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EXPERIMENTS ON THE EFFECT OF FREEBOARD ON THE STABILITY OF A BREAKWATER CROWN WALL

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Van Oord / TU Delft

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Introduction

Crown wall on a rubble mound breakwater

Crown wall on top of a breakwater at Dikkowita Port (www.xbloc.com)

- Reduce wave overtopping;
- Easy access to the structure;
- Infrastructure on top of flat surface.

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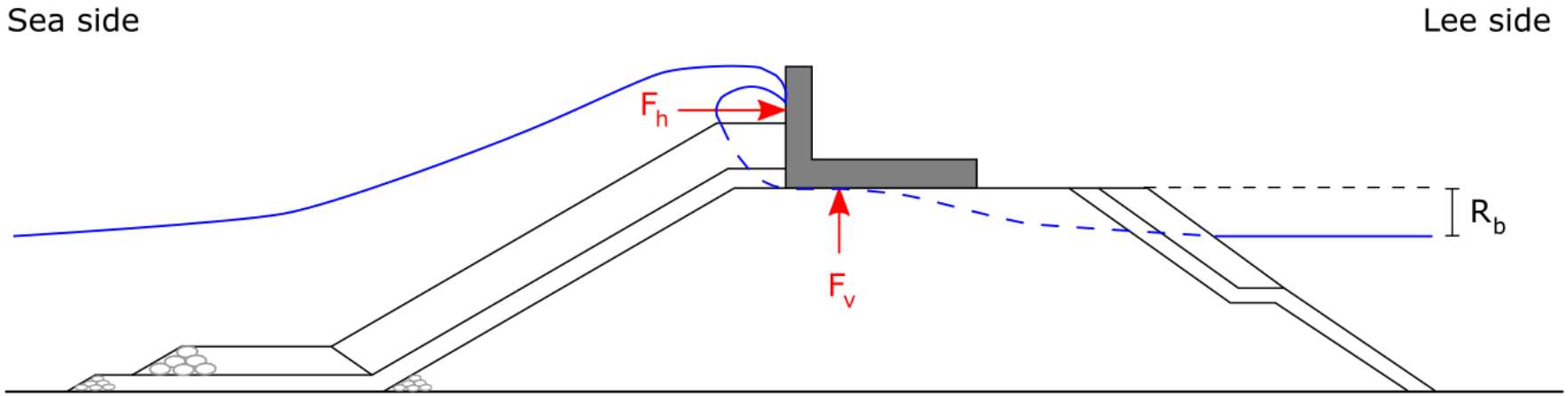
Introduction

Crown wall on top



Design

- Depends on these loads;

- Wave load calculation methods convert wave conditions and geometric properties of the structure into loads.

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Introduction

Research motivation

Based on a breakwater project by Van Oord:

- Wave load calculation methods proved to be too conservative for increasing base freeboard.

Research question

What causes current design methods to be not accurate enough in the design of the crown wall on top of a rubble mound breakwater?

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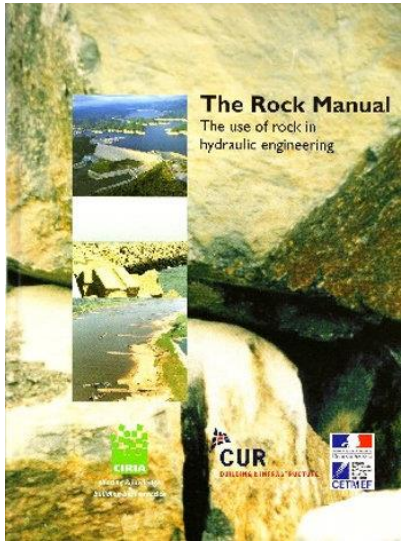
Introduction

