

# Flexible groynes made of Xstream blocks - The future of river management

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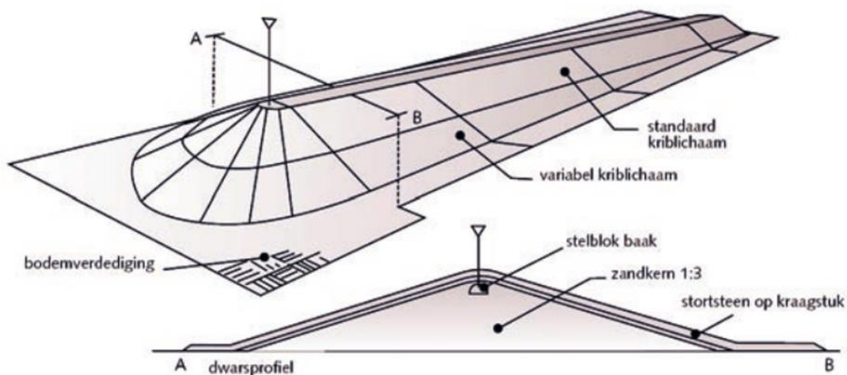
# River groynes

- **Function** of river groynes:
  - Provide a navigable depth
  - Protecting the river banks from erosion
  - Maintaining the river course
- **Issues** with river groynes:
  - Climate change: increased river discharge; groynes increase water levels
  - Bigger inland ships: increased hydraulic loads; damage to groynes, outflanking
  - Large scour holes and local sediment deposition in the navigation channel
  - Riverbeds are lowering due to manmade actions: stability groynes affected
  - Frequent maintenance required to repair damages



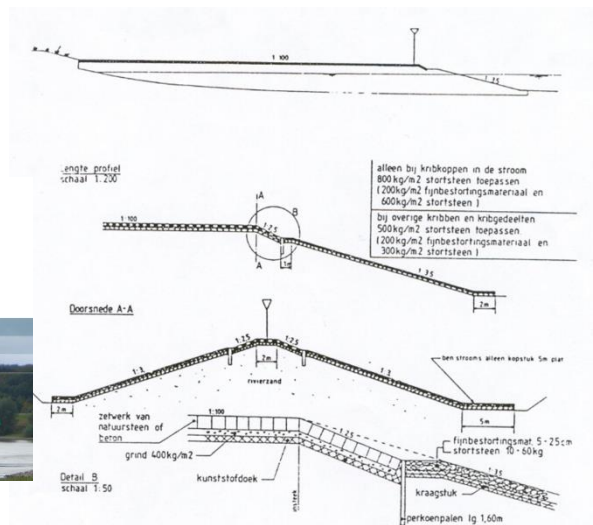
# Conventional Groynes

- Many **different** materials: sand, rock, pitched blocks, gravel, geotextile etc.
- **Many** transitions/details between materials
- Difficult to **adapt to climate change**: lowering/shortening is not easy
- Gentle slopes, **large volumes** of materials
- **Impermeable** fixed structure



## Praktische voorbeelden van sedimentsturing in de IJssel

Aanzet tot pilotprojecten op knelpunten





# The concept of Flexible Groynes

- Groyne made of only **one** material, interlocking **Xstream** blocks
- Xstream blocks are **small versions of Xbloc** concrete armour units
- Because of interlocking, **steep** slopes possible, up to 1:1
- **60%** porosity, **permeable** structure
- Placed **directly on the riverbed**, no geotextiles or mattresses



# Pilot study Flexible Groynes



- **Innovation** for Self Supporting River Systems
- Together with **Rijkswaterstaat** and **partners**
- Meteoor for **production** of Xstream blocks
- Van den Herik for **construction** of the Flexible Groynes
- Deltares for **research**
- Part of the **maintenance contract** for the **IJssel** river
- **3 pilot groynes** constructed in November 2019 in the IJssel river



