Journal of Mines, Metals and Fuels, *71(12D): 71-76; 2023. DOI: 10.18311/jmmf/2023/47986*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.com/index.php/jmmf*

Structural and Modal Analysis of Chassis Frame Using Mild Steel

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Abstract

The frame, suspension, wheels, and brakes make up a two-chassis. wheeler's The two-overall wheeler's design is mostly determined by its chassis. The primary carrying systems of a vehicle are its chassis. The frame acts as a foundation on which components like the engine and transmission are attached. It can be made of alloy, steel, or aluminium. The goal of this effort is to create a chassis that must be tested for jerk motions within the vehicle. By making suggestions to the business, the problem of jerking and brake noise will be resolved. CATIA V5 was used to model the chassis, and ANSYS was used to analyse it in order to check for stress, displacement, and deformation. Results for 5mm and 10mm diameter thickness were obtained after the chassis model was examined using ANSYS.

Keywords: *ANSY Chassis, Frequency, Jerking, Mild Steel, Von- Misses Stress*

1.0 Introduction

The frame serves as a foundation for mounting components like the engine and gearbox. Therefore, it is crucial that the frame not give way over a bumpy road surface. Additionally, it shouldn't cause distortion in the physique. Steel, aluminium, or an alloy can be used to make the frames of two-wheelers. The frame is primarily made of hollow tubes. Resonance will happen if the two-wheeler frame's inherent frequency and the stimulation frequency coincide. Resonance will cause the frame to oscillate in an unsafely large range, which could cause excessive deflection and failure. Experimental modal analysis is crucial for resolving these issues. Experimental modal analysis can be used to determine the intrinsic structural qualities of natural frequency, damping, and mode shapes. Finding the modal parameters of a structure for all modes in the desired frequency range is known as experimental modal analysis (EMA). This paper's primary goal is to use experimental modal analysis to determine the natural frequency, damping, and mode shape of a two-wheeler frame[1-10].

2.0 Modeling and Analysis

Steel, aluminium, or an alloy are used to make motorcycle frames. The steel alloy is examined using numerical analysis. Below are listed the qualities of its materials.

Material: Mild Steel
Young's Modulus: 1.90E+11 N/mm^2
Poison's ratio: 0.29
Density: 7680 Kg/m^3

2.1 CATIA Model

Catia v5 R20 is used to design 3d model of chassis frame, the chassis was modeled with circular hollow section with the properties of mild steel[2] (Figure 1).

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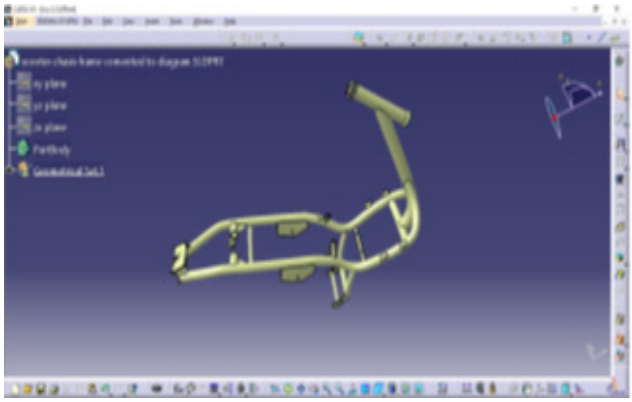


Figure 1. Chassis frame model using Catiav5.

2.2 Vibrational Analysis

CATIA CAD models are typically saved with the.CAT Part extension. The file with the .CAT Part extension cannot be imported or opened in Ansys. To open any Catia cad model, you must first export the file in.iges (initial Graphics Exchange Specification) format in order to import data into Ansys software. Furthermore,.iges is used to transfer data (2D, 3D designs) between any two different softwares

