Multidisciplinary Journal for Applied Research in Engineering and Technology (MJARET)

Vol. III Issue 4, August – 2023, Pages: 22-26

DOI : https://doi.org/10.54228/mjaret00823005 **ISSN : 2583-1100**

Modelling Design and Analysis of E-Kart Chassis cross section using Ansys

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Abstract: The aim of this study is on the vehicle chassis material for E-Kart, both in terms of its design and its analysis. Different models were considered with various dimensional strategies and designed using Fusion 360 software. The modelled chassis were subjected to finite element analysis using Ansys workbench for its performance characteristics and geometric integrity. In this model, three different cross sections like circular, square and I section is used to examine the strength of the material. Next, the maximum stress generated and deflection are calculated for the aforementioned materials while applying the same load to the model. The design stage includes structure modelling, analysis, testing, validation and fabrication using finite element techniques. It was found that the rectangular cross section showed higher von-Misses integral strength stability when compared with “I” and circular cross section.

Keywords - E-Kart Chassis, Seamless Tube, Cross sections, Modelling, Analysis.

Introduction

A go-kart is a type of small racing vehicle that typically lacks suspension and only occasionally makes use of a differential. There are many different kinds of go-karts, including those powered by internal combustion engines, electricity, solar energy, and hybrid propulsion systems. It's a lightweight racing car with a little engine. The chassis is the main support structure of any vehicle. When building a chassis, it's important to think about where you'll put items like the braking unit, driver's cabin, rear gearbox drive, front drive unit and battery power. Crush zones were added to the front, rear, centre, and sides of the whole chassis. Petroleum-based products, used in around 93% of today's autos, are expected to be gone by 2050. A more carefully crafted chassis design will result in a more economical car. The chassis frame is the backbone of a car, to which are linked the various subsystems such as the gearbox, steering, suspension, braking system, etc. The vehicle's frames are both rigid and adaptable. As the car moves along the road, it experiences excitations from the engine and gearbox, as well as from the road's surface. Wherever there are moving or rotating pieces in equipment, there will be vibration issues.

Excessive strains, unwanted noise, loosened components, and even catastrophic failure may result from vibration. Heavy machinery may cause vibrations to spread through the buildings built to hold them. Material fatigue caused by cyclic change in the produced stress may cause the structure or machine component to fail when exposed to vibration. Authors Agrawal and Razik: Maximum shear stress, equivalent stress, and load deflections were used as optimisation targets for the automobile chassis. For the purpose of slimming down, a sensitivity study was conducted. The results of the CATIA v5 modelling demonstrated the need for a more accurate FE model of the TATA 1612 chassis. Maximum equivalent stress and total deformation created on the big vehicle under varied weights were researched by Sitaram Anjaneyulu and

Raju. CATIA, a powerful modelling software, was used to conduct two kinds of analysis to investigate the geometry's behaviour. George: -were looked at how a formula SAE vehicle chassis is built, analysed, and tested. First, we'll talk about the various loading scenarios and needs of the vehicle frame, with an emphasis on road input and load routes inside the structure. The next step was to create a basic spring model to use in setting goals for chassis and frame rigidity. The torsional rigidity of the chassis, including the frame, is modelled here together with the rates of the suspension springs and antiroll bars. Next, a finite element model was created to facilitate the investigation of various frame ideas. This project intends to make greater use of design principles while developing the chassis for an E-kart with cutting-edge machinery. The objective of this paper is First, we'll look at the various chassis materials cross section, and then we'll build a new design that combines low vehicle weight with high load capacity. To conduct a static analysis of the structure with the use of ANSYS workstation and finally to monitor the effects of a variety of loads.

CHASSIS

The E-kart chassis is a tubular frame constructed from a variety of tubing and other components. Since there is no suspension, the chassis of an E-kart must provide both stability and torsional stiffness while still being somewhat flexible. It has enough heft to support the weight of the operator and their gear. The chassis was developed with the operator's comfort and security in mind. The chassis was built with ride safety in mind, and it can handle the weight without weakening. The chassis is the primary framework of a vehicle. It links the suspension to the drivetrain and everything else that matters. The chassis has five primary purposes: to house the vehicle's passengers and their belongings; to protect the occupants and any third parties; to install the vehicle's suspension and drive train; and to create a rigid structure connecting all mounting points. Components should be mounted firmly to avoid interference and improper operation due to motion.

2. Materials and Methods

Material selection:

The foundation of the resultant chassis must be strong and stable enough to endure any anticipated strain during usage in order to provide a structure that offers a safe environment for the user. Many factors, including attempts to minimise weight, cost, and impact on the environment, play a role in making material choices. Different kinds and dimensions may be preferable depending on the material's potential use. Requirements, Design calculations and Analysis, Considerations, Testing, and Acceptance were all part of the design process.

