

# XblocPlus

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Efficient Wave Protection: Resilient – Sustainable – Economical



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# Adapting to Climate Change

Climate Change → sea level rise + higher waves

Coastal Adaptation needed

1<sup>st</sup> choice: soft structures (beaches, dunes, mangroves) if possible

2<sup>nd</sup> choice: hybrid structures (combination hard armour with mangroves / beach / dunes)

3<sup>rd</sup> choice: hard structures (revetment, groynes) with focus on nature value



# What is XblocPlus?

Xbloc is a concrete revetment block against high waves

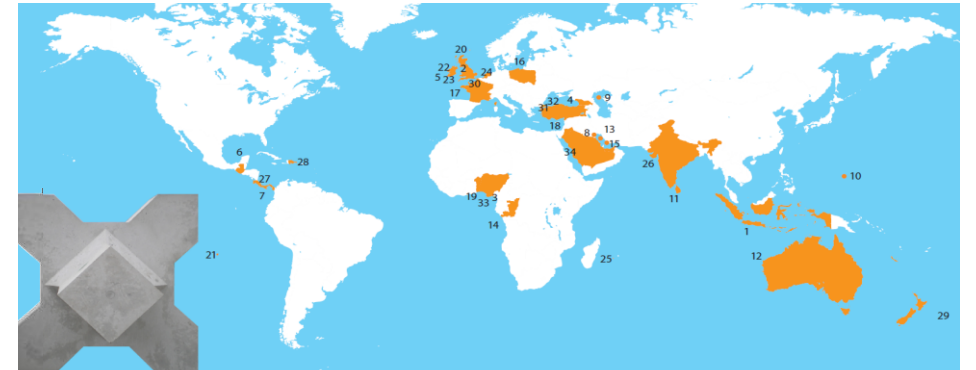
Xbloc applied worldwide since 2003

XblocPlus is improved version of Xbloc

Pattern placement instead of random placement

Consequences of pattern placement:

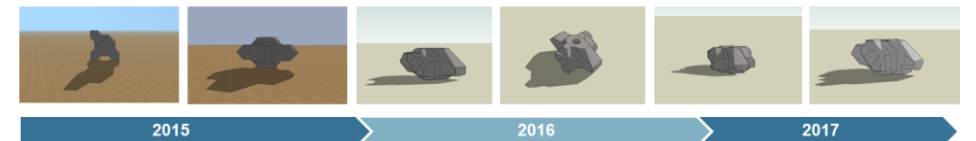
- aesthetic appearance
- increased resilience to climate change
- faster and safer construction
- modular system -> adaptable and circular



Xbloc



XblocPlus





### Xbloc

random placement

Under layer requirements identical

25% safety margin

More blocks & concrete

Industrial look



### XblocPlus

pattern placement

Under layer requirements identical

100% safety margin -> resilience climate change

Less blocks & concrete

aesthetic appearance



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# Why XblocPlus?

Resilience to climate change

Most economical

Circular use

Minimum Carbon Footprint

Aesthetics

Safety against more severe storms

Reduced material quantities & 30% - 50% fewer blocks

Blocks can be re-used

Relative to other hard structures (concrete and rock)

Smooth, architectural finish - Ideal for marinas and shore protections in urban environments



# Stakeholder value XblocPlus

Designer:	safe design -> lower risk of claims
Contractor:	more economical fast & safe construction
Project Owner:	stronger structure for lower price resilient & adaptable to climate change less maintenance
Residents & recreationists:	aesthetics; biodiversity
Environment:	low carbon footprint stimulate biodiversity circularity

