Industrial Science
Vol.1,Issue.5/June. 2014 **ISSN** : 2347-5420

Research Papers

STRUCTURAL DESIGN OF COMPOSITE DRIVE SHAFT FOR REAR-WHEEL DRIVE ENGINE

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Abstract

In current market, drive shaft is the most important component to any power transmission application; automotive drive Shaft is one of this. A drive shaft, also known as a propeller shaft or Cardan shaft, it is a mechanical part that transmits the torque generated by a vehicle's engine into usable motive force to propel the vehicle. Physically, it is tubular in design, with an outside and inside diameter, which spins at a frequency governed by engine output. Drive shaft must operate in high and low power transmission of the fluctuating load. Due this fluctuating load it becomes fail and tends to stop power transmission. Thus it is important to make and design this shaft as per load requirement to avoid failure. Now a day's two pieces steel shaft are mostly used as a drive shaft. . The two-piece steel drive shaft consists of three universal joints, a center supporting bearing and a bracket, which increases the total weight of an automotive vehicle and decreases fuel efficiency. However, in this project work an attempt is made to evaluate the suitability of composite material for the purpose of automotive drive shaft application. A Static and Dynamic analysis, composite shaft is analyzed using Finite Element Analysis Software for composites with the objective of minimizing the weight of the shaft, which is subjected to the constraints such as torque transmission, critical buckling torque capacity and also we are modifying the geometric shape to improve efficiency.
1.Drive shaft is the most important component to any power transmission application.
2.Drive shaft must operate in high and low power transmission of the fluctuating load.
3.Due this fluctuating load it becomes fail and tends to stop power transmission. Thus it is important to make and design this shaft as per load requirement to avoid failure.
4.In this project work an attempt is made to evaluate the suitability of composite material such as Carbon Epoxy for the purpose of automotive drive shaft application. . A Static and Dynamic analysis, composite shaft is analyzed using Finite Element Analysis Software for composites with the objective of minimizing the weight of the shaft, which is subjected to the constraints such as torque transmission, critical buckling torque capacity
5.In this both static and dynamic analysis is performed on the shaft of varying dimensions (Outer diameter, inner diameter, length)

KEYWORDS:

Structural Design , Composite Drive , Rear-wheel ,drive Engine .

1.0 INTRODUCTION

A driveshaft is the connection between the transmission and the rear axle of the car. As shown in Figure 1, power generated by the engine is transferred to the transmission via a clutch assembly. The transmission is linked to the driveshaft by a yoke and universal joint, or u-joint, assembly. The driveshaft transmits the power to the rear end through another yoke and u-joint assembly. The power is then transferred by the rig and pinion or rear differential to the rear wheels.

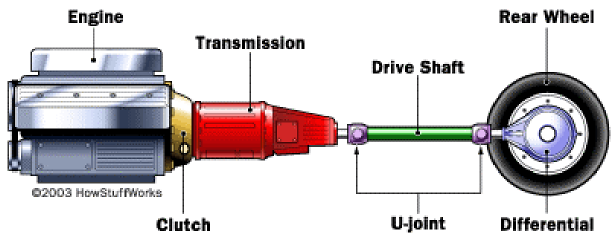

Figure.1

The entire driveline of the car is composed of several components, each with rotating mass. The rule of thumb is that 17-22% of the power generated by the engine is lost to rotating mass of the drive train. The power is lost because it takes more energy to spin heavier parts. This energy loss can be reduced by decreasing the amount of rotating mass. Light weight flywheels and transmission gears, aluminum and carbon-fiber drive shafts, riffle-drilled axels, and aluminum hubs are all examples of replacement or modified parts used to reduce the amount of rotating mass.

Power transmission can be improved through the reduction of inertial mass and light weight. Substituting composite structures for conventional metallic structures has many advantages because of higher specific stiffness and higher specific strength of composite materials. Composite materials can be tailored to efficiently meet the design requirements of strength, stiffness and composite drive shafts weight less than steel or aluminum.

