Hydraulic stability and overtopping performance *of a new type of regular placed armor unit*

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- Physical model tests performed
- Hydraulic stability
- Roughness coefficient

What is this new armor unit?

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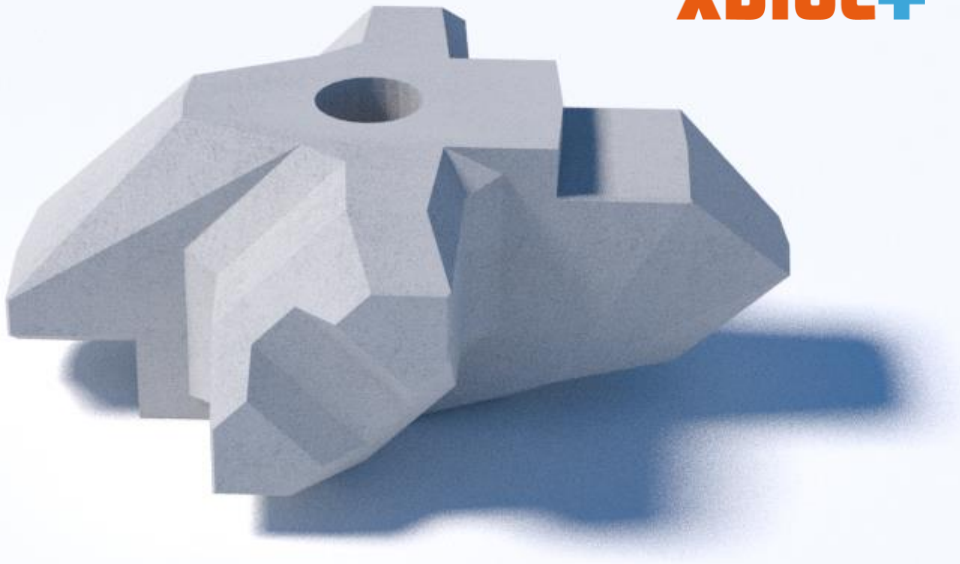
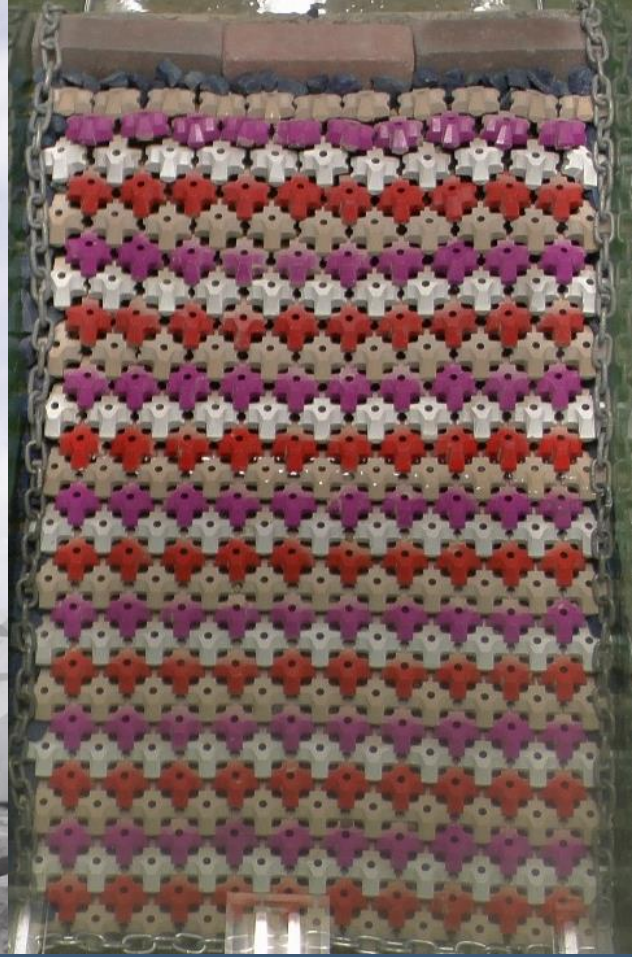
XblocPlus

- Regular placed
- Single layer
- Interlocking
- Unreinforced concrete
- Breakwater and shore protection armor unit





