Model Test of the OC3-Hywind Floating Offshore Wind Turbine

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ABSTRACT

A large number of offshore wind farms with fixed foundations have been installed in Europe with relatively state-of-the-art techniques. However, the installation of floating wind farms in deeper water is encouraged by the stronger and steadier winds, the lower visibility, the absence of ship lanes restrictions and the economic potential. Compared to a fixed foundation, a floating offshore wind turbine (FOWT) may sustain more complicated environmental conditions including stochastic winds and waves. One of the FOWT concepts was designed and analyzed. It consists of a three bladed 5-MW up wind turbine, which is the basic model under the IEA Annex 23 Subtask 2 Offshore Code Comparison Collaboration (OC3) project, and supported by an OC3-Hywind spar buoy platform. The platform is connected by three mooring lines to the sea bed. To study motion characteristics of the OC3-Hywind platform, a model was built with a 1/128 scale ratio. The model test was carried out in various sea states, including rotating rotor effect with wind in the Ocean Engineering Wide Tank of the University Of Ulsan (UOU). The characteristic motions of the OC3-Hywind platform were captured and the RAO and significant motion were obtained.

KEY WORDS: 5-MW Floating Offshore Wind Turbine; Model test; Rotating Rotor Effect; RAO; Significant Motion.

INTRODUCTION

With worldwide environmental regulations and sudden fluctuations in oil prices, the development of alternative energy to fossil fuel begins in earnest. The Korean government suggested ‘Low Carbon Green Growth’ as a new vision and the latest paradigm of national development. Korea, whose dependence on overseas energy is about 97%, chose the development of green energy as a national project. Especially because they give an impetus to floating wind power generation, we expect that our industrialization will accelerate rapidly. Normally offshore wind turbines receive better wind quality in deepwater than shallow water. Presently, most of offshore wind turbine installations are fixed support structures in shallow water. Offshore wind turbines which are installed using floating structures in deep sea water, were employed by many countries because of the vast wind resource potential.

One floating offshore wind turbine concept is spar buoy (called OC3-Hywind); chosen for its simplicity in design, suitability in modeling, and propinquity to commercialization. Using this concept, a floating offshore platform was designed by Jonkman (2009) to support a 5-MW wind turbine (Jonkman, Butterfield, Musial, and Scott, 2009).

This paper presents results of the model scale experiments of the OC3-Hywind 5-MW Floating Offshore Wind Turbine. With a 1/128 scale ratio, we carried out model tests in the Ocean Engineering Wide Tank of UOU to study the characteristic motions of the FOWT platform by obtaining its RAOs and significant motions.

MODEL TEST

The outline of Model test

The model test was carried out at the Ocean Engineering Wide Tank, in order to evaluate the characteristic of motions of a floating offshore wind turbine under wave and wind conditions (Lewis, 1989; Sclavounos, 2009). With the Wide Tank dimension L*B*D = 20m*30m* 2.5m, before carrying out model test in various conditions of sea states including rotating rotor effects with wind, all model test conditions were verified. Wave and wind were measured using wave probe and anemometers at the position where the model would be installed. The model was referred from the OC3-Hywind system. The geometric model scale ratio is 1/128 and the physical model is built on the Froude number.

Table 1. OC3-Hywind of Floating Wind Turbine Properties (1/3)

<table>
<thead>
<tr>
<th>Item</th>
<th>Full-Scale Specification</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Depth</td>
<td>320 m</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Rotor mass</td>
<td>110,000 kg</td>
<td>0.0525 kg</td>
</tr>
<tr>
<td>Rotor Diameter</td>
<td>126 m</td>
<td>0.984375 m</td>
</tr>
</tbody>
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