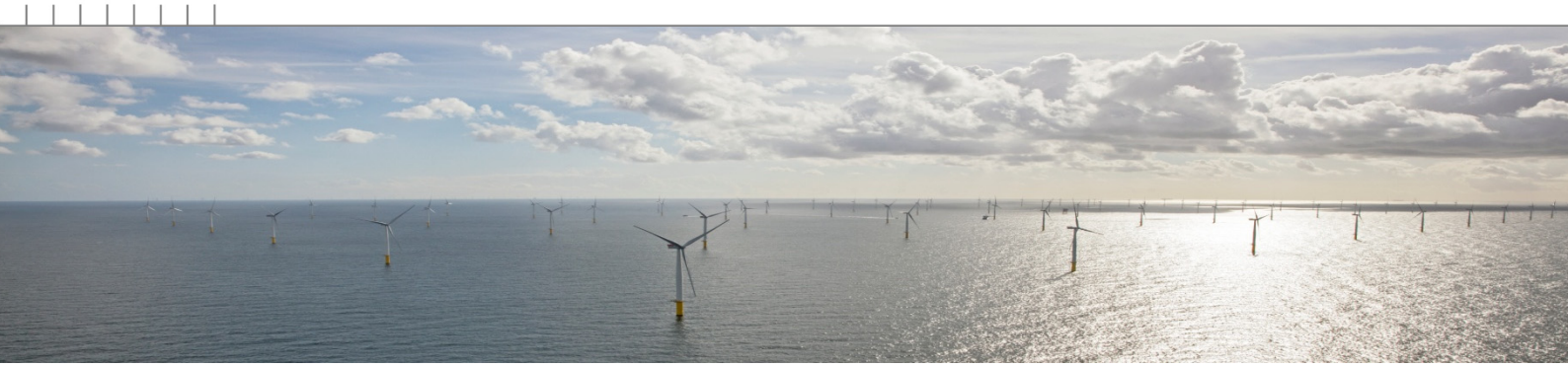

CFD for Current Loads

The average loads due to current are an important design parameter for mooring, offloading operations or for a Dynamic Positioning (DP) system. Traditionally, these current loads have been obtained in wind tunnels and/or model tow-tests in the basin. With the recent increase in CFD capabilities, current loads can be determined with CFD with similar accuracy as experiments at a lower cost and with shorter turn-over time.

CFD simulations can be used to:

- Determine current loads of a single vessel
- Determine shielding effects
- Determine shallow water effects
- Investigate scale effects and dynamic loads

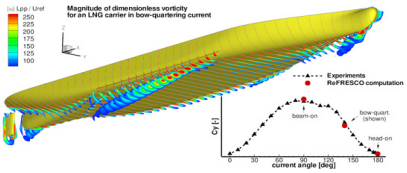

Figure 1: Calculated flow field and Cy coefficient for a LNG Carrier.

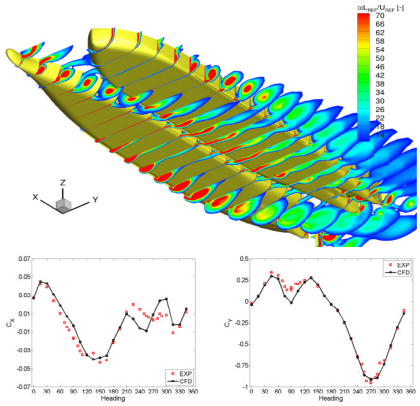

Figure 2: Overview of shielding effects. The top panel gives an overview of the vorticity in a side-by-side operation, below are the Cx (left) and Cy (right) coefficients for one of the two vessels, comparing CFD to experiments.

CFD philosophy at MARIN

MARIN has been developing viscous flow CFD codes since the beginning of the 1990's. The philosophy behind our own CFD code ReFRESCO is "Reliable", "Fast" and dedicated to "ships and offshore constructions". This is reflected in robust developments, and combining proven technology with new trends. Special attention is paid to accuracy within all ReFRESCO developments: code verification, solution verification and solution validation is done for any new application. In order to perform large calculations, MARIN has its own cluster, with 4000 cores available.

Current loads

MARIN has extensive experience in determining current loads for a range of offshore structures. Figure 1 shows an example of the flow around a LNG carrier in bow quartering current, where the sharp bilge keels are a large source of vorticity. The graph on the bottom right shows the comparison between CFD and measurements, where the agreement is within 5%.

Shielding effects

During an offloading, maintenance or installation process, two structures can be in close proximity. These can be two vessels or for instance a vessel close to a floating wind turbine. As a result of this close proximity, the current forces on the two objects are different compared to the undisturbed conditions. CFD can be used to determine this shielding effect on both objects. Furthermore, free surface effects in between the two vessels can be investigated.

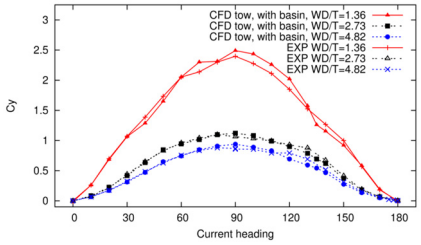

Figure 3: Influence of water depth (lines) on the Cy coefficient for LNG Carrier. CFD simulations are compared to tow-tank experiments.

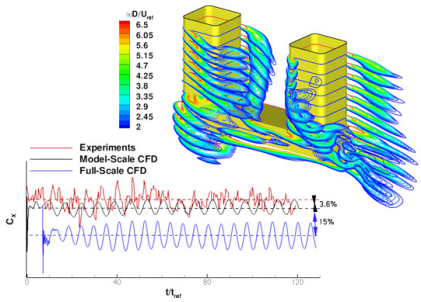

Figure 4: Dynamic current loads on a simplified pontoon. Dynamic loads are compared to model scale experiments, and full scale CFD has been conducted to determine the scale effects.

For more information contact MARIN:
Patrick Schrijvers
T +31 317 49 35 96
E p.schrijvers@marin.nl

Arjen Koop
T +31 317 49 32 68
E a.koop@marin.nl

Shallow water effects

When operating in shallow water conditions, the current load coefficients are significantly higher compared to the deep unrestricted water coefficients. Differences can be up to a factor 2.5 for extremely shallow water conditions, as shown in Figure 3. Comparison of CFD results to experiments has been done for different water depths, with good agreement between experiments and CFD.

Dynamic loads and scale effects

Current loads can vary in time due to, for instance, vortex shedding. This phenomenon can be computed with transient CFD. An example is shown in Figure 4, which presents the flow around a simplified pontoon. These dynamic loads can be used to determine the maximum load that the mooring system should be able to endure.

Furthermore, when combined with model tests, CFD can be used to investigate scale effects, since it is possible to compute the flow at prototype scale. For the simplified pontoon of Figure 4, the difference in the average current load between model scale and full scale is estimated to be around 15%.

ReFRESCO Operation

Are you interested in performing your own CFD computations, or would you like to collaborate with MARIN? Our CFD code ReFRESCO is available to you through ReFRESCO Operation. Please contact refresco@marin.nl for further information.