Development of automatic package for prediction of ship resistance

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Contents

Introduction

- Growing interest in fuel efficiency due to CO_2 reduction policies and reduction of volume of ship operation
- Required resistance performance prediction of ship operating in various states in accordance with the loading method and loading capacity
- Can be applied to CFD resistance estimation of running state
- CFD result of the ship is expecting as well as experiment with resistance estimation
- To find optimized cruising conditions fast and conveniently, automatization is considered

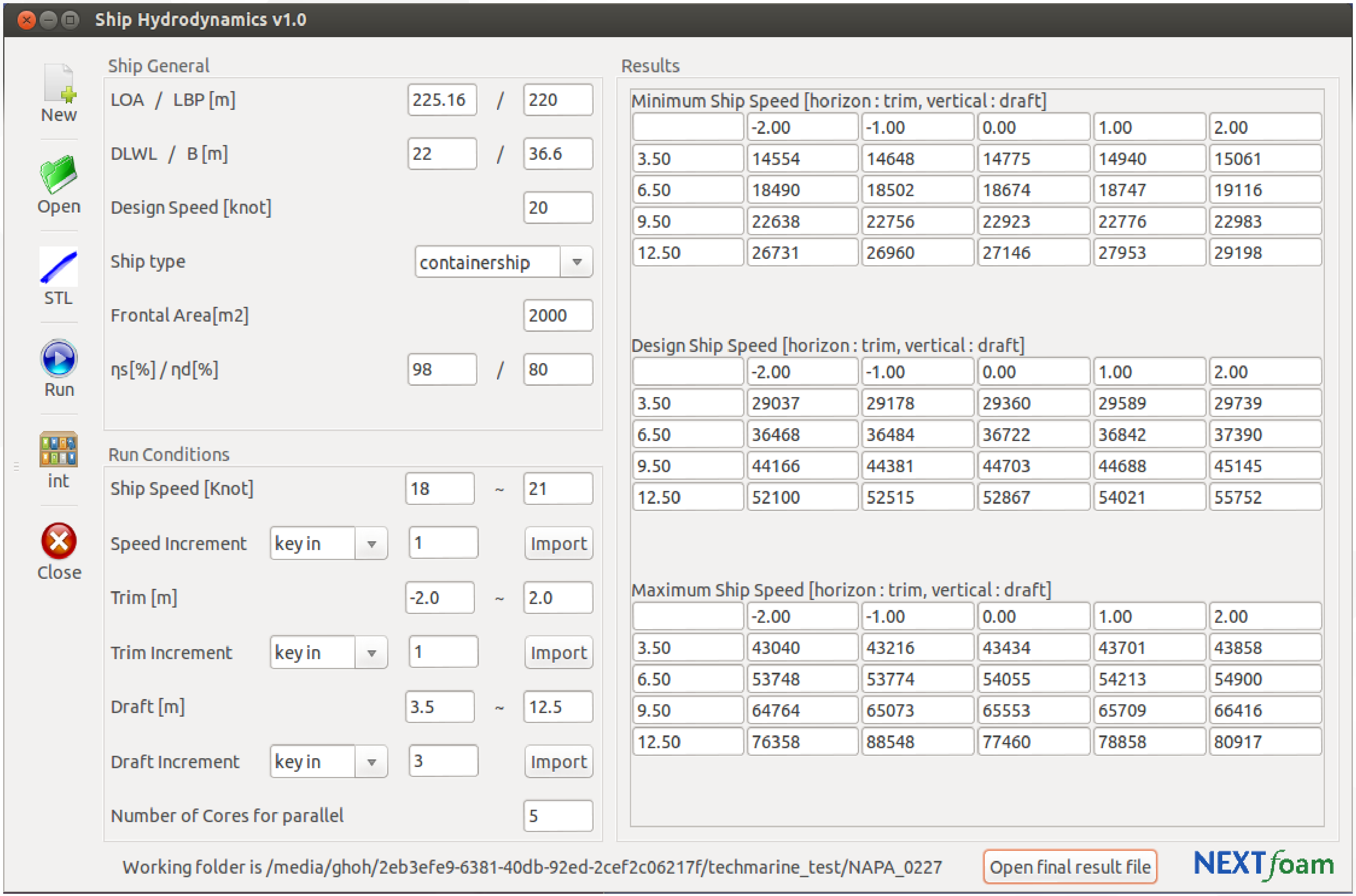
Purpose of the project

- To make a forecast of resistance to operating conditions as hull types
- It is necessary to obtain in a short time analysis
- Can be simulated with only simple input without a CFD expert
- The predictable engine horsepower without a basic knowledge of marine engineering

