International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

Modeling and Analysis of Composite Drive Shaft for an Automobile

1. B.Srinivas & 2. Samudrala Venkata Sanjeev Kumar

1. ASSISTANT PROFESSOR Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA - 507318

2. M.Tech, Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA – 507318

ABSTRACT :

Automotive drive Shaft is a very important components of vehicle. The overall objective of this paper is to model and analyze a composite drive shaft for power transmission. Substituting composite structures for conventional metallic structures has many advantages because of higher specific stiffness and strength of composite materials. This work deals with the replacement of conventional two-piece steel drive shafts with a Composite material's. In this work ***epoxy cure resin, high strength carbon epoxy, venylester****is used as composite material ,The design parameters were optimized with the objective of minimizing the weight of composite drive shaft. The design optimization also showed significant potential improvement in the performance of drive shaft. In this present work an attempt has been to estimate the deflection, stresses, natural frequencies under subjected loads using FEA. Further comparison carried out for* ***alclad aluminum alloy*** *materials and weight of the shaft is optimized and stress intensity factor found for both Steel and composite drive shafts.*

INTRODUCTION :

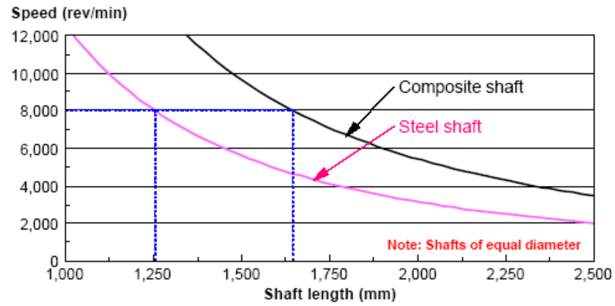
Rapid Technological Advances in Engineering Design Field result in finding the alternate solution for the conventional materials. The design engineers brought to a point to finding the materials which are more reliable than conventional materials. Researchers and designers are constantly looking for the solutions to provide stronger and durable materials which will answer the needs of fellow engineers. Drive shafts are used as power transmission tubing in many applications, including cooling towers, pumping sets, aerospace, trucks and automobiles. In the design of metallic shaft, knowing the torque and the allowable shear stress for the material, the size of the shaft's cross section can be determined. In the today's days there is a heavy requirement for light weight materials vehicle. The conventional steel material is replaceable by advanced composite materials. Composite materials are favored by most of the scientist in the design of automobiles due to its higher specific strength and stiffness. Weeton et al. stated the possibilities of replacing the conventional steel material by composites in the field of automobile. Weeton et al describe the possibilities of composites used to replace the steel leaf spring as well as steel drive shaft. The advanced composite materials such as graphite, carbon, Kevlar and glass with suitable resins are widely used because of their high specific strength (strength / density) and high specific modulus (modulus / density). The first application of composite drive shaft to automotive was the one developed by Spicer U-joint divisions of Dana Corporation for the Ford econoline van models in 1985.

Drive shafts for power transmission are used in many applications, including cooling towers, pumping sets, aerospace, structures, and automobiles. In metallic shaft design, knowing the torque and the allowable service shear stress for the material allows the size of the shaft's cross-section to be determined. Beard more also states the potentials of composites in structural applications. Conventional steel drive shafts are manufacture in two pieces to increase its fundamental natural bending frequency. The conventional assembly of drive shaft is made up in two pieces and joined together by u-joints due to which the overall weight of the assembly is increased.

The composite drive shaft has advantages like considerable weight reduction, symmetric composite assured the dynamic balance of increasing operating speed, electrically non conductive, custom end fitting considerations, vibrations and harshness (NVH), long fatigue life and also it reduce the bearing & journal wear.

1.2COMPOSITE MATERIALS

The advanced composite materials such as graphite, carbon, Kevlar and Glass with Suitable resins are widely used because of their high specific strength (strength/density) and high specific modulus (modulus/density). Advanced composite materials seem ideally suited for long, power driver shaft (propeller shaft) applications. Their elastic properties can be tailored to increase the torque they can carry as well as the rotational speed at which they operate. The drive shafts are used in automotive, aircraft and aerospace applications. The automotive industry is exploiting composite material technology for structural components construction in order to obtain the reduction of the weight without decrease in vehicle quality and reliability. It is known that energy conservation is one of the most important objectives in vehicle design and reduction of weight is one of the most effective measures to obtain this result.



