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Design and Fabrication of Hybrid Propeller Shaft using Composite Material

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Abstract:
This project presents a design and fabrication of propeller shaft using Fiber Reinforced Polymer (FRP). Composition is by using Glass/epoxy and aluminum. The main reason that we chose this combo is that among all the composite pairs, these two have better nature i.e. it has high strength to weight ratio and stiffness to weight ratio. To be in short, we took two shafts whose efficiency will be compared. One shaft is to be made using regular conventional steel and the other is to be made using composite pair respectively. Finally, we compared and justified that by replacing steel with composite can make huge differences. The procedure for designing and fabricating the shafts will be encountered in the following sections.

I. INTRODUCTION

A drive shaft is a mechanical device for transferring power from the engine or motor to the point where useful work is applied. Most engines or motors deliver power as torque through rotary motion. This is extracted from the linear motion of pistons in a reciprocating engine. From the point of delivery, the components of power transmission from the drive train. The drive shafts are carriers of torque which are subject to torsion and shear stress, which represents the difference between the input force and the load. They thus need to be strong enough to bear the stress, without imposing too great an additional inertia by virtue of the weight of the shaft. The drive shaft, which is usually made from seamless steel tubing, transfers engine torque from the transmission to the rear driving axle. Now, a limited number of vehicles are equipped with fiber composite reinforced fiberglass, graphite, and aluminum drive shafts. The advantages of using these materials are weight reduction, torsion strength, fatigue resistance, easier and better balancing, and reduced interference from shock loading and torsion problems.

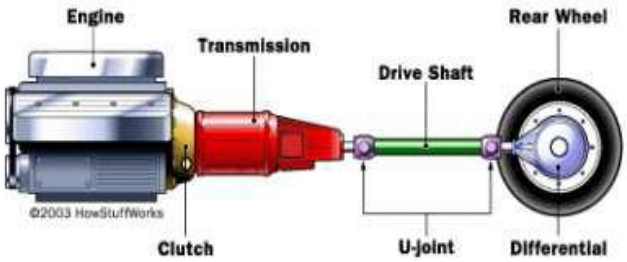

Figure.1. Location of Propeller/Drive Shaft

II.STEEL VS COMPOSITE

Traditionally, drive shaft is from steel which transfer power from the transmission to the rear axle of the vehicle. As a direct response to industry demand, for greater performance and efficiency in light trucks, vans and high performance automobiles, the graphite, carbon, fiberglass, and aluminum driveshaft tube were developed. The main reason for this is a significant saving in weight of drive shaft. The composite drive shaft has a mass of about **2.7 kg**, while the amount for steel drive shaft is about **10 kg**. When a steel drive shaft break 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. Steel is an alloy that consists mostly of iron and has carbon content between **0.2% and 2.1% by weight**, depending on the grade.

III. WHAT'S IN THIS PROJECT?

Though this idea of composite propeller shaft already exists, we are looking forward to make a new try in the sense of showing that the efficiency is more by fabricating the composite shaft and com0. Paring with the conventional. Since many papers have been published regarding the analysis of each composite and their properties, a new approach of **Epoxy/Glass and Aluminum** combo has been chosen based on the study. The Main idea is using the Textile Composite in this project. The common composition used nowadays **is 60% Fiber and 40%Resin.** But, we wish to use the Composition by **60% Resin and 40% Fiber** which is not appreciable**.** So, finally we decided to fabricate a metal **assisted Composite Propeller Shaft.**

IV. DIMENSIONS

Base-Chromium Coated Iron Plate	L-18 inches, B-16 inches, t-3mm
Side wall-CC Iron Plate-2 nos	L-16 inches, B-16 inches, t-3mm L-13 inches, B-16 inches, t-3mm Hole Dia-27
U Joints, Roller bearing - 2 nos.	Hole Dia-1.1 inch (28 mm)
Dynamometer- 1 no	As per requirement
Motor- 1 No.	0.5hp
Side Support – Chromium coated Iron Plate-2 nos	As per motor and Dynamometer dimensions
Shaft- 1) Structured Steel 2)Epoxy / Glass	Dia-1 inch(25.4mm), L-10 inches(254mm)

V.SKETCH & CAD DESIGN

Sketching has been done by normal Pencil and Paper and 2D model has been designed using **AUTOCAD** and **CATIA.**

