International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 07, July-2018

Review Paper on Design and Optimization Of Composite Propeller Shaft For Light Motor Vehicle

Mr.Sandip R Mali
P.G. Student
Department of Mechanical Engineering
P.V.P.I.T Budhgaon
Sangli, India

Mr.S.S. Patil
Associate Professor
Department of Mechanical Engineering
P.V.P.I.T Budhgaon
Sangli, India

***Abstract*—The propeller shaft is the very important component in a vehicle, forward and reverse motion of the vehicle can be done by the shaft. i.e. transmission of torque from the engine to wheels is performed by a shaft. This shaft is known as a propeller shaft, the overall objective is to design and weight optimization of propeller shaft of the light motor vehicle. This paper deals with the replacement of conventional steel shaft with E glass fiber. In this work, E glass fiber is used as the composite material. Weight is minimized. Natural frequency and mode shape of propeller shaft are analyzed also carrying out experimental investigation and predict failure of drive shaft using suitable software.**

***Keywords*—Propeller Shaft, E Glass Fiber, Optimization, Light Motor Vehicle Etc**

I. INTRODUCTION

Nowadays composite material is using an automotive application. Because of latest technology metallic composite parts are replaced by the composite. High-quality steel is a common material used to construct propeller shaft. The steel shaft is manufactured in a two-piece to increases bending natural frequency .i.e. Two piece shaft which increases the total weight of vehicle and degrees of power transmission. Now replacing steel shaft SM45C with composite gives many advantages due to higher specific strength and stiffness of composite materials. Also, composite drive shafts have a lower modulus of elasticity which results in degrees of stress and best shock absorber when torque is more Composite materials having a lesser weight than steel shaft SM45C and aluminum with similar strength. Composite shaft is manufactured in a single piece which eliminates assemblies of three universal joints, a bracket and a center support bearing of the two-piece driveshaft. This paper deals with design and optimization of E glass epoxy fiber composite propeller shaft and compares the result with a steel shaft Also by suitable FEA software determining natural frequency and mode shape of the shaft.

II. LITRATURE REVIEW

V Jose Ananth Vino et al [1] This paper deals with the replacement of conventional propeller shaft with the composite shaft. Design parameter was optimized for optimizing the weight of the shaft. the modeling is done by SOLIDWORKS software. He evaluated stress under subjected load, defection and natural frequency using Ansys.

S Dharmadhikari J P Giri et al [2] Study deals with design and analysis of composite drive shaft using Ansys and genetic algorithm.

S Shinde et al [3] This paper deals with Design of propeller shaft For Mahindra considering torque capacity, Shear stress, and critical rpm requirement. And epoxy and aluminum material used for replacement of conventional shaft.

Bhirud P.P et al [4] This paper deals with the replacement of steel shaft with E glass resign composite drive shaft. ANSYS is used as analysis software.

Salaisivabalan T et al [5] This paper deals with propeller shaft of MARUTI OMNI to design shaft for its minimum dimension. then part can be created in NX 8.5 and after modeling Torsional buckling analysis and model analysis can be carried out in NX NASTRAN. Obtained results can be compared.

Parshuram D et al [6] in this work studied weight optimization of the shaft by using the composite material. design of the shaft is carried out in CATIA and analysis is carried out in ANSYS.

B Wankhede et al [7] they studied Failure analysis of automotive front wheel drive shaft. the drive shaft is commonly subjected to torsional and bending stress due to which fatigue and fractural failure may occur. some common causes of failure may like design defect raw material, Manufacturing defects.

C G Rothe et al [8] this paper deals with design and analysis of composite drive shaft. In this composite shaft and genetic algorithm is successfully applied for weight optimization of the shaft. The main aim is to design procedure with FEA. the parameter was optimized by genetic algorithm .and modeling is done in CAD software to perform static, buckling and model analysis of both shaft by using ANSYS Software.

