

Failure Analysis and Fatigue Life Improvement of Steering Mechanism of Heavy Commercial Vehicles Using FEA

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ABSTRACT

Tie rods or Track rods are an integral part of vehicle's steering system. Just as its name suggests a Tie rod ties vehicle's steering rack to the steering arm. It is used to give direction to tires according to steering wheel movement. A tie rod assembly is attached to each end of the relay rod. The tie rod assembly consists of inner and outer tie rods that are usually connected through an adjusting sleeve. Tie rod may get fail due to varying forces and bumping of vehicle during steering. The forces from the steering are also considered during the static condition of car. The finite element models of the modified tie rod also analyzed to find stiffness and stress distributions in each component.

KEYWORDS: Track Rods, Steering System, Tie Rod etc

INTRODUCTION

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

The efforts required where car is moving are comparatively less with stationary car. The working strength of the tie rod is that of the product of the allowable working stress and the minimum cross-sectional area.

Objectives

The aim of the project is to accurately find out the buckling loads and the fatigue life of Tie rods, especially ones that are critical in compression used in automobile industries. To perform the fatigue analysis of the existing tie rod and to modify the design of the tie rod for infinite life.

Literature review

1. The paper "FEA OF TIE ROD OF STEERING SYSTEM OF CAR", entitled by Manik A. Patil, Prof. D. S. Chavan, Prof. M. V. Kavade, Umesh S. Ghorpade is studied the FEA analysis of Tie rod is carried out to check its natural frequency, maximum stress analysis and deformation. The

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most percentage weight of vehicle is taken by suspension system; however tie rod may get fail due to fluctuating forces during steering and bumping of vehicle. The forces from the steering is also considered during the static condition of car. Vibration and fatigue of Tie rod has been continuously a concern which may lead to structural failure if the resulting vibration and stresses are severe and excessive. It is a significant study which requires in-depth investigation to understand the structural characteristics and its dynamic behavior. This paper presents and focuses on some Finite Element (FE) analysis of a typical tie rod of a car will be carried out and natural frequency will be determined.

2. The paper “*RIGID BODY DYNAMIC SIMULATION OF STEERING MECHANISM*” entitled by V. D. Thorat, S. P. Deshmukh studied Project work present rigid multi body dynamic analysis approach in design. The application of this methodology simplifies design process and give correct result. For the case study here work of design done on Ackerman steering mechanism for tipper. In this first according to Ackerman conditions basic geometry is design and then

optimize it for static loading, modal analysis and then for dynamic forces generated on steering linkages while turning using Rigid Dynamics tool in Ansys.

3. The paper “*FINITE ELEMENT ANALYSIS OF TIE-ROD FOR SPACECRAFTS*” entitled by Kiran S Sankanagoudar, Dr. H. K. Amarnath, Prashant D. Bagalkot, Mukund Thakur This paper describes the design and mechanism for the deployment of Equipment panel of a spacecraft. For this a tie rod is designed and analysis is done in UG NX 7.5, the design analysis section provides data on linear Buckling analysis. Both the ends of the Tie rod are hinged so that the Equipment panels assembled to Tie –rod can be tilted from Horizontal condition to vertical condition. And safety of factor taken is 3.0.

