DESIGN AND ANALYSIS OF DRIVE SHAFT IN CAE TOOL AND ANSYS

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ABSRTACT: A Propeller/Drive Shaft is a device on which a propeller is attached to and transfers the power from the engine to the propeller. In the design of automobiles, the industry is exploiting in order to obtain reduction of weight without significant decrease in vehicle quality and reliability. This is due to the fact that the reduction of weight of a vehicle directly impacts its fuel consumption. Particularly in city driving, the reduction of weight is almost directly proportional to fuel consumption of the vehicle. A propeller shaft is a longitudinal drive shaft used in vehicles where the engine is suited at the opposite end of the vehicle to the drive wheels. A propeller shaft is an assembly of one or more tubular shaft connected by universal, constant velocity or flexible joints. Thus, in this project work the propeller shaft of a vehicle was chosen and analyzed by replacing it with different materials. The analysis was carried out for five different materials in order to suggest the most suitable material that would give the maximum weight reduction while conforming to the stringent design parameters of passenger cars.

Introduction: In the process of designing a vehicle, one of the most important objectives is the conservation of energy and the most effective way to obtain this goal is the reduction of weight of the vehicle. There is almost a direct proportionality between the weight of the vehicle and its fuel consumption, particularly in city driving. The automotive industry is exploiting composite material technology for structural component construction in order to obtain reduction of weight, without decrease in vehicle quality and reliability. Properties can be tailored to increase the torque they carry as well as the rotational speed at which they operate. In this project, the conventional propeller shaft has been replaced with different types of material to carry out a comparative analysis, thus determining the most suitable replaceable material

Aim and Scope of the Work

The project aims to reduce the weight of the propeller shaft assembly by using different materials . For this project work, the drive shaft of a car was chosen. The modeling of the propeller shaft assembly was done using CATIA V5R19. A Leaf spring has to be designed to meet the stringent design requirements for automobiles. A comparative study of five different materials was conducted to choose the best-suited material. Steel (SM45C) was chosen for reference and the rest of the five different materials were analyzed. The material properties of the composites were obtained based on the Classical Lamination Theory with the help of a code written in C language. The analysis was carried out using ANSYS 10.0 Workbench for the following materials.

The first was Steel (SM45C) which was used for reference purpose

Two Composites. They are 1) Boron and 2) Kevlar

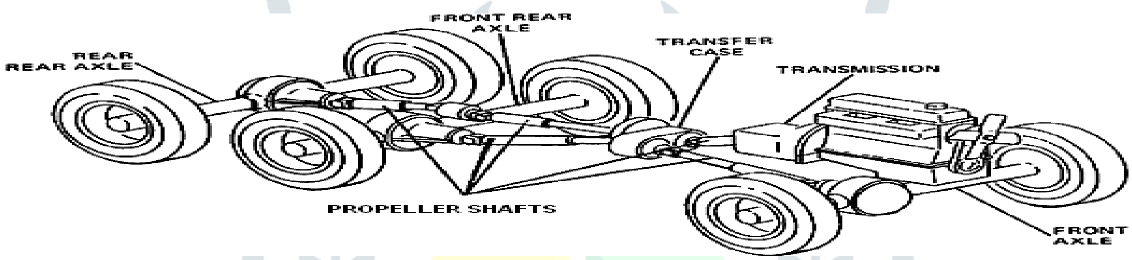
Other components: Aluminum, Glass Fiber, Carbon-Glass.

1. LITERATURE SURVEY

Agarwal B.D. and Broutman L. J. have extensively reviewed the theoretical details of composite materials and composite structures in, “Analysis and performance of fiber composites”, 1990. The Spicer U-Joint Division of Dana Corporation for the Ford Econoline van models developed the first composite DRIVE shaft in 1985. The General Motors pickup trucks which adopted the Spicer product enjoyed a demand three times that of projected sales in its first year.

John. W. Weeton briefly described the application possibilities of composites in the field of automotive industry to manufacture composite elliptic springs, drive shafts and leaf spumes in “ Engineers guide to composite materials, American Society for metal, 1986”. Beard more and Johnson discussed the potential for composites in structural automotive applications from a structural point of view. Pollard studied the possibility of the polymer Matrix composite usage in driveline applications. Faust et.al, described the considerable interest on the part of both the helicopter and automobile industries in the development of lightweight drive shafts. Procedure for finding the elastic moduli of anisotropic laminated composites is explained by Azzi.V.D. He also discussed about anisotropic strength of composites.

2. DRIVESHAFT:



Schematic arrangement of Underbody of an Automobile

A DRIVE shaft is a device on which a DRIVE is attached to and transfers the power from the engine to the DRIVE. This terminology is typically used when discussing a ship or boat DRIVE as an airplane's version is typically mounted to a hub. The DRIVE shaft runs from the engine through a seal in an in board engine application. It then runs through the hull and into a bearing just ahead of the DRIVE. The DRIVE shaft must run true and straight, free of any bends or it will vibrate the vessel as well as pre-maturely wear out the bearings and seals.The DRIVE shaft is typically made of hardened steel and incorporates a spline on the end of the shaft where the DRIVE mounts.

