iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VIII **Month of publication:** August 2022

DOI: https://doi.org/10.22214/ijraset.2022.46504

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VIII Aug 2022- Available at www.ijraset.com

Design, Analysis and weight optimization of LMV shaft by using AL + GF composite

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Abstract: Aluminum composites are mainly used due to their lower weight and high strength among the Metal Matrix Composites. Aluminum is selected as matrix and E-glass fiber is selected as reinforcement. Fabrication of composite is done by the winding of composite method. Each shaft fabrication content of E-glass fiber and aluminum with different ratios depends on ANSYS results. The present article attempts to evaluate the mechanical properties of E-glass fiber-reinforced composite and study the effect of reinforcement on the matrix alloy through mechanical properties.

The results are analyzed for different types of winding angles with an aluminum layer. The mechanical properties of composites have improved with the increase in the weight percentage of glass fiber in the aluminum matrix.

Keywords: Drive Shaft, Static Analysis, Twisted testing, Composite Material.

I. 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.

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 diff erence 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.

An automotive drive shaft is a rotating shaft that transmits power from the engine to the differential gear of rear wheel drive (RWD) vehicles. The torque that is produced from the engine and transmission must be transferred to the rear wheels to push the vehicle forward and reverse.

The drive shaft must provide a smooth, uninterrupted flow of power to the axles. [3] The drive shaft and differential are used to transfer this torque.

Moreover, a composite driveshaft can be perfectly designed to effectively meet the strength and stiffness requirements. Since composite materials generally have a lower elasticity modulus, during torque peaks in the driveline, the drive shaft can act as a shock absorber. Moreover, the breakage of composite a drive shaft (particularly in SUV's) is less -risky, since it results in splitting up of the fine fibers as compared to the scattering of broken steel parts in various directions.

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 the And Weight Optimization Of Composite Drive Shaft Using ANSYS Design, Analysis basic concepts of composite materials are discussed in the following section to better acquaint ourselves with the behavior of composites.

II. METHODOLOGY

After referring to multiple references it was understood that how composite drive shaft having optimum weight can be selected using the exact methodology.

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For this process we use CATIA V5 R20 and ANSYS workbench 14.5 software

1) 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 a final solution results are derived from ANSYS software.
2) 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 a final solution results are derived from ANSYS software.
3) Compare conventional drive shaft and composite drive shaft results.
4) For validation, we require the results derived from theoretical and experimental calculations.
5) To perform the experiment, we manufacture the sample composite material and conventional drive shaft. Testing of these two shafts is been done in torsion test machine and the results are been derived.
6) Later CAD model for these two shafts having same dimensions was been generated and was imported in ANSYS. Results were derived after this process and were compared with the experimental results.
7) Theoretical calculations for sample conventional and composite drive shaft were calculated.
8) Lastly ANSYS, theoretical and experimental results were compared and preferable shaft was selected in automobile.

