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MODELING AND ANALYSIS OF AUTOMOTIVE DRIVE SHAFT USING NANO COMPOSITE MATERIALS

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ABSTRACT

All vehicles have transmission shafts. The weight decrease of the drive shaft can have a specific job. In general weight decrease of the vehicle is a highly important objective, in the event that it is very well accomplished without increment in cost and diminishing in quality and unwavering quality. It is conceivable to accomplish outline of composite drive shaft with less weight to build the primary common recurrence of the shaft.

The automobile companies must use Nano composite material innovation for auxiliary parts development keeping in mind the end goal to get the decrease of the weight without diminish in vehicle quality. This work manages the substitution of ordinary two-piece steel drive shafts with a Nano Composite materials. In this work Epoxy E-Glass UD, Kevlar Epoxy is utilized as Nano composite material, it is realized that decrease of weight is a standout amongst the best measures to get this outcome. As a matter of fact, there is very nearly an immediate proportionality between the weight of a vehicle and its fuel utilization, especially in city driving.In this present work an endeavor has been done to assess the Natural frequency, mass comparison, elastic stresses and strains, deflection under subjected loads utilizing FEA. Facilitate correlation did for Steel materials and weight of the shaft is enhanced.

INTRODUCTION

DRIVE SHAFT

The term Drive shaft is a shaft, which is utilized to the transmit of motion starting with one point then onto the next.

Drive shafts are transporters of torque and are liable to torsion and shear pressure, proportionate to the distinction between the torque and the load. They should thusly be sufficiently solid to endure the pressure, while staying away from a lot of extra weight as that would thusly build their inactivity.

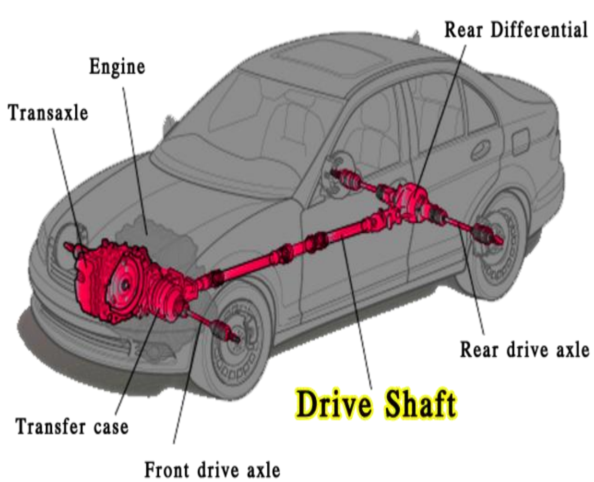


Figure. Drive Shaft Arrangement for an automotive

PURPOSE OF THE DRIVE SHAFT:

The torque that is created from the engine need to be exchanged to the returned wheels to drive the automobile ahead and turn around. The drive shaft must provide a smooth, continuous movement of power to the axles. The drive shaft and differential are utilized to trade this torque.

- In first, it must transmit torque from the transmission to the differential gear box.
- Amid the movement, it is essential to transmit most noteworthy low-prepare torque made by the engine.
- The drive shafts ought to moreover be fit for turning at the brisk velocities required by the vehicle.
- The drive shaft ought to moreover work through continually hinting at change edges between the transmission, the differential and the axles. As the back wheels move over blocks, the differential and axles climb and down. This improvement changes the edge between the transmission and the differential.
- The drive shaft length ought to similarly be fit for changing while in the meantime transmitting torque.

The Science of Drive Shaft:

When you hit the throttle, flywheel wheel is rotated by the engine. The flywheel trades essentialness to the transmission that is traded to the differential, turning the tires and putting the capacity to the ground. It's similarly as straightforward as that? The driveshaft is only an association between the tranny and the raised. The issue is this is the essential view about the driveshaft-it's a direct association. The reality of the situation is, while you can't get quality through the driveshaft, you can totally lose it.

