CONCRETE CANVAS®

Concrete Impregnated Fabric

RAIL ROAD MINING PETROCHEM AGRO UTILITIES PUBLIC WORKS DEFENCE DESIGN SHELTER

GLOBAL ACTIVITY MAP

SECTORS

RAIL

ROAD

PETROCHEM

PUBLIC WORKS

UTILITIES

MINING

DEFENCE

AGRO

DESIGN

Erózna ochrana svahov, Parla, Spain

SECTORS

RAIL

ROAD

PETROCHEM

PUBLIC WORKS

UTILITIES

MINING

DEFENCE

AGRO

DESIGN

Erózna ochrana svahov, Oman

SECTORS

RAIL

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PETROCHEM

PUBLIC WORKS

UTILITIES

MINING

DEFENCE

AGRO

DESIGN

Opláštenie bariér zberných a havarijných nádrží, UK

SECTORS

RAIL

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PETROCHEM

PUBLIC WORKS

UTILITIES

MINING

DEFENCE

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DESIGN

Oprava kanálov, Wales, UK

SECTORS

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DESIGN

Oprava vodných kanálov, Scottish Power, UK

SECTORS

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DESIGN

Výstielka kanálov a drenážných línií, Myra Falls, Canada

SECTORS

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DESIGN

CCS betónové nafukovacie úkryty, Europe

SECTORS

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DESIGN

Bellavista zavlažovacie kanálové systémy, Chile

SECTORS

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PETROCHEM

PUBLIC WORKS

UTILITIES

MINING

DEFENCE

AGRO

DESIGN

“Zošitý betón”, Florian Schmid, Germany

CC INTERNATIONAL CUSTOMERS

CC UK CUSTOMERS

Example End Users

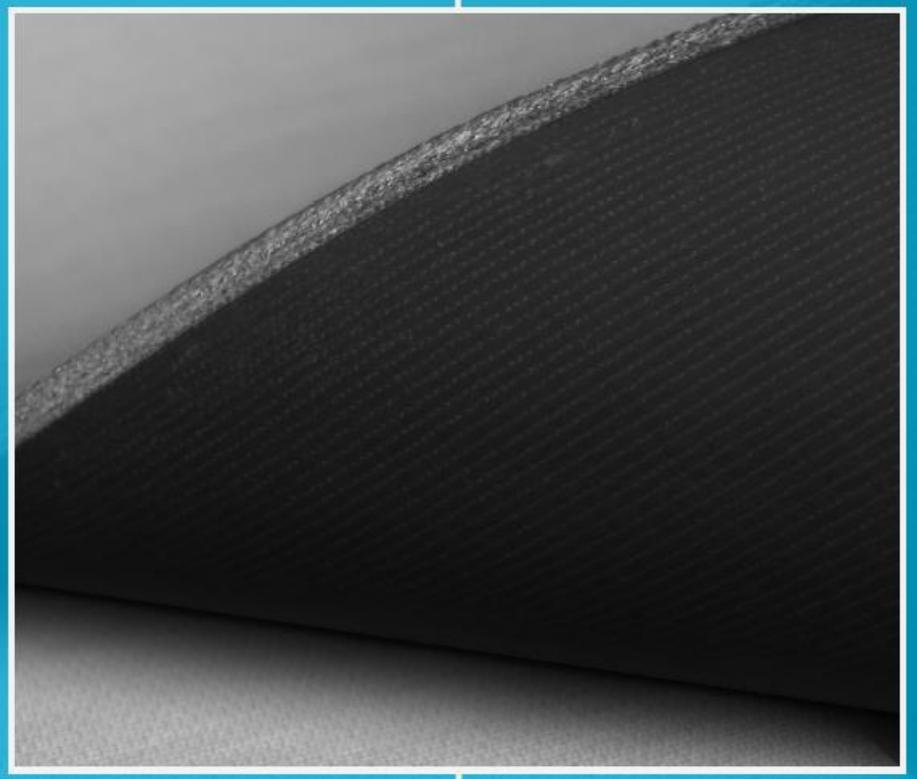
CC UK CUSTOMERS

Consultant Engineers / Contractors

CC MINING CUSTOMERS

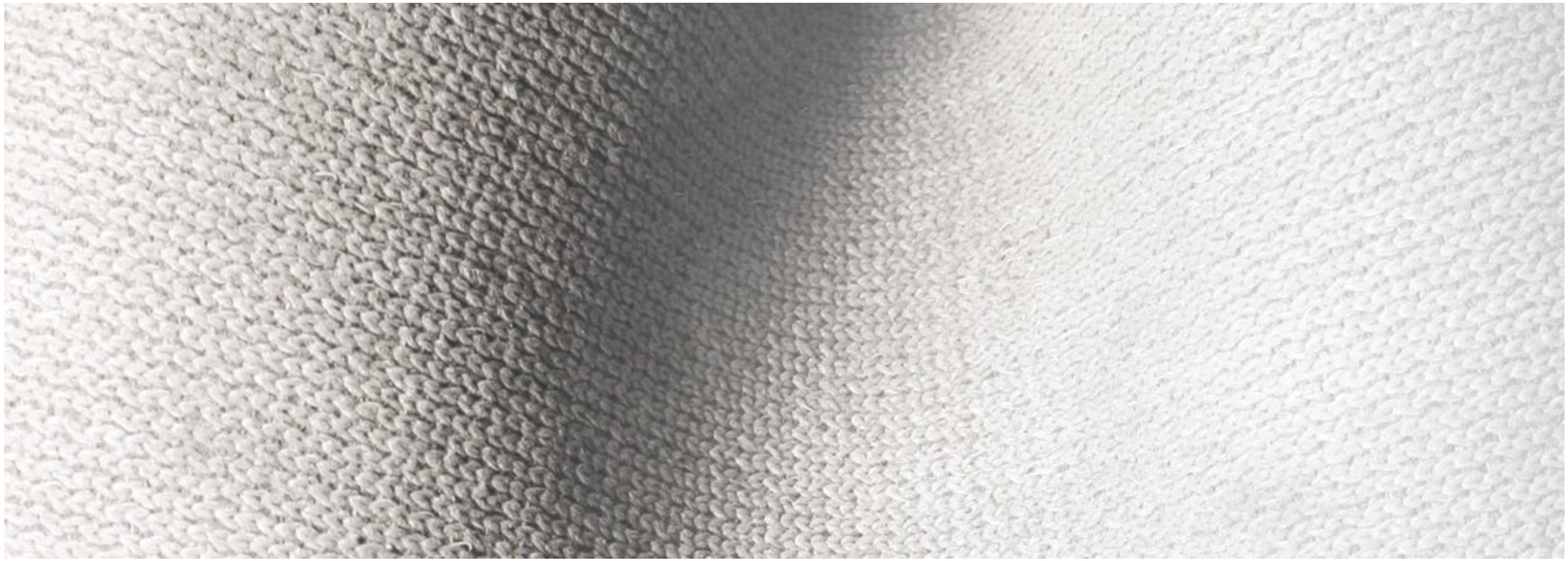
CC PETROCHEM CUSTOMERS

CONCRETE CANVAS



WHAT ARE GCCM'S?

Geosynthetic Cementitious Composite Mat (GCCM): a factory assembled geosynthetic composite consisting of a cementitious layer contained within layer or layers of geosynthetic materials. The cementitious portion of the GCCM becomes hardened when properly hydrated after a certain amount of time, which is recorded when known.

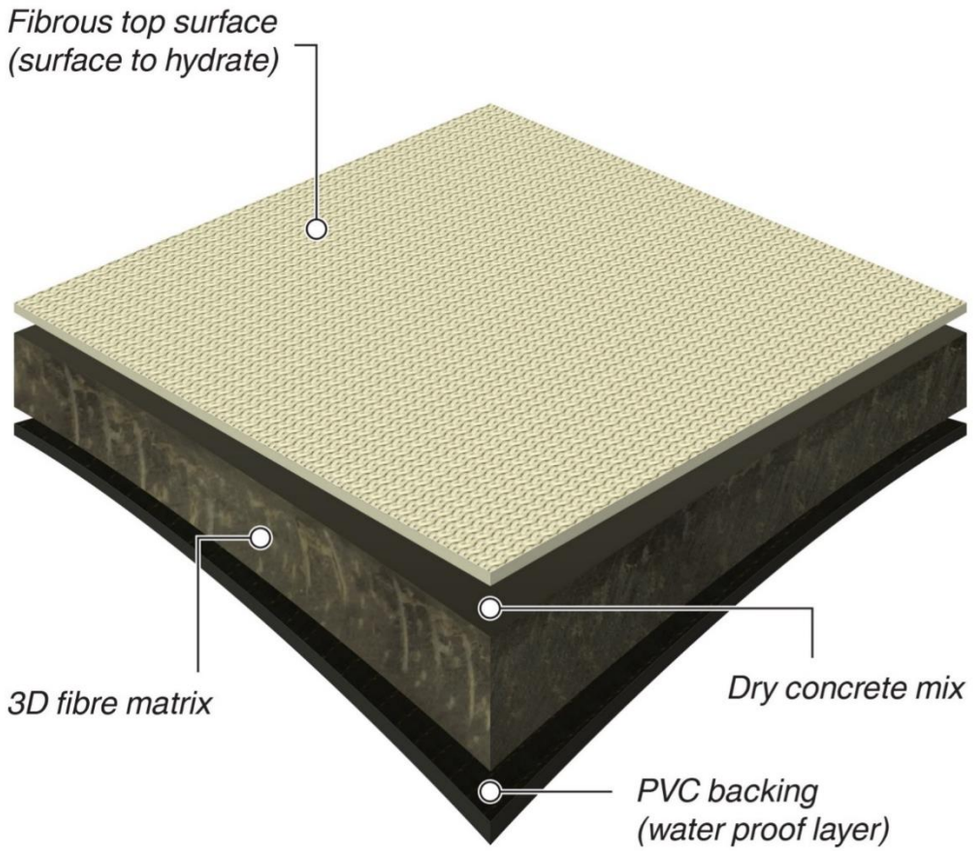


WHAT IS CONCRETE CANVAS (CC) ?

Concrete Canvas (CC) je flexibilná betónom impregnovaná tkanina, ktorá tvrdne po hydratácii a tvorí tenkú ,trvácnu a vode odolnú betónovú vrstvu.

Concrete Canvas (CC) sa skladá:

- Vláknitá hydratačná vrchná vrstva
- Štruktúrovaná vláknitá matrica 3D
- Suchá cementová zmes
- Vodo nepriepustná PVC vrstva



CC DELIVERY FORMATS

CC je dodávaný v troch formátoch:

CC Bulk Roll

Up to 200sqm of concrete on a single pallet

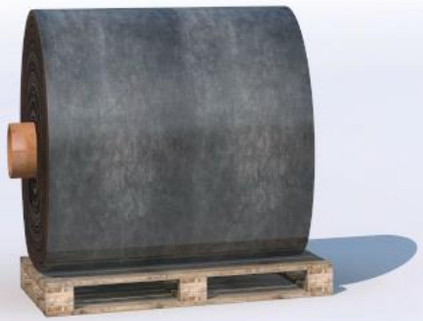
CC Batched Rolls
(CC5 and CC8 only)

Man portable batched rolls of 5 or 10sqm

CC Wide Rolls

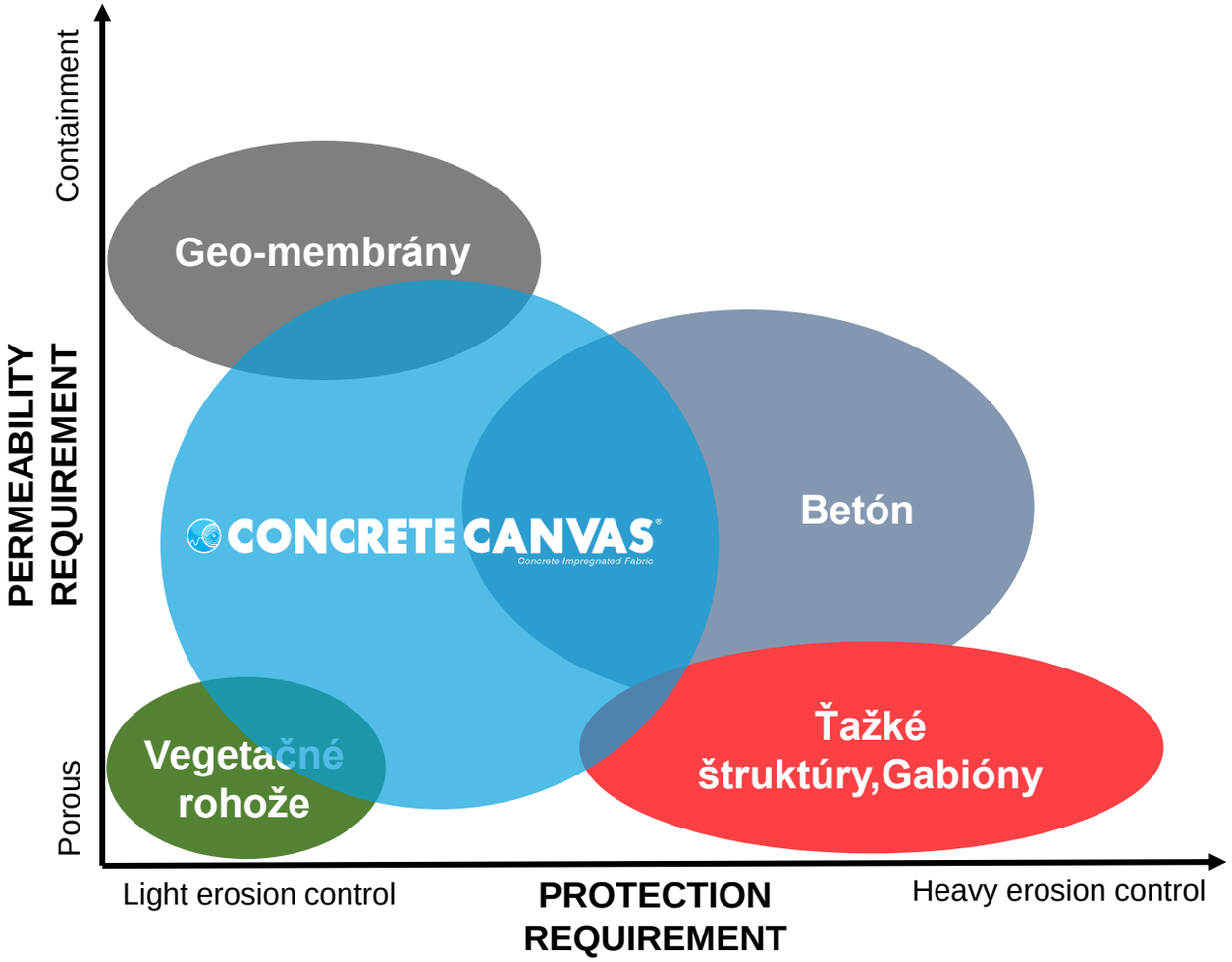
Available in 2, 3 and 4m widths

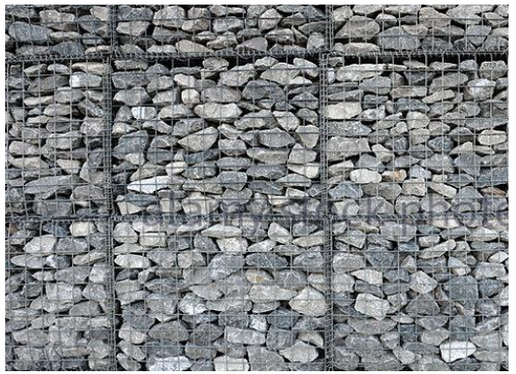
CC LOGISTICAL FOOTPRINT



1 Bulk Roll = *2 x 17T Ready-mix Trucks*

CC MARKET POSITIONING





CC WEIGHTS AND DIMENSIONS

CC technické špecifikácie

CC	Hrúbka (mm)	Balený zvitok (m2)	Veľký zvitok (m2)	Zvitok šírka(m)
CC5	5	10	200	1.0
CC8	8	5	125	1.1
CC13	13	N/A	80	1.1

CC	Váha () (kg/m²)	Hustota(pred hydratáciou) (kg/m³)	Hustota po hydratácii (set) (kg/m³)
CC5	7	1500	+30-35%
CC8	12	1500	+30-35%
CC13	19	1500	+30-35%

CC HYDRATION

Spôsob hydratácie

Postriekajte vláknitú vrchnú vrstvu vodou a namočte CC tak aby bol premočený aj niekoľko minút po hydratácii.

