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A Review on Design and Analysis of Ladder Chassis

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Abstract- One of the major challenges is of designing of the chassis. Design of chassis is begins with analysis of load cases. There are four loads acting on chassis to be considered. These loads are important considerations in design of chassis because of ride safety and comfort of passengers. The magnitude of stress arises from these loads can be used to predict the performance of chassis. Automotive chassis is made of a steel frame, aluminum or composite. In this study past literature has been done.

Keywords-Ladder Chassis, FEM, Static, Automotive.

I. INTRODUCTION

Automotive industry is one of the major industries around the globe [1]. Chassis is a central part of automotive vehicle and it carry the load of components such as engine, gearbox, clutch, fuel tank etc. These loads include the weight of each component. Therefore, chassis should be rigid enough to absorb the shock, twist, vibration and other stresses. Bending and torsional stresses are the main design consideration for the chassis apart from this it has better handling characteristics [2]. Therefore, the chassis must provide the strength needed for supporting the components to keep the ride safe. Chassis is the skeleton of vehicle, and it is the load carrying structure, so it has to be designed [3].

One of the major challenges is of designing of the chassis. Design of chassis is begins with analysis of load cases [1]. There are four loads acting on chassis to be consider namely: (1) bending loads (2) torsion loading (3) combine bending and torsion loading (4) lateral loading (5) inertia forces when vehicle accelerates and deaccelerates. These loads are important considerations in design of chassis because of ride safety and comfort of passengers.

The magnitude of stress arises from these loads can be used to predict the performance of chassis. Automotive chassis is made of a steel frame, aluminum or composite [4].Due to recent advancement in composites, lightweight composites material like carbon fiber, epoxy glasses etc. are used. As they are light in weight and better strength as compared to conventional steel used in chassis frame [2].

In conventional frame, two long side members and 5 to 6 cross members joined together by riveted joints. In integral frame all units of vehicle are attached to body which are mostly used in light commercial vehicles and in semi-integral frame half part is fixed to engine and suspension system [5]. Various section of cross-members is used in chassis for instance I and C-section are used mostly for cross-members as they provide better resistance towards bending and torsional loading.

Many researchers have done optimization related works. There is always a new challenge in designing of a new product such as load sustainability, occupied minimum space, light weight and off course cost is low. In such cases it is difficult to predict the optimize design. Many design engineers use optimization methods to get the optimized design [6].

Nowadays automotive engineers are more interested in reducing the weight of chassis without compromising its performance. Apart from this many scholars have done the optimization of chassis. For instance, Cavazzuti et. al. [7] optimized the design of chassis. Sobieski et al. [8] have done the optimsation of chassis using bending and torsion loading as a constraint. Sklad [9] addressed the optimsation of chassis towards light weight. Sethupathi et al. [10] have done the optimsation of FSAE chassis using FEA.

II. LITERATURE REVIEW

Purushotham(2020) presented in his work a stress and deflection analysis of a three-wheeler passenger and load carrier chassis and modifying into one chassis for both types. Main focus of his work was to reduce the tooling cost and increasing the rate of production. To achieve this author performed a finite element analysis of the existing chassis of passenger vehicle. Software package used for this analysis was ANSYS.

Sane et al. (2020) performed stress analysis of a light commercial vehicle chassis by using finite element method. Initially analysis of the existing chassis of the vehicle was performed and values of the stress and deflection were obtained. A total of nine different load cases were considered for the analysis of the chassis.

Godse and Patel (2019) performed a static load analysis of T A T A Ace Ex Chassis using ANSYS Workbench. In their work the authors performed static analysis of the existing chassis of the vehicle and found out the maximum value of stress and deflection. Author performed optimization exercise by the method of reinforcement techniques to reduce the value of stresses and increase the payload.

Rane et al. (2019) did their work in the use of optimization techniques for redesign of the forklift chassis by the use of finite element analysis. Author focused their work on the study of the optimum material distribution to get an idea of the load flow path based on which new design with higher strength to weight ratio as compared with original design could be obtained.

Patel et al. (2018) carried out a sensitivity analysis for weight reduction of different cross-sections of truck chassis. The important criteria for the analysis of the chassis were maximum stress, maximum equilateral stress and deflection. The author performed his work towards the optimization of the automotive chassis for which a proper finite element model of the chassis was developed in PRO-E and finite element analysis was carried out using the ANSYS Workbench.

Costi et al. (2017) performed topology optimization on the automotive chassis and comparison was made between spider and coupe type of chassis. In their work the authors explain the setup of the optimization process, domain of optimization and the performance targets set to perform optimization.
Sharma et al. (2016) performed a stress analysis study of TATA Turbo Truck SE 1613. In the study finite element analysis was used in analyzing the chassis and author also explains its importance in minimizing the number of physical tests. For analysis model of Tata truck chassis is used.
Prabhakaran et al. (2016) focused their work towards weight reduction of chassis by performing structural analysis. Basic calculations for the chassis frame were done analytically based on the bending theory and values of stress and deflection were obtained. Finite element analysis for the existing chassis was performed for overload condition and stress and deflection values were obtained.

Reddy and Reddy(2014) investigated the modelling and analysis of container chassis using FEM to improve load carrying capacity and reducing the failure of chassis with bending by adding stiffeners. The rectangular stiffeners to be placed in between the cross members and fastened to chassis by means of bolts. The analysis results of Ansys-14 shows that there is reduction in von misses stress in chassis with stiffener up to the extent of 37.11% compared to without stiffener while stress intensity reduced up to 36.23% and deflection reduced by 36.16%.

Bhat et al. (2014)redesigned the chassis for tractor trolley. The existing trolley chassis uses “C” cross section and material used is mild steel. The total capacity of the trolley is 60KN but the self-weight of trolley and other accessories is 13 KN. Redesign is done by changing cross section from “C” to “I” by without change inmaterial and dimension. The change in cross section resulted in more safer stresses than previous cross section and 31.79 kg reduction in weight, so cost of chassis ultimately reduced.

Nalawade (2014) did the static structural analysis and modal analysis of a TATA 407 truck chassis. Modelling is done in CATIA, and finite element analysis is done using ANSYS workbench. After carrying out the analysis on the ladder frame with structural steel and E-Glass composite the results are obtained that maximum shear stress and equivalent stress generated in E-glass is under acceptable limit and total deformation is also within the limit. It also shows that for the same load carrying capacity E- glass is more suitable than steel and thereby able to reduce the weight by 60-68% and increase in stiffness.

Sharma et al. (2014) have designed the heavy vehicle chassis and analyzed with the help of ANSYS-15.0. The dimension of the TATA LPS 2515 EX chassis is used for the structural analysis of the heavy vehicle chassis with three different alloys subjected to the same conditions of the steel chassis.

Swami and Tuljapure (2014) investigated the static structural analysis of truck chassis with the help of ANSYS software. Here the chassis of Eicher 20.16 is of ladder frame type which has two side members or longitudinal members of C- cross section and seven transverse members called cross members of C- cross section. The result from graph shows that as the side member thickness increases, initially there is slight decreasein the maximum value of von misses stress but afterwards it starts increasing. The rate decreases in just before the end and again increases at the end.

III.CONCLUSION

In this study, design analysis and shape optimization of ladder chassis frame is performed. Static analysis is performed on ladder chassis frame to find out the stress, strain and displacement in a ladder chassis due to acting loads. SolidWorks software is used for the modelling of ladder chassis frame and ANSYS is used for the static analysis of ladder chassis fame. Coming to shape optimization, the cross-section of cross-members will be changed accordingly C, T & I and tested for the same. Advance high-speed steel and CFRP is considered and tested for performance.

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