Failure Analysis and Fatigue Life Improvement of Existing Steering Mechanism (Tie-Rod) of Heavy Commercial Vehicles using FEA

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Abstract— The tie rods are mandatory components of vehicles steering system. According to its name a Tie rod ties vehicles steering rack to the steering arm. A failure may occur due to varying forces and undulation of vehicle during steering in tie rod. The forces on the steering are also considered during the static condition of car. The vibration and buckling of the tie rod may lead to structural failure if the resulting vibration and stresses are undesirable and excessive, So the research work is aimed to assess the vibration, buckling strength of the existing tie. The FE models of the tie rod also analyzed to get the stiffness and stress distributions in each component.

Key words: Track Rods, Steering System, Tie Rod

I. INTRODUCTION

The tie rod is an important member in vehicle suspension system. It performs an important task of transferring the motion from the steering system to the suspension system. In a cars steering wheel is connected to the steering gear steering wheel turns the wheels. The steering gear is connected to the wheels via the tie rod ends. The job of the tie rods end is to ensure the wheels are aligned. It provides adjustment for wheel alignment that keeps the tires from wearing out on the inner and the outer edges. If they wear out the wheels will lose alignment and you may find that the tires and steering wheel are shaking when you are driving the car. To evaluate the structural performance of tie rod, we need to consider the load coming on tie rod. From the various studies and practical observations, it is found that tie rod is primarily under compressive loads and hence fails in buckling. Moreover due to suspension components fluctuating loads are also coming on the tie rod due to the random loads coming on suspension of vehicle.

II. OBJECTIVE

The aim of the project is to perform fatigue analysis of Tie-Rod of heavy commercial vehicle TATA 1210 which is very popular model in the transport industry and to modify the existing design in such a way that its life becomes infinite.

A. Methodology

- Data collection from site.
- CAD modelling of existing system.
- Finite Element Modelling.
- Analysis of the tie rod in FEA.
- Optimization of design.
- Results discussion.
- Conclusion.