Opakujte hydratáciu CC po uplynutí jednej hodiny ak :

- Inštalujete CC5™
- Inštalujete na prudkom svahu alebo vertikálne

Upozornenie :

- Odporúča sa intenzívne prehydratovať materiál. CC sa môže hydratovať aj pod vodou alebo aj morskou vodou. Viac vody neškodí ale zlepšuje hydratačný proces.
- CC sa musí hydratovať aktívne. Nespoliehajte sa na dážď alebo iné prírodne hydratácie (topenie snehu, atmosférická vlhkosť ,atď.).
- Použite ružicu na postrek vody (vid CC zoznam nástrojov). Nehýbte s materiálom a nechoďte po ňom do vytvrdnutia.
- Čas tvrdnutia je redukovaný v teplých prostrediach a predĺžený vo veľmi chladných prostrediach.
- CC bude vytvrdnutý počas 24 h a jeho pevnosť sa ďalej vylepší v priebehu času.
- Ak CC nie je dostatočne hydratovaná, alebo vyschne počas prvých piatich hodinách, pevnosť materiálu bude redukovaná. Ak je hydratácia prerušená nehýbte s materiálom a zopakujte hydratáciu.

Pozri: *Concrete Canvas Hydration Guide* for installation in low temperatures or drying conditions.

- Nízke teploty sú ak prízemná teplota je v rozsahu 0 až 5°C and alebo sa očakáva pokles pod 0°C počas 8 h po hydratácii.
- Za teplé rýchloschnúce prostredie sa považuje ak: teplota je (>22°C), rýchlosť vetra (>12km/h), priame slnečné žiarenie alebo nízka vlhkosť (<70%).

CC Vlastnosti

Hydratačná fáza

Pracovný čas počas ktorého je možné CC upravovať
1-2 h podľa teploty
CC dosiahne 80% pevnosť po 24 h po hydratácii .

Pevnosť

Veľmi vysoká pevnosť počas 24 h je základná charakteristika CC.
Typická pevnosť je nasledovná :

Pevnosť na tlak tests based on ASTM C109 – 02 (initial crack)
- 10 day compressive failure stress (MPa) 40

Pevnosť na ohyb tests based on BS EN 12467:2004 (initial crack)
- 10 day bending failure stress (MPa) 3.4

Pevnosť v ťahu data (Initial crack)

	Length direction	Width direction
CC5	6.7	3.8
CC8	8.6	6.6
CC13	19.5	12.8

Reaction to fire

CC has achieved **Euroclass B certification** :
BS EN 13501-1:2007+A1:2009 B-s1, d0

Flame Resistance : **MSHA ASTP-5011**
Vertical and Horizontal Certification Passed

Age Testing (minimum 50 year expected life)

Freeze-thaw testing (ASTM C1185) 200 Cycles
Freeze-thaw testing (BS EN 12467:2004 part 7.4.1) Passed
Soak-Dry testing (BS EN 12467:2004 part 5.5.5) Passed
Heat-Rain testing (BS EN 12467:2004 part 5.4.4) Passed
Water impermeability (BS EN 12467:2004 part 5.4.4) Passed**

Other

Abrasion Resistance (ASTM C-1353)
Approximately 7.5x greater than 17MPa OPC Passed

Manning's Value n = 0.011

Root Resistance (DD CEN/TS 14416:2005) Passed

Chemical Resistance (BS EN 14414)
- Acid (pH 1.0) (56 day immersion at 50°C) Passed
- Alkaline (pH 13.0) (56 day immersion at 50°C) Passed
- Hydrocarbon (56 day immersion at 50°C) Passed
- Sulfate Resistance (28 day immersion at pH 7.2) Passed

Impact Resistance of Pipeline Coatings
ASTM G13 (CC13™ only) Passed

Permissible Shear & Velocity CC8™ (ASTM D-6460)
- Shear (Pa) 1200
- Velocity (m/s) 10.7

CC MATERIAL TEST DATA

Pre-Set CC Properties

Setting

Working Time
1-2 hours subject to ambient temperature
CC will achieve 80% strength at 24 hours after hydration.

Post Set CC Properties

Based on CC hydrated in accordance with the CC Hydration Guide.

Strength

Very high early strength is a fundamental characteristic of CC.
Typical strengths and physical characteristics are as follows :

***Compressive* tests based on ASTM C109 – 02 (initial crack)**

- **10 day compressive failure stress (MPa)** **40**

Bending tests based on BS EN 12467:2004 (initial crack)

- 10 day bending failure stress (MPa) 3.4

Tensile data (Initial crack)

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Core Applications

Channel lining

Slope protection

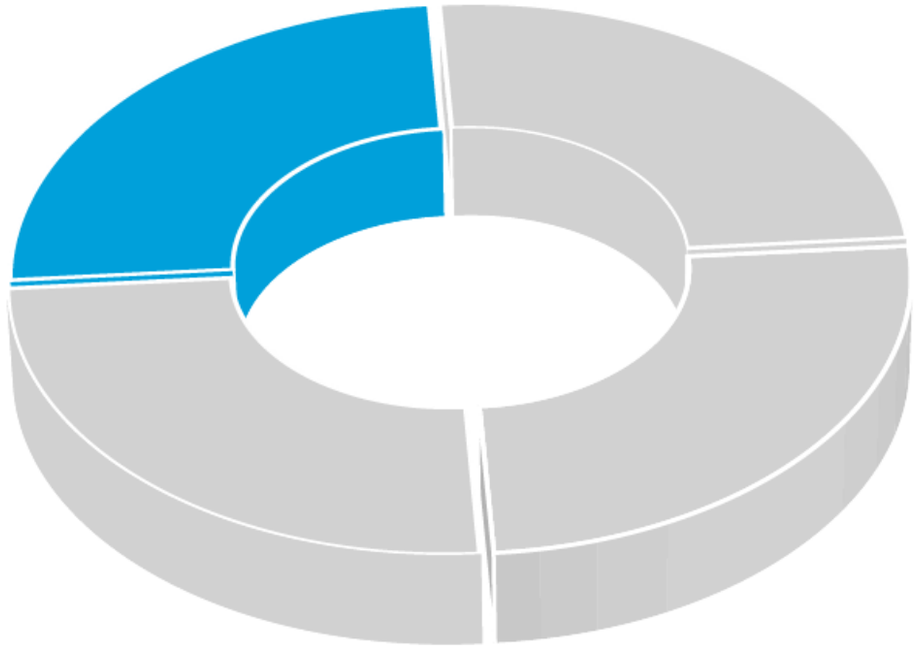
Bund lining

Concrete remediation

Other

- Weed suppression
- Culvert repair
- Gabion reinforcement
- Pipe protection
- Mining vent / blast walls
- Cable covering / protection

Rapid install
Up to 10X faster than conventional concrete
Up to 200 linear M/hour



03/02/2010

Church Village Bypass, UK

Highways Agency

3 Longitudinal Layers

Costain Group

Installed in 45 minutes rather than scheduled 3 days

Granted EA approval

ROAD

CC KEY BENEFITS

Rapid install
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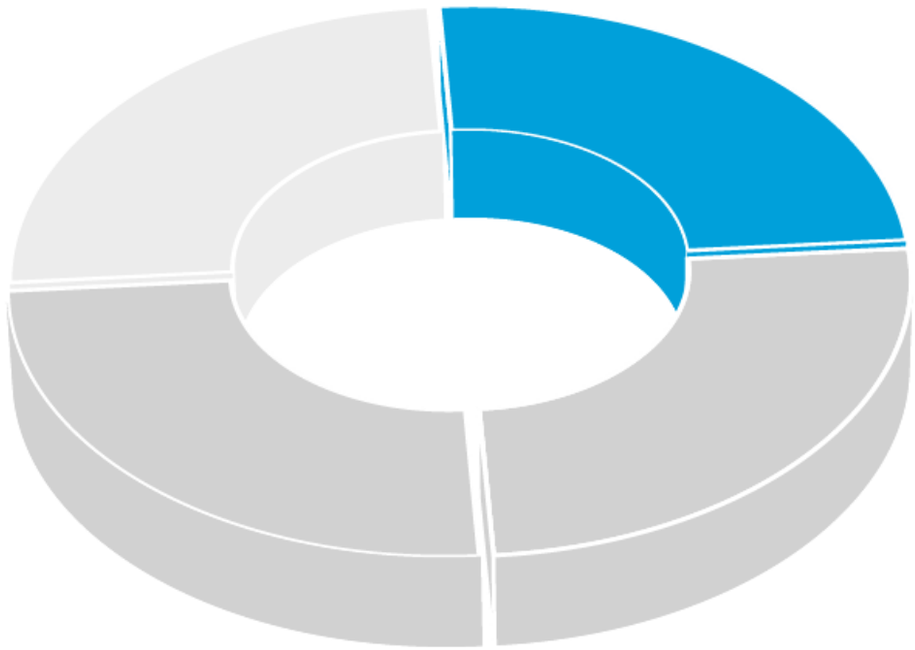
Up to 200 linear M/hour



Easy to use
Low logistical footprint / Safe
Minimal training required
Install in adverse conditions

10/09/2009

Gloucestershire, UK

Network Rail

1 Longitudinal Layers

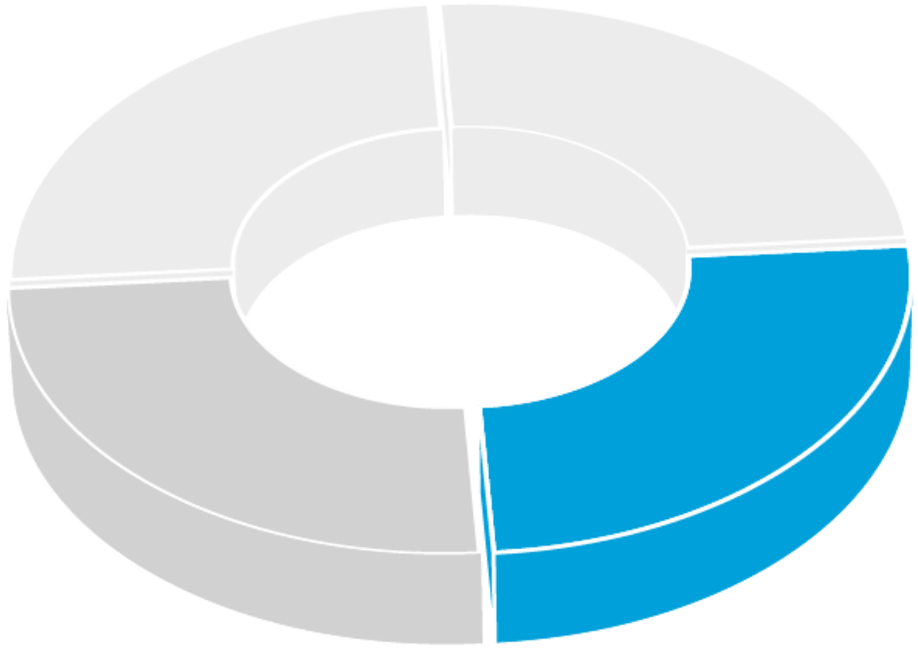
AMCO

Time critical as AMCO paying for access to site
Project installed in 8hrs instead of 3 weeks

RAIL

CC KEY BENEFITS

Rapid install
Up to 10X faster than conventional concrete
Up to 200 linear M/hour



Easy to use
Low logistical footprint / Safe
Minimal training required
Install in adverse conditions

Low project cost
More cost effective than any other conventional concrete solution

CC COST COMPARISON

Lining Materials	Materials (£/sqm)	Labour & Plant (£/sqm)	Total inc. o/heads (£/sqm)	Installation Time (sqm/day)
In situ Concrete	£16.02	£18.13	£42.25	40
Precast Concrete Paving Slabs	£19.76	£12.98	£40.51	40
Sprayed Concrete	£42.53	£4.84	£58.61	130
Concrete Canvas CC8	£29.40	£0.99	£37.60	412

Concrete Canvas (CC) is typically 10x faster and 20% less expensive than conventional concrete.

**Source: Report compiled by Engineers Incorporated Ltd of Cardiff 2011*

CC KEY BENEFITS

Rapid install
Up to 10X faster than conventional concrete
Up to 200 linear M/hour

Eco friendly
Material savings up to 90%
Transport efficient
Low wash out rate
Low alkaline reserve

Easy to use
Low logistical footprint / Safe
Minimal training required
Install in adverse conditions

Low project cost
More cost effective than any other conventional concrete solution

Methods

Screws - *stainless at 200mm centres*

Strength ***
Impermeability *

Screws & Sealant - *single bead of Clearfix*

Strength ***
Impermeability *

Adhesive sealant - *double bead of Clearfix*

Strength ***
Impermeability **

Grout - *CC can supply approved mix*

Strength ****
Impermeability ****

Notes

- Overlap CC by a minimum of 100mm in the direction of water flow.
- Hydrate material under overlap prior to jointing.

Methods

To soil

Pegs

Anchor Trench

Soil Nails / Ground Anchors

To concrete

Mortar

Masonry Fixings

To other

Rock Bolts

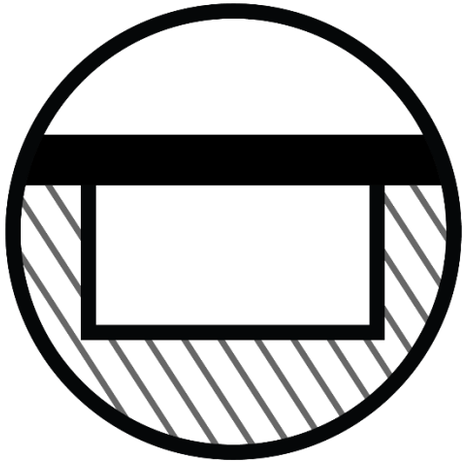
Hogs Rings

Tech Screws

Notes

- Essential to prevent water undermining CC along exposed edges
- Ensure material is in intimate contact with the ground – avoid voids

