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Investigation of Composite Torsion Shaft Using Finite Element Method

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Abstract: **Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The Composite materials based on the metals are said to be the Metal Matrix Composites. Metal composite materials have found application in many areas of daily life for quite some time. Often it is not realized that the application makes use of composite materials.**

This research attempt is made to evaluate the sustainability of composite material such as FRP and CRFP epoxy/glass for the purpose of automotive transmission application using finite element method in Ansys.Initially literature review will be done to understand the approach. 3D model will be prepared to carryout analysis on model. Structural and vibrational analysis will be done by implementing different layer orientations on FRP & CRFP'S.

I. INTRODUCTION

Composite materials (or composites for short) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure.

The most primitive composite materials were straw and mud combined to form bricks for building construction. The most advanced examples perform routinely on spacecraft in demanding environments. Those composites closest to our personal hygiene form our shower stalls and bath tubs made of fiberglass. Solid surface, imitation granite and cultured marble sinks and counter tops are widely used to enhance our living experiences.

Composites are materials created by combining dissimilar materials with a view to improve the properties or to create materials with desired properties

Table: 1 Comparison of the properties of metals and FRC

S.No	Material	Specific Gravity(gm/cc)	Tensile strength (Gpa)	Elastic modulus (Gpa)	Specific strength
1	Aluminum alloy	2.8	0.46	72	0.16
2	Titanium	4.5	0.93	110	0.21
3	Steel alloy	7.8	0.99	207	0.13
4	E-glass/epoxy	0.45	2.54	140	0.43

1.1 Importance of the composite materials

A material is any substance employed in making some useful thing or artifact. The metals and ceramics are materials used in industries as good conductors and refractory materials respectively. Insulation was based on natural products such as wood, paper, shellac and gutter percha. Since early 1900's one of the most fruitful development in materials has been the discovery and exploitation of synthetic of high polymers.

The polymers are substances, which consists of long chains or networks, built up by the repeated linkage of small reactive molecules. Each of the simple unit is called a 'mer' hence a polymer is simply the result of joining together of many identical units. Depending on the detailed chemistry and the spatial arrangement of the chains and their cross-links, the following can be produced.

Plastics, rubber, adhesives, coatings, fibers with a clearer understanding of the chemistry and physics of these materials it has become possible to combine them with fibers in order to produce an enormous range of unknown substances which are loosely referred to as "advanced composites".

Advanced Fiber Reinforced Plastics (FRP) composites have emerged as an important class of engineering materials for load bearing applications with all round properties for many engineering and social applications. These plastic matrix composite systems can be divided into fiber reinforced thermo-set matrix composites, fiber reinforced thermoplastics and matrix composites. A variety of manufacturing methods are being used for making products out of these materials.

1.2 Need for composite materials:

Development of new composites and new applications of composites is accelerating due to the requirement of materials with unusual combination of properties that cannot be met by the conventional monolithic materials. Actually, composite materials are capable of covering this requirement in all means because of their heterogeneous nature. Properties of composites arise as a function of its constituent materials, their distribution, and the interaction among them and as a result an unusual combination of material properties can be obtained.

II. MODEL ANALYSIS OF COMPOSITE SHAFT WITH STEEL 75DIA

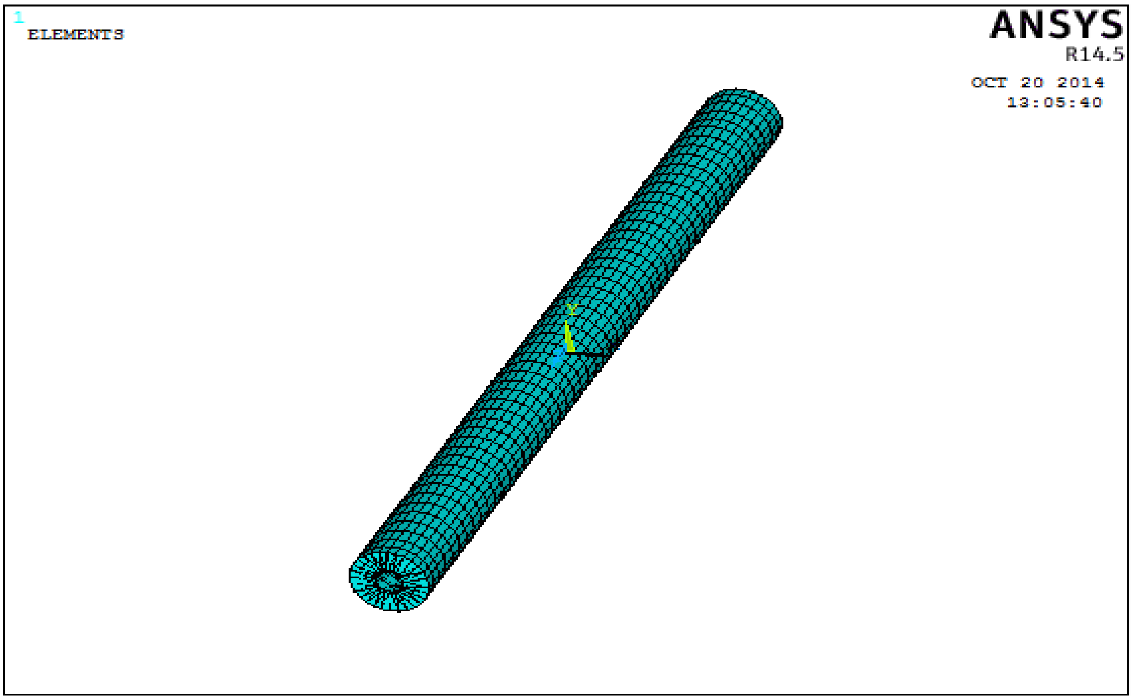

Figure.1: meshed modal

Default solid Brick element was used to mesh the components. The shown mesh method was called Tetra Hydra Mesh. Meshing is used to deconstruct complex problem into number of small problems based on finite element method.

