BEST: International Journal of Management, Information Technology and Engineering (BEST: IJMITE)
ISSN (P): 2348-0513, ISSN (E): 2454-471X,
Vol. 4, Issue 4, Apr 2016, 83-96
© BEST Journals

DESIGN AND ANALYSIS OF PROPELLER BLADE USING CATIA & ANSYS SOFTWARE

SUDHAKAR UPPALAPATI[1], K.V.RAGHAVULU[2] & KRANTHI KUMAR SINGAM[3]
[1,2]Associate Professor, Department of Mechanical, MarriLaxman Reddy
Inst of Tech and Management, Hyderabad, Telangana, India
[3]PG Student, Department of Mechanical, Mother Theressa College of
Engineering & Technology, Peddapally, Karimnagar, India

ABSTRACT

Fiber strengthened composites have found wide spread use within naval applications recently. Boats and under drinking water vehicles like torpedoes Submarines etc. Torpedoes which are made for deeper and moderate depths require minimization of structural weight for increasing payload, performance/velocity and operating range for the purpose Aluminium alloy casting can be used for the fabrication of propeller cutting blades. In current years the increased dependence on the light-weight structural aspect with acoustic insulation, has resulted in use of fiber content reinforced multi covering composite propeller. Today's work provides out the structural evaluation of any CFRP (carbon fibre reinforced cheap) propeller cutting tool which proposed to displace the Metal propeller cutting tool. Propeller is put through an exterior hydrostatic pressure on either area of the cutting blades with regards to the operating depth and movement across the propeller also bring about differential hydrodynamic pressure between face and again surfaces of rotor blades. The propeller edge is modeled and designed so that it can with stand the static fill distribution and locating the strains and deflections for both aluminium and carbon fiber content reinforced cheap materials. This work in essence handles the modeling and design research of the propeller cutting tool of your torpedo because of its durability. A propeller is intricate 3D model geometry. This involves top quality modeling CATIA software can be used for making the cutter model. This record includes brief information regarding Fiber Reinforced Plastic material materials and the features of using amalgamated propeller over the traditional metallic propeller. Through the use of ANSYS software modal research and static structural evaluation were completed for both light weight aluminum and CFRP

KEYWORDS: Aluminum, Carbon Fiber Reinforced Plastic, CATIA, ANSYS

INTRODUCTION

Sea propeller is an element which forms the main part of boats since it offers the mandatory propulsion. Fiber strengthened plastics are thoroughly found in the manufacturing of varied structures like the sea propeller. The hydrodynamic areas of the look of composite sea propellers have fascinated attention because they're important in predicting the deflection and performance of the propeller cutter.For making an optimized sea propeller you have to comprehend the variables that effect the hydro-dynamic action. Since propeller is a intricate geometry, the examination could be achieved only by making use of numerical tools. Most sea propellers are constructed of metal materials such as bronze or metallic. The features of replacing metal with an FRP composite are that the latter is corrosion-resistant and lighter. Another important advantage is usually that the deformation of the composite propeller can be manipulated to boost its performance. Propellers always turn at a regular speed that maximizes the efficiency of the engine unit. When the dispatch sails at the designed swiftness, the inflow perspective is near its pitch viewpoint. When the dispatch sails at a lesser acceleration, the inflow position is smaller. Hence, the strain on the propeller rises as the dispatch speed lowers. The propulsion efficiency is also low when the inflow perspective is definately not the pitch perspective. In case the pitch perspective can be reduced when the inflow perspective is low, the efficiency of the propeller can be better then. Traditionally marine propellers are constructed of manganese-nickel-aluminum-bronze (MAB) or nickel-aluminum-bronze (NAB) for superior corrosion resistance, high-yield strength, reliability, and affordability. Moreover metallic propellers are put through corrosion, cavitations destruction; tiredness induced breaking and has relatively poor acoustic damping properties that can result in noises credited to structural vibration. Moreover, composites will offer the potential benefits associated with reduced corrosion and cavitations damage, improved fatigue performance, lower noise, improved material damping properties, and reduced lifetime maintenance cost. In addition the load-bearing fibers can be aligned and stacked to reduce fluttering also to increase the hydrodynamic efficiency.