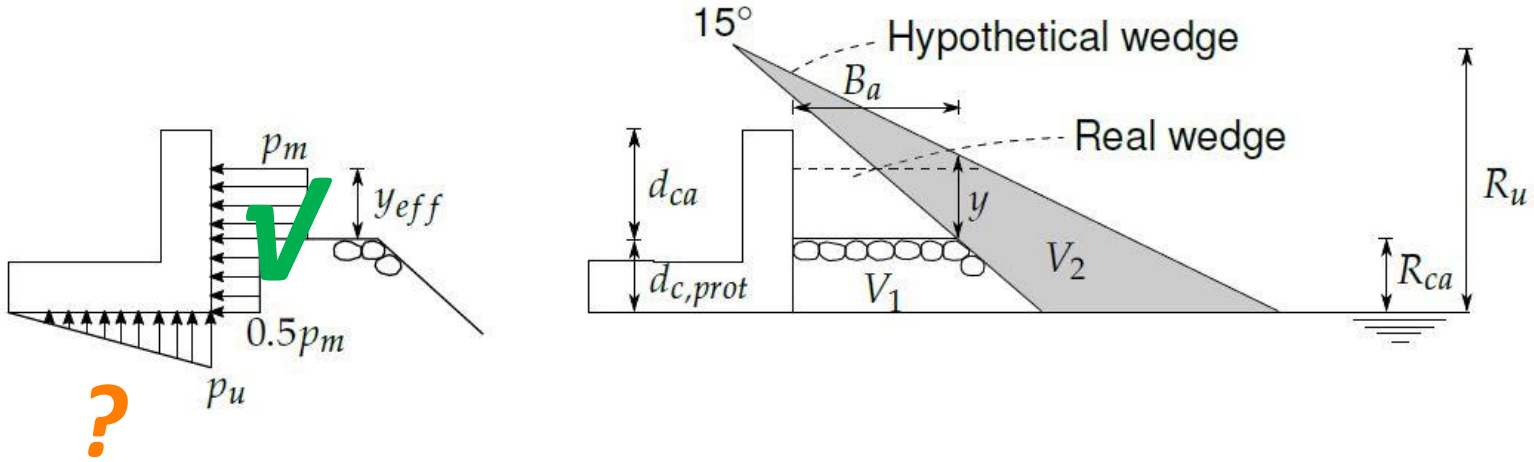
Current design methods

Pedersen (1996)

↓

Nørgaard (2013)





Pressure distribution according to PEDERSEN [1996]

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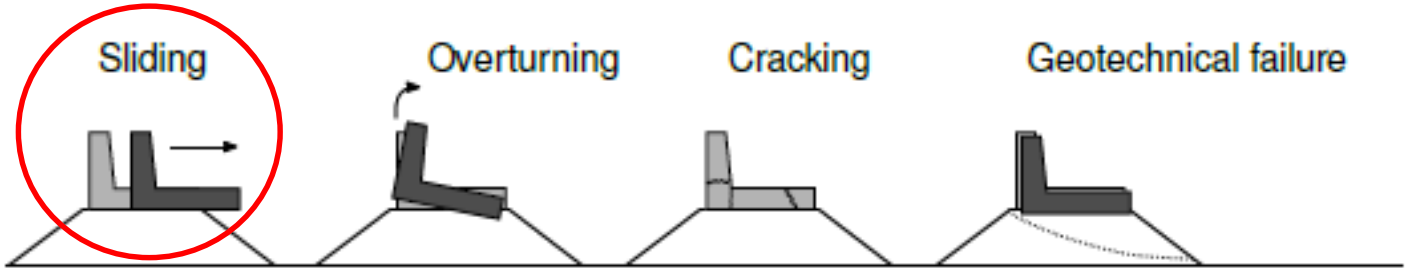
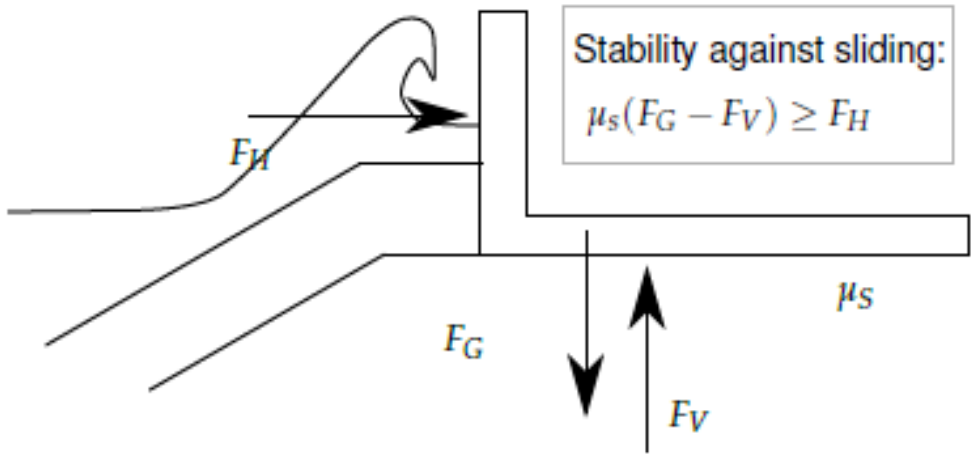
Introduction
Failure modes



Crown wall failure modes, [PEDERSEN, 1996]

