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Design Analysis and Weight Optimization of LMV Drive Shaft by Using AL + GF Material

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Abstract: Aluminium is mainly used due to their lower weight and high strength among the Metal Composites. Fabrication of composite is done by the winding of composite glass fibre over the aluminium shaft method. Each shaft fabrication content of E-glass fibre and Aluminium with different ratios depends on ANSYS results. The present article attempts to evaluate the mechanical results for Aluminium and Glass fibre composite shaft for torsion test. The results are analyzed for different combination of Aluminium and glass fibre layer. The mechanical properties of composites have improved with the increase in the weight percentage of Aluminium in composite.

I. INTRODUCTION

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. 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 fibres 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.

A. Introduction to Drive Shaft

Drive shaft is been used in the automobiles. They are mainly used in the commercial vehicles such as vans, trucks, SUV's etc. There should be a medium from where the motion from engine is been transferred to the rare wheels. To transfer this motion from the engine to the rare wheels, drive shaft plays an important role. Whenever the distance between the engine and rare wheels is more than 1.5m use of two-piece drive shaft is been used. Dive shaft is one of the important parts of the vehicle, without which we cannot transfer motion from engine to the rare wheel smoothly. In order to conserve natural resources and economize energy, weight reduction has been the main focus of Automobile manufacturer in the present scenario. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes .The suspension drive shaft is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the unsprung weight.

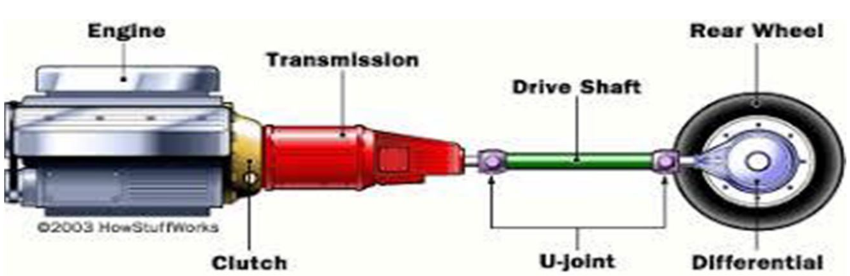

Fig 1 One-Piece Drive Shaft

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.

