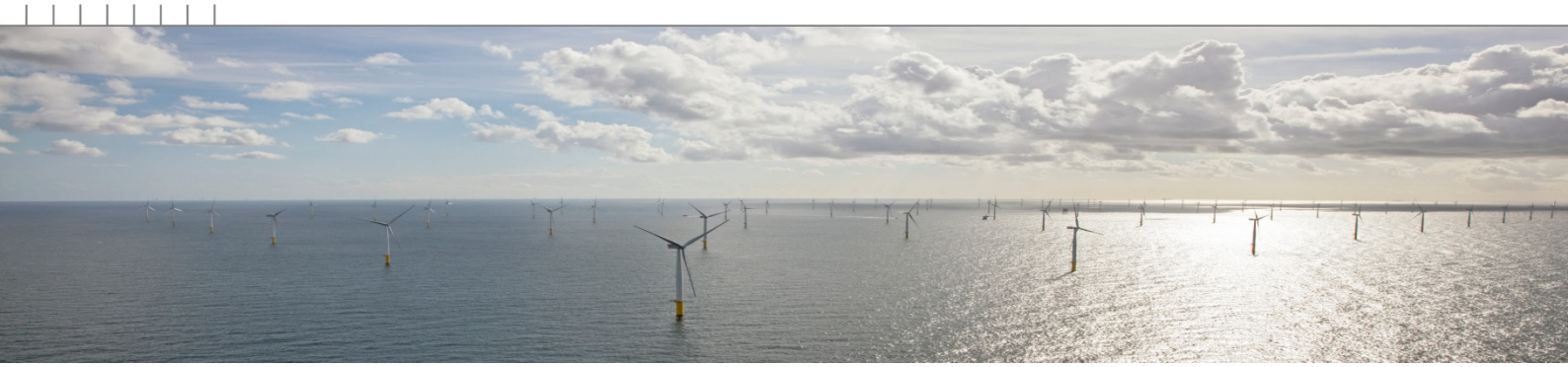

CFD for Wind Loads

The wind loads on structures at sea play an important role during installation and in the design for operational conditions. For some locations, the wind load is even the predominant load factor. Traditionally, wind loads are determined in wind tunnels. With the recent increase in CFD capabilities, wind loads can be determined with CFD with a similar accuracy as wind tunnel tests at similar costs and reduced turn-over time.

CFD simulations can be used to determine:

- Wind loads on individual vessels;
- Wind loads during offloading operations (two or more vessels);
- Shielding effects.

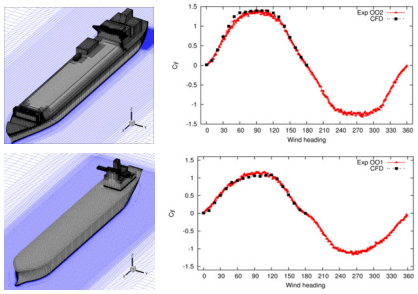

Figure 1: Calculated wind loads for a membrane tanker (top) and shuttle tanker (bottom) with the numerical mesh shown on the left and the comparison between wind tunnel (red) and CFD (black) on the right.

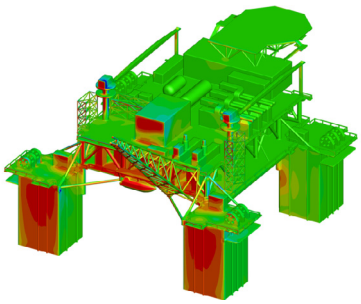

Figure 2: Pressure distribution on a semi-submersible.

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.

Wind loads on structures at sea

Figure 1 presents the wind loads as calculated for a membrane tanker and shuttle tanker, with very good (within 5%) agreement between CFD and wind tunnel measurements. With the increase in computation power, more and more complex structures can be computed. An example is presented in Figure 2, which shows a semi-submersible including all geometric details, as present in the wind tunnel model.

Offloading operations

In addition to wind loads on individual vessels, the wind loads on two objects can be determined. This can be two vessels during an offloading operation, or for instance a wind turbine installation vessel next to a wind turbine. An example of a tandem offloading operation is presented in Figure 3. Due to the presence of the upstream vessel, the downstream vessel can experience significantly different wind loads.

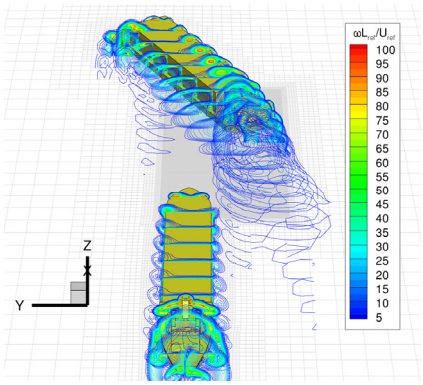

Figure 3: Vorticity distribution around two vessels during a tandem offloading operation.

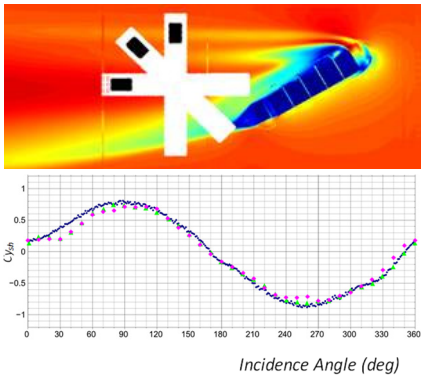

Figure 4: Shielding effects. Top gives an overview of the velocity field during an offloading operation, below is the Cy coefficient for the downstream vessel, comparing wind tunnel data with predictions.

Shielding effects

CFD can be used to compute the wind forces during an offloading operation, but each new position of the shielded vessel requires a new calculation. Therefore, a method has been developed that uses the CFD results for the velocity field behind a single vessel to obtain the wind forces on a shielded vessel. In this manner, simulations of one vessel can be used for multiple locations of the shielded vessel. An example is presented in Figure 3. The top panel shows the velocity field around the upstream vessel (in blue). The downstream vessel is shown in white, and is not actually present in the CFD simulation. Based on the calculated velocity field and the unshielded wind coefficients of the downstream vessel, the shielded wind forces for the downstream vessel are computed (bottom graph, compared to wind tunnel data in blue). With this method, the wind loads during a complete offloading operation can be determined.

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.

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