



DEME

Dredging, Environmental
& Marine Engineering

LuXeal – the easy to handle aquitarde

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1. Introduction

2. Needs

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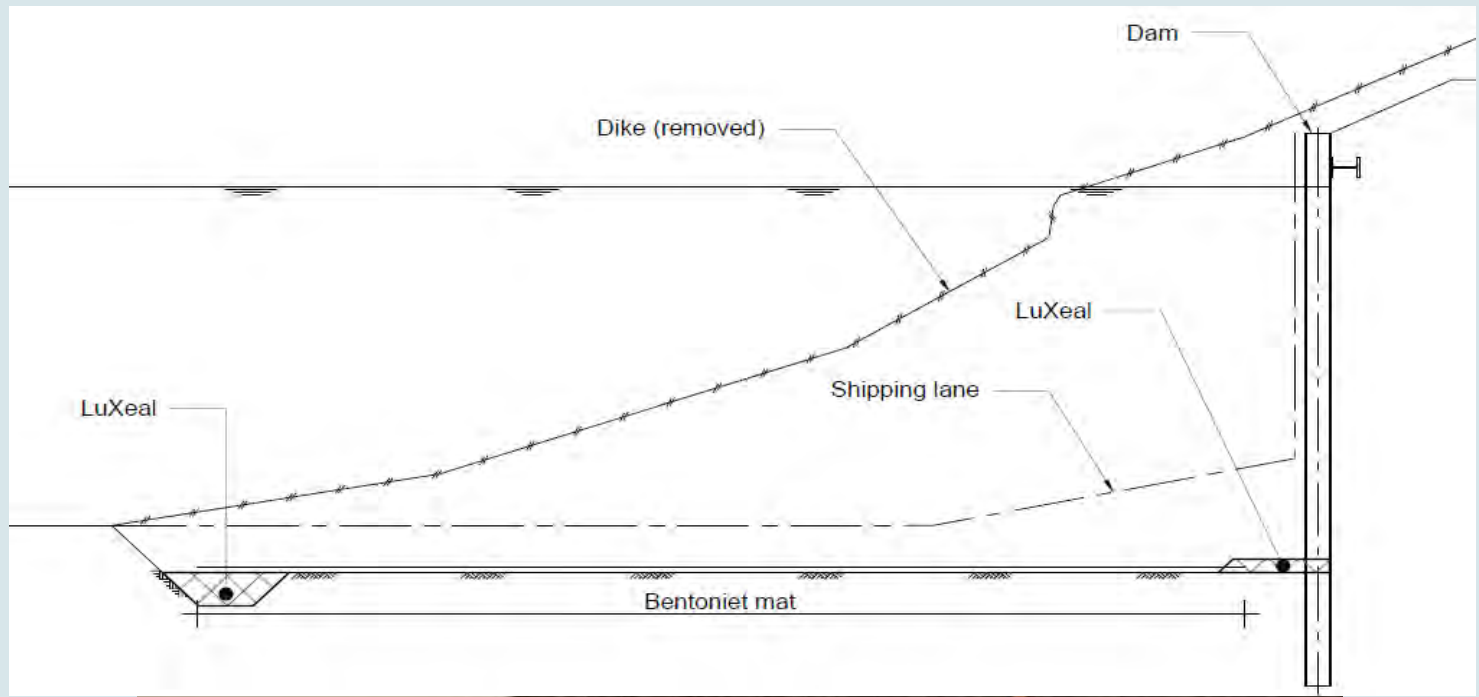
1. Introduction