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Background

Xbloc units are designed for random placement

Xbloc units random placement:
Good packing density

Xbloc units regular placement:
High packing density

Background

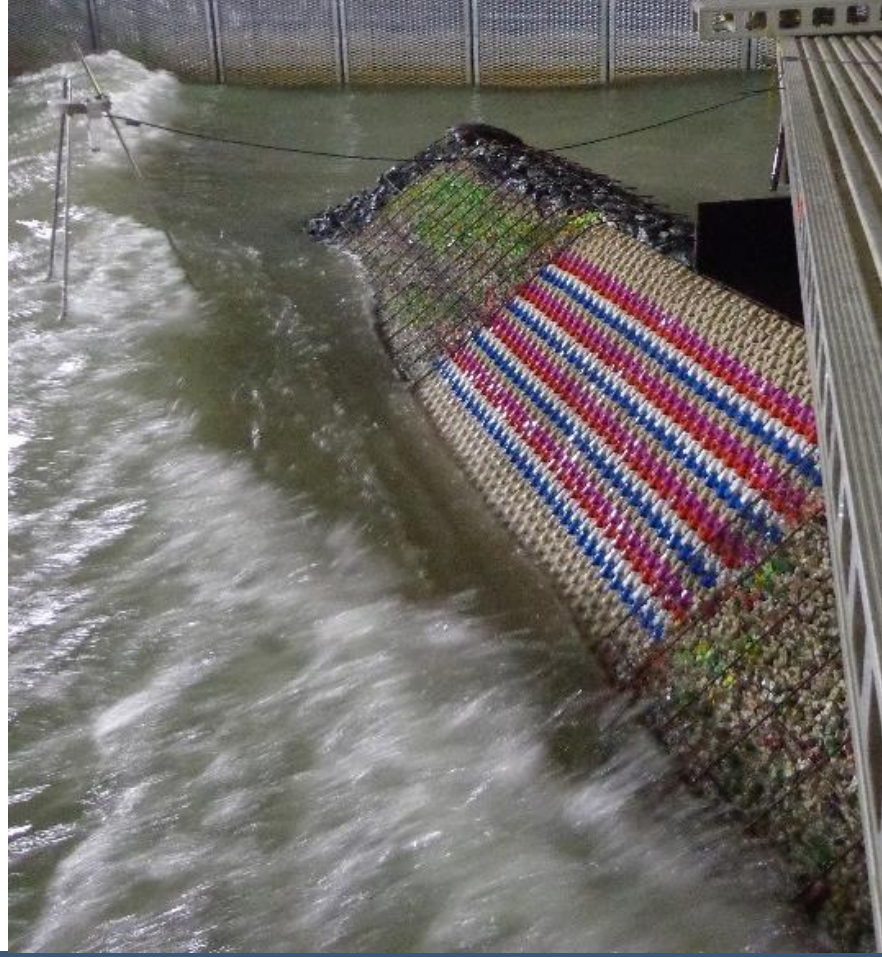
XblocPlus units are designed for regular placement

Physical model tests

In total more than 600 tests

of which:

- >400 tests with the final shape
- 35 3D model tests (θ = 0°, 30° and 60°)
- More than 300 overtopping tests