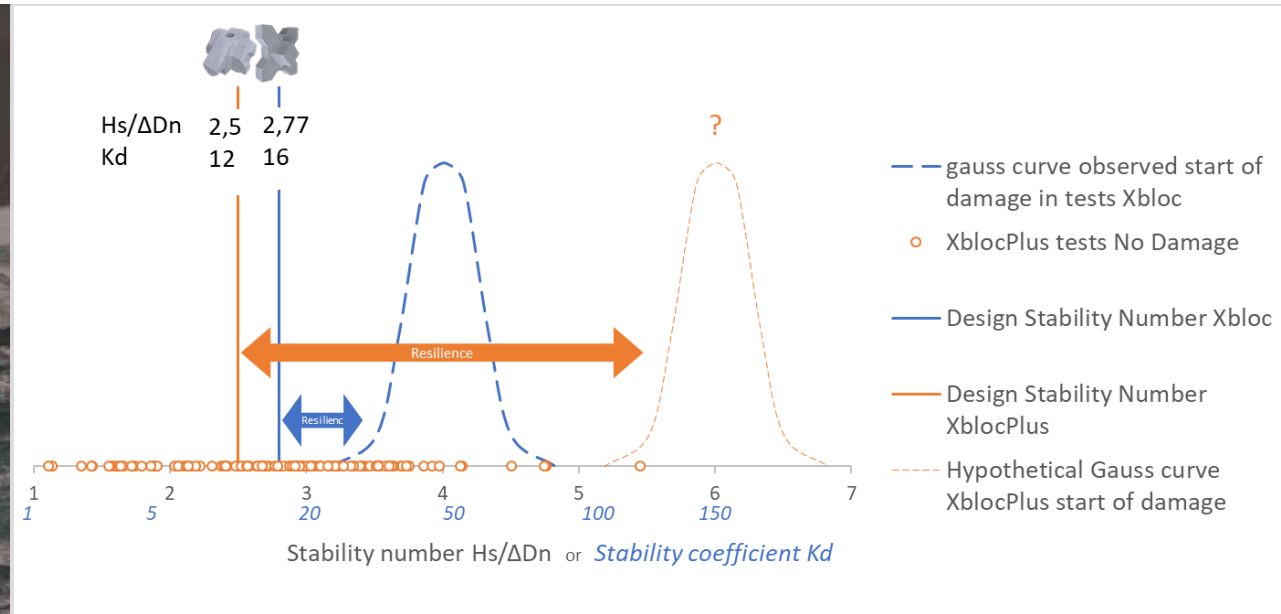


# Reliability & Resilience for Climate Change

Structures designed for 30 up to 100 years; which design wave height to use?

Resilience for higher wave heights

No damage even if waves are 2x higher than design wave

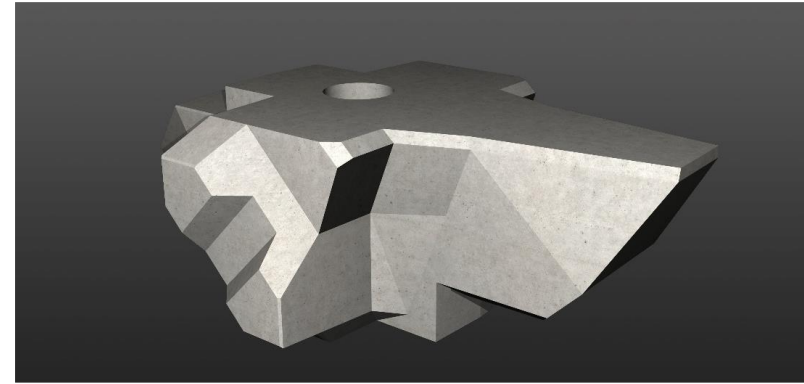


# Climate Adaptable

## Rising Sea Level

XblocPlus structure can be adapted for raising sea level (higher than currently predicted):