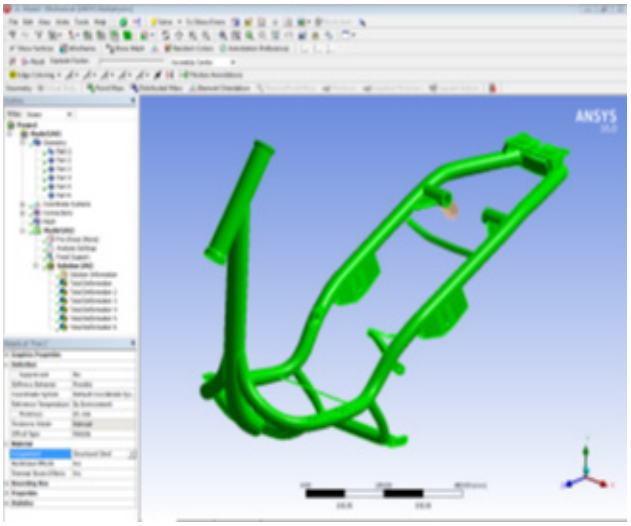


Figure 2. Imported the chassis igs file to ansys workbench.

2.3 Modal Analysis

Test 1: Inner diameter 45mm, outer diameter 50mm, thickness 5mm

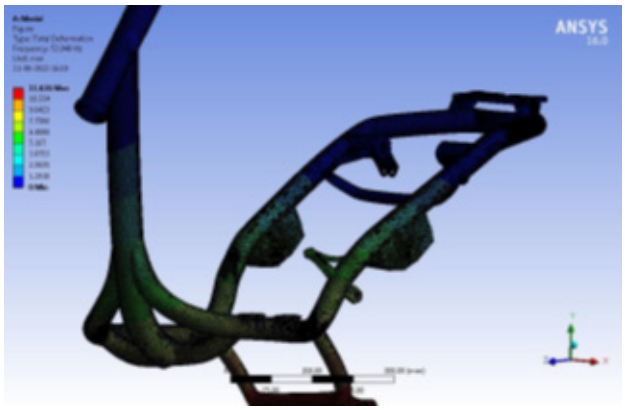


Figure 3. Total deformation on mode 1.

For Mode 1 at the Frequency of 53.948Hz the deformation found maximum11.626mm

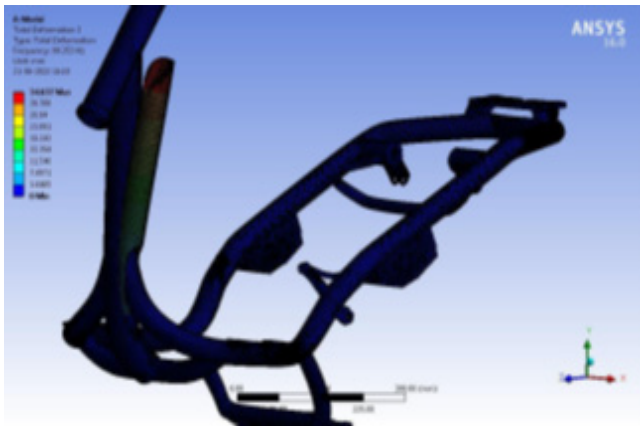


Figure 4. Total deformation on mode 2.

For Mode 2 at the Frequency of 80.353Hz the deformation found maximum 34.637mm

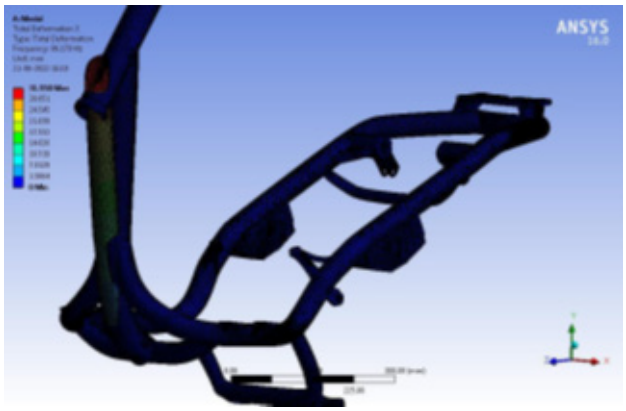


Figure 5. Total deformation on mode 3.

