125

EU-NORSEWIND

Investigation of flow distortion effects on offshore instrumentation

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Abstracts

Data is a key component for all offshore wind projects. However, there remains significant challenges ahead, not least of which is the availability of good quality data to facilitate better project planning and accurate yield prediction. To address this the EU-NORSEWInD project was established in order create a wind atlas of the North, Baltic and Irish seas by mounting instrumentation on offshore installations to assess the local wind conditions.

Because all offshore installations are large structures it was deemed necessary to assess the interference effect of the structures on the wind data acquired.

Objectives

The University of Strathclyde in Glasgow was tasked with assessing the interference effect of the installation platforms on the data measured by the anemometers.

There are several types of anemometers employed on the platforms: LiDAR (LEOPSPHERE and ZephIR), SODAR (AQS AQ500) and the more conventional cup and vane met masts. The methods by which each anemometer derives the wind vector lead to different requirements in the analysis of the platform flow field to determine if there are interference effects present in the data acquired.

Assessing the effect of interference on mast data is relatively simple due their, essentially, point measurement technique. However, the remote sensing (RS) techniques rely an spatially averaged measurements which complicate the assessment of interference. Figure 1 shows the four measurement locations employed by the LEOPHERE LiDAR

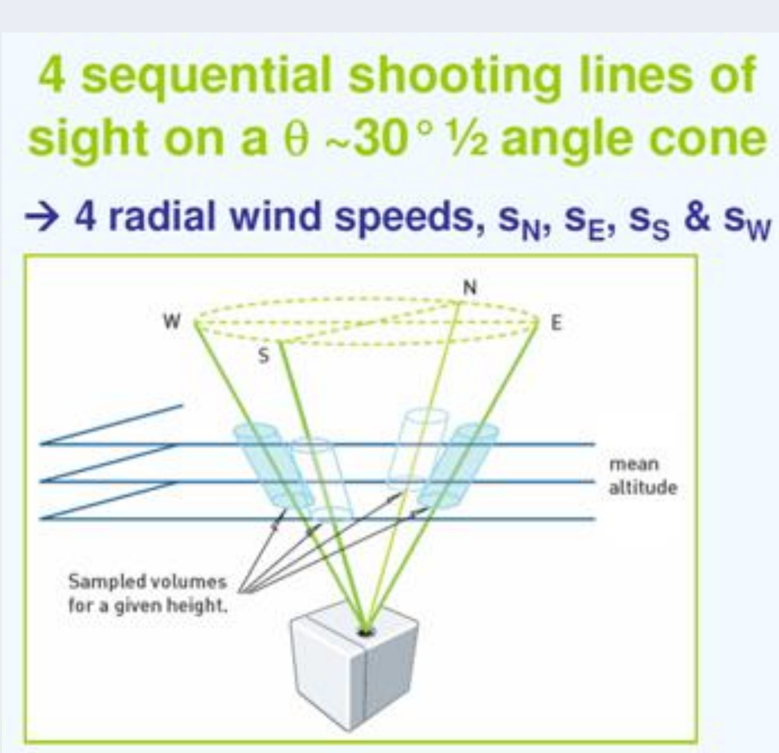

Figure 1; LIDAR wind measurement [1]

Also, due to the directional ambiguity present in the data analysis it is necessary for the device to know, a priori, the general wind direction. If the device is mounted in a region of reverse flow there is a possibility of a 180º error in the wind direction measurement

It is well documented that in, complex terrain, the LIDAR and SODAR measurements may become biased by the distortion of the flow field caused by variation in the surrounding terrain [1,2]. To date most of the interference effects considered have been due to hills and trees as the RS devices have been deployed in open countryside. For the EU-NORSEWInD project, however, the RS devises have been placed close to large, man made, structures and the possible interference effects

Methods

To assess the effects of the platforms on the RS measurements the flow fields over each platform has been simulated by Computational Fluid Dynamics (CFD). CFD allows the flow field around each platform to be calculated and the velocity vector at any point in the flow field to be determined.

To verifiy the accuracy of the CFD model, sub scale wind tunnel tests of the platforms are also conducted. Figure 2 shows a 75th scale model of an offshore platform in the University of Strathclyde 1.5m, open working section, low speed wind tunnel. Measurements in the low speed wind tunnel were made with a DANTEC Streamline constant temperature (CTA), triple wire, hot wire anemometer mounted on a three dimensional traversing rig, figure 3.

Figure 2; Low speed wind tunnel model.