H banker et al [9] they studied various composite materials for the composite drive shaft. This paper deals with various composite propeller shaft material like E glass/epoxy, HS carbon/Epoxy, HM Carbon/epoxy, Polystyrene etc. he compared various materials propeller shaft. And analysis is carried out in ANSYS software.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 07, July-2018

S P Maske et al [10] This paper deals with Failure analysis and design optimization of propeller shaft of Bus. the SAE 1045 Steel shaft is replaced by Chromium steel SAE 3145 and analysis can be carried out in ANSYS.

D Khushwaha et al [11] this paper deals with optimal design and analysis of composite drive shaft for a light commercial vehicle. The design is carried out in PRO E and analysis in ANSYS.

III. DESIGN OF SHAFT

The torque transmitted by engine must be transmitted to wheels by a shaft to forward and reverse motion [2] Design of shaft is important to calculate torque transmission capacity, Torsional buckling capacity, the diameter of the shaft and natural frequency. Mechanical properties of steel as given below [2]

Mechanical Properties	Symbol	Units	Steel
Young's Modulus	E	Gpa	207
Shear Modulus	G	Gpa	80
Poisson's ratio	N	-	0.3
Density	P	Kg/ M^3	7600
Shear Strength	Ss	MPa	370

Various formulas for designing shaft as given below [2]

a) Mass (m)-

$$m=\rho AL=\rho \times \pi/4 \times (D_0{}^2 \times D_i{}^2) \times L$$

b) Torsional buckling capacity-

$$Tcr= (2\pi r^2 t)(0.272)(Ex\ Ey^3)^{0.25}(t/r)^{1.5}$$

c) Torque -

$$\frac{T}{J}=\frac{\tau}{r}$$

Where T-Torque, J-polar moment of inertia,τ- Maximum shear stress, r-radius of the shaft.

d) Bending natural frequency [4] -

$$F_{nb}=\frac{\pi}{2}*\sqrt{\frac{E*I}{m*L^4}}$$

e) Critical speed [2] -

$$N_{Cr}=60*F_{nb}$$

As per Taguchi matrix clearly indicates ratio of diameters for hollow shaft is inversely proportional to mass of shaft [3] due to limited space available below vehicle, the maximum diameter is allowed for shaft is 75mm in case of Mahindra load king, Standard shaft of 50-100 mm are available at different size in steps of 2 mm.

The different parts of the drive system as shown in fig below [8]-

1. U-bolt nut
2. U-bolt washers
3. U-bolt
4. Universal joint journal
5. Lubrication fitting
6. Snap ring.
7. Universal joint sleeve yoke
8. Spline seal
9. Dust cap
10. Drive shaft tube

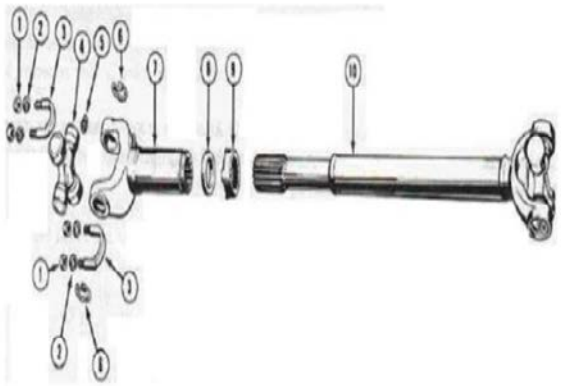


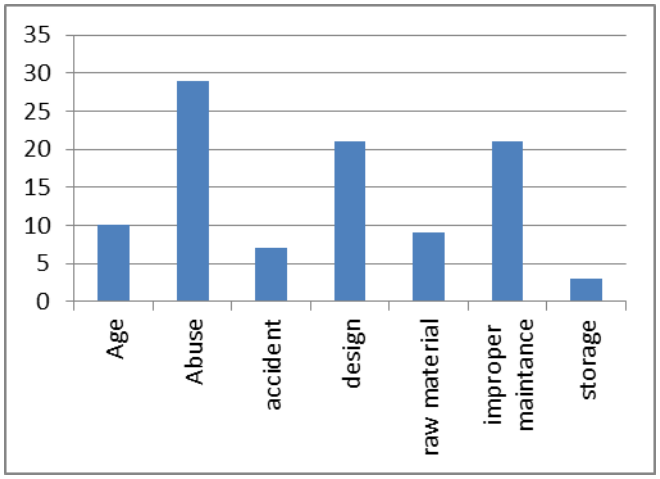
Fig-component of shaft [8]

