xbloc®

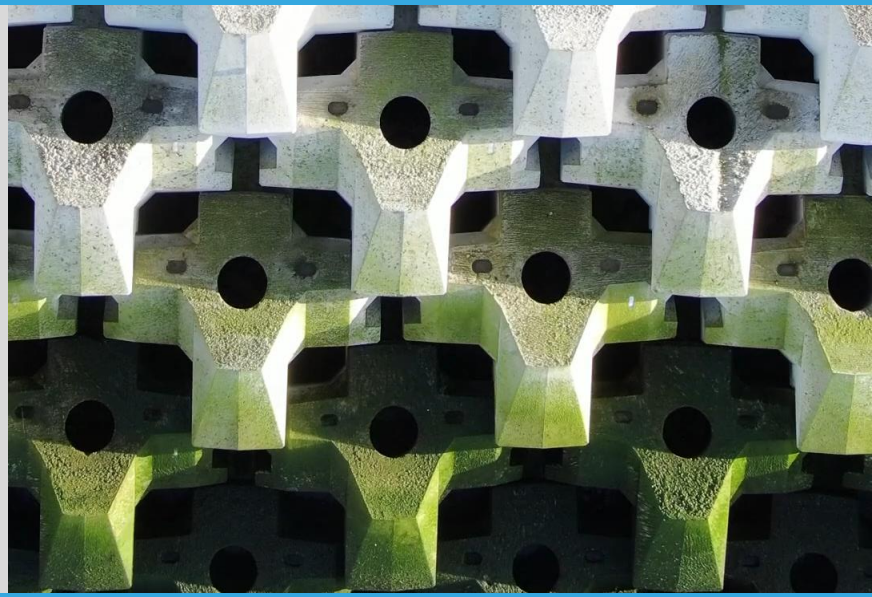
Delta Marine Consultants

Case study Shore Protection UK

bam xbloc+ xbloc xstream

XblocPlus leads to:

- 57% reduction on costs
- 28% reduction on CO2 emissions
- Nature value in hard structure
- Resilience against climate change
- No maintenance needed



Designs used for calculations

DESIGNS
ECONOMICAL
SUSTAINABLE
CO2 EMISSION
Biodiversity
CLIMATE
RESILIENT
MAINTAINANCE

Equivalent Cross Sections

Assumed design conditions

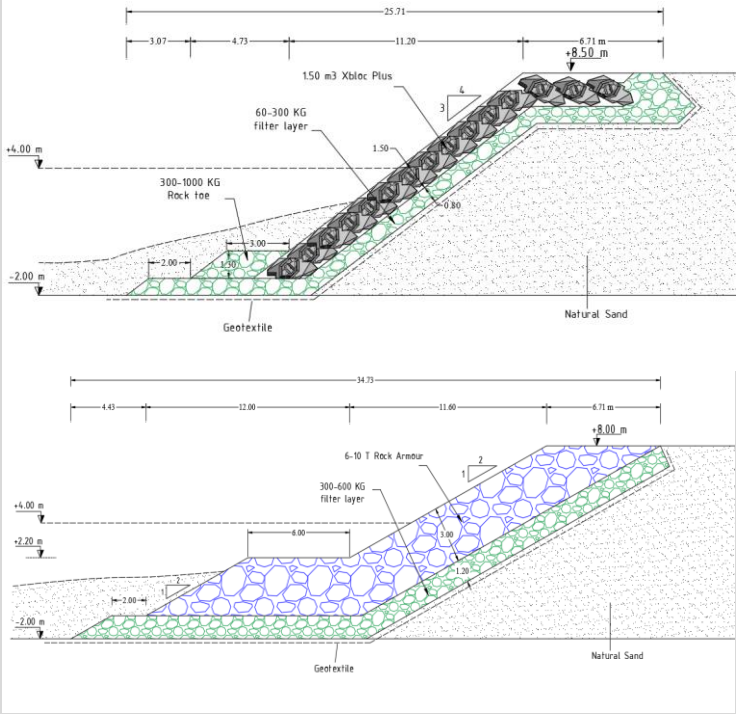
- 100 year wave height Hs=3m (2015 wave climate)
- Tp=7s
- Design high water level CD+4m

Stability

- Rock armour designed with Vd Meer equation with S=2
- XblocPlus armour with Xbloc Calculator