III. FINITE ELEMENT ANALYSIS

A. MS Shaft

1) Model

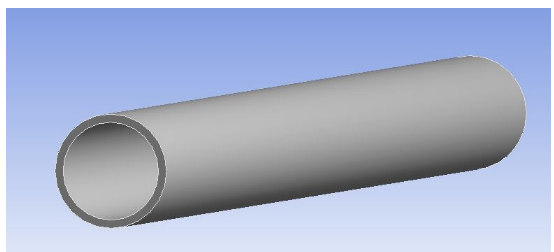

Fig.1 Geometry imported in ANSYS of MS

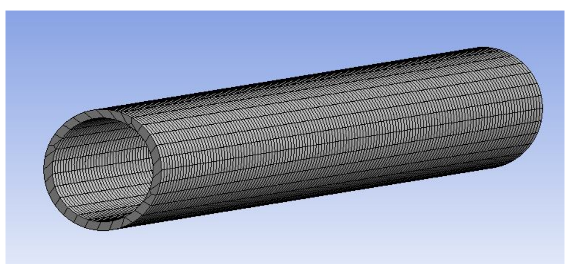

Fig. 2 Meshing of MS shaft

2) Boundary Condition

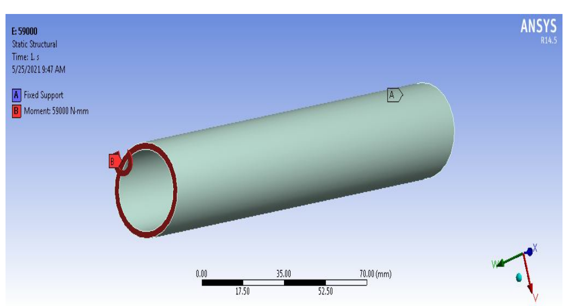

Fig 3 Boundary condition of moment 59000 N-mm apply on MS shaft

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3) Total Deformation

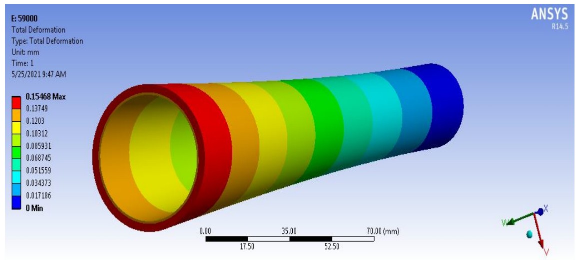

Fig 4 Total Deformation of moment 59000 N-mm apply on MS shaft

4) Stress

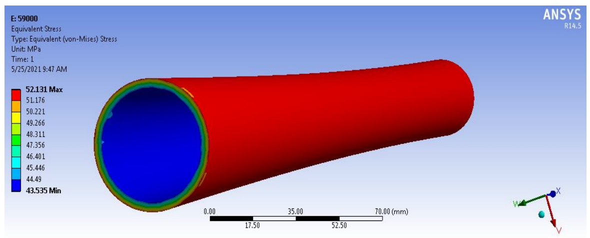

Fig 5 Stress of moment 59000 N-mm apply on MS shaft

B. MATERIAL AL + GF

1) Model

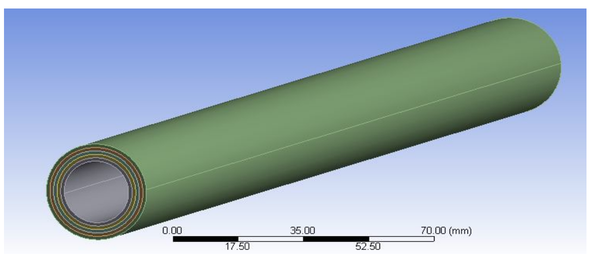

Fig.6 Geometry imported in ANSYS of GF+Al

2) Meshing

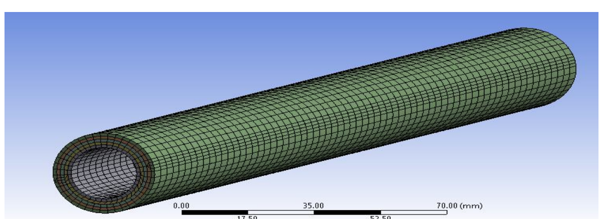

Fig. 7 Meshing of GF+Al composite shaft

3) Boundary condition

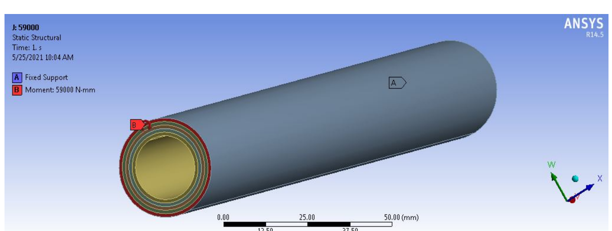

Fig 8 Boundary condition of moment 59000 N-mm apply on GF+Al shaft

4) Total Deformation

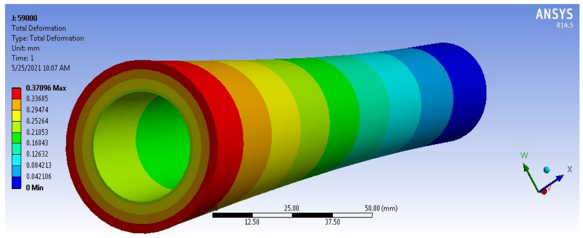

Fig 9 Total Deformation of moment 59000 N-mm apply on GF+Al shaft

5) Stress

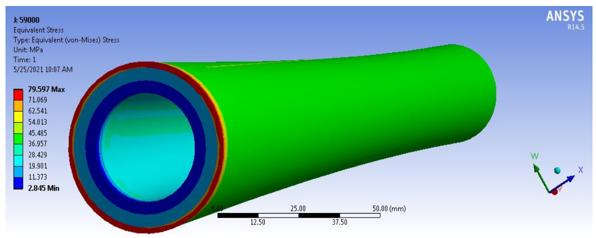

Fig 10 Stress of moment 59000 N-mm apply on GF+Al shaft

IV. RESULT TABLE

A. FEA Results for M.S. Shaft

Sr.No.	Moment (Nmm)	Stress (MPa)	Deformation (mm)
1	10787	0.028	9.53
2	21557	0.056	19.63
3	34323	0.089	30.32
4	4903	0.128	43.32
5	59000	0.154	52.131

Table 1 FEA result for M.S. Shaft

B. FEA Results for G.F.+ Al Shaft

Sr.No.	Moment (Nmm)	Stress (MPa)	Deformation (mm)
1	10787	0.0041	27.01
2	21557	0.138	29.107
3	34323	0.22	46.302
4	4903	0.3149	66.15
5	59000	0.3789	79.59

Table 7.2 FEA result for G.F. Shaft

C. Practical Testing Result

Sr. no.	Torque	Twiting Angle	
		M.S.	AL+GF
1	10787	0.1	0.1
2	21557	0.2	0.4
3	34323	0.3	0.9
4	4903	0.4	1.2
5	59000	0.5	1.6

