PowerCem Technologies

Innovations for better solutions!

RoadCem Bound Soil Piling Platforms

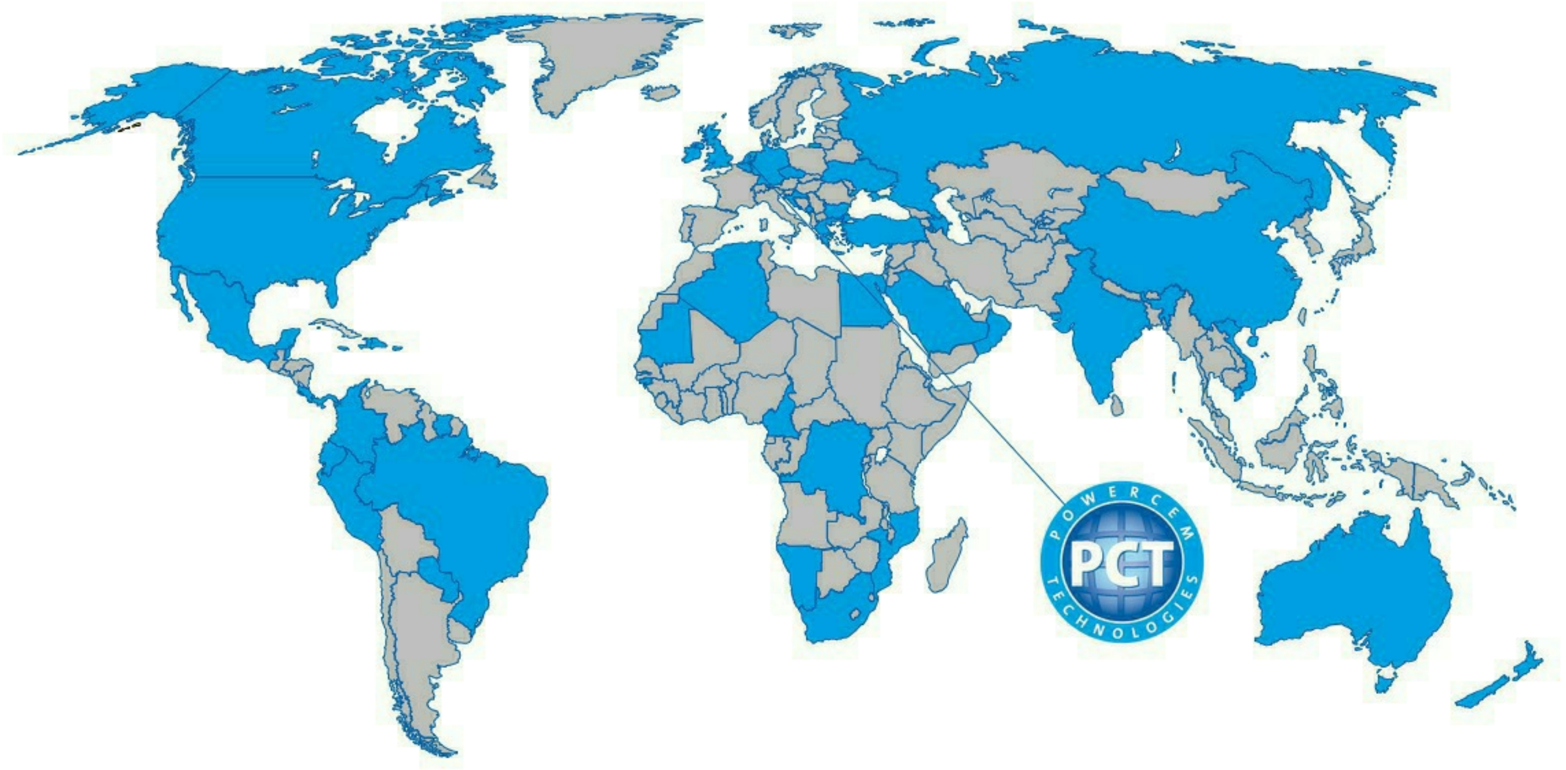
Sustainable, Safe and Sensible.

PowerCem Technologies – Who are we?

- PowerCem Technologies BV, established in 1996
    - UK Office:– Founded 2011 in Derby
- Based in Moerdijk, The Netherlands
- Specialisation: Improving cement-bound materials
- Products used worldwide

