International Journal of Research in Advent Technology, Special Issue, March 2019
E-ISSN: 2321-9637
3rd National Conference on Recent Trends & Innovations In Mechanical Engineering
15th & 16th March 2019
Available online at www.ijrat.org

Torsional Strength of Composite Drive Shaft

P.Srinivas[1]

[1]Assoc. Professor, Department of Mechanical Engineering, NNRG, Hyd, Telangana, India

Abstract: Propeller shaft associates gearbox to the last drives apparatuses of the vehicle through general joint and fills in as drive shaft. A "composite" is when at least two distinct materials are joined together to make a predominant and one of a kind material. Substituting composite structures for customary metallic structures have many points of interest due to higher stiffness and strength of composite materials.
This work an endeavor has been done examination of basic steel drive shafts with a carbon fiber and glass fiber composite drive shaft and interaction of this work deal with **Comparison of "shear stress" between different composite materials and steel, "angle of twist" with torque for Steel and carbon fiber composite** for anautomotive application
This project is analysis done on drive shaft with different composite materials with structural steel and concludes that the use of composite materials for drive shaft would induce less amount of stress which additionally reduces the weight of the vehicle. CREO is the modelling package used to model the drive shaft arrangement and ANSYS is the Analysis package used to carry out analysis.

Key words: Composite Drive Shaft, Finite Element Analysis, Shear stress, Angle of Twist

1. INTRODUCTION

The general stability of drive shafts under torsion has been studied by many researchers. Greenhill [1] for the first time in 1883 presented a solution for torsional stability of long solid shafts. This method of solution can be extended for calculating of the first torsional buckling mode of a hollow shaft. The first and oldest buckling analysis of thin-walled cylinders under torsion was presented by Schwerin [2] in 1924. However, his analysis did not show a good agreement with experimental results.

In 1931 Kubo and Sezawa [3] presented a theory for calculating the torsional buckling of tubes and also reported on experimental results for rubber models. However, this theory did not show an agreement with experimental results. Lundquist [4] performed extensive experiments on the strength of aluminum shafts under torsion reported in 1932.
There was still no analytical solution until 1933 for simulation of the buckling behavior of drive shafts, so experimental results were the only basis for the Research of Donell [5]. In 1934 he presented a theoretical solution for the instability of drive shafts under torsion. He used the theory of thin-wall shells

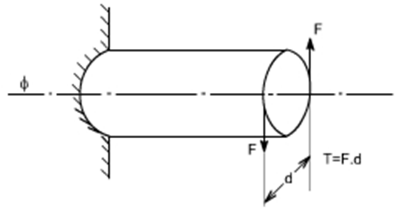
2. PROBLEM STATEMENT

When a hollow shaft is subjected to torsion, at a certain amount of torsional load instability occurs. This is called the torsional buckling load.
Therefore, the torsional buckling load is important in the design of drive shafts. This parameter is even more critical in the design of composite shafts, because composite drive shafts are often made longer. Although increasing the length of drive shaft does not change the static torsional stress, it can decrease the torsional buckling load capacity of the shafts. Therefore, the calculation of the torsional buckling load for composite drive shafts is very important. In the following section it is shown that the design must be such that the torsional buckling strength of a shaft must be higher than the static torsional strength.

Second, the stacking sequence of the layers affects the torsional buckling capacity of drive shafts. Therefore, selection a suitable stacking sequence can increase the torsional buckling load of the composite shafts.
Thirdly, in general composite drive shafts have a lower torsional buckling capacity in comparison with metallic shafts for the same geometry. An important reason is the existence of interlaminar shear stresses and the coupling between the in-plane and out-of-plane stresses for composite shafts. In a metallic shaft under torsion, the shear stress is the only existing stress, however, for a composite shaft all stresses can exist.

3. ANALYTICAL RELATIONS TO CALCULATE THE TORSIONAL SHEAR OF COMPOSITE SHAFTS

Consider a shaft rigidly clamped at one end and twisted at the other end by a torque T = FXd applied in a plane perpendicular to the axis of the bar such a shaft is said to be in torsion.



Effects of Torsion: The effects of a torsional load applied to a bar are
To impart an angular displacement of one end cross – section with respect to the other end
To setup shear stresses on any cross section of the bar perpendicular to its axis.

GENERATION OF SHEAR STRESSES
The physical understanding of the phenomena of setting up of shear stresses in a shaft subjected to torsion may be understood from the figure 1.

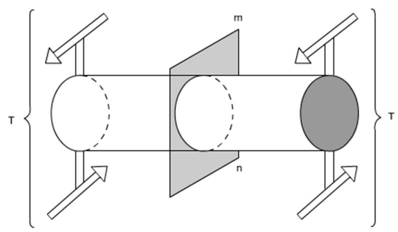


Fig 1: Here the cylindrical member or a shaft is in static equilibrium where T is the resultant external torque acting on the member. Let the member be imagined to be cut by some imaginary plane ‘mn'.

