Methodology for Analysis of FEA Designing and Stress of Propeller Shaft

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ABSTRACT: This paper deals with enhancing the shear stress shaft by changing material use in construction of the propeller shaft to obtained to reduce the weight in the previous study. Further, to design the parallel shaft with the suitable material which minimize the maximum stress level compare to the previous study.

1. Introduction

In all vehicles, the driving force allows the outer motorcycle to turn faster than the inner motorcycle in curves [1,2]. It is important that the outer bike turns faster than the inner bike, which is very important for the rotation of the car. This would help the wheel spin efficiently. The external and internal speed of two drive wheels corresponds to the input speed of the crankshaft. The increase in the speed of one wheel is well regulated by decreasing the speed of the other wheel. The differential mechanism is activated via the longitudinal drive shaft towards the pinion, causing the pinion to rotate. This feature would reduce the number of gears in the system. The driveshaft (also known as driveshaft or cardan shaft) is a component of a vehicle's transmission to transfer torque from the gearbox to the differential, which then transfers that torque to the wheels to move the vehicle [2] used to transmit the pair between components separated by a distance, as different components must be in different places in the vehicle. A front-engined rear-wheel drive car should have a long driveshaft connecting the rear axle to the transmission, as these parts are located on opposite sides of the car. Until driving on the wheels, a car may use a transmission shaft to distribute energy from an engine/transmission towards the other side of the car. To pass energy from a central differential, transmission, or transmission to the wheels, two short transmission shafts are widely used. There are two forms: a single universal ligament spinning rod and a multiple or more ligaments most commonly supported by Hotchkiss. Pan Hard Lavas has branded or patented this device as a Pan Hard system. A half shaft is a transmission shaft that links a rear differential to a rear wheel. The fact indicates that a back axle is made up of two of these trees. Instead of a transmission shaft, early cars used chain or belt systems. To transfer energy to the wheels, others have used generators and electric motors. A propeller shaft or transmission shaft is a transmission shaft that links the transmission to the rear differential. A sliding joint and one or more of the universal joints are part of the cardan shaft. The automotive industry uses different types of transmission shafts: One-piece drive shaft, two-piece drive shaft, crossing axis. There were at least two transmission shafts, one from the transmission box to each axle. The transmission case was central to some larger vehicles and was driven by a short driving shaft. The front axle drive wing is considerably shorter and stiffer for vehicles the size of a Land Rover than the rear axle, making it harder to build a reliable motor shaft. The universal articulation presents a more sophisticated form. On a shaft connector a “shaft protector” is used to protect the shaft against contact and to detect failures. A transmission jointly develops the main engine to the transmission on a transmission test bench. Motorcycle motors are frequently designed with the drive shaft extending in longitudinal direction and parallel to the frame. Instead of two rotations in the power transmission, only one is needed.

2. Literature Review

Paboeuf et al. [1] explained the design steps leading up to the demonstrator, from hydrodynamic calculations to structural assessment and comprehensive sea trials.

Choi et al. [2] argued that in today's reality, where the technical development of the automobile must be environmentally friendly and highly efficient, a reduction in the weight of the driveshaft is also necessary for the operation of the car. Some car manufacturers have developed the driveshaft for automotive actuators and are applying it to their production, achieving a weight reduction of more than 30% by replacing steel materials with high strength aluminum alloys. For the propeller shaft, high-rigidity, high-precision aluminum tube manufacturing technology is required due to noise and vibration problems. In this study, 7003 aluminum alloy seamless tubes are hot extruded and cold drawn. Forming processes are simulated and modified to reduce plastic deformations and standardize them. More valuable tubes can be obtained through modifications. Extrusion with hollow billets and optimization of drawing tools for the production of high strength and precision aluminum tubes for the drive shaft are introduced.

Ganguly et al. [3] is a multi-layer viscoelastic drive shaft mounted on three plain bearings. The higher order finite element model is developed using an operator-based constitutive relationship that includes various asymmetries from various sources such as gyroscopic effect, internal damping and sleeve bearing support. A large number of higher-order model states and the presence of asymmetry complicate the post-processing system. Modified System Equivalent Reduction Expansion (SEREP) process is applied for model reduction where the left and right eigenvectors of the original propeller shaft system are used. Different numerical results are compared to test the efficiency of the reduced model. Although SEREP can be found in the literature, its application to the more realistic higher-order asymmetric system is entirely new.

