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On the accuracy of unsteady RANS to predict hull-pressure fluctuations induced by a cavitating propeller

Unsteady cavitation on ship propellers operating in behind-hull condition can induce large hull-pressure fluctuations. The hull forms at the stern together with the propeller characteristics determine the severeness of the excitation forces; hence the pressure pulses must be considered at design stage to avoid undesired vibrations. Computational Fluid Dynamics (CFD) simulations proved successful in the prediction
of the pressures at frequencies corresponding to the first harmonic component of the blade passage frequency (BPF) [1][2]. However, the method, based on the unsteady Reynolds-Averaged Navier-Stokes(RANS) equations, underpredicts the higher harmonic components [3][4].
In this study, a multi-phase unsteady RANS approach is employed for validation of the pressure pulses on a model scale container vessel; the model was tested at the Hamburg Ship Model Basin as part of the European project SONIC[5]. The amplitude of the first, second and third harmonics of the BPF are large due to the extent of sheet and tip vortex cavitation, which poses a challenge for the computational method. The accuracy and the numerical requirements (hence the cost) are studied, in anticipation of including the pressure fluctuations in automated design-optimization techniques.

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