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Analysis of Glass Fiber reinforced composite Torsion Bar

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ABSTRACT

Torsion bar is used in automobile suspension system. Torsion bars are used to absorb force generated by the movement of the vehicle. Torsion bas are generally made up of steel. The weight of steel torsion bar is much higher. Use of composite material can minimize weight of torsion bar. The density of glass fiber reinforced plastic (GFRP) is less compare to steel material therefor the glass fiber material has more strength to weight ratio. The model of torsion bar is created in ANSYS workbench software. The one end of the bar is fixed and the moment is applied at other end. The results of shear stress, maximum shear stress and strain energy are obtained.

Keywords: Torsion bar, Glass fiber, ANSYS Workbench etc.

1. Introduction

A torsion bar suspension, also known as a torsion spring suspension, is a general term for any vehicle suspension that uses a torsion bar as its main weight-bearing spring. The figure 1 shows 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.

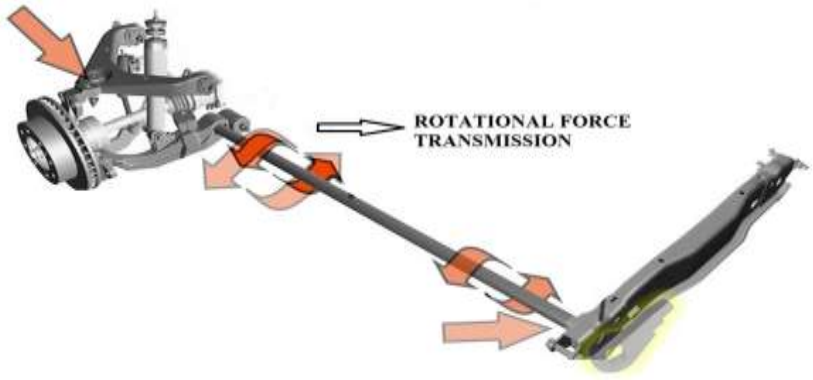

Fig.1 Torsion Bar

A spring made as a torsion bar exhibits different fatigue behavior in regard to different elastic plastic preset torques[1].A reduction of stress concentration at the end of the spring by reducing the diameter and twist length of bar, which causes to reduction of rods weight[2].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 life time 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 engineer. 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. For this drawback of the existing material there is lots of risk [3]. By using alternative material we reduce the weight of the system, increase the strength of torsion bar. The material we are using is composite material [5].

2. Material Selection

Polymer composites are gaining popularity in many industrial applications due to their higher specific strength and modulus. Nowadays, the fiber reinforced composites have dramatically come into use. These composites have gained so much recognition because of their processing advantages and good technical properties like strength, density, impact, stiffness, elastic modulus, creep rate, damping. Furthermore, these properties showed considerable improvement with increasing silk fabric content. The attractive features of glass fiber have been their low cost, light weight, high current into mechanical energy, is the most important component of a turbine system. This consists of the specific modulus, renewability and biodegradability the main advantage of the glass fiber is its low cost. Its other advantage is its high tensile strength, low chemical resistance and excellent insulating properties. The figure 2 shows glass fiber material. The properties of steel and glass fiber are enlisted in table 1 and table 2 respectively.

Table 1.Properties of Steel Material

Material	E(GPa)	G(GPa)	ρ(g/)	Poisson's ratio
Steel	200	85	7.85	0.3

Table 2.Properties of Glass Fiber Material

Properties	**Values**
Young's modulus in X direction (GPa)	50
Young's modulus in Y direction (GPa)	8
Young's modulus in Z direction (GPa)	8
Poisson's ratio XY	0.3
Poisson's ratio YZ	0.4
Poisson's ratio XZ	0.3
Shear modulus XY (GPa)	5
Shear modulus YZ (GPa)	3.8461
Shear modulus XZ (GPa)	5
Density (g/cc)	2.1

3.Modeling And Meshing Of Bar

The modeling of bar is created in ANSYS workbench 18.2. The 16 mm diameter and 450 mm length is given to the bar to create the geometry.The figure 3 shows the modeling of bar.The meshing is After updating the geometry and model data materials are created in Ansys engineering data.With the fine size meshing of the rod will done. The meshing of rod is shown in figure 4.

