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European Technical Assessment

ETA-19/0086 of 22/03/2019

General Part

Technical Assessment Body issuing the European Technical Assessment:	British Board of Agrément
Trade name of the construction product:	Concrete Canvas and Concrete Canvas Hydro
Product family to which the construction product belongs:	Product Area 8 – Geotextiles, geomembranes and related products
Manufacturer:	Concrete Canvas Ltd Unit 3, Block A22 Severn Road Treforest Industrial Estate Pontypridd CF37 5SP Tel: 0345 680 1908 website: www.concretecanvas.com
Manufacturing plant(s):	Unit 3, Block A22 Severn Road Treforest Industrial Estate Pontypridd CF37 5SP
This European Technical Assessment contains:	13 pages including 1 Annex which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No. 305/2011 on the basis of:	EAD 080009-00-0301 *Geosynthetic Cementitious Composite Mats and Barriers*

1 Technical description of the product

1.1 General

Concrete Canvas(1) (CC) and Concrete Canvas Hydro(1) (CCH) Geosynthetic Cementitious Composite Mats and Barriers (see Figure 1) are flexible concrete impregnated fabrics for use in a range of geotechnical applications.

(1) Registered trademark.

The products consist of a three-dimensional fibre matrix containing a high early strength gain concrete mix that hardens when hydrated to form a thin, durable and waterproof concrete layer.

The products are provided with a PVC backing to provide the waterproof capability, while the internal fibre matrix provides the tensile strength once the concrete is set and prevents any crack propagation.

Both products can be hydrated by either spraying or by being fully immersed in water.

Concrete Canvas

The products comprise:

- A top polyester layer to contain the dry powder mix
- A three-dimensional fibre matrix containing a specially-formulated dry concrete mix which hardens on hydration
- A PVC backing bottom layer, to contain the dry concrete mix and provide a low permeability liner.

The products are available in three types: CC5, CC8 and CC13 and their properties are given in Table 1.

Table 1 Properties of Concrete Canvas products

Product type	Concrete thickness (mm)	Bulk roll size (m^{-2})	Roll width (m)	Mass (unset) ($kg \cdot m^{-2}$)	Concrete mean density (unset) ($kg \cdot m^{-3}$)	Change in density when set (%)
CC5	5	200	1.0	7	1430-1540	+30 to 35
CC8	8	125	1.1	12	1430-1540	+30 to 35
CC13	13	80	1.1	19	1430-1540	+30 to 35

Concrete Canvas Hydro

The products comprise:

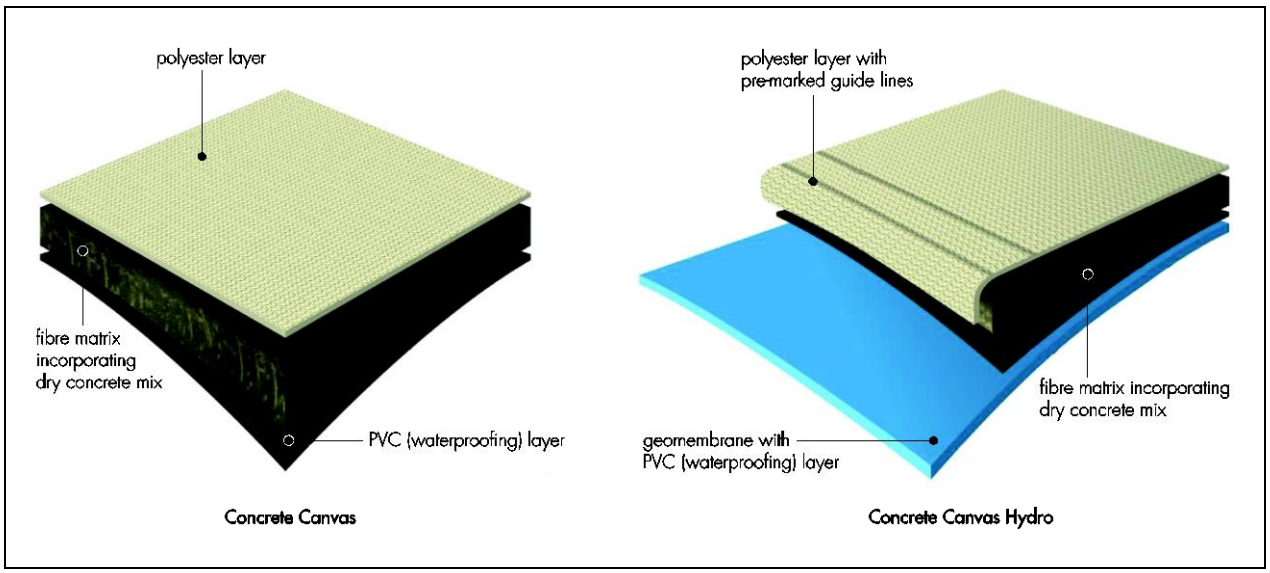
- A top polyester layer (incorporating pre-marked alignment guide) to contain the dry powder mix
- A three-dimensional fibre matrix containing a specially-formulated dry concrete mix which hardens on hydration
- A high impermeability, chemically-resistant PVC geomembrane backing bottom layer incorporating a high visibility welding strip allowing joints to be thermally-bonded for on-site testing.

