Assessing Cavitation Nuisance using LES in OpenFOAM

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Abstract

In this contribution, we will review and discuss recent years progress in simulating unsteady cavitating flows in OpenFOAM at the Dept of Shipping and Marine Technology at Chalmers[1-5], and what we believe is needed to further advance predictions and reliability. Using Large Eddy Simulation together with a mixture assumption and a finite rate mass transfer modeling following Kunz et al. [6], we have demonstrated in our numerical simulation the presence of several cavitation mechanisms important to capture when studying cavitation nuisance for hydrodynamic machinery, such as marine propellers and power turbines. These phenomena include the presence and action of reentrant jets, e.g. cutting of sheet cavities and causing shedding, but also some intrinsic details of secondary cavitation, Bark et al. [7], influenced by shear layers, vortex roll-up and interaction.

The discussion will be based on fairly well resolved 3D simulations of a NACA0015 hydrofoil, and the developing sheet cavitation on the foil. Cavitation on the NACA0015 is a popular case indicated by the multitude of contributions at the 7th Int. Symposium on Cavitation in Ann Arbor in September 2009. We will point on some of the physical features mentioned above and discuss their importance in the aim of assessing cavitation nuisance numerically. From a modeling point of view, a comparison between the behavior of the Kunz model and the Sauer model [8] will be made.

Furthermore, we will demonstrate how this extends to more complex applications and show results from our simulations on the E779A propeller in both homogeneous [4] and wake inflow [4,5] to indicate that engineering applications are within reach in the near future. Apart from the increased complexity in geometry, we here also capture the additional effects of the interaction between the leading edge sheet cavity and the tip vortex and the leading edge desinence as the propeller blades exits the wake

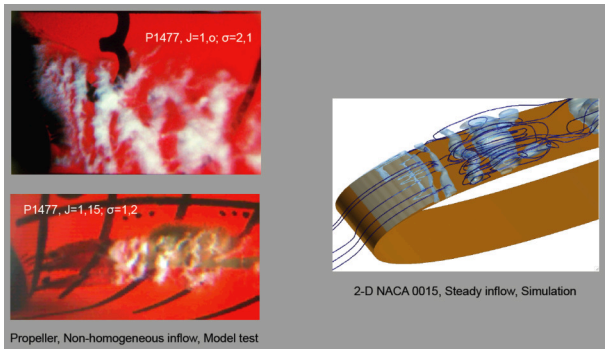

Figure 1. Vortex group cavitation downstream a mainly glassy sheet on a propeller during model testing and simulated by Large Eddy Simulation, LES, at a 2D foil with some streamlines indicated.

Key words: Cavitation, Mulitphase modeling, LES

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