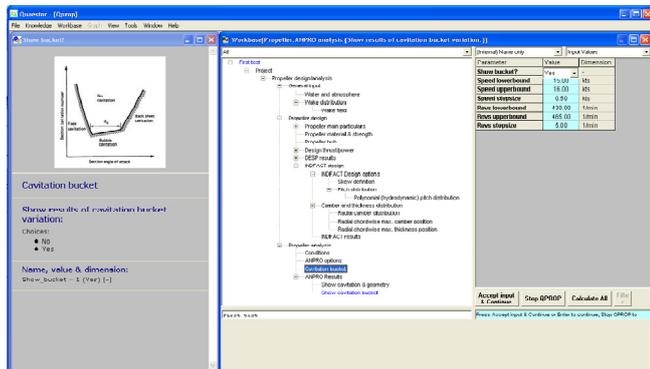


Propeller design and analysis workflow solutions

QPROP

QPROP provides propeller design and analysis workflow solutions based on the Quaestor knowledge-based workflow framework. QPROP greatly reduces the time spent on iterative propeller design, analysis and reporting activities as all incorporated tools make use of the same pool of project-related input data and (intermediate) results.



Example of a QPROP workflow

The workflow is arranged on the basis of the tools that are included per software suite. Two standard suites are available, either combined or separately:

1. Propeller selection and design suite
2. Propeller analysis suite

Apart from enabling a much more efficient use of the incorporated design and analysis tools QPROP allows you to perform specific sets of calculations and analyses with a combination of tools. In both suites for example, QPROP generates a cavitation bucket, being the operational envelope of a propeller in terms of cavitation, (relationship between cavitation number, propeller loading and cavitation occurrence by cavitation type). This requires multiple ANPRO runs the results of which are parsed, summarised and graphically presented in an Excel spreadsheet.

Furthermore, the QPROP workflow presents the variety of input data of the software tools orderly and well structured in a single graphical user interface. All input and (intermediate) output is managed in solutions, each being part of a project. Data consistency is maintained by Quaestor, so if you make any change in one of the inputs, the framework will re-execute all dependent calculations.

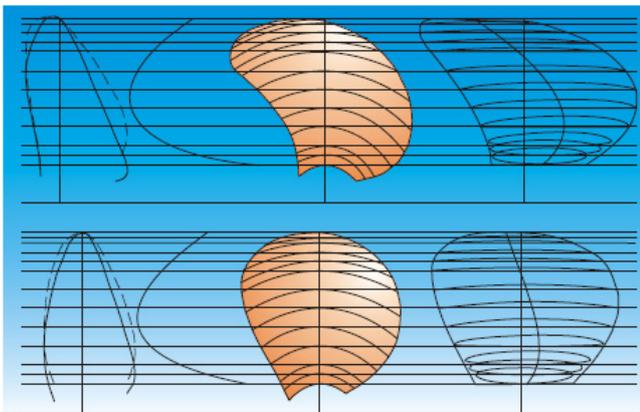
The QPROP suites comprise different software tools. For each software tool a separate leaflet is available with a detailed description. In this leaflet the general workflow of the QPROP framework is described.

Propeller selection and design suite

The QPROP propeller selection and design suite comprises the tools CSPDP or DESP, and INDFACT. The design process can be started either with CSPDP or DESP. Although CSPDP is not a Quaestor-based application, the output of CSPDP can be loaded as input in QPROP as starting point. CSPDP offers the designer a quick design and selection tool for three types of propellers: open propellers, ducted propellers and tunnel thrusters (respectively B-series, Ka-series and the Mitsubishi TT propellers). The result of CSPDP is a propeller geometry with sections based on the applied propeller series without the effect of radial wakes. As an alternative to CSPDP, propeller selection can be performed with DESP, based on the well known Holtrop & Mennen method. DESP allows you to perform a power prediction and preliminary propeller selection based on the Wageningen propeller series. DESP is a Quaestor-based application. Departing from the results of CSPDP, DESP or from other sources, a wake-adapted propeller can be designed with INDFACT. INDFACT is a lifting line program which implies a hydrodynamic model of the propeller using straight bound vortices for the blades of the propeller and a series of free vortices behind these blades, positioned on concentric cylinders and having constant pitch.



INDFACT incorporates an iteration procedure which combines cavitation on both sides with a strength calculation. It produces chord length, section thickness and camber distributions.



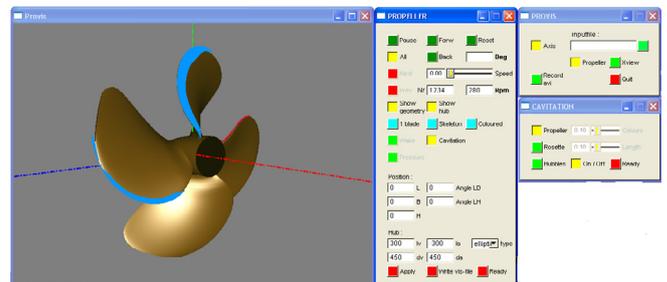
Propellers with varying skew in INDFACT

INDFACT does not provide information on unsteady behaviour of the propeller in the ship's wake, nor does it provide input for FEM calculations. The propeller geometry generated by INDFACT can be used as input for ANPRO as part of the following Propeller analysis suite. Before running the propeller analysis in ANPRO, the designer can modify the camber distribution in QPROP proposed by INDFACT while maintaining the design virtual pitch.

Propeller analysis suite

The QPROP propeller analysis suite comprises the tools ANPRO and PROVIS. ANPRO uses a robust lifting surface method for the computation of the quasi instationary blade loading of a propeller in a ship's wake field. With this tool experienced propeller designers are able to make a well-balanced design regarding propeller efficiency and harmful cavitation types such as pressure side cavitation and isolated cavitation patches. The result of the complete workflow can be displayed in de QPROP GUI and PROVIS, the 3D visualisation tool for cavitation patterns computed by ANPRO. For ducted propellers, the program DUCTPROP can be included in QPROP. DUCTPROP uses a model where the propeller is replaced by an actuator disk with prescribed radial loading distribution combined with a vortex distribution around the duct. The induced velocities are provided as input to ANPRO.

This suite can be used to analyse propellers that are designed in the propeller selection and design suite or originating from other sources, which will be the case if this suite is used without the propeller selection and design suite.



Visualisation of cavitation patterns in PROVIS

Application

QPROP can be used to design moderately loaded fixed pitch and controllable pitch propellers, with and without nuzzle, depending on the software tools that are included.

References

- 'QUAESTOR: Taxonomy-based compositional modelling and product configuration', M. Th. van Hees, IMDC, Trondheim, May 2009.
- 'The Wageningen propeller series', MARIN publication No. 92-001, G. Kuiper 1990.
- 'A Statistical Resistance Prediction Method with a Speed Dependent Form Factor', Holtrop, J., SMSSH088, Varna, October 1988.
- 'Moderately Loaded Propellers with Finite Number of Blades and in an Arbitrary Distribution of Circulation', SNAME, Vol. 60, 1952.
- 'Unsteady lifting surface theory for ship screws: Derivation and numerical treatment of integral equation', W. van Gent, Journal of Ship Research, Vol. 19, No. 4, December 1975, pp 243-253.
- 'On the calculation of ducted propeller performance in axisymmetric flows', MARIN publication No. 696, J.A.C. Falcao de Campos.

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