AUTOMOBILE COMPOSITE DRIVE SHAFT MODELING AND MATERIAL OPTIMIZATION

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ABSTRACT

A mechanical device used in vehicles is the drive shaft. This drive shaft is most commonly referred to as a propeller shaft, and when it comes to construction, it is a long, cylindrical structure made up of three universal joints. The helical gear box is used to transmit the rotating motion from the drive shaft to the differential. The back wheels are driven by this rotating motion. Using CATIA parametric, which facilitates design automation and product development processes and, as a result, results in an ideal design, the 3D model of an automotive drive shaft is created. While composite shafts may be constructed as single-piece shafts, lowering the total weight, traditional drive shafts are made in two sections to reduce the bending natural frequency. The replacement of composite materials (Kevlar, e- glass epoxy) can results in considerable amount of weight reduction if compared to conventional steel shaft. The composite drive shaft made up of high modulus material is designed by using CAD software and tested in ANSYS for optimization of design or material check and providing a best material.

INTRODUCTION

Several different applications, such as cooling towers, pumping systems, aircraft, trucks, and cars, employ drive shafts as power transmission pipes. When designing a metallic shaft, the size of the shaft's cross section may be estimated by knowing the torque and the maximum permitted shear stress for the material. The shaft inner radius has a unique value when the outer radius is constrained by the area beneath the vehicle cabin because the geometric parameter (polar moment of inertia of the cross-sectional area divided by the outer radius) equals the torque divided by the allowed shear stress. The drawbacks of metallic drive shafts are their weight, low critical speed, and vibration properties. Several automotive and industrial issues associated with the use of traditional metal drive shafts have been resolved by composite drive shafts ones because the performance is limited due to lower critical speed, weight, fatigue and vibration. Numerous solutions such as flywheels, harmonic dampers, vibration shock absorbers and multiple shafts with bearings, couplings, and heavy associated hardware have shown limited success in overcoming the problems. When the length of steel drive shaft is beyond 1500 mm, it is manufactured in two pieces to increase the fundamental natural frequency, which is inversely proportional to the square length and proportional to the square root of specific modulus. A drive shaft of composites offers excellent vibration damping, cabin comfort, reduction of wear on drive train componentsand increasing tires traction. In addition, the use of one piece torque tube reduces assembly time, inventory cost, maintenance, and part complexity. The term Drive shaft is used to refer to a shaft, whichis used for the transfer of motion from one point to another. Whereas the shaft, which propel are referred to as the propeller shaft. Propellers are usually associated with ships and planes as they are propelled in water or air using a propeller shaft because apart from transmitting the rotary motion from the front end to the rear end of the vehicle forward. The shaft is the primary connection between the front and the rear end which performs both the motion and propelling the front end. Thus, the terms Drive Shaft and Propeller Shaft are used interchangeably.

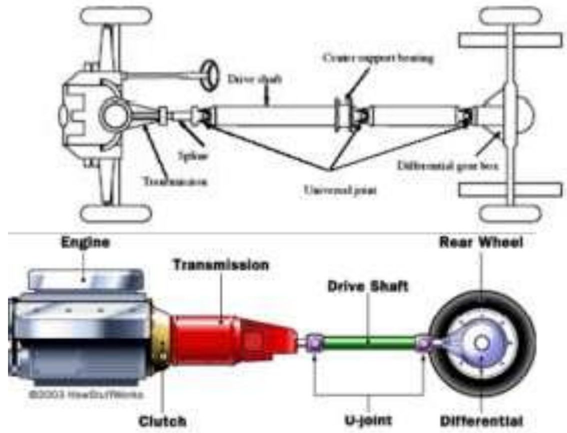


Fig : Conventional Two-Piece Drive ShaftArrangement

The propeller shaft is a longitudinal drive shaft used in vehicles where the engine is situated at the opposite end of the vehicle to the driven wheels. A propeller shaft is an assembly of one or more tubular shaft connected by universal, constant velocity or flexible joints. The number of tubular pieces and the joints depends on the distance between the gearbox and the axle. On some four wheel drive vehicles one propeller shaft is used to power the rear wheels as with rear wheel drive and a second propeller shaft is used to power the front wheels. In this case the second propeller shaft is replaced between a transfer gear box and the front axle. Hence, it can be observedthat a drive shaft is one of the most important components, which is responsible for the actual movement of the vehicle once the motion is producedin the engine. The designing of such a critical component is usually stringent, as any fracture in this part could lead to as catastrophic failure of the vehicle when it is in motion.

