Analysis of Torsion Bar of Light Motor Vehicle Car Using Alternative Material

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Abstract:
Now a days, customers are needs comfortable car so that its more concrete given to the suspension system. Mostly torsion bar is made by steel but alternate material is used. We have using alternate material such as epoxy/ e-glass, nylon etc. In this paper we are study or investigation of torsion deflections and energy storage of the composite bar in torsion bar suspension system. In this, a round solid steel bar is machined and wounded with E-Glass/ Epoxy. It is manufactured by filament winding process and also investigate the static and dynamic characteristics of torsion bar used in vehicle suspension system. It also comparing with steel properties and reduce the un- sprung weight of torsion.

Keyword: Torsion Bar, Epoxy/ E-Glass, Resilience

Introduction

Vehicles which use torsion bar suspension set-ups are commonly defense vehicles, off-road and some light vehicles. Some of the more notable and widely used vehicles which feature torsion bar suspension systems are the BAE System FV 150 Warrior armored vehicle and FV 430 Bulldog. For success design would consider parameter as 1) A High sprung-to-unsprung-mass-ratio, (2) A Mass-Spring-Damper system between the vehicle body and the wheels, and (3) Torsion Bar.

Torsion bar suspension is commonly used on tracked vehicles, although there are some wheel driven vehicles using this type of suspension. The most requirement of suspension system are Low initial cost, Minimum weight, Minimum tyre wear, Minimum deflection consistent with required stability The suspension works by having one end of the bar fixed in position on the vehicle chassis to prevent rotation, whilst the other end is connected to a control arm and wheel hub. The control arm is fixed to the chassis using rubber bushings which allow only vertical movement about the mounting points. The torsion bar is connected to the control arm through a number of spines which translate the vertical movement of the control arm into a rotational or torsional force.

A torsion bar is a made from a material with a high torsional yield to allow for the high loads which the bar will experience. When the load is applied to the bar, rotation along its centre axis will occur, the angle the bar will rotate is governed by the torsional resistance of the material the bar is made from, commonly known as “effective spring rate”. The effective spring rate is a calculation that is made up of the following parameters; bar length, cross sectional area and material properties. Alternate material is using such as Epoxy/ E-glass, nylon etc. stress analysis, to outperform those made from steel. Its better than steel because most efficient and effectively of material. Its reduce un-sprung weight of the torsion bar.

Alternative Material

Torsion bars as automotive suspension spring elements have been made mostly by E- Glass/Epoxy. Its performance of springs depended on the strength and stiffness properties but Its attractive because of low weight of fiber reinforced plastics and high limit of strains. Now a days various of composite material is used as various applications in mechanical industry. The composite materials and its properties are more studied and implement the required material to improve the performance of the torsion bar suspension system. Also requirement parameters are to be tested and identified experimentally.

Resilience is the ability of a material to absorb energy when it is deformed elastically and release that energy upon unloading. The modulus of resilience is defined as the maximum energy that can be absorbed per unit volume without creating a permanent distortion. The specimen is made up of reinforced composite material of steel and E-Glass fiber coated with Epoxy resin, also its wounded by using a filament winding technique. The material properties are given below for torsion bar.

<table>
<thead>
<tr>
<th>Material</th>
<th>Steel</th>
<th>E-Glass</th>
<th>Epoxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young’s modulus (E) [MPa]</td>
<td>200</td>
<td>80</td>
<td>3.5</td>
</tr>
<tr>
<td>Modulus of rigidity (G) [MPa]</td>
<td>85</td>
<td>30</td>
<td>1.3</td>
</tr>
<tr>
<td>Density (g) [g/cm³]</td>
<td>7.85</td>
<td>2.58</td>
<td>1.54</td>
</tr>
<tr>
<td>Poissons Ratio</td>
<td>0.3</td>
<td>0.23</td>
<td>0.33</td>
</tr>
</tbody>
</table>
The study of experimental is prepared according to the standard test method but standard test method for identifying torsion deflections at room temperature. The machine setup is used to identify the applied torque and angle of twist are recorded simultaneously when the applied load are shear in nature, shear rigidity and yield strength. These properties can be determined from the recorded values and this properties are mostly commonly measurement for torsion bar.