- exchange top rows by XP-Overtop
- increase crest level





# Most economical

Due to high resilience: larger XblocPlus

As a result: number of blocks needed reduced significantly

## Xbloc

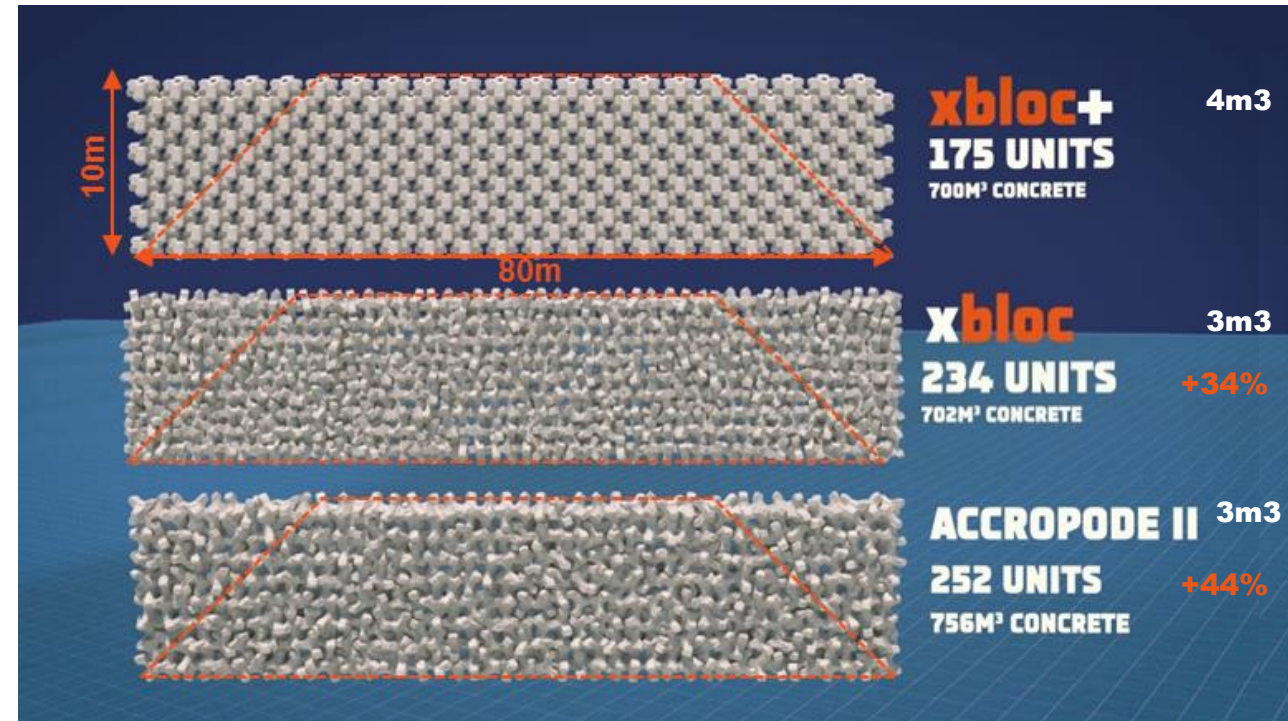
- Concrete use equal to XblocPlus
- 34% more blocks to cover same breakwater

## Accropode-II

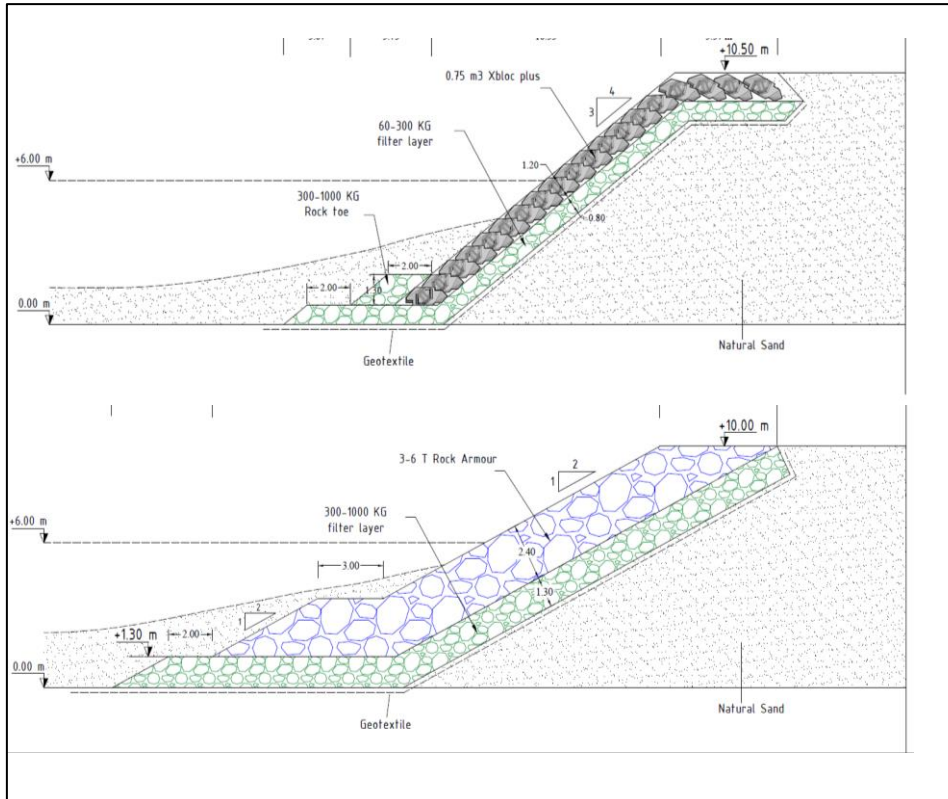
- 8% more concrete
- 44% more blocks to cover same breakwater

