ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

FAILURE ANALYSIS AND EVALUATION OF A COMPOSITE MATERIAL AUTOMOTIVE DRIVESHAFT BY USING FEM

Amol B. Rindhe* and S. R. Wagh

* Mechanical Engineering Department, SSGMCE, Shegaon, India

ABSTRACT

In an automobile industry a drive shaft play a major role in power transmission and it is generally is made of conventional metallic structure is replace by composite structure because they have higher strength and higher specific stiffness ,as we used Kevlar or Carbon epoxy it having some drawback. In this paper work is deals with the replacement of conventional composite material drive shaft with a Eglass carbon /Epoxy,High strength carbon /Epoxy and High module carbon /Epoxy to overcome the drawback of conventional composite material drive shaft.

In this paper we are work for suggesting the best composite material for drive shaft and improve the life of drive shaft and also saving the percentage of material.

KEYWORDS: Drive shaft, Composite material, ANSYS11.0, Material Saving.

INTRODUCTION

Composite driveshafts can increase torque and can help prevent injuries such as a traditionally made of steel, a driveshaft transfers power from the transmission to the rear axle of the vehicle. If a steel driveshaft fails, however, it can project shrapnel in all directions and even dig into the ground, catapulting the vehicle into the air.

According to a commercial manufacturer of composite auto parts, drive shafts in race cars can pose serious threat of injury and even death to the driver inside, as shrapnel can penetrate the car and rollover can increase the chance of severe injury.

Composite driveshafts are made of carbon and polymer fiber that is designed to break into small fiber fragments or “broom” upon failure,
posing little danger.

Composite driveshafts are also lightweight, requiring less energy to spin, effectively increasing the amount of power that the engine can transmit
to the wheels

METHODOLOGY

Design of composite material drive shaft

Torque transmission capacity of drive shaft.

$$T = \frac{S_s \pi (d_o^4 - d_i^4)}{16 \times d_o \times F.S}$$

Where,
S_s = Shear strength
d_o = Outer diameter of shaft
d_i = Inner diameter of shaft
$F.S$ = Factor of safety

Torsional buckjing capacity of drive shaft.

$$T_b = 2\pi r^2 t\,(0.272)\left(E_x E_y^3\right)^{\frac{1}{4}}\left(\frac{t}{r}\right)^{\frac{3}{2}}$$

Where,
r = mean radius of shaft
t = Thickness of shaft
E_x = Elastic modulus in axial direction
E_y = Elastic modulus in tangential direction

Bending natural frequency of drive shaft.

$$f_{nb} = \frac{\pi}{2L^2} \times \sqrt{\frac{E_x I_x}{m'}}$$

Where,

$$I_x = \frac{\pi}{64} \times (d_o^4 - d_i^4)$$

$$m' = \rho\left(\frac{\pi}{4}\right) \times (d_o^2 - d_i^2)$$

Where,

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

f_{nb} = Natural frequency
L = Length of shaft
I_x = Moment of inertia of cross section of shaft
m' = Mass of shaft per unit length

Mass of deive shaft

$$m = m' \times L$$

Persentage saving material.

$$= \left(1 - \frac{m_{new}}{m_{old}}\right) \times 100$$

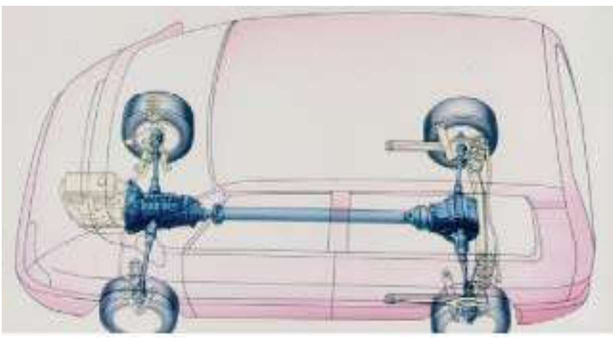

Fig-1; Composit material drive shaft

Table 1. Existing material Result [1]

Design Constraint	Steel	Kevlar	Carbon/ Epoxy
Bending natural frequency (Hz)	160.89	101.903	101.903
Mass of shaft (Kg)	8.601	3.4652	1.2923

