ANALYSIS OF COMPOSITE DRIVE SHAFT USING ANSYS

Ashwini Shanthi .A[1], Kalyani.K[2]
[1,2]Department of Mechanical, Anurag Group of institutions,Venkatapur, Telengana , India

Abstract
The present investigation deals with analysis of composite drive shaft by replacing the conventional stainless steel with composite materials. Composite materials used in this analysis were high strength carbon epoxy, E-glass epoxy and high modulus carbon epoxy. Instead of regular two piece steel drive shaft, a single long continuous shaft is manufactured using composite materials. By using ANSYS software, model, static, and buckling analysis on these materials is done.
Keywords: E-glassepoxy, Specific modulus, Degrees of Freedom, Torque

I. INTRODUCTION

Drive shaft is a mechanical component which is used in automobiles. Most popularly this drive shaft is known as the propeller shaft, while coming to the construction it was long cylindrical structure consists of thee universal joints. Drive shaft is used to transfer the rotary motion to the differential by using the helical gear box. This rotary motion is used to run the rear wheels. In many cases we use stainless steel shaft for the fabrication of drive shaft. This drive shaft has wide applications in automobile world, used in the vehicles like trucks, buses, aero planes etc

II. PROBLEM DESCRIPTION

Stainless steel was mainly used because of its high strength. But this stainless steel shaft has less specific strength and less specific modulus. Stainless steel has less damping capacity. Because of its higher density of molecules of stainless steel, its weight is very high. Because of increase in weight fuel consumption will in increase, the effect of inertia will be more.

Because of increase in weight of the propeller shaft we are replacing the stainless steel with the composite materials, which are very less weight when compared to that of stainless steel. The cost of composite materials is less when compared to that of stainless steel.

III. COMPOSITE MATERIALS AND ITS CLASSIFICATION

Composite materials are used in the fabrication of drive shaft in place of stainless steel. Composite materials have high specific strength and high specific modulus. Thermal conductivity properties are different for these composite materials.

Because of using various composite materials in layer by layer the Conductivity properties vary for each material, because of this reason there was drastic increase in thermal conductivity. The molecular density is less when compared to that of stainless steel the weight will be decreased.

Mainly we use E-glass epoxy HS carbon epoxy Kevlar glass fiber materials are used in manufacturing.

Composite materials are classified according to their properties

Metal matrix composites Polymer matrix composites Ceramic matrix composites

These composite materials are classified based on the matrices composite material composites. Polymer matrices are not stronger than metal matrix; these composites are made in composite resin.

3.1 Applications of Composite Materials

AUTOMOTIVES: Glass/epoxy leaf springs for heavy trucks, clutch plates, drive shafts, frames, engine blocks etc.

SPACE: Remote manipulator arm, high gain antenna, antenna ribs, struts etc.
AIRCRAFTS: driveshaft, rudders, elevators etc.

Table 1: Comparison of Stainless Steel with Composite Materials

PROPERTY	STAINLESS STEEL	COMPOSITE MATERIALS
Specific Strength	Low	High
Specific Modulus	Low	High
Weight	High	Low
Cost	High	Low
Corrosion	High	Low
Thermal Conductivity	Medium	Medium
Damping Capacity	Medium	High

IV. TYPES OF DRIVE SHAFT

There are various type of transmission shaft among them following are important

1. Transmission shaft.
2. Machine shaft.
3. Spindle.
4. Automobile drive shaft.
5. Ship propeller shaft.
6. Helicopter tail rotor shaft.

These drive shafts can be manufactured by replacing the stainless steel with the composite materials.

4.1 Improvements Made To the Drive Shaft

Long continuous drive shaft is made by replacing the discontinuous two piece conventional drive shaft.
Reducing the weight of the drive shaft. Increase in natural frequency.
Decrease in bending stress using various stacking sequence.
Increase in torque transmission and torsion buckling activities

4.2Comparison of Mechanical properties

MECHANICAL PROPERTY	STAINLESS STEEL	HSCARBON/E-GLASS EPOXY
Youngs Modulus	207Gpa	210Gpa
Shear Modulus	80Gpa	70Gpa
Shear Strength	370Mpa	420Mpa
Density	7600Kg/m3	1600Kg/m3

4.3 Analysis Of Composite Drive Shaft Using ANSYS

ANSYS is an analysis tool which was used by mechanical engineers to check the feasibility of any product before launching into the market. Various analysis can be done before launching the product into the market. Various types of analysis techniques were used among them model, static and buckling, CFD etc.
In this scenario we consider buckling, model, and static analysis by finite element technique. From these analysis techniques we got the following results.

