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AUTOMOTIVE TIE ROD FOR BETTER PERFORMANCE AND OPTIMIZATION ACCORDING TO MATERIAL AND DESIGN PARAMETERS

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ABSTRACT :- The past few decades have seen outstanding advances in the use of light weight materials in structural applications. There can be little doubt that, within engineering circles, composites have revolutionized traditional design concepts and made possible an unparalleled range of new and energizing prospects as suitable materials for development. In this work, a light weight Aluminum tie bar was created to supplant the traditional steel tie bar. This new composite tie bar can accomplish high flexible strain and gives a predictable compaction strain to the stack throughout long activity time. To form the complex thread shape of the tie bar without compromising its tensile strength, different types of material were adopted for the thread and rod parts.

Key ward: Tie Rod, Light Weight material.

I. INTRODUCTION

Tie rods are an integral part of your vehicle's steering. Just as its name suggests, a tie rod ties your vehicle's steering rack to the steering arm. The steering arm is attached to the wheel. There are two types of steering systems: rack-and-pinion steering and re-circulating ball or mechanical steering. A rack-and-pinion steering system is a very simple operation. When you turn your steering wheel, a pinion gear, which is joined to your guiding shaft, will move along the controlling rack. The guiding rack, joined to both front wheels, will move as per how you turn your wheel. The tie bars are answerable for communicating the power from the guiding rack to the controlling arm and moving the wheel. The re-coursing ball or mechanical guiding framework is somewhat more mind boggling than the rack-and-pinion system. The mechanical system includes a gearbox. When you turn your wheel, your steering shaft will set several gears in motion that control the pitman arm. The pitman arm moves the steering rack according to how you steer. Again, like in the rack-and-pinion system, the steering rack is connected to the tie rods, which are connected to the steering arms. The tie rods are the connection from your steering system to your wheels. These two systems,

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however complex, contain a very simple, yet important part, the tie rod. Tie rods play a crucial role in your steering system. Without tie rods, your steering system would fail. Tie rods are the pivot point between your steering system and your steering arm and wheel. The outer tie rod end is adjustable. This means that you can change the length of the tie rod to fix your vehicle's alignment. As you can see, the simple tie rods are very important. They are responsible for moving your wheels when you steer and for making turning possible.

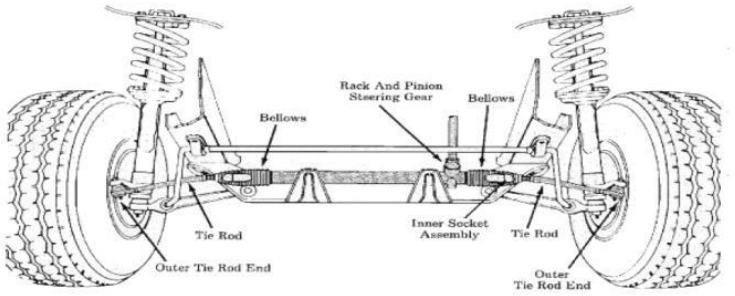

Fig1. Basic rack and pinion steering

II. LITERATURE SURVEY

Kiran S Sankanagoudar, Dr.H.K.Amarnath, Prashant D. Bagalkot, Mukund Thakur, study on 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.

In this paper, the linear Buckling analysis method for the Tie-rods is presented. Since, the tie-rod is the main drive element for tilting of the equipment panel. It is suggested to co-relate the Analytical and FE results with experimental

values. Above results indicates that the induced stresses are within permissible limits and hence, the design is safe.

Raghavendra K, Ravi K, in this paper have studied tie rod for the theoretical, experimental and modal analysis of tractor. Different materials of tie rod like Aluminum A6016, Cast iron C1540, Mild steel SAE 1020 have taken. Static analysis is performed with 41000 N loading applied as compressive force in Y directions. Simulations were made and stresses, displacements were calculated. A tie rod is a slender structural rod that is used as a tie and capable of carrying tensile and compressive loads. As the ratio of its length to the radius of gyration of its cross section is normally quite large, it would likely buckle under the action of compressive forces. When it becomes worn out, steering will become more difficult there by producing clunking noise. The vehicle will also typically be pulling or (dragging) to either side (left or right). Thus the aim of the project is to analyze tie rod for active to improve the mass and buckling load of tie rod. The

objectives of this study are to carry out the theoretical, experimental and modal analysis of tractor Tie rod to find different modes shapes by analysis FE software.

Wei Duan, Suraj Joshi, in this paper reports the results of full-scale tensile rupture experiments on two categories of Large-scale steel tie rods provided by China JULI Corporation: (i) LG75-00 steel tie rods with triangle threaded connection, and (ii) LG100-00 steel tie rods with trapezoidal threaded connection. The full-scale tensile rupture experiments were carried out to test the maximum allowable axial working load under different numbers of turns of engaged threads. The results of these experiments suggest strong guidelines on the minimum number of turns of thread engagement for preventing the failure of thread teeth of steel tie rods in practical shear and bending applications.