Overtopping

- Overtopping calculated with Vd Meer
- Equal overtopping for both designs



Material Quantities and Unit Prices

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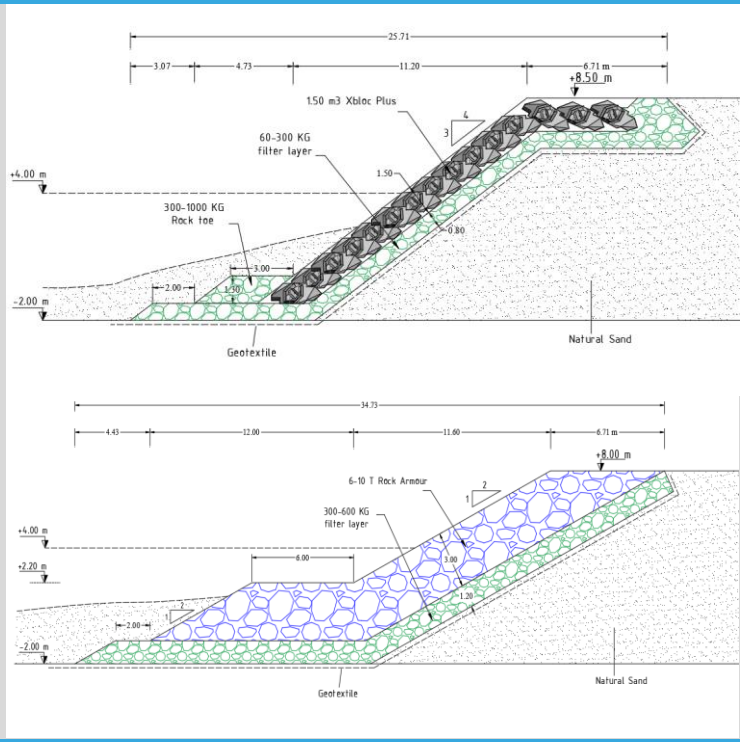
Material quantities*

		Rock design	Xbloc Plus design
Geotextile	[m2]	40.36	33.51
0.3-1 ton rock	[ton]	86.2	7.8
3-6 ton rock	[ton]	154.04	-
60-300 kg rock	[ton]	-	54.2
Xbloc Plus	[m3]	-	10.8

Unit prices

Unit prices for materials including installation		
geotextile	euro/m2	13,4
quarry run	euro/ton	60
60-300kg rock	euro/ton	60
300-1000kg rock	euro/ton	60
1-3ton rock	euro/ton	62
3-6ton rock	euro/ton	63
XblocPlus	euro/m3	200



Cost Comparison

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Costs

Material quantities multiplied by following unit rates:

Rock design

Material	Price rates	Unit price	Quantity	Price [€/m]
Geotextile	Euro/m2	13	40.36	525
300-1000 kg rock	Euro/ton	40	86.2	3448
3-6 ton rock	Euro/ton	55	154.04	8472
			TOTAL	**11,445**

57% cost saving →

Xbloc Plus design

Material	Price rates	Unit price	Quantity	Price [€/m]
Geotextile	Euro/m2	13	33.51	436
60-300 kg rock	Euro/ton	35	54.2	1,897
300-1000 kg rock	Euro/ton	40	7.8	312
Xbloc Plus	Euro/m3	250	10.8	2,691
			TOTAL	**5,336**

CO2 Comparison

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CO2 Emissions*

CO2 Emissions for material production – transport & installation		
	CO2-eq	
rock from quarry close by	Per ton	13
rock armour Norway	Per ton	25,5
XblocPlus concrete	Per m3	265

* Based on EN 15804: Sustainability of construction works - Environmental product declarations – Core rules for the product category of construction products

Rock design

Material	Quantity [Tons]	CO2-eq
Armour	154.04	3,928
Filter Rock	86.2	1,121
	TOTAL	**5,049**

28% CO2-eq saving →

Xbloc Plus design

Material	Quantity [m3]	Quantity [tons]	CO2-Eq
Concrete Armour	10.8		2,853
Toe Rock		8	101
Filter Rock		54	705
		TOTAL	**3,659**

Sustainable - biodiversity

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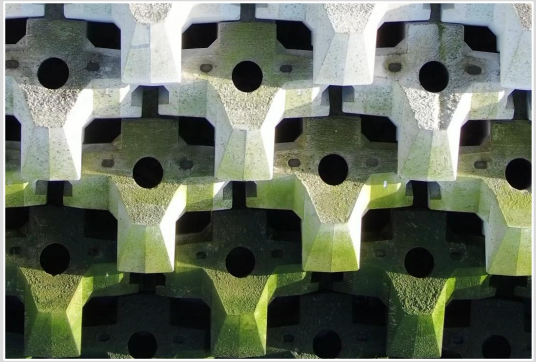
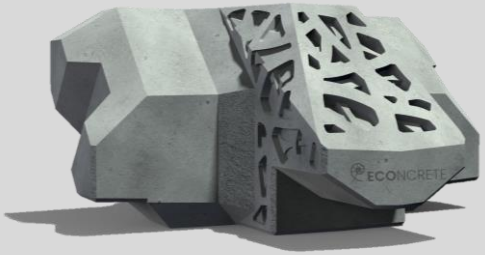



