Optimization of Chassis by using Finite Element Analysis Method for Automobiles

Matam Vishwanath Swamy[1], K Viswanath Allamraju[2]
[1]*PG student, Department of Mechanical Engineering, Institute of Aeronautical Engineering, Dundigal, Hyderabad*
[2]*Associate Professor, Department of Mechanical Engineering, Institute of Aeronautical Engineering, Dundigal, Hyderabad*

***Abstract*—The frame is the main structure of the vehicle body. All other components are attached to it; a term for this design is to build the body on the frame. The structure consists of an internal framework that supports the artificial object in its construction and use. It is like an animal skeleton. The main objective of the article is to improve the efficiency of the heavy-duty structure with C-section for heavy vehicles by using solid CAD tool work. These assemblies are the main parts and are the main frame (staffers, longer) with the required dimensions. Applied load is 93931 N. Two materials are considered for Chassis with AISI 304 Steel (M1) and Chassis with 4130 Steel (M2). Total deformation, equivalent stress and equivalent strain are determined and compared between two models. The cross section of the Chassis is C-section. The optimized Chassis is M1. The deformation is found low for M1 in comparison to M2. The formability is high in M1 than M2.**

***Index Terms*—Finite element Analysis, Chassis, AISI 304 Steel, 4130 Steel, C-section**

I. INTRODUCTION

The chassis is the framework for supporting the body, engine and other parts of the vehicle. The chassis provides complete vehicle support and rigidity. The structure usually consists of two longitudinally extending passages and several cross ducts intersecting the members. The cross members have a small cross-section so that the storage space is extended longitudinally. Structural integrity is a key aspect of the design and must be considered at all stages. The suspension and chassis of the two wheels is a major part of the vehicle system. It consists of an internal framework that supports the object to be created. The lower part of the vehicle consists of the chassis and running gear such as the engine, transmission system, suspension system, etc.

II. LITERATURE SURVEY

Numerical investigation is applied on aerofoil and solar heaters and finite element analysis on crank shaft is done for optimization[1-3].FEA is used to achieve the optimum performance; piezoelectric materials are useful in controlling the vibrations and amplitudes can be reduced to 80 percent and also ecofriendly at both higher and lower frequency working zones [4]. Eigen analysis of sundry clamped free beam of various materials in FEA and two zone modeling of combustion, performance is done experimentally [5-6]. Some of the FEM applications are mentioned in [7-9] to work in low frequency environments, the type of element used in studying the analysis is tetrahedron element which is having three nodes. The degree of freedom of element at each node is 3. Modal analysis on energy harvesters is done for efficient power generation by using FEM analysis. Ansys tool can also be used for piezo electric materials for doing structural analysis, fatigue analysis, modal analysis for Eigen frequencies for determining the optimum performance to minimize the time and wastage of materials [10-13]. In this article, the optimization of chassis is designed by using finite element analysis through considering AISI 304 Steel and 4130 Steel. The cross section of Chassis frame is C-section.

III. RESULTS AND DISCUSSION

FEM Structural analysis of C-section Chassis is done in Ansys Workbench. The size of the element is 10 mm. The type of element is mentioned in the section of introduction. The applications of 4130 steel is for milling cutters, heavy crushing vehicles, gears, drill bits, bearings etc. 4130 steel is known as chromium molybdenum steel and is considered as low carbon

steel. AISI 304 stainless steel is having good formability than 4130 steel.

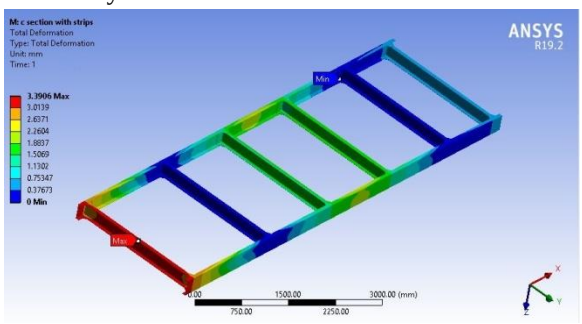

Fig.1 Total deformation of AISI 304 steel chassis

Fig.1 represents the C-section chassis deformation values, it has steel AISI 710 material, and the maximum deformation value is 3.3906mm, and the minimum deformation value is 0mm.

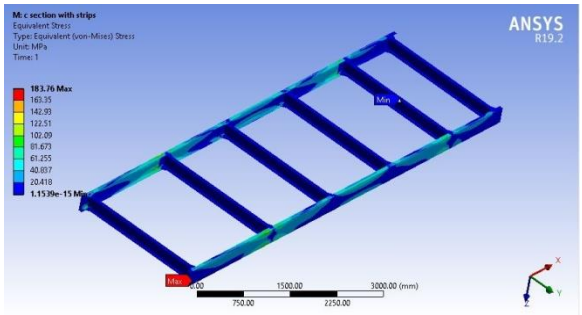

Fig.2 Equivalent Stress of AISI 304 steel chassis

Fig.2 represent, the C-section chassis stress values, it has steel AISI 710 material, the maximum stress value is 183.76MPa, and the minimum stress value is 1.1539e-15 MPa.

