Milliken®

Concrete Cloth™

Licensed from CONCRETE CANVAS®

Changing the way you think about concrete.

Milliken™

Overview

Founded in 1865

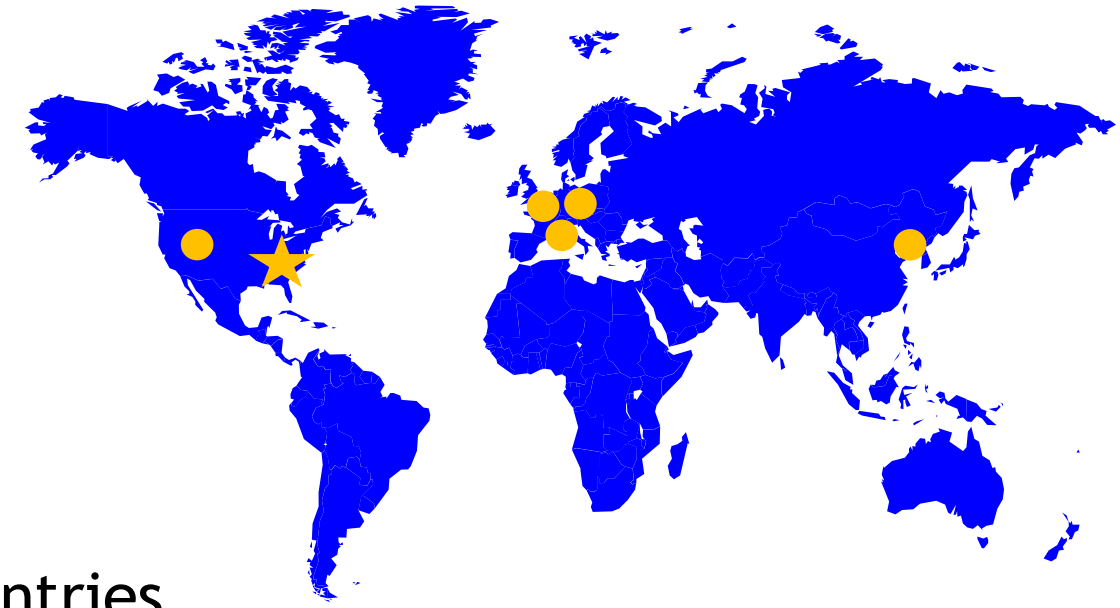
Privately held

Over 48,000 products

~7,000 associates

Manufacturing in 5 countries

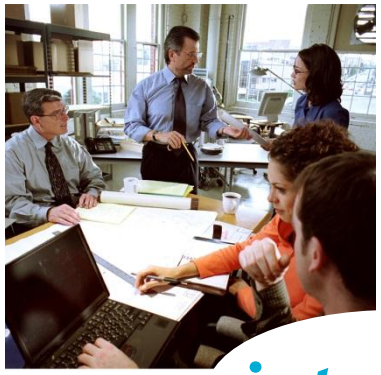
Operations throughout Americas, Europe and Asia



Milliken Vision

to be the **greatest** privately-held company in the world

customers



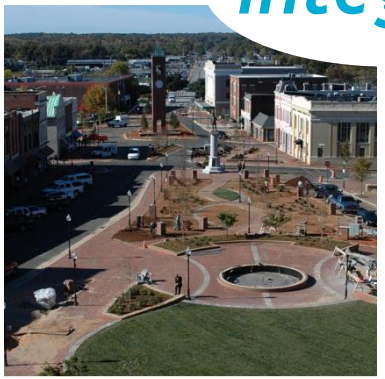
shareholders

great
to do business with

great
to own

integrity

great
corporate citizen



great
to be part of

communities

associates

Key Markets

Specialty Chemicals

Floor Coverings & Interiors

Protective & Performance Textiles

Industrial Products






Product Introduction

Agenda

- Introduction to Concrete Cloth™
- Civil Applications
- Military Applications
- Concrete Cloth Properties & Milliken Testing Program

Concrete Cloth™ is a geocomposite

It combines the flexibility of geotextile fabrics with the durability of hardened concrete!