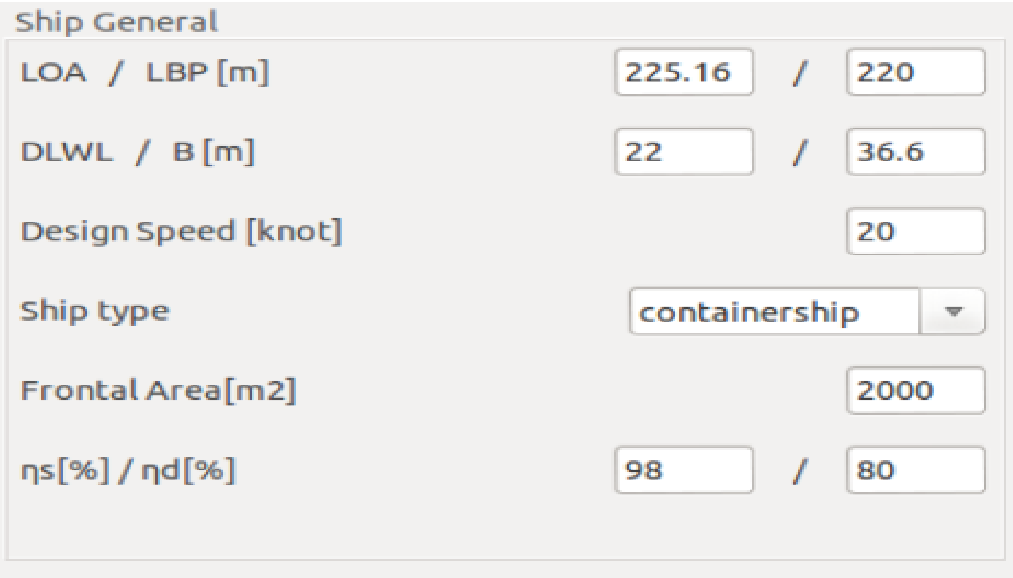
Assumptions

- Estimated by a CFD viscous resistance with a maximum value of the resistance of the ship
- Expand by a real ship resistance of model ship
- We run a double-body model computation to enormous time limit and amount of computation
- The estimated by comparison of analysis results with model test results for the wave resistance