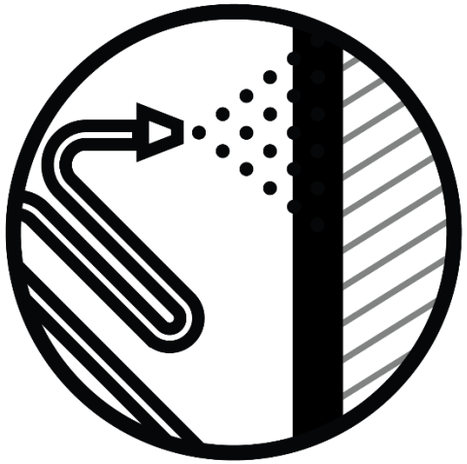
CC 4 INSTALLATION PRINCIPLES



AVOID VOIDS

SECURE CC

PREVENT INGRESS



HYDRATE FULLY

CONCRETE CANVAS®

Concrete Impregnated Fabric

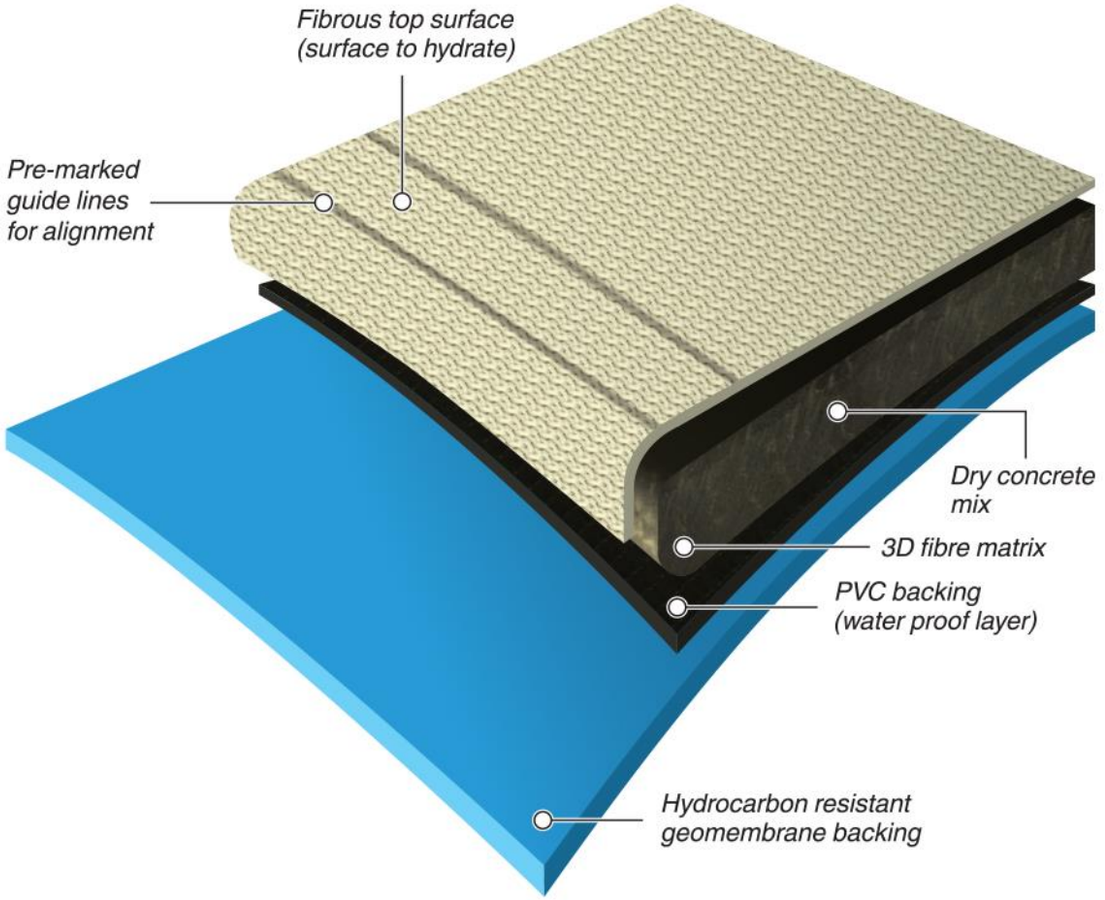
CCHYDRO™

RAIL ROAD MINING PETROCHEM AGRO UTILITIES PUBLIC WORKS DEFENCE DESIGN SHELTER

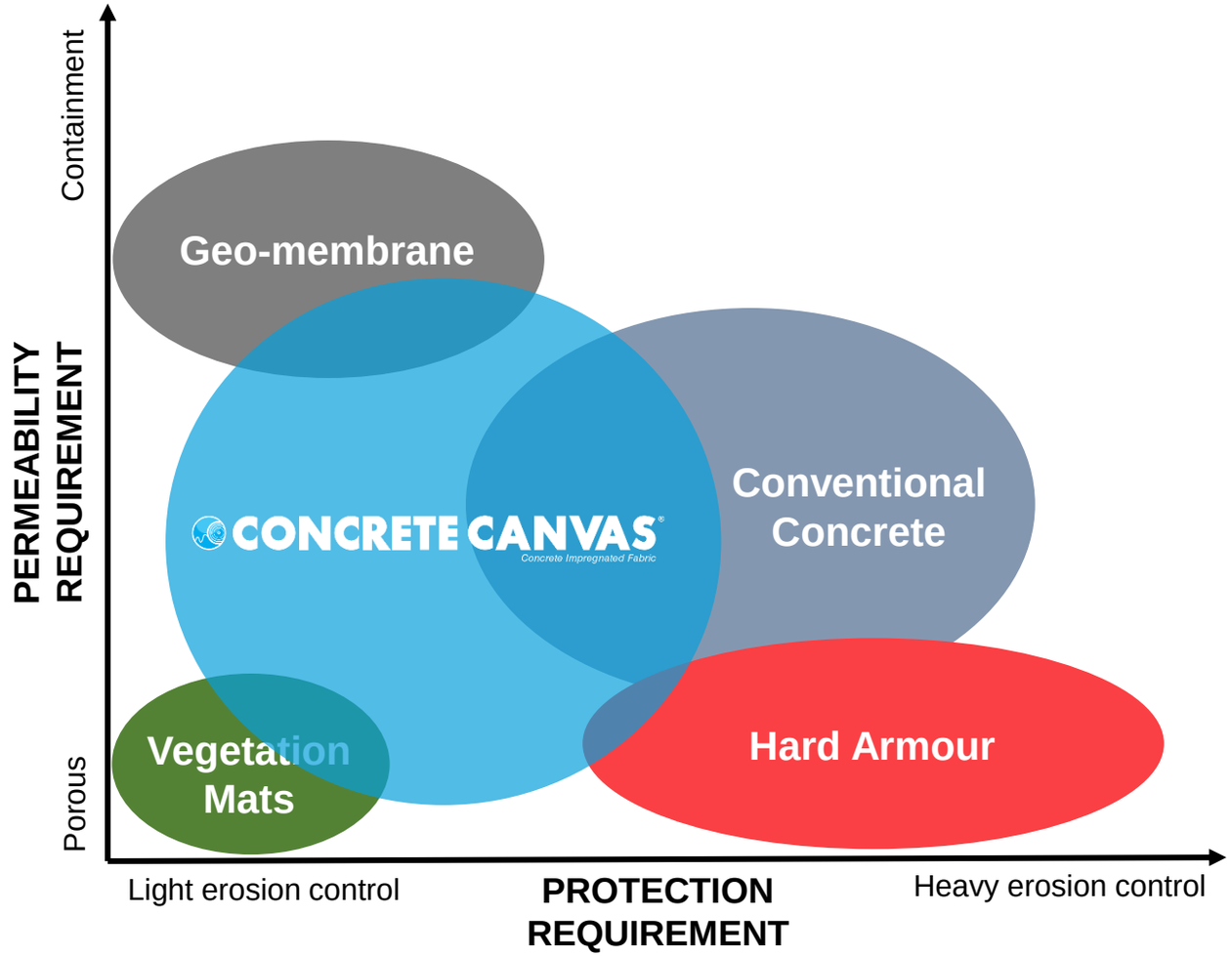
WHAT IS CC HYDRO™ ?

CC Hydro™ combines the company's concrete impregnated fabric technology with a high impermeability, chemically resistant geomembrane liner, which allows joints to be thermally bonded for on-site air channel testing.

- CC's concrete impregnated fabric technology.
- Chemically resistant geomembrane backing.
- Providing impermeability of k = $1x10^{-12}$m/s for containment.
- High visibility welding strip allowing for testable joints.



CC HYDRO™ MARKET POSITIONING



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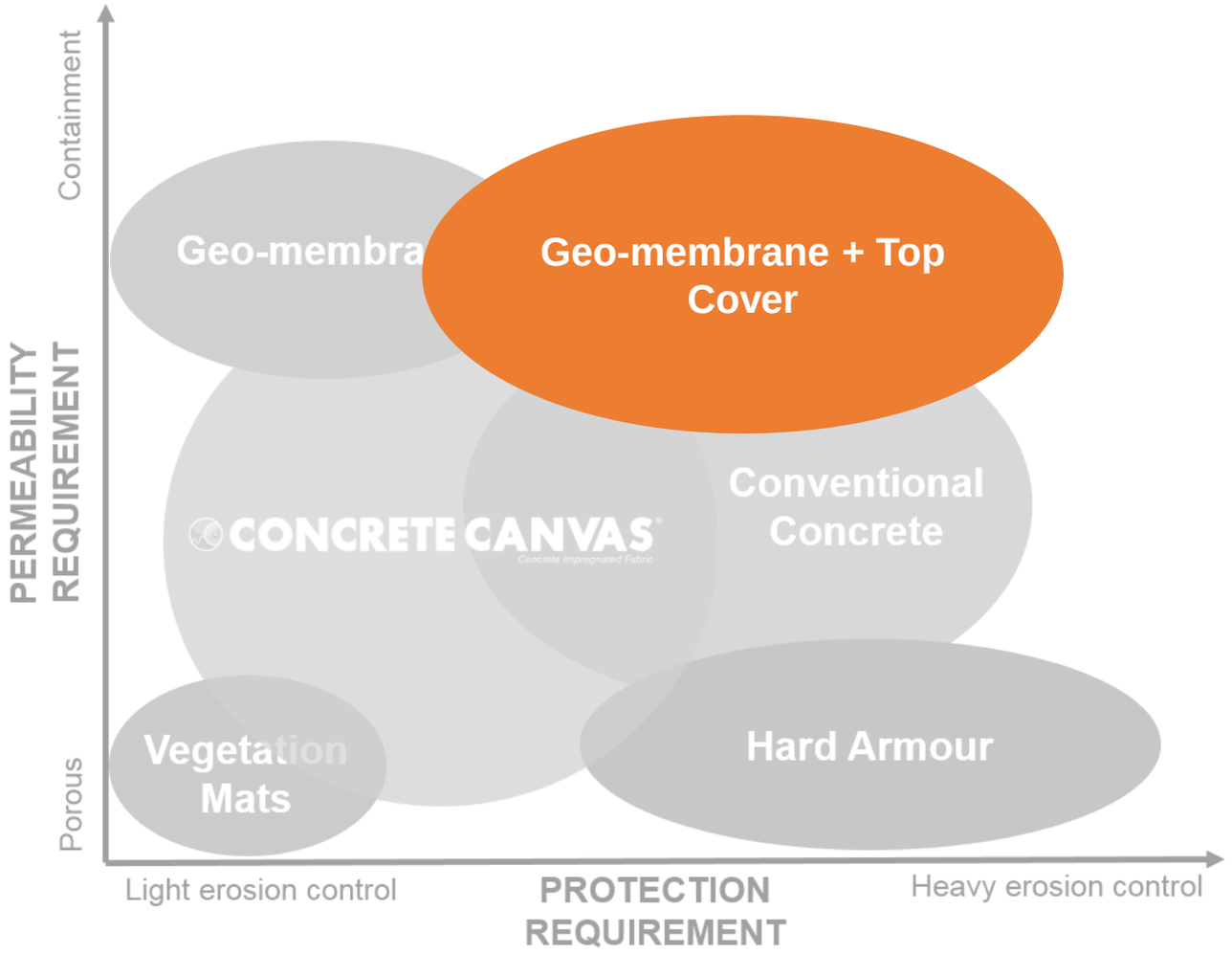

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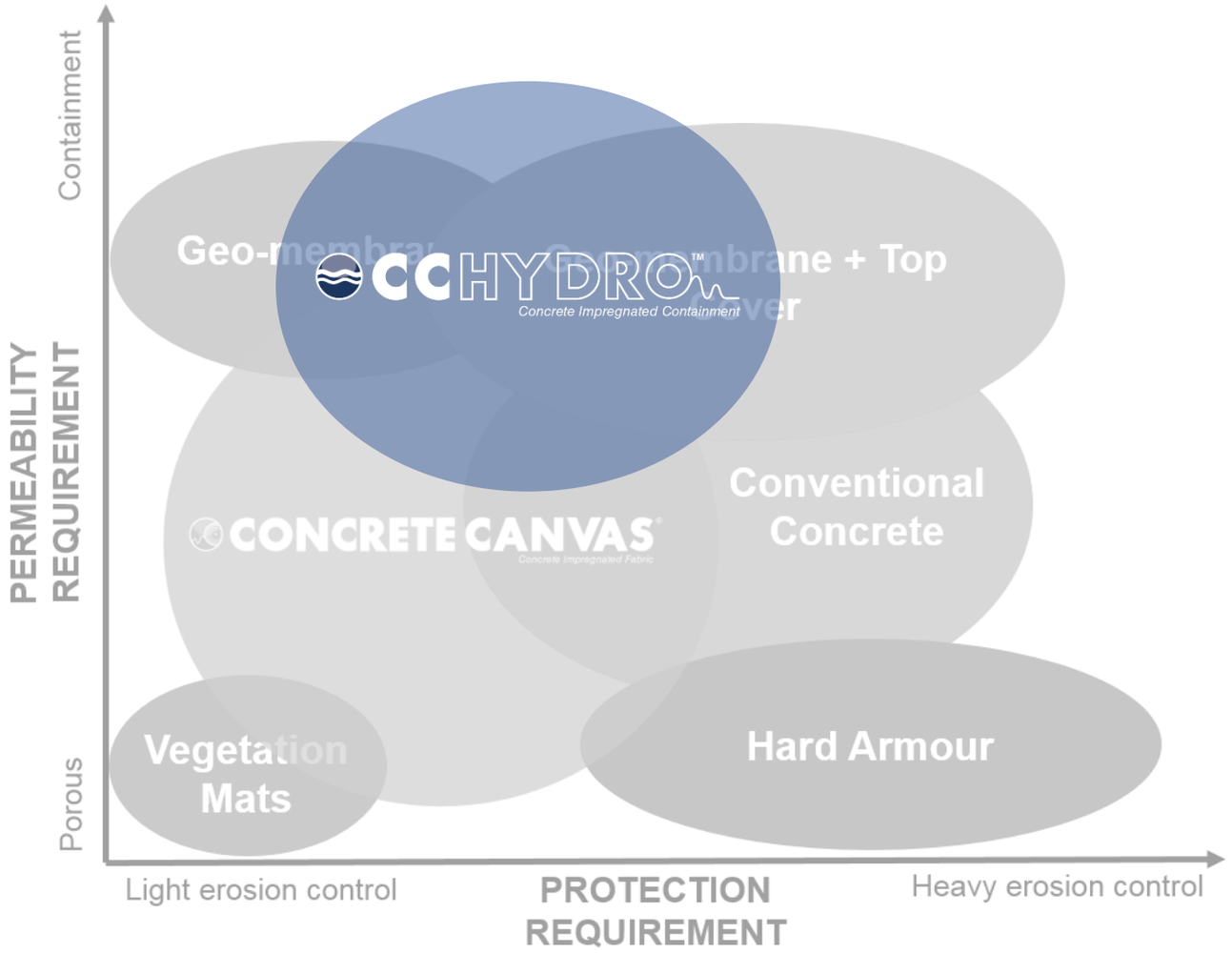
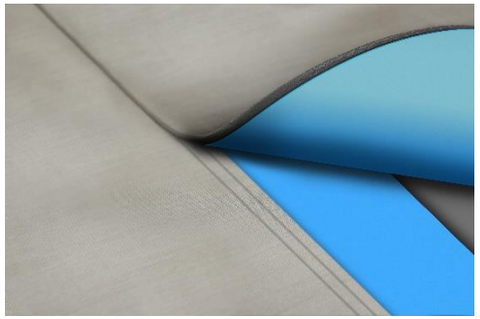
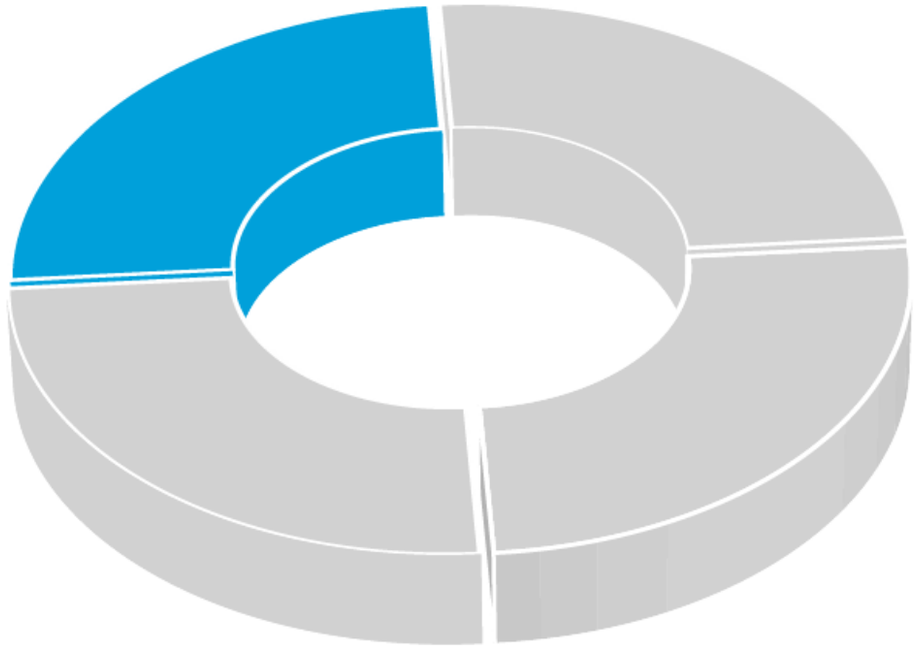


CC HYDRO™ KEY BENEFITS

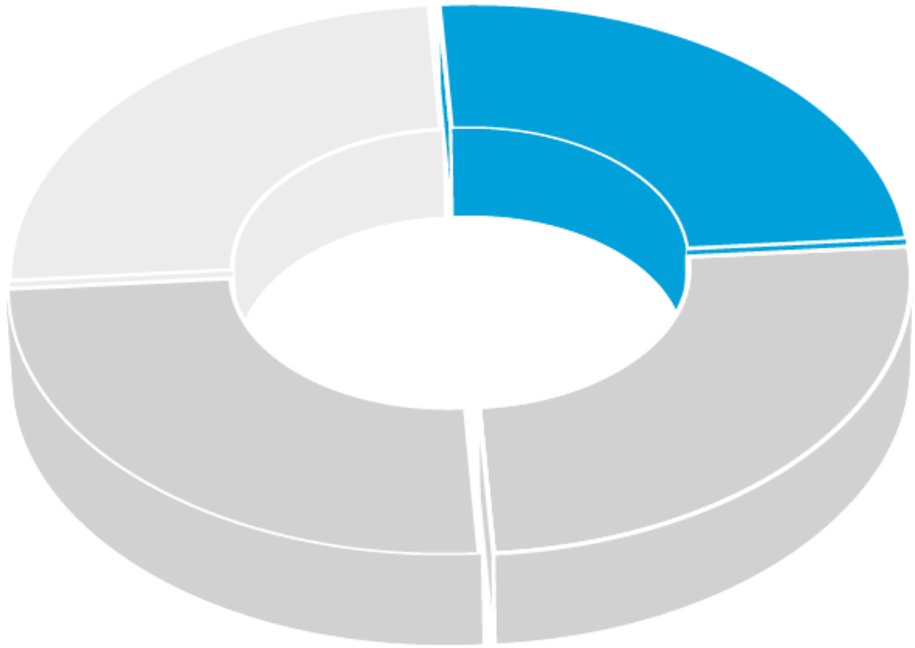
All in one solution
Impermeability of conventional concrete
Durability and protection of concrete



