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Design and Analysis of Propane Powered Go Kart Chassis

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***Abstract*—Race Engineering has gone to a whole new level in today's world. From single cylinders to V12 engines, by means of innovation man has been able to extract all the raw power he requires. In our work we are utilizing a Propane powered Turbojet engine as the power source for our Go Kart. A Go kart in simple definition is a small vehicle which does not consist of suspension or a differential. This makes it perfect for our purpose as the Kart will be driven by the thrust developed by the Turbojet. This paper discusses about the Design and Analysis of the Go Kart that has been designed giving prime importance to safety and ergonomics. The modelling and analysis are performed using 3-D software such as CATIA V5 and NASTRAN/PATRAN. The loads are applied to determine the deflection of chassis. The analysis results indicate that design of the chassis was successful as it was not only light weight but could withstand all the tests which ensured driver safety & reliability of the frame.**

Keywords—Turbojet; Go Kart; NASTRAN/ PATRAN; Catia; Analysis.

I. INTRODUCTION

A Go Kart is a compact, lightweight, recreational racing vehicle which does not require a suspension or a differential. It's generally used for racing around a flat track and hence has a low ground clearance. The main parts of the Go Kart are the engine, chassis, steering, axle, tires and bumpers. Out of these the most important and crucial are the chassis and steering systems. The load of the driver, engine, brakes, fuel system, and steering mechanism will be supported by chassis hence it must be designed and analyzed with utmost care to provide the necessary strength to it, to protect the driver in case of accident. The driver's cabin must be capable of withstanding all shock loads. In order to achieve this, certain parameters have to be adjusted such as selection of a high strength material, cross section of the pipe being used, and providing optimum number of longitudinal and lateral members. The project aims to discover, combined with proper research to create a chassis with enhanced performance. While endeavoring to accomplish these significant aims, the project will concentrate on a specific objectives like:

- Protection of the driver by selection a material with high strength and an appropriate cross section of the pipes for weight reduction.
- Make sure that the driver is comfortable in the cabin, provide space if necessary
- Design in such a way that the cost of manufacturability is less.

II. DESIGN CONSIDERSTIONS

A. Safety Harness

A five point harness connected to the most rigid member of the roll cage guarantees reliability to ensure driver safety which has to be installed with good engineering practices and must be worn smugly. All belts must join with a single metal-to-metal quick release lever type buckle.

B. Structural Rigidity

General edge basic inflexibility is critical to improve the abilities of a 4-wheeler vehicle. To quantify the general frame rigidity, tensional inflexibility examination was led through FEA. The goal of the tensional inflexibility investigation was to control the case plan inside of the FEA programming to build the measure of torque per level of chassis deflection. By theoretically increasing the value, the genuine vehicle could be able to be more torsionally unbending, making it ready to withstand more intensive without failure. To accomplish this investigation, a simulated torque of which is proportional to the gross weight is computed i.e. Gross weight = 140 kg and the equivalent force that is.

$F = M \times g$

$F = 140 \times 9.81$

$F = 1373.4$ N

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C. Weight

Keeping the chassis as light as possible was the basic need. At the point when force is restricted, vehicle weight is an expansive variable in vehicle execution. The casing is one of the biggest and heaviest segments of the auto, and which is the reason uncommon consideration was put on the vehicle's casing weight. The system used to minimize weight comprised of deciding characterized objectives for the frame and utilizing the right material in the best places to finish those objectives.

D. Aesthetics

Aesthetically, the move confine configuration is enhanced by the utilization of more adjusted corners than the straight. The interesting utilization of adjusted corners takes into account an all the more satisfying look to the vehicle's body and additionally a decreased number of welded joints. The utilization of nonstop twisted pipes likewise decreased the no of joints the lack of sharp edges on the move confine takes into consideration the outline of more streamlined body boards which look smoother, as well as positively affect the general streamlined drag powers.

III. MODELLING

The 3-D modelling of chassis is created by Catia V5.

