

Determination of Stress in Propeller Blade through FEA

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Abstract—Propeller design aim at achieving high propulsive efficiency at low levels of vibration and noise.As a neighborhood of the analysis static structural testing was conducted by varying material properties in pre-processing stage.. After importing IGES file,further analysis was done using ABAQUS.Achieving the high propulsion efficiency had become quite difficult,since ships are becoming larger and larger.SOLIDWORKS modeling software is used in the generation of BLADE MODEL and For FEA[Finite Element Analysis],ABAQUS software is used.Properties of a certain element is introduced in the software,for the generation of the stress resultsThe propeller model developed in SOLIDWORKS is converted in to IGES file and then imported to mesh for developing fine mesh of the model.

Keywords—ABAQUS, FEA, mesh, propeller , SOLIDWORKS

I. INTRODUCTION

The propeller may be a vital component for the safe operation of ship stumped . it's therefore important to make sure that ship propeller have adequate strength to with stand the forces that influence them. Fiber reinforced plastic composite have high strength to weight and these materials have better corrosion resistance, lower maintenance, nonmagnetic property and it even have stealth property for naval vessels. The forces that act on a propeller blade arise from thrust and torque of the propeller and therefore the force on each blade caused by its revolution round the axis A propeller may be a sort of fanthat transmits power by converting motion into thrust.A pressure difference is produced between the forward and rear surfaces of the shaped blade, and air or water is accelerated behind the blade . Propeller dynamics are often modeled by both Bernoulli's principal and law. A propeller is that the commonest propulsion on ships, imparting momentum to a fluid which causes a force to act on the ship. Three, four, or five blades are commonest in marine propellers, although designs which are intended to work at reduced noise will have more blades. The blades are attached to a boss (hub), which should be as small because the needs of strength allow - with fixed pitch propellers the blades and boss are usually one casting.

A ship needs system to maneuver in water, so by employing a thrust – producing mechanism the ship moves. There are many thrust-producing devices called propellers like screw propellers, pump jet, water jet etc which producing by high speed crafts, ships, pleasure crafts and torpedoes. The speed of marine vehicle depends on the selection of system . The thrust from the propeller is transmitted to maneuver the ship through a transmission which consists of a rotational motion generated by the most engine crank shaft, intermediate shaft and its bearings, stern tube shaft and its bearing and eventually by the propeller itself.Surface piercing propeller has emerged as an integrated solution for high-speed craft, to beat the issues like cavitations, low draught & shallow water restrictions that's prominent with these crafts. it's also easily adaptable for various operating speeds. These propellers operate in partially submerged condition, mostly in inclined position and draws in bubble along the blade on the rear surface. The air bubbles contract or expand on the surface right along its underwater operation and avoid cavitations and its imp lied problems like vibration, erosion and thrust breakdown. This propeller eliminates the appendage drag thanks to the brackets, shafts including the drag thanks to Magnus effect of the shaft . In is best suitable for little and high - speed crafts and has virtually no limit on size of propeller thanks to draught restrictions. These propellers are freely adoptable for giant range of auto speeds by adjusting the immersion.It is suitable for very high craft to achieve high speeds. Steering requirements can also be

met partially by adjustment of the angles of the shaft. Fiber reinforced plastics are extensively utilized in the manufacturing of varied structures like radomes, wingtips, stabilizer tips, antenna covers, flight controls including the marine propeller. The hydrodynamic aspects of the planning of composite marine propellers have attracted attention because they're important in predicting the deflection and performance of the propeller blade. Reinforced plastic features a high strength-to-weight ratio and is immune to mildew and decay. Because it's easy to fabricate, it's equally suitable for other parts of the marine propeller. Reinforced plastic may be a sandwich-type material. It's made from two outer facings and a middle layer. The facings are made from several layers of glass cloth, bonded along side a liquid resin. The propeller model developed in SOLIDWORKS is converted in to IGES file then imported to HYPERMESH for developing fine mesh of the model. As a neighborhood of the analysis static structural testing was conducted by varying material properties in pre-processing stage. After importing IGES file, further analysis was done using ABAQUS

II. PROBLEM STATEMENT

After reading research papers which were proposed for analyzing the stress on propeller blade we come to one sub conclusion that many ships and naval vessels meet with accidents due to propeller failure, which is ultimately caused by improper load distribution on surface propeller blade also, main cause is due to improper analyzing of stress which is going to get applied by varying hydropressure which is caused due to high turbulent flow of waves that are caused in the abyss. Selection of material in manufacturing of propeller plays a crucial role for analyzing the stress on it. As there are few materials which come to the failure over the course of time and due to high turbulent flow of water currents. Hence we can use different types of composite material to conquer this affair.

III. METHODOLOGY

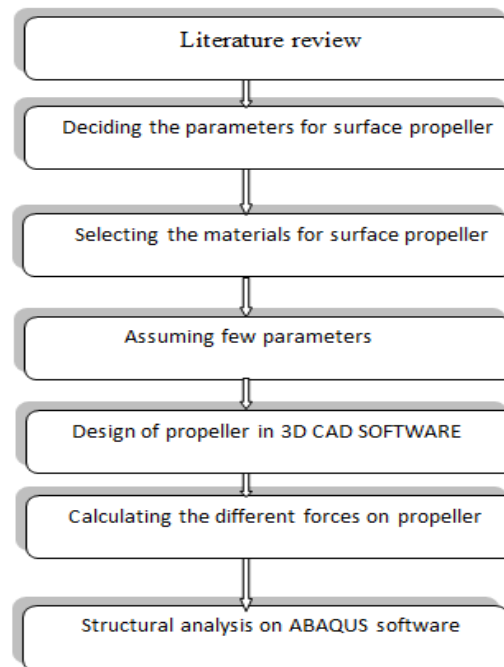


Table 3.1: Methodology flow chart

By referring different research papers which have proposed analysis over a propeller blade, concluding the important points and we proceed to the further process. For the ease of the overall procedure, we consider suitable properties of the material, geometry and dimensions for smoothing its further analysis. Hence it can function suitably. Specific metals or composite materials can only be used for propeller. Selecting improper material may lead to ultimate failure. Hence selection of material plays a crucial

