iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** IV **Month of publication:** April 2019

DOI: https://doi.org/10.22214/ijraset.2019.4585

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue IV, Apr 2019- Available at www.ijraset.com

Modeling, Analysis and optimization Front Axle of Alto Maruti-800 LMV Car for Weight Reduction

Amol A. Sangule[1], Prof. Mane S. S.[2], Prof. Dalwe D.M.[3]
[1]*Research Scholar ,M.E. Mechanical Engineering, S.T.B.E.C. Tuljapur*
[2]*Assistant Professor, Department of Mechanical Engineering, S.T.B.E.C. Tuljapur*
[3]*Guide, Assistant Professor, Department of Mechanical Engineering, S.T.B.E.C. Tuljapur*

Abstract: ***The Front Axle is most important part in load carrying vehicle. The failure of Front Axle is serious concern to vehicle and thus for human life. So it is necessary to analyze the axle ability to withstand typical service loading which develops stress in the axel resulting into failure. Further the objective of analysis is to improve its product quality while reducing development time, material and manufacturing costs while maintaining the stress levels. In this paper for Analysis front axle of Alto Maruti-800 LMV Car used. The objective of the project is to analysis and optimization the front axel for reducing weight.***
Index Terms: Front Axle ; Finite Element Analysis (FEA), weight optimization

I. INTRODUCTION

The front dead axle supports the weight of front part of the vehicle, facilitates steering, absorbs shocks which are transmitted due to road surface irregularities and also absorbs torque applied on it due to braking of vehicle. Front axle is made of I-section in the middle portion and circular or elliptical section or I section at the ends. The special x-section of the axle makes it able to withstand bending loads due to weight of the vehicle and torque applied due to braking. A typical LCV front axle consists of main beam, stub axle, and swivel pin or kingpin. The wheels are mounted on stub axles. The front axle beam is subjected to bending loads due to vertical forces due to mass present above in static condition of the vehicle, while driving a around a corner results in multiple forces such as twisting forces on kingpin or steering knuckle, axial forces between Pad and spring interface along the length of the beam and unsymmetrical vertical loads due to centrifugal action. Current article carries on the numerical simulation towards the front axle to understand comprehensively the automobile front axle's stress, the strain distribution under different varieties of conditions, and provides the scientific theoretical base for the designer, thus improves design quality, shortens design cycle and reduces design cost.

II. LITERATURE REVIEW

Min Jhang, Lijun Li (2016) analyzed stress and fatigue life of front axle beam by finite element analysis and experimental method. Also, investigate the effect of crack parameters like length and depth on fatigue life [1].

M.M. Topac (2008) evaluated the fatigue failure prediction and fatigue life of a rear axle housing prototype by using Finite element analysis of heavy duty truck. [2].

N. León , O. Martínez, P. Orta C., P. Adaya (2000) performed Various experiments and numerical methods were adopted to obtain the stress analysis of a frontal truck axle beam and improved the quality of product by reducing the development time has given the case studies on front axle beam where he explains the complete procedure of analysis of front axle beam. Also explains how he reduced the weight of front axle beam by parametric optimization. [3]

Raed EL-Khalil , works on Discrete simulation and computer modelling serve as an effective means for the analysis and optimisation of manufacturing systems. Simulation and computer modelling tools provide a quantitative means for the analysis of a current manufacturing process as well as evaluating alternative designs and/or systems. Siddarth Dey, P.R.V.V.V Sri Rama Chandra Murthy. D, P.Baskar done Structural Analysis of Front axle beam of a Light Commercial Vehicle (LCV)-(2014) to determine the load capacity of the front rigid axle of a LCV and determine its behavior at static and dynamic conditions. [5]

III. METHODOLOGY

During the front axle modeling process, according to the front axle structural characteristics and the subsequent mesh divide ease, it guarantees the front axle's structure characteristic as well as convenience following finite element analysis, and carries on the partial simplification to the front axle structure, thus establishes front axle's finite element computation shell model.

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue IV, Apr 2019- Available at www.ijraset.com

IV. DESCRIPTION OF PROBLEM

Almost all automobile have front axle. The weight reduction of the drive can have a certain role in the general weight reduction of the vehicle and is a highly desirable goal, if it can be achieved without increase in most and decrease in quality and reliability . It is possible to achieve design of front axle with less weight to increase the first

The present work includes the simulation (stress analysis) of front axle of Alto Maruti-800 LMV Car subjected to load, equal to vehicle weight. The stress analysis was carried out using a FEA software .and Autodesk mechanical simulation software's. The analysis was done for three different cross sections.