For Mode 3 at the Frequency of 86.179 Hz the deformation found maximum 31.558mm

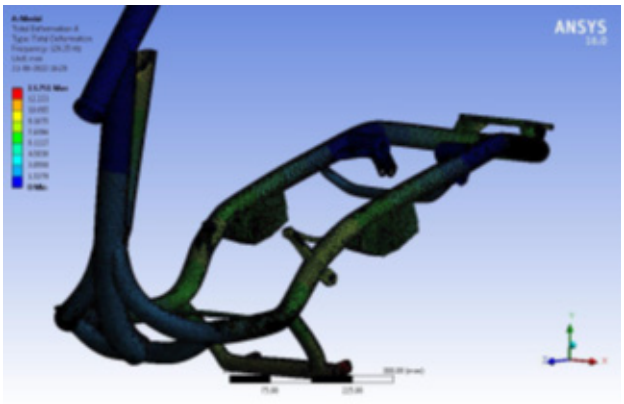


Figure 6. Total deformation on mode 4.

For Mode 4 at the Frequency of 126.35 Hz the deformation found maximum 13.751mm

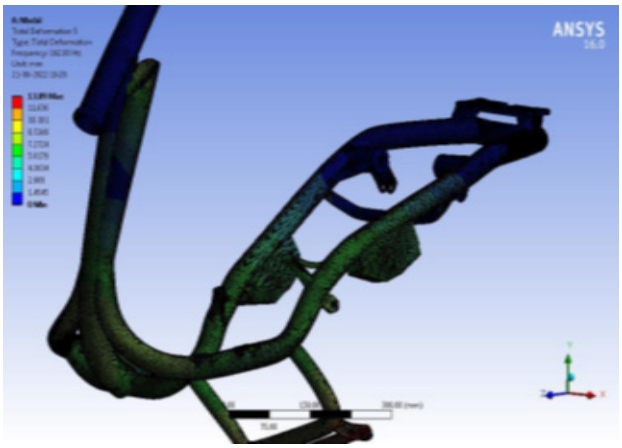


Figure 7. Total deformation on mode 5.

For Mode 5 at the Frequency of 162.03Hz the deformation found maximum 13.09mm

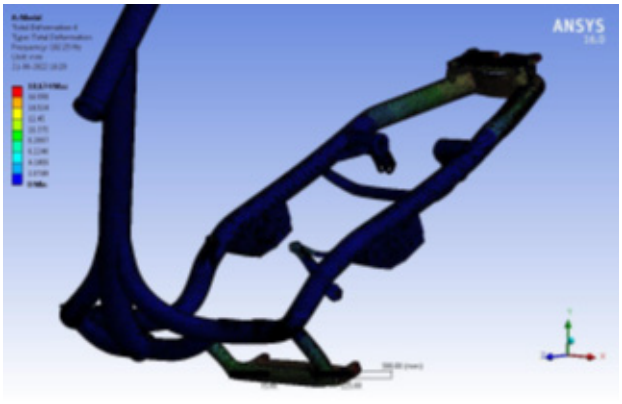


Figure 8. Total deformation on mode 6.

For Mode 6 at the Frequency of 182.25Hz the deformation found maximum 18.674mm

2.4 Results of Vibrational Analysis

The maximum deformation in vibrational analysis for chassis frame is found. The purpose of vibration analysis is to determine the response of structures to vibration loads that are random in nature. The response of a sensitive electronic component mounted in a vehicle subjected to the vibration from the engine, pavement roughness, and acoustic pressure.

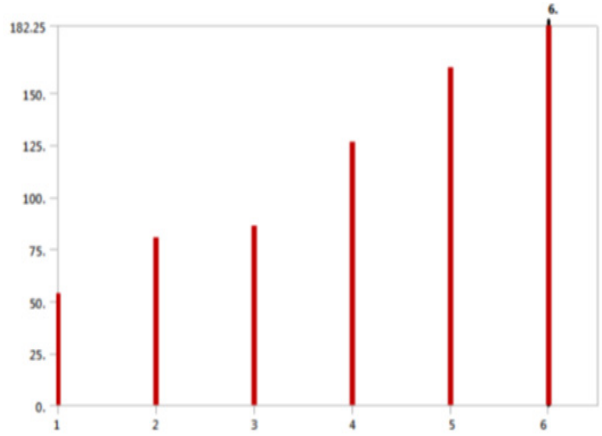


Figure 8. Bar chart indicating the frequency at each calculated mode.

