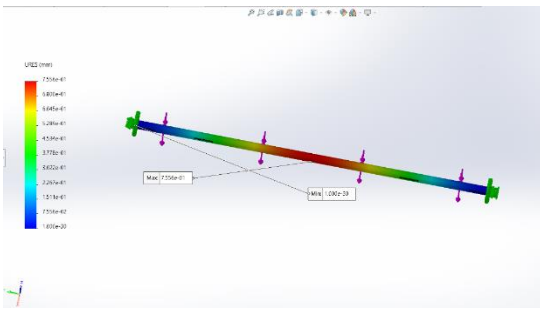
**DRIVE SHAFT**



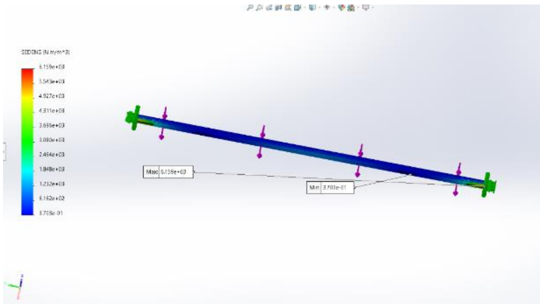
Stress: -



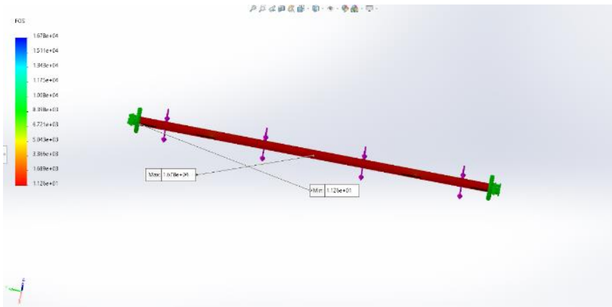
Deformation: -



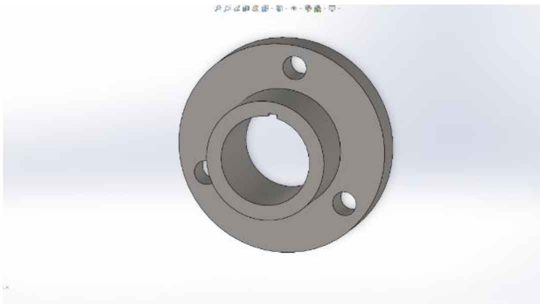
Strain: -



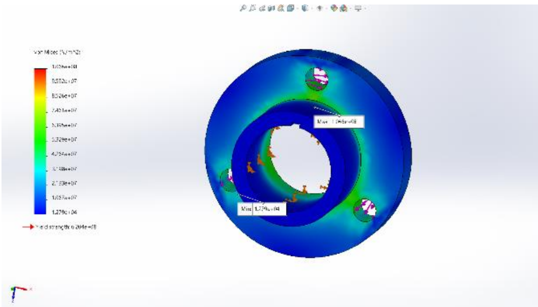
Factor of safety: -



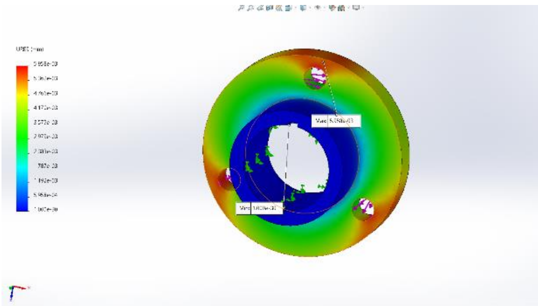
**WHEEL HUB**



Stress: -



Deformation: -



Strain: -

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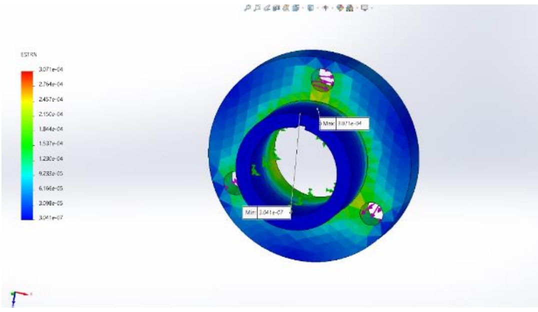
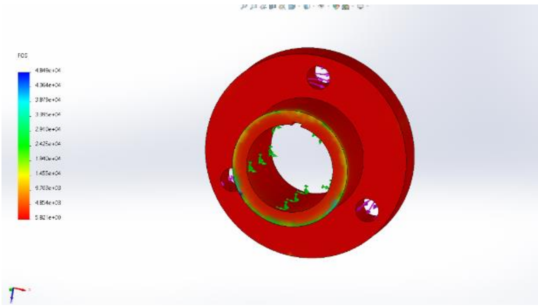


Factor of safety: -



## IV. CONCLUSION

This paper provided the basic idea of design and analysis of a Go Kart chassis for beginners considering the SAE standards and aesthetics of the vehicle. The material AISI 1018 is selected for chassis frame and the overview of choosing this material is done by considering various calculations and comparison. The impacts test done on front, side and rear was provided to understand the total deformation occurred in each case and Displacement occurred in each case and factor of safety's occurred in each case. Two designs of go-kart chassis we had taken into considerations to check which design ergonomically gives better results; it seems both designs have different form factors in different cases. Drive Shaft and Wheel Hub are important too so the analysis of Drive and Wheel Hub Is also done in terms of Stress, Strain, Deformation and Factor of Safety.

## V. REFERENCES

[1] S. Krishnamoorthi, L. Prabhu, M. Shadan et al., Design and analysis of electric Go-Kart, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.09.413

[2] Jay Prakash Srivastava, Gankidi Gangadhar Reddy, Kavvampelly Surya Teja, Numerical investigation on vibration characteristics and structural behaviour of different go-kart chassis configuration, https://doi.org/10.1016/ j. matpr.2020.06.488

