Analysis of Hollow Torsion Bar Made of E- Glass Fiber Reinforced Composite Material

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Abstract: **The purpose of this study is to investigate stress values of composite torsion bar suspension system. In this analytical study, round solid composite bar is taken. The analytical was carried out on a ANSYS, which was built specifically to investigate the static characteristics of torsion bar used in vehicle suspension system. This paper provides fundamental knowledge of structural test and significant parameters such as stress, total deformation, equivalent stress are highlighted. Thus the deflections were obtained analytically. The results of this study could provide a better light weight torsion suspension system.**

Keywords: **Torsion bar, Ansys, Total deformation , Stress**

I. INTRODUCTION

A torsion bar suspension, also known as a torsion spring suspension or torsion beam suspension, is a general term for any vehicle suspension that uses a torsion bar as its main weight bearing spring. One end of a long metal bar is attached firmly to the vehicle chassis; the opposite end terminates in a lever, the torsion key, mounted perpendicular to the bar, that is attached to a suspension arm, a spindle, or the axle. Vertical motion of the wheel causes the bar to twist around its axis and is resisted by the bar's torsion resistance. The effective spring rate of the bar is determined by its length, cross section, shape, material, and manufacturing process.

The most common place to find a torsion bar is in the suspension of a car or truck, in machines used for production or in other precision devices. The flexibility of the spring is the main reason that a torsion bar is used. If a more rigid structure were used such as a steel rod were used too much load bearing pressure would be placed on the both the wheels and the under body of the vehicle. A torsion bar works by resisting the torque on it. When one end of the torsion bar is affixed to an object that cannot be moved, the other end of the bar is twisted, thus causing torque to build up. When this happens, the torsion bar is resistant to the torque and will quickly back to its position once the torque is removed. Vertical motion of the wheel causes the bar to twist around its axis and is resisted by the bar's torsion resistance. The effective spring rate of the bar is determined by its length, cross section, shape, material and

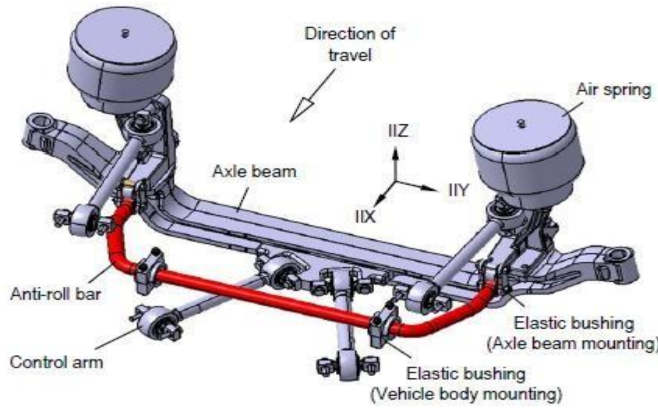


Fig 1 position of torsion bar

manufacturing process. Torsion bars are used as automobile suspension. They offer easy adjustment on ride height depending on the weight of the car. Torsion bars are essentially metal bars that function as a spring. At one end, the torsion bar is fixed firmly in place to the chassis or frame of the vehicle. The other end of the bar may be attached to the axle suspension, or a spindle, depending on the specification of the vehicle. As the vehicle moves along the road. The forces generated by the motion of the vehicle create torque on the bar, which twists it along its axis. Counteracting the torque is the fact that the torsion bar naturally wants to resist the twisting effect and return to its normal state. In doing so, the suspension provides a level of resistance to the forces generated by the movement of the vehicle. This resistance is the key principal behind a torsion bar suspension system. The torsion bar do not offer what is known as progressive spring rate.

1.1 Literature Review

Experimental investigation on torsion bar suspension system using e- glass fiber reinforced composite material by M. Manikandan, K. Raja, V.S. Chandrasekar in this paper, a descriptive outline about by introducing a composite structure having maximum energy which will increase the lifetime of the torsion bar used upon two dynamic perspectives, such as riding and handling of vehicle This study reveals that the composite steel bar can store more energy which will obtain even at higher efficiency, when θ=12°(angle of twist) while comparing with conventional steel torsion bar.

Analysis of passive and semi active controlled suspension systems for ride comfort in an omnibus passing over a speed bump by T. Ram Mohan Rao*, G. Venkata Rao, k.Sreenivasa Rao & A. Purushottam This paper describes the modeling, and testing of skyhook and other semi active suspension control strategies. The control performance of a three-degree-of-freedom quarter car semi active suspension systems is investigated using Matlab/Simulink, model. The objective of this paper is to present a comprehensive analysis of novel hybrid semi-active control algorithms and to compare the semi-active and passive systems in terms of human body vibrational displacements and accelerations.

Automated design analysis of anti-roll bars by kemal çalişkan Vehicle anti-roll bars are suspension components used for limiting body roll angle. They have a direct effect on the handling characteristics of the vehicle. Design changes of anti-roll bars are quite common at various steps of vehicle production, and a design analysis must be performed for each change. Finite Element Analysis (FEA) can be effectively used in design analysis of anti-roll bars.