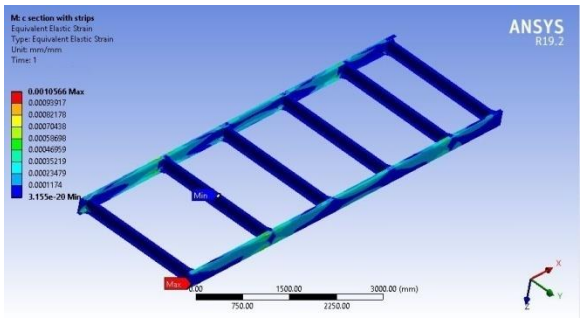

Fig.3 Strain of AISI 304 steel chassis

Fig.3 Above image, represent the strain value of C-section chassis and here the material property is steel 710 maximum strain is 0.0010566 minimum strain is 3.155e-20.

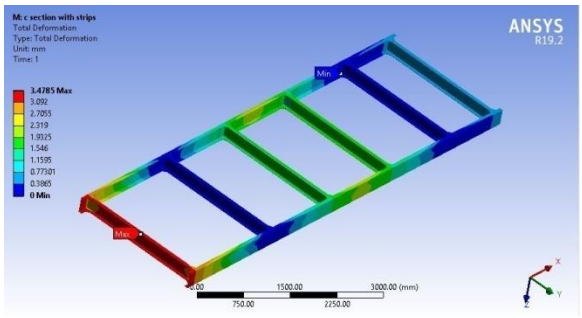

Fig.4 Total deformation of 4130 steel chassis

The C-section chassis deformation values, it has steel 4130 material, and the maximum deformation value is 3.4785mm, and the minimum deformation value is 0mm is shown in Fig.4.

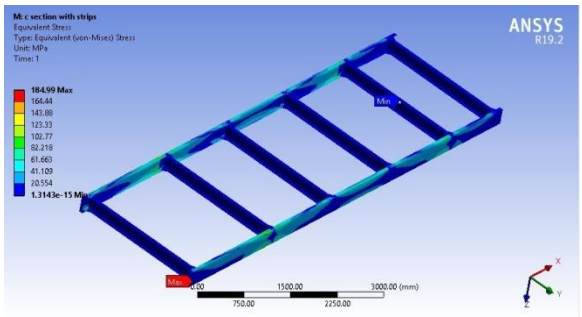

Fig.5 Equivalent Stress of AISI 304 steel chassis

The C-section chassis stress values, it has steel 4130 material, the maximum stress value is 184.99MPa, and the minimum stress value is 1.3143e-15 MPa is shown in Fig.5.

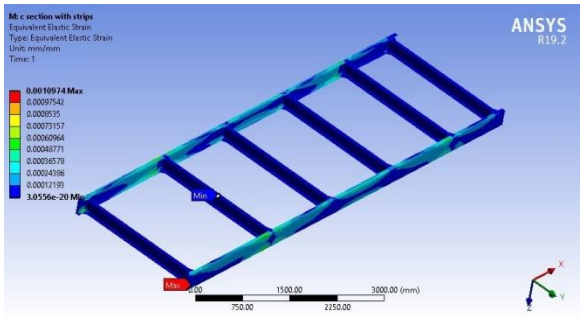

Fig.6 Strain of AISI 304 steel chassis

Fig.6 represents the strain value of C-section chassis and here the material property is steel 4130 maximum strain is 0.0010974 minimum strain value is 3.0556e-20.

