Calm Water Performance

Project 3

Handed out: **November 18**
Due in: **December 9**

You will determine the resistance, sinkage, and trim for the Duisberg Test Case. This is a hull that is typical of a 14,000 TEU Containership. It is a tutorial case for OpenFOAM, and experimental data is available (el Moctar *et al* 2012). An image of the hull is shown in figure 1.

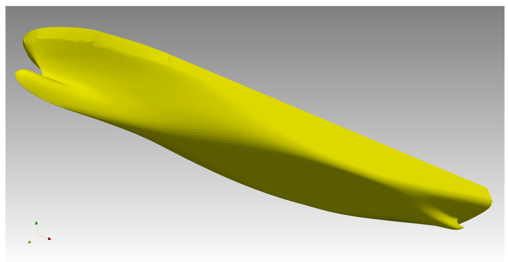

FIGURE 1. Rendering of the DTC Hull

A case is provided in the repository. It is very similar to the tutorial case provided from OpenFOAM, with a slightly modified mesh strategy. This case should run about twice as fast as the tutorial case, and with similar accuracy. If you want to make the case run even faster, change the refinement level on the body to a level 1 (it is set for level 2), and the mesh will be smaller, and the time step size larger.

This case is setup to run at a Froude number of 0.218, and a model scale factor of 1:59.407, just as in the provided journal article. You are asked to compute the resistance, sinkage and trim, at three total Froude numbers: 0.218, 0.200, and 0.183.

Your report is limited to 3 pages. Please be thorough in your write-up and use graphs judiciously. Formatting is very important to clearly communicate your results. Include the following components in your report:

Computational Setup: State the solver that you used, and the grid parameters like the total cell count and near-wall spacing (y^+). State the boundary conditions that you use on the inlet for the velocity and turbulence variables. State the mass properties for the condition that you simulate. Show an image of the grid.

Resistance, Sinkage and Trim: Plot the resistance, sinkage and trim for each Froude number and compare with the experimental data that is provided. I suggest that you use dimensionless quantities, such as $C_T = 2R_T/\rho U^2 S$. Note that since the solver has variable density, the force that is written in the `postProcessing` directory does not have ρ in it. Sinkage can be plotted made dimensionless using the ship length. Plot the trim in degrees, and define the convention as to whether positive trim is bow up or bow down.

Wave Field: Plot the wave field for each Froude number, and comment on the differences. To visualize the wave field I recommend that you use the 0.5 contour of the alpha field. Use a contour filter to do this. Then, use the calculator filter to create a field using the value of coordsZ. I also suggest using extract block to add the hull to your contour of alpha = 0.5.

Extra Credit: Perform an additional simulation that demonstrates something interesting. Suggestions are to build a different grid, study how scalable the simulation is by testing the run time on different processors, simulate the same Froude number at a different Reynolds number (such as full scale), etc.