A REVIEW PAPER ON MODELLING AND ANALYSIS OF A SUBMARINE PROPELLER

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Abstract

A ship propeller is a mechanical device like fans that use to produce the propulsion force of the ship motion. It is used to generate the thrust by rotational motion of the propeller. Propeller is used in marine, ships. Torpedoes and submarine etc. which require high strength. The propeller is subjected to an external hydrostaticpressure between face and back surface of the blade. So that the propeller blade modeled and design as its can be with stand the static load and distribution. The present work can be carries out the modeling and analysis of propeller blade for its strength for torpedo. The present study static analysis, dynamic analysis and thermal analysis are carried out. The fiber composite material is used for propeller blade which replaced of aluminum. The fiber composite is light weight, highly corrosion resistance, better strength compare to aluminum material.

1.INTRODUCTION

A propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference isproduced between the forward and rear surfaces of the airfoil-shaped blade, and a fluid (such as air or water) isaccelerated behind the blade. Propeller dynamics, like those of aircraft wings, can be modelled by either or both Bernoulli's principle and Newton's third law. A marine propeller of this type is sometimes colloquially known as a screw propeller or screw, however there is a different class of propellers know as cycloidal propellers – they are characterized by the higher propulsive efficiency averaging 0.72 compared to the screw propeller's average of 0.6 and theability to throw thrust in any direction at any time. Their disadvantages are higher mechanical complexity and higher costMarine propeller is a component which forms the principal part of ships since it gives the required propulsion. Metalmatrix composite material is extensively used in the manufacturing of various structures including the marine propeller. The hydrodynamic aspects of the design of composite marine propellers have attracted attention because they are important in predicting the deflection and performance of the propeller blade. For designing an optimized marinepropeller one has to understand the parameters that influence the hydro-dynamic behaviour. Since propeller is a complex geometry, the analysis could be done only with the help of numerical tools. Most marine propellers are made of metal material such as bronze or steel. The advantages of replacing metal with an composite are that the latter is lighter and corrosion resistant. Another important advantage is that the deformation of the composite propeller can be controlled to improve its performance. Propellers always rotate at a constant velocity that maximizes the efficiency of the engine. When the ship sails at the designed speed, the inflow angle is close to its pitch angle. When the ship sails at a lower speed, the inflow angle is smaller. Hence, the pressure on the propeller increases as the ship speed decreases. The propulsion efficiency is also low when the inflow angle is far from the pitch angle. If the pitch angle can be reduced when the inflow angle is low, then the efficiency of the propeller can be improved.

Traditionally marine propellers are made of manganese-nickel-aluminum-bronze (MAB) or nickel-aluminium-bronze (NAB) for superior corrosion resistance, high-yield strength, reliability, and affordability. More over metallic propellers are subjected to corrosion, cavitations damage; fatigue induced cracking and has relatively poor acoustic damping properties that can lead to noise due to structural vibration. Moreover, composites can offer the potential benefits of reduced corrosion and cavitation's 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 and to improve the hydrodynamic efficiency.

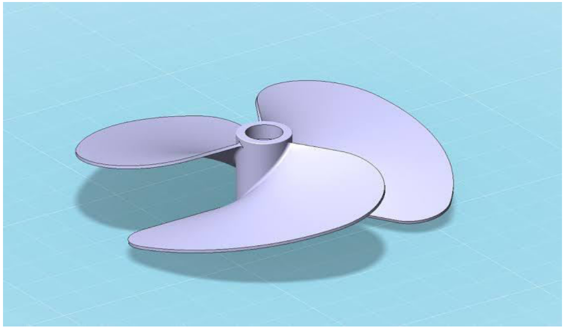
1.1 Types Of Marine Propellers

Controllable pitch propeller

A controllable pitch propeller one type of marine propeller is the controllable pitch propeller. This propeller has several advantages with ships. These advantages include: the least drag depending on the speed used, the ability to move the sea vessel backwards, and the ability to use the "vane"-stance, which gives the least water resistance when not using the propeller (e.g. when the sails are used instead).

Skewback propeller:

An advanced type of propeller used on German Type 212 submarines is called a skewback propeller. As in the scimitar blades used on some aircraft, the blade tips of a skewback propeller are swept back against the direction of rotation. In addition, the blades are tilted rearward along the



longitudinal axis, giving the propeller an overall cup-shaped appearance. This design preserves thrust efficiency while reducing cavitation's, and thus makes for a quiet, stealthy design.

Modular propeller

A modular propeller provides more control over the boats performance. There is no need to change an entire prop, when there is an opportunity to only change the pitch or the damaged blades. Being able to adjust pitch will allow for boaters to have better performance while in different altitudes, water sports, and/or cruising.

LITERATUREREVIEW

Y.S Rao and B.S.Reddy [2] shows composite propeller blades are safe in case of resonance phenomena in their harmonic analysis. Vibration defect can also be controlled in case of composite as damping effect is more. They had done a comparison of harmonic analysis using ansys software between aluminium metal and S2 Glass fabric/Epoxy. From their result maximum displacement in case of composite is 0.08192 which very less than aluminium propeller blade 0.1784.

M.A.Khan et al[3] observed inter laminar shear stress for composite material considering different no of layer and shows there is strong bonding between the layers. Eigan value analysis shows composite material has 80.5% more natural frequency than aluminium propeller. In their static analysis they had shown composite consist of separate layer.

V Ganesh et al. [4] had done static and modal analysis for aluminium propeller and composite (carbon reinforced plastics) propeller. From their analysis it shows blade deflection in case composite propeller is very less compare to aluminium. Besides that they also observed the stress strain variation for the strength analysis.

