WEDA 33 / TAMU 44

Beneficial Use of Dredged Contaminated Sediments Using Geotextile Tube Technology

Presented by:
Tom Stephens

materials that make a difference

Project Location

Embraport Terminal

The Project

The Project

The Project

- 850,000 m2 total area
- 2.0 million TEU/yr
- 2 billion liter/yr bulk liquid
- 1.1 km pier length
- Will Be Largest Terminal In South America
- Rated Most Innovative Port Project on KMPG’s 2012 Infrastructure 100 Global Projects List

The Challenge

- 50% of Project Footprint Was Located In Wetlands and Tidal Zone
- 600,000 m3 of Contaminated Sediments to Be Removed From Entrance Channel and Turning Basin
- Limited Available Area for Onsite UDF
- Required Large Volume of Imported Select Fill
- Traditional Engineering Solutions Threaten The Economic Viability of Project

An Example of a Traditional Solution

The Solution

Use Geotextile Tube Dewatering Technology to contain and dewater 600,000 m3 of contaminated sediments

• Create Geotextile Tube Dewatering Cells within the designed fill area

•The Contained, Dewatered and Consolidated Contaminated Sediments within the Geotextile Tubes would replace approximately 450,000 m3 of imported select fill

• The Beneficial Use for the Contaminated Sediments would greatly reduce project construction cost

The Parties

- Odebrecht :
  - Joint Venture Partner
  - Project Management
  - General Contractor

- Allonda Environmental :
  - Environmental Engineering
  - Dewatering Cell and Water Treatment Operations

- Jan de Nul and Trepasa:
  - Dredging Contractors

The Design

- Enclose the tidal flat area of the project with 3.5m high clay berms

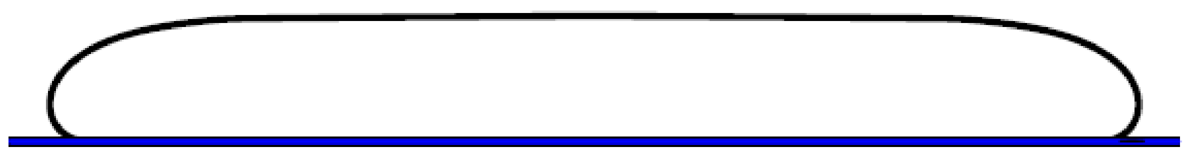
- Construct Geotextile Tubes Dewatered Cells equal to 235,000 m2 within the tidal flat area of the project site

- Install in the Dewatering Cells 13,500 l/m 36.5m Cir. Geotextile Tube units with a volume capacity of 35.2m3/m

- Install a 1.0m thick Container Storage Pavement System over the consolidated Geotextile Tubes

The Geotextile Tube Design

Geotube® Simulator
Cross Section



1/17/10	Project:	Embraport Geotube Cross Section

Units:	Metric	
Water Level:	Fully Emerged	
Geotube® Height (H) =	2.2	m
Geotube® Circumference (C) =	36.5	m
Relative Density of Fill Material =	1.4	sg
Geotube® Fabric Type:	GT500	
Geotube® Fabric Type:	Rigid Mechanical	

Circumferential Tensile Force (T) =	16.96	kN/m
Geotube® Base Contact Width (B) =	15.84	m
Geotube® Filled Width (W) =	17.24	m
Geotube® Cross Section Area (A) =	35.21	sq m
Geotube® Volume Per Unit of Length (V) =	35.21	cu m/m
FS of Circumferential Failure =	4.6	FS
Axial Direction FS (AFS) =	4.4	FS
FS of Fill Port Failure =	4.7	FS

The Dewatering Analysis

TENCATE Geotube

Geotube® Estimator

Metric Units Input - Known Volume

Version 11.2A

Tom Stephens

Project Name:	Embraport Terminal
Location:	Santos, SP, Brazil
Contact:	Luiz Escobar, Leo Melo Casar
Date:	5/6/2007
Type of Material:	Marine Sedimants

Input		Units
Volume	680,000	Cubic Meters
Specific Gravity	2.65	
% Solids in Place	40.0%	
% Solids During Pumping	10.0%	
Target dewatered % Solids	63%	
% Coarse grain & sand*	20.0%	

* % 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.