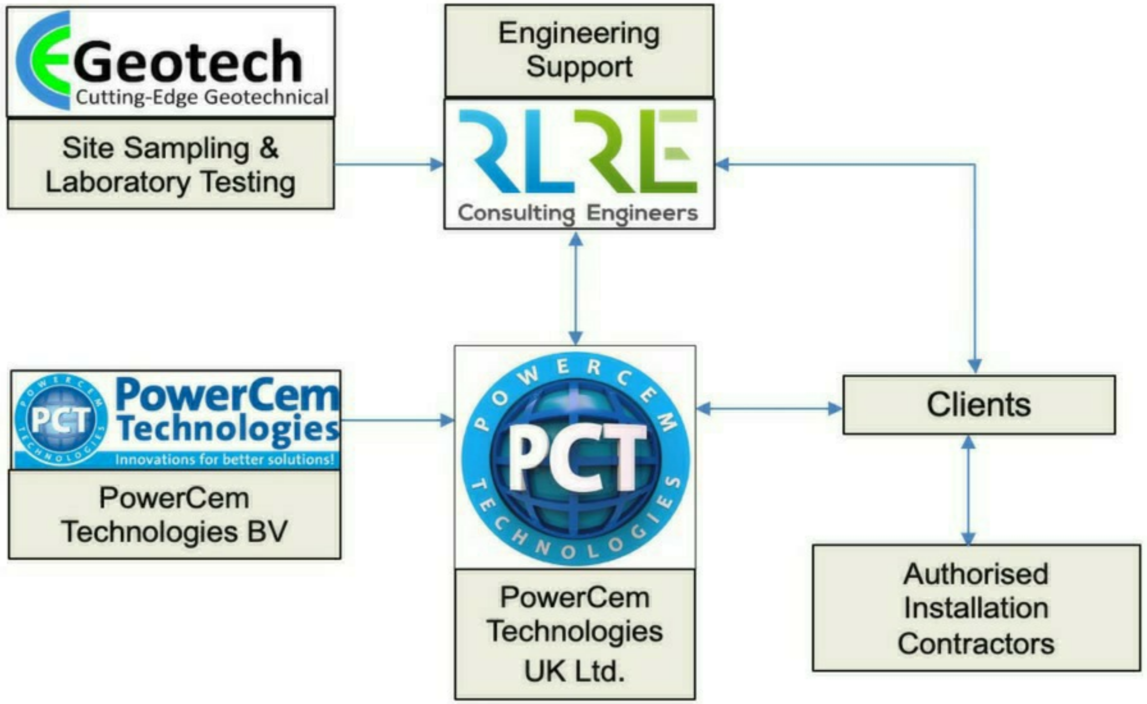
PowerCem Global Partner Network

POWERCEM WORLDWIDE



Globally RoadCem has stabilised over 11,500,000m^2 of soils

PowerCem Technologies in the UK



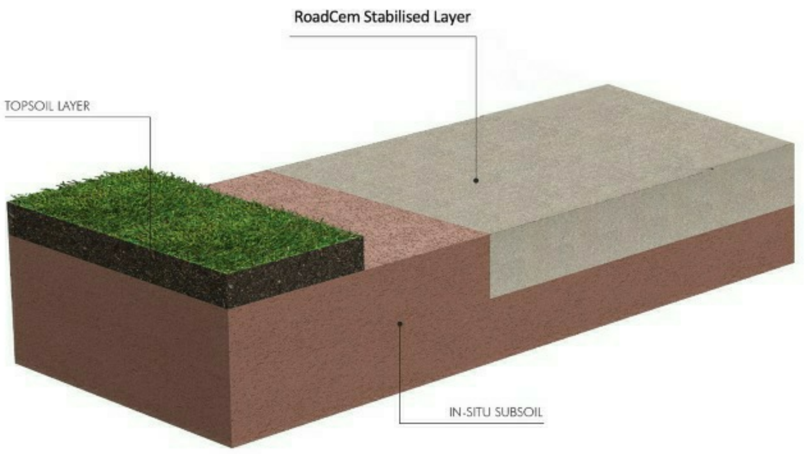
PowerCem Technologies in the UK

Rodgers Leask Consulting Engineers

- Engineering partners to PowerCem UK
- Independent third-party organisation with offices in Derby, Birmingham, Bristol, Liverpool and Nottingham
- Providing:-
  - Site sampling and lab testing co-ordination
  - Design analysis, calculations and specifications
  - Optimised mix designs to meet client requirements
  - Technical liaison for client, contractor and consultants
  - Design Performance Warranties & Piling mat certification for all rig types

RoadCem Soil STABILISATION: Single Layer Piling Platforms

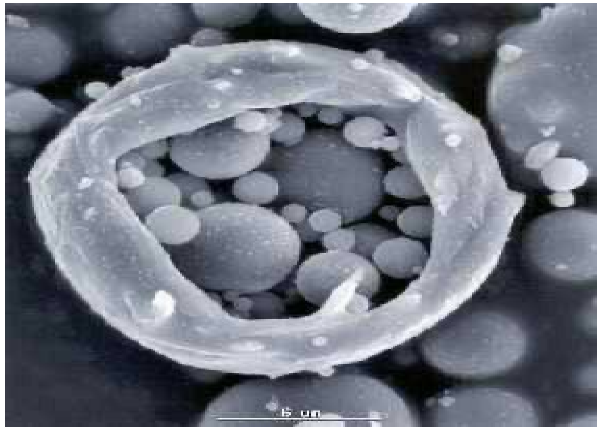
- Controlled mixing of a cementitious binder and RoadCem additive directly into soils at varying degrees of moisture content
- Improves the compressive strength and flexural stiffness and most importantly creates a piling mats with high visco-elastic properties which absorbs vibration
- Produces robust PERMANENT changes in soil material properties such as STRENGTH, DURABILITY and DUCTILITY which prevents cracking & breakaway
- Waterproof layer – no softening of stabilised layer in saturated soils or flood events
- **High resistance to expansive secondary sulphate reaction**
- Can be used with over-wet soils or those with higher organic contents >5%
- Lower residual pH levels after curing compared to pure cement binders



PowerCem Piling Mat technology in action

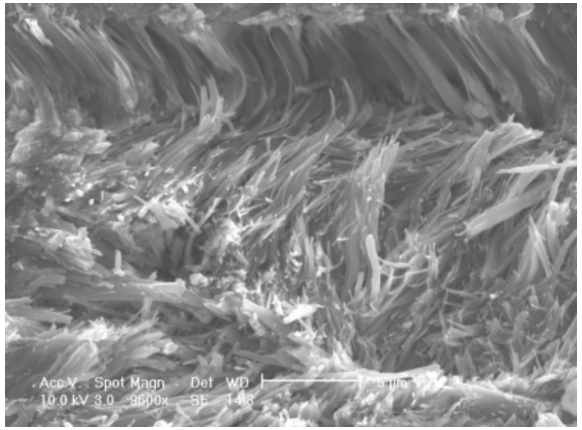
- PowerCem products are an inert blend of synthetic Zeolites, alkali earth metals and other natural minerals
- They act as a catalyst to improve the end performance characteristics of the cementitious products in question
- This is often referred to as '*Nanotechnology*'

Traditional Cement



Cement glues the aggregate particles together forming a 'brittle bond'

Cement with RoadCem additive:



Cement with RoadCem forms needle like elements , **interlocking** the aggregate particles in a 'flexible matrix'

PowerCem Piling Mat technology in action

Based on a large number of piling mat projects around the World and at the request for design information, we have made a general table for the thickness of this type of construction for all different UK in-situ soil types.