Actually, there is almost a direct proportionality between the weight of a vehicle and its fuel consumption, particularly in city driving. Composites consist of two or more materials or material phases that are combined to produce a material that has superior properties to those of its individual constituents. The constituents are combined at a macroscopic level and or not soluble in each other. The main difference between composites, where as in alloys, constituent materials are soluble in each other and form a new material which has different properties from their constituents.

PROPERTIES OF COMPOSITE MATERIALS

The physical properties of composite materials are generally not isotropic (independent of direction of applied force or load) in nature, but rather are typically orthotropic (depends on the direction of the applied force or load). For instance, the stiffness of a composite panel will often depend upon the orientation of the applied forces and/or moments. Panel stiffness is also dependent on the design of the panel. In contrast, isotropic materials, composite materials exhibit different properties in different directions. The relationship between forces/moments and strains/curvatures for an isotropic material can be described with the following material properties: Young's Modulus, the Shear Modulus and the Poisson's ratio, in relatively simple mathematical relationships. For the anisotropic material, it requires the mathematics of a second order tensor and up to 21 material property constants. For the special case of orthogonal isotropy, there are three different material property constants for each of Young's Modulus, Shear Modulus and Poisson's ratio--a total of 9 constants to describe the relationship between forces/moments and strains/curvatures.

SURVEY

The upbringing information on the topic to be considered in present research work and focuses on the importance of current study. The objective is to analyse the effect of various parameters influencing the mechanical and wear behaviour of FRPs composite. The literature survey is based on the following aspects:

On mechanical properties of Epoxy cure Resin composites

Rout et al.investigated the mechanical properties and erosion wear of **Epoxy cure Resin** composite with filled and unfilled rice husk particulates. Experimental design was also done using Taguchi optimization technique to determine the optimal parameters, which minimizes the wear rate. They concluded that factors like filler content, impact velocity, impingement angle and erodent size has more significant effect on wear rate, and at 15 wt% of rice husk shows maximum wear resistance. Tensile modulus, hardness and impact energy improves with addition of filler content. Decline in flexural and tensile properties of the composites were noticed. Al-Hasani [10] studied the tensile strength and hardness of **Epoxy cure Resin** composite at different volume fraction as layers. Three types of composite samples were prepared, woven roving, randomly oriented and sandwich which consists of (woven roving and Random oriented). It was found that sandwich composite exhibits higher value of tensile strength 254 N/mm2 whereas, nine layered **Epoxy cure Resin** woven roving composites exhibited higher hardness of 62.1 BHN.

Koricho et al. studied the bending fatigue behaviour of twill epoxy composite. Bending fatigue behaviour of composites specimens were analysed by displacement controlled bending fatigue test. Samples were subjected to different fatigue loadings with maximum level up to 0.75 times the ultimate flexural strength of the material, After 1 million cycles residual properties of selected specimen were measured. They found experimentally that tensile stresses are damaging while compressive stresses are beneficial.

Deng et al. experimentally investigated the influence of different types of fibre cross-section (round, oval and peanut-shaped) aspect ratio on interlaminar shear strength, interlaminar fracture toughness, and charpy impact test. They reported that delamination resistance of composites is lower for the composites having larger fibre cross-section compared to the composites reinforced with round cross-section, because of the fibre overlapping. Same trend were observed for different tests like double-cantilever beam (DCB), short-beam-shear (SBS), and end-notched flexure (ENF) and however larger aspect ratio fibre reinforced composite shows better energy absorbing capacity than composites reinforced with conventional round fibres.

M. Baghani, H. Mazaheri and H. Salarieh have presented analytical expression for large amplitude free vibration of shaft. They have also considered geometric non-linearity and have solved the

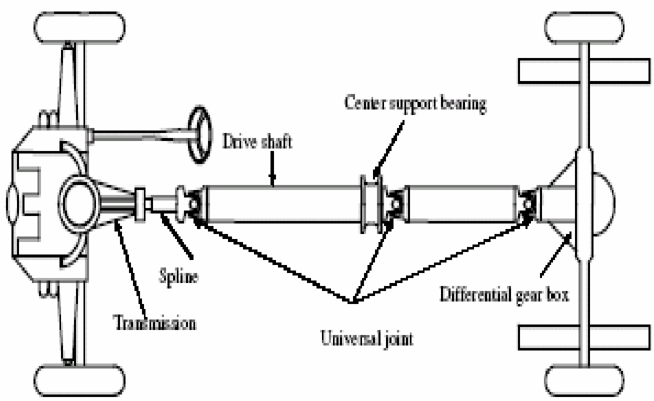
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

expression using Variational Iteration Method (VIM). Also the different nonlinear frequencies have been considered for different shapes of modes.