1) Solid circular
2) Solid circular with hollow circular hole
3) Solid circular with hollow square hole

A. Objective

1) Effect of load acting on the axle
2) Design verification trough classical approach and failure criteria for frontal axle design.
3) FE approach for study the stress \strain and deformation.
4) Customized methodology for mechanical integrity.
5) To reduce the weight of axle .



Fig :- IV a) Front Axle



Fig :- IV b)Front Axle failure

V. MATERIAL DESCRIPTION

The front axle is made of C-45 which has the properties as mentioned below:
Poisson's Ratio: 0.3
Young's Modulus: 210GPa
Yield Stress: 250 MPa
Double shear stress: 631.846N/mm^2
Tensile Ultimate Strength: 736.55N/mm^2
Density: 7850 kg/m3

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue IV, Apr 2019- Available at www.ijraset.com

VI. FINITE ELEMENT ANALYSIS

A. Modelling and Meshing

The geometry is drafted based on the dimensions of geometric design parameters. The axle is 3dimensionally modeled then meshed properly to divide it into elements and nodes. Finite element model was generated using free meshed nodes quadratic tetrahedral element due to their flexibility in curved and complex shapes, which has three degrees of freedom per node.

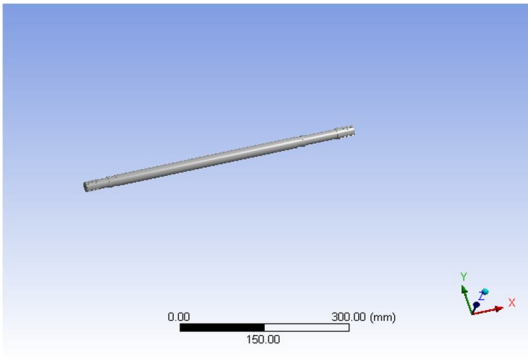


Fig. VI a):-CAD MODEL

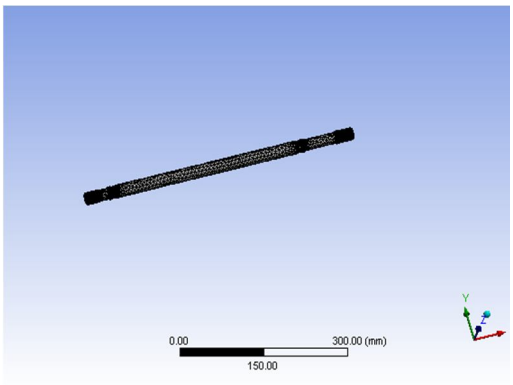


Fig. VI b): MESHING

B. Meshing Statistics

Node	715762
Element	466701
Mesh Type	Tetrahedron

VII. ANALYSIS RESULT

A. Solid axle(Existing design

Von mises stress defines the maximum yielding stress at the particular location which useful before manufacturing in actual practice.

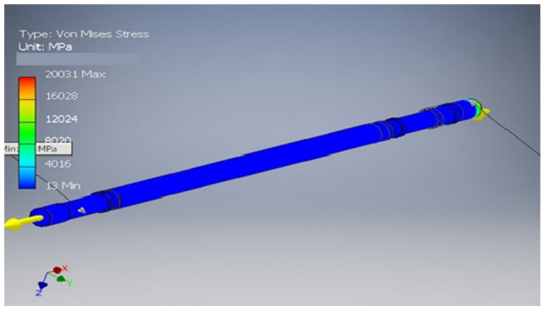


Fig VII (a) :-von mises stress

©IJRASET: All Rights are Reserved

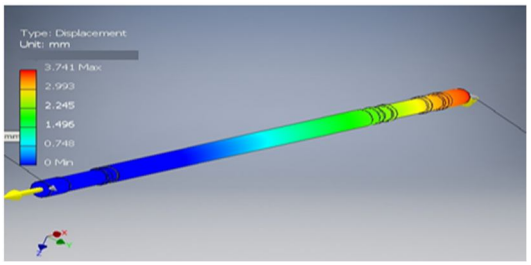


Fig VII (b):- Displacement

The axle is continuously crush under tensile and compression forces. The analysis is done considering only sectional forces excluding dynamic and self-weight of the structure. Total deformation is the outcome for individual area which is the integrated for total structure deformation

