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Design and Analysis of Heavy-Duty Vehicle Chassis

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ABSTRACT

Automotive Chassis is the main body of a vehicle which act as a frame work for supporting the other part of vehicle. It should work on various parameter like shock, twist, vibration etc. it should have adequate bending stiffness for better handling characteristics. Stress and equilateral stress are basic characteristics for designing of a firm chassis. There are many industrialized sectors using truck as means of transportation for logistics, agricultures, factories and other industries. In this paper, three different material was adopted on the C-section truck frame design. ASTM A302, HSS 550 and ASTM A710 were structurally analysed on the heavy truck frame through finite element analysis. The results were compared and the best truck chassis material was identified with lower stress and deflection.

Keywords : Chassis Design, Structural Analysis, Vibrational analysis, Buckling Analysis.

I. INTRODUCTION

Automotive chassis is a French word that was initially used to represent the basic structure. It is the supporting frame like backbone of any automobile to which the body of an engine, axle assembles are affixed. Tie bars, which are essential parts of frames, are fasteners that bind different automotive components together [1]. Chassis should be rigid enough to withstand the shock, twist, vibration and other stresses. [2]. The modal investigation of the vehicle frame will help to calculate the natural frequency and modal shapes of the parts. The rigidity of the system can be evaluated and resonance might be bypassed [4]. The design analysis of truck frame using finite element method was useful to identified the performance of the chassis, as its design strength cannot be found using empirical formulas [5]. On the investigation load sharing on the vehicle chassis is not constant across its total span area, so that to the concentration of load it can be vary the area of ladder chassis. On this analysis, the effect of decrease in cross-section area with limitations of various stresses and deflection, decrease in the area will make difference in the quantity of material used for ladder chassis [6]. The finite element method formulation of the problem results in a system of algebraic equations. Finite Element Method (FEM) is one of the methods to locate the critical point [7].

II. METHODOLOGY

Required parts are first model in CATIA V5 which is excellent CAD software's, which makes the modelling easy and user friendly. The model is then transferred in IGES format and exported into the Analysis software Ansys11.0. The assembly is analysed in Ansys in three steps. Pre-processing: The geometry (physical bounds) of the problem is defined. The mesh may be uniform or non-uniform. The physical modelling is defined. Boundary conditions are defined. This involves specifying the chassis behaviour and properties at the boundaries of the problem. For transient problems, the initial conditions are also defined. The simulation is started and the equations are solved iteratives a steady-state or transient. Finally, a postprocessor is used for the analysis and visualization of the resulting solution [3].

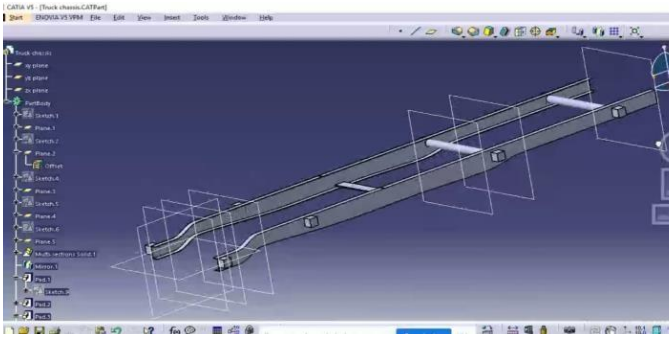

Fig 1. CAD Model of C-Section.

III. CHASSIS FRAME WITH THREE MATERIALS

- STATIC STRUCTURAL ANALYSIS
- MODEL OR VIBRATIONAL ANALYSIS
- BUCKLING ANALYSIS

IV. STATIC STRUCTURAL ANALYSIS

A) C Section (Comparison between ASTM A302, HSS 550 and ATSM A710)

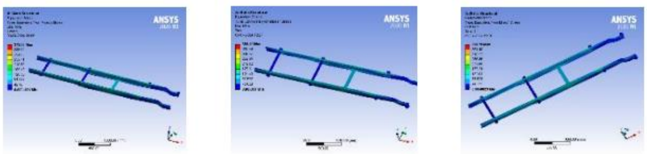

Fig 2. Equivalent stress result.

