CONCRETE CANVAS®
Concrete on a Roll

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CONCRETE CANVAS®

Concrete on a Roll

INSTALLATION GUIDE: SLOPE PROTECTION

RAIL ROAD MINING PETROCHEM AGRO UTILITIES PUBLIC WORKS DEFENCE DESIGN SHELTER

Winner
Technical Innovation Award

Innovation Award
ICE Wales Cymru Awards 2017

2014 Fast Track 100
16th fastest growing
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2014 Queen's Award
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2013
Macrobert Award
Finalist

2013 Innovation Award Winner
Railtex Exhibition

2012 R&D 100
Award winner
R&D Magazine

2009 Winner
Material Connexion Medium Award
Material of the Year

D&AD Yellow Pencil Award
Winner
Product Design

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INSTALLATION GUIDE: SLOPE PROTECTION

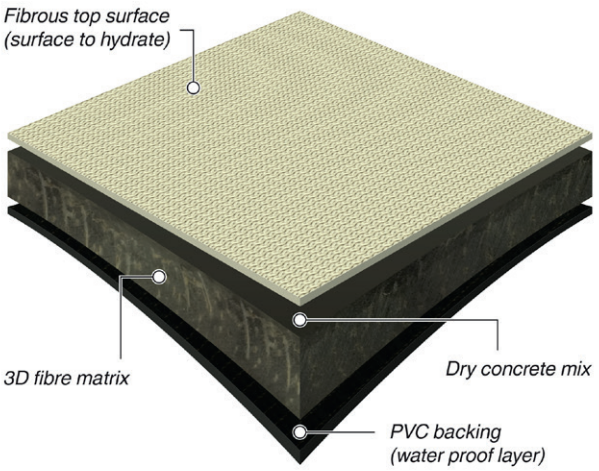
1.0 Introduction

1.1 Background

Concrete Canvas® is part of a revolutionary new class of construction materials called Geosynthetic Cementitious Composite Mats (GCCMs).

It is a flexible, concrete impregnated fabric that hardens on hydration to form a thin, durable, water proof and fire resistant concrete layer.

Essentially, it can be described as 'concrete on a roll' and is used for a wide variety of applications including the rapid lining of drainage channels, providing slope protection, weed suppression, culvert repair and general concrete remediation.



1.2 Scope

- This document provides guidance procedures for the installation of CC as **slope protection** in a manner that maximises safety, efficiency, and the physical integrity of the material and channel.
- This document provides useful information for installers, customers and specifiers of Concrete Canvas® GCCM (CC) and provides an overview of installation techniques for the lining of channels.
- The versatile nature of CC means that this document is not exhaustive and is intended for guidance purposes only. Exceptions to this guideline may be required to address site-specific and/or product-specific conditions.
- The performance of the CC is wholly dependent on the quality of its installation. It is the installer's responsibility to adhere to these guidelines where applicable and to the project specification and drawings.

CC Slope Protection, Highway A24, Peso da Régua, Portugal

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2.0 Specification and Installation Essentials

2.1 Specifying the correct CC Thickness

CC is available in 3 thicknesses, CC5™ (5mm), CC8™ (8mm) and CC13™ (13mm).

- CC5™ is the standard thickness used for slope protection and is suitable for the majority of applications where surface water flow is from direct rainfall only.
- CC8™ should be considered for applications where the slope will be taking additional water run-off, for example on spillways and outfalls and the flow rate is below 8.6m/s.
- CC13™ should be considered where flow rates are above 8.6m/s or where the CC might be prone to impacts from debris or a high level of abrasion.

CC Type	Thickness (mm)	Roll Width (m)	Dry Weight (kg/sqm)	Batched Roll Coverage (sqm)	Batched Roll Length (m)	Bulk Roll Coverage (sqm)	Bulk Roll Length (m)
CC5™	5	1.0	7	10	10	200	200
CC8™	8	1.1	12	5	4.55	125	114
CC13™	13	1.1	19	N/A	N/A	80	73

2.2 Specifying the correct CC Roll Format

CC is available in **Bulk Rolls** or as smaller **Batched Rolls**.

- **Bulk Rolls** offer the quickest installation but must be deployed using heavy lifting equipment and a spreader beam. Bulk Rolls are generally more efficient to use than Batched Rolls, in terms of material use and transportation.
- For sites where this isn't suitable, man portable **Batched Rolls** can be installed without the need for plant and are well suited to smaller scale works in restricted access areas.
- CC is now also available in Wide Rolls of up to 4 times the standard roll width. Contact Concrete Canvas for further details.

