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A Review on Modeling and Analysis of Front Axle of Alto Maruti-800 LMV Car for Weight Reduction

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Abstract: ***Front axles can be live axles and dead axles. A live front axle contains the differential mechanism through which the engine power flows towards the front wheels. Almost all automobile have front axle. A Design and optimization of axles weight is the important for manufacturing and maintain the weight of axles with higher rigidity under working conditions. Several attempts for optimization of axles has been carried out by many researchers considering the static parameters to run the component for safer working conditions .The weight reduction of the drive have a important role in the general weight reduction of the vehicle, 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 main objective of this paper is to focus on to study the various methods preferred for designing and optimizing the axles for safer working under various boundary conditions.***
Keywords: ***Front Axle, Finite Element Analysis (FEA), Light Commercial Vehicle (LCV), Optimization.***

I. INTRODUCTION

The axles serve to transmit driving torque to the wheel, as well as to maintain the position of the wheels relative to each other and to the vehicle body. The axles in a system must also bear the weight of the vehicle plus any cargo. The front axle beam is one of the major parts of vehicle suspension system. It houses the steering assembly as well. Front axel contribute more weight of the total vehicle weight. Hence proper design of the front axle beam is extremely crucial . During last few decades due to global economic scenario optimum vehicle design is major be concerned. The conventional prototype testing is a versatile technique for evaluation of performance but it is time consuming, very costly and reproduction of test results and optimization of design is very difficult. Finite Element Analysis (FEA) is widely used in automobile sector for axel analysis this purpose due to its versatility in scientific evaluation, reproducibility of the results.

II. LITERATURE SURVEY

Much research work has been done in the field of analysis of front axle. The literature review of some papers gives more information about their contribution in design and analysis, optimization of front axle.

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. The expected load cycles required to fail during the vertical fatigue tests of a rear axle housing prototype is studied and mechanical properties were determined of housing material [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. This paper will present an analysis and optimisation of a new manufacturing system for front suspension axle assembly process utilising computer modelling and simulation. This paper is sponsored by one of the original equipment manufacturers axle assembly plant in North America. The main objective of this paper is to determine the optimal offline buffer locations for a front axle assembly line to achieve maximum throughput within budget limitations [4]

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. This work analyses the static, transient and modal analysis of the front axle beam. The geometry of axle is created in Pro-E WildFire5.0 software which is imported to ANSYS14.5. A fine congregate finite element model (meshed) is generated using the software to assess the strength and capability of the product to survive against all forces and vibrations. [5]

Prathapa.A.P , N. G.S. Udupa done Structural Analysis of Front axle apart from above loads is critically subjected to cyclic and shock loads. In case of four wheelers, Six wheelers and multi axle vehicles role of frontal axle is most important since it drives the rear axle .A robust design of frontal axle involves load calculations and load considerations for four wheeler and six wheeler, Followed by preliminary and detailed design considerations . In the light, of the above an automobile truck frontal axle is considered for the topic of research to understand its behavior to the loads during service conditions and also at off design conditions for four wheeler and also for six wheeler. The study involves load calculations for various conditions namely four wheeler, six wheeler ,gyroscopic couple ,Fatigue, dead weight This work is focused on structural evaluation of front axle using FEA approach with preliminary detailed design considerations which, includes Gross weight of the vehicle ,Inertial loads, dynamic loads and Rolling resistance. Commercial FE software (ANSYS) is used to determine the structural integrity of Frontal axle. [6]

Ru-xiongLi ,Song-huaJiao , Jin-lvWang ,In this paper automobile front axle taken for both process of exact roll forging billet and die design are studies as the result blank making roll forging die of front axle , pre molding roll forging die and final forming roll forging die are design seperatoly. [7]

Hemant L. Aghav1, M.V.Walame ,presents Front axle of heavy duty truck is the important component of vehicle and needs good design under the various loading conditions of the complete vehicle. Aim of the work is to stress analysis and predict the life of front axle for vertical, and vertical and braking loading case. The fatigue life of front axle is generally estimated by stress life approach and strain life approach method. Front axle beam assembly was modeled in the NX cad software. Meshing and Stress analysis is performed by ANSYS workbench and fatigue analysis is performed by NCODE design life ANSYS tool under different loading cases. Fatigue life of axle obtained by FEA method is more than 2 x 105 cycles, which is considered as safe for vertical loading case. Similarly, Fatigue life of axle obtained is more than 4 x 103 cycles, which is considered as safe for vertical and braking loading case. The max stress region is below spring pad of axle for vertical loading and in the goose neck of axle for vertical and braking loading case. [8]