Concrete Cloth™ can be used:

- *Where a hardened protective surface is required*
- *Where conventional concrete is difficult or impossible to install.*

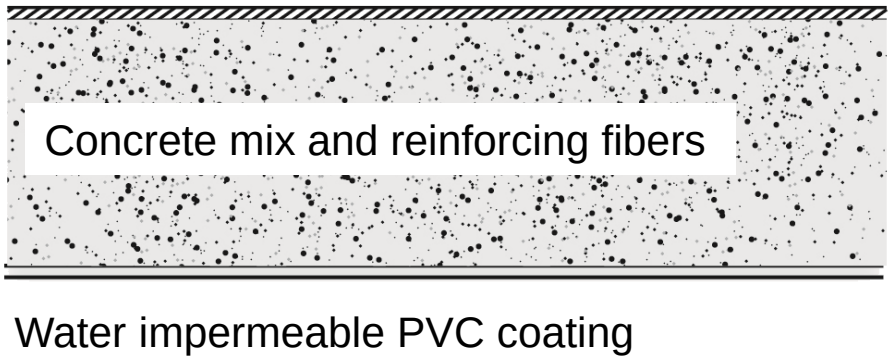
What is Concrete Cloth™?

A flexible cement-impregnated fabric that hardens when hydrated to form a thin, durable concrete layer.

Concrete Cloth™ (“CC”) consists of:

- Dry concrete mix
- Reinforcing fiber matrix
- Fabric top surface
- PVC bottom coating

CC Section View



CONCRETE CANVAS LTD - History

Original Application:

- *Self-Contained, Portable, Semi-Permanent Shelters*

CONCRETE CANVAS SHELTERS

CONCRETE CANVAS SHELTERS

Concrete Cloth™ comes in two roll varieties:

Portable Batched Rolls

Bulk Roll

Concrete Cloth™ Roll Characteristics

CC	Thickness (in)	Batch Roll Size (ft^2)	Bulk Roll Size (ft^2)	Roll Width (ft)
CC5	0.20	108	2150	3.3
CC8	0.31	54	1345	3.6
CC13	0.51	N/A	860	3.6

CC	Mass (unset) (lb/ft^2)	Density (unset) (lb/ft^3)	Density (set) (lb/ft^3)
CC5	1.4	93.6	+30-35%
CC8	2.5	93.6	+30-35%
CC13	3.9	93.6	+30-35%

Key benefits of Concrete Cloth™

- *Quick:* Unroll, place and wet
- *Simple:* Cannot be over-hydrated
- *Versatile:* One material, many uses
- *Durable:* Wear-resistant concrete
- *Robust:* Fiber matrix reinforcement
- *Portable:* Easily transported and deployed without specialized equipment

Concrete Cloth™ Civil Applications

- Ditch lining
- Erosion and scour protection
- Slope protection, weathered rock protection
- External pipe protection & ballast
- Internal culvert repair
- Secondary containment
- Weed control

CC Ditch Lining

- *Natural:* CC can be shaped to follow a natural watercourse; woven surface can green over time
- *Environmentally friendly:* Minimal washout, low alkaline reserves
- *Easy Installation:*
  - Easily laid on steep slopes, in the rain
  - Ideal for limited access sites
  - Can be installed in the rain & sets underwater

Various CC Ditch Lining Projects...

CC Ditch Lining Case Study – New Installation

March 2011

CC13 Bulk Rolls

1240SQM

1 Cross Width Layer

Ystrad Mynach, UK

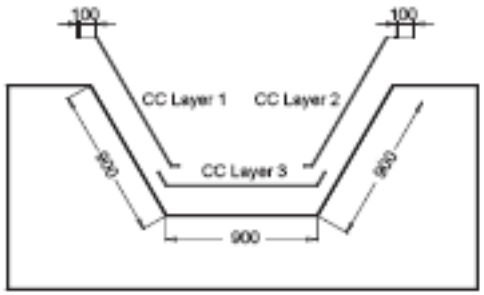
BAM Nuttall

BAM Nuttall's site manager stated: Eliminated risks associated with pouring concrete, access time reduced, and no haul roads needed. (Saved 2 weeks, no sub-contractors were required)

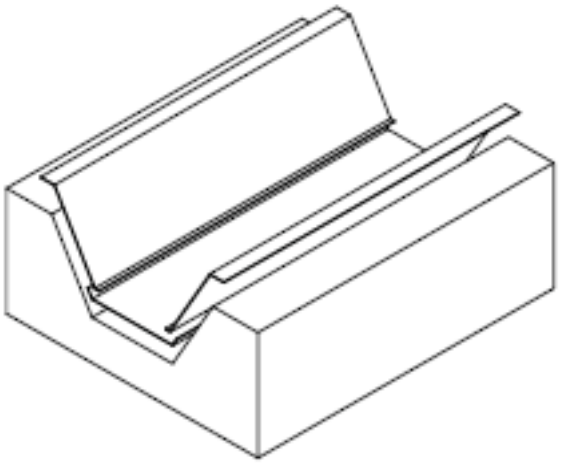
CC Ditch Lining Construction Methods...

3 Layer CC Longitudinal Layup

Fig 3.

