2018-09-11

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

1. Design of Model Test
2. Scaling Laws
3. 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
Facilities

- Wave generation and absorption
- Basin and flume flow
- Towing tanks
- Blockage effects
Wave generation

- Wave makers
  - Deep water generation
  - Shallow water generation
Piston wavemaker
Table 4.1 Biéssel 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

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

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

Flap wavemaker
Table 4.1 Biéssel transfer functions for four common types of wavemakers

Hinged

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

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

Elevated Hinged

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

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

Wave absorption

Images from: http://www4.edesign.co.uk
Coastal Basin
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>
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Hydrodynamic Modelling and Well-being in Engineering
University of Plymouth (COAST Lab) and University of Exeter (Penryn Campus)