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) Boundary Condition

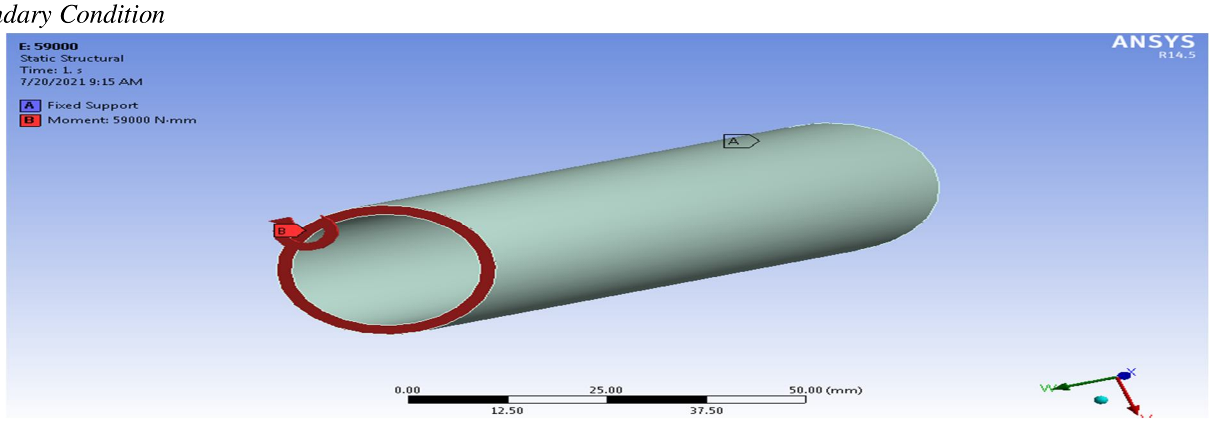

Fig 1 Boundary condition of moment 59000 N-mm apply on MS shaft

2) Total Deformation

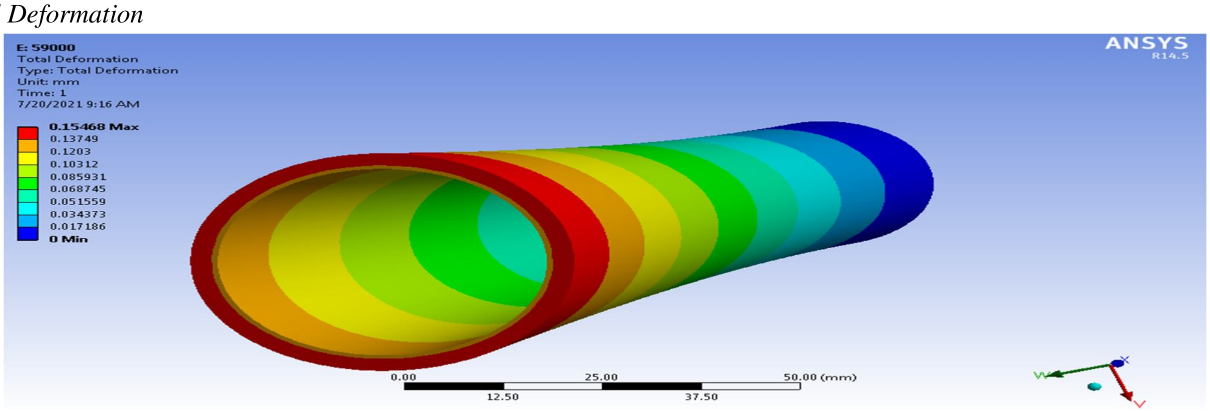

Fig 2 Total Deformation of moment 59000 N-mm apply on MS shaft