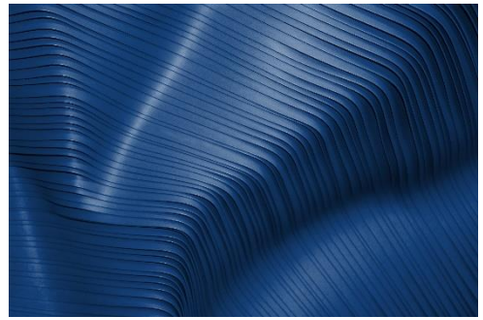


CC HYDRO™ KEY BENEFITS

All in one solution
Impermeability of conventional concrete
Durability and protection of concrete

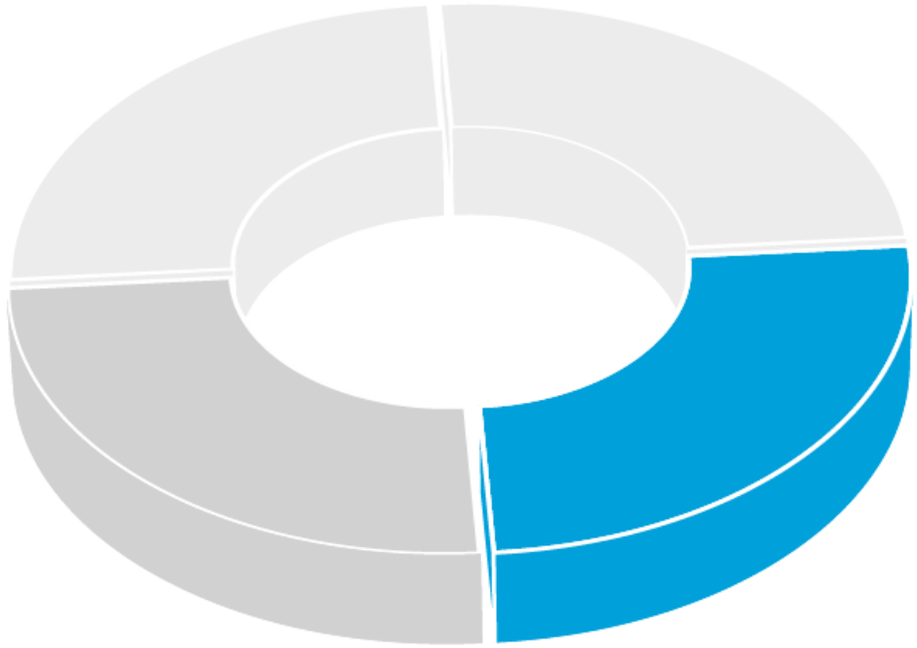


No top cover
No additional excavation
No contaminated arisings
No costly import of fill



CC HYDRO™ KEY BENEFITS

All in one solution
Impermeability of conventional concrete
Durability and protection of concrete



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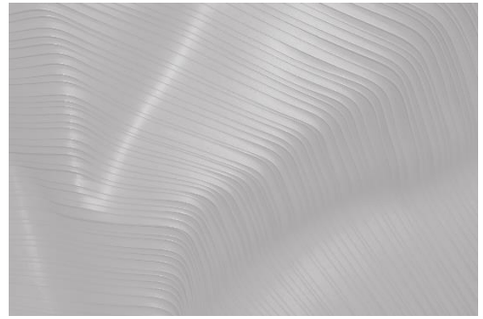
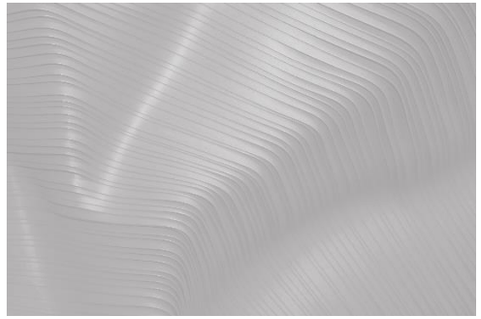


Life cycle costs
Weed suppression
No contaminated fill

CC HYDRO™ KEY BENEFITS

All in one solution
Impermeability of conventional concrete
Durability and protection of concrete

No top cover
No additional excavation
No contaminated arisings
No costly import of fill



Maintain volume capacity
Installed directly onto existing
Infrastructure for refurbishment

Life cycle costs
Weed suppression
No contaminated fill

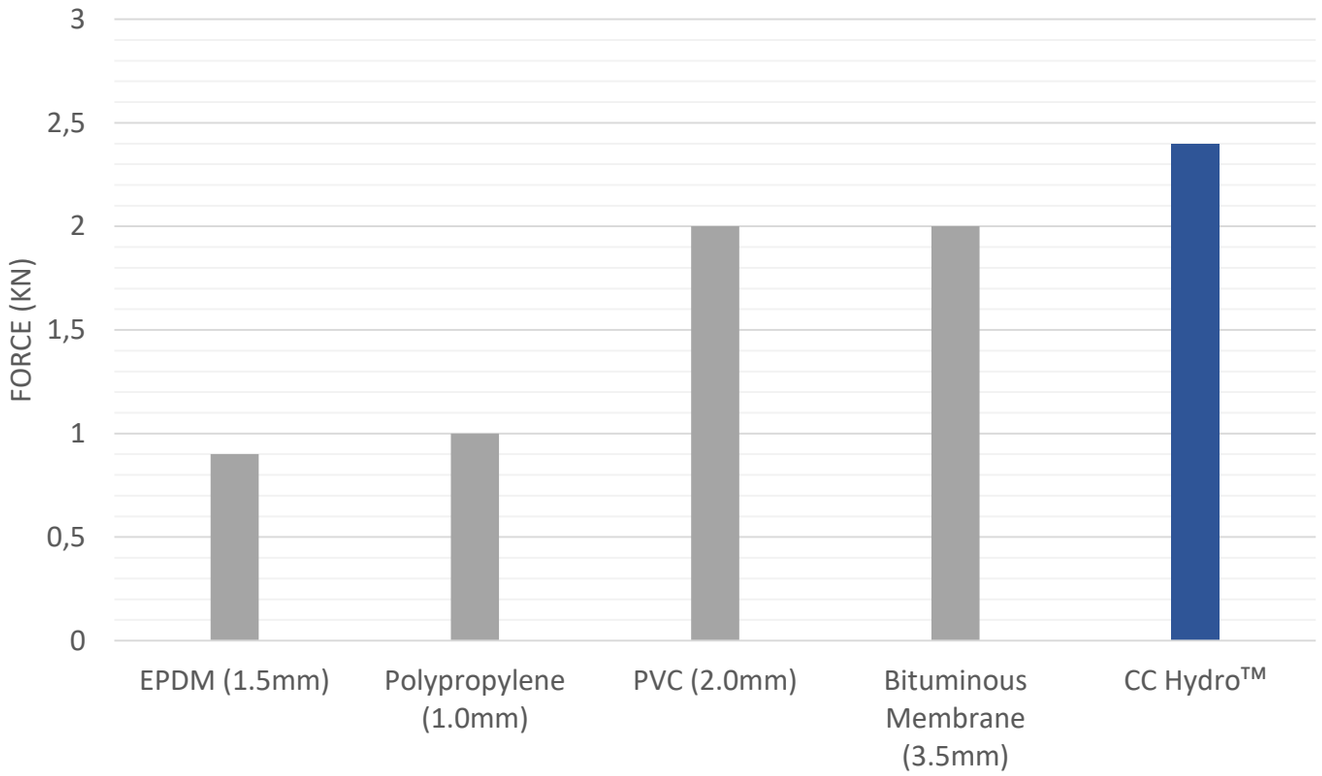
CC HYDRO™ KEY PROPERTIES

High Impermeability

	Permeability (m/s)
Water	$7.5x10^{-13}$
Diesel	$1.6x10^{-12}$
Welded Joint	$8.1x10^{-12}$

Durable

Comparison of published puncture resistance values for a variety of common geosynthetic membranes



According to BS ISO 12236:2006 Geosynthetics – Static Puncture Test (CBR Test)

CC HYDRO™ KEY PROPERTIES

Chemical Resistance

	CC Hydro™	Polypropylene	HDPE	PVC	Bitumenous Membrane
Acid▲	A/A	A/A	A/A	A/A	A/A
Diesel	B/B	B/X	A/A	B/X	X/X
Digestate	A/A	A/A	A/A	A/A	A/A
Ethanol	A/A	A/A	A/A	A/A	A/B
FAME (Biodiesel)	A/B	B/X	B/B	X/X	X/X
Leachate	A/A	A/A	A/A	A/A	A/A
Paraffin (Kerosene)	A/B	B/X	B/X	B/X	X/X
Petrol (Gasoline)	A/B	X/X	B/B	X/X	X/X
Sewage$^{\Delta}$	A/A	A/A	A/A	A/A	A/A

24 hour / 28 day

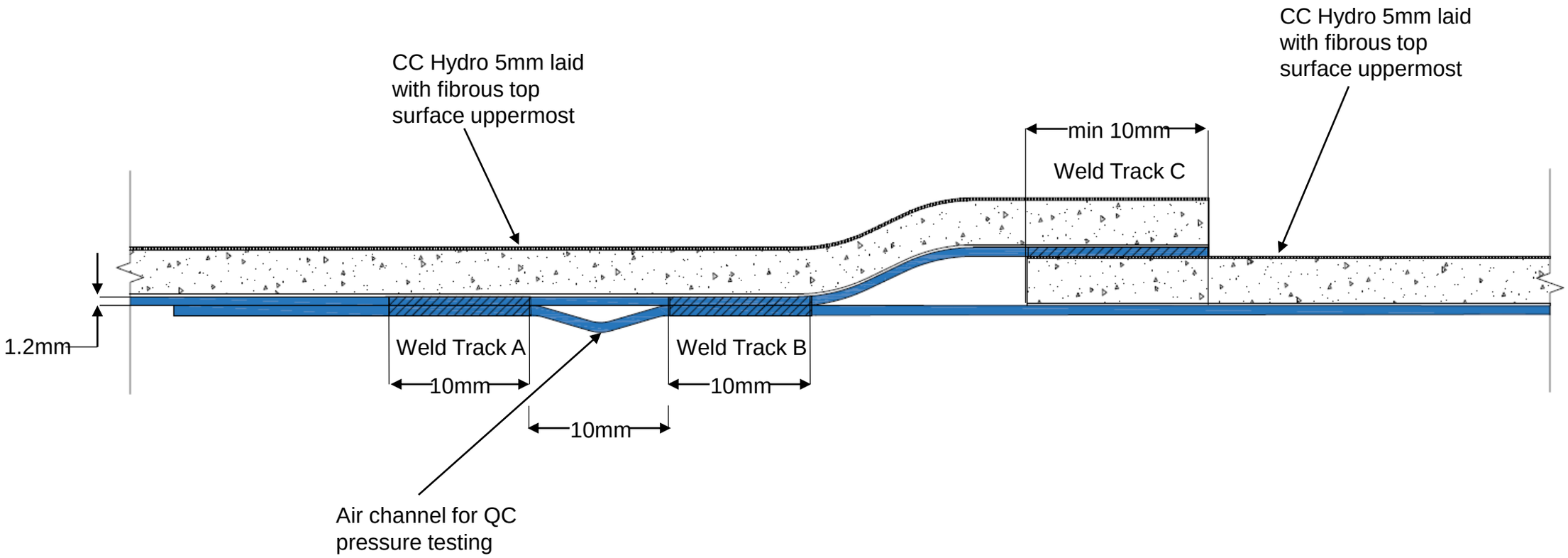
Rating Key

- A – Fluid has little or no effect
- B – Fluid has minor or moderate effect
- C – Fluid has severe effect

▲0.1 M H_2SO_4 pH1.2

$^{\Delta}$Synthetic according to OECD 303

CC Hydro™ thermally welded overlap joint



CC Hydro™ GCCM Physical Properties

Product	Concrete Thickness (mm)	Bulk Roll Size (sqm)	Roll Width (m)
CCH5™	5	150	1.0
CCH8™	8	100	1.0

Product	Mass (unset) (kg/m²)	Density (unset) (kg/m³)	Density (set) (kg/m³)
CCH5™	9.2	1500	+30-35%
CCH8™	14.2	1500	+30-35%

CC HYDRO™ JOINTING

Alignment

Cleaning

Welding

Testing

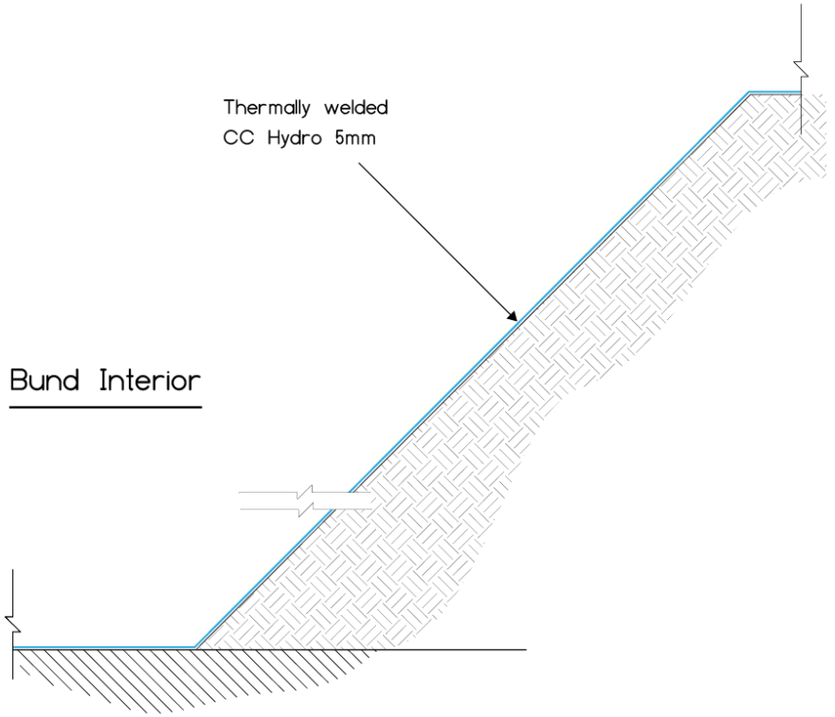
Core Applications

Bund lining

Channel lining

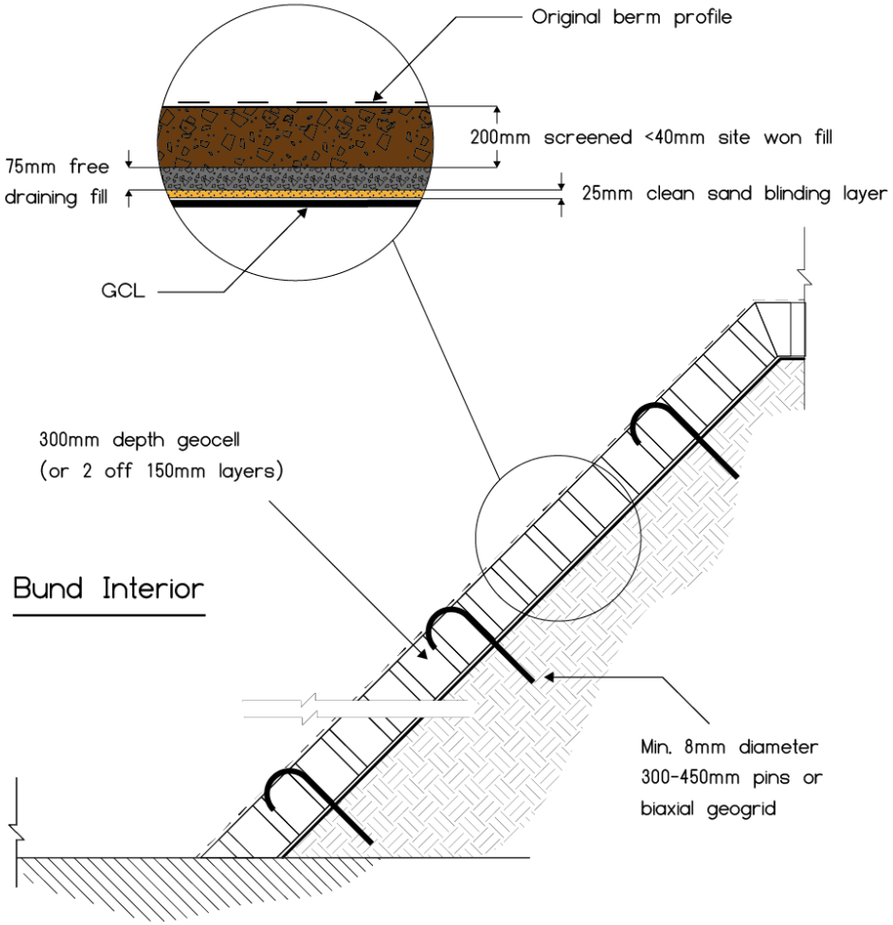
Lagoon lining

CC HYDRO™ VS GCL & GEOCELL SOLUTION



Detail A - Typical CC/CC Hydro lined bund section

Not to scale.