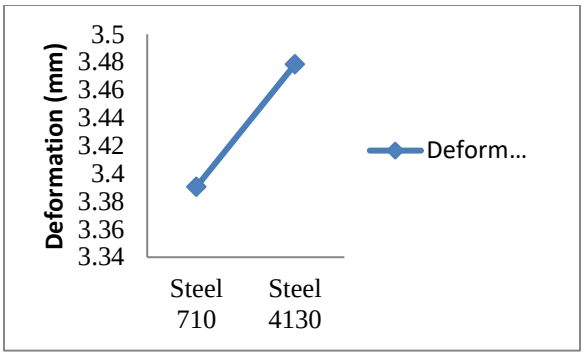

Fig.7 Total Deformation of AISI 710 steel and 4130 Steel

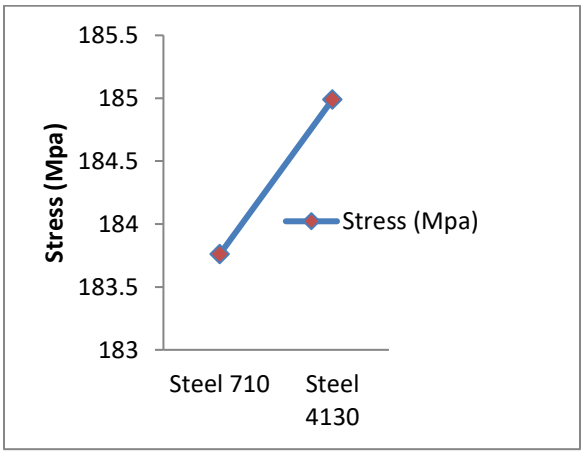

Fig.8 Equivalent Stress of AISI 710 steel and 4130 Steel

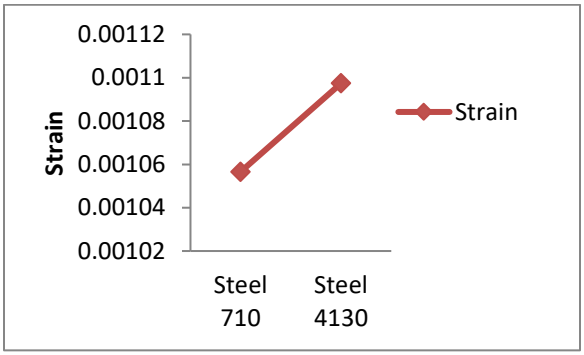

Fig.9 Equivalent Strain of AISI 710 steel and 4130 Steel

Total deformation, Equivalent stress and Equivalent strain of M1 is low in comparison to M2.It is shown in Fig.7-Fig.9. The stress developed in M1 is 183.76 MPa and in M2 is 184.99 MPa under the load of 93931 N. The equivalent strain developed in M1 is 0.0010566 and M2 is 0.0010974 under the load of 93931 N. The stress developed in M1 is 3.3906 mm and in M2 is 3.4785 mm under the load of 93931 N.

IV. CONCLUSION

The finite element analysis of Chassis is done in this article by considering AISI 304 Steel and 4130 Steel. The total deformation, Equivalent stress and equivalent strain values are observed low for M1 in relation to M2 through finite element analysis (FEA) under the same load therefore M1 is considered as optimum model because of AISI 304 stainless steel having good formability than 4130 steel. FEA is very important to design the optimum chassis for minimizing the man, machine and materials and also reduce fabrication time and wastage of materials.

REFERENCES

[1] Yadav, A.S.; Alam, T.; Gupta, G.; Saxena, R.; Gupta, N.K.; Allamraju, K.V.; Kumar, R.; Sharma, N.; Sharma, A.; Pandey, U.; Agrawal, Y. A Numerical Investigation of an Artificially Roughened Solar Air Heater. Energies 2022, 15, 8045. https://doi.org/10.3390/en15218045

[2] K Vishwanath Allamraju, Junaid Mohammed, Design and Analysis of Single Cylinder, Crankshaft Using Finite Element Method, International Journal of Research, 8(11) pp.126-134(2022).

[3] Yagya Dutta Dwivedi,, Sudhir Sastry Y. B., B.D.Y Sunil, Ch. V. K. N. S. N.moorthy,K .Viswanath Allamraju, Numerical Study of Bio-Inspired Corrugated Airfoil Geometry in a Forward Flight at a Low Reynolds Number, WSEAS TRANSACTIONS on FLUID MECHANICS,DOI:10.37394/232013.2022.17.12, 17,pp.119-127(2022).

[4] K. Viswanath Allamraju, K. Sharath Kumar,Finite element analysis of a spring isolator,Materials Today: Proceedings,Volume 60, Part 2,Pages 949-952(2022).

[5] K. Viswanath Allamraju, Emani Poojitha, Eigen analysis of sundry clamped free beam made of steel, smart material and composite materials, Materials Today: Proceedings, Volume 60, Part 2, Pages 880-883(2022).

[6] Arun Kumar Wamankar, T. Ravi Kiran, Deenoo Pawar, K. Viswanath Allamraju,Two-zone modelling of combustion, performance and emission formation in DI diesel engine operating

on carbon black-water-diesel slurry, Materials Today: Proceedings,Volume 62, Part 6,Pages 4341-4350(2022).

[7] K Viswanath Allamraju, Getting Started with Project Based learning for Mechanical Engineers, Edition 1, Mahi Publications, 2021.

[8] K.Satyanarayana , Rohit Yadav,P.V.N Lohith,D.Yasoda, A.Bharadwaj, K. Jeevan, K. Viswanath Allamraju, Modelling and Analysis of Diesel Engine Muffler using CFD Analysis, 12(5)pp.181-190 (2022).

[9] K. Viswanath Allamraju, Dynamic analysis of Piezo composite for energy harvesting, Materials Today: Proceedings,Volume 60, Part 2,Pages 961-964(2022).

[10] K.Viswanath Allamraju, K. Sharath Kumar, Finite element analysis of a spring isolator, Materials Today: proceedings https://doi.org/10.1016/j.matpr.2021.12.012.

[11] K.Viswanath Allamraju, Linear and Non linear electrical behaviour of energy harvester, Volume 5, Issue 2, Part 1, 4277-4282(2018).

[12] K.Viswanath Allamraju, Modal analysis of PZT discs for uni axial impact loaded energy harvesters, Volume 4, Issue 2, Part A, 2682-2686(2017).

[13] K. Viswanath Allamraju, Design and Performance of prototype clamped free beam novel energy harvester for low power applications, Volume 4, Issue 2, Part A, 3542-3548(2017).