## Consequences

- Reduced construction time
- Under layer exposure to waves during construction reduced



# Economics compared to Rock Armour



Compared to rock revetment:

- Steeper slope (hence wider beach)
- Less material
- Lower costs

Rock cross section: 190 ton/m (all rock gradings combined)  
XblocPlus cross section: 67 ton/m (concrete + rock gradings)

With tentative unit rates for UK projects:  
Rock cross section 9,700€/m  
XblocPlus cross section 4,200€/m

# Safety during construction



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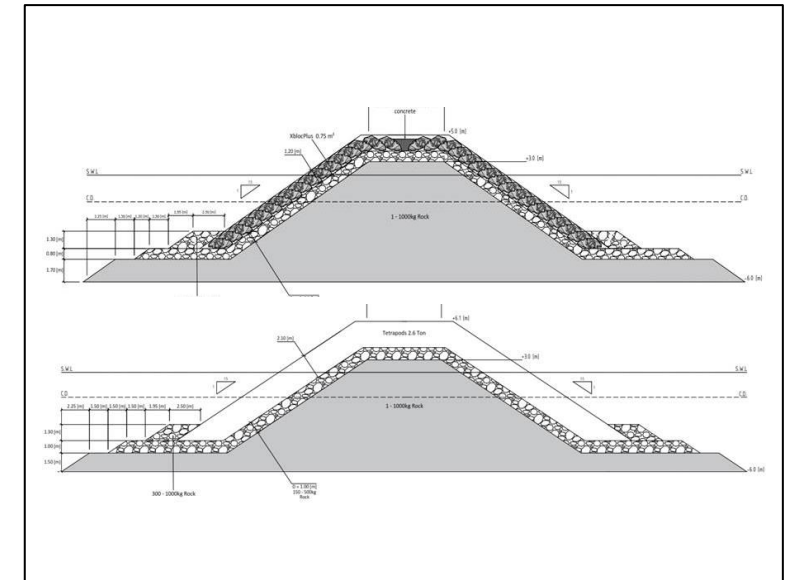
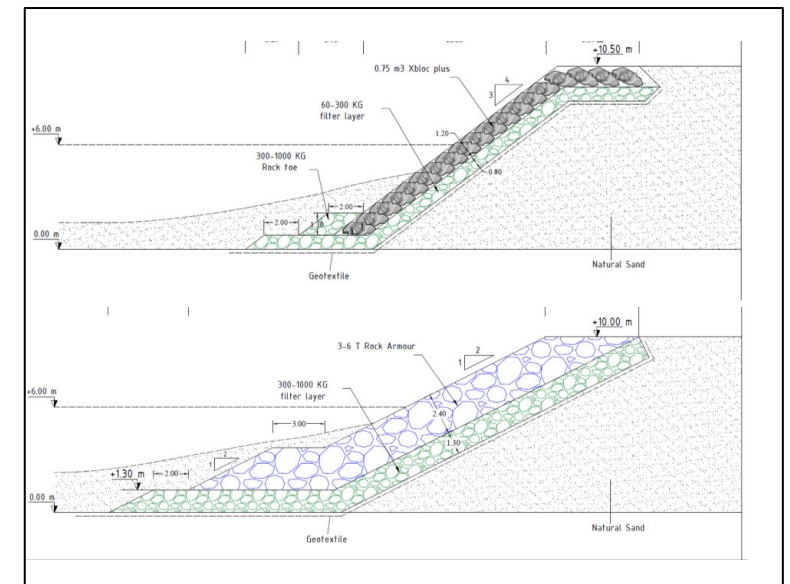
# Sustainable: Material Quantities