Detail B - Typical GCL/Geocell lined bund section

Not to scale.

CC HYDRO INSTALLATION

CC HYDRO BERM LINING

CONCRETE CANVAS®

Concrete Impregnated Fabric

CC SHELTERS

RAIL ROAD MINING PETROCHEM AGRO UTILITIES PUBLIC WORKS DEFENCE DESIGN SHELTER

WHAT ARE CC SHELTERS (CCS) ?

Concrete Canvas Shelters (CCS) are rapidly deployable hardened shelters that require only water and air for construction.

CCS have two major advantages over conventional tented shelter:

Operational: CCS enable a hardened structure from day one of an operation. They provide much better environmental protection, increased security and vastly improved medical capability.

Financial: CCS have a design life of over 10 years, whereas tents wear out rapidly and must then be replaced. CCS are a one stop solution, saving effort and cost over the lifetime of medium to long term operations.

CCS DEPLOYMENT

Delivery

CCS are supplied folded in polyethylene, airtight, water and rot proof acks within ISPM15 heat treated timber/ply panel crates.

CCS DEPLOYMENT

Inflation

An electric fan is activated which inflates the plastic inner to lift the structure until it is self supporting. The shelter is then pegged down with ground anchors around the base.

CCS DEPLOYMENT

Hydration

The CCS is then hydrated by spraying with water. Water does not need to be potable and sea water may be used.

Setting

The Concrete Canvas cures in the shape of the inflated inner and 24 hours later the structure is ready to use. Access holes can be cut to allow the installation of services.

CCS DEPLOYMENT

Earth Berming

CCS structures have been modelled to withstand a very high distributed compressive load, enabling berming by sandbags, local fill material or snow. This gives the shelters excellent thermal properties and can provide protection against shrapnel, blasts and small arms fire. The above shows CCS buried using a cellular geo-textile product to provide force protection.

CCS DEPLOYMENT

Earth Berming

CCS structures have been modelled to withstand a very high distributed compressive load, enabling berming by sandbags, local fill material or snow. This gives the shelters excellent thermal properties and can provide protection against shrapnel, blasts and small arms fire. The above shows CCS buried using a cellular geo-textile product to provide force protection.

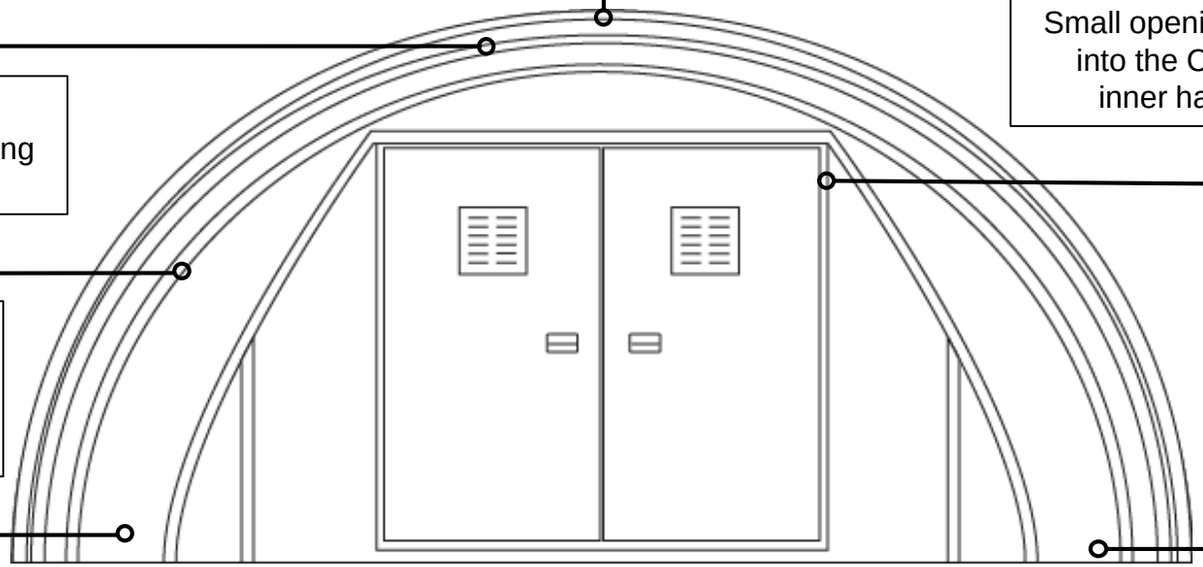
CCS KEYFACTS

Insulating
CCS concrete shells have good thermal properties. When buried they provide excellent insulation and a very large thermal mass.

Force protection
The compressive structure of CCS has been modelled to be covered with sand or earth (berming) to provide protection against small arms fire and shell fragments.

Ports / Conduits
Small openings for services can be cut or drilled into the Concrete Canvas shell. The inflatable inner has two manifolds AC/Ducting access.

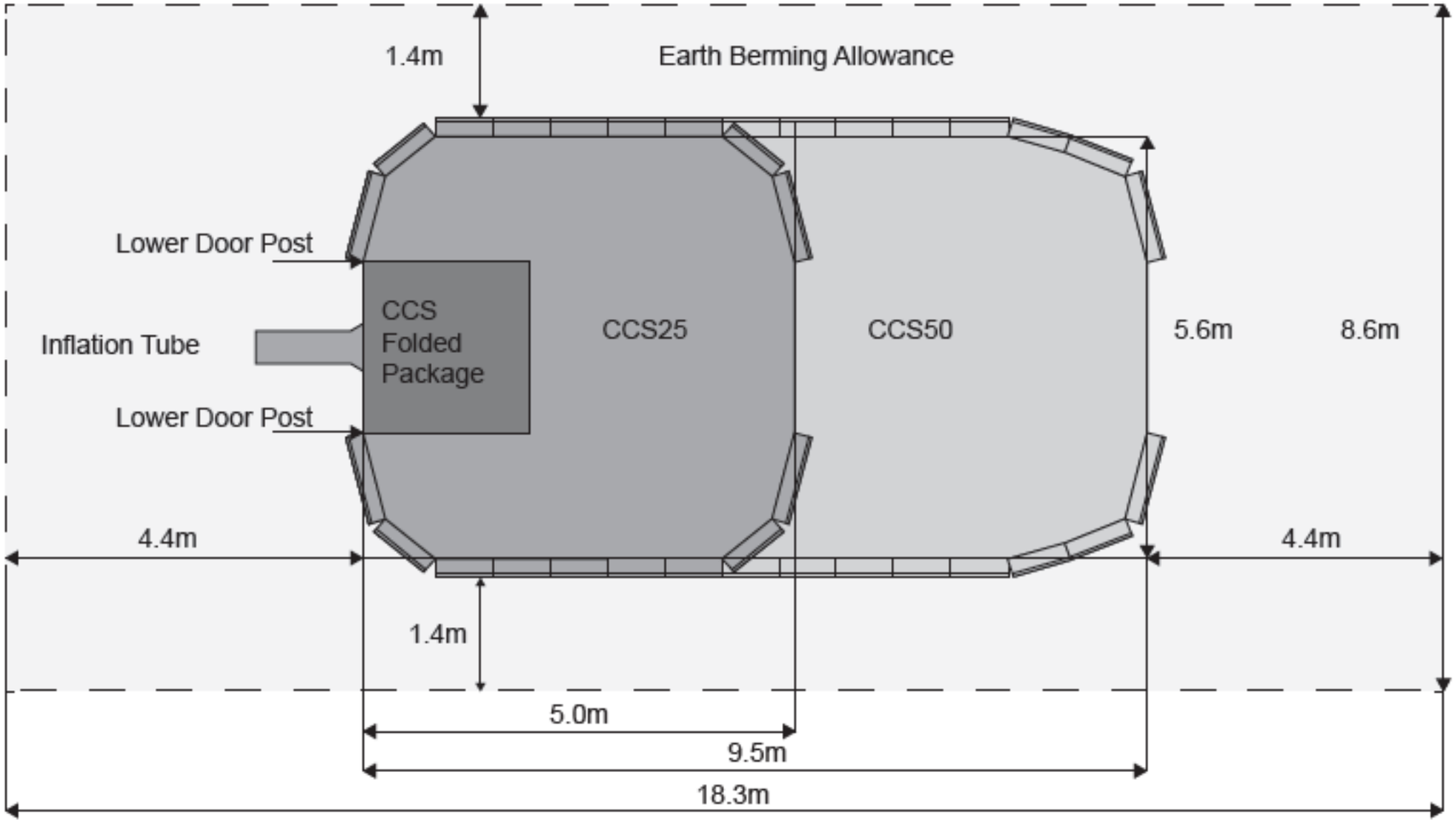
Durable
CCS are far more durable than tenting with a design life of over 10 years.



Modular
CCS structures are designed as part of a modular system; units can be docked together to create arrays of structures to suit operational requirements.

Rapid
A 25sqm CCS can be deployed by 2 people in less than 1 hour and is ready to use in only 24 hours.

CCS DEPLOYMENT FOOTPRINTS



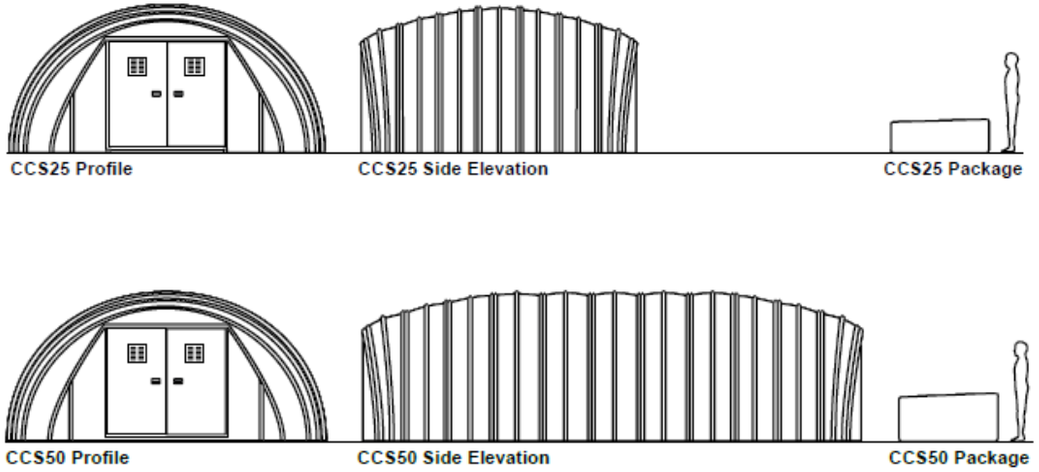
CCS KEY PROPERTIES

Pre-deployment (Crate) dimensions				
Unit	Length (m)	Width (m)	Height (m)	Weight (kg)
CCS25	2.61	2.30	1.13	1900
CCS50	2.90	2.24	1.70	3100

General Specification			
Unit	Water Requirement (L)	Width (m)	Height (m)
CCS25	1000	6022	4-6
CCS50	2000	120	8-10

CCS KEY PROPERTIES

Post-deployment dimensions				
Unit	Length (m)	Width (m)	Height (m)	Weight (kg)
CCS25	5.00	5.60	2.45	25.00
CCS50	9.50	5.60	2.60	50.00



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CONCRETE CANVAS®

TECHNICAL APPENDICES

CC Installation
- CC 4 Principles
- CC Channel Lining Animation (Web)
- CC Speed Trial Demonstration (Web)

CC Technical Material Properties
- CC Flow Rates / Flume Testing
- CC Mannings Testing
- CC Chemical Resistance
- CC Rockfall Impact Testing
- CC Biogenic Corrosion
- CC Logistical Footprint
- CC Compressive Strength
- CC Tensile Strength
- CC Flexural Strength
- CC Puncture Resistance
- CC CO2 Data

CC Certification
- CC CE Certification : BS EN 12467:2004
- CC Fire Certification

Miscellaneous
- CC Production Rates / Capacity

Compressive Strength (N/mm2)

ASTM C109 Cube Test = **40MPa**

a) **Resistencia a la compresión**

Probeta N°	Edad (días)	Densidad (kg/m^3)	Carga (kN)	Resistencia a la compresión en probetas cúbicas de 5 cm (MPa)	
				Probeta	Promedio
1	1	2.180	129	49,6	49,2
2	1	2.170	127	48,8	
3	3	2.170	143	55,0	55,4
4	3	2.170	145	55,8	
5	7	2.160	158	60,8	59,3
6	7	2.160	150	57,7	

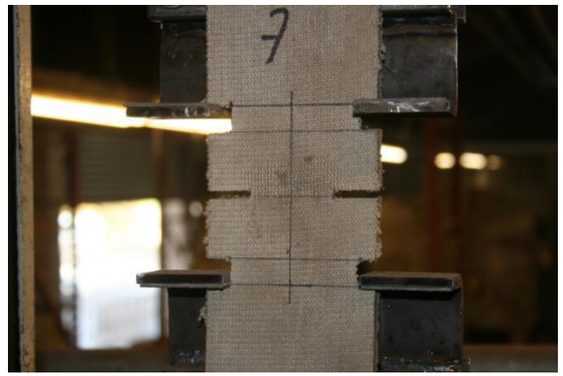
Bending Strength of 3.4 MPa (N/mm2)

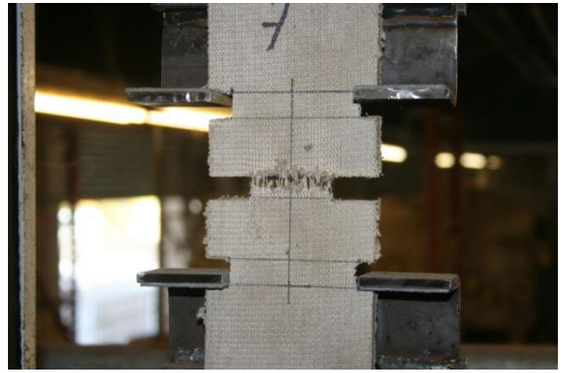
BS EN 12467
Based on In-house testing
3-point bend test

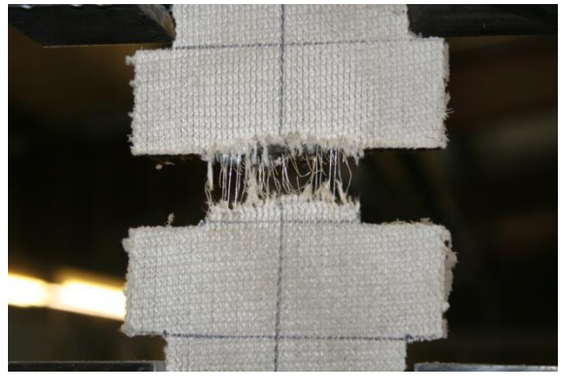
Tensile Strength (first crack)

	Length direction (kN/m)	**Width direction** (kN/m)
CC5	6.7	3.8
CC8	8.6	6.6
CC13	19.5	12.8

