Introduction to Tube Dewatering Technology

Royal TenCate
TenCate Geosynthetics

Gerben van den Berg
Manager Environmental Remediation
Geotube® technology for dewatering

![Geotube technology for dewatering](image1.png)

![Geotube technology for dewatering](image2.png)

![Geotube technology for dewatering](image3.png)
Municipal and Industrial WWT
Mining WWT
Mining Lagoon Management
ENVIRONMENTAL REMEDIATION PROJECTS

- Uncontaminated use in berms: Kampen (NL)
- Contaminated use in berms: Zutphen (NL)
- Uncontaminated dike reinforcement: Dubbele Wiericke (NL)
- Uncontaminated use for subterranean surface elevation: Herne (GE)
- Landscaping co-using contaminated sediments: Tianjin Eco-City (CN)
- Container platform construction with contaminated sediments: Embraport (BR)
Project: Port la Forêt

- Landscaping with contaminated sludge
- Dewatered and consolidated tubes transformed in football pitch
Project: Port la Forêt

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Project: Tianjin Eco-City, China

Google photo of Tianjin Eco-city Project with wastewater containment lake located at the center of the development site

- 2.56 km² wastewater containment lake
- Discharges from nearby domestic, agricultural and industrial sources since 1976
- Lake sludge sediments contain heavy metals eg. Hg, As, Cu, Cd and also DDT.
Project: Tianjin Eco-City, China

- In-situ sludge volume: 2,600,000 m³ at 10% ds
- Dewatered volume: 460,000 m³ at 60% ds
- Dewatering area: 12,000 m²
- Circumferences: 27.4 to 30.5 m
- Total tube length: 16.25 km
TenCate Geotube®: example

- Reconstitution of berms: uncontaminated sludge
Tube dewatering for examples

- Creation of a nature reserve within a sand filled TenCate Geotube® dike structure
- Bioremediation of contaminated sediments in safe confinement area
Reuse of contaminated sediments, Zutphen NL

Reconstruction of berms using TenCate Geotube® units hydraulically filled with (contaminated) sediments
TenCate Geotube ® : example

• Creation of an anchored floating structure
TenCate Geotube ® : example

• Creation of an anchored floating structure: Sediment Storer
TenCate Geotube ® : example

- Sediment storing second possibility
TenCate Geotube ® : example

- Sediment storing second possibility
Tube dewatering: examples

- Creation of protective dams against the potential effects of earthquakes
Project: Embraport Brasil

The Challenge

- 50% of project area are wetlands and tidal zones
- 600,000 m³ of contaminated sediments
- Insufficient inland disposal area
- Large volume of imported select fill required
- Traditional engineering solutions threaten economic viability of project
Project: Embraport Brasil

The Solution

- Use the 650,000 m³ of contaminated sediments
- To form the required 450,000 m³ of select fill
- Use 3 dredges
- Pumping 1,500 m³/hr total
- In @ 36,6m tubes
Project Location

Embraport Terminal
### Geotube® Estimator

**Metric Units Input - Known Volume**

**Version 11.2A**  
**Tom Stephens**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Embraport Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Santos, SP, Brazil</td>
</tr>
<tr>
<td>Contact:</td>
<td>Luiz Escobar, Leo Melo Casar</td>
</tr>
<tr>
<td>Date:</td>
<td>5/6/2007</td>
</tr>
<tr>
<td>Type of Material:</td>
<td>Marine Sediments</td>
</tr>
</tbody>
</table>

#### Input

<table>
<thead>
<tr>
<th>Volume</th>
<th>680,000</th>
<th>Cubic Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>2.65</td>
<td></td>
</tr>
<tr>
<td>% Solids in Place</td>
<td>40.0%</td>
<td></td>
</tr>
<tr>
<td>% Solids During Pumping</td>
<td>10.0%</td>
<td></td>
</tr>
<tr>
<td>Target dewatered % Solids</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td>% Coarse grain &amp; sand*</td>
<td>20.0%</td>
<td></td>
</tr>
</tbody>
</table>

* % Coarse grain & sand is removed from the calculation for volume reduction due to dewatering and added back in at the end in required Geotube® volume.