Kumar et al. [4] discussed the fact that although most ship propellers are composed almost entirely of metal alloys, there has recently been a trend towards studying propeller composite materials. Carbon fiber is therefore a strong candidate as an alternative material for propellers due to its extremely high strength and favorable strength / weight ratio. This article examines the design, analysis, and basic force aspects of a carbon composite propeller for use as a pod propulsion unit. Propellers are dynamic rotor machines and are subject to fatigue. It is therefore one of the important considerations in choosing the material. Therefore, a long-term study must be well established not only in terms of strength, hydrodynamic performance, but also fatigue properties if carbon composite propellers are to be used in place of traditional propellers. This study presents the design of a helix based on a favorable orientation of the stack of multiple layers using unidirectional carbon fiber and epoxy resin, the manufacturing technique and the results of hydrodynamic performance tests. To this end, the propeller conforms to standard NACA profiles for high efficiency. The study reports the force analysis based on the modeling of the sequence of the layers and the mapping of the directional properties of carbon fiber. To validate the results, a segmented load frame was designed and the strains measured in the radial direction. The results allow to verify the deformations obtained and therefore to confirm the analytical approach to obtain dynamic stresses and deformations.

Kulakov et al. [5] used literature data to analyze the theoretical loads that develop in the ship's shaft. An examination of the stress state of different thicknesses of fiberglass and carbon-reinforced plastic shafts is performed, which are loaded with axial force, torque and bending by concentrated force. The results provide the information needed to optimize the design of composite ship wells.

Rao et al. [6] This article is dedicated to studies on carbon-reinforced plastic (CFRP) and composite FRP hollow shafts for motor vehicles. The failure analysis was performed using the maximum stress criteria and it was found that the fault torque is much higher than the nominal torque.

Mohammed et al. [7] This study on reducing the weight of the crankshaft can play a role in the overall reduction of vehicle weight and is a very desirable goal. The replacement of conventional metal structures with composite structures has many advantages due to the greater specific rigidity and strength of the composites. Advanced composites such as graphite, carbon, kevlar and glass with appropriate resins are widely used due to their high specific strength and high specific modulus. Advanced composites seem to be ideal for long shaft applications. The automotive industry uses composite technology to build components to reduce weight without compromising the quality and reliability of the vehicle. It is known that energy saving is one of the most important goals in vehicle design and that weight reduction is one of the most effective measures to achieve this result. In fact, there is an almost direct proportionality between the weight of a vehicle and its fuel consumption, especially when driving in the city. This project is currently being analyzed on a transmission shaft made of various composite materials and concludes that the use of composite materials for the propeller shaft would reduce the load, which would further reduce the weight of the vehicle. CATIA is the modeling software package for the propeller shaft assembly and ANSYS, the analysis software package for performing the analysis.

Hatwar et al. [8] In this article, polymer materials reinforced with synthetic fibers such as glass, carbon and aramid are presented, as well as the advantages of high rigidity and a high strength-to-weight ratio compared to construction materials. classics, me. h. Wood, concrete and steel, offer.

3. Methodology

Analysis of Shaft by Application Of Fem Under Static Conditions

The static behavior analysis with the ANSYS 18.5 software was performed on the shaft of a centrifugal pump. The above analysis is performed for loads including:

• Effect of radial force between two bearings e

• Couple at the start of the tree.

Modeling and analysis of the static behavior of the wave take place in a concrete case according to a defined procedure, carried out in the following phases:

a. Modeling of the pump shaft;

b. Discretization of the geometric model;

c. Discretization of the geometric model through the network of finite elements;

d. Definition of boundary conditions and load;

e. Processing - resolution of the general mathematical model; is

f. Presentation of the calculation results in numerical and graphic form.