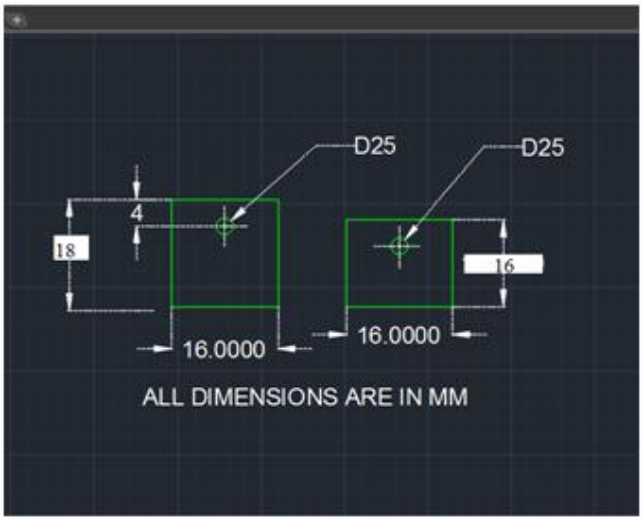

Figure.2. Left and right side view

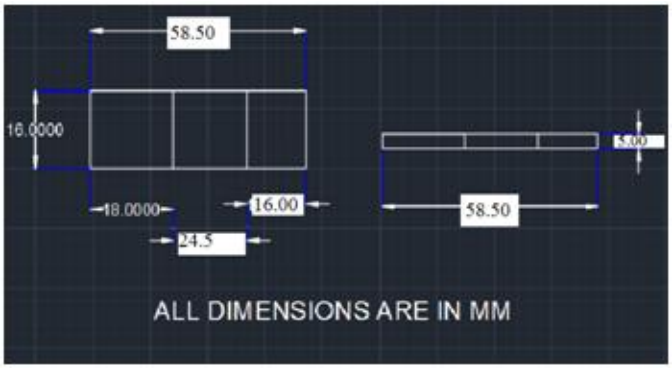

Figure.3. 2D Top View

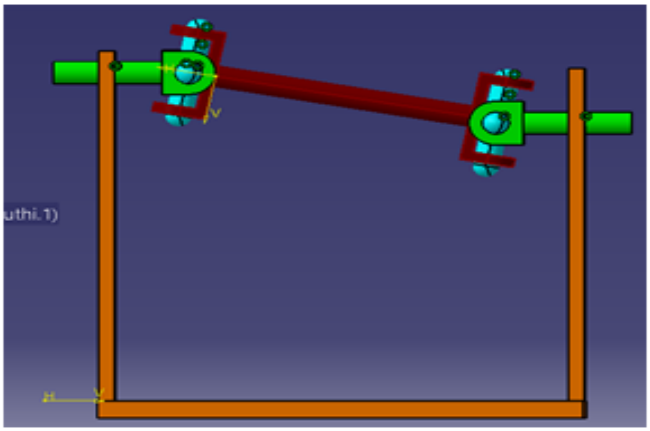

Figure.4. 3D Front view

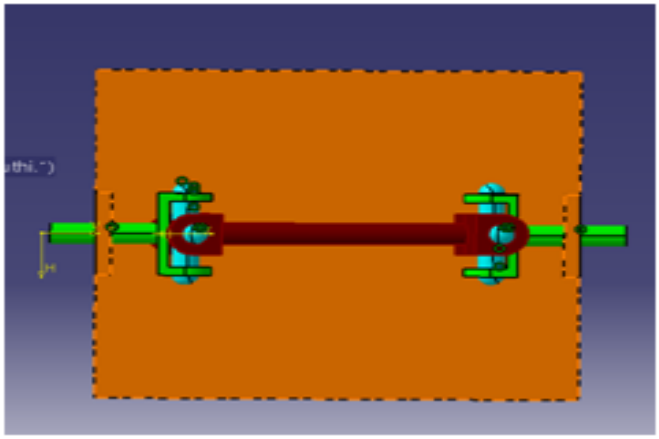

Figure.5. 3D Plan view

VI. LITERATURE SURVEY

Nearly **6** Journal Papers have been studied completely and many analysis results were taken and guided under it. The list of papers has been listed below:

S.No	PAPER DETAILS	AUTHOR DETAILS	WHAT WE HAD OBSERVED
1.	ISSN 2248-9967 volume 4, no. 1(2014), pp.21-28	ARUN RAVI PG School, TKM College of Engineering; Kollam, Kerala, India	**So we finally observed that:** A hallow shaft of 100-50 mm outside diameter using high strength carbon as best one. The weight saving of the HS Carbon is **24% (100-50 &solid)** compared to same dimensions of shaft.
2.	ISSN 1990-9233; IDOSI Publication, 2016.	S.Mohan and M.Vinoth Priya darshini Engineering College, Vaniyambadi, India	**So we finally observed that:** When the cost of composite materials compared with boron to HS Glass/Epoxy is low and **best one.**
3.	ISSN (Online): 2319 -7064	Mujahid Khan, M.A.Mateen, D.V.Ravi Shankar Nizam Institute of Engineering and technology.	**So we finally observed that:** Orientation of ±45* is found to be better for the composite drive shaft compare to conventional steel drive shaft. Simple shaft and hybrid aluminum-**glass/epoxy shaft** is fabricated by simple winding method.