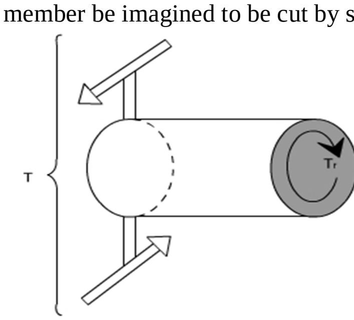


Fig 2: When the plane ‘mn' cuts remove the portion on R.H.S. and we get a fig 2. Now since the entire member is in equilibrium, therefore, each portion must be in equilibrium. Thus, the member is in equilibrium under the action of resultant external torque T and developed resisting Torque Tr .

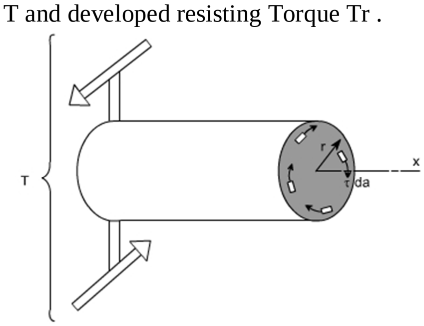


Fig 3: The Figure shows that how the resisting torque Tr is developed. The resisting torque Tr is produced by virtue of an infinites mal shear forces acting on the plane perpendicular to the axis of the shaft. Obviously such shear forces would be developed by virtue of sheer stresses.

Therefore we can say that when a particular member (say shaft in this case) is subjected to a torque, the result would be that on any element there will be shear stresses acting. While on other faces the complementary sheer forces come into picture. Thus, we can say that when a member is subjected to torque, an element of this member will be subjected to a state of pure shear.

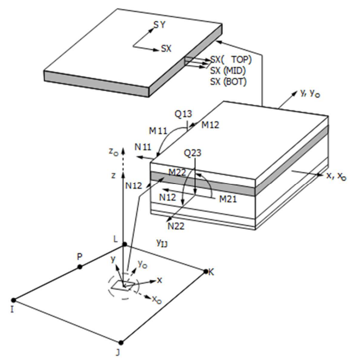
Shaft: The shafts are the machine elements which are used to transmit power in machines.

Twisting Moment: The twisting moment for any section along the bar / shaft is defined to be the algebraic sum of the moments of the applied couples that lie to one side of the section under consideration. The choice of the side in any case is of course arbitrary.

Shearing Strain: If a generator a – b is marked on the surface of the unloaded bar, then after the twisting moment 'T' has been applied this line moves to ab'. The angle '□' measured in radians, between the final and original positions of the generators is defined as the shearing strain at the surface of the bar or shaft. The same definition will hold at any interior point of the bar.

4. FINITE ELEMENT ANALYSIS TO CALCULATE THE TORSIONAL STRESS OF COMPOSITE SHAFTS

SHELL181 Input Summary



xo = Element x-axis if ESYS is not provided.

x = Element x-axis if ESYS is provided.

Degrees of Freedom

UX, UY, UZ, ROTX, ROTY, ROTZ if KEYOPT(1) = 0
UX, UY, UZ if KEYOPT(1) = 1

In this research, finite element analysis is performed using ANSYS software. To model the composite shaft, the shell 181 element is used and the shaft is subjected to torsion. The shaft is fixed at one end in tangential directions and is subjected to torsion at the other end. After performing a static analysis of the shaft, the stresses are saved in a file.

fig shows shaft shell model (mid surface model)

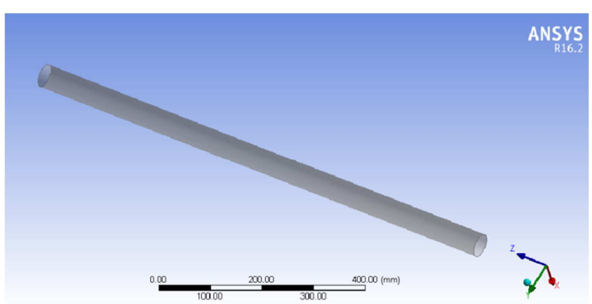


fig shows shear strain

International Journal of Research in Advent Technology, Special Issue, March 2019
E-ISSN: 2321-9637
3rd National Conference on Recent Trends & Innovations In Mechanical Engineering
15th & 16th March 2019
Available online at www.ijrat.org