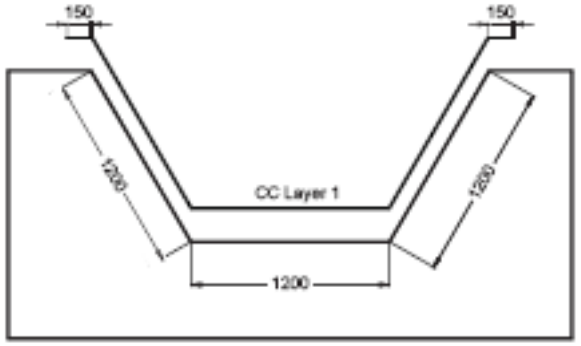


900mm x 900mm x 900mm ditch
3 Cloth Layers
150mm edge overlap

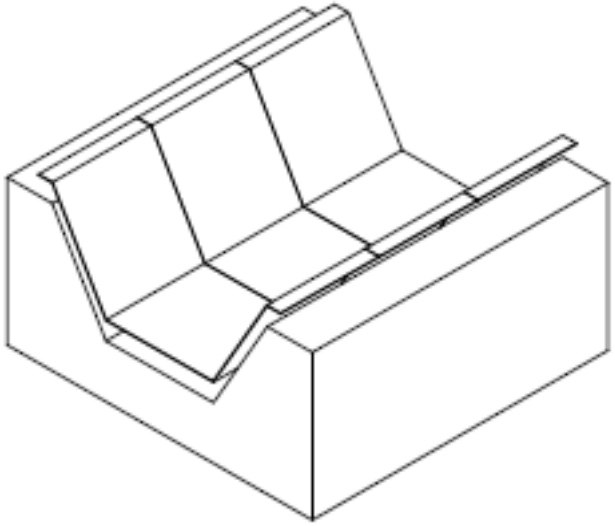


1 Layer CC Cross Layup

Fig 4.



1200+ mm x 1200+ mm x 1200mm ditch
1 Cloth Layer



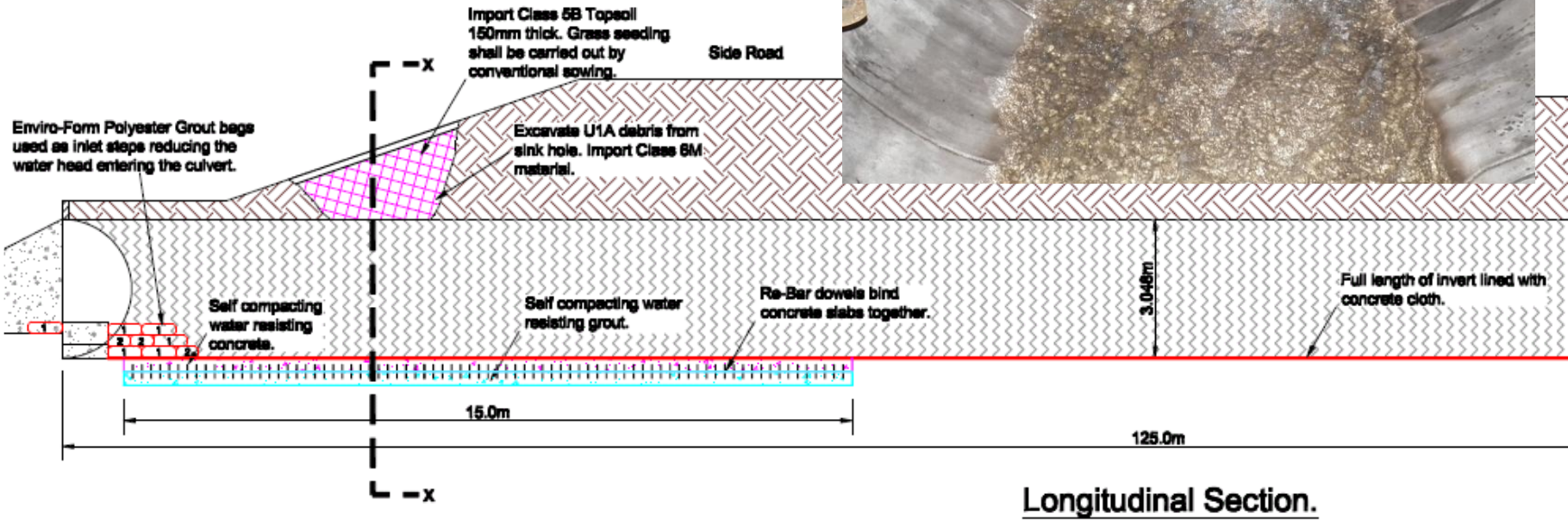
CC Ditch Lining Installation Method

1. Prepare ground (if required)
2. Unroll and lay the Concrete Canvas
3. Fix in-place (pegs, anchor trench or both) if desired
4. Join adjacent layers
5. Hydrate
6. Set




CC Ditch Lining Project – Ditch Rehabilitation

Bear Scotland M80 Culvert Repair



Longitudinal Section.