3) Stress

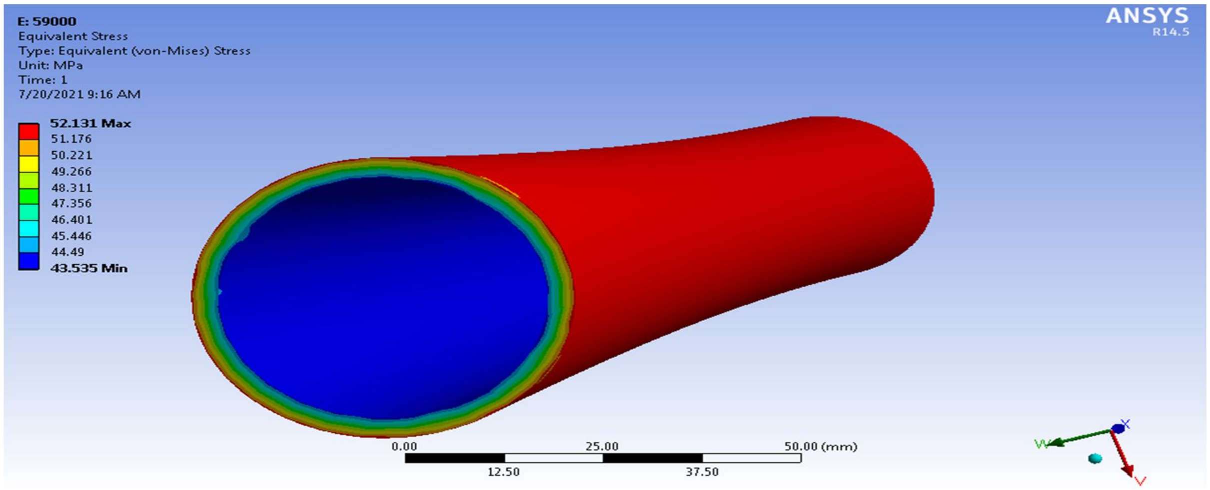

Fig 3 Stress of moment 59000 N-mm apply on MS shaft

4) Shear Stress

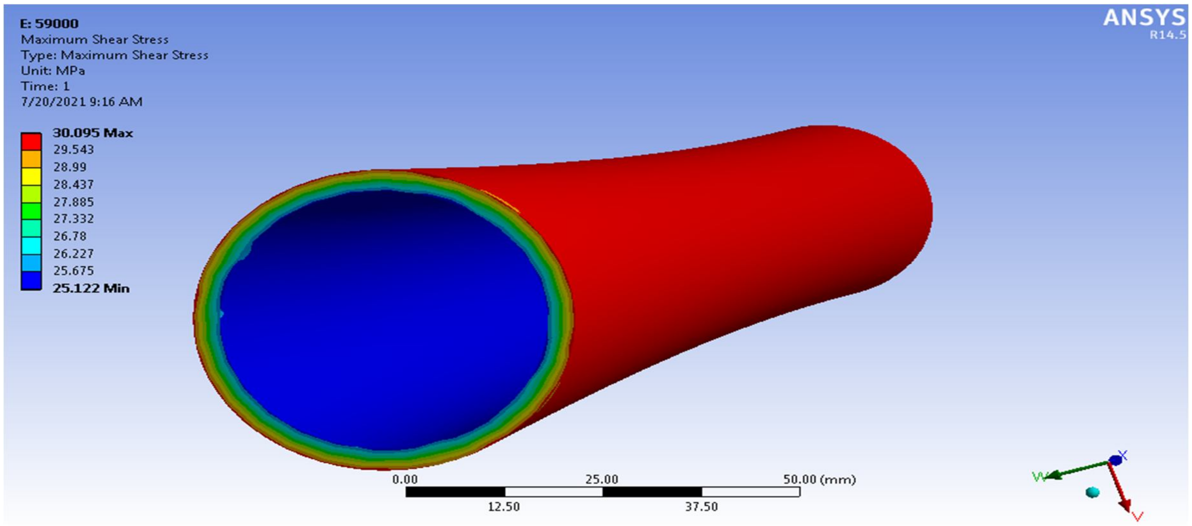

Fig 4 Shear Stress of moment 59000 N-mm apply on MS shaft

B. MATERIAL 3AL + 2GF

1) Boundary condition

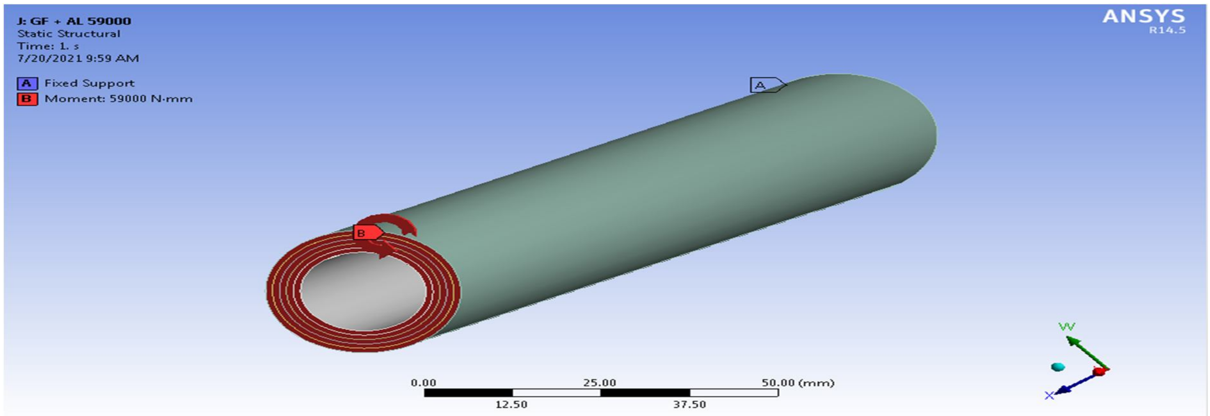