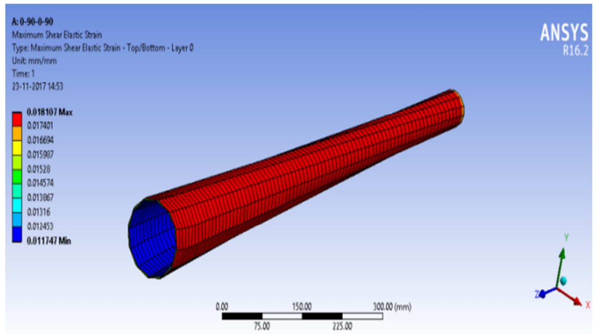
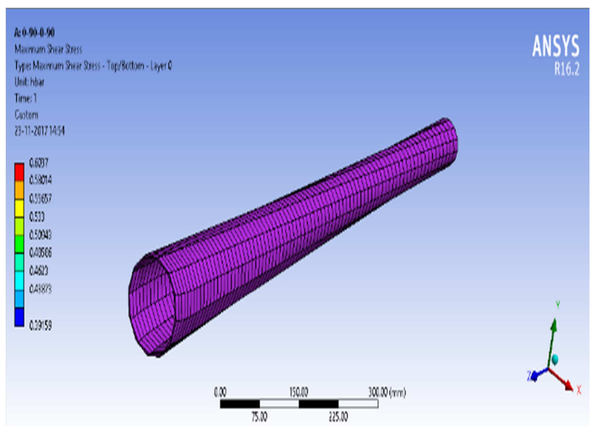
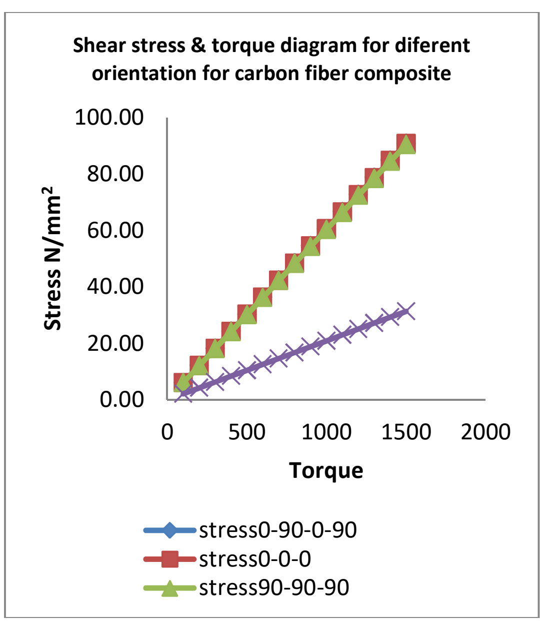
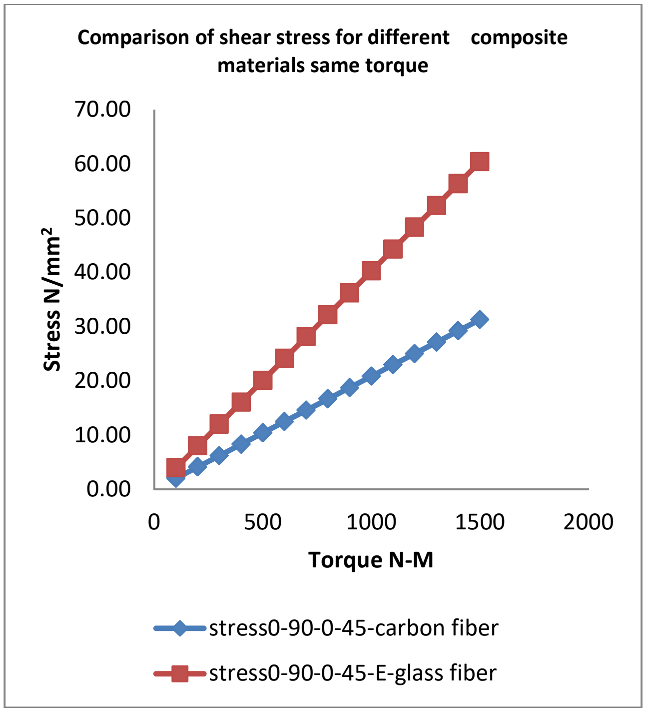


fig shows shear stress







5. DISCUSSION AND RESULTS

The results obtained from analysis show that by using finite element analysis, the strength of a composite drive shaft was simulated. In this the effect of boundary conditions and the stacking sequence of the composite layers on the strength of the drive shaft is studied. It is shown that increasing of the applied torque on the shaft increases the torsional shear strength. The results obtained in this work are summarized in the following:

• The boundary conditions of the shaft do not have much effect on the torsional shear.
• The fiber orientation of a composite shaft affects the torsional shear.
• The stacking sequence of the layers for a composite shaft also affects the twisting angle.
• The finite element modeling presented in this analysis is able to predict the torsional shear and angle of twist.

REFERENCES

[1] Greenhill AG. On the strength of shafting when exposed both to torsion and to end thrust. In: Proc Instn Mech Engrs, London; 1883. p. 182.

[2] Schwerin E. Torsional stability of thin-walled tubes. In: Proceedings of the First International Congress for Applied Mechanics, Delf, The Netherlands; 1924. p. 255–65.

[3] Sezawa K, Kubo K. The buckling of a cylindrical shell under torsion. Aero Research Inst, Tokyo Imperial University, Report No. 176; 1931.

[4] Lundquist E. Strength tests on thin-walled duralumin cylinders in torsion. NACA No. 427; 1932.

[5] Donnell LH. Stability of thin-walled tubes under torsion. NACA Report 479; 1934. p. 95–115.

[6] Ambartsumyan SA. Theory of anisotropic shells. TT F-118, NASA; 1964. p. 18–60.