2.5 Static Analysis

Test 2: static analysis for 5mm thickness

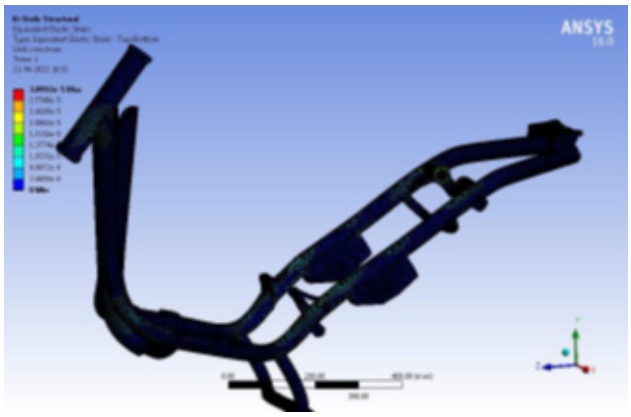


Figure 9. Static structure (elastic strain).

The maximum value at which an object will rebound and revert to its original shape when the load is removed for values of 0.030992mm.

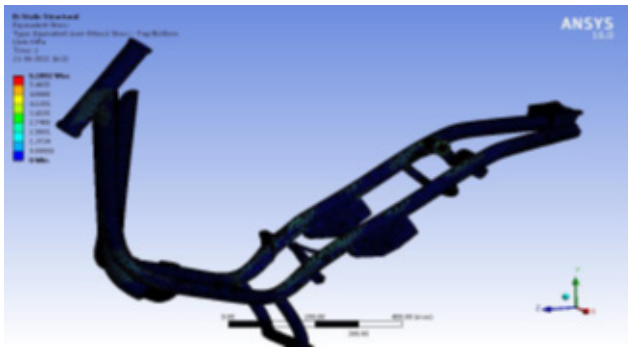


Figure 10. Static structure (equivalent stress).

6.1802 MPa is the Equivalent stress it represents a material's status for ductile material

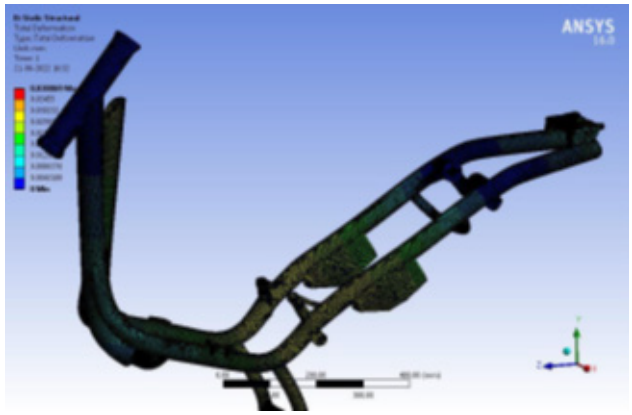


Figure 11. Static structure (total deformation).

2.6 Modal Vibrational Analysis

Test 3: Inner diameter 40mm, outer diameter 50mm, thickness 10mm

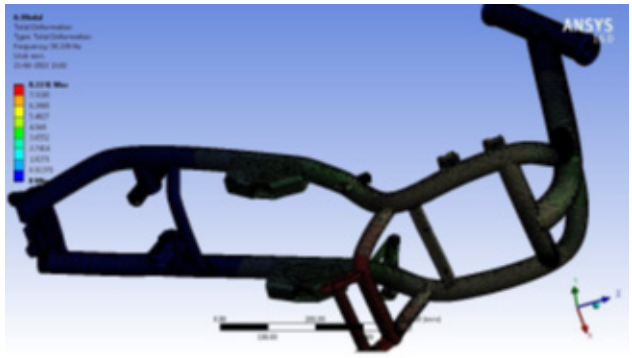


Figure 12. Total deformation on mode 1.

For Mode 1 at the Frequency of 58.338Hz the deformation found maximum 8.2241mm

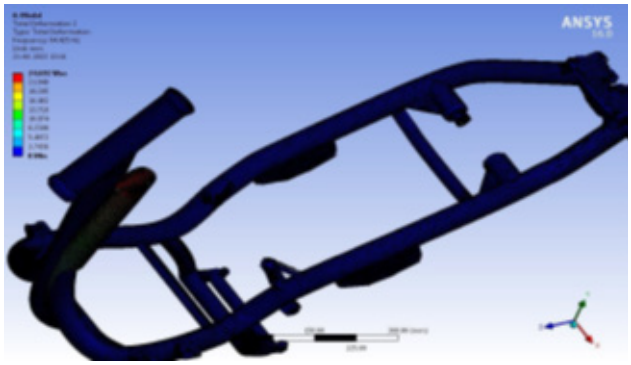


Figure 13. Total deformation on mode 2.