Praktische voorbeelden van  
**sedimentsturing in de IJssel**

Aanzet tot pilotprojecten op knelpunten

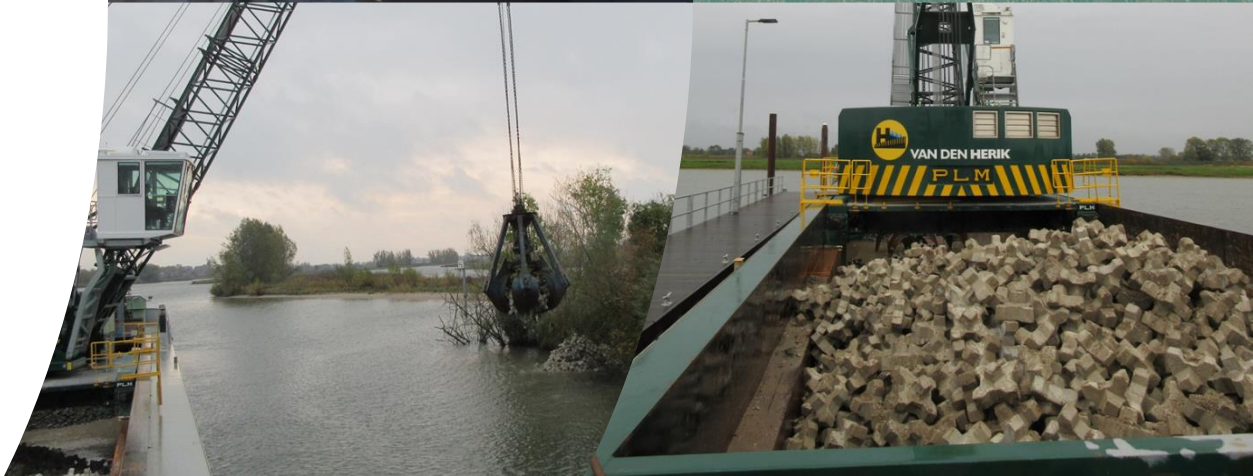
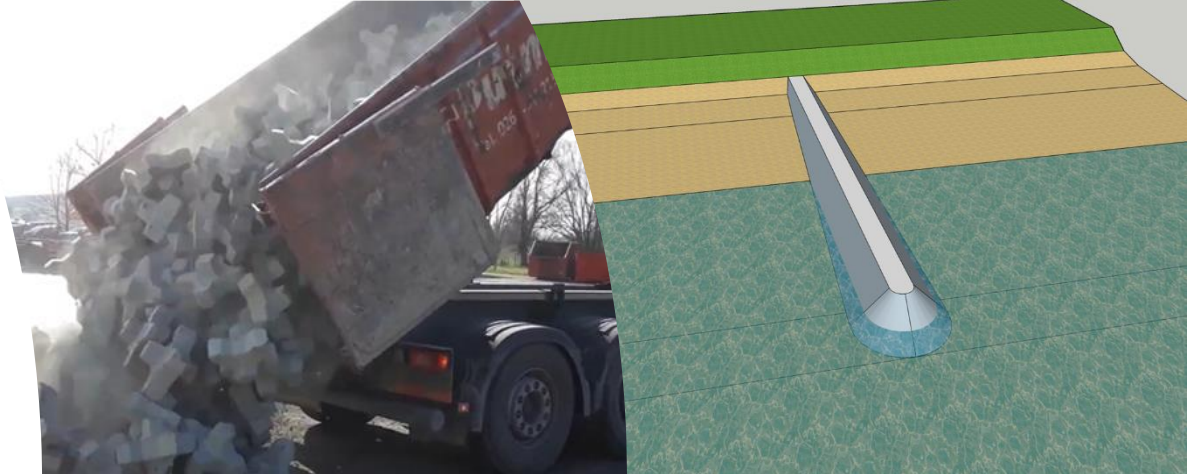


# Advantages of Flexible Groynes

- Groyne structure will **adapt** to changing riverbed levels / scour holes
- Groyne structure is **flexible**, easy to lower height, shorten or lengthen
  - Adapt structure when needed for sediment steering
  - Adapt structure when needed because of climate change
- Groyne structure is **permeable**,
  - less flow concentration around head
  - absorption of wave energy by passing ships
  - forms a habitat for river life
- **No transitions**, therefore less maintenance and easier to maintain
- Because of steep slopes and high porosity, **reduced volume** material required