Stability criterion



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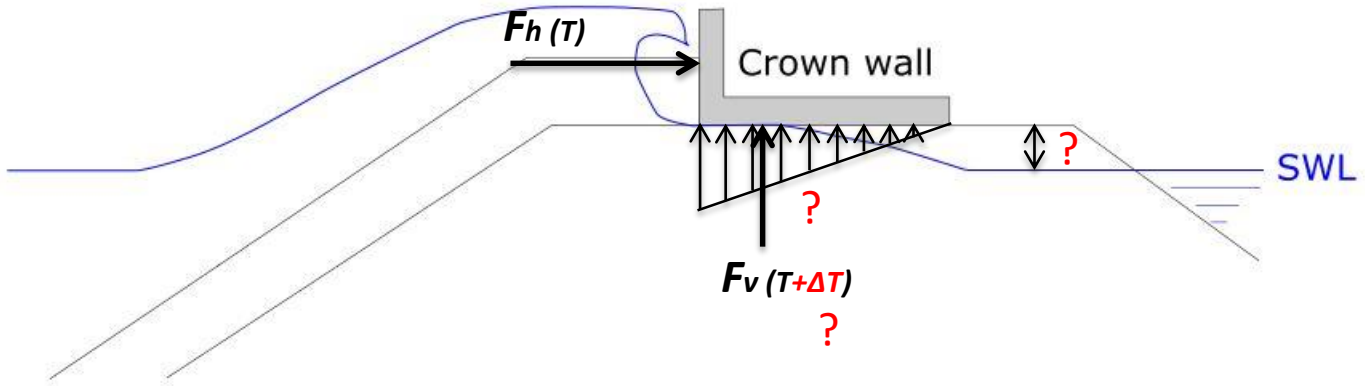
Knowledge gaps



-Little data freeboard;

-Distribution upward pressure;

-Phase lag.

Methodology

Experimental research

Waterlab of Civil Engineering & Geosciences
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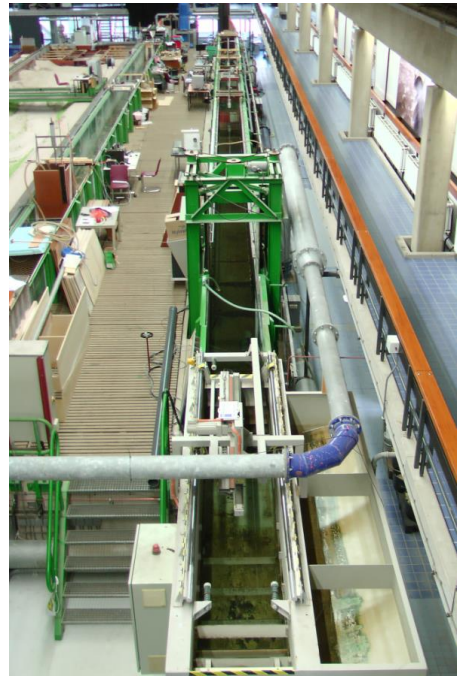
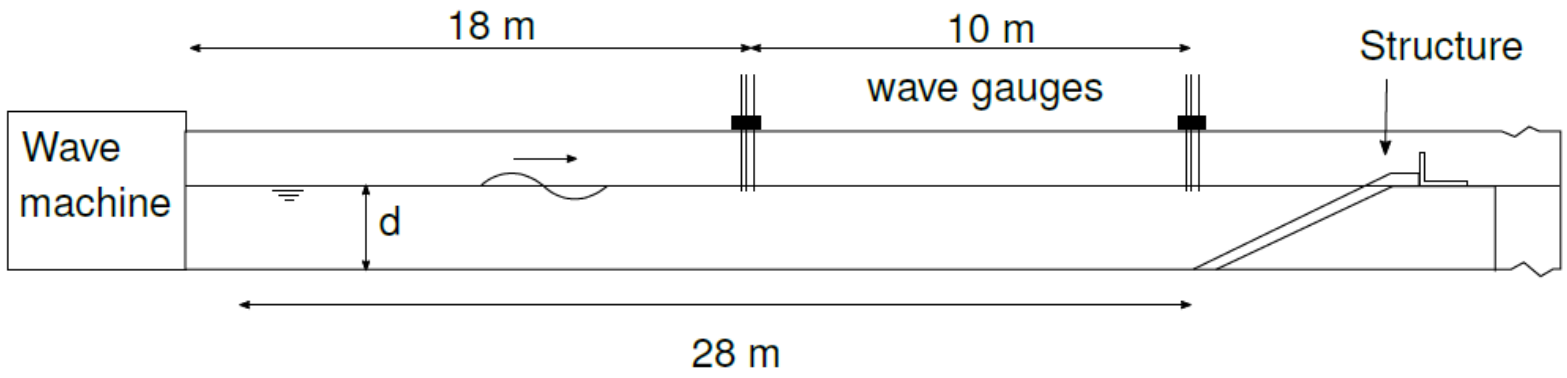
- Effective length: 42 m;
- Width: 0.80 m;
- Height: 1.00 m;
- Automatic reflection compensation.