By graphically representing the status of the model analyzed, the following representations are provided: Contour (which shows changes in shifts and characteristic stresses throughout the model, with the boundaries between adjacent areas indicated by solid lines);

b. the deformed model under load;

c. Reaction forces on the model.

Preparation of model

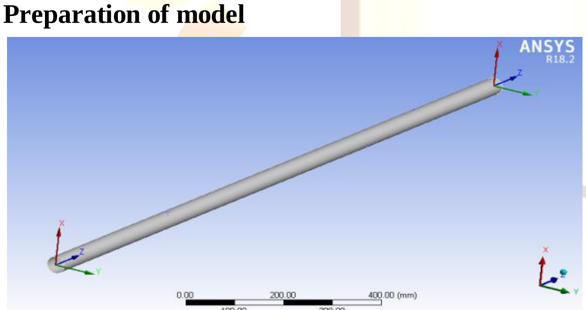

Figure 1: CAD model in shaft ANSYS

Properties	Value
Density (kg/m^3)	1600 kg/m3
Elastic modulus (pa)	1.9e+011
Poisson ratio	0.3

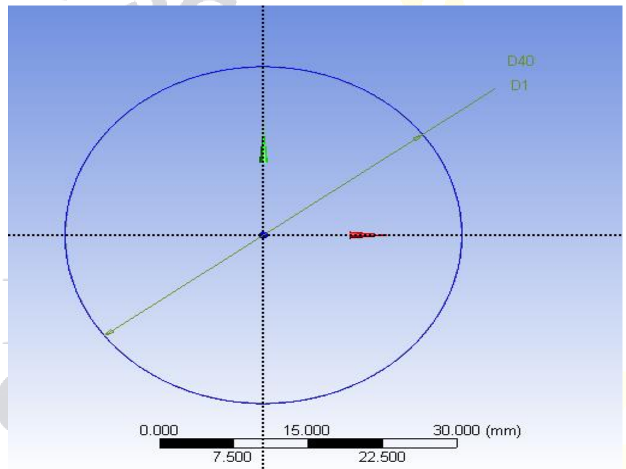

Figure 2: front view on shaft

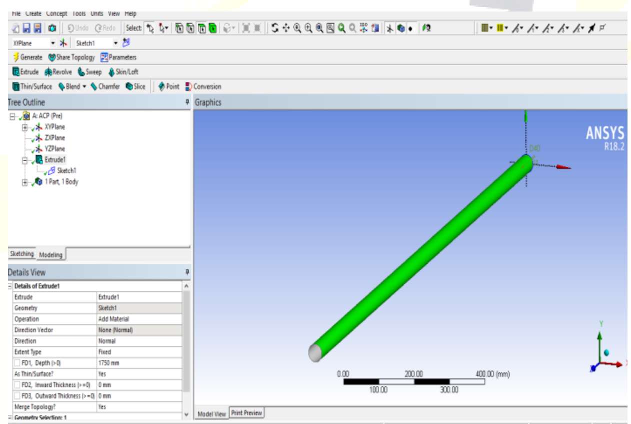

Figure 3: dimensions of shaft

4 Boundary Condition

Define Boundary conditions:-

As the figure 4 shows one end of the transmission shaft is fixed to a shaft connected to the gearbox. Therefore, all degrees of freedom are stopped for this purpose, as shown in Figure 4. Another end of the shaft is connected to the differential shaft. When the gimbal is subjected to a torque (2030 Nm), a moment is applied around the Z axis, as shown in the figure.

