# Static and dynamic analysis of composite propeller

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**ABSTRACT**

Generally, manufacturing propeller has so many constraints like Over-weight, high complex in flexibility, high manufacturing cost and so on, it is difficult to construct a ship propeller. In recent years due to the development of composite material the difficulties in manufacturing a composite ship propeller has been rectified. Moreover it seems that composite material can withstand more force than the aluminium. In this project a small plate of composite plate is fabricated and subjected to tests. Those test results are given as input for the analysis. The material chosen for making composite plate is glass fibre. That glass fibre is subjected to tensile and flexural test and the results are given as inputs. A series of 14 results has been obtained from the analysis, and the results shows a positive response towards the glass fibre than the aluminium.

**KEY WORDS:** Propeller shaft, FEA Analysis, Composite Propeller

## 1. INTRODUCTION

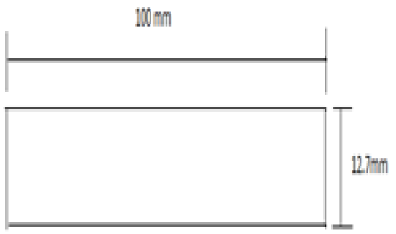
Propeller is a rotating fan like structure which is used to propel the ship by using the power generated and transmitted by the main engine of the ship. The transmitted power is converted from rotational motion to generate a thrust which imparts momentum to the water, resulting in a force that acts on the ship and pushes it forward.

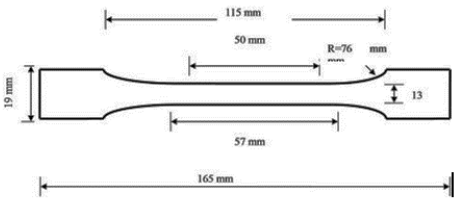
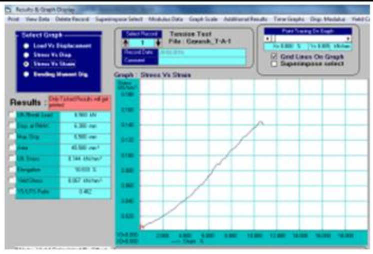
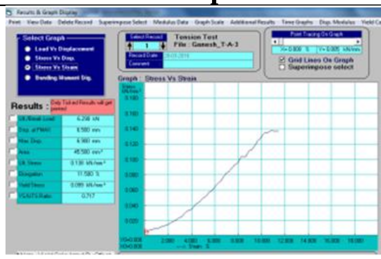
When the propeller turns through the water the water will hit against the blade's rear side, the pressure side and create a high overpressure. In the same way the propeller's leading side, the suction side, pulls itself through the water by creating a vacuum. The blade's suction and pressure effects start the water to move, and forces it away at almost a right angle to the blade surface. The propeller blade's force, which is equal to the pressure difference across the blade, can be split up into two components equal to, firstly the rotation, (which gives the torsional torque), and secondly, the forward movement (the propeller's thrust).

**E-Glass fibre -**E-Glass or electrical grade glass was originally developed for standoff insulators for electrical wiring. It was later found to have excellent fibre forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fibreglass. Glass fibres are generally produced using melt spinning techniques. These involve melting the glass composition into a platinum crown which has small holes for the molten glass to flow. Continuous fibre can be drawn out through the holes and wound onto spindles, while short fibres may be produced by spinning the crown, which forces molten glass out through the holes centrifugally. Fibres are cut to length using mechanical means or air jets. Fibres dimension and to some extent properties can be controlled by the process variable such as melt temperature and drawing/spinning rate. The temperature window that can be used to produce a melt of suitable for fibre forming. As fibres are being produced, they are normally treated with sizing and coupling agents. These reduce the effects of fibre-fibre abrasion which can significantly degrade the mechanical strength of the individual fibres. Other treatments may also be used to promote wetting and adherence of the matrix material of the fibre.

**Testing Analysis:**

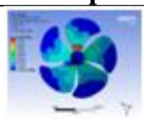
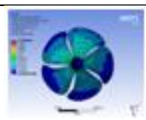
**Table.1.Testing analysis**

| Flexural test specimen | | Load Vs Displacement |
|---|---|---|
|   | **Flexural test specimen according to ASTM Standard** |  **sample 1** |
|  | **Flexural test specimen of Composite material** |  **sample 2** |

| | | |
|---|---|---|
|  | **Flexural test Equipment** | <br>**sample 3** |
| **Tensile Test Specimen** | | **Stress vs Strain** |
|  | Image of tensile test specimen according to ASTM standards | <br>**Sample 1** |
|  | Image of tensile test specimen of composite material | <br>**Sample 2** |
|  | **Image of tensile test equipment** | <br>**Sample 3** |

