



## *Performance Improvement of Torsion Bar & Bracket Bolt by design change in Vehicle Front suspension System*

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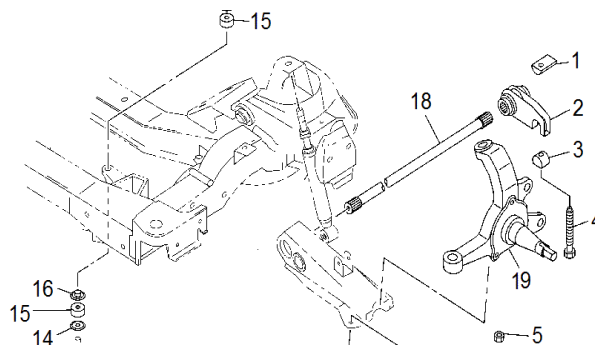
### ABSTRACT

Indian roads are one of the longest and busiest in the world after 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 Vehicles have to travel in different terrains, Road & load condition across India. 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 however, the road condition in India are not Similar as per the driving condition. As the road conditions are not same & being abnormally not suitable as per the vehicle design, the vehicle performance is also affected & causes different levels of wear & tear in different moving parts. The vehicles are not able to sustain the road load while moving and get damage, one of the most common issues in the damage of the suspension system. As the complete load transfer during rolling is transferred to suspension system, a robust design is anticipated to take road thrust. In this research, we performed an analysis of the Torsional bar suspension system using the finite element method and improve the method of vehicle height adjustment.

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

### 1. INTRODUCTION

2. The chassis or body of the vehicle is mounted on the axles through the spring elements that are used to isolate the vehicle body from the road shock in the form of bounce, pitch, and roll. Due to these shocks, the uncomfortable ride is occurring and also causes some extra stress in the vehicle frame or body. All the parts which perform the function of isolating the vehicle from road shocks are called suspension system. Torsion Bar is a component of suspension system just like spring, the helical spring is straightened which used to keeps vehicle stable during cornering and prevents from rolling, it also helps to maintain stability of the vehicle & maintains correct height when the bump and jerk occurred. It is an elastic cross-section bar which mounted such a way that, one end is fixed to the chassis or car body and other are connected to suspensions lower links and some amount of torque or load is always applied on it which may help to maintain the vehicle height from the road surface. Almost all of Multi Utility Vehicles in India uses a Torsion Bar in Front suspension system which serves the purpose of spring & providing cushion



**Fig 1** Suspension system

The vehicles on Indian Road have to travel in different road & load condition, sometimes the road condition is very severe to drive & becomes challenge for the driver, as per road & load condition the vehicle height, wheel alignment & suspension system faces changing condition, therefore it's very important for all the Car Manufacturers to design the suspension system such that the damage to vehicle can be minimized. To avoid that damage, we manage the ground clearance height through torsional bar by using trim height adjustment but most of the cases the torsional bar bracket and trim height adjuster bolt also fails on rough road & over load conditions.

In my project on one of the OEM manufacturing SUVs & MUVs, it is observed taking survey on different drivers & vehicle owners, they use to carry a set of Torsion Bar Mounting Bracket & Bolt as a backup while driving in severe road condition & hilly terrains.. The Design aspects mainly the torsion bar diameter, Bolt shank diameter & bracket thickness & maintaining correct trim height reduces the chance of breakage.

Problem Statement: - Survey has been conducted across India & met with different Vehicle drivers & owners to understand the vehicle issue on suspension system, verbatim was collected & found that Most of vehicle users and local mechanics don't know the proper procedure of torsional bar fitment, like proper height and gap of bracket with the cross member of vehicle body due to this the torsional bar bracket assembly may fail on rough road, under variable loading conditions. Many car owners face this dilemma.

As the correct Trim height could not be maintained, the wheel Alignment values specially Caster & Vehicle height changes causing repeat failures.



Fig 2system Image



Fig 3Break part

### 3. FEA SIMULATION

3.1 CAD modelling: - CAD stands for Computer-Aided Design; with the help of computer aided design software we can create new design, modified it or may analysis it also. There is so many cad software is used in industries currently like pro-e, cre-o, catia, solid works etc. CAD software are used to increase the productivity, improve the quality of design, improve communication between deign and requirement virtually. That is not only for mechanical engineering but it is also useful for other engineering's also. That's software is very useful in automobile industries for making virtual prototype. In our case we use creo parametric 4.0 as a CAD software, and design our model as per given dimensions.