GUI

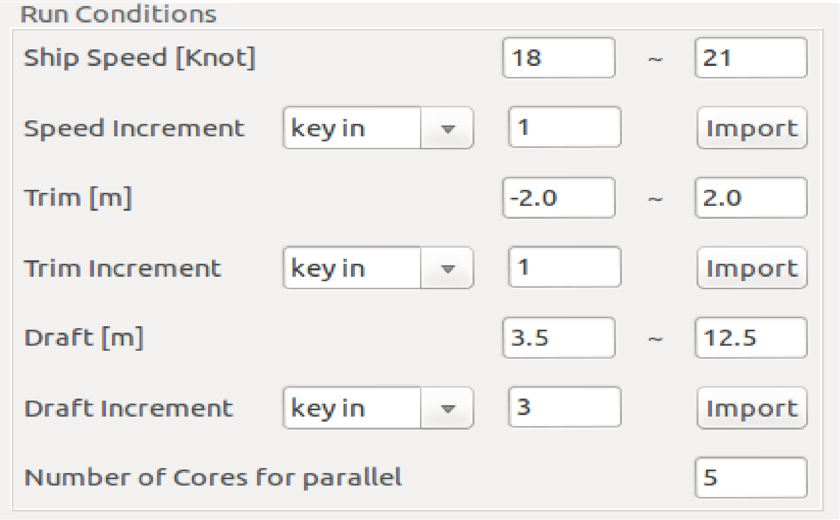

Ship Hydrodynamics v1.0
New
Open
STL
Run
int
Close
Ship General
LOA / LBP [m] 225.16 / 220
DLWL / B [m] 22 / 36.6
Design Speed [knot] 20
Ship type containership
Frontal Area[m2] 2000
ηs[%] / ηd[%] 98 / 80
Run Conditions
Ship Speed [Knot] 18 ~ 21
Speed Increment key in 1 Import
Trim [m] -2.0 ~ 2.0
Trim Increment key in 1 Import
Draft [m] 3.5 ~ 12.5
Draft Increment key in 3 Import
Number of Cores for parallel 5
Results
Minimum Ship Speed [horizon : trim, vertical : draft]
-2.00 -1.00 0.00 1.00 2.00
3.50 14554 14648 14775 14940 15061
6.50 18490 18502 18674 18747 19116
9.50 22638 22756 22923 22776 22983
12.50 26731 26960 27146 27953 29198
Design Ship Speed [horizon : trim, vertical : draft]
-2.00 -1.00 0.00 1.00 2.00
3.50 29037 29178 29360 29589 29739
6.50 36468 36484 36722 36842 37390
9.50 44166 44381 44703 44688 45145
12.50 52100 52515 52867 54021 55752
Maximum Ship Speed [horizon : trim, vertical : draft]
-2.00 -1.00 0.00 1.00 2.00
3.50 43040 43216 43434 43701 43858
6.50 53748 53774 54055 54213 54900
9.50 64764 65073 65553 65709 66416
12.50 76358 88548 77460 78858 80917
Working folder is /media/ghoh/2eb3efe9-6381-40db-92ed-2cef2c06217f/techmarine_test/NAPA_0227
Open final result file
NEXTfoam

Input values



- Specifications principal dimension input to be calculated hull
  - LOA, LBP, breadth, draft, design speed
  - mesh can be created needed for analysis at the input of the minimum
- Selection of the hull types for the total resistance estimation
  - tanker, cargo ships, oil carrier, container, car carrier, destroyer
- Enter the frontal projected area for total resistance coefficient
- Select quasi propulsive efficiency for estimating engine horsepower, the shaft transmission efficiency

Operation posture



- Variable input to the desired operating position
  - speed, trim angle, draft
  - automatic a number of meshes generation to meet operating position
  - only variable speed, trim, draft and easily create cases for calculation
  - creation the vertices of blockMesh according to trim and draft
  - addition to the min, max value searchableBoxes in snappyHexMesh according to the trim and draft
- Used to calculate the number of core can be selected

Output values

Results

Minimum Ship Speed [horizon : trim, vertical : draft]

	-2.00	-1.00	0.00	1.00	2.00
3.50	14554	14648	14775	14940	15061
6.50	18490	18502	18674	18747	19116
9.50	22638	22756	22923	22776	22983
12.50	26731	26960	27146	27953	29198

Design Ship Speed [horizon : trim, vertical : draft]

	-2.00	-1.00	0.00	1.00	2.00
3.50	29037	29178	29360	29589	29739
6.50	36468	36484	36722	36842	37390
9.50	44166	44381	44703	44688	45145
12.50	52100	52515	52867	54021	55752