Loads applied

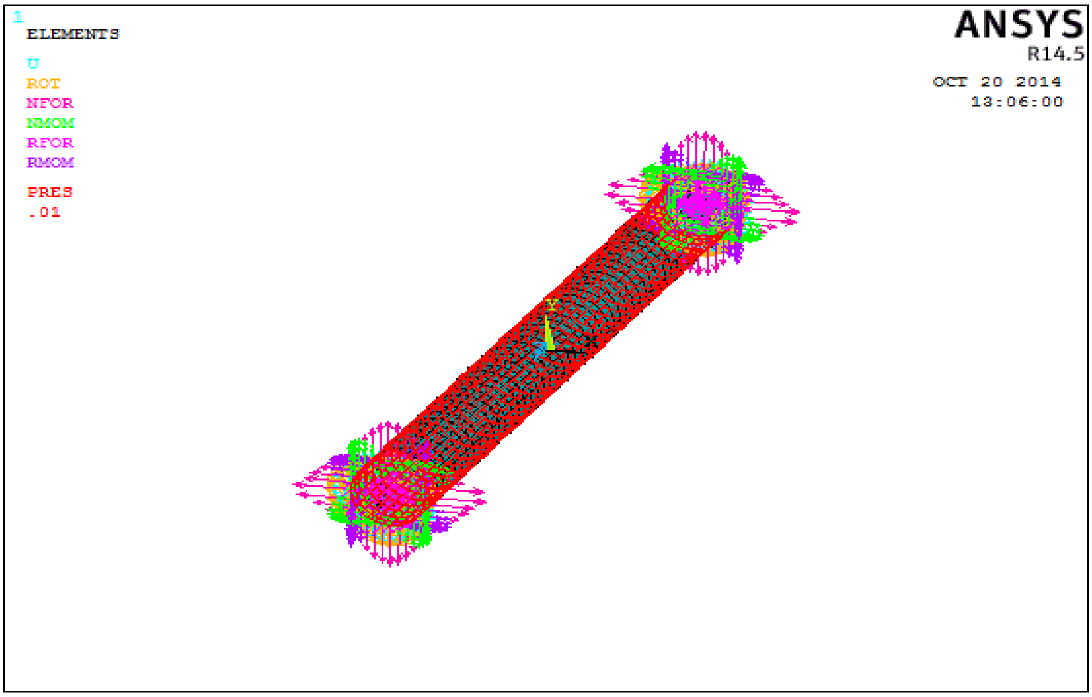

Figure.2: loads applied on a shaft

Von-misses stress

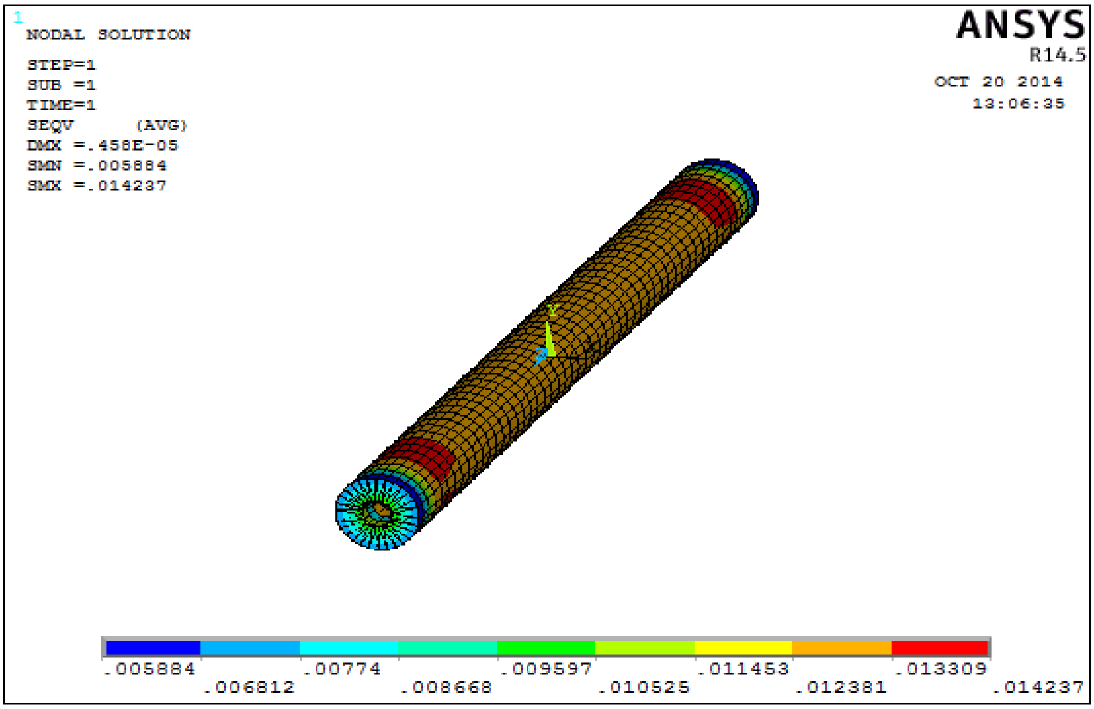

Figure.3: von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object.