Parametric optimization to reduce stress concentration at corner bends of solid and hollow stabilizer bar by Preetam Shinde1, M.M.M. Patnaik in this paper, a descriptive about the function of stabilizer bars in motor vehicles is to reduce the body roll during cornering. This project looks into the performance of stabilizer bar with respect to their stress variations at corner bends and weight optimization. The focus is on the stress concentration at the corner bends of a stabilizer bar, that is designed for an automotive vehicle, which is reduced by optimizing the shape of the critical regions in two types of stabilizer bars, one is solid and other is hollow.

Analysis of an automobile suspension arm using the robust design method by hemin m. mohyaldeen in this paper, a descriptive outline about the features of torsion bar and damping system as they relate to suspension system is revealed and the performance for arm our and non-arm our military tracked vehicles. It envisages the following as the functions of suspension system.

Improving off-road vehicle handling using an active anti-roll bar by Paul Hendrik cronjé in this paper, a descriptive outline about the handling of the vehicle without sacrificing ride comfort on rough roads, the solution generated was to use the soft suspension of the 4S4 (soft springs and low damping) to absorb the irregularities in the road and control body roll with an active anti-roll bar (AARB).

CFRP torsion bar: load introduction problem by Gerald R. Kress, Paolo A. Ermanni in this paper,a descriptive about The shown design solution can not be optimum since failure will occur within the load-introduction zone before the fiber-wound body can store a maximum of deformation energy. However, the low values of failure indices adjacent to the side disk, of whether the proposed design principle is feasible, in the affirmative.

Simulation of suspensions, torsion bars, and fifth wheel for semitrailers using finite elements by R. Mirables in this paper a descriptive about Mechanical suspensions sometimes mount some additional parts, called torsion bars that act when a relative vertical distance appears between the two wheels of an axis, and then they apply a torsion moment to reduce this displacement and avoid that a wheel has an excessive jump.

1.2 Problem Identification

The suspension arms are the essential elements in the vehicle as shown in conventionally these parts made of steel, which is a heavy metal then today try to use aluminum, a lighter metal, economic and easy to produce. Uncertainty propagation and quantification are a challenging problem in engineering. Automotive suspension systems provide compliant connections between vehicle body structures and wheel axles. They play a key role in determining the vibration and handling of a vehicle.

Due to dynamic deflections of a vehicle which is travelled in a rough roads cause the performance loss and also reduce the lifetime of systems connected with the suspension system .The suspension control arm of the passenger car is subjected to loads and consequently stresses of a high magnitude. gineer. While this component integrates with the suspension system of the vehicle, the lower arm takes up the load during the ride .Failure of this component during the ride could jeopardize the suspension system and could lead to accident including risk of life or injury.

II. MATERIALS

Glass fibers are generally produced using melt spinning techniques. These involve melting the glass. Composition into a platinum crown which has small holes for the molten glass to flow. C continuous fibers can be drawn out through the holes and wound onto spindles, while short fibers may be produced by spinning the crown, which forces molten lass out through the holes centrifugally. Fibers are cut to length using mechanical means or air jets. Fiber dimension and to some extent properties can be controlled by the process variables such as melt temperature (hence viscosity) and drawing/spinning rate. The temperature window that can be used to produce a melt of suitable viscosity is quite large, making this composition suitable for fiber forming. As fibers are being produced, they are normally treated with sizing and coupling agents. These reduce the effects of fiber-fiber abrasion which can significantly degrade the mechanical strength of the individual fibers. Other treatments may also be used to promote wetting and adherence of the matrix material to the fiber.

Table-1: Mechanical properties for some common fibers

Materials	Density(Kg/m^3)	Tensile Strength(N/m^2)	Young's modulus(N/m^2)
E glass	2.55	2000	80
S glass	2.49	4750	89
Carbon	2.00	2900	525

III. EXPERIMENTAL STUDY

Given the nature of the stresses over the component, a prototype would be aimed for testing. The test setup typically involves a facility for tensile testing with a provision of fixture for the component. Universal Testing Machine could also be engaged for checking the resistance of the component to tensile and/or shear loads. The experimental results shall be documented, compiled and compared for validating the analytical approach of solving the problem

Calculation

Volume of the solid shaft

: $v = \pi r^2 h$

$=3.14*25.4*25.4*100$

$=202580.24\ mm^3$

Volume of the hollow shaft

: $v = \pi(r1^2 - r2^2)h$

$=3.14*(25.4^2-12.4^2)*100$

$=154299.6\ mm^3$

Material saving

$v=202580.24-154299.6$

$=48280.64\ mm^3$

IV. RESULTS AND DISCUSSION

The data measured from the torsion testing was used to calculate the maximum energy, the composite torsion bar which can be absorbed or retrieved when the twisting load is released.