Causes of failure –

The failure analysis is important to find out various causes of failure and find out prevention of it [7]. A product fails in service or failure occurs during manufacturing or during production processing. it is very important to prevent failure and in any case, one must determine causes of failure to prevent future occurrence. The common causes of service failure are [7]

Abuse-

- Road condition
- Environment condition
- Improper material
- Poor storage condition



FFig-Distribution of causes of failure [7]

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 07, July-2018

IV. MODELING AND ANSYS SIMULATION

1. Selection of element type- SHELL181 may be used for layered application of structural steel.it allows up to 250 layers. The element has 6 degrees of freedom at each node. Translation in nodal X,Y & Z and rotation about X,Y & Z axes. Shell181 provides us to use different material properties in X, Y and Z direction [9].

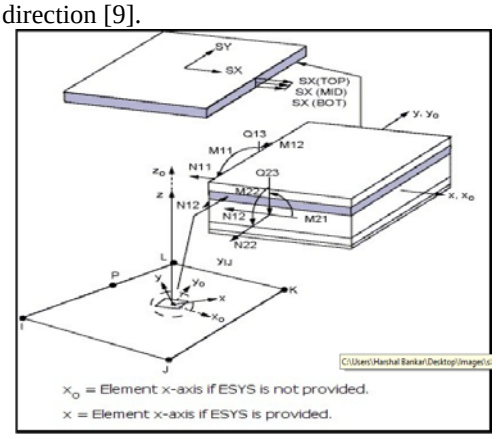


Fig-selection of element type [9]

2. Selection of plies- stress in each ply is calculated and then by using first ply failure criteria, failure of all laminate is determined. When the first ply fails laminate is assumed as fail. This is GA showing a variation of Young's modulus of laminas.

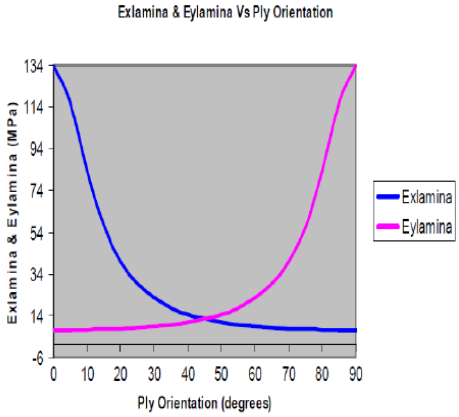


Fig- Ply orientation [9]

From above fig found that Young's modulus in the x-direction is higher for smaller ply angles, also falls down from above 25 degrees. and in case of Y-direction constant at lower ply angles and increases suddenly above 70 degrees [9]. The shear modulus in fig shows that maximum value between 30 to 70 degrees.

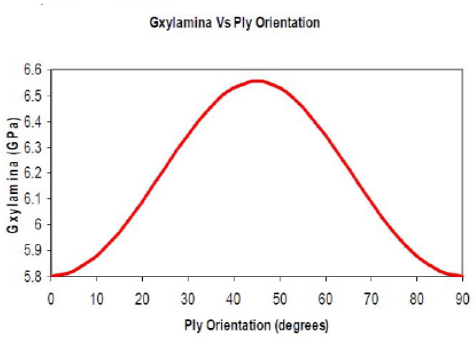


Fig-shear modules and ply orientation [9]