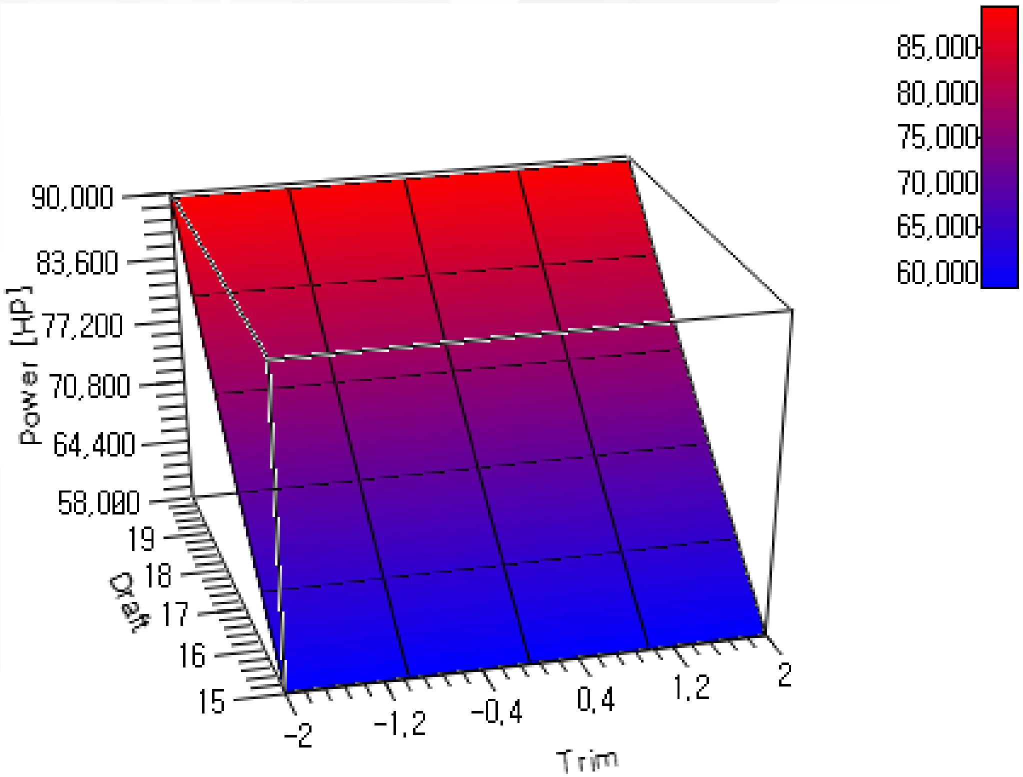
Maximum Ship Speed [horizon : trim, vertical : draft]

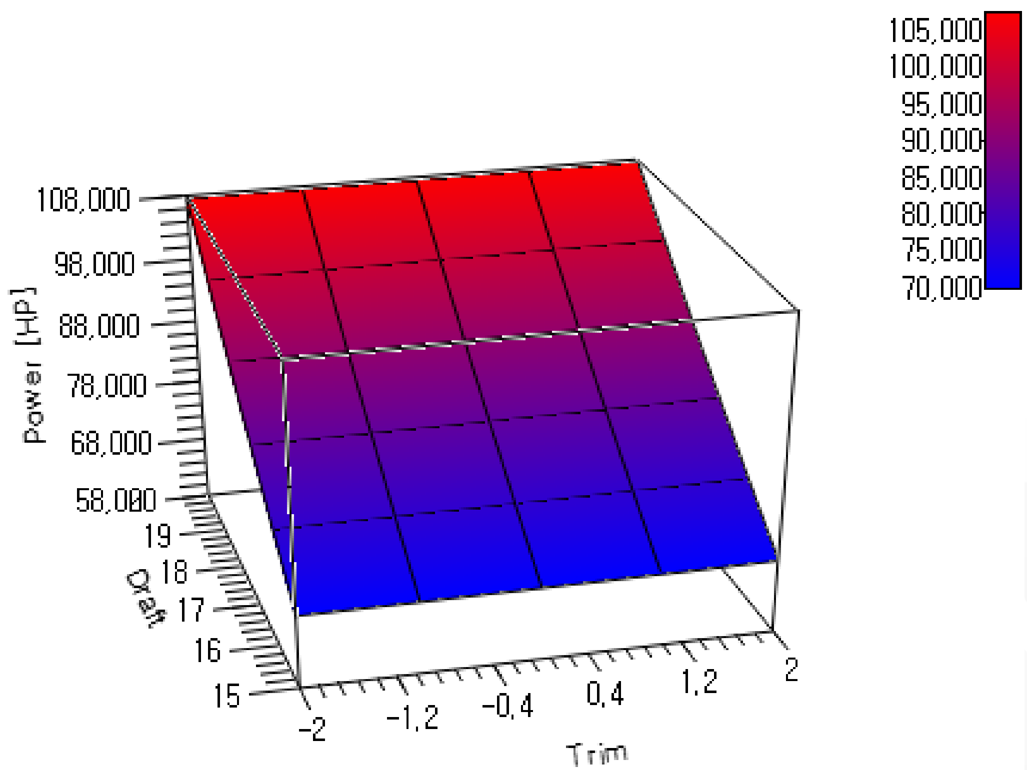
	-2.00	-1.00	0.00	1.00	2.00
3.50	43040	43216	43434	43701	43858
6.50	53748	53774	54055	54213	54900
9.50	64764	65073	65553	65709	66416
12.50	76358	88548	77460	78858	80917