Production:

Pumping Rate (LPM)	10,000	
Hours per Day	24.0	
% Efficiency	60%	

Material type:

Sand and/or Minerals

Percent of Maximum Filled Capacity

90%

For MDS Applications:

Legal Hauling Capacity	14	Tons

Output		Units
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:

Circumference X Pumping Height	*Meters*	
9.15m X 1.52m	93,433	
13.72m X 1.67m	51,995	
18.29m X 1.83m	34,276	
22.87m X 1.98m	24,640	
24.39m X 1.98m	22,836	
27.44m X 1.98m	19,920	
36.56m X 2.13m	13,425	
22.87m X 1.98m	24,640	Selectable

Estimated MDS Geotube® Units:

MDS Dimensions	*Each*
6.86m X 6.7m	59,276.0

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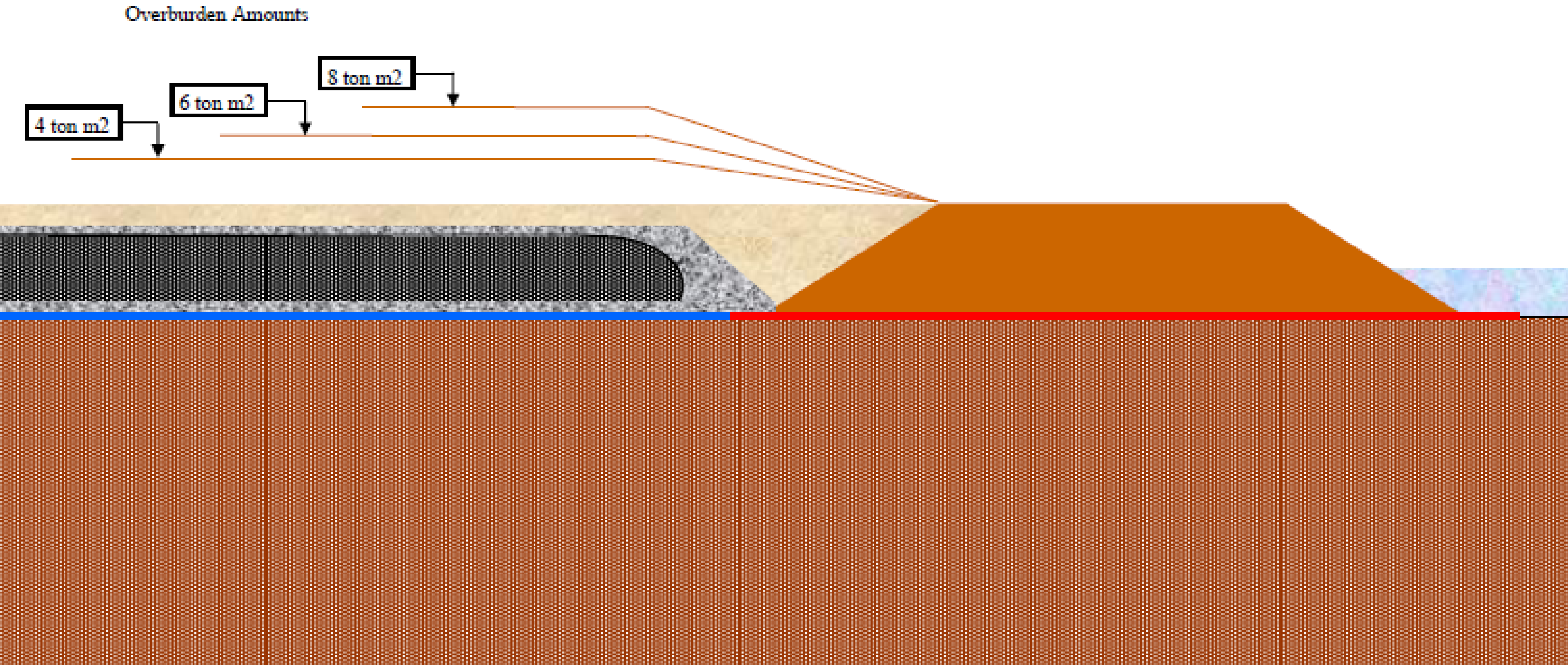
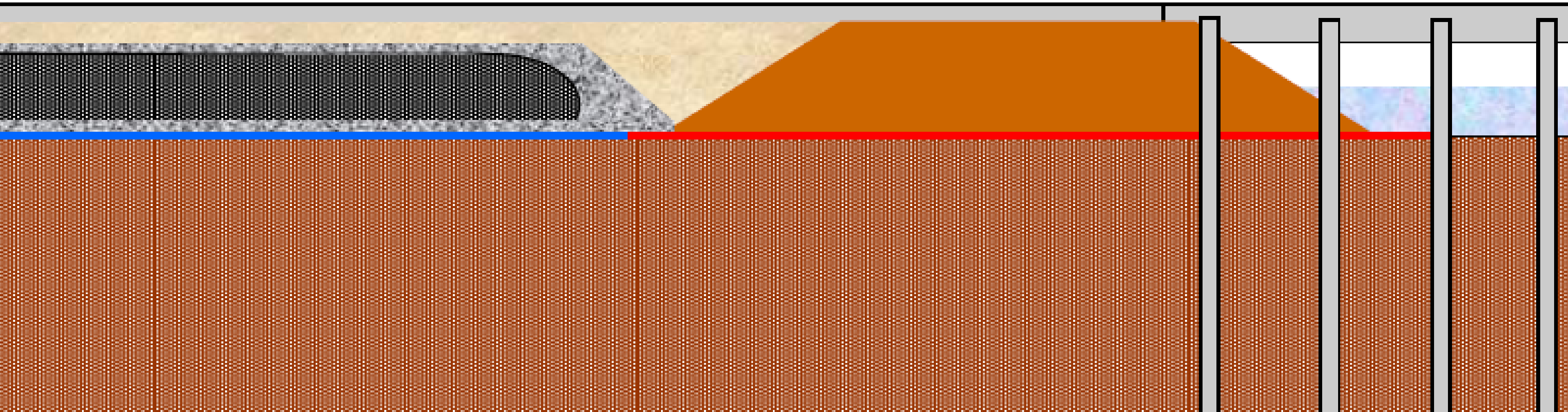
The Settlement and Consolidation Design

