South Elmsall Constructed Wetlands

September 2024 / April 2025

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Overview

Development of RoadCem a cement modification catalyst began in the Netherlands over twenty years ago. Based on Nano quantities of alkali earth metals to extend crystal growth.
Encouraged by the results, zeolites were added to control/extend the hydration process using their natural ability to absorb and release moisture. This allowed control of the availability of water during the second phase of hydration to prevent CSH pasting interfering with the hydration process.
Testing carried out by Coventry University showed that would provide strength without swell on treating high sulphate clay. Our RoadCem was used at a mix ratio of 1% by weight of cement and swell was reduced to almost zero.
To validate this, result the hydration process was studied and to quote Samuel Ngambi senior researcher: "The evolution of extended crystallisation in the hydration mechanism of the stabilised products with the incorporated RoadCem as revealed by SEM indicated a "wrapping" (matrix of interlocking filaments) structure – a phenomenon which is responsible for the improved mechanical properties of the stabilised soils."
What has been shown here is that the longer crystals developed by adding RoadCem are wrapping around the particles being bound, unlike with cement alone when the particles are literally glued together.
Coventry University also observed that the dense void free product formed by adding RoadCem to the cement mix was noticeably less permeable.
"The moisture retention of the RoadCem-modified soils was initially higher but reduced subsequently as the saturation level increased with decreasing suction. This phenomenon confirmed that the soils stabilised by including RoadCem are waterproof in nature which ensures reduced porosity and suction even at reduced water content."
It has been proved both in the laboratory and field applications that RoadCem can bind organic topsoil and low moisture peats to form durable, impermeable infrastructure.
With the confidence that we had a product/technology that could be used to treat in-situ topsoil to form strong durable bound earth structures, we approached Eric Wright Water Ltd and suggested that soil stabilisation on their proposed Yorkshire Water constructed wetland development at South Elmsall could save carbon, cost and construction time.
All parties agreed that it would be a sustainable environmental breakthrough if this project could be carried out without importing stone and clay soil to site also avoiding the use of plastic liners.

POWERCEM TECHNOLOGIES

Rogers Leask Design & Testing For Wetlands Project

It is understood that the primary purpose of the stabilised layer is to provide a low permeability liner for the proposed lagoons. The tri axial cell permeability test result of 3.4 x 10-08 represents a very low permeability and is only marginally above the specification for puddle clay. In addition, this is based on only 2 days curing time; permeability would be expected to decrease further following additional curing time.

The classification tests results for the topsoil generally meet the requirements of the specification.

With regards to dispersibility, the classification "ND3" typically suggests that the soil is relatively non-dispersive, meaning it retains its structural integrity when in contact with water.

The "Rate of Flow" of 1.50 ml/s indicates the rate at which water flowed through the soil-water mixture, which is relatively low, and consistent with non-dispersive soils.

The "Colour Cloudiness" described as "Barely visible" suggests that there was only minimal cloudiness or turbidity in the water after the test. This is a positive sign for non-dispersive soils.

The "Hole Diameter After Test" of 1.60 mm indicates that there was some enlargement of the pinhole during the test, but it remained relatively small. This enlargement could be due to a small amount of dispersion but is not considered to be excessive.

Although the ND classification is slightly greater than the puddle clay specification, the material is considered to be relatively non-dispersive.

The ability of the soil to disperse will diminish further following additional curing time.

Values of Total Potential Sulphate (3 times total sulphur) are less than 0.25%, which is the recommended limit above which lime/cement binders may not be considered suitable due to the potential for swelling.

The risk of swelling due to sulphates is therefore considered to be minimal, although further testing is recommended to confirm this preliminary assessment.

On the basis of the above and the laboratory tests undertaken, the permeability and dispersibility of the topsoil following stabilisation with RoadCem and Cement additives is considered to be sufficiently low for the proposed application of a lagoon liner in principle. It is recommended that site trials are undertaken to confirm the above, and appropriate in-situ testing undertaken following placement to confirm suitably low permeability has been achieved, in accordance with an Engineer’s Specification.

The pinhole test device is an instrument for direct measurements of the dispersibility anderodibility of fine-grained soil, using a flow of water passing through a small hole in a the specimen (Sherard et al. 1976), under hydraulic heads (H) ranging between 50 and 1020 cm.

Dispersibility is assessed by observing effluent colour and flow discharge through the hole, by visual inspection of the hole after the completion of the test.