4.	Industrial science, vol.1,Issue.5/June.2014 ISSN: 2347-5420	B.China Brahmaiah and M.v.Mallikarjun QIS College of Engg & Tech.	**So we finally observed that..** Instead of using combination material better to use perpendicular angles for the reinforcement. Using this shaft we can increase the mechanical efficiency by reducing the weight of automobiles.
5.	International Journal Of Science and Research ISSN (Online):2319-7064	Pankaj K. Hatwar, Dr.R.S.Dal Govt college of Engg ,	**So we finally observed that:** The usage of composite material has resulted in considerable amount of weight saving in a range of **81% to 72%** when compared to conventional steel drive shaft.
6.	Research Journals of Recent Sciences, Vol.4(9),9-15, sep(2015) ISSN 2277-2502	Vinodh kumar S, Sampath v and Baskar School of Mech.	**So we finally observed that:** E-GLASS has 75% reduction in Von Mises stress and 74%reduction in weight than structural steel . E-CARBON has 79%reduction in Von Mises stress and 80% reduction in weight than structural steel.

VII. ANALYSIS

The Analysis have been made using ANSYS FEA Software regarding Journal Papers

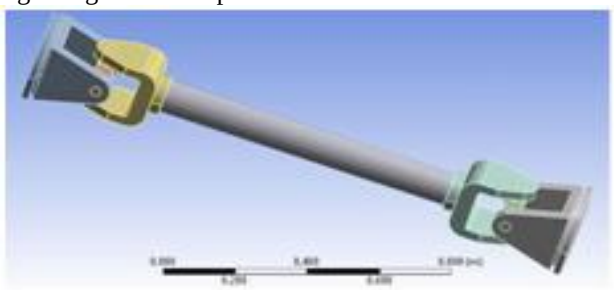

Figure.6. 3D model Material properties.

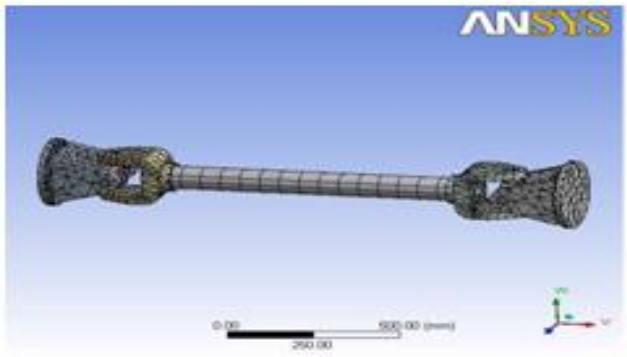

Figure.7. FE model.

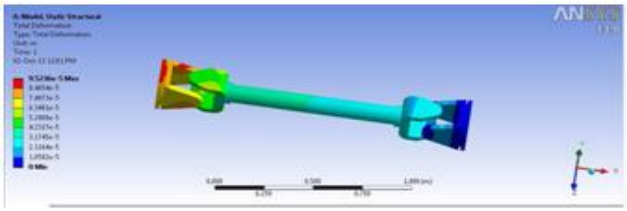

Figure.8. Total deformation (carbon fibre).

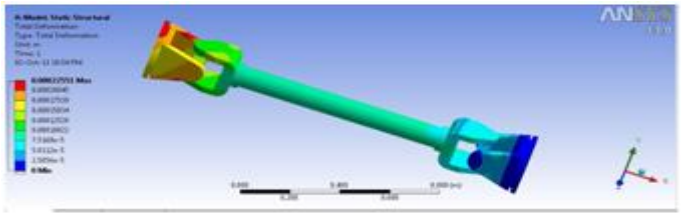

Figure.9. Total deformation (structural steel).

VIII. WHY WE CHOSE THIS PARTICULAR MATERIALS?

1) Base: Chromium coated Iron Plate (Less Cr content)

- Reason: Since chromium has natural protection against corrosion and it can also absorb vibration when compared to normal non-coated steel.

2) Shaft: E-Glass + Aluminium/PVC Pipe (Mandrel)

- Reason: It is called as Textile fibre. It is highly affordable too. And also it is lightweight when made as solid shaft. So this particular combo has been chosen.

IX. METHOD OF CALCULATION

Initially the Base Component has been fabricated. According to the dimensions, the base plate has been removed and pieces were welded respectively. Now the hole of diameter according to the bearing dimensions has been drilled on side walls. Initially we used Wood turning Lathe for Filament Winding Process. Then we used hollow steel shaft of length 10 inch and diameter 1 inch (25.4mm); then the output Power has been noted. The we took Hollow Al Mandrel and E-glass was wounded on it. Then the Power was noted.

X. CALCULATIONS

For Structured Steel:

Let N=160 rpm, d=25.4mm, t= 65 N/mm2

T=pi/16*65*10^6*(25.4*10^-3)^3
= 209.1435 N-m
P= (2*pi*160*209.1435)/60=**3.504 KW.**
For Composite Material:
Let N=160 rpm, d=25.4mm, t= 90N/mm2
T =pi/16*90*10^6*(25.4*10^-3)^3
=289.583 N-m
P= (2*pi*160*289.583)/60= **4.852 W.**
Thus,
Power O/P
(Composite Shaft) > Power O/P
(Structured Steel Shaft)

XI. RESULT

The power output from the Composite Shaft is higher to Steel Shaft. Thus we conclude that the shaft made with Composite can replace the Conventional Shaft in terms of weight, Cost etc. So we are sure that this particular **metal assisted Composite Shaft** can create some impact regarding Composite Material.

XII. REFERENCES

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