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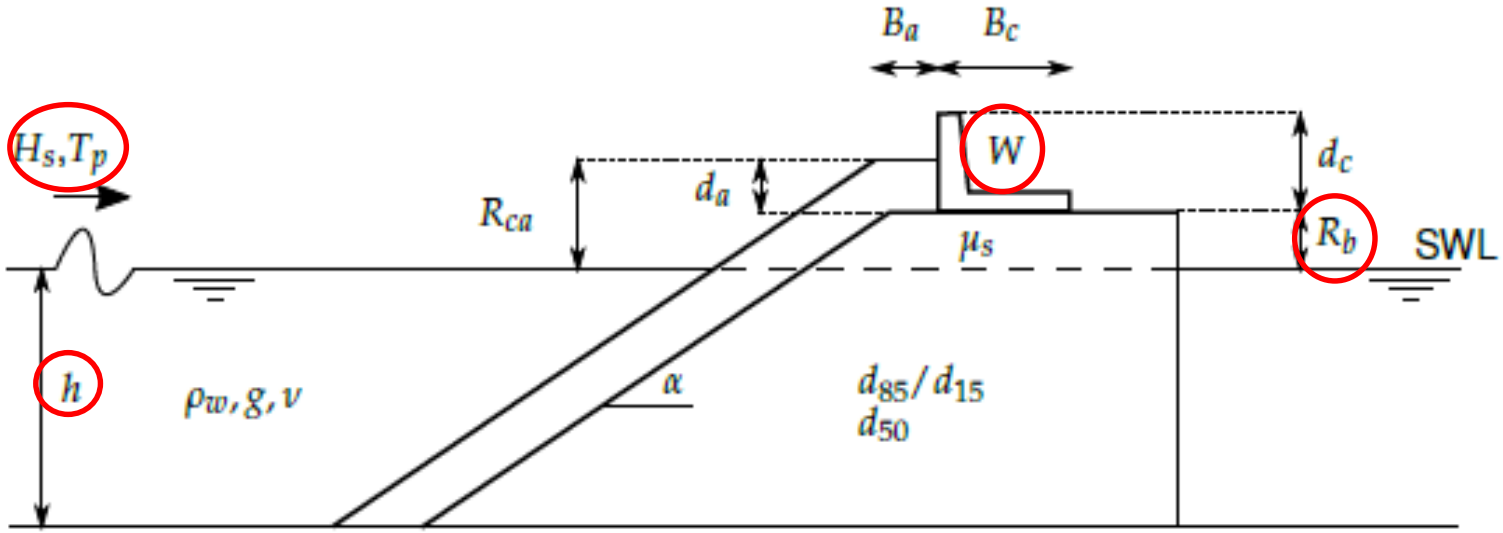
Methodology

Experimental research



Parameter ranges

H_s = 0.09-0.16 m

T_p = 1.23-3.18 s

$H_s / L_{0p} (=s_{0p})$ =0.01 and 0.04

R_b = 0-0.09 m

$H_s/(R_b+d_a)$ =0.71-1.48

h = 0.56-0.65 m

W=varied to obtain instability threshold by iteration

- 2D tests;
- 1000 waves (JONSWAP) each run;
- Dn50(core) = 0.015m;
- Dn50(armour) = 0.037 m;
- Crown wall: Tricoya

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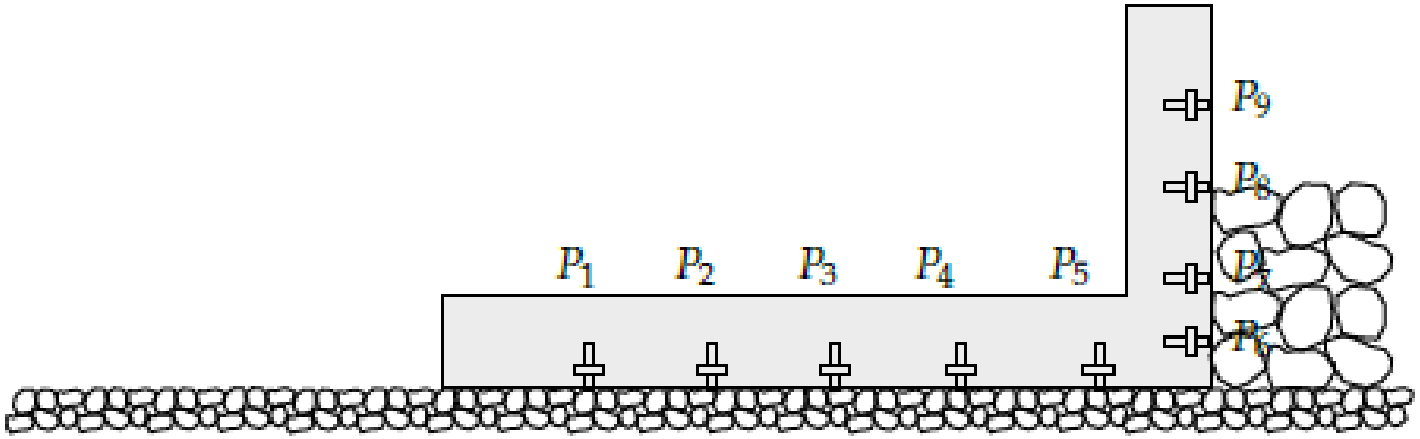
Methodology

Test subjects



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Methodology

Failure - sliding

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Methodology

Test series 1

- Adapted weight until stability/failure;
- Dataset of critical weights;
- For 28 test conditions (at least 4 times each).

