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MARITIME REPORTER AND ENGINEERING NEWS

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Determine Wind Loads with CFD

Report highlights how Computational Fluid Dynamics (CFD) are playing an increasingly important role in the assessment of wind loads.

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Wind forces are an important design parameter in ship motions, maneuvering situations, offshore mooring and for Dynamic Positioning (DP) systems. CFD can be utilized to assess wind loads and by using CFD, the complex flow behavior in and around the wake of objects can be better understood.

Within the Offloading Operability JIPs, wind tunnel measurements were carried out to determine the wind loads on a number of vessels e.g. Membrane (Prismatic) and Moss (Spherical) type LNG carriers, a shuttle tanker and an FPSO. For all of the vessels CFD calculations were carried out using MARIN's in-house URANS code ReFRESCO.

In Figure 1 the computational mesh for the Membrane-type LNG Carrier is illustrated. Ten million grid cells were used. The calculated forces are very dependent on the atmospheric velocity profile used, therefore different profiles were compared with the profile measured in the wind tunnel. Then the development of the profile in the CFD calculations is investigated. Using the correct wind tunnel profile, the wind loads were calculated for the angles 0 to 180 degrees in steps of 10 degrees. Overall, the calculated coefficients agree with the measured values.

Figure 2 shows the results for the Membranetype LNG Carrier. The Cx and Cy coefficients agree very well with the measurements but the figure shows that the Cm is slightly over-predicted in the CFD. A major advantage of CFD is that detailed flow visualizations can be made. In Figure 3 the pressure distribution on the Membranetype LNG Carrier is shown to illustrate the high and low-pressure regions. This information can be used to optimize the design and location of deck structures.

With CFD the wind loads on typical offshore vessels can be predicted with reasonable accuracy in a cost-efficient manner. The next step is to investigate and predict shielding effects on a vessel positioned in the wake of another ship. Preliminary results are presented in 1. However, this is a difficult problem due to the large geometric complexity, grid sizes and the accuracy that has to be achieved regarding the calculation of the wake of the upstream ship.

1. Koop, A., Klaij, C., Vaz, G. "Predicting Wind Loads for FPSO Tandem Offloading Using CFD," OMAE2010, Shanghai, China. June, 2010.

Figure 3:
Calculated pressure distribution on the surface of the Membrane LNG Carrier for wind heading 180 degrees.

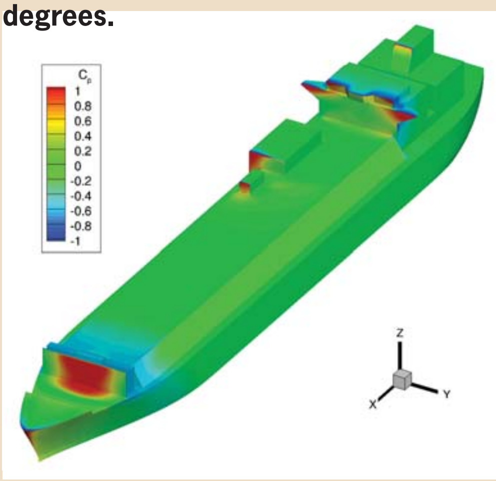

Figure 2:
Calculated and measured force coefficients for Membrane type LNG carrier.

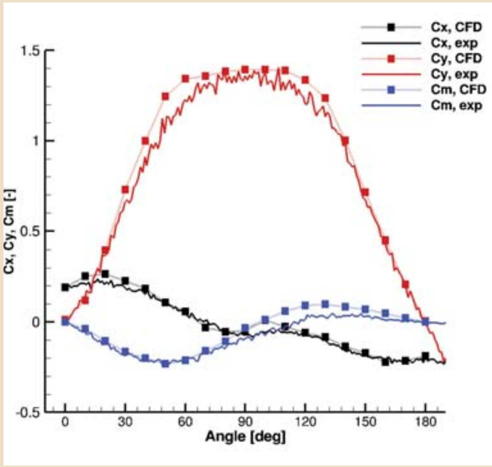

Figure 1:
Computational mesh for the Membrane type LNG Carrier. A total of 10 million grid cells are used.