SC/Tetra

Cradle
MSC Software Company

CFD Application of Simplified Propeller Model to Simulate Propeller/Rudder Interactions

Case Study of SC/Tetra

SC/Tetra and infinitely bladed propeller theory are used to analyze propeller and rudder performance

Propeller-Rudder Interaction

Interactions between the hull, propeller and rudder are critical considerations when examining the propulsion performance of a vessel. Analysis methods that rotate a realistically shaped propeller are becoming more practical. However, a high calculation load is still the main bottleneck.

To address this, a simplified model based on the infinitely bladed propeller theory [1-3] was used with SC/Tetra. This propeller model has been verified in a variety of applications and reduces the calculation load. In this case study, the simplified propeller model was used to simulate the performance of a propeller and the associated propeller-rudder interactions. Analysis results were compared with test measurements.

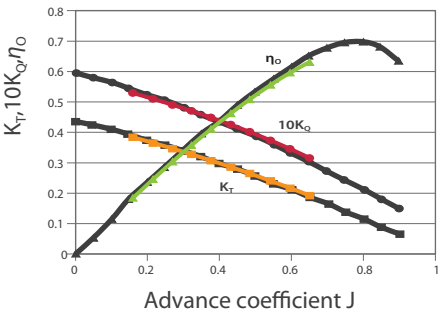
[1] Kuniharu Nakatake. 1967. Report of the West-Japan Society of Naval Architects, 34th volume: p25-36

[2] Fumio Moriyama.1979. Report of the Japan Ship Technology Research Association. 16th volume, 6th issue: p361-376

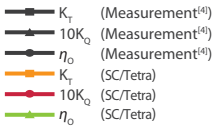
[3] Takero Tamada, Jun Ando. 2015. Conference book of the Japan Society of Naval Architects and Ocean Engineers. 21st issue: p555-558

Infinitely bladed propeller theory

Individual performance of propeller

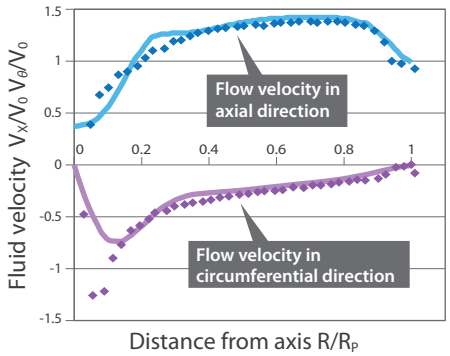


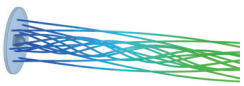
Comparison between measurement and calculated values of thrust and torque coefficients

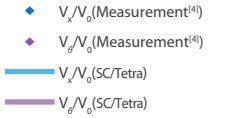


Performance of propeller can be predicted with high accuracy

Slipstream of propeller





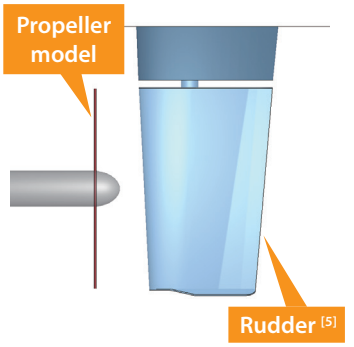


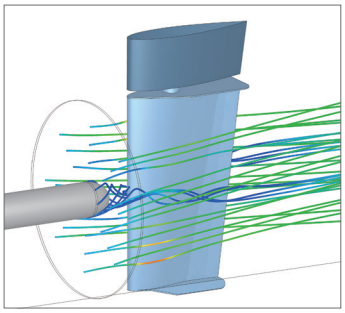
Slipstream of propeller can be simulated with small calculation load

Fluid velocity at 1.446 R_P behind propeller (R_P: propeller radius)

[4] Kazuyuki Ouchi, Masahiro Tamashima, Toshio Kawasaki, Koizuka Hajime. 1989. Journal of the Society of Naval Architects of Japan. 165th issue: pp.43-53

Analyzing propeller-rudder interaction

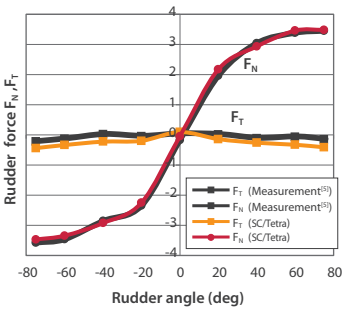




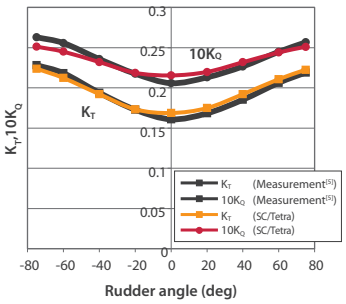
Comparison between analysis and test results

Performance of propeller and rudder during interaction

Rudder normal force F_N and rudder drag F_T



Thrust coefficient K_T and torque coefficient of $10K_Q$

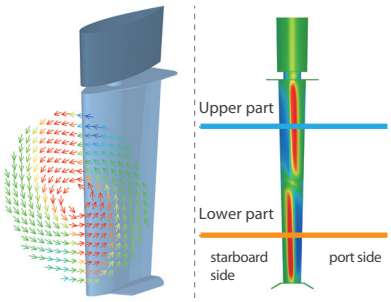


Effects of propeller-rudder interaction can be accurately assessed

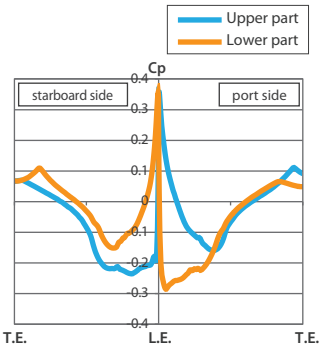
[5] Yukio Tomita, Takayuki Wakabayashi. 2001. Fune no kagaku. 54th volume: p58-61

Rotational flow near front edge of rudder and surface pressure distribution

Rotational flow near front edge of rudder



Surface pressure distribution on rudder



Can be utilized for design improvements

Notes

Propeller-rudder interactions were analyzed with a low calculation load by applying the infinitely bladed propeller theory to SC/Tetra. Analysis results closely agreed with measurements. The next step is to include the interactions with the hull. This will establish the simplified propeller model as a valuable tool for accurately estimating vessel propulsion performance using SC/Tetra.