LITERATURE REVIEW

L.V. Pavan Kumar Maddula, Ibrahim Awara. Concentrated on fuel effectiveness and vehicle outflows and has driven the car business to investigate low weight elective plans for power train framework components. The display work clarifies how a potential outline change of drive shafts driven by a longing to decrease weight and cost can prompt to NVH (Noise, Vibrational& Harshness) issues brought on by driveshaft resonances and clarifies how utilizing numerous dynamic vibration safeguards(DVA) can tackle the issue to meet client desire while enhancing efficiency.

CuipingFeng, Zhihong Dong, Yuliang Yang, ChaoxingXie, Kai Wanget. With the guide of Finite Element Analysis (FEA) and enhancement programming, communications between various DVA's on a framework was comprehended and ideal damper parameters for compelling damping was distinguished. The last DVA configuration was tried and checked on the vehicle for ideal trait execution. Victor Baumhardt, ValdineiSczibor[3]have concentrated the significance of Halfshafts as Halfshafts are essential segments from vehicle powertrain. They are the components mindful to transmit torque and revolution from transmission to wheels. Its fundamental plan comprise of a strong bar with joints at every outrageous. Be that as it may, contingent upon its length, the regular recurrence of first bowingmode may have a model arrangement with motor, bringing about undesired clamor on vehicle inside. Joseph V. Gabiniewicz, Douglas M. Dough puncher, Michael Testani[4] Historically, driveshaft torque information has been gotten utilizing slip rings. Sliprings, in any case, are costly, and require time-seriousdriveshaft alterations for appropriate establishment. Also, the time and cost required in field overhauling units is restrictive Chaithanya G Rothe et. al., broke down the outline requirements because of the physical geometry (bigger range) of the drive shafts utilized as a part of the said applications, including car applications, the shear quality which determines the heap conveying limit, is of minor plan significance since the disappointment mode is commanded by clasping;

along these lines, the fundamental outline components are the twisting common recurrence and the torsional clasping quality, which are elements of the longitudinal and loop bowing firmness, individually. The variable of the cover thickness bigly affects the clasping quality, and a slight impact on the bowing regular recurrence.

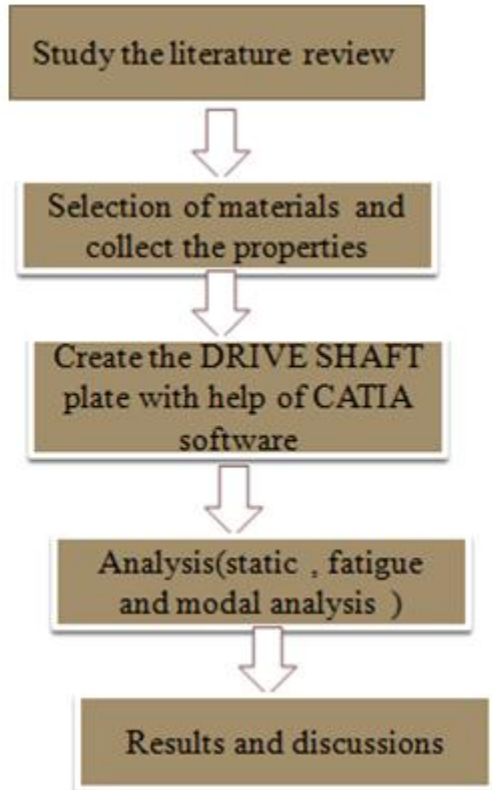
MATERIALS USED

A drive shaft can be made of different materials based on required strength and service conditions. In this an examination is established on materials of iron family element, an alloy and a carbon element. This gives a better choice of chain sprocket based on application. As materials reduce in weight, noise and cost will improve efficiency of drive shaft .

Properties	Steel	E-glass	Kevlar	Boron
Density(Kg/m^3)	7850	1950	1440	2450
Young's modulus (GPa)	207	52.36	132	420
Poisson's ratio	0.3	0.24	0.35	0.2

Dimensions of Drive Shaft:				
S.No		Description	Notations	Value
1		Outer diameter	D	70mm
2		Inner diameter	d	56mm
3		Thickness of the shaft	t	7mm
4		Length of the shaft	L	1800mm
5		Radius of the shaft	r	31.5mm

METHODOLOGY



MODELING AND ANALYSIS

In industry there are created a variety of problems to be solved and for their solutions various methods and procedures exist. The role of technical education is also to show to students the instruments and to enable them to gain practical experience for solving problems in production . CAx applications are one of theses options, as some production challenges effectively addressed them and it is therefore important that students meet with significant representatives. In particular it is the area of CAD, CAM and CAE. Teaching for CAD/CAM/CAE systems at technical universities is an important area of the education of students. By gaining experience in using the software from the areas of computer aided design, manufacturing, engineering, etc. the opportunities are increased to the students in the labour market, especially in industrial areas. This is important now that around the cities industrial zones are being made and the companies in these zones often use different software of this type.

