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Review and Analysis of Various Composite Propeller Shaft

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***Abstract*-The replacement of conventional steel driveshaft of automobiles with an appropriate composite driveshaft with different combinations of fibers at a time. For reducing the bending natural frequency the conventional steel shafts are made in two pieces, where to reduce the overall weight the composite material drive shaft is made in single piece. Various composites can be designed and analyzed for their appropriateness in terms of torsional strength, bending natural frequency and torsional buckling by comparing them with the conventional steel driveshaft under the same grounds of design constraints and the best-suited composite will be recommended. Light has been thrown upon the aspects like mass saving, number of plies and ply distribution.**

***Keyword* - Hybrid, natural frequency, buckling, ply distribution.**

I. INTRODUCTION

A driveshaft is a rotating shaft that transmits power from the engine to the differential gear of a rear wheel drive vehicles Driveshaft must operate through constantly changing angles between the transmission and axle. To increase the natural frequency the drive shaft is manufactured in two pieces. The steel drive shaft with two pieces has three universal joints and one bearing at the centre. We can improve the power transmission by reducing the weight and mass inertia. So we replace conventional steel with composite materials. The composite materials have high strength and high stiffness. We can use different combinations of composite materials. For purpose of higher strength we use two or three materials at once to get higher strength.

II. LITERATURE REVIEW

D Sarath Kumar et al. [1] in this work, a split type propeller shaft is modelled and analysed using under FE analysis using ANSYS software. Then the geometry of the shaft is modified accordingly for the application of composite material replacement. This new geometry is analysed same as the previous one under various material conditions. This analysis is carried out using ANSYS software. For the comparison of materials, the materials used in this work are, SM45C, E Glass composite, HM and HS Copper composites and Kevlar composite. The results are obtained by applying appropriate boundary conditions and the tabulated and the better material for replacement purpose is suggested finally and stating the application of composite materials and the role of ANSYS for the analysis of composite material.

B. James Prasad Rao et al. [2] this paper is related to investigations on Carbon Reinforced plastics (CFRP) and Glass Fiber Reinforced Plastics (GFRP) composite hollow shafts for automobiles. Failure analysis has been carried out using maximum stress criteria and it is found that the failure torque is well above the design torque level. For accurate design solution, the propeller shaft was analyzed using FEM techniques (ANSYS package). The propeller shaft was geometrically modeled using FEM "3D-shell99 element and solid46 layered element". To check all failure modes, linear static analysis, vibration

Eigen value analysis, buckling analysis and harmonic analysis were done.

Raffi Mohammed et al. [3] the weight reduction of the drive shaft can have a certain role in the general weight reduction of the vehicle and is a highly desirable goal. Substituting composite structures for conventional metallic structures has many advantages because of higher specific stiffness and strength of composite materials. The advanced composite materials such as graphite, carbon, Kevlar and Glass with suitable resins are widely used because of their high specific strength and high specific modulus. Advanced composite materials seem ideally suited for long, power driver shaft 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.

III. CATEGORIES OF COMPOSITE MATERIAL

Composite consist of two or more material phase that are combine to produce a material that has superior properties to these of its individual constituent. Technologically the most important composite are those in which the dispersed phase is in the form of fibre. The composite materials can be classified on the basis of micro structures, multi phases, reinforcements, manner of packing of fibers layered compositions, method of compositions, matrix system, processing methods, etc. [5] Composite materials can be classified as:

1) Polymer Matrix Composites.

2) Metal Matrix Composites.

3) Ceramic Composites.

The fibers are either long or short. Long and continuous fibers are easy to orient and process, whereas short fibers cannot be controlled fully for proper orientation. The principal fibres in commercial use are various types of glass, carbon, graphite and Kevlar. All these fibers are incorporated in matrix form either in continuous length or in discontinuous length.

PARTICULATE COMPOSITES:

It consists of particles immersed in matrices such as alloys and ceramics. They are usually isotropic because the particles are added randomly. Particulate composites have advantages such as improved strength, increased operating temperature, oxidation resistance, etc

Typical examples include use of aluminum particles in rubber, silicon carbide particles in aluminum, and gravel, sand, and cement to make concrete.

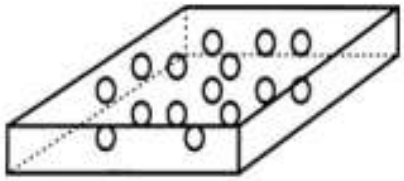

Fig. 1 Particulate composite

FLAKE COMPOSITES:

It consists of flat reinforcements of matrices. Typical flake materials are glass, mica, aluminum, and silver. Flake composites provide advantages such as high out-of-plane flexural modulus, higher strength, and low cost. However, flakes cannot be oriented easily and only a limited number of materials are available for use.