Fig. 1: Front View

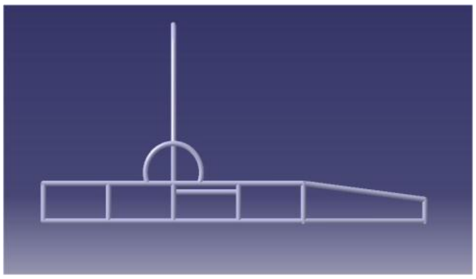

Fig. 2: Side View

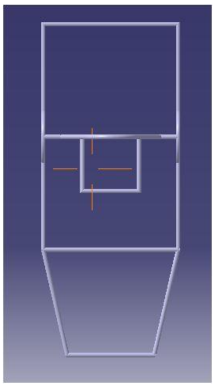

Fig. 3: Top View

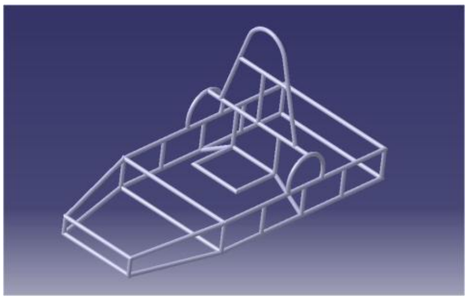

Fig. 4: Isometric View

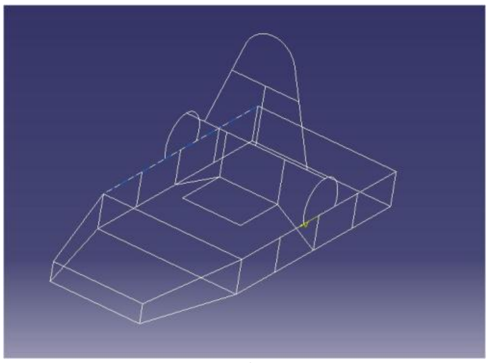

Fig. 5: Wire frame model

IV. MATERIAL SELECTION OF THE CHASSIS

The roll cage is a system which plays an important role in supporting all the sub systems and is designed to maintain integrity and safety. It also maintains minimum spacing around the driver and also gives the necessary comfort to the driver. Material chosen for the frame is AISI 1018. This material meets the necessary mechanical properties as per the designed roll cage. Circular cross-section is employed for the chassis development as it helps to overcome difficulties as increment in dimension, rise in the overall weight and decrease in performance due to reduction in acceleration. Circular section is always a preferred over other cross section become it resist the twisting effects. Circular section is selected for torsional rigidity. The primary member has an outer diameter 25.4 mm and is 3 mm thick. The secondary member also has an outer diameter of 25.4 mm and is 1 mm thick.

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TABLE I MATERIAL PROPERTY

Material Property	AISI 1080
Density (g/cm^3)	7.8
Elasticity (GPa)	210
% Elongation	18-29
Strength to weight ratio (KN/Kg)	55-60
Ultimate tensile strength (MPa)	430-470
Yield tensile strength (MPa)	240-400

V. ANALYSIS OF THE FRAME

Simulation of Load analysis was also performed using Finite Element Method (FEM) and results showed that the chassis designed was able to sustain all the vertical loading & impact loads like front impact, rear impact and side impact respectively. Fig. 7 to Fig. 13 shows the results of analysis conducted on the frame.

NASTRAN/ PATRAN was used for analysis of frame. After several iterations meshing size 10 mm was finalized with Beam element. Beam element was chosen as it is applicable to ladder & space frames and it is faster than shell method as solver assumes beam simplification in the model.

To calculate the impact force, Impulse equation was used. The rate of change of momentum for this a vehicle of mass 150 kg was assumed to hit the vehicle with an oncoming velocity of say 60 kmph i.e.16.67 m/s. In case of an elastic collision with impact duration of 0.3sec (generally ranges between 0.1-0.5 sec) the impact force obtained is:

F = Mass * Velocity / Impact time

Front Impact: (Impact time = 0.15 sec)
F = 150 * 16.67 / 0.5
F = 15588.67 N

Side Impact: (Impact Time = 0.35 sec)
F = 150 * 16.67 / 0.35
F = 7144.28 N

Rear Impact (Impact Time = 0.3)
F = 150 * 16.67 / 0.3
F = 8335 N

A. *Front Impact Analysis:*

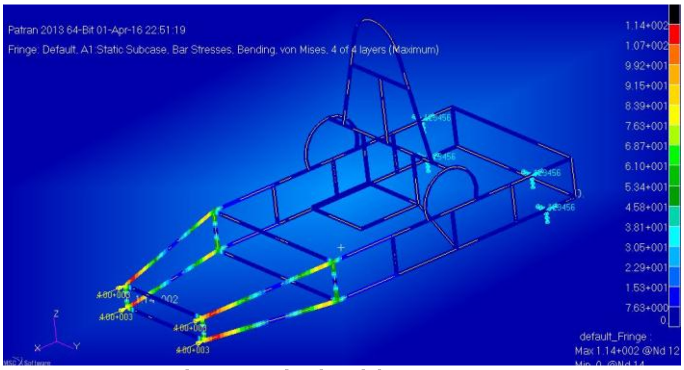

Fig. 6: Bending Stress developed during Front Impact Test

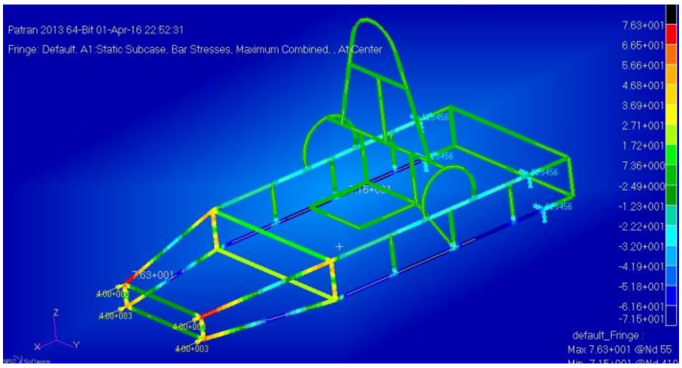

Fig. 7: Maximum Stress developed during Front Impact Test

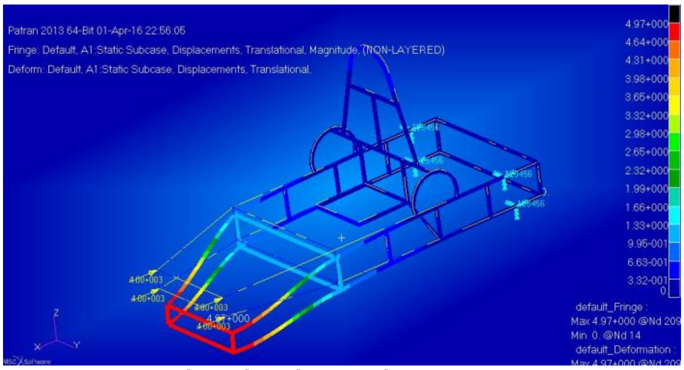

Fig. 8: Translational Displacement during Front Impact Test

B. *Side Impact Analysis:*

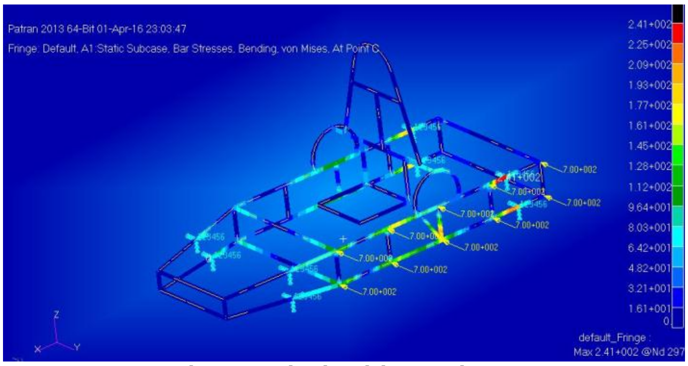

Fig. 9: Bending Stress developed during Side Impact Test

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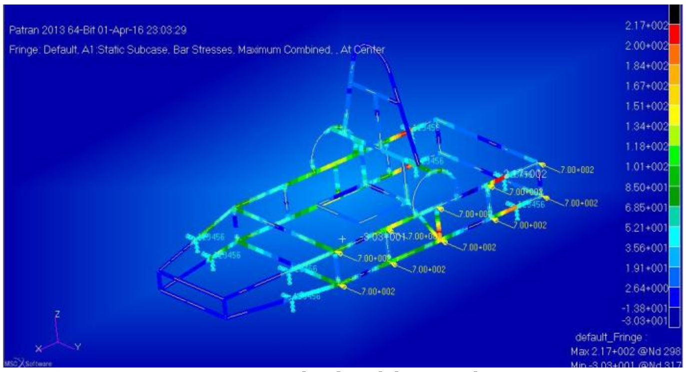

