
TenCate
materials that make a difference

TenCate Geosystems in Marine constructions

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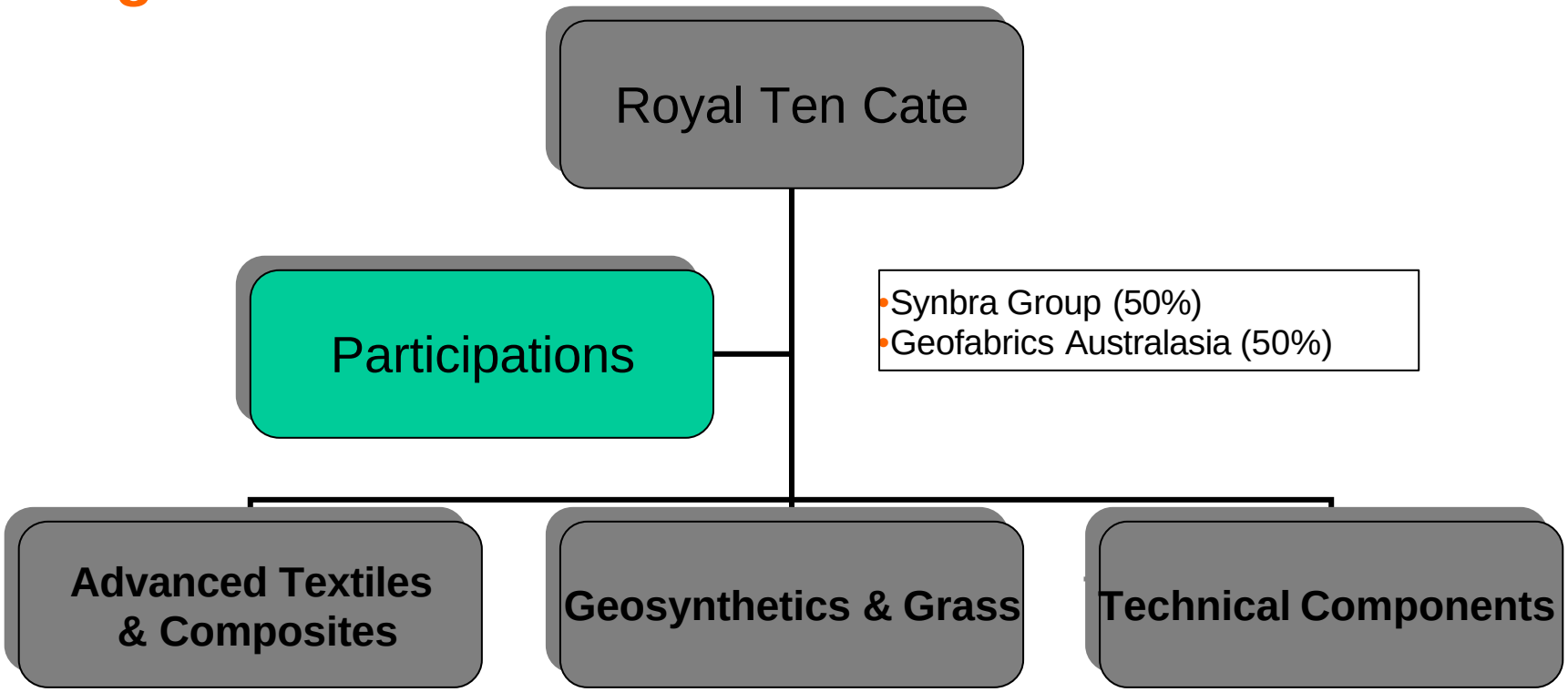
TENCATE
materials that make a difference

Organization

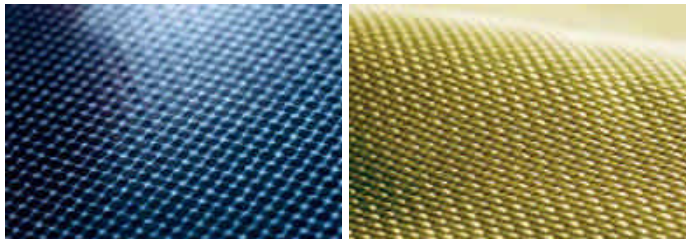


- TC Nicolon
- TC Polyfelt
- TC Bidim
- TC Mirafi
- TC Baycor

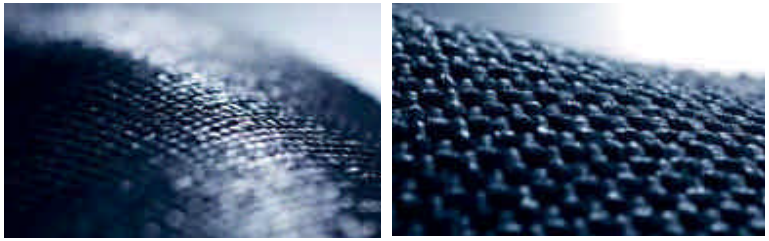
We combine fibers and chemicals to create materials that outperform existing alternatives

Protective & Outdoor Fabrics

Aerospace & Armour Composites



Geosynthetics & Industrial Fabrics



Grass

Strategic product, market, technology combinations

Key product / market combinations in functional materials

Protective & Outdoor Fabrics

Emergency Response Clothing

Industrial Safetywear

Tent & Awning Fabrics

Personal & Vehicle Armour

Aerospace Composites

Aircraft Composites

Spacecraft Composites

Geosynthetics

Costal Protection & Development

Road Stabilization & Construction

Industrial Fabrics

Trampolines, Pool & Truck Covers

Agriculture & Aquaculture

Grass

Sports Grass

Landscaping Grass

TENCATE

TENCATE Mirafi

TENCATE Nicolon

TENCATE Polyfelt

TENCATE Bidim

TENCATE Geotube

Systems made from woven geotextiles

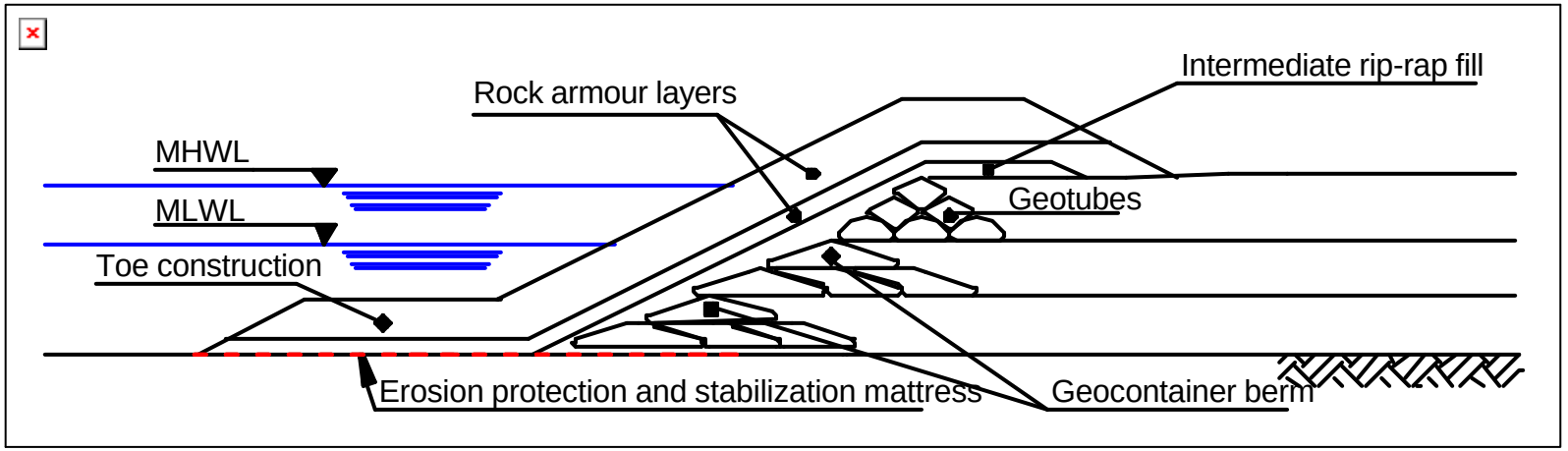
- Mattresses for slope and scour protection and basal reinforcement
- Geotube® systems for bund construction
- Geocontainer® for bunds or breakwater cores in deep water

Geosystems

- Geobag system; 2 till 10 m^3
- Geotube® system; 100 tot 750 m^3
- Geocontainer® system; 100 tot 600 m^3

Geosystems are sand filled elements made out of woven high strength textiles. The textiles used are special designed for Geosystems with the same strength in both directions.