Fig 5 Boundary condition of moment 59000 N-mm apply on 3AL + 2GF shaft

2) Total Deformation

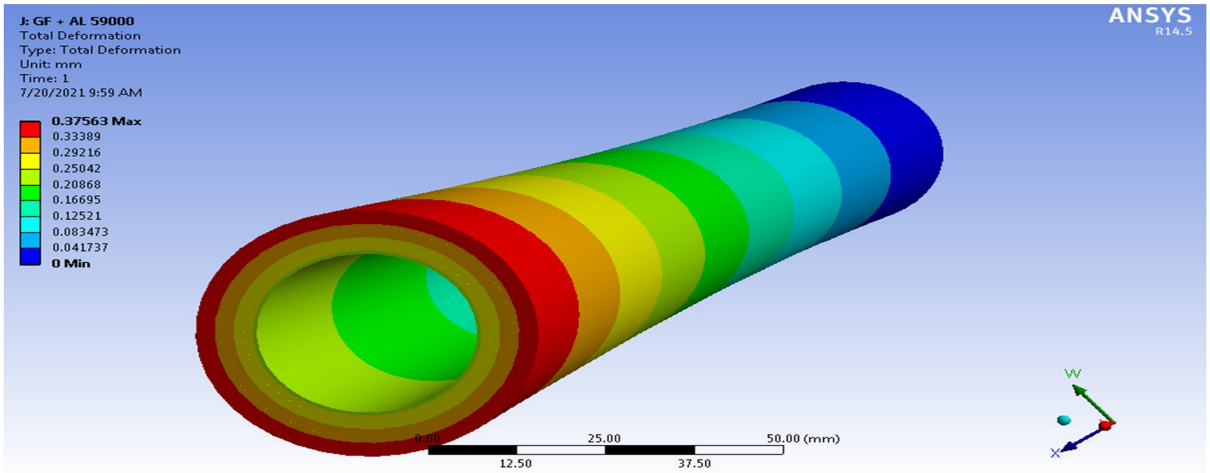

Fig 6 Total Deformation of moment 59000 N-mm apply on 3AL + 2GF shaft

3) Stress

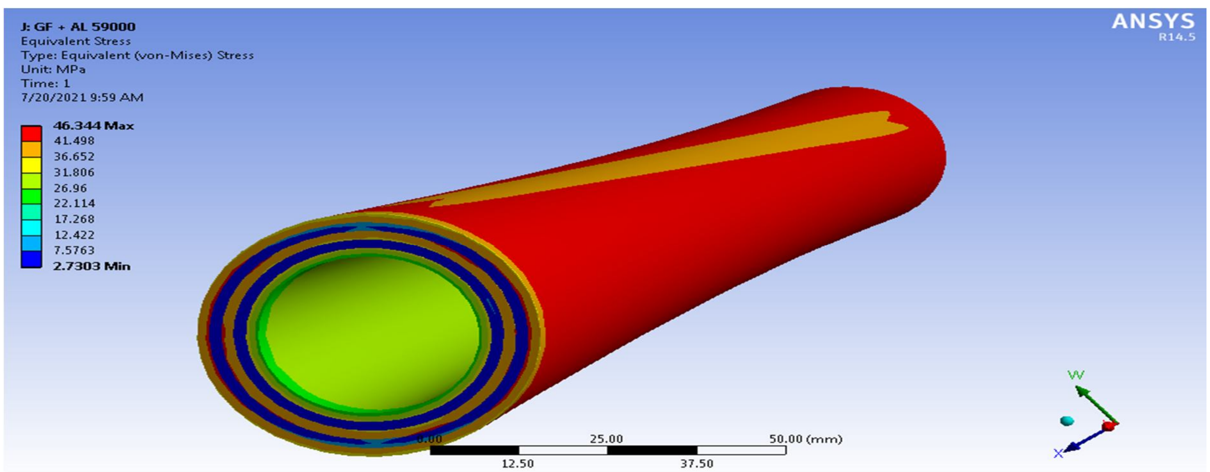

Fig 7 Stress of moment 59000 N-mm apply on 3AL + 2GF shaft