Due to the fact that the type of vehicles during the "lifetime" of this construction is on all the sites practically the same:

- pilling drilling machines
- trucks, that are delivering the piles

Based on the Bearing Capacity an estimation of the type of soil is made and a mix design is estimated and the mechanical properties of the stabilisation (1).

These mix designs are indicative, and might need to change if local circumstances are requiring this (large amounts of organic material in soil).

For the calculation of the bending moments, strains under the tires of the trucks (2) the multi-layer elastic methodology is used.

With the computer program BISAR the stresses and strains are determined.

For the calculations for the minimum thickness of the pilling drilling machines (3), the Hetenyi Method was used.
With this method the bending moment, and the shear strength can be accurately determined under the specific continuous tracks of the pilling drilling machines.

PowerCem Piling Mat technology in action

1. Mix Designs and mechanical properties of the stabilised material.

Sub grade [E_{dyn}: MPa]	Modulus of subgrade reaction [N/mm³]	Soil type	RoadCem [kg/m³]	Cement [kg/m³]	Stiffness [E_{dyn}: MPa]	Breaking strain [µm/m]	Flexural strength	Shear strength
20	0,020	Clay	2,4	240	2500	240	0,75	0,50
30	0,025	Clay	2,2	220	3000	230	0,90	0,60
40	0,030	Clay	2,2	220	3500	210	1,05	0,70
50	0,035	Clay	2,0	200	4000	190	1,20	0,80
60	0,040	Sandy clay	1,8	180	4500	170	1,35	0,90
70	0,045	Sandy clay	1,8	180	4500	170	1,35	0,90
80	0,050	Sandy clay	1,8	180	4500	170	1,35	0,90
90	0,055	Sand	1,6	160	5000	150	1,50	1,00
100	0,060	Sand	1,6	160	5000	150	1,50	1,00
110	0,065	Sand	1,6	160	5000	150	1,50	1,00
120	0,080	Sandy gravel	1,4	140	5500	140	1,65	1,10
130	0,085	Sandy gravel	1,4	140	5500	140	1,65	1,10
140	0,090	Sandy gravel	1,4	140	5500	140	1,65	1,10
150	0,095	Sandy gravel	1,4	140	5500	140	1,65	1,10

PowerCem Piling Mat technology in action

2. **Calculation of the stresses and strains for the heavy truck that are delivering the piles.**

For the calculation we assumed a standard axle load of 100 kN, with 4 wheels per axle.

PROPERTIES						DESIGN		
Sub grade [E_{dyn}; MPa]	Modulus of subgrade reaction [N/mm³]	Soil type	RoadCem [kg/m³]	Cement [kg/m³]	Stiffness [E_{dyn}; MPa]	Minimum Thickness [cm]	Strain [µm/m]	Safety factor
20	0,020	Clay	2,4	240	2500	30	202	1,19
30	0,025	Clay	2,2	220	3000	25	214	1,07
40	0,030	Clay	2,2	220	3500	25	179	1,17
50	0,035	Clay	2	200	4000	25	146	1,30
60	0,040	Sandy clay	1,8	180	4500	25	134	1,27
70	0,045	Sandy clay	1,8	180	4500	25	130	1,31
80	0,050	Sandy clay	1,8	180	4500	25	126	1,35
90	0,055	Sand	1,6	160	5000	25	113	1,33
100	0,060	Sand	1,6	160	5000	25	110	1,36
110	0,065	Sand	1,6	160	5000	20	146	1,03
120	0,080	Sandy gravel	1,4	140	5500	20	133	1,05
130	0,085	Sandy gravel	1,4	140	5500	20	130	1,08
140	0,090	Sandy gravel	1,4	140	5500	20	127	1,10
150	0,095	Sandy gravel	1,4	140	5500	20	125	1,12

PowerCem Piling Mat technology in action

3. Calculation of the stresses and strains for the pilling drilling machine.

For the drilling machine the following assumptions are made:

Type of drilling machine:

Woltman THW 4017

Weight 40 ton

Tracks 900 x 4850mm

PROPERTIES						DESIGN				
Sub grade [E_{dyn}: MPa]	Modulus of subgrade reaction [N/mm³]	Soil type	RoadCem [kg/m³]	Cement [kg/m³]	Stiffness [Edyn: MPa]	Thickness [cm]	Flexural strength. Stress [MPa]	Flexural strength. safety factor	shear Stress [MPa]	shear safety factor
20	0,020	Clay	2,4	240	2500	55	0,69	1,09	0,10	5,00
30	0,025	Clay	2,2	220	3000	45	0,92	0,98	0,12	5,00
40	0,030	Clay	2,2	220	3500	35	0,99	1,06	0,15	4,67
50	0,035	Clay	2,0	200	4000	30	1,19	1,01	0,18	4,44
60	0,040	Sandy clay	1,8	180	4500	30	1,18	1,14	0,18	5,00
70	0,045	Sandy clay	1,8	180	4500	25	1,31	1,03	0,21	4,29
80	0,050	Sandy clay	1,8	180	4500	25	1,25	1,08	0,21	4,29
90	0,055	Sand	1,6	160	5000	20	1,48	1,01	0,27	3,70
100	0,060	Sand	1,6	160	5000	20	1,42	1,06	0,27	3,70
110	0,065	Sand	1,6	160	5000	20	1,37	1,09	0,27	3,70
120	0,080	Sandy gravel	1,4	140	5500	15	1,52	1,09	0,36	3,06
130	0,085	Sandy gravel	1,4	140	5500	15	1,47	1,12	0,36	3,06
140	0,090	Sandy gravel	1,4	140	5500	15	1,43	1,15	0,36	3,06
150	0,095	Sandy gravel	1,4	140	5500	15	1,39	1,19	0,36	3,06

PowerCem Piling Mat technology in action

PowerCem technology is available in the UK and enables any materials including organic top soils to be effectively stabilised to build strong, flexible piling mats for both driven and auger piles?

