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Analysis of noise propagation from a hydrofoil using Navier-Stokes equations and Kirchhoff as well as Ffowcs-Williams and Hawkings methods

P. Ghadimi*, S. Kermani

Department of Maritime Engineering Amirkabir University of Technology

Abstract

In the present article, hydro-acoustic computations of a hydrofoil has been accomplished, using Navier-Stokes and Kirchhoff as well as Fowcs-Williams-Hawkings methods and the results have been compared against each other. A hydrofoil NACA-0012 in water has been considered at Reynolds number 5×10^6 and hydrodynamic analysis has been conducted at seven different angles of attack, using Ansys-CFX solver. For the acoustic computation, a computer code named AcoPy has been developed which has the capability of parallel processing. Sound pressure level has been obtained for these methods at angle of attack of 10 degrees for five different surface integrals and at distances of 0, 0.01, 0.076, 0.25, and 1.0 of the hydrofoil chord. The computed sound pressure levels have been compared against those obtained by the Navier-Stokes equations. Finally, by comparison of the results of various surface integrals, an optimum surface integral has been determined for the Kirchhoff as well as Fowcs-Williams-Hawkings methods. On the other hand, acoustics behavior of the foil has been presented for various angles of attack. It was concluded that the FWH method, due to the consideration of nonlinear behavior of the pressure, produces better results than the Kirchhoff method.

Keywords: Hydroacoustic analysis, Hydrofoil, Navier-Stokes equations, Kirchhoff method, Ffowcs-Williams and Hawkings method.

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* Corresponding author E-mail: pghadimi@aut.ac.ir

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