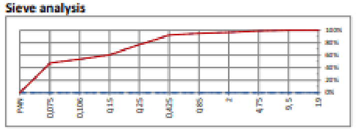
According to Sherard et al. 1976, the test is highly reproducible and the results of each individual test can be categorized easily.

RL RODGERS LEASK
Consulting Civil & Structural Engineers

POWERCEM TECHNOLOGIES

Top Soil Testing Results for Wetlands Project

Sieve analysis



Atterberg Limits

Plastic Limit	PL	24
Liquid Limit	LL	37
Plasticity Index	PI	13

Design

Soil (dry)	10.767 g	
RoadCem	**0,8 kg/m³**	0,05%
Cement	**81 kg/m³**	5,0%
w.c.f.	0,50	2,5%

Amounts

Soil	13.200 g
RoadCem	5,4 g
Cement	538 g
Water	269 g
Volume mixture	*8,1 dm³*

Water

Nat. moisture content	2.433 g	22,6%
Water to optimum	0 g	0,0%
Water for cement	269 g	2,5%
Additional water	0 g	0,0%
Total water	**2702 g**	**25,1%**

Samples (4" cylinders)

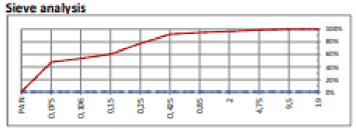
Amount (volume)	6 pcs	5,7 dm³
Density of mix		1988 kg/m³
Minimum soil required		11,3 kg

Unified Compressive Strength (UCS)

2 days	**1767 g**	**2,6 N/mm²**
	1747 g	2,5 N/mm²
	1786 g	2,6 N/mm²
5 days	**1692 g**	**3,5 N/mm²**
	1684 g	3,4 N/mm²
	1700 g	3,7 N/mm²
28 days	**1657 g**	**4,4 N/mm²**
	1659 g	4,8 N/mm²
	1655 g	4,0 N/mm²

Comments

Sieve analysis



Atterberg Limits

Plastic Limit	PL	24
Liquid Limit	LL	37
Plasticity Index	PI	13

Design

Soil (dry)	10.767 g	
RoadCem	**1,1 kg/m³**	0,07%
Cement	**113 kg/m³**	7,0%
w.c.f.	0,50	3,5%

Amounts

Soil	13.200 g
RoadCem	7,5 g
Cement	750 g
Water	375 g
Volume mixture	*8,1 dm³*

Water

Nat. moisture content	2.433 g	22,6%
Water to optimum	0 g	0,0%
Water for cement	375 g	3,5%
Additional water	0 g	0,0%
Total water	**2808 g**	**26,1%**

Samples (4" cylinders)

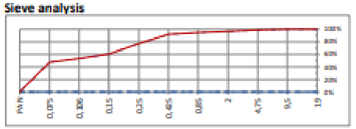
Amount (volume)	6 pcs	5,7 dm³
Density of mix		*1988 kg/m³*
Minimum soil required		*11,3 kg*

Unified Compressive Strength (UCS)

2 days	**1788 g**	**2,8 N/mm²**
	1790 g	2,8 N/mm²
	1785 g	2,7 N/mm²
7 days	**1714 g**	**3,8 N/mm²**
	1723 g	3,7 N/mm²
	1705 g	4,0 N/mm²
28 days	**1679 g**	**4,9 N/mm²**
	1673 g	5,0 N/mm²
	1685 g	4,8 N/mm²

Comments

Sieve analysis



Atterberg Limits

Plastic Limit	PL	24
Liquid Limit	LL	37
Plasticity Index	PI	13

Design

Soil (dry)	10.767 g	
RoadCem	**1,5 kg/m³**	0,09%
Cement	**146 kg/m³**	9,0%
w.c.f.	0,50	4,5%

Amounts

Soil	13.200 g
RoadCem	9,7 g
Cement	969 g
Water	485 g
Volume mixture	*8,1 dm³*

Water

Nat. moisture content	2.433 g	22,6%
Water to optimum	0 g	0,0%
Water for cement	485 g	4,5%
Additional water	0 g	0,0%
Total water	**2918 g**	**27,1%**

Samples (4" cylinders)

Amount (volume)	6 pcs	5,7 dm³
Density of mix		*1988 kg/m³*
Minimum soil required		*11,3 kg*

Unified Compressive Strength (UCS)

2 days	**1812 g**	**3,1 N/mm²**
	1792 g	3,0 N/mm²
	1832 g	3,2 N/mm²
5 days	**1728 g**	**4,2 N/mm²**
	1749 g	4,1 N/mm²
	1706 g	4,2 N/mm²
28 days	**1709 g**	**5,5 N/mm²**
	1701 g	5,5 N/mm²
	1716 g	5,5 N/mm²

