SLOPE PROTECTION

Project Info

- 02 / 11 / 16
- CC13™ Bulk Rolls
- 1,040m²
- Vertical layers
- Pontypridd, South Wales, UK
- Natural Resources Wales
- CC used to provide slope protection to sections of the River Taff.

Completed CC lined section of River Taff

In November 2016, Concrete Canvas (CC) GCCM* was used as a remedial slope protection solution to line sections of embankments of the River Taff in South Wales.

From its confluence at Cefn-coed-y-cymmer the River Taff flows south, passing through Pontypridd before turning southeastward and flowing through the centre of Cardiff. It empties into Cardiff Bay, near to the mouth of the River Ely in South Wales, taking on several tributaries from the surrounding valleys.

Sections of the river bank are formed from grouted rip-rap embankments which are believed to have been installed in the early 1950's. A particular section, within the Treforest Industrial Estate, was showing signs of degradation; the condition of the concrete riprap was such that it was heavily cracked, showing signs of severe spalling of the face and established vegetation growth. Remediation was required to provide an effective erosion protective layer to the river bank that would mitigate any further scour, which would eventually undermine a walkway along the crest of the bank and adjacent industrial areas.

Following successful similar works at Crindau in Newport, Concrete Canvas Ltd were approached by Natural Resource Wales to provide a remedial solution.

*Geosynthetic Cementitious Composite Mat

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Rip-rap Embankment Prior to Remedial Work

The area considered for remediation was approximately 220 linear metres in length and the incumbent grouted riprap revetment was approximately 4m in height, terminating halfway up the 8m slope. The revetment butted into a concrete kerb at the toe, which capped sheet piling beneath. The bank was presumed to be stable but showed signs of erosion which could potentially cause issues in the future.

It was considered to simply re-point sections of the rip-rap, but this would represent a costly stop gap solution, which wouldn't address the underlying drainage issues. Replacing the rip-rap in its entirety would involve the costly excavation and import of fill in a difficult access area.

Other solutions were considered, including sprayed concrete (shotcrete or gunite), in-situ poured concrete, concrete or reno mattresses and vegetation mats and hydro seeding. However, these solutions posed issues such as the requirement for specialist contractors, contamination of the river, time consuming form work requirments, heavy plant requirement and insufficient resistance to high flow rates, respectively.

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Concrete Canvas® (CC) is an impermeable cement impregnated geotextile that hardens on hydration to form a durable, fibre reinforced concrete layer. It is widely used by the likes of Network Rail, Highways England and the Environment Agency for a range of applications, including the rapid lining of drainage channels, providing slope protection, weed suppression, culvert repair and general concrete remediation. It combines the robustness of a precast or poured concrete solution, with the ease of installation and impermeability of a plastic geomembrane.

CC offers a number of technical USP's which led to its specification on this project;

Erosion Protection: CC has much greater abrasion resistance compared to conventional concretes. For example, when tested to ASTM C-1353, CC demonstrated approximately 7.5x greater abrasion resistance compared to a 17MPa OPC (Ordinary Portland Cement).

Durability: CC has a minimum design life of over 50 years in severe operating conditions and in a UK climate. The material has been age tested through cycles of Free-Thaw, Soak-Dry, Heat Rain and Water Impermeability according to BS EN 12467:2004 and passed. In addition to exceptional weathering performance, the material has excellent chemical resistance and will not degrade in UV.

Weed Suppression: CC provides excellent weed suppression: the material has been tested against Root Resistance DD CEN/TS 14416:2005 and passed.

Flow Rates: CC has been independently tested for permissible shear forces and flow velocities by third party test houses. The product exceeded the test house capabilities and has not been tested to failure. When tested to ASTM D-6460, CC8 material, when properly anchored, was able to withstand shear forces of 1200Pa and flow rates of 10.7m/s.

Ecology: The River Taff supports a number of migratory fish, including salmon, sea trout, and eel. It was therefore critical to minimise the environmental and ecological impact of any remedial solution. CC has a low wash out rate and a low alkaline reserve, which when combined with the volume of water required to hydrate the material, means it is not required to first treat CC washout prior to discharging into the adjacent river. The run-off would not affect the pH levels of the local watercourse.

Aesthetics: Whilst preventing root growing vegetation which would require regular maintenance, the fibrous top surface of CC will attract moss growth in the right conditions and essentially 'green' over in time. This combined with the mottled finish of the material, creates an aesthetic more sympathetic to the surrounding environment than conventional concrete methods.