Geosystem Application



Books and rules

In 2004 the book of the CUR, NL, Geotextiele zandelementen was printed.
Experiences from out of Europe.

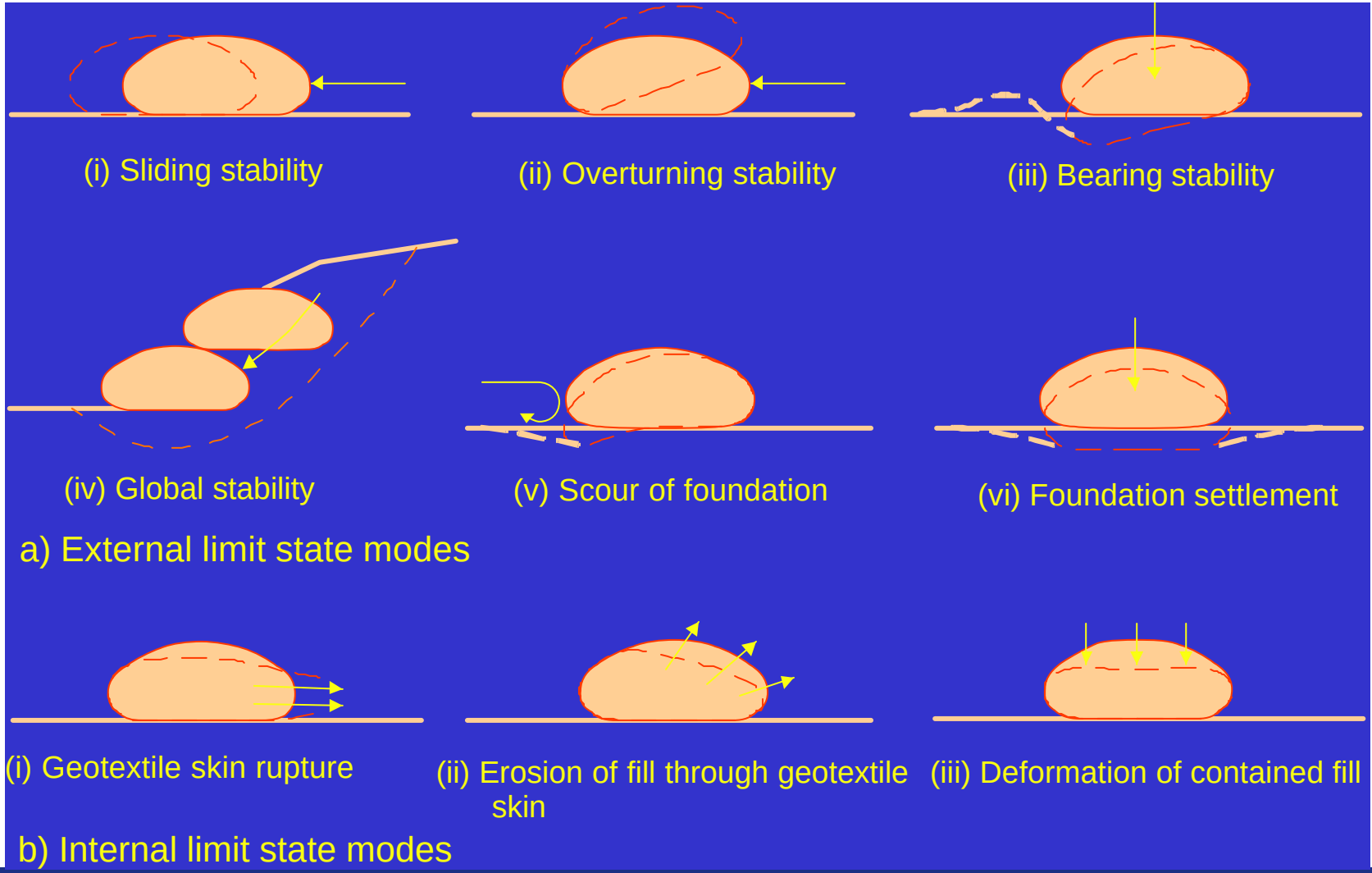
Application Geobags

Geobags used to create an artificial island.

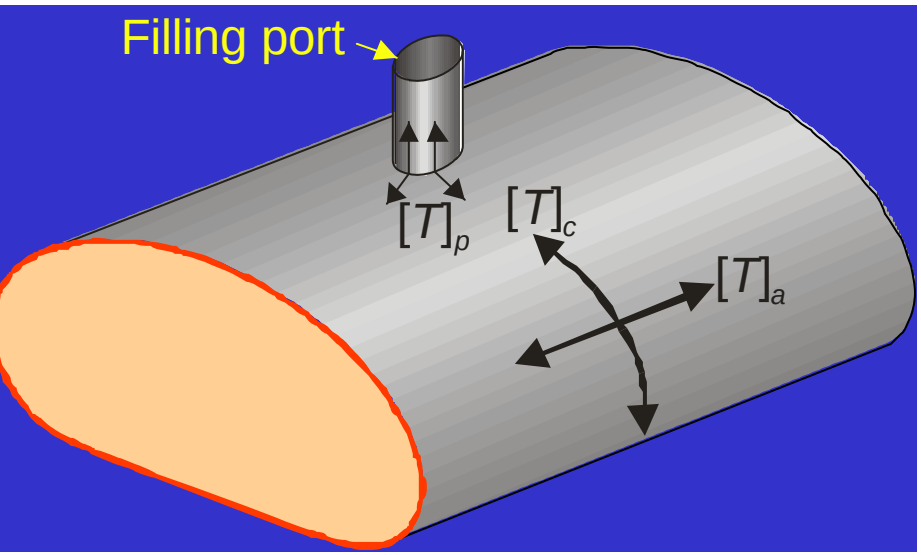
Geotube® system

- Will be filled on position.
- Filling hydraulically with a mixture of sand and water.
- Lengths vary between 30 till 100 meter.
- Diameter vary between 1,6 till 5 meter diameter.
- In relative short period a dam can be constructed.
- Essential is fabric strength and confection, seam strength.