Installing a RoadCem in-situ piling mat will reduce build time by two thirds and provide the piling contractor with a safe flat deflection free mat allowing easy rig set up.

Have you had any of the following problems with a stone piling mat?

- Settlement issues as the weak sub soils compact under the heavy stone mat.
- Mats that need to be far larger than the piling area to allow for the problems of shear.
- Dangers of moving top heavy rigs onto and off the unbound stone mat, at commencement and end of operations.
- Dangers of moving top heavy rigs around the unbound stone mat.
- Unpredictability and delays when setting up the rig for each pile on the unbound stone mat.
- Deflection of the piles due to hard and soft areas/large pieces of stone.
- Heavy rains causing the stone fines to migrate lower in the mat, leaving loose material on top
- Frost getting into trapped water in the mat.
- Piles snagging in the geogrid supporting the stone.
- Costs removing the stone and geogrid/mat is cost consuming and labour intensive.
- All materials used are now classed as contaminated and must be land filled or recycled cleaned). Both costly options.

Benefits of RoadCem soil stabilisation:

- **The RoadCem product facilitates a more efficient chemical reaction between the water and cement within the bound material leading to:-**
  - Reduction of un-hydrated ‘free’ cement powder within the mix
  - Reduction of latent water within pores of stabilised materials
  - Can be used to stabilise **sulphate bearing soils: Clays, Glacial Tills (Boulder Clays), alluvium soils, sands and Mudstones**
  - Greater cement hydration means lower residual pH levels
  - Increased strength characteristics without brittle behaviour
  - Higher flexural stiffness - increased Young's Modulus –enhanced flexibility
  - Highly waterproof product – **no secondary sulphate reaction** and no leaching of cement minerals into surrounding soils when saturated for prolonged periods of time
  - **ROBUSTNESS, FLEXURAL STRENGTH, IMPERMEABLE, UNREACTIVE, REVERSIBLE**

RoadCem – Stabilisation of sulphate bearing soils

RoadCem has been used successfully on a number of UK projects to stabilise in-situ soils with high sulphate levels – where the use of standard GGBS has proved insufficient or too expensive to control the reaction.

The high dynamically stiff layer produced by the use of RoadCem means additional engineered benefits can be realised such as thinner bituminous layers as well as a elimination and/or substantial reduction in the thickness of the granular layers.

RoadCem – Stabilisation of sulphate bearing soils

Independent research published in 2020 has verified the performance of RoadCem in the stabilisation of soils with TPS levels of +10%.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Full Length Article

Incorporation of a nanotechnology-based product in cementitious binders for sustainable mitigation of sulphate-induced heaving of stabilised soils

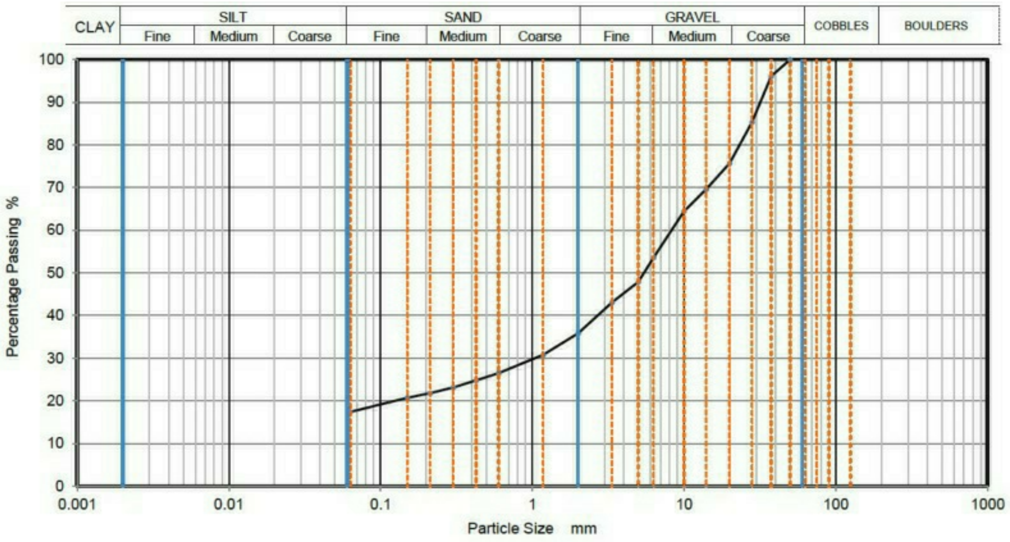
Eyo U. Eyo [a,*], Samuel J. Abbey [b], Samson Ngambi [a], Eshmaiel Ganjian [a], E. Coakley [a]

[a] School of Energy, Construction, Environment, Faculty of Engineering, Environment, Computing, Coventry University, Coventry, United Kingdom
[b] Faculty of Environment and Technology, Department of Geography and Environmental Management, Civil Engineering Cluster, University of the West of

Download paper from our website – Powercem.co.uk or read within the FAQ section:-
https://www.powercem.co.uk/wp-content/uploads/2021/02/Mitigation-of-Sulphate-Heave-in-Cement-Stabilised-Soils-Coventry-University-Sept-2020.pdf

RoadCem – Stabilisation of sulphate bearing soils

Independent laboratory testing carried out in 2020 has also confirmed the performance of RoadCem in the stabilisation of natural soils with TPS levels of +3%. Showing less than 0.1mm soaked swell after 7 days.

