Offshore & Dredging Engineering

Technische Universiteit Delft

Hydrodynamic interaction of an offshore floating support structure and tidal energy converter

As the world's energy demands continue to rise and the effect of the climate change become more apparent, it is clear that Offshore Industries are continues searching for new and innovative sources of energy that do not emit harmful greenhouse gasses into the atmosphere. One of the sources of energy generations is by use of the Tidal Energy Converter (TEC).The Tidal Energy/Power extracted from the TEC is a predictable energy source, which comes from the tidal current, waves and the evolution of the turbine motion itself. The TEC is mainly developed for converting kinetic-energy into electrical-energy, which is supported with help of an Offshore Floating Support Structure (OFSS).

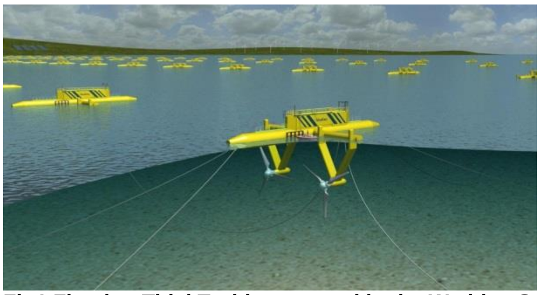

Fig1.Floating Tidal Turbine moored in the Wadden Sea

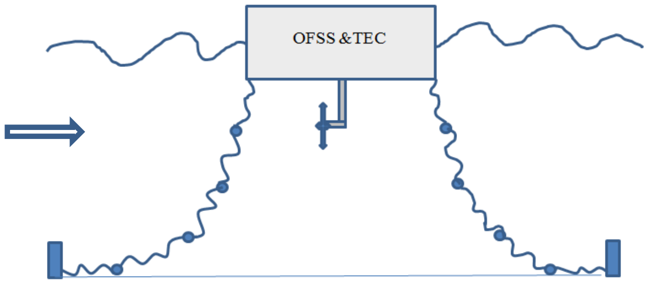

Fig2.Model representation of dynamic coupled system

This work studies mainly the effect of the thrust and power generation of a horizontal axis tidal turbine imposed under certain surge and pitch motion. Furthermore, the floating moored platform is coupled with the tidal turbine in order to analyse the influence of the hydrodynamic interaction between the platform and the turbine see Fig.2. To gain understanding of the coupled dynamic system, it will first be subjected to a single harmonic wave and current, analysed in 2D plane.

The tidal turbine behaviour is described with the Actuator Disk Momentum (ADM) Model and Blade Element Momentum (BEM) model whereby each of the models are compared with the reproduced experimental data. Both models are executed at blade pitch angles (ϴ) of $5,7$ and $9\ deg$ .The latter model will be used to further extend the quasi-static model into the dynamic BEM model. As with every turbine system, a control system regulates the turbine to maintain the desired power output. The static BEM as well as the dynamic BEM model are analysed from optimal operation criteria particularly for the fixed rotational speed and control rotational speed. Also the models are analysed at different oscillatory frequencies at ϴ examined under the same hydrodynamic conditions. The results provide an insight into the added mass effect in the axial direction on the blade and will support our understanding with this kind of phenomenon, for a rotor operating in unsteady flow better.

Simulation of the floating turbine vs fixed turbine are compared at a water depth of 105 m and a single harmonic wave, with an amplitude of 1 m. The results for thrust and power extracted from the floating turbine are higher due to the relative velocity acting on each blade section. However the fixed turbine captures only the incoming wave loading whereas the floating turbine is subjected to the wave loading and the motion of the platform

Fig3.Fixed Andritz Hydro Hammerfest Turbine

Student
Satish Soekhoe
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Sponsor
Delft Technical University

Thesis committee
Prof.dr. A. Metrikine
Ir. A. Jarquin Laguna
Dr.ir. K.N. van Dalen
Ir. C. Keijdener