CC Pipe Repair

CC Used for Culvert Headwall

CC Slope Protection (Spanish Rail)

CC Slope Protection (Spanish Rail)

Vegetation Control (Under stairs) -

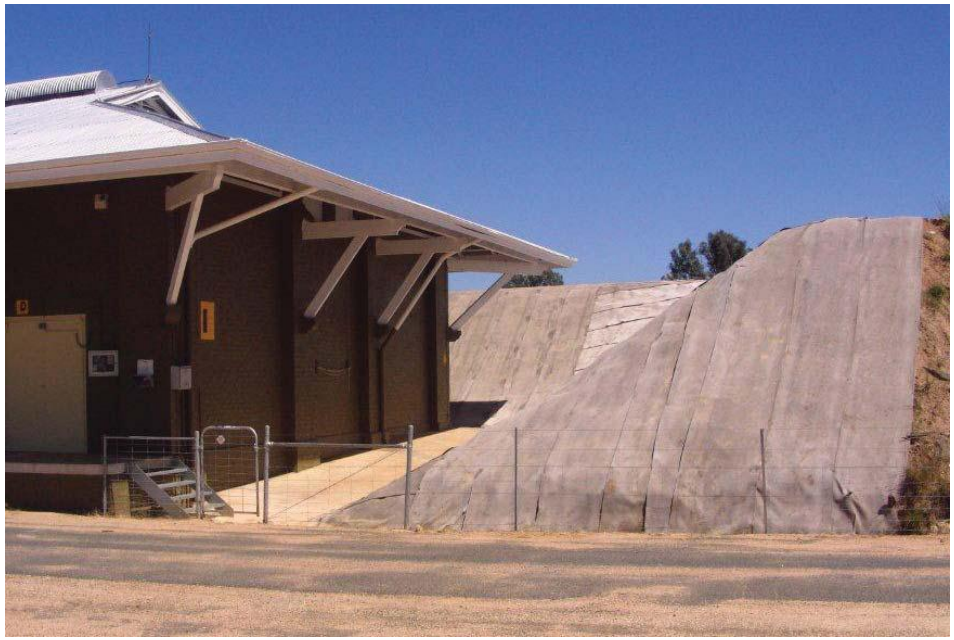
UK Environmental Agency

Pipe Protection & Pipe Ballast

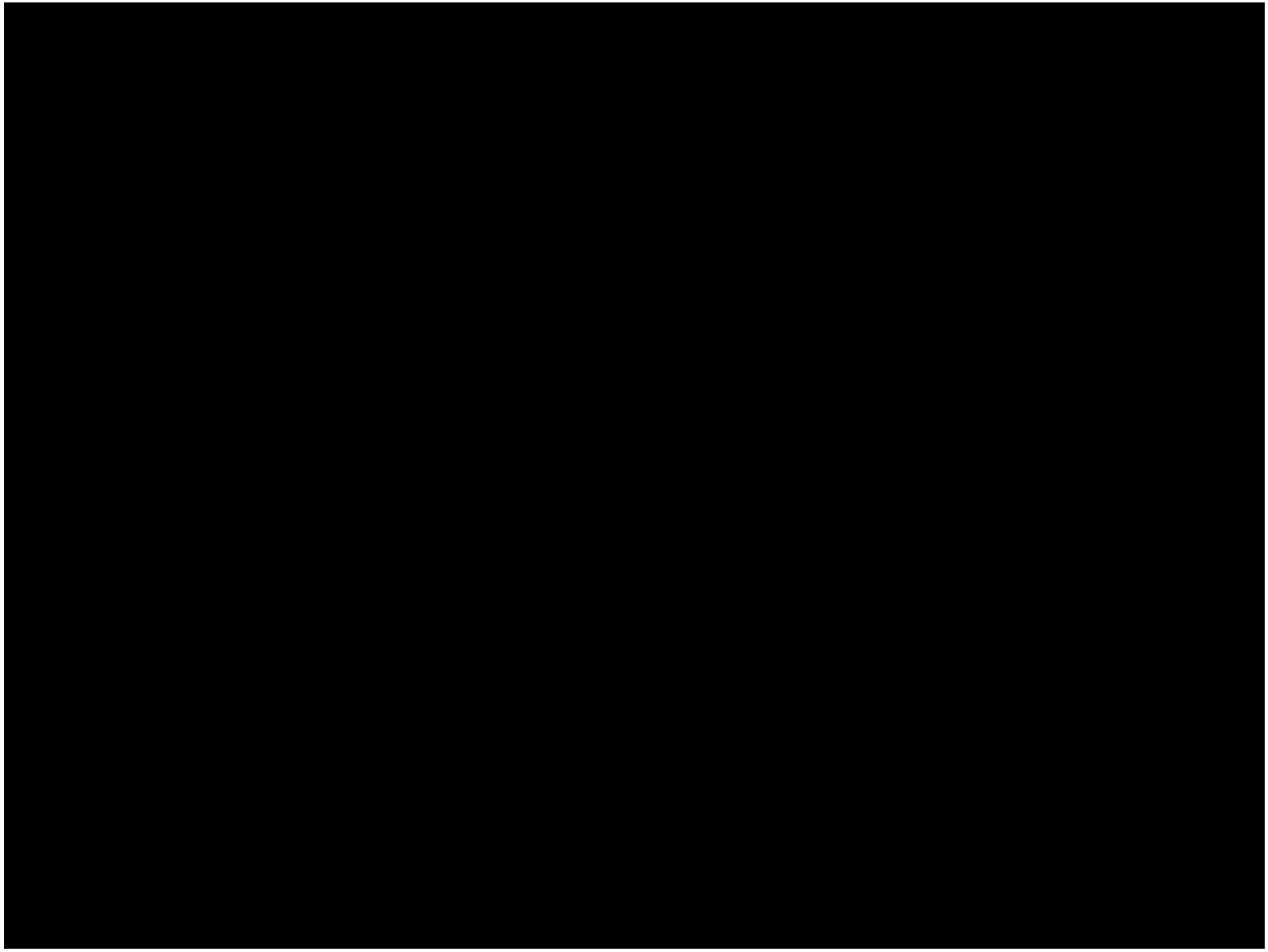
- 2000sqm CC13

- Joint protection

Secondary Containment (South America)



Military Applications for Concrete Cloth



Military Applications for Concrete Cloth™

- Force Protection
- Structure Upgrades
- Helipad Construction / Dust Suppression
