Physical modelling as a tool in the design process of coastal structures

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Physical modelling at DEME

- 2011: SARB island (UAE) – 2D (overtopping, stability) and 3D (overtopping, stability, wave agitation).
- 2017: Cotonou coastal protection (Benin) – 2D (rock stability).
- 2018: Hail & Gasha (UAE) for tender – 2D (stability, overtopping).

Also to study scour around offshore windmill foundations (DEME Offshore):

- Hohe See (Germany).
- Merkur (Germany).
- Trianel Borkum West (Germany).
- Seamade (Belgium).
Timeline of the design process of coastal structures

- Tender launch
  - Design requirements
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Tender design
  - Tender launch
  - Design requirements
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Client’s requirements
  - Tender design
  - Design requirements
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Detailed design
  - Client’s requirements
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Final design
  - Detailed design
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Physical modelling 2D
  - Final design
  - Physical modelling 2D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- Physical modelling 3D
  - Final design
  - Physical modelling 3D
  - Construction method
  - Material availability
  - Cost
  - Etc.

- A case
  - Physical modelling 2D or 3D
  - Final design
  - Physical modelling 2D or 3D
  - Construction method
  - Material availability
  - Cost
  - Etc.
An example of 3D physical modelling

Temporary rock structure protecting a future development area.

Scale 1:40.

Design stability criteria: initiation of damage.

Design overtopping criteria: \( q < 1 \text{ l/s/m} \)
Design conditions with a return period 1/10 years for a temporary structure

Prototype values

<table>
<thead>
<tr>
<th>Return period [years]</th>
<th>( H_m ) [m]</th>
<th>( T_p ) [s]</th>
<th>( h_{toe} ) [m]</th>
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<tr>
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<td>1.30</td>
<td>7.5</td>
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<tr>
<td>1/100</td>
<td>3.30</td>
<td>9.3</td>
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<tr>
<td>Cyclone</td>
<td>3.80</td>
<td>14.5</td>
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</tbody>
</table>

Calibration of waves with a spending structure.
1000 waves with a JONSWAP spectrum (\( \gamma = 3.3 \)).
Measurement of wave conditions offshore and at the toe of the structure.
The shore protection is stable for design conditions

Overtopping: <0.01 l/s/m for design conditions (criteria: 1 l/s/m)

Stability (except cyclone conditions):

![Graph showing stability conditions]

- Intermediate damage
- Initiation of damage
- Design conditions
The relation between DEME and the COB will be productive

State-of-the-art facility near our HQ to perform 3D physical modelling for the design of coastal structures.

Also physical modelling related to offshore projects.

Close collaboration with the COB partners.

Research projects to push forward the frontiers of knowledge.
Take-home messages

The use of physical modelling is an intrinsic part of the design process of coastal structures.

The fulfillment of the design criteria can be checked. Optimizations can be tested.

At DEME we are looking forward to becoming active users of the COB.
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