COMPOSITE MATERIALS

The propelled composite materials, for instancecarbon fibers, Kevlar epoxy and Glass epoxy with Suitable tars are by and large used as a result of their high specific quality and high specific modulus. Propelled composite materials have all the earmarks of being preferably suited for long, control driver shaft applications. Their versatile properties can be customized to build the torque they can convey and additionally the rotational speed at which they work. The drive shafts are used in car, air ship and aviation applications.

Classification

And the major composite classes based on structural organization of the matrix are -

- Polymer-Matrix
- Metal- Matrix
- Ceramic- Matrix
- Carbon- Carbon
- Hybrid

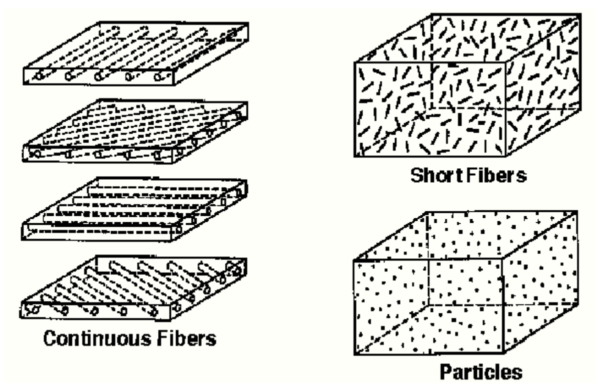


Figure Formation of laminate by composite materials

NANO COMPOSITE MATERIALS

Nanocomposite is a multiphase strong material where one of the stages has one, a couple of measurements of under 100 nanometers (nm), or structures having Nano-scale rehash removes between the particular stages that make up the material.
The thought behind Nanocomposite is to utilize building hinders with measurements in nanometer range to outline and make new materials with phenomenal flexibility and change in their physical properties.

Literature review

C. Sivakandhan&P.sureshprabhu[1], studied that the epoxy/glass fibrecomposite can be employed in the drive shaft. Moreover, author believes that the real ANSYS
analysis should be done to verify the stability ofdeveloped composite material under the proposedconcept. The usage of composite materials and optimization techniques has resulted in considerableamount of weight saving when compared toconventional steel drive shaft.

Ashwani Kumar, Rajat Jain and Pravin P. Patil[2], highlights the study of structural and modal analysis of single piece drive shaft for selection of material. Heavy vehicle medium duty transmission drive shaft was selected as research object.
L.V. Pavan Kumar Maddula, Ibrahim Awara [3], focused on fuel effectiveness of a vehicle and has driven the car business to investigate low weight elective plans for framework components. Agarwal B. D. and Broutman L. J extensively reviewed the theoretical details of composite materials and composite structures [4]. The Spicer U-Joint Division of Dana Corporation for the Ford Econoline van models developed the first composite propeller shaft

THEORY
MATERIAL:
Design Specifications:
Torsion is the fundamental load passes on by the drive shaft. It should have proposed to have enough torsional quality to pass on the torque without frustration. In addition, the probability of torsional catching must be considered for a thin tube. The third huge blueprint need is that the drive shaft has a bowing typical repeat which is sufficiently high. A perfect blueprint of the draft shaft is appealing, which is slightest costly and lightest anyway meets most of the above load requirements. In light of some tried and true assembled data the more than three load-passing on necessities are sketched out.

LOAD REQUIREMENTS FOR DRIVE SHAFT DESIGN:

Regular	Values	Safety factor
Peak torque for 10 lakh cycle reversed fatigue	670 N-m	3 for Nano composites, 2.0 for metals, composite
Minimum buckling torque	2050 N-m	1.05
Minimum bending natural frequency	95 Hz	0.05

DIMENSIONS FOR THE DRIVE SHAFT

Length of the drive shaft	1500 mm
Mean radius of the drive shaft	.5m

Design requirements and specifications

S.no	Name	Notation	Unit	Value
1	Ultimate Torque	Tmax	Nm	3500
2	Max. Speed of shaft	Nmax	Rpm	6500
3	Length Of Shaft	L	Mm	1250

In real scenario shaft is subjected to 3 types of effects, which are following and buckling, vibration and torsion

Design of Steel Drive Shaft

Mass of steel drive shaft:

"m= ρAL= ρ × Π/4 × (do2- di2) ×L" … (1)

= 7760 x 3.14/4 x (0.01– 0.0090) x 1.5

m = 8.91 Kg

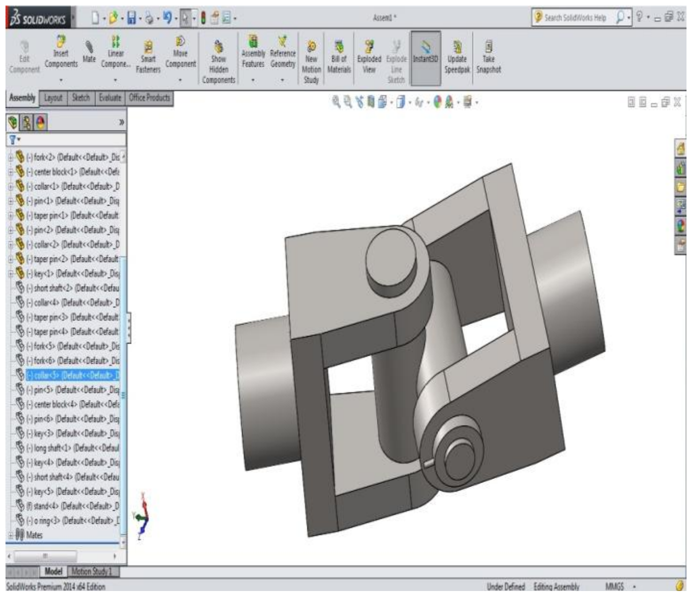
Torque transmission capacity of drive shaft:

T=Ss*π (do4 − di4)/16tdo

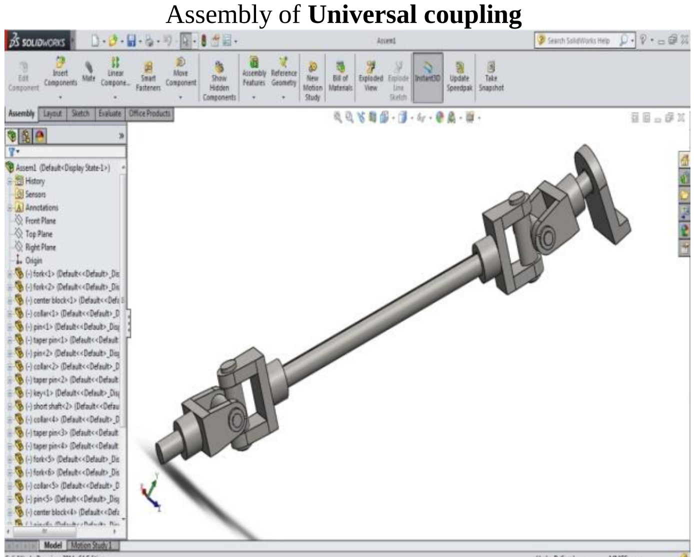
= 370*10^6* Π (0.1^4-0.095^4)/16*0.03*0.1 … (2)

T =44.919*10^3 N-m

Creating the modeling in Solid works:



Assembly of **Universal coupling**

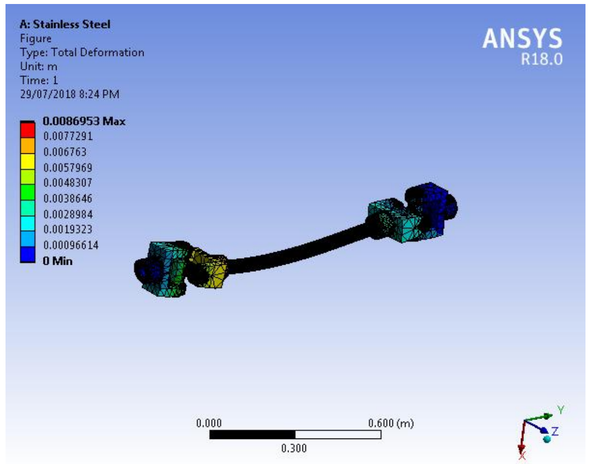


Assembly of **Drive shaft, either ends with universal coupling**

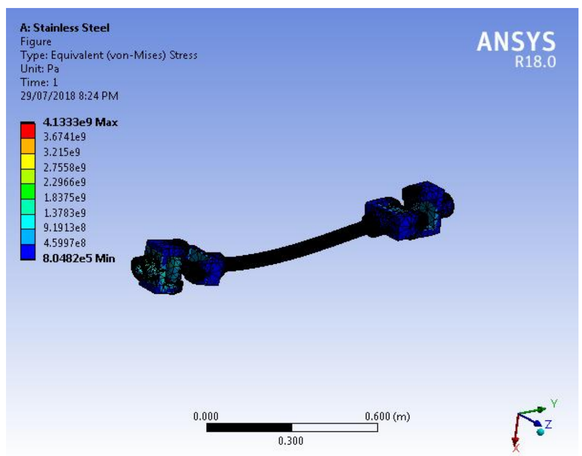
STATIC STRUCTURAL ANALYSIS:

This analysis decides the stresses &strains, displacements and forces in Component Shapes or segments due to loads that don't actuate huge inertia and damping impacts. Unfaltering stacking and reaction stipulations are accepted; that is, the lots and the structure's response are anticipated to fluctuate progressively as for time. It can be operated and executed by using the ANSYS solver