It is important to select an equal number of ply angles for maximum Young's and shear modulus.
The analysis is carried out in Ansys [16] as shown in fig,

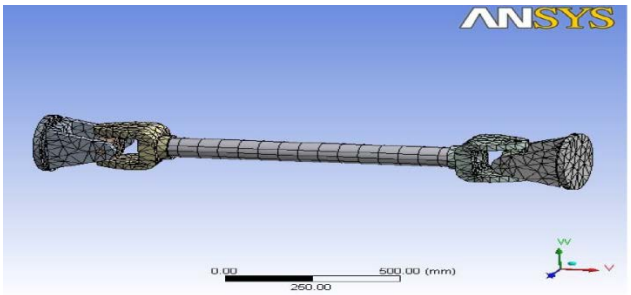


Fig-Meshing of shaft [16]

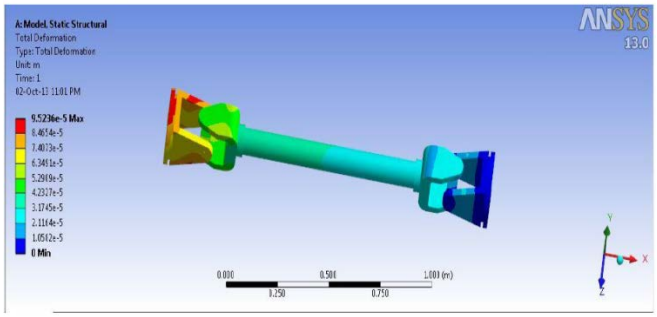


Fig-deformation of shaft [16]

For modeling purpose, there is so many software like as CATIA, SOLIDWORKS, UG-NX, Pro E and for analysis ANSYS, HYPERMESH, ABACUS are used. The modeling and analysis purpose various author used the software as shown in a pie chart.

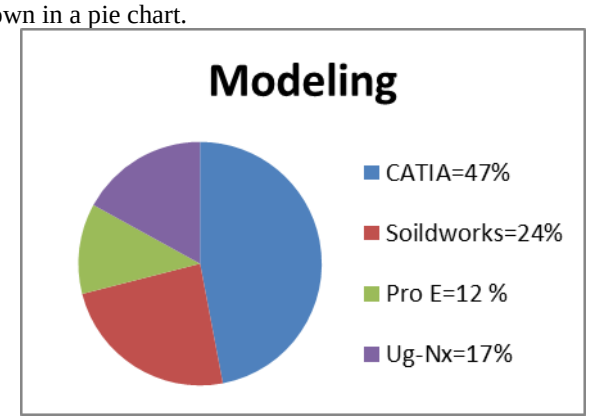


Chart-Modeling/Designing

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 07, July-2018

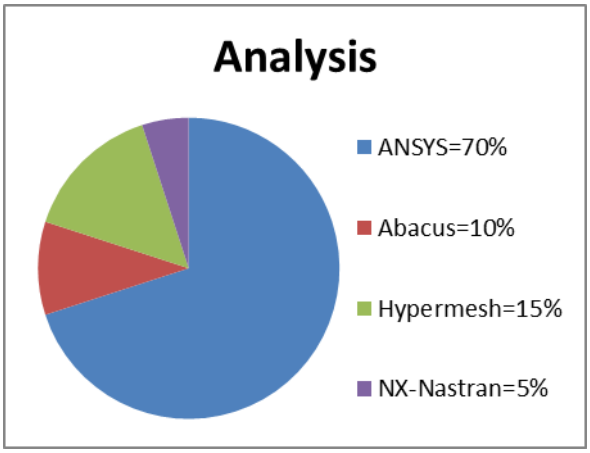


Chart-Analysis chart

V. CONCLUSION

The replacement of steel drive shaft results in a reduction of weight of automobile vehicle. FEA analysis is used to predict deformation of the shaft.it concluded that E glass epoxy material is used as shaft material. The composite material is free from corrosion apart from the lightweight use of composite also ensure less noise and vibration. The composite material is recyclable hence able to reuse. Less Fuel consumption because of the light in weight composite shaft and much better natural frequency than steel shaft [24]