Test series 2

- Sliding;
- Uplift;
- Horizontal & Vertical pressures;
- For 7 test conditions (at least 4 times each).

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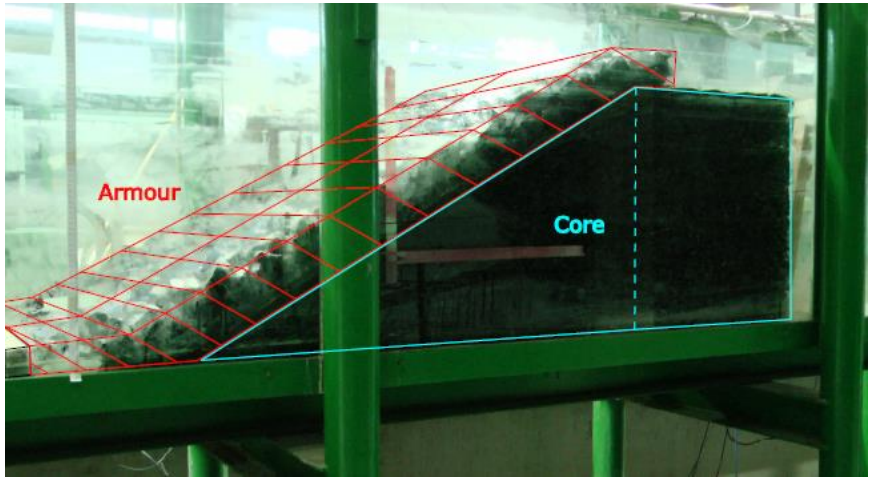
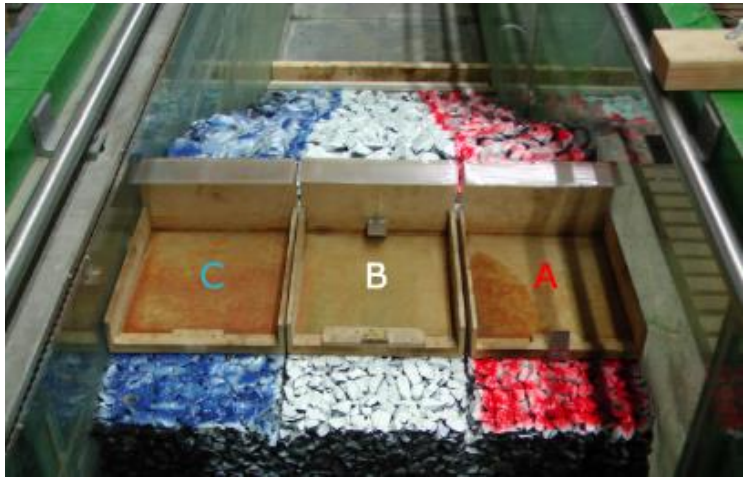
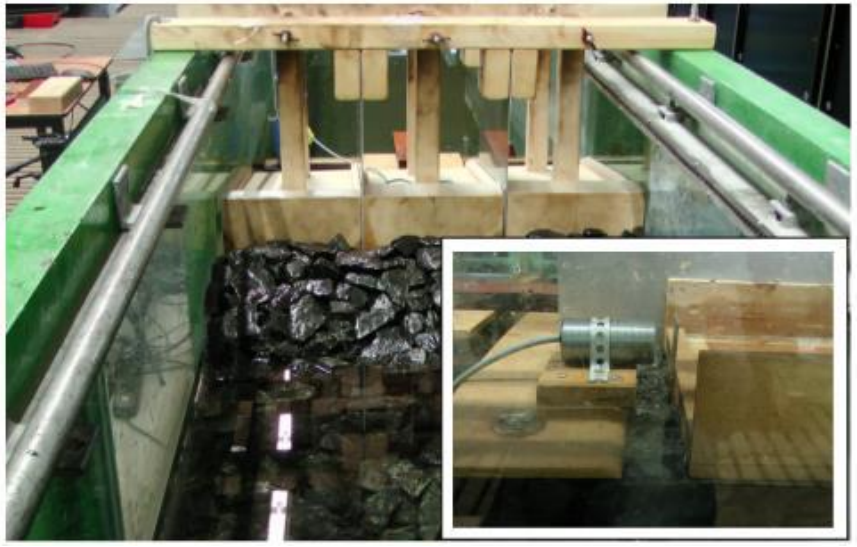
Methodology