# Construction of Flexible Groynes

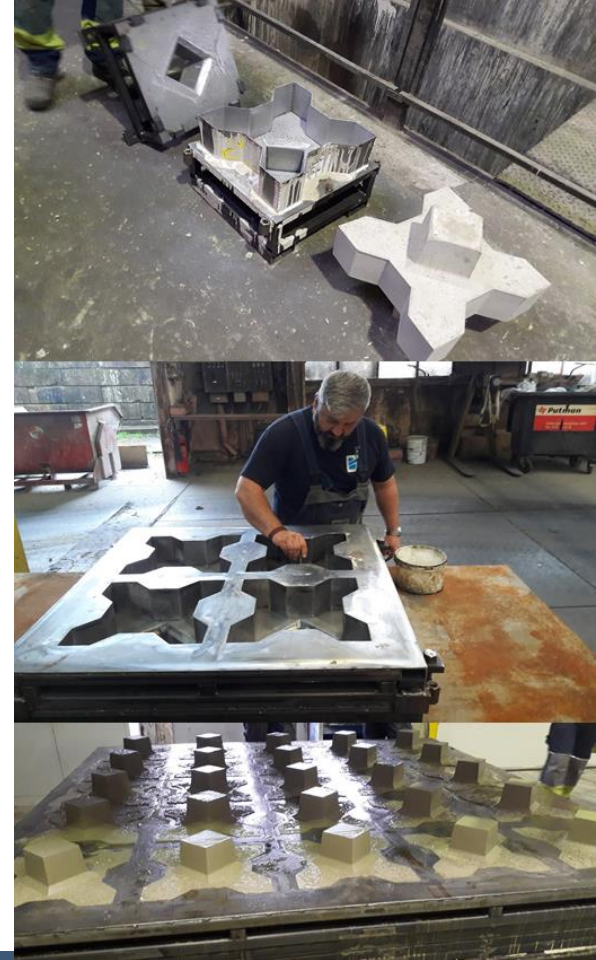
- Xstream blocks transported in bulk by truck/ship
- Xstream blocks placed in bulk, by orange peel grab
- Xstream blocks 27 kg, 34 cm height
- Steep slopes of 1:1
- Fast construction to defined outer profile





# Casting of Xstream blocks

- At Meteor, along the **IJssel** river
- For the pilot, Xstream blocks have been **wet cast** in series
- In future **dry cast** system will be used for speed
- For the pilot more than **14.000 blocks** have been produced





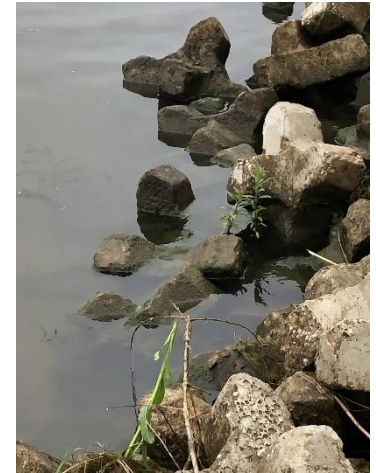
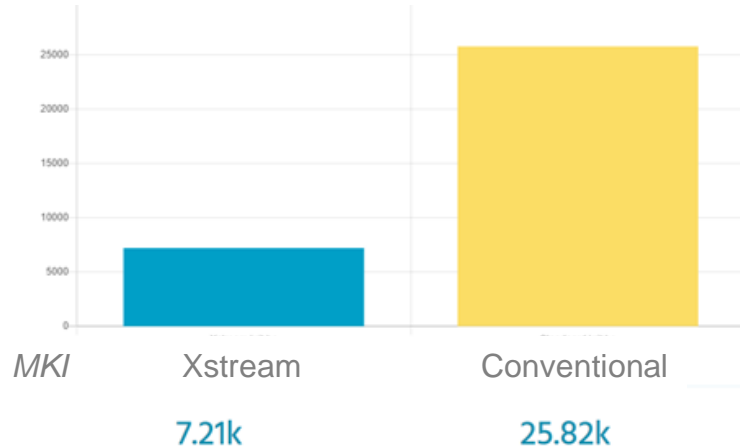
# Research and Monitoring

- By a.o. Deltares, Rijkswaterstaat, Aquadrone and TU Delft students
- Monitoring of:
  - Riverbed levels and scour holes
  - Groyne crest and slopes
  - Permeability
- Three 1:1-year floods in the past 2 years
- Research on, amongst other things:
  - Lab study stability of Xstream blocks in waves and currents
  - Permeability
  - Flow around permeable and impermeable groynes
  - Development of scour holes
  - Strength of blocks, production methods
  - Life Cycle Analysis



# CO2 footprint & Ecology

- Less than half of that of a conventional groyne
- LCA analysis is in progress
- Nature is **integrating** with the technical groynes



# Conclusions

## Flexible Groynes:

- **Innovative** system for **sediment** steering / **river** management
- Adaptable to effects of **climate change**
- **Resilient** to severe hydraulic loading
- **Reduced** local erosion / sedimentation
- **Fast** construction
- Low **CO2 footprint**

# Thanks for your attention

## Q&A