Design and Analysis of Eicher 20.16 Chassis using Ansys 12.0

Jothiprakash P*, Raju K, Sivaraman B
Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur 639113, Tamil Nadu
***Corresponding author: E-Mail: jothiprakashmech@gmail.com**

ABSTRACT

Chassis is the structural back bone of any vehicle. The supporting of the components is the main function of the chassis and also to withstand the loads applied on it. While applying the load the chassis may undergo stress and deformation and it should be within a limit otherwise it leads to failure of the chassis. This paper presents the study of stress and deformation occurred in the chassis frame of EICHER 20.16 due to static and impact load. It was calculated for the chassis frame and analysis was carried out to find which load would leads to the chassis failure. The 3-D model of the chassis was prepared and analysis was done by ANSYS 12.0 work bench.

KEY WORDS: Stress and Deformation, Static Load, Impact Load, EICHER 20.16, ANSYS 12.0.

1. INTRODUCTION

The main component of automobile is a chassis frame were engine, transmission system, wheels are mounted. Hence it is considered as the significant component. Under different conditions the chassis frame is the most crucial element that gives strength and stability. The problem that identified in the existing chassis is the chassis failure. The aim of the present work is to analyze the stress and deformations that developed on the chassis by applying static and impact load and reduce the chances for failure of chassis by analyzing the various materials for chassis design. Loads taken for analysis were static and impact load. Static load are the loads that are applied gradually and concentrated in the same place for very long time. These forces are either independent of time or dependence of time. A common problem results from an impact load is structural analysis. In both cases, the loads are not noticeable but can be easily resultant by the use of mechanics.

Michael Broad and Terry Gilbert of North Carolina State University in this paper Design, Development and Analysis of the NCSHFH.09 Chassis presented a detailed overview of design and development of chassis. Sirisha (2013), dealt with the development of frame less chassis and analysis of the chassis. The modeling of the chassis was done by modeling software CATIA V5. Ravinder Pal Singh (2010), done the research work on structural performance analysis of formula SAE car. The work shown in this paper introduces several concepts of frame's load distributions and consequent deformation modes. Dheeraj and Sabarish (2014), has presented the journal related to Analysis of Truck Chassis Frame Using FEM. Rajappan and Vivekanandhan Mailam (2013), has presented the paper which dealt with static and model analysis of chassis by using fea.

2. METHODS OF PROPOSED SYSTEM

In the existing EICHER 20.16 chassis, chassis failures were occurred due to the development of stress and deformations. The aim of the present work is to find the stress and deformation developed in the chassis due to the static and impact loading and also to find which load will lead to the chassis failure.

The design of the chassis frame is modeled in ANSYS 12.0 work bench for the given dimension of EICHER 20.16 truck. The analysis of the chassis is also done in the ANSYS 12.0 workbench and the results are concluded based on the analysis.

Model No. = 20.16
Side bar of the chassis are made from "C" Channels with 230 mm x 76 mm x 6 mm.
Front Overhang (a) = 1588 mm.
Rear Overhang (c) = 2145mm.
Wheel Base (b) = 4800 mm.
Width of the chassis = 2250 mm.
No. of cross members = 4 at Dim. (mm) 3033,1000,1000,1000,1000,1500

Material Used and Their Properties

St 52 is the chassis Material
Young's modulus (E) = 2.1 E^5 N / mm^2
Poisson ratio (1/m) = 0.31
Radius of gyration (R) = 230/2 =115 mm
Where,
St 52 is the notation of steel in German standards. In German standard St denotes the alloy steel with low carbon (02.1 = Non-hardened, 02.2 = Hardened and tempered), "52" means a minimum tensile strength of 52 kg per sq. mm. In SI units, this is 510 MPa.

Load Carrying Capacity of Chassis

Truck Capacity = 11400 kg
= 111834 N

Chassis of Truck with 25% overload = 139792.5 N
Engine with body weight = 2700 kg
= 26487 N
Chassis total load = Chassis of Truck with 25% overload + Engine with body weight
= 139792.5 + 26487
= 166279.5 N

There are two beams on the chasis. So load acting is half of the Total load acting on the chassis.

Load acting on the single beam = 166279.5/2
= 83139.75 N.