4) Shear Stress

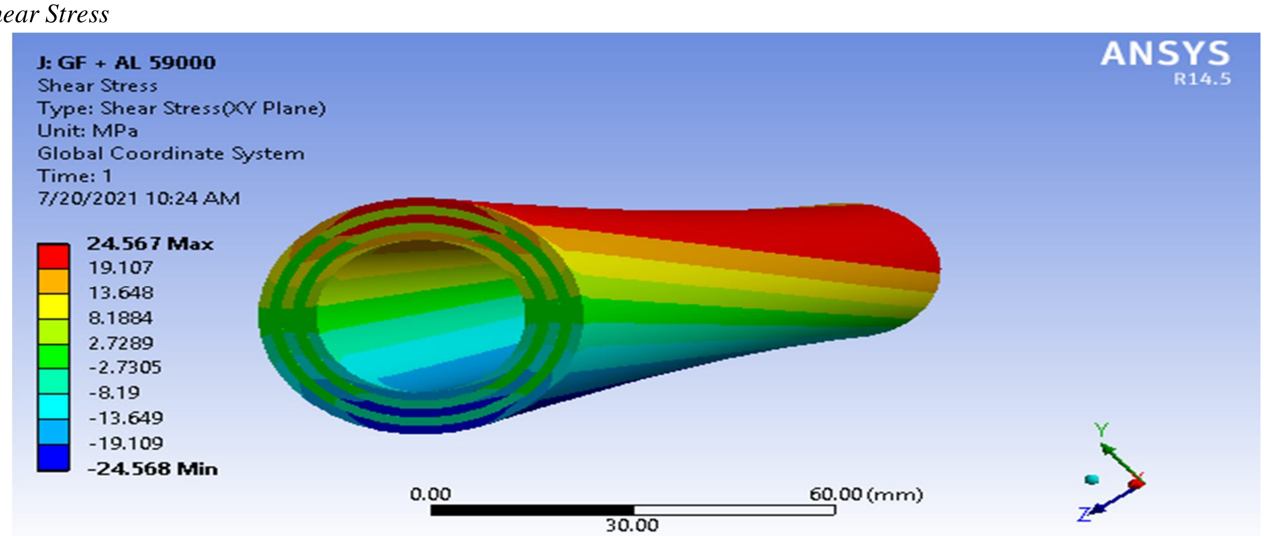

Fig 8 Shear Stress of moment 59000 N-mm apply on 3AL + 2GF shaft

C. Analysis of Original Drive Shaft

1) Boundary Condition

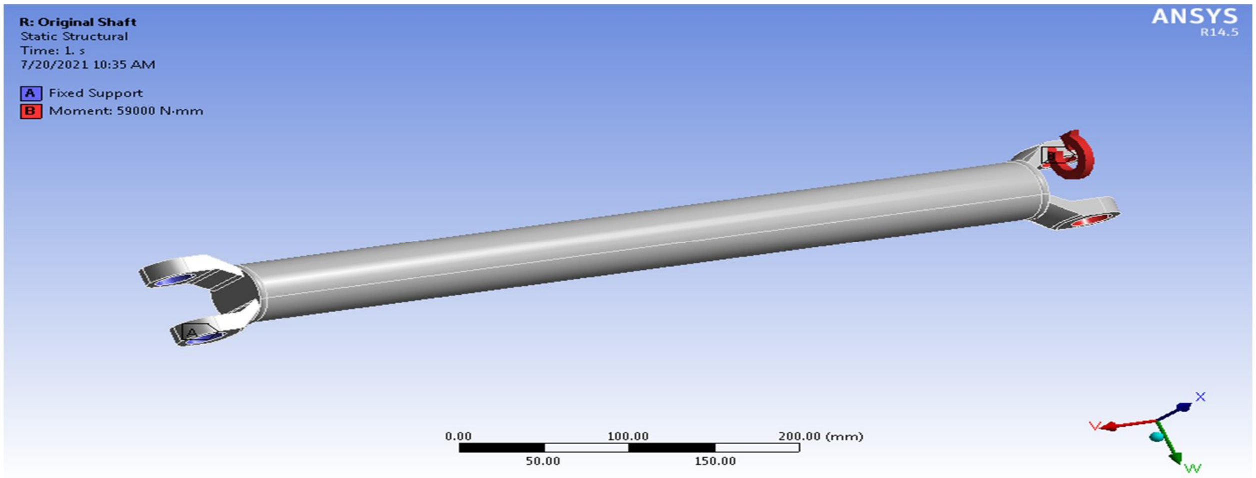

Fig 9 Boundary condition of moment 59000Nmm applied to Original Drive Shaft

2) Stress