:ef2c06217f/techmarine_test/NAPA_0227 Open final result file NEXTfoam

- possible that horse powers according to the running posture can be checked
- Engine horsepower is listed in the table can be saved to a file worksheet
- can be compared the resistance in a similar posture

Comparison of power performance





- Open final result file

GUI instruction

- Click the icon to run GUI
- First, create a working directory
- stl file open
  - need stl file in order to perform calculations
  - surface must be closed for the quality of the Mesh
- Input values insert
- running condition setting
- run

Solving

- by using the result of the model, estimating the resistance of the ship

- Currently, in consideration of the free-surface influence of model scale ship, being analyzed CFD multiphase flow for resistance estimation

- Due to project characteristics, run the double-body analysis
  - requires analysis of a large number at a time

- OpenFOAM-2.1.1, simpleFoam, k-Epsilon model

Engine horse power

- In the ship simulation, prediction of drag coefficient is the most important

- Using the dimensionless drag constant, the resistance of full-scale ship is calculated

$$R_T = 1/2\, \rho_S V^2 S_S C_{TS}$$

- Calculate the effective horsepower

$$PE(N) = R_{TS} * V_S \qquad PE = PE(w)/735$$

- Calculate delivered horsepower considering the quasi propulsive efficiency(ηd)

$$P_D = P_E / \eta_D$$

- Calculate shaft horsepower considering shafting efficiency(ηs); engine output

$$P_S = P_D / \eta_S$$

Total resistance(ship)

- assumption that equilibrium of the model CR and the ship
- The total resistance of ship separated as follows:

$$C_{TS} = C_{FS} + C_R + C_A + C_{AA}$$

  - CFS, friction coefficient calculated by the equation ITTC1957
  - CA, model-ship correlation factor, LWL, length of waterline

$$C_A = [105(k_s / L_{WL})^{(1/3)} - 0.64]\, x10^{(-3)}$$

  - air resistance coefficient, CAA ; AT the front projection area, S is the wetted surface area

$$C_{AA} = 0.001\ x\ AT / S$$

Total resistance(model)