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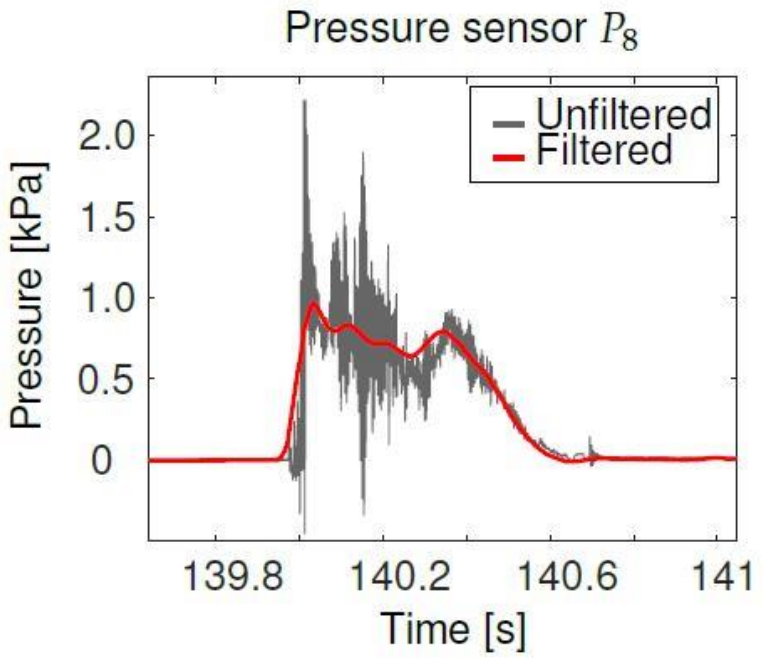
Results/Analysis
General findings

Filtered pressures



Consequence → Merely a qualitative analysis: ``Is pressure experienced?''

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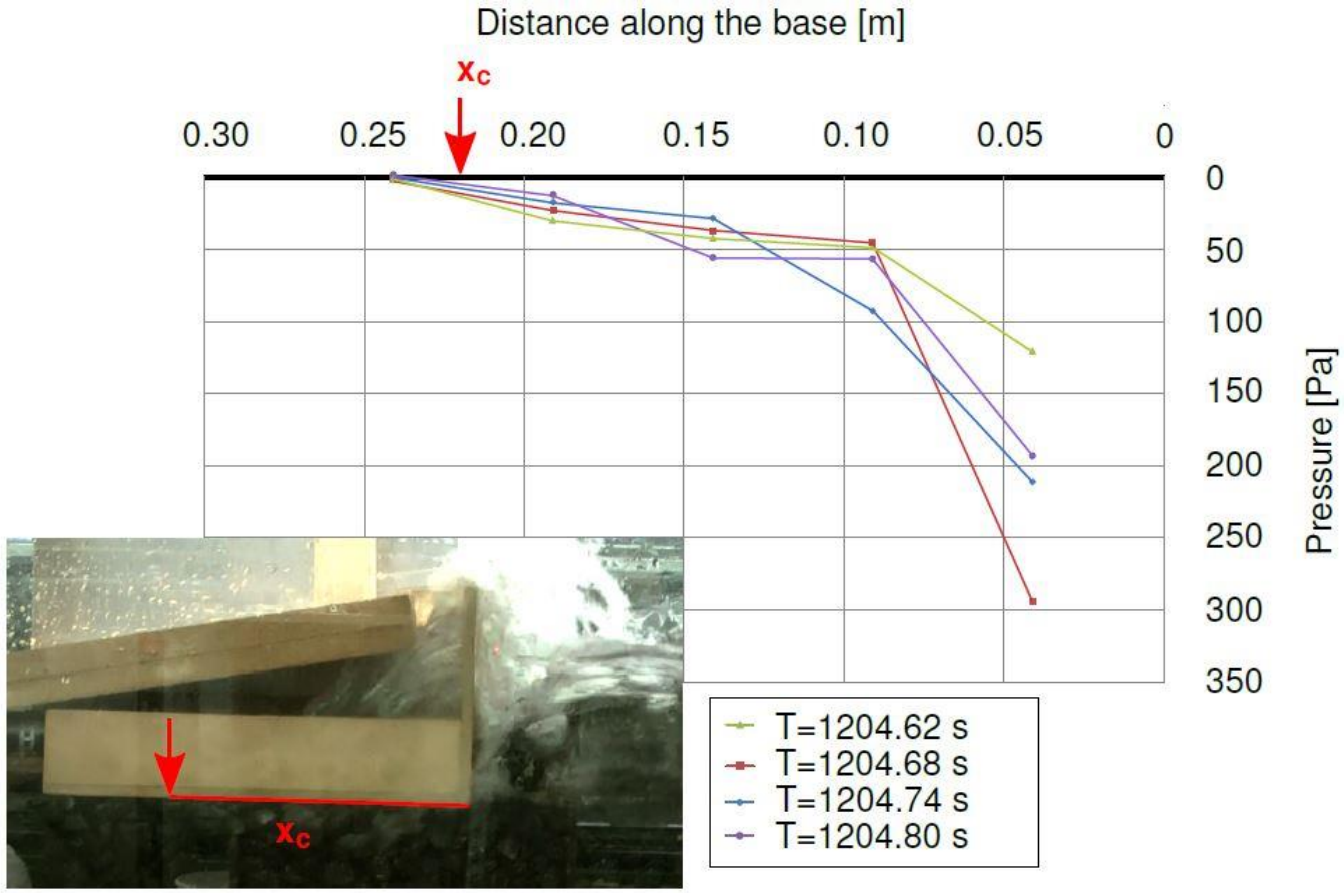
Results/Analysis