Geotube® systems: limit state modes

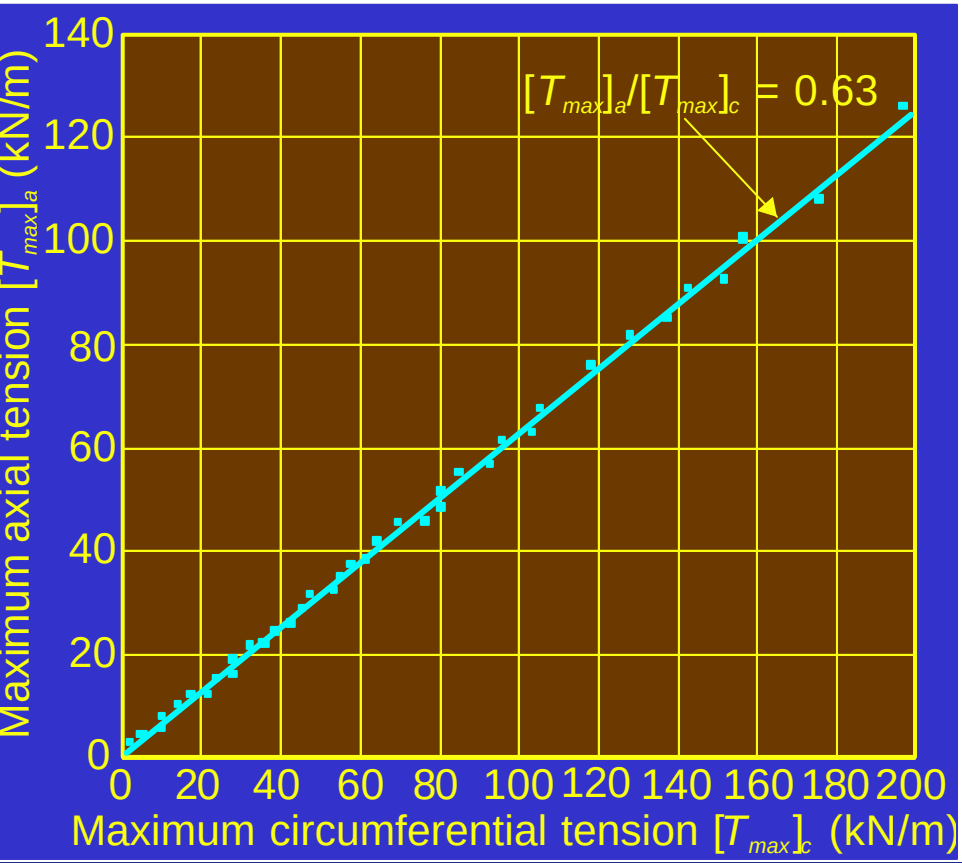


Geotube®: generated tensions



- Tensions generated at 3 locations – circumferential, axial and at filling port connections
- Tensions generated depend on size of tube and degree of filling
- First determine circumferential tensions, then axial tensions, and finally filling port connection tensions

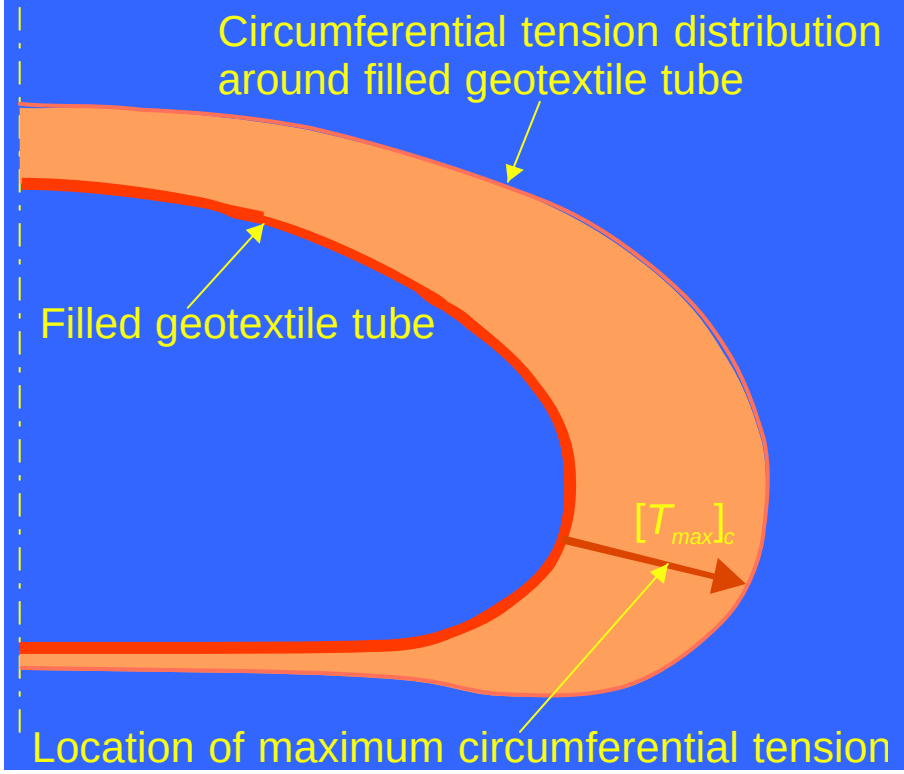
Geotube® system: maximum axial tensions



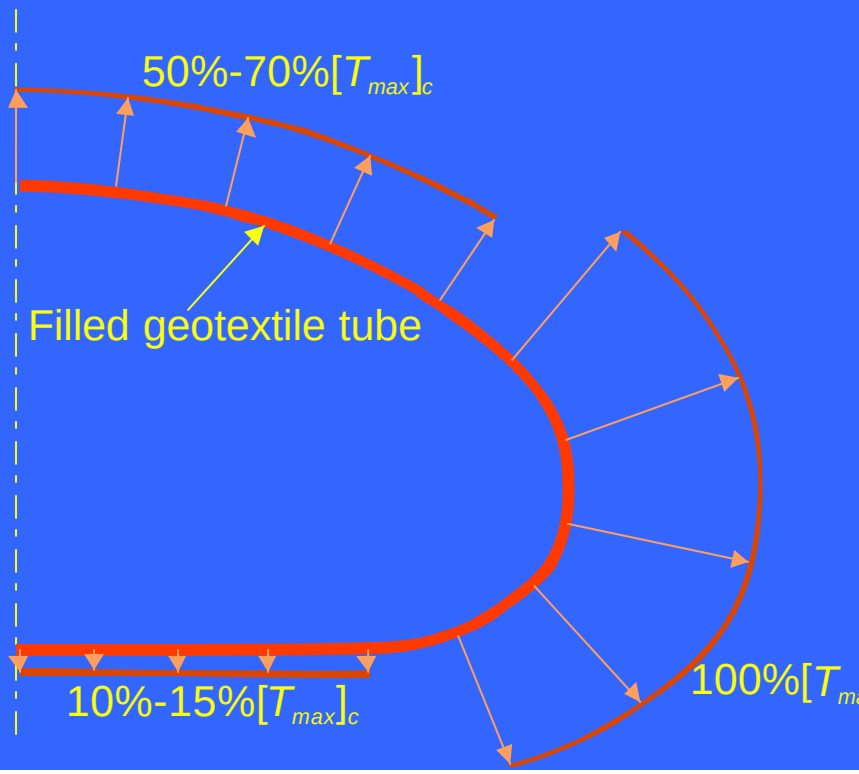
- Generated axial tensions are a function of filling pressure and tube filling height
- As expected, good relationship between maximum circumferential tension and maximum axial tension
- The port connection tensions are a function of filling pressure and filling height
  - Can be significant when maximum tube filling heights are required

Geotube® system: distribution of circumferential tension

a) Circumferential tension distribution around a filled geotextile tube



b) Approximation of circumferential tension distribution in terms of $[T_{max}]_c$



Design table for dimensions

diameter	circum	height	fill	width	width	recommended
				max	base	high strength
D	C	H	F	W	Wb	fabric
m	m	m	m3/m1	m	m	
1,60	5,0	1,0	1,7	2,0	1,7	GT 750 M
2,50	7,9	1,5	4,1	3,2	2,7	GT 750 M
3,25	10,2	2,0	6,9	4,2	3,5	GT 1000 M
4,00	12,6	2,4	10,4	5,1	4,3	GT 1000 M
5,00	15,7	2,7	16,3	6,4	6,0	GT 1000 M

Dimensions for a fill of 80 % and application under water

Design with Geotube® systems

Determine the appropriate height:

- on shore 60 % of theoretical diameter
- submerged 70 % of theoretical diameter.

Installation/filling time

Giving: Geotube® diameter 4 meter
fillingheigth 2,4 meter, length 50 meters.