Example of mossed CC channel lining

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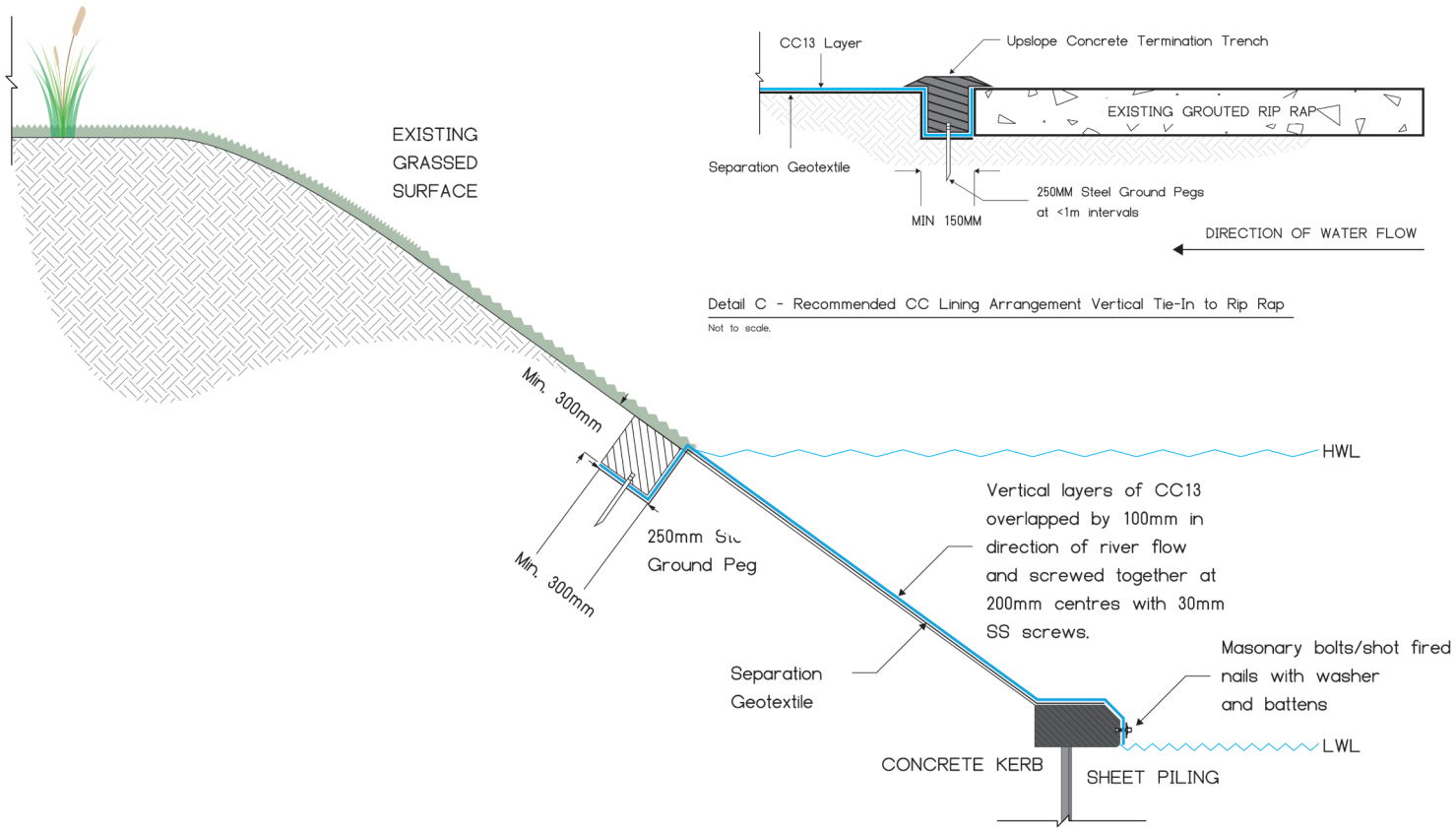

General Arrangement Schematic

CC is available in three different thicknesses, CC5, CC8 and CC13 which are 5, 8 and 13mm thick respectively. CC5 is typically only used for reinstating existing concrete infrastructure or for non-trafficked bund lining protection. CC8 (8mm) is typically specified for channel lining projects where the CC is being laid directly onto a soil substrate. CC13 (13mm) is typically specified for high flow rate projects, trafficked areas or for any project where the material is likely to be subjected to loading.

Given the shear force loads the material was likely to be subjected to, the potentially fast flow velocities of the River Taff and the likelihood of impact from flotsam and impact from debris, CC13 was specified. A temporary aggregate road access was constructed using site won river material to allow plant access which allowed for the CC13 to be deployed via bulk rolls dispensed from spreader beam.

It was initially considered to deploy the CC material directly onto the existing grouted riprap facing, but further inspection of the condition of the riprap showed potential large voids would form when the CC was draped over the uneven surface. Many of the grouted rocks had also spalled or come loose which would compromise the stability of the CC lining. Furthermore, the uneven surface of the riprap would produce an uneven surface finish creating the potential for pooling.

Instead, it was decided to first remove the riprap using plant and grade the slope to a uniformly smooth finish. The slope was graded to a profile acceptable to NRW's requirements as CC's draping qualities reflect the exact profile of any substrate it is laid onto. Grading of the slope also removed any underlying vegetation which is important prior to the deployment of CC. Following grading of the profile, it was then covered with a layer of separation geotextile (120gsm Terram T1000) prior to deploying the protective CC layer. This geotextile layer mitigated wash out of the substrate fines through tidal action between the CC joints.