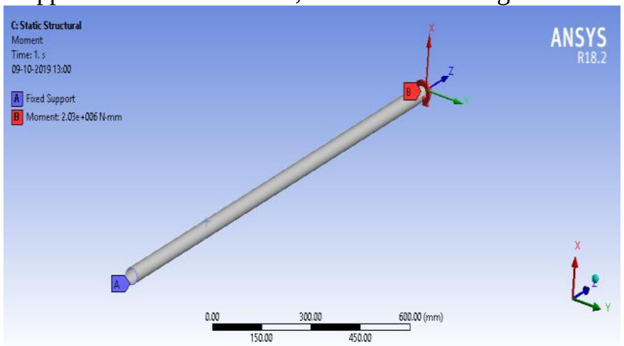

Figure 4: Define boundary conditions

In this study two material used for analysis Carbon HM and Carbon

Validation:-

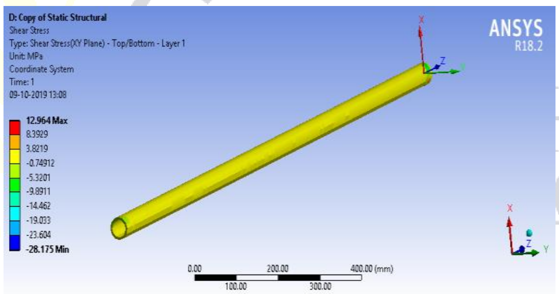

Figure 5: Top layer-1 shear stress value

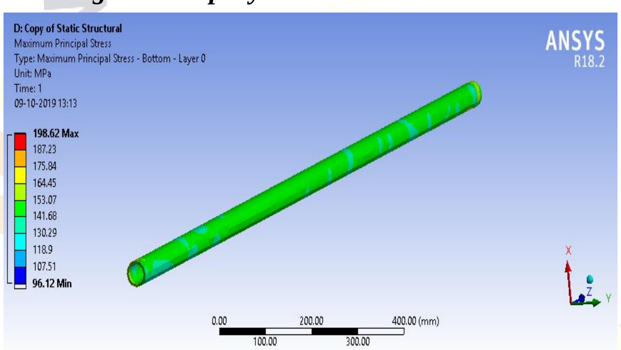

Figure 6 Equivalent stress

1. **Case-2 New material analysis :-**

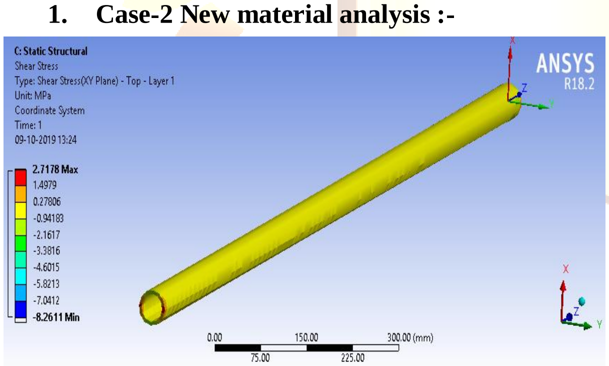

Figure 7 Shear stress for Layer 1(Top)

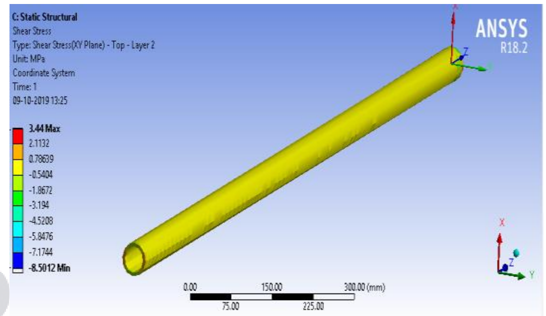

Figure 8 Shear stress for Layer 2(Top)

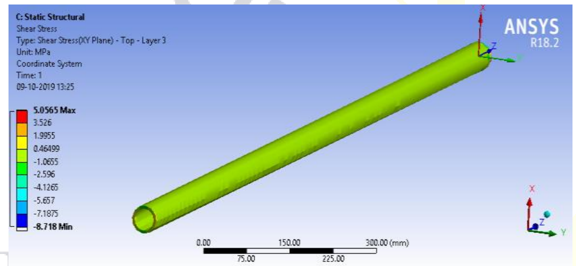

Figure 9 Shear stress for Layer 3(Top)

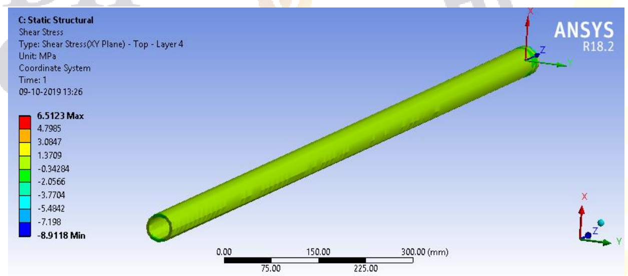

Figure 10: Shear stress for Layer 4(Top)

