The use of Geosynthetic Cementitious Composite Mats (GCCM's) for Erosion Control Applications

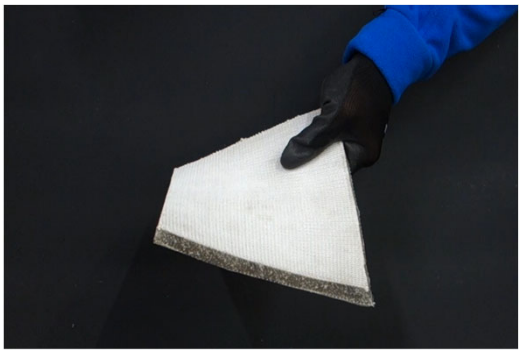
"Will is Director and co-founder of Concrete Canvas Ltd, which together with Peter Brewin, he has led from a university start-up to a multinational manufacturing business selling into over 80 countries around the world.

Will originally studied Engineering at the University of Bristol in the UK and Berkeley in the US and also has degrees from the RCA and Imperial College in London."

Will Crawford (MEng MA DIC)
Director
Concrete Canvas Ltd

1

New Class of Geosynthetic material

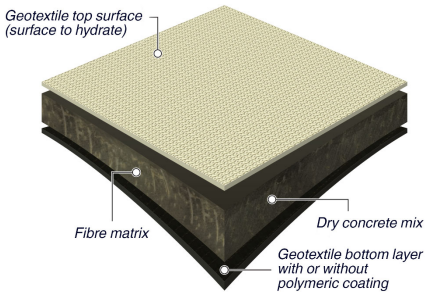


GCCMs change from flexible to rigid on hydration

2

GCCMs (Geosynthetic Cementitious Composite Mats)

Flexible concrete filled geosynthetic that hardens when hydrated to form a thin, durable waterproof concrete layer. Used for **erosion control** and **containment** applications.



GCCMs: **Erosion Control**

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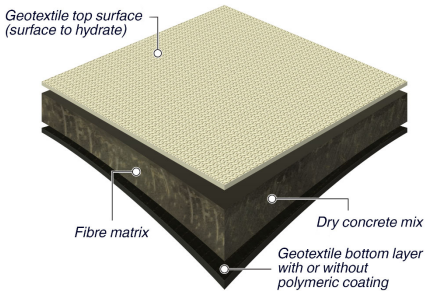
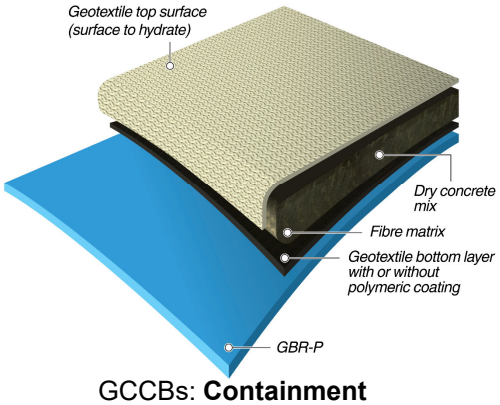
Flexible concrete filled geosynthetic that hardens when hydrated to form a thin, durable waterproof concrete layer. Used for **erosion control** and **containment