4.4 Finite Element Analysis

Finite element analysis is a computer based numerical technique is used to for calculating the strength and behavior of the engineering structures. The structure on which the analysis can be done is divided into large number of finite elements and required stress at the desired point can be calculated. The accuracy of the structure depends on the no of finite elements made.

4.5 Static Analysis

Static analysis deals with the conditions of equilibrium of the bodies acted upon by the forces. Types of static analysis

- Linear
- Non linear

Kinds of loads that can be applied in static analysis includes

1. Pressures, moments, and externally applied forces.
2. Non-zero displacements imposed.
3. Inertial forces such as gravity and gravity.

4.6 Model Analysis

The body under the equilibrium was disturbed from its state by the action of some external inherent force then the system undergoes vibrations these vibrations are called free vibrations. It will vibrate with its natural frequency and its amplitude. Model analysis is used to determine the natural frequencies and mode shape of the structures

4.7 Analysis on E-Glass Epoxy

E-glass epoxy has the following results in von-mices and in all DOF

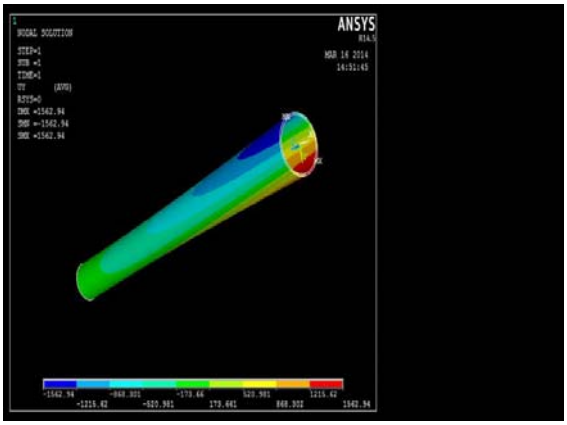