Fig : 3d model of drive shaft INTRODUCTION ANALYSIS

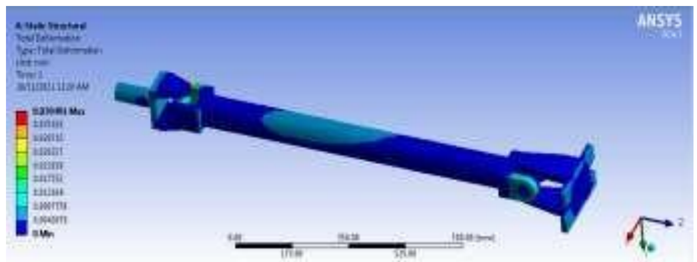
Structural analysis software enables you to solve complex structural engineering problems and make better, faster design decisions. Structural analysis is a thorough evaluation to guarantee that the distortions in basic investigation a structure will be enough lower than as far as possible, and disappointment of basic won't happen. The point of basic investigation is to plan a structure that has the correct quality, inflexibility, and wellbeing. Disfigurements in a structure can be either flexible that is absolutely recoverable, or inelastic that is lasting. Auxiliary examination aids the plan of structures that meet their useful prerequisites, are practical and alluring. Basic examination incorporates the orders of mechanics, elements, and disappointment hypotheses to register the inward powers and weights on the structures to be planned. It simply means the analysis of structures for the external forces acting upon it. It is only after the analysis; one will be able to design the structure accordingly to carry out those loads safely during the life span of the structure.

FATIGUE ANALYSIS

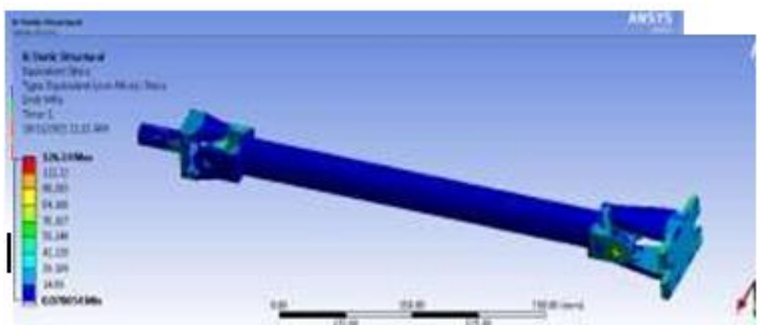
Fatigue Analysis Overview. Description. Fatigueanalysis establishes whether your modelissusceptible to fatigue damage when subjected to avarying load. You can use constant amplitude loadingfor situations in which the stress cycles are regular,such as a rotating shaft operating at a constant speed.

