SC/Tetra

Cradle
MSC Software Company

Tank Test Simulation of Blunt Ship (Towing Condition) 1/2

Using SC/Tetra to perform tank test simulation of a blunt ship and to examine the effectiveness of Energy Saving Devices (ESD)

Analysis Objectives

Tank tests of ship models play vital roles in enhancing the propulsive performance of ships and the development of ESD, which have been actively developed as they have significant effects on ships' energy efficiency. In this case study, SC/Tetra was used to perform tank test simulation of a ship in towing condition. The simulation is targeted at a blunt ship where bilge vortices, which are key factors in CFD estimation of the propulsive performance of ships, are generated prominently.

Overset grid function of SC/Tetra was used to examine the effectiveness of ESD in towing test condition.

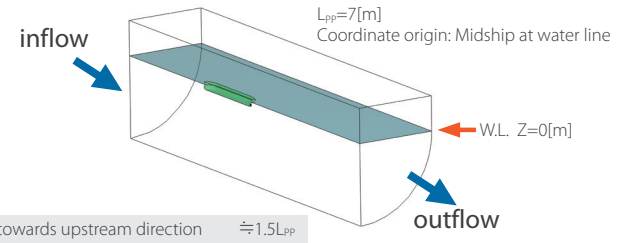
Principal particulars of model ship*1

*1 JAPAN Bulk Carrier (JBC)

		Model scale
Length between perpendiculars	L_{PP} [m]	7.0
Length of waterline	L_{WL} [m]	7.125
Maximum beam of waterline	B_{WL} [m]	1.125
Depth	D [m]	0.625
Draft	T [m]	0.4125
Wetted surface area w/o ESD	$S_{0\_w/oESD}$ [m^2]	0.2494
Wetted surface area with ESD	S_{0_wESD} [m^2]	0.2504
Service speed	Fn	0.142
	U [m/s]	1.179
	Re	$7.46 \cdot 10^6$

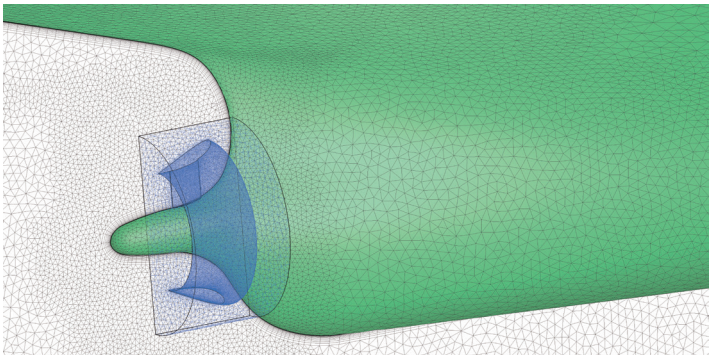
* Reference: Tokyo 2015 A Workshop on CFD in Ship Hydrodynamics
http://www.nmri.go.jp/institutes/fluid_performance_evaluation/cfd_rd/cfdws15/index.html

Analysis domain



From F.P. towards upstream direction	$\fallingdotseq 1.5L_{PP}$
From A.P. towards downstream direction	$\fallingdotseq 2.5L_{PP}$
Width and depth	$\fallingdotseq L_{PP}$
Above water line	$=3$[m]

Considering ESD using overset grids



Overset grids allocated around ESD

Analysis details*

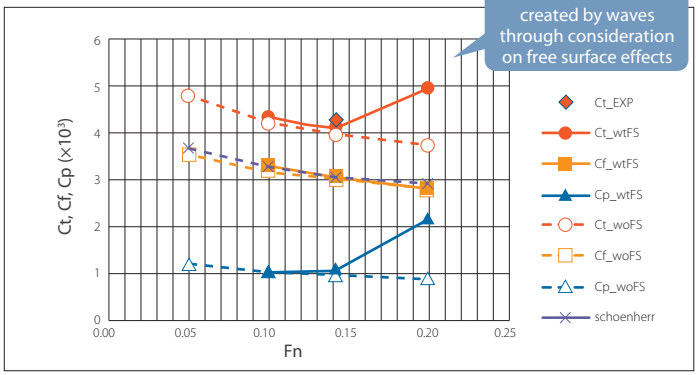
* Half model is used

Ship speed change test [without ESD]
- Without free surface (Double model)
- With free surface