Drive shaft

Functions of the Drive Shaft

- First, it must transmit torque from the transmission to the differential gear box.

- During the operation, it is necessary to transmit maximum low-gear torque developed by the engine.
- The drive shafts must also be capable of rotating at the very fast speeds required by the vehicle.
- The drive shaft must also operate through constantly changing angles between the transmission, the differential and the axles. As the rear wheels roll over bumps in the road, the differential and axles move up and down. This movement changes the angle between the transmission and the differential.
- The length of the drive shaft must also be capable of changing while transmitting torque. Length changes are caused by axle movement due to torque reaction, road deflections, braking loads and so on. A slip joint is used to compensate for this motion. The slip joint is usually made of an internal and external spline. It is located on the front end of the drive shaft and is connected to the transmission.

Applications:

1. Drill press spindles-impart motion to cutting tool (i.e.) drill.

2. Lathe spindles-impart motion to work-piece.

Apart from, an axle and a spindle, shafts are used at so many places and almost everywhere wherever power transmission is required. Few of them are:

1. Automobile Drive Shaft: Transmits power from main gearbox to differential gear box.

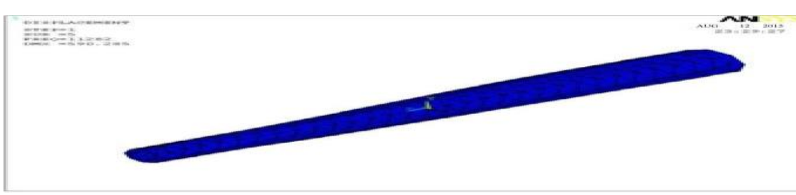
2. Ship DRIVE Shaft: Transmits power from gearbox to DRIVE attached on it.

3. Helicopter Tail Rotor Shaft: Transmits power to rail rotor fan. This list has no end, since in every machine, gearboxes, automobiles etc. shafts are there to transmit power from one end to other.

5. MODAL ANALYSIS OF SHAFT

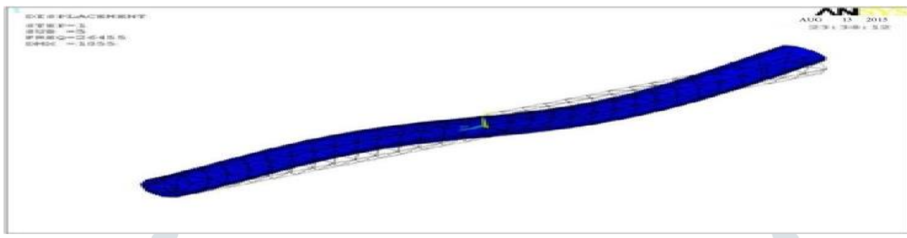
Steel

S.No	Frequency	Deflection Max
1	682.335	592.787
2	690.768	591.99
3	4191	613.97
4	4259	615.107
5	11282	590.285



BORON

S.No	Frequency	Deflection Max
1	1582	1013
2	1605	1011
3	9727	1050
4	9915	1052
5	2645	1055

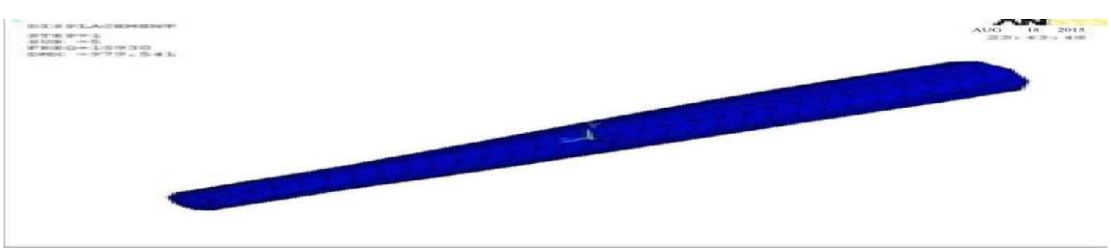


Kevlar

S.No	Frequency	Deflection Max
1	1250.4	1362
2	1264.1	1361
3	7679.9	1411
4	7786.3	1413
5	20414	1342

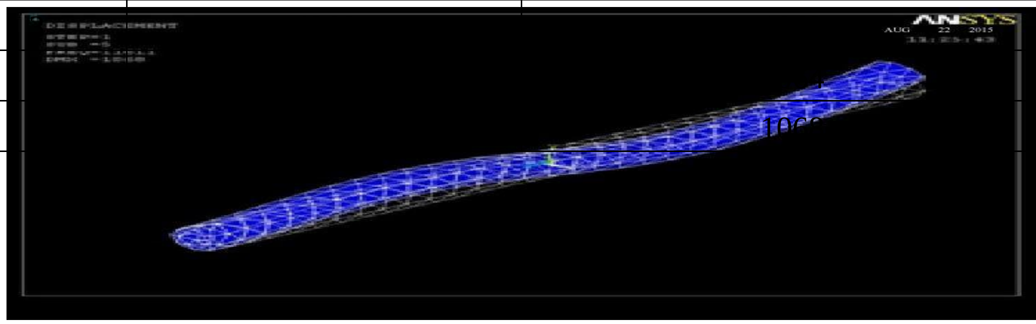
Aluminium

S.No	Frequency	Deflection Max
1	671.605	994.756
2	678.653	993.799
3	4125	1030
4	4179	1032
5	10930	979.541



