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Design and Analysis of Composite Shaft Using Ansys Simulation

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Abstract: ***In this project, designing a drive shaft with composite materials. The traditional drive shaft is made of single material like steel and in two parts, which relate to the help of universal joints this causes increase in weight and sometimes failure at joints at high loads. Hence designing a shaft in single part without any joints in between. The shaft designed is lighter in weight which will help in increasing efficiency. After designing the shaft, analyzing the traditional steel shaft and the composite shaft using analysis tools like Catia and Ansys, and compare the values of both the shafts, this was theoretical checking. Experiment is conducted to check the torsional forces in both the shafts on a torque tester and comparison is done to check whether the composite shaft will carry loads like steel drive shaft without failure.***

Keywords: Composite shaft; Design; Drive Shaft; Automobile; Ansys; Model; Light vehicle

1. 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. [9]A drive shaft, or propeller shaft (prop - shaft), or Carbon shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. Drive shafts are carriers of torque. They are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the stress, while avoiding too much additional weight as that would in turn increase their inertia. Composite materials have been widely used to improve the performance of various types of structures. Compared to conventional materials, the main advantages of composites are their superior stiffness to mass ratio as well as high strength to weight ratio. Because of these advantages, composites have been increasingly incorporated in structural components in various industrial fields. Some examples are helicopter rotor blades, aircraft wings in aerospace engineering, and bridge structures in civil engineering applications. Some of basic concepts of composite materials are discussed in the following section to better acquaint ourselves with the behavior of composites.

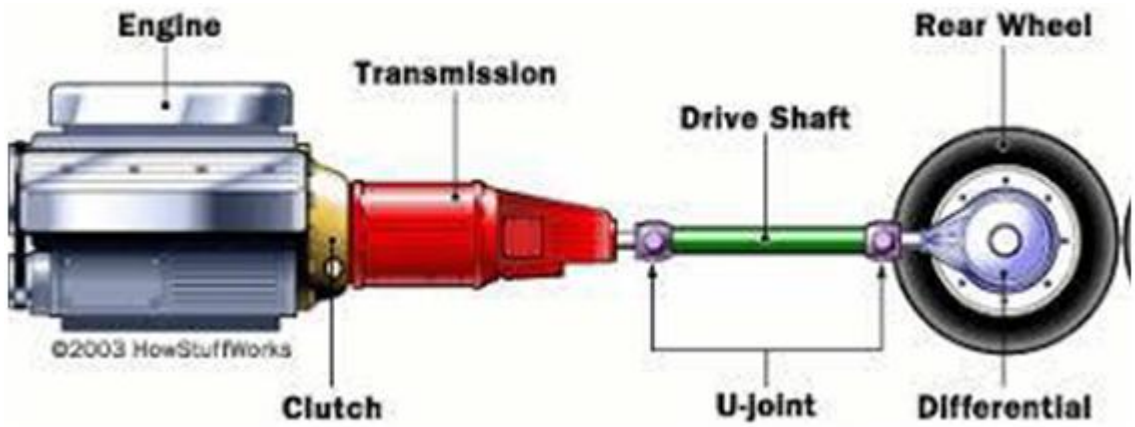


Figure 1.1: Model of Transmission layout

2. Methodology

After referring to multiple references it was understood that how composite drive shaft having optimum weight can be selected using the exact methodology. For this process we use CATIA V5 R20 and ANSYS workbench 14.5 software

- CAD model of conventional drive shaft is prepared in CATIA V5 R20 as per actual dimension. Then this model is imported to ANSYS workbench 14.5 software. For pre - processing and to derive final solution results are derived from ANSYS software.
- CAD model of composite drive shaft is prepared in CATIA V5 R20 as per actual dimension. Then this model is imported in ANSYS workbench 14.5. For pre - processing and to derive final solution results are derived from ANSYS software.