- Expedient Resurfacing
- Ditch/Tank Lining
- Slope Protection

Concrete Cloth™ First Military Application – Sandbag Reinforcement in Afghanistan (British Military)

Before

After

CC8 – Frontline – Sept 2008

Prevents degradation from incoming fire, outgoing flash and erosion

CC Gabion Protection Repair / Reinforcement

CC Dust Suppression

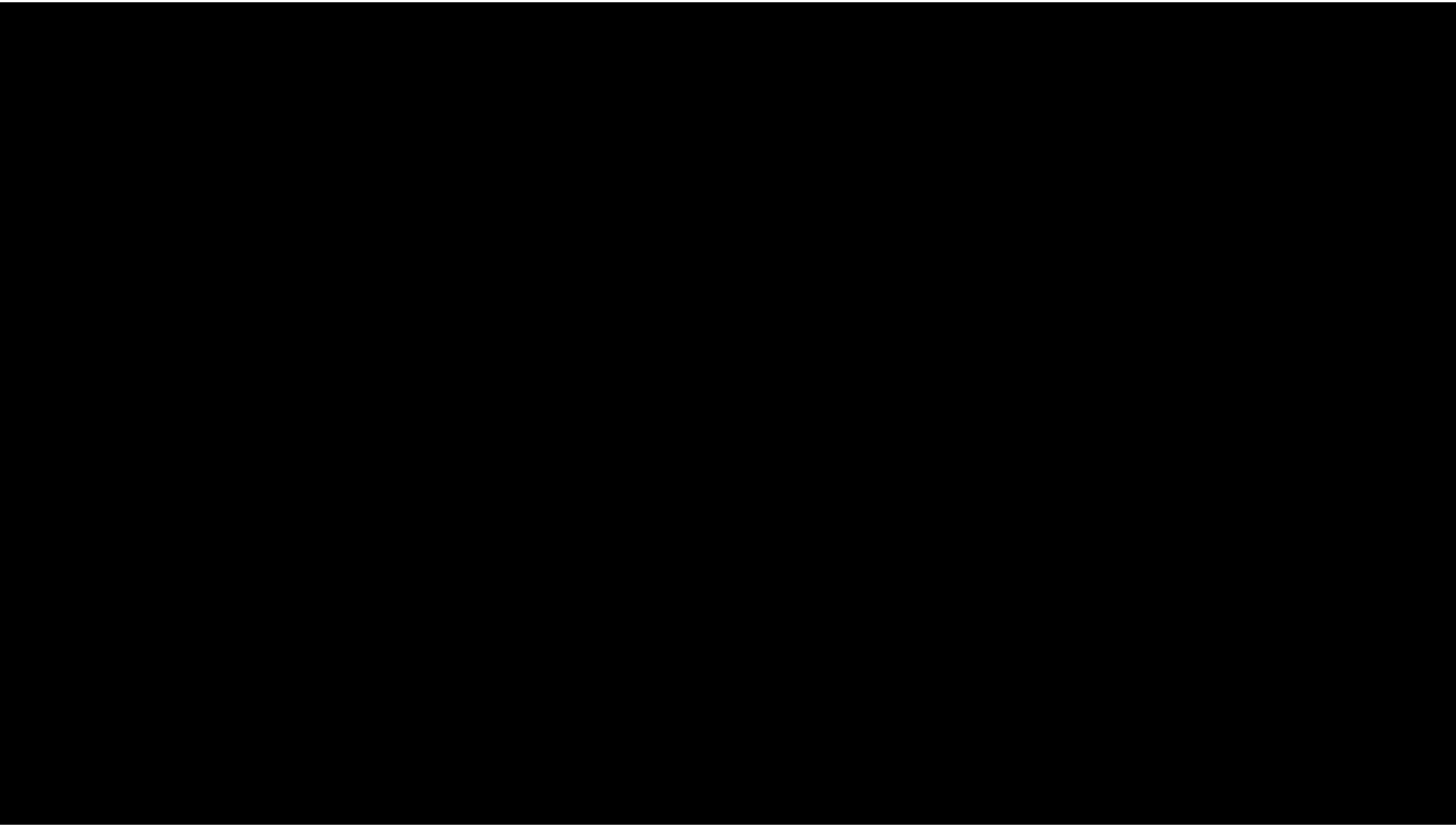
- CC4 light-weight variant
- Initial Trials at Waterbeach Barracks by 12 (AS) Eng Gp
- Covered perimeter of HLS
- Conforms to Ground