The products are available in two types: CCH5 and CCH8 and their properties are given in Table 2.

Table 2 Properties of Concrete Canvas Hydro products

Product type	Concrete thickness (mm)	Bulk roll size (m^{-2})	Roll width (m)	Mass (unset) ($kg \cdot m^{-2}$)	Concrete mean density (unset) ($kg \cdot m^{-3}$)	Change in density when set (%)
CCH5	5	150	1.0	8	1430-1540	+30 to 35
CCH8	8	100	1.0	13	1430-1540	+30 to 35

Figure 1 Geosynthetic Cementitious Composite Mats and Barriers



2 Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

2.1 Intended use

The products are for use as both erosion control and containment applications and the intended uses can be outlined as:

- Channel Lining
- Slope Protection
- Bund Lining
- Remediation
- Culvert Lining
- Weed Suppression
- Lagoon Lining.

Concrete Canvas is intended for use in erosion control applications such as channel lining, slope protection, bund lining, remediation for existing concrete structures affected by environmental degradation and cracking, and culvert lining. The product acts as an effective weed suppressant and provides additional impermeability.

Concrete Canvas Hydro is intended for use as a combined impermeable liner and protection layer for containment applications, such as secondary containment bund lining, channel lining, lagoon lining, and other containment applications such as new-build or remediation of existing infrastructure.

2.2 Assumed working life

The provisions made in this ETA are based on an assumed intended working life of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be used as a means for selecting the appropriate product in relation to the expected economically reasonable working life of the works.

2.3 Manufacture

The Manufacturer ensures that the manufacturing process is in conformance to ISO 9001 : 2015 and is committed to manufacturing products to the highest quality standards to ensure all materials meet the stated material performance level.

2.4 Design

It is essential that Concrete Canvas and Concrete Canvas Hydro lined projects are properly designed in accordance with the Manufacturers guidelines taking into account project specific requirements and site conditions. The Manufacturer can provide standard design details, case studies and installation guidelines on request to facilitate this process. The design is carried out under the responsibility of a suitably qualified and experienced individual.

2.5 Packaging, transport and storage

Concrete Canvas is available in three roll formats: Bulk rolls, man portable Batched rolls and Wide rolls. The quantity per roll differs between the various thicknesses of product. Concrete Canvas Hydro is available in Bulk rolls only.

Bulk rolls weigh between 1500 and 1600 kg and are supplied on 150 mm cardboard cores which can be hung from a spreader beam and unrolled using standard plant equipment. Batched rolls are supplied on 75 mm cardboard cores with carry handles. All product types and thicknesses can also be supplied to custom lengths.

Bulk and Batched rolls are individually wrapped and palletised on heat-treated wooden pallets measuring 1.2 by 1.0 m. Wide rolls are similarly supplied, individually wrapped in airtight polyethylene packaging for pole handling. All rolls are provided with a basic hydration guide in English. Details of typical container and truck loading quantities, weights and dimensions can be obtained from the manufacturer.