III. CAD MODEL

A. Existing Cad Model of Tie Rod

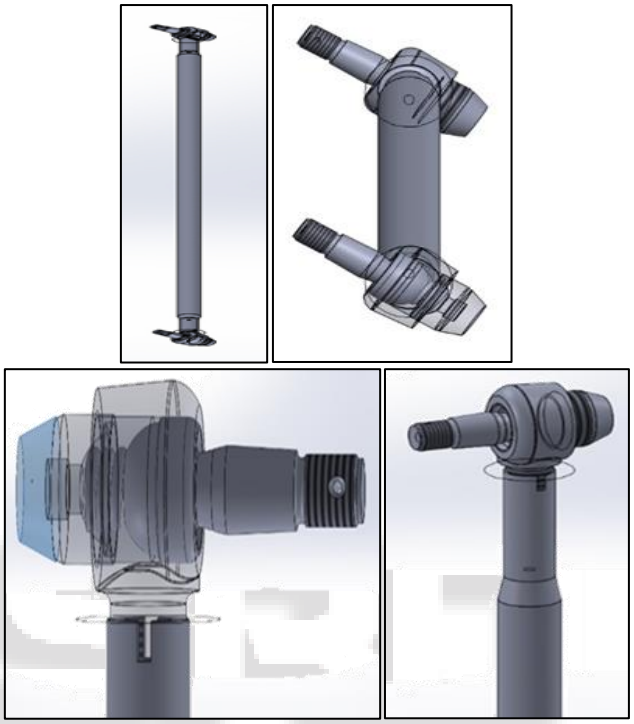


Fig. 1: Existing Cad Model of Tie Rod

B. Existing Tie rod Finite Element Model and Boundary conditions

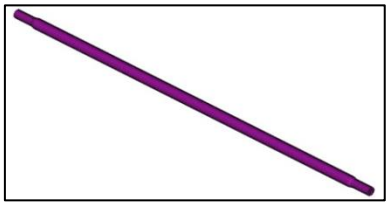


Fig. 2: Existing Tie rod Finite Element Model and Boundary conditions

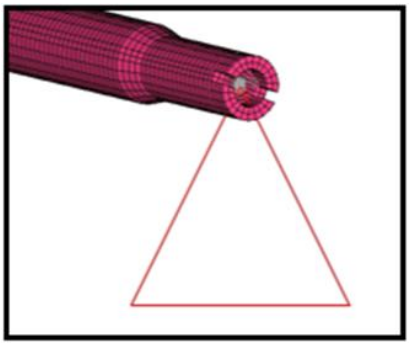


Fig. 3: Boundary Conditions: Rod constrained at both ends

- 5 Node Penta element- 1552
- 8 Node Hexa element- 45248
- Total- 46802

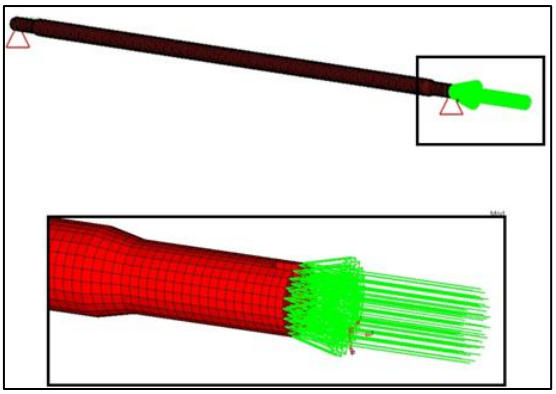
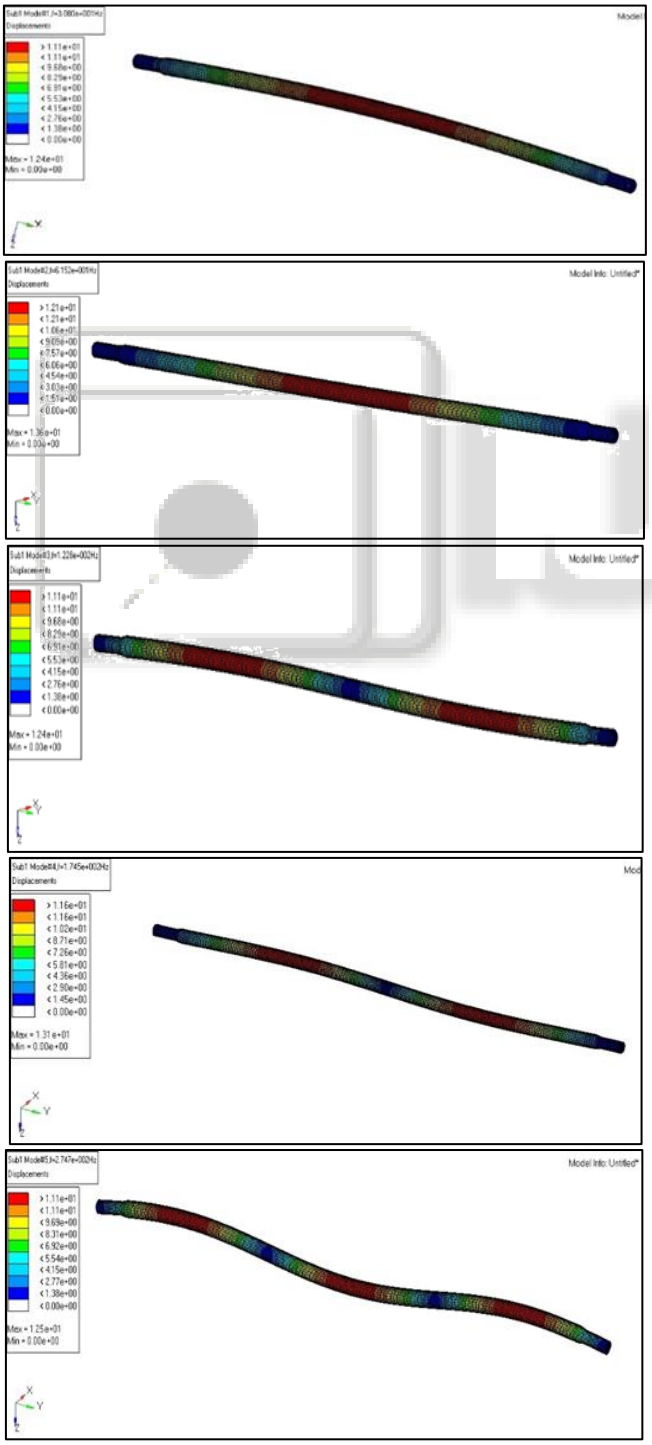