Deflection of Chassis for Cantilever Beam:

Here the chassis is considered as a cantilever beam,

Y = [(w x l^4) / (8 x E x I)]

Where,

Y = Deflection at the free end of beam, mm
w = Load per unit length, N
l = Length of beam, mm
E = Young's modulus of the material of the beam
I = Area moment of Inertia of beam about an axis passing through its centre of gravity

Y = [(1 x 8533^4) / (8 x 2.1 x 10^5 x 16622980)]
=189.84mm

Calculation for static load

Stress, $\sigma = \frac{P}{A}$
=166279.5/2172
=767.16 N/mm^2

Calculation for impact load

$$\sigma = \frac{P}{A} + [\frac{P}{A} + \sqrt{[(1 + \frac{2AEh}{PL})]}]$$

Where,

σ = Stress developed in the chassis, N/mm^2
P = Static load acting on the chassis frame, N.
A = Area of the chassis, mm^2
E = Young's modulus
h = Distance from which the impact load acting on the body, mm.

σ = 767.6[767.6+$\sqrt{[1 + \frac{2*2172*2.1e5*1000}{166279.5*2250}}$]]
= 626.42*10^3 N/mm^2

$\sigma = \frac{P}{A}$

626.42*10^3 = P/ 2172

Impact load

P=1.36*10^9 N

3. RESULTS AND DISCUSSION

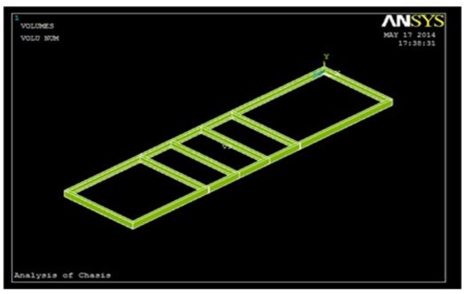

Figure.1. Chassis design

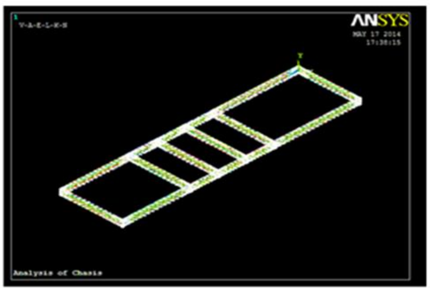

Figure.2. Meshed chassis frame

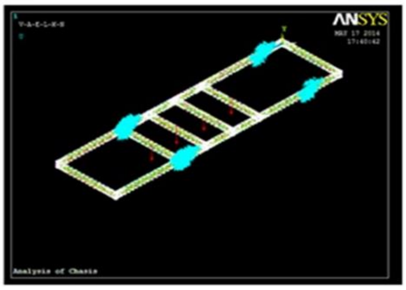

Figure.3. Chassis with static load

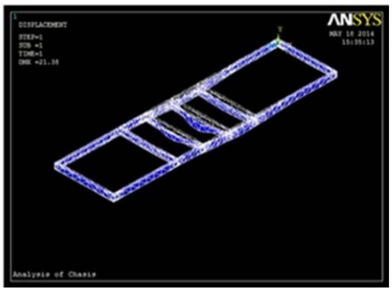

Figure.4. Deformed and Un deformed shape of chassis

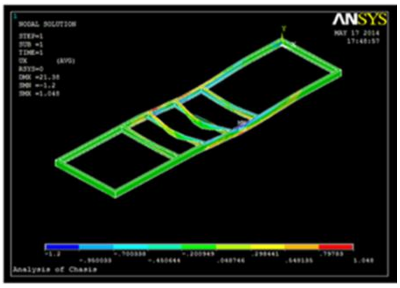

Figure.5. Displacement of chassis in x direction

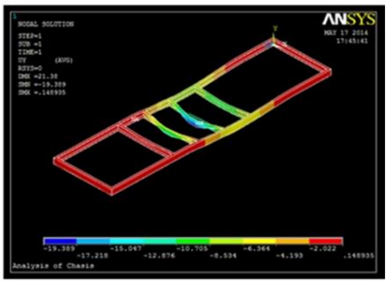

Figure.6. Displacement of chassis in y direction

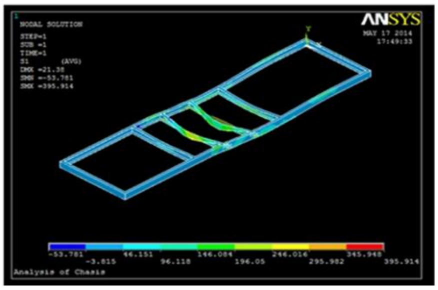

Figure.7. 1st Principal stress of chassis

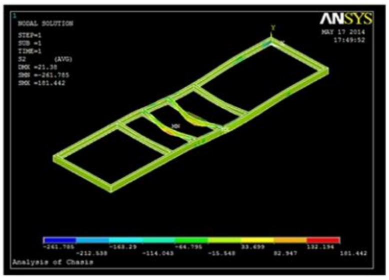

Figure.8. 2nd principal stress of chassis

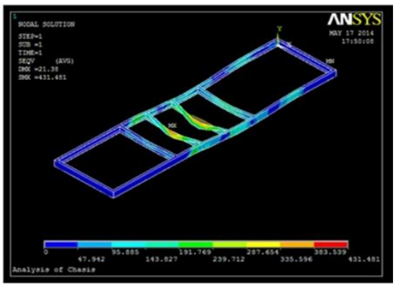

Figure.9. Von misses stress of chassis

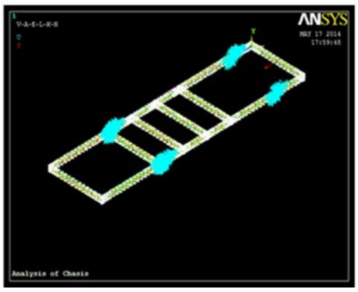

Figure.10. Chassis with impact load

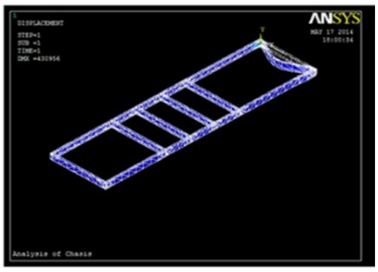

Figure.11. Deformed and Un deformed shape of chassis

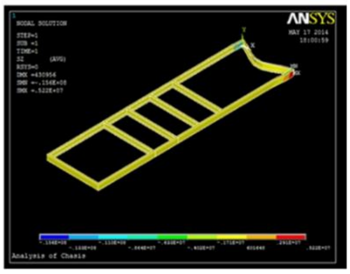

Figure.12. Stress along z direction of chassis

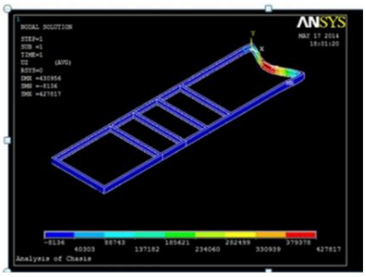

Figure.13. Displacement along z direction of chassis

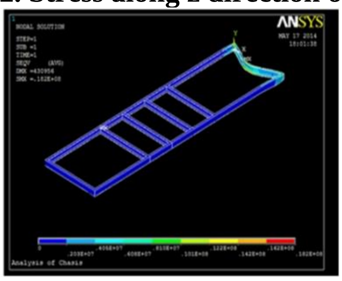

Figure.14. Von misses stress of chassis

