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Go-Kart - A Working Prototype and Related Simulation Analysis using ANSYS

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Abstract : A go kart has been designed and developed by mechanical department for the Indian Karting Race (IKR). Indian Karting Race is a national level championship organized and conducted by Imperial Society of Innovative Engineers (ISIE). Various teams from all over the nation try to design and fabricate a low-cost go-kart and then compete with each other in different rounds such as in the designing phase and in safety round. The students had a great chance to prove their knowledge which they gained from the subject of automobile engineering and ic engine. The designing is done in commercial software SolidWorks 2016 and the software ANSYS 14.0 was used to perform finite element analysis. Two designs were made for the comparison so that a suitable design with higher factor of safety, best load consideration and good sporting vehicle can be selected.

Keywords: Go-Kart, Indian Karting Race, Imperial Society of Innovative Engineers, Finite Element Analysis

I. INTRODUCTION

Go-kart are the vehicles used mainly for the motorsports which is very famous in USA but nowadays many Indian companies and institutes have shown their keen interest in this as a challenging event and also as a source of economy. Indian Karting Race (IKR) is the one such event which encourage students to design and develop the go-kart for the competition and every year this event is organised on Buddh International Circuit (BIC), Greater Noida (India). The event judges the team on the criterion of their design, innovation and on safety features along with the great driving skills. The go-karting is the most economic sport as well as a hobby for some professionals it is a hobby. Go-kart is an open wheeled car with the wheels outside the main body and generally it is a single seat vehicle. With the motorsport comes a great responsibility of sensible design and safety analysis which is mostly done on the commercial software's. SolidWorks [2016] is used to generate the 3-D model of the go-kart and then the simulation [finite element analysis] was done on Ansys 14.0 software. Finite Element Analysis [FEA] is done on the 3-D models to generate the front impact, side impact, total deformation. Based on the result and calculation further changes are discussed.

2 Designing

2.1 Design Requirements

1. The engine can be used up to the limit of 160-cc.
2. The engine must be single cylinder, four stroke and air/liquid cooled.
3. The chassis material should be seamless tubes of 1 to 2 inches with a minimum wall thickness of 1.2 mm.
4. The ground clearance of the vehicle must be minimum 1 inch and maximum 5 inches with the driver sitting inside.

After the discussion 110-cc engine was provided to the team and on the basis of size and position of the engine two designs were done on the commercial software SolidWorks 2016 and the best design with higher potential was chosen to fabricate.

2.2 Material Selection

The AISI 1018 mild steel was chosen because it has the suitable carbon percentage which gives the material both hardness and strength and also it is easy to weld. Also, it was cheaper than the AISI 4130 and was easily available at the time of requirement.

Table 1: Composition of Material

Chemical Properties	%
Carbon	0.17
Iron	98.65
Manganese	0.75
Phosphorous	0.030
Sulphur	0.045

Table 2: Vehicle Design Parameters

Parameters	Maximum Limit
Length	142.24 cm
Width	96.52 cm
Weight	24 kg

3 Finite Element Analysis

Ansys workbench is the renowned software used for the static and motion analysis of any structure which is performed before the fabrication to ensure the minimum and maximum limits of the structure under various scenarios.

The finite element analysis is the most certain criterion followed to generate and analyse the front impact, rear impact, side impact and total deformation of any vehicle. Here we analysed two designs and selected the one which was best.

For the analysis the force is always applied on the impacted side of roll cage which is the first point of contact under any collision. For front impact the force is applied on the front side of the roll cage and vice-versa in the case of rear impact. The force is applied on the side for the side impact analysis.

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4.1 First Design

It was the first design which we came up with and we analysed this but after the result and discussions we changed the design.

