Modelling & Structural Analysis of Propeller Blade

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Abstract **- Propellers produce thrust through the production of lift by their rotating blades. Propeller hydrodynamics is therefore part of the broader field of lifting-surface theory, which includes such varied applications as aircraft, hydrofoil boats, ship rudders, and sailboat keels. Air and water propellers have much in common from a theoretical point of view, particularly if one's attention is restricted to air propellers operating at low Mach numbers (where compressibility effects are negligible) and to water propellers operating without cavitations. The cross sections of most lifting surfaces are also similar in appearance, being designed to produce a force at right angles to their motion through the fluid (lift) with a minimum force parallel to their direction of motion (drag).**

Conventionally a propeller surface representation is generated by fitting a B-spline surface through a collection of given propeller blade sections using CATIA V5. And analysis is done on different material in ANSYS 16 WORKBENCH and forces are calculated.

Keywords: Blades, Propeller, modelling, design, Thrust

I. INTRODUCTION:

Produce thrust through the production of lift by their rotating blades. Propeller hydrodynamics is therefore part of the broader field of lifting-surface theory, which includes such varied applications as aircraft, hydrofoil boats, ship rudders, and sailboat keels. Air and water propellers have much in common from a theoretical point of view, particularly if one's attention is restricted to air propellers operating at low Mach numbers (where compressibility effects are negligible) and to water propellers operating without cavitations.

The cross sections of most lifting surfaces are also similar in appearance, being designed to produce a force at right angles to their motion through the fluid (lift) with a minimum force parallel to their direction of motion (drag). In spite of these fundamental similarities, air and water propellers generally look very different. The reason is that propellers for ships are limited, for practical reasons, in diameter, and they are also limited by cavitation in the amount of lift per unit blade area that they can produce. As a result, marine propellers have blades that are much wider in relation to their diameter than would be found in aircraft propellers.

II. DESIGN PARAMETERS:

We consider a propeller consisting of K identical, symmetrically arranged blades attached to a hub that is rotating at constant angular velocity ~o about the x-axis. The hub is either idealized as an axisymmetric body as shown or ignored completely. The geometry of the blades and hub is prescribed in a Cartesian coordinate system rotating with the propeller. The y-axis is chosen to pass through the midchord of the root section of one blade, which we designate the key blade. Tl~e z-axis completes the right-handed system. An equivalent cylindrical coordinate system in which r is the radial coordinate and 0 = 0 on the y-axis is also used here. www.annualreviews.org/aronline Annual Reviews Annu. Rev. Fluid Mech.

MARINE PROPELLERS 375 The blade is formed starting with a midchord line defined parametrically by the radial distribution of skew angle 0m(r) and rake Xm(r). By advancing distance +½e(r) along a helix of pitch angle cpp(r), one obtains the blade leading edge and trailing edge, respectively, and the surface formed by the helical lines at each radius form the reference upon which the actual blade sections can be built

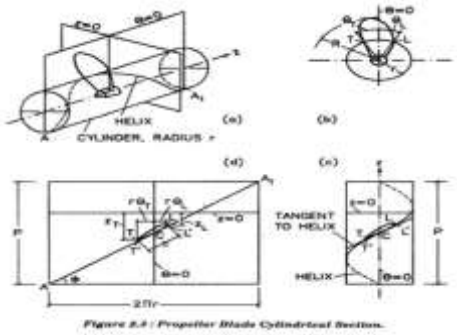


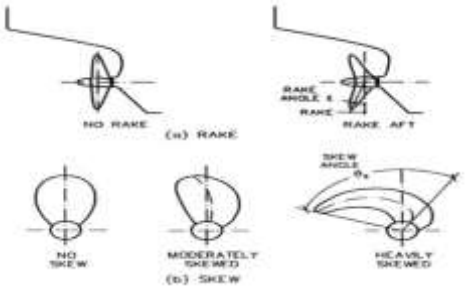
Figure 5.4 : Propeller Blade Cylindrical Section.

EFFECT OF PITCH

Pitch converts the torque of the propeller shaft to thrust by deflecting or accelerating water as tern

Speed without overloading the engine Increasing pitch increases thrust but increasing pitch too much reduces the efficiency of the engine and propeller combination by slowing the engine

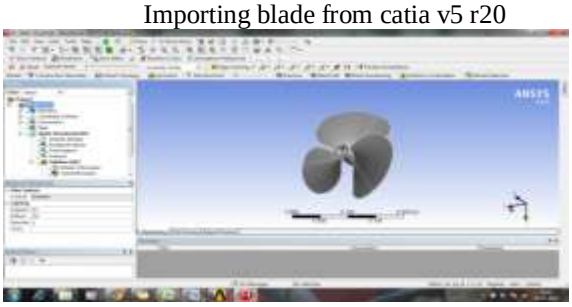
On the otherhand ,while too little pitch will not overloadors low the engine, it will not accelerate as much water as tern and thus will not generate max imum possible thrustor speed.



