Numerical Study of Roughness Model Effect at Actual Ship Scale

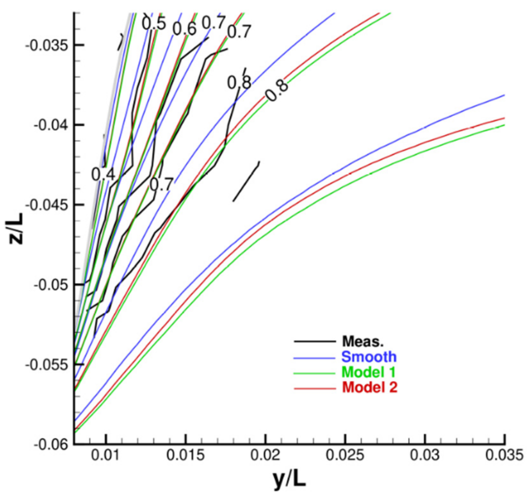
Kunihide Ohashi*

* National Maritime Research Institute (NMRI)
6-38-1 Shinkawa, Mitaka,Tokyo, Japan
e-mail: k-ohashi@nmri.go.jp

ABSTRACT

Numerical study of roughness effects at an actual ship scale is performed. An in-house structured CFD solver [1] which is capable the overset-grid method is used. The governing equations are 3D RANS equations for the incompressible flow. The artificial compressibility approach is used for velocity-pressure coupling. Spatial discretization is based on the finite-volume method. An interface capturing method based on the single phase level-set approach is employed to capture free surfaces. A propeller effect is taken account for the body force model which is based on the potential theory. The weight values for the overset-grid interpolation is determined by the in-house system [2] which is based on the Ferguson spline interpolation. Two roughness models which are based on the low-Reynolds number type and the two equation turbulence model are employed.

First, the roughness models are examined on the two dimensional flat plate case at the Reynolds number 1.0 x 10^8 and 1.0 x 10^9. The resistance coefficient increases with the roughness height, and the uncertainty analysis about the resistance coefficient is performed. Additionally, the distributions of the non-dimensional velocities u^+ based on the non-dimensional heights y^+ are compared with changing the roughness height. Next, the roughness models are applied to the flows around a ship in the actual scale with the free surface at the self-propulsive condition. The Reynolds number is 2.43 x 10^9 and the Froude number is 0.153. The four computational grids are overlapped. The velocity contours are compared with the measured results of the actual ship. The results with the roughness models show the good agreement comparing with the smooth surface condition.



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