Selection of Materials

Materials used

Table 1. Different crossection with grades

Circular cross section	AISI 1018 Grade
Rectangular cross section	AISI 1040 Grade
I Section	AISI 4310 Grade

Table 2. Properties of the material grades

Properties	AISI 1018	AISI 1040	AISI 4310
Density (gm/cc)	7.87	7.845	7.87
Tensile Strength (Mpa)	440	620	670
Yield Strength (Mpa)	370	415	435
Modulus of Elasticity (Gpa)	205	190-210	205
Shear Modulus (Gpa)	80	80	80
Poisson Ratio	0.29	0.27-0.3	0.29
Elongation in Break (50mm)	15%	25%	25.5 %
Rockwell Hardness	71	93	92
ThermalConductivity (W/mK)	51.9	51.9	42.7

Techniques used:

Static analysis is often used to evaluate numerous parameters like stress, deflection, strain, strain energy, volume, weight, etc. by taking into account dynamic situations.

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Design and Modelling:

The chassis was designed in Fusion 360. Fusion 360 is a dynamic 3D modeling software. It's a robust modeling application that takes care of everything from concept through manufacturing, with its 3D parametric capabilities and 2D tools. Fusion provides a 3D preview option for your creations.

Analysis:

Static, dynamic, fluid flow, and thermal assessments are just some of the many that may be performed with the help of Ansys 19.2, a robust simulation package. It is possible to load the IGS/IGES file containing the chassis design into the ANSYS program.

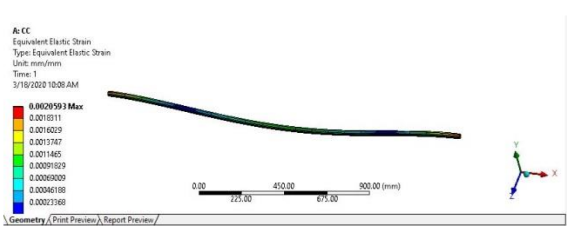
Meshing and Load:

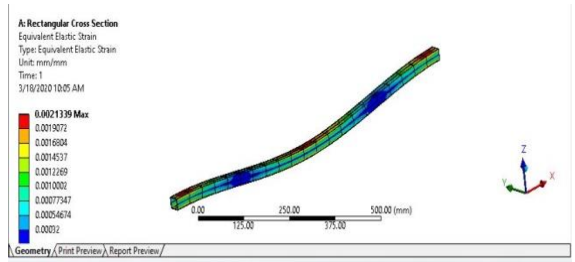
A 3516-node model consisting of 180282 cubic and tetrahedral elements is mesh-processed. For this model, we consider the static forces exerted by the truck body and the load applied to the truck chassis. Maximum loaded weight is supposed to be distributed uniformly over the whole length of the chassis structure. The chassis is represented by a boundary-constrained finite element model.

Material Utilization

As the material type becomes selected, finding out how to best optimize the material usage is one of the most challenging aspects of construction. It is of great importance to minimize the weight and volume of material. The is because of the drive to create the best possible circumstances for emissions and manufacturing aspects related to environmental impacts to be reduced to a minimum.

Equivalent Elastic Strain





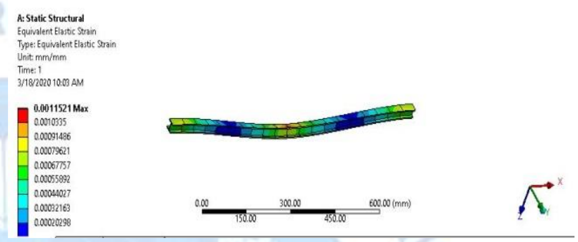
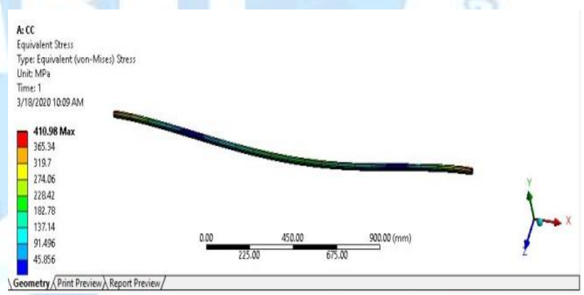
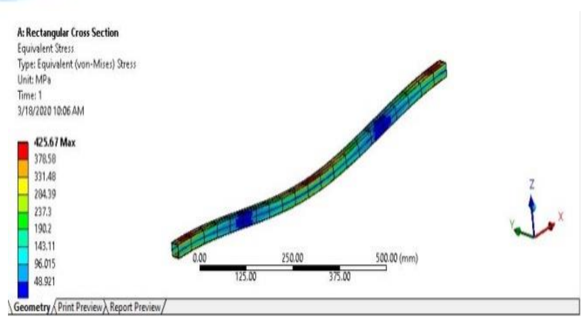


Table 3: Equivalent Elastic Strain

S. NO.	Cross Section	Max Strain (mm)	Min Strain (mm)
1	Circular AISI 1018	0.020593	0.00023368
2	Rectangular AISI 1040	0.0021339	0.00032
3	I Section AISI 4310	0.0011521	0.00020298