The chassis diagram was drawn using ANSYS and the application of static and impact load was analyzed. From the result obtained, the maximum deflection is less than the theoretical value and maximum stress values due to the static load was found to be 431.41 N/mm^2 which is also less than the theoretical value. Hence the chassis design is safe and it does not undergo any failure under static load.

While comparing the impact load given to the chassis, the result obtained shows that the maximum deflection exceeds the theoretical value and also the maximum stress value obtained was $182x10^8$ N/mm^2 which is also larger as compared to the theoretical stress value. Hence the chassis undergoes failure in the case of impact load.

When the static load (P) of 165279.5N was applied on the cross members of the chassis. This found to be safe under this condition. Now the impact load of $1.36x10^9$ N hits on the front of the chassis it undergoes high stress and deflection .Chassis would deform highly along the z direction of both displacement and stress. This could be called as failure of chassis. Hence the failure of chassis occurs due to impact load.

4. CONCLUSION

Analyzed report indicates that static load has no effect on the chassis failure and the impact load applied causes the chassis to get failure. For the effective utilization of chassis the material has to be considered. By selecting suitable material for chassis the failure can be arrested.

REFERENCES

Abhishek Singh, Vishal Soni, Aditya Singh, Structural Analysis of Ladder Chassis for Higher Strength, International Journal of Emerging Technology and Advanced Engineering, 4 (2), 2014.

Athijayamani A, Manickam C, Kumar J, Natesan Diwahar,Mechanical and wear behaviors of untreated and alkali treated roselle fiber-reinforced vinyl ester composite, Journal of Engineering Research, 3 (3), 2015.

Chandrasekar M, Rajkumar S, Valavan D, A review on the thermal regulation techniques for non-integrated flat PV modules mounted on building top, Energy and Buildings, 86, 2015, 692–697

Dheeraj S, Sabarish R, Analysis of Truck Chasis Frame Using FEM, Middle-East Journal of Scientific Research, 20 (5), 2014, 656-661.