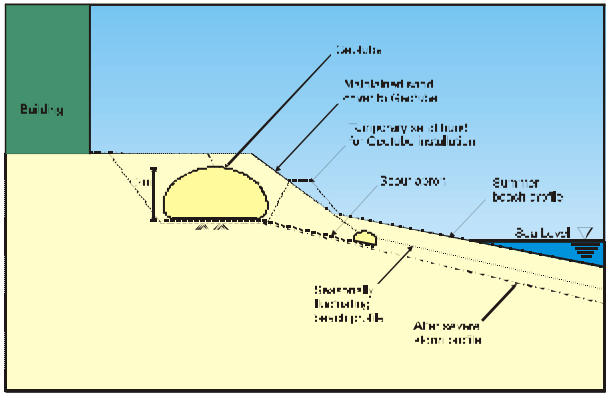
Total volume to be filled with 50 x 10,4 = 520 m3

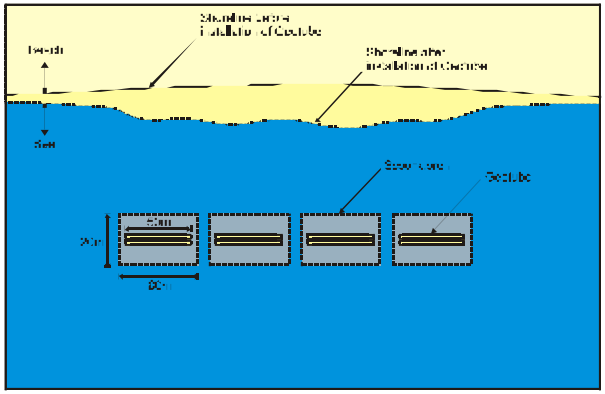
pumpcapacity 400 m3/hour at 15 % mixture (60 m3/hour)

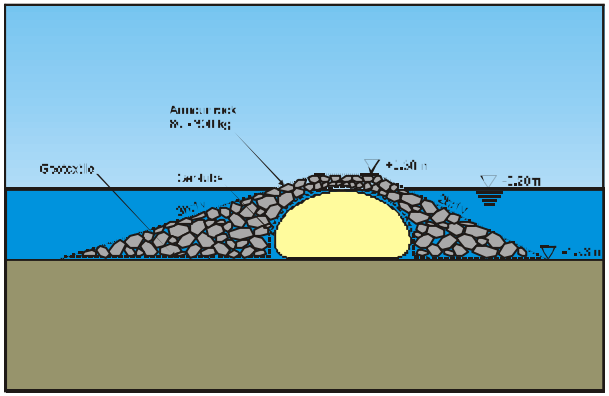
It will take around 520/60= 9 hours to fill the Geotube®.

Geotube® system filling

Applications







Temporary Dam in Morocco

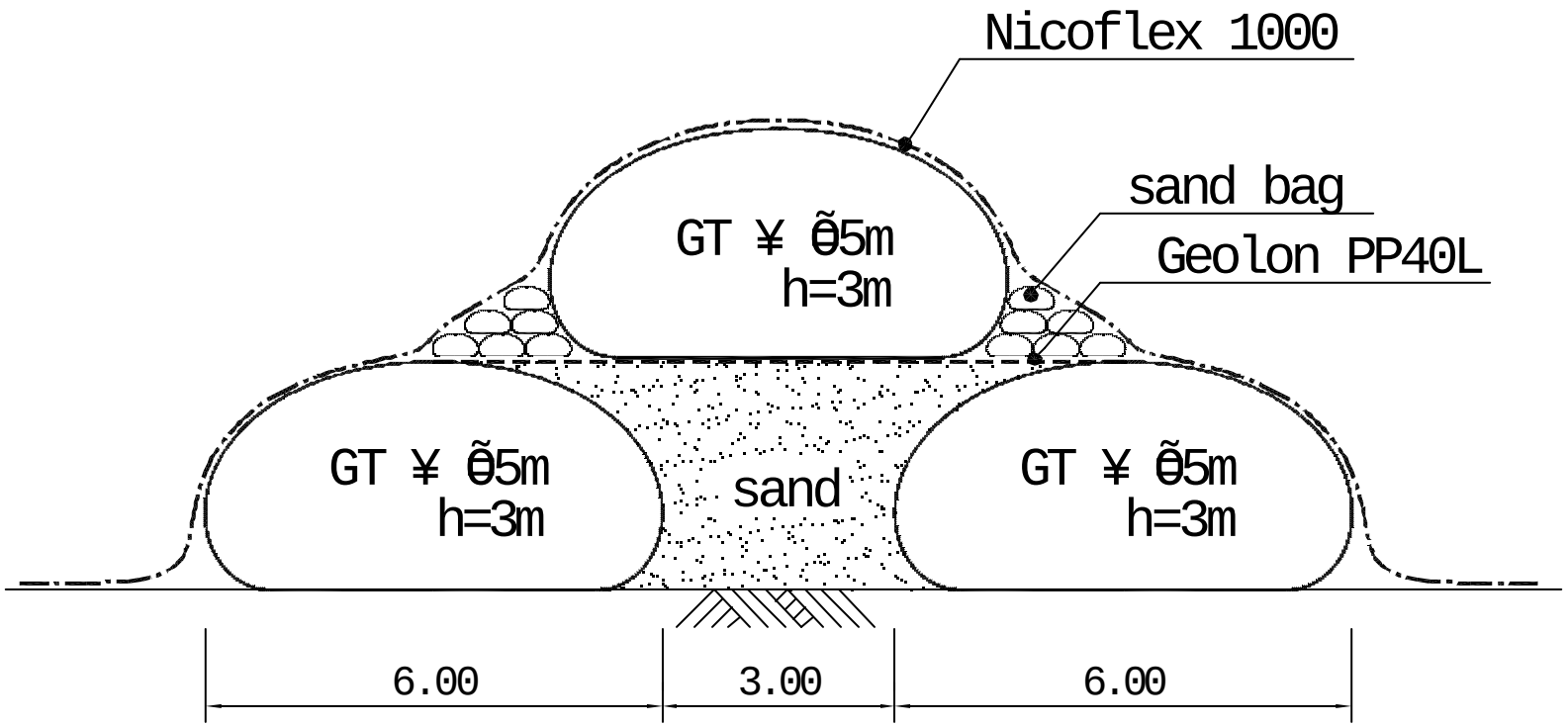
- Final Dam height 6 meter
- Constructed out 3 Geotube®, diameter 5 meter, fill height 3 m.
- 2 bottom Geotube® installed with a distance of 3 meter to create a flat installation surface for the top Geotube®.
- Geotube length approximately 70 meter.
- Material used Geolon® PP 200 S, seam strength 160 kN/m1.
- Finally covered with Nicoflex, impermeable liner.

Geotube® system

Building a temporary dam in Morocco

Geotube® system

Building temporary dam in Morocco



Geotube® system

Building a temporary dam in Morocco

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Geotube® system

Building a temporary dam in Morocco

GEOTEXTILE TUBE APPLICATION FOR INCHEON BRIDGE PROJECT, KOREA

Introduction

- The Incheon Grand Bridge will be a 12.3 km, dual three-lane tolled bridge to connect Songdo City within the Incheon Free Economic Zone and Incheon International Airport located on Yongjong Island
- When completed it will be Korea's longest bridge and anticipated to be the fifth-longest cable stayed-bridge in the world

Introduction

- A section consists of the symbolic cable-stayed bridge that will have a 74 m high navigational clearance to allow ocean going vessels of up to 100,000 tons to enter and leave the Port of Incheon
- However, 8.7 km of the sea crossing consists of concrete box girder viaducts built in shallow water over tidal mud flats

Introduction

Bridge layout superimposed over satellite map

Introduction

Artist impression of proposed Incheon Bridge

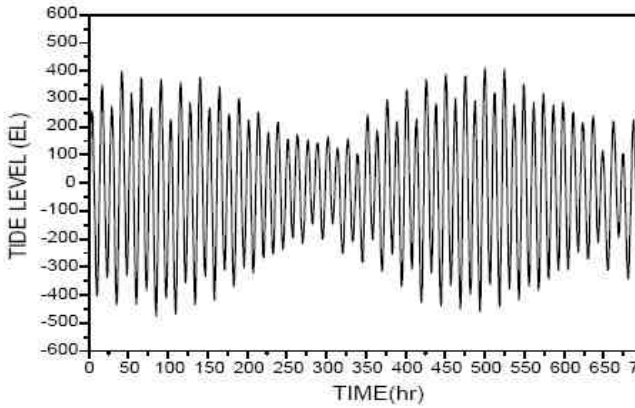
Introduction

- Geotube® systems were used as reclamation dykes, stacked in tiers up to a height of about 7 m over soft estuarial deposits
- The Geotube® systems used comprised of 3, 4 and 5 m diameters, with lengths between 15 to 60 m