Concrete Canvas and Concrete Canvas Hydro must be stored under cover in dry conditions away from direct sunlight and in the manufacturer's sealed packaging. It is not recommended to store in shipping containers in direct sunlight where temperatures may exceed 40°C for prolonged periods. If stored correctly, the products have a shelf life of 24 months.

2.6 Installation, maintenance and repairs

Concrete Canvas and Concrete Canvas Hydro must be installed in accordance with the Manufacturer's installation guidelines. For details of sub-base preparation and on-site quality control and quality assurance procedures, a sample specification can be obtained from the Manufacturer.

In most instances, properly installed products will not require any cleaning or maintenance. However, applications which incorporate silt traps, baffling or for some site-specific conditions, some periodic maintenance will require the removal of accumulated silt. For all schemes, it is necessary to periodically inspect the lined asset for signs of structural or hydraulic compromise. Any maintenance or repair should be conducted in accordance with the Manufacturers guidelines.

3 Performance of the product and references to the methods used for its assessment

3.1 Essential characteristics of the product

Table 3 Essential characteristics of the product and product performance

No.	Essential characteristic	Product performance
Basic requirement for construction works 1: Mechanical resistance and stability (1)		
1	Thickness	Annex 1
2	Mass per unit area and Density	Annex 1
3	Flexural strength	Annex 1
4	Static Puncture resistance	Annex 1
5	Dynamic Puncture resistance	Annex 1
6	Pyramid puncture resistance	Annex 1
7	Strength of internal linking fibres	Annex 1
Basic requirement for construction works 4: Safety and accessibility in use		
8	Resistance to chemicals	Annex 1
9	Durability	Annex 1
Basic requirement for construction works 7: Sustainable use of natural resources		
10	Abrasion resistance	Annex 1
11	Freeze – Thaw	Annex 1
12	Water Permeability	Annex 1
13	Gas Permeability	Annex 1

3.2 Assessment methods

3.2.1 General

The assessment of the essential characteristics in Clause 3.1 for the intended use in the sense of the basic requirements for construction works No. 1, 4 and 7 of Regulation (EU) No 305/2011 has been made in accordance with European Assessment Document EAD 16-08-0009-03.01 *Geosynthetic Cementitious Composite Mats and Barriers*.

3.2.2 Identification

This European Technical Assessment is issued on the basis of agreed data that identify the assessed product. Changes to materials, composition or characteristics of the product, or to the production process, could result in these deposited data being incorrect. The British Board of Agrément should be notified before the changes are implemented, as an amendment of the European Technical Assessment is possibly necessary.

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document (EAD) No. 16-20-0089.03.02, the applicable European legal act: 1998/214/EC(1) and amended by Decision 2001/596/EC(2) of the European Commission, the system of assessment and verification of constancy of performance [see Annex V to Regulation (EU) No 305/2011] is as follows:

System 2+:

(1) Official Journal of the European Communities L 80 of 18 March 1998.
(2) Official Journal of the European Communities L 209 of 02 August 2001.

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at the British Board of Agrément.

On behalf of the British Board of Agrément

Date of issue: 22 March 2019

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

ANNEX 1 Essential characteristics

A.1 Mechanical resistance and stability (BWR 1)

A.1.1 Thickness *[dry (uncured) samples]*

Table A1 Thickness (in mm) test results

Product type	Sample										Mean	Standard deviation
	1	2	3	4	5	6	7	8	9	10		
CC5	4.83	4.83	4.76	4.61	4.67	4.67	4.57	4.58	4.64	4.69	4.68	0.09
CC8	7.74	7.85	8.08	7.99	7.84	7.90	8.02	7.56	8.07	7.96	7.90	0.16
CC13	13.72	13.10	13.33	13.67	13.50	13.50	13.62	13.16	13.32	13.26	13.42	0.22
CCH5	5.57	5.48	5.20	5.58	5.56	5.64	5.88	5.69	5.88	5.80	5.63	0.21
CCH8	9.20	8.93	8.61	8.95	8.89	8.67	8.63	8.86	9.01	9.12	8.89	0.20