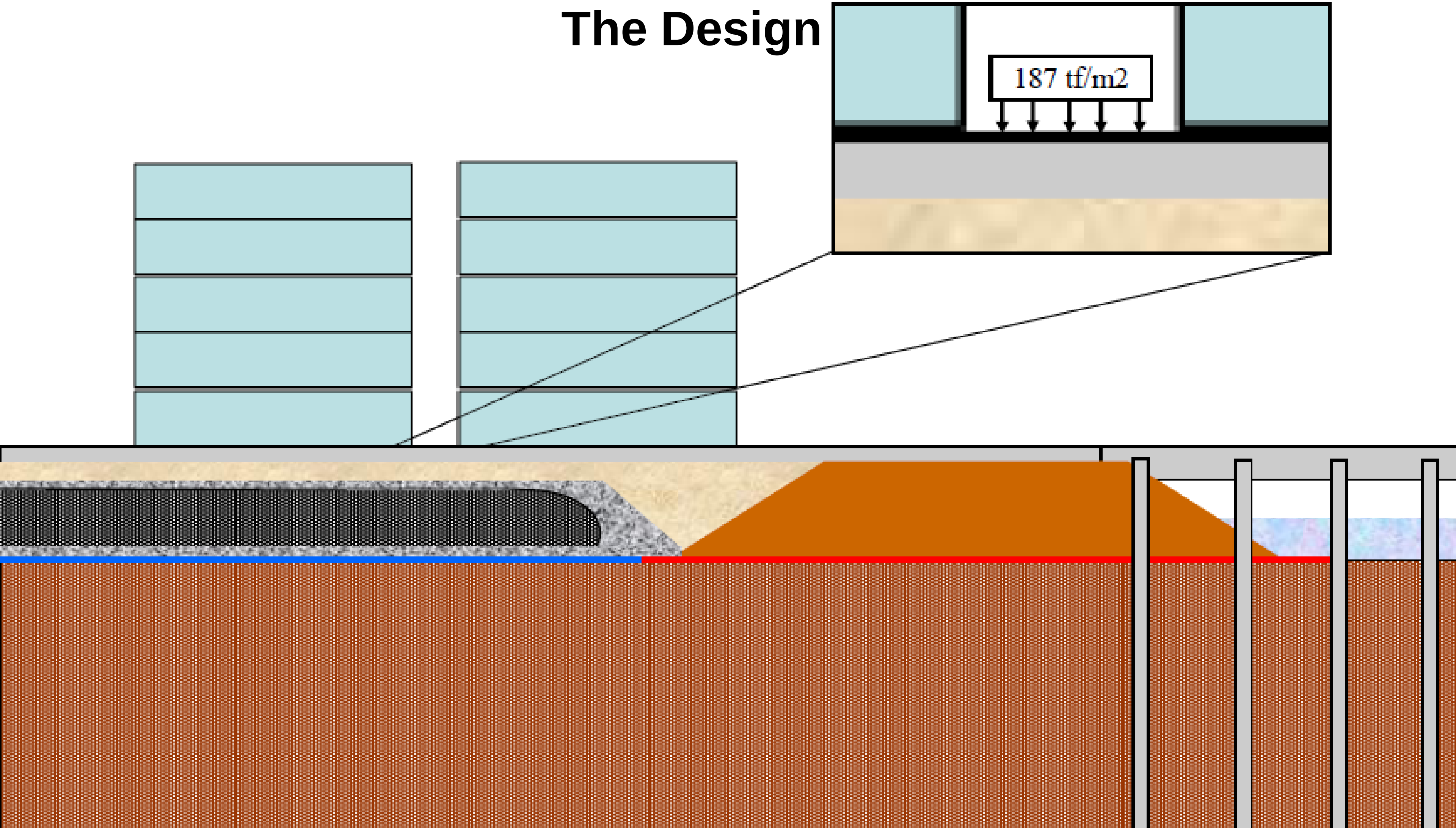


The Large Scale Consolidation Test

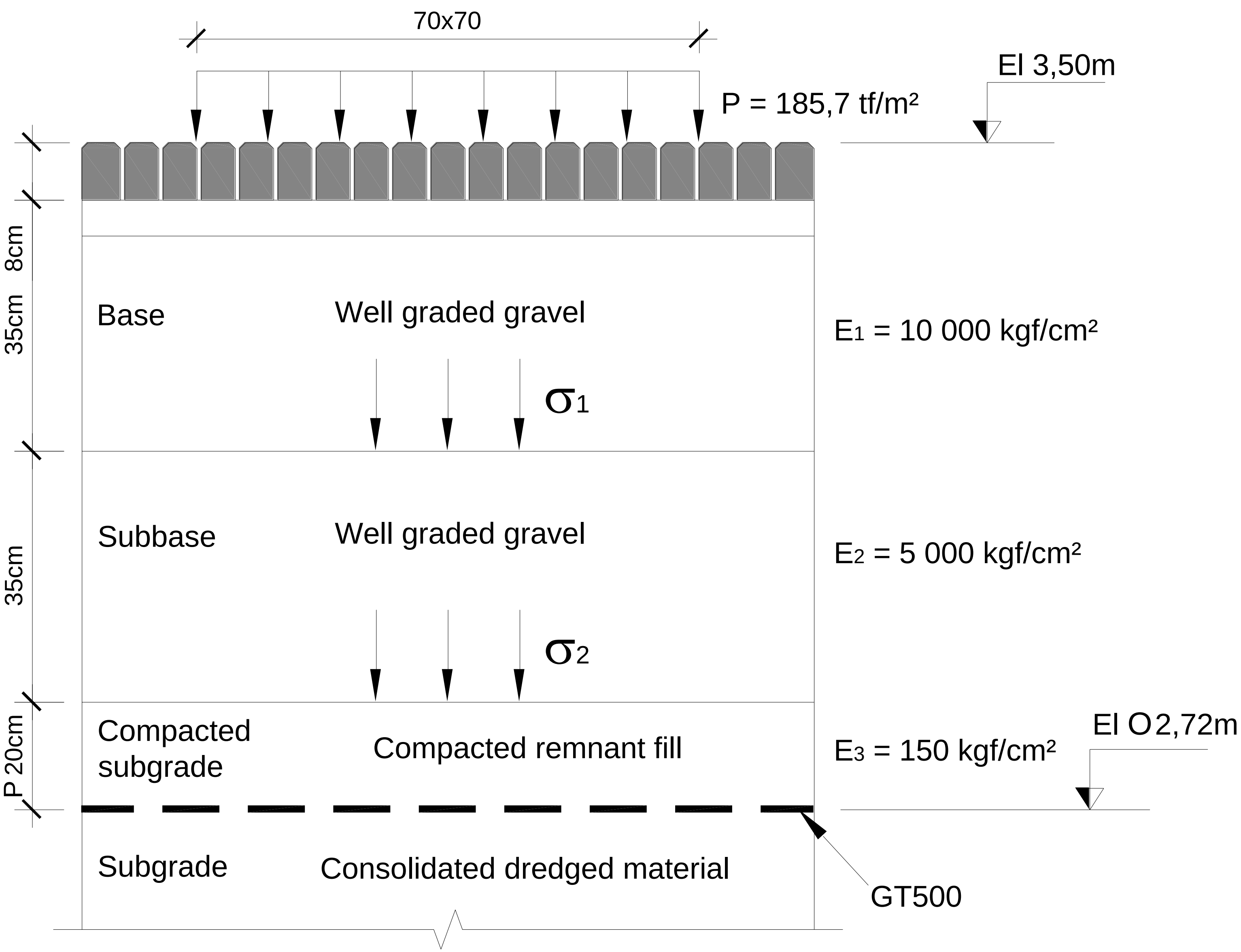
The Design



The Design



The Pavement Design



The Pavement Design

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 $\varphi = 50^o$, 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