Artist impression of proposed Geotube® artificial island

Contractual details

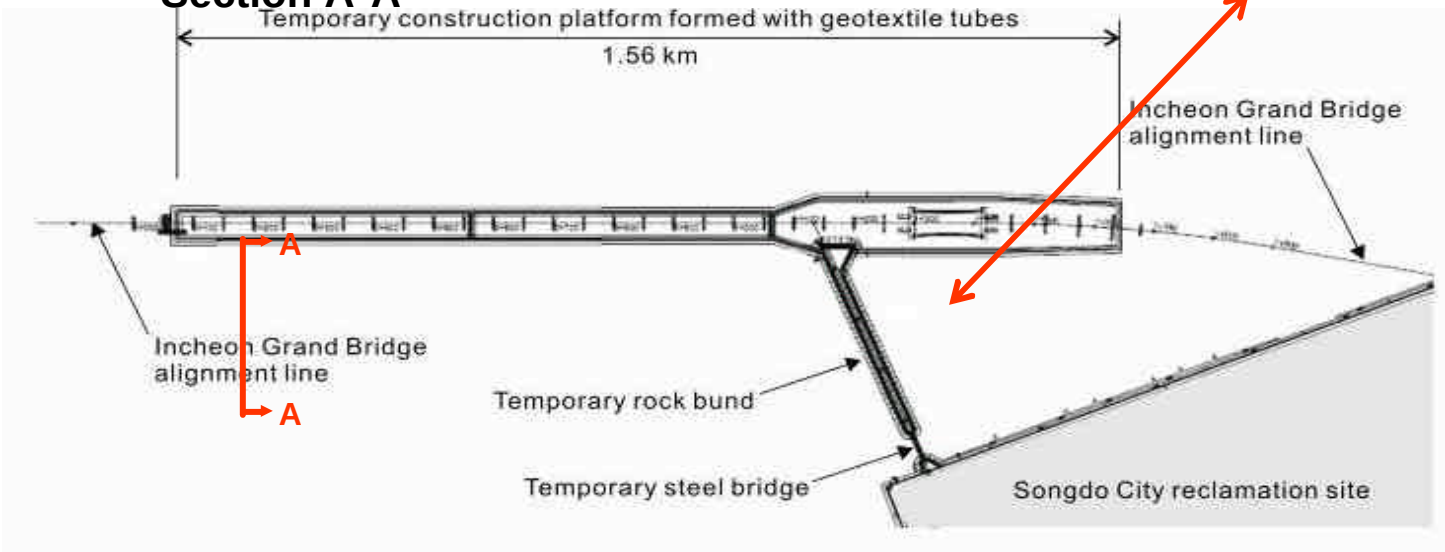
- Detailed designs for the textile tube artificial island done by Seil Engineering Ltd and a geotechnical research team of the University of Incheon
- Design conditions (Shin & Oh, 2006) are summarized as follows:
  - Approximate H.H.W. : E.L. +4.635m
  - Significant wave conditions
    - Direction, WSW
    - Wave height : 2.06 m
    - Period : 10.0s
    - Wind velocity : 22.04m/s
  - Tidal conditions
    - Velocity : 0.58 to 0.73 m/s (low tide)
    - Maximum tidal difference : 9.27 m
    - Tide elevation : see Figure



