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Design and Optimization of Passenger Car Torsion Bar

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ABSTRACT: *The passenger car comfortability depends on the suspension system. The car can be designed for softer and harder suspension system. The type of the suspension system is important in stability of the vehicle. Hence it is very important to design optimum suspension system for passenger car. The Torsion bar is most important component in the small car. In this paper the Torsion bar is designed. The Nylon is considered as alternative material for Torsion bar. The torsion test report is exhibited. It is also compared with Mild steel properties. Reducing weight of the un-sprung have an effect on the fuel consumption. Hence alternative material is selected and justified.The modeling and failure analysis is done using CATIA and ANSYS.*

Keywords: *Torsion Bar, Torsion spring, Torsion beam, Suspension bar.*

I. INTRODUCTION

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 baris 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 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.

II. OBJECTIVES

In this paper for analysis of torsion bar following objectives are considered.
The torsion test is conducted on the mild steel specimen.
The NYLONE specimen is subjected for torsion test.
The properties of the NYLONE are studied.
The ANSYS analysis is done on mild steel torsion bar.
The NYLONE as torsion bar report is prepared.
In a torsion spring the elastic properties of long thin bar is used to produce a rectilinear spring rate that is comparable to that of the coil spring. The torsion bar itself may have any number of different cross section ranging from most widely used circular bar to an oval bar or a rectangular bar.

Characteristics of Nylon

Nylon is very much suitable for hosiery and the knitted fabrics because of its smoothness, light weight and high strength. Nylon is lustrous fiber. The luster of the fiber can be modified by adding the de blustering agent at the molten stage.The nylons are polyamides with recurring amide groups. They contain carbon, oxygen, nitrogen and hydrogen elements.Nylon has good tenacity and the strength is not lost with age. Nylon has a high strength to weight ratio. It is one of the lightest textile fibers is at the same time also one of the strongest. It is one of the fibers which are added at the points of wear such as knees and seats of jeans and toes and heels of socks. The strength of the nylon fabric is lost when wet. Nylon has excellent abrasion resistance. Nylon has good elasticity which makes it much suitable for the apparel purposes. The excellent elasticity would mean that the nylon materials return to their original length and shreds the wrinkles or creases. Nylon like other fibers has its own limit of elasticity. If stretched too much, it will not completely recover its shape. The high elongation and excellent elastic recovery of nylon contributes to the outstanding performance. Nylon recovers to its original shape at knees and ankles instead of bagging. Nylon fabrics have excellent resilience. Nylon fabrics retain their smooth appearance. Fabrics of nylon filament yarn have excellent draping qualities. The drape of the fabrics made from nylon can be varied depending on the yarn size. The light weight sheer fabrics of nylon night gowns have high-draping quality. The medium-weight dress fabrics can drape very nicely. The heat conductivity of the nylon fabrics vary depending upon the fabric construction, the type of nylon (staple/filament) used in the construction. Good machinability and less cost easy to replace are some of the advantages of nylon.

IV Nylonand MS Specimen results and analysis

Nylon calculations:

G=Modulus of rigidity (N/mm^2), T=Torsion in the shaft (N-mm), Θ=Angle of twisting in rotation (deg)
L=effective length of bar (mm), J=polar moment of inertia (mm^4), τ =shear stress, D=diameter of shaft
F.O.S=2

$G=\frac{T\times L}{J\times\Theta}$

$J=\frac{\pi}{32}\times(25)^4$

383500mm

$\Theta=\frac{\pi}{180}\times 7=1.222$

$G=\frac{20400\times195}{383500\times1.222}=84.89$ N/mm^2

$\tau=\frac{T}{J}\times r \qquad =\frac{T}{J}\times\frac{d}{2} \qquad \tau=\frac{20400\times25}{3835000\times2}$ =6.66 N/mm2

Mild steel calculations:

$G=\frac{T\times L}{J\times\Theta}$

$J=\pi/32\times(25)^4$

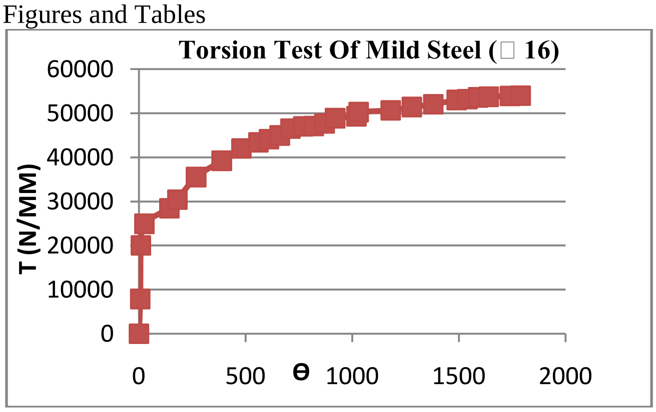
383500mm4

$\Theta=\frac{\pi}{180}\times 8=0.140$ rad.

