



CC lined tailings channel in abrasive conditions, controlling water containing 60% sediment



# CONCRETE CANVAS®

Concrete on a Roll

## ABRASION RESISTANCE



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## 1.0 Why is Abrasion Resistance an Essential Concrete Canvas Characteristic?

One of the principle features of Concrete Canvas® GCCM\* (CC) material is that for the majority of erosion control applications it remains exposed throughout its operational life and can therefore be subjected to abrasive conditions. These conditions typically occur in channelling or culvert remediation applications where the top surface of the lining is subject to a range of water flow velocities and bed loads of silt, sand or cobbles during storm events. These actions can wear the surface of the lining. Abrasion resistance is therefore an essential characteristic of GCCM materials.

## 2.0 Test Methodology

CC is often used to replace unreinforced poured concrete for channel lining works. In the UK, the poured concrete mix is commonly specified as the standard mix ST4 to BS 8500-2. An ST4 mix typically reaches a compressive strength of 20 N/mm<sup>2</sup> after 28 days.

Concrete Canvas Ltd have tested the abrasion resistance of the ST4 cement mix at two slump classes, low slump S2 and high slump S4, to compare against the abrasion resistance of the CC8™ material.

Testing was conducted based on ASTM C1353 “Test Method Using Taber Abraser for Abrasion Resistance” with modifications in accordance with European Assessment Document EAD 16-08-0009-03.01 for GCCMs. The Taber Abraser (Abrader) is similar to a rotating stone that grinds against the concrete wearing surface. Sample material of GCCM or concrete plates are placed under an abrasive rotating wheel and depth of wear after every 1000 revolutions (cycles) is measured. A minimum of 8000 cycles is completed. A low depth of wear represents good abrasion resistance; a higher depth of wear represents a lower resistance to abrasion.

## 3.0 Summary of Results

		Age (Days)		
		1	7	28
CC Cementitious Barrier	Depth of Wear (mm/1000 cycles)	-0.198	-0.161	-0.149
ST4 (S2) Cement (low slump)	Depth of Wear (mm/1000 cycles)	Unusable	-0.96	-0.353
	Equivalent Resistance vs CC	N/A	17%	42%
ST4 (S4) Cement (high slump)	Depth of Wear (mm/1000 cycles)	Unusable	-1.671	-0.823
	Equivalent Resistance vs CC	N/A	10%	18%

The results of the testing indicate that the abrasion resistance of the ST4 cement mix is significantly affected by curing time with no ability to resist abrasion after 24 hours. In comparison the cementitious barrier of the CC8™ material achieves good abrasion resistance after 24 hours.

The abrasion resistance of the ST4 cement mix is also affected by slump class. The higher slump S4 cement mix has poor abrasion resistance compared to the lower slump S2 mix.

CC material has been successfully used on channel lining projects subject to constant water flow and bed load for over 10 years, demonstrating excellent abrasion resistance. Although every erosion control application is unique, **the testing has demonstrated that the CC8™ product has superior abrasion resistance to the typical concrete mix that is specified for poured concrete channel lining projects.**

\* Geosynthetic Cementitious Composite Mat



## 4.0 Supporting Information

### 4.1 Concrete Canvas

Concrete Canvas® CC8™ GCCM samples were prepared in accordance with ASTM D8030 “Standard Practice for Sample Preparation for GCCM”, which involves hydrating the samples by full immersion, a process that ensures the highest water:cement ratio possible for the GCCM is achieved. A high water:cement ratio has the effect of reducing the compressive strength of the mix and therefore reduces the resistance of the material to abrasion.

For Concrete Canvas® GCCMs, the typical water:cement ratio achieved by hydration to ASTM D8030 is 0.3.

Once cured to the required test duration (1,7,21 and 28 days), the samples were then cut to 100mmx100mm squares before abrasion testing commenced.

Abrasion of the Concrete Canvas® GCCM occurs in two phases. The top surface is primarily polyester fibres, containing some of the concrete from the cementitious core as it becomes embedded within the fibres during the hydration process. Independent abrasion resistance testing of the top surface fibres by BICS laboratories for the Concrete Canvas® European Technical Assessment ETA-19/0086, determined that after 28 days the surface fabric abraded over 1000 cycles with a mean depth of wear of 0.628mm/1000 cycles.

While this abrasion resistance is sufficient for most channel lining and culvert lining applications, the central cementitious core provides superior abrasion resistance in very abrasive conditions.