Design of Propeller Blade

- Open CATIA V5 R16
- Close the Product Window
- Start – Mechanical Design – Wireframe and Surface Design – Enter Part Name as **Propeller Blade –** OK
- Now we are in a surface modeling - Select Top (XY) plane – Sketch tool
- Now we are in sketcher workbench - Draw a circle with 60 dia – Exit workbench
- Extrude it with 50 mm on both sides total 100 mm height as shown

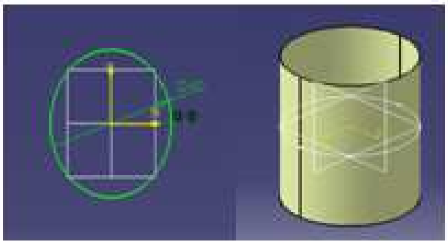


Figure 1: Propeller Design

- Create a point on the right plane at a distance of 30 mm from vertical 4 mm from horizontal as , Create the helix with 92 mm height and 276 pitch as shown

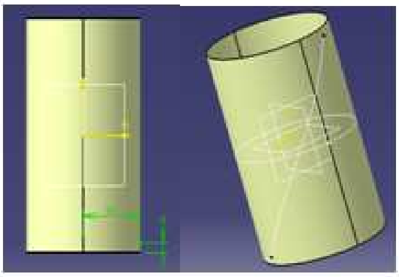


Figure 2: Helix Created

- Create the blade as shown below by using sweep tool, round the corners with corner tool with R 80 and R 40 as shown below

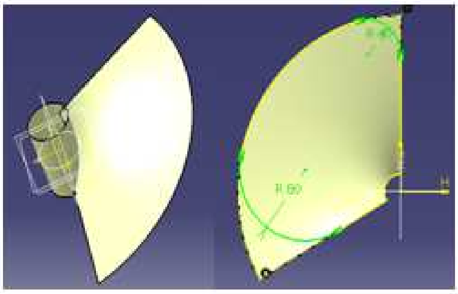


Figure 3: Sweep Created

- Extrude the rounded sketch with supports as shown below, split it with split tool as shown below in

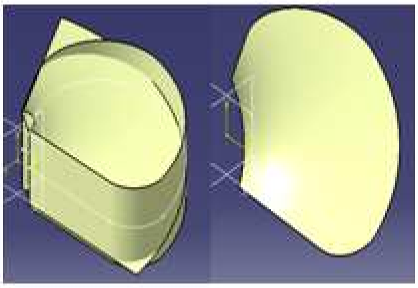


Figure 4: Extrude

- Now enter into part modeling to add thickness to the blade, by using thick surface tool add the thickness 4 mm.