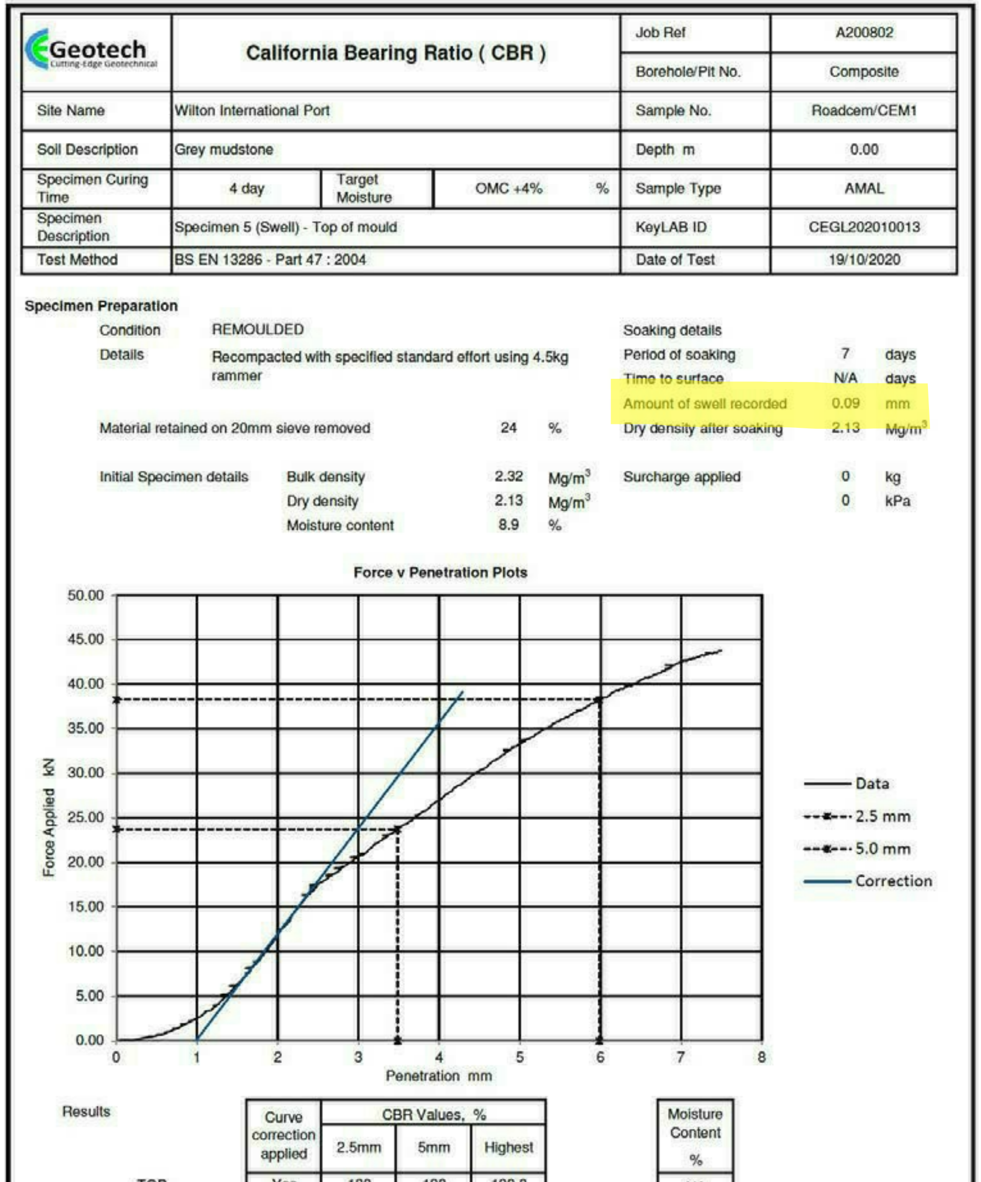


Project: [redacted]

Client: CE Geochem	**Chemtest Job No.:**				20-26877
Quotation No.:	**Chemtest Sample ID.:**				1075624
	Client Sample ID.:				Composite
	Sample Type:				SOIL
	Date Sampled:				01-Oct-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Total Sulphur	U	2175	%	0.010	1.0
Moisture	N	2030	%	0.020	4.6
Acid Soluble Sulphur	N		%	0.010	0.050
Water Soluble Sulphur	N		%	0.010	0.044
Oxidisable Sulphides as SO4	N		%	0.030	2.9
Total Potential Sulphate as SO4	N	2175	%	0.030	3.0
pH	U	2010		4.0	9.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.66
Sulphate (Acid Soluble)	U	2430	%	0.010	0.15

RoadCem – Stabilisation of sulphate bearing soils

Independent laboratory testing carried out in 2020 has also confirmed the performance of RoadCem in the stabilisation of natural soils with TPS levels of +3%. Showing less than 0.1mm soaked swell after 7 days.