3.2 FEA modelling: - Generally we have three techniques to solve any engineering problem, first one is Analytical method in which we got solution through formulas or hand calculations, it is a classical approach, it is assumed to 100 % accurate, but this solution only applicable for only simple problems. A second technique is numerical method; it is basically a mathematical presentation of a problem in which we use matrix to solve any engineering problem using CAE software, in this technique we do not need to make prototype, it is a simple technique in which we design and analysis our product using computer system. Using this technique, we can easily test our product, or make changes according to requirements, but the results cannot be believed blindly, we need to verify our results by other any techniques. The third technique is physical testing of prototype, but that technique is obsolete from the industries because that is time consuming method and some time it may very costly when we have to make more than one prototype. In this research work we are using the numerical method through some specific software called hyper mesh developed by Altair that is used as a pre-processor and as a solver we are using.

Element Quality Criteria: -

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

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

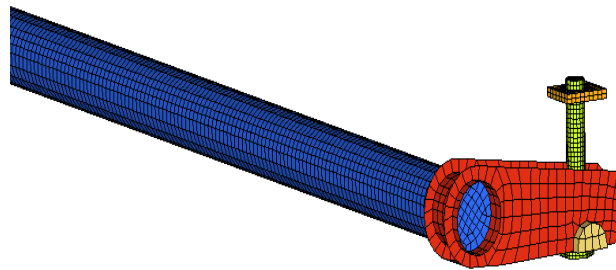


Fig 4 Mesh Size and Distribution

#### 4. RESULTS AND DISCUSSION

After prepare FEA model in pre-processor we applied moment of 500NM.

Part	Maximum Displacement	Maximum stress	Yield stress	FOS
1. Torsion bar	10.25	33.40	810	>1
2. Bracket	9.785	200.7	240	>1
3. Bolt	4.318	817.6	600	<1
4. Bolt support	4.005	93.64	300	>1
5. 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.

1. Changed the bolt grade from 6.8 to 10.9 grade as per ISO 898-1:2013.
2. Change the thickness of plate from 6.5mm to 10 mm.

Then check the final results after modifications.

Table 4 Results of simulation

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

Torsional bar and bracket assembly fitment: - Under this type of failure in torsional bar bracket assembly, we developed one measuring tool for proper fitment of torsional bar bracket called as happy tool. There are basically two tools as shown in figure tool A and B. Tool A is in shape of triangular piece with an angle 18.3 degree and tool B is a 56 mm cube, generally used for initial alignment of torsional bar height adjuster with chassis plane.

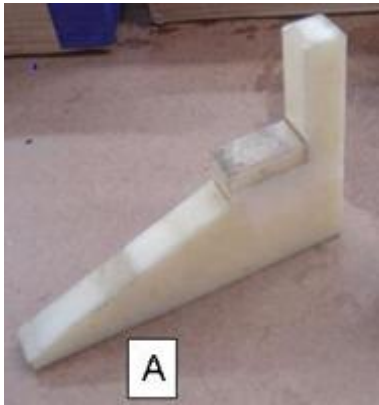


Fig 5 Tool image A

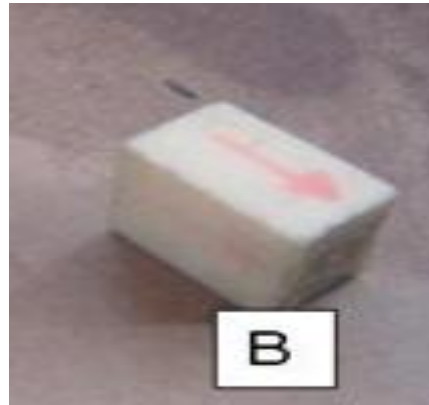


Fig 6 Tool image B

There are some steps for usage of happy tool in torsional bar fitment.

1. Park a car on a plan floor , jack up then place the happy tool B in between the rubber stoper and lower arm as shown in figure.
2. Insert the torsional bar new or old then use happy tool A for initial alignment as shown in figure.
3. Tight the assembly as per specified torque
4. Remove the happy tools
5. Do the allignmnet as per procedure.

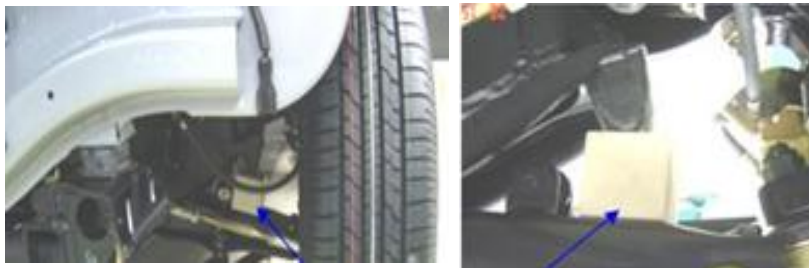


Fig 7Initial Alignment



Fig. 8before tightening



Fig 9 After tightening

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## 5. CONCLUSION

The stress analysis of torsion bar and bracket assembly analysis has been investigated by finite element analysis on torsional load. It was concluded that in torsional bar and bracket assembly only bolt and plate will failed under variable loading, after material grade and thickness improvement that whole assembly passed the stress analysis. And also the uses of happy tool were very effective for fitment process and reduce the failure due to improper height and gap.

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