Channel Bank Protection with Making Use of Sand Filled Fabricated Geosystems

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Bank protection

Common systems used for revetment constructions

Common systems used for revetments construction

- Rock-filled gabion and mattress
- Riprap
- Concrete blocks

2

Bank protection

Geosystems used for revetment constructions

Alternative systems used for revetments construction

- Concrete mattress
- Sand filled mattress

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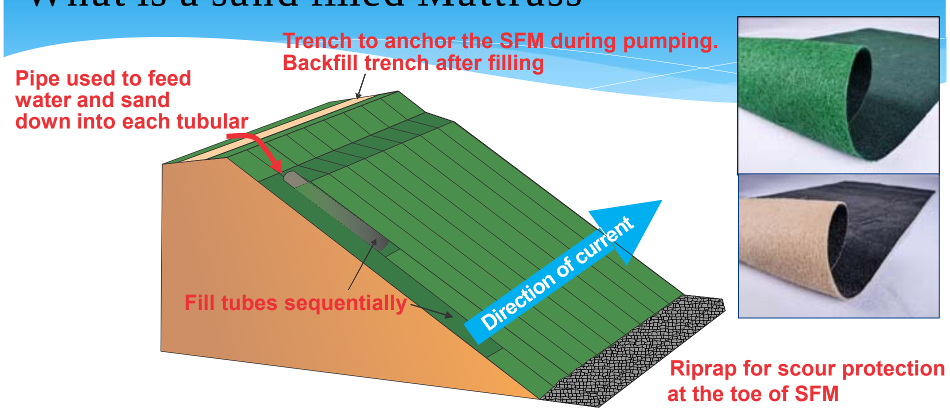
What is a sand filled Mattrass



Double fabric layer product; the two layers of fabric are systematically linked with uniformly spaced parallel stitches in the machine direction

The top layer is an engineered composite fabric that provides **excellent abrasion resistance** and durability. It is capable of **trapping settling sediments** and particles.

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Internal space created between the two fabric layers are filled with sand

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Internal space created between the two fabric layers are filled with sand

6

Retention Pond protection

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Advantages of Sand Filled Mattress

- Cost effective
- Easy installation process
- Does not require heavy machinery for installation
- Flexible and can follow curves and bends easily
- Can be installed in water if required
- Can be filled with local available sand
- Low Carbon footprint.

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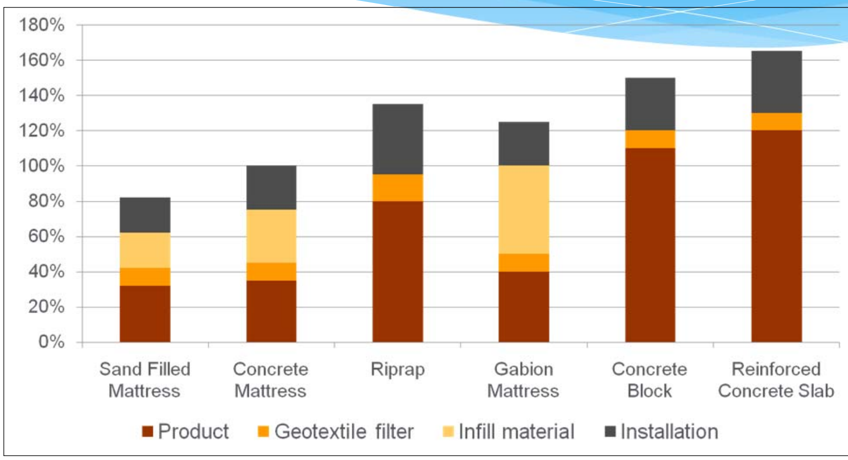
Relative cost comparison



Comparison done based on a Malaysian project

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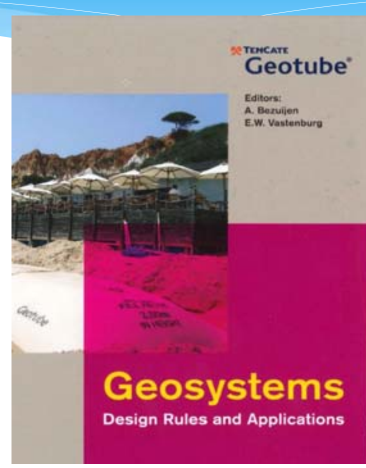
Check for Design rules the booklet

- Geosystems Design rules and application
- www.Taylorfrancis.com
- ISBN: 978-0-415-62148-9
- Contains example calculations.