The Modulus of resilience is used to construct through the torque-twist diagram and also the yield strength and stress-strain is obtained from the torque-twist diagram. In yield strength is identifying by of setting 2% offset of stress-strain diagram, the yield strength of the specimen is calculated by area. Twisting moment ranges between 10 to 12 KN.m obtained by a vehicle.

Results
The data collected from the torsion testing machine was used to calculate the maximum energy and composite material of torsion bar which can be absorbed when the twisting load is released. The table shown are as following

Stiffness of steel properties of torsion bar is calculated approximate 50 KN/m and stiffness of composite material properties of torsion bar is calculated approximate 57KN/m from data table. Experimental results and graph are shown in below

Table No. 1: Experimental results of torsion bar [steel property]

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisting moment [N.m]</td>
<td>0</td>
<td>1750</td>
<td>3500</td>
<td>5240</td>
<td>7000</td>
<td>8730</td>
<td>10450</td>
</tr>
<tr>
<td>Angle of deflection [°]</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Resilience [J]</td>
<td>0</td>
<td>30.4</td>
<td>6</td>
<td>121.85</td>
<td>274.487</td>
<td>761.54</td>
<td>1096.62</td>
</tr>
</tbody>
</table>

Table No. 2: Experimental results of torsion [composite material property]

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisting moment [N.m]</td>
<td>0</td>
<td>2010</td>
<td>4040</td>
<td>6050</td>
<td>8070</td>
<td>10060</td>
<td>12072</td>
</tr>
<tr>
<td>Angle of deflection [°]</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Resilience [J]</td>
<td>0</td>
<td>35.11</td>
<td>7</td>
<td>140.47</td>
<td>316.06</td>
<td>561.88</td>
<td>877.94</td>
</tr>
</tbody>
</table>

The stiffness of composite torsion bar is approximate value taken 57KN/m.

Results:

k=50KN/m

![Graph](https://via.placeholder.com/150)

Fig. 1: Experimental results of graph of conventional steel torsion bar

The stiffness of composite torsion bar is approximate value taken 57KN/m.

![Graph](https://via.placeholder.com/150)

Fig. 2: Experimental results of graph of composite torsion bar

The following fig. 3 shows comparison of twisting moment between Conventional steel and Composite material of torsion bar.

![Comparison](https://via.placeholder.com/150)

Fig. 3: Comparison of twisting moment between Conventional steel and Composite material of torsion bar

The above fig. indicate that relationship of twisting moment between conventional steel and composite material of the
torsion bar. In this fig, indicate that the linearly increase up-to yield point or yield stress which is required for how much maximum energy can store in torsion bar. This results angle of twist up to 12° and its beyond at some point torsion bar gets failed.

The following fig.4 shows that comparison of resilience between Conventional steel and Composite material of torsion bar

![Comparison of resilience between Conventional steel and Composite material of torsion bar](image)

Fig.4:- Comparison of resilience between Conventional steel and Composite material of torsion bar

The above fig. indicate that relationship of resilience between conventional steel and composite material of the torsion bar. In this fig. indicate that the composite material of torsion bar is more energy stored than the conventional steel of torsion bar. The Steel/E-glass composite fiber is maximum energy storage as well as releasing energy when it is deformed elastically and upon unloading correspondingly.

Conclusion

It is highly stressed parts and made by composite material. In this material structure have maximum energy which gives increase the lifetime of the torsion bar. It is uses depends upon two dynamic point of view such as riding and handling of the vehicle.

In this paper we have study tells that it can be store up maximum energy, which gives maximum angle of twist(θ=12°) at higher efficiency with comparing of conventional steel torsion bar.

References