The Construction

The Construction

March 2011

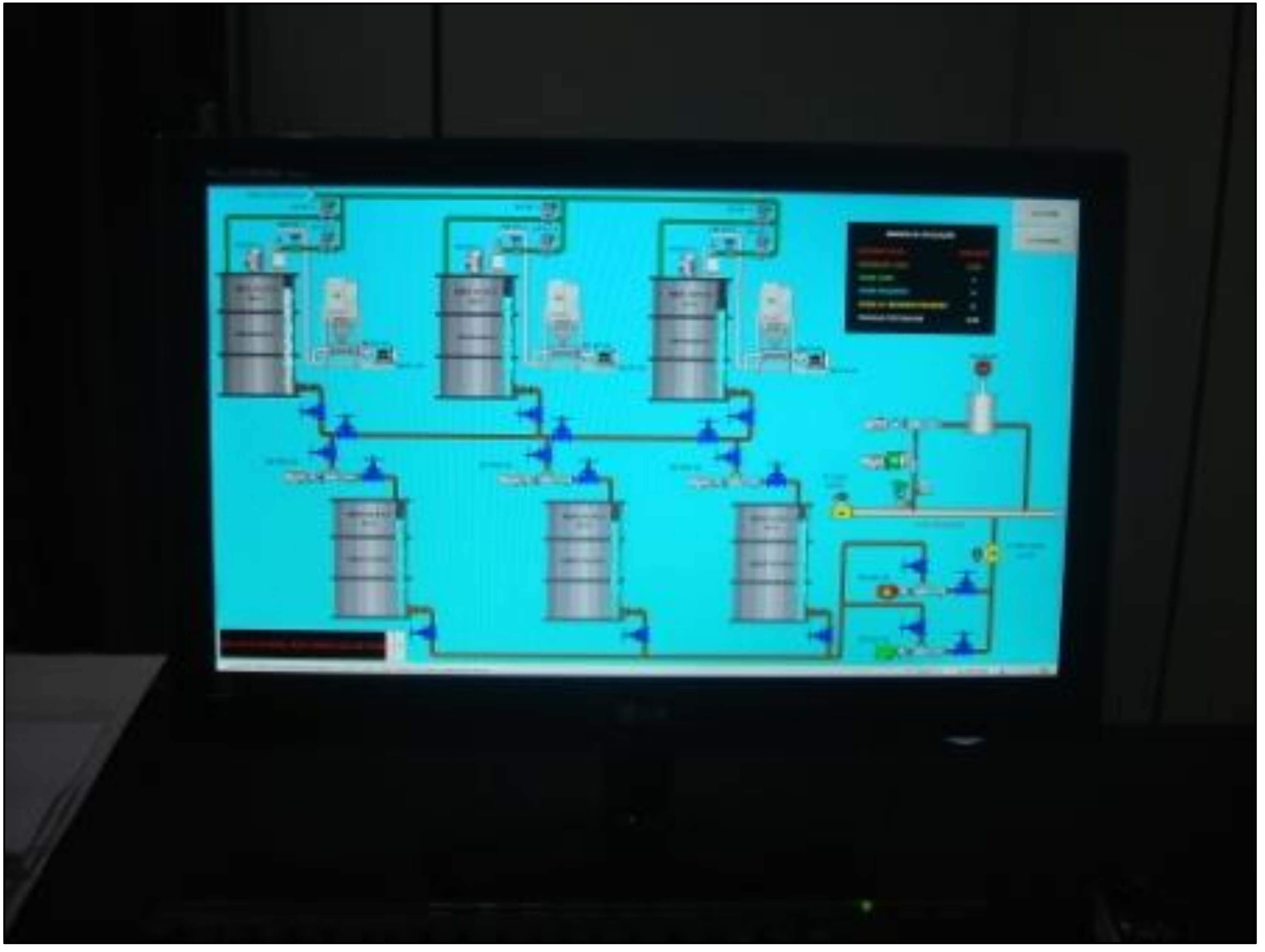
The Dewatering Operation

May 2011

The Dewatering Operation

May 2011

The Dewatering Operation



The Dewatering Operation

May 2011

The Dewatering Operation

May 2011

The Dewatering Operation

The Construction

The Construction

The Construction

The Construction

March 2013

The Construction

May 2013

The Project In Operation

Aug. 2013

The Project In Operation

Aug. 2013

The Conclusion

- Geotechnical / Environmental Standards of Practice and Modeling Tools are available to predict the actual field results of Geotextile Tube Technology

- Geotextile Tubes can be used to contain, dewater, and consolidate certain marine contaminated sediments to a sufficient degree of consolidation and in significant quantities such to allow for use as structural fill

- The utilization of Geotextile Tube Technology created a savings for construction of the Embraport project in excess of $50 million/USD

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Questions are welcome.

Thank you for your interest.

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