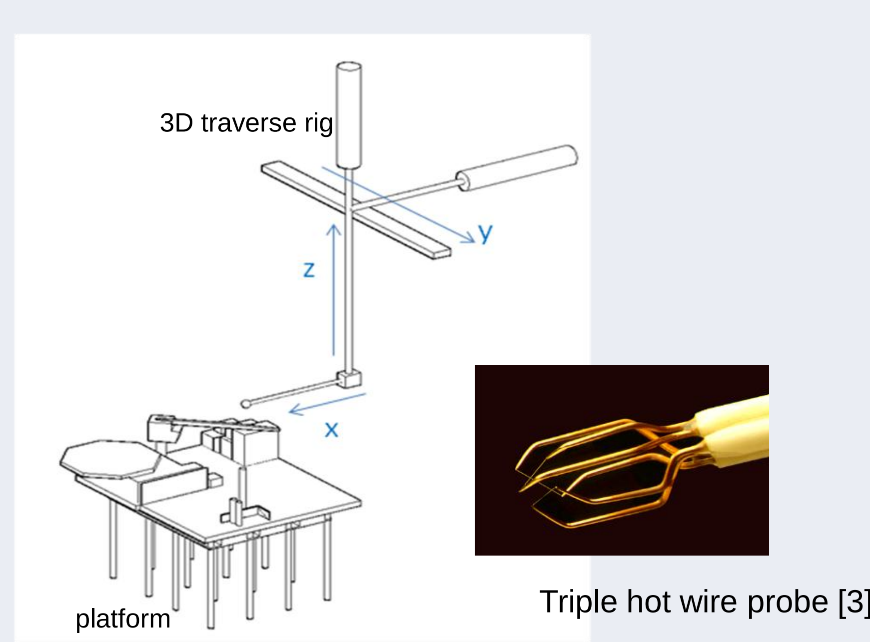

Figure 3; Probe and traverse system

Results

Figure 4 shows the distortion of the flow field by the representation of three dimensional streamlines. Figure 5 shows velocity vectors which exhibit recirculation zones where the flow may be found in the opposite direction to the free stream

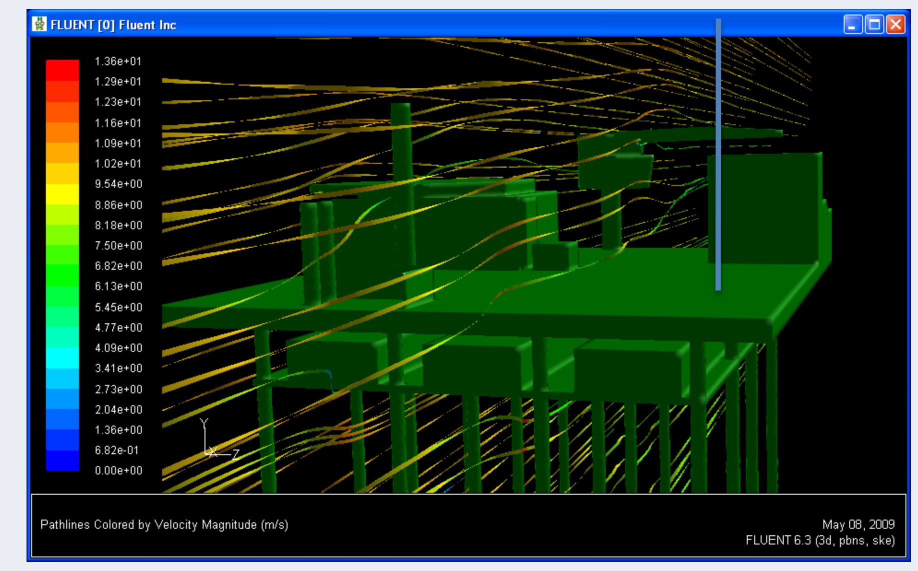

Figure 4; Streamlines over an offshore platform from CFD.