XblocPlus layer has 60% porosity → low material quantities

Low material quantities → reduced CO2 footprint

- Concrete blocks: XblocPlus uses less concrete and fewer blocks
  - Rock armour: XblocPlus reduces material quantities
- Transport of rock important CO2 component

- Shore protection example: 28% CO2 reduction on structure
- Breakwater example: 61% CO2 reduction on armour layer
- Afsluitdijk: 56% CO2 reduction on armour layer

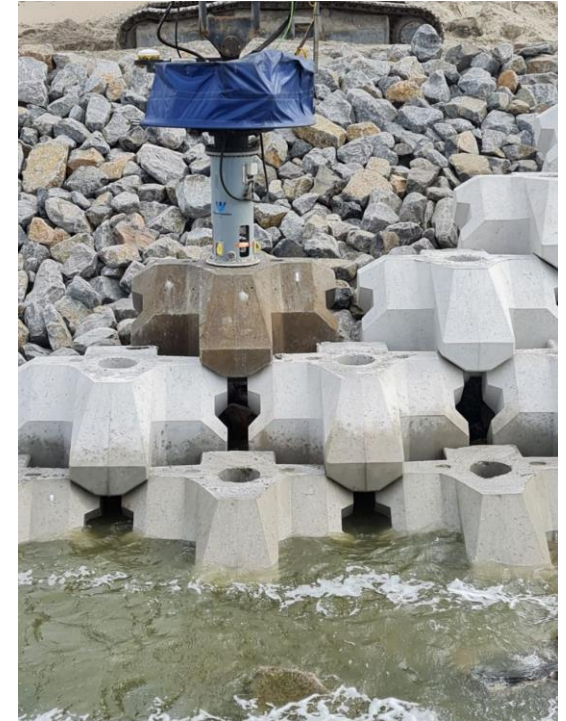


# Sustainable: Material Composition

Many programs in the industry to reduce CO2 footprint of concrete and use circular materials

Proeftuin Afsluitdijk with Rijkswaterstaat

- 15 concrete mixes
- 2 blocks each
- 20 years monitoring



Cooperation of Rijkswaterstaat, Level, SGS, Smart Circulair Products, BTE Nederland B.V., HeidelbergCement, C2CA Technology B.V., Dyckerhoff Basal Betonmortel b.v., Sibelco Group, Mobilis TBI en BAM Infra Nederland.

# Stimulation of Marine Life

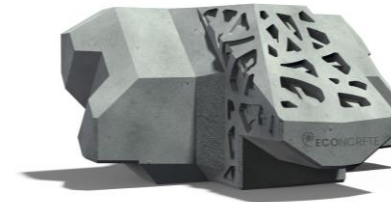
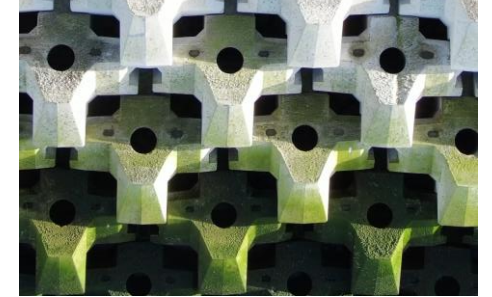
Breakwaters and shore protections provide habitat for marine life

XblocPlus pattern placement enables us to adjust suitable parts of the block to stimulate marine life.

Parameters to influence

- Creation of tidal pools and holes in the block
- Roughness
- Concrete composition

We cooperate with partners & marine biologists to create optimum eco-enhancement per project