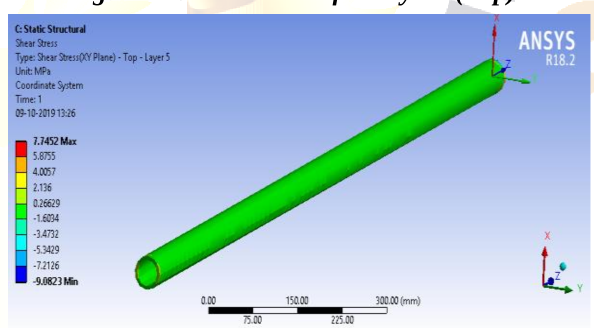

Figure 11 Shear stress for Layer 5(Top)

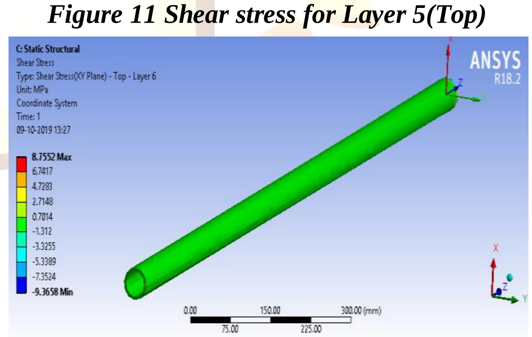

Figure 12 Shear stress for Layer 6(Top)

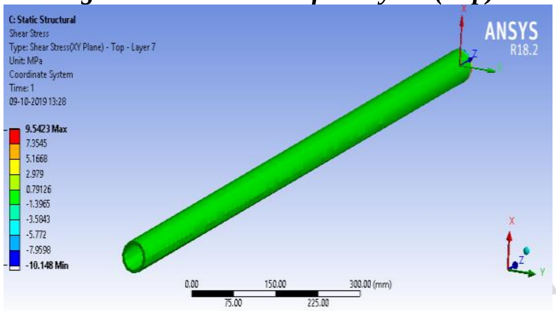

Figure 13 Shear stress for Layer 7(Top)

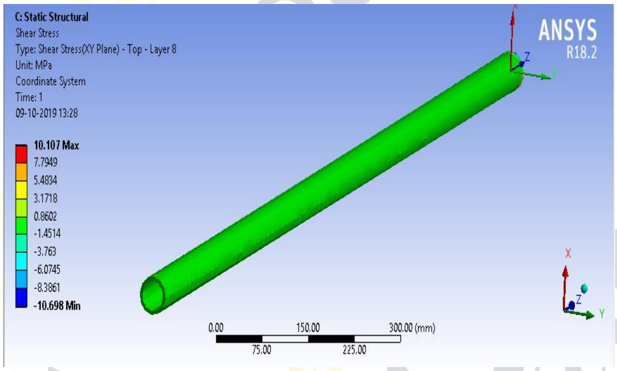

Figure 14 Shear stress for Layer 8(Top)

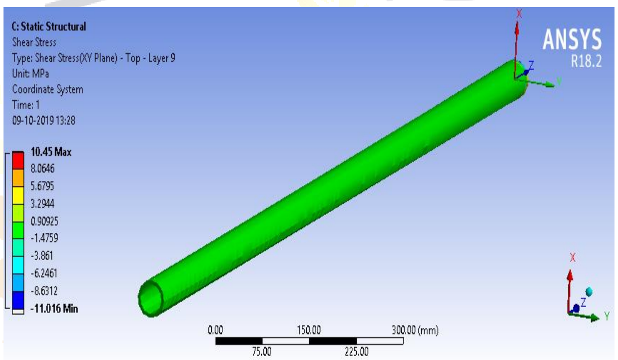

Figure 15 Shear stress for Layer 9(Top)