2. Needs



1. Ensure a watertight continuity on both sides of the bentonite mattresses





2. Be used as temporary watertight layer close to sensitive locations

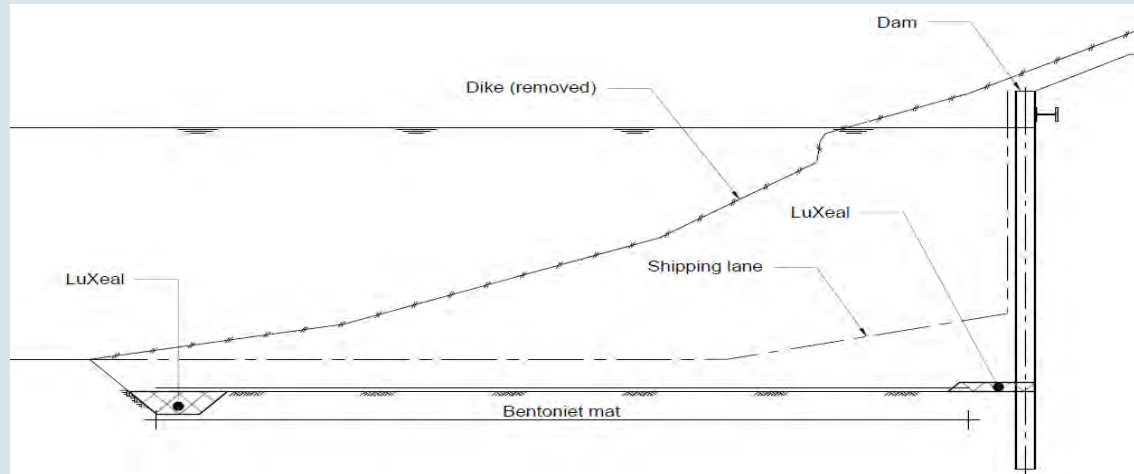




3. Specific requirements

1. Determine the necessary watertightness using the Darcy law

$$Q = \frac{K_0 \times H_0 \times x_0}{L \times \cos \alpha} \times \left(1 - \frac{x_0 \times \tan \alpha}{2 \times H_0} \right) \left[\frac{m^2}{s} \right]$$





2. Find an easy to place material for which

- No compaction is needed
- An acceptable placement tolerance (5cm) is achievable
- A local and cheap supply is feasible





4. Development and tests



Challenge :

- Find an easy to place watertight layer

Different solutions:

- Clay?
- Sand mixed with bentonite?
- Concrete?





Different solutions -> different problems

- Clay
 - Need for compaction
 - Very difficult to place underwater
 - High turbidity





Different solutions -> different problems

- Sand bentonite mixture
 - Need for compaction
 - Poor resistance to current
 - Also difficult to place underwater





Different solutions -> different problems

- Concrete
 - Brittle behavior -> Cannot heal itself
 - Price



Each problem has a solution

? ? ?

LUXEAL -> gravel bentonite mixture



- Angular <-> rounded ?
- Fine <-> coarse ?
- Well graded <-> well sorted ?

- Powder, granular, pellets ?
- Natrium enhanced or not ?
- 5 – 10 – 20%? ?





Laboratory tests

- First tests in DEME's own laboratory



Problems

- Geotextile by-pass or clogging
- Limited possible height of layers
- Variable water pressure





Laboratory tests

- First tests at the University of Liège according to the NF X 30-44 norm

Problems

- Geotextile by-pass
- Wall effect
- Limited diameter





Laboratory tests

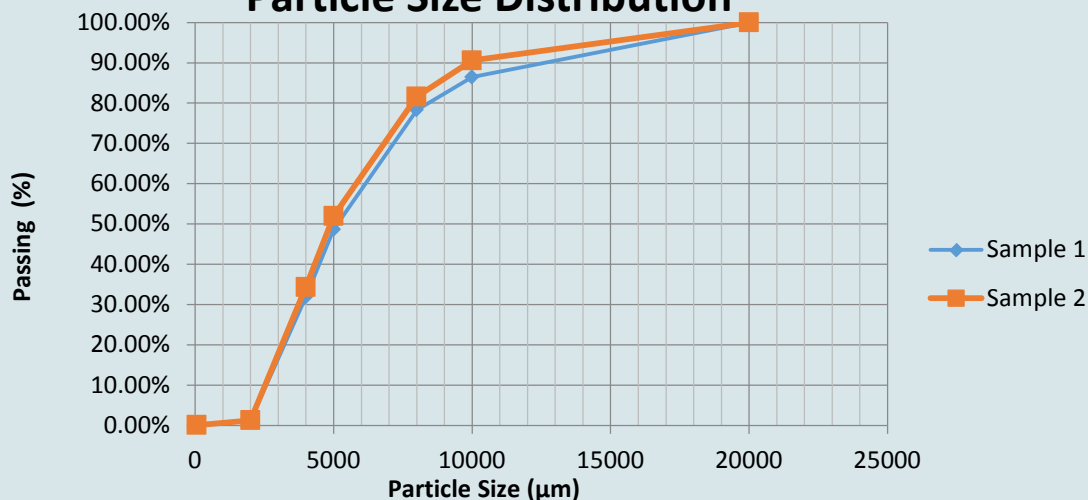
- Development of a new test cell together with the ULg
- Height => 700mm
- Diameter => 190mm
- Possibility to properly fit a geotextile