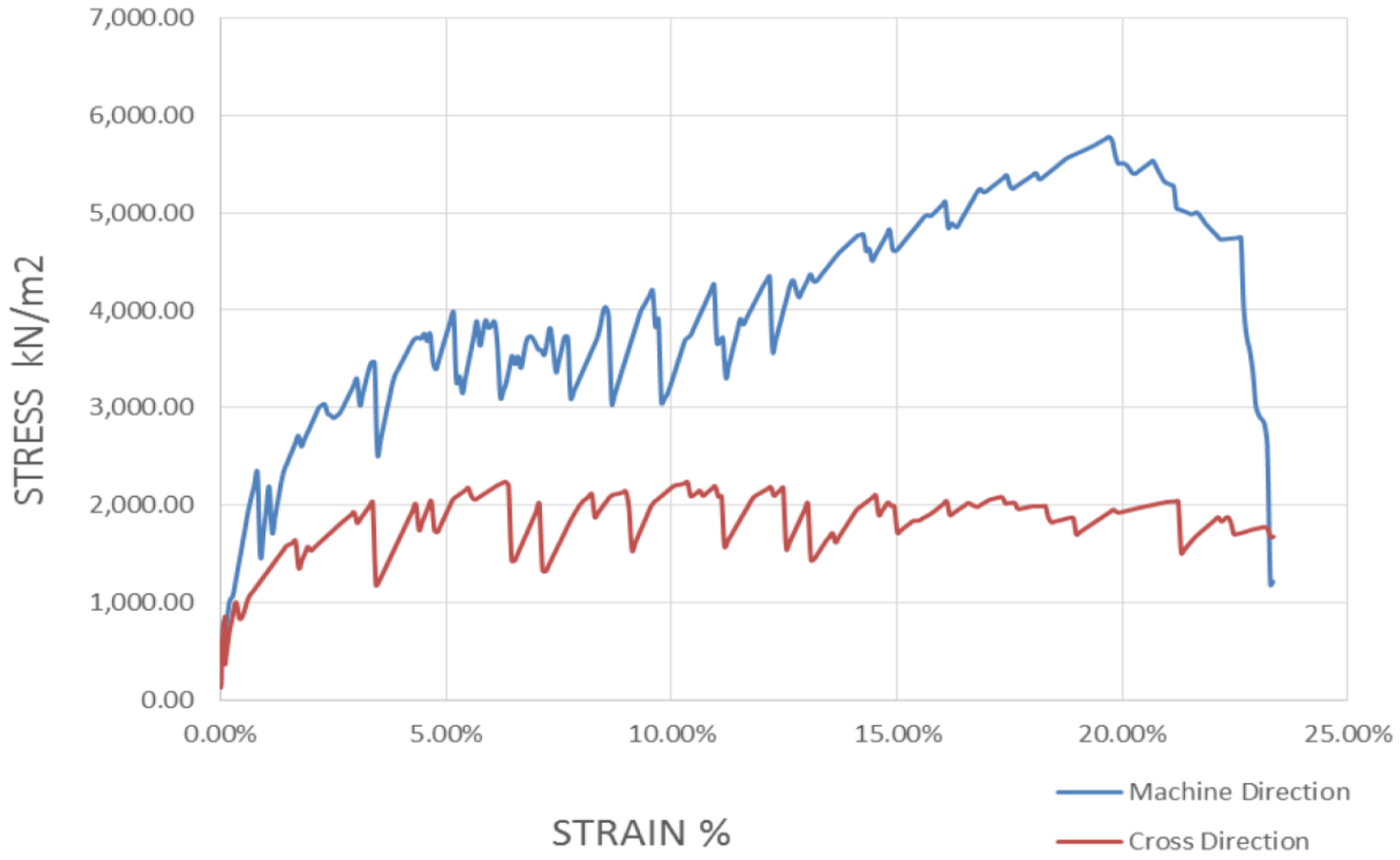
Cured sample size of 300x100mm.
Two 25mm horizontal slots cut on either side of specimen to reduce test width to 50mm.
Tensile test machine run at 50mm/ minute.







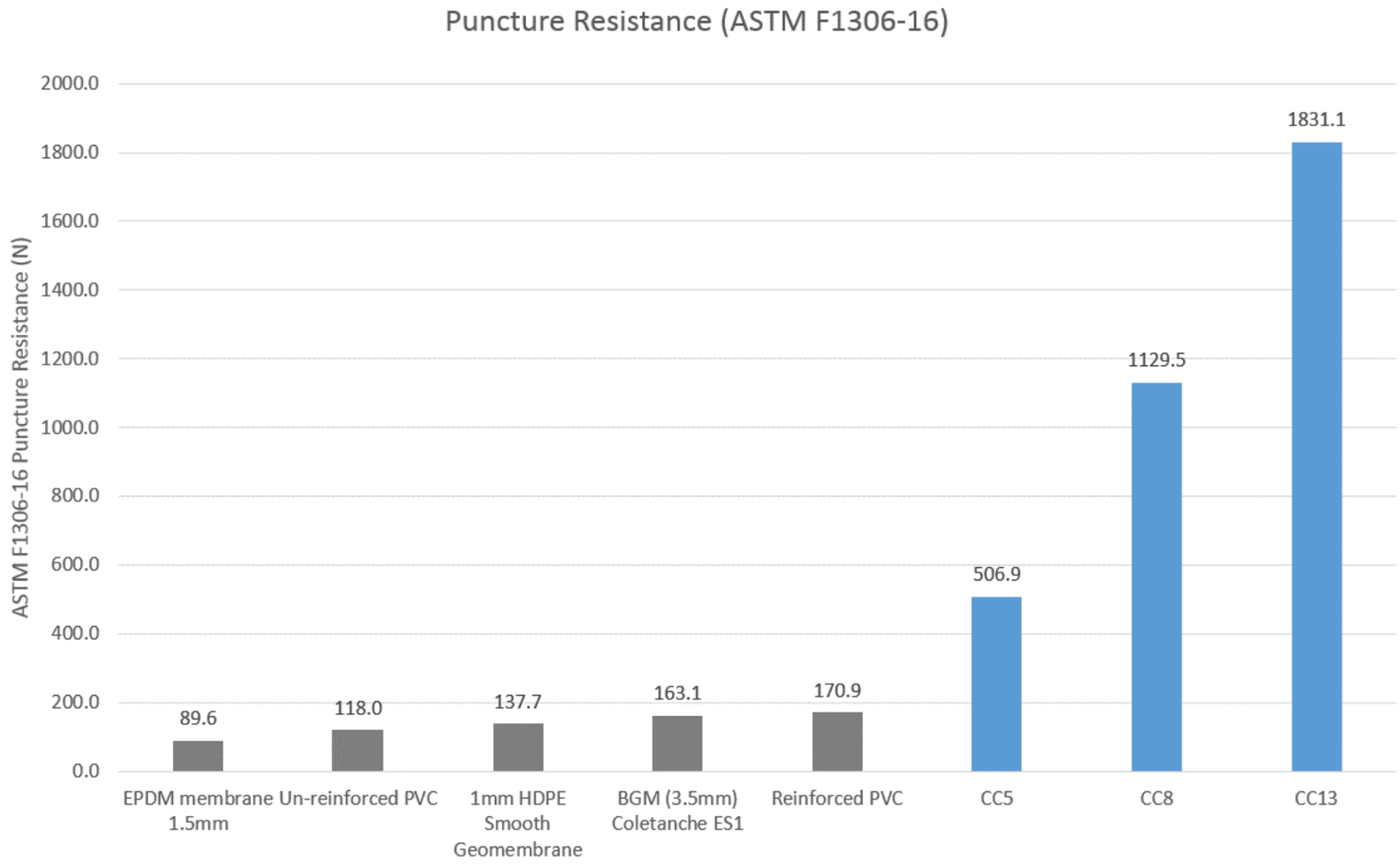
Flexural Strength



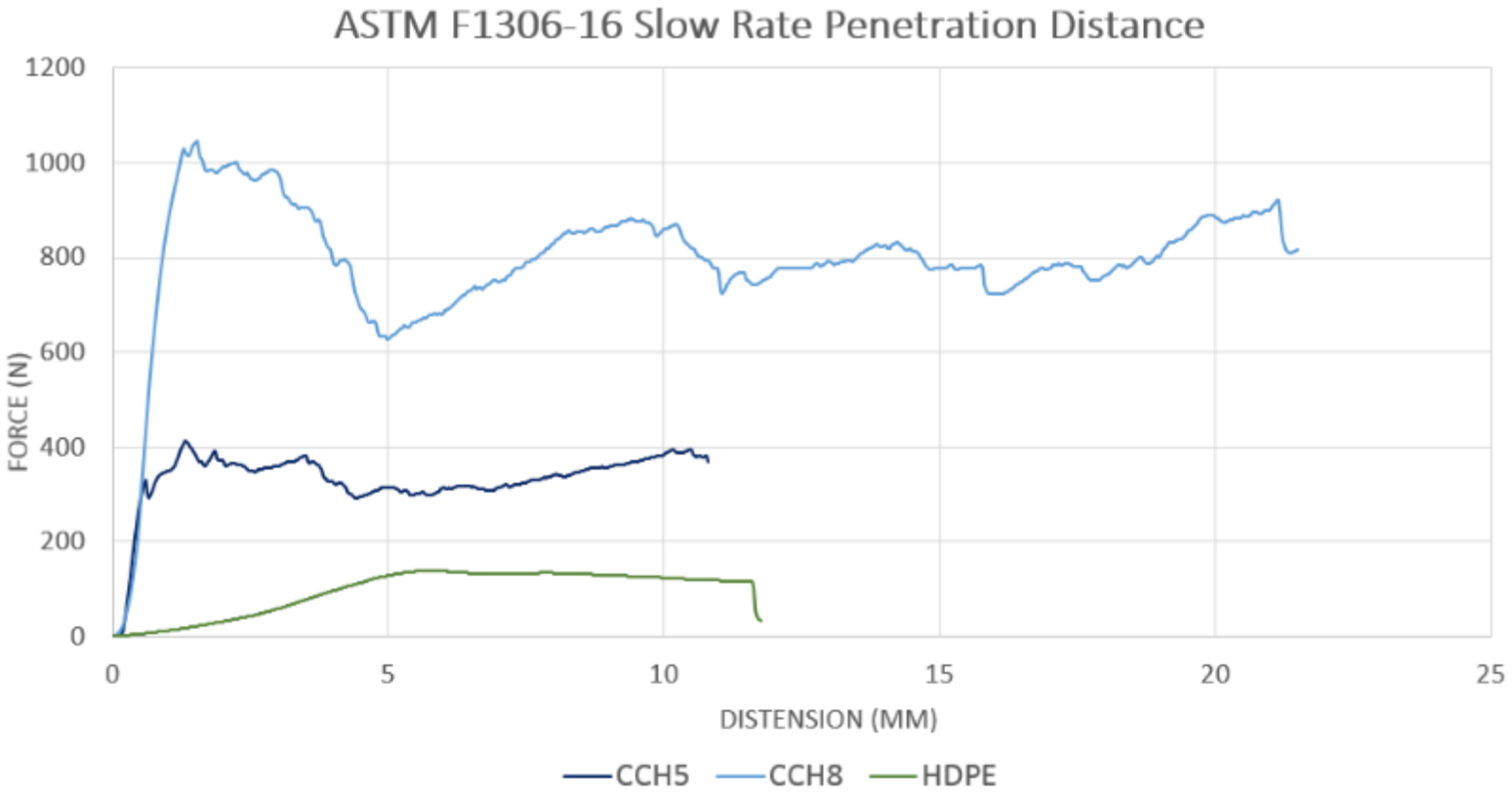
Three phases in failure:

1. Initial Elastic Phase
2. Incremental Rupture Phase
3. Final Rupture

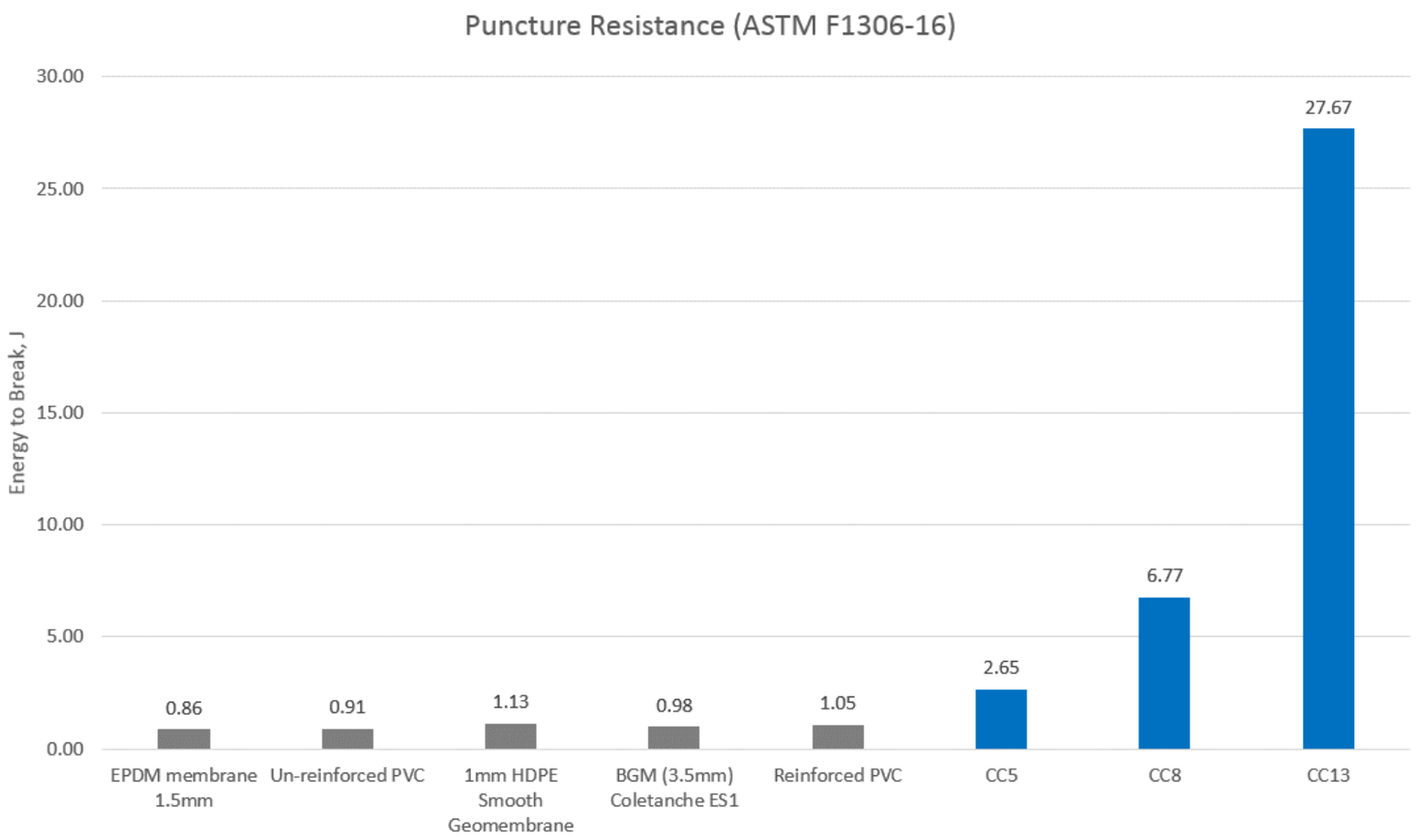
Puncture Resistance (peak force)



Puncture Resistance (energy)



Puncture Resistance (energy)

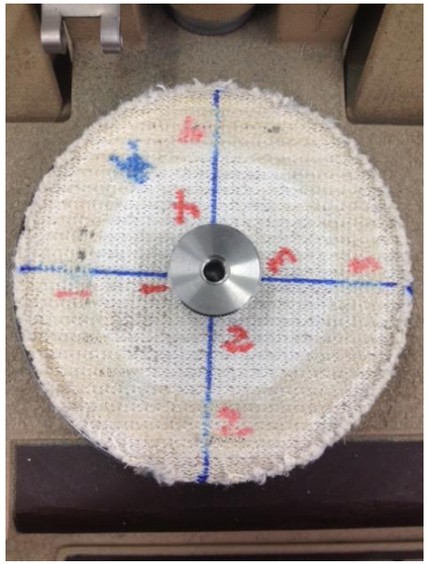


Abrasion Resistance

Overview of Taber Abrasion

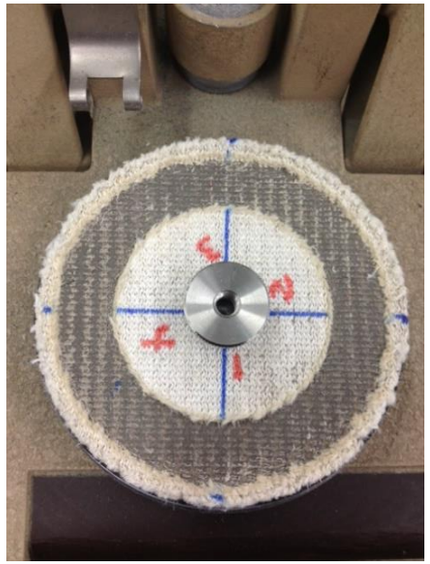
- Equipment: Taber 5150 Abraser
- Two H22 Abrasive wheels (coarse/high abrasion)
- 1000 g weights on each wheel
  - Estimate ~18 psi pressure at abrasion surface
- Resurface abrasive wheel with diamond tip every 500 cycles
- Measure change in mass and change in thickness versus number of cycles
- Testing similar to ASTM C-1353

