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Design and Analysis of Torsion Bar & Bracket using Finite Element method

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A B S T R A C T

In Modern Indian Automotive Industries, Torsion Bar or a straightened Helical Spring is one of the main components fitted on front suspension system. Unlike a helical spring, it absorbs the road shock & while doing so, twisted at one end of its fitment & returns to its original position once the load is removed. In doing so it maintains the correct vehicle height & keeps vehicle safe during ride on rough roads. It also helps in maintaining the stability of vehicle thereby improving the comfort during ride. As the torsion bar twists, it resists up & down movement. One end of the bar made of heat-treated alloy spring steel is attached to the vehicle frame, the other end is attached to the lower arm of the front suspension system.

Keywords: Torsion Bar design is most commonly used on Front Suspension system on almost all MPVs & SUVs. INTRODUCTION

1 Introduction

When the wheels move up & down the lower control arm is raised and lowered. This twists the torsion bar which causes it to absorb road shocks. The torsion bars are fitted on most of the MPS & SUV globally because they can be mounted low and out of the way driveline components. In this research work, we performed an analysis of the Torsion bar and bracket using Hyper mesh 19.3 as a preprocessor and used nonlinear solver as Opti struct.Indian roads are one of the longest and busiest in the world after the United States has an approximate length over 5,897,671 kilometers. Every day Indian roads transport 65 percent freight and over 85 percent of passenger vehicles. The contribution of the road in the Indian economy is around 4.7 percentages and that is more than the Indian railway's contribution towards the Indian economy but also the road condition in India are not good enough, that is the home of several very bad roads near some cities and most of the villages. Due to the road conditions our vehicles not able to sustain the road load while moving and got damage, one of the most common issues in the damage of the suspension system. Most of the vehicle with lower ground clearance cannot sustain that road shock and got damage and most of cases the vehicle wheel alignment got disturbed. To avoid that damage, we manage the ground clearance height through torsional bar by using trim height adjuster but most of the cases the torsional bar bracket and trim height adjuster bolt & bracket also sheer off during driving in rough road & overloaded condition. As per the vehicle users review they suggest to carry one extra pair of this height adjuster assembly .The design of the Torsion bar bracket bolts with tool will significantly reduce the chance of breakage of Torsion bar suspension system. The Design aspects mainly the torsion bar diameter, Bolt shank diameter & bracket thickness.

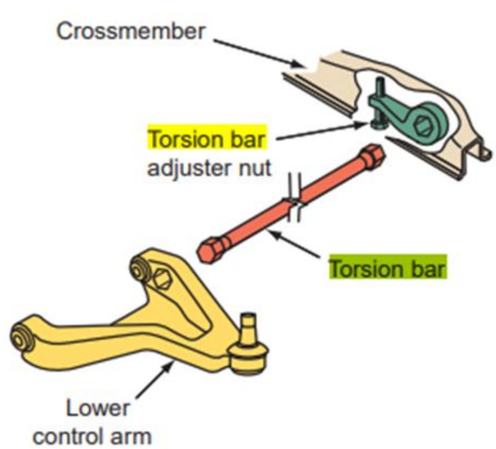

Fig. 1 A Torsion Bar set up in Front Suspension System

Indian customers while purchasing an MPV or SUVs keeps in mind only the Fuel efficiency, Space in passenger compartment, speed & torque while eliminating the safety features. Vehicle height is on of the safety issue on most of the Indian cars & SUVs. Customers are likely unaware about an important factor; the engine's power or vehicle speeds are utterly useless if the driver cannot control the vehicle. Certainly, many people may recognize the importance of the suspension for comfort, but they are less aware about vehicle suspension. In fact, the suspension system plays a vital role in vehicle performance, stability, and safety. Now automotive manufactures turn their attention towards the suspension system, an area usually ignored by customers while purchasing the vehicle.Historic horse-drawn carts had an early form of a suspension system, where the platform swung on iron chains attached to a wheeled frame on the carriage as shown in figure. That suspension system model was the basis for all suspension systems until the end of the 19th century. Obadiah Elliot is the first person who used a spring in the suspension system of a automotive vehicle, and Mors of Paris first fitted a suspension system with shock absorbers in 1901. Today, there are many kinds of suspension systems with complex structures and elements, some of which will be discussed here.