Geotech Cutting-Edge Geotechnical	California Bearing Ratio (CBR)			Job Ref	A200802
				Borehole/Pit No.	Composite
Site Name	Wilton International Port			Sample No.	Roadcem/CEM1
Soil Description	Grey mudstone			Depth m	0.00
Specimen Curing Time	4 day	Target Moisture	OMC +4% %	Sample Type	AMAL
Specimen Description	Specimen 5 (Swell) - Top of mould			KeyLAB ID	CEGL202010013
Test Method	BS EN 13286 - Part 47 : 2004			Date of Test	19/10/2020

Specimen Preparation

Condition	REMOULDED			Soaking details	
Details	Recompacted with specified standard effort using 4.5kg rammer			Period of soaking	7 days
				Time to surface	N/A days
				Amount of swell recorded	0.09 mm
Material retained on 20mm sieve removed		24	%	Dry density after soaking	2.13 Mg/m^3
Initial Specimen details	Bulk density	2.32	Mg/m^3	Surcharge applied	0 kg
	Dry density	2.13	Mg/m^3		0 kPa
	Moisture content	8.9	%		

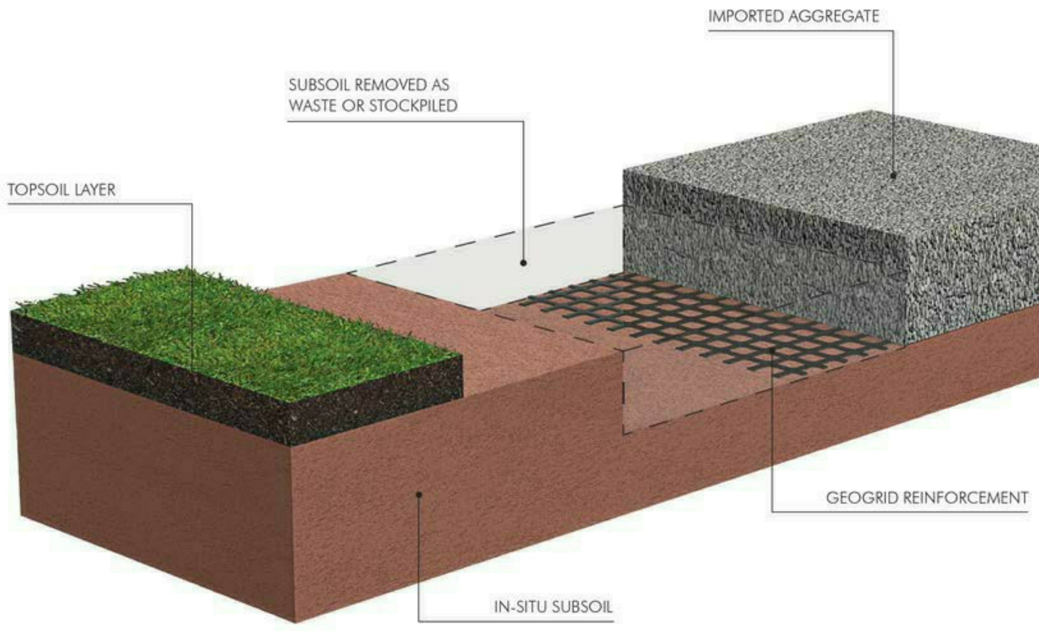
Results

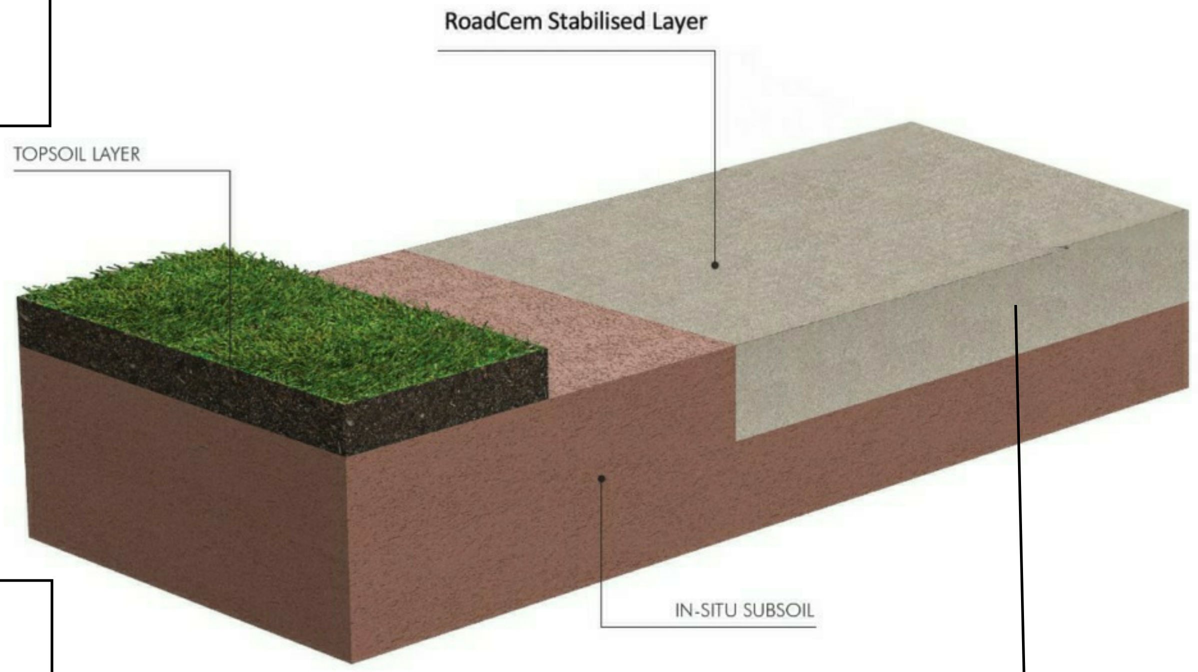
Curve correction applied	CBR Values, %			Moisture Content %
	2.5mm	5mm	Highest	

Traditional aggregate and Geogrid solution vs RoadCem method

Because the RoadCem layer will be around ten times stiffer than the stone layer, even allowing for the Geogrid support, the engineered thickness can be as much as a third the thickness.

