CFD Application in Offshore Floating Wind Turbine – Approach to Full System Behaviour Assessement

Yuanchuan Liu * and Qing Xiao†

* College of Engineering
Ocean University of China
Qingdao 266100, China
Email: yuanchuanliu@ouc.edu.cn

† Department of Naval Architecture, Ocean and Marine Engineering
University of Strathclyde
100 Montrose Street, Glasgow
e-mail: qing.xiao@strath.ac.uk - Web page: http://www.strath.ac.uk

ABSTRACT

Wind energy is becoming one of the fastest growing renewable energy sources. The abundance of wind resource in offshore areas makes offshore wind turbines a popular choice. With a recent tendency to install offshore wind turbine in deep-water areas, there is an increasing demand to develop the improved design tools for FOWT system. The main technical challenges for a fully coupled FOWT system include (a) the structural damage of large scale wind turbine blades due to the unsteady aerodynamic loading from strong wind; (b) the floating platform dynamic motion responses due to the hydrodynamic loading under extreme wave and current conditions; (c) the large tension loads of mooring system associated with the non-linear motion of floater.

The existing industry design tools mainly adopt the concepts developed from either onshore wind turbine or from that bottom-fixed wind turbine. The methodologies used for the design of wind turbine blades are mostly based on the empirical equations or simplified models such as Blade Element Method (BEM), Vortex Method or Actuator Disc Theory etc. In addition, to consider impact of the floating platform motions, the traditional potential flow theory are used, which either entirely ignore the viscous effect or include contain levels via introducing empirical equations. Therefore, the above models are not accurate enough for industry design of a full FOWT system under large wave and strong wind conditions. To overcome this, recently, the high fidelity Computational Fluid Dynamic (CFD) tool has been used to analyse this complex problem. In this paper, we will start an overview of the state of the art investigations on the CFD simulation of FOWT. This will cover the existing FOWT problems examined by the researchers; the comparisons among the results which are achieved from various software and their differences from the FAST (Fatigue, Aerodynamics, Structures, and Turbulence) from National Renewable Energy Laboratory (NREL). The future directions will be discussed.

REFERENCES

1. Liu YC, Xiao Q, Incecik, A, Peyrard, C (2018) Aeroelastic analysis of a floating offshore wind turbine in platform-induced surge motion using a fully coupled CFD-MBD method, *Wind Energy*, 1–20
2. M. Sergio Campobasso, J. Drofelnik, Andrea G. Sanvito, A. Jackson, Y. Zhou and Q. Xiao, Compressible Navier-Stokes analysis of floating wind turbine rotor aerodynamics, Proceedings of IOWTC 2018 ASME 2018 1st International Offshore Wind Technical Conference November 4-7, 2018, San Francisco, CA
3. Zhou Y, Xiao, Q, Liu YC, Incecik, A, Peyrard A, Nonlinear impact of focused wave on floating platform for offshore floating wind turbine – a CFD study, to be presented at 38th International Conference on Ocean, Offshore and Arctic Engineering, June 6-13, 2019, Glasgow, UK
4. Liu YC, Xiao Q, Incecik, A, Peyrard, C and Wan DC, (2017), Establishing a fully coupled CFD analysis tool for floating offshore wind turbines, *Renewable Energy*, Vol. 112 pp. 280-301 DOI: 10.1016/j.renene.2017.04.052

5. Hussain, R., H. Yue, W. E. Leithead and Q. Xiao. Modelling and analysis of controlled aeroelastic tailoring blade wind turbine, 20th IFAC World Congress, Toulouse, France, July –14, 2017: 10342-10347.
6. Robertson, A. N.; Wendt, F.; Jonkman, J. M.; Popko, W.; et al. OC5 Project Phase II: Validation of Global Loads of the DeepCwind Floating Semisubmersible, *Wind Turbine Energy Procedia* , 2017, 137, 38 - 57
7. Skaare, B.; Nielsen, F. G.; Hanson, T. D.; Yttervik, R.; Havmøller, O. & Rekdal, A. Analysis of measurements and simulations from the Hywind Demo floating wind turbine Wind Energy, 2015, 18
8. Xue, W. (2016) "Design, numerical modelling and analysis of a spar floater supporting the DTU 10MW wind turbine", NTNU.