# Hybrid Solutions

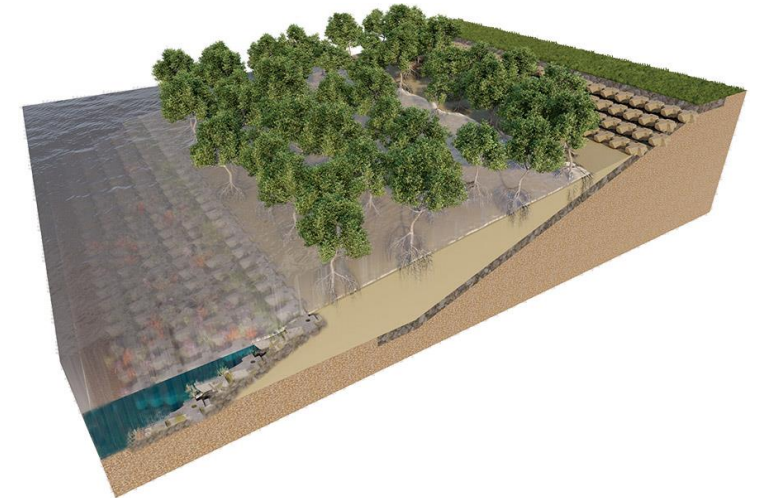
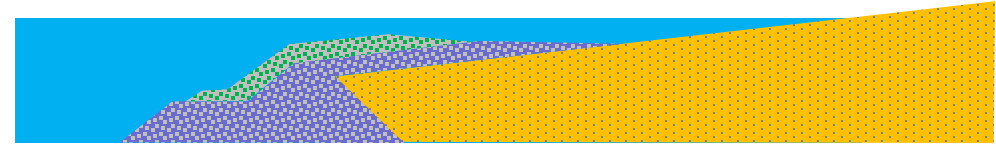
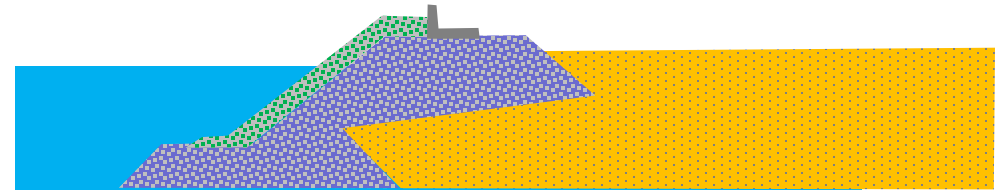
Beach / mangrove forest or concrete seawall?

Traditional sea walls are high concrete structures

High crest needed to limit wave overtopping

No access to or view on the sea

We are working towards solutions that combine stability provided by hard armour with functionality of e.g. beaches or mangrove forests.



# Impressions of Afsluitdijk Project



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# Historic Background

1918 Zuiderzee law

1927 Start construction

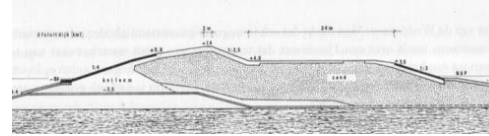
1932 Final closure

1940 Kornwerderzand maintains WW II

1953 Afsluitdijk withstands storm

1975 Opening motorway A7

2007 celebrations 75-years



# OVERVIEW DIKE SECTIONS







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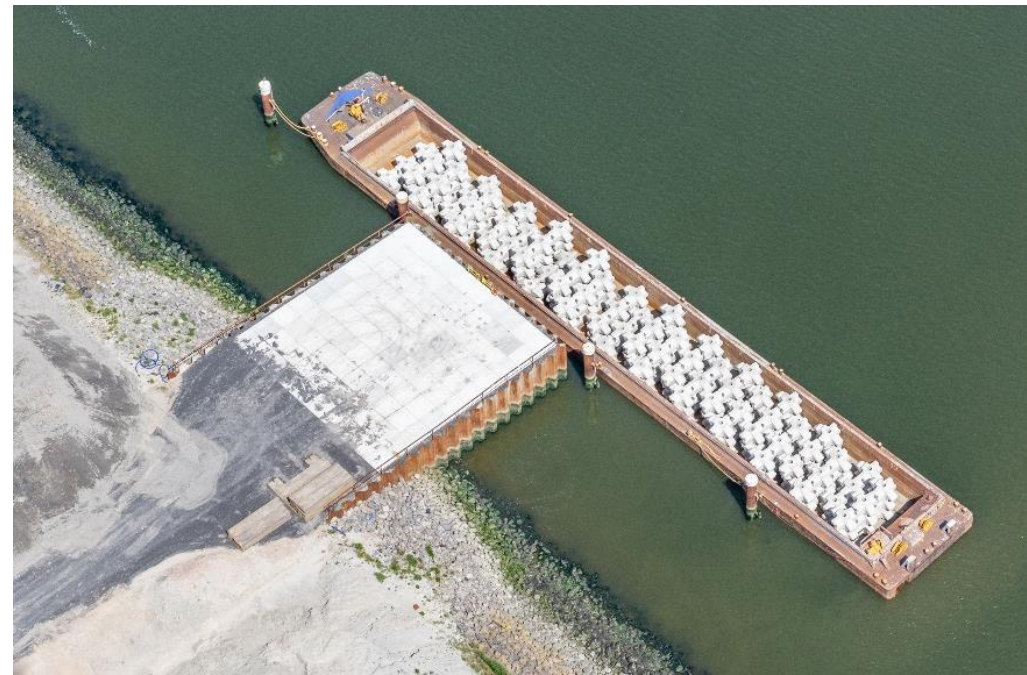