STEEL SHAFT

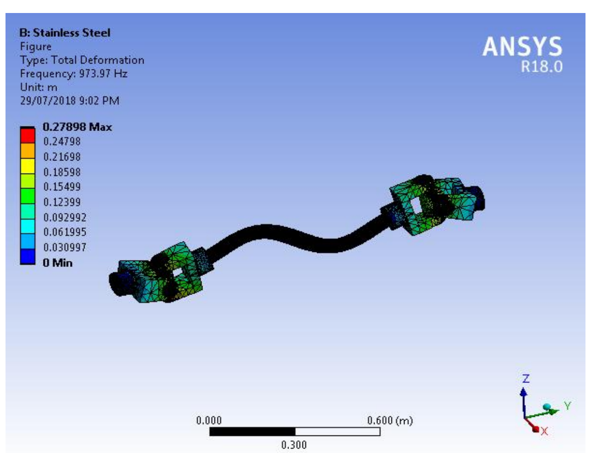


Total Deformation

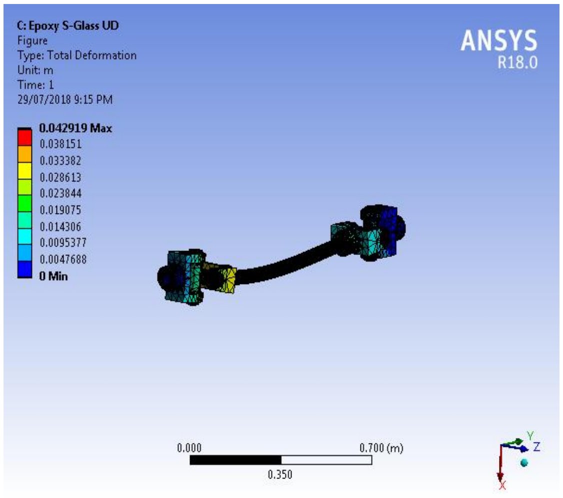


Equivalent Stress

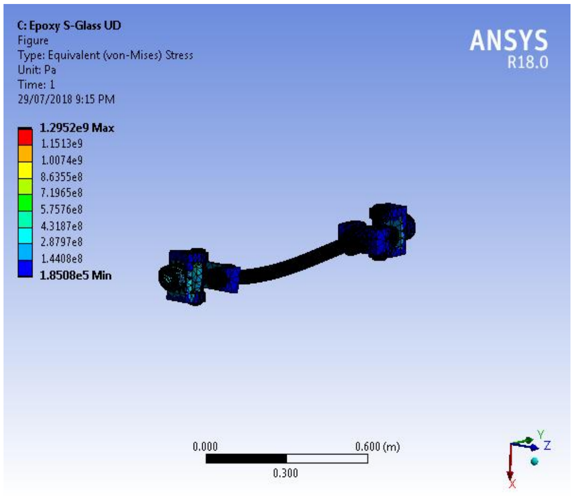
Modal analysis on steel



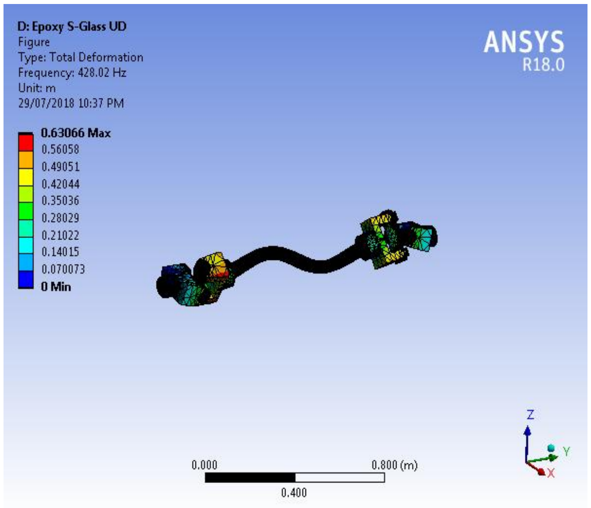
Kevlar epoxy - structural total deformation



Kevlar epoxy structural stress



Kevlar epoxy modal analysis



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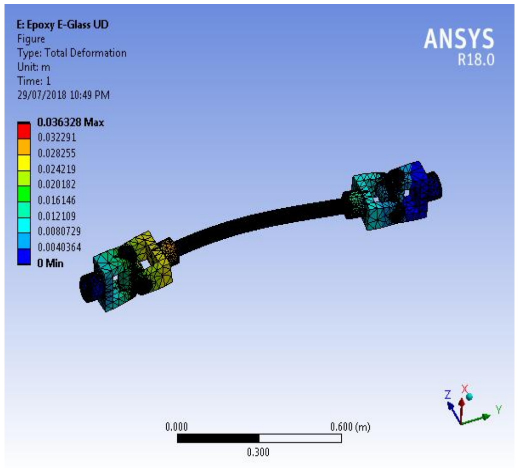
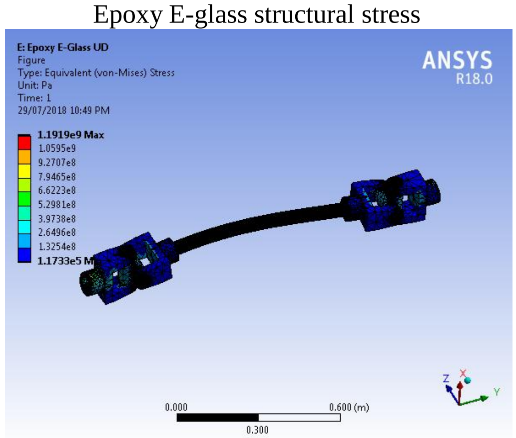
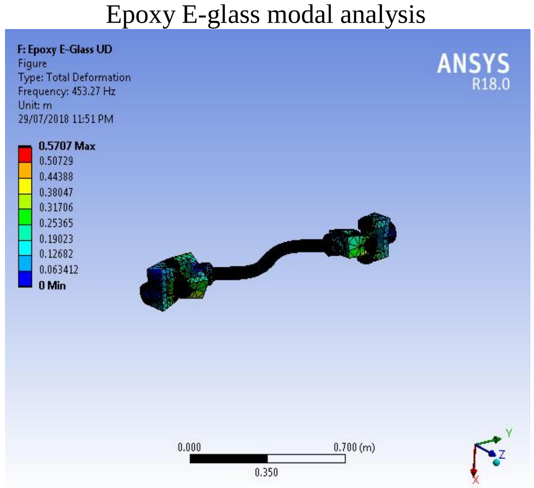
Epoxy E-glass structural total deformation