Lianhua Wang, Jianjun Ma, Jian Peng and Lifeng Li have investigated the nonlinear vibrations and the parametric instability of the structure on the elastic foundation. The motion equation is obtained by the Hamilton equation considering the inextension. The discrete modal is obtained by Galerkin equation.

2.1 DRIVE SHAFT

The term Drive shaft is used to refer to a shaft, which is used for the transfer of motion from



one point to another. Whereas the shaft, which propel are referred to as the propeller shaft. Propellers are usually associated with ships and planes as they are propelled in water or air using a propeller shaft because apart from transmitting the rotary motion from the front end to the rear end of the vehicle. The shaft is the primary connection between the front and the rear end which performs both the motion and propelling the front end. Thus, the terms Drive Shaft and Propeller Shaft are used interchangeably.

CONCLUSION

The subject of the drive shaft is very extensive and is difficult to explain in few pages. This attempt is to summarize some important results. So finally, concluded that by conducting the structural analysis on drive shaft with composite materials **epoxy cure resin, venylester,**and alloy materials **alcladaluminium alloy, HS carbon.** By observing the results and concluded that the most effective material epoxy cure resin which has low deformation, stress and strain factors, it’s a light material which satisfies all heavy load conditions.

We also conclude that composite material venylester and epoxy cure resin have relatively good load bearing factors when compared to present using material ie;Hs carbon steel.

When coming to model analysis in ansys on imported design, we observed that all materials have relatively equal frequency deformation.

Among all those alclad aluminium alloy has relatively good behaviour and followed by, HS carbon , venylester epoxy cure resin.

Atlast we want to conclude from above results that using composite material in place of single metal is preferrable.

REFERENCES:

[1] Dai Gil Lee and Hak Sung Kim “Design and manufacture of an automotive hybrid aluminum/composite drive shaft” journal of composite structure, Vol 63, 2004 pp.87-99.

[2] M. A. Badie, A. Mahdi, and A. R. Abutalib “Automotive composite drive shafts: Investigation

of the design variable effects" International Journal of Engineering and Technology, Vol. 3, No.2, 2006, pp. 227-237.

[3] S A Mutasher, B BSahari, A M S Hamouda, and S M Sapuan "Static and dynamic characteristics of a hybrid aluminium/composite drive shaft" Journal of Materials Design and Applications, Vol .63, 2007 pp 221-235.

[4] Dr. Ammar Ali Hussein Al-filfily "Optimum Design of Composite Laminated Plate Using Genetic Algorithm and RSM" Engineering and Technology Journal, Vol. 29, No. 5, 2011.

[5] ThimmegowdaRangaswamy, and SabapathyVijayarangan "Optimal Sizing and Stacking Sequence of Composite Drive Shafts" journal of Material science, Vol.11, No.2, 2005.

[6] ZoricaDordevic, StevanMaksimovic and IvanaIlic "Dynamic Analysis of Hybrid Aluminum/Composite Shafts" Journal of Scientific Technical Review, Vol.53, No.2, 2008.

[7] S. E Singh, H. B. H. Gubran and K. Gupta "Developments in Dynamics of Composite Material Shafts" International Journal of Rotating Machinery, Vol. 3, No. 3, 1997 pp. 189-198

[8] R.R Ajith, T. Rangaswamy, S. Vijayarangan and G. Chandramohan "Genetic Algorithm Based Optimal Design Of Composite Shaft" International journal of Material Science and Engineering, December2004.

[9] Durk Hyun Cho, Dai Gil Li, Jin Ho Choi "Manufacture of one-piece automotive drive shafts with aluminum and composite materials" journals of Composite structure**,** Vol. 38, No. l-4, 1997 pp. 309-319.

[10] Ch. Hochard "Optimum design of laminated composite structures" journal of composite structure, Vol. 63, 2004 pp. 159-165.

[11] Robert M. Jones "Mechanics of Composite Materials" Second edition McGraw Hill Book Company.INC., 1999.

[12] M. Li, and G. Li and S. Azarm "A KrigingMetamodel Assisted Multi-Objective Genetic Algorithm for Design Optimization" Journal of Mechanical Design, Vol. 130, MARCH 2008.