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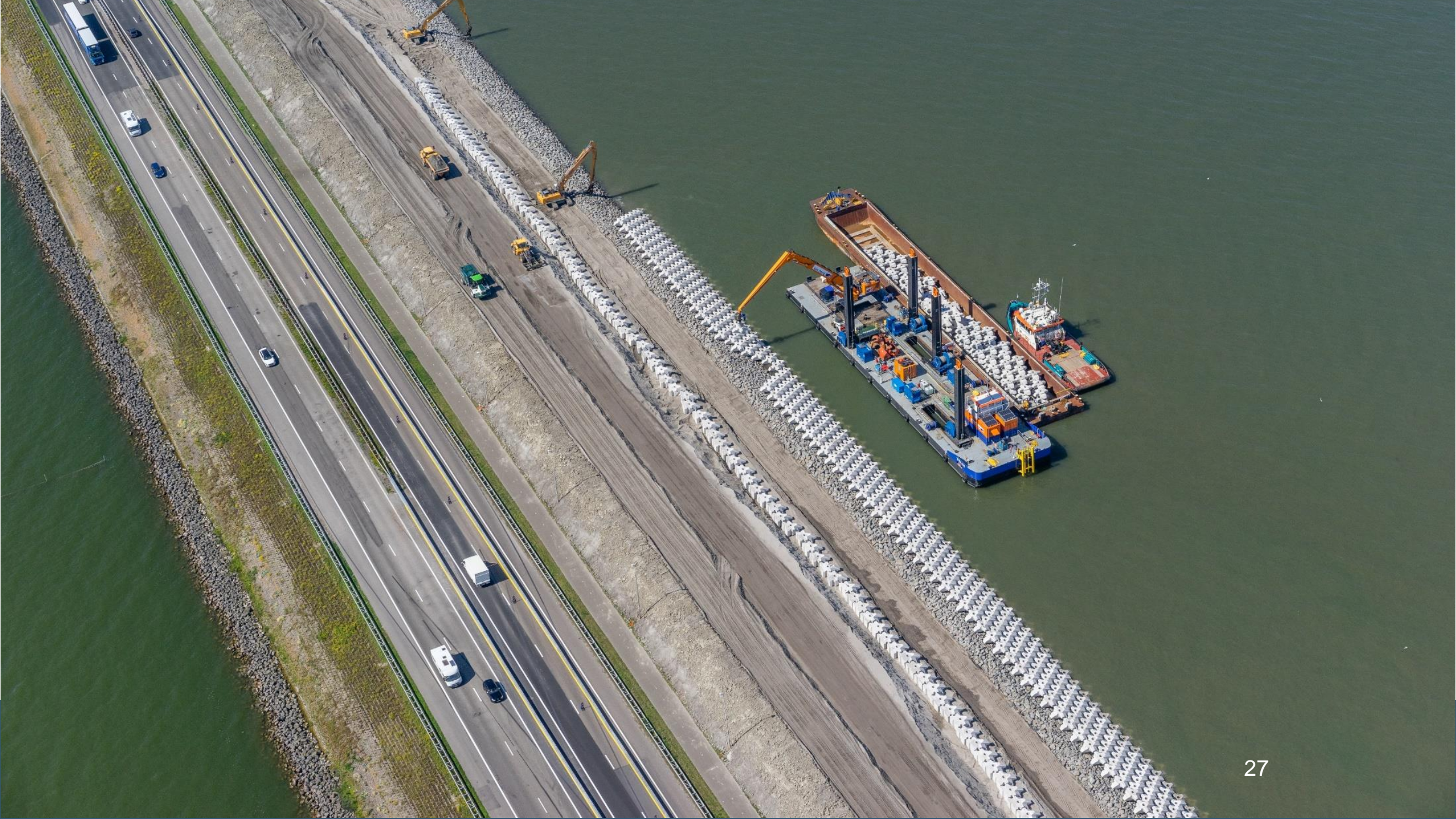