Epoxy E-glass structural stress

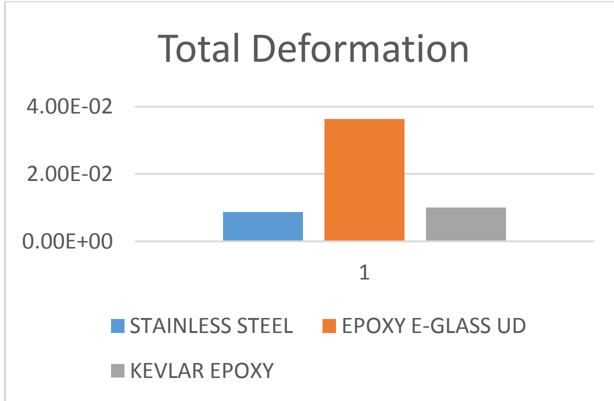


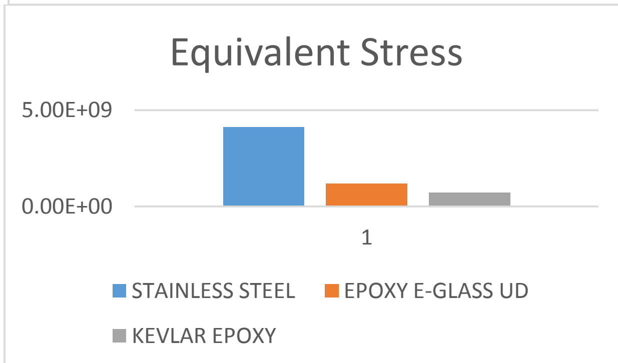
Epoxy E-glass modal analysis

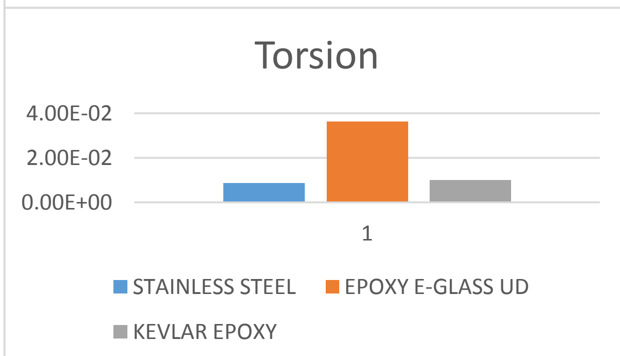


RESULTS AND DISCUSSIONS

The accompanying results are observed by the investigation and are appeared below by drawing an examination between Steel, Epoxy E-glass UD, Kevlar epoxy.