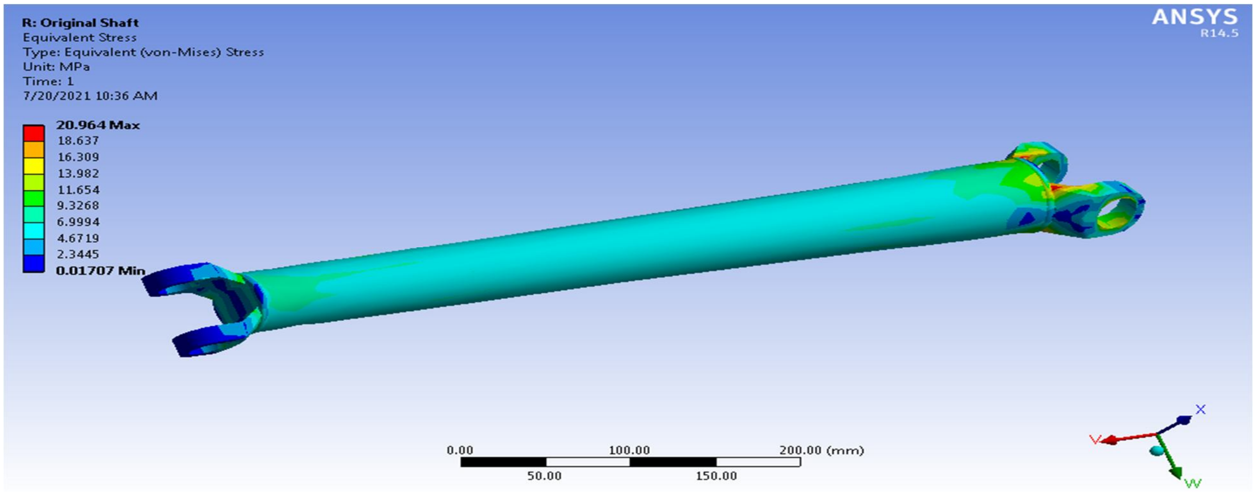

Fig 10 Stress of moment 59000 N-mm apply on original shaft

3) Deformation

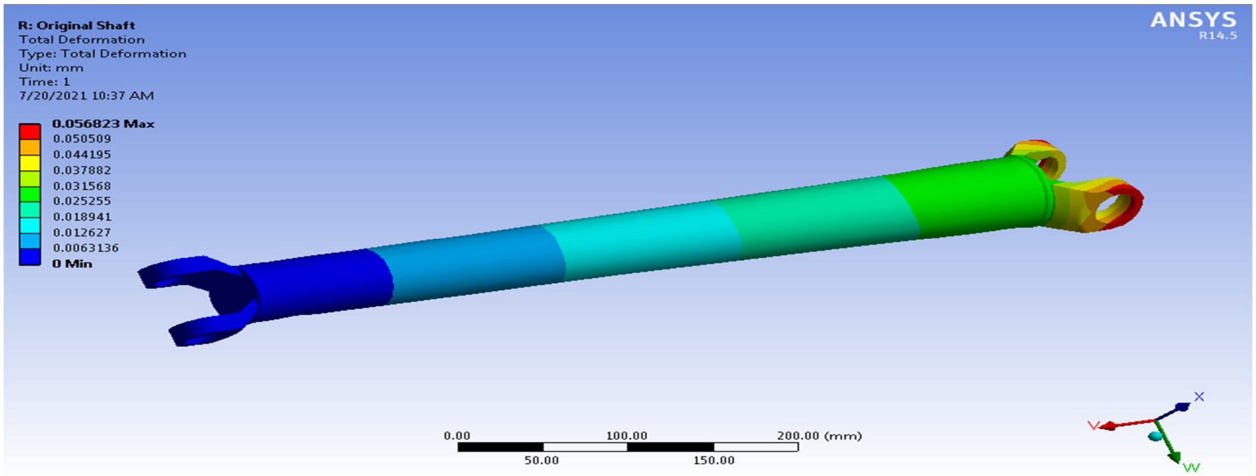

Fig 11 Deformation of moment 59000 N-mm apply on original shaft

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D. Analysis of Proposed Drive Shaft