Tidal elevation

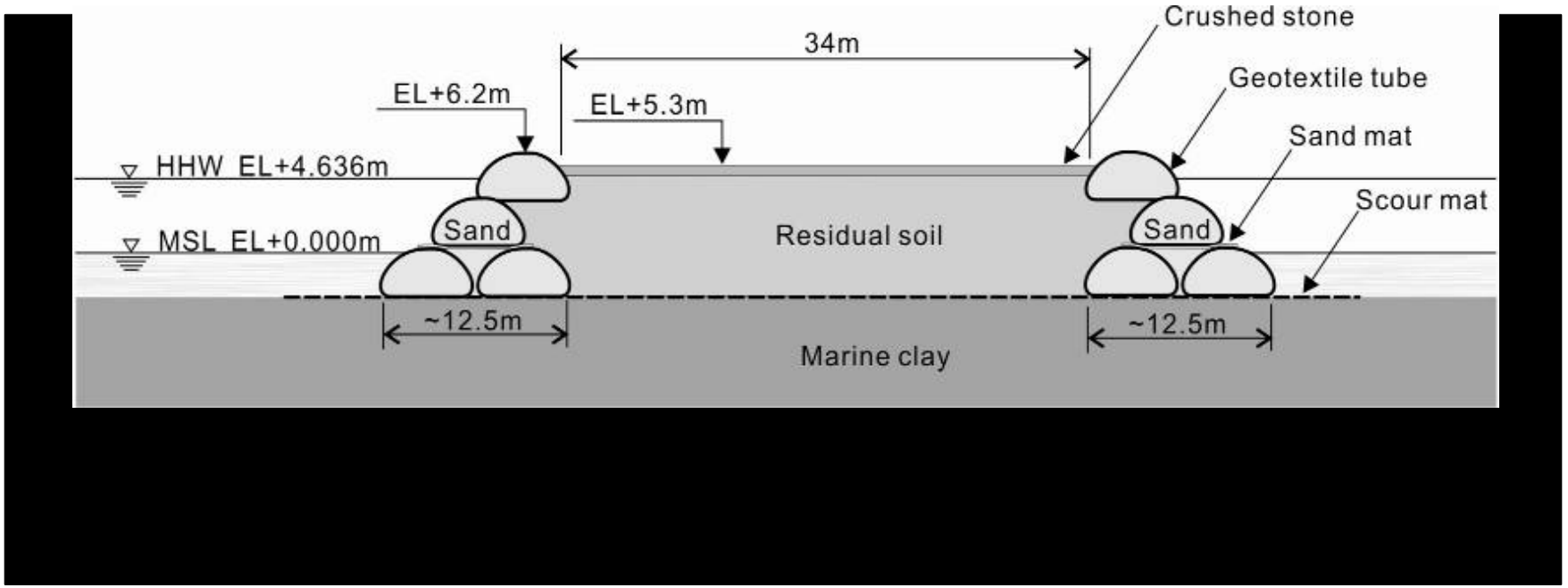
Contractual details

Section A-A



Plan view of geotextile tube artificial island

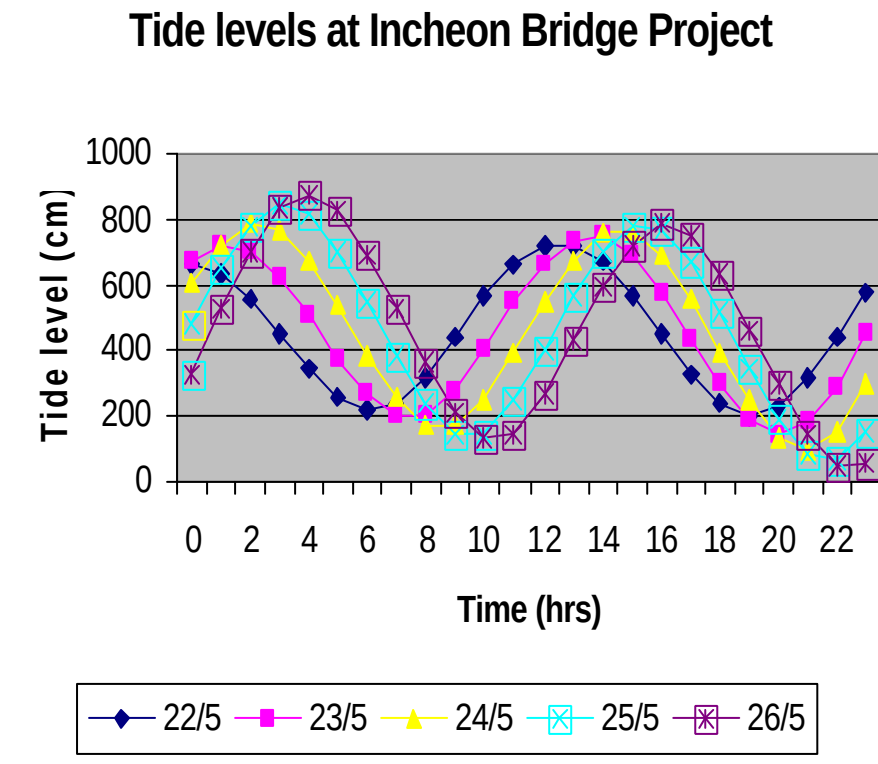
Contractual details



Typical cross section of Geotube® artificial island

Installation

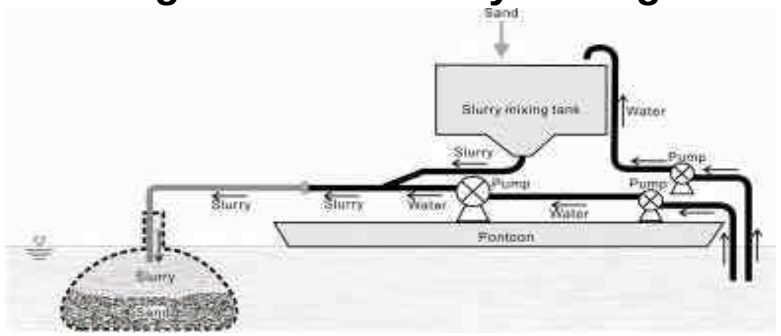
- Tide
  - diurnal
  - range 9m
- Site is dry during low tide – laying of scour apron and textile tube
- Filling of textile tube during high tide when water is available for mixing with imported sand



Installation

- Sand supply barge – 1,800 m^3
- Work barge
  - Crane
  - Mixing tank
  - Water pumps
  - Excavators
- Booster pump at 450HP, 1,500 rpm, delivering 150 to 180 m^3/hr
- Pump outlet pressure at 3.5 psi

Placing sand into slurry mixing tank



Schematic of mixing and pumping setup

Installation

Overall view of one installation equipment setup for Incheon Bridge Project

Installation

Laying of scour mat during low tide

Installation

Laying of bottom Geotube® (outer) during low tide

Installation

Laying of bottom Geotube® (inner) during low tide

Installation

Sand filling and leveling between bottom Geotube® systems during low tide

Installation

Installation of sand mat above bottom Geotube® systems

Installation

Laying 2nd level Geotube® above sand mat

Installation

Pumping of 2nd level Geotube® with sand slurry

Installation

Bottom & 2nd level Geotube® completed for 1 side of artificial island

Installation

Backfilling behind Geotube® dyke with residual soil

Installation

Installing upper level Geotube®

Installation

View of partially completed Geotube® artificial island

Installation

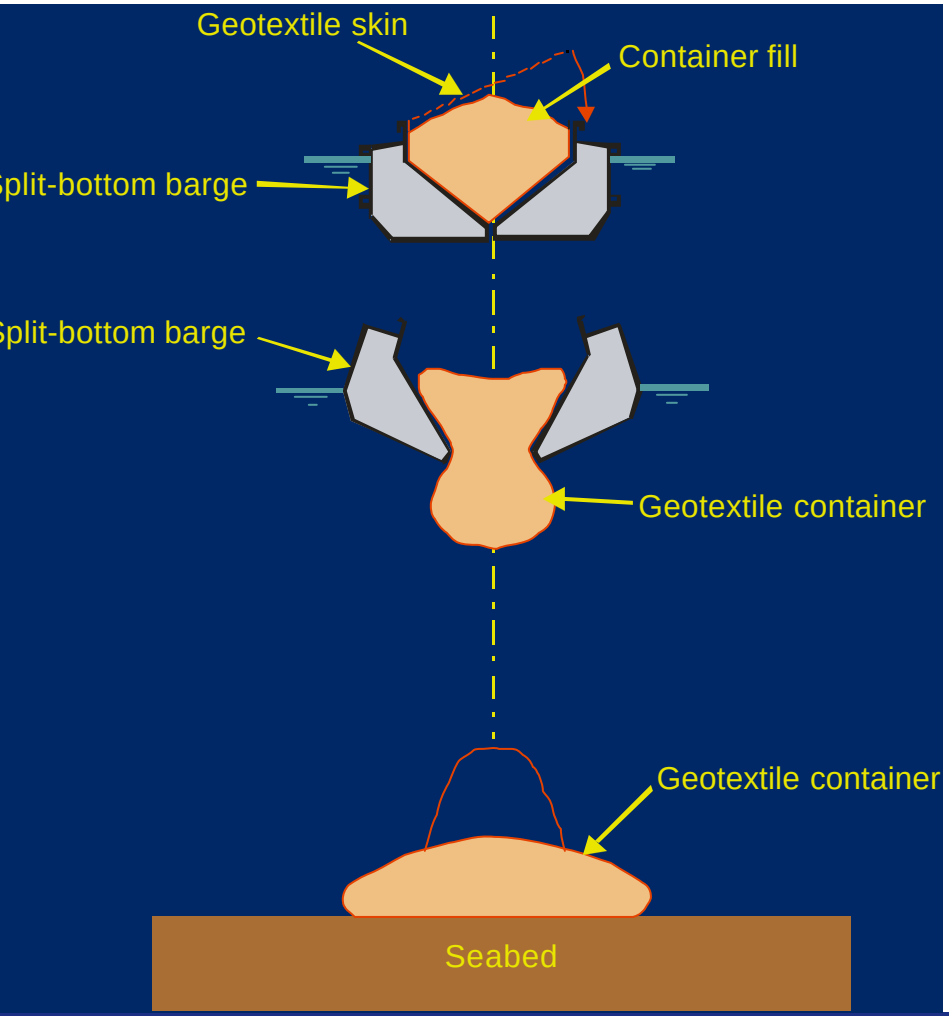
Bridge foundation and pier works in full swing on completed artificial island