Methodology

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

CAD Model

1. CAD Model of Modified Tie Rod



Fig. 1: CAD Model of Modified Tie Rod

2. Modified Tie Rod Finite Element Model and Boundary Conditions

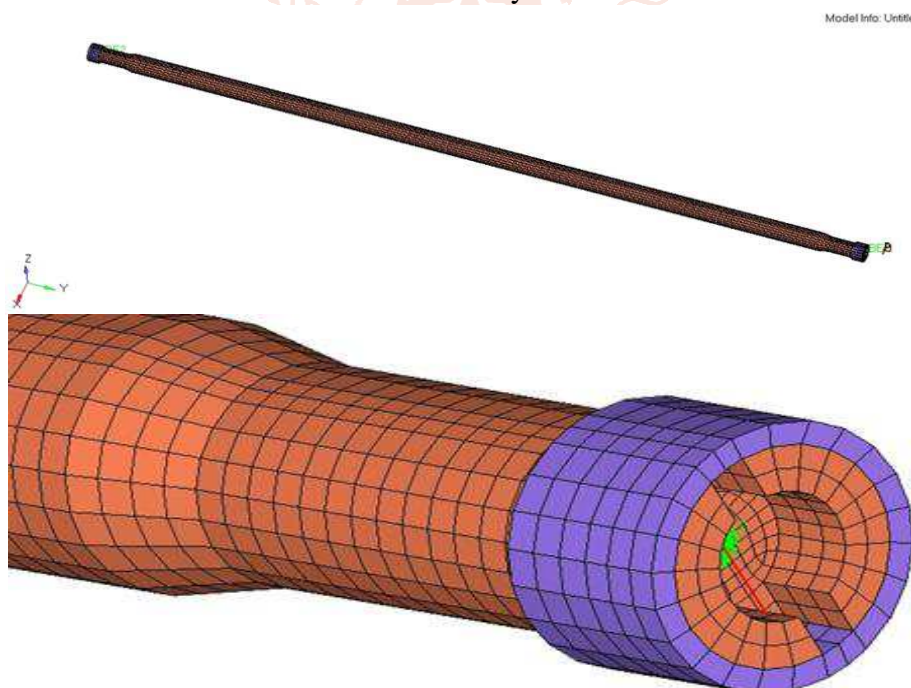
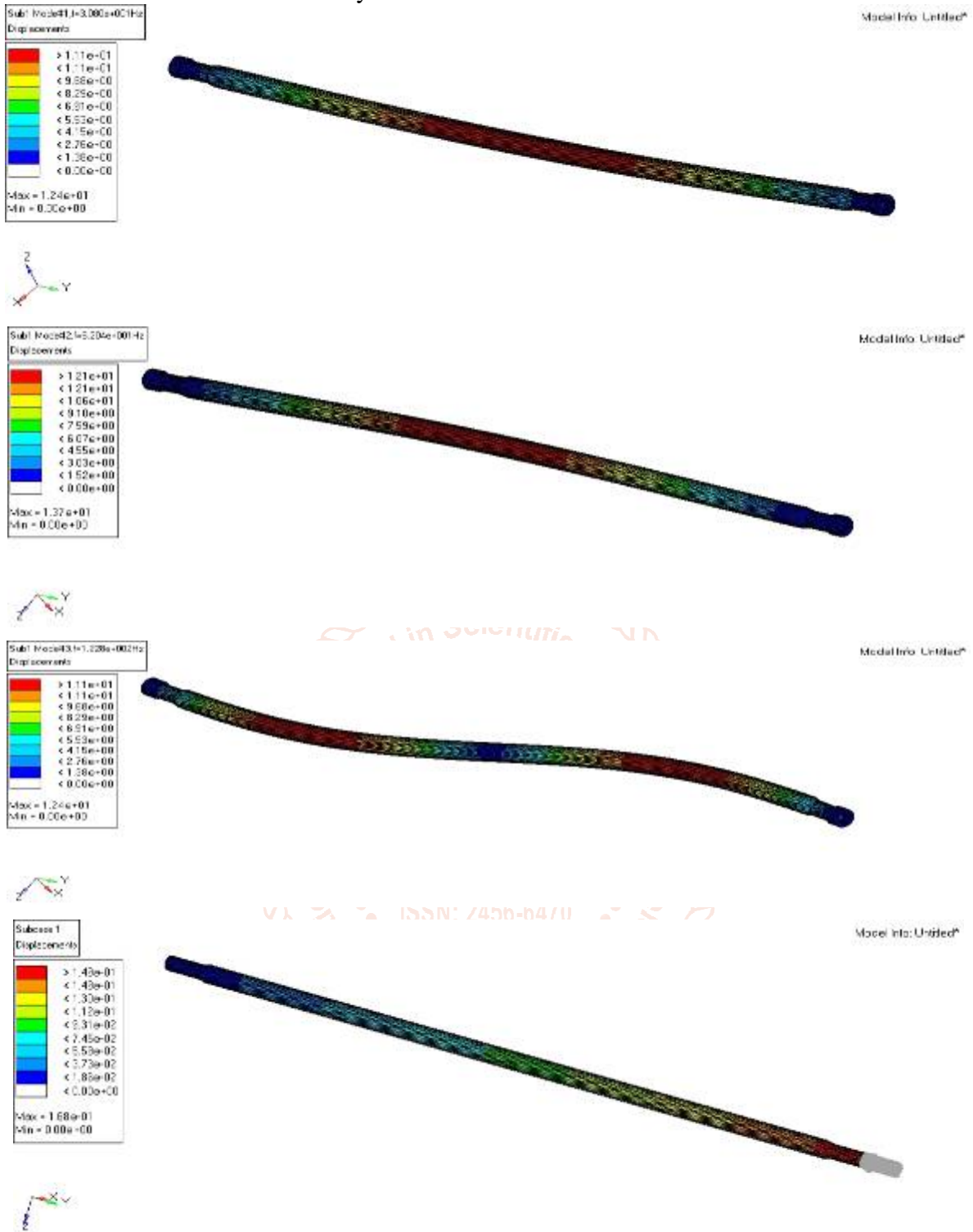


Fig. 2: Modified Tie rod Finite Element Model and Boundary conditions

3. Modified Tie rod Finite Element Analysis and Results



Conclusion

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. Connecting bushes at both end added to the tie rod to increase the stiffness of the rod against stresses. And finally to validate the modified design again modal, static and transient dynamic analyses were carried out. And result stress 100Mpa obtained which is within the allowable limit.

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