- Compare conventional drive shaft and composite drive shaft results
- For validation, we require the results derived from theoretical and experimental calculations.
- To perform the experiment, we manufacture the sample composite material and conventional drive shaft. Testing of these two shafts has been done in torsion test machine and the results are been derived.
- Later CAD model for these two shafts having same dimensions has been generated and was imported in ANSYS. Results were derived after this process and were compared with the experimental results.
- Theoretical calculations for sample conventional and composite drive shaft were calculated.

Finite Element Analysis of Shaft

- **Finite Element Analysis of drive shaft**

In heavy vehicles conventional shaft are used as they must bear with extreme load. For our project work conventional shaft of Maruti Omni car is used which is considering as a light passenger vehicle.

- **FEA of mild steel shaft**

Conventional Shaft is a medium between rare wheel and engine. Conventional Shaft transfers the motion of engine to the rare wheel. As the passenger weight increases engine load is increased resulting in the increase of the torque. This means, as the overall weight of the vehicle increases torque applied to the engine also increases. i. e., Overall weight is directly proportional to the applied torque to the engine. Driving shaft is a type of the tube having some thickness. Dimensions of the shaft are modified according to the vehicle requirements. This means, thickness or length of the shaft is varied as per the requirements. But, when the thickness of the shaft is increased, overall weight of the shaft will be increased, resulting in the decrease of the overall efficiency. Hence moderate dimensions are used to generate the shaft. Maruti Omni's actual dimension satisfies these specifications hence we can consider it's dimensions for the initial setup.

Selection of Components

- Material of drive shaft
- Composite material steel
- Glass fibre
- CAD model
- Static analysis (twisting angle & torsional stress)
- Comparison of results
- Theoritical calculation
- Comparison of results
- Experimental calculation testing on torsion machine
- Comparison of results and model analysis
- Proposed suitable material steel/ glass fibre

Pros and cons

Advantages of Composite Material

1) High strength, durability.
2) Improved stiffness, fatigue, and impact resistance.
3) Good thermal conductivity and corrosion resistance
4) Lesser weight i. e., more strength to weight ratio.

Limitations of Composite Material

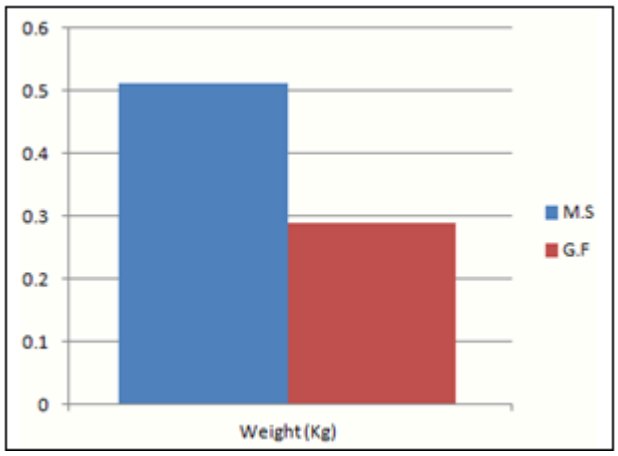
1) Comparatively high cost than metals.
2) Improvements in processing and manufacturing techniques are needed for application
3) Composites do not necessarily give higher performance in all the properties used for material selection.

3. Result

From the FEA, analytical calculations and experimental testing results are being derived. Result will be within the range.

Weight Comparison for M. S and G. F Drive Shaft

Weight of M. S. derived using Analytical method: 0.512 Kg
Weight of G. F. derived using Analytical method: 0.289 Kg
Graph 7.4: Weight comparison - Analytical
Results for Analytical Calculation show stress induced on of composite shaft is less compared to the Mild steel shaft. Also, the weight reduction of the composite drive shaft to that of conventional shaft is 56.44 %.
Graph shows Weight Comparison – Analytical



4. Conclusion

Composite Glass fibre shaft has less weight than conventional steel drive shaft for analysed stress.
Hence composites can be suggested for driving shaft of light passenger vehicle.
Reducing weight and increasing strength of products have high demands in the automobile world

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