



# CONCRETE CANVAS™

*Concrete Impregnated Fabric...*

## INSTALLATION GUIDE : SLOPE PROTECTION



ROAD



RAIL



AGRO



POWER



PETROCHEM



MINING



DESIGN



OTHER



2013 Macrobert Award  
Finalist



2013 Innovation Award Winner  
Railtex Exhibition



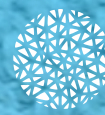
2012 R&D 100 Award winner  
R&D Magazine



2011 Expert's Choice Winner  
Most Innovative Product



2011 Brit Insurance  
Designs of the Year Nominee



2009 Winner  
Material ConneXion Medium Award  
Material of the Year



2007 Winner  
D&AD Yellow Pencil Award  
Product Design



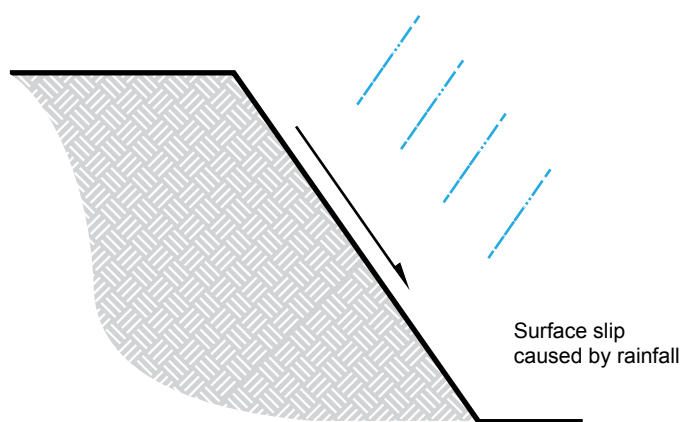
## Concrete Canvas™ Installation Guide: Slope Protection

Concrete Canvas (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.

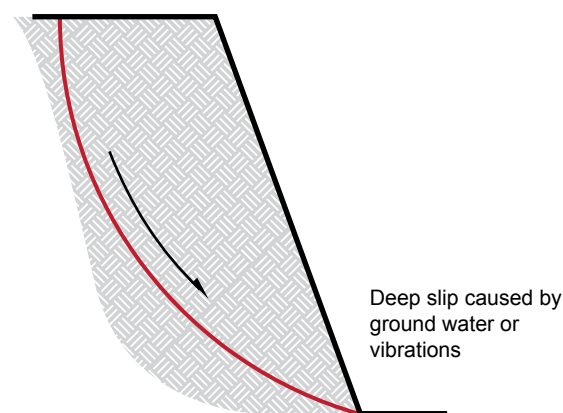
Here are some key questions that you may need to consider before specifying or purchasing CC:

### Is the application Slope Protection or Slope Stabilisation?



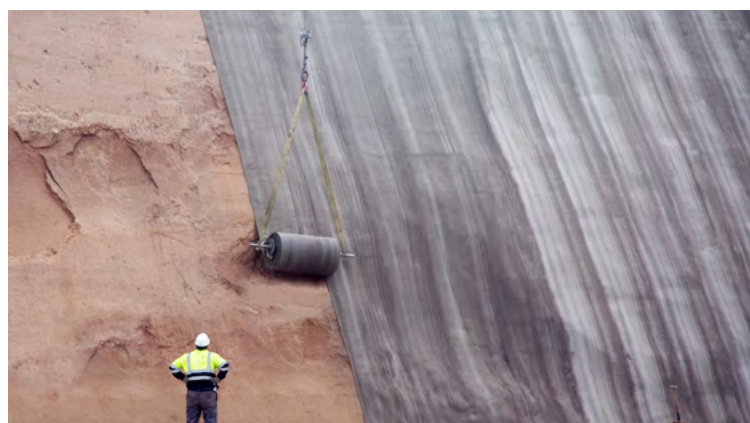
**Slope Protection**

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 suffering from deep slip (where a large mass of the slope collapses). 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 of this type of design for many projects but must be included as part of a solution designed by a qualified geotechnical engineer. A good example is the CC “**Cloudhill Quarry**” case study.



CC Slope Protection project, Alcobendas Tunnel Station, Spain



CC Slope Stabilisation project, Cloudhill Quarry, UK

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 using 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 (mm)	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 layup?

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



Longitudinal layup

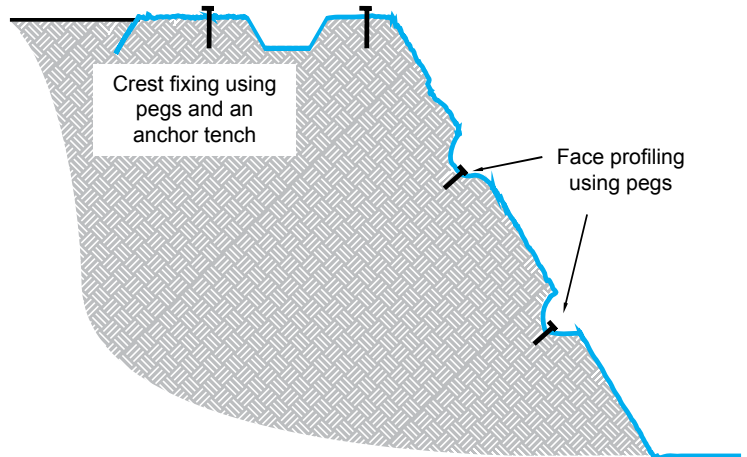


Transverse layup



## 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 (eg self weight, water flow etc), however typical spacing for a longitudinal layup is at every joint along the crest. It is particularly 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 crest of slope with ground pegs and anchor trench