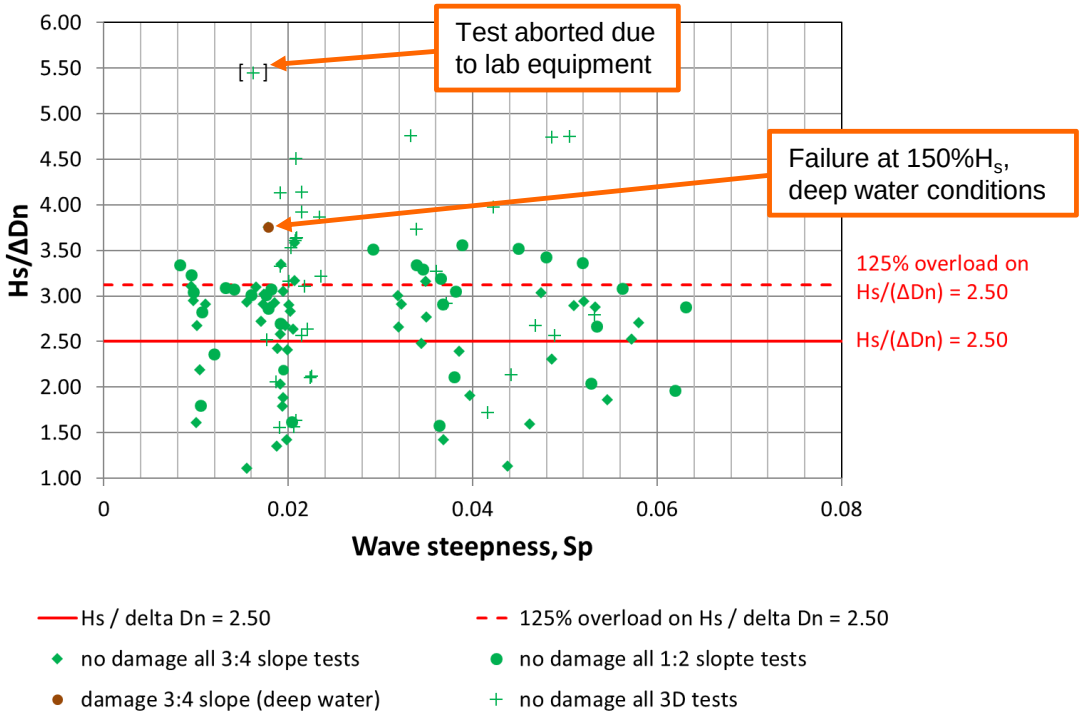


Physical model tests

<u>Tested parameters include:</u>

- Wave steepnesses between 0.01 to 0.06
- Wave heights from 60%H_s to 250%H_s
- Slope inclinations of 1:2, 2:3 and 3:4

