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Designing & 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) Propellers are simple looking devices having no adjustable or moving parts. All of the manufacturers produce propellers similar in shape and design. They do vary in minor ways one from another. Given this similarity there must be some underlying reason for it. The purpose of this article is to discuss the 'why' of this similarity and the consequences that flow from it.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.

INTRODUCTION :

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 cavitation.

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.

In addition, propellers are generally located in close proximity to the stern of a ship. This choice is based both on consideration of propulsive efficiency and on such practical matters as machinery arrangement and vulnerability to damage. Since the flow near the stern is nonuniform, an inevitable consequence is the development of vibratory forces on the propeller blades and on the hull. Decisions concerning the number of blades and the shape of the blade outline are influenced to a great extent by the need to minimize this excitation. As an example, a photograph of a recently designed propeller for a seismic exploration vessel.

The computational model used in its design, which we discuss later, is illustrated. The complex blade shape is required because this propeller must have very low levels of vibratory excitation and be completely free of cavitation under certain operating conditions. The complete field of marine propeller hydrodynamics is far too broad to cover adequately in a single paper. In this review we restrict our attention to single-unit propulsors, as illustrated in. Multicomponent propulsors consisting of pairs of counterrotating propellers, combinations of rotors and stators, or propellers combined with fixed or rotating shrouds are all of current interest but are not covered here. Propeller cavitation is an extensive field of its own, which we also do not cover except as a motivation for determining accurate pressure distributions on the blades.

However, the reader should be aware that computational techniques for noncavitating flows, which we do describe, have been extended to the case of cavitating flows. Recent work in this particular area is reviewed in Van Houten et al. (1983). Another important aspect of propeller hydrodynamics that we do not cover here is the interaction of the pressure field of the propeller with the hull. The published literature in this field is extensive, and the interested reader might possibly start with publications by Breslin et al. (1982), Vorus (1976), and ¥orus et al. (1978). In this review we first discuss the onset flow to the propeller, which must be known before one can proceed with the solution of the propeller problem. We then formulate briefly the problem of the flow around a propeller in general terms, at which point we look specifically at the problems of designing a propeller for a given distribution of lift, analyzing a given propeller both in circumferentially uniform flow and in the unsteady flow resulting from a nonuniform onset field.

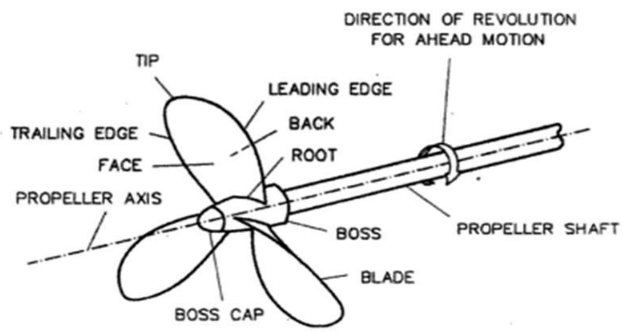

Figure 2.1 : A Three-Bladed Right Hand Propeller.

2.Implementation:

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.

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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. These sections can be defined in standard airfoil terms by a chordwise distribution of camber f(s) and thickness t(s), where s is curvilinear coordinate along the helix.

The propeller is operating in an unbounded, incompressible fluid, in a prescribed effective onset flow, as described in the preceding section. This flow is defined in a fixed coordinate system in which the x and Xo axes are identical, and the y and Yo axes are coincident at time t = 0. If we ignore the variation of the effective onset flow, both with respect to time and longitudinal position Xo, and make use of the cyclic nature of the flow, we can write down the velocity components in the following generally accepted