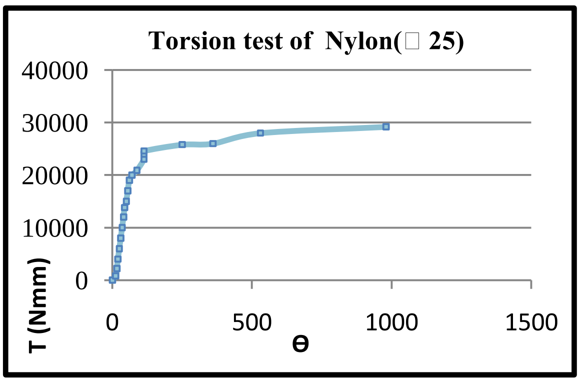
$G=\frac{31000\times178}{383500\times0.140}=102.8$ N/mm^2

$\tau=\frac{T}{J}\times r \qquad =\frac{T}{J}\times\frac{d}{2} \qquad \tau max=\frac{31000\times25}{383500\times2}$ =1.01 N/mm2

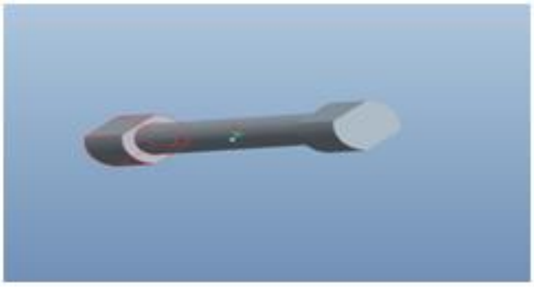
Figures and Tables



Graph 1



Graph 2



Test specimen

Test performance photo.

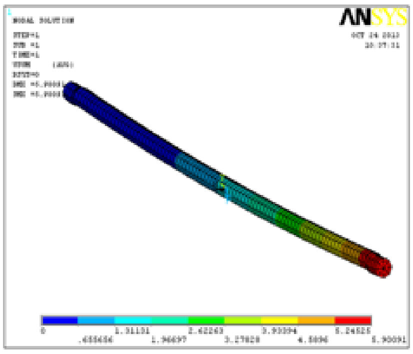


Fig 1

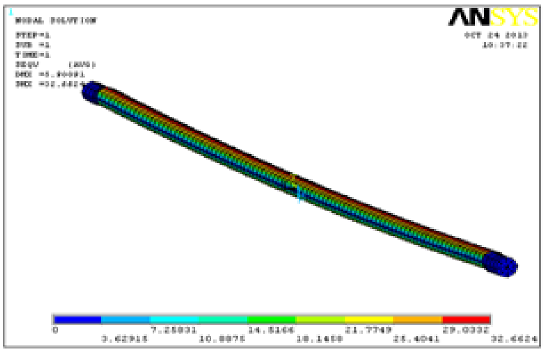


Fig 2

Table 1

Sr. No.	Material	Diameter	Max shear stress N/mm^2	Torsional rigidity N/mm^2
1	Nylon	25	6.66	102.89
2	Mild steel	25	1.01	86.89

The above table 1 show the Nylon as much better material for the torsion bar.
The ANSYS analysis on torsion bar of the bar diameter of 25mm. and Effective length of 95mm. is considered for the analysis. The torque of 150N-mm. is applied, maximum Equivalent stress on the rod is found to be 32.66 N/mm^2 and the maximum displacement on rod is 5.9mm and the results are shown on the fig 1.

The fig 2 show the ANSIS result for applied torque 350 N-mm and the center is kept as fixed point and the ends are rotated by Appling atorsion load350 N-mm. the maximum equivalent stress of 5.9 N/mm^2 with maximum displacement of 5.9 mm. Hence it is justified that the Nylon can be used as torsion bar.

III. CONCLUSION

The Ansys result of the torsion bar shows a favorable results to select Nylon as alternative material for torsion bar. The Mild steel rod of diameter of 25 mm and length 95 mm specimen results are tabulated. The applied load of 150 N-mm. the results show max equivalent stress on the rod 32.66 N/mm^2 , also the max displacement is 5.9 mm.

For comparing the nylon and mild steel the specimen is subjected for torsion test. The mild steel specimen diameter is 16 mm. The torque of 50,000 N/mm is applied, it took 17,500 degree, which is 5 revolution to break. The torsion rigidity is 102 N/mm2 and maximum shear stress of 1.01 N/mm^2 .it took around 5 revolutions to break. However in practice the torsion bar will not be rotated so many rotations. The MS is used due to cost and easy machinability. The results tabulated above show the nylon can be one of the alternative material for torsion bar.

The Nylon is one such material can be used for torsion bar. The test results are good and also reduce the weight of the un-sprung mass of the vehicle. The fuel consumption will reduce.
Our test results for diameter 25 mm and applied torque 30,000 N/mm show 10000 rotation. That is around 2.7 revolutions to break. In practice the torsion bar will be rotated to a maximum of 900 rotation. The torsion rigidity of 84.89 N/mm^2 and maximum shear stress of 6.6 N/mm^2 .

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