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"Design, Analysis and Weight optimization of Composite Drive Shaft using ANSYS"

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Abstract - *Nowadays due to high strength to weight ratio of composite material, attention of engineering researchers as a substitution for metal elements in automobiles is increased. This work deals with various composite material like E-glass/Epoxy, high strength Carbon/Epoxy and high modulus carbon/Epoxy for an automotive application for the replacement of conventional two piece steel drive shafts with single-piece. The objective of this paper is to optimize the design parameter by minimizing the weight of composite drive shaft and maintaining the functionality.*

Key Words: Composite drive shaft, E-glass/Epoxy, Carbon/Epoxy, torque transmission, weight reduction

1. INTRODUCTION:

Applications such as, pumping sets, aerospace, cooling towers, trucks and automobiles include drive shafts for power transmission tubing. In metallic shaft design, the size of the shaft's cross section can be determined by knowing the torque and the allowable shear stress for the material. There is unique value for the shaft inner radius when the outer radius is limited by the space under the car cabin, as the geometric parameter (polar moment of inertia of the cross- sectional area divided by the outer radius) is equal to the torque divided by the allowable shear stress. Weight, low critical speed and vibration characteristics are the limitations of metallic drive shaft. Composite drive shafts have solved many automotive and industrial problems accompanying once the usage of the conventional metal. The performance is limited due to lower critical speed, weight, fatigue and vibration. Several solutions such as harmonic dampers, vibration shock absorbers and multiple shafts with bearings, flywheels, couplings and heavy associated hardware have shown partial success in overcoming the glitches. When the length of steel drive shaft is further than 1500 millimetre, it is manufactured in two pieces in order to increase the fundamental natural frequency. The fundamental natural frequency is proportional to the square root of specific modulus and inversely proportional to the square length. Cabin comfort, reduction of wear on drive train components, vibration damping and increasing tires traction is offered by a drive shaft of composites. In addition, the usage of one piece torque tube decreases inventory cost, assembly time, maintenance, and part complexity [8].

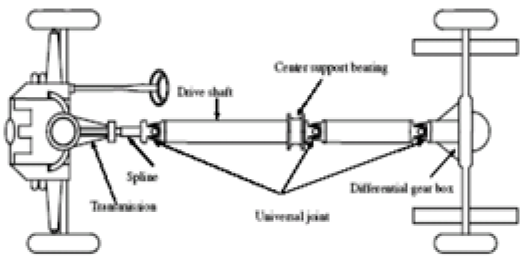

Fig -1: Design of drive shaft in vehicle

2. LITERATURE SURVEY:

Review of Design of Hybrid Aluminium/ Composite Drive Shaft for Automobile

To replace the steel drive shaft of an automobile, the hybrid aluminium/composite drive shafts have been designed. With the aim of minimizing the weight of the shaft, one-piece hybrid aluminium/composite drive shaft for rear wheel drive automobile has been designed. This shaft was subjected to the constraints such as torsional buckling capacities, torque transmission and natural bending frequency. In comparison with the conventional steel drive shaft, the mass of the hybrid aluminium/composite drive shaft will be very less. The fundamental natural frequency and static torque capability were 9390 rpm and 4320 Nm respectively, which surpassed the design requirements. To increase the reliability of joining and to reduce manufacturing cost, the aluminium tube and a press fit joining method between the steel yoke with protrusions on its surface was developed [3].

Design of a Composite Drive Shaft and its Coupling for Automotive Application

This paper deals with; 1-piece composite drive shaft has been replaced by 2-piece steel drive shaft. Some important constraint were been obtained after reviewing the design procedure along with finite element. The design has been acquired through the composite drive shaft made of high modulus carbon/epoxy multilayered composites. To gain natural frequencies of the composite shaft, modal analysis was been conducted. Study was done on the effect of changing the carbon fiber orientation angle on natural frequency. Considerable amount of weight reduction i.e. about 72% when compared to conventional steel shaft has been achieved after the replacement of composite materials. The outcomes also showed that the orientation of fibers has great impact on the dynamic characteristics of the composite shafts [4].

Design, Comparison and Analysis of a Composite Drive Shaft for an Automobile

To substitute the steel drive shaft of an automobile, the High Strength Carbon composite drive shafts have been planned. Subject to the constraints such as torsional buckling capacities, torque transmission and natural bending frequency; with the help of High Strength Carbon composites, 1-piece composite drive shaft for rear wheel drive automobile has been considered to fulfil the objective of minimization of weight of the shaft. Examination of the High Strength Carbon composite drive shafts have been done to replace the steel drive shaft of an automobile. Related to same dimensions of steel shaft, the weight savings of the HS Carbon is 24 % (100-50 & Solid) [5].