**Analysis of Aluminium and GFRP:**

**Table.2. Analysis of Aluminium and GFRP**

| Fea analysis | Static analysis | | Dynamic analysis | |
|---|---|---|---|---|
| | Aluminium | Gfrp | Aluminium | Gfrp |
| |  |  |  |  |
| Equivalent elastic strain | 1.922 e-7 | 2.2221 | 2.1398 | 40.363 |
| Equivalent elastic stress | 8326.3 Pa | 1.206 e10 Pa | 1.4455 e11 Pa | 1.6267 e11 Pa |
| Total deformation | 2.0222 e$^{-8}$ m | 40.494 m | 17.915m | 157.77 m |
| Directional deformation | 1.2207 e$^{-8}$ m | 14.232 m | 9.1254m | 18.105m |
| Elastic strain intensity | 1.7661 e$^{\wedge-7}$ | 2.212 | 2.9912 | 30.051 |
| Normal elastic strain | 2.148 e$^{-8}$ | 1.328 | 1.3253 | 14.797 |
| Shear elastic strain | 1.61 e$^{-7}$ | 0.93562 | 0.87328 | 10.858 |
| Maximum principal stress | 7014.6 Pa | 1.1731 e10 Pa | 1.5623 e11 Pa | 1.6459 e11 Pa |
| Middle principal stress | 949.57 Pa | 4.8851 e9 Pa | 5.0638 e10 Pa | 6.8028 e10 Pa |
| Minimum principal stress | 728.67 Pa | 1.5706 e9 Pa | 3.3538 e10 Pa | 4.5292 e10 Pa |
| Maximum shear stress | 4714 Pa | 6.7439 e$^{9}$ Pa | 7.7706 e$^{10}$ Pa | 9.162 $^{e10}$Pa |
| Stress intensity | 9428 Pa | 1.3488 e$^{10}$ Pa | 1.5541 e$^{11}$ Pa | 1.8324 e$^{11}$ Pa |
| Normal stress | 1722.3 Pa | 1.0065 e$^{10}$ Pa | 9.3446 e$^{10}$ Pa | 9.8041 e$^{10}$ Pa |
| Shear stress | 4292.5Pa | 2.8525 e$^{9}$ Pa | 2.3309 e$^{10}$ Pa | 3.3103 e$^{10}$ Pa |

## 3. RESULT

**Table.3.Results of static analysis and dynamic analysis**

| Fea analysis | Static analysis | Dynamic analysis |
|---|---|---|
| Equivalent elastic strain | This shows GFRP can with stand more deforming force than the Al | This shows GFRP can with stand more deforming force than the Al |
| Equivalent elastic stress | Equivalent stress is higher of GFRP .it can withstand more load than Al | Equivalent stress is higher of GFRP .it can withstand more load than Al |
| Total deformation | The GFRP posses higher value of total deformation which shows that it is better than the Al | The GFRP posses higher value of total deformation which shows that it is better than the Al |
| Directional deformation | The Max directional deformation of GFRP is higher than the aluminium which shows the GFRP is better | The Max directional deformation of GFRP is higher than the aluminium which shows the GFRP is better |
| Elastic strain intensity | GFRP has higher elastic strain intensity than the Al .so GFRP is better the Al | GFRP has higher elastic strain intensity than the Al .so GFRP is better the Al |
| Normal elastic strain | The Al has lower normal elastic strain than GFRP .so GFRP is better tha Al | The Al has lower normal elastic strain than GFRP .so GFRP is better tha Al |
| Shear elastic strain | GFRP has more shear elastic strain the Al,it is better than Al | GFRP has more shear elastic strain the Al,it is better than Al |
| Maximum principal stress | The max principle stress for GFRP is higher than Al,it is better Al | The max principle stress for GFRP is higher than Al,it is better Al |
| Middle principal stress | Middle principal stress is more for GFRP, so GFRP is better than Al | Middle principal stress is more for GFRP,so GFRP is better than Al |
| Minimum principal stress | GFRP is better tha AL because the min Principle stress of GFR is higher than the AL | GFRP is better than Al because the min Principle stress of GFR is higher than the AL |
| Maximum shear stress | The max shear stress of Al is lower than that of GFRP,GFRP is better than Al | The max shear stress of Al is lower than that of GFRP,GFRP is better than Al |
| Stress intensity | Stress intensity of GFRP is higher that the Al so GFRP is better than Al | Stress intensity of GFRP is higher tha the Al so GFRP is better than Al |
| Normal stress | GFRP is better than Al,since it has higher normal stress | GFRP is better than Al,since it has higher normal stress |
| Shear stress | The max shear stress of GFRP is higher than the Al .So the GFRP is better than Al | The max shear stress of GFRP is higher than the Al .So the GFRP is better than Al |

## 4. CONCLUSION

From the above static and dynamic analysis we have obtained 14 sets of results. These 14 sets of results include equivalent elastic strain, equivalent stress, total deformation, directional deformation, elastic strain intensity, normal elastic strain, shear elastic strain, maximum principle stress, middle principal stress, minimum principal stress, maximum shear stress, stress intensity, normal stress, shear stress. All the results like stress and strain in common are more than the aluminium for GFRP, each and every sets of results are in favour to glass fibre than that of aluminium. So we can manufacture a ship propeller with better mechanical properties by using composite material .Moreover the general characteristics of composite material are better than the isotropic materials. Therefore we can manufacture a ship propellers in glass fibre rather manufacturing in aluminium.

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