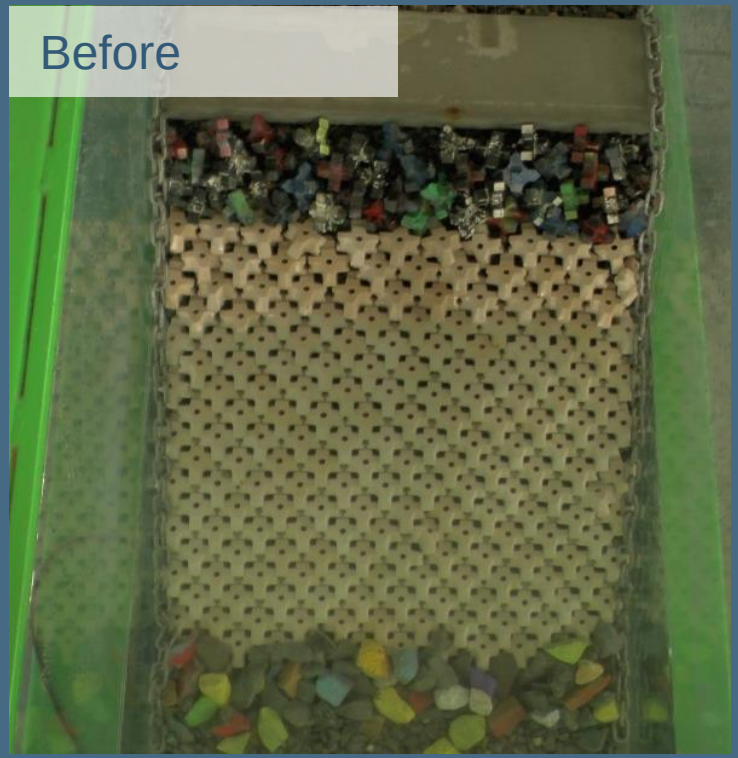
Hydraulic stability for all tests

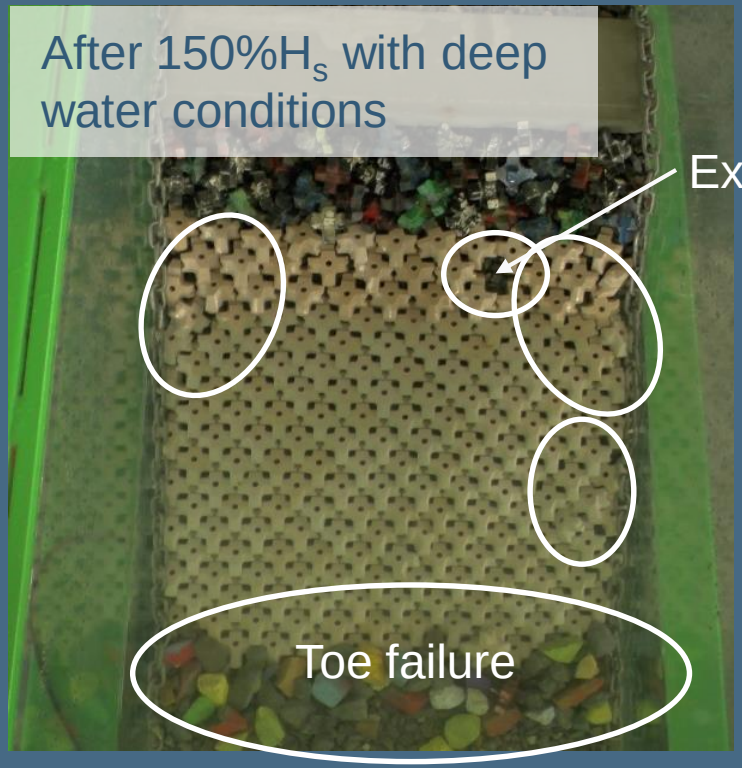


Design equation:

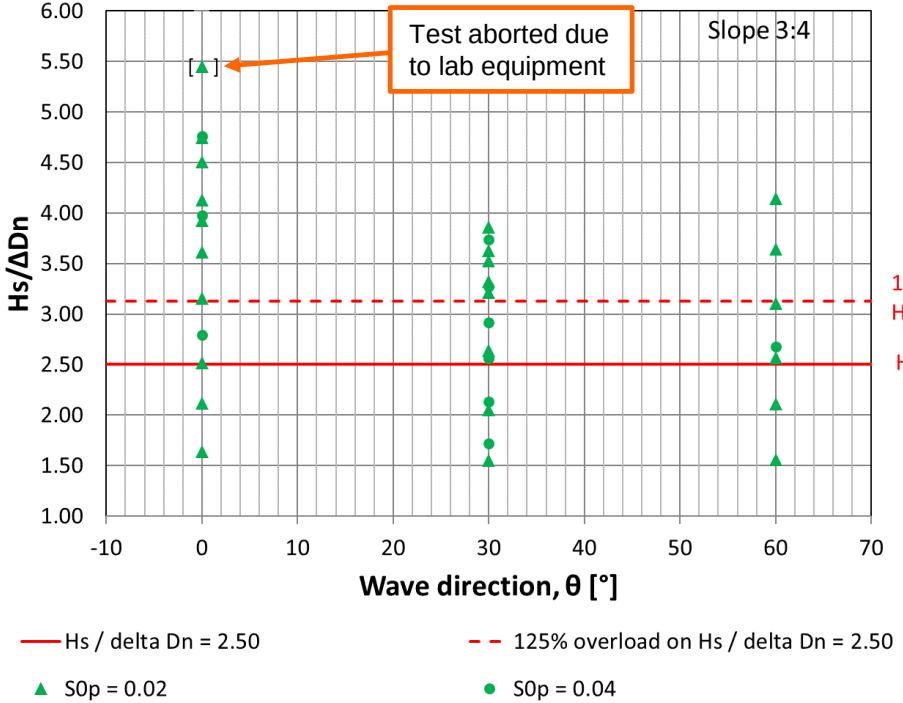
$$\frac{H_s}{\Delta D_n} = 2.5$$

Failure deep water test





Hydraulic stability 3D model tests



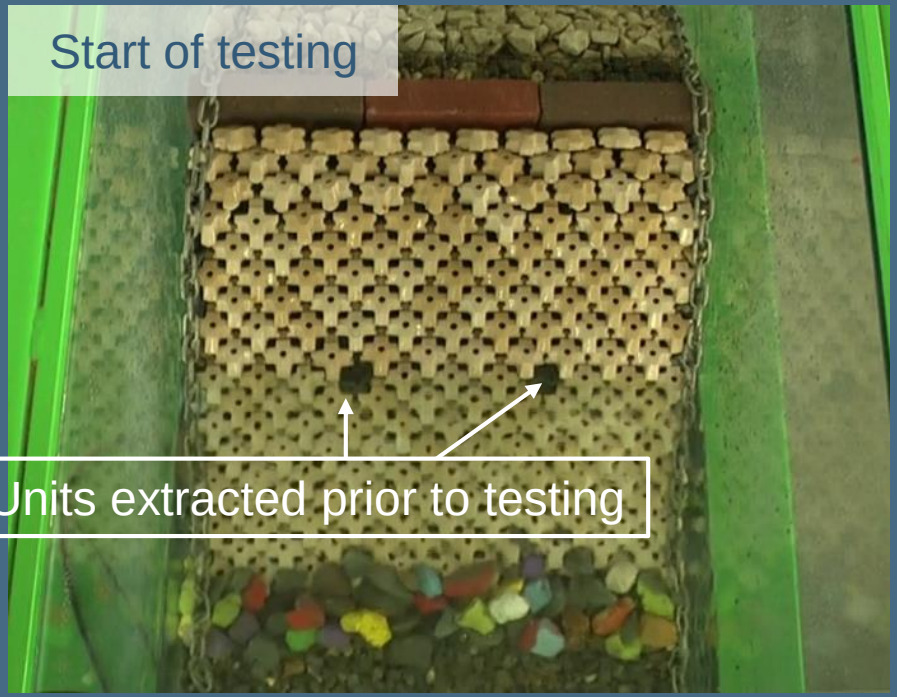
Design equation

3D model tests

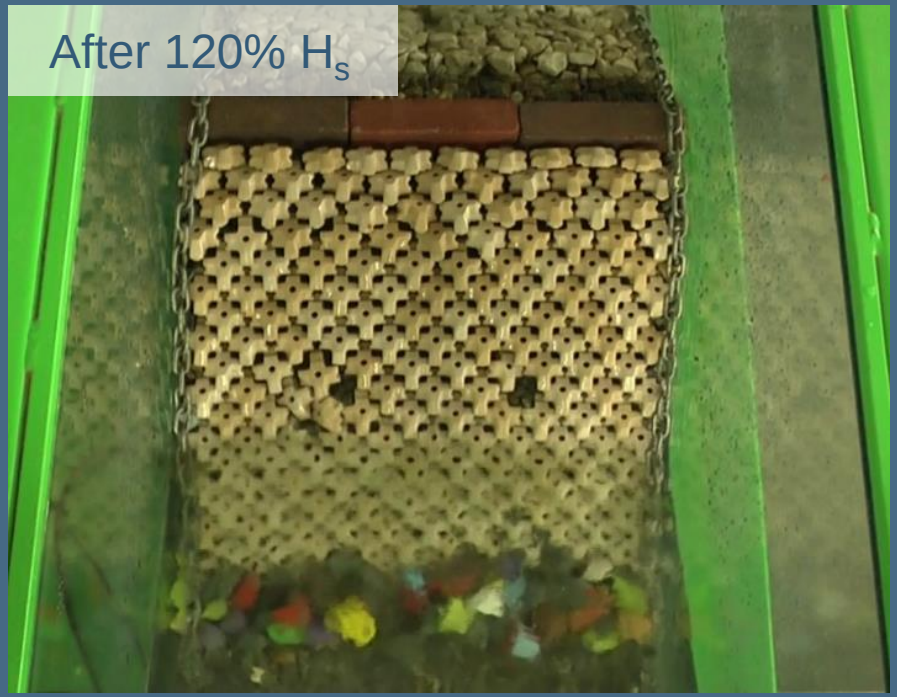
200%H_s overload conditions

S0 = 0.06, θ = 0°