### 4.2 ST4 Concrete

The ST4 concrete mix is commonly specified when poured concrete channel lining is installed in the UK, but it has a wide range of uses including for kerb backing and unreinforced bases for temporary structures and internal floor slabs.

The ST4 concrete mix consists of 42.5R cement, water, 4-20mm gravel and 0/4MP concrete sand. ST4 is one of the wetter standard mixes and the fluid consistency enables it to be trowelled to form the finished channel profile. The additional water required to create the fluid consistency reduces the strength of the cured concrete, but ST4 mixes typically reach a compressive strength of 20 N/mm<sup>2</sup> after 28 days.

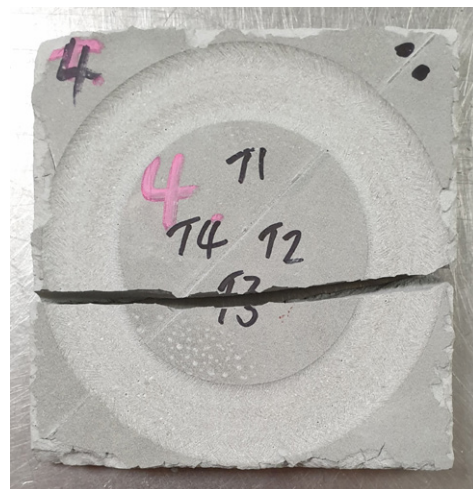
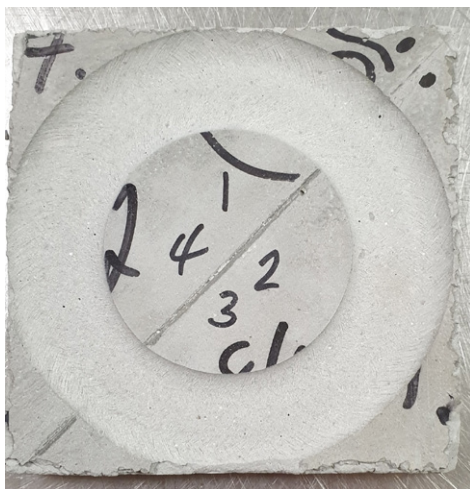
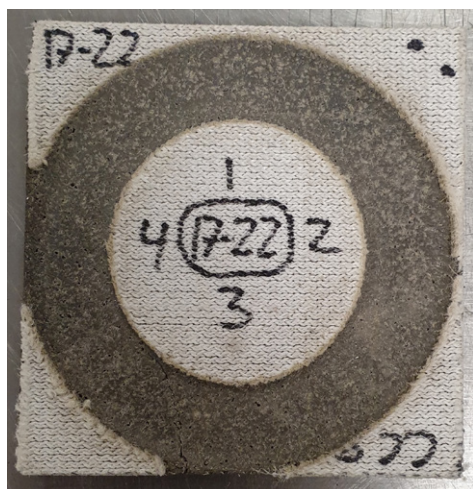
In real world conditions, the abrasion of the ST4 concrete occurs due to flowing water or bed loading from sediment, so the weakest component of the material (the cement) will wear at a faster rate than the harder components (sand and gravel). Over time the aggregate will be loosened by the loss of cement and will eventually spall.



Taber Abrader Testing

It was therefore considered that abrasion resistance of the ST4 cement only would provide the best indication of real world performance for comparison purposes. Cubes of cement were cast at water:cement ratios to represent the same ratios of the original S2 and S4 slump classes (excluding the water absorbed by the aggregate), before again curing to the required test duration (7,21 and 28 days) and then cutting slices to 100mmx100mm squares for abrasion testing.