a) Total Deformation

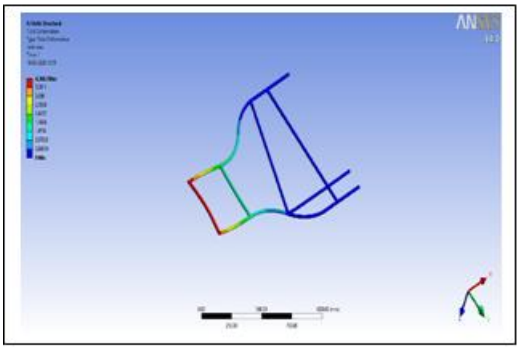

Figure 1: Total Deformation on Front Impact

b) Elastic Strain

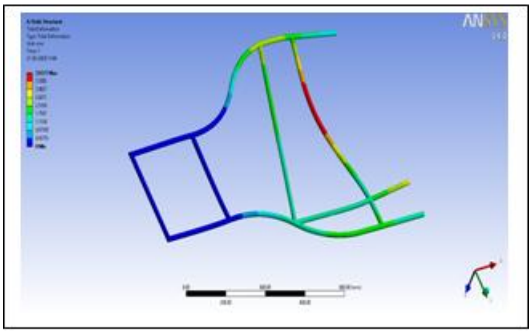

Figure 2: Elastic Strain

c) Rear Impact

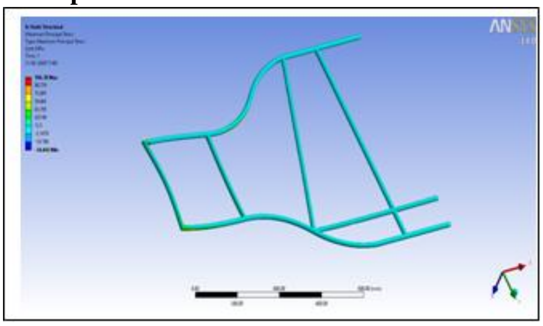

Figure 3: Deformation on Rear Impact

d) Principal Stress

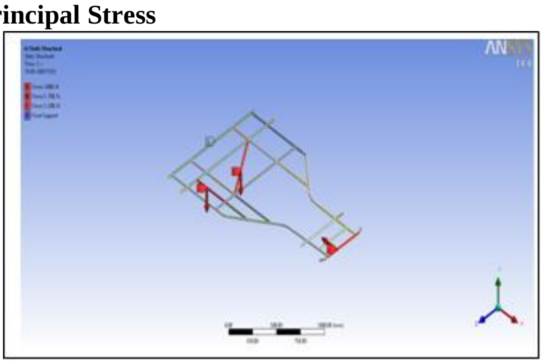

Figure 4: Principal Stress

4.2 Second Design

The previous design was not able to withstand the heavy loads and impacts in case of any failure or collision so we improvised the design and introduced some cross sections in design for better strength.