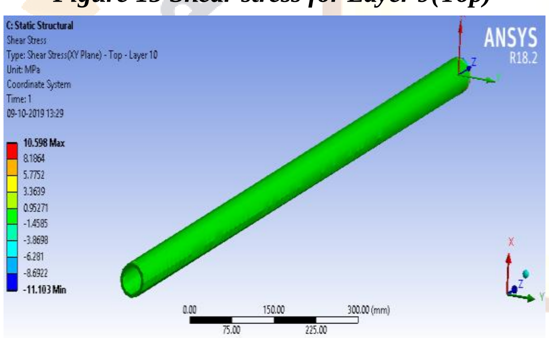

Figure 16 Shear stress for Layer 10(Top)

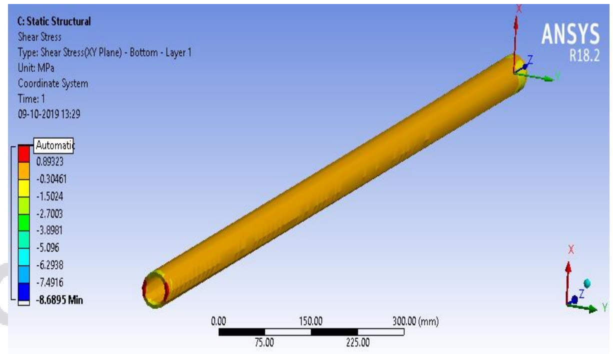

Figure 17 Shear stress for Layer 1(Bottom)

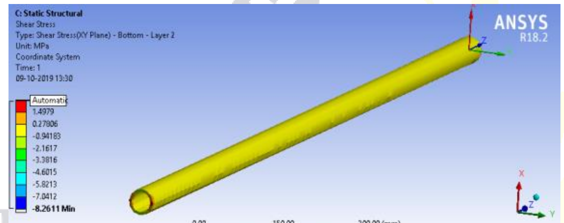

Figure 18 Shear stress for Layer 2(Bottom)

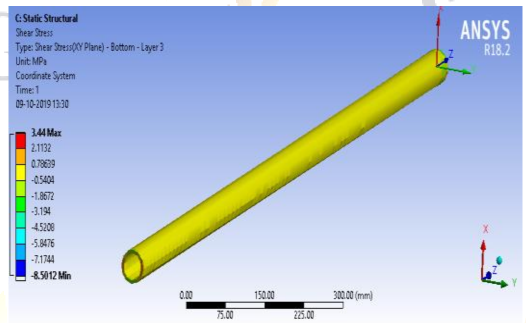

Figure 19 Shear stress for Layer 3(Bottom)

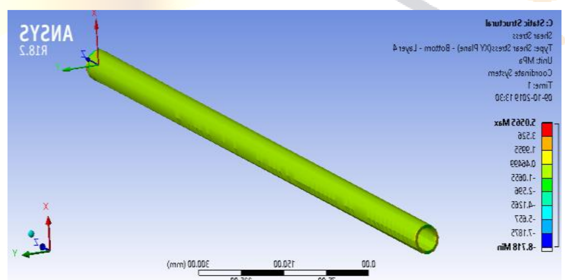

Figure 20 Shear stress for Layer 4(Bottom)

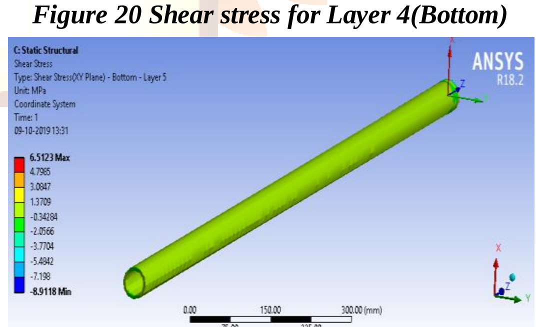

Figure 21 Shear stress for Layer 5(Bottom)

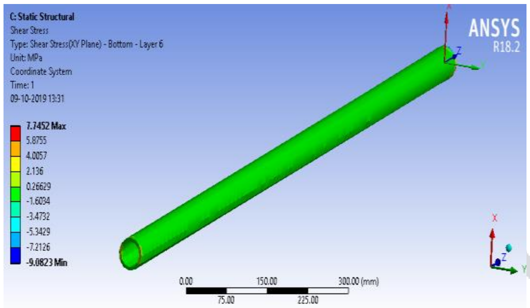

Figure 22 Shear stress for Layer 6(Bottom)