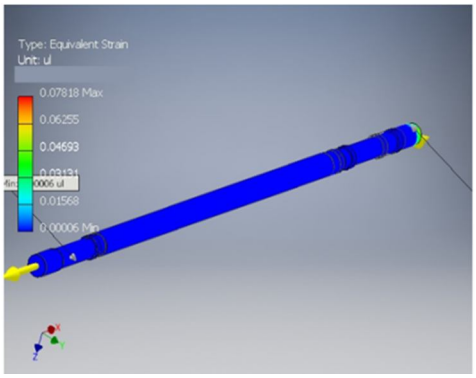


Fig VII (c):- Equivalent strain

VIII. RESULT AND DISCUSSION

A. For a existing design with Solid Axle when applied weight load then Von misses stress are 18316.5Mpa also factor of safety is 15 max to 2.09 min. front axel with a weight can sustain all loads in the running condition .

B. For case a Solid Axle with hollow hole (ϕ4mm) when applied weight load then Von misses stress are increased slightly 20031 Mpa also factor of safety is 15 max to 2.15 min. front axel a weight reduced with reduced safety factor .

C. For case Solid Axle with hollow square hole (5*5mm) when applied load on axel component then Von misses stress are decreases 17409.3 Mpa also factor of safety is 15 max to 2.06 min. front axel a weight reduced with better safety factor

case	Load Applied in KN	Displacement	Von mises stress(Mpa)	Part Volume (mm^3)
Solid axel	54	4.22	3389	172389
Hollow axel	54	5.0438	1831.5	165666
Squre hole	54	5.3220	1749.3	159014

IX. CONCLUSION

A. Results obtained from analysis front axel can sustain all loads in the running condition. This FAB (Front Axel Beam) will be used to for future light commercial vehicles which have carrying capacity of 1185 kg. In future the loading conditions and the need to be evaluated for determining the total load carrying capacity of the Front axel shaft .2)Stresses induced in modified design are in ranges also reduce weight of vehicle .

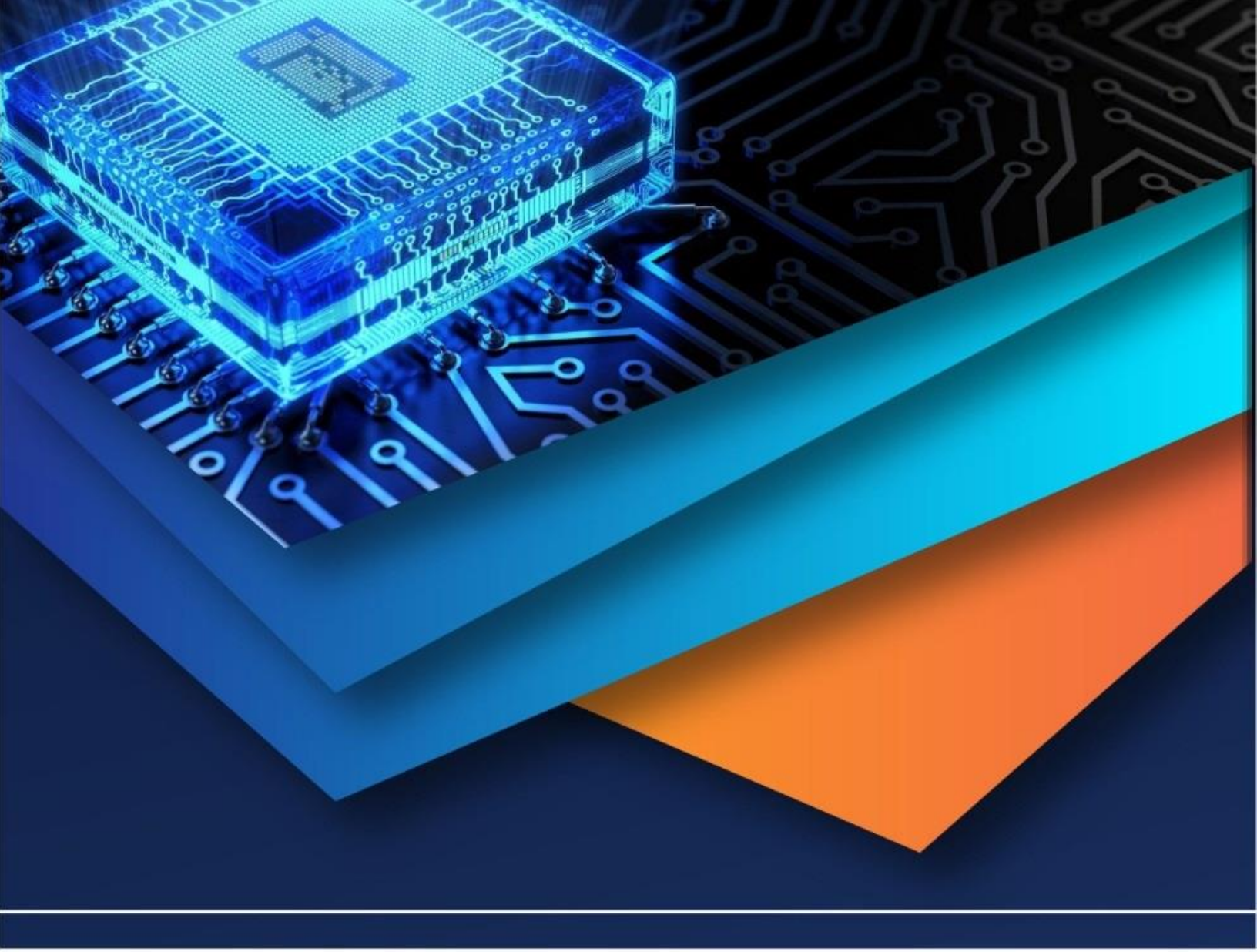
B. The static strength analyzed Analytical results can confirm the modified design and help to avoid expensive and time consuming development loops and also allow the number of high-cost test carriers to be substantially reduced, so design periods is shortened. In the meantime it can be used to determine testing positions of the load spectrum and examine testing results.