A.1.2 Mass per unit area and Density *[dry (uncured) samples]*

Table A2 Mass per unit area ($g \cdot m^{-2}$) and Density ($kg \cdot m^{-3}$) test results

Product type	Sample										Mean	Standard deviation	Declared mass per unit area (mean)($kg \cdot m^{-2}$)	Density ($kg \cdot m^{-3}$)
	1	2	3	4	5	6	7	8	9	10				
CC5	7698	7202	7201	7054	7209	7043	7146	7068	7186	7132	7194	188	7	1536
CC8	12023	11943	12254	12294	11925	12067	12343	12180	12411	12054	12149	171	12	1538
CC13	20191	20194	20553	20203	20386	19647	20006	20111	20207	20109	20161	237	19	1507
CCH5	8341	8526	8723	8486	8622	8735	8879	8707	8643	8710	8637	152	8	1574
CCH8	13484	13420	13346	13425	13292	13320	13373	13528	13426	13415	13403	72	13	1538

A.1.3 Flexural strength *[tested at 24 hours (+/-4 hours) from hydration]*

Table A3 Flexural strength and Modulus of Elasticity test results for CC5

Test (units)	Sample										Mean	Standard deviation
	1	2	3	4	5	6	7	8	9	10		
Machine Direction												
Initial Flexural Strength (MPa)	7.52	7.53	7.71	6.81	7.22	7.28	7.22	7.30	7.54	7.30	7.34	0.25
Deflection at Initial Break (mm)	0.47	0.33	0.45	0.62	0.38	0.41	0.56	0.29	0.37	0.49	0.44	0.10
Final Flexural Strength (MPa)	13.92	13.79	13.25	14.03	13.72	13.27	13.51	13.66	13.77	14.02	13.69	0.28
Initial Modulus of Elasticity (MPa)	7764	8640	8394	6480	8763	7788	7867	9186	9294	8877	8305	849
Cross Machine Direction												
Initial Flexural Strength (MPa)	6.83	5.50	5.81	6.63	5.94	6.64	6.08	6.43	5.60	6.45	6.19	0.47
Deflection at Initial Break (mm)	0.53	0.58	0.61	0.83	0.80	0.61	0.90	0.73	0.73	0.84	0.71	0.13
Final Flexural Strength (MPa)	5.18	5.86	5.58	6.07	5.46	5.80	5.37	5.19	5.29	5.67	5.55	0.30
Initial Modulus of Elasticity (MPa)	7333	5884	5572	6151	5515	7590	6235	6769	5602	6752	6340	743

Declared values (machine direction) (mean):	
- Initial Flexural Strength (MPa)	4.0
- Final Flexural Strength (MPa)	>10.0

Table A4 Flexural strength and Modulus of Elasticity test results for CC8

Test (units)	Sample										Mean	Standard
	1	2	3	4	5	6	7	8	9	10		deviation
Machine Direction												
Initial Flexural Strength (MPa)	5.17	5.91	6.34	5.62	5.53	5.19	5.72	5.63	5.78	5.35	5.62	0.35
Deflection at Initial Break (mm)	0.42	0.45	0.42	0.47	0.65	0.59	0.67	0.42	0.67	0.52	0.53	0.11
Final Flexural Strength (MPa)	8.83	9.39	8.56	9.04	8.75	9.22	9.27	8.69	9.37	8.76	8.99	0.31
Initial Modulus of Elasticity (MPa)	3881	3902	4579	3638	3368	3458	3352	3609	3596	3488	3687	365
Cross Machine Direction												
Initial Flexural Strength (MPa)	4.82	5.14	4.51	4.79	4.66	5.05	5.10	5.10	5.20	4.67	4.91	0.24
Deflection at Initial Break (mm)	1.18	1.22	0.75	0.89	0.75	0.76	0.68	1.11	0.89	0.87	0.91	0.19
Final Flexural Strength (MPa)	6.63	6.26	6.42	5.78	6.59	6.17	6.33	6.37	6.71	6.04	6.33	0.28
Initial Modulus of Elasticity (MPa)	2667	2516	2528	2697	2635	2733	3073	3099	3039	2813	2780	219