After selecting Structural define type of element in Pre-processors, select Add/edit, a dialogue box namely Element

type appears, click on button ADD and select Solid 10 node 187 in library of element type and then click ok.

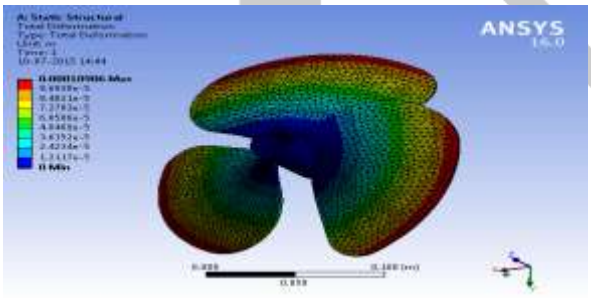
Importing blade from catia v5 r20



Applying rotation velocity factors

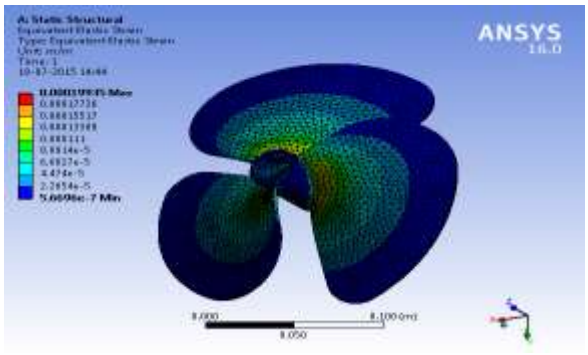
Applying pressure on surface blade

Total Deformation



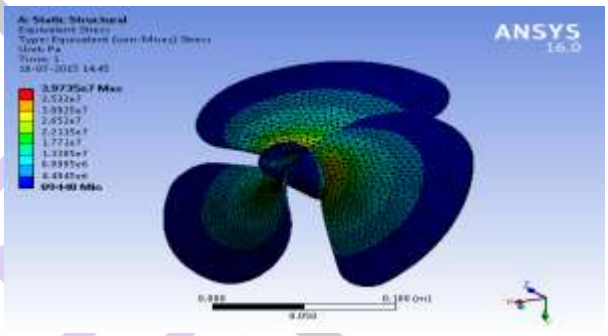
Total Deformation Max	0.00010906
Total Deformation Min	0

Equivalent Elastic Strain



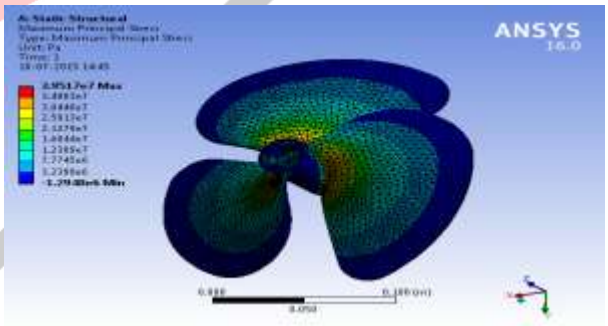
Equivalent Elastic Strain Max	0.00019935
Equivalent Elastic Strain Min	5.6696e-7

