VERIFICATION AND VALIDATION FOR CFD SIMULATION OF KRISO CONTAINER SHIP

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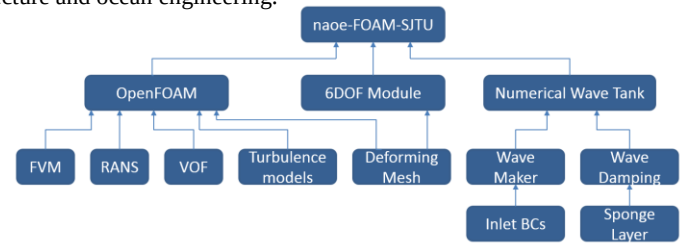
SUBMISSION EXPLANATION

Test cases: Case 2.1
Name of the Code: naoe-FOAM-SJTU
Institution: Shanghai Jiao Tong University

Solver and calculation procedure

naoe-FOAM-SJTU: A self-developed RANS solver based on the open source platform OpenFOAM and mainly applied for the hydrodynamic problems in naval architecture and ocean engineering.

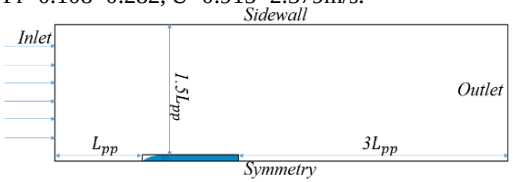


High Performance Computing

Computational Expenses: 3.382M grid (fine) is solved on 20 processors for calculation. Simulation took 58 hours of clock time and 1160 hours of CPU time.
Hardware: IBM nx360M4 which consist of 20 CPUs/node with 64GB memory per node, processor clock speed of 2.8GHz, and bandwidth of 56Gbps.

Modeling

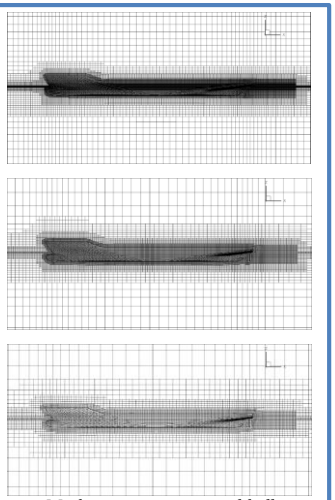
Model: KRISO Container Ship (KCS) at six different Froude numbers. Lpp=7.2786m
Fr=0.108~0.282, U=0.915~2.379m/s.



Computational domain

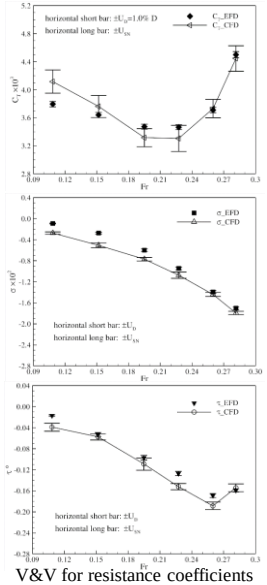
	Number of Mesh	h_{i+1}/h_i
Fine Mesh	3.382M	1.4
Medium Mesh	1.243M	1.4
Coarse Mesh	0.457M	/

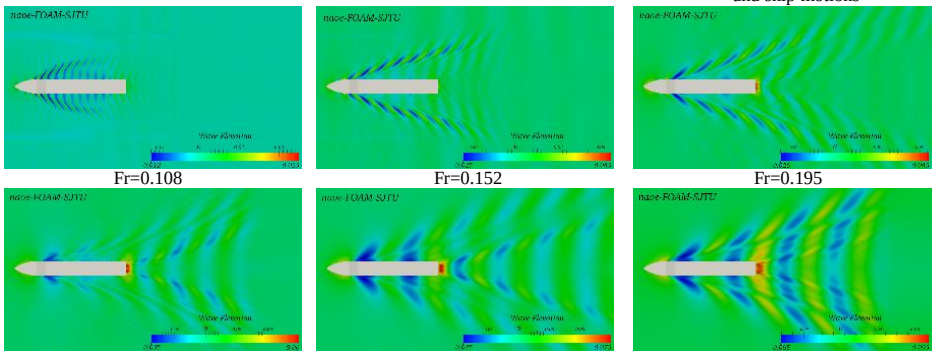
Number of mesh for three sets systematic grid


Mesh arrangement around hull

Numerical Analysis & Results

All six cases for V&V are in calm water condition with three sets of systematic grids from fine to coarse.
Simulation results and simulation numerical uncertainty for resistance coefficients and ship motions are compared with the experimental data and data uncertainty in right figures.
In prediction of resistance, the comparison errors between simulation results and experimental data are not more than 5% except the case at the lowest speed. For the case at the lowest speed, the resistance value is so little that the error of percentage seems larger. And the verification and validation study shows that the level of simulation uncertainty is not larger than 4.50% for most cases.
In terms of ship motions, the comparison errors between simulation results and experimental data are respectively high, although the validation uncertainty is in a low level. The trend of the error and uncertainty for ship motions is similar to the trend for resistance, that is, cases at high speeds have error and uncertainty in lower level.
The free surfaces at different speeds are shown as below figures.


V&V for resistance coefficients and ship motions


Fr=0.108 Fr=0.152 Fr=0.195
Fr=0.227 Fr=0.260 Fr=0.282
Wave patterns at six different speeds

References

Shen, Z.R, Cao, H.J and Wan, D.C (2012). "Manual of CFD solver for ship and ocean engineering flows: naoe-FOAM-SJTU," Register No.2012SR118110, Shanghai Jiao Tong University.
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Ye, H.X, Shen, Z.R, and Wan, D.C (2012). "Numerical prediction of added resistance and vertical ship motions in regular head waves," Journal of Marine Science and Application, 11(4), 410-416.