Gravel

Bentonite

Particle Size Distribution



- Granular => 0.5 – 2.0mm
- Sodium enhanced bentonite with a swelling capacity of 1250% its dry weight
- 6% of total mixture weight has been retained as optimal proportion



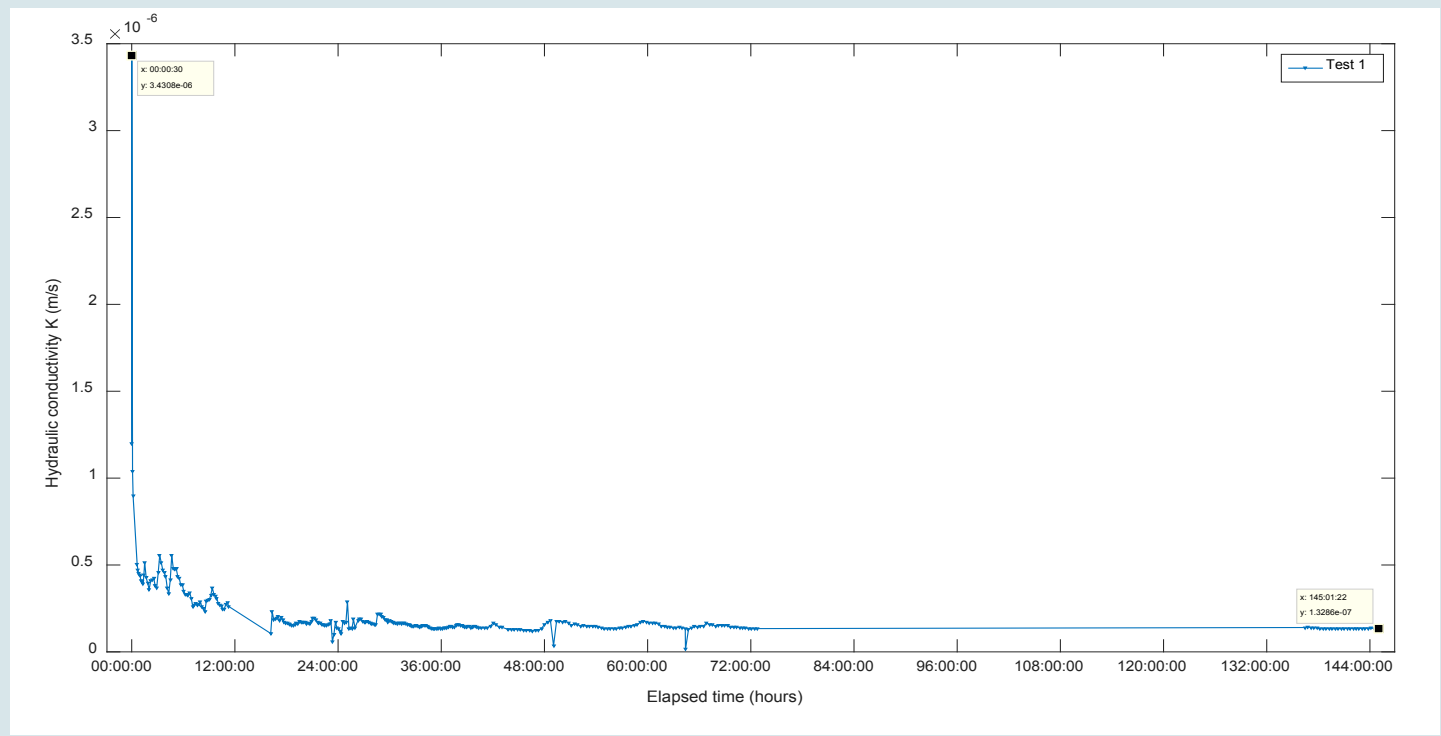
Laboratory tests : Results

Property	Silt layer	Silt layer (t=1 h)	Silt layer (t=16 h)	Mixture (t=0 h)	Mixture (t=1 h)	Mixture (t=3 h)	Mixture (t=58 h)	Mixture (t=264 h)
Length (mm)	130	130	130	370	370	370	370	370
Diameter (mm)	190	190	190	190	190	190	190	190
Inj. Pressure (bar)	0.835	0.750	0.725	0.725	0.725	0.725	0.725	0.725
Hydraulic head (m)	8.35	7.5	7.25	7.25	7.25	7.25	7.25	7.25
Permeability (m/s)	$2.15 \cdot 10^{-6}$	$1.54 \cdot 10^{-6}$	$3.22 \cdot 10^{-6}$	$5.42 \cdot 10^{-6}$	$1.36 \cdot 10^{-6}$	$8.89 \cdot 10^{-7}$	$2.54 \cdot 10^{-7}$	$2.68 \cdot 10^{-7}$

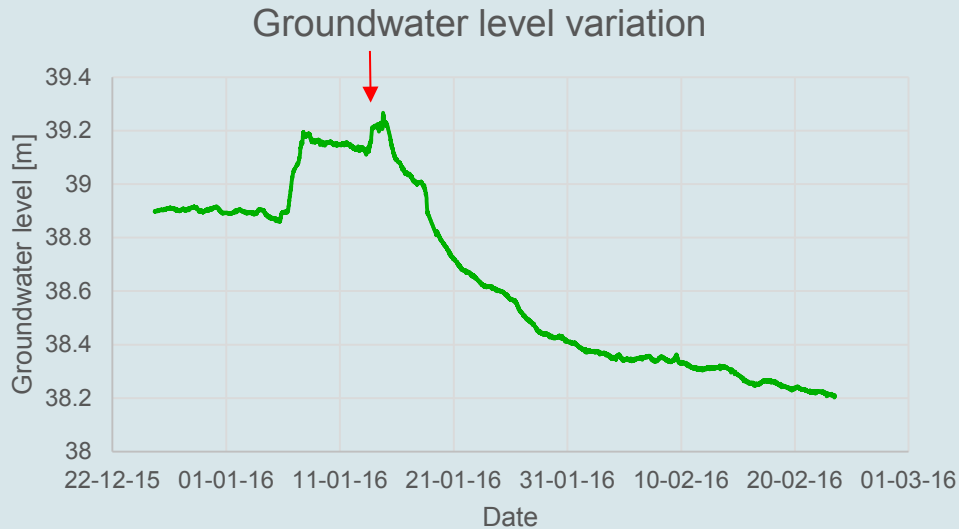




Laboratory tests : Results



Large scale tests



- Area => 30x25m = 750m²
- 20 cm of LuXeal
- Covered after 4 days



5. Discussion



- Problems in the development
 - Lack of knowledge
 - Non-existence of standardized test and certified laboratories
- Results
 - The goal has been achieved => a hydraulic conductivity of $2 \cdot 10^{-7}$ m/s with an easy to place mixture
 - The efficiency of the LuXeal is questionable when placed on very permeable soil ($K > 10^{-5}$ m/s)
 - The mixture can easily be placed using a bucket





6. Conclusion



- The gravel-bentonite mixture offered an cheap and easy to place alternative to the well-known materials such as clay, concrete and sand-bentonite mixture
- Further research will focus on obtaining a watertight mixture that can reach lower hydraulic conductivities on more permeable substrates
- The innovation and its further development convinced the management of De Vries & van de Wiel to apply for a patent on the invention





Questions ?