Composite materials are used in large volume in various engineering structures including spacecrafts, airplanes, automobiles, boats, sports' equipments, bridges and buildings. Widespread use of composite materials in industry is due to the good characteristics of its strength to density and hardness to density. The possibility of increase in these characteristics using the latest technology and various manufacturing methods has raised application range of these materials. Application of composite materials was generally begun only at aerospace industry in 1970s, but nowadays after only three decades, it is developed in most industries. Meanwhile, the automotive industry considered as a mother one in each country, has benefited from abilities and characteristics of these advanced materials. Along with progress in technology, metallic automotive parts are replaced by composite ones. One of them is drive shaft (propeller shaft), which numerous researches have been done on it in recent decades. Drive shafts are usually made of solid or hollow tube of steel or aluminum. Over than 70% of single or two-piece differentials are made of several-piece propeller shaft that result in a rather heavy drive shaft [1]. Figure 1 shows a photographic view of two-piece steel and a sample composite drive shaft. Composite drive shafts were begun to be used in bulk in automotives since 1988. The graphite/carbon/fiberglass/aluminum driveshaft tube was developed as a direct response to industry demand for greater performance and efficiency in light trucks, vans and high performance automobiles. The main reason for this was significant saving in weight of drive shaft; the results showed that the final composite drive shaft has a mass of about 2.7 kg, while this amount for steel drive shaft is about 10 kg. The use of composite drive shafts in race cars has gained great attention in recent decades. When a steel drive shaft breaks, its components, are thrown in all directions such as balls, it is also possible that the drive shaft makes a hole in the ground and throw the car into the air. But when a composite drive shaft breaks, it is divided into fine fibers that do not have any danger for the driver. Numerous studies have been carried out to investigate the optimal design and analysis of composite drive shafts with different materials and layers orientation. Pollard studied different applications of composite drive shafts for automotive applications. He compared the advantages and disadvantages of them at various conditions. Rangaswamy optimized and analyzed a one-piece composite drive shaft using genetic algorithm and ANSYS. They found that the use of composite materials lead to the significant reduction in weight compared to steel drive shaft. They also reported that the fiber orientation of a composite shaft strongly affects the buckling torque. Rastogi implemented a FEA approach to design and analyze a composite drive shaft in different conditions. A one-piece composite drive shaft for rear wheel drive automotive application is designed and analyzed using ANSYS software. Since performance of conventional drive shafts can be severely limited by the critical speed and large mass inertia moment of metal shaft. Photographic view of a two-piece steel and one-piece composite drive shaft .