Karthe M, Tamilarasan M, Prasanna S.C, Manikandan A, Experimental Investigation on Reduction of NOX Emission Using Zeolite Coated Converter in CI Engine, Applied Mechanics and Materials, 854, 2017, 72-77.

Krishnan M, Karthikeyan T, Chinnusamy TR, Venkatesh Raja K, A novel hybrid metaheuristic scatter search-simulated annealing algorithm for solving flexible manufacturing system layout Eur J Sci Res, 2012, 52-61.

Manickam C, Kumar J, Athijayamani A, Karthik K, Modeling and multiresponse optimization of the mechanical properties of Roselle fiber-reinforced vinyl ester composite, Polymer-Plastics Technology and Engineering, 54 (16), 2015, 1694-1703.

Prabhu T, Ramesh C, Kumar J, Sivakuma S, Hybrid Solar PVT System based on Neural Network Models to track optimal Thermal and electrical power, International Journal of Applied Engineering Research, 10 (28), 2015, 22075 – 22081.

Prasanna S.C, Ramesh C, Manivel R, Manikandan A, Preparation of Al6061-SiC with Neem Leaf Ash in AMMC's by Using Stir Casting Method and Evaluation of Mechanical, Wear Properties and Investigation on Microstructures, Applied Mechanics and Materials, 854, 2017, 115-120.

Prasanna S.C, Ramesh C, Property Evaluation of Aluminium Metal Matrix Composites Fabricated Using Stir Casting Method for Hand Lever In Automobile Applications, International Journal of Applied Engineering Research (IJAER), 10 (85), 2015.

Rajakumar S, Balasubramanian V, Balakrishnan. M, Friction surfacing for enhanced surface protection of marine engineering components, erosion-corrosion study , Journal of the Mechanical Behavior of Materials, 25 (3-4), 2016, 111–119.

Rajappan R, Vivekanandhan M, Static and Modal Analysis of Chassis by Using Fea, The International Journal of Engineering and Science (IJES), 2 (2), 2013, 63-73.

Ramesh C, Manickam C, Prasanna S.C, Lean Six Sigma Approach to Improve Overall Equipment Effectiveness Performance, A Case Study in the Indian Small Manufacturing Firm, Asian Journal of Research in Social Sciences and Humanities, 6 (12), 2016.

Ramesh C, Valliappan M, Prasanna S.C, Fabrication Of Ammcs By Using Stir Casting Method For Hand Lever, International Journal of New Technologies in Science and Engineering, 2 (1), 2015.

Ramesh M, Karthic KS, Karthikeyan T, Kumaravel A, Construction materials from industrial wastes—a review of current practices, International journal of environmental research and development, 2014, 317 – 324.

Ramesh R, Ramesh C, Design, analysis and fabrication of canard wing configuration, International Journal of Research and Innovation in Engineering Technology, 2 (9), 2016.

Ramesh..M Karthikeyan. T.,Effect Of Reinforcement Of Natural Residue (Quarry Dust) To Enhance The Properties Of Aluminium Metal, Journal of Industrial Pollution Control, 2013.

Ravi Chandra M, Sreenivasulu S, Syed Altaf Hussain, Modeling and Structural analysis of heavy vehicle chassis made of polymeric composite material by three different cross sections**,** International Journal of Modern Engineering Research (IJMER), 2 (4), 2012, 2594-2600.

Ravinder Pal Singh, Structural Performance Analysis of Formula Sae Car, Jurnal Mekanikal, 31, 2010, 46 – 61.

Sethusundaram P.P, Arulshri K.P, Mylsamy K, Biodiesel blend, fuel properties and its emission characteristics Sterculia oil in diesel engine, International Review of Mechanical Engineering, 7 (5), 2013.

Sharma P.K, Nilesh Parekh J, Darshit Nayak, Optimization and Stress Analysis of Chassis in TATA Turbo Truck SE1613,International Journal of Engineering and Advanced Technology (IJEAT), 3 (3), 2014.

Sirisha K.P, Lalith Narayana R, Gopichand A, Srinivas, Structural and Modal Analysis on A Frame Less Chassis Construction of Heavy Vehicle for Variable Loads, International Journal of Engineering Research and Applications (IJERA), 3 (4), 2013, 2318-2323.

Thanneru Raghu Krishna Prasad, Goutham Solasa, Nariganani SD Satyadeep, Static Analysis and Optimisation of Chassis and Suspension of an All-Terrain Vehicle, International Journal of Engineering and Advanced Technology (IJEAT), 2 (5), 2013.

Vijayan V, Karthikeyan T, Design and Analysis of Compliant Mechanism for Active Vibration Isolation Using FEA Technique, International Journal of Recent Trends in Engineering, 1 (5), 2009.