A Review on Analysis of Composite Torsion Bar

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***Abstract*- Torsion bar suspension is used on tracked vehicles like armored tanks; artillery guns etc., but there are some four wheelers like luxury sedans, pickup trucks etc. which are using this type of suspension. The torsion bar is just a length of metal rod fixed at one end to the vehicle body and the other end to the suspension lower link of wheel hub .The working of suspension is simple, when the wheel of the vehicle hits a bump in the road the control arm which is connected to the wheel hub rotates which in turn twists the torsion bar which is fixed at one end with the vehicle body. The torsion bar is gripped by the control arm through numbers of splines on the control arm which only translates the vertical movement of the control arm to the rotational or torsional force. There is some amount of load which is permanently applied to the bar for maintaining the car's ride height. This research work is carried out to make a brief comparison between traditionally used mild steel for torsion bar with the composite materials like Carbon fiber and E-Glass fibers and find out which are best in every perspective. The Research is carried by using FEA software with CAD modelling of the torsion bar.**

Index Terms- Torsion Bar, Composite Material FEA, Mild Steel.

I. INTRODUCTION

A torsion bar is a very simple device: A metal rod that can be loaded by twisting it, and then twists back when released. By securely anchoring one end, and fitting a lever to the other, it can be used in a suspension system to handle the vertical motions of a wheel. It's a similar to energy-storage principle to the wind-up elastic band found on common toy planes and the like ones. The stiffness of the spring is directed by both the resistance of the torsion bar to twisting, and the length of the suspension arm it is attached with. The torsion bar's resistance to twisting is directed by its thickness and length. If two torsion bars are of the same diameter, then whichever is longer will have the least resistance to twisting - and if they're the same length, either one has the lower diameter will be easier to twist. Most commonly torsion bars are made up from mild steel, a torsion bar consist of splines at both ends which are used to attach it to the mounting hub rigidly. There are two ways of installing a torsion bar: Either anchored to the chassis at one end and the suspension at the other or mounted to the chassis in the center, with a suspension unit at both ends. In torsion bar the twisting properties of a steel bar are used to create the coil-spring-like motion. One end of the bar is fixed rigidly to the vehicle chassis. The other end is fastened to a wishbone, which acts like a lever that moves in perpendicular direction to the torsion bar. When the wheel hits any stone or projections on the path, vertical motion is transferred to the wishbone and then, through the levering action, to the torsion bar. The torsion bar then twists sideways of its axis to provide the spring force.

In this dissertation a torsion bar will be considered under analysis. A finite element method approach will be considered for modelling the problem. Conventionally used material is compared with the composite materials for finding optimal material for torsion bar. Different fiber orientations of the composite materials will be simulated using viable FEA software. The results obtained from the FEA simulation will be compared thoroughly with the result of conventional material. Appropriate boundary conditions will be selected and results will be obtained by the analysis. If the results are validated then an experimental setup is prepared for the real time load testing on composite torsion bar.

By considering all above facts, this paper tries to cover literature which deals with study and Finite Element Analysis of Composite Torsion Bar.

II. LITERATURE REVIEW

Many of researchers have contributed in development of Torsion Bar and their research work also leads toward the use of composite material.

Design and optimization of passenger car torsion bar
Design of torsion bar for small cars is carried out in this work. Nylon is chosen as alternative material for torsion bar rather than mild steel. Torsion Test has been performed on the torsion bar made up of nylon and steel. Modelling of torsion bar is done on CATIA and failure analysis is done on ANSYS. Favorable results are found out for Nylon in this work. The unsprung mass of the vehicle is reduced and also it increases the fuel efficiency of the vehicle. [1]

Analysis of Glass fiber Reinforced composite torsion bar
The work is carried out to find whether Glass Fiber Reinforced Plastic (GFRP) is best alternative of Mild steel for Torsion Bar. Modelling and analysis, both are done on ANSYS Workbench Software. The boundary Conditions used in the analysis are one end of the bar is fixed and the other is twisted or loaded to the defined load. It is found that shear stresses and maximum shear stress of both steel and GFRP are approximately same. Also analysis shows that the strain energy of the GFRP is more than that of mild steel which indicates that GFRP has more Strength to Weight ratio. The use of GFRP is much effective and useful than that of mild steel due to low density which decreases the weight of the vehicle and more absorption strain energy shows its more strength to weight ratio. The dimensions of the bar can be increased upto some extent to increase its capability. [2]

Experimental Investigation on torsion bar suspension system using E- Glass Fiber Reinforced composite material
Combination of Steel and E-Glass/Epoxy is done in this experiment. In this experiment the E-Glass/Epoxy is used as reinforcement for the steel bar. The study is carried out by machining a round steel bar which is wounded with E-Glass/Epoxy with the help of filament winding process. A specifically Built Torsion Test machine is used for investigating the static and dynamic characteristics of torsion bar. The torsion bar used in suspension is a highly stressed part therefore by introducing composite material which have the ability of absorbing maximum strain energy will increase the lifecycle of torsion bar. [3]