1) Boundary Condition

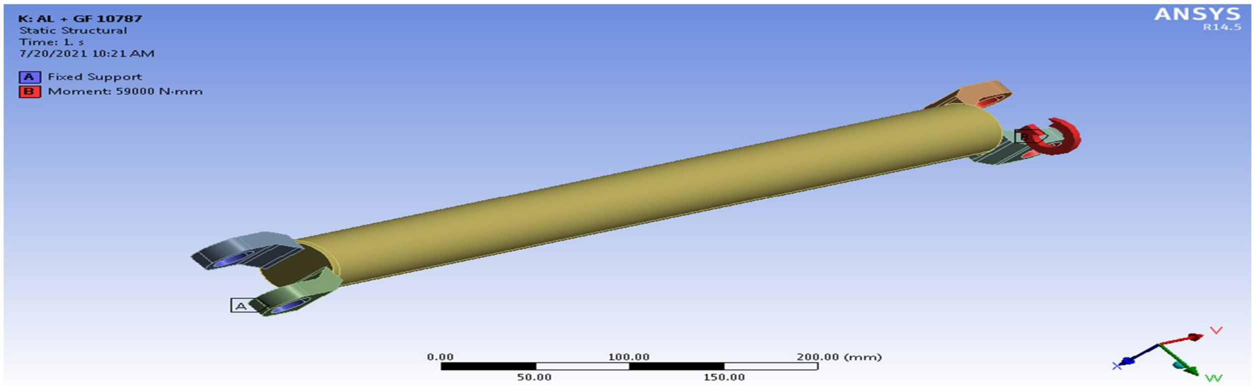

Fig 12 Boundary condition of moment 59000Nmm applied to Proposed Drive Shaft

2) Stress

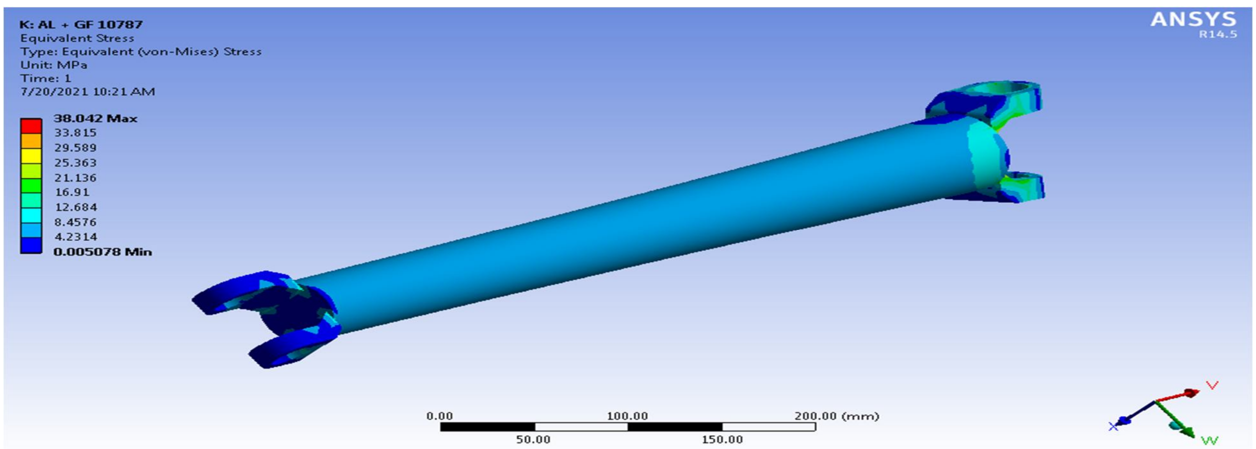

Fig13 Stress of moment 59000 N-mm apply on proposed shaft

3) Deformation

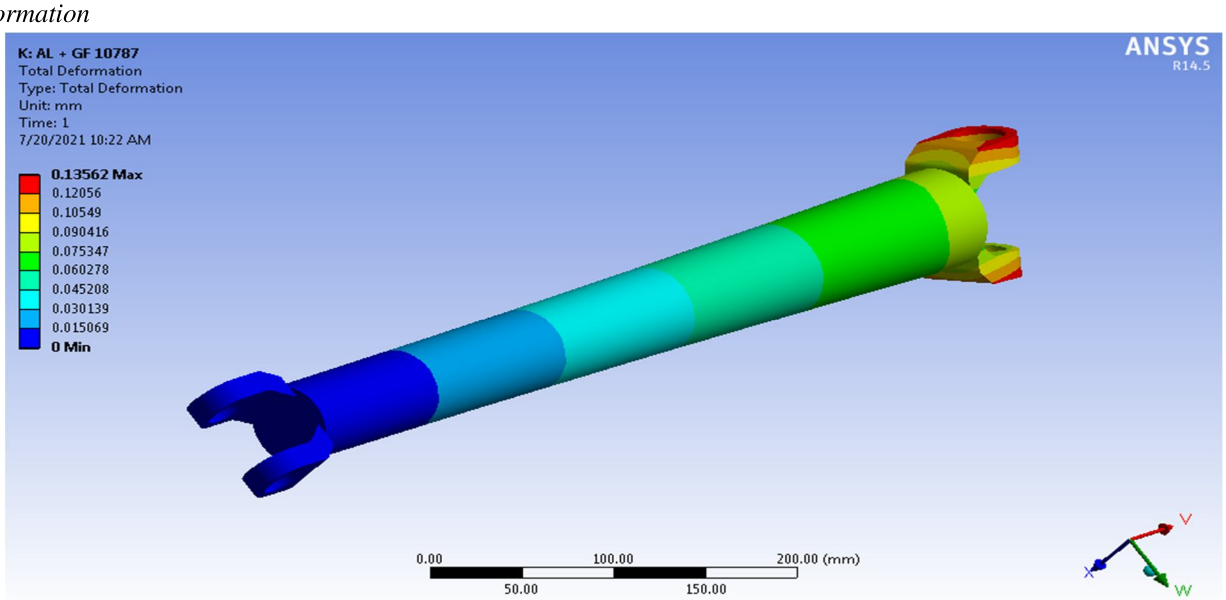

Fig 14 Deformation of moment 59000 N-mm apply on proposed shaft

IV. RESULT TABLE

A. FEA Result of Steel Shaft

Sr. No.	Moment (Nmm)	FEA	
		Shear Stress (MPa)	Deformation (mm)
1	11800	6.019	0.03095
2	23600	12.038	0.06187
3	35400	18.057	0.092806
4	47200	24.076	0.12374
5	59000	30.095	0.15468

Table 1 FEA result for steel Shaft

B. FEA Results for 3AL + 2GF Shaft

Sr.No.	Moment (Nmm)	Stress (MPa)	Shear Stress (MPa)	Deformation (mm)
1	11800	9.0804	5.2424	0.069041
2	23600	18.538	9.8267	0.15025
3	35400	27.806	14.74	0.22538
4	47200	37.075	19.653	0.3005
5	59000	46.344	24.567	0.37563

Table 2 FEA result for 3AL + 2GF Shaft

C. Weight

Sr. No.	Material	Weight (Kg)
1	Original	3.881
2	Proposed	2.394

Table 3 Weight of both Shafts

D. Final Shaft

Sr. No.	Shaft	Stress (MPa)	Deformation (mm)
1	Original	20.964	0.0568
2	Proposed	38.042	0.1356