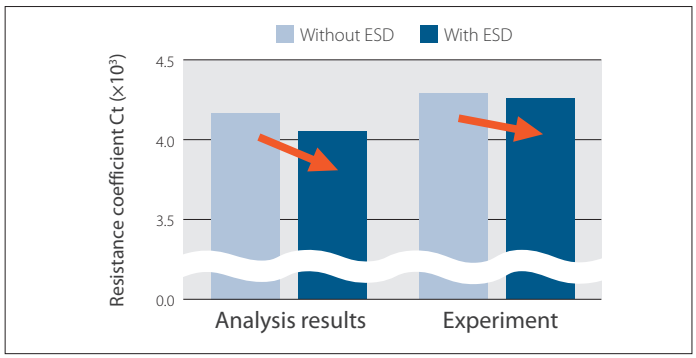
Comparison with experiment
- Resistance coefficients with/without ESD at design speed
- Wake distribution with/without ESD at design speed
- Wave height distribution without ESD at design speed

Analysis results

Resistance test

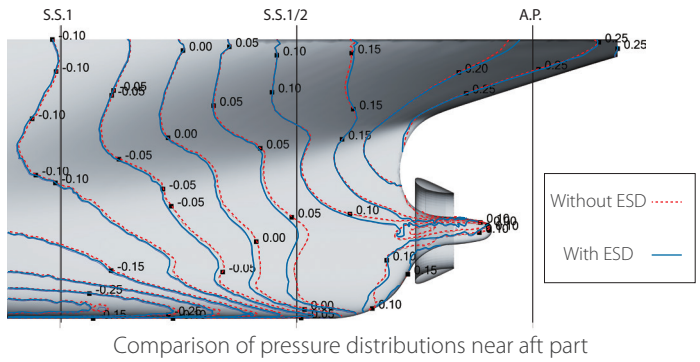


Resistance coefficients



Possible to estimate the tendency that hull resistance is reduced by attaching ESD

Pressure distribution on hull surface



Comparison of pressure distributions near aft part
[$Cp=P/(0.5 \cdot \rho \cdot U^2)$]
Pressure recovers near aft part by attaching ESD

Tank Test Simulation of Blunt Ship (Towing Condition) 2/2

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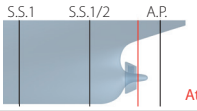
Analysis results