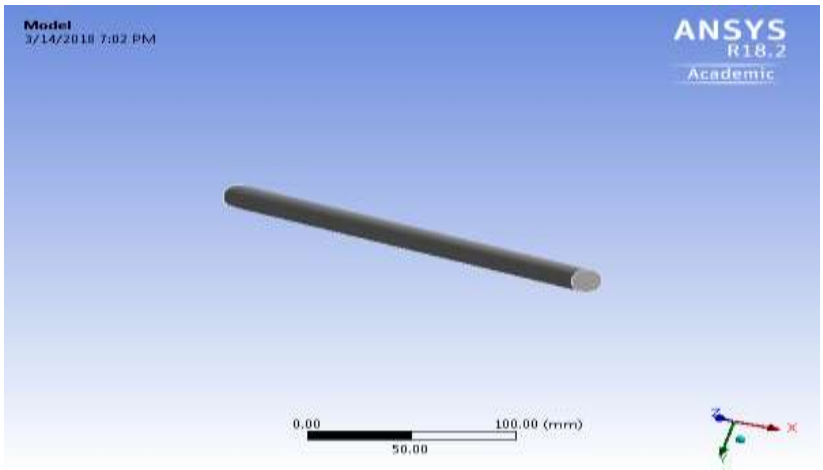

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Fig.3 Modeling of steel rod

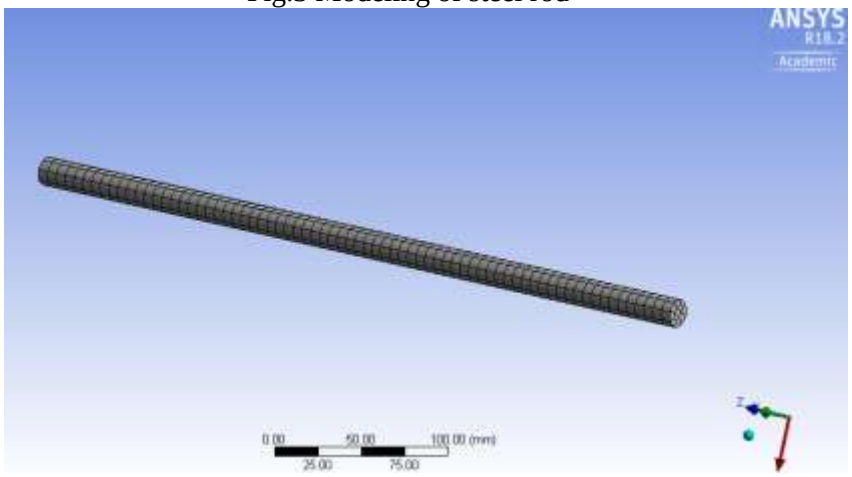

Fig.4 Meshing of steel rod

4. Results

4.1 Analysis result of current steel material

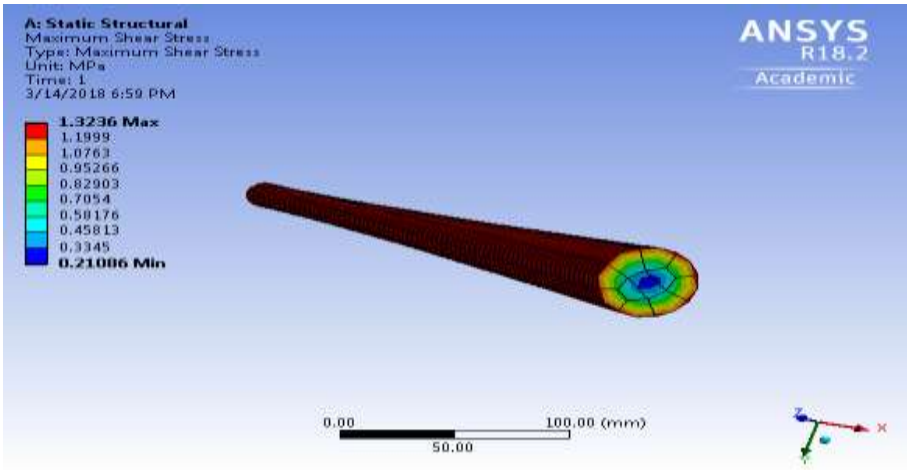

Fig.5 Maximum Shear Stress of steel rod

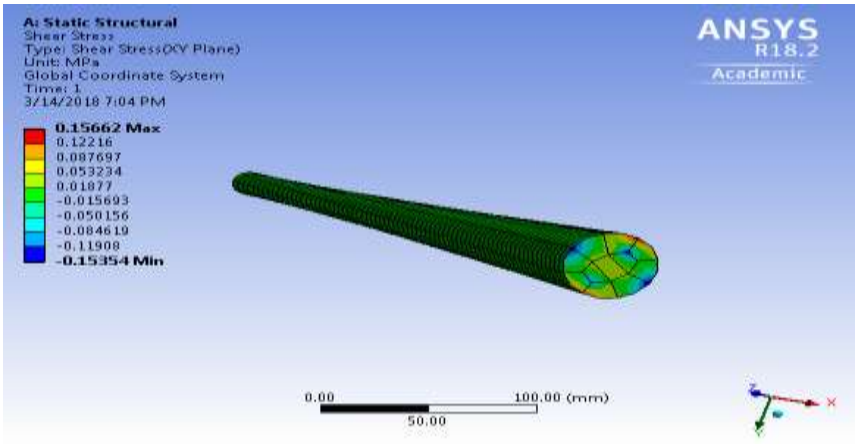

Fig.6 The shear stress of steel rod

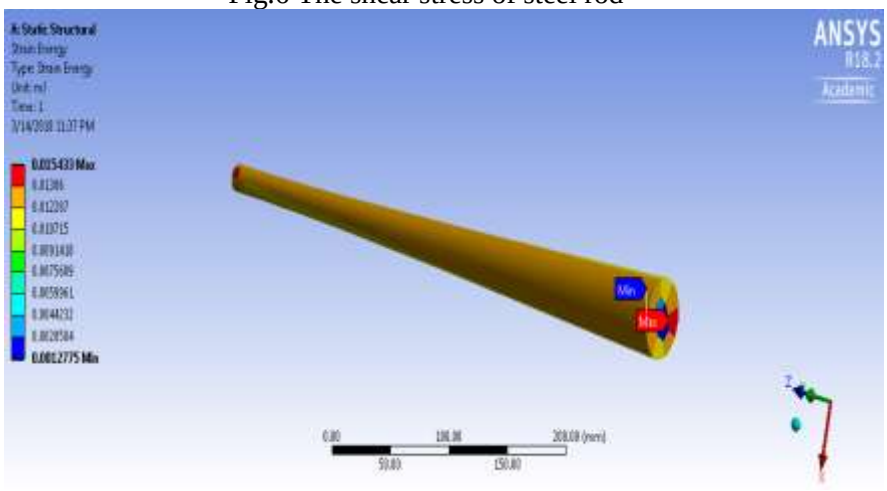

Fig.7 The strain energy of steel rod

4.2 Analysis result for glass fiber rod

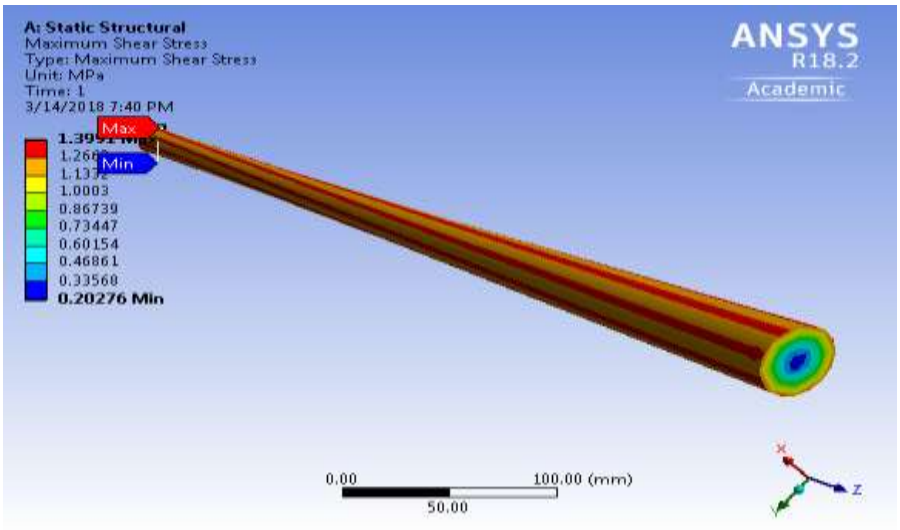

Fig.8 The Maximum Shear stress of glass fiber rod

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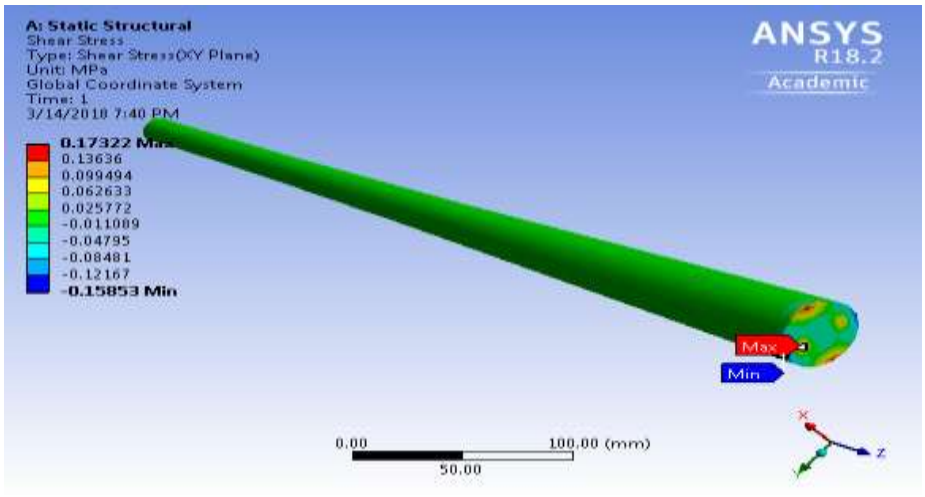