Expedient Resurfacing

Other Applications?

Marine – Boat ramp extension

Boat Ramp Extension - Concrete Cloth



Current Milliken Testing Program

Basic Properties:

- *Index Properties:* Thickness, Mass, Surface Friction
- *Structural Properties:* Compressive Strength, Flexural Strength, CBR test
- *Durability:* Freeze-Thaw, Impact, Peel, UV, Abrasion
- Installation best practices

Cure Properties:

- Development of Cement Microstructure with Hydration

Hydraulic Properties:

- Mannings Coefficients, Channel Flow Testing, Overtopping Tests

Current Partner Test Labs and Institutes:

- CTL Group
- Geosynthetic Institute

UNCURED STATE PROPERTIES -

Product	Thickness (in) ASTM D5199	Mass Per Unit Area (psf) ASTM D5261 and ASTM D5993	Roll Width (ft)	Machine Direction Strip Tensile Strength (lb/in) ASTM D5035
CC5	0.21	1.4	3.3	60
CC8	0.28	2.5	3.61	110
CC13	0.51	3.89	3.61	115

Table 1: Indicative Properties of Uncured Product

CURED STATE PROPERTIES -

Product	Thickness (in) ASTM D 5199	Mass per unit area (psf) ASTM D5261 and D5993	3 Point Bending strength (psi) ASTM C1185	Machine Direction Strip Tensile Strength (lb/in) ASTM D5035	Compressive strength (psi) ASTM C473 and ASTM C773
CC5	0.25	1.8	493	40	5800
CC8	0.34	3.4	493	50	5800
CC13	0.62	5.2	493	110	5800