When produced from the existing site soils replacement of soils with imported stone is never needed.



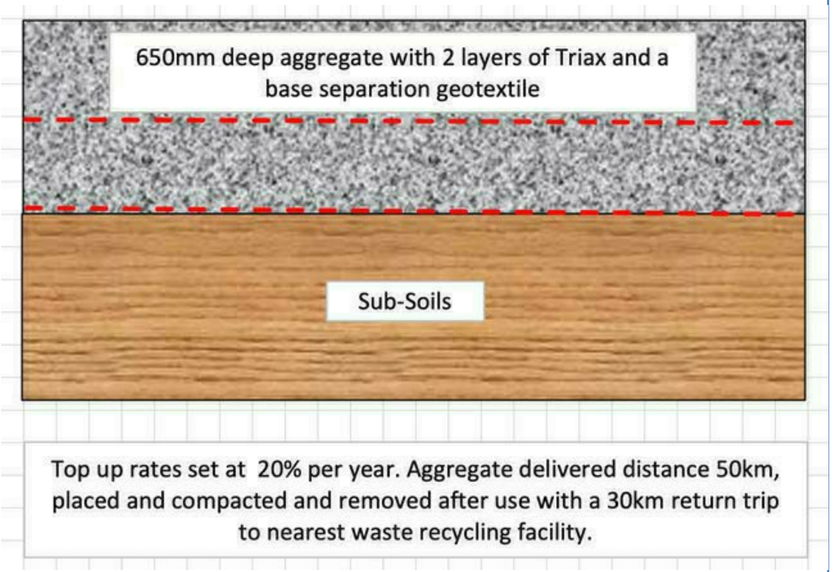


The stone piling mat will suffer from weather/water damage and will need continued maintenance.

The RoadCem piling mat has a frost and water resistant surface and will need no maintenance

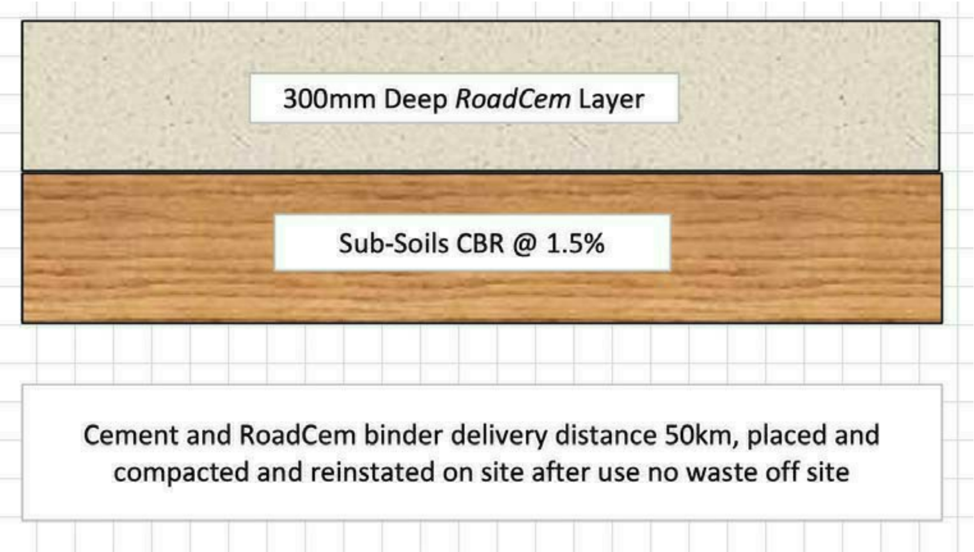
RoadCem – Sustainability Comparisons

- **Traditional aggregate haul road compared to a RoadCem single layer solution**



61 $KgCO_2/m^2$

37 $KgCO_2/m^2$



RoadCem – Environmental benefits

REDUCE Vehicle Movements

Eliminate the need for aggregate imports to site and the export disposal of any surface layers after use.

+85% Typical Reduction Achievable

MINIMISE CO_2 – Use the most sustainable solution

LCA assessments show that by adopting a single layer solution embedded CO_2 can be kept to an absolute minimum

>20% CO_2 reduction over soil enhancement
>60% CO_2 reduction over aggregate solutions

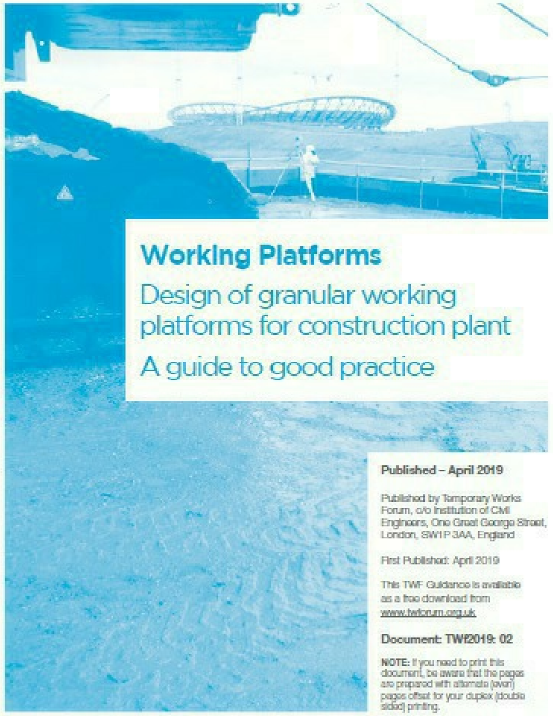
SAVE TIME – Reduce Construction Programmes

A RoadCem solution can save weeks of programme time with +2000m² of single layer product installed each day

Up to 90% reduction in programme time

RoadCem – Working Platforms

- **Designed using the new TWF Design Methodology**



Working Platforms

Design of granular working platforms for construction plant

A guide to good practice

Published – April 2019

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First Published: April 2019

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Document: TWf2019: 02

NOTE: If you need to print this document, be aware that the pages are prepared with alternate (even) pages offset for your duplex (double sided) printing.