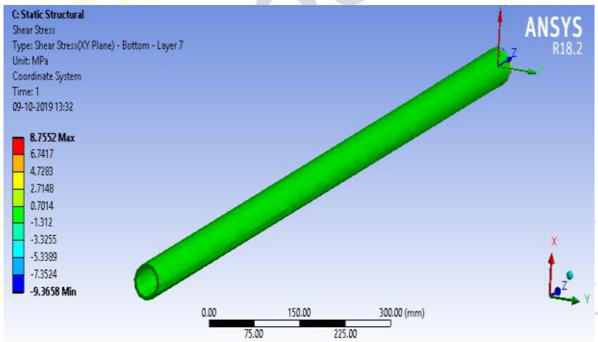

Figure 23 Shear stress for Layer 7(Bottom)

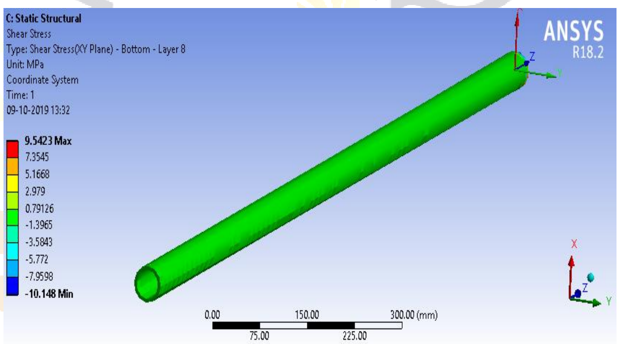

Figure 24 Shear stress for Layer 8(Bottom)

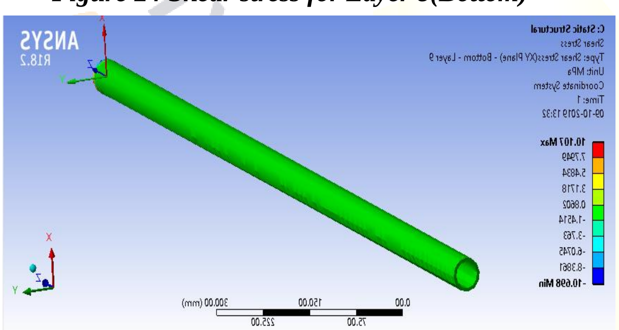

Figure 25 Shear stress for Layer 9(Bottom)

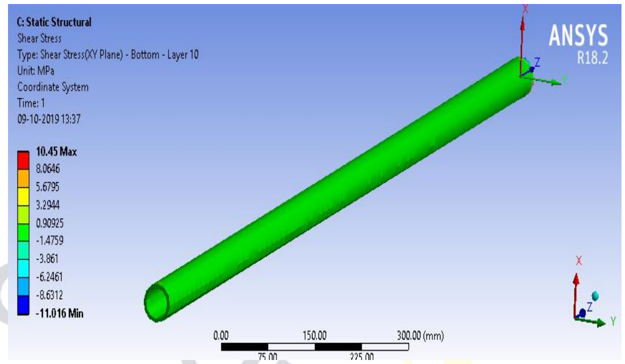

Figure 26 Shear stress for Layer 10(Bottom)