Declared values (machine direction) (mean):	
- Initial Flexural Strength (MPa)	4.0
- Final Flexural Strength (MPa)	>6.0

Table A5 Flexural strength and Modulus of Elasticity test results for CC13

Test (units)	Sample										Mean	Standard
	1	2	3	4	5	6	7	8	9	10		deviation
Machine Direction												
Initial Flexural Strength (MPa)	4.94	6.28	4.39	5.88	6.35	5.07	4.94	4.87	6.03	4.78	5.35	0.71
Deflection at Initial Break (mm)	0.61	0.44	0.61	0.50	0.50	0.60	0.50	0.50	0.59	0.65	0.55	0.07
Final Flexural Strength (MPa)	7.56	8.09	7.63	7.88	7.30	7.03	7.72	7.50	7.17	7.83	7.57	0.33
Initial Modulus of Elasticity (MPa)	2276	2795	2355	2701	2753	2516	2364	2457	2801	1725	2474	328
Cross Machine Direction												
Initial Flexural Strength (MPa)	2.67	5.32	4.49	5.48	4.03	3.16	4.39	4.86	5.57	5.33	4.53	1.00
Deflection at Initial Break (mm)	0.65	1.07	0.51	0.64	0.69	0.41	0.78	1.06	0.99	0.90	0.77	0.23
Final Flexural Strength (MPa)	4.03	4.74	5.00	4.97	4.88	4.48	5.08	5.29	5.11	5.21	4.88	0.38
Initial Modulus of Elasticity (MPa)	1095	2240	2324	2462	1850	1509	2182	1950	2181	2284	2008	423

Declared values (machine direction) (mean):	
- Initial Flexural Strength (MPa)	4.0
- Final Flexural Strength (MPa)	>6.0

Table A6 Flexural strength and Modulus of Elasticity test results for CCH5

Test (units)	Sample										Mean	Standard
	1	2	3	4	5	6	7	8	9	10		deviation
Machine Direction												
Initial Flexural Strength (MPa)	5.99	4.52	6.31	6.27	7.62	6.90	6.23	7.58	7.40	7.46	6.63	0.97
Deflection at Initial Break (mm)	0.57	0.42	0.79	0.34	0.47	0.50	0.40	0.56	0.39	0.60	0.50	0.13
Final Flexural Strength (MPa)	13.69	11.67	13.98	14.62	15.73	15.27	16.10	15.73	15.84	15.67	14.83	1.38
Initial Modulus of Elasticity (MPa)	2708	3355	5837	6265	6582	6055	6628	6377	8226	7487	5952	1698
Cross Machine Direction												
Initial Flexural Strength (MPa)	6.02	7.15	4.29	5.70	6.15	6.38	5.04	6.23	5.41	5.81	5.82	0.79
Deflection at Initial Break (mm)	0.55	0.42	0.18	0.39	0.57	0.59	0.65	0.38	0.46	0.64	0.48	0.15
Final Flexural Strength (MPa)	9.02	10.13	8.24	9.24	9.14	9.29	8.33	9.37	8.47	8.78	9.00	0.57
Initial Modulus of Elasticity (MPa)	6233	8184	8122	6290	6069	6294	4192	7388	5388	5300	6346	1263

Declared values (machine direction) (mean):	
- Initial Flexural Strength (MPa)	4.0
- Final Flexural Strength (MPa)	>13.0