Design and Analysis of Composite Drive Shaft using ANSYS and Genetic Algorithm A Critical Review

Numerous methods are been used for design optimization in a supposition that all the design variables are continuous. But almost all the variables are discrete in an actual optimization structure. To imitate the metaphor of natural biological evolution, GA is a stochastic global search algorithm which is been used. Applying the principle of the survival of the fittest to produce better and better approximations to a solution, GA operates on a population of potential solutions. By the process of selecting individuals, a new set of approximations is created using operators borrowed from natural genetics at each generation according to their level of fitness in the problem domain and breeding them together. Evolution of populations of individuals that is better suited to their environment than the individuals that were produced from this process, just as in natural adaptation [6].

3. PROBLEM DEFINITION

The torque transmission capacity should be more than 59000 Nmm and fundamental natural bending frequency must be higher than 6500 rpm to avoid whirling vibrations in passenger cars, small trucks and vans. It has been found that the critical speed of shaft is inversely proportional to the square of its length as stated in the theory of whirling. By increasing the length of shaft, the vibration problem could be solved but due to space limitations it cannot be permitted. So the only option for the manufacturers is to manufacture the shaft in two pieces.

4. METHODS

1 Modeling of implant & surrounding bone

The 3D Model of Propeller Shaft is done using CATIA V5R20 which enables design automation and product development processes and thereby brings about an optimum design.

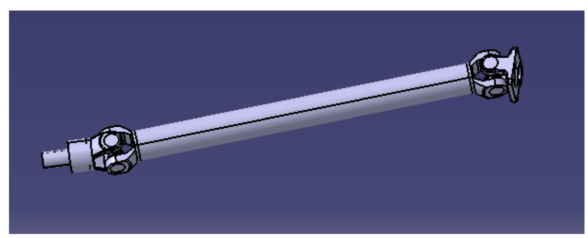

Fig -2: 3D model of Drive shaft

In this study, the mechanical properties of the propeller shaft are treated to be homogenous, isotropic and linear elastic. High Strength Glass fiber is selected for composite drive shaft as compared to Structural Steel which is currently in use. Figure 3 and 4 shows the properties of Structural Steel and High Strength Glass fiber respectively.

Property	Value	Unit
Density	7850	kg m^-3
⊞ Isotropic Secant Coefficient of Thermal Expansion		
⊟ Isotropic Elasticity		
Derive from	Young's M...	
Young's Modulus	2E+11	Pa
Poisson's Ratio	0.3	

Fig -3: Properties of Structural steel

Properties of Outline Row 3: Glass Fiber

	A	B	C
1	Property	Value	Unit
2	Density	2E-06	kg mm^-3
3	Orthotropic Elasticity		
4	Young's Modulus X direction	43000	MPa
5	Young's Modulus Y direction	6500	MPa
6	Young's Modulus Z direction	6500	MPa
7	Poisson's Ratio XY	0.27	
8	Poisson's Ratio YZ	0.06	
9	Poisson's Ratio XZ	0.06	

Fig -4: Properties of Glass Fiber

2 Finite element model

For the present study ANSYS Workbench 14.5 is used. Workbench is been imported from the propeller shaft model. Meshing of this imported model is done by using Tetrahedral elements.

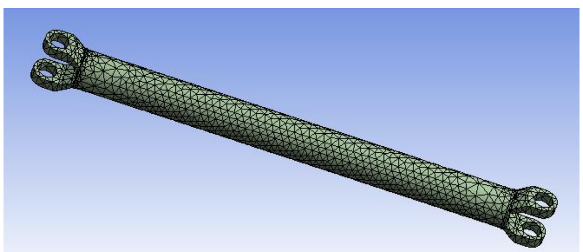

Fig -5: Meshing of Original Drive shaft

3 Loading and boundary conditions

The Gearbox is on action in maximum load condition for a shaft at which the differential (Wheel) movement is arrested. Three boundary conditions are been applied in a Moment of 590000 Nmm.

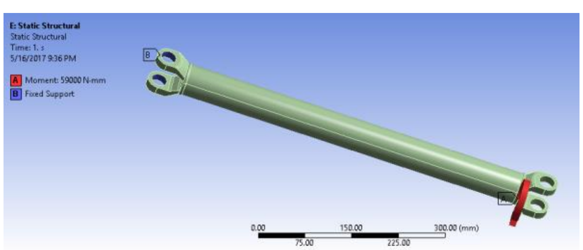

Fig -6: Boundary condition of Drive shaft

5. RESULT

Equivalent strain, Equivalent Stress and Total deformation are been considered for evaluating the results in the current FEA study.