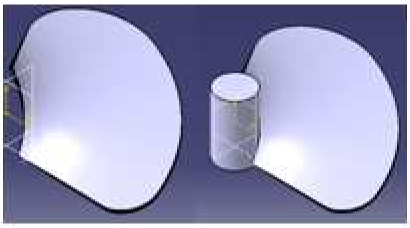


Figure 5: Part Model

- Using edge fillet tool add round at joining location of blade and hub

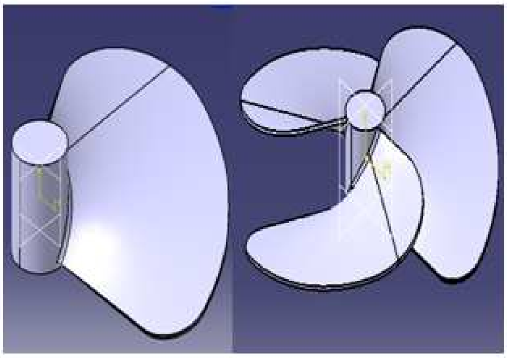


Figure 6: Pattern Blade

- Remove the material as shown by using pocket tool

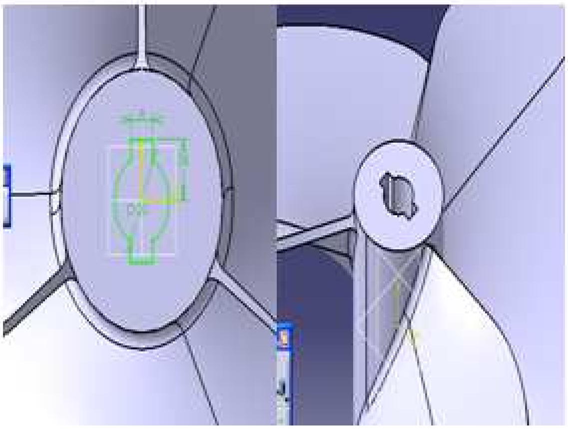


Figure 7: Pocket Tool

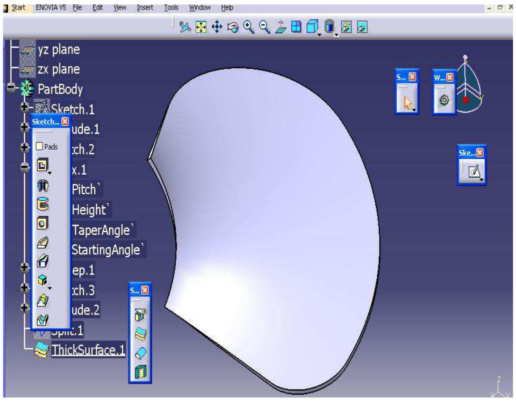


Figure 8: Propeller Blade Design

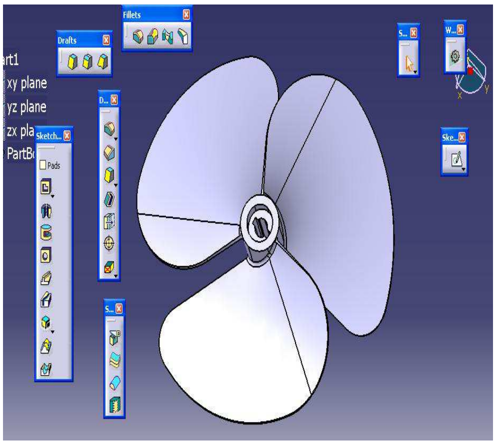


Figure 9: Model of a Propeller

Calculations

Total Area of the circle $=\pi R^2$

$= 3.141 X 30^2$

$= 2826.9\ mm^2$

Total Blade Area $= \pi r^2$ X DAR

= 2826.9X0.92

=2600.748 mm^2

(DAR = TBA/TAC = 2600.748/2826.9=92 %)

Relationship between Pitch & Pitch Angle

Formula: Pitch = 2π r X Tan a

Where: a = pitch angle and r = radius andπ=3.14159

Pitch Angle = 120

Pitch = 326.318 mm

Speed = (RPM/Ratio)(Pitch/C)(1-S/100)

Speed = (1000/0.5X326.316/1)(1-0/100) assumeRatio=1/2, =39.1581 km/hr Slip(S)=0

Boat Speed V_B = 24.3317 mile/hr; (1 mile = 1.609344 kilometers)

The thrust (T) is equal to the mass flow rate (.m) times the difference in velocity (V).

$T = m \times (V_B - V_A)$

Mass Flow Rate per hr (m) = area of blade x speed of the boat

$= 2600.74 \times 10^{-6} \times 39.1581 \times 10^3$

$= 101.840\ m^3/hr$

Thrust (T) = $m \times (V_B - V_A) = 101.840 \times 39.1581 \times 10^3$

= 3987860.9 N

= 3.98 MN

Properties of Carbon Fiber Reinforced Plastic (Compare To Metals)

- High flexibility
- High tensile strength
- Low weight
- High resistance
- High temperature tolerance
- Low thermal expansion
- Highest strength-to-weight ratio