Fig.9 The Shear stress of glass fiber rod

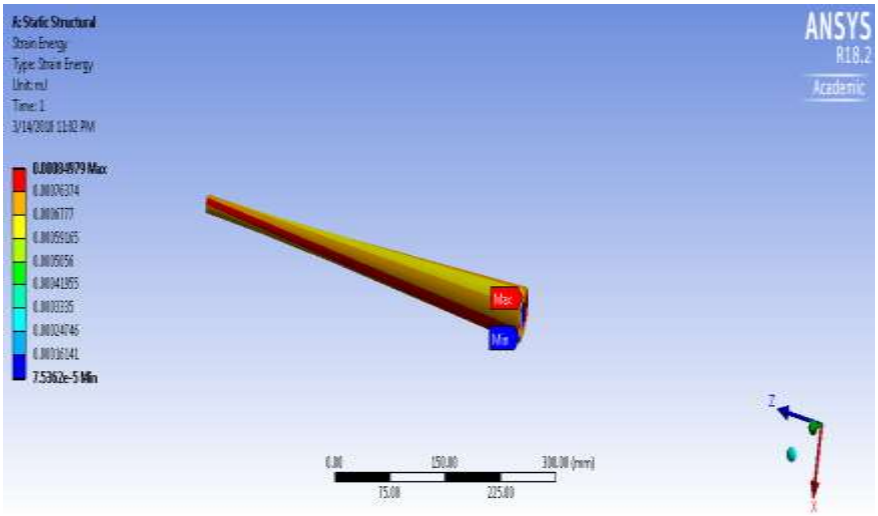

Fig.10 The strain energy of glass fiber rod

The load condition is given to the rod .The one end of the rod is fixed and moment is given at other end of 1000 Nmm. The maximum shear stress distribution of steel and glass fiber material shows in figure 5 and figure 8.The shear stress distribution of steel and glass fiber material shows in figure 6 and figure 9. The strain energy distribution of steel and glass fiber material shows in figure 7 and figure 10. The results obtained from finite element analysis are tabulated below.

Table 3.Shear Stress

Sr. No.	Material	Shear Stress (MPa)
1	Steel	0.15662
2	Glass Fiber	0.17322

Table 4.Maximum Shear Stress

Sr. No.	Material	Maximum Shear Stress (MPa)
1	Steel	1.3236
2	Glass Fiber	1.3991

Table 5.Strain Energy

Sr. No.	Material	Strain energy (MJ)
1	Steel	0.015433
2	Glass Fiber	0..00084979

5. Disscusion

Following graphical represantion shows the variation of the shear stresses developed in the rod shows in figure 11, comparision of maximum shear stress of bothe material shows in figure 12 and the comparision of strain energy devleoped in steel and glass fiber material of material shows in figure 13 .The maximim shear and shear stress values of the steel are less than the glass fiber rod. The strain energy means the absorbtion capacity of the glass fiber rod is maximum than steel rod.

