



# CONCRETECANVAS

## INSTALLATION GUIDE: SLOPE PROTECTION



RAIL



ROAD



MINING



PETROCHEM



AGRO



UTILITIES



MUNICIPAL



DEFENCE



DESIGN



2014 Fast Track 100  
16th fastest growing  
company in the UK.



2014 Queen's Award  
for Enterprise in  
Innovation



2013 Macrobert Award  
Finalist



2013 Innovation Award Winner  
Railtex Exhibition



2012 R&D 100 Award winner  
R&D Magazine



2011 Expert's Choice Winner  
Most Innovative Product



2011 Brit Insurance  
Designs of the Year Nominee



Material ConneXion®  
MEDIUM AWARD  
MATERIAL OF THE YEAR 2009  
2009 Winner  
Material ConneXion Medium Award  
Material of the Year



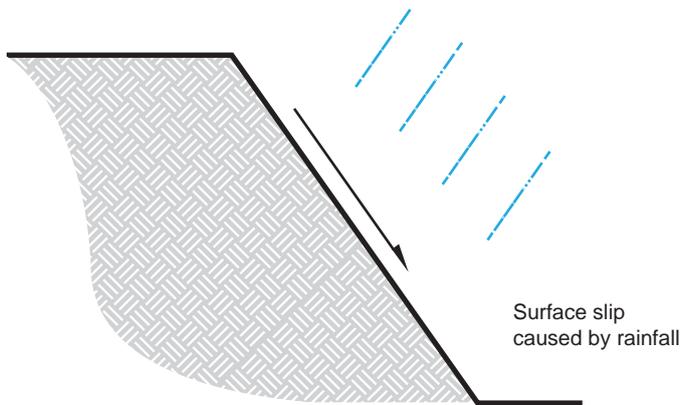
2007 Winner  
D&AD Yellow Pencil Award  
Product Design

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 Jointing and Fixing Guide*. The versatile nature of CC means that this document is not exhaustive and is intended for guidance purposes only.

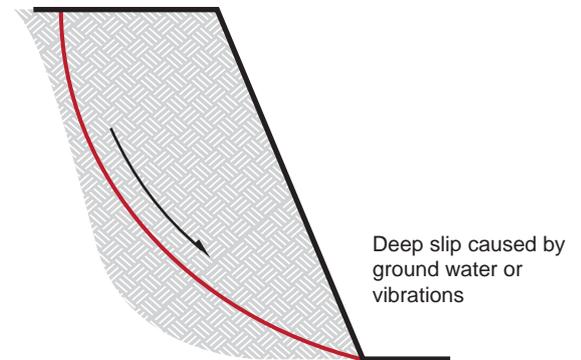
Here are some key questions that you may need to consider before specifying or purchasing CC:

## Is the application Slope Protection or Slope Stabilisation?



### Slope Protection

Slope Protection is suitable for applications where the body of the slope is inherently 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 Alcobendas Tunnel Station* case study. 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 is suitable for applications where the body of the slope is 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 qualified geotechnical engineer. A good example is the *CC Karapiro Gully* case study.



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.

## Which 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.

## Which format?

CC is available as large bulk rolls (1.5 to 1.6T) or as smaller man-portable batched rolls (60 to 70kg). Installation is fastest using bulk rolls dispensed from a spreader beam (available for hire/purchase). For sites where heavy lifting equipment is not available or access is limited, the batched man-portable rolls should be used.

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



CC Bulk Roll



CC Batched Roll

## Which layout?

Standard practise 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 layout is used, care should be taken to position the overlap in the direction of water flow (like shingled roof tiles).



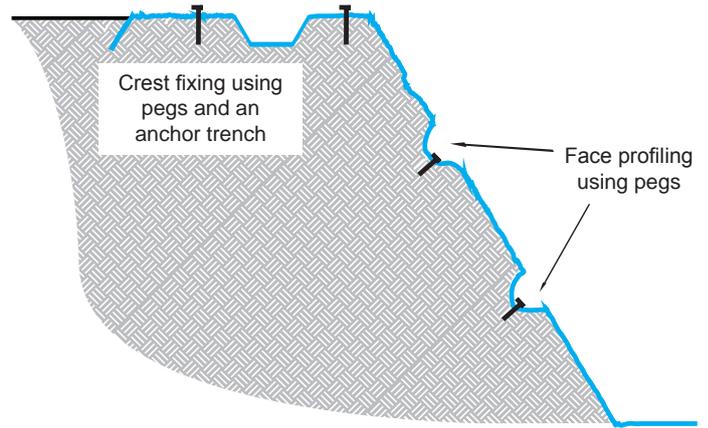
Longitudinal layout



Transverse layout

## Which fixing method?

CC should be securely fixed at the crest of the slope, with additional fixings 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 important 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; this 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 minimum washer/head diameter of 15mm or a clamping bar for most fixings of this type to prevent pull-through.