Tensile Strength & Youngs Modulas

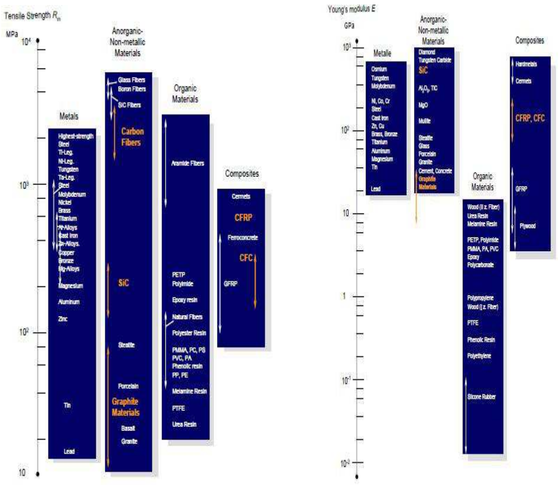


Figure 10: Tensile Strength Comparison & Youngs Modulus

Resistivity & Thermal Expansion Coefficient

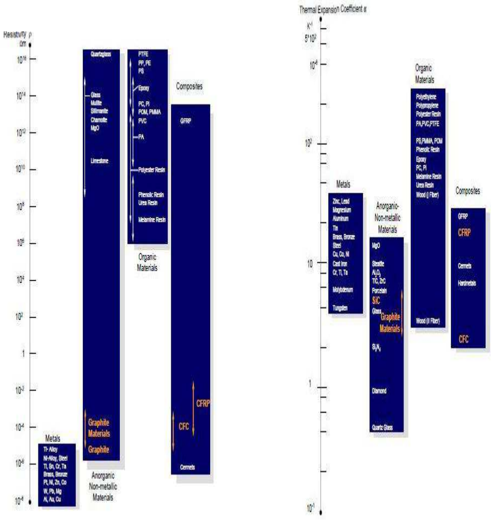


Figure 11: Resistivity & Thermal Expansion Coefficient

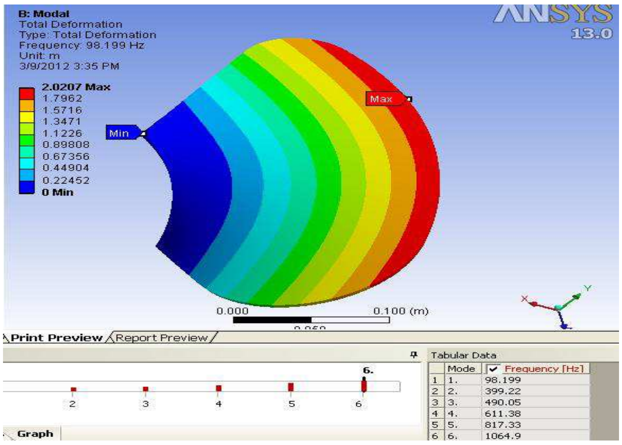
Modal Analsys

Alumnium

Frequency Table

Table 1

S.NO	MODE	FREQUENCY
1	1	98.199
2	2	399.22
3	3	490.05
4	4	611.38
5	5	817.33
6	6	1064.9



B: Modal
Total Deformation
Type: Total Deformation
Frequency: 98.199 Hz
Unit: m
3/9/2012 3:35 PM

Tabular Data

	Mode	☑ Frequency [Hz]
1	1.	98.199
2	2.	399.22
3	3.	490.05
4	4.	611.38
5	5.	817.33
6	6.	1064.9

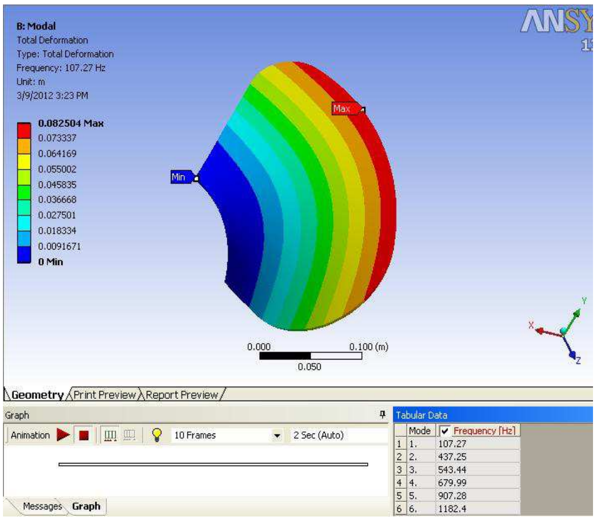
Figure 12: Analysis for Aluminum

Carbon Fiber Reinforced Plastic

Frequency Table

Table 2

S.NO	MODE	FREQUENCY
1	1	107.27
2	2	437.25
3	3	543.44
4	4	679.99
5	5	907.28
6	6	1182.4



B: Modal
Total Deformation
Type: Total Deformation
Frequency: 107.27 Hz
Unit: m
3/9/2012 3:23 PM