Von misses stress considers all directional and principal stresses. Max stress=0.014237

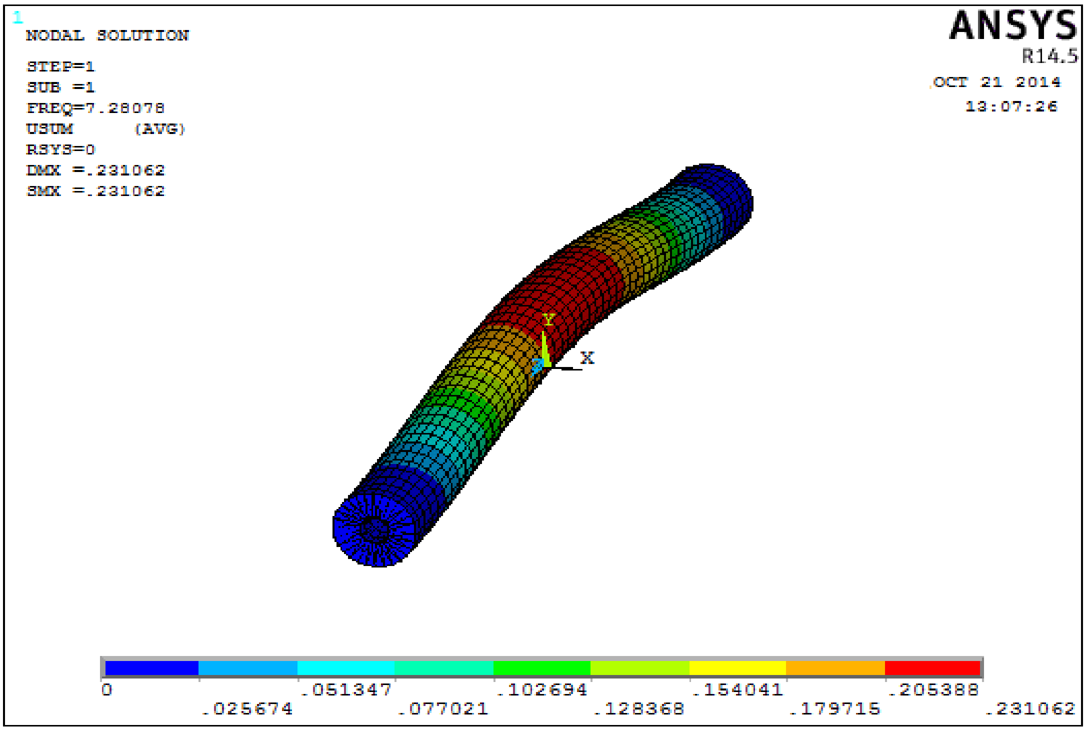

Figure.4: mode shape value1due to natural frequency. The value is 7.28078

Harmonic analysis

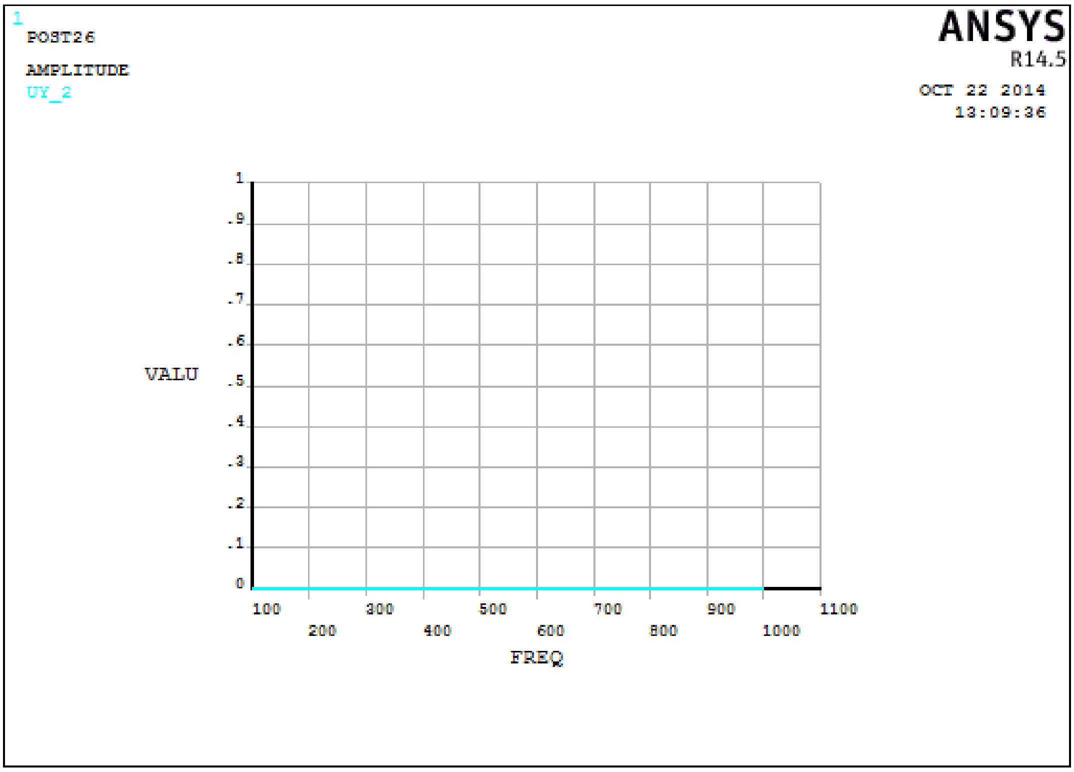

Figure.5