role in the functioning of the propeller. We design a 3D propeller model on Solidworks, by giving it approximate dimensions and angles, so that it can mimic the actual propeller. Thereafter, we import it to the desirable FEA software i.e. ABAQUS. Then the model is assigned proper material. In the final step, as per the finite element analysis, we impose the boundary conditions and proper directed pressure. Henceforth, the results are generated.

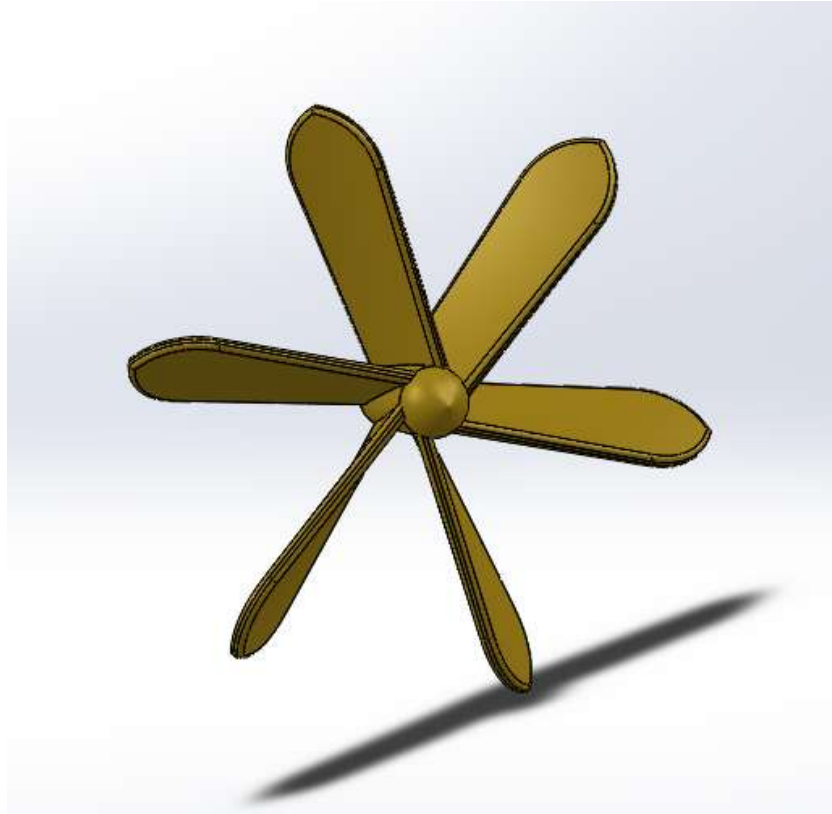


Figure 3.1: solidworks design of propeller

Table 1

Dimensions specifications

Sr. No.	Entity	Dimension	Sr no.	Entity	Dimension
01	Hub Diameter	1 meter	06	Blade Width	1.5 meter
02	Hub diameter (inner)	0.8 meter	07	Blade thickness	0.2 meter
03	Hub Length	2 meter	08	Blade fillet corner	0.1 meter
04	No. of Blades	6	09	Blade Area	6 meter ²
05	Blade Length	4 meter	10	Skew Angle	15 ⁰

Table.2

Mechanical properties of materials

Material	Stress(MPa)	Tensile strength	Modulus of elasticity	Hardness no.	Sp. Gravity
Manganese bronze	200	510	107	145	8.2
Chromium Stainless steel	450	680	200	220	7.8
Low carbon steel	250	450	200	130	7.9
Austenitic cast iron	235	435	105	150	7.1
NAB	295	635	125	208	7.5

Among All above materials NAB (Nickel Aluminium Bronze) is selected for propeller blade owing to its high tensile strength and moderately high modulus of elasticity Propellers being rotating devices need to withstand very high hydrodynamic force centrifugal force , torque and hydrodynamic lift. So NAB is suitable according to the design parameters

Table 3

Some mechanical properties of NAB

Properties	Values
Shear strength	415 MPa
Proof strength	295 MPa
Specific heat	420 J/kg-K
Thermal conductivity	42W/m-K
Elongation	17%
Modulus of rigidity	49 GPa
Poisson's ratio	0.32
Fatigue limit in water (for 10 ⁷ cycles)	205-235 MPa
Coefficient of linear expansion	17.1x10 ⁻⁶

IV. CONCLUSION

After doing overall analysis we will get the stress values on different materials on propeller blade. Henceforth we will be able to filter an optimum stress of the following material to withstand different stresses in ocean. Getting a brief idea for propeller manufacturing and its various performing functions. Finally we have concluded that the main thing about this project is that we can analyze a huge body structure into small scale 3D structures which are affected by many forces under water ultimately leading to high efficiency of expense in ground stage of production of the product, also by selecting the materials of optimum properties and efficiency. Therefore one can reduce the manufacturing cost of the ship propeller.

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