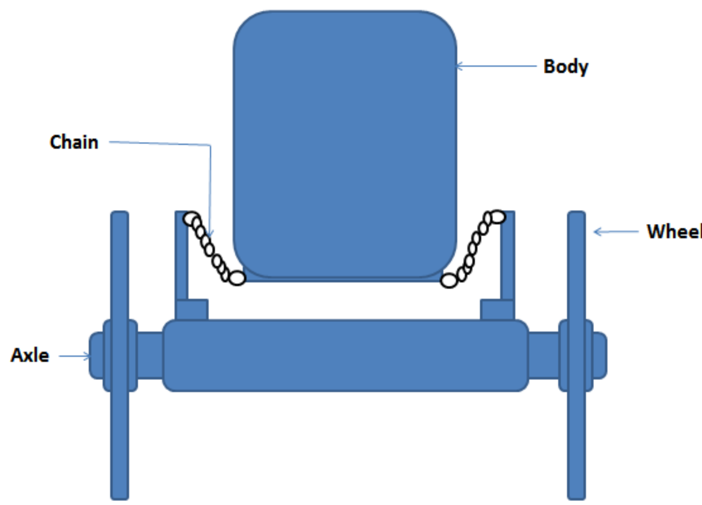

Fig. 2 - Early horse-drawn carts

1. Methodology

It may seem like the suspension system is a set of springs and shock absorbers which connect between the wheels and the vehicle body. A vehicle suspension system mainly provides a smooth and comfortable ride over rough roads conditions while ensuring that the wheels always in contact with the ground. The suspension system contains three major features: a structure that supports the vehicle's weight and determines suspension geometry, a spring that converts kinematic energy to potential energy or vice versa, and a shock absorber that is a mechanical device designed to dissipate kinetic energy.

An automotive suspension connected between wheels to a body while carrying the vehicle's weight. It allows for the relative motion between wheel and the body. Generally suspension system reduces a wheel's degree of freedom from 6 to 3 on the front axle and to 2 on the real axle. The suspension system also supports steering, brakes, and associated road loads.

Fig.3- Wheel Degree of freedom

The research work consists of design and analysis of Torsional bar and bracket assembly of a passenger car for its performance enhancement and effecting compliance to the standard practices in the Industry using Implicit Finite Element Code. The main objective of this work is to determine the first normal mode frequency and try to improve the design. In order to achieve the our objective, the design developed using CRE-O parametric 4.0, then CAE model was prepared by HYPERMESH 17.3 preprocessor. The different type of element are used in model according to subparts, like 3D hexahedral elements are used for Solid parts, 2D Shell elements are used for Brackets. In this FEM mode, total number of node are around 12810 and total number of shell and solid elements are around 10672. The Element quality criteria Is Considered from experimental method for better result quality described below.

Table 1 Element quality criteria for 2D element with 5mm Average size-

Warpage	15	Min. Length	2
Aspect ratio	10	Max. Length	8
skew	60	Jacobian	.65

Table 2Element quality criteria for 3 D elements with 5mm Average size-

Max. Length	3	Tet collapse	.2
Max. Length	8		

Table 3Material properties assigned according to subparts as show in table below.

Part	Property	Density	Elasticity Modulus	Poisson Ratio	Yield stress
Torsion bar	Solid	7.8E-9 Tons/mm3	2.1E5 MPa	.3	810 MPa
Bracket	Shell 2.5	7.8E-9 Tons/mm3	2.1E5 MPa	.3	240 MPa
Bolt	Solid	7.8E-9 Tons/mm3	2.1E5 MPa	.3	480 MPa
Bolt Support	Solid	7.8E-9 Tons/mm3	2.1E5 MPa	.3	300 MPa
Plate	Shell 5.6	7.8E-9 Tons/mm3	2.1E5 MPa	.3	300 MPa

After the pre-processing work, we applied boundary condition in the model and prepare this model for Static analysis using optistruct solver.

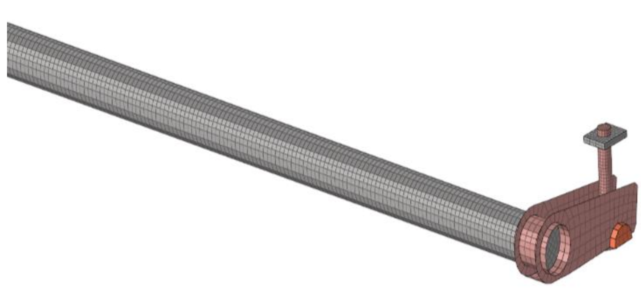

Figure 4- CAE Model

2. RESULTS AND DISCUSSION

Using optistruct solver this model took some seconds to run and solve the problem, then using Hyperview postprocessor the results shown in the form of contour. The Simulation shaded by some different colours, Blue represents zero or minimum and red represent maximum displacement and stress.

Table 3 Results of displacement

Part	Maximum Displacement	Maximum stress	Yield stress	FOS
Torsion bar	10.25	33.40	810	>1
Bracket	9.785	200.7	240	>1
Bolt	4.318	817.6	480	<1
Bolt support	4.005	93.64	300	>1
plate	.0085	517.7	300	<1

Modification in design: - There are two parts, which may fail under torsional load, we are considered some modifications described below.
Changed the bolt grade from 6.8 to 10.9 grade.
Change the thickness of plate from 6.5mm to 10 mm.
Then check the final results after modifications.

Table 3 Results of displacement and stress

Part	Maximum Displacement	Maximum stress	Yield stress	FOS
Bolt	4.318	817.6	840	>1
plate	.0085	280	300	>1

3. CONCLUSION

- In this Research work stress analysis of torsion bar and bracket assembly has been investigated using finite element analysis. It was concluded that in torsional bar and bracket assembly only bolt and plate will failed under variable loading, after some titration like material grade and thickness improvement, assembly passed the stress analysis.

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