CC fixed at crest of slope with concrete anchor bolts

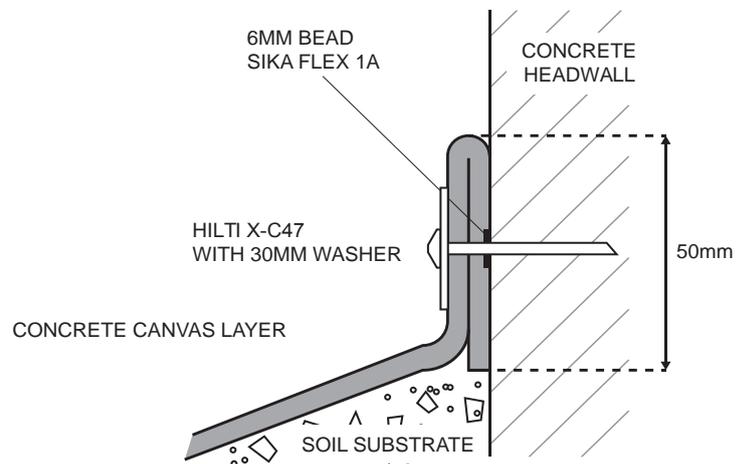


Diagram of typical fixing to concrete headwall using Hilti nail

**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



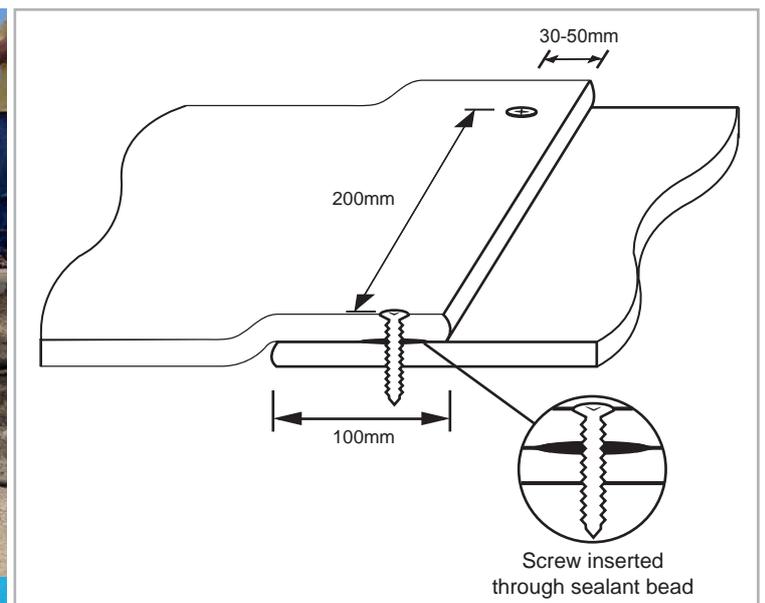
CC fixed to slope using rock bolt

## 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 intervals 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 and Fixing* for more jointing methods.



Jointing adjacent layers of CC using stainless steel screws



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 an adhesive sealant such as Clearfix or a concrete mortar joint may be used.

## Installation

### 1. 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.

### 2. 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) layout 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.

### 3. 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 layouts). CC may need to be 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.

### 4. 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 Hydration Guide* for instructions on the correct hydration procedure. Please note that you should not rely on precipitation to hydrate the material.



## 5. 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, suitable collated screws are available from Concrete Canvas® Ltd. If a screwed joint is not appropriate, for example where a higher level of impermeability is required, please refer to the CC *User Guide: Jointing and Fixing*.



## 6. 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.



## 7. 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.



## Concrete Canvas® GCCM Material Data



## Concrete Canvas® GCCM Physical Properties\*

Product	Thickness (mm)	Batch Roll Size (sqm)	Bulk Roll Size (sqm)	Roll Width (m)
CC5™	5	10	200	1.0
CC8™	8	5	125	1.1
CC13™	13	N/A	80	1.1

Product	Mass (unwet) (kg/m²)	Density (unwet) (kg/m³)	Density (set) (kg/m³)
CC5™	7	1500	+30-35%
CC8™	12	1500	+30-35%
CC13™	19	1500	+30-35%

## Pre-Set Concrete Canvas® GCCM Properties

### Setting

#### Working Time

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

### Method of Hydration

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

#### Re-spray the CC again after 1 hour if:

- Installing CC5™
- Installing on a steep or vertical surface

#### Notes:

- An excess of water is always recommended. CC will set underwater and in seawater.
- CC must be actively hydrated. For example do not rely on rainfall or snowmelt.
- Use a spray nozzle for the best results (see CC equipment list). Do not jet high pressure water directly onto the CC as this may wash a channel in the unset CC.
- CC has a working time of 1-2 hours after hydration. Do not move or traffic CC once it has begun to set.
- Working time will be reduced in hot climates and increased in very cold climates.
- CC will set hard in 24 hours but will continue to gain strength over time.
- If CC is not sufficiently wetted, or dries out in the first 5 hours, the set may be delayed and strength reduced. If the set is delayed avoid trafficking the material and re-wet with an excess of water.

Refer to the **Concrete Canvas Hydration Guide** for installation in low temperatures or drying conditions.

- Low Temperature Conditions occur when the ground surface temperature is between 0 and 5°C and rising or is expected to fall below 0°C in the 8 hours following hydration.
- Drying Conditions occur when there is one or more of: high air temperature (>22°C), wind (> 12km/h), strong direct sunlight or low humidity (<70%).

## Post Set Concrete Canvas® GCCM Properties

Based on Concrete Canvas GCCM® hydrated in accordance with the Concrete Canvas® Hydration Guide.

### Strength

Very high early strength is a fundamental characteristic of CC. Typical strengths and 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)

	Length direction (kN/m)	Width direction (kN/m)
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 7.4.2) 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** (ASTM D6460) 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

Product exceeded large scale testing capabilities and was not tested to failure.

To achieve these permissible values, the CC material must be properly anchored with a system designed to meet or exceed these values.

## Other Information

\* Occasionally there will be a Beam Fault (fabric imperfection under 100mm wide running across the width) in a Bulk Roll. This fault is unavoidable due to the manufacturing process and the fault will be clearly marked with a white tag, there will be a maximum of (1) one Beam Fault in any Bulk Roll. A joint may need to be made on site where there is a Beam Fault as the material at a fault will not reach the performance specified in this Data Sheet. The maximum un-useable material due to any Beam Fault will be 100mm. There are no beam faults in standard batched rolls.

\* Indicative values

\*\* For containment applications it is recommended to use CC Hydro™

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