Comments

PowerCem Technologies

www.powercem.com

South Elmsall Sewage Treatment Works Wetlands

Philosophy

The primary objectives for using PowerCem products in wetland construction are:

1. To significantly reduce the carbon footprint of the construction
2. To preserve virgin aggregate resources
3. To avoid the use of a manufactured membrane
4. To create a facility that can be maintained simply and safely throughout its intended design life
5. To use materials that can be fully recycled at end of life of the facility, with zero waste

Project Details

The goal of the project was the creation of 5 no. wetland cells at Yorkshire Water Sewage Treatment Works (STW) in South Elmsall, Yorkshire, covering a total area of approximately 25,300m^2 in order to provide sewage water treatment and retention capacity and help reduce storm overflow discharges into Frickley Beck, a tributary of the River Don. Pollutants and nutrients from the storm water will be broken down and removed by a planting regime within the cells. The wetlands will accommodate a flow of 440 l/s of diluted waste water.

Methodology

The design of the wetlands was engineered to ensure a balanced cut/fill; no soil to landfill and no imported soil or granular material.

The wetland was constructed in a field adjacent to the existing sewage treatments works, between the railway line and the beck.

The superficial vegetation was stripped off and the topsoil removed and stockpiled.

The bulk earthworks were carried out to create the plateaus for each of the 5 cells.

The bases of the cells were stabilised in-situ, to a depth of 250mm, utilising RoadCem and

South Elmsall Sewage Treatment Works Wetlands

The topsoil was stabilised ex-situ, placed in 250mm layers and compacted, to form the perimeter and internal embankments to the cells.

The embankments were formed oversized and trimmed back to the final profile after 1 week.

Prior to commencement laboratory tests had been carried out to prove the impermeability and strength of the stabilized soils. The target permeability was to match the characteristics of
puddle clay..

The first cell to be completed was filled with water, estimated to be in the region of 6 million litres, which successfully proved the low permeability and robustness of the construction.

The stabilised embankments have been cut through to enable the installation of the in-situ concrete inlet and outlet structures and the precast concrete inter cell cascades.
Examining the embankments in section at the cuts gave further confidence on the strength and consistency of the stabilized material.

Carbon Footprint

The original design intent was to export all of the topsoil to landfill and to import a similar quantity of clay to form the cells.

It is estimated that this would have involved around 3,000 heavy goods vehicle movements.

Access to the STW is along a single-track road, through South Elmsall train station car park.

The original design included construction of a 650m long temporary access road across fields to the main road to the south of the site, requiring 2 bridges over the beck and a formal junction at the main road.

Stabilising the site won materials reduced the HGV movements to simply delivery of the RoadCem and cement and the construction plant.

The temporary road was not required with the RoadCem design, creating a very significant saving in quarried stone and the carbon footprint associated with the construction of the haul road.
At the end of the project the field would have been reinstated and the construction materials would have been waste due to contamination with soil from the vehicles.

Based on detailed studies of other projects in the UK and globally it is estimated that the reduction in carbon footprint would be in the region of 80%. The data to carry out the detailed study at South Elmsall is not available.

The omission of the liner is a further saving in carbon footprint in terms of the manufacture and transport of the membrane.

South Elmsall Sewage Treatment Works Wetlands

Technology

Cement and lime simply ‘glue’the particles together, resulting in a brittle material with little tensile strength.

RoadCem significantly enhances the stabilisation process by wrapping the particles in a needle like matrix, which can be observed at a microscopic level.

The resultant material has good tensile strength, a high modulus and is relatively impermeable.

This means that large areas can be stabilised with excellent crack control, such that movement joints are not required.

A greater proportion of the cement is included in the hydration process which improves the durability of the stabilised material.

Contaminants are locked into the microstructure, preventing leaching of contaminants.

RoadCem can be used with soils which are not suitable for lime, or cement stabilisation such as soils with high organic content and clays with high sulphate content and high-volume change potential.

Design and Verification

The final layout of the cells and the cut/fill model were carried out by Civil Engineers from Rodgers Leask Ltd.

The soil sampling, laboratory testing, geotechnical design and site monitoring and verification were carried out by Geotechnical Engineers from Rodgers Leask Ltd.

Maintenance and End of Life

The stabilised material forming the bases and embankments of the cells enables mechanical plant to enter the cells for maintenance without damaging the integrity or the water retaining properties. The use of a liner would have made maintenance more difficult.