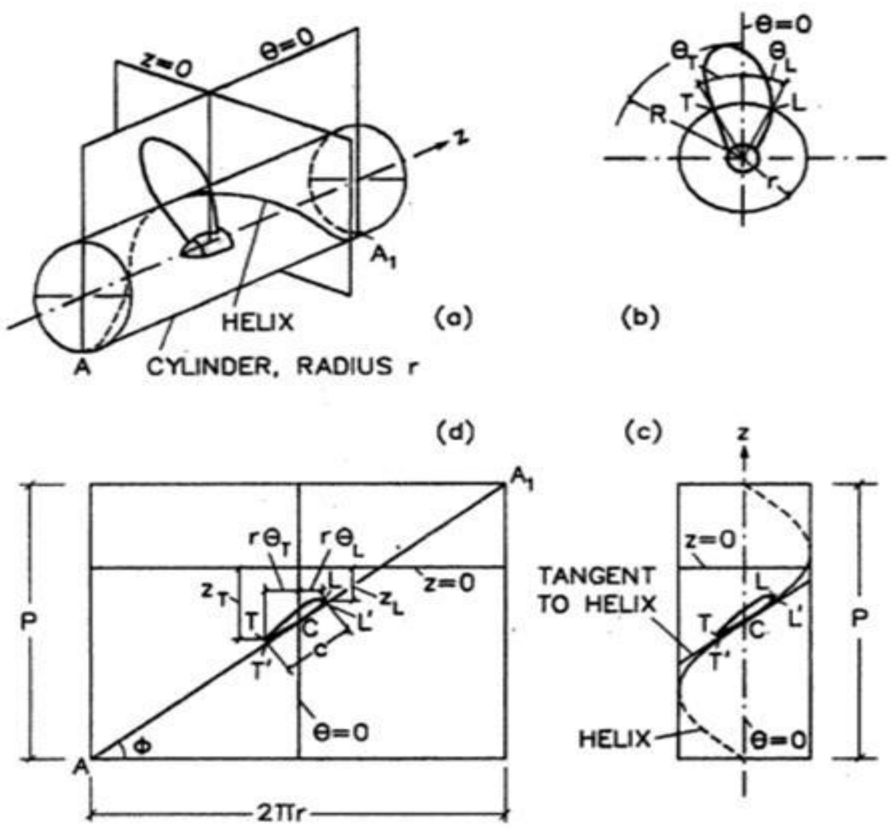

Figure 2.3 : Propeller Blade Cylindrical Section.

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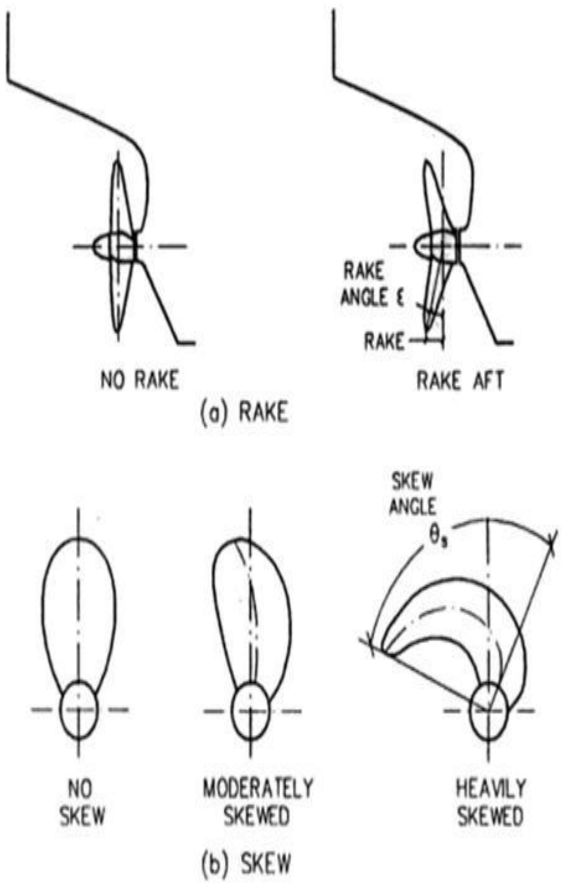
EFFECT OF PITCH

Pitch converts the torque of the propeller shaft to thrust by deflecting or accelerating water as tern The fundamental task in selecting a propeller is tochoo sea pitch and diameter that will generate the maximum thrust possibl eat normal operating 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.



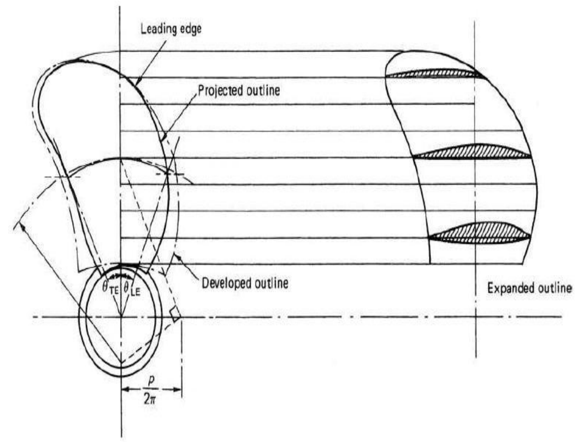


Figure 3.11 Outline definition

$$\left.\begin{aligned} K_Q &= \sum_{n=1}^{47} C_n (J)^{S_n} (P/D)^{t_n} (A_E/A_O)^{u_n} (Z)^{v_n} \\ K_T &= \sum_{n=1}^{39} C_n (J)^{S_n} (P/D)^{t_n} (A_E/A_O)^{u_n} (Z)^{v_n} \end{aligned}\right\} \quad (6$$

where the coefficients are reproduced in Table 6.6.

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.

Excuding 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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