Abrasion Resistance



500 Cycles

1500 Cycles

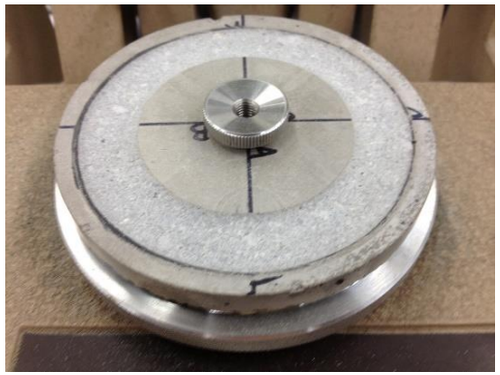


2000 Cycles

6500 Cycles

Abrasion Resistance

20Mpa (2300 psi) concrete, 4700 cycles

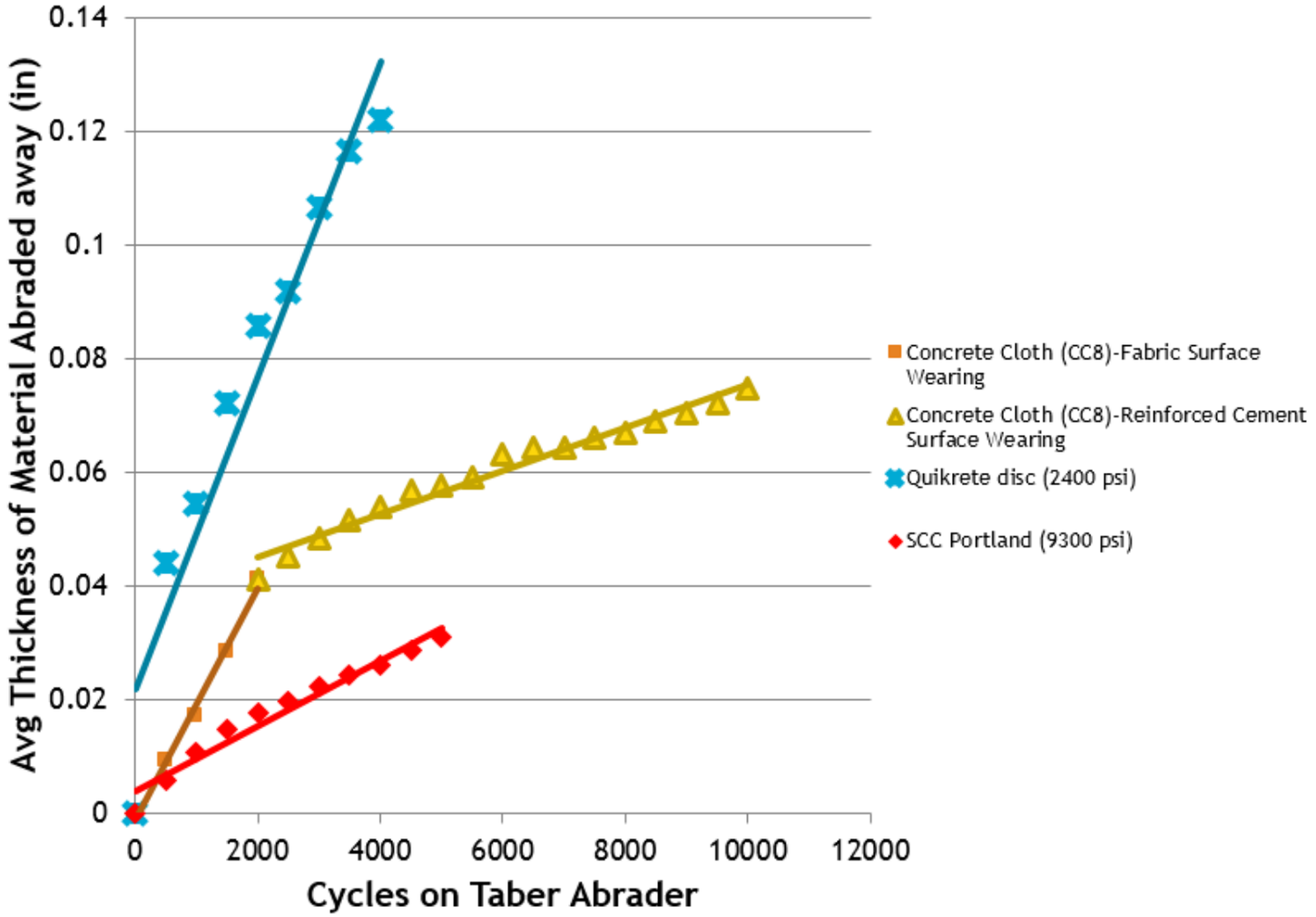


64Mpa (9300 psi) concrete, 5000 cycles

Concrete Canvas CC8, 6500 cycles

GCCMs have abrasion resistance similar to high compressive strength concrete, but will not fall apart (fiber reinforced) as it experiences wear.

Abrasion Resistance



Test method based on ASTM C1353:

"Test Method Using the Taber Abrader (Abrader) for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic".

Durability (EN 12467)

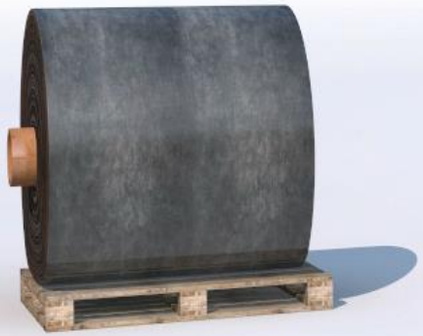
Physical requirements and characteristics	Classification	Requirement	Result
Apparent density: (set CC)	N/A	>1900 kg/m3	Pass
Bending strength	Class 1	4-7MPa	Pass
Water impermeability	Category A	Impermeable	Pass
Warm water: (60 ± 2) °C	Category A	(56 ± 2) days	Pass
Durability requirements			
Soak-dry: 6hrs at (60 ± 5) °C drying & 18hrs immersed in water >5°C	Category A	50 cycles	Pass
Freeze-thaw: 1-2hrs at (-20 ± 4) °C freezing & 1-2hrs immersed in water (20 ± 4) °C	Category A	100 cycles	Pass
Heat-rain (2hrs 50mins ± 5 min water spray & 2hr 50mins ± 5 min radiant heat)	Category A	50 cycles	Pass

Expected Life (UK climate)	Min 50 Years

Table 1. Comparison of tons of material used - GCCM vs conventional concrete*.

GCCM thickness (mm)	Roll width (m)	Mass unset (kg/m2)	Portable roll size			Bulk roll size (m2)			Concrete alternative (2400 kg/m3)	
			Length (m)	Area (m2)	Weight (kg)	Length (m)	Area (m2)	Weight (kg)	Concrete thickness (mm)	Weight of concrete (kg)
5.0	1.0	7.0	10	10	70	200	200	1,400	75	36,000
8.0	1.1	12.0	5	4.5	60	113	125	1,500	100	30,000
13.0	1.1	19.0	-			73	80	1,520	150	28,800

GCCM LOGISTICAL FOOTPRINT



1 Bulk Roll = *2 x 17T Ready-mix Trucks*

Return

CC PRODUCTION RATES / CAPACITY

Existing Capacity (Peak)		
CC5	380 Rolls/Month	76,000 sqm
CC8	520 Rolls/Month	65,000 sqm
CC13	740 Rolls/Month	59,200 sqm

Sustained Capacity		
CC5	250 Rolls/Month	50,000 sqm
CCH5	100 Rolls/Month	15,000 sqm
CC8	180 Rolls/Month	22,500 sqm
CCH8	100 Rolls/Month	10,000 sqm
CC1348	Rolls/Month	3,200 sqm

Return

BS EN 12467:2004 ‘Fibre-cement flat sheets – Product specification and test methods’.

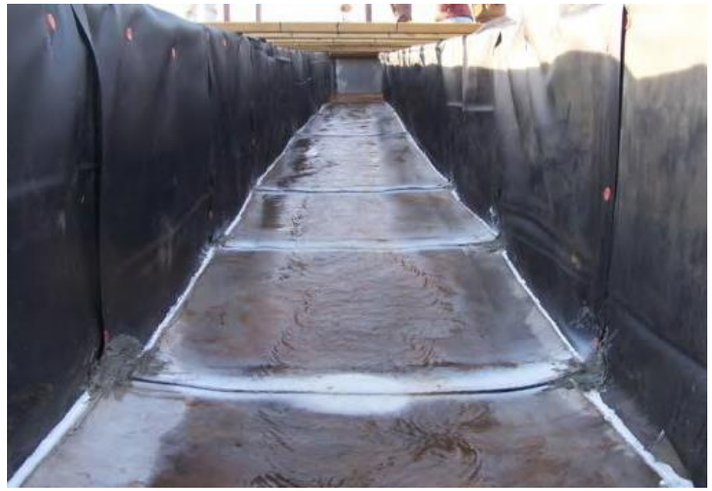
Physical requirements and characteristics	Classification	Requirement	Result
Apparent density: (set CC)	N/A	>1900 kg/m3	Pass
Bending strength	Class 1	4-7MPa	Pass
Water impermeability	Category A	Impermeable	Pass
Warm water: (60 ± 2) °C	Category A	(56 ± 2) days	Pass
Durability requirements			
Soak-dry: 6hrs at (60 ± 5) °C drying & 18hrs immersed in water >5°C	Category A	50 cycles	Pass
Freeze-thaw: 1-2hrs at (-20 ± 4) °C freezing & 1-2hrs immersed in water (20 ± 4) °C	Category A	100 cycles	Pass
Heat-rain (2hrs 50mins ± 5 min water spray & 2hr 50mins ± 5 min radiant heat)	Category A	50 cycles	Pass

Return

FLUME TESTING

Concrete Canvas during installation

Weighting edges during initial 24-hour cure



Joints painted to assist with detecting movement

Initial flow at 4psf

CC MANNINGS TESTING

Test Setup: The intent of this testing was to measure the Manning's *n* using ASTM D6460 and a trapezoidal channel. The trapezoidal channel with low slope provides an accurate hydraulic radius and the least turbulent flow. It should be noted that the higher flow levels still were somewhat turbulent leading to varying flow depths and velocities from cross-section to cross-section. The channel was "calibrated" by lining it with polyethylene sheeting to create a very, very low friction condition to compare to. The Manning's n for this calibrated condition was 0.010.

Cross-Section	to channel bottom	to water surface	water depth, ft	area, ft2	velocity, ft/sec	R, ft	Q, cfs	Manning's n
1	686	647	0.13	0.29	7.35	0.11	2.12	0.011
	686	627	0.19	0.46	9.09	0.16	4.20	0.011
	686	604	0.27	0.68	9.87	0.21	6.74	0.012
	686	586	0.33	0.87	10.00	0.25	8.71	0.013
2	787	751	0.12	0.26	7.10	0.10	1.88	0.010
	787	739	0.16	0.36	8.79	0.13	3.20	0.010
	787	724	0.21	0.50	10.06	0.17	5.02	0.010
	787	672	0.38	1.04	10.99	0.28	11.42	0.013
3	645	614	0.10	0.22	7.13	0.09	1.60	0.009
	645	597	0.16	0.36	8.05	0.13	2.93	0.011
	645	577	0.22	0.55	10.35	0.18	5.65	0.010
	645	565	0.26	0.66	11.20	0.21	7.42	0.010
4	690	645	0.15	0.34	7.01	0.13	2.38	0.012
	690	633	0.19	0.44	7.59	0.16	3.37	0.013
	690	606	0.28	0.70	9.32	0.22	6.55	0.013
	690	587	0.34	0.90	9.92	0.26	8.97	0.014
5	605	582	0.08	0.16	7.03	0.07	1.14	0.008
	605	565	0.13	0.30	8.99	0.11	2.67	0.009
	605	555	0.16	0.38	10.14	0.14	3.87	0.009
	605	532	0.24	0.59	10.98	0.19	6.52	0.010
6	689	646	0.14	0.32	7.00	0.12	2.25	0.012
	689	620	0.23	0.56	7.46	0.18	4.14	0.014
	689	596	0.31	0.80	9.11	0.24	7.26	0.014
	689	589	0.33	0.87	10.01	0.25	8.72	0.013
7	677	640	0.12	0.27	7.22	0.11	1.97	0.010
	677	629	0.16	0.36	8.63	0.13	3.15	0.010
	677	597	0.26	0.66	10.05	0.21	6.66	0.012
	677	568	0.36	0.97	10.40	0.27	10.10	0.013
8	764	730	0.11	0.25	6.55	0.10	1.62	0.011
	764	721	0.14	0.32	8.80	0.12	2.83	0.009
	764	684	0.26	0.66	9.73	0.21	6.45	0.012
	764	684	0.26	0.66	9.59	0.21	6.36	0.012

Avg Depth 1:	0.12	Avg Manning's *n* 1:	0.010	Overall Average Manning's *n*
Avg Depth 2:	0.17	Avg Manning's *n* 2:	0.011	
Avg Depth 3:	0.25	Avg Manning's *n* 3:	0.012	
Avg Depth 4:	0.31	Avg Manning's *n* 4:	0.012	0.011

CC MANNINGS TESTING

Completed Installation

Spraying Water to Hydrate Concrete Cloth

Return

CC FIRE CERTIFICATION

Concrete Canvas has achieved the classification:

B-s1, d0

This classification is the highest possible for flammable materials and can be broken down as below.

B	The panels contribute little or insignificantly to fire.
s1	The panels contribute little or insignificantly to the development of smoke.
d0	The panels do not create flaming particles or droplets when subjected to fire.

Return

CC CHEMICAL RESISTANCE

		CC5	CC8	CC13
Acid	Mean Strength (N)	56.9N	121.7N	326.3N
	Retained Strength (%)	**123%**	**172%**	**117%**
Alkaline	Mean Strength (N)	58.8N	96.9N	332.7N
	Retained Strength (%)	**138%**	**140%**	**116%**
Hydrocarbon	Mean Strength (N)	64N	105N	396N
	Retained Strength (%)	**115%**	**99%**	**103%**

Concrete Canvas products showed no loss of flexural strength following chemical immersion.

Return

Test : ASTM G13

Grade : Concrete Canvas 13mm Standard Set
Aggregate type : 50mm/ 2” Hard Limestone

DATE of TEST : 25/26th February 2010
LOCATION of TEST : Saint Gobain PAM, UK
PIPE TYPE : 6” dia expoxy coated steel pipe
TEMP. : 6 C (overnight 3 C)

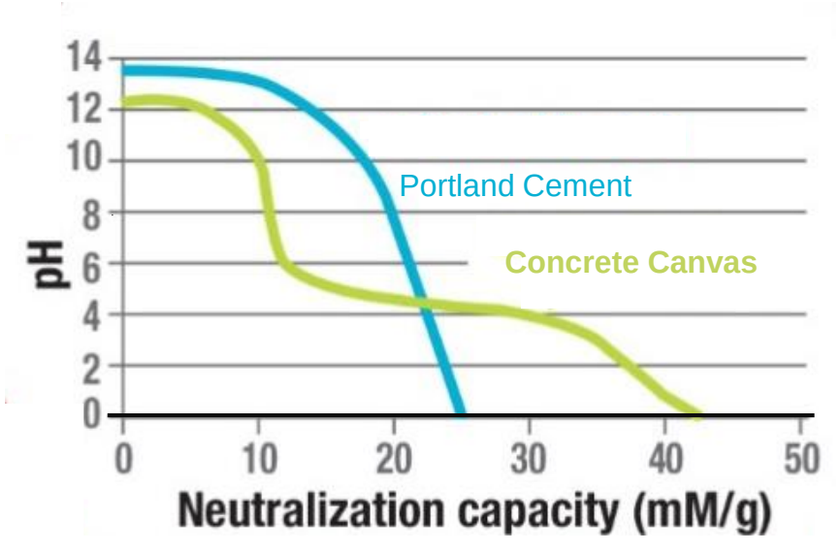
NO DAMAGE TO PIPE COATING

Return

CC BIOGENIC CORROSION PRINCIPLES

Biogenic Corrosion is driven by the biological activity of various strains of acidophilic bacteria. A tiny biofilm of Thiobacillus Thiooxidans – also called Thiobacillus Concretivorus because they “eat away” concrete – can produce enough sulfuric acid to corrode up to 25mm of concrete within a single year when the worst conditions are combined.