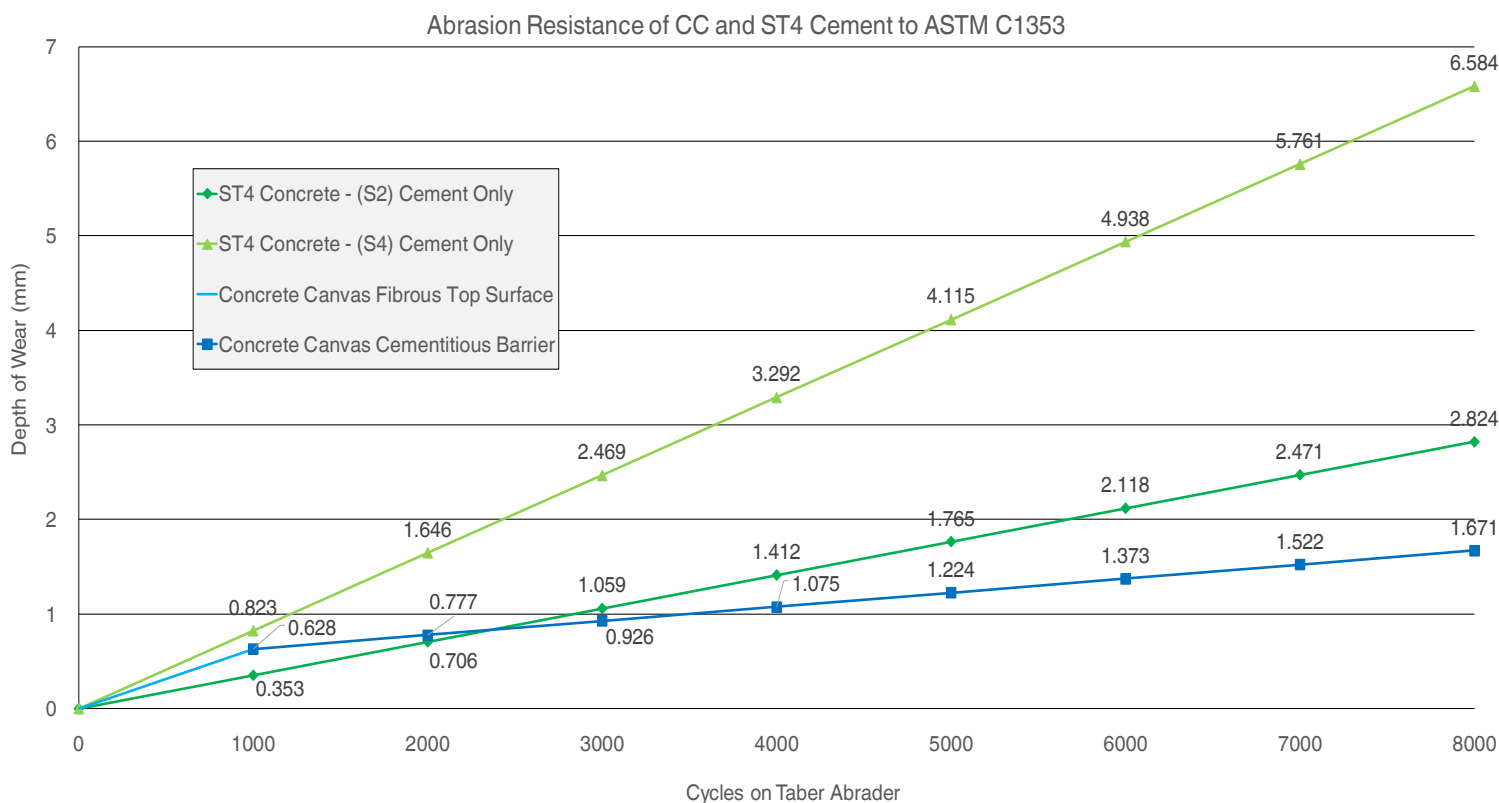
## 6.0 Comparison



Test samples after 8000 cycles (images from left to right) CC8™, ST4 (S2) Cement, ST4 (S4) Cement

An important note is that the ST4-S4 sample cracked and fell apart on removal from the Taber Abrader. The fibre reinforcement in the cementitious barrier of the Concrete Canvas® GCCM does not allow this to happen.

Results of the abrasion resistance (depth of wear versus cycles on the Taber Abrader) are presented in the graph below:



### References

- BS 8500-2:2006+A1:2012 Concrete. Complimentary British Standards to BS EN 206-1. Specification for constituent materials and concrete.
- ASTM C1353 "Test Method Using Taber Abraser for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic".
- European Assessment Document: EOTA EAD DP (16-08-0009-03.01), December 2017, Geosynthetic Cementitious Mats and Barriers.
- ASTM D8030 "Standard Practice for Sample Preparation for GCCM".
- European Technical Assessment ETA-19/0086 of 22/03/2019, Concrete Canvas and CC Hydro
- ARD-2019-01 ST4 Concrete Abrasion Test, Concrete Canvas Internal Test Report.