Temporary Works forum

RoadCem – Piling Platforms

Research set-up into the Visco-Elastic Behaviour of RoadCem Piling Mats

In tests carried out by Delft University a single size sand (1780/m3) was used (fractions 0.5/1mm) in addition to 0.09% m/m of RoadCem material in relation to sand, as well as 9.14% m/m OPC (CEM 1 42.5 N).

The OMC (optimum moisture content) at MPD (maximum proctor density) was 11% m/m.

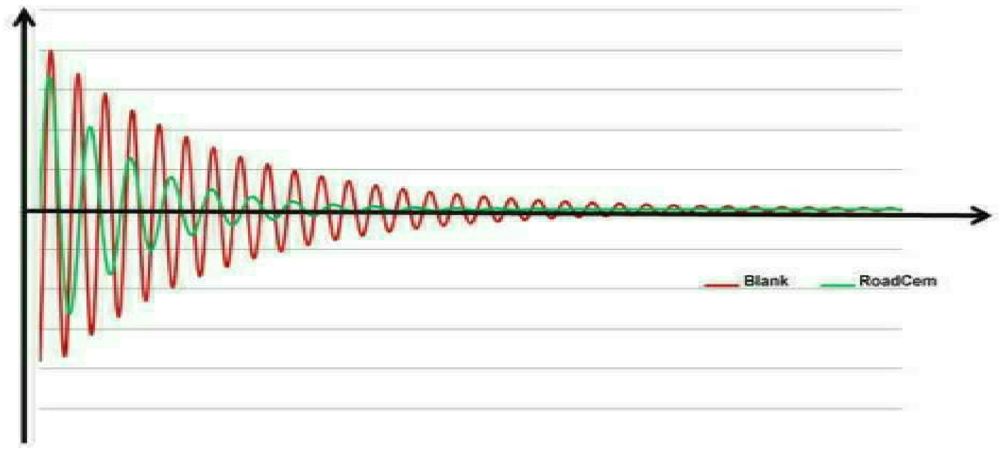
The reference mixture was composed with 9,14 m/m OPC (CEM 1 42.5N) under equal conditions prepared without any RoadCem added. The visco-elastic and ductility properties of RoadCem were found by conducting dynamic tests.

Dynamic Testing

These dynamic tests are carried out using non-destructive ultra-waves in order to determine the dynamic- elastic modulus. By means of destructive four- point bending tests in which repetitive loads at a fixed frequency are applied, a superior fatigue performance is confirmed.

By observing the longitudinal displacement mode after excitation, the dynamic modulus is obtained, as well as the dampening characteristics, which relate to the visco-elastic properties of the material being tested.

It is very clear that the pattern for cement treated stabilisation with added RoadCem (shown green) is showing a restrained vibration compared to the cement alone stabilised material (shown as red) this will improve safety during piling, reducing BOUNCE and improving alignment.



Delft University of Technology

RoadCem – Piling Platforms

- **All types of piling rigs and cranes can be used safely & effectively on a RoadCem piling mats**

RoadCem – Piling Platforms

- Existing very soft made ground at Hull WWTW
- Mott MacDonald Bentley project
- Soft ground stabilised to enable site piling and lifting operations to be safely carried out.

- RoadCem working platform ready for use.
- Allowing piling rig and crawler crane to operate directly on the RoadCem layer. No surface stone layer required.

RoadCem – Piling Platforms

- During even the wettest conditions RoadCem platform allows heavy construction work to meet challenging programmes.
- Piling, Crane lifts, MEWP, laydown all perfectly supported straight off the RoadCem surface.

RoadCem – Piling Platforms

Walton on Thames Road Bridge for Costain / Atkins

RoadCem soil stabilisation is up to 12x stiffer than stone for piling mats and heavy crane/rig platforms.

Soil stabilisation is a sustainable method for the construction of in-situ bound soil base for infrastructure applications.

Where longer lasting and/or heavier loadings are required RoadCem is the proven answer. Just a 1% addition by weight of cement enables cement to become a far superior soil binder.

Winner of multiple industry awards the Walton on Thames Road bridge built for Surrey County Council by Costain/Atkins used cement with added RoadCem to create really strong bound soil crane and piling rig platforms from the existing alluvial site soils.

With no added surface protection and/or cover these stabilised soil working platforms were used for the two-year construction period without damage by heavy plant and crawler cranes.

Walton on Thames Bridge
Project of the Year Winner £10-£50 million

RoadCem – Piling Platforms

- RoadCem working platform for construction of new terminal surface water pumping station on the Sandringham Estate at Wolferton
- Heavy plant working over soft silty soils with high water table
- Platform rotovated back to granulised soil and returned to nature upon completion within arable land areas.

RoadCem – Piling Platforms

- Note: soft organic silty soil underlying platform
- Sheet piling driven through RoadCem platform without any localized overbreak

RoadCem – Piling Platforms

- Office headquarters project
- RoadCem piling mat and working platform
- RoadCem stabilised layer replaced all permanent road subbase stone
- RoadCem layer under external block paved areas forming new car parks

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Innovations for better solutions!