IBERDROLA INGENIERÍA TLPWIND

“An easy way to drive costs down”

Juan Amate López / Víctor de Diego Martín / Laura García Marugán / Pablo Gómez Alonso
Iberdrola Ingeniería y Construcción

Abstract

IBERDROLA INGENIERÍA y CONSTRUCCION (IIC) has designed and developed an innovative TLP concept, TLPWIND, specifically to become a cost effective solution that can withstand the worst scenarios in deep waters. The design methodology has been applied and verified for two different scenarios. Two successful basin test campaigns prove that the concept behaviour is extremely good under the most severe conditions ever tested (31 m waves) and water depths ranging from 80 to 100 m. The 5 MW TLP float has a total weight of only 825 to 1,050 tons (depending on site’s conditions), with an overall cost of 1.0 - 1.2 Million €/MW. These extremely positive results guarantee that IIC TLPWIND will be cutting edge worldwide.

Design Methodology

IIC has been developing since 2009 a design methodology specifically suited for the design of a cost-effective TLP for Offshore Wind: This methodology assures that an optimized solution will be delivered specifically suited to the site and its metocean conditions. A multi-parametrical optimisation approach is used to get to a solution. TLP transportation issues are considered since early design stages, establishing specific restrictions to the platform design.

Numerical simulations are based on a coupled model, where waves, current and wind effects are considered simultaneously. A powerful specific in-house software tool, Iberdrola FEM, has been developed specifically to solve the saline/aero/hydro/structural problem on a coupled manner.

TLPWIND Concept

The TLPWIND concept consists of a central cylindrical column and four pontoons symmetrically distributed on its bottom. In the top of the central column, a conical frustum allows a smooth transition between the main cylinder diameter and the WTG tower diameter. Each of the outer ends of the four pontoons incorporates a porch which allows the connection of two tendons per pontoon. These two lines per pontoon assure a complete redundancy of the tether system.

The internal structural scantling of the floaters structure and its tether system was designed in accordance with the main Offshore Design Standards (DNV-OS-J101, DNV-OS-J103, DNV-OS-C105 and recommended practices DNV-RP-C201, DNV-RP-C202 among others). Main particulars are provided below for the two different designs already tested:

<table>
<thead>
<tr>
<th>TLPWIND Main Particulars</th>
<th>2 MW</th>
<th>5 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>Aberdeen (UK)</td>
<td>Estarta de lares (Spain)</td>
</tr>
<tr>
<td>Water Depth / Hsmax(Tp) / Hmax(Tp)</td>
<td>100 m / 10 m (15s) / 20 m</td>
<td>80 m / 15 m (15 s) / 31 m</td>
</tr>
<tr>
<td>Wind Turbine</td>
<td>G-8X 2 MW</td>
<td>NREL 5 MW</td>
</tr>
<tr>
<td>Operational Draught</td>
<td>24 m</td>
<td>40 m</td>
</tr>
<tr>
<td>Pontoon Length</td>
<td>35 m</td>
<td>64 m</td>
</tr>
<tr>
<td>Displacement</td>
<td>2,500 t</td>
<td>3,400 t</td>
</tr>
<tr>
<td>TLP Steel weight</td>
<td>750 t</td>
<td>1,050 t</td>
</tr>
<tr>
<td>Surge RMS (Oper./Survival)</td>
<td>2,30 m / 4,000 m</td>
<td>1,63 m / 3,10 m</td>
</tr>
<tr>
<td>Pitch Angle MAX (Oper./survival)</td>
<td>0.64° / 0.58°</td>
<td>0.70° / 1.0°</td>
</tr>
<tr>
<td>Nacelle accelerations RMS / MAX (Survival)</td>
<td>0.95 m/s² / 4.10 m/s²</td>
<td>0.83 m/s² / 2.93 m/s²</td>
</tr>
</tbody>
</table>

TLPWIND Transportation & Installation Methodology

The IIC TLP concept allows transportation and installation with the WTG pre-installed onshore. In order to increase the stability during these critical phases, a system of reusable floaters will be temporarily connected to the ends of the pontoons.

These floaters incorporate a variable ballast system which allows to actively adjusting the platform draught according to the different requirements of each stage (launching, transportation or installation).

Design Verification

Two model testing campaigns were conducted at the CEHIPAR and CEMANavec hydrodynamic test tanks. Damaged conditions are also considered in order to verify that platform compartmentalization is sufficient. Also accidental conditions like 1 or 2 mooring lines were broken are simulated. Platform was stable even in survival conditions with two cables broken. Towing tests were also successfully performed, including a study on different towing velocities (3-5 knots).

The model tests results obtained from the different basin tests, have verified that numerical simulations performed with Iberdrola FEM have a good correlation for both designs: 5 MW & 2 MW OWTs.

Conclusions

TLPWIND design is a very competitive solution due to its low LCOE in comparison with other designs. Moreover, some of the TLPWIND advantages are presented below:

• Very good dynamic response.
• Better steel weight optimization & lower displacement & Optimized Cost than other floating designs.
• Fully Redundant design with 2 tether lines per pontoon, full operation even with one line out of service.
• Allows WTG & floaters onshore assembly at multiple fabrications yards and fully transportation and installation with standard vessels and severe conditions.
• Low dependence on WTG loads & weights. Significant decrease of COST / MW ratio.

References


EWEA 2014, Barcelona, Spain: Europe's Premier Wind Energy Event