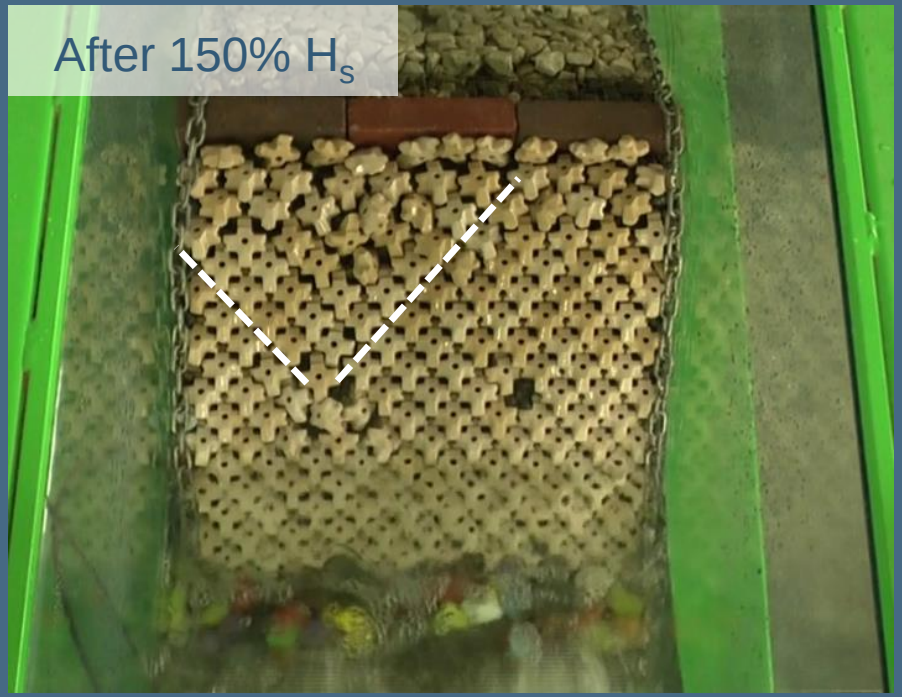
Resilience of damaged armour layer



Resilience of damaged armour layer



Resilience of damaged armour layer



Hydraulic stability - conclusions

Large safety margin

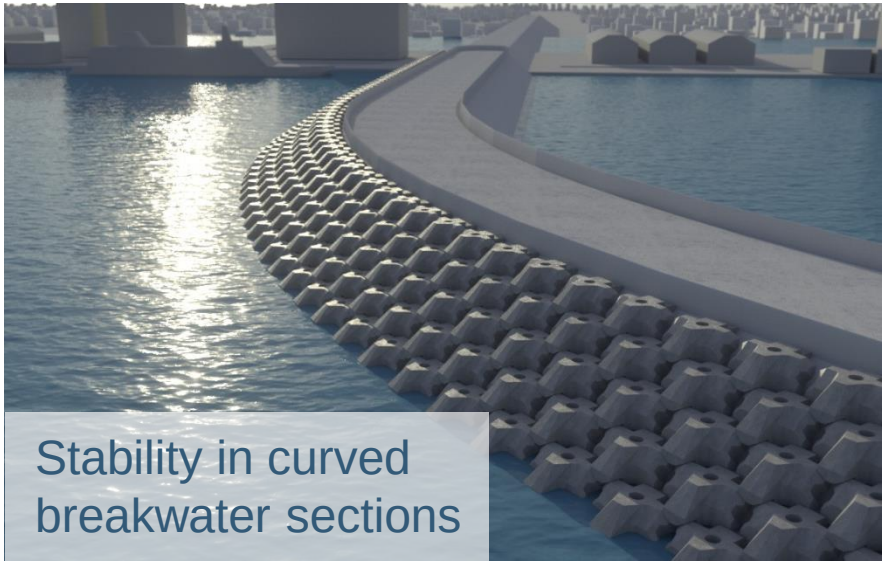
between chosen stability number and tested stability