Surveys in Dutch coastal waters on Xbloc and XblocPlus structures:

- Hard structures form habitat for marine life
- Rough concrete & Tidal Pools effective to stimulate marine life
- Cooperation with ECOncrete to create more nature value in hard structures



Maintenance Comparison

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Assumptions (Monte Carlo Simulation)

Lifetime of both designs: 50 years

Location: South UK

Design for 100 year wave height

Damage Assessment:

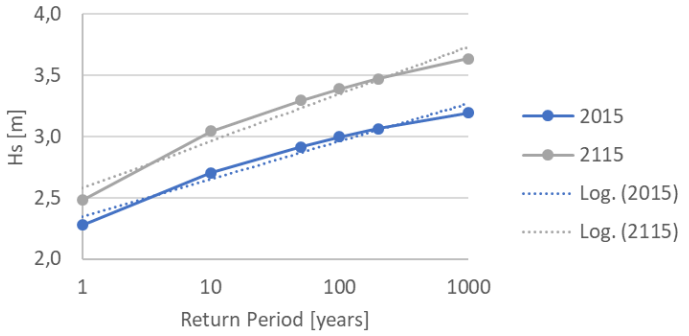
Rock Armour Design

- Vd Meer equation used to calculate damage development in multiple storm events
- Maintenance applied when S accumulative >= 5
- Following year S=0

XblocPlus design

- Maintenance applied at $\frac{Hs}{D_n * \Delta} \geq 4$

Extreme wave heights at -2m CD in South UK without climate change (2015) and with climate change (2115)



Maintenance Comparison

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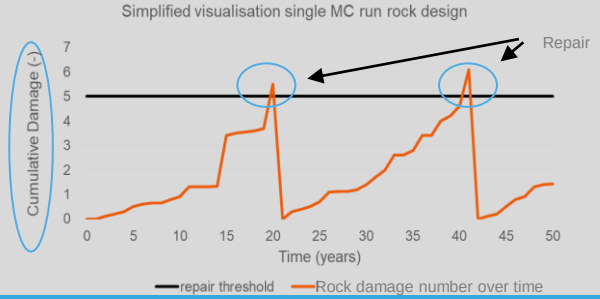
Method (Monte Carlo Simulation)

1. Draw 1 extreme storm per year from extreme wave climate distribution (South UK)
2. Determine damage progression for each storm (50 years total)
3. MC simulation with 1000 runs
4. Simulation gives probability repair and the expected nr. of repair operations needed in 50 years.

Rock damage number over time

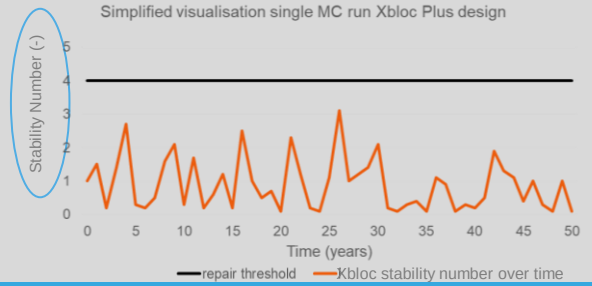
Rock design - single MC run hypothetical example

Damage progression: damage progresses with each storm. Repair needed if threshold level is exceeded (twice in example below)



Xbloc Plus design - single MC run hypothetical example

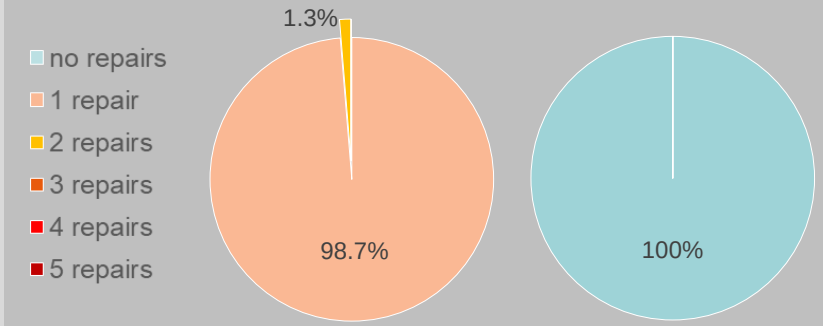
Damage progression: damage only if a threshold wave height is exceeded. Repair is needed if damage occurs (none in example below).