Analysis of Hollow Torsion Bar Made of E- Glass Fiber Reinforced Composite Material.
The focus of investigation is to find out different stresses generated in a composite torsion bar suspension system. The analysis is done on a round solid composite bar and is done using ANSYS software. The material used throughout the experiment is Glass Fiber. This research paper indicates towards the basic knowledge of structural experiments and highlights significant parameters such as stress, total deformation, equivalent stress etc. Comparison between hollow anti roll bar and solid anti roll bar is carried out and results come in favor of hollow anti roll bar. With the increase in cross sectional diameter of bar the roll stiffness also increase but on the other hand deflection and stress decreases. The Hollow bar has less weight than that of solid bar but the stresses on hollow bar for the same load conditions. [4]

CFRP TORSION BAR: LOAD INTRODUCTION PROBLEM
This paper focuses on the use of Carbon Fiber Reinforced Plastic (CFRP) for making a torsion bar. A brief comparison between CFRP and mild steel is done by simplified stress analysis to find out whether CFRP outperform the mild steel. Whole investigation is focused on how to introduce load and also how to solve it by a invented design and manufacturing principle. In the experiment there is a restriction to full utilization of fiber matrix due to early matrix cracking but it shows the CFRP torsion bar can store much higher deformation than that of steel torsion bar. The experiment leads to a design form in which a steel mandrel is used as a holder around which the CFRP is wounded. [5]

Material selection for automobile torsion bar using fuzzy topsis tool
The paper shows a multi-criteria decision making approach towards the selection of composite material when partial or incomplete information is present. The process developed complies of selection of evaluation criteria, identification of potential composite material and use of fuzzy theory to

determine criteria values under uncertainty. Application of Fuzzy TOPSIS is used to evaluate and to select best material which replaces the conventional mild steel for torsion bar. Technique for Order Performance by Similarity to Ideal Solution is the full form of TOPSIS. Materials which are used in the experiments are S-Glass/Epoxy, Kevlar 49(K49)/Epoxy, Carbon Fiber, E-Glass/Epoxy. It is found that E-Glass fiber is most suitable for replacing conventional steel bar. This experiment validates TOPSIS material selection method and found to be more accurate than conventional methods. [6]

Optimal design and analysis of automotive composite drive shaft

This study deals with introduction of a new process for designing drive shaft of composite material is suggested. Multilayered composite drive shafts of E-Glass/Epoxy and HS Carbon/Epoxy are been designed in this research. Geometrical Analysis is used for optimization of designed drive shaft and ANSYS is used to understand better stacking sequence and torque transmission capacity. From 48% to 86% weight reduction is achieved when using composite material drive shaft as compared to steel shaft. Orientation of fibers strongly affects the buckling torque in shaft. [7]

Design Analysis of an Automotive Composite Drive Shaft

There are two types of design which are proposed in this paper in which one is purely made up of Graphite/Epoxy Lamina while the other is made with use of Aluminum and Graphite/Epoxy. The parameters which are analyzed here are torsional buckling and bending natural frequency. The research also considered progressive failure analysis of the selected design. For the progressive failure analysis "PROMAL" software has been used. The result shows that both the design of drive shaft is superior to that of the conventional drive shaft. If the cost is considered than the hybrid shaft which is made of aluminium and Graphite/Epoxy lamina outperform both the conventional and the other proposed design. The "PROMAL" ensures that the hybrid shaft will not fail catastrophically which ensure the safety of vehicle. [8]

Design and analysis of composite drive shaft

The paper is projected for replacement of conventional shaft with a composite shaft. The shaft is designed through CATIA V5 and the analysis is performed on ANSYS for optimized result. Materials considered for this experiment are Steel, E-Glass/Epoxy, HS-Glass/Epoxy and HM Carbon Epoxy. Natural frequencies are calculated by Bernoulli-Euler theory and Timoshenko beam theory. The shaft which outperforms the others is HS Carbon/Epoxy composite drive shaft. The weight reduction is tremendous and encouraging to replace the conventional two piece drive shaft. [9]

Optimum Design and Analysis of a Composite Drive Shaft For an Automobile by Using Genetic Algorithm and Ansys

The paper shows brief comparison between composite materials and steel shaft. Composite materials considered for analysis are E-Glass/Epoxy, HS Carbon/Epoxy, HM Carbon/Epoxy, Kevlar fiber. Genetic Algorithm is used for optimization for optimal number of layers and thickness of ply and fiber orientation of each layer. Use of CLT ensures that all the composites used have stress values within the allowable limit. The deflection found in composites as well as steel is approximately same. The natural frequency of E-Glass and Carbon Fiber are less than that of steel. Capacities of torsional buckling are much less of composites than that of steel. [10]

III. CONCLUSION

By the above literature review various methods and material to carryout finite element analysis of torsion bar made up of various composite materials are studied. In earlier researches conventional mild steel torsion bars were considered as new material and developed. To optimize the power to weight ratio of today's performance vehicles it is necessary to develop new applications of composite material. So it is very important to consider scope of Composite material in designing of the torsion bar. The feasibility of the composite material against the conventional Mild Steel as Torsion bar in suspension system in the vehicles is very high.

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