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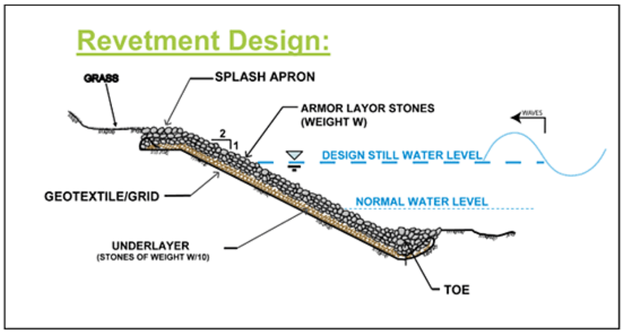
Design, input parameters

- Levels
  - Toe Level
  - Crest Level
  - Design SWL
- Revetment Slope (n)
- Design Flow (u_{cr})
- Design Wave (H_s & T_p), and/or



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Design Stability against flow

- The stability criterion of Sand Filled Mattress under longitudinal flow attack is as follows (Pilarczyk, 1990; CUR 217, 2006, Geosystems booklet 2012):

Equation	Notations
	Δ = buoyant relative density of structural unit [-]; D_e = effective thickness of revetment [m]; Φ = stability parameter [-];
$\Delta D_e \geq 0.035 \frac{\Phi}{\Psi} \frac{K_T K_h}{K_s} \frac{(u_{cr})^2}{2g}$	Ψ = Shields parameter [-]; K_T = turbulence factor [-]; K_h = depth parameter [-];
	K_s = slope parameter [-]; u_{cr} = critical flow velocity along the structure [m/s]; g = gravitational acceleration [m/s²].

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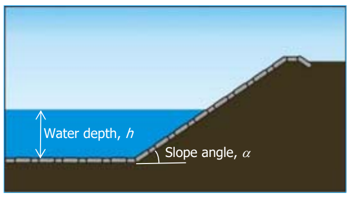
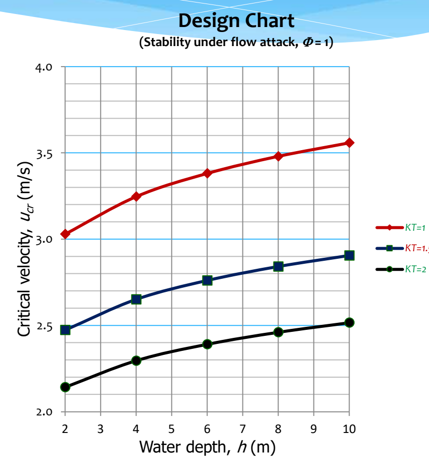
DESIGN
Stability against flow attack

- Design Chart may be used for design under following conditions:
  - Continuous top layer
  - Slope angle, α up to 1:1.5 (33.7°)
  - K_T = 1 for normal turbulence in channels
  - K_T = 1.5 for higher turbulence: channel bends
  - K_T = 2 for strong turbulence: hydraulic jumps, sharp bends, local disruptions





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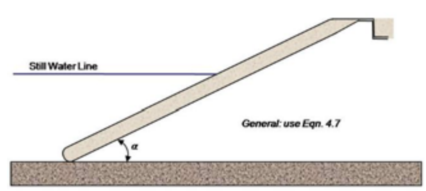
DESIGN
Stability against wave attack

- The stability criterion of Sand Filled Mattress under wave attack is as follows (Pilarczyk et al, 1998; CUR 217, 2006; Geosystems 2012):
- It should be pointed out that Sand Filled Mattress is not suitable for strong waves (generally H_s < 0.5 m)

Apply	S_m
$\frac{H_s}{\Delta D_e} \leq \frac{S_m}{\xi^{2/3}}$	For SFM, S_m = 4 to 5



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DESIGN
Filtration

- Opening size of geotextile related to base soil
  - AOS ≤ $f(d_n)$
- A minimum permeability is often required based on one of the following
  - Water flow rate
  - Darcy's permeability
  - Permittivity

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DESIGN
Sand Tightness Criteria

Hydraulic load	Requirement 1	Requirement 2
Stationary load (current)	$O_{90} < 5D_{10}\sqrt{C_u}$	$O_{90} < 2D_{90}$
Dynamic load (wave)	$O_{90} < 1.5D_{10}\sqrt{C_u}$	$O_{90} < D_{90}$

O_{90} = pore size of the Sand Filled Mattress;
D_{10} = sieve size through which 10% fraction of the sand material passes;
D_{60} = sieve size through which 60% fraction of the sand material passes;
D_{90} = sieve size through which 90% fraction of the sand material passes;
C_u = uniformity coefficient (= D_{60}/D_{10})

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DESIGN

Geotechnical stability

- Assessment of risk of geotechnical failure
  - Risk during construction
  - Stability of completed structure
  - Risk during intermittent scour events
  - Risk during seismic events