Geocontainer®

Geocontainer® system

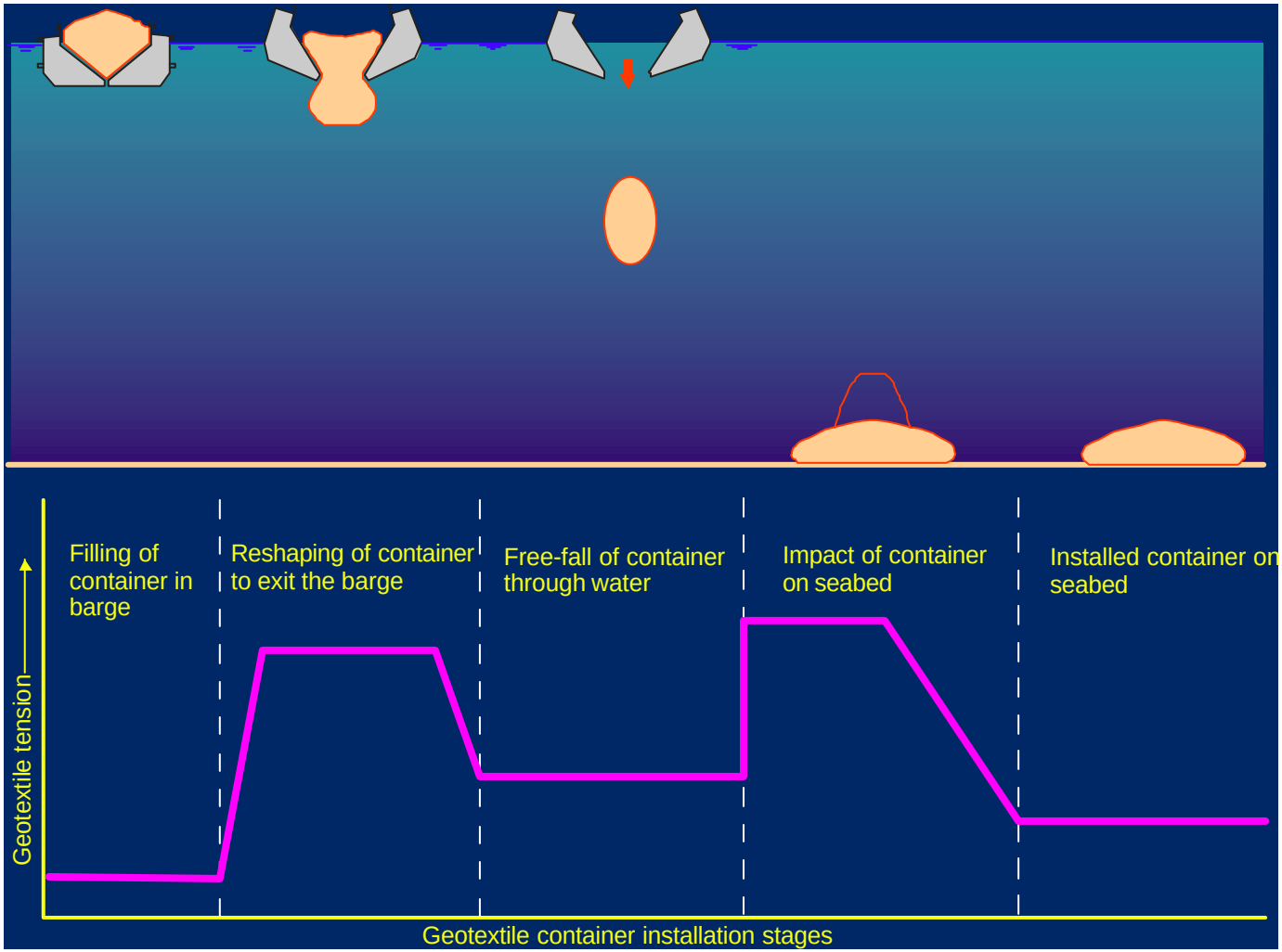
- Geocontainer® systems are in principle large big sandbags.
- These will be placed in a split barge and filled with sand . The Geocontainer® system will then be closed and the barge opened. The Geocontainer® system will than be dumped on the bottom.
- Capacity varies from 120 m^3 till 600 m^3
- Geocontainer® system are especially made for a given split barge

Geocontainer® system



- Geocontainer® are installed by split-bottom barges
- Two types of applications:
  - Structural, submarine, mass-gravity units
  - Contained, submarine disposal of contaminated sediments
- For hydraulic applications container volumes are in range 100 to 600 m^3
  - Smaller volumes give better installed tolerances and are more easily installed but are more costly

Geocontainer: tensions generated in fabric



Geocontainer® system

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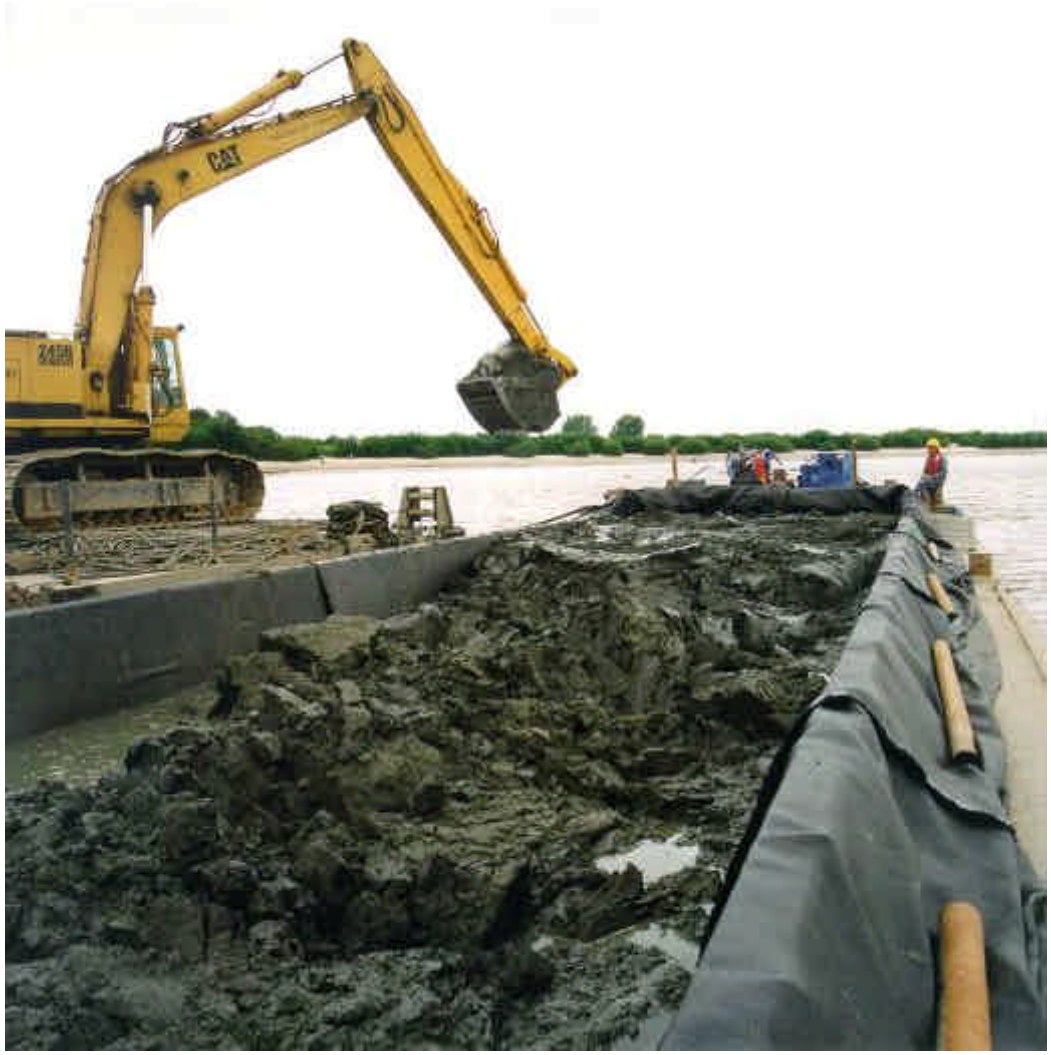