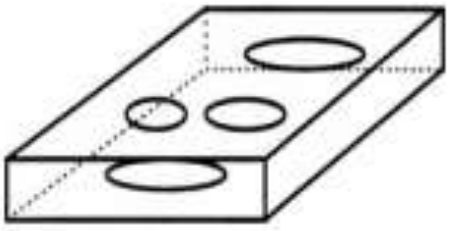

Fig. 2. Flake composite

FIBER COMPOSITES:

It consists of matrices reinforced by short (discontinuous) or long (continuous) fibres. Fibres are generally anisotropic and examples include carbon and aramids. The Examples of matrices are resins such as epoxy, metals such as aluminum, and ceramics such as calcium–alumino silicate. The fundamental units of continuous fibre matrix composite are unidirectional or woven fibre laminas.

Laminas are stacked on top of each other at various angles to form a multidirectional laminate.

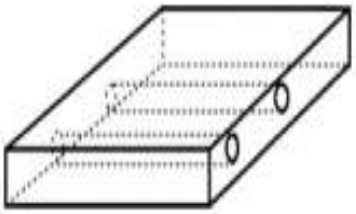

Fig.3. Fibre composite

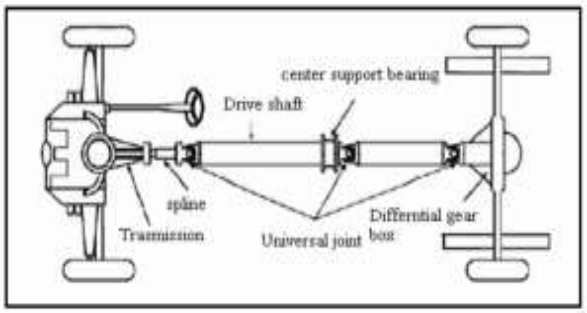

Fig.4 Conventional two-piece steel drive shaft for a rear wheel drive vehicle

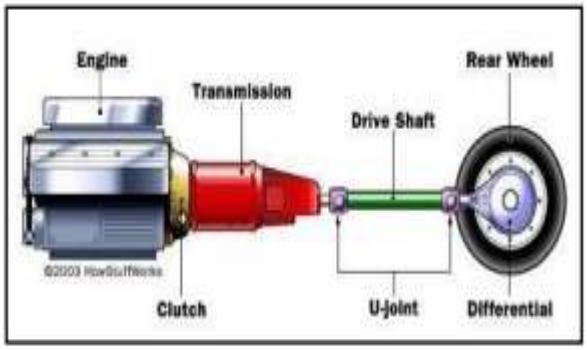

Fig.5 advanced one piece composite drive shaft for rear wheel drive vehicle

Advanced polymer composites these polymers include epoxy, phenolic, acrylic, urethane, and polyamide. Each polymer has its advantages and drawbacks in its use:

1) Polyesters: The advantages are low cost and the ability to be made translucent; drawbacks include service temperatures below 170°F (77°C), brittleness, and high shrinkage of as much as 8% during curing.

2) Phenolic: The advantages are low cost and high mechanical strength; drawbacks include high void content.

3) Epoxies: The advantages are high mechanical strength and good adherence to metals and glasses; drawbacks are high cost and difficulty in processing.

4) Epoxy: Epoxy resins are the most commonly used resins. They are low molecular weight organic liquids containing epoxide groups. Epoxide has three members in its ring: one oxygen and two carbon atoms. The Reaction of epichlorohydrin with phenols or aromatic amines makes most epoxies. Hardeners, plasticizers, and fillers are also added to produce epoxies with a wide range of properties of viscosity, impact, degradation, etc.

Although epoxy is costlier than other polymer matrices, it is the most popular PMC matrix. More than two-thirds of the polymer matrices used in aerospace applications is epoxy based. The main reasons why epoxy is the most used polymer matrix material are

- High strength.
- Low viscosity and low flow rates, which allow good wetting of fibers and prevent misalignment of fibers during processing.
- Low volatility during cure.
- Low shrink rates, which reduce the tendency of gaining large shear stresses of the bond between epoxy and its reinforcement
- Available in more than 20 grades to meet specific property and processing requirements.

IV. MERITS OF COMPOSITE DRIVE SHAFT

1. They have high specific modulus and strength.

2. Reduced weights.

3. The fundamental natural frequency of the carbon fiber composite drive shaft can be twice as high as that of steel or aluminum because the carbon fiber composite material has more than 4 times the specific stiffness of steel or aluminum, which makes it possible to manufacture the drive shaft of passenger cars in one piece. A one-piece composite shaft can be manufactured so as to satisfy the vibration requirements. This eliminates all the assembly,

connecting the two piece steel shafts and thus minimizes the overall weight, Vibrations and the total cost.

4. Due to the weight reduction, fuel consumption will be reduced

5. They have high damping capacity hence they produce less vibration and noise

6. They have good corrosion resistance

7. Greater torque capacities than steel or aluminum shaft

8. Longer fatigue life than steel or aluminum shaft

9. Lower rotating weight transmits more of available power

V. CONCLUSION

The replacement of steel drive shaft 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

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