No rocking observed

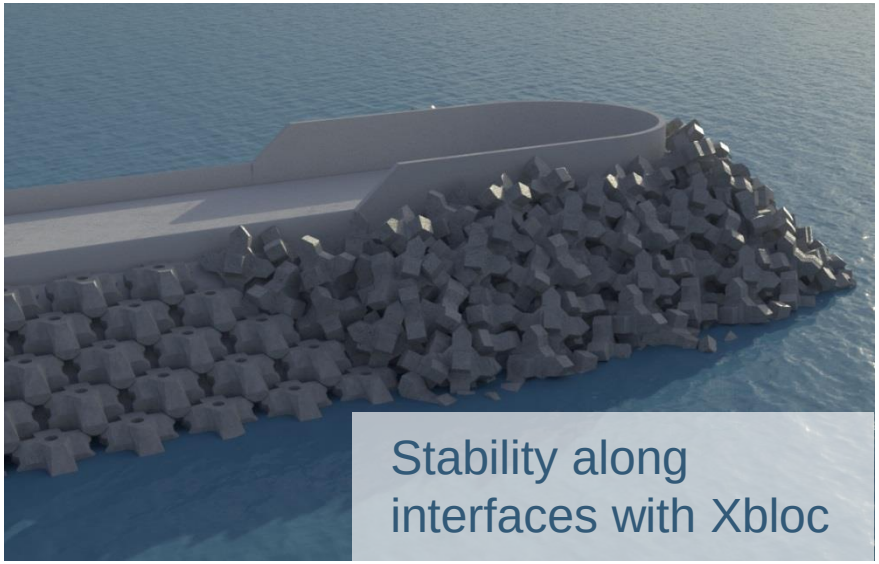
during testing

Hydraulic stability - conclusions

Still to be tested:



Stability in curved breakwater sections



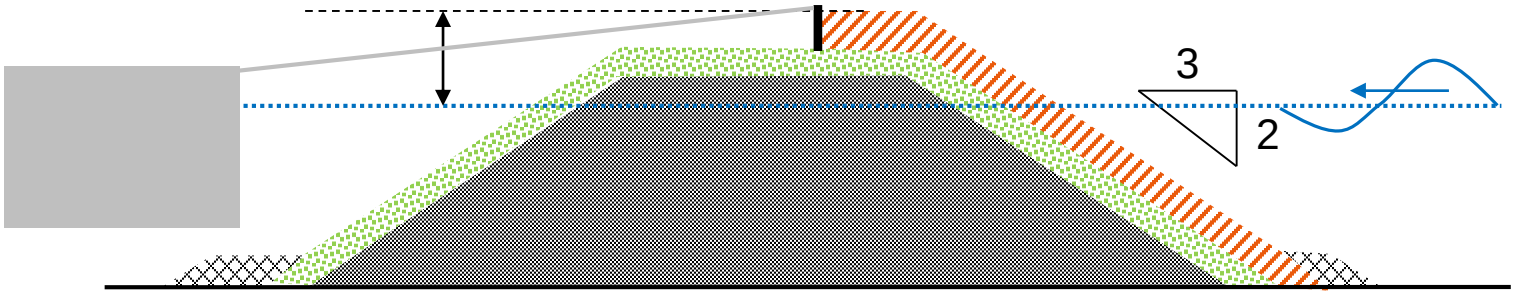
Stability along interfaces with Xbloc

Roughness coefficient

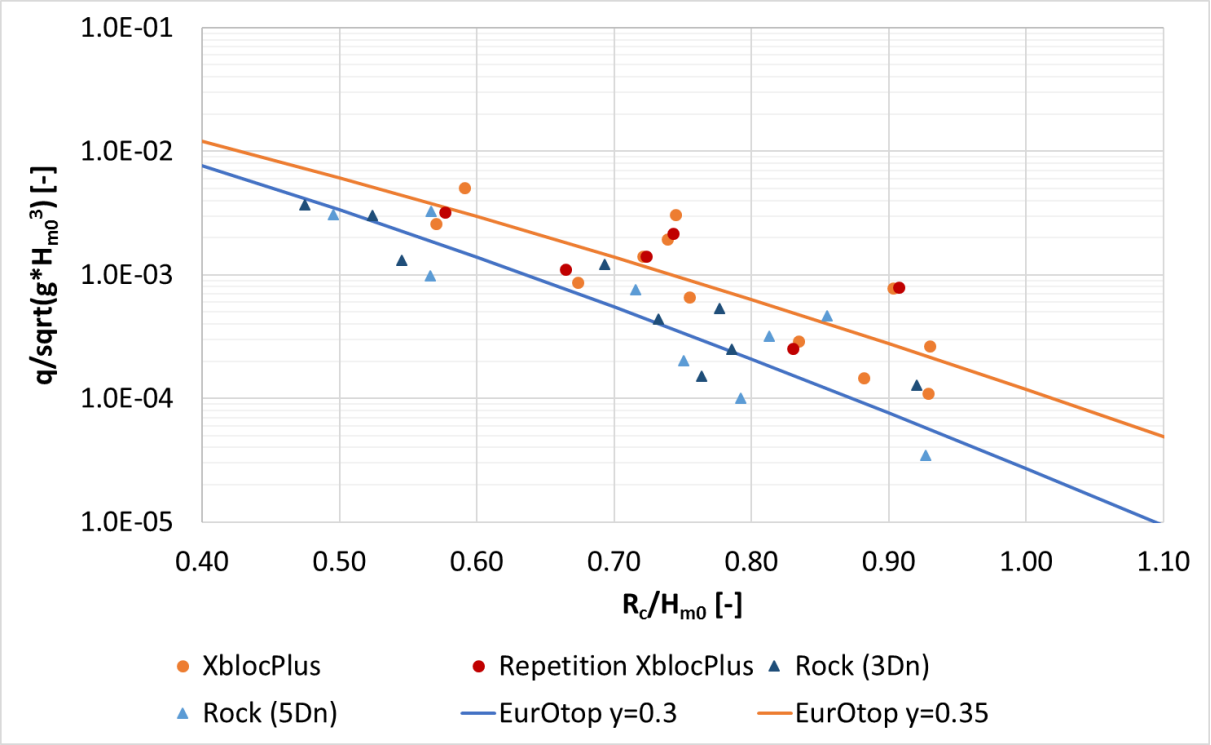
Wave height:
41% - 92% $H_{s,design}$

Relative freeboard:
0.47 – 0.93

Wave steepness:
0.01 – 0.04

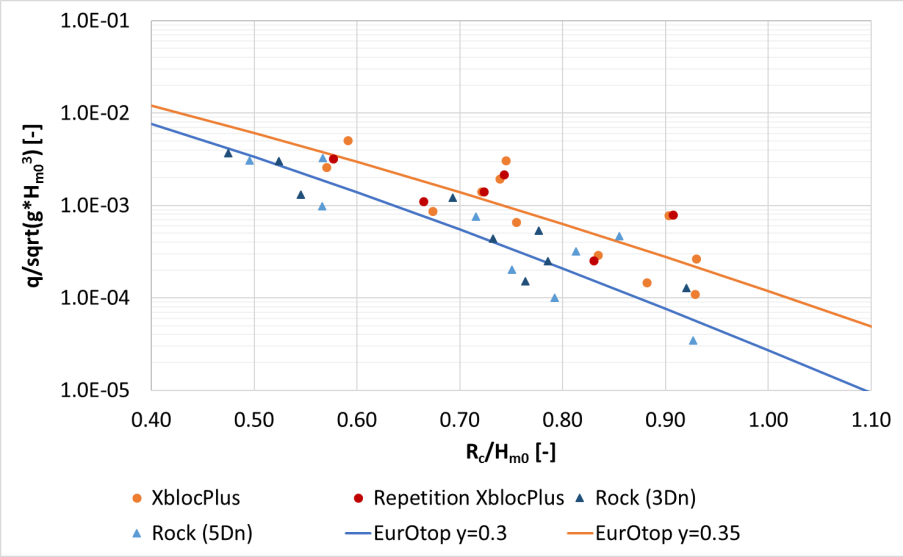


Roughness coefficient



Roughness coefficient

- Roughness coefficient for rock at $3D_n$ and $5D_n$ is $\gamma_f = 0.30$
- Roughness coefficient for XblocPlus (all tests) is $\gamma_f = 0.35$
- Correction factor for rock $c_f = \frac{0{,}40}{0{,}30} = 1.29$
- Roughness coefficient XblocPlus $\gamma_f = 0.45$



Thank you for your attention!