Table 3 Practical Testing result for M.S. & AL + GF Shaft

V. CONCLUSION

Reducing weight and increasing strength of products have high demands in the automobile world. Composite materials can satisfy these demands considerably. The present work involves the static analysis of conventional steel shaft and composite shaft. Model is prepared in CATIA V5R20 and then analysis is performed through ANSYS R14.5. A comparative study has been made between steel and composite shaft to find out material having high strength to weight ratio. From the results obtained it is concluded that,

1) Stress occurred in the composite drive shaft is less as compared to conventional drive shaft.
2) Results obtained through ANSYS are validated from experimental testing.
3) Comparison of the results also shows that the results derived using all the calculation methods are similar to each other. Hence, FEA results can be considered as valid method for design purpose.
4) Composite Glass fiber shaft has less weight than conventional steel drive shaft for analyzed stress. So composites can be suggested for driving shaft of light passenger vehicle.

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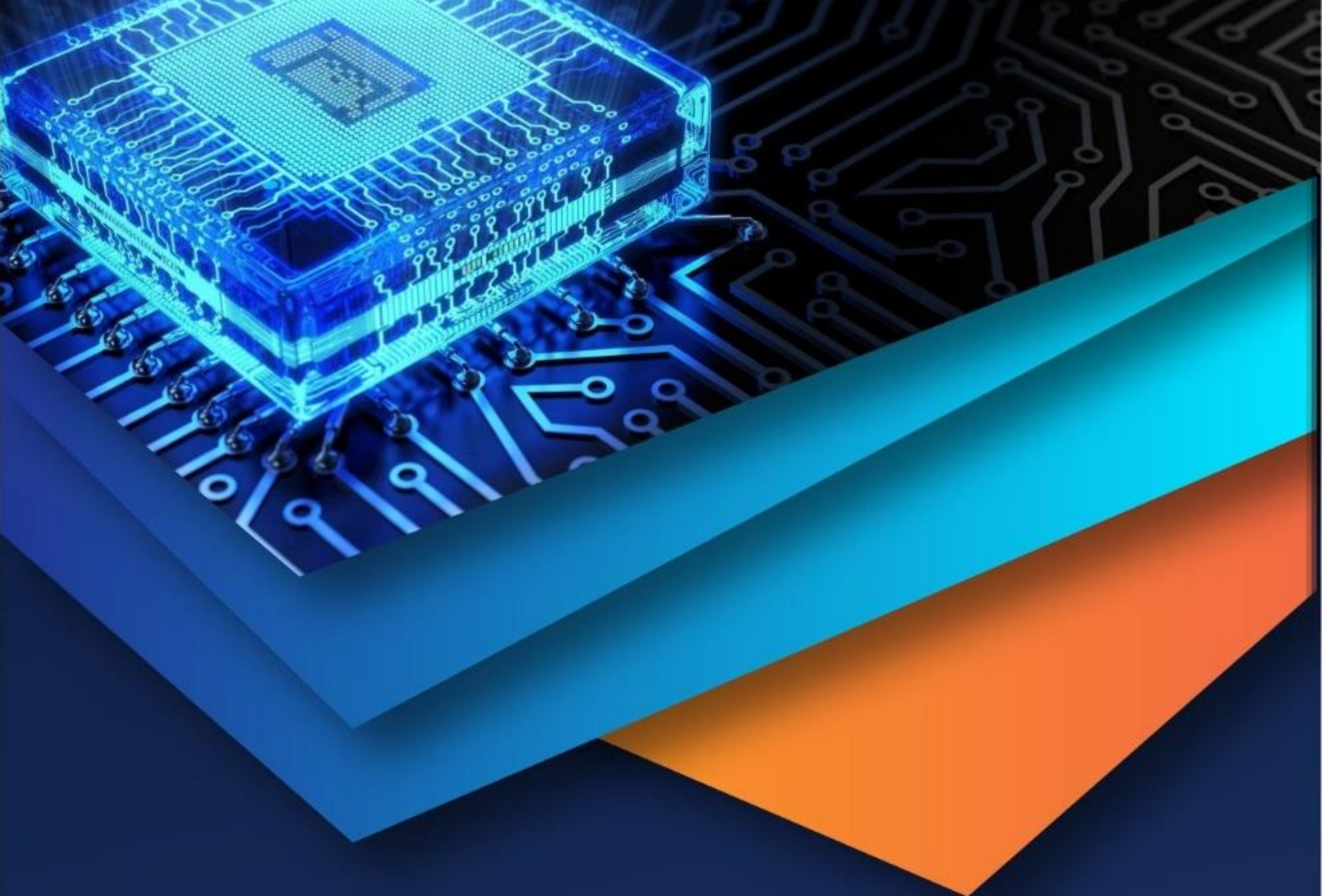

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