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Erosion protection of overtopping sections with concrete mattresses

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Simon Ebbert

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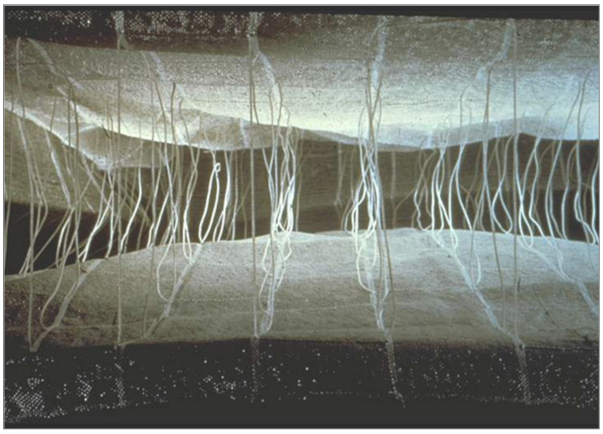
Simon Ebbert is member of the DIN working group for microplastics (NA 119-01-06 GA).

Agenda

- What are concrete mattresses?
- Design of concrete mattresses
- Benefits of concrete mattresses
- Installation follow up of concrete mattresses
- Case studies

What are concrete mattresses?

Concrete mattresses consists out of two basic components



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Geotextile formwork + Highly fluid concrete

What are concrete mattresses?

General types of mattresses

State-of-the-art cover lining and erosion control with concrete mattresses.

Permeable cushion mattress with built-in hinge zones, designed for high hydraulic loads and settlement-prone bases.

The permeable concrete mat for use on stable subsoil and lower hydraulic loads.

The plantable concrete mat for erosion protection, ideally suited for shore protection above the permanent water level or for standing water bodies.

Impermeable

Permeable

- Thickness controlled by
  - Binder length
  - Size and distance of filterpoints
- Shrinkage depends on the type chosen
  - Vertical binders
    - Up to 4 % areal shrinkage
  - Cross binders or filterpoints
    - Up to 30 % areal shrinkage

Design of concrete mattresses

- Type according to application
  - Sealing
  - Erosion protection
  - Ballast layer
  - Mechanical protection
- Thickness according to flow- or wave load
  - Different approaches available
    - Pilarczyk
    - Hawkswood
    - …
- Special tests
  - Permeability
  - Ice load
  - Tensile strength
  - Overtopping stability

Benefits of concrete mattresses

- Flexible system, which adapts to the underground
- High hydraulic resistance
  - q_{max} >= 2,0 m³/s*m
- Vegetable (certain types)
- Installation on steep slopes possible
- Underwater installation common practice
- Robust and long lasting
- Installation speed: up to 2000 m²/d

Inlet with a maximum inclination of 1:1,5 and an approx. length of 160 m for a max. discharge of 5 m³/s

Benefits of concrete mattresses

Non- Coherent

Coherent

Benefits of concrete mattresses

Overview and comparison of q and slope inclination

Revetment type	Max. slope [1:n]	q_{max} [m³/(s*m)]
Pitched stone[1)]	6	≤ 1.0
Rip-rap[1)]	4	≤ 1.0
Geosynthetic gabions[1)]	4	≤ 1.0
Mastix asphalt[1)]	6	≤ 1.0
Grass paver[1)]	6	≤ 1.0
Soil solidification[1)]	4	≤ 1.0
Filterpoint or Crib mat[2)]	2.5	> 2.0

[1)] [LfU BW - Überströmbare Dämme und Deichscharten]
[2)] Derived from the model tests at the TU Wien

q = 0,50 m³/(s*m)

q = 2,50 m³/(s*m)

Installation follow up of concrete mattresses

- How it should be done:

1. Preparation/leveling of the subsoil

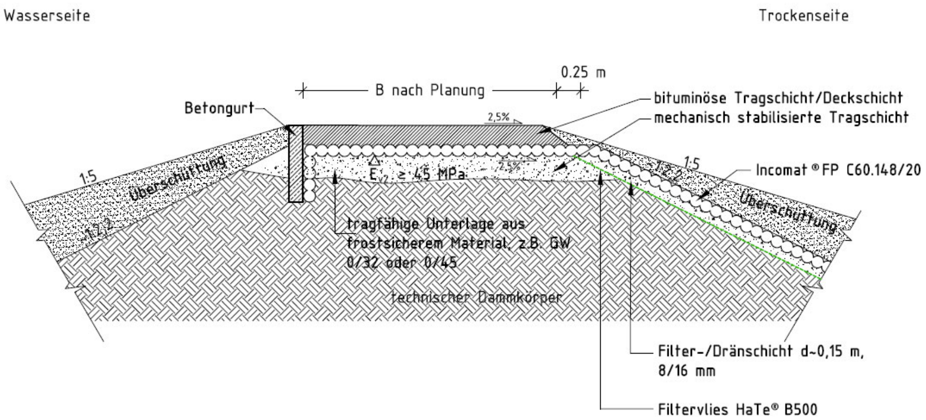
2. Lay out of the pre-fabricated panels

3. Filling of the mattress with highly fluid concrete/mortar

- Also possible...:

Case studies

Pellendorf, Austria (2010)



Design (navigable crest)

Case studies

Pellendorf, Austria (2010)

Empty concrete mattress (lay-out in 1h with 5 workers)

Filling of the mattress (stepwise)

Case studies

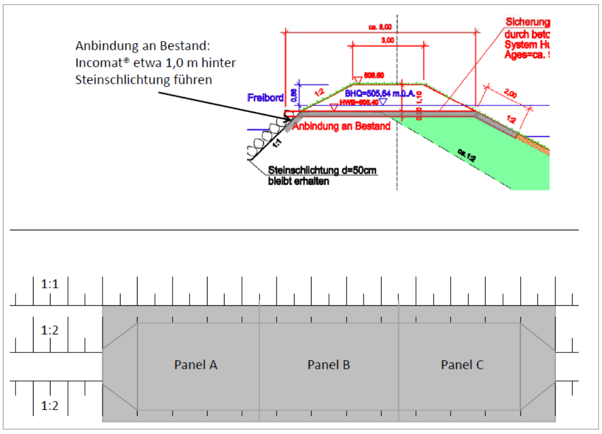
Pellendorf, Austria (2010)

Crest with anchor trench (concrete slab)

After filling (duration 7h with 5 workers)

Case studies

Picheldorfer Bach, Austria (2011)



Design of the crest

Levelled subsoil

Case studies

Picheldorfer Bach, Austria (2011)

After completion

After completion (air side)

Case studies

Picheldorfer Bach, Austria (2011)

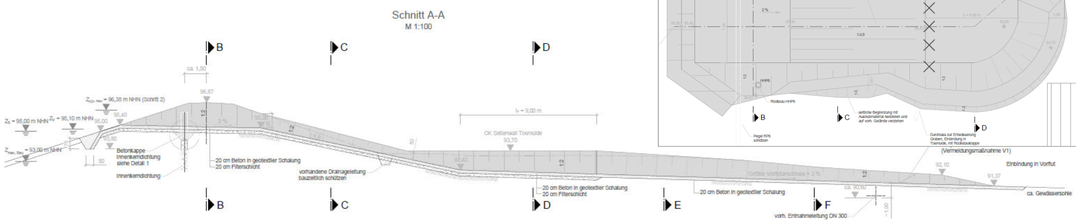
Vegetated (spring 2013)

Vegetated (spring 2013)

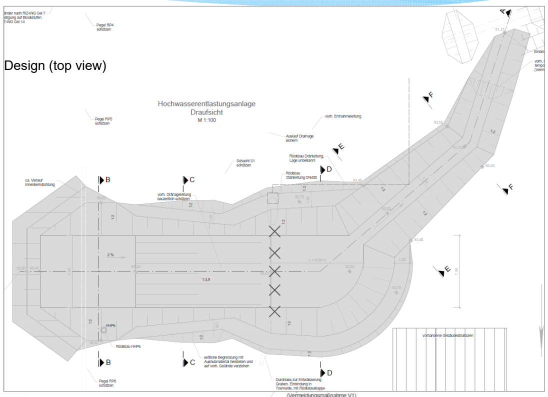
Case studies

Badrina Schadebach, Germany (2015)

Design (longitudinal cross section)



Design (top view)



Case studies

Badrina Schadebach, Germany (2015)

Levelled channel (covered with nonwoven)

Levelled crest (covered with nonwoven)

Case studies

Badrina Schadebach, Germany (2015)


Channel after installation of concrete mattress


Close up: mouthing drainage pipe

Case studies

Badrina Schadebach, Germany (2015)


Vegetated (2017)


Crest (2017)

Case studies

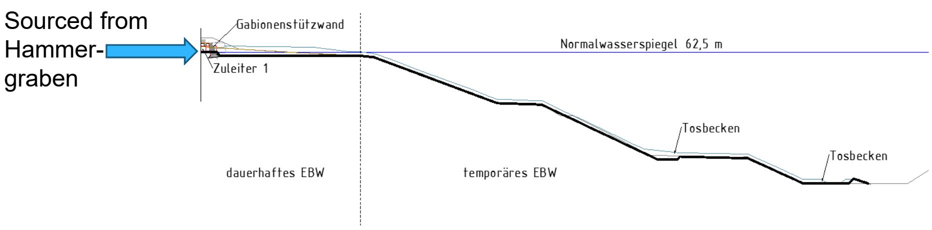
Cottbuser Ostsee, Germany (2017)

- Former soft coal pit "Cottbus Nord"
- Approx. 220 mio to of soft coals in 30 years
- Biggest artificial lake with 19 km² surface
- Filling water from nearby river
  - Max. 5 m³/s

Source: www.googlemaps.de

Case studies

Cottbuser Ostsee, Germany (2017)



Permanent section:
- ~ 40 m long section
- Permanent visible

Temporary Section:
- ~120 m long section
- Not visible after flooding

Design (longitudinal section)

Case studies

Cottbuser Ostsee, Germany (2017)


After completion


Inauguration in 2018

Case studies

Cottbuser Ostsee, Germany (2017)


During filling (04/2019)

Thank you for your attention