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# Analysis and Optimization of Two Wheeler Chassis for Weight Reduction

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Maharashtra, India<sup>5</sup>

**ABSTRACT-** A two wheeler frame consists of various components which provide stiffness to vehicle. The strength of vehicle depends on components used, considering road conditions. Now a days two types of frames namely square and tubular are mostly used. Objective of this paper is to focus on vehicle frame model to analyze destructive testing methodologies. This paper is useful to study analysis of motorcycle frame.

**KEYWORDS:** ,frame, stiffness, ANSYS

## I. INTRODUCTION

In this paper whole problem related with motor cycle frame with their constraints. Due to increased competition in market the manufacturers are facing more problems for their survival mostly in automotive sector they have to face problems like manufacturing light weight bodies and more stiffness etc. To increase vehicle capacities like speed, loading capacity, mileage, grade ability of vehicle. It is necessary to concentrate on weight and size of systems and components of which vehicle is made. Therefore it is considered as the most valuable element of a vehicle as it holds all the components and part together. The strength of vehicle frame varies according to material used. It is necessary that the frame should be not buckle due to varying road conditions such as uneven road surfaces and that any distortions which may be produced should not be transmitted to the body. As commonly used frame materials steel and carbon epoxy shows different strength results. As optimization process involves preparation of cad model of the existing component which can be done with the help of 3D modeling softwares like CATIA VS, Pro-E, and Solidworks. And the analysis of this model can be done with the help of software like ANSYS which help in calculating maximum stress and displacement values of the model. In this paper, more focus on vehicle frame is discussed as the framework of vehicle is main structure on which various subassemblies are bolted which further protects main parts of vehicle. Due to complexity, cost, weight distribution, speed, stiffness, Power output may be different for different vehicles there is no perfectly ideal frame design. This paper deals with design of two-wheeler chassis frame and its weight optimization. Various loading conditions like static and dynamic loadings will be carry out on the chassis and the structural stability of the chassis will be analyse by using alternate material while maintaining the strength. The various materials will be study and the best material will be selected as the solution.

## II. LITERATURE REVIEW

**Manoj Jaya Prakash Swain Prof. Amit Kumar[1]** this paper studied the chassis frame with composite material to attain socio-economic benefits. In this paper Author highlighted that the composite materials are proving themselves as promising material in replacing automotive components for better mechanical properties. In this it is emphasized that the Chassis frame is base for all automotive components and absorb all running forces and impact forces thus needs to be strong enough.

**R4K. Venkatarao and J. Chandra Sekhar [2]** have designed and analyzed the **TATA 1109 EX2 vehicle chassis frame**. In this paper the analysis is done with two different composite materials namely E-glass/Epoxy and S-glass/Epoxy subjected to the same pressure as that of a steel frame. The results are then compared with existing steel material as tabulated in below table

Author finally concluded that by employing a polymeric composite heavy vehicle chassis for the same load carrying capacity, there is a reduction in weight of 70% to 80%.

**M. Ravi Chandra, S. Sreenivasulu, Syed Altaf Hussain[3]** in this paper author have also designed and analyzed the vehicle chassis of a TATA 2515EX vehicle. In this work three different composite heavy vehicle chassis have been modeled by considering three different cross-sections namely C, I and Box type cross sections.

**Archit Tomar & Dheer Singh [4]** in his work of static analysis, modal analysis and design modification in chassis frame have tried to optimize weight of frame by using composite material. Author designed the EICHER 11.10 chassis frame in CATIA V5R19 and structural analysis.

**C. H. Neeraja a C. R. Sireesha and D. Jawaharlal [5]** in this paper authors have modelled a suspension frame used in two-wheeler. Modelling is done in Pro/Engineer. They have done structural and modal analysis on suspension frame using four materials Steel, Aluminium Alloy A360, Magnesium and carbon fiber reinforced polymer to validate our design. By observing the results, for all the materials the stress value are less than their respective permissible yield stress values.

