STUDY OF ANALYSIS OF BUS PASSENGER TIE ROD: A REVIEW

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Abstract

This paper focuses on the study of buckling load on the Tie rod of steering system that undergoes an axial compression. Because of the external factors like road condition, different driving situations, different road adhesion, traffic conditions, vibrations and sudden jerks are sets up in tie rod. Tie rod generally buckle under the action of compressive force due to the large ratio of tie rod length to its radius of gyration. When it becomes worn out, steering will become more difficult and the vehicle will also typically be pulling or dragging to either side. Thus the aim of the project is to analyze tie rod for to improve the mass and buckling load of tie rod and to find out maximum deformation and stress. Present research is divided in two parts. First, to conduct survey amongst the buses, examine the causes of failure and second is to design and analysis to recommend best possible alternatives of Tie Rod with the aid of advanced design tools like CAD. Tie Rod failure is one of the major problems facing for MSRTC workshop supervisor.

Key Words: *Buckling Load, Compressive Load, CAD, FEM, MSRTC Bus, Tie Rod etc…*

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1. INTRODUCTION

Tie rod is the part of steering system of an automobile. Tie rod is slender in structure and used to tie and sustain compressive and tensile loads. The primary function of tie rod is to transfer the motion from steering arm to steering knuckle. Though maximum weight of vehicle is sustained by the suspension system, Fluctuating Forces and vibration due to bumps form automobile vehicle transmits to tie rod which may cause it to fail. The most percentage of forces on tie rod is compressive. Structural failure also takes place due to high severity of vibration and forces. Force required in static condition of passenger bus is more as compared to moving bus. Research shows that geometry and boundary conditions highly affected the magnitude of buckling and scatter of cylindrical column. Tie rod also contains imperfection in geometry and boundary conditions. So to find out buckling load is important in tie rod that undergoes critical compression in vehicle. The diameter of the rod is determined by considering the rod in two failure cases.

1] Compression failure 2] Buckling failure. So aim of this paper, to predict the buckling load analytical study will be done which gives a systematic approach for tie rod. Tie rod must therefore be strong enough to bear the stresses, deflection and vibration. In present work focus is given on optimization of existing tie rod by using suitable CAD software and its model analysis will also be done using ANSYS workbench.

2. LITERATURE REVIEW

V.D.Thorat, Prof. S.P.Deshmukh [1] Developed rigid multi body dynamic analysis approach in design. The applications of this methodology simplify design process and give correct result. For the case study here work of design done on Ackerman steering mechanism for TATA tipper. In this first according to Ackerman conditions basic geometry is designed and then optimized it for static loading, modal analysis and then for dynamic forces generated on steering linkages while turning using Rigid Dynamics tool in Ansys. Results shown rigid dynamics approaches for design reduces time for optimization, simulation and provide the chance to take most corrective action. Author concluded that rigid dynamics approach is used in modern design techniques for various domains.

Prof Raghvendra K, Ravi K [2] developed the Design iteration like different materials, shape, size and buckling load factor & studied theoretical, experimental and modal analysis of tractor Tie rod by analysis software. Author concluded with Results decreases displacement, stress, mass count and increases buckling Eigen value then buckling load for Mild steel SAE 1020 when compared to Aluminum A6016 and Cast iron C1540.

Mr. P M Chavan, Prof. MM Patnaik [3] studied buckling strength and compared performance of buckling for Tie rod for different materials. It is found that the mode shape , natural frequency , stiffness value and capacity for buckling load is high for carbon steel. So author concluded and validates that Carbon steel material is suitable for the manufacture of the Tie rod of vehicle as it shows better mechanical properties compared to cast iron and aluminum alloy material.

Mr. Patil, Prof. Chavan, Prof. Agade [4] studied on the Tie rod that undergoes continuous vibrations when vehicle is running .The analysis of Tie rod is carried out with FEA to check its natural frequency, maximum stress analysis and

deformation in Ansys software, Author concluded that the distribution of deformation and stress did not exceed the yield strength value and that there were neither damages nor failure of Tie rod. Author concluded that the tie rod was taken for analysis is safe.

Mr. Yongsheng Li [5] performed study on steering tie rod for cracking with strength and buckling analysis theory, which showed a low risk of failure. A "necking down" method was used to optimize the length and location by Arc Length Algorithm, proved by pressing and impact test. Simulation results are consistent with tests. Concluded that "necking down" can alleviate cracking and improve quality efficiently on premise of mere decrease in pressure resistance.

Mr. Sankanagoudar, Dr. Amaranth, Prashant D., M.Thakur [6] designed and developed mechanism for the deployment of Equipment panel of a spacecraft. Analysis is done in UG NX 7.5. The linear Buckling analysis method is used. Since, the tie-rod is the main drive element for tilting of the equipment panel, Analytical and FE results compared with experimental values & concluded that induced stresses are within permissible limits and hence, the design is safe.

Mr. Lei Zhang, En'guo Dong [7] studied the comparison of the dynamics characteristics of multi-body rigid model and the rigid-flexible coupling model built using the software of ADAMS and ANSYS .The stress based on the torque during bumping found maximum in three vehicle conditions i.e. the steering course, the driving straight course, and the bumping course, the torque during a bumping found higher. Finally author concluded that the stress due to bumping should be calculated to avoid failure.