Nagendra Reddy H R , Altaf Bhandari, Manjunath S L, Madhu M S,Siddesh , Present study to focus on mechanical integrity and life evolution of front axle using FEA approach, blending the classical approach for preliminary design considerations and loading conditions, including Gross weight of the vehicle, Inertial loads Gradient resistance and rolling resistance. Consider the selected front axle is proved to be beam of uniform strength. And Customized methodology of analysis through sub modelling technique, dynamic characteristics subjected to cyclic loading good man dia-gram are utilised to find life evaluation [9]

Sumit P.Raut, Laukik P.Raut in a review of various techniques used for shaft failure analysis .The various methodology used for failure analysis of the shaft used in different application by various authors are reviewed in this paper. This paper presents the comparison of the different methodology used, their application and limitation by various authors. The objective of present work is to study the various methodologies used for the shaft failure analysis and to choosiest methodology suitable for the failure analysis of shaft used in gear box which is mounted on the overhead crane to prevent repetitive failure. Shaft failure leads to heavy loss due to stoppage and repairing cost associate with the breakdown. [10]

Ketan Vijay Dhande1, Prashant Ulhe, On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to its surroundings, with the wheels rotating around the axle.

The axles serve to transmit driving torque to the wheel, as well as to maintain the position of the wheels relative to each other and to the vehicle body. The axles in a system must also bear the weight of the vehicle plus any cargo. The front axle beam is one of the major parts of vehicle suspension system.. In present research work design of the front axle for Ashok Leyland 1612 Comet heavy commercial vehicle were done.

The approach in this work has been divided into two steps. In the first step front axle was design by analytical method. For this, the vehicle specifications, its gross weight and payload capacity in order to find the stresses and deflection in the beam has been used. In the second step front axle were modeled in NX-CAD and meshed in HYPERMESH software module. The meshed model was solved in ANSYS software. The FE results were compared with analytical design. [11]

A. Literature Gap

Review of literature suggested that many authors have reported determination of stress, deflection and analysis of the automobile axel for different boundary conditions and some researchers have worked on the calculation of critical points in the automobile axel , still there exists to redesign and modify the geometry of the automobile axel to optimize the weight of the automobile axel and check the physical properties under given condition for safer work.

B. Problem Identification

Front axle optimization is very important part of weight and cost reduction. Front axle is very large number of mass production component and performance depends on it. Lighter weight Front axle gives higher fuel efficiency and low cost. In the optimization of the Front axle geometry, manufacturing processes, and material analysis were studied with different constraints, part manufacturing feasibility and cost also. The optimization process includes the geometry changes of Front axle without changing the other components.

III. NEED FOR ANALYSIS

A finite element stress analysis need to be carried out at the failure region to determine the stress distribution and possible design improvement. Since suitable software like UG or CATIA V5 is normally utilized for creating the geometry of the component (3D model), this could be further extended over the scope of CAE during the natural phase of design progression. The design verification can be achieved without elaborate need for prototypes at each phase saving time and effort. A final prototype for the final design review can be employed for verifying the analytical results.

IV. OBJECTIVES

A. Identify and study using software tools (for simulation/ analysis), the nature and characteristics of stresses acting on the component
B. Evaluate the influence of the loads/ mass/ geometry/ boundary conditions over the nature and extend of stresses
C. Review the existing design and consider improvement for negating the harmful influences of undue stresses (Torsion or Shear)
D. Carry out physical experimentation to validate the model.

V. CONCLUSIONS

Stress plays a major role and acts as the decision maker. From the above review it has been observed that the experimental, and numerical analysis is carried out to check the stress, deflection and modal frequencies of front axel also optimization of the front axel is carried out to reduce the material and cost. The decrease in the front axel weight reduces the inertia force. Geometry of axel plays important roll in manufacturing and design Looking at the values of stresses induced in circular cross section, the values are higher than the square cross section but compared to circular cross section,. Which means circular section will need less material for manufacturing. So, we can conclude that while manufacturing axle, one can prefer circular over square shaped axle. On the premise of the load spectrum, strength analysis and optimization design can be carried out to lighten the weight of front axle finally.