Table A7 Flexural strength and Modulus of Elasticity test results for CCH8

Test (units)	Sample										Mean	Standard deviation
	1	2	3	4	5	6	7	8	9	10		
Machine Direction												
Initial Flexural Strength (MPa)	6.40	5.13	7.29	6.82	5.06	6.35	5.72	6.48	4.16	6.94	6.03	0.99
Deflection at Initial Break (mm)	0.40	0.85	0.66	0.59	0.24	0.40	0.28	0.51	0.73	0.52	0.52	0.19
Final Flexural Strength (MPa)	14.87	13.66	11.48	14.85	14.34	14.53	13.96	14.66	13.37	15.21	14.09	1.08
Initial Modulus of Elasticity (MPa)	5576	5587	3901	4659	4749	4739	5151	4318	4822	4902	4840	517
Cross Machine Direction												
Initial Flexural Strength (MPa)	7.03	6.66	6.35	6.35	7.22	4.47	6.54	6.14	5.51	5.59	6.19	0.81
Deflection at Initial Break (mm)	0.45	0.52	0.32	0.47	0.77	0.60	0.52	0.89	0.84	0.63	0.60	0.18
Final Flexural Strength (MPa)	11.95	12.15	15.53	11.04	11.82	12.45	11.68	8.24	14.67	13.19	12.27	1.99
Initial Modulus of Elasticity (MPa)	5176	5409	5571	4301	4667	2482	4161	2792	3591	4200	4235	1044.4

Declared values (machine direction) (mean):	
- Initial Flexural Strength (MPa)	4.0
- Final Flexural Strength (MPa)	>13.0

A.1.4 Static Puncture resistance *(tested no earlier than 28 days from hydration)*

Table A8 Puncture Force (kN) test results

Product type	Sample					Mean	Standard Deviation	Declared value (mean)
	1	2	3	4	5			
CC5	2.19	2.17	2.06	1.88	2.11	2.08	0.12	2.0
CC8	3.73	4.21	4.27	3.99	4.22	4.08	0.23	4.0
CC13	3.71	4.49	4.00	4.62	4.43	4.25	0.38	4.0
CCH5	3.61	3.57	3.60	3.67	3.81	3.65	0.09	3.5
CCH8	4.55	4.54	4.65	4.81	4.70	4.65	0.11	4.5

Table A9 Puncture Displacement (mm) test results

Product type	Sample					Mean	Standard Deviation
	1	2	3	4	5		
CC5	34.40	35.60	34.60	33.10	34.50	34.40	0.90
CC8	43.00	43.50	43.70	44.00	42.70	43.40	0.50
CC13	5.00	6.27	4.32	5.54	5.65	5.35	0.73
CCH5	32.90	31.80	32.20	32.20	34.20	32.70	1.00
CCH8	32.00	36.60	33.60	36.50	36.50	35.10	2.10

A.1.5 Dynamic Puncture resistance *(tested no earlier than 28 days from hydration)*

From the five samples tested per product range the impact caused the concrete to crack, but the probe did not make a full penetration through the product. Therefore the perforation depth was recorded as zero.

A.1.6 Pyramid puncture resistance *(tested no earlier than 28 days from hydration)*

Table A10 Pyramid puncture resistance (in N) test results

Product type	Sample										Mean	Standard Deviation	Declared value (mean) (kN)
	1	2	3	4	5	6	7	8	9	10			
CC5	4266	4303	4263	4524	4179	4402	4265	4106	4198	4565	4307	148	4.0
CC8	7072	6751	7249	8340	7521	7309	7217	6753	7119	7088	7242	452	7.0
CC13	10632	11579	12514	10798	12044	12387	13408	15681	14740	12142	12593	1614	12.5
CCH5	7190	8567	8800	7410	7309	6081	6653	7908	7247	9717	7688	1080	7.5
CCH8	11469	9955	8662	8893	10202	10871	11353	9534	10929	10142	10201	972	10.0

A.1.7 Strength of internal linking fibres [dry (uncured) samples]

There is no difference between Concrete Canvas and Concrete Canvas Hydro values.