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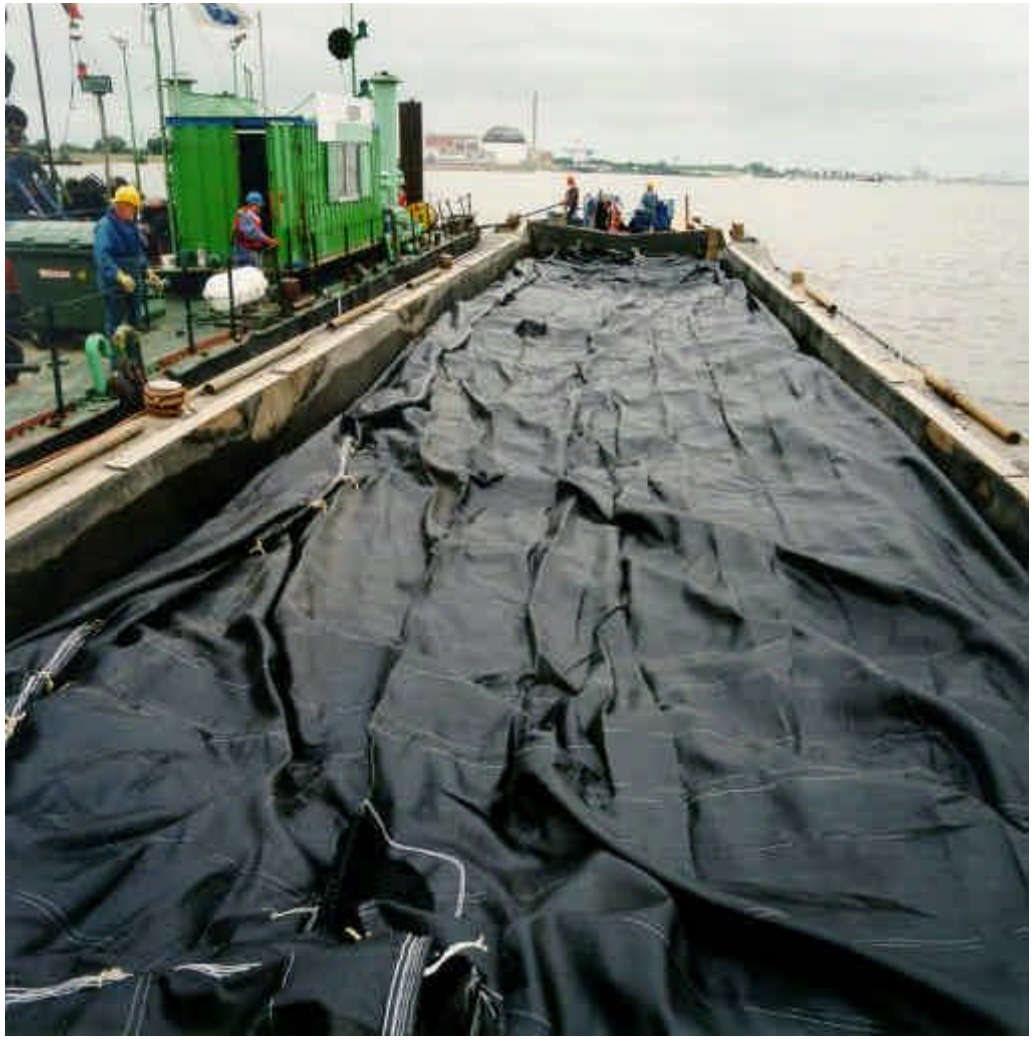

Geocontainer® system

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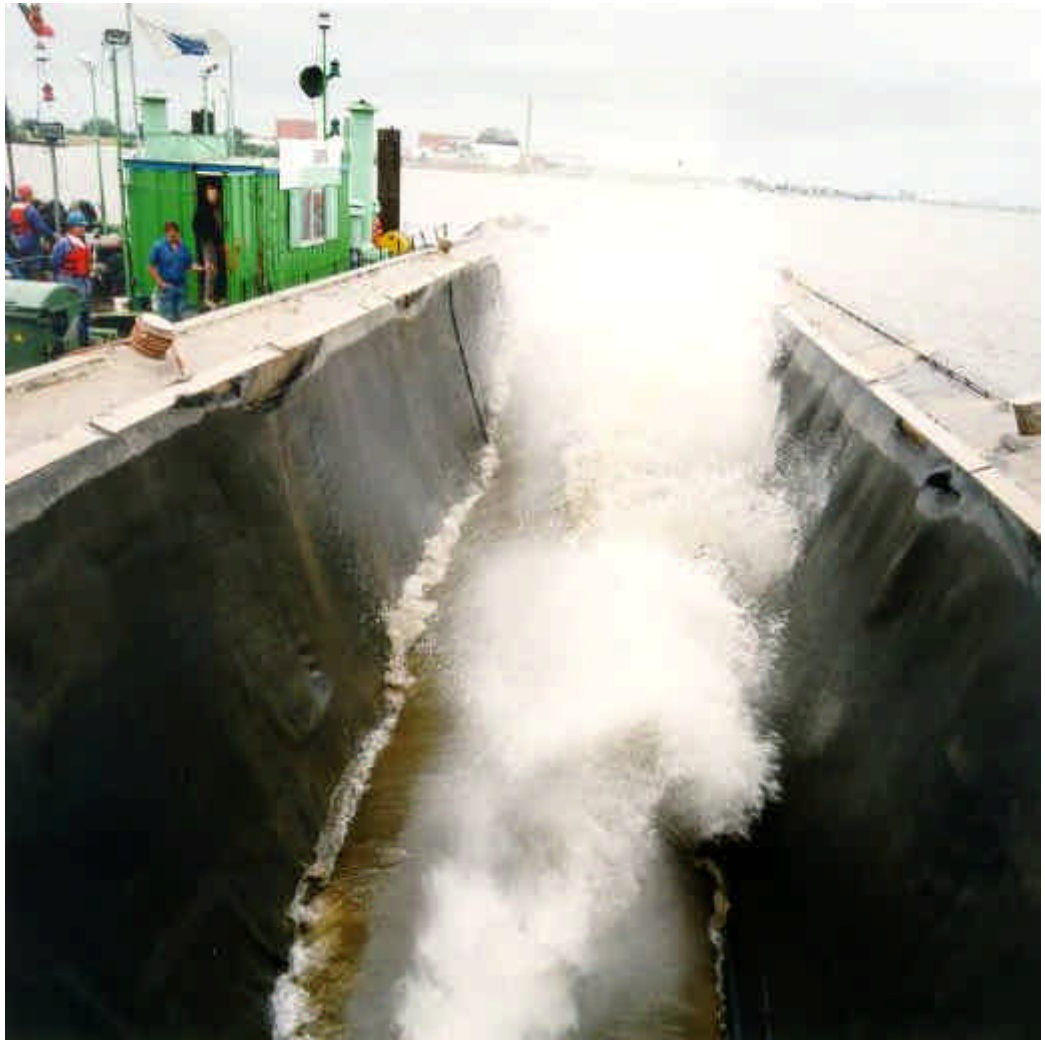
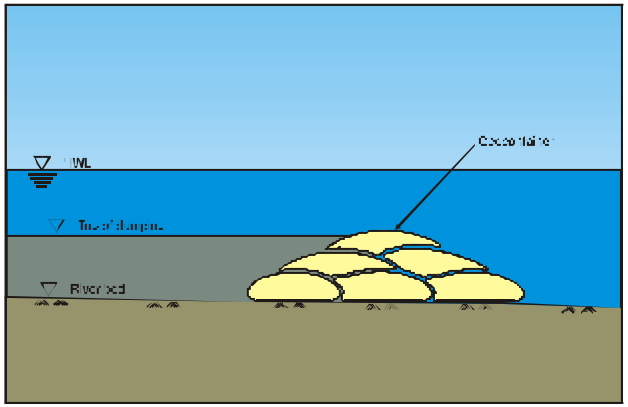


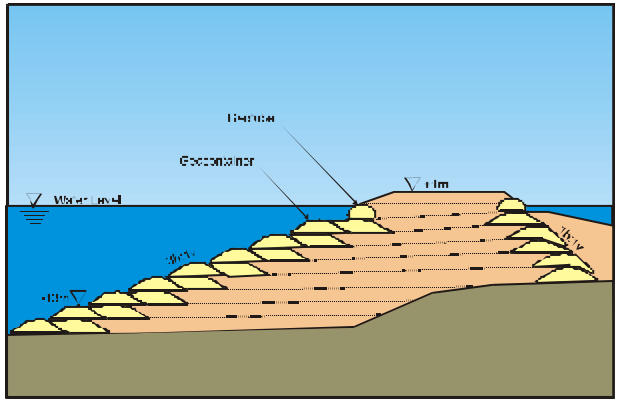
Geocontainer® system

Geocontainer® system

Application:

- core for breakwater, dam or dike;
- under water berm;
- Filling of erosion holes;
- dispose of contaminated sludges.





New developments

- New guideline had been printed for designers and engineers, with calculation models the CUR 217
- Order at www.cur.nl.
- Currently only available in the Dutch language but translation will come out in 2008.

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