[3] Ramagiri Sai Kiran, Sandhineni Sai Chandu, Design and Analysis of Go – Kart Chassis using Distinctive Materials, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 8 Issue VII, July 2020, http://doi.org/10.22214/ijraset.2020.7050

[4] Nitish Kumar Saini, Rohit Rana, Mohd. Nawaz Hassan, Kartik Goswami, Design and Impact Analysis of Go-kart Chassis, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 9, 2019 (Special Issue).]

[5] International Journal of Engineering Applied Sciences and Technology, 2016 Vol. 1, Issue 9, ISSN No. 2455-2143, Pages 95-102 Published Online July – August 2016 in IJEAST (http://www.ijeast.com)

[6] Design and fabrication of ago-kart vehicle with improved suspension and dynamics, a project report by Prabhudatta Das, 2010A4PS660G

[7] International Journal of Mechanical and Industrial Technology ISSN 2348-7593 (Online) Vol. 4, Issue 1, pp: (150-164), Month: April 2016 - September 2016, Available at: www.researchpublish.com

[8] International Journal of Research in Engineering, Science and Management Volume-1, Issue-10, October-2018 www.ijresm.com | ISSN (Online): 2581-5782

[9] International Journal of Science, Engineering and Technology Research (IJSETR) Volume 7, Issue 1, January 2018, ISSN: 2278 -7798

[10] International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 08 | Aug -2017 www.irjet.net p-ISSN: 2395-0072

[11] J. P. Srivastava, B. Krishna Chaithanya, K. Sai Teja et al., Numerical study on strength optimization of Go-Kart roll-cage using different materials and pipe thickness, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.08.217

[12] A. Chauhan, L. Naagar, S. Chawla, Design and analysis of a Go-Kart, Int. J. Mech.

[13] Ind. Technol. 3 (5) (2016) 29–37