**Conle and Chu [6]** did research about fatigue analysis and the local stress –strain approach in complex vehicular structures. Structural optimization of automotive components applied to durability problems has been investigated

**Ferreira et al Filho Et. al. [7]** have investigated and optimized a chassis design for an off road vehicle with the appropriate dynamic and structural behaviour in July 2011

- **Findings from literature review :**

By studying all above paper, it is found that there is very less was done on two wheeler chassis for weight reduction by changing the thickness and materials. The work on different types parts are done. The same problem will be resolved in this project. The study and development of full chassis will be done. The different thickness, unwanted supports and different types of materials will be studied in this project. Also the optimum cage design will be given as solution.

- **Scope :**

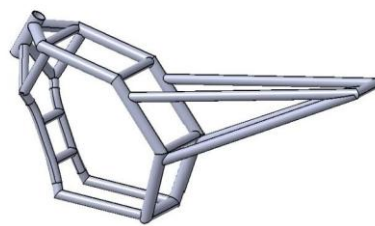
Presently the issue raised in this world is of pollution due to bi-products of petroleum. The light weight vehicles are manufactured so that there should be less consumption of fuel. In our project we will work on the vehicle chassis of two wheeler. The overall weight of this vehicle can be optimized and a appropriate solution can be given comparing to existing one. We will work on various optimizing parameters like thickness, stress bearing supports, unwanted supports, various materials which can be used for cage by keeping same load carrying capacity. Various analytical iteration on thickness, materials will be done and a optimum solution will be provided as a best solution. For modelling of chassis CATIA software will be used and for analysis ANSYS software will be used.

## II. DESIGN MODELLING AND ANALYSIS

Analysis can be done using Finite Element Analysis which can be used to determine mode shapes. ANSYS software can be used for analysis purpose. By making finite element chassis model and checking for appropriate meshing with all shell elements and after that analysed with different frequencies. This frequencies plays important role in dynamic behaviour of chassis. Two wheeler frames are mostly made of steel, aluminium or an alloy. The material properties of material which we used for analysis are given below

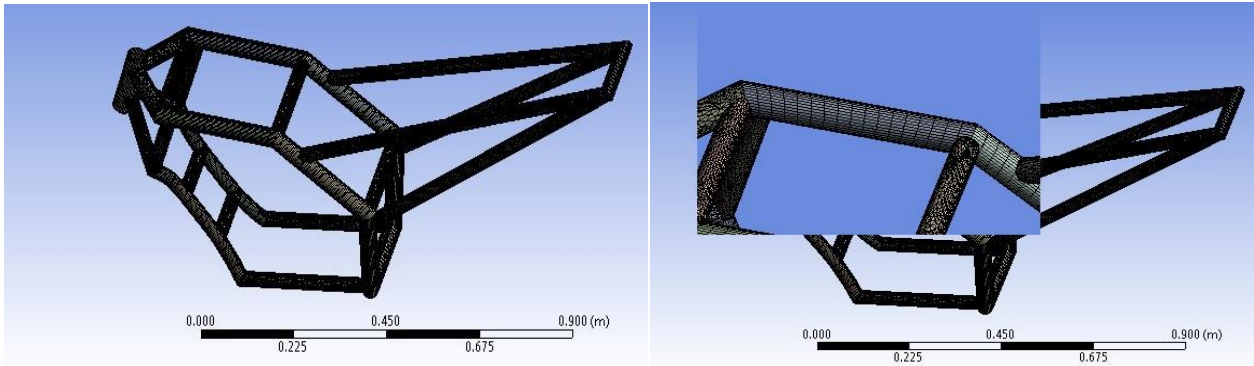
Sr.No.	Material	Density (Kg/m <sup>3</sup> )	Young's Modulus (Gpa)	Poisson's Ratio
1	Steel	7850	210	0.3
2	aluminium	2700	68.9	0.33
3	Carbon fibre	3020	71.3	0.33
4	titanium	4430	119	0.34

Figure shows the cad model of Yamaha FZ vehicle chassis designed in CATIA software.



