CONCRETE CANVAS® USA

Concrete on a Roll

A 21st Century Technology for Erosion Control & Water Conveyance Applications using Geosynthetic Cementitious Composite Mats (GCCMs)

VERSION 21.08.16 BL

AGENDA

- **Overview of GCCMs**
- **Design Review – ASTM D8364**
- **Installation, Applications, Benefits**
- **Case Histories**

INTRODUCING GCCMs…

What is a GCCM - Geosynthetic Cementitious Composite Mat

ASTM D4439:

A factory-assembled geosynthetic composite consisting of a cementitious material contained within layer or layers of geosynthetic materials that becomes hardened when hydrated.

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

GCCMs can be used:

- *When soft armor protection will NOT work ! (lack of vegetation)*
- *When **hard armor** is required*

GCCMs cannot be used:

- *Driveways and sidewalks*
- *Where there is daily traffic*

TYPES OF GCCM?

A flexible concrete filled geosynthetic that hardens when hydrated to form a thin, durable waterproof concrete layer.

GCCMs consists of:

- Dry concrete mix

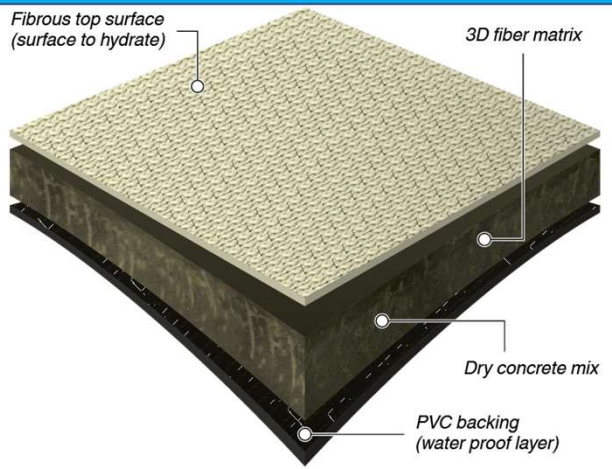
- Geotextile layer(s)

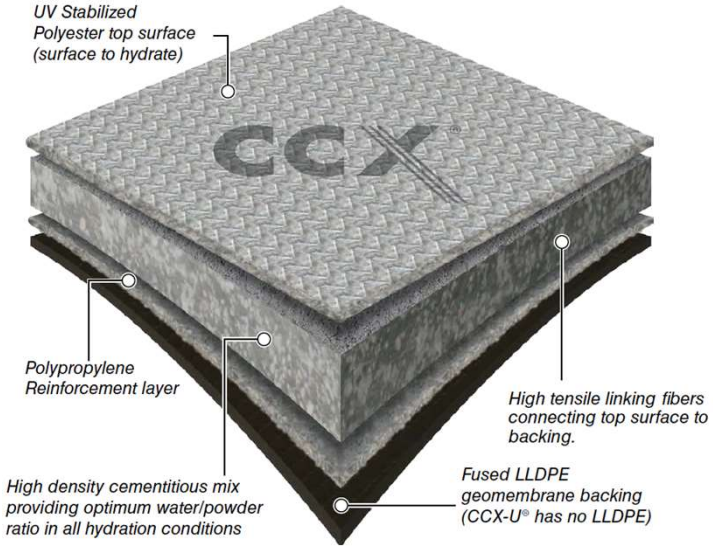
  -3D Fiber Matrix – smaller profile – more flexible – better conformance to uneven subgrade

  -Two Nonwoven geotextiles stitched together – larger profile – designed for water conveyance, irrigation, stormwater, wastewater

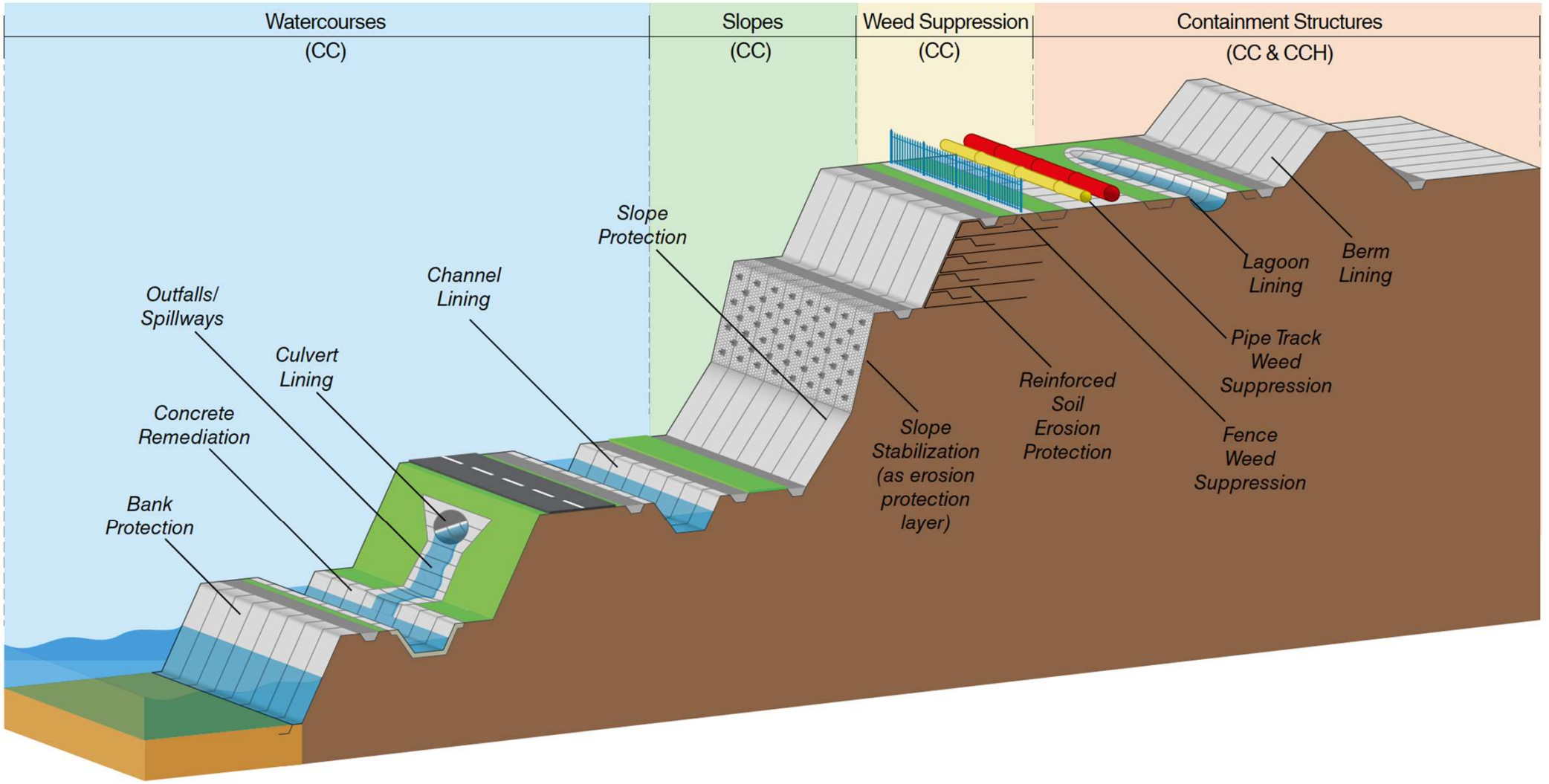
-Water impermeable lower surface

- Concrete is porous. Membrane prevents water from permeating through the plane of the GCCM
- PVC for erosion control – mechanical connection only
- LLDPE for containment – mechanical and/or thermal bonding





Typical GCCM Applications



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- Overview of GCCMs
- **Design Review – ASTM D8364**
- Installation, Applications and Benefits
- Case Studies

GCCM Specific Standards:

- ASTM D8364 “Standard Specification for GCCM Materials”
- ASTM D8030 ‘Standard Practice for Sample Preparation for GCCM’
- ASTM D8058 ‘Standard Test Method for Determining the Flexural Strength of a GCCM Using the Three-Point Bending Test’
- ASTM D8173 ‘Standard Guide for Site Preparation, Layout, Installation, and Hydration of GCCMs
- ASTM D8329 ‘Standard Test Method for Determination of Water to Cementitious Materials Ratio for GCCMs and Measurement of the Compressive Strength of the Cementitious Material Contained Within’
- ASTM D8479 ‘Standard Test Method for Determining Peel Strength of GCCM Materials’
- ASTM D8480 ‘Standard Test Method for Determining Tensile Strength of GCCM Materials’

Classification of GCCM Materials by Applications

Type I GCCMs:

- Lowest requirements for abrasion and wear
- For low shear stress and low flow velocity applications
- Not subject to impact loads (traffic, heavy debris, wave action)
- Installed over dense subgrades (concrete/rock)
- Remediation, erosion control, slopes, berms

Type II GCCMs:

- Greater requirements for abrasion and wear
- For higher shear stress and flow velocity applications
- Subject to impact loads (and wave action)
- Installed over medium dense subgrades
- Canals, drainage applications, armouring, slopes, berms

Type III GCCM:

- Where additional flexural strength is required due to loose subgrades or for more severe conditions
- Higher grade types would be expected to be more durable and longer lasting than lower grade types in the same application, or for debris prevention expected.

ASTM Categories & Properties

GCCM Property	Test Method	State of GCCM	Unit	Minimum Values Unless Specified		
				Type I	Type II	Type III
Thickness	ASTM D5199	uncured	in	0.18	0.27	0.27
Thickness	ASTM D5199	cured - 24 hrs	in	0.18	0.27	0.27
Mass per Unit Area	ASTM D5993	uncured	lb/ft^2	1.33	2.15	2.15
Density	ASTM D5993/D5199	uncured	lb/ft^3	78	78	78
Flexural Strength - Initial Breaking Load	ASTM D8058	cured - 24 hrs	lb_f/in	3.5	8.5	21
Flexural Strength- Initial Flexural Strength	ASTM D8058	cured - 24 hrs	psi	500	500	500
Flexural Strength- Final Flexural Strength	ASTM D8058	cured - 24 hrs	psi	580	580	580
Compressive Strength of Cementitious Mix	ASTM D8329	cured - 28 days	psi	5,800	7,200	8,700
Pyramid Puncture Resistance	ASTM D5494 Type B	cured - 28 days	lb_f	450	780	1,000
Abrasion Resistance (maximum value)	ASTM C1353	cured - 28 days	in/1000 Cycles	0.012	0.012	0.012
Tensile Strength - Final	ASTM D6768	uncured	lb_f/in	45	45	45
Tensile Strength - Initial	ASTM D4885	cured - 28 days	lb_f/in	20	36	50
Tensile Strength - Final	ASTM D4885	cured - 28 days	lb_f/in	57	108	108
Freeze - Thaw (residual Initial Flexural Strength after 200 cycles)	ASTM C1185	cured - 28 days	%	80	80	80

PHYSICAL PROPERTIES COMPARISON - OVERVIEW

COMPARISON OF ASTM D8364 – GCCM TEST PROPERTIES

ASTM Test Method/Property/Units	ASTM D8364 Type 1	Type 2	CCT1	CCT2	CCX-M
D8329 – Compressive Strength (psi)	5,800	7,200	6,500	8,700	10,150

- As concrete is a key component of a GCCM, compressive strength is of paramount importance. The compressive strength is directly related to a GCCM performance as it relates to:
  - Abrasion resistance
  - Flexural Strength
  - Freeze-thaw Durability
  - Chemical resistance
  - As shown in ASTM D8364, compressive strength below 5,800 psi is not suitable for GCCM applications

- It is also important to ensure any compressive strength reported is tested to ASTM D8329 as this method was developed specifically for GCCM to model the worst-case behavior of a field hydrated GCCM. It does not consider the best-case precision as would be expected in a concrete mixing facility.

ASTM D8329 GCCM COMPRESSIVE STRENGTH

Standards designed for testing mixed concrete products (such as ASTM C109) can be modified using artificially low water to cement ratios to prepare GCCM test samples that will give misleadingly high compressive strengths

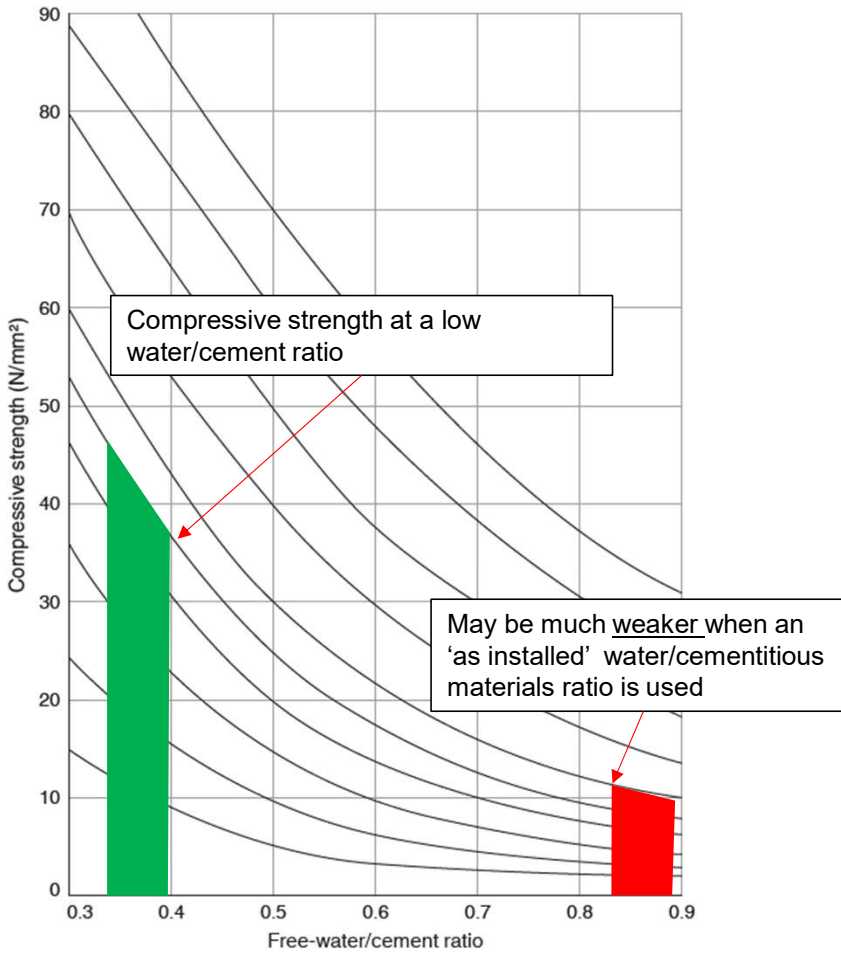


Figure 4. Relationship between compressive strength and water/cement ratio.

PHYSICAL PROPERTIES COMPARISON - OVERVIEW

COMPARISON OF ASTM D8364 – GCCM TEST PROPERTIES

ASTM Test Method/Property/Units	ASTM D8364 Type 1	ASTM D8364 Type 2	CCT1	CCT2	CCX-M
D8058 – Initial Flexural Strength (psi)	500		580	580	580
D8058 – Initial Breaking Load (lb_f/in)	3.5	8.5	4.3	10	14
D8058 – Final Flexural Strength (psi)	580		1,400	850	1,450

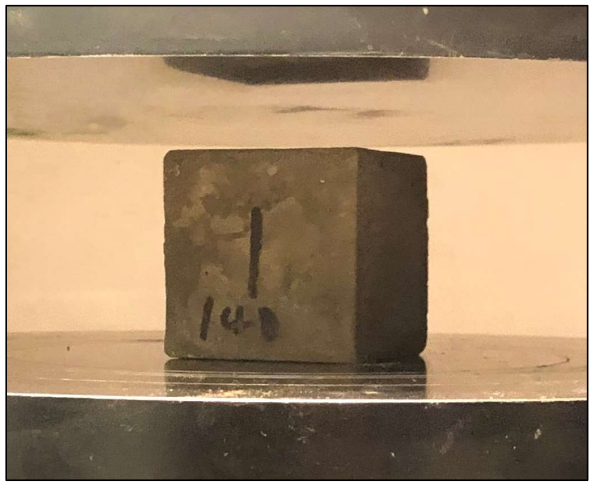
- Flexural strength is another important test for assuring a high quality GCCM. The flexural strength provides insight into how the material will perform as it relates to:
  - Compressive strength
  - Abrasion resistance
  - Freeze-thaw durability
- GCCM with lower flexural strength are more likely to disintegrate over time due to a weaker concrete mix
- GCCM with higher flexural strength are indicative of well constrained product with controlled water to cement ratios.

ASTM D8058 GCCM FLEXURAL STRENGTH

ASTM D8058-19: Standard Test Method for Determining the Flexural Strength of a GCCM using a Three-Point Bending Test

Geosynthetics are strong in tension but weak in compression

Concrete is strong in compression but weak in tension

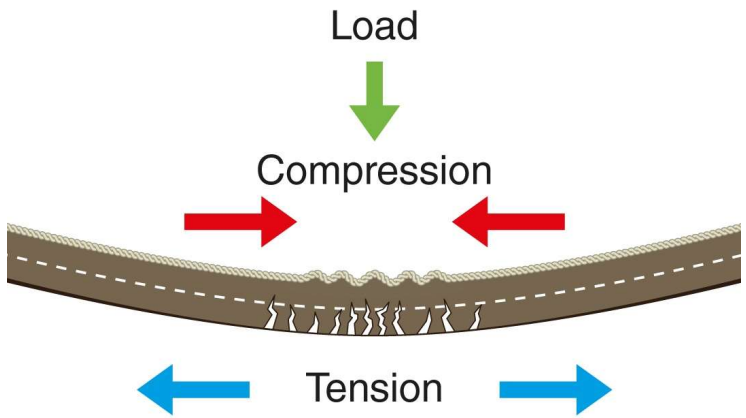


Tensile testing of GCCMs does not provide information on the quality of the cementitious material

ASTM D8058-19

Tests the compressive strength of the concrete component and the tensile strength of the geotextile component.

This is important because it may experience both in field applications.



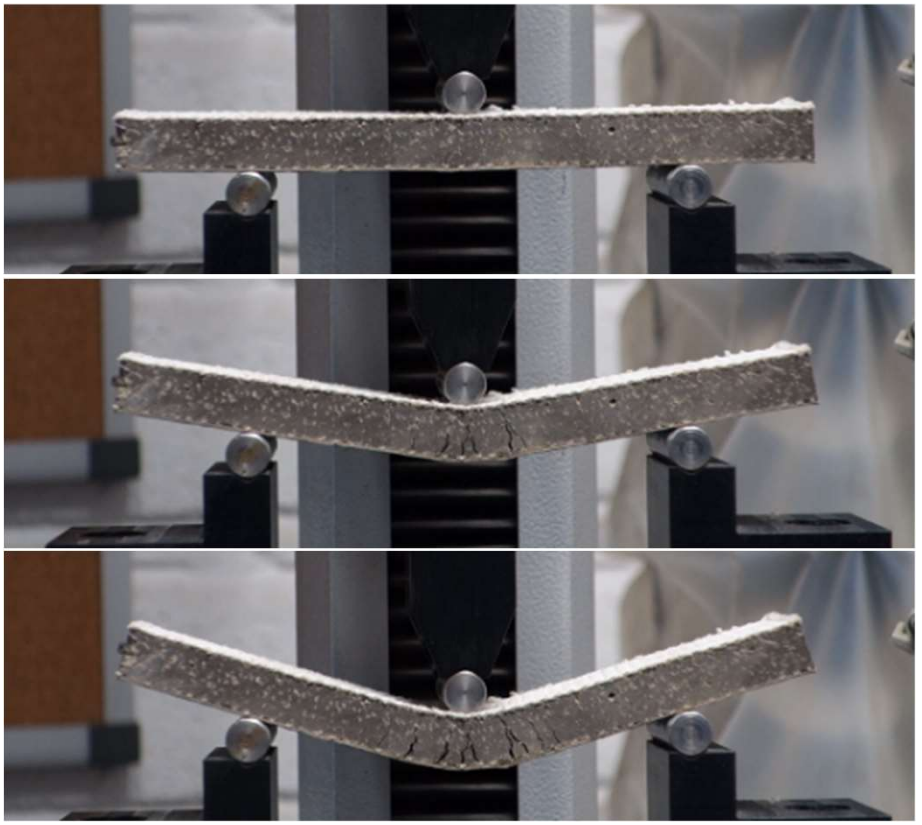
Flexural Strength testing of cured GCCMs **provides the best overall indication of the in-service performance** of a GCCM by compressing one surface while simultaneously extending the other and is considered the standard index test for this class of material.

ASTM D8058-19

Compressive strength tests the concrete strength, but takes 28 days to complete.

Flexural strength testing is a quick index test in much the same way that tensile testing has been used for other geosynthetics.

Flexural strength testing of GCCM's provides the best overall indication of its performance in its hardened (cured) state.



3 point Bending test for Flexural Strength

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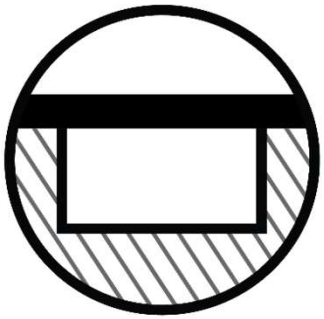
4 INSTALLATION PRINCIPLES



AVOID VOIDS

SECURE CC

PREVENT INGRESS

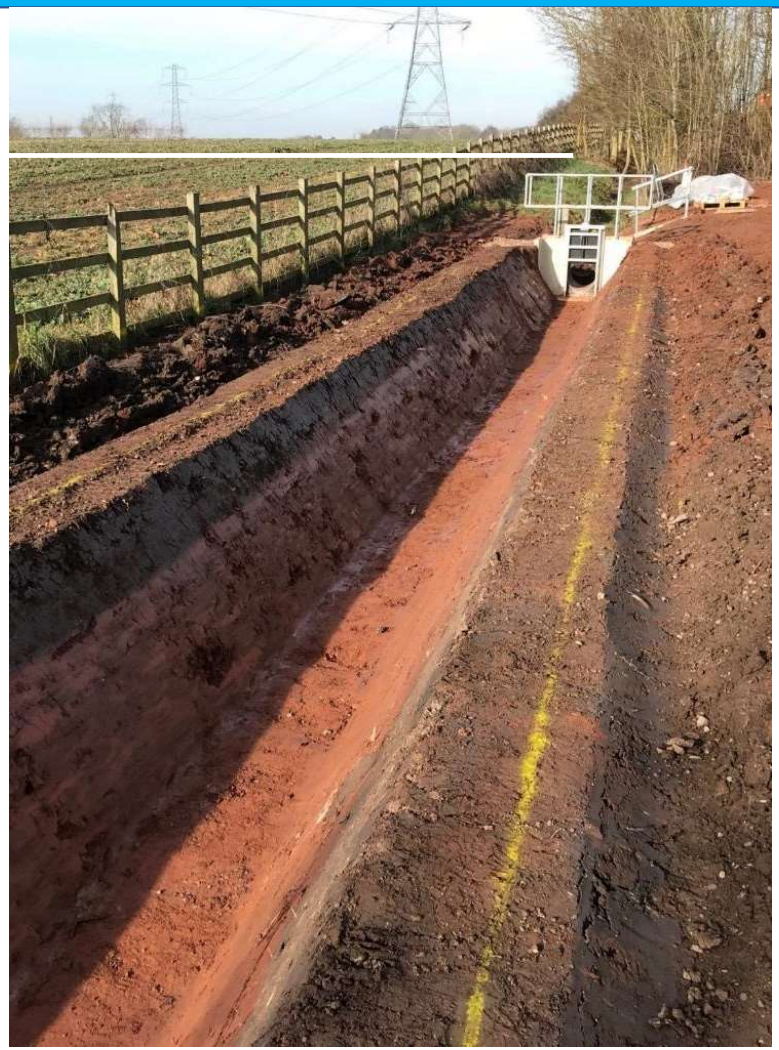
HYDRATE FULLY

AVOID VOIDS

Prepare the substrate so it is well compacted, geotechnically stable and has a smooth and 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 minimize 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



4 INSTALLATION PRINCIPLES

AVOID VOIDS

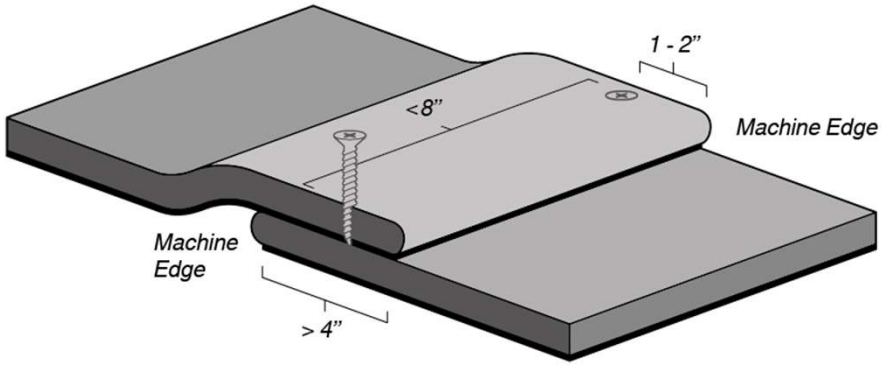
SECURE CC

PREVENT INGRESS

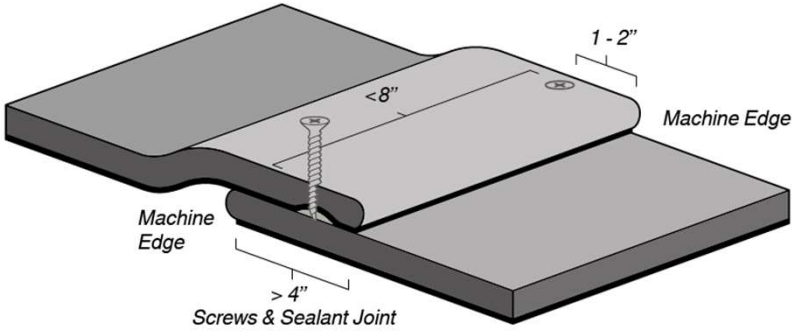
HYDRATE FULLY

JOINTING

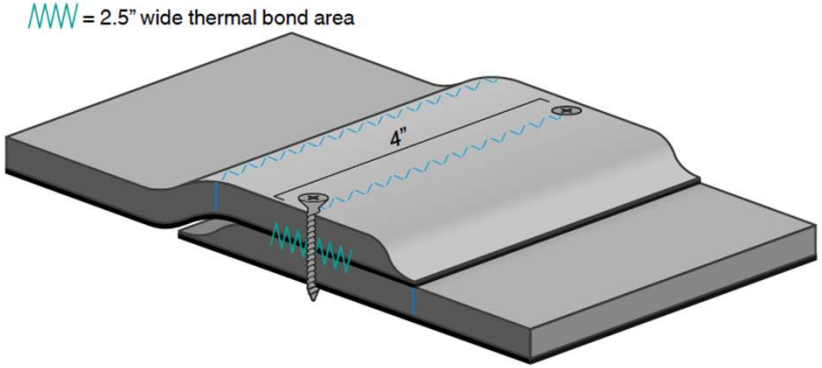
SCREWED JOINT



SCREWED & SEALED JOINT



THERMAL BONDING WITH SCREWS



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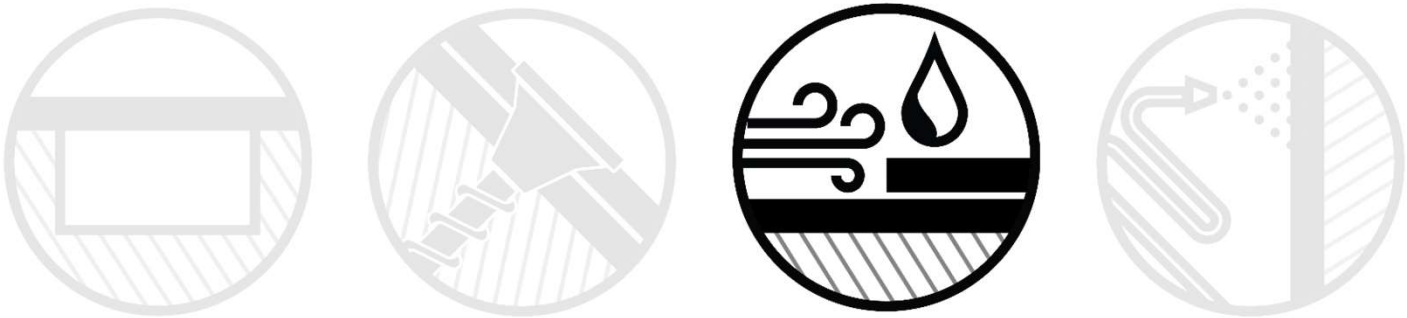

AVOID VOIDS

SECURE CC

PREVENT INFILTRATION

HYDRATE FULLY

ANCHORS

To a soil substrate;

Pegs
- Galvanized J-Pegs
- 10” long
- Inserted through overlapped GCCM layers within anchor trench

Anchor Trenching
- Essential for the majority of installations
- Prevent undermining from water and wind uplift
- Provide a neat termination
- Minimum dimensions 6” x 6” x 6”
- Typically used in conjunction with pegs

Intermediate Anchors
- Required for high load applications or poor ground conditions
- Specification by certified geotechnical engineer

4 INSTALLATION PRINCIPLES

AVOID VOIDS

SECURE CC

PREVENT INGRESS

HYDRATE FULLY

METHOD OF HYDRATION

Spray the fiber surface with water until it feels wet to touch for several minutes after spraying.

Notes:

- GCCM will set underwater. An excess of water is always recommended
- GCCM must be actively hydrated.
- Do not use high pressure water jet as this may wash the concrete powder contained in the unset GCCM
- GCCM has a working time of 1-2 hours after hydration. Do not traffic on GGCM once it has begun to set
- Working time will be reduced in warmer climates and increased in very cold climates
- GCCM will set hard in 24 hours but will continue to gain strength over time

TYPICAL APPLICATIONS

EROSION CONTROL

CONTAINMENT

CHANNEL LINING

SLOPE PROTECTION

BERM LINING

REMEDIATION

CULVERTS

HARD ARMOR

SCOUR

WEED SUPPRESSION

DRAINAGE APPLICATION

HIGHWAY 20 – CCX-M
Midland, TX
2023

- Drainage ditch to divert stormwater along highway
- CCX-M was chosen in lieu of concrete and rip-rap due to cost and speed of installation
- Installation of 1,800 sf took 2 hours

"Meeting our schedule is very important to us. Some of our products require thousands of cubic yards of concrete for drainage and rip rap applications. CCX will allow us to greatly speed up the installation process and help us meet our schedule."
Juan Gasca - Corporate Project Controls Manager, Pulice Construction

DRAINAGE APPLICATION

I-64– CCX-M
Charlottesville, VA
2022

- Drainage ditch to divert stormwater along highway
- CCX-M was chosen in lieu of specified pour-in-place concrete due to cost and speed of installation

SLOPE PROTECTION APPLICATION

Durham, NC 2021

- 30,000 SF CCT1
- Areas of existing concrete were cracking and allowing
- Preferred over rip-rap or poured concrete as no heavy equipment was required
- Difficult to access areas

SLOPE PROTECTION/EROSION CONTROL – ENVIRONMENTAL APPLICATIONS

GA Power Project 2023 – Norcross GA – 15,000 SF CCT1

Slope had to be graded and vegetation removed.

SLOPE PROTECTION/EROSION CONTROL – ENVIRONMENTAL APPLICATIONS

GA Power Project 2023 – Norcross GA – 15,000 SF CCT1

Difficult to access area. Rolls had to be cut to size behind the 12' wall and transported over for installation. Installation crew tethered to wall for safety due to steep slope.

DITCH APPLCATION

COLORADO DOT 2022

CHANNEL APPLICATION - 5 Year Ageing Case Study

DITCH LINING – New Orleans Flood Protection Authority 2022 (Installed in 2017)

SLOPE PROTECTION

Vertical slopes with long runs are possible with GCCMs

CULVERT REMEDIATION

BENEFITS OVER TRADITIONAL METHODS

RAPID INSTALL
Up to 10x faster than conventional concrete.
>12,000 sf/day for large projects

EASE OF USE
Minimal training required
Low logistical footprint
Install in adverse conditions

LOWER PROJECT COSTS
More cost effective than any other conventional concrete solution

ECO FRIENDLY
Material savings of up to 90%
Transport efficient
Low wash out rate, low alkaline reserve
Embodied CO_2 savings

VALUE PROPOSITION

LOW LOGISTICAL FOOTPRINT

1 Bulk Roll provides the equivalent coverage area of two 17T ready-mix cement trucks

- Reduced vehicle movement
- Reduced transportation CO_2
- Reduced health & safety risks

ECO FRIENDLY

KEY BENEFITS

ECO-FRIENDLY

NRW
CHANNEL LINING
BRECON, WALES
2010

PUBLIC WORKS

Reformation of a creek taking run-off water from a salmon hatchery in South Wales.

- Attracts naturally occurring bio-mass
- Organic contours
- Safely discharged into adjacent river
- Low embodied carbon

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HENRY MILLER ID

CANAL LINING

DOS PALOS, CA

2023

IRRIGATION DISTRICT

EARTHEN CANAL LINING

GCCM to conserve water and mitigate irrigation water seepage.

-

Dos Palos, California

HENRY MILLER ID

CANAL LINING

DOS PALOS, CA

2023

IRRIGATION DISTRICT

CCX-M™ Trial

EARTHEN CANAL LINING

GCCM to conserve water and mitigate irrigation water seepage.

- Conserve water
- Reduce seepage
- Thermally bonded joints
- Alternative to shotcrete and membrane
- Self installed

Dos Palos, California

HENRY MILLER ID

CANAL LINING

DOS PALOS, CA

2023

IRRIGATION DISTRICT

EARTHEN CANAL LINING

GCCM to provide conserve water and mitigate irrigation water seepage.

- ¼ mile canal section
- 30,000 SF GCCM
- Installed in 3.5 days

Dos Palos, California

CITY OF LYNN HAVEN

CHANNEL LINING

FLORIDA, USA

2022

DOT & PUBLIC WORKS

3050SQFT CCX-M™

CHANNEL REMEDIATION

GCCM installed to prevent sediment build-up within a ditch.

Lynn Haven, Florida

CITY OF LYNN HAVEN

CHANNEL LINING

FLORIDA, USA

2022

DOT & PUBLIC WORKS

3050SQFT CCX-M™

CHANNEL REMEDIATION

GCCM installed to prevent sediment build-up within a ditch.

Lynn Haven, Florida

CITY OF LYNN HAVEN

CHANNEL LINING

FLORIDA, USA

2022

DOT & PUBLIC WORKS

3050SQFT CCX-M™

CHANNEL REMEDIATION

- 185 lf of ditch
- 3,050 sf
- Self-installed
- 3.5 hours to install

Lynn Haven, Florida

CHANNEL APPLICATION FOR LANDFILL

Installation Process for Landfill in Mansfield LA 10/24:

- Excavate Channel
- Excavate Anchor Trenches
- Deploy Material
- Join and Anchor Material
- Hydrate

Project Info

- 10 / 23 / 24
- CCX-MAT®(CCX-M®) Bulk Rolls
- 50,632ft²
- Transverse layers
- Mansfield, Louisiana, USA
- Lemoine Industrial Group
- To provide erosion control to a storm water diversion channel at a newly extended landfill site.

Completed Project

- Installation took 5 days

SLOPE PROTECTION FOR LANDFILL

Chester County Landfill - 2024

- Base of the slope was being damaged by erosion from water runoff
- Needed a long-term solution with minimal maintenance and environmental impact

SLOPE PROTECTION FOR LANDFILL

Chester County Landfill

- 5,000 sf
- Installation took 6 hours

Our crew was very happy with the installation process, technical resources available and the look of the finished product. It is great that you do not have to worry about over hydrating the product when you are finished. Overall, (they) were great partners on this project, and we are looking forward to working with them in the future" - **Christine Schwarz, *Project Manager, Hallaton Environmental Lining***

CONCLUSION

DESIGN & BID

Specification & Quoting

1. USE ASTM D8364
2. SPECIFY QUALIFIED INSTALLERS – GCCM AND/OR SIMILAR
3. LET US KNOW ABOUT THE PROJECT

INSTALLATION

4 principals

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PRESENTER

CONCRETE CANVAS® USA