DESIGN CALCULATIONS OF COMPOSITE MATERIAL DRIVE SHAFT

Table 2 . Design requirements and specifications

Sr.No	Name	Notation	Unit	Value
1	Torque	T_{max}	Nm	3500
2	Max Speed	N_{max}	rpm	6500
3	Length	L	mm	1250
4	Outer dia	d_o	mm	90

Table 3 . Properties of E-glass/epoxy,HS carbon/epoxy,HM carbon/epoxy

Sr. No	Property	Units	E-glass/ epoxy	HS carbon/ epoxy	HM carbon /epoxy
1	E_{11}	GPa	50	134	190
2	E_{22}	GPa	12	7	7.7
3	G_{12}	GPa	5.6	5.8	4.2
4	V_{12}	-	0.3	0.3	0.3
5	$S_1^t = S_1^c$	MPa	800	880	870
6	$S_2^t = S_2^c$	MPa	40	60	54
7	S_{12}	MPa	72	97	30
8	ρ	Kg/m^3	2000	1600	1600

RESULTS AND DISCUSSION

Table 3 . Analytical Result

Design Constraint	E glass/ epoxy	HScarbo n/epoxy	HMcarbo n/epoxy
Torsional buckling capacity (Nm)	29593.8	3771.70	3765.54
Bending natural frequency (Hz)	112.98	127.71	157.68
Mass of shaft (Kg)	4.431	1.1328	1.132
Thickness (mm)	6.77	2.04	2.04

ANSYS RESULTS

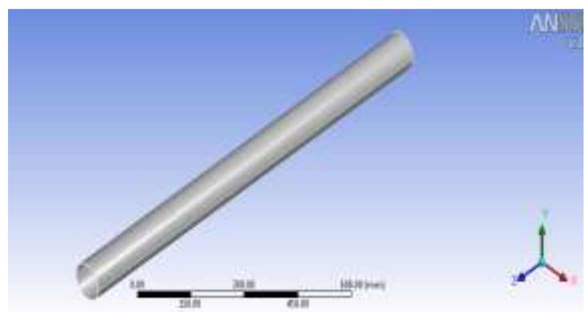

Fig- Model Geometry of drive shaft

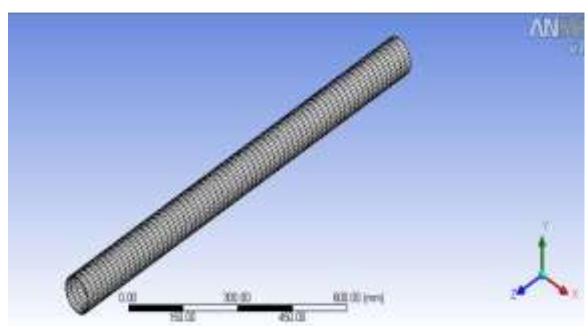

Fig- Mesh model of drive shaft

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

E-glass/epoxy

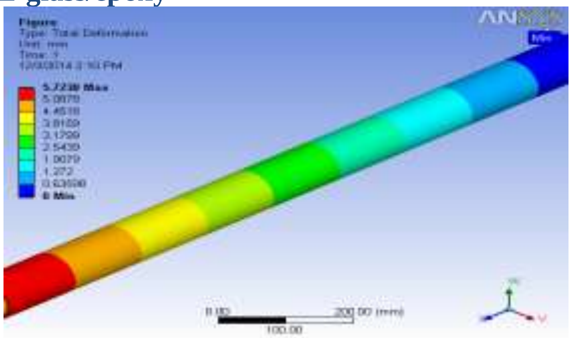

Fig- Natural Frquency Analysis of E-glass/ epoxy

Table 4.

Zones	Value in mm	Discussion	Natural Frquency Analysis (Hz)
Blue	0	Shows very low deformation occurred at one end	111.08
Red	5.7238	Shows very high deformation occurred at other end portion	

HS carbon/epoxy

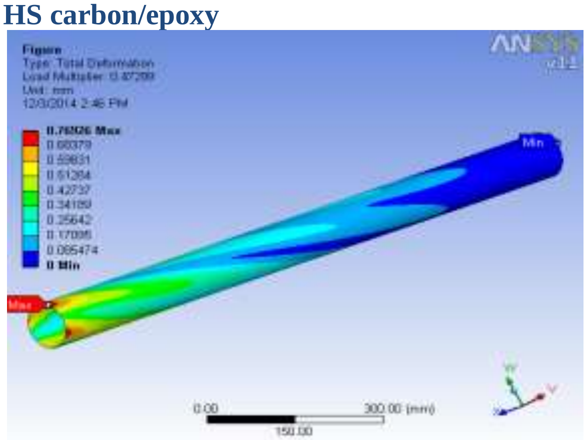

Fig- Natural Frquency Analysis of HS carbon/ epoxy

Table 5.