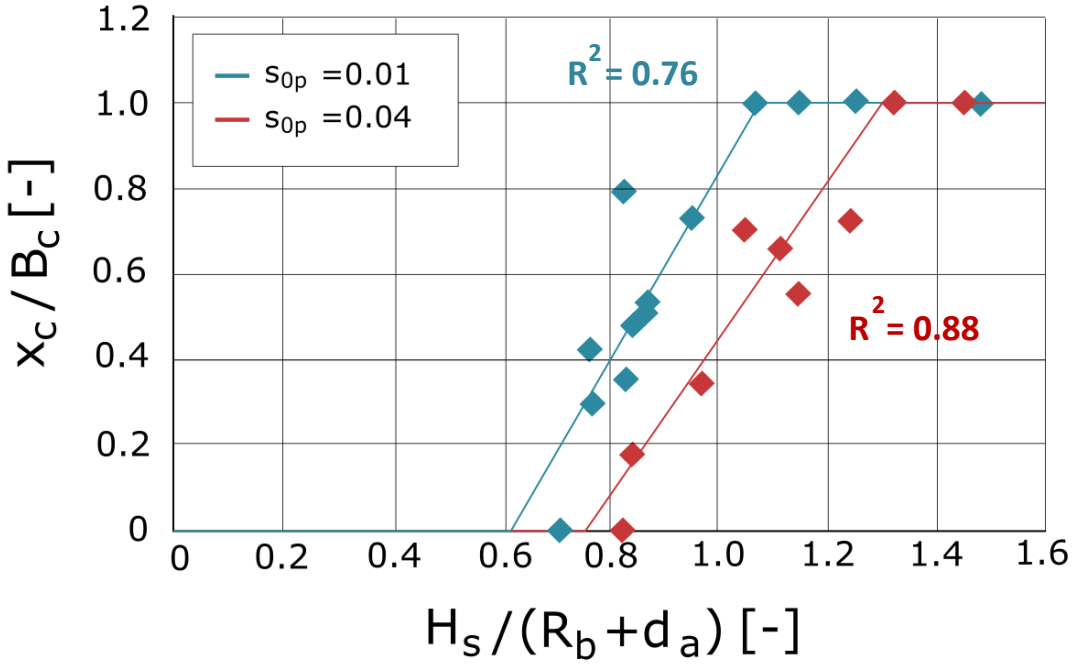
Upward pressure

Effective length:



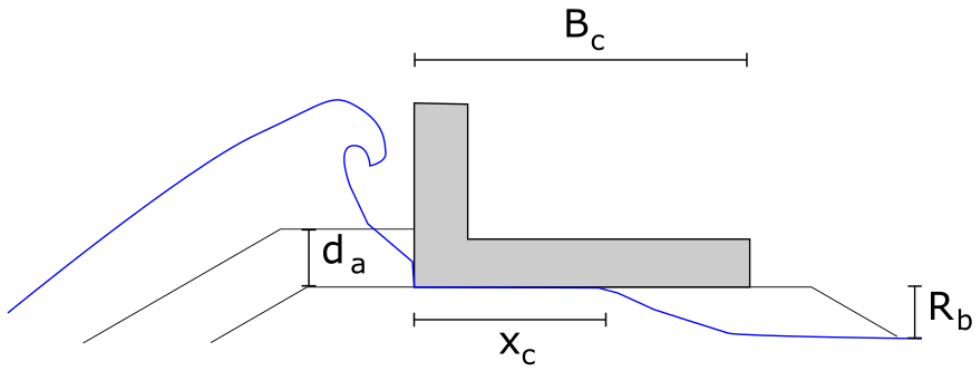
Results/Analysis

Upward pressure



Reduction factor upward load:

Xc/Bc=Yv



$$\gamma_v = 1.2 \frac{H_s}{R_b + d_a} s_{0p}^{-0.14} - 1.44$$

with a minimum of 0 and a maximum of 1.