Tabular Data

	Mode	☑ Frequency [Hz]
1	1.	107.27
2	2.	437.25
3	3.	543.44
4	4.	679.99
5	5.	907.28
6	6.	1182.4

Figure 13: Analysis of CFRP

Default Mesh

Aluminium

Table 3

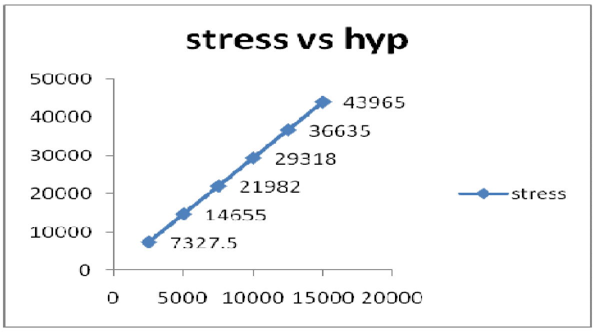
Hydrostatic pressure	Stress	Strain
2500	7327.5	1.032
5000	14655	2.0641

Table 3: Contd.,

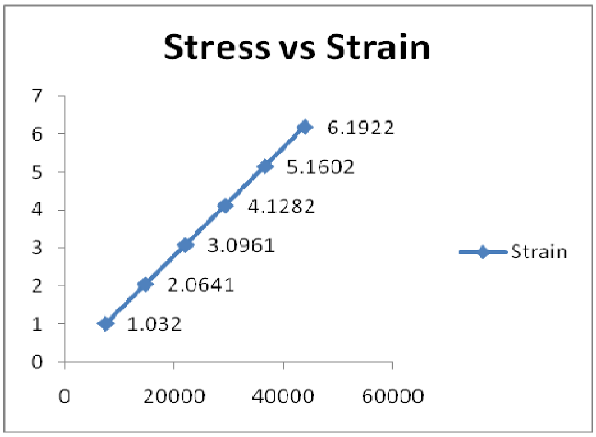
7500	21982	3.0961
10000	29318	4.1282
12500	36635	5.1602
15000	43965	6.1932

ELEMENTS: 15130, **NODES:** 36035

Graphs



Graph 1



Graph 2

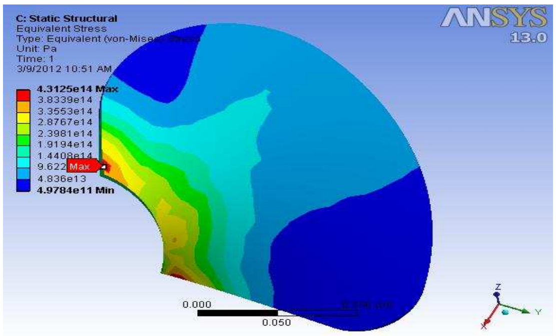


Figure 14: Static Structure for Stress

CARBON FIBER REINFORCED PLASTIC:

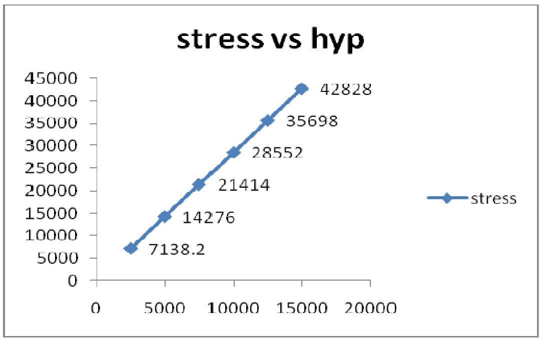
ELEMENTS: 15130

NODES: 36035

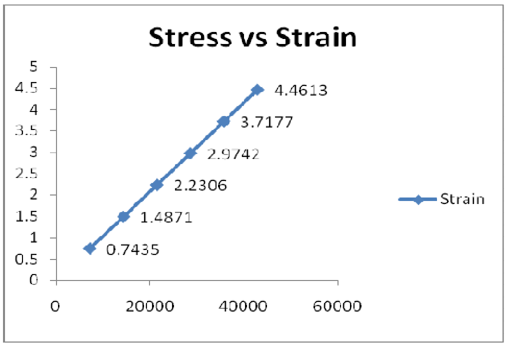
Table 4

Carbon fiber reinforced plastic		
Hydrostatic Pressure	**Stress**	**Strain**
2500	7138.2	0.7435
5000	14276	1.4871
7500	21414	2.2306
10000	28552	2.9742
12500	35698	3.7177
15000	42828	4.4613

Graphs



Graph 3



Graph 4

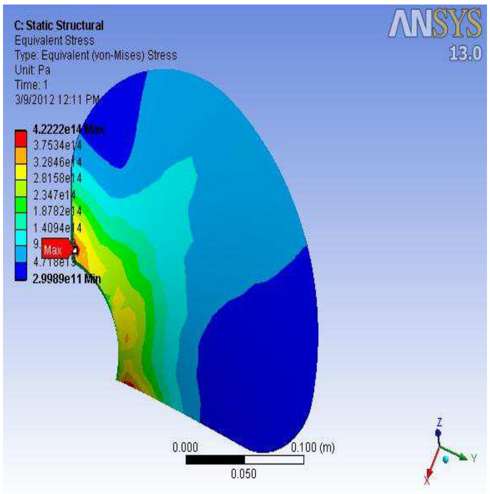


Figure 15: Static Structure for Equivalent Stress

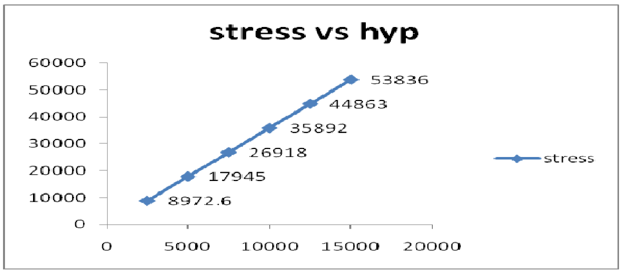
AT MESH

- **Aluminium**

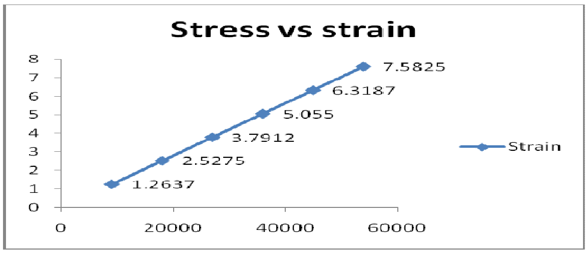
Table 5

Hydrostatic pressure	Stress	Strain
2500	8972.6	1.2637
5000	17945	2.5275
7500	26918	3.7912
10000	35892	5.055
12500	44863	6.3187
15000	53836	7.5825