Table A11 Strength of internal linking fibres (kN·m) test results

Product type	Sample					Mean	Standard deviation	Declared value (mean):
	1	2	3	4	5			
CC5 and CCH5								
- *Machine Direction*	3.68	4.22	4.07	4.10	4.39	4.09	0.26	4.0
- *Cross Machine Direction*	1.04	1.64	1.47	1.59	1.52	1.45	0.24	
CC8 and CCH8								
- *Machine Direction*	4.44	5.47	4.39	4.54	4.42	4.65	0.46	4.5
- *Cross Machine Direction*	3.19	3.17	3.65	3.79	2.52	3.26	0.50	
CC13								
- *Machine Direction*	4.25	5.52	5.33	5.87	4.19	5.03	0.76	5.0
- *Cross Machine Direction*	2.34	2.19	3.30	4.24	4.25	3.26	0.99	

A.2 Safety and accessibility in use (BWR4)

A.2.1 Resistance to chemicals

Chemical resistance of hardened (cured) Concrete Canvas Hydro. The evaluation is based on the change in flexural strength instead of by change in tensile strength. Samples are tested no earlier than 28 days from hydration**.**

Table A12 Resistance to chemicals test results — Concrete Canvas Hydro

Test Method/Retained Values (%)	CCH5		CCH8	
	Machine Direction	Cross Machine Direction	Machine Direction	Cross Machine Direction
Method A; Test Liquid: 10% solution H_2SO_4				
Initial Flexural Strength	78.8	68.1	84.5	72.6
Deflection at Initial Break	119.8	89.0	146.0	115.6
Final Flexural Strength	68.6	72.9	79.6	75.6
Declared Initial Flexural Strength value (mean)	79		85	
Method B; Test Liquid: Saturated suspension $Ca(OH)_2$				
Initial Flexural Strength	131.7	89.9	137.8	105.0
Deflection at Initial Break	175.1	191.6	137.6	145.0
Final Flexural Strength	115.7	94.7	109.5	85.0
Declared Initial Flexural Strength value (mean)	132		138	
Method C; Solvation & Swelling (35% vol diesel, 35% vol paraffin, 30% vol lubricating oil HD30),				
Initial Flexural Strength	127.7	88.0	109.9	103.9
Deflection at Initial Break	193.8	151.9	140.4	182.5
Final Flexural Strength	110.3	97.9	105.4	105.0
Declared Initial Flexural Strength value (mean)	128		110	
Method D; Test Liquid: Synthetic Leachate				
Initial Flexural Strength	132.6	98.0	129.3	112.7
Deflection at Initial Break	169.6	166.6	197.3	145.5
Final Flexural Strength	119.9	103.1	99.1	128.0
Declared Initial Flexural Strength value (mean)	133		129	

A.2.2 Durability

For each specific characteristic tested, the evaluation is based on the change in flexural strength instead of by change in tensile strength stipulated in those durability Annexes. Samples are tested not earlier than 28 days from hydration.

A.2.2.1 Weathering (UV)

Table A13 Weathering (UV) resistance test results for CC5

Retained Values (%)	Machine Direction	Cross Machine Direction
Initial Flexural Strength	72.4	112.6
Deflection at Initial Break	188.4	43.0
Final Flexural Strength	66.4	103.4
Initial Modulus of Elasticity	47.4	159.7

A2.2.2 Microbiological resistance

The values declared for CC5 can be used for CC8 and CC13 and the values declared for CCH5 can be used for CCH8.

Table A14 Microbiological resistance test results for CC5 and CCH5

Retained Values (%)	CC5		CCH5	
	Machine Direction	Cross Machine Direction	Machine Direction	Cross Machine Direction
Initial Flexural Strength	107.8	119.6	137.6	85.4
Deflection at Initial Break	108.6	109.1	120.0	97.2
Final Flexural Strength	113.6	103.4	113.6	108.9
Initial Modulus of Elasticity	96.7	92.5	126.0	61.4
Declared value (mean)	108		137	

A.2.2.3 Leaching resistance

Ten samples from CC5 and CCH5 products were tested and the results are given in Table A15. The values declared for CC5 can be applied for CC8 and CC13 and the values declared for CCH5 can be applied for CCH8.