Pradeep Mahadevappa Chavan1, M MM Patnaik, this paper deals to assess buckling strength and compare buckling performance of Tie rod for different materials. Finite element models of the Tie rod also analyzed to obtain stiffness and stress distributions in each component. Based on the experimental test results, theoretical calculation results and finite element analysis with NASTRAN results, stiffness values are validated. The mode shape and natural frequency results for different materials obtained in the normal modal analysis are compared. In buckling analysis, the load factor obtained for different materials were compared and critical buckling load is calculated and is validated by theoretical calculations.

III. PROBLEM STATEMENT

With bad tie settings the car will most likely go in unexpected directions when the suspension hits a bump in a turn or when braking (only really bad enough to be a problem when doing it much harder than normal driving). The other problem is rapid tire wear. If it is way out your tires will be toast fast and tires are usually more expensive than an alignment.

Tie rod ends are kind meant to wear out to prevent damage to the much more expensive steering rack and power steering pump

.

Fig.2 Image of a broken tie rod

3.1 Concluding Remark

By using above case studies, we can determine the working and design (always very tricky) of tie rod. The tie rod takes most of the load that the road has on the wheels of the motor vehicle. Based upon studies, we can apply boundary conditions to the model and carry out analysis. Analysis can be done on FEA software's to determine the nature of failure caused due to stresses developed.

3.2 Objectives

The main objective of the study is to perform static analysis on tie rod under various loading conditions. Another objective is to propose an optimized model which will have better performance.
To achieve this objective following steps must be take

1. To study various research papers to know the work done on tie rod.
2. To draw CAD model in CatiaV5
3. Study boundary conditions and loadings acting on the tie rod.
4. Carryout analysis.

3.3 Scope

It is proposed to do static analysis on tie rod, as per the following.

1. Experimental Analysis: - Testing the tie rod under actual conditions and carrying out the calculations.
2. Theoretical Analysis: - Running the problem in any FEA software and comparing the results with the experimental analysis.

IV. FINITE ELEMENT METHOD

4.1 Loads on Tie rod:

The CAD model of Tata 483 DL Turbo (Diesel Intercooled) Tie rod is taken for analysis.

Max. GVW	2670
Max. permissible FAW	1160
Max. permissible RAW	1550
Kerb weight (with spare wheel, tools, full tank)	2040

To find vehicle weight on steered axle:
Total weight of the car (GVW) = 2670kg
Mass of the vehicle is splitted –
Mass of front axel wheel = 1160/2= 580 kg

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Bump case:
Force = mass*acceleration*3g
=580*9.81*3
=17069 N
Braking case:
Braking force = mass*acceleration*1g
= 580*9.81
5689 N

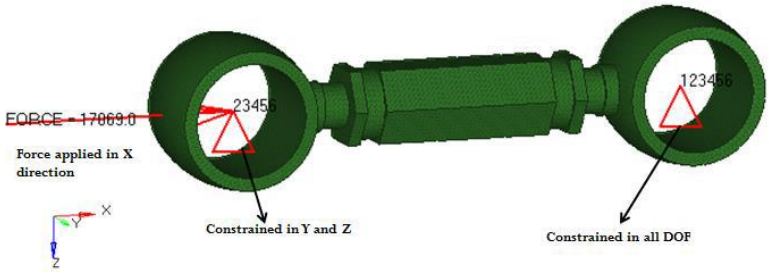

Fig 3: Loads and Boundary condition in Hypermesh

4.2 Material Properties of Mild Steel

Table 1: Material properties of Mild steel

Property	Value
Young's Modulus, E	210 GPa
Poisson's Ratio ,ν	0.33
Density, ρ	7800kg/m3
Yield Stress, σyield	250 MPa
Ultimate Tensile Stress, σuts	290 MPa

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4.3 Vonmises stress for tie rod:

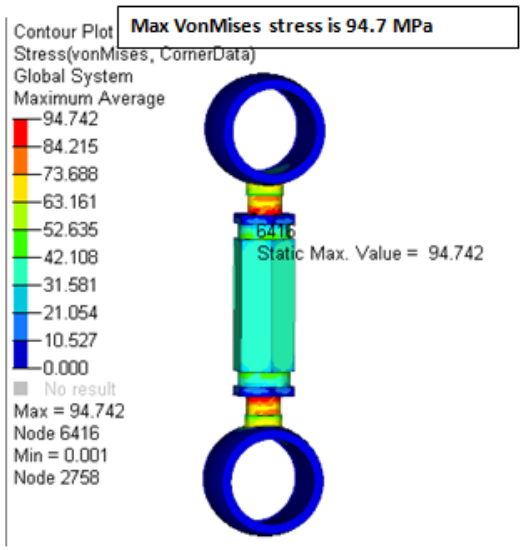

Fig.4 : von-mises stress for MS hexagonal tie rod

Deformation:

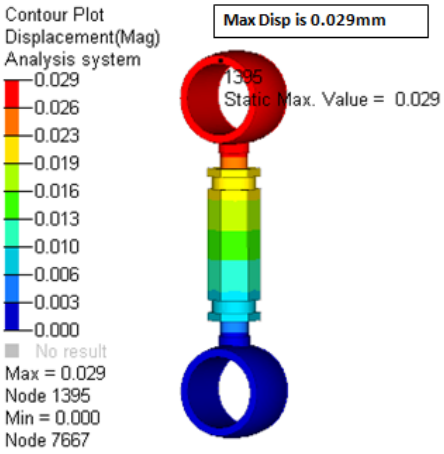

Fig.5: Displacement result for MS hexagonal tie rod

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Below image shows meshed model and loads applied on tie rod using Aluminum material.

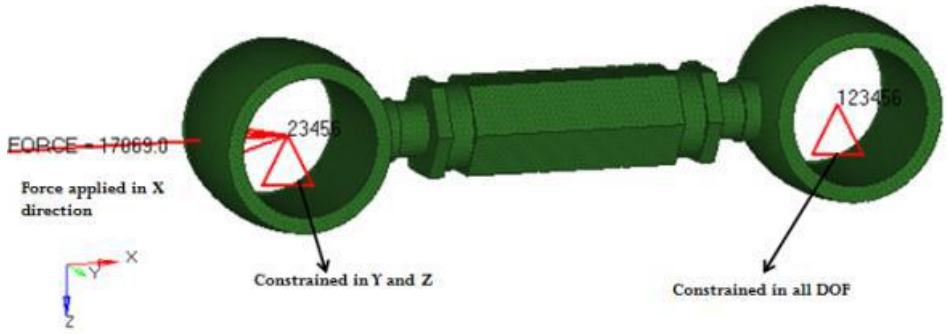

Fig.6: Hexagonal tie rod for Aluminum material

loading condition
Following are the results displayed for stress and deformation:

4.4 Von-mises stress for tie rod:

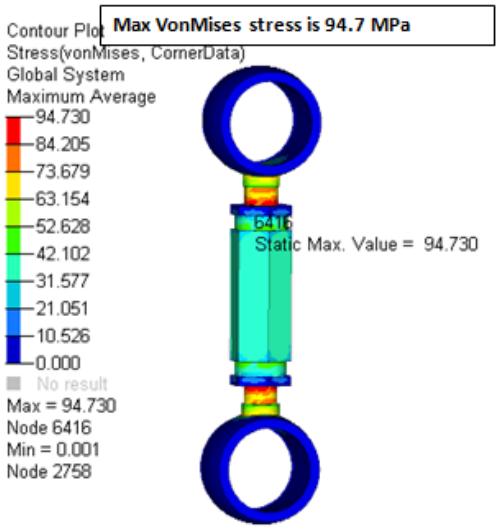

Fig.7 : von-mises stress for tie rod (Aluminum)

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Deformation:

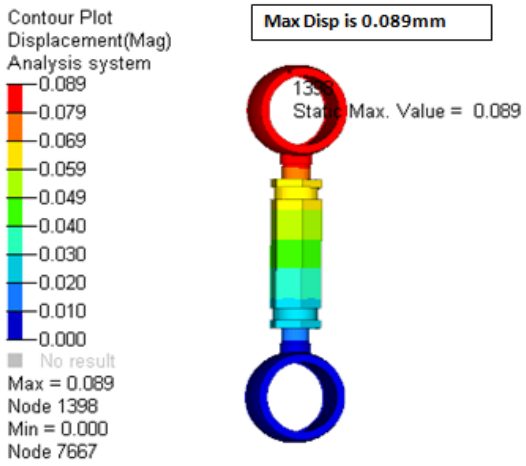

Fig.8: Displacement result for tie rod (Aluminum)

Table2. FE results comparison. Stress, deformation and mass.

	Hexagonal Tie rod	
	MS	Al
Stress, MPa	94.72	94.73
Deformation, mm	0.029	0.089
Mass, Kg	1.132	0.39

V. CONCLUSION

The FEA analysis of tie rod is carried out over conventional model. The tie rod with different material is analyzed for MS and Al material at the given working conditions. The best of all the emphasis is picked for the creation i.e tie bar made of Al material which is having pressure esteem as 94.73Mpa which is not exactly passable value. From the results it can be concluded that the validation of results show close resemblance with a % error of 8.62%

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