Mr. Anthony DeLugan [8] Developed nonlinear analysis method to accurately predict the buckling load of tie rod in axial compression. Tie rod end of an aerospace that contains two outer corrosion resistant (CRES) steel rod ends and hollow aluminum rod body is selected. Both a linear analysis and nonlinear analysis is performed. Results indicated that the Arc Length method among all three nonlinear analysis techniques is found suitable to accurately predict the buckling load.
Mr. Dobrivoje, B. Jeremić, [9] conducted critical analysis of failure modes and its effect for light commercial vehicle steering tie rod joint. Author studied the critical element factor of mechanical system that limit reliable and safe operation . he also studied about corrective measures for reducing acuteness , present the fastest and cheap method for reliability and finally quality of product .

3. OBJECTIVES OF THE PROJECT

The main objectives of this project are as follows:

- Initially the correct measurement of the Passenger bus Tie rod component will be taken.
- Using recorded measured dimension, 3D CAD model for bus tie rod will be prepared using PRO-E.
- All require investigation will be done on model.
- Suitable boundary conditions will be applied.
- Through static analysis Determination of displacement and stresses generated will be carried out .
- Analytical approach for finding the stiffness and critical buckling load.
- Study of vibration transmitted to Tie Rod from bus will be done ,
- Validation of results.

4. SCOPE OF PROBLEM

Tie rod undergoes mostly compressive load. The strength of tie rod depends upon safe design stress and minimum cross section area. Warned out tie rod may cause dragging and erratic steering that may finally lead to tire wear. Tie rod failure may be due to different reasons such as material, faulty design, fatigue load and wear of tie rod. Initially theoretical study of tie rod will be done. To find maximum deformation and stress distribution are main task in this study. The 3-D model will be prepared and Analysis will be carried out using finite element analysis software for Tie-rod. The results will be compared with practical and theoretical results.

5. REASON FOR SELECTING PROJECT?

Maharashtra State Road Transport Cooperation (MSRTC) Passenger Buses has failure of tie rod due Cracking to and Buckling as shown in Fig: 5.1 & 5.2.
As the Tie rod fails the bus will be pulling or dragging to either side. It is revealed that the Tie rod failure is genuine problem facing to MSRTC workshop supervisor. So it's important to design the tie rod for its strength.

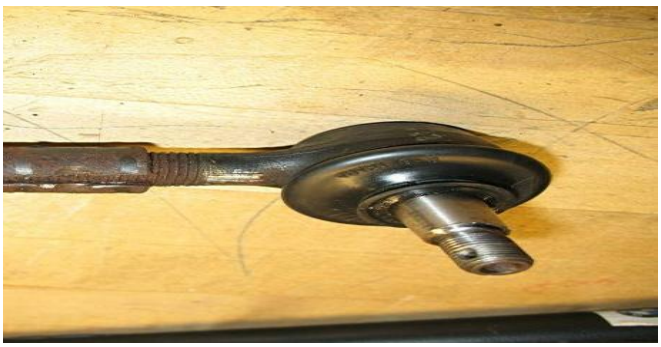

Fig 5.1: Cracking of Tie Rod

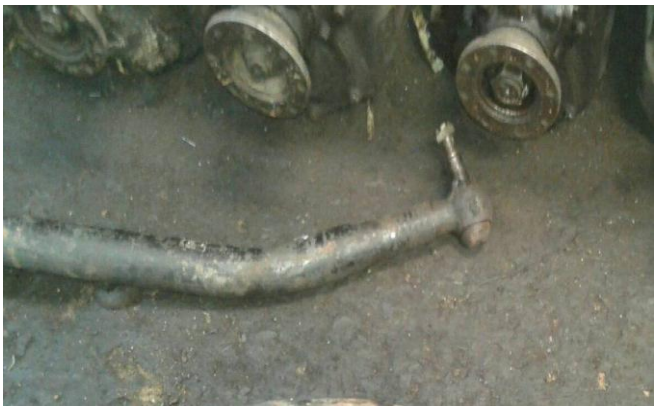

Fig 5.2: Buckling of Tie Rod

6. CONCLUSION

The aim is to solve MSRTC workshop problem of Tie Rod failure of passenger bus; keeping this in mind we have started the project work. We have planned to design the new Tie Rod and reduced the existing problems by using CAD and FEM.

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BIOGRAPHIES

Mr. P. R. Vithalkar was born in India, MH. in 1983. He received his B.E. (Mechanical) from JDIET College, YAVATMAL, Affiliated from SGBAU , in 2006. Worked as a Process Engineer in Automobile company from AUG 2006 to JUNE 2013, Present he is doing M.Tech CAD/CAM)from BDCOE College, Affiliated from RSTMNU Sevagram, Wardha DIST, Maharashtra.

Dr. R. R. Gawande obtained his Masters degree in Production Engineering and Completed his PhD in SCM Production from RTMNU, Maharashtra, India. He has 14 + years of teaching experience; from AUG 2001 working as a Associate professor in Mechanical Department, BDCOE Sevagram, Wardha.