Table 4 Analysis results of both Shafts

E. Testing Results

Sr.No.	Moment (Nmm)	Twisting Angle	
		Steel	3Al + 2GF
1	11800	0.1	0.1
2	23600	0.2	0.4
3	35400	0.3	0.9
4	47200	0.4	1.2
5	59000	0.5	1.6

Table 5 Testing results of both shafts

V. CONCLUSION

In this work, an attempt was made to fabricate Al/E-glass fibres composites by the layer lamination process. The effect of the E-glass fibres on the bonding properties of Al strips was investigated because of its impact on the mechanical properties of the composites. The results were concluded as follows:

1) Stress occurred in the composite drive shaft is within the allowable limit.
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 fibre 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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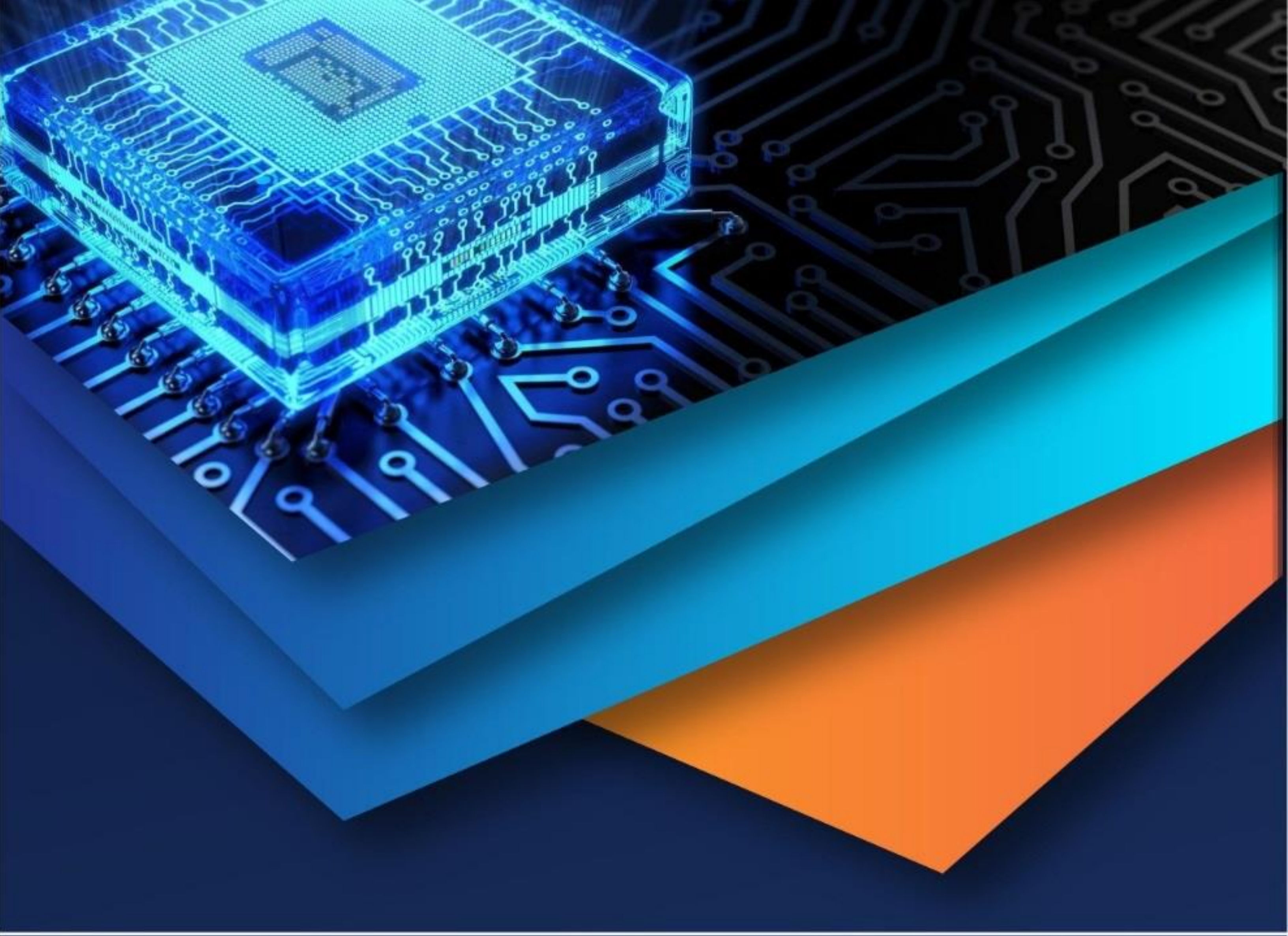

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