Maintenance Comparison

Present wave climate

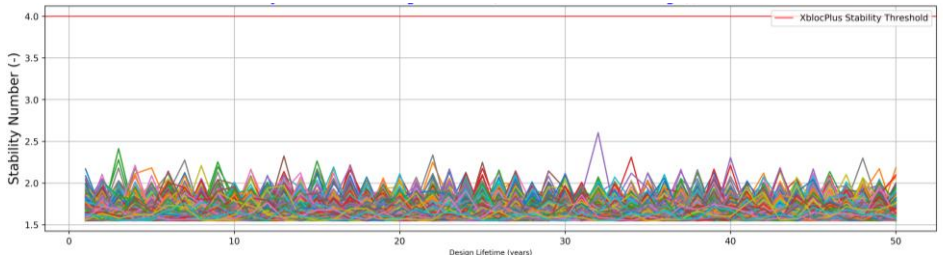
Probability of repairs during 50 year lifetime (1000 simulations)



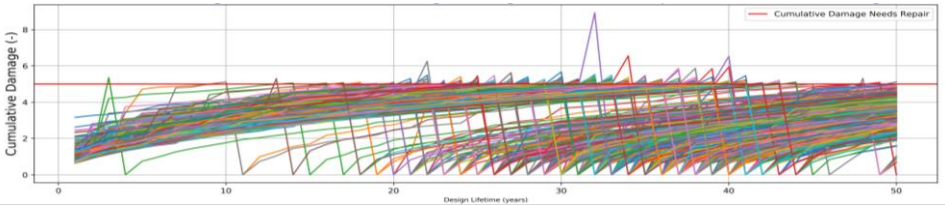
Rock: maintenance needed

Xbloc Plus: No maintenance

Xbloc plus stability numbers during 50-year lifetime (1000 simulations)



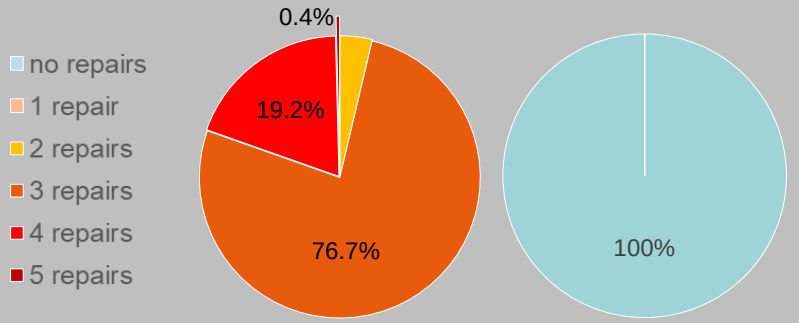
Cumulative damage of rock armour during 50-year lifetime (1000 simulations)



Maintenance Comparison

Future wave climate

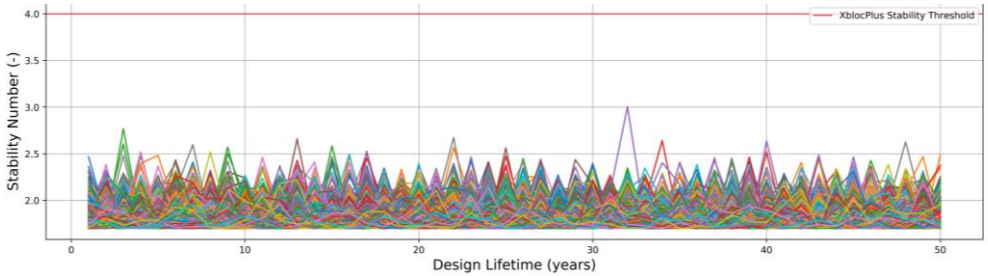
Probability of repairs during 50 year lifetime (1000 simulations)



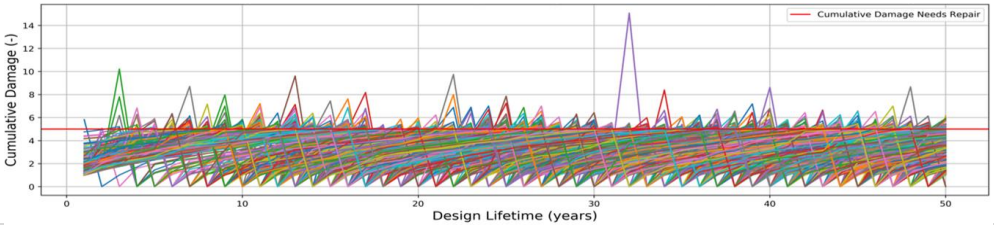
Rock:
3 to 4 x maintenance

Xbloc Plus:
No maintenance

Xbloc plus stability numbers during 50-year lifetime (1000 simulations)



Cumulative damage of rock armour during 50-year lifetime (1000 simulations)



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Conclusions

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