For Mode 2 at the Frequency of 84.425Hz the deformation found maximum 24.692mm

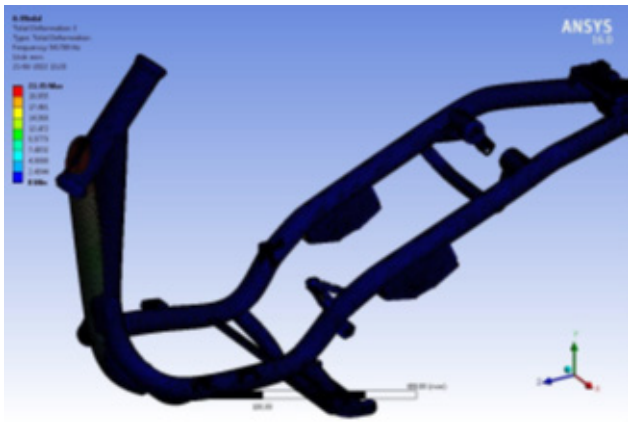


Figure 14. Total deformation on mode 3.

For Mode 3 at the Frequency of 94.788Hz the deformation found maximum 22.45mm

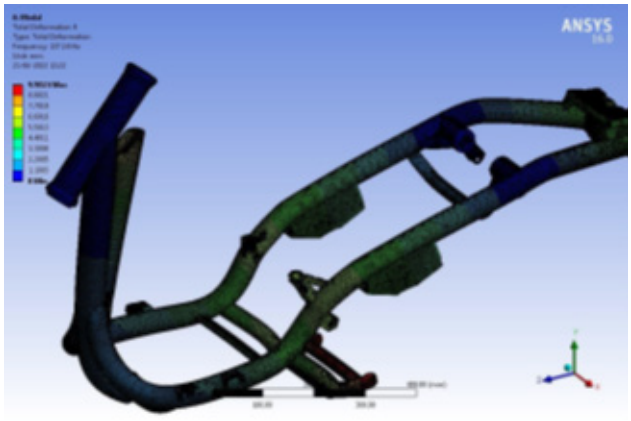


Figure 15. Total deformation on mode 4.

For Mode 4 at the Frequency of 137.14Hz the deformation found maximum 9.9024mm

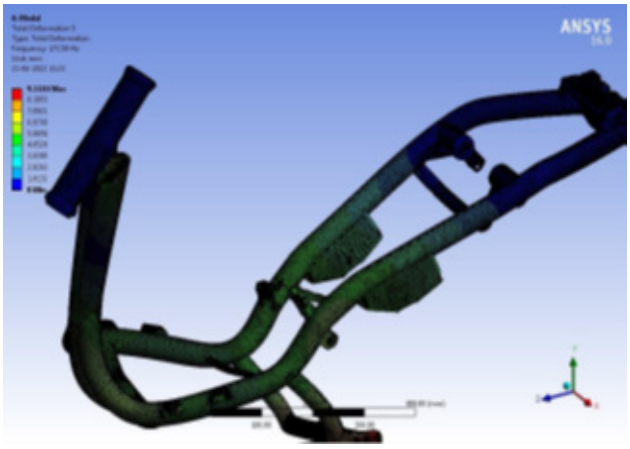


Figure 16. Total deformation on mode 5.

