The Importance of Getting Your Feet Wet: Field Measurements from the OPERA project

Sam Weller and Lars Johanning

Southampton 6th July 2017
Wind Turbine Development

Wave Energy Converters
Barriers to Development

Context: High levels of risk
Barriers to Development

Context: High levels of risk

- Lack of wave energy design convergence
- Commercial competitiveness and IP concerns
Barriers to Development

Context: High levels of risk

Lack of wave energy design convergence + Commercial competitiveness and IP concerns = Little or no knowledge or data sharing
Barriers to Development

Context: High levels of risk

Lack of wave energy design convergence

Commercial competitiveness and IP concerns

Little or no knowledge or data sharing

Result: Lack of progress, similar pitfalls

Image: Pinterest
Open Sea Operating Experience to Reduce Wave Energy Cost

- 42 months
- €8M
- 4 innovations
- 2 years of data
- 50% cost reduction target

Images: OPERA project
Open Sea Operating Experience to Reduce Wave Energy Cost

- 42 months
- €8M
- 4 innovations
- 2 years of data
- 50% cost reduction target
MARMOK-A5 oscillating water column

- 5m diameter (max)
- 41.8m long
- ~160 Tonnes
- Currently with 2x 15kW turbines, 1x 30kW to be installed April/May 2018
- 85m water depth
Work Package 2: Mooring loads assessment and reduction, shared mooring validation
Work Package 2: Mooring loads assessment and reduction, shared mooring validation

Planned load measurement locations

Karratu mooring system
Work Package 2: Mooring loads assessment and reduction, shared mooring validation

How do we measure tensions here?
Work Package 2: Mooring loads assessment and reduction, shared mooring validation

A load shackle cable system

Karratu mooring system
Load Shackle Cable System + device instrumentation

Node 4
- Load Shackle 4A
- Load Shackle 4B
- Signal cable 4A
- Wire Rope Assembly 4
- 8.5t Shackle
- Signal cable 4B
- Wire Rope Assembly WEC
- 4.75t Shackle
- Signal cable 1A
- 4.75t Shackle
- Wire Rope Assembly 1
- 4.75t Shackle
- 3.25t Shackle

Node 1
- Load Shackle 1A
- Load Shackle 1B
- Signal cable 1A
- Wire Rope Assembly 1
- 8.5t Shackle
- Signal cable 1B
- Wire Rope Assembly WEC
- 4.75t Shackle

To anchor

DGPS and 3DoF IMU

WEC Hull
- Cable Bundle 1
- Cable Bundle 4

opera
Measured tension time-series: Calm before the storm

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>31/1/17</td>
<td>10:20-11:20</td>
<td>1.1-1.2</td>
<td>9.1-10.5</td>
<td>292-298</td>
</tr>
</tbody>
</table>
Measured tension time-series: Calm before the storm

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>31/1/17</td>
<td>10:20-11:20</td>
<td>1.1-1.2</td>
<td>9.1-10.5</td>
<td>292-298</td>
</tr>
</tbody>
</table>
# Measured tension time-series: Storm build up

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2/17</td>
<td>06:00-0700</td>
<td>2.1-2.6</td>
<td>13.3-14.3</td>
<td>304-306</td>
</tr>
</tbody>
</table>
Measured tension time-series: Storm build up

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2/17</td>
<td>06:00-0700</td>
<td>2.1-2.6</td>
<td>13.3-14.3</td>
<td>304-306</td>
</tr>
</tbody>
</table>
Measured tension time-series: Mild storm

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/2/17</td>
<td>13:00-1400</td>
<td>4.2-4.8</td>
<td>8.2-9.4</td>
<td>304-305</td>
</tr>
</tbody>
</table>

86kN
Measured tension time-series: Mild storm

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/2/17</td>
<td>13:00-1400</td>
<td>4.2-4.8</td>
<td>8.2-9.4</td>
<td>304-305</td>
</tr>
</tbody>
</table>
Simulated responses: Mild storm

<table>
<thead>
<tr>
<th>Date</th>
<th>Time range</th>
<th>Hs [m]</th>
<th>Tp [m]</th>
<th>Direction [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/2/17</td>
<td>13:00-1400</td>
<td>4.2-4.8</td>
<td>8.2-9.4</td>
<td>304-305</td>
</tr>
</tbody>
</table>
The Importance of Getting Your Feet Wet

• Wave energy conversion is currently perceived as being high risk

• Progress in the sector has been hampered by a lack of knowledge and data sharing

• The OPERA project aims to address this by testing shore-based and offshore devices and publishing the results

• Numerical simulations can only go so far and models need to be validated by long-term field data.
Acknowledgements

The work is part of the OPERA (Open Sea Operating Experience to Reduce Wave Energy Cost) project which is funded from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654.444.

Further info


S.Weller@exeter.ac.uk
+44 1326 259414