Fig 1: All DOF analysis for E-Glass Epoxy

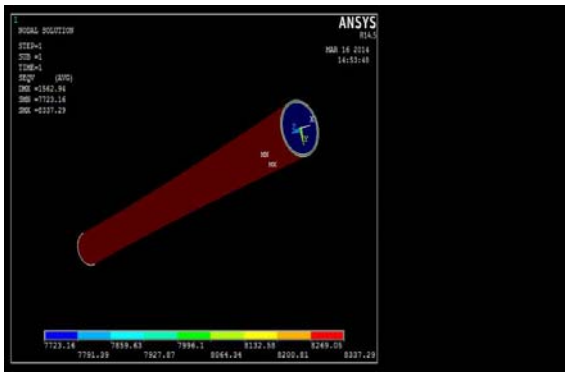

Fig 2: Von-Mises analysis of E-Glass Epoxy

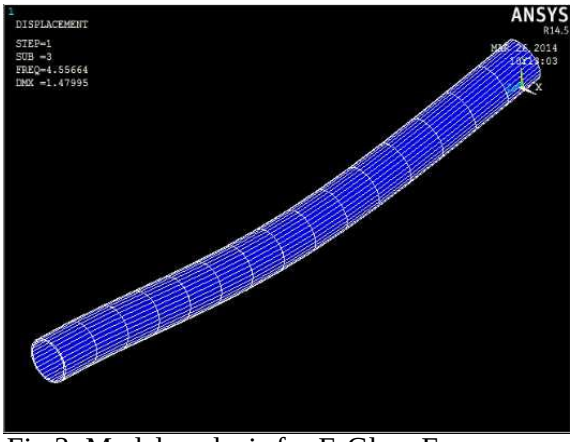

Fig 3: Model analysis for E-Glass Epoxy

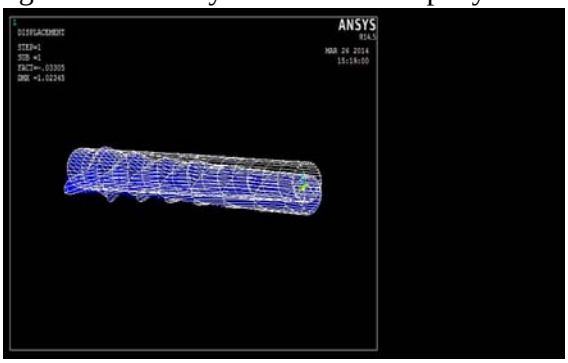

Fig 4: Buckling analysis of E-Glass Epoxy

HS-carbon epoxy has the following results in ANSYS

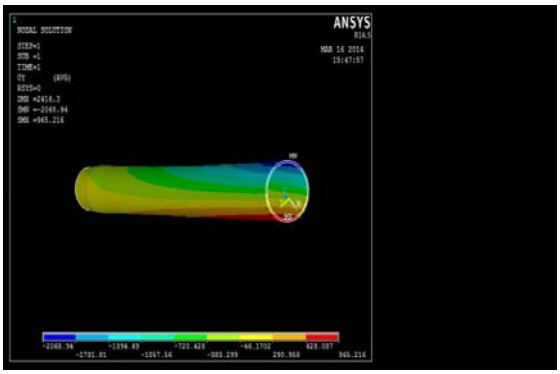

Fig 5: All DOF analysis for Hs-Carbon Epoxy

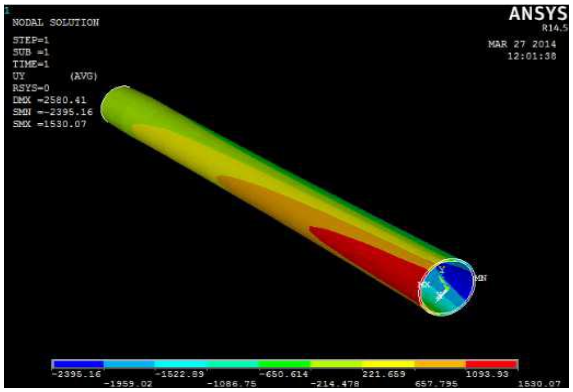

Fig 6: Von Mises analysis for HM-Carbon Epoxy

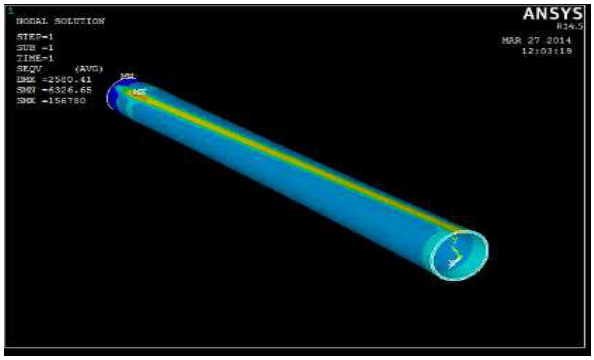

Fig 7: Von Mises analysis for HM-Carbon Epoxy

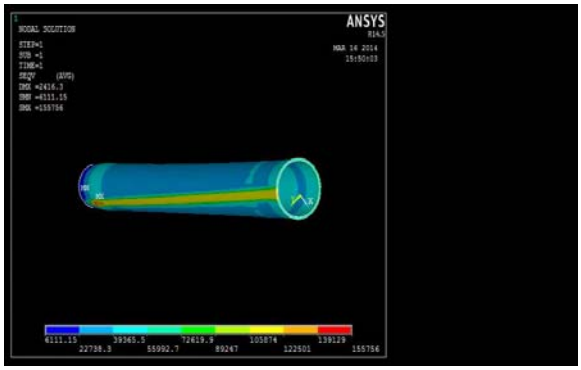

Fig 8: Von-Mises analysis for the HS-Carbon Epoxy

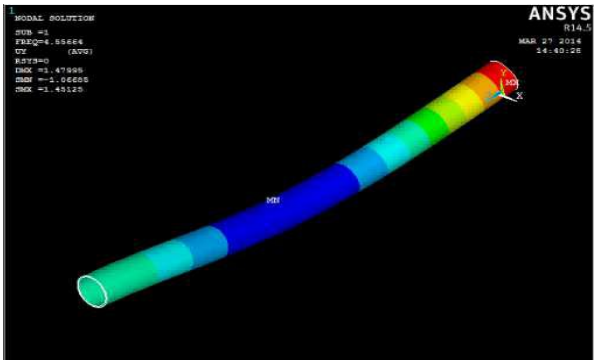

Fig 9: Model Analysis for HM Carbon Epoxy

I. CONCLUSION

Hence by using composite materials weight of the drive shaft was successfully decreased. Finite element analysis was used in this work to predict the deformation of the shaft. Bernoulli–Euler and Timoshenko beam theories was used to know the natural frequency. Hence single piece high strength carbon/epoxy composite drive shaft has been proposed to design to replace two piece conventional steel drive shaft of automobile.

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