#### Output

| Total Volume Pumped | 3,397,016,508 | Liters |
| Wet Volume per day | 8,639,994 | Liters |
| Wet Volume per day | 8,638.9 | CM |
| Total Bone Dry Tons | 289,639.0 | Tons (metric) |
| Estimated Pumping Days | 393.2 | Days |
| Estimated Dewatered Volume | 415,528.3 | CM |
| Estimated Dewatered Weight | 731,744.6 | Tons (metric) |

#### Estimated Geotube® Quantity:

<table>
<thead>
<tr>
<th>Circumference X Pumping Height</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.15m X 1.52m</td>
<td>93.433</td>
</tr>
<tr>
<td>13.72m X 1.67m</td>
<td>51.995</td>
</tr>
<tr>
<td>18.29m X 1.83m</td>
<td>34.276</td>
</tr>
<tr>
<td>22.87m X 1.98m</td>
<td>24.640</td>
</tr>
<tr>
<td>24.39m X 1.98m</td>
<td>22.836</td>
</tr>
<tr>
<td>27.44m X 1.98m</td>
<td>19.920</td>
</tr>
<tr>
<td>36.56m X 2.13m</td>
<td>13.425</td>
</tr>
<tr>
<td>22.87m X 1.98m</td>
<td>24.640</td>
</tr>
</tbody>
</table>

#### Estimated MDS Geotube® Units:

<table>
<thead>
<tr>
<th>MDS Dimensions</th>
<th>Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.86m X 6.7m</td>
<td>59,276.0</td>
</tr>
</tbody>
</table>

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**Disclaimer:** No warranty or guarantee expressed or implied is made regarding the performance of any product since the manner of handling and use is beyond our control. This document should not be construed as engineering advice, and the final design should be the responsibility of the project engineer and/or the project manager.
Project: Embraport

The Design

Overburden Amounts:
- 4 ton m²
- 6 ton m²
- 8 ton m²
Project: Embraport

The Design
Project: Embraport

The Design
The Design

Project: Embraport

- Base: Well graded gravel
  - $\sigma_1$
- Subbase: Well graded gravel
  - $\sigma_2$
- Compacted subgrade: Compacted remnant fill
- Subgrade: Consolidated dredged material
- GT500

- $E_1 = 10,000 \text{ kgf/cm}^2$
- $E_2 = 5,000 \text{ kgf/cm}^2$
- $E_3 = 150 \text{ kgf/cm}^2$

- $P = 185.7 \text{ tf/m}^2$
- $E_1 = 3.50 \text{ m}$
- $E_0 = 0.72 \text{ m}$

- $P = 20 \text{ cm}$
For verification, the gravel has no cohesion, therefore $c = 0$, and the footing is at surface level, therefore $D = 0$ and $q = 0$ which simplifies the formula to

Solve for the Allowable Bearing Capacity,

where $B = 0.7m$, $\gamma = 2.1T/m^2$, $S_\gamma = 0.8$ for a square footing as indicated by Terzaghi and $N_\gamma = 763$ for $\phi = 50^\circ$, giving:

$$q_u = 0.8 \times 2.1 \times 0.7 \times 763/2 = 448.6(T/m^2)$$

which leads to the safety factor:

**Bearing Capacity FS = (448.6 / 185.7) = 2.42**
Project: Embraport

The Construction
Project: Embraport

The Construction
Project: Embraport

The Construction
Project: Embraport

The Dewatering Operation
Project: Embraport

The Dewatering Operation
Project: Embraport

The Dewatering Operation
Project: Embraport

The Dewatering Operation
Project: Embraport

The Conclusion

• Safe US$ 50M
• Create the biggest terminal in Latin America
The TenCate Geotube® carbon footprint calculator explained.
Frontpage after opening the **calculator**

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**Sustain TenCate Dewatering CO2 Comparison Calculator Version 2011-02**

The following sheets provide carbon calculations for the TenCate Geotube® system in comparison with mechanical dewatering systems.

It has been created by independent consultants at Sustain Ltd

**GO TO CALCULATOR**
Désignation

Commune de MARTIGUES
Canal Saint - Sébastien
Réalisation de dragages
et réparation du quai Aristide Briand
PLAN DES ZONES DE RESSUYAGE DE BOUES DE DRAGAGE

Échelle: 1/1250e
Date: Août 2010

Christian BRÁNDI
Chef de Pôle
Aménagement Durables du Littoral
Marseille

Direction Départementale des Territoires et de la Mer
des Bouches-du-Rhône
Territoire de la mer et du littoral
Pôle Aménagement Durables du Littoral
16, rue Antédème ZITARRA
13202 Marseille CEDEX 3
Téléphone : 04 91 26 04 84
Télécopie : 04 91 26 45 81

Zone de ressuyage de boues de dragage
Martigues: platform op naastgelegen parking
Martigues: op maat
Martigues: het filtraat
Martigues
Martigues
Conclusion

• Geotextile containment solutions have been successfully applied to manage and dispose of contaminated sediments in thousands of projects worldwide.

• Geotextile containment solutions have gained acceptance in recent years to solve a wide variety of problems related to management and disposal of contaminated sediments.

• Reuse of dredged sediments can lead to substantial savings to project owners.

• Dredged sediments should be seen as valuable construction materials, rather than waste materials.

• Engineers should use the knowledge about the possibilities of silts/sediments in combination with tube consolidation, use the extensive experience of companies like TenCate and embrace these new, creative techniques.
There is more possible than you may think…

Or would she be dancing on a tube?

Thanks you for your attention!