Figure.3

2.0 STATIC ANALYSIS

2.1 Composite shaft with steel 75dia

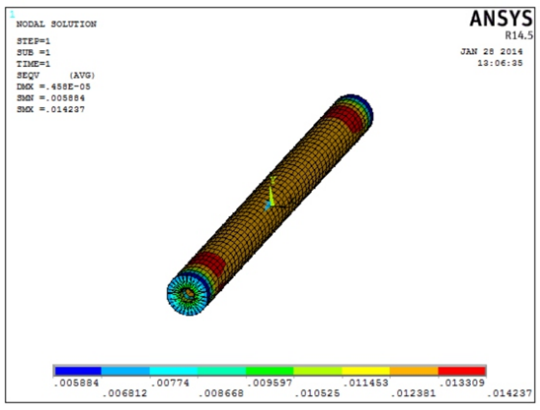

Figure.4.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.014237

2.2 Composite shaft with steel 70dia

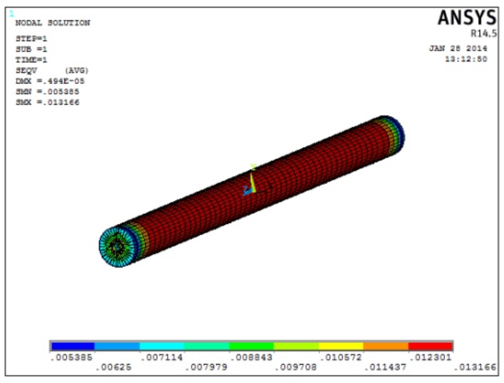

Figure.5.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013166

2.3 Composite shaft with e-glass 75dia

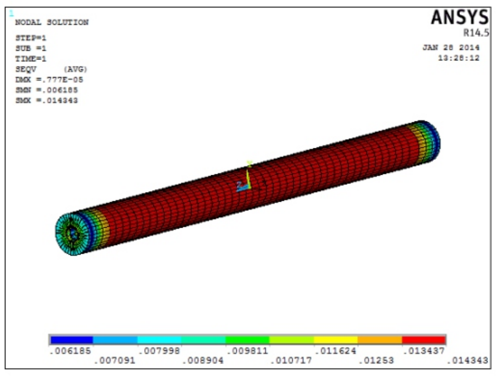

Figure.6.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.014343

2.4 Composite shaft with e-glass 70dia

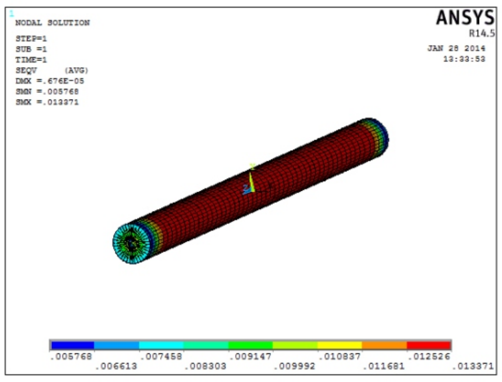

Figure.7

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013371

2.5 Composite shaft with s-glass 75dia

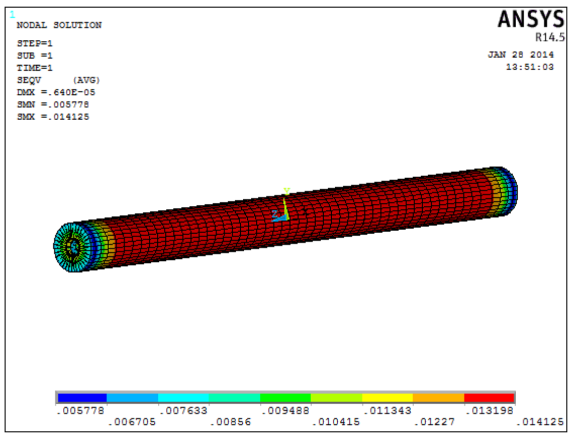

Figure.8

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.014125

2.6 Composite shaft with s-glass 70dia

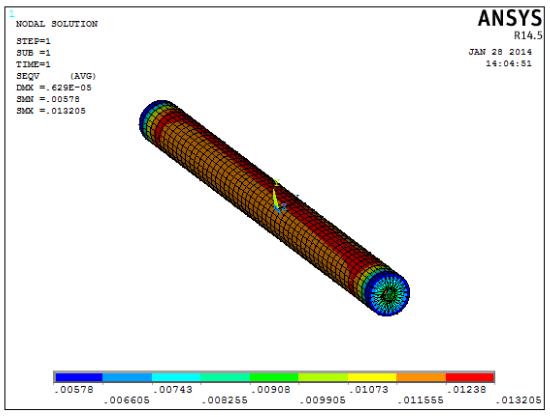

Figure.9.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress= 0.013205

2.7 Composite shaft with e-glass 3-layers

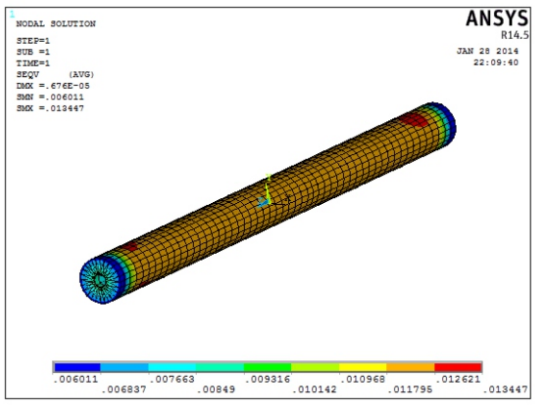

Figure.10.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013447

2.8 Composite shaft with s-glass 3-layers

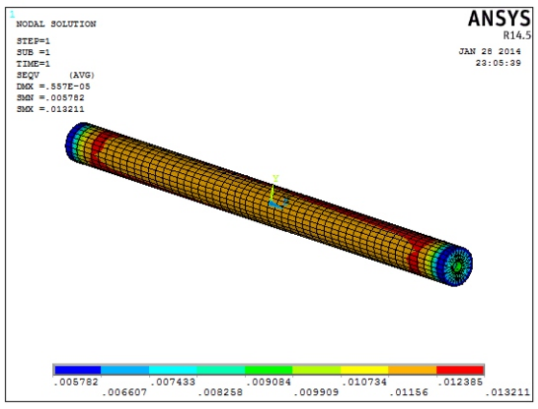

Figure11.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013211

2.9 Composite shaft with S-glass 5-layers 90 – 45 – 0 - -45 - -90

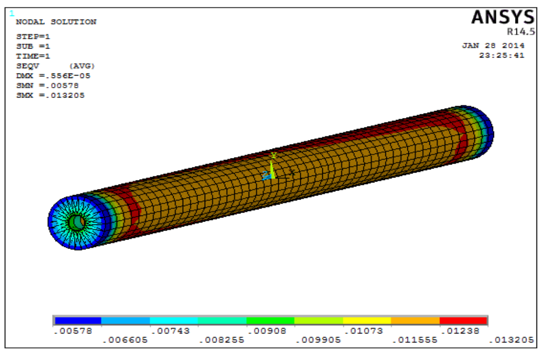

Figure.12.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013205

2.10 Composite shaft with s-glass 5-layers 90 - 0 - 90 - 0 – 90

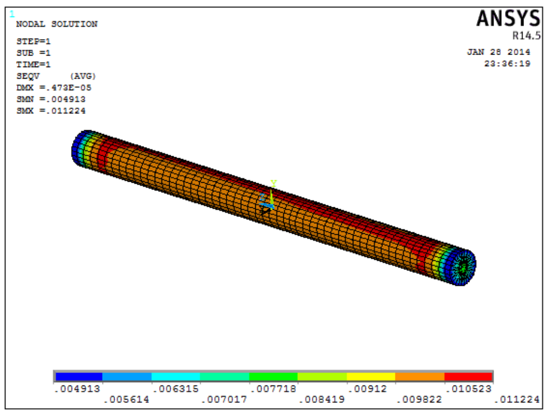

Figure.13.

The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.011224

3.0 RESULTS & DISCUSSIONS

[illegible] composite shaft	{Ç99[		9 D[! {{		{ D[! {{	
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a h59-5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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a h59-3	[illegible]	[illegible]	[illegible]	[illegible]