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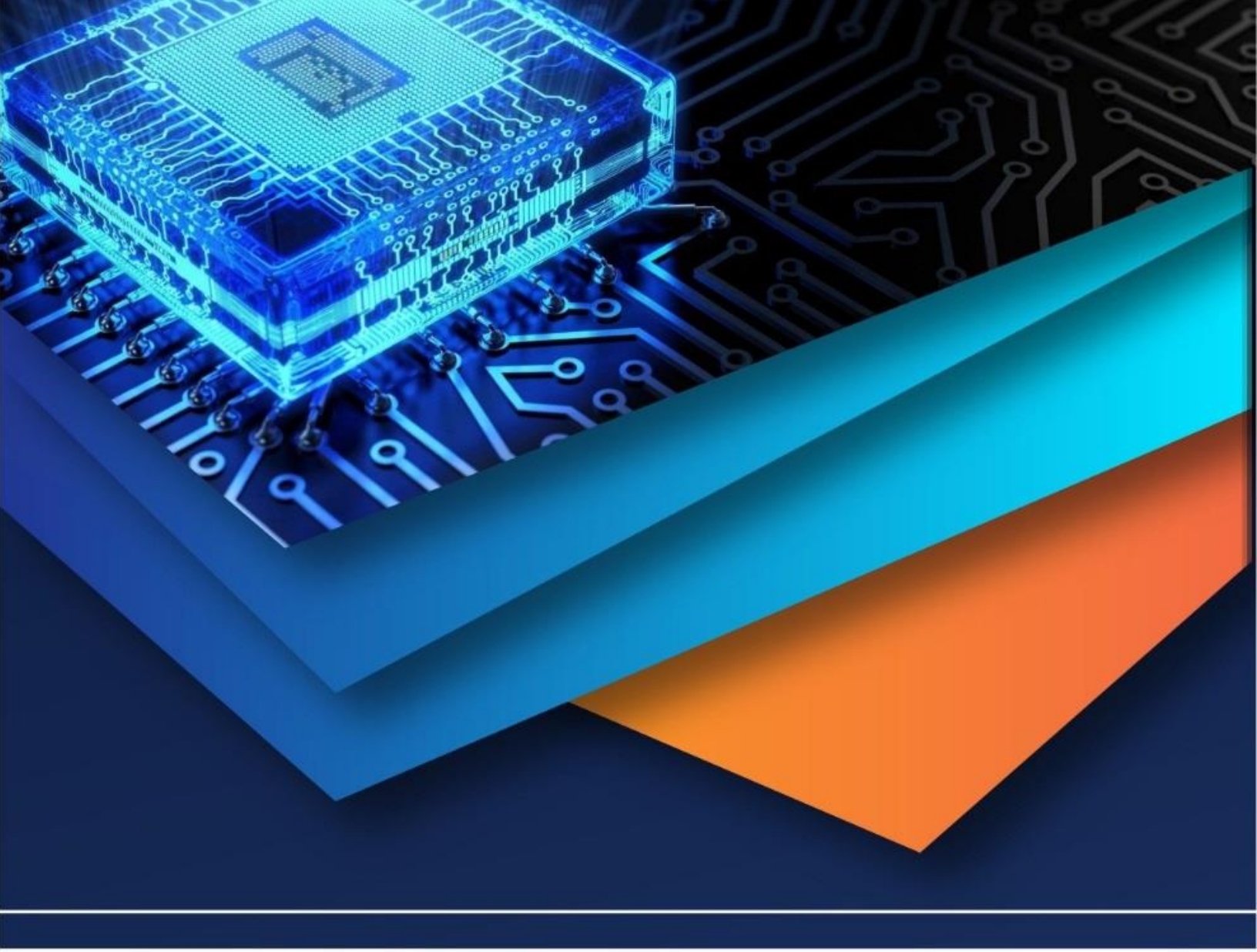

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