Graphs



Graph 5



Graph 6

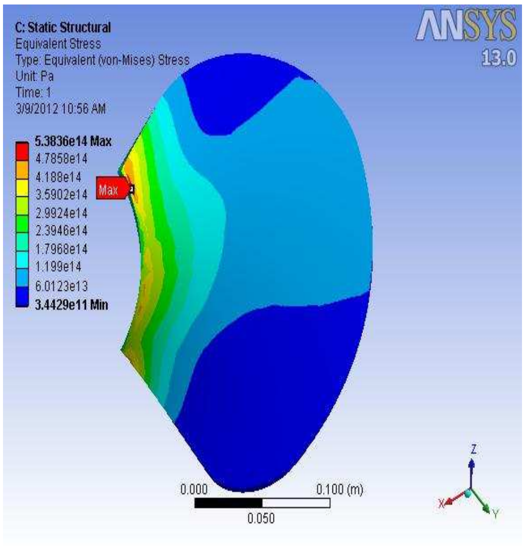


Figure 16: Static Structure Showing Blade

- **Carbon Fiber Reinforced Plastic**

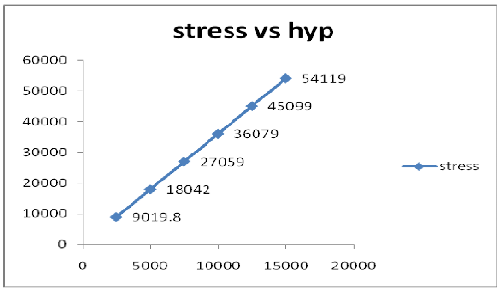
Table 6

Hydrostatic pressure	Stress	Strain
2500	9019.8	939.56
5000	18042	1879.1
7500	27059	2818.7
10000	36079	3758.2
12500	45099	4697.8
15000	54119	5637.4

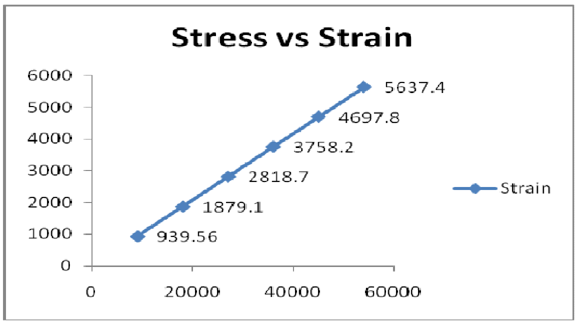
Graphs

ELEMENTS: 71430

NODES: 147120



Graph 7



Graph 8

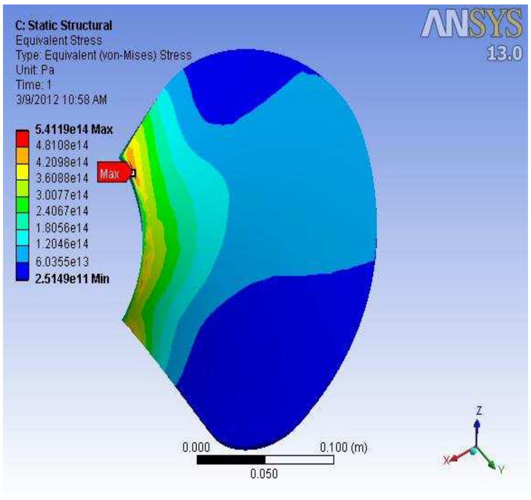


Figure 17: Static Structure in Ansys

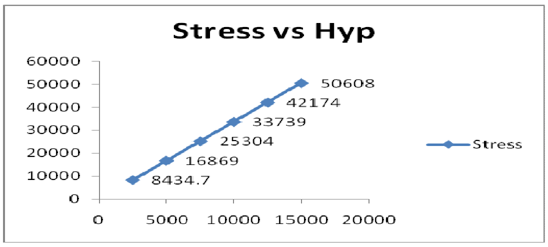
AT MESH

- **Aluminium**

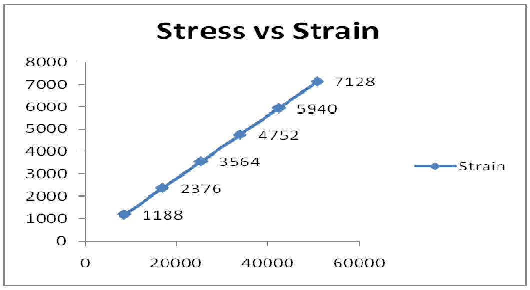
Table 7

1.ALUMINIUM		
Hydrostatic Pressure	**Stress**	**Strain**
2500	8434.7	1188
5000	16869	2376
7500	25304	3564
10000	33739	4752
12500	42174	5940
15000	50608	7128