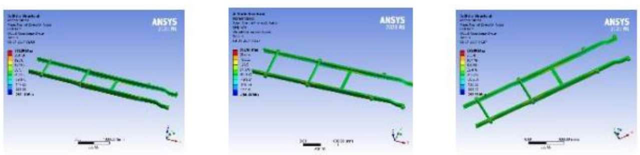

Fig 3. Normal stress result

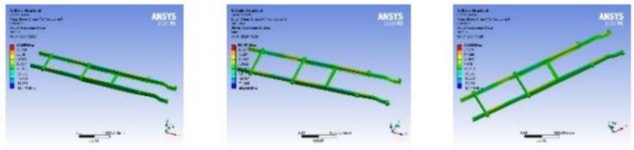

Fig 4. Shear stress result

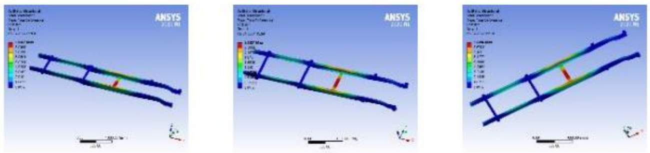

Fig 5. Total Deformation result

Table-1: Result of Structural Analysis

Properties	ASTM A302	HSS 550	ASTM A710
Equivalent Stress (Mpa)	379.06	394.41	398.79
Normal Stress (Mpa)	333.28	332.94	323.06
Shear Stress (Mpa)	97.24	87.161	87.214
Total Deformation (mm)	9.04	2.81	9.6

V. MODEL OR VIBRATIONAL ANALYSIS

C Section (Comparison between ASTM A302, HSS 550 and ATSM A710)

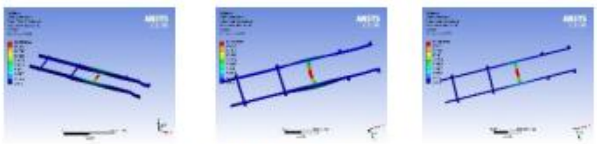

Fig. 1st Mode Deformation

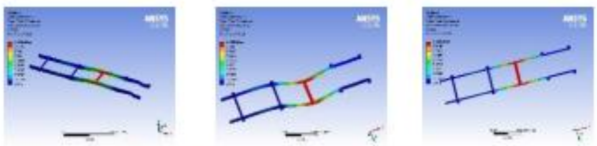

Fig. 2nd Mode Deformation

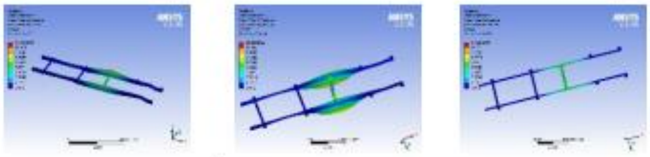

Fig. 3rd Mode Deformation

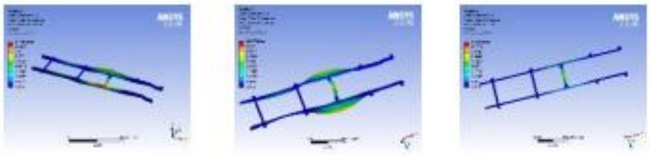

Fig. 4th Mode Deformation

Table-2 : Result of Vibrational Analysis

Sr. No.	Properties	AST A302	HSS 550	ASTM A710
1	Total Deformation (mm)	16.38	16.32	16.33
2	Total Deformation (mm)	7.44	7.41	7.4
3	Total Deformation (mm)	12.59	12.56	12.56
4	Total Deformation (mm)	12.71	12.67	12.68
5	Total Deformation (mm)	13.05	13.12	13.15

VI. BUCKLING ANALYSIS

C Section (Comparison between ASTM A302, HSS 550 and ATSM A710)

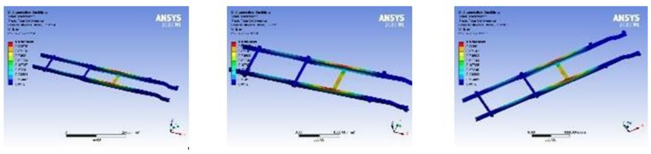

Fig 6. Total Deformation in buckling result

Table-3 : Result of Buckling Analysis

Properties	ASTM A302	HSS 550	ASTM A710
Total deformation (mm)	1.202	1.205	1.204

VII. CONCLUSION

By observing all the results, it is found that the HSS 550 material gives the better results than remaining two materials. It has better strength and ability to absorb vibrations. ASTM A302 and A710 are having maximum normal stress values. Also, the shear stress value is greater than HSS 550 material value. But only 2.81mm Total Deformation value proves the better option as a HSS 550 material.

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