CC Bulk Rolls and Batch Rolls

Longitudinal layup

Transverse layup

2.3 Which layup?

Standard practice is to lay CC vertically down the length of the slope (longitudinal) as this provides the fastest method of installation and allows each roll to be securely fixed at the crest of the slope. If a transverse layup is used, care should be taken to position the overlap in the direction of water flow (like shingled roof tiles) and hydraulic shear force loads should be considered when selecting the jointing method..

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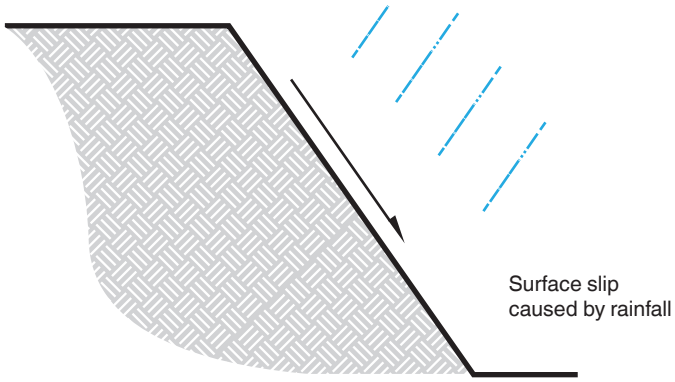
Concrete Canvas® is part of a revolutionary new class of construction materials called Geosynthetic Cementitious Composite Mats (GCCMs). It is a flexible, concrete impregnated fabric that hardens on hydration to form a thin, durable, water proof and fire resistant concrete layer. Essentially, it's concrete on a roll. Concrete Canvas® GCCM (CC) can be used to provide a hard wearing erosion control surface for rapidly protecting slopes, outfalls, spillways and over-toppings. CC is typically used as an alternative to conventional concrete, such as shotcrete, and where vegetated slopes are unsuitable due to the high flow rates, arid climate or poor soil conditions.

The following guide provides useful information for installers, customers and specifiers of CC as an overview of installation techniques for protecting slopes with CC. It should be used together with the other relevant guides such as the *CC User Guide: Jointing & Fixing*. The versatile nature of CC means that this document is not exhaustive and is intended for guidance purposes only.

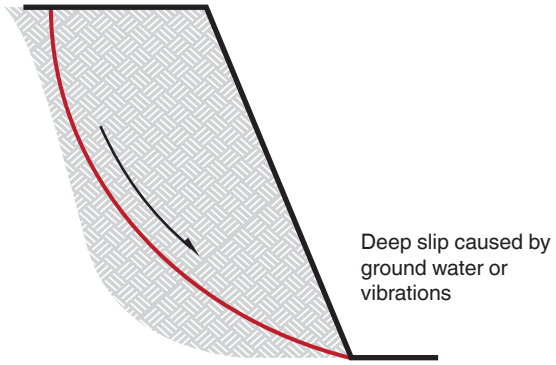
Here are some key questions that you may need to consider before specifying or purchasing CC:

2.4 Is the application Slope Protection or Slope Stabilisation?



Slope Protection

Slope Protection describes applications where the body of the slope is geotechnically stable but the surface of the slope is prone to erosion from weathering and surface slip. Typically this might be on a sandstone rock face such as in the *CC Case Study: Alcobendas Tunnel Station*. Or on slopes constructed from a mixture of rock and soil, where rainfall causes loss of fines which then risks destabilising the slope, such as in the CC *Cundinamarca Slope* case study.



Slope Stabilisation

Slope Stabilisation describes applications where the body of the slope is geotechnically unstable and is at risk of deep slip (a large mass of the slope collapsing). This may be caused by ground-water lubricating the soil or from other factors such as ground vibration. Conventional solutions include shotcrete, steel mesh and soil nails which are used to stabilise the slope by providing structural reinforcement. CC can substitute for the shotcrete component for many projects but must be included as part of a solution designed by a geotechnical engineer. A good example is the *CC Case Study: Karapiro Gully*.

CC Slope Protection project, Alcobendas Tunnel Station, Spain

CC Slope Protection and Stabilisation project, Karapiro Gully, New Zealand

This guide focuses on slope protection, although a lot of the same techniques can be applied to slope stabilisation.