K.B.Yeo et al.[5] done some prediction about the stress distribution around a propeller blade through finite element method. Considering wagenigen B Series 3 bladed propeller and stainless steel as material hydrodynamic analysis carried out. With a increasing rotational speed developed stress also increase and after 3000 rpm it cross it Pritam Majumder, K.M. Pandey and N.V. Dashpande Journal of Basic and Applied Engineering Research p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 3, Issue 3; January-March, 2016 272 critical stress and chance of failure may occurs.

E.A. De Barros and J.L.D.Dantas [6] proposed a model for the measurement of hydrodynamic force and momentum through CFD simulation. Their prediction value compare with the experimental data. Their simulated results show that wake coefficient is 0.36 where as experimental results shows 0.22.

W.Y.San et al. [7] given a numerical prediction based on CFD, FEM and BEM for submarine structure about its propeller excited acoustic response. Unique solution obtained by applying boundary condition in Refined Integral Algorithm and pointing the CHIEF points normal to the interior field. Field point is calculated by global mesh refinement scheme considering QUAD8 as a boundary element. Error refining have done up to 10-4 maximum limit. In BEM model of sphere RIA applied for HIE integral calculation. Open water characteristic of 4381 propeller investigated by CFD and experimental result compare with achieve result. "Sub marine + propeller" system was simulated by CFD to get propeller variation of torque and thrust. SST turbulent model developed to observe flow details in boundary of the submarine.

B. G. Paik et al. [8] compared the performance characteristics of flexible propellers based on different fabrication. Three models made of cutter Carbon/epoxy and glass/epoxy tested in medium size cavitations tunnel of MOERI. The thrust produce in the blade and advance ratio variation are responsible for the flexibility of the propeller because it reduce the pitch angle of the blade. The relation of the produced thrust and sound pressure observed from acoustic noise measurement test. Tailoring method done for effective control with TiO2 as tracer particle. Blade flexibility effect on propeller wake was observed by Particle image velocimetry (PIV) technique.

C Georgaides et al. [9] proposed a design of a underwater hexapod robot which is propel by paddles. The main aim was characterized the forces generated by the paddle oscillating in water. For that a paddle trajectory based on cubic spline developed. Here the thrust produce depends on the inflow estimation which is done by replace volume of water by the paddle. An experimental set up is done for thrust measurement. Experimental data collection and control of paddle is done by Lab VIEW program. The vehicle moving in a stationary body of constant properties, translation motion following Newton's equation and rotational motion Euler's equation are some assumption. For better understanding 3ds max®, a graphic and animation software used for animation purpose.

O. Barannyk et al. [10] experimentally investigated the propulsion system of a oscillating flexible plate with the combination effect of heave translation and pitch rotation. The motivation comes from caudal area of a fish and goal gain through a no. of experiment at different depth of submerge and measuring the force. A flat rectangular plate with blunt leading and tailing is consider as a propulsion system and considering frequency and amplitude of pitch and heave as a parameter of sinusoidal motion a hydrodynamic oscillating propulsion is represented. Flexibility part made by polydiethylsiloxane(PDMS). Sinusoidal motion created by two parker HV23 stepper motor. 16 bit digital data acquisition board table was used with 3 axis load cell to measure force and frequency with LabView code. MatLab also help in the recording of data. Flow pattern observed by particle image velocimetry and from experimental result it is seen that thrust co-efficient increase proportionally with chord wise flexibility.

A. Mazumder and H.H Asada [11] investigated on a spheroidal Appendage-free under water vehicle to investigate the nuclear reactor inspection and other purpose. Mainly they focused on compact, multi DOF propulsion system and a high stable control system. For that a non linear hydrodynamic model is generated and analysed its controllability and stability by the application of water jet with Coanda effect valve and unique bidirectional centrifugal pump which generate four directional flows. Based on the analysis information a robot prototype designed which used to developed PD controller.

T. I. Fossen and M. Blanke [12] suggest a non linear output feedback controller for UUV propeller. This is done from the feedback of estimated axial flow velocity. Using single propeller the simulation explain more accurate result. Lyapunov stability theory applied here. Assuming propeller revolution and axial flow velocity have the same signs two theorem of global exponential stable (GES) established. Disturbance created on thrust and torque by axial flow velocity compensate by estimated result which is so important from various point of view.

C. Y. Hsu et al. [13] studied the stress concentration effect due to the penetrations in the pressure hull of a deep diving submersibles and its structural design. For that author investigate on shallow cylindrical shell by Hibbitt and Karlsson's methodology of FEM and analyse the curvature effect and failure modes on spherical deep diving vehicle under external pressure. Stress distribution at different curved angle of a circular hole helps to develop a design a data. For the study of elastro-plastic behaviour of material Von Mise's Yield criteria are used. Meshing is done by 9 nodes doubly curved thin shell element and considers 5 DOF.

M. A. MacIver et al. [14] design underwater vehicle based on weakly electric fish sensory system, propulsion scheme and body design principle. Here they utilize an idealized ellipsoidal body model, Kirchhoff's equation and optimal control algorithm for generating trajectories. By applying artificial electro sensory around the AUV an Omnidirectional sensing volume created.

CONCLUSION

Modeling and simulation of marine propeller has done using CATIA software. After observing the static analysis and modal analysis values we conclude that CFRP has better stress bearing capacity compared with the other materials and it has better strength when the loads are applied . On doing static analysis of marine propeller it is clear that, the maximum Stress, strains and deformations are induced in Nibral , Al-6061,GFRP materials compared to othermaterials(composites)CFRP.

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