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III. STATIC ANALYSIS OF COMPOSITE SHAFT WITH STEEL 70DIA

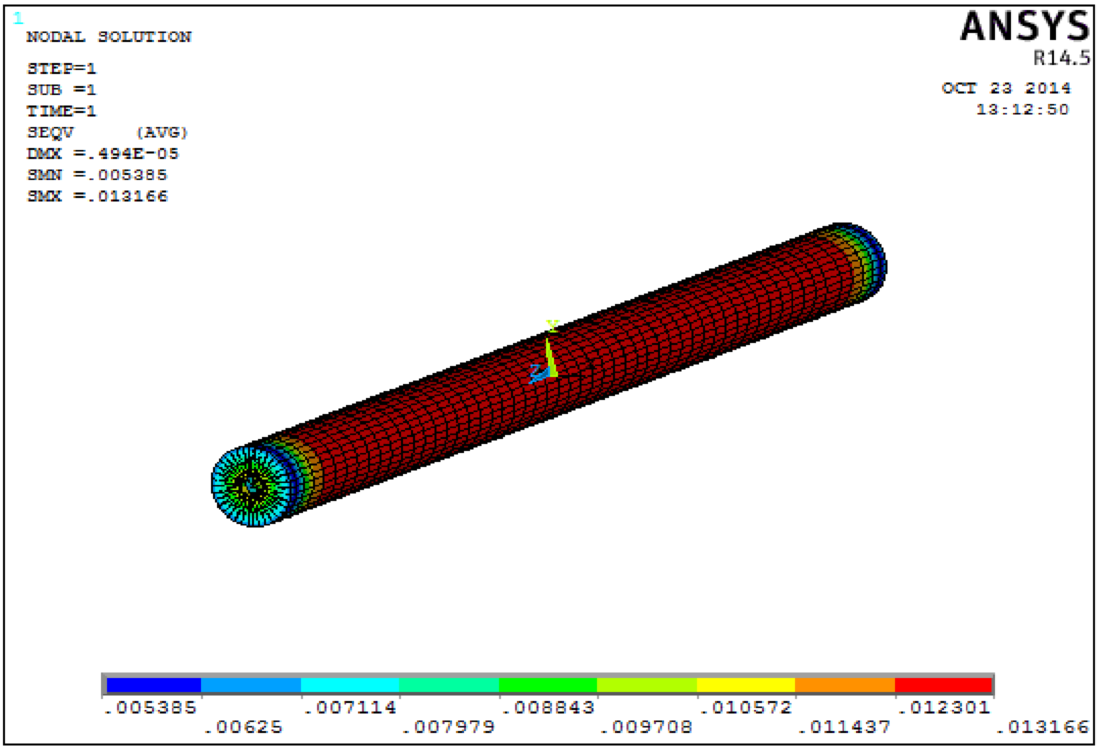


Figure.6: von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object.

Von misses stress considers all directional and principal stresses. Max stress=0.013166