For Mode 5 at the Frequency of 173.58Hz the deformation found maximum 9.1184mm

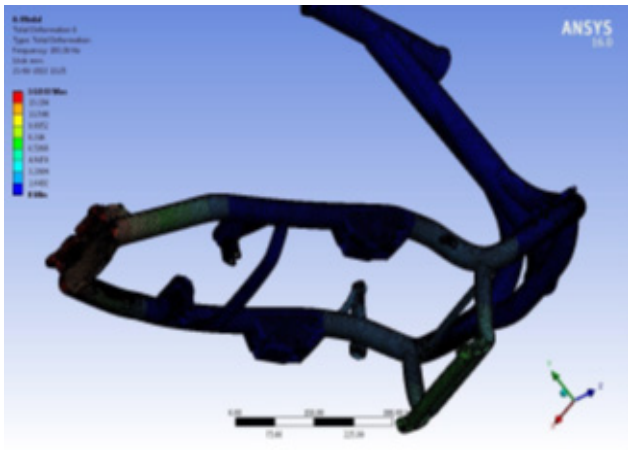


Figure 17. Total deformation on mode 6.

For Mode 6 at the Frequency of 193.36Hz the deformation found maximum 14.843mm

2.7 Static Analysis

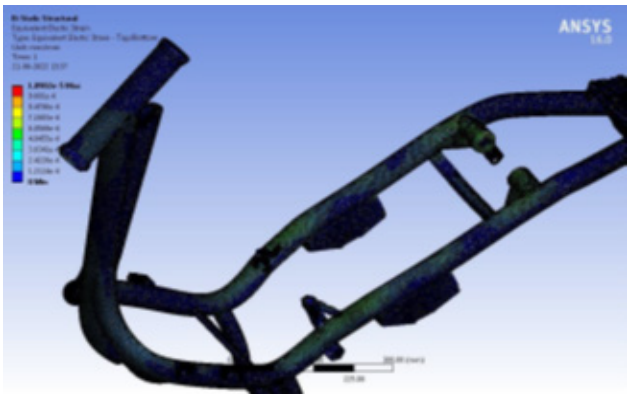


Figure 18. Static structures (equivalent elastic strain).

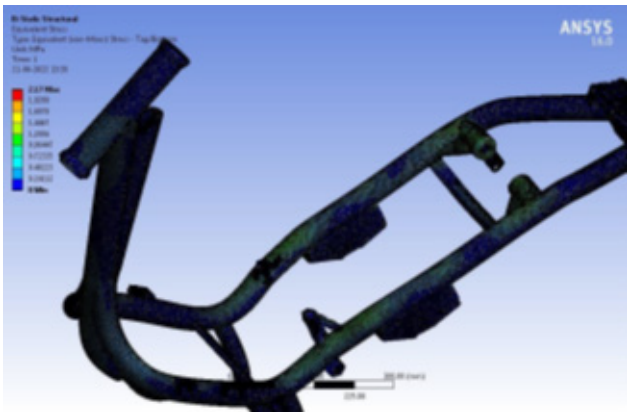


Figure 19. Static structures (equivalent stress).

3.0 Result and Discussion

3.1 Result of Modal and Vibrational Analysis for 5mm and 10mm Thickness

Comparing mode 1 vibrational analysis to modes 4 and 5, less deformation is observed. In addition, it is

Table 1. Result and discussion of static analysis

Type of design	Total deformation	Maximum stress	Maximum Strain
Existing design	0.038868mm	6.1802Mpa	$3.099x10^{-5}$mm
Modified design 1	0.016925mm	2.17Mpa	$1.0902x10^{-5}$mm

noted that when compared to mode 1, modes 2 and 3 exhibit greater deformation. Mode 1, 4, and 5 have a maximum difference of 5 mm, whereas modes 2 and 3 show a greater difference. From 50 Hz to 200 Hz, the total chassis performance was measured. The human body will absorb frequency in the 0 Hz to 50 Hz range, and above this frequency, various bodily sections will absorb the energy.

The Analysis was done using ANSYS software for 5mm & 10mm diameter steel tube, stress obtained for 10mm thickness were 2.17MPa, deformation of 0.016925mm. Hence 10mm thickness can withstand more impact load than 5mm thickness.

4.0 Conclusion

The following are the conclusions for this work mentioned below:

1. Customer feedback at the service centres for the two wheeler for the Jerking was minimized.
2. Chassis was modelled using CATIA V5 and analyzed by using ANSYS successfully.
3. Chassis design was validated for the jerk motions in the vehicle.
4. Performance of two wheeler was improved for some of the parameters compared to other two wheelers.
5. Analysis was done using ANSYS software for 5mm & 10mm diameter steel tube, the results of 10mm diameter was found good.

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