Table A15 Resistance to chemicals test results for CC5 and CCH5

Test Method/Retained Values (%)	CC5		CCH5	
	Machine Direction	Cross Machine Direction	Machine Direction	Cross Machine Direction
Method A; leaching by hot (de-ionized) water				
Initial Flexural Strength	114.8	97.0	125.4	116.9
Deflection at Initial Break	101.6	88.5	80.9	93.1
Final Flexural Strength	123.5	115.2	98.8	105.0
Initial Modulus of Elasticity	134.7	96.7	121.3	121.0
Declared Initial Flexural Strength value (mean)	115		125	
Method B; leaching by aqueous alkaline liquids : Saturated $Ca(OH)_2$				
Initial Flexural Strength	83.7	85.0	125.5	100.0
Deflection at Initial Break	101.0	113.0	85.0	106.6
Final Flexural Strength	95.0	96.2	106.4	105.9
Initial Modulus of Elasticity	97.7	80.7	117.7	80.7
Declared Initial Flexural Strength value (mean)	84		125	
Method C; leaching by organic alcohols (30% vol methanol, 30% vol isopropanol, 40% vol glycol)				
Initial Flexural Strength	99.0	99.2	110.1	112.4
Deflection at Initial Break	132.9	139.4	84.8	136.7
Final Flexural Strength	120.7	128.4	117.3	155.2
Initial Modulus of Elasticity	91.2	63.8	81.2	93.4
Declared Initial Flexural Strength value (mean)	99		110	

A.2.2.4 Thermal ageing

Table A16 Thermal ageing test results — Concrete Canvas Hydro

Retained Values (%)	CC5		CCH5	
	Machine Direction	Cross Machine Direction	Machine Direction	Cross Machine Direction
Initial Flexural Strength	70.9	75.8	65.9	95.5
Deflection at Initial Break	99.2	12.0	125.1	102.3
Final Flexural Strength	102.6	108.0	67.6	177.6
Initial Modulus of Elasticity	67.1	54.8	63.2	80.6
Declared Initial Flexural Strength value (mean)	71		66	

A.3 Sustainable use of natural resources (BWR 7)

A.3.1 Abrasion resistance

The abrasion resistance of the fibrous top surface of the hardened (cured) Concrete Canvas (CC5) product was measured and the abrasion resistance for the other products will be conservatively considered the same.

Table A17 Abrasion resistance test results for CC5

Product type	Sample				Mean	Standard deviation	Declared value (mean)
	1	2	3	4			
Fibrous Top Surface Abrasion							
- Mass loss (g/1000 cycles)	-1.66	-2.42	-1.73	-1.73	-1.89	0.36	
- Depth of wear (mm/1000 cycles)	0.606	0.780	0.645	0.480	0.628	0.124	
Cementitious Barrier Abrasion							
- Mass loss (g/1000 cycles)	-1.94	-1.85	-1.31	-1.88	-1.75	0.29	
- Depth of wear (mm/1000 cycles)	0.178	0.218	0.148	0.240	0.196	0.041	0.2

Notes:

Accessory weight per arm	1000 g
Number of wear cycles recorded	8000
Revolutions to wear surfaces of fabric	1000.

A.3.2 Freeze – Thaw

The freeze-thaw resistance of the hardened (cured) Concrete Canvas (CC5) product was measured and the resistance for the other products will be conservatively considered the same.

Table A18 Climatic performance (freeze-thaw – 100 cycles) test results for CC5

Retained Values (%)	Machine Direction	Cross Machine Direction
Initial Flexural Strength	101.5	109.7
Deflection at Initial Break	79.0	129.8
Final Flexural Strength	104.7	105.1
Initial Modulus of Elasticity	121.8	91.3
Declared Initial Flexural Strength value (mean)	101	

A.3.3 Water Permeability for Concrete Canvas Hydro

Table A19 Water permeability of the PVC component

Test (units)	Declared value
Water Permeability($m^3/m^2/d$)	$1x10^{-6}$
Water Permeability (m/s)	$1x10^{-11}$

A.3.4 Gas Permeability for Concrete Canvas Hydro

The gas permeability of the PVC layer achieved $4.98*10^{-12}$ $(cm^3)\cdot cm)\cdot(cm^{-2})$ (s^{-1})(Pa). The declared value is given in Table 22.

Table A20 Gas permeability of the geomembrane component

Test (units)	Declared value
Gas Permeability $(cm^3)\cdot(cm)\cdot(cm^{-2})\cdot(s^{-1})$ (Pa)	5.0×10^{-12}