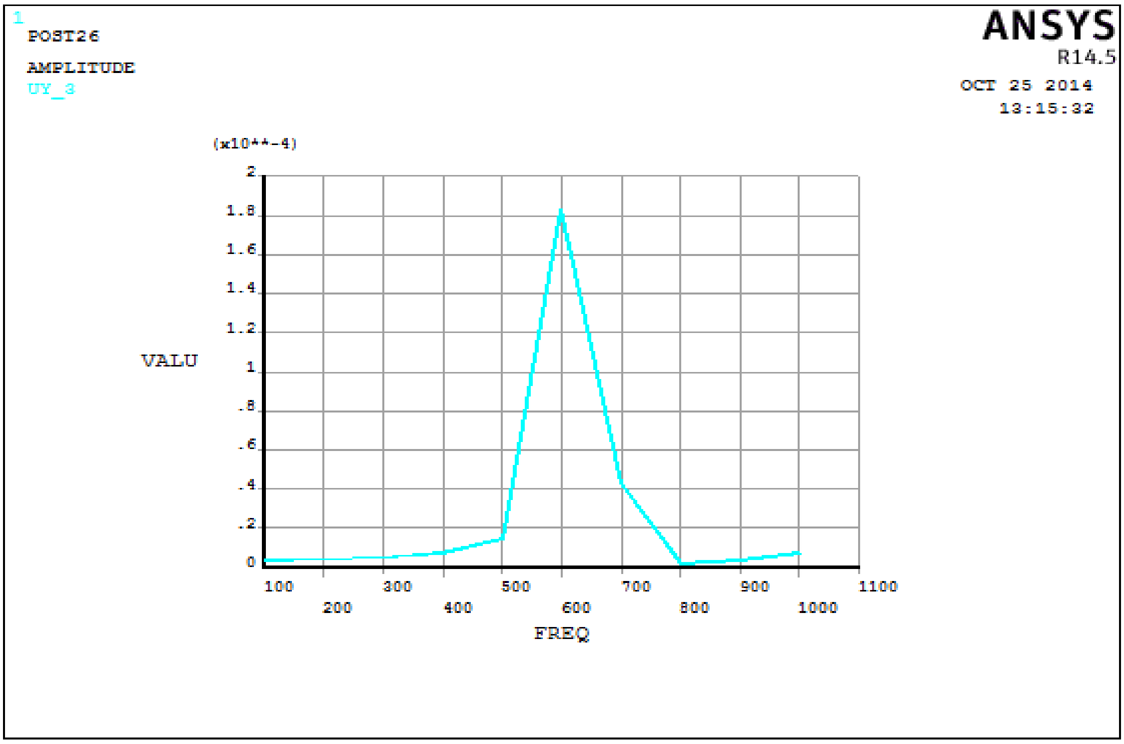
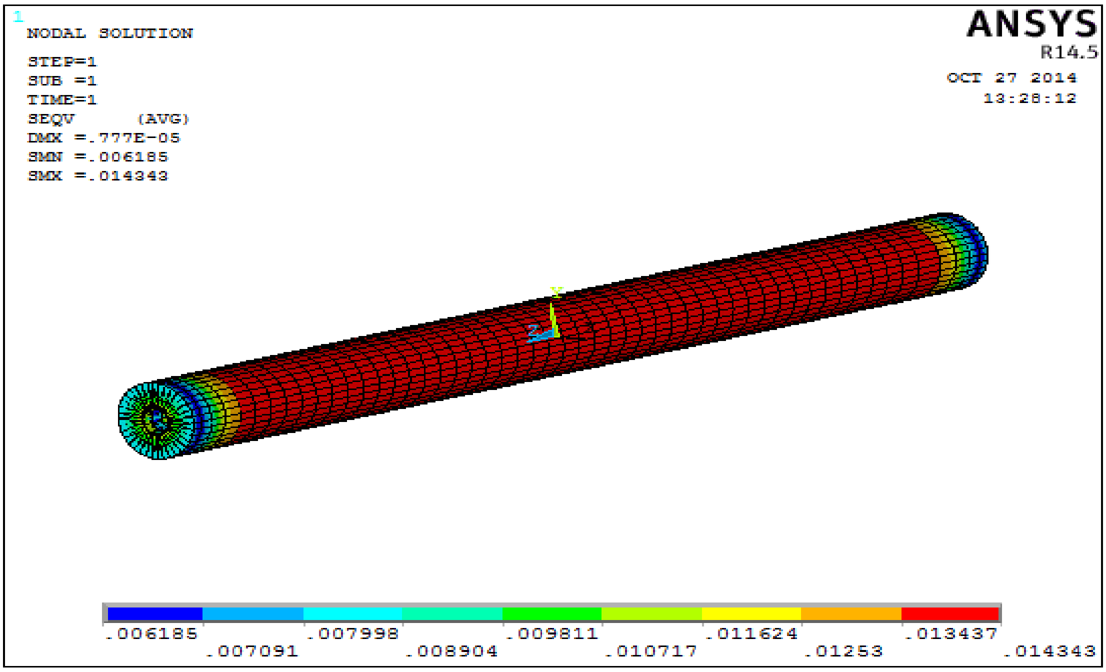


Figure.7: graphs of displacement due to loads, natural frequency and external frequencies acting on composite shaft.

Static analysis of composite shaft with e-glass 75dia

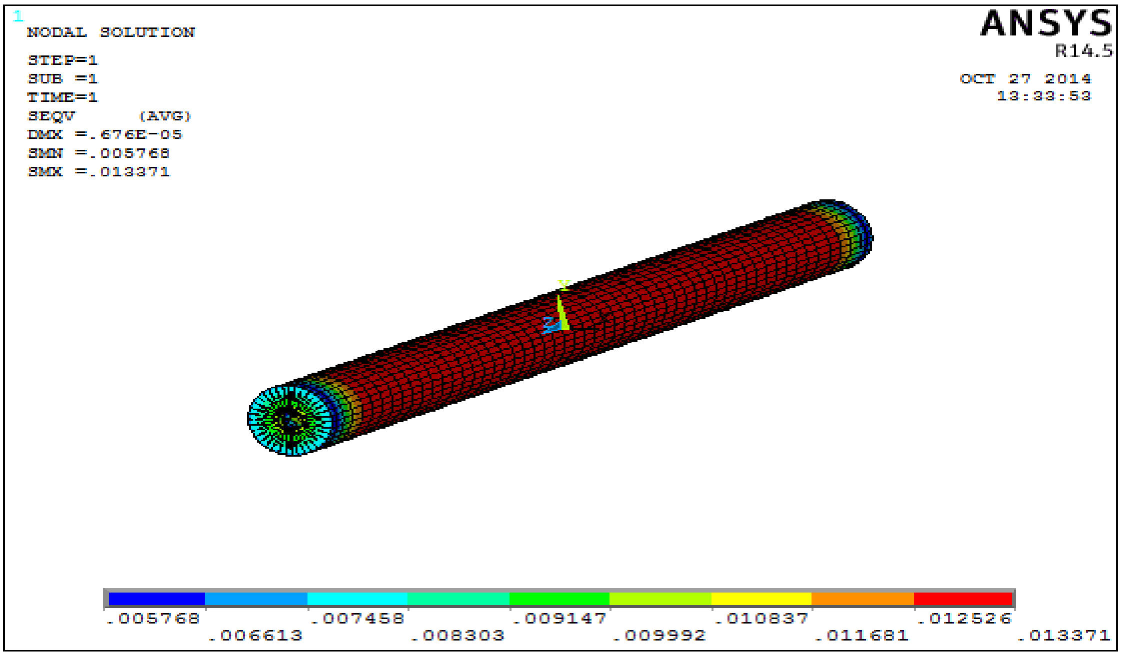
Von-misses stress:



The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.014343

Static analysis of composite shaft with e-glass 70dia

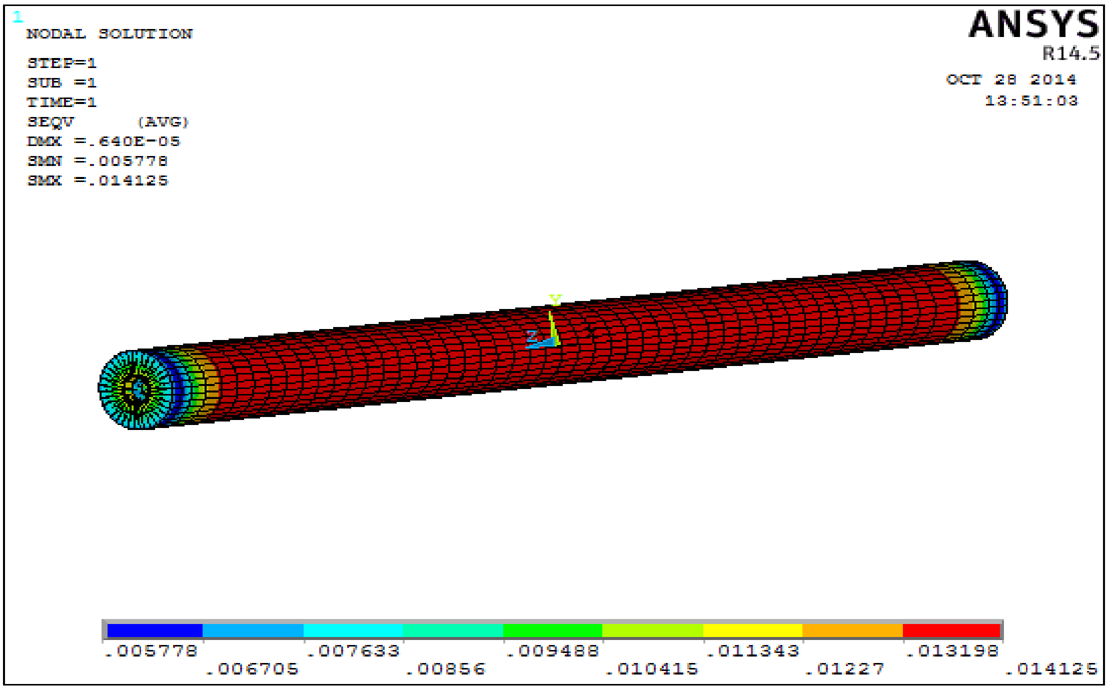
Von-misses stress:



The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013371

Static analysis of composite shaft with s-glass 75dia

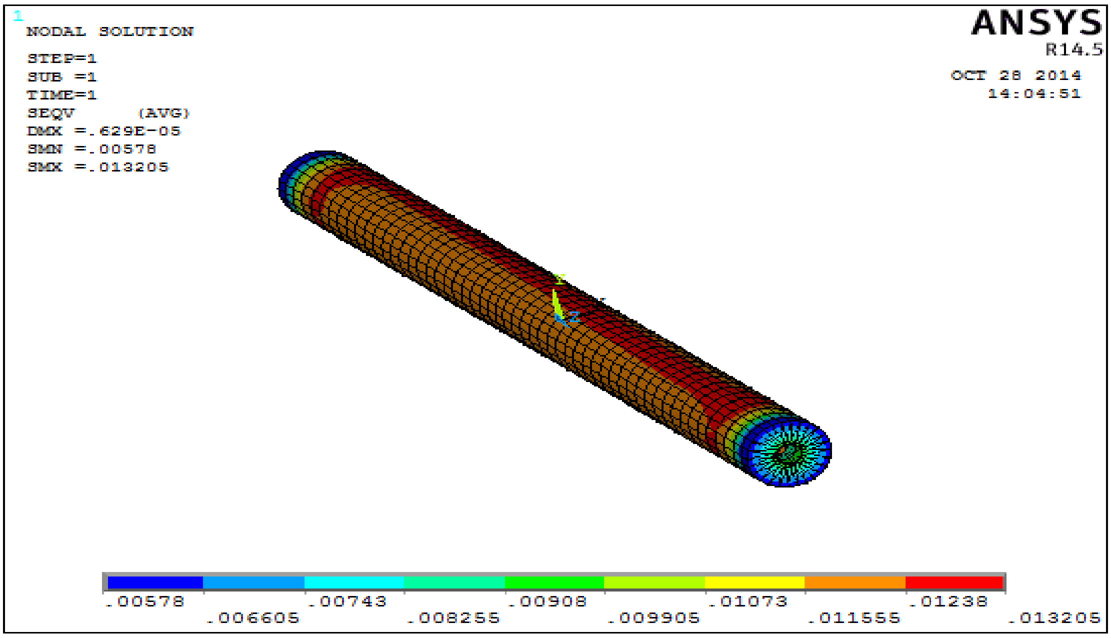
Von-misses stress:



The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.014125

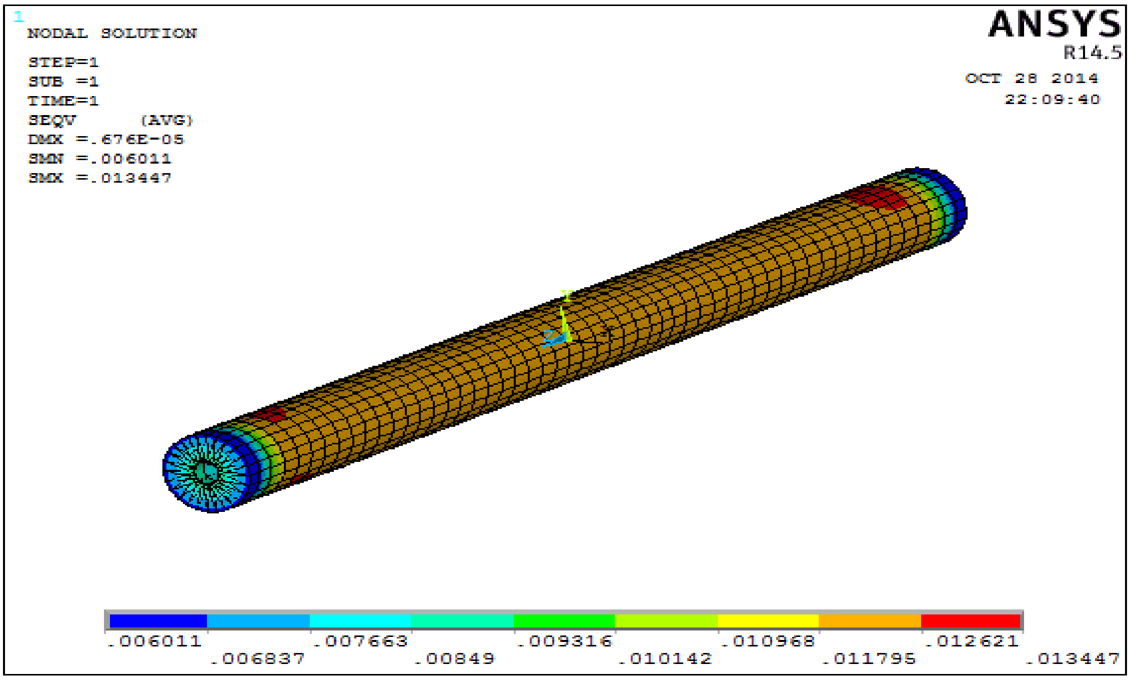
Static analysis of composite shaft with s-glass 70dia

Von-misses stress:



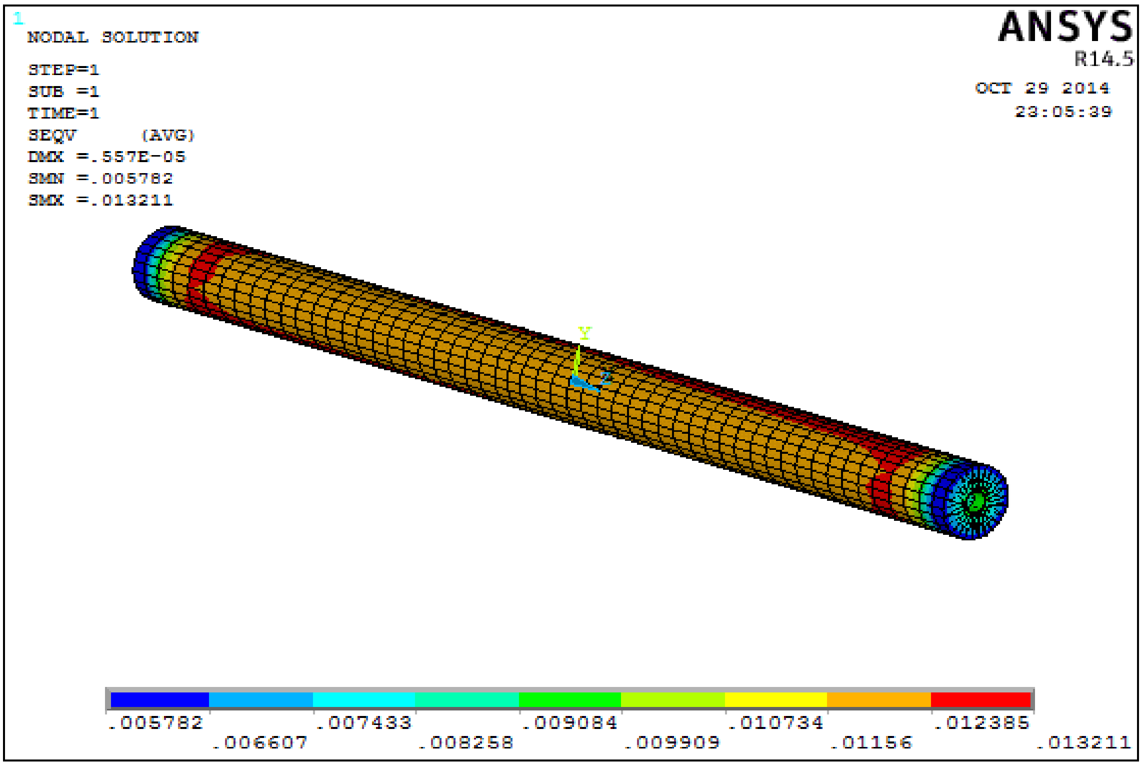
The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress= 0.013205