EQUIVALENT STRESS

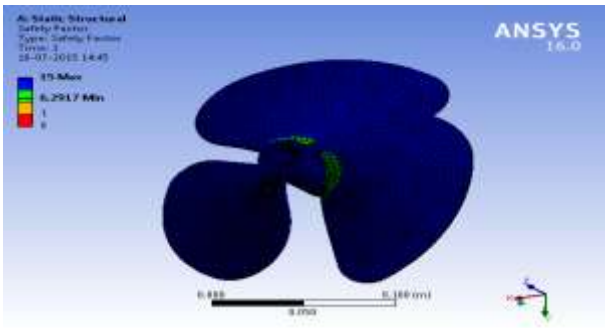


Equivalent Stress Max	3.9735e7
Equivalent Stress Min	89448

MAXIMUM PRINCIPAL STRESS

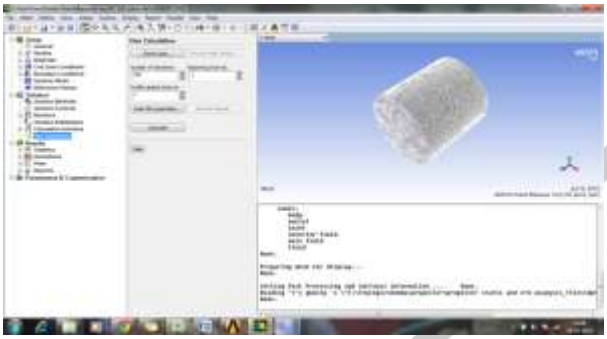


Maximum Principal Stress Max	3.97517e7
Maximum Principal Stress Min	-1.2948e6

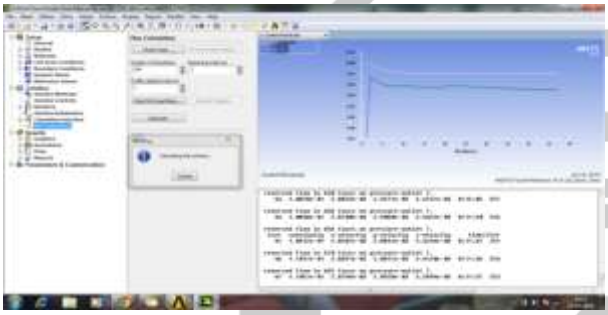


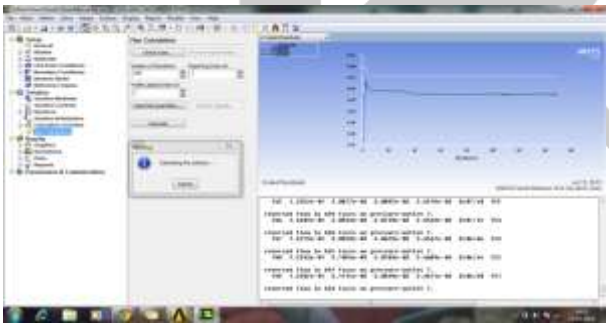
Safe Ty Factor 6.2917

Applying Boundary Coundation



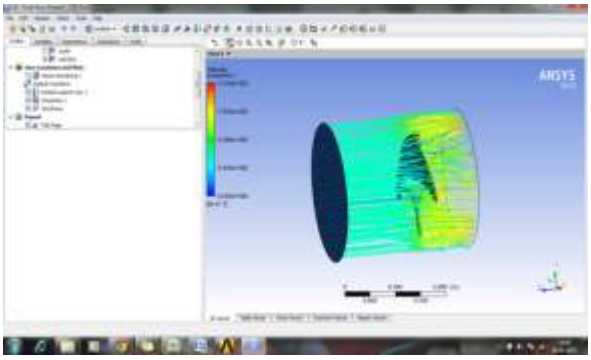
RUNNING PROGRAMS



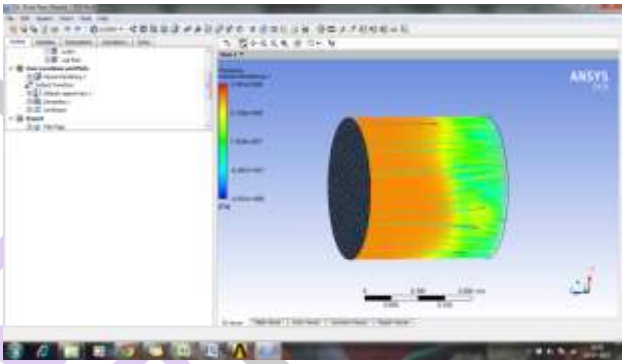


FINAL VIEW

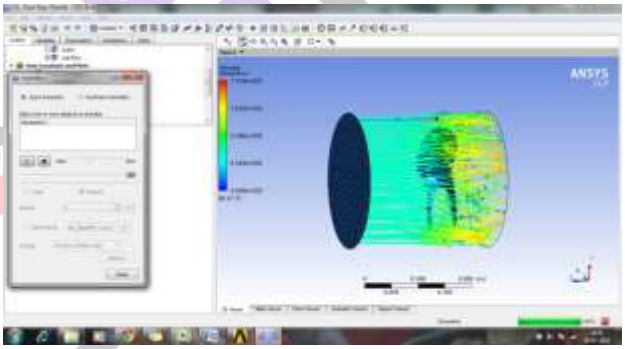
VELOCITY VARIANCE



PRESSURE VERIANCE



STREAM FLOW ANIMATION



CONCLUSION

- Propeller creates a high pressure and low pressure volume which helps vessels to move in forward direction.
- Design of propeller blade plays an important role. So we carefully designed propeller blades with required dimensions using CAD TOOL SOFTWARE namely CATIA V5R20 which has many advanced tools which helps for accurate design
- Wireframe and surface design workbench is employed from CATIA V5 R20 which has many single axis tools which is used for design.
- Excluding material tools are employed from part design workbench.
- STRUCTURAL ANALYSIS is done in ANSYS 16 WORKBENCH under required boundary condition and followed by CFD ANALYSIS is done in fluent workbench.

- We get maximum 1.108e3 velocity which is a pretty good velocity and we get pressure difference of 3.561e8 by which there is a large pressure difference when compared to its minimum pressure values..
- By basic pressure difference the whole body moves in the region where the pressure is low so in this criteria body moves.

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