CAD-model of FZ v2 chassis

**ANSYS Meshing** is a general-purpose, intelligent, automated high-performance product. Produces the most appropriate **mesh** for accurate, efficient multiphysics solutions. Fine meshing is required to increase solution accuracy.



a) Meshing

b) Meshing (detailed view)

Mesh statistic are as follow:

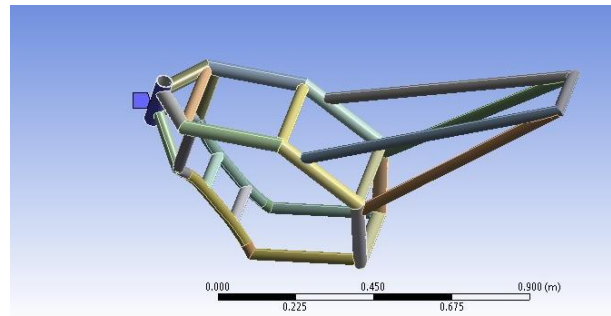
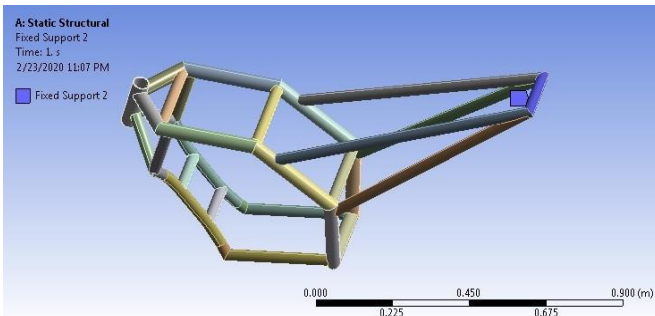
1. Minimum edge length:  $1.7811 \times 10^{-2}$  mm
2. No. of element: 22475
3. No. of nodes: 59053

Mesh quality check:

Sr. No.	Mesh Quality Parameter	Required	Achieved
1	Skewness	<0.7	0.55
2	Jacobian	Ideal value 1	1
3	Warping	<30, Ideal value 0	9
4	Aspect Ratio	<5	5
5	Orthogonal Quality	>1	0.6079

### III. RESULT AND DISCUSSION

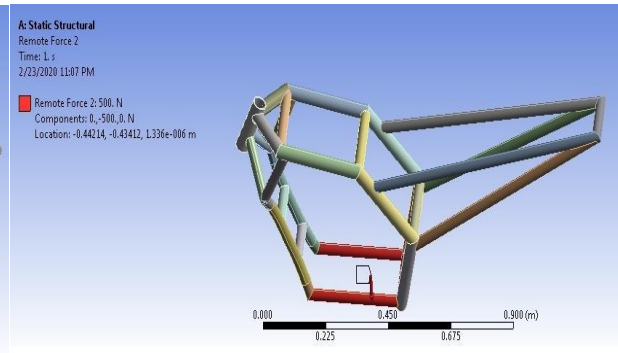
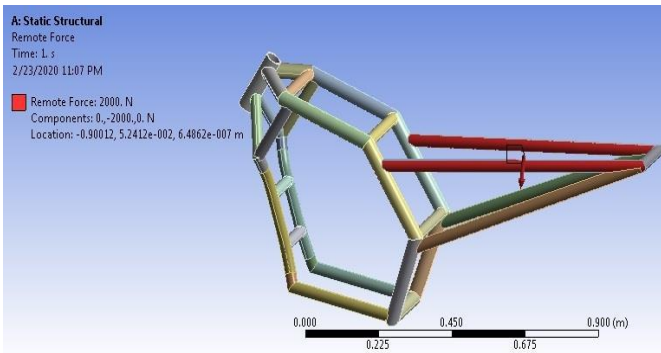
Modal analysis is more perfect tool to describe, understand and modelling structural dynamics. Physical deformations can be calculated on and inside a part or an assembly. Fixed supports prevent deformation; locations without a fixed support usually experience deformation relative to the original location. Deformations are calculated relative to the part or assembly world coordinate system. The set of individual modes of vibration are related to the dynamic behaviour of



a structure in a given frequency range.