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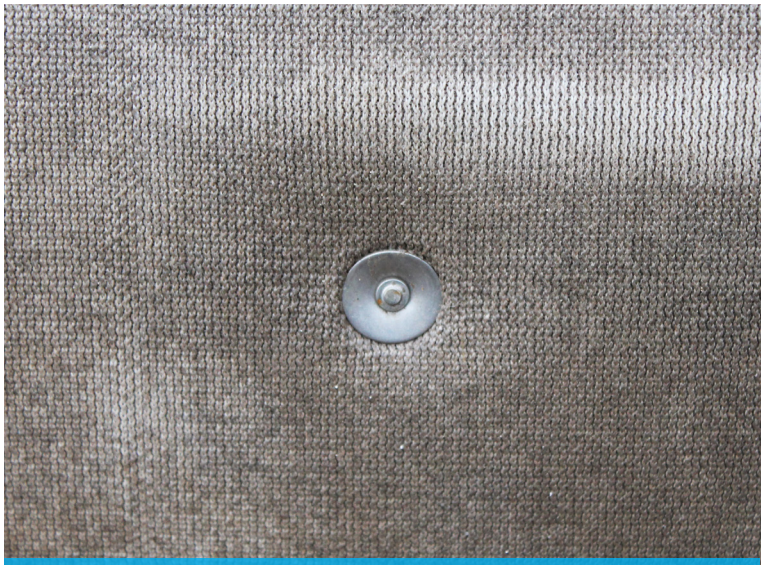
Preparation of the slope; regrading and placing of the geotextile

Dispensing of bulk roll CC13 via spreader beam.

Fixing of the overlapped CC layers using SS screws at 150mm centres

Hydration of the CC lined sections using water from the River Taff

Anchor trenching of the CC13 midway up the embankment.



Hilti shot fired masonary nail with washer to secure the CC to the kerb.

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CC can be deployed for slope protection either in long continuous horizontal layers perpendicular to the slope, or in shorter vertical layers in line with the slope. For this installation, the material was deployed vertically for the following reasons:

- Vertical layers could be individually anchor trenched at the crest of the slope and fixed mechanically onto the concrete kerb at the toe. Lining the material horizontally, would have required intermediate fixings on the slope face to maintain the CC in position, as only the top and bottom horizontal layers would be anchor trenched at the crest or mechanically fixed at the toe.

- Vertical shorter layers of CC were more easily positioned square to the slope to produce a more uniform finish and to better accommodate any variations in the profile.

- Vertical shorter layers allowed for the material to be installed in several phases of installation over the course of several days as required. Best practice when installing horizontal longer layers is that the material is fully deployed in a single phase of installation. It was critical to ensure that the installation of the CC started downstream of the river and that subsequent overlapped layers were lapped in the direction of river flow. This ensured that water flows over the overlapped joints rather than into them, which could potentially run the risk of water ingress and material displacement.

- CC layers were overlapped by a minimum of 100mm in the direction of water flow and then subsequently screwed together through the overlap at 150mm centres using 30mm SS screws. The screws effectively created a monolithic structure of the individual CC layers, greatly increasing the overall strength of the lining as well as helping prevent displacement through shear force. By only screwing the layers together and not applying an adhesive sealant, a natural weep path was created between the overlapped layers allowing water transition between the substrate and the Canvas. This allowed the release of any build-up of hydrostatic pressure within the embankment, whilst still mitigating water ingress from surface run-off or rainfall.

Crest anchor trenching

Grouted termination to rip rap

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Completed CC13 lined section of the River Taff

At the crest, the uppermost edges of the vertical CC layers were captured within a minimum 300mm x 300mm anchor trench, ensuring that the Canvas was fed across the full width of the base. Once in position, each layer was pinned within the anchor trench to the substrate using 250mm length galvanised steel pegs. The captured CC material was hydrated prior to back filling the anchor trench.

The incumbent concrete kerb at the toe of the slope provided an ideal point at which to mechanically fix the individual CC layers to the slope to prevent displacement. Each CC vertical layer was draped across the full height of the kerb and captured to the vertical face using concrete masonry anchors with washers.

The side edges of the CC layers were anchor trenched at the interface with the rip-rap within concrete poured backfill to prevent water ingress. A series of drainage chambers were installed along the length of the embankment.

"Concrete Canvas is an excellent innovative product for two important reasons: firstly it offers the required erosion protection to protect a critical asset and prevent future erosion. Secondly, it minimises the environmental effects that you would normally associate with other concrete products. It also has the added bonus that the product is maintenance free and quick to install, therefore offering huge cost benefits."

Phil Poole
Operations Delivery Technical Support Team Member
Cyfoeth Naturiol Cymru / Natural Resources Wales

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Painted CC slope

Following the installation, Natural Resources Wales discussed the possibility of painting the CC material installed on the slope to help it blend in with the surroundings more successfully. The material can be painted using specialist masonry paint post-install, and this has been successfully done for an installation in the Middle East in the past.

Members of the Concrete Canvas team went down to the installation site and painted a section of the slope as a trial in order to see how the paint would set and colour over time. NRW were happy with the results, and CC continued to paint the rest of the slope in sections until the entire 220 metre width of slope had been painted green. The paint will continue to weather over time, and gradually blend into the surroundings.

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