a) Front Impact

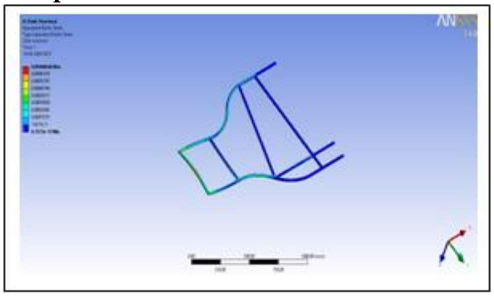

Figure 5: Applied Load for Front Impact

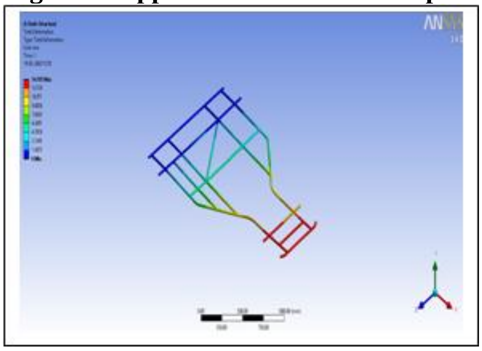

Figure 6: Total Deformation on Front Impact

b) Rear Impact

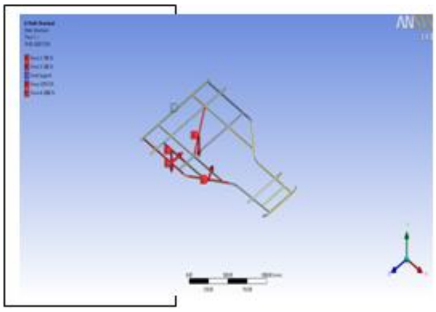

Figure 7: Applied Load for Rear Impact

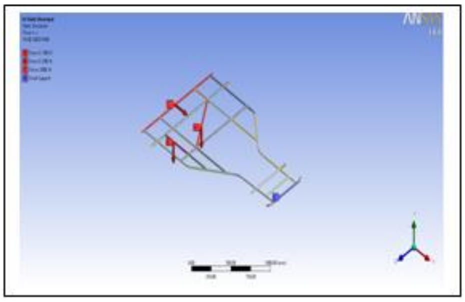

Figure 8: Total Deformation on Rear Impact

c) Side Impact

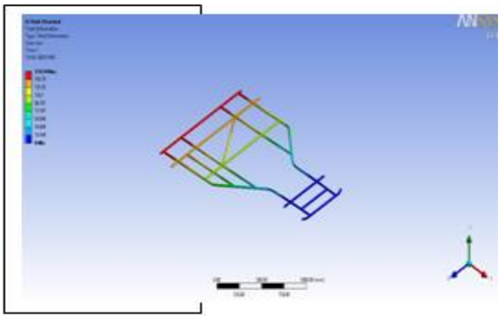

Figure 9: Applied Load for Side Impact

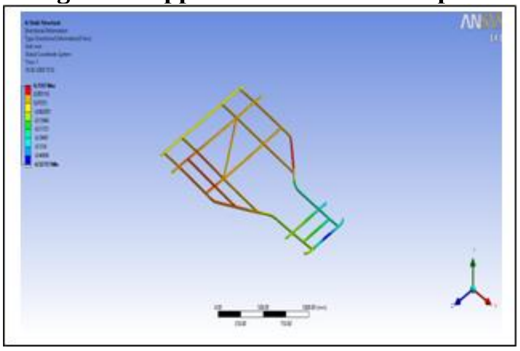

Figure 10: Total Deformation on Side Impact

In both designs the force of 2000 N was applied and the result was discussed with team and the second design was selected for the fabrication of go-kart.

The results for both the designs were formulated in the tabular form.

Object Name	Geometry
State	Fully Defined
Definition	
Type	Design Modeller
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Colour
Bounding Box	
Length X	1458.4 mm
Length Y	935.7 mm
Length Z	21.3 mm
Properties	
Volume	8.5495e+005 mm³
Mass	6.7114 kg
Scale Factor Value	1.
Statistics	
Bodies	18
Active Bodies	18
Nodes	21161
Elements	4952
Mesh Metric	None
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate System	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Attach File Via Temp File	Yes
Analysis Type	3-D
Mixed Import Resolution	None
Decompose Disjoint Faces	Yes
Enclosure and Symmetry Processing	Yes

Table 3: Results from First Design

Object	Geometry
State	Fully Defined
Definitions	
Type	Design Modeller
Length Unit	Inches
Element Control	Program Controlled
Display Style	Body Colour
Bounding Box	
Length X	1951.7 mm
Length Y	21.336 mm
Length Z	1392. mm
Properties	
Volume	2.1214e+006 mm³
Mass	16.653 kg
Scale Factor Value	1.
Statistics	
Bodies	31
Active Bodies	31
Nodes	43946
Elements	17742
Basic Geometry Options	
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated Files	No
Use Instances	Yes
Smart CAD Update	No

Attach File via Temp File	Yes
Analysis Type	3-D
Decompose Disjoint Faces	Yes
Enclosure and Symmetry Processing	Yes

Table 4: Results Obtained from Second Design

Object Name	Solid
State	Meshed
Graphical Properties	
Visible	Yes
Transparency	1.
Definition	
Supressed	No
Stiffness Behaviour	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Material	
Assignment	Structural Steel
Nonlinear Effect	Yes
Thermal Strain Effects	Yes
Bounding Box	
Length X	419.48 mm
Length Y	21.336 mm
Length Z	622.3 mm
Properties	
Volume	1.1521e+005 mm^3
Mass	0.90444 kg
Centroid X	-520.9 mm
Centroid Y	-4.3158e-003 mm
Centroid Z	-9.5923e-003 mm
Moment of Inertia Ip1	37825 kg-mm^2
Moment of Inertia Ip2	37825 kg-mm^2
Moment of Inertia Ip3	78.078 kg-mm^2
Statistics	
Nodes	1832
Elements	870
Mesh Metric	None

Table 5: Front Part Detailed Information for Second Design

II. CONCLUSION

Two designs of go-kart were made and on the basis of factor of safety, load consideration and good sporting vehicle was selected. Along this the environmental impact due to the vehicle was also considered. The use of finite element analysis was very valuable during the designing of go-kart it gave us the upper hand to calculate the load consideration and factor of safety from other commercial software's.

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