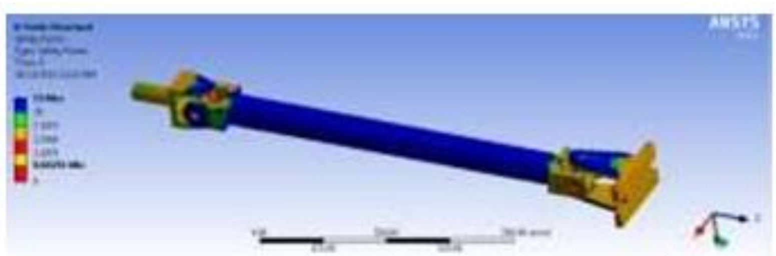
STATIC ANALYSIS OF DRIVE SHAFT

TOTAL DEFORMATION

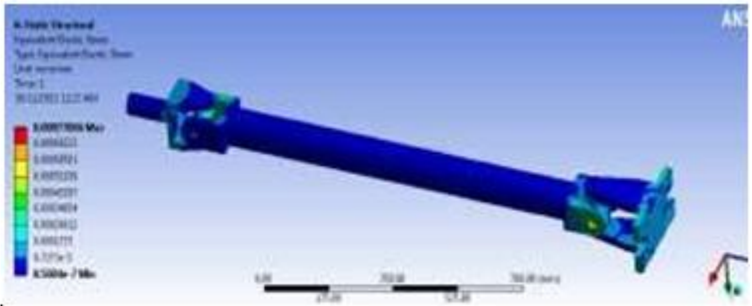


VON-MISES STRESS

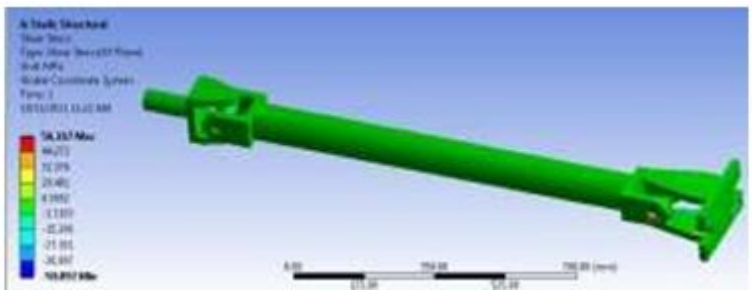




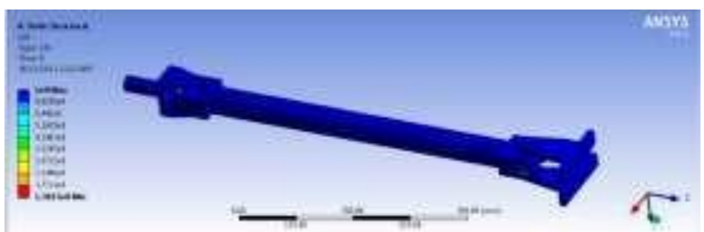
STRAIN



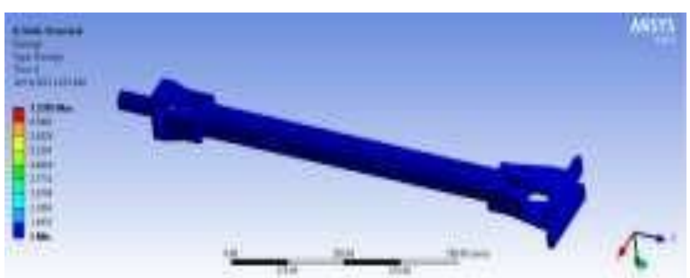
SHEAR STRESS



FATUIGE ANALYSISLIFE

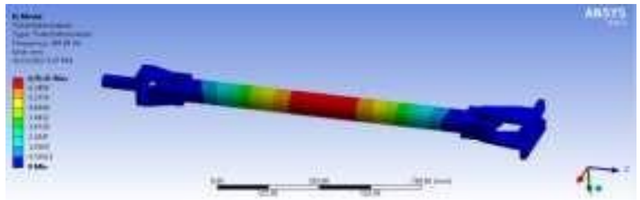


DAMAGE

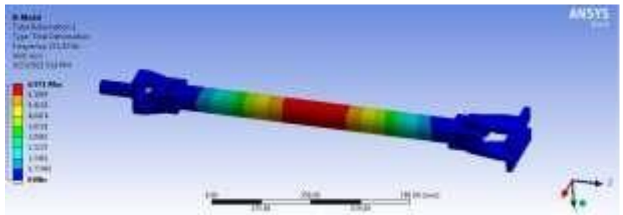


SAFTEY FACTOR

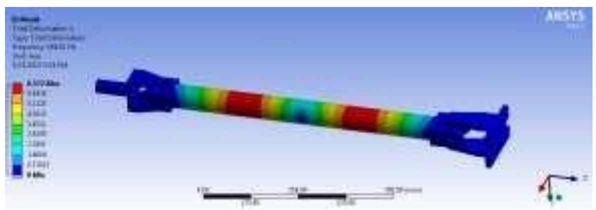
MODAL ANALYSIS OF DRIVE SHAFTTOTAL DEFORMATION 1



TOTAL DEFORMATION 2



TOTAL DEFORMATION 3



RESULTS AND DISCUSSIONS

Table: static analysis results

Material	Deformation (mm)	Stress (N/mm²)	Strain	Shear stress (N/mm²)
AISI 1050 steel	0.04178	133.56	0.00082579	59.423
Kevlar	0.039491	126.24	0.00077866	56.167
E-GLASS	0.038371	122.66	0.00075657	54.574
BORON	0.037267	119.13	0.0007348	53.004