Table 2: **Indicative Properties of Cured Product**

Flexural Behavior-Load versus Strain

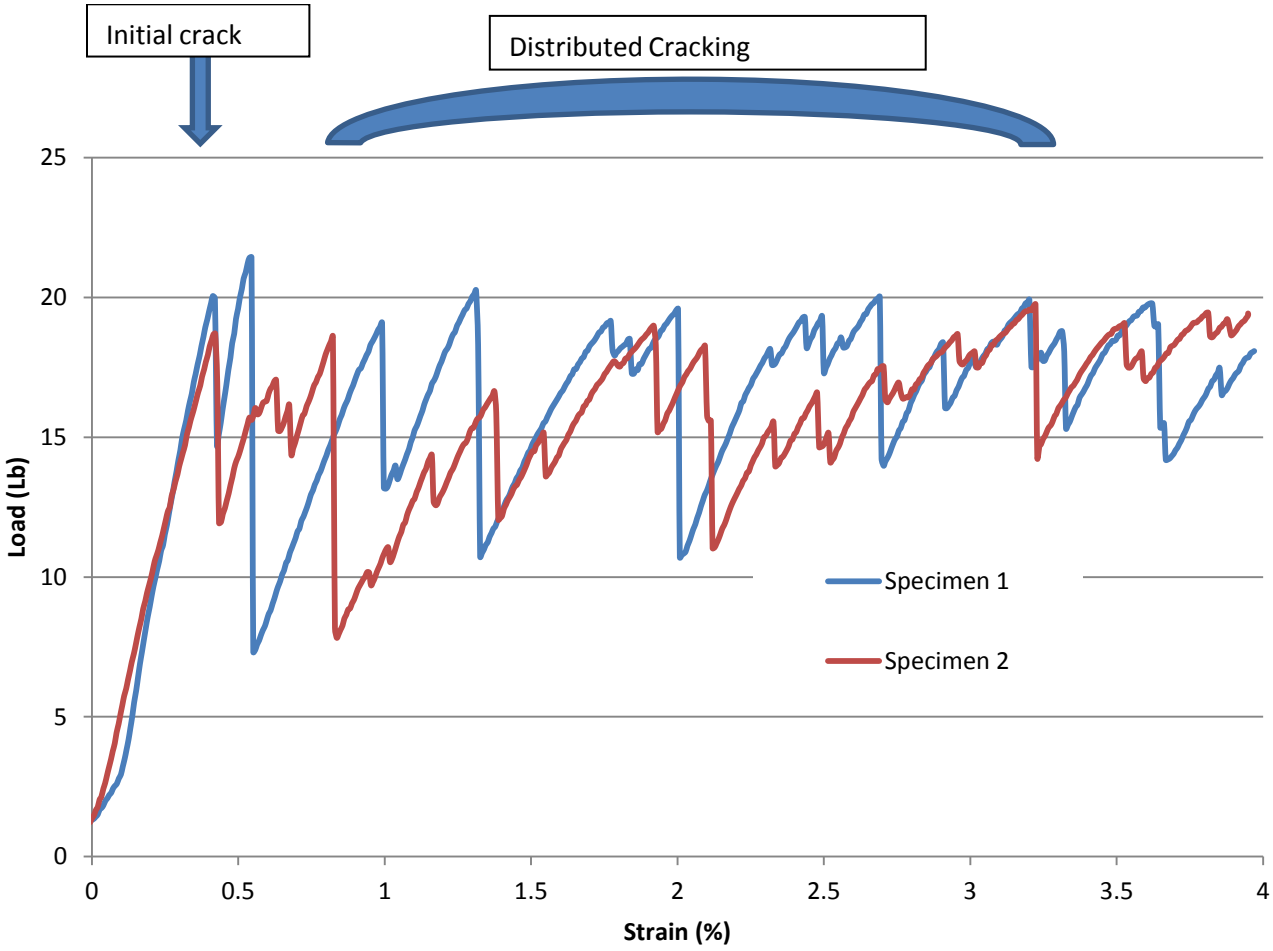


Figure 2 - Flexural Behavior of CC8: ***pseudo-ductile*** behavior. The 3-point bending strength is calculated based on the first peak (initial crack).

CURED PRODUCT CHARACTERISTICS

- Note that thickness increases upon hydration.
- The mass per unit area also increases due to the water that has been incorporated in curing the formulated concrete.
- Strip tensile results are defined as the load where concrete cracking occurred. Three point bending strength is measured for the machine direction and is defined as the flexural strength when the cured concrete component initially cracks.
- Comparison of Geosynthetic component with the uncured product, then the cured material using strip tensile strengths illuminates the multiphase characteristics of this material.

FABRIC, UNCURED AND CURED STATE PROPERTIES

Product style	CC8 MD (lb/inch))	Strain (%)	Comments
3D Fiber Matrix	170	90	No dry concrete mix powder
Soft (uncured) specimen	185	65	concrete filled, uncured
Hard (cured) specimen	215	40	hydrated