<u>Equivalent Von-Mises Stress:</u>





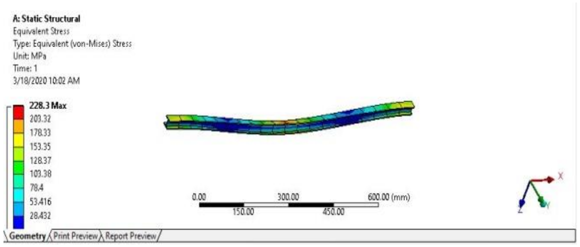
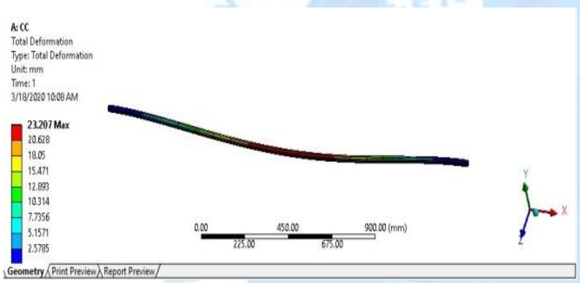
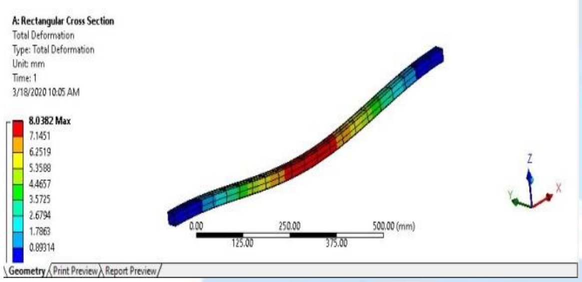


Table 4: Equivalent Von-Mises Stress Values

SNO	Cross Section	Max Strain (MPa)	Min Strain (MPa)
1	Circular AISI 1018	410.98	45.856
2	Rectangular AISI 1040	425.67	48.921
3	I Section AISI 4310	228.3	28.432

Total Deformation





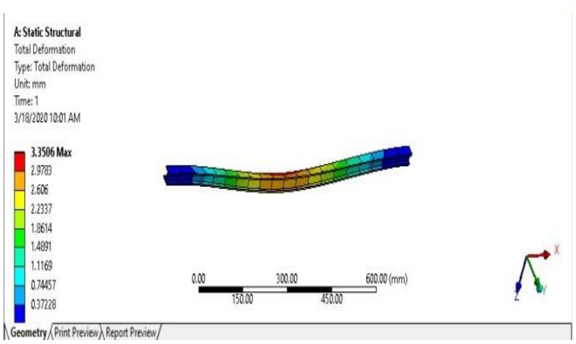


Table 5: Total Deformation

SNO	Cross Section	Max Stain (mm)	Min Strain (mm)
1	Circular AISI 1018	23.207	2.5785
2	Rectangular AISI 1040	8.0382	0.89314
3	I Section AISI 4310	3.3506	0.37228

The vehicle's strength and weight bearing capability are based on its cross section's form and size. The dimensions 210mm x 76 mm x 6 mm were used because they were readily available. The pipe has a 6mm wall thickness and an outside diameter of 25.4mm. In order to ensure that the vehicle's chosen frame material strength and size is enough. Different cross sections, such as circular, rectangular, and I section may be tested for the material's strength and dimensional stability using the finite element approach. Finite element values were used to determine the best material to use and the optimal cross section to use. From the table 3, 4and 5When comparing the von-Misses integral strength stability of circular and square cross sections, rectangular cross section was determined to be superior. The values in the I segment have been optimised with weight reduction in mind. it's all about the proportions of the various parts and how the load is distributed. Compared to an open I section, the torsional characteristics of a rectangular section are much better for a given cross sectional area. It's more durable against bending stresses and axial loads as well. The compression flanges of I-shaped sections need to be restricted because of their weakness in lateral bending resistance. However, unlike circular parts, which are mass-produced and commonly accessible in all but the smallest sizes, rectangular sections are neither as common nor as easily obtained. Since tension is concentrated more in the corners of a rectangle, circular components, solid or hollow, are subject to less pressure than their square or rectangular counterparts. It is impossible to have an uneven distribution of stress in a circular cross section. Thus, it is not prone to failure in the ordinary sense. On the other hand, the edges of regular polygons like squares, rectangles, and triangles are particularly vulnerable to stress concentration and breakage.

Justification: circular hollow tubes are light in weight

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Conclusion:

The chassis is analysed using 3 different cross-section materials, with the findings then being compared to those obtained using the optimised cross section material. It is analysed using finite element techniques to prove its effectiveness. There were many challenges throughout the design process.

When comparing the von-Misses integral strength stability of I, circular and rectangular cross sections, rectangular was determined to be superior. But based on the availability and other aspects it is recommended to have circular cross section for an excellent racing kart the chassis design were design with circular cross section tubular structure, so as to maintain the chassis structural integrity to achieve maximum performance.

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