Zones	Value in mm	Discussion	Natural Frquency Analysis (Hz)
Blue	0	Shows very low deformation occurred at one end	125.12
Red	0.76926	Shows very high deformation occurred at other end portion	

5.3 HM carbon/epoxy

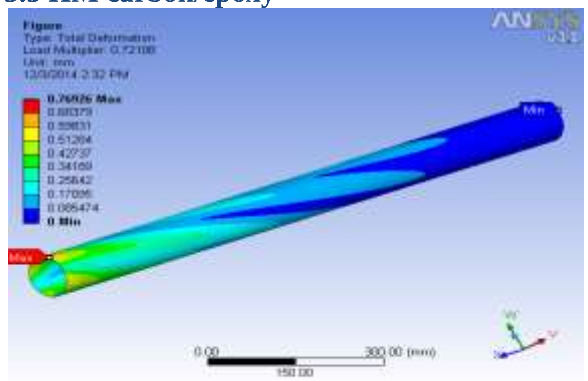

Fig- Natural Frquency Analysis of HM carbon/ epoxy

Table 6.

Zones	Value in mm	Discussion	Natural Frquency Analysis (Hz)
Blue	0	Shows very low deformation occurred at one end	154.73
Red	0.76926	Shows very high deformation occurred at other end portion	

CONCLUSION

I) Bending natural frequency of HS and HM carbon/epoxy drive shaft is nearly equal to steel drive shaft so less chance of failure.

II) By using HS and HM carbon/epoxy we save 86.89% of material.

III) So the life of HS and HM carbon/epoxy drive shaft is more, compare to other composite material drive shaft.

IV) The finite element modeling presented in this analysis is able to predict the buckling torque.

V) A best material to design a composite drive shaft is suggested i.e HS and HM carbon/epoxy.

REFERENCES

[1] R. Srinivasa Moorthy, Yonas Mitiku & K. Sridhar , "Design of Automobile Driveshaft using Carbon/Epoxy and Kevlar/Epoxy Composites" , American Journal of Engineering Research (AJER), (2013)

[2] D.Dinesh, F.Anand Raju "Optimum Design And Analysis Of A Composite Drive Shaft For An Automobile By Using Genetic

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

Algorithm And Ansys"/ International Journal Of Engineering Research And Applications(IJERA) Vol. 2, Issue4, July-August 2012.

[3] Mohammad Reza Khoshravan, "Design and Modal Analysis Of Composite Drive Shaft For Automotive Application", International Journal of Engineering Science and Technology (IJEST), (2011)

[4] M.A.K. Chowdhuri et. al "Design Analysis of an Automotive Composite Drive Shaft" International Journal of Engineering and Technology Vol.2(2), 2010, 45-48, (2010)

[5] Gay, D.; V. Hoa, S.; W. Tsai, S. "Composite materials: design and application", CRC press, (2004).

[6] Pollard, A. "Polymer matrix composite in drive line applications". GKN technology, Wolverhampton, (1999)

[7] Rangaswamy, T.; Vijayrangan, S. "Optimal sizing and stacking sequence of composite drive shafts". Materials science, Vol. 11 No 2., India,(2004).

[8] Pappada, S.Rametto R.,"Study of a composite to metal tubular joint". Department of Materials and Structures Engineering ,Technologies and Process, CETMA , Italy,(2002).

[9] Madhu K.S.1, Darshan B.H.2, Manjunath K ,"BUCKLING ANALYSIS OF COMPOSITE DRIVE SHAFT FOR AUTOMOTIVE APPLICATIONS", Journal of Innovative Research and Solutions Volume No.1A, Issue No.2, Page No: 63 - 70, Jan – Jun 2013