Table 3: Summary of strip tensile strength for different conditions

2 INCH STRIP LOAD VERSUS STRAIN BEHAVIOR FOR DIFFERENT CONDITIONS

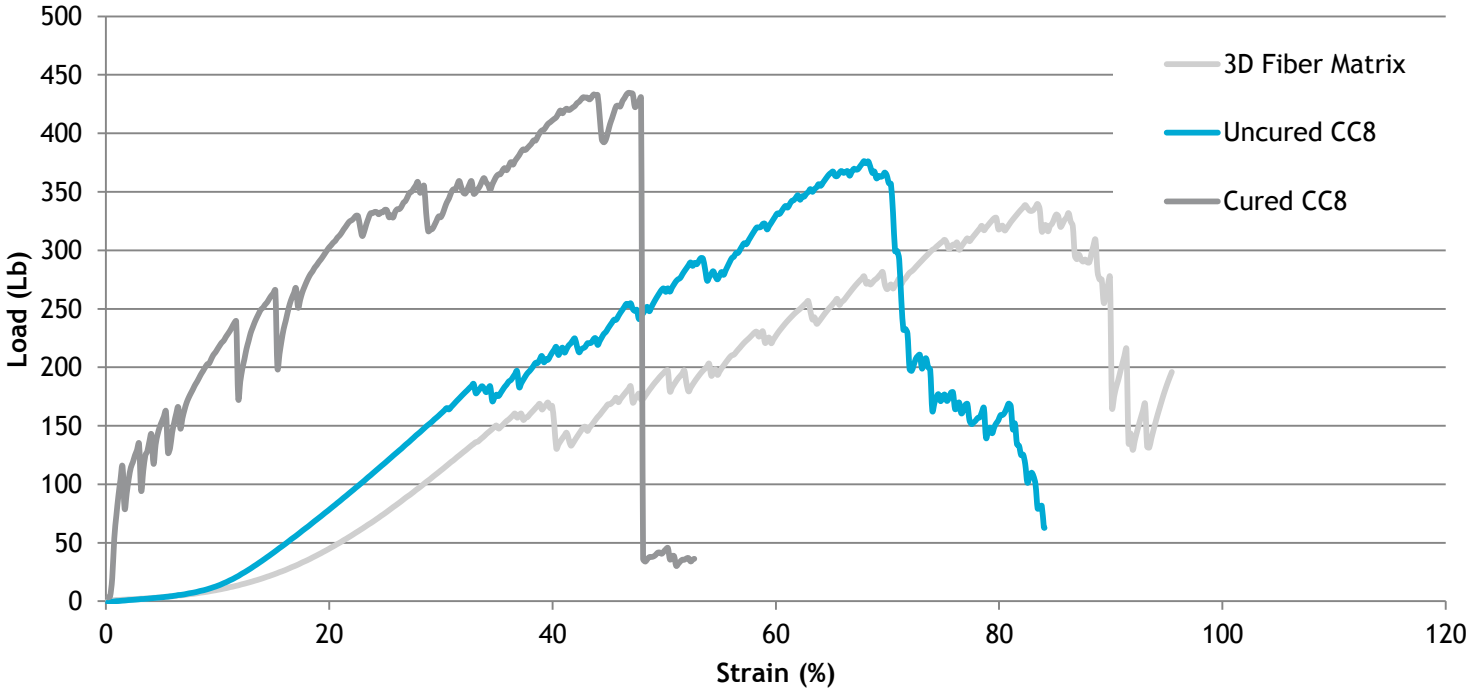


Figure 3 - Tensile Behavior for a 2 inch wide strip of GCCL: pseudo-ductile behavior

Hydraulic Capacity Flume Testing – TRI in SC

2 channels 2 ft. wide and 40 ft. long were lined with Concrete Cloth

CC8 was selected and precut into strips to fit into the channel widths

Concrete Cloth was then installed over subgrade, using transverse overlapping and then longitudinal seams

Edge effects were minimized by using a thin membrane affixed to CC and run up the side of flume.

Test was performed using gradual flow increases until max system capacity was reached.

Hydraulic testing at TRI - SC

Hydraulic Capacity Flume Testing – TRI in SC

Hydraulic Capacity Flume Testing – TRI in SC

Results:

No adverse effects on the installed Concrete Cloth, either the panels, or the seams after being subjected to maximum flow capacity

Maximum velocities of over 25 feet per second were applied

Maximum shear stresses on the concrete Cloth exceeded 12 psf

Manning coefficient was calculated to be approximately 0.022 to 0.025

Concrete Cloth a Few Case Histories

Milliken™

Southeast US Landfill Slope Protection

- Date: May 2012
- Engineer: CH2M Hill
- Application: Slope Protection
  - A geotextile wraparound reinforced soil slope had been constructed at this location, required because of the proximity to the property line. Attempts to vegetate the slope face were not completely successful, so the decision was made to cover and protect this slope face. Concrete Cloth (CC8) was selected as the protection medium.

Before

Note the RSS facing wraparound

Day 1

Day 2

Spray marking for the right side anchor trench

Right side anchoring of the Concrete Cloth

Day 2

Note that the lighter colored zone was hydrated on day 1

Finished Installation

Willow Creek Mine - Lined and Armored Ditch

Sump at Willow Creek - Prior to

Final profile of North Ditch 2

Sump - Partial Layout and

Sump Portion Completed

Middle Creek Junction

Completed - Lined and Armored