When the cells are eventually decommissioned the stabilised soil can be recycled, either as a growing medium, or as an aggregate for use elsewhere.

South Elmsall Sewage Treatment Works Wetlands

What does RoadCem Stabilised Soil Look Like?

The photographs below shows a 250mm deep block cut out of the base of a cell with a floor saw, this allows the wetlands cascades to be precast off site and cemented into precut channels in the RoadCem stabilised soil base/embankments. The ductile RoadCem structure retains its water tight integrity with no breakaway or cracking.

PowerCem Proposals

Stabilised Alluvium top soils to form strong water tight containment basins.

- Remove and store existing 250 mm of top soils, to allow access to clay sub soils which will be removed for later placement as reed growing medium.
- Replace and stabilise top soils with RoadCem to form water tight containment cells. Before replacing clay for reed planting and installing connecting pipe work between cells.

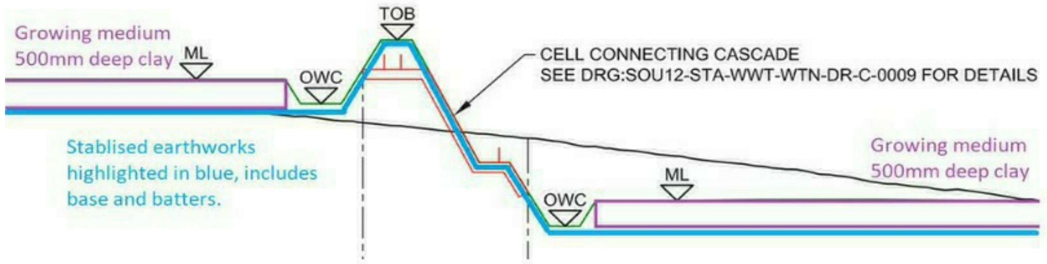


IMAGE SOURCE, YORKSHIRE WATER

The Benefits of RoadCem Soil Stabilisation

Project benefits gained from the use of RoadCem in-situ soil stabilisation:-

- Reduced earthworks and necessity to remove top soils from site or import materials to site.
- RoadCem offers rapid production of the impermeable stabilised bearing/bund layers.
- Non-leaching stabilisation means no environmental contamination concerns during installation or from subsequent saturation of the RoadCem stabilised layer once the water is introduced. Also avoiding the environmentally sensitive need to use plastic membranes.
- RoadCem is not a 'soft stabilisation' technique it forms robust, crack free layers that will not soften over time when exposed to standing and/or running water.
- The RoadCem treated basins will have a high dynamic stiffness allowing dumpers and plant to operate across the basins to place the growing medium and also to carry out any future maintenance and /or growing medium replacement.
- RoadCem stabilised soil has a really high insulation value (Ulster University FireSERT Dept) this can help keep water warmer increasing winter wetland efficiency.

RoadCem Soil Stabilisation: Technical Information

RoadCem is a patented additive used to enhance cement based soil stabilisation. It is an inert blend of synthetic Zeolites, and alkaline earth metals formed into a powdered Product and supplied in 25 kg bags.

RoadCem enhances the behaviour of the cementitious reaction acting as a catalyst to produce a unique form of Nano-scale crystal growths within the cement bound material promoting the formation of long needle like crystals which create a binding lattice between and around the soil particles filling any voids.

This crystalline structure differs from that with a standard cement stabilisation where gluing between adjacent soil particles occurs to develop strength, creating a strong but inherently brittle bind which can be prone to cracking.

This binding lattice matrix produces higher tensile strengths and flexural stiffness of the end product, making it more robust and resistant to cracking able to withstand high loadings, and repeated soaking and saturated conditions.

The key source of structural failure in hydraulically bound materials, comes from porosity. Pores cause cracks, structural failure and enable the penetration of water and corrosive agents.

Porosity is very important, in determining the strength of a material. Pores in stabilised soils determine the strength and overall ability of the construction material to withstand mechanical strain caused by heat, shear forces or water/chemical degradation.

Pores with RoadCem are normally of a size range 2.5 to 20 Nano meters (nm) (or 0.0025 to 0.02 microns) and are considered harmless pores.

Pores in cement stabilised soils without RoadCem will normally be larger decreasing the mechanical strength, density, as well as the ability of the stabilised soil to resist degradation and long term saturation.

When the pores in the stabilisation are filled by adding RoadCem, the mechanical strength, density and life span of the structure increases substantially.