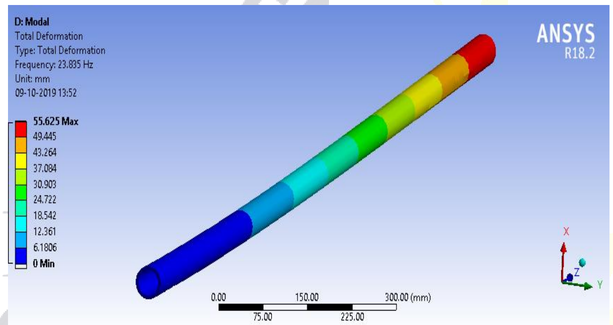

Figure 27 Analysis of deformation at 23.8Hz frequency

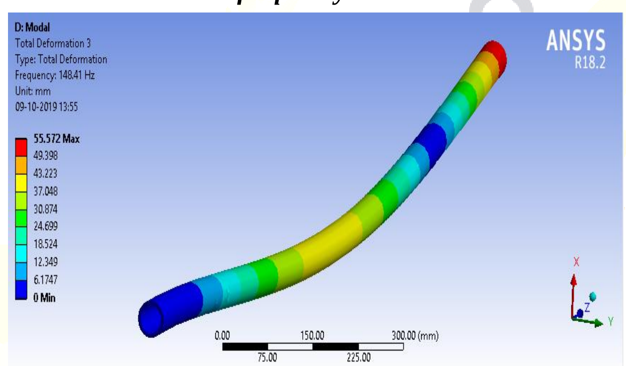

Figure 28 Analysis of deformation at 148.41Hz frequency

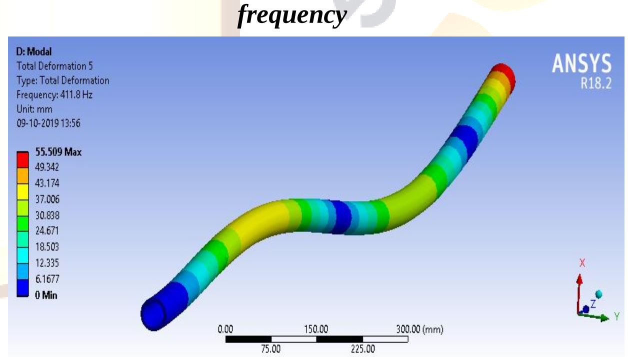

Figure 29 Analysis of deformation at 411.8Hz frequency

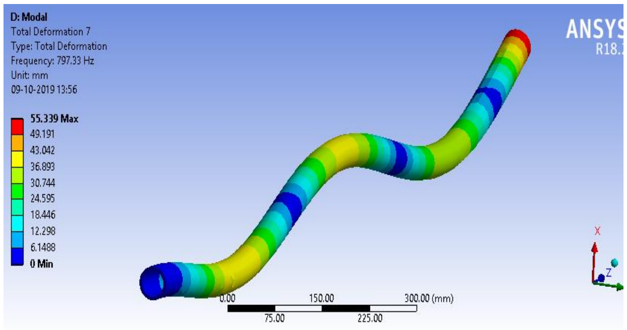

Figure 30 Analysis of deformation at 797.33 Hz frequency

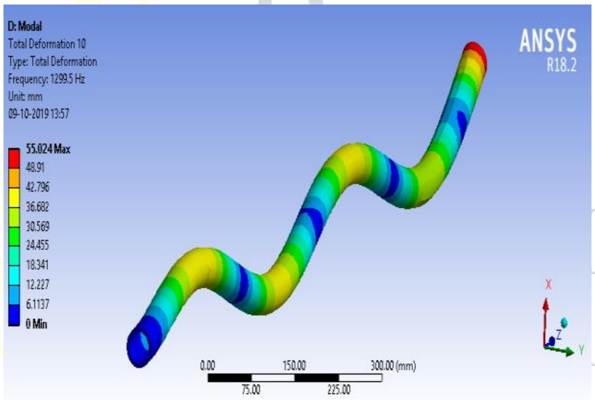

Figure 31 Analysis of deformation at 1299.5 Hz frequency

4. Conclusion

The total weight of carbon fiber shaft is reduced. The total weight of the carbon fiber shaft is 2.4 kg is less then to previous study material. The maximum stress obtained in the shaft is 181Mpa is lower than pervious result. The share stress value in top first layer is 2.68 mm and top final layer 9.59mm, and bottom layer share stress value maximum value 9.45mm and minimum value 2.04mm. The stresses and displacement amplitudes of propeller shafts are reaching maximum values at the frequencies, which are far away from the operating frequency range. The torsional buckling load is higher (nearly 5 times) than the ultimate torque transmission by the shaft, so it is safer.

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