Summer School - Tuesday 11 September 2018 - Experimental planning I: Facilities and set-up

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Experimental planning I: Facilities & set-up

Dr Carlos Perez-Collazo
11th Sep 2018
Experimental planning

Design of Model Test

Scaling Laws

Model Properties and restraints

Selection of Test Facility

Calibration of the facility

Selection of facility instrumentation and design of the experimental set-up

Calibration of instrumentation

Design of the Model and selection of drought and water depth

Selection of Model materials and model instrumentation

Model construction

Model calibration

Set-up of test in the facility

Debugging the system

In-place calibrations

Test runs

Analysis of test data

Documentation
Facilities

Joint PRIMaRE and UK&CHN | CORE
Summer School
10-14th of September 2018

Hydrodynamic Modelling and Well-being in Engineering
University of Plymouth (COAST Lab) and University of Exeter
(Penryn Campus)
- Wave generation and absorption
- Basin and flume flow
- Towing tanks
- Blockage effects
Wave generation

- Wave makers
  - Deep water generation
  - Shallow water generation
Piston wavemaker
Piston wavemaker

Table 4.1  Biésel transfer functions for four common types of wavemakers

**Piston**

\[ S(z) = S_0 \]

\[ \frac{H}{S_0} = \frac{2 \sinh^2(kh)}{\sinh(kh) \cosh(kh) + kh} \]

**Elevated Piston**

\[
\begin{align*}
S(z) &= S_0 & (z + h) > h_0 \\
S(z) &= 0 & (z + h) < h_0 
\end{align*}
\]

\[ \frac{H}{S_0} = \frac{2[\sinh(kh) - 2 \sinh(kh_0) \sinh(kh)]}{\sinh(kh) \cosh(kh) + kh} \]

Flap wavemaker
Flap wavemaker

Table 4.1 Biessel transfer functions for four common types of wavemakers

**Hinged**

\[
S(z) = \frac{S_0}{h} (h + z)
\]

\[
\frac{H}{S_0} = \frac{2 \sinh^2(kh)(1 - \cosh(kh) + kh \sinh(kh))}{kh(\sinh(kh)\cosh(kh) + kh)}
\]

**Elevated Hinged**

\[
S(z) = \begin{cases} 
S_0 \frac{h+z-h_0}{h-h_0} & ; (z+h) > h_0 \\
0 & ; (z+h) < h_0 
\end{cases}
\]

\[
\frac{H}{S_0} = \frac{2[\sinh(kh)((h-h_0)k\sinh(kh)-\cosh(kh)+\cosh(kh_0))]}{k(h-h_0)[\sinh(kh)\cosh(kh) + kh]}
\]

Wave absorption

Images from: http://www4.e design.co.uk
Flumes
Towing tank

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Hydrodynamic Modelling and Well-being in Engineering
University of Plymouth (COAST Lab) and University of Exeter
(Penryn Campus)
Limitations
Limitations
Blockage effect

Waves
Model width to tank width > 5 : 1

Currents
Cross-section of the model to cross-section of the channel < 10%.
## Standard tests - wave

<table>
<thead>
<tr>
<th>Test series</th>
<th>TRL Level</th>
<th>Facility</th>
<th>2D-3D</th>
<th>Test duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series A: Linear regular waves</td>
<td>1-4</td>
<td>flume-basin</td>
<td>2D</td>
<td>50-100 waves (300 if resonance)</td>
</tr>
<tr>
<td>Series B: Non-linear regular waves</td>
<td>3-5</td>
<td>flume-basin</td>
<td>2D</td>
<td></td>
</tr>
<tr>
<td>Series C: Long-crested irregular waves</td>
<td>1-5</td>
<td>flume-basin</td>
<td>2D</td>
<td></td>
</tr>
<tr>
<td>Series D: Spectral shape</td>
<td>2-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td>1 h full scale or (&gt; 700 waves)</td>
</tr>
<tr>
<td>Series E: Directional long-crested waves</td>
<td>2-5</td>
<td>Basin</td>
<td>3D</td>
<td></td>
</tr>
<tr>
<td>Series F: Short-crested waves</td>
<td>2-5</td>
<td>Basin</td>
<td>3D</td>
<td></td>
</tr>
<tr>
<td>Series G: Combined waves and ocean currents</td>
<td>2-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td>test specific</td>
</tr>
<tr>
<td>Series R: Repeatability</td>
<td>1-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td></td>
</tr>
</tbody>
</table>
Survivability tests - wave

<table>
<thead>
<tr>
<th>Test series</th>
<th>TRL Level</th>
<th>Facility</th>
<th>2D-3D</th>
<th>Test duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series H: Long-crested</td>
<td>2-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td></td>
</tr>
<tr>
<td>Series I: Long-crested and directional</td>
<td>3-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td></td>
</tr>
<tr>
<td>Series J: Short-crested</td>
<td>3-5</td>
<td>basin</td>
<td>3D</td>
<td>3 hrs (full scale)</td>
</tr>
<tr>
<td>Series K: Combined wave and ocean current</td>
<td>3-5</td>
<td>basin</td>
<td>3D</td>
<td></td>
</tr>
<tr>
<td>Series R: Repeatability</td>
<td>2-5</td>
<td>flume-basin</td>
<td>2D-3D</td>
<td></td>
</tr>
</tbody>
</table>