Slip failure causing collapse of portion of revetment protected river bank

Slip failure analysis using SLOPE-W

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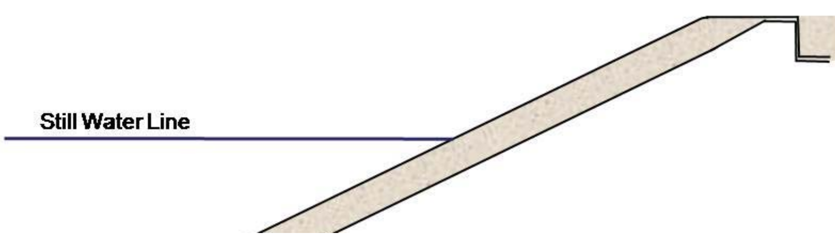
Sand Filled Mattress

Trenching



The Sand Filled Mattress should be terminated at a bench or crest, buried in a trench.

The trenching should be located above SWL and wave run-up limit

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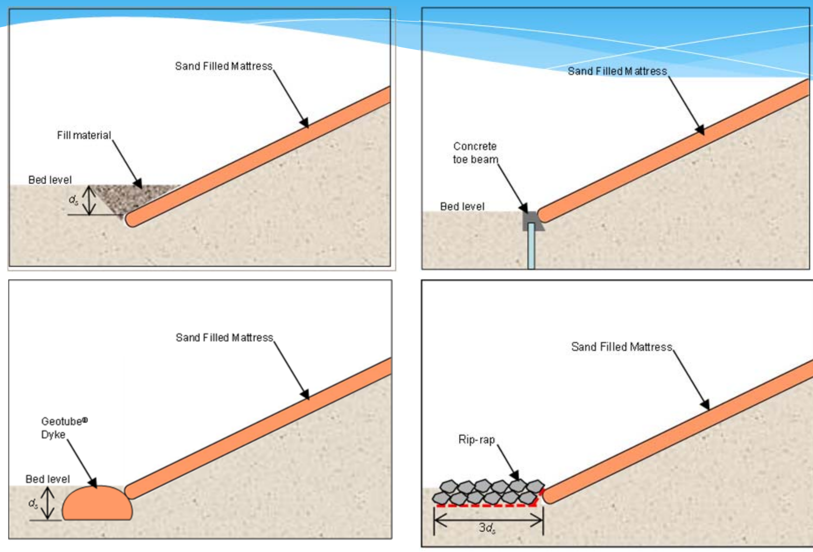
Sand Filled Mattress

Toe protection



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DETAILING

Termination

* Appropriate termination details should be adopted at the ends of the structure to prevent undermining of the structure
* Methods may be similar to those used for crest and toe details but tend to be very site specific
* Some examples:
  * wing walls
  * revetment curved back in plan

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Model Specifications

Sand Filled Mattress

The specification for Sand Filled Mattress is dependent on the design and the selection of product grade; but typically includes the following:

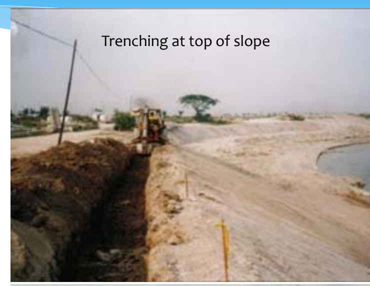
Wide width tensile strength & extension	**(ISO 10319)**
CBR puncture strength	**(ISO 12236)**
Drop cone perforation diameter	**(ISO 13433)**
Abrasion resistance	**(BAW RPG 3.11)**
UV resistance	**(ASTM D4355)**
Pore size	**(ISO 12956)**
Permeability	**(ISO 11058)**
ISO 9001 certified **QA/QC tested at laboratories with certified accreditations**	

Semenyih Water Dam 2, Dengkil, Malaysia

Non-woven geotextile filter stitched to the bottom of the sand filled mattress

INSTALLATION

- Some pre-installation planning is usually necessary; this may include estimation of panel sizes, as well as cutting and seaming of panels to suit a site situation
- Slope preparation, trenching and other profiling may be needed before the Sand Filled Mattress is laid out according to the Engineer's instructions



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INSTALLATION

- Panels of Sand Filled Mattress are placed over prepared slope

Laying out of SFM panels

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INSTALLATION

Flexible enough to follow to smooth curvatures

Shaping edges to handle sharp angular changes

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INSTALLATION

- When the Sand Filled Mattress is laid out in position, sand is pumped into the internal space created in-between the two fabric layers
- This is typically done using a hopper system and water is used to wash down the sand;
- The sand fill meet the specifications provided by the Engineer.

Sand introduced through hopper

Lifting top layer to allow easy flow of sand

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INSTALLATION

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More information

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