a h59-4	[illegible]	[illegible]	[illegible]	[illegible]
a h59-5	[illegible]	[illegible]	[illegible]	[illegible]

In this paper it is observed different materials which are suitable for composite shaft.
The 75 diameter shaft is suitable for shaft due to its structural stability and the composites having very less stress due to its construction of material structure and the material matrix.
The multiple layers with the variation of angles splitting the load.

4.0 CONCLUSION

In this paper work analysis on composite drive shaft is done to increase the efficiency as well as to decrease the cost and weight.

In the first step data analization is done to understand the problem and rectification methodology.

In the next step a 3d surface model was generated for analysis purpose.

In the next step analysis is done on 75Dia and 70Dia by varying materials steel, FRP (E-glass), and CRF (S-glass) and also analysis work is done by applying layered matrix.

In the next step analysis is done on reduced thickness using layers method with reinforcement angles.

As per the above results 70 dia with 12 mm wall thickness shaft with S-glass (CRF) with 90-0-90-0-90 angles is suitable for drive shaft due to low stress, less weight and less manufacturing cost. Even if we observe previous they have used combination of CRF and FRP but the combination type shaft manufacturing having errors while joining both to gather.

Instead of using combination material better to use perpendicular angles for the reinforcement.

Using this type of shaft we can increase the mechanical efficiency by reducing the weight and this type of shafts are easy to manufacture and cost effective.

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