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REVIEW OF OPTIMIZATION OF COMPOSITE DRIVE SHAFT USING ANSYS

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ABSTRACT

Driveshafts are critical components of heavy-duty automobiles. Automotive driveshaft’s are typically made of two pieces of alloy steel, although a single piece of composite material can be used in its stead. Our primary goal is to analyse the design process, which will lead to the discovery of an important parameter through finite element analysis. The high modulus composite drive shaft is built using SOILDWORKS software and evaluated in ANSYS for design optimization or material check and delivering the best material. Using composite materials instead of a typical steel shaft can result in significant weight savings. The dynamic properties of the composite shafts should also be thoroughly analysed.

Keywords: Drive shaft, Failure analysis, Composite material, FEM

1. Introduction:

When other parts of a drive train can't be connected directly due to distance or the requirement to allow for relative movement, a drive shaft or Cardan shaft is a mechanical component that transmits torque and rotation. Drive shafts are subjected to torsion and shear stress because of their role as torque carriers, which is equal to the torque input minus the load. This means that they must have the ability to withstand the stress, but also avoid putting on too much weight, as it would only increase their inertia. Before the power reaches the wheels of a car, a longitudinal shaft can be employed to transfer the power from the engine/transmission. There are two short drive shafts that are connected to the wheels via a central differential (transmission or transaxle).

Drive shafts are also used in the automotive industry's testing facilities for research and development. An internal combustion engine's speed and torque can be sent to a dynamometer using a drive shaft on an engine test stand. The use of a'shaft guard' at a shaft connection protects the drive shaft from touch and allows for the early diagnosis of a failure in the shaft. Transmission test stands use a drive shaft to link the engine and the transmission. It is common for composite materials to have lower elastic modulus. This means that the driveshaft can reduce stress on the drive train by acting as a shock absorber when torque peaks occur in the driveline. Numerous studies have been conducted on hybrid drive shafts and the methods used to attach the hybrid shafts to universal joint yokes. However, this study examines the design in a variety of ways. Composite structures have several advantages over traditional metallic constructions because of their higher particular stiffness and specific strength. Drive shafts made of a composite material are lighter than those made of steel or aluminium of the same strength, making them more efficient and environmentally friendly.

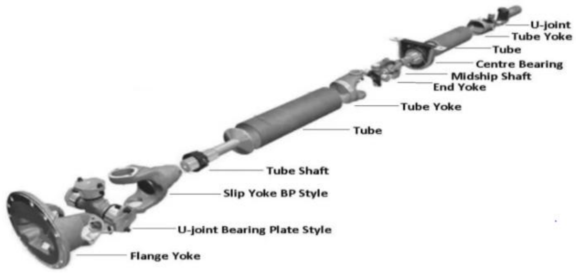

Fig. 1 Schematic diagram of propeller shaft

2. LiteratureReview

In this part, we'll talk about recent studies that we think are relevant to our current project. This section is dedicated to papers that have been published.

A.R. Abu Talib et al. [1] investigated hybrid, carbon/glass fiber-reinforced epoxy composite vehicle drive shafts. A 44.5 percent loss in natural frequency was detected when the winding angle of the carbon fibres was changed from 00 to 900, while a 46.07 percent reduction in buckling strength was found when the stacking sequence was changed from the best to the worst. The 900 degree angle of fibre arrangement provides the greatest buckling strength. For example, at 00, the natural frequency is at its highest, but falls as the fibre angle approaches 900.

Shaw D, Simitses DJ, Sheinman[2] Laminate cylindrical shells under torsion and compression were studied for their Imperfection Sensitivity (ISR). Because cylindrical shells in torsion are less sensitive to flaws than nonlinear shells, they found that linear analysis was more than enough.

R. SrinivasaMoorthy [3] studied the use of carbon/epoxy and kevlar/epoxy composites in the design of automotive drive shafts. A mass savings of 89.576 percent was observed when using Carbon/Epoxy in place of the traditional SM45C steel driveshaft; a savings of 72.53% was found when using Kevlar/Epoxy. Carbon/Epoxy requires 14 plies with a wall thickness of 1.82 mm, whereas Kevlar/Epoxy requires 44 plies with a wall thickness of 5.72 mm. Carbon/Epoxy driveshafts have sufficient torsional buckling capacity and bending natural frequency to match the design criteria.

HarshalBankar [4] drive shaft weight reduction and material optimization using composite materials have been researched. When the ply angle is reduced, they discovered that the Young's modulus in the X direction is larger, but rapidly drops below 25 degrees. It is only when the Y direction remains constant and abruptly increases above 70 degrees that the ply angle changes. The ply's shear modulus also reaches its highest value between 30 and 70 degrees. The shaft is put through its paces by both normal and shear loads. There must be an equal number of ply angles for both Young's and shear modulus in order to meet these two conditions. It is possible to use the composite shaft at greater frequencies than the steel one because of its reduced weight.

Ali S. Hammood [5] Glass fibre reinforcement epoxy composite material fatigue strength decreased with increasing fibre orientation angle due to a decrease in module of elasticity (strength) of composite materials, according to a study on this topic. Fibre orientation angle affects fatigue cycle count, with maximum fatigue cycles occurring at fibre angle (00) and minimum fatigue cycles occurring at fibre angle (900). The composite material's fatigue strength and fatigue cycle count decrease as the fibre orientation angle increases, rise as the composite material's strength rises, and fall as the composite material's strength falls. Surface fatigue of composite materials is parallel to fibre direction for oblique loads, and perpendicular to fibre direction for unidirectional fibres.