Fig. 4: Boundary Conditions: force at one end of the rod

C. Existing Tie Rod Finite Element Analysis and Results



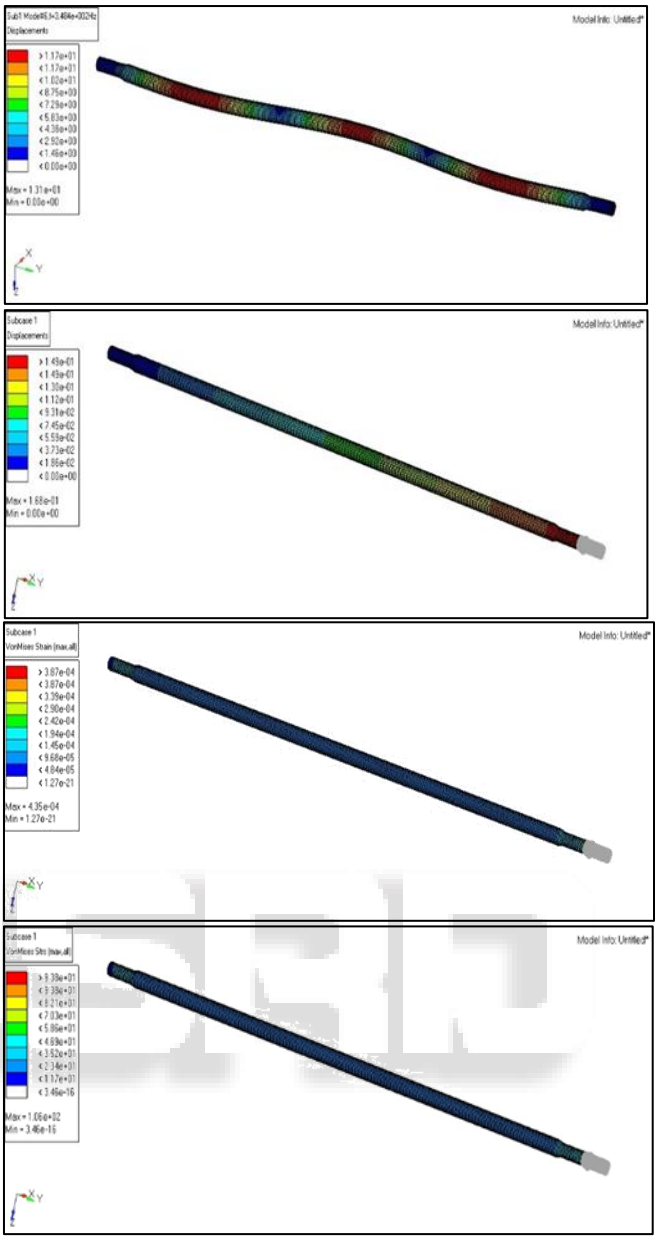


Fig. 5: Existing Tie rod Finite Element Analysis and Results

IV. CONCLUSION

In modal analysis we obtained natural frequencies and mode shapes. Displacement stresses and strains obtained by performing static analysis of existing model. For existing model stresses were in safe limit further we had to check problem for transient dynamic response. By performing transient analysis we obtained 140Mpa stresses at both ends, under repeated loading structure will fail at this stress so there was a scope for modification.

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