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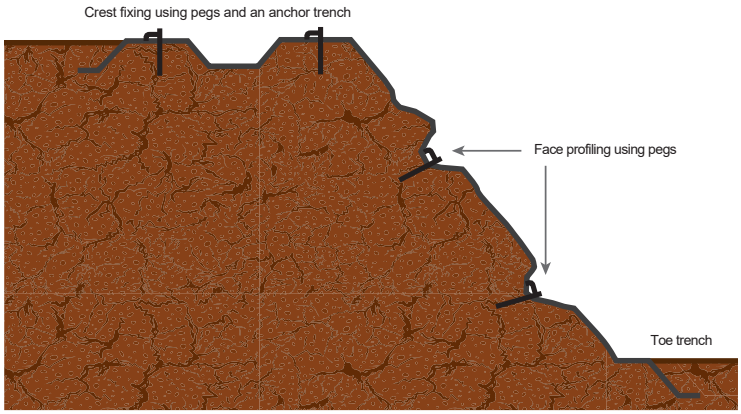
2.5 Which fixing method?

CC should be securely fixed and anchor trenched at the crest of the slope. The anchor trench is essential in order to prevent water flow below the material which may undermine the CC. Additional fixings should be used down the face for profiling or additional support as required.

The following provides examples of suitable fixings for different substrates. For full details of jointing and fixing methods please see the *CC User Guide: Jointing & Fixing.*



To Soil: CC can be fixed to a soil substrate using pegs, an anchor trench, soil nails or ground anchors. The most common method of securing CC at the crest is using a combination of pegs and an anchor trench. Peg length and spacing should be determined based on the pull-out force requirement (e.g. self weight, water flow etc.), however typical spacing is at every joint along the crest. It is essential to prevent water ingress between the CC and the substrate at the crest as this can lead to undermining. An effective means of sealing this top edge is by burying the exposed CC in an anchor trench backfilled with concrete or site fill material. An anchor trench also provides a neat aesthetic transition to the surrounding landscape.

CC fixed at the crest of a slope with ground pegs and anchor trench

Concrete anchor trench constructed over CC at the crest of a slope

To Concrete: CC can be fixed to a concrete substrate (such as a headwall) using conventional masonry fixings such as self tapping masonry bolts, wedge anchors and “Hilti” type nails. We recommend a fixing with a minimum shank diameter of 3mm and minimum washer/head diameter of 16mm or a clamping bar to prevent pull-through.

CC fixed at crest of slope with concrete anchor bolts

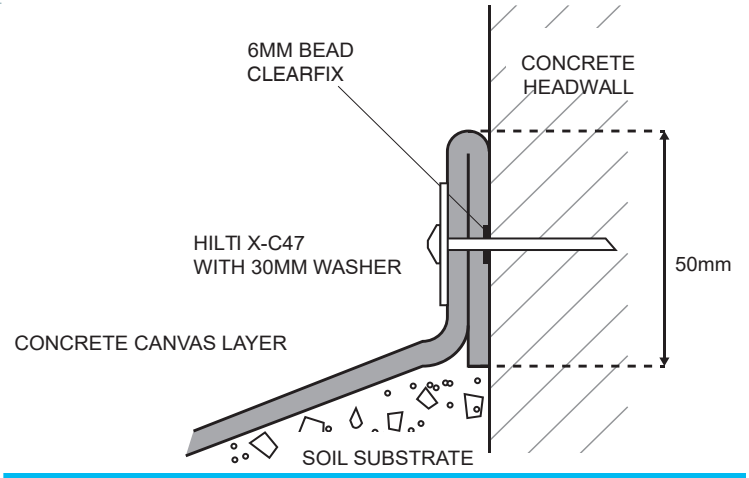


Diagram of typical fixing to concrete headwall using Hilti nail

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To Rock: CC can be secured onto rocky substrates using rock bolts; the number and type of fixings should be selected based on the pull-out force requirement. A suitable head design should be selected to prevent stress concentrations. A minimum head diameter of 15mm is normally recommended and plates up to 150mm are often used. Large anchor plates should be circular where possible or have radiused corners to avoid stress concentrations.

Rock bolt and large anchor plate with radiused corners

CC fixed to slope using rock bolt

2.6 Which jointing method?

A suitable jointing method should be selected based on the loading and water impermeability requirements of the project. The standard method of jointing for slope protection is to use a screwed joint which provides a good mechanical bond and sufficient impermeability for most slope protection applications. We recommend using stainless steel screws inserted at 200mm centres along the overlap. The screws should be positioned between 30-50mm from the edge of the joint and applied prior to hydration or immediately afterward. The concrete within CC will then set around the thread of the screws. Please see the *CC User Guide: Jointing & Fixing* for more jointing methods.