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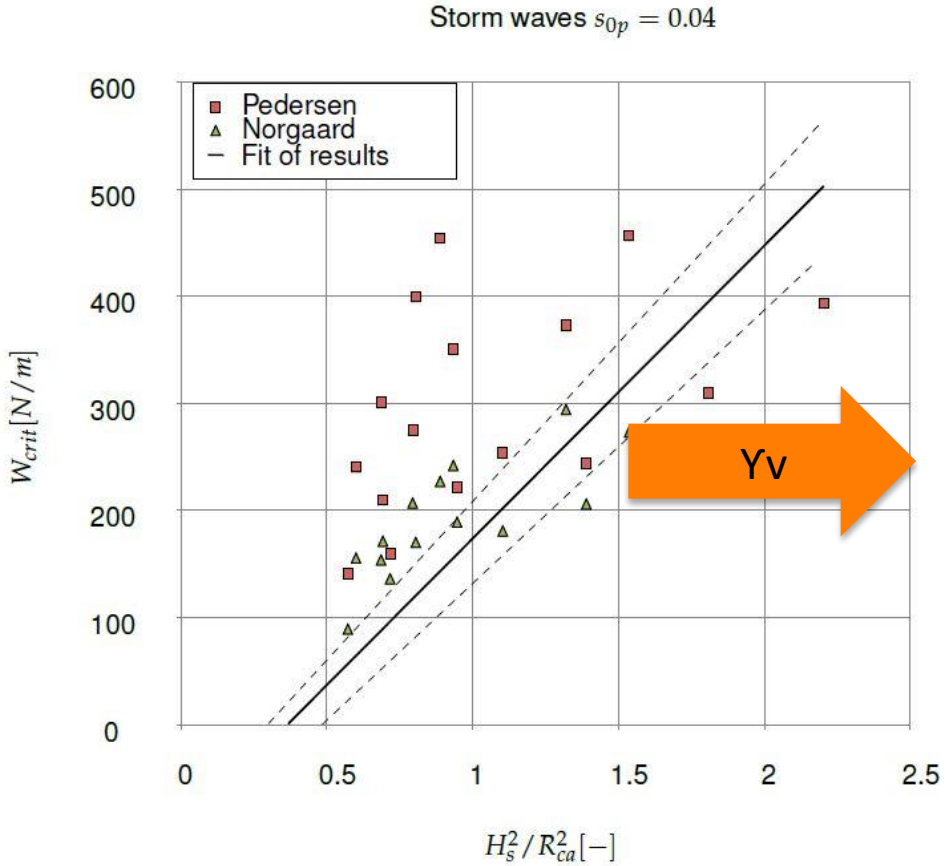
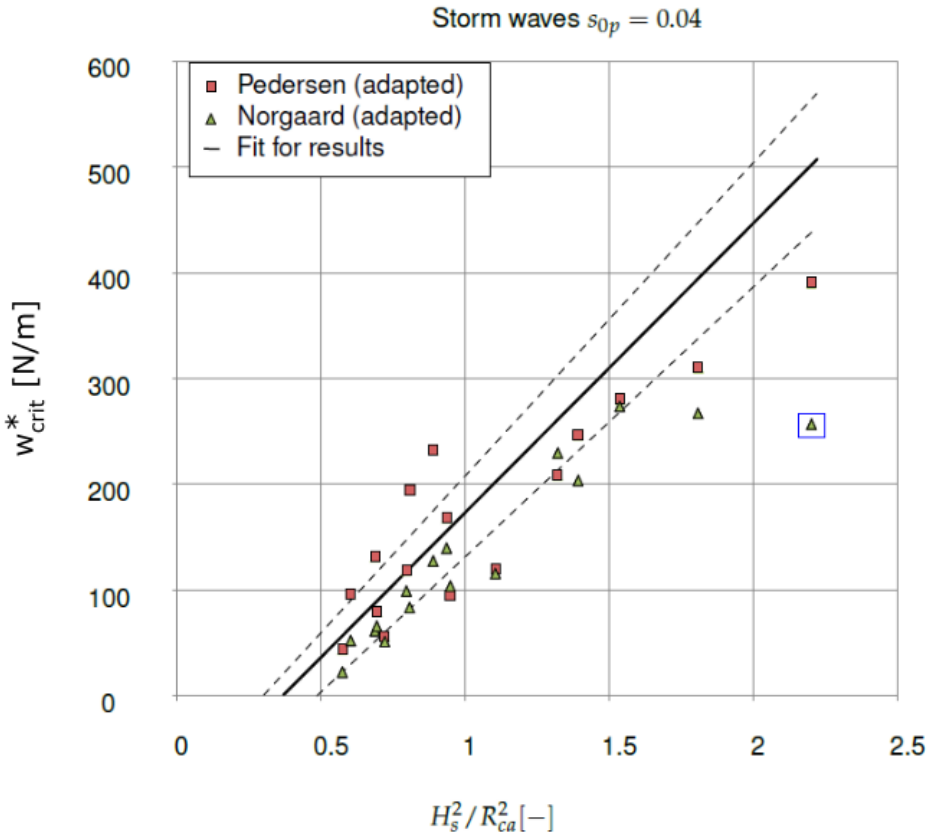
Results/Analysis

Comparison to conventional methods



Yv



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Conclusions

Research question:

What causes current design methods to be not accurate enough in the design of the crown wall on top of a rubble mound breakwater?

Answer:

- Effective length x_c (**Pu*Yv**);
- Different shape of upward pressure distribution;
- The effect of phase lag is not as significant as expected.

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Questions?

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