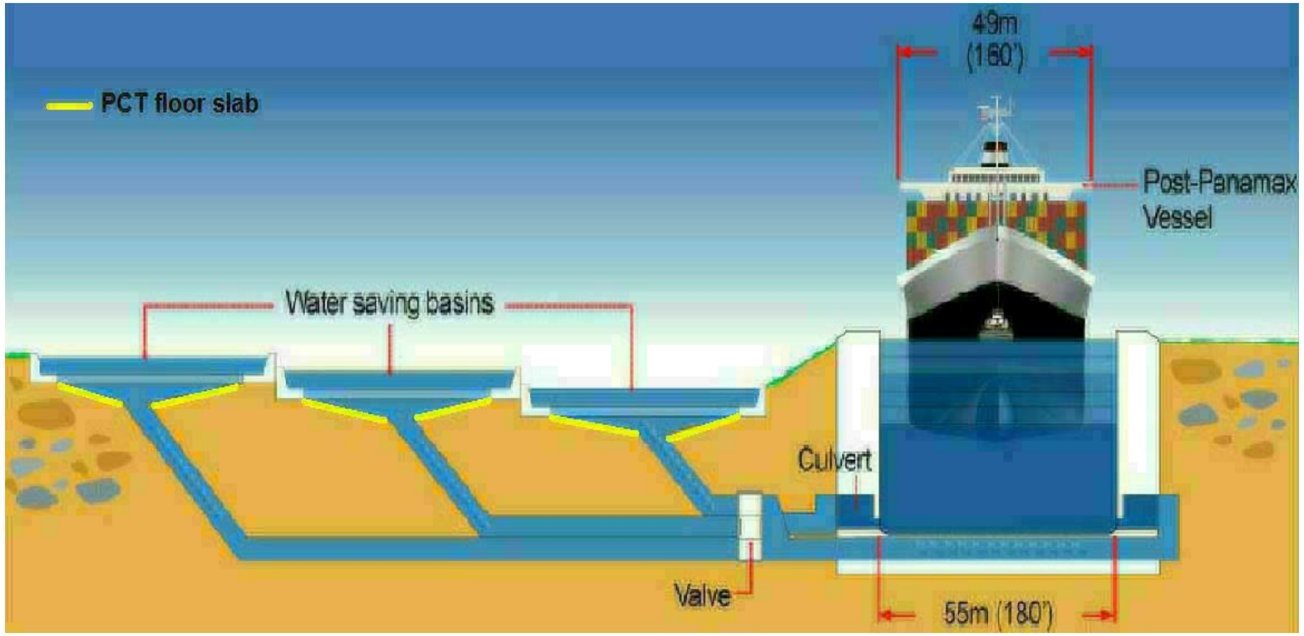
Despite the very wet weather at the start of the project in September followed by unusually cold temperatures and snow in December/January.

Progress at South Elmsall has continued on schedule.

As using alluvium topsoil for the permanent structure of the water basins has not been utilised in the UK before, there has been a learning curve for all parties.

Nothing has proved beyond the capabilities of the construction team from DNS (Midlands) and it is fair to say that lessons learned will make the next project far easier.

The biggest lesson learned is to be patient with the weather and that The concept of reusing existing site materials is perfectly possible when new technologies like RoadCem are used in a sensible sustainable way.



RoadCem in-situ stabilised soils used for lining the three Water Basins

New Locks for the Panama Canal

2012-2014

The Three large RoadCem treated Water Basins have performed without problems since installed.

STRENGTH CONTINUES TO INCREASE

Fall Line
TESTING & INSPECTION PANAMA, S. de R.L.

The Panama Canal
Third Set of Locks Project
Compressive / Tensile Strength Cylinders (LAB)

Project Name	ATLANTIC	Project Number	F100013	Date Sampled	7-Jun-12	Time Sampled**	02:30 p.m.	Time Batched**	N/A
Sample No.	5003	Mix Design ID**	N/A	Design Strength	N/A	Technician	AS-RS	Mixing Time**, s	N/A
Ticket #**	N/A	Truck #**:	70	Batching Plant I.D.**	N/A	Checked By	ER		

Sample Location: ☐ Field ☑ Lab ☐ Plant — Placement Location** POWER CEMENT F300 LAB TEST (35 CILINDROS 3 VIGAS) — w/cm** N/A