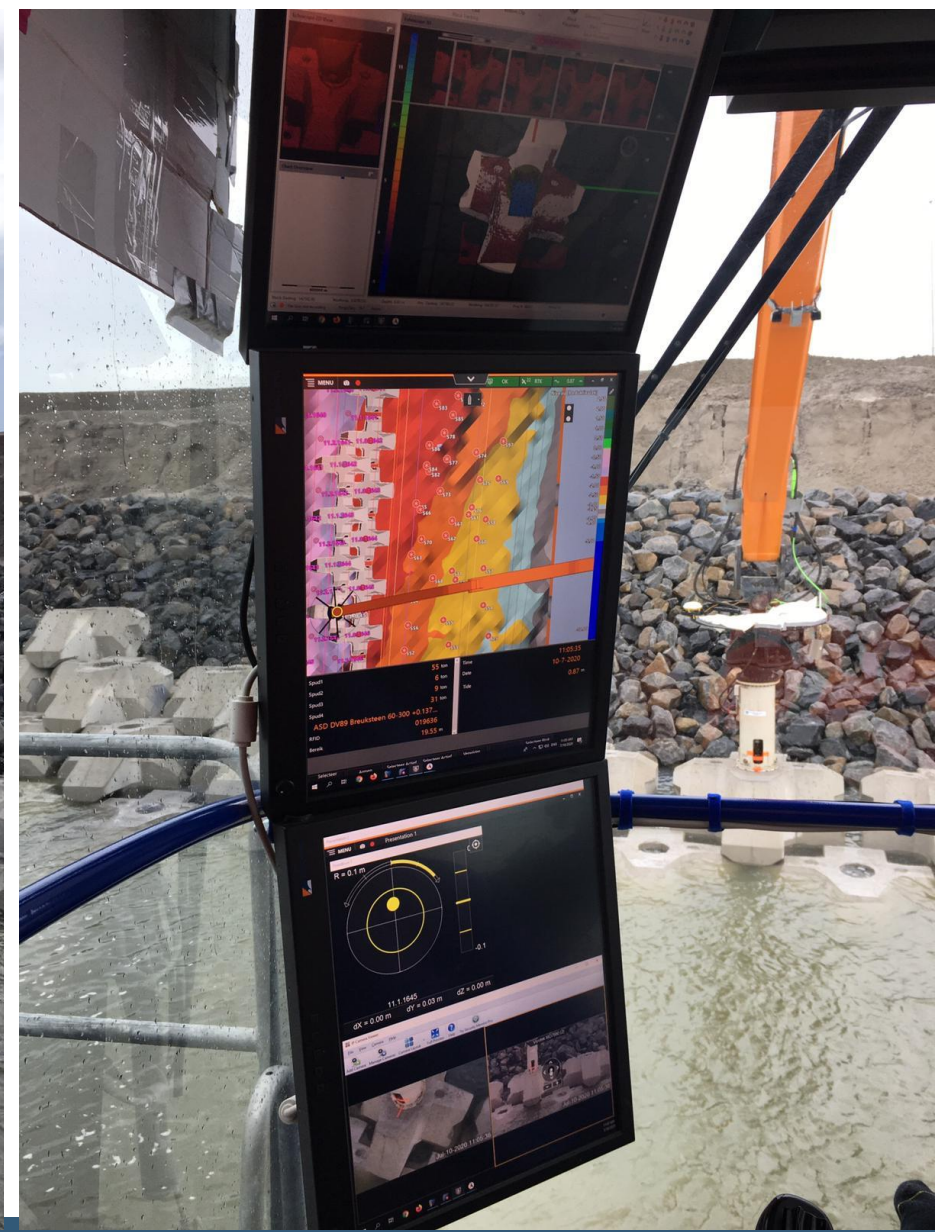
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# Conclusions

Climate Change will require concrete wave protection

XblocPlus provides resilient, sustainable and economic wave protection

Development in coming years towards:

- further CO2 reduction of material
- stimulation of biodiversity
- hybrid, multifunctional wave protection