©IJRASET: All Rights are Reserved

REFRENCES

[1] Min Zhang, Xiangfei Ji, Lijun Li, A research on fatigue life of front axle beam for heavy duty truck, Advances in Engineering Software 91 (2016) 63–68.
[2] Esa Ervasti, Ulf Stahlberg, A quasi-3D method used for increasing the material yield in Closed-die forging of a front axle beam, Journal of Materials Processing Technology 160 (2005) 119–122.
[3] .M. Topac , H. Gunal , N.S. Kuralay, Fatigue failure prediction of a rear axle housing prototype by using finite element analysis , Engineering Failure Analysis 16 (2009) 1474–1482 [4]. Leon, Reducing the Weight of a Frontal Truck Axle Beam Using Experimental Test Procedures to Fine Tune FEA, MSC Automotive Conference., 2010.
[4] Ferhat Dikmen,Meral Bayraktar, Rahmi Guclu, Railway Axle Analyses: Fatigue Damage and Life Analysis of Rail Vehicle Axle, International Journal of Fatigue, 2012.
[5] Lorenzo Morello, Andrea Tonoli, The Automotive Body –Volume- II: System Design, springer pub. , New York, 2011.
[6] Prevention", 9th edition, vol. 11, Metals Park, OH (1986) pp. 13–65.
[7] Heyes, AM, "Automotive component failures", Eng Fail Anal, 1998, pp.129– 141.
[8] Heisler, H, "Vehicle and engine technology", 2nd ed, London, SAE International, 1999.
[9] Vogwell, J, "Analysis of a vehicle wheel shaft failure", Engineering Failure Analysis, 1998, Vol. 5, No. 4, pp. 271277.
[10] ASM metals handbook, "Fatigue and fracture", vol. 19, Metals Park (OH), 1996.
[11] , H, "Failure analysis of an automobile differential pinion shaft", Engineering Failure Analysis 13 (2006), pp. 1422–1428.
[12] Asi Osman, "Fatigue failure of a rear axle shaft of an automobile", Engineering Failure Analysis 13 (2006), pp. 1293– 1302.
[13] Bayrakceken, H, Tasgetiren, S, Yavuz, I, "Two cases of failure in the power transmission system on vehicles: A universal joint yoke and a drive shaft", Engineering Failure Analysis 14 (2007), pp. 716–724.
[14] CAD/CAM - Mastering, Ibrahim Zeid –-Tata McGraw Hill Publishing Co.
[15] Computer Integrated Design and Manufacturing, D.D. Bedworth, M.R Henderson & P.M.Wolfe- -Tata McGraw Hill Pub. Co
[16] Design of Machine Element by J.F. Shigley, McGraw Hill Publications
[17] Design of Machine Element by M.F.Spotts, Pearson Education Publication
[18] Production Technology by P. C. Sharma
[19] Milkell P. Groover, " Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons, New Jersey, 4th edition, 2010.
[20] Paul DeGarmo, J.T. Black, Ronald A. Kohser, " Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.
[21] http://www.chinahisea.com/suzuki_alto_axle_1702.html

©IJRASET: All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)