Slump (mm)	90	Air Temp. (ºC)	28	Concrete Temp.* (ºC)	32.8	Air (%)	1.2
Mtl. & Pot Weight (kg)	21.37	Pot Weight (kg)	3.85	Pot Volume (m^3)	0.0071	Unit Weight (kg/m^3)	2468

Wet Sieve? ☐ Yes ☑ No

Scale ID 3375 ☑ Scale Check — Air Meter ID 5000 — Thermometer ID 3371 — Slump Cone ID 3050

Mix Type		SPECIFICATIONS	Slump	Air	Concrete Temp	Air Temp
	MARINO		N/A	N/A	N/A	N/A

Age (day)	Date	Cyl No.	Height (mm)	Dia (mm)	Area (mm^2)	Fracture Type	Weight (kg)	Unit Weight (kg/m^3)	Test Method	Initials	Total Load (kN)	Strength (MPa)	Checked By
3	10-Jun-12	1	304.8	152.4	18241.47	3	14.047	2526	C	M.A	414.7	22.7	SB
7	14-Jun-12	2	304.8	152.4	18241.47	4	14.09	2534	C	M.A	484.8	26.6	SB
7	14-Jun-12	3	304.8	152.4	18241.47	3	14.03	2523	C	M.A	502.7	27.6	SB
28	5-Jul-12	4	304.8	152.4	18241.47	5	14.05	2527	C	M.A	634.8	34.8	JH
28	5-Jul-12	5	304.8	152.4	18241.47	4	14.06	2529	C	M.A	662.5	36.3	JH
90	5-Sep-12	6	304.8	152.4	18241.47	4	14.06	2529	C	DG	878	48.1	MM
90	5-Sep-12	7	304.8	152.4	18241.47	4	14.05	2527	C	DG	857.8	47.0	MM
120	5-Oct-12	8	304.8	152.4	18241.47	4	14.03	2523	C	HM	1025.2	56.2	MM
120	5-Oct-12	9	304.8	152.4	18241.47	4	14.02	2522	C	HM	1059.8	58.1	MM
		10											
		11											
		12											

Test Method: C = Compression E = Modulus of Elasticity T = Split Tensile

*The measured temperature represents the temperature of the test sample at the time of testing only.
** As reported in GUPC's batching ticket
Abbreviations Used: Dia = diameter, Mtl. = material, Temp = Temperature, Predet. = predetermined
Referenced ASTM Standards: C172, C143, C138, C231, C173, C31, C617, C1231, C39, C496, C1064

Erick Reveles

Firmado digitalmente por Erick Reveles
Nombre de reconocimiento (DN): cn=Erick Reveles, o=Fall Line Testing and Inspeciton Panama, ou, email=Erick.Reveles@falllinetsting.com, c=<n
Fecha: 2012.10.05 16:50:18 -05'00'

G00/FALTWS0017
Rev. 031212

Fall Line Testing Inspection Panama, S. de R.L.
Piso 6 • Oficina 608
Panama, Panama

1/1

PERMEABILITY TESTING- PANAMA CANAL BASINS

CEDEM
Centro de Diagnosis y Evaluación de Materiales.
Sabino del Valle No.516 Col. Valle de León
Tel / Fax 52+(477) 636.54.18 / 43 Email: cone2@axtel.net
37140 León, Guanajuato, México.

CLIENTE	POWERCEM MEXICO	FECHA EMISION	14 DE AGOSTO DE 2012
LOCALIZACION	CANAL PANAMA	No. REPORTE	1
ATENCION	ING. OROZCO	No. CONTROL	1

CONCRETO ENDURECIDO, MASA ESPECIFICA, ABSORCION Y VACIOS NMX C 263 / ASTM C 642

MTRA	FECHA	MUESTRA	CLASIF	ALTURA	DIAM	PESOS (grs)				ABS-I	ABS-E	g1	g2	VACIOS
No.	ELAB	UBICACIÓN	TIPO	(cm)	(cm)	A	B	C	D	(%)	(%)	Mg/m³	Mg/m³	(%)
E24	11-07-12	ConcreCem	CIL	29.8	15.0	12,125	12,550.0	12,360.0	7,120.0	3.51	1.94	2.31	2.42	4.48
E25	11-07-12	ConcreCem	CIL	29.8	15.0	12,205	12,625.0	12,440.0	7,171.0	3.44	1.93	2.32	2.42	4.46
E26	11-07-12	ConcreCem	CIL	25.0	15.0	10,120	10,285.0	10,235.0	5,840.0	1.63	1.14	2.30	2.36	2.62
E27	11-07-12	ConcreCem	CIL	30.0	15.0	11,875	12,060.0	12,050.0	6,655.0	1.56	1.47	2.20	2.27	3.24
5														
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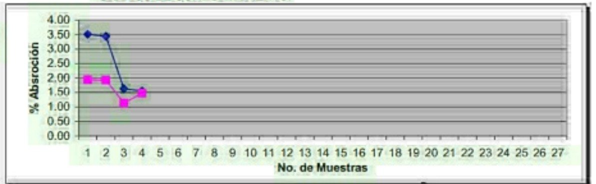
22														
23														
24														
25														
ESTADISTICOS		MEDIA		28.7	15.0	11,581.3	11,880.0	11,771.3	6,696.5	2.53	1.62	2.28	2.37	3.70
		DESV. EST.		2.4	0.0	1120.7	1221.0	1037.9	616.4	1.1	0.4	0.1	0.1	0.9