Fig. 10: Maximum Stress developed during Side Impact Test

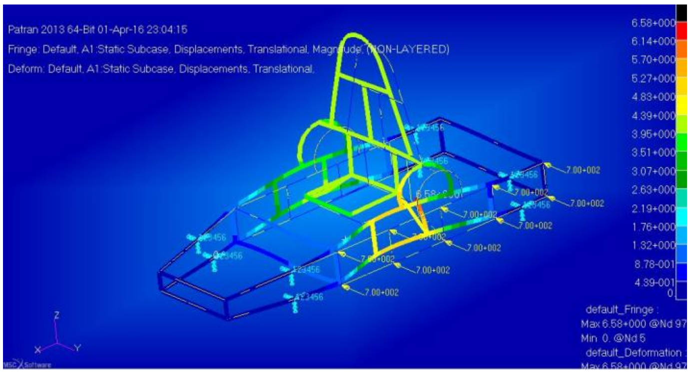

Fig.11: Translational Displacement during Side Impact Test

C. Rear Impact Analysis

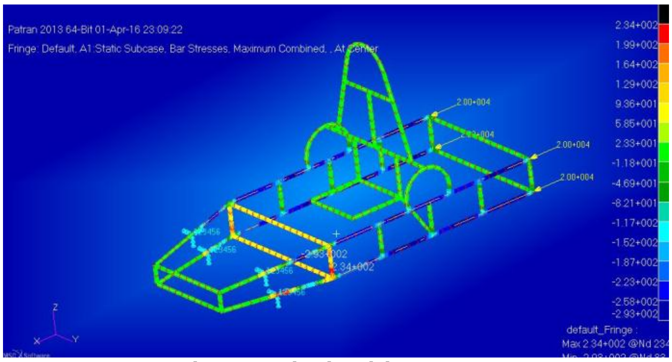

Fig. 12: Bending Stress developed during Rear Impact Test

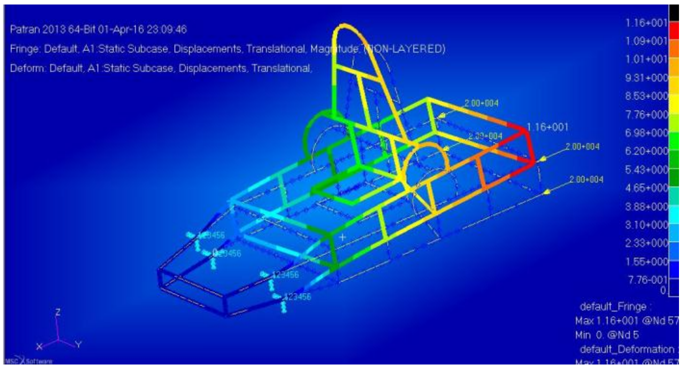

Fig.13: Translational Displacement during Rear Impact Test

TABLE II ANALYSIS RESULTS

Result	Front	Side	Rear
Stress Max. (MPa)	114	234	217
Translational Displacement (mm)	4.97	11.6	6.58
Rotational Displacement (mm)	8.79	2.23	1.51
Factor of Safety	3.2	1.6	1.7

The results of CAE indicated that design of frame was successful as it was not only light weight but could withstand all the tests which ensured driver safety & reliability of the frame.

VI. CONCLUSION

This paper discusses about the design ,analysis of a go-kart vehicle chassis .The go –kart was designed in such a way that it provides provisions for all the sub components mountings such as knuckle ,brake pedal ,acceleration pedal ,steering mounting ,propane turbocharger, seat mountings and other driver accessories. The chassis was also designed with proper driver ergonomics and safety. To come up with good chassis we have designed different chassis and made necessary changes and suitable chassis was selected. The designing process was carried out using CATIAV5.

The static finite element was carried out using MSC PATRAN and MSC NASTRAN. We carried out front impact, rear impact and side impact analysis for the chassis and obtained the maximum stress and displacements from analysis results. The obtained results were satisfactory with proper FOS and minimum displacements.

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