- separate components of model resistance based on froude approximation

$$C_{TM} = C_{RM}(Fn) + C_{FM}(Rn)$$

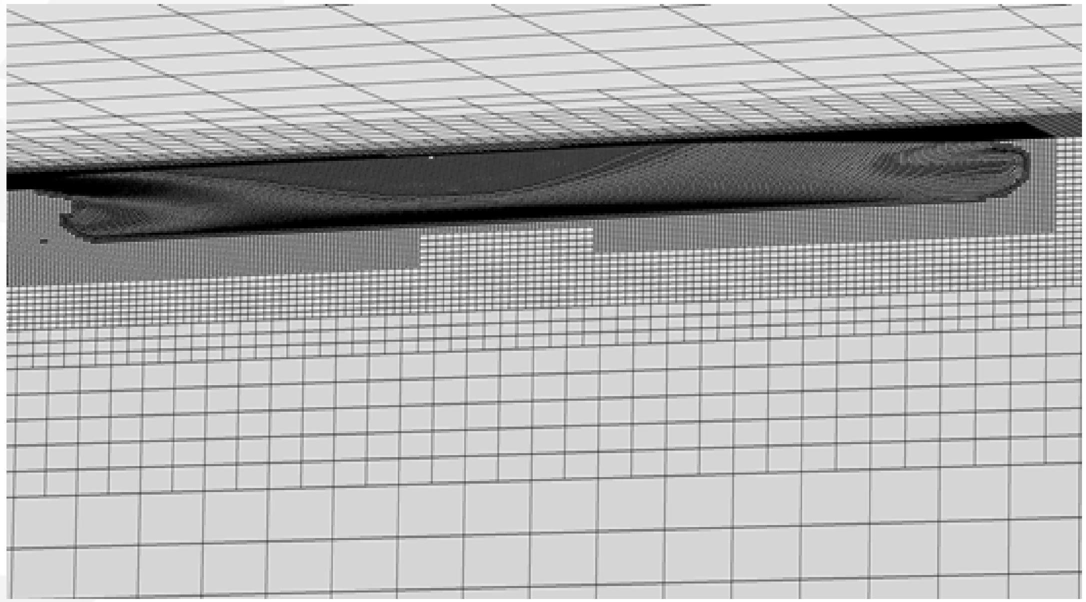
- To perform the analysis of similar geometrically models like Fn is a dimensionless constant

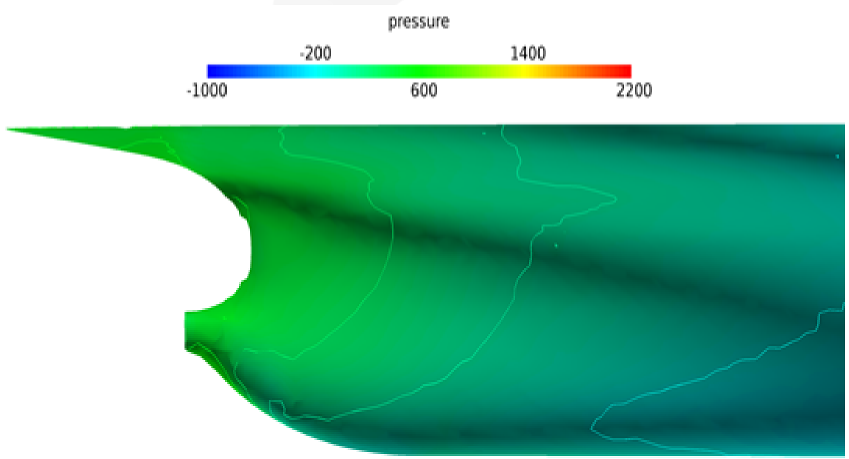
- Cd that came out in double-body model computation, value containing the friction resistance component and pressure resistance due to the viscosity

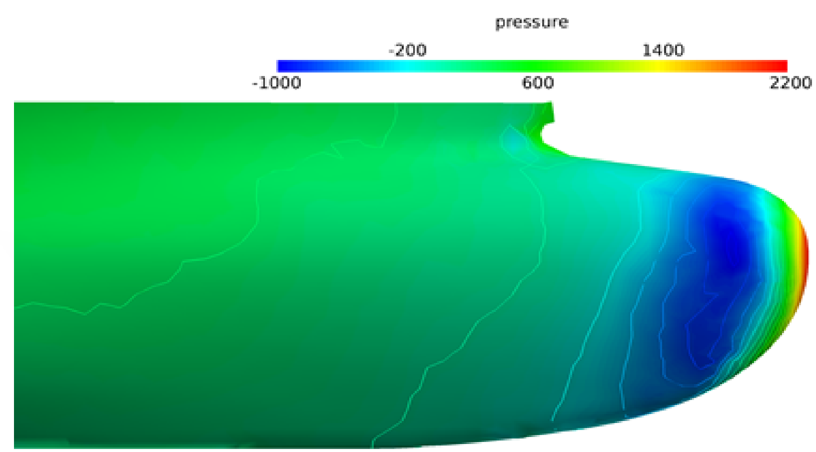
- the segmentation of the total resistance