SIMBOLOGIA.

A	Masa Seca (grs)
B	Masa saturada por inmersión y superficialmente seca (grs)
C	Masa saturada por ebullición y superficialmente seca (grs)
D	Masa de la probeta sumergida (grs)
g1	Masa especifica seca (grs)
g2	Masa especifica aparente (grs)
ABS-I	Absorción por Inmersión
ABS-E	Absorción por Ebullición

GRAFICO DE COMPORTAMIENTO:



OBSERVACIONES:

Absorción después de Inmersión:	2.53	%
Absorción después de la Ebullición:	1.62	%
Masa especifica seca:	2.28	Mg/m³
Masa aparente:	2.37	Mg/m³
% Volúmen de poros permebles:	3.70	%

Las muestras elaboradas con ConcreCem presentan menor absorción y % de volumen de poros permeables.

Ing. Alfonso Rafael Ayala Pérez.
Gerente Técnico
Ced. Prof. No.2076742

Registro No.6002 CNEC | Registro No.PCL/LB/001 OPM | Registro No. 2-314 DRO/DU | CEDEM-ABS-01C

CENTRO DE INVESTIGACIONES DE INGENIERIA
FACULTAD DE INGENIERIA
UNIVERSIDAD DE SAN CARLOS DE GUATEMALA

INFORME No.: 235 S.S. **O.T. No.:** 32.421

INTERESADO: Productora Acuario, S.A.
PROYECTO: Represa
ASUNTO: Ensayo de Permeabilidad Cabeza Variable
NORMA: ASTM D 5856-00
UBICACIÓN: Escuintla
MUESTRA No.: 1 **PROFUNDIDAD:** X metros
DESCRIPCIÓN DEL SUELO: Limo Arenoso Color Café
FECHA: Lunes, 28 de Abril de 2014

RESULTADO DEL ENSAYO:

Caudal de Entrada = 1,24 x 10^{-10} m³/s
Caudal de Salida = 0,00 m³/seg
Coeficiente de Permeabilidad= 0,00 x 10^{-9} cm/s

OBSERVACIONES:
Muestra proporcionada por el interesado.
Mezcla de Suelo, Cemento (180kg/m³) y POWERCEM (1,8 kg/m³).
Previo a ensayar se realizó curado de la muestra.

UNIVERSIDAD DE SAN CARLOS DE GUATEMALA
FACULTAD DE INGENIERIA
CENTRO DE INVESTIGACIONES DE INGENIERIA
SECCIÓN DE MECÁNICA DE SUELOS