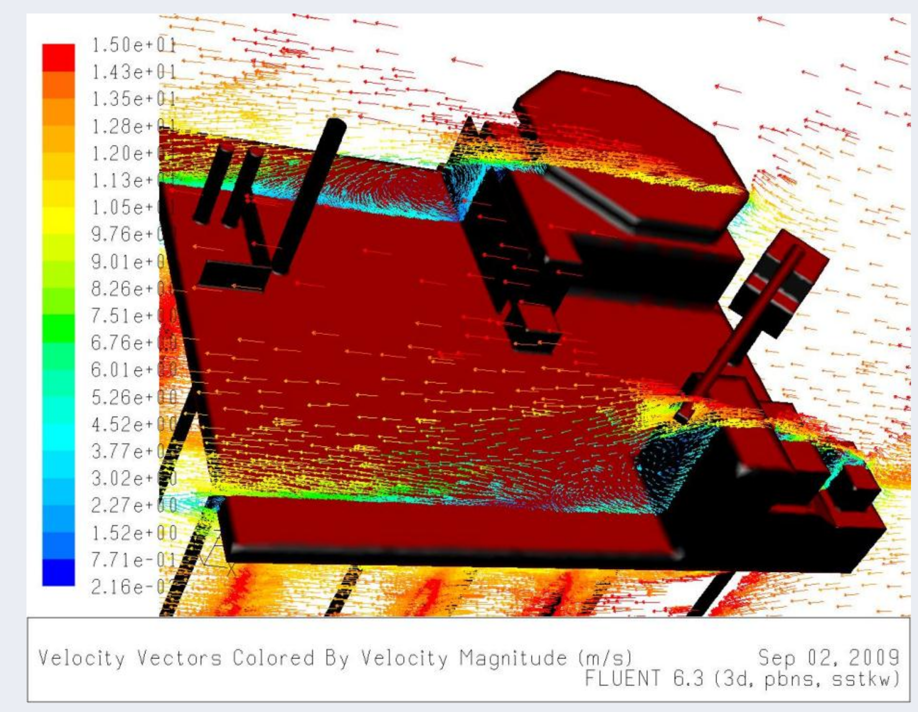

Figure 5; velocity vectors which exhibit recirculation zones

A comparison between the wind tunnel data, shown twice to check repeatability, and simulation data may be seen in figure 6. The location of the traverse is shown by the blue line in figure 2

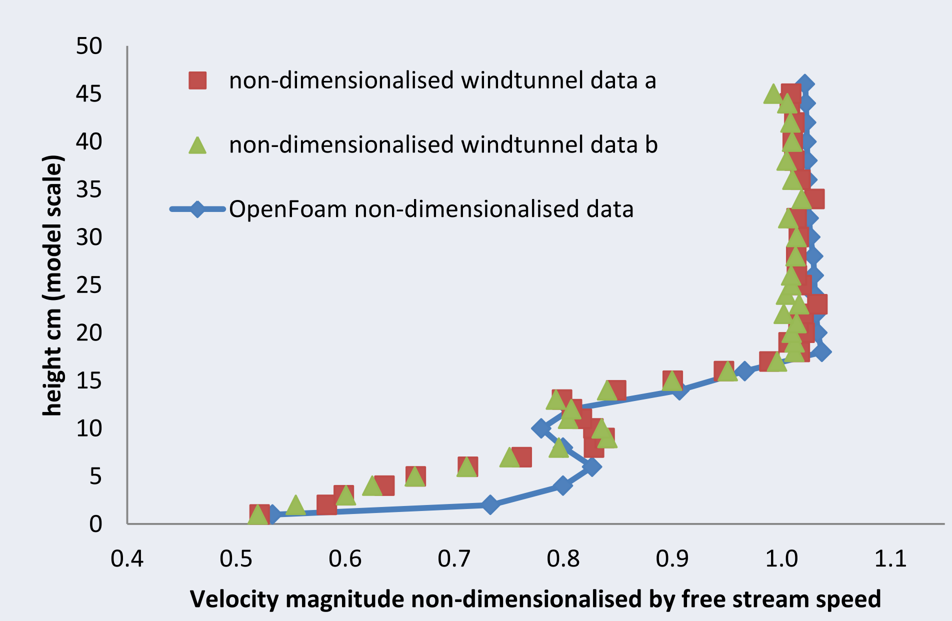

Figure 6; Comparison between CFD and experimental data

Figure 6 shows that the CFD and experimental data agree reasonably well. From the CFD data the velocity at the proposed full scale measurement heights are calculated using the same algorithm as the LIDARs and the effect of the distortion on the measured data assessed.

Conclusions

It has been shown that, through a combination of CFD and experimental techniques the flow field over an offshore structure can be simulated and the interference on the calculated velocity vector from an RS anemometer determined.

References

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2. " Modelling Conically Scanning LiDAR Error In Complex Terrain With WAsP Engineering", F. Bingol, J.Mann, D. Foussekis. Risø-R-1664(EN)
3. " Probe Catalogue", Dantec Dynamics