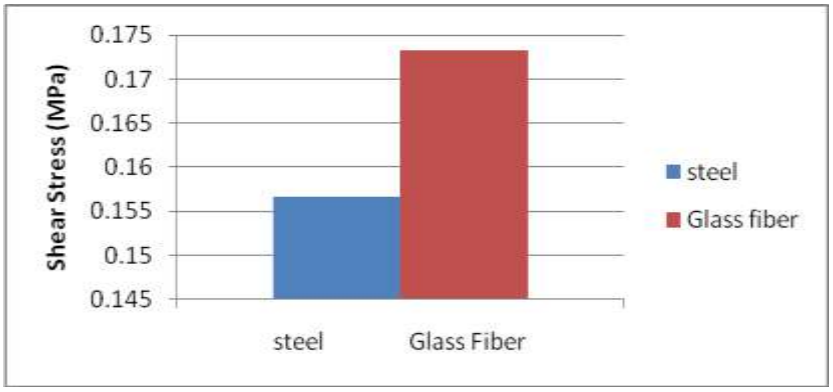

Fig.11 Comparison of the shear stress

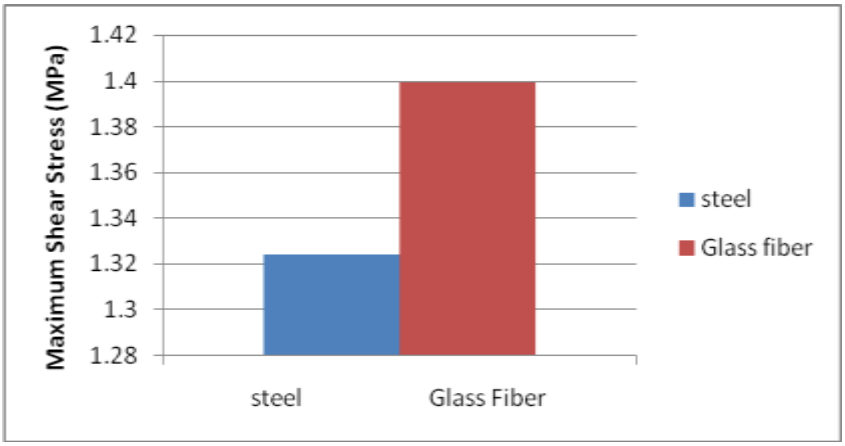

Fig.12 Comparison of the Maximum shear stress

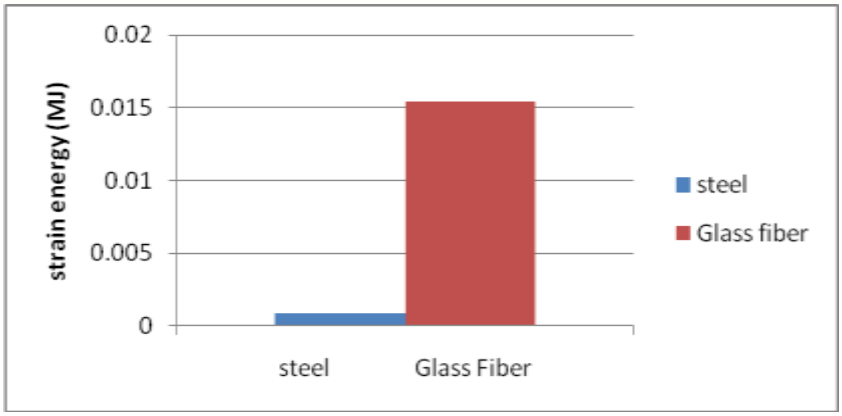

Fig.13 Comparison of the strain energy

6. Conclusion

The Comparative study of steel and glass fiber for torsion bar is studied in this paper .The properties young's modulus and modulus of rigidity of steel is more but the density of glass fiber material is less as compare to steel material. So we can optimize the weight of torsion bar. After giving the load to the bar the shear stresses and maximum shear stresses are approximately same for both the steel and glass fiber material rod, also strain energy of glass fiber material is more therefore torsion bar with Glass Fiber Reinforced material has more strength to weight ratio. The geometry of torsion bar can be increased to have minimum value of torsional shear stress.

7. Acknowledgment

I would like to express my deep sense of gratitude to my supervisor Prof. S. B. Kumbhar for his inspiring & invaluable suggestions. I am deeply indebted to him for giving me a chance to study this subject & providing constant guidance throughout this work. I acknowledge with thanks, the assistance provided by the Department staff, Central library, staff &computer faculty. Finally, I would like to thanks to my colleagues and friends for directly and indirectly helping me for the same.

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