Concrete anchor trench constructed over CC at crest of 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 bolt

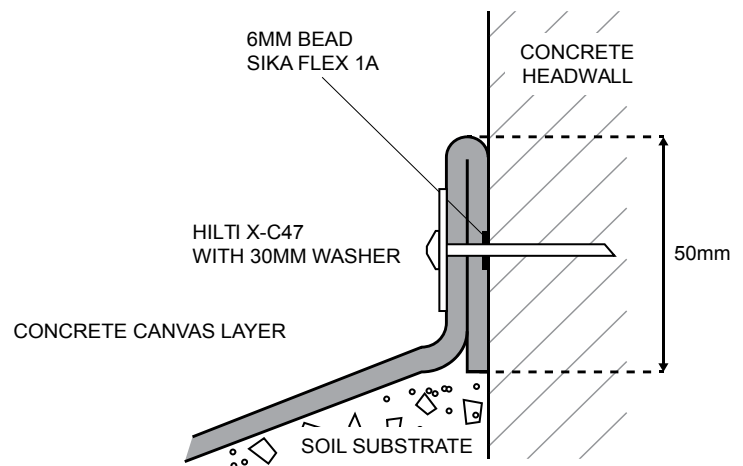


Diagram of typical fixing to concrete headwall using Hilti nail



**To Rock:** CC can be secured into 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



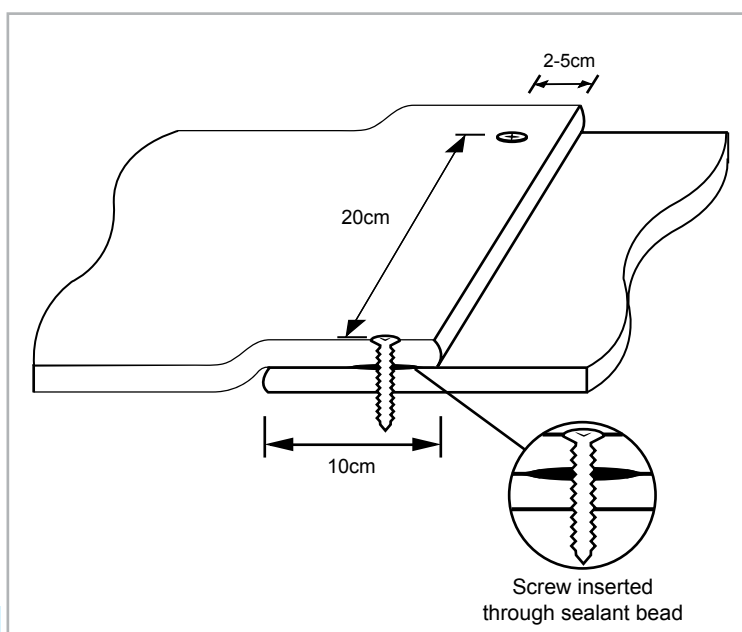
CC fixed to slope using rock bolt

## 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 20cm intervals along the overlap. The screws should be positioned between 2-5cm from the edge of the joint and applied prior to setting when the CC is still unset. The concrete within CC will then set around the thread of the screws. Please see the CC “User Guide: Jointing and Fixing” for a full range of 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 Sikaflex 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 CT1 or Corroplast 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 CC 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.

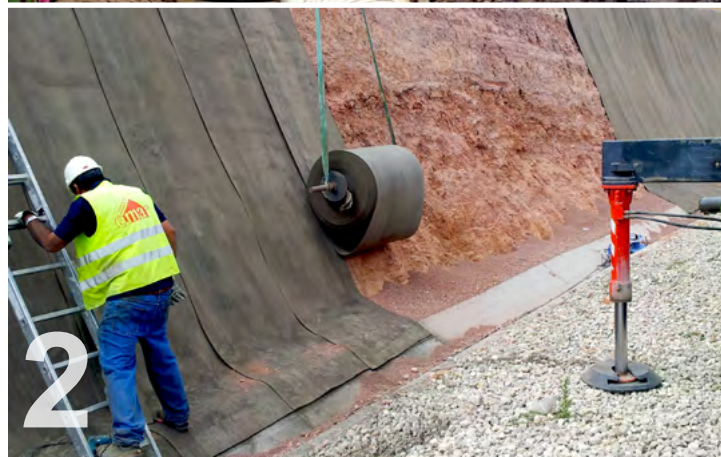
When laying the CC ensure that the fibrous surface of the CC is facing upwards and the PVC membrane is in contact with the ground. For longitudinal (vertical orientation) layup the CC should first be secured at the crest of the slope, using one of the methods described above, and then unrolled down the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

### 3. Positioning and Profiling CC

When positioning subsequent CC rolls, ensure that there is at least a 10cm overlap between layers and that all overlaps are in the direction of water flow (primarily for transverse layup). 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.

### 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 natural precipitation to hydrate the material.





## Installation cont.

### 5. Jointing CC

The fastest and easiest method of jointing is using stainless steel screws at 20cm spacing as described above. These can be applied using an auto-fed collated screw driver, suitable collated screws are available from Concrete Canvas. 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 approx 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.