VI. REFERENCES

[1] V. Jose Ananth Vino, Dr. J H Husssain "Design, and analysis of propeller shaft" International journal of innovative research in science, Engineering and technology vol 4, issue 8, August 15

[2] S R Dharmadhikari "Design and analysis of composite drive shaft using ANSYS and GA" IJOR vol 3, Issue 1, Jan-Feb 13 pp 490-496

[3] S. Shinde "Design and optimization of propeller shaft made up of composite materials" International engineering journal pp 1046-1053

[4] Bhirud Pankaj Prakash "Analysis of drive shaft" international journal of mechanical and production engineering, ISSN 2320-2092, vol 2, issue 2, Feb 14

[5] Salaisivabalan T, Natarajan R "Design, and analysis of propeller shaft of an automobile using composite materials" international journal of innovative research of science, engineering, and technology, vol 5, issue 5, may 2015

[6] Parshuram D, "Design and analysis of hybrid drive shaft for automotive" The International Journal of Engineering And Science (IJES), vol 2, issue 2, P 160-171,2013

[7] Bipin Wankhede "Failure analysis of automotive front wheel drive shaft "Journal of information knowledge and research in mechanical engineering, ISSN 0975-668XI, vol 4, issue 1

[8] Chaitanya Rothe "Design and Analysis of Composite Material Drive Shaft" International Journal of Innovative and Emerging Research in Engineering Volume 2, Special Issue 1 2015

[9] H. bankar, "Material optimization and weight reduction of the drive shaft by using composite material" IOSR journal, volume 10, issue 1, Nov-dec 13

[10] SP Maske "Failure analysis and design modification of propeller shaft of bus" IJRASET, vol 4, Issue 10.ISSN 2321-9653

[11] D Khushwa "Optimal analysis and composite drive shaft for a light motor vehicle" IJAERD, ISSN 2348-6406.

[12] B.C brahmana "Structural design of composite drive shaft for rear wheel drive engine" Industrial science, Vol 1, Issue 5, June 2014

[13] S.S Dhore "FEA and Optimisation of composite drive shaft" IJIERT, ISSN: 2394-3696, Vol 3, Issue 10 oct 2016

[14] Anindya Bhar "Free vibration analysis and weight optimization of composite drive shaft" Indian J sci research 77-81,2017.

[15] Shrikant reedy "Evaluation on the failure of an automobile drive shaft" International journal on latest trends in engineering technology, Vol 8, Issue 8, Pp 59-67

[16] A Murlidhr "Design to replace steel drive shaft in an automobile with hybrid aluminum metal matrix composites" International journal and magazine of engineering and technology, ISSN no 2348-4845

[17] Arun Ravi "Design and analysis of drive shaft" International review of applied engineering research, ISSN NO-2248-9967, Issue 1 Vol 4, Pp21-28.

[18] Dr. R Mohan "design and analysis of composite drive shaft" IJSER, ISSN NO-2229-5518 Vol 7, Issue 5, May 2016.

[19] S.R Mohan "Design and FEA of automotive propeller shaft using composite materials " SSRG International journal of mechanical engineering, special issue April 2017

[20] V S Bhajantri "Design and analysis of composite drive shaft" IJRET, ISSN-2319-1163

[21] P Jaya Naidu "Analysis of drive shaft for automotive applications" IOSR vol 10, Issue 2, nov 2013, pp-43-46

[22] D.S Ghorpade "Design and analysis of composite drive shaft "IJORET March 2015

[23] V V Maheta "Design, Analysis and optimization of composite drive shaft" IJIRST, Vol 1, Issue 12, May 2015

[24] Dr. B. James Prasad Rao, U. "International Journal of Innovative Research in Science, Engineering and Technology" Vol. 5, Issue 11, November 2016