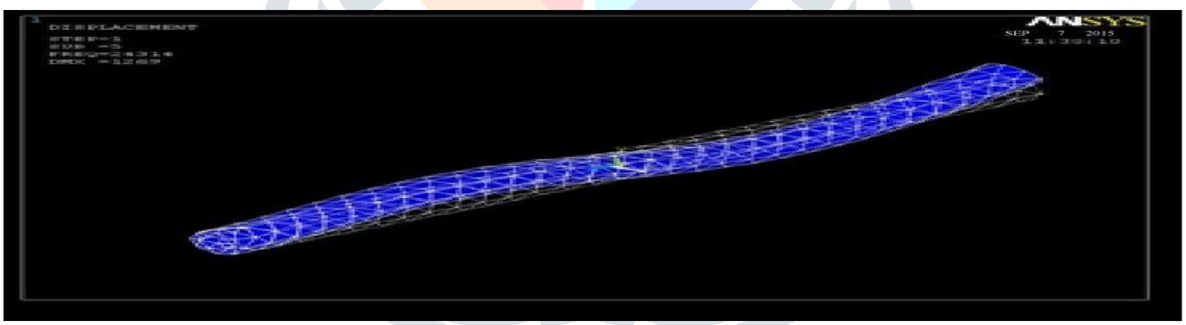
Glass Fiber

S.No	Frequency	Deflection Max
1	694.105	1025
2	704.157	1023
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]



Carbon Glass

S.No	Frequency	Deflection Max
1	1454	1217
2	1475	1215
3	8958	1262
4	9112	1264
5	24314	1269



6. RESULTS AND DISCUSSIONS

A total of five materials were chosen for the comparative analysis, including steel, which was used for reference.

S.NO	MATEARIAL	DEFLECTION MAX	STRESS MAX	STRESS MIN
1	STEEL	0.524006	2017	237.875
2	BORON	0.269346	2097	415.505
3	KEVLAR	0.844302	1976	226.193
4	ALUMINIUM	1.571	1966	222.657
5	GLASS FIBER	1.424	2106	256.657
6	CARBON-GLASS	0.454	2106	256.541

7. Conclusion

The presented work was aimed at reducing the fuel consumption of the automobiles in particular or any machine, which employs drive shafts, in general. This was achieved by reducing the weight of the drive shaft with the use of different materials. The Drive shaft of a vehicle was chosen for determining the dimensions, which were then used for creating a model in CATIA V5R19. Being a complex assembly of a number of parts, it had to be analyzed only for drive shaft in ANSYS 10.0. A total of five materials were chosen for the comparative analysis, including steel, which was used for reference.

Taking into consideration the weight saving, deformation, shear stress induced and resonant frequencies it is observed that Boron has the most encouraging properties to act as the replacement for steel out of all the materials.

8. References

1. Das M.P., Jeyanthi Rebecca L., Sharmila S., "Evaluation of antibacterial and antifungal efficacy of Wedelia chinensis leaf extracts", Journal of Chemical and Pharmaceutical Research, ISSN : 0975 – 7384, 5(2) (2013) pp.265-269.
2. Beardmore, P. et al. The Potential for Composites in Structural Automotive Applications

   J. of Composites Science and Technology 26 1986: pp. 251 – 281.
3. M. Bharathi, Golden Kumar, Design Approach For Pitch Axis Stabilization of 3-Dof Helicopter System an LQR Controller, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN 2278 - 8875 , pp 351-365 Vol. 1, Issue 5, November 2012.
4. Vijayan T , Performance Image Compression using Lifting based EEWITA, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN (Print) : 2320 – 3765, pp 10501-10508,Vol. 3, Issue 7, July 2014.
5. Khoshravan M R and Paykani A (2012), “Design of a Composite Drive Shaft”, *Journal of Applied Research*, Vol. 10, December 6, pp. 826-834.
6. Belingardi.G, Calderale.P.M. And Rosetto.M, 1990, “Design Of Composite Material Drive Shafts for Vehicular Applications”, Int. J. of Vehicle Design, Vol.11, No.6, pp. 553-563.
7. Jin Kook Kim. Dai GilLee, and Durk Hyun Cho, 2001, “Investigation of Adhesively Bonded Joints for Composite DRIVE shafts”, Journal of Composite Materials, Vol.35, No.11, pp.999-1021.
8. Azzi.V.D and Tsai.S.W, 1965, “Elastic Moduli of Laminated Anisotropic Composites”, Journal of Exp. Mech, Vol.5, pp 177-185.
9. [10]Azzi.V.D and Tsai.S.W, 1695, “Anisotropic Strength of Composites”, Journal of Experimental .Mech. Vol.5, pp.134-139.
10. Pollard. A, 1989, “Polymer Matrix Composites in Driveline Applications”, Journal of Composite Structures, Vol.25, pp.165-175.