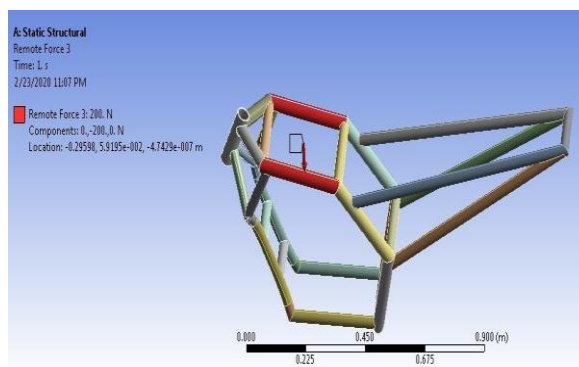
Boundary Condition: Fixed support 1

Boundary Condition: Fixed support 2



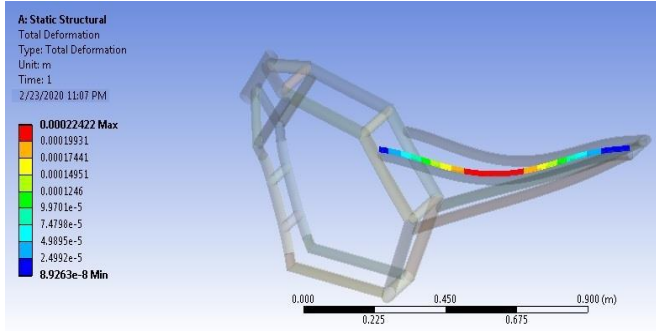
Boundary Condition: Riders Weight

Boundary Condition: Engine Load

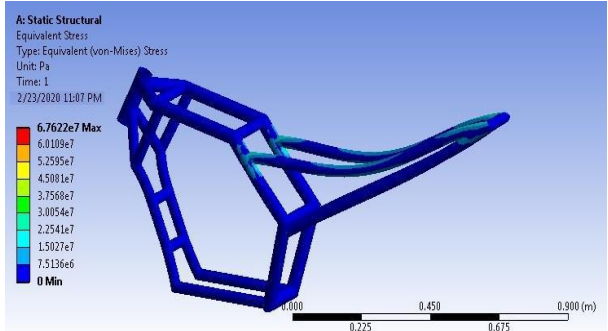


Boundary Condition: Fuel Tank Load

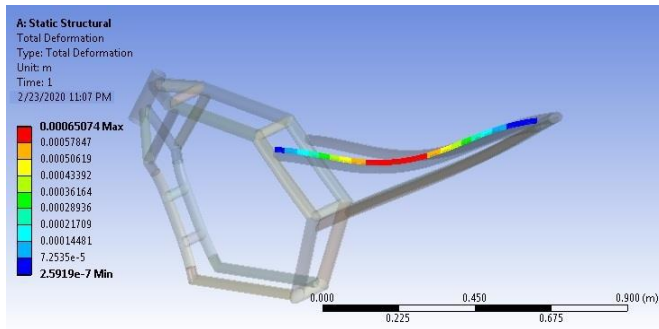
• Total Deformation and Von mises Stress of chassis for different materials:



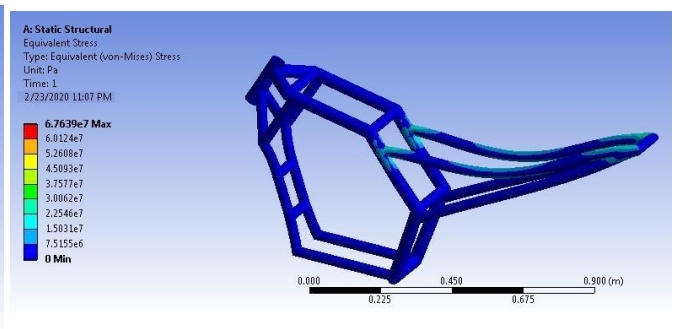
Total deformation: steel



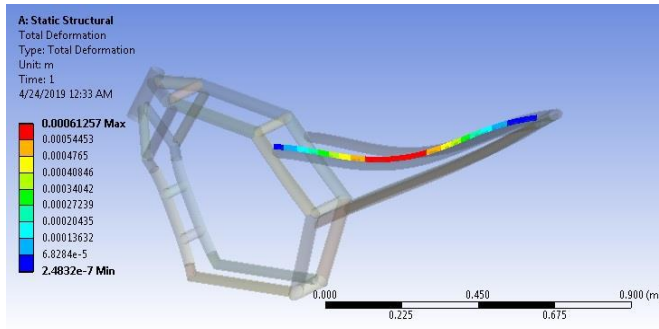
Von mises stress: steel



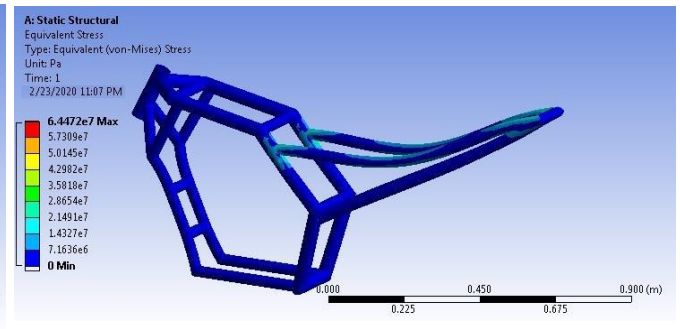
Total deformation: aluminium



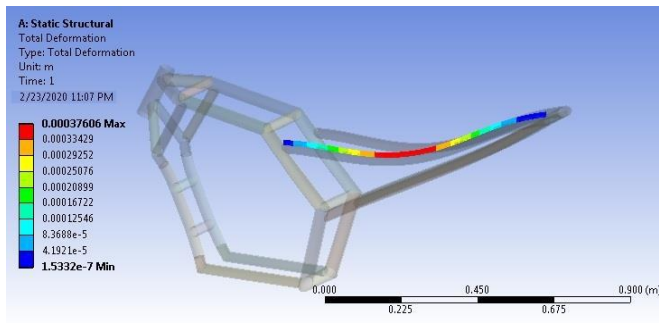
Von mises stress: aluminium



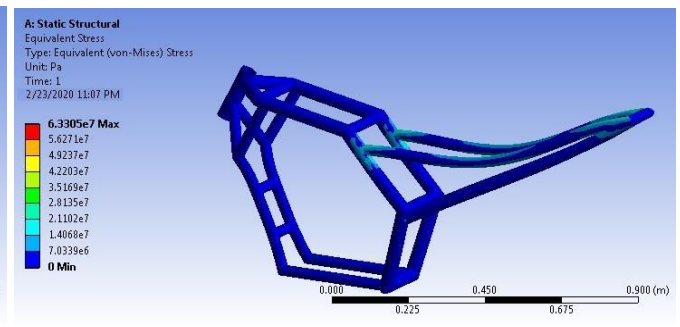
Total deformation: carbon fibre



Von mises stress: carbon fibre



Total deformation: titanium



Von mises stress: titanium

**FEA Results of chassis: Bykeeping same dimension and changing material of component**

Design	Von mises stress (MPa)	Total deformation (m)	Maximum permissible stress (MPa)	F.O.S.
Steel (SA 106 Gr b)	67.639	0.000224	250	3.69
Aluminium (Al 6061)	67.62	0.0006507	284	4.199
Titanium	63.33	0.000376	930	14.68
Carbon Fibre	64.47	0.00061	324	5.02

Table: Result table 1

Von mises stress for existing chassis design is 67.639 MPa which is below the maximum permissible stress. Hence design is safe . For weight reduction purpose we have Changed material of chassis.For Aluminium ,Titanium, Carbon fibre stress are 67.62 MPa and 63.33 MPa ,64.47 MPa but these stress value is below maximum permissible stress for steel.

Design	Weight	Weight reduction
Aluminium	7.55 Kg	65.64 %
Titanium	12.403 Kg	43.56 %
Carbon Fibre	9.6 Kg	56.31 %

Table: Result table 2

**IV. CONCLUSION**

Analysis has been completed of selected two wheeler chassis of Yamaha FZ v2 for modal analysis. From above results we can conclude that from the selected alternative materials aluminium can be the alternative for steel. By using it we can reduce the weight of vehicle. By doing this weight reduction we can increase the fuel efficiency of vehicle.

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