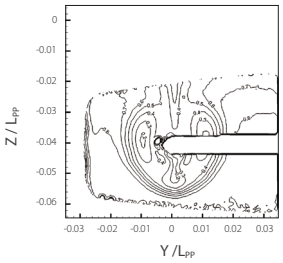
Wake distribution

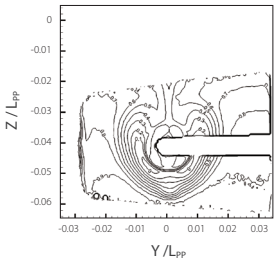


At propeller plane

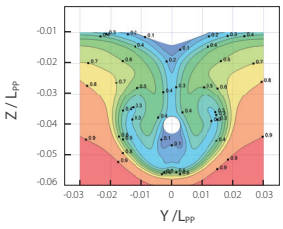
At A.P. section

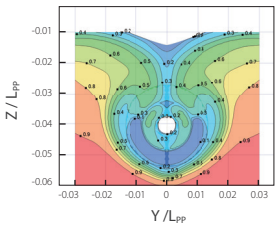
Experiment





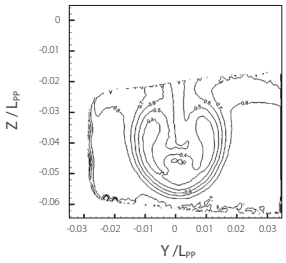
Analysis results

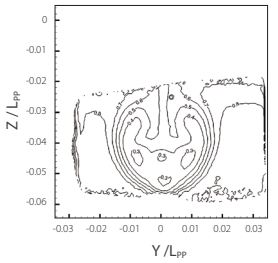




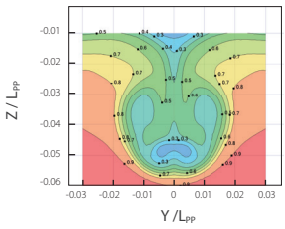
Without ESD | With ESD

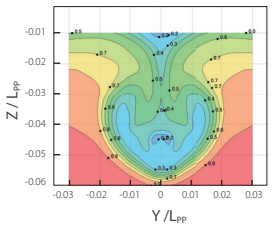
Experiment





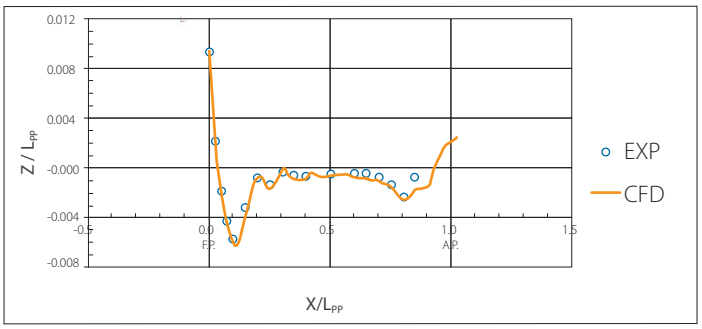
Analysis results



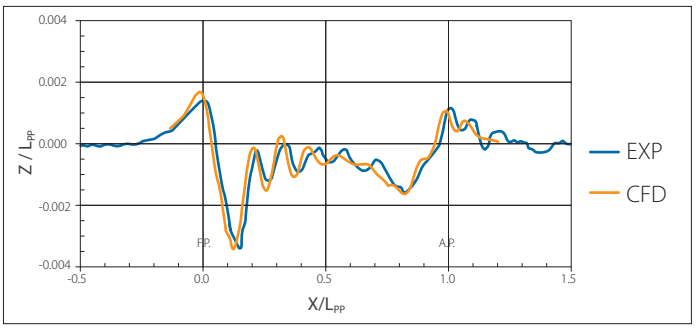


Without ESD | With ESD

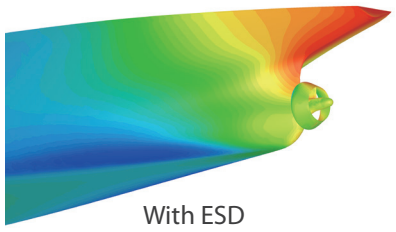
Wave profiles on hull surface



Longitudinal wave height distribution (Y/Lpp=0.19)

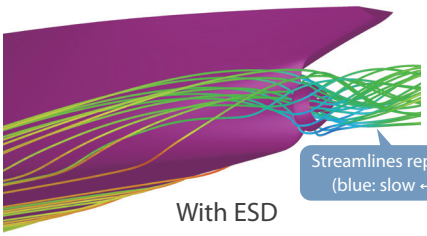


Surface pressure distribution near aft part



With ESD

Streamlines in 3D near aft part



Streamlines represent velocity
(blue: slow ⟷ red: fast)

With ESD

Notes

- The case study of a blunt ship showed that it is possible to reproduce bilge vortices near aft part, which are key factors when considering the propulsive performance of ships.
- The case study also showed SC/Tetra's overset grid function is effective for examining the effect of ESD and evaluating whether ESD help improve energy efficiency.
- Further evaluation of the ship in self-propulsion condition is possible by additionally considering rotation of an actual propeller or by applying the simplified propeller model based on the infinitely bladed propeller theory.