Table 2 : Experimental result composite torsion bar

Bar type	Parameter	Value (N)
Solid	Tensile test	770
	torsion test	1200
Hollow	Tensile test	890
	torsion test	1080

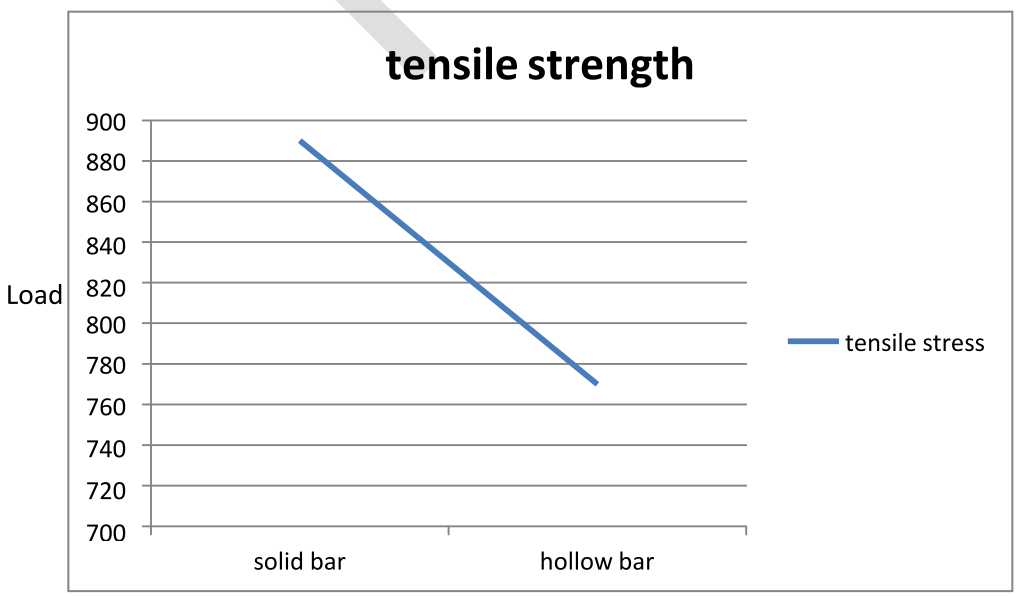
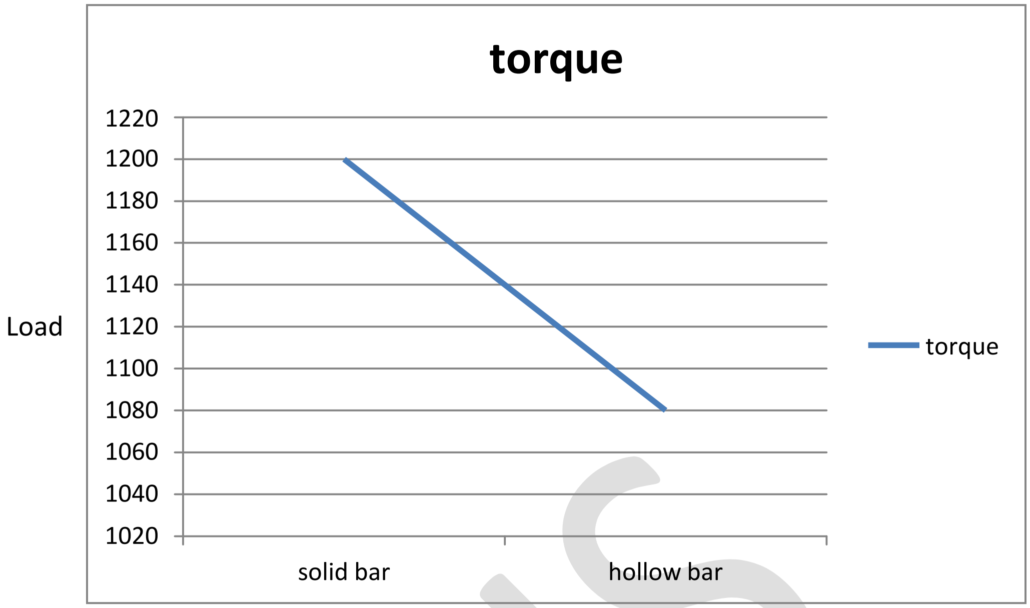


Fig – 2: Tensile stress vs bar type

Performance of reinforced composite material e-glass fiber are determined experimentally, the torque –bar



Torque vs bar type

V. CONCLUSIONS

1. Increasing the cross-sectional diameter of an anti-roll bar will increase its roll stiffness and decreases deflection and stress.
2. The weight of the hollow anti-roll bar is less than the solid bar, while the stresses on the hollow bar are higher for the same load conditions.
3. In Hollow bar, as the thickness increases, stress, strain and deflection decreases while weight of bar increases
4. The advantage of using hollow bar reduce the mass but it increase the stress concentration over the rod
5. Instead of using solid shaft the deals to use hollow bar it saves the material and cost and the performance is never affect in the function

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