Ban, Bakir [6]Fibre orientation was examined in relation to composite materials' mechanical properties. At 90 degrees, impact strength is the lowest; at 180 degrees, it is the highest; yet at 45 degrees, it remains constant. The fibres in discontinuous specimens are aligned at a 90-degree angle, which has the greatest impact on hardness. Having a fibre orientation angle of 90°, glass fiber/epoxy composite specimens with cracks that propagate perpendicularly to the external load action fail randomly and the cracks propagate in various directions.

B Stanly Jones Retnam [7] Compared to other hybrid bamboo/glass fibre composites, the hybrid specimen with orientation 450 generated a tensile strength of 92.26 N/mm2 and a flexural strength of 387.725 N/mm2 according to the study. The hybrid specimen with a 450 orientation had much higher flexural strength and impact strength than any of the other specimens tested. According to the hardness test results, the 00/900 hybrid specimen has a hardness of 62.3 HR, while the 450 orientation enhances the mechanical properties of the composites.

K.Vasantha Kumar [8] it was found that the tensile qualities of a bi-directional woven fabric glass epoxy composite laminate can be improved by changing the angle at which the fibres are oriented in relation to the load, size, and shape of the composite laminate.

Amol S. BhanageÀ [9] a review of A Review: Automotive Drive Shaft Finite Element Simulation The driving shaft buckled when the imposed torsion load could not be supported by its bending stiffness along the hoop direction, as was discovered using Composite Materials. The optimum stacking sequence is [45o/-45o/0o/90o] with a normal bending stiffness, while the worst stacking is [0o/90o/- 45o/45o]. The effect of stacking sequence on buckling strength.

C G Rothe et al [10] this article examines the design and analysis of a composite drive shaft. A genetic algorithm has been used successfully to reduce the weight of this composite shaft. Procedure design with FEA is the primary goal. The genetic algorithm was used to optimise the parameter. As part of this process, both shafts are modelled in 3D using ANSYS software to undertake static, buckling, and model-based analysis.

H banker et al [11] there was a lot of research done on various composite materials for the shaft. Polystyrene, HS carbon/epoxy, and HM carbon/epoxy are among the composite materials examined in this study. He compared propeller shafts made of various materials. And ANSYS software is used for the analysis.

ErcanSevkat [12] studied the effects of impact loadings on the residual torsional characteristics of composite shafts. Carbon-reinforced composite shafts had the maximum impact resistance, whereas glass-reinforced composites had the lowest. The hybrid composite shafts' resistance was in the middle of the glass and carbon spectrum.

Arun Ravi et al. [13]A high-strength carbon/epoxy hollow composite drive shaft was modelled and analysed in Solidworks and ANSYS. The external diameter of each shaft is 100 mm, while the internal diameter is 50 mm. Steel and High Strength Carbon are compared using static analysis, which calculates total deformation, along with identical elastic strains and stresses as well as a comparable elastic deflection, and High Strength Carbon is 24% lighter than steel.

Sagardharmadhikari et al. [14]A high-strength carbon/epoxy hollow composite drive shaft was modelled and analysed in Solidworks and ANSYS. The external diameter of each shaft is 100 mm, while the internal diameter is 50 mm. Comparing steel to High Strength Carbon utilising static analysis (which determines the total deformation of both materials), High Strength Carbon is 24 percent lighter when the dimensions remain the same.

V.S. Bhajantri et al. [15] Engineers simulated composite drive shafts made of carbon fibre and epoxy resin and studied the effects of fibre angle orientations. There were comparisons to steel shaft results for maximum deformation and maximum stresses. High-strength carbon epoxy allows for a weight reduction of 50% when compared to steel. Deflection and shear stress were affected by different fibre angle orientations. Multilayered composite shafts benefit greatly from fibre angle orientation because it reduces weight, increases strength, promotes progressive failure (which gives early notice of failure), and reduces power usage.

BelawagiGireesh et al. [16] Analyzing and modelling the composite drive shaft was accomplished using ANSYS software. Comparisons are made between steel's maximum deformation, maximum and minimum stresses and fibre orientations in the 45-45-45-45 composite shaft. The orientation of the fibres results in a weight reduction of up to 72%, increased strength, a progressive failure mechanism (which warns of failure before it occurs), and a reduction in energy consumption.

Panduranga V Chopde et al. [17] In order to perform torsion, modal, and vibration analysis on these shafts under various loading conditions, the researchers modelled the steel shaft, as well as glass/carbon/epoxy composite drive shafts. Composite drive shafts have significantly better buckling torque transmission, torque transmission, and bending natural frequency than standard steel shafts, and they can be employed under extreme vibration circumstances.

Parshuram D et al. [18] modal analysis and comparison of deformation, stresses, and natural frequencies on diverse composite materials such as Carbon/epoxy, Boron/epoxy, Kevlar/epoxy, Carbo-Keve/epoxy, Aluminum-Boron, and Steel Between 72% and 81% of the weight of a standard steel shaft can be saved by using a composite shaft.

M.R. Khoshravan et al. [19] the inherent frequencies of the high modulus carbon epoxy composite shaft were studied. Using a composite drive shaft instead of a steel one saves 72% of the weight. By studying natural frequencies, it was found that changing the orientation of the carbon fibers had a positive effect on the dynamic properties of composite shafts.

AsmamawGebresilassie [20] tested three E-Glass/epoxy resin composite shafts for torque and critical speed under various conditions of lengths and diameters in both theoretic and numerical analysis The results reveal that the deflection and torque, the stress and strain, and the torque are all linearly related.

3. Conclusion

Analytical solutions for steel and composite propeller shafts are compared for a number of criteria. The composite propeller shaft outperforms the steel propeller shaft in terms of performance.

- Compared to steel, carbon fibre has a higher tensile strength.
- Composite materials have a greater weight-to-strength ratio than steel.
- Internal damping is a property of composite materials.
- The weight of a composite drive shaft can be reduced by up to 90% compared to a steel drive shaft.

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