$$C_{TM} = C_W(Fn) + C_{VP} + C_F, \quad C_d = C_{VP} + C_F$$

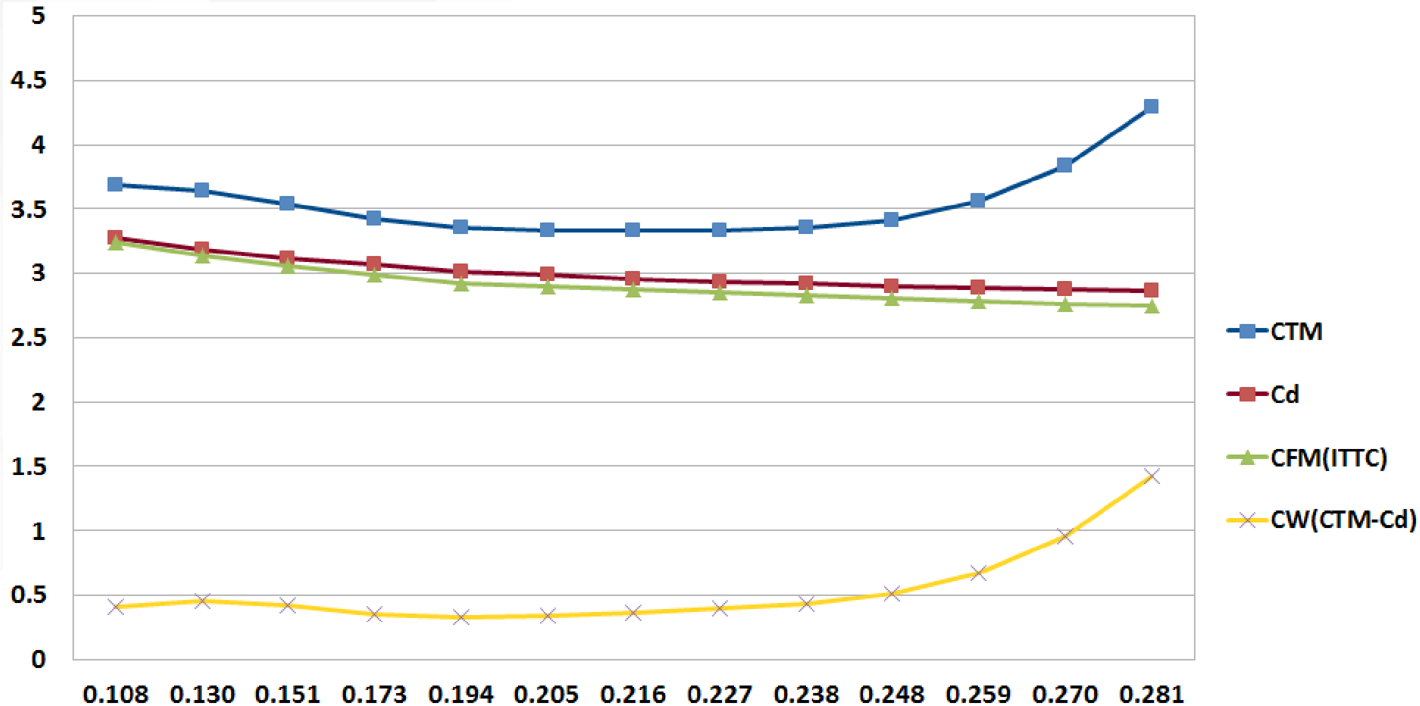
Calculation result of KCS







Wave resistance of KCS



- a sum of Cw and Cd that came out in CFD analysis result is the total resistance coefficient of the model
- the total resistance of model scale ship is computed from the CFD results and wave resistance
- reflect that characteristic wave resistance at the design speed or more will increase rapidly

Summary

- Development of automatic package for prediction of ship resistance
  - For non-experts to perform CFD analysis
  - Minimum input variables like the length, breadth, draft and speed
  - Consideration for various trims and drafts, and ship types
  - Obtain the horse power for various conditions
  - Automatic mesh generation, analysis, calculating resistance and horsepower

Thank you for your attention.

Questions??