Static analysis of composite shaft with e-glass 3-layers



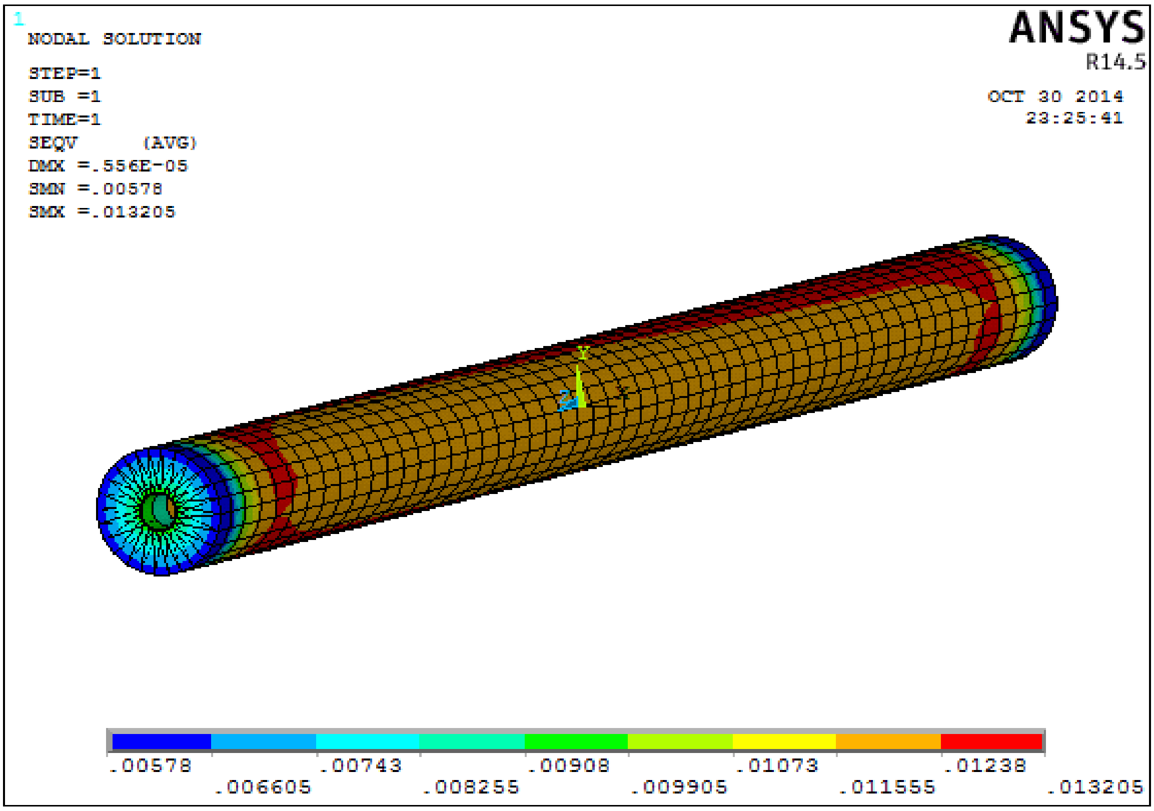
The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013447

Static analysis of composite shaft with s-glass 3-layers



The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013211

Static analysis of composite shaft with S-glass 5-layers 90 – 45 – 0 - -45 - -90



The above image is showing von misses stress value with the help of color bar. Color bar is used to determine the value ranges on object. Von misses stress considers all directional and principal stresses. Max stress=0.013205

Static analysis of composite shaft	STEEL		E GLASS		S GLASS	
	75Ø	70Ø	75Ø	70Ø	75Ø	70Ø
DISPLACMENT	0.458E^{-05}	0.494E^{-05}	0.777E^{-05}	0.676E^{-05}	0.640E^{-05}	0.629E^{-05}
STRESS	0.014237	0.013166	0.014343	0.013371	0.014125	0.013205
STRAIN	0.118E^{-06}	0.109E^{-06}	0.198E^{-06}	0.185E^{-06}	0.163E^{-06}	0.172E^{-06}
MODE-1	7.28078	6.78066	9.8811	9.09297	11.2549	9.60812
MODE-2	7.28781	6.7854	9.88892	9.09919	11.264	9.6197
MODE-3	18.1125	17.146	24.7418	23.0219	28.1434	24.1415
MODE-4	18.1536	17.1689	24.7782	23.0523	28.1854	24.2108
MODE-5	20.8746	20.7437	28.5887	28.1375	32.1998	29.5384

	E GLASS 3LAYERS	S GLASS 3LAYERS	S GLASS 5LAYERS 90 – 45 – 0 -45 - -90	S GLASS 5LAYERS 90 - 0 - 90 - 0 – 90
DISPLACMENT	$0.676E^{-05}$	$0.557E^{-05}$	$0.556E^{-05}$	$0.473E^{-05}$
STRESS	0.013447	0.013211	0.013205	0.011224
STRAIN	$0.186E^{-06}$	$0.152E^{-06}$	$0.152E^{-06}$	$0.129E^{-06}$
MODE-1	8.96789	10.2152	10.2138	10.2138
MODE-2	8.97836	10.2275	10.2261	10.2261
MODE-3	22.5614	25.6665	25.6632	25.6622
MODE-4	23.6252	25.7402	25.7369	25.7369
MODE-5	27.8807	31.4024	31.4002	31.4002

IV. CONCLUSION

In this project work analysis on composite drive shaft is done to increase the efficiency as well as to decrease the cost and weight.

In the first step data analization is done to understand the problem and rectification methodology.

In the next step a 3d surface model was generated for analysis purpose.

In the next step analysis is done on 75Dia and 70Dia by varying materials steel, FRP (E-glass), and CRF (S-glass) and also analysis work is done by applying layered matrix.

In the next step analysis is done on reduced thickness using layers method with reinforcement angles.

As per the above results 70 dia with 12 mm wall thickness shaft with S-glass (CRF) with 90-0-90-0-90 angles is suitable for drive shaft due to low stress, less weight and less manufacturing cost. Even if we observe previous they have used combination of CRF and FRP but the combination type shaft manufacturing having errors while joining both to gather.

Instead of using combination material better to use perpendicular angles for the reinforcement.

Using this type of shaft we can increase the mechanical efficiency by reducing the weight and this type of shafts are easy to manufacture and cost effective.

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