Graphs



Graph 9



Graph 10

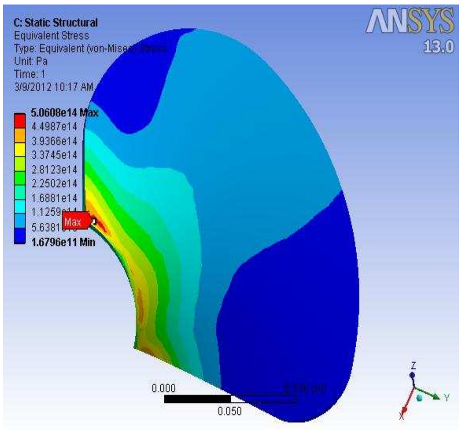


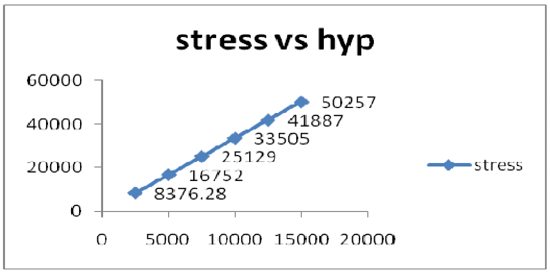
Figure 18: Static Structure for Aluminium

- **Carbon Fiber Reinforced Plastic**

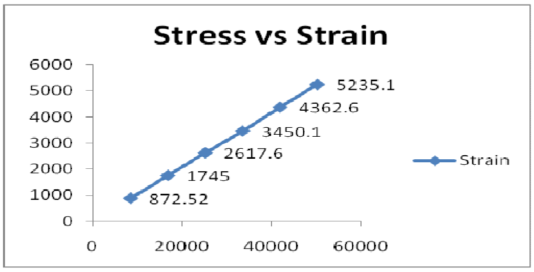
Table 8

Hydrostatic Pressure	Stress	Strain
2500	8376.28	872.52
5000	16752	1745
7500	25129	2617.6
10000	33505	3450.1
12500	41887	4362.6
15000	50257	5235.1

Graphs



Graph 11



Graph 12

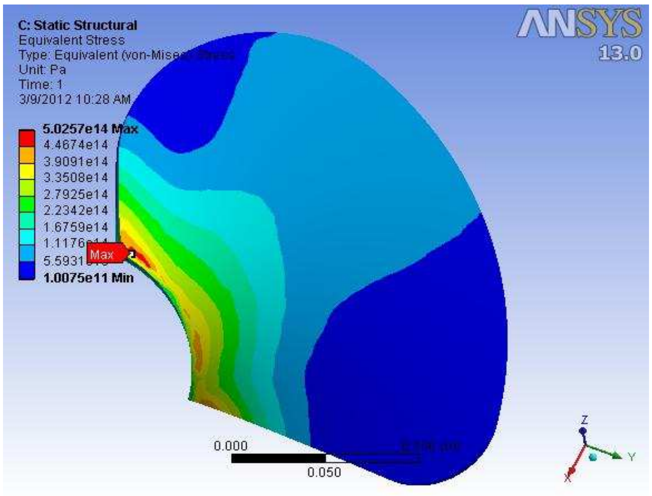


Figure 19: Static Structure for CFRP

CONCLUSIONS

We conclude that amalgamated propellers have significantly more advantages over the traditional metallic propellers. We focused on the material and composite durability examination of the propeller cutting tool carried out utilizing the finite factor method. The propeller knife is modeled and designed so that it can with stand the static fill distribution and locating the strains and deflections for both lightweight aluminum and carbon dietary fiber reinforced clear plastic materials. Mainly this work holds out the structural evaluation of the CFRP (carbon fibre reinforced cheap) propeller knife which proposed to displace the Metal propeller blade

REFERENCES

1. Properties of engineering materials by RAHiggin (second edition)
2. Engineering material properties and selection by Kenneth G.Budinski, Michael K.Budinski
3. Mechanics of composite materials by Robert M.Johnes
4. An Accurate Four-Quadrant Nonlinear Dynamical Model for Marine...Ralf Bachmayer, Louis L Whitcomb, Mark AGrosenbaugh - 2000 - IEEE JOURNAL OF OCEANIC ENGINEERING
5. Nonlinear Output Feedback Control of Underwater Vehicle Propellers...Thor I Fossen, MogensBlanke - 2000 - IEEE JOURNAL OF OCEANIC ENGINEERING