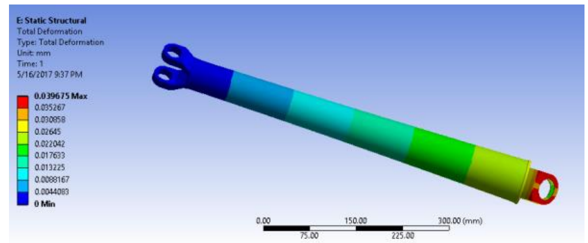

Fig -7: Total deformation of Original Drive shaft

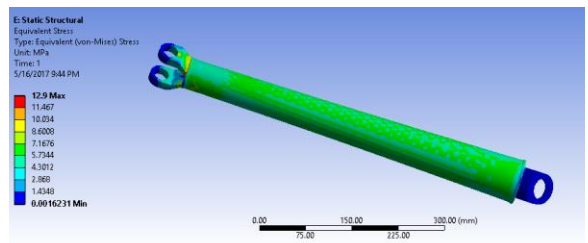

Fig -8: Total stress of Original Drive shaft

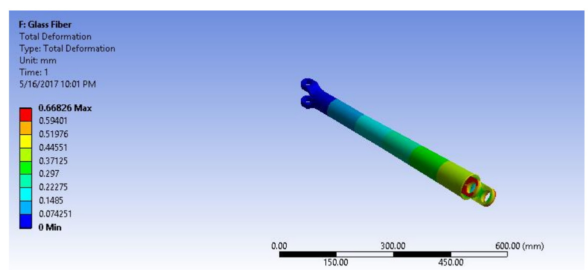

Fig -9: Total deformation of Glass Fiber Drive shaft

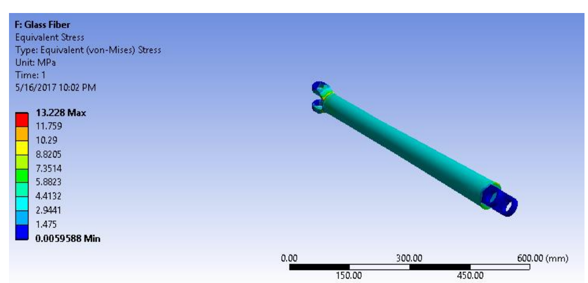

Fig -10: Total stress of Glass Fiber Drive shaft

Table -1: Result Table

Sr. No.	Material	Deformation	Stress	Weight
1	M.S.	0.039	12.9	4.72
2	G.F.	0.66	13.22	2.26

6. Conclusion

1. Reduction in weight of an automobile is the outcome of replacement of conventional drive shaft.
2. To forecast the deformation of shaft, finite element analysis is been used in this work.

REFERENCES

[1] S. Gummadi and A.J Kumar, "Optimum design and analysis of a composite drive shaft for an automobile," 2007.

[2] V. S. Bhajantri, S. C. Bajantri, A. M. Shindolkar and S. S. Amarapure, "Design and Analysis of Composite Drive Shaft, International Journal of Research In Engineering and Technology," 3(3), 2014.

[3] B. K. Suryawanshi and P. G. Damle, "Review of design of hybrid aluminum/composite drive shaft for automobile, International Journal of Innovative Technology and Exploring Engineering," 2(04), 2013.

[4] M. R. Khoshravan and A. Paykani, "Design of a composite drive shaft and its coupling for automotive application," Journal of applied research and technology, 10(6), pp.826-834, 2012.

[5] A. Ravi, Design, "Comparison and Analysis of a composite Drive Shaft for an Automobile," International Review of Applied Engineering Research, ISSN, pp.2248-9967, 2014.

[6] S. R. Dharmadhikari, S. G. Mahakalkar, J. P. Giri, and N. D. Khutafale, "Design and Analysis of Composite Drive Shaft using ANSYS and Genetic Algorithm A Critical Review," International Journal Modern Eng., Res. 3, no. 1 pp. 490-496, 2013.

[7] R. S. Moorthy, Y. Mitiku and K. Sridhar, "Design of automobile driveshaft using carbon/epoxy and kevlar/epoxy composites," American Journal of Engineering Research (AJER), 2(10), pp.173-179, 2013.

[8] D. Parshuram and S. Mangsetty, "Design and Analysis of Composite/Hybrid Drive Shaft for Automotives," The International Journal of Engineering and science, 2(01), pp.160-171, 2013.

[9] H. Bankar, V. Shinde and P. Baskar, "Material optimization and weight reduction of drive shaft using composite material," Journal of Mechanical and Civil Engineering, 10(1), pp.39-46, 2013.

[10] G. Kaviprakash, I. D. Lawrence and A. P. Regan, "Design and Analysis of Composite Drive Shaft for Automotive Application," in International Journal of Engineering Research and Technology, Vol. 3, No. 11 IJERT, November 2014.