Atentamente,

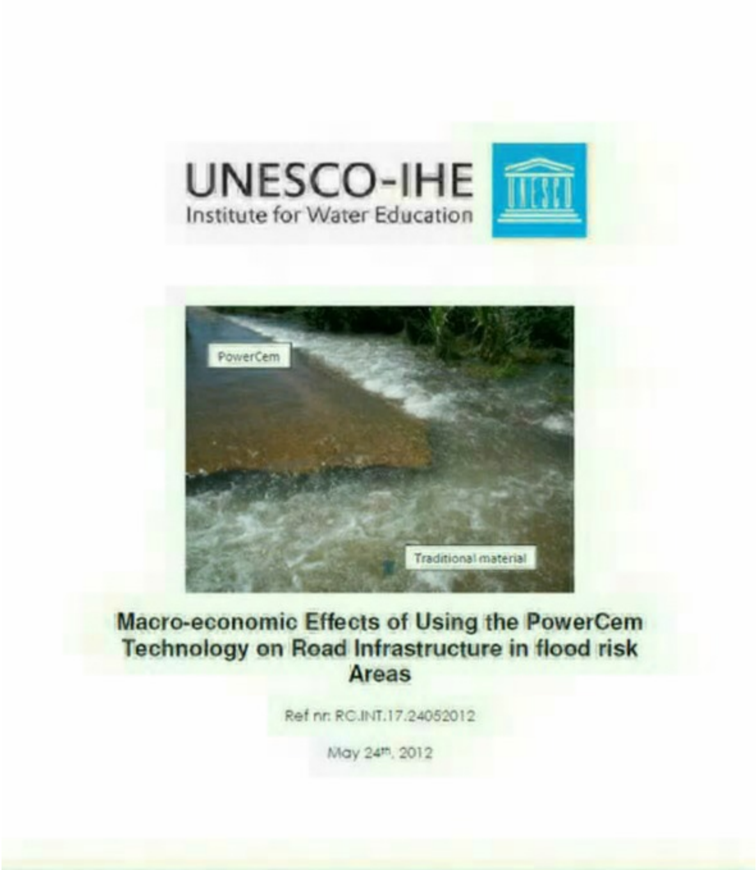
UNIVERSIDAD DE SAN CARLOS DE GUATEMALA
CENTRO DE INVESTIGACIONES DE INGENIERIA
DIRECCION

Ing. Omar Enrique Medrano Mendez
Jefe Sección Mecánica de Suelos

Vo. Bo.

Inga. Telma Maricela Cano Morales
DIRECTORA CII/USAC

FLOOD RESISTANT – IMPERMEABLE ROADCEM UNESCO RECOMMENDED


UNESCO-IHE
Institute for Water Education

Macro-economic Effects of Using the PowerCem Technology on Road Infrastructure in flood risk Areas

Ref nr: RC.INT.17.24052012

May 24th, 2012

Allows roads to remain open even after floods which wash out traditions roads

Conventional deep stone road with concrete surface

Stabilised soil road treated in-situ with RoadCem

PowerCem Technologies
Innovations for better solutions!

Riverside defences for the Motupe and La Leche Rivers in Peru

20 km of riverbank reconstruction using RoadCem to bind and stabilise the in-situ riverbank soils.

PowerCem were requested to design of a mixture of local soil with cement and RoadCem additives, so that the soil reaches specific values of compressive strength and, in turn, permeability, so that the lateral dikes fulfil the function of retaining the waters of the rivers that on many occasions have exceeded the capacity of the channel, flooding surrounding land with the consequent losses.

PowerCem Technologies
Innovations for better solutions!

SABANA YEGUA DAM

Dam runoff treated and sealed with RoadCem to prevent abrasion damage

PowerCem Technologies

WATER RESERVOIRS BUILT IN ISRAEL & EGYPT

Large Reservoirs constructed using in-situ soils stabilisation, with and without liners

PowerCem Technologies
Innovations for better solutions!

WATER RESERVOIRS BUILT IN ISRAEL & EGYPT

These are very good projects to construct with RoadCem. If you have samples and the in-situ soil characterization we
can start to prepare three different mix designs. Checking the impermeability / water absorption / shear strength / pressure and displacement.

Clay + Dutch material + 2% cement							E	
stretch vs tension	0,75	mm	400	kPa	7,07	kN	9425	kN/m^2
	0,38	mm	150	kPa	2,65	kN	6976	kN/m^2
	0,22	mm	60	kPa	1,06	kN	4819	kN/m^2
Clay + Dutch material + 4% cement							E	
stretch vs tension	0,72	mm	400	kPa	7,07	kN	9817	kN/m^2
	0,70	mm	150	kPa	2,65	kN	3787	kN/m^2
	0,21	mm	60	kPa	1,06	kN	5049	kN/m^2
Clay + Dutch material + 6% cement							E	
stretch vs tension	0,63	mm	400	kPa	7,07	kN	11220	kN/m^2
	0,48	mm	150	kPa	2,65	kN	5522	kN/m^2
	0,28	mm	60	kPa	1,06	kN	3787	kN/m^2

Design conclusion

The pressure strength of all three sample mixtures are perfectly acceptable.

Experience says that a critical shear strength of 100 á 150 kPa suffices.

The results would say that the 2% mix would be sufficient, but variations in material and mechanical installation factors have to be taken into account.

A normal factor is 1,25, so the 4% mix gets a CSS of 152 kPa. This is perfect for both strength & cost.

Large Reservoirs constructed using in-situ soils stabilisation, with and without liners

CANALISATION CAIRO

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