- **Neutralisation Capacity**
- AH3 Barrier
- Bacterio-Static Effect
- Stabilisation of pH around alumina solubility threshold



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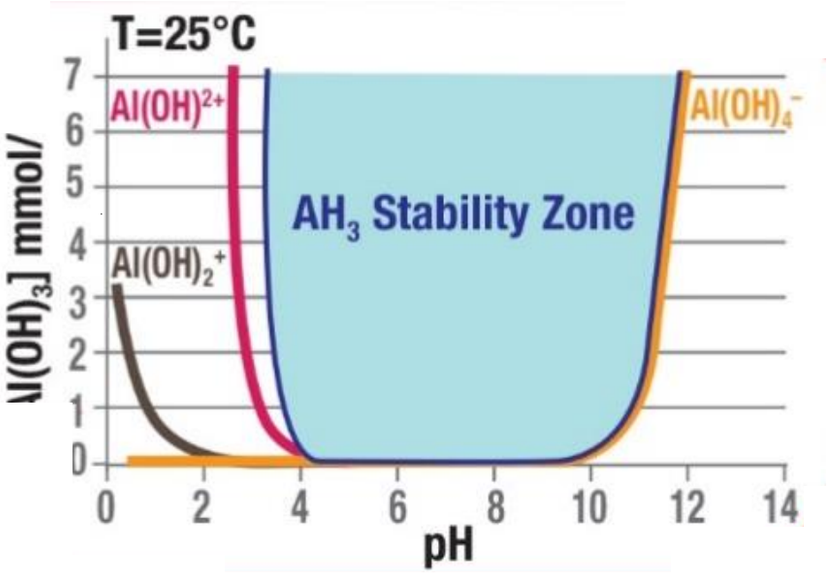

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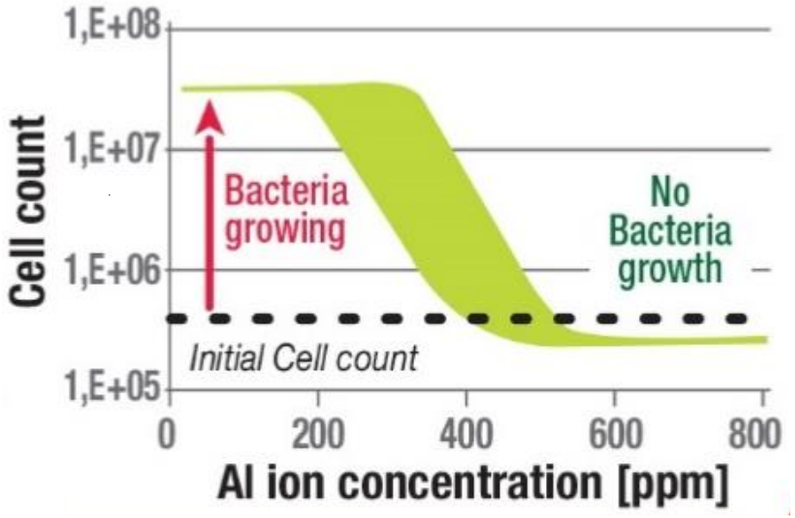

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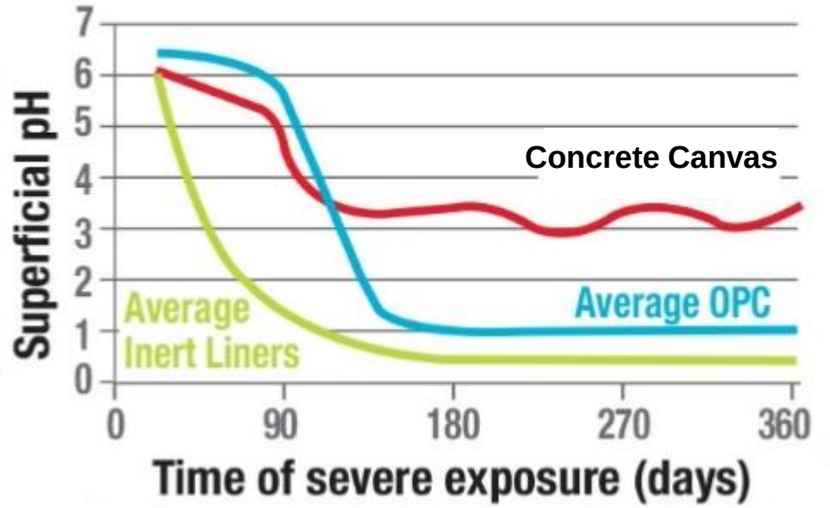


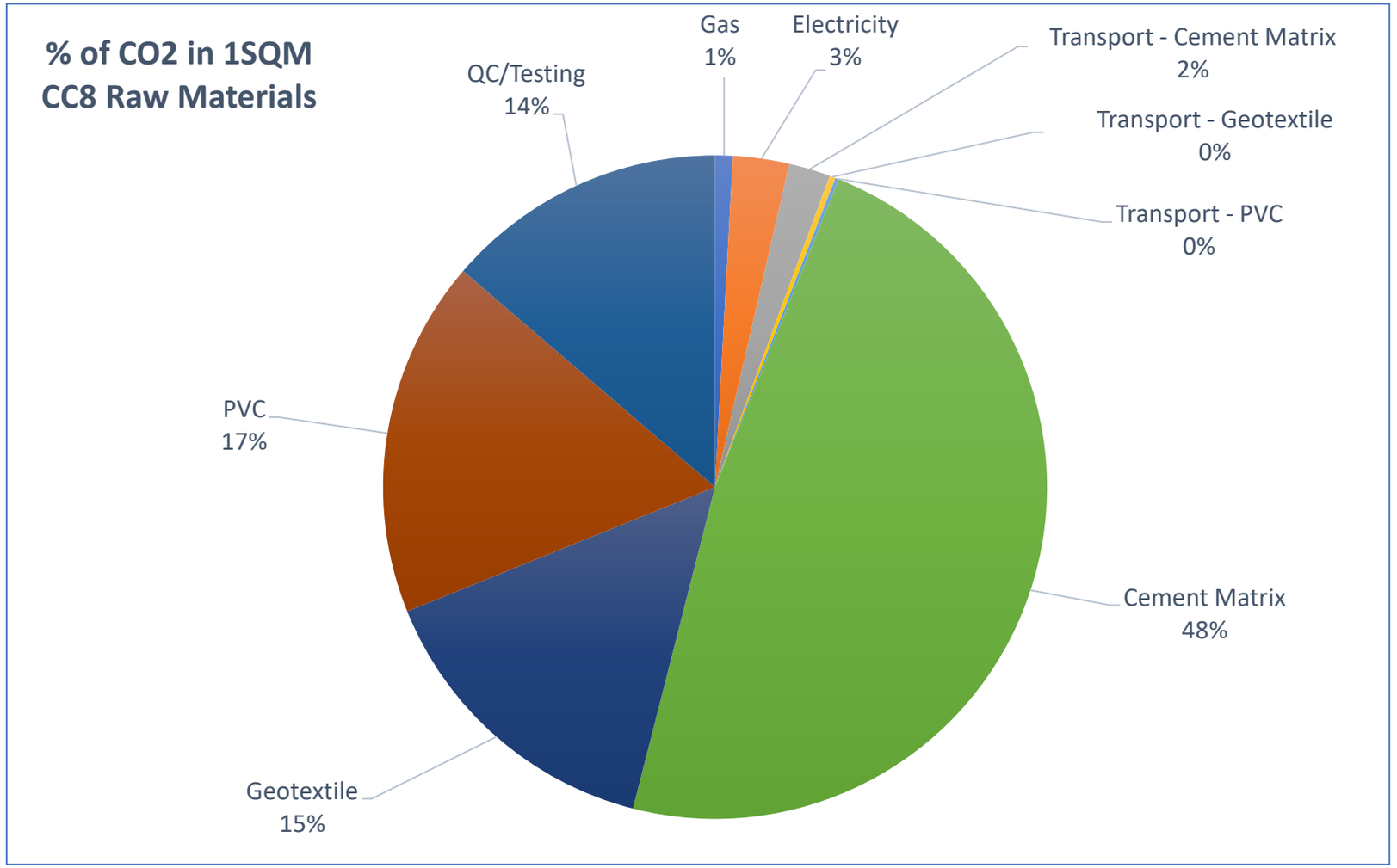
Return

Concrete Canvas Carbon Research

- Concrete Canvas have carried out a Life Cycle Assessment to ISO14040 and prepared an Environmental Product Declaration as per EN15804

- Life Cycle Analysis (LCA) for a square metre of each grade of CC and CC Hydro has been determined for product stage modules ‘A1 to A3’ – raw material supply, transport of raw materials and manufacturing associated processes.

- The average values of the environmental impacts for the production of CC have been calculated on the basis of the 2016 annual production volumes.



Concrete Canvas Carbon Research

Parameter	Unit	RESULTS OF THE LCA – ENVIRONMENTAL IMPACT:		
		1 Square Meter of Concrete Canvas ® CC5	1 Square Meter of Concrete Canvas ® CC8	1 Square Meter of Concrete Canvas ® CC13
Global warming potential (GWP)	Kg CO_2-Eq.	9.59	16.13	24.08

Parameter	Unit	RESULTS OF THE LCA – RESOURCE USE:		
		1 Square Meter of Concrete Canvas ® CC5	1 Square Meter of Concrete Canvas ® CC8	1 Square Meter of Concrete Canvas ® CC13
Total use of renewable primary energy resources	MJ	1	1.7	2.8
Total use of non-renewable primary energy resources*	MJ	1.6	2.8	4.6
Net use of fresh water	M^3	0	0	0

* Methodology: CML - natural gas (38.84 MJ/m3) 8006-14-2 m3 ~ **38,84 MJ**

Concrete Canvas Carbon Research

- In order to determine the relevance of this data, consider replacing a typical 150mm poured concrete channel with CC8. C20 concrete Embodied Carbon data taken from the ICE database for construction materials:

ST4 , (C20/24 Mpa)	kg CO2 / kg	Concrete Density kg/m3	Weight of 150mm x 1Sqm	KG CO2/SQM
Total	0.100	2400	360	**36.00**

- 1sqm CC8 contains 16.13kg CO2/sqm, therefore when considering raw materials alone, a Concrete Canvas channel will contain 45% of the Embodied Carbon of a conventional concrete channel. **A saving of 55%.**

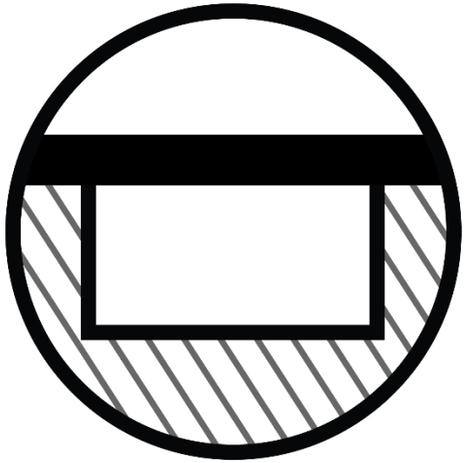
- This excludes carbon costs for the Construction Process Stage. Firstly, Transport. Assuming CC travels 100miles and Concrete only 20miles to a construction site:

Transport to Site Comparison	Tonnes	Miles	kg CO2e / Tonne/Mile Delivery	Tonne/Mile CO2	Kg CO2 / sqm
Concrete Full Load	***17***	***20***	***0.161***	***54.74***	**0.44**
Pallet of CC	***1.6***	***100***	***0.161***	***25.76***	**0.21**

- Based on this example, Concrete Canvas provides a 50% saving in transport carbon costs

- Construction Installation Process carbon costs also need to be considered. Concrete Canvas is typically 10 times faster to install than poured concrete so significant carbon savings are expected, but have not been included in this research due to the variable nature of installation processes

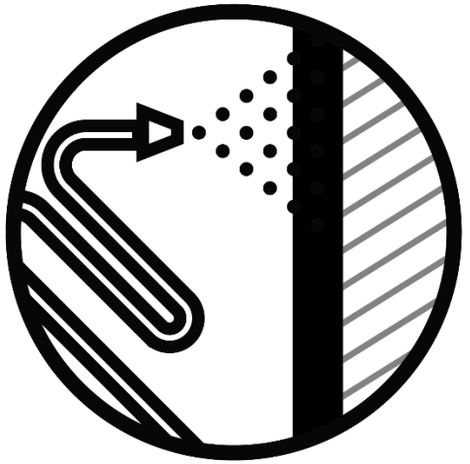
Return



AVOID VOIDS

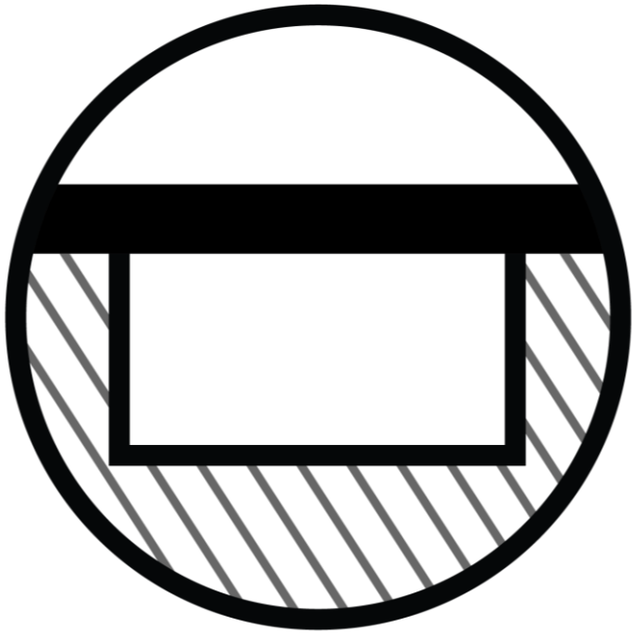
SECURE CC

PREVENT INGRESS



HYDRATE FULLY

Return



AVOID VOIDS

Prepare the substrate so that surfaces are well compacted, geotechnically stable with a smooth, uniform surface.

- For ***soil*** substrates, remove any vegetation, sharp or protruding rocks and fill any large void spaces. Ensure the CC makes direct contact with the substrate to minimise soil bridging or potential soil migration under the layer.

- For ***concrete*** substrates, remove any loose or friable material, cut away any protruding exposed re-bar and fill any large cracks or voids.

SECURE CC

Secure CC
It is important to ensure that the CC is **Jointed** at every overlap between layers and that those layers are **Fixed** to the substrate.

Jointing Layers
Overlapped CC layers should be securely jointed together, typically this is achieved using stainless steel screws applied with an auto-fed screw gun at regular intervals. Correct screw placement will help ensure intimate contact between CC layers, prevent washout of the substrate, and limit potential weed growth.

An adhesive sealant can be applied between the layers to improve the joint impermeability.

A non-penetrative method of jointing is to ‘thermally bond’ the CC layers together. This also improves joint impermeability. For more Jointing options see the CC Jointing and Fixing Guide.

Fixing Layers
When fixing to a soil substrate, ground pegs (eg J-pegs) are typically used.

On rock or concrete substrates, CC layers can be jointed together and fixed to the substrate using masonry bolts, percussion anchors or shot fired masonry nails. Stainless steel fixings with washers are recommended.

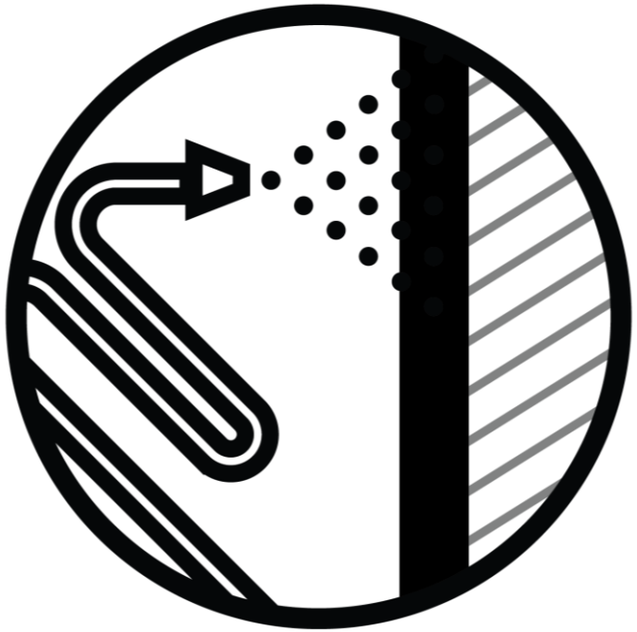
PREVENT INGRESS

It is important to prevent water or wind ingress between the CC and the substrate, both around the perimeter of the installation and along the joints..

For **soil substrates**, this is typically achieved by capturing the entire perimeter edge of the CC within an anchor trench.

On **rocky or concrete substrates**, the perimeter edge should be sealed with a concrete fillet or an adhesive sealant.

All overlapped CC layers should be lapped in the direction of water flow.



HYDRATE FULLY

It is critical to properly hydrate CC, taking into account the quantity of material used and ambient temperature conditions.

- Always ensure hydration through the fibrous top surface.
- Spray the fibre surface with water until it feels wet to touch for several minutes after hydration (the ‘Thumb Test’).
- Ensure to hydrate any overlapped areas and anchor trenched material prior to backfilling.

Follow the CC Hydration Guidelines.

Return

CHANNEL LINING

SLOPE LINING

BUND LINING

REMEDIATION

WEED SUPPRESSION

TEMP WORKS

CULVERT LINING

LAGOON LINING

GABION LINING

DESIGN APPLICATIONS