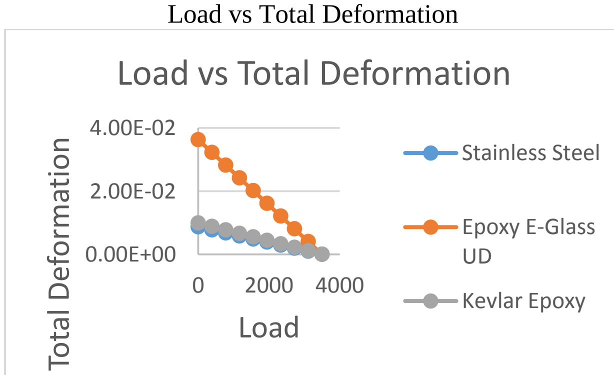




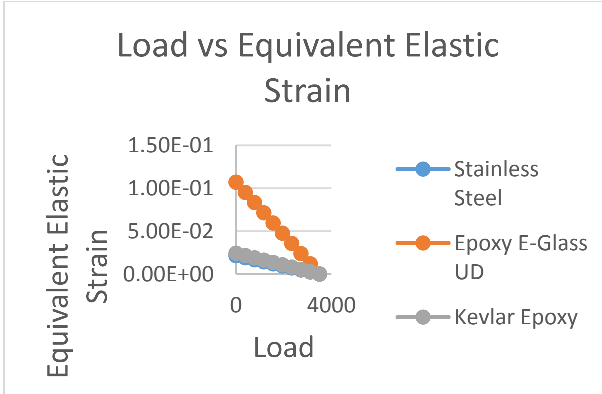


GRAPHS

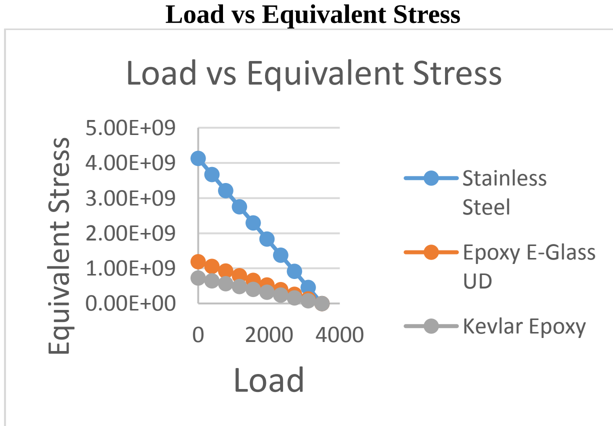
Load vs Total Deformation

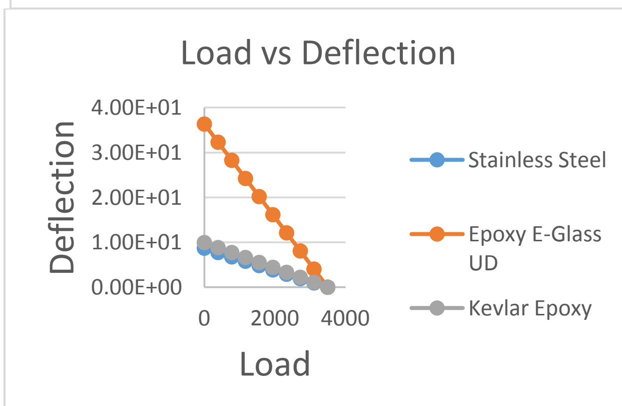


Load vs Equivalent Elastic Strain



Load vs Equivalent Stress



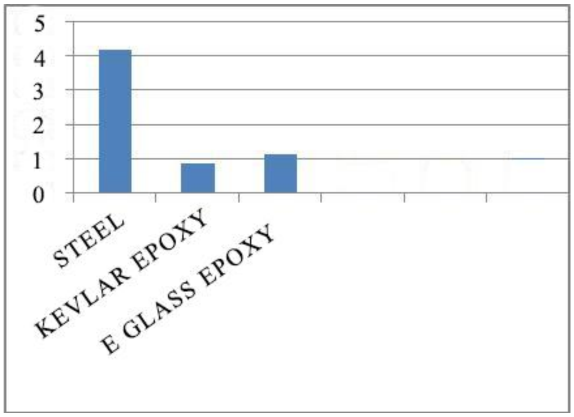


Load vs Deflection

Material	Total Deformation	Equivalent Elastic Strain	Equivalent Stress	Deflection	Frequency Hz	Torsion N/mm^2
Epoxy E-Glass UD	0.0363	0.1071	1.19E+09	36.328	75.639	0.036328
Kevlar Epoxy	0.0099	0.0242	1.01E+08	8.94	198.79	0.009937
Stainless Steel	0.0087	0.0214	4.13E+09	8.70	159.18	0.008695

The Weight Consideration between Steel, Kevlar Epoxy and Epoxy E glass UD Drive Shafts:

The weight of Kevlar epoxy drive shaft is much less as in contrast to different material, for example, steel and Epoxy E glass is proven in figure below



CONCLUSION

The usage of Nano composite materials has resulted in massive amount of weight saving in the range of 85% to 75% when in contrast to conventional steel drive shaft.

Focusing over of the weight deduction, deformation, deflection, torsional shear stress induced, Equivalent elastic stress and strain it is clear that Kevlar/epoxy composite has the most reassuring properties to go about as substitution to convectional steel

The present work was gone for diminishing the fuel utilization of the automobiles specifically or any machine, which utilizes drive shaft, when all is said in done. This was proficient by decreasing the mass of the drive shaft with the use of Nano composite materials.

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