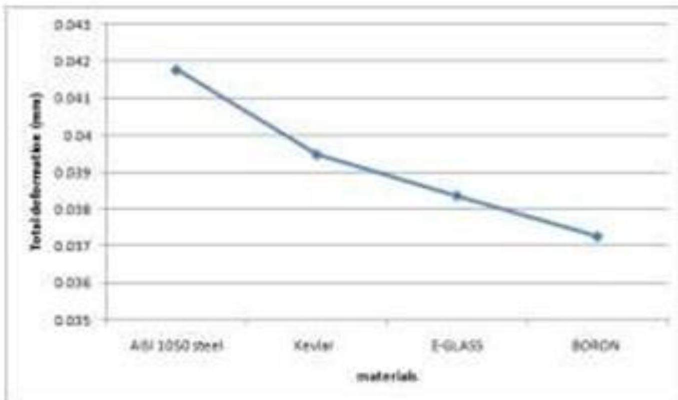
Table: fatigue analysis results

Material	Life		Damage	Safety factor	
	Min	Max		Min	Max
AISI 1050 steel	1.125e-8	1e-9	8.8814	0.642	15
Kevlar	1.38e-8	1e-9	7.2395	0.682	15
E-GLASS	1.53e-8	1e-9	6.5218	0.702	15
BORON	1.704e-8	1e-9	5.8663	0.723	15

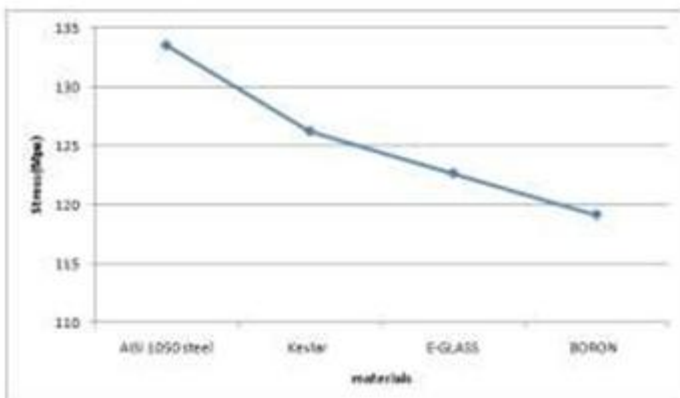
Table : Modal analysis results

Material	Mode1 (mm)	Frequency (Hz)	Mode2 (mm)	Frequency (Hz)	Mode3 (mm)	Frequ (Hz)
AISI 1050 steel	6.9141	209.45	6.971	231.43	6.572	894.8
Kevlar	6.9214	214.72	6.9711	236.21	6.5721	896.0
E-GLASS	6.9363	221.6	6.9934	242.61	6.593	900.3
BORON	6.9364	231.12	6.9935	251.33	6.5931	902.6

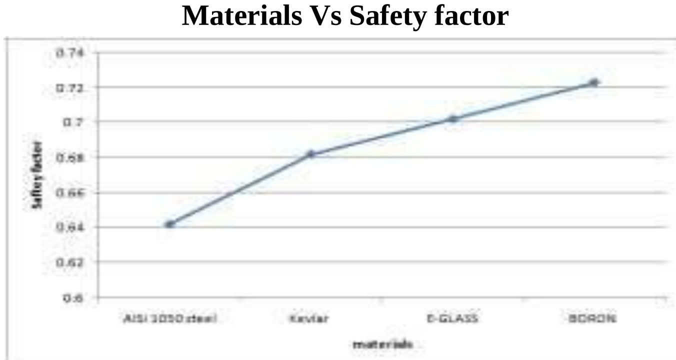
Materials Vs deformation



Materials Vs Stress



Materials Vs Safety factor



CONCLUSION

In this project, steel is an option (AISI 1050 steel, Kevlar , E-GLASS and BORON FIBERS). The four materials for the drive shaft can be examined. Check the various loads and stresses as well. In order to examine the effects of stable loading conditions on a structure, static and fatigue analyses are utilized. We may select that material for the drive shaft by acquiring the greatest results.
The goal of the study that was given was to decrease the amount of gasoline used by any machine that uses drive shafts, whether it be a car in particular or a machine in general (AISI 1050 steel, Kevlar , E-GLASS and BORON FIBERS) seeing the outcomes of the static analysis, the Von misses and shear stress minimum at boron fiber when we compared to other and existing materials. By observing the Fatigue analysis results, the safety factor Maximum at boron fiber when we compared toother and existing materials
So we can prefer to use the boron fiber material for designing of the drive shaft.

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