Jointing adjacent layers of CC using stainless steel screws

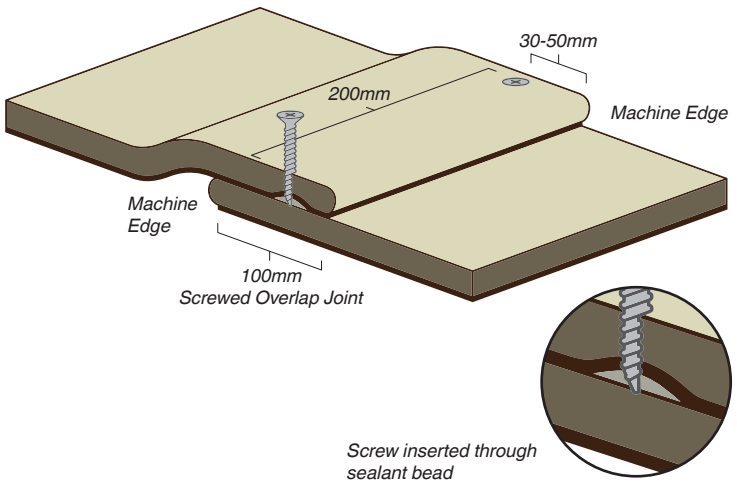

Diagram showing screw inserted through sealant bead

If a higher level of impermeability is required (for example on an outfall) then a bead of sealant such as Clearfix can be applied in the overlap prior to screwing. If screws are not suitable (for example if laying on a geomembrane) then a double bead of adhesive sealant such as Clearfix or a thermally bonded joint may be used.

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3.0 Four Key Installation Principles of CC - Please refer to Hydration Guide

4.0 Installation Methodology

4.1 Equipment Required

- Sufficient CC to complete project
- Safety mask and gloves
- Cutting equipment, snap off knife or disc cutter
- Metal or plastic fixing pins
- Lump Hammer
- Screwdriver and stainless screws or alternative method to join the CC layers
- Water supply

See *CC Equipment List* for full details. Dust hazard. Wear appropriate PPE. Consult *CC SDS* document.

4.2 Ground Preparation

CC will conform closely to the underlying surface contours of the slope. For slopes with a high degree of surface undulation it is recommended to grade the slope if possible, to reduce voids from forming between CC and the substrate. Where it is not possible to grade the slope, voids can be reduced by profiling with suitable fixings. For the best results it is also recommended that loose soil, vegetation, soft ground and protruding rocks are removed.

4.3 Fixing and Laying CC

The fastest and easiest method of laying CC is using bulk rolls hung from a spreader beam. If access for heavy lift plant equipment is limited, batched rolls may be used. The procedure for laying bulk and batched rolls is the same.

When laying the CC ensure that the fibrous surface of the CC is facing upwards and the PVC membrane is in contact with the ground. For longitudinal (vertical orientation) layup the CC should first be secured at the crest of the slope, using one of the methods described above, and then unrolled down the length of the slope.

4.4 Positioning and Profiling CC

When positioning subsequent CC rolls, ensure that there is at least a 100mm overlap between layers and that all overlaps are in the direction of water flow (primarily for transverse layups). CC may need to fixed down the face of the slope for profiling or to provide additional support. It is preferable to locate fixings along the overlaps where possible, hydrating under the overlap first.

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4.5 Hydrating CC

Once positioned, CC should be hydrated by spraying with water (sea water may be used). Spray the fibre surface with water until it feels wet to touch for several minutes after spraying. An excess of water should be used as CC cannot be over hydrated (minimum ratio of water: CC is 1:2 by weight). Re-spray the CC again after 1 hour if installing CC5™, installing on steep slopes or installing in warm climates. It is important to ensure that overlapped and anchor trenched sections are hydrated. Refer to the *CC User Guide: Hydration,* for instructions on the correct hydration procedure. Please note that you should not rely on rainfall to hydrate the material.

4.6 Jointing CC

The fastest and easiest method of jointing is using stainless steel screws at 200mm spacing. These can be applied using an auto-fed collated screw driver. If a screwed joint is not appropriate, for example where a higher level of impermeability is required, thermal bonding or an adhesive sealant joint can be used. Please refer to the *CC User Guide: Jointing & Fixing*.

4.7 Setting

Once hydrated, CC remains workable for approximately 1-2 hours in a UK climate. In warm climates, working time may be reduced. CC will harden to 80% of its 28 day strength in 24 hours and is ready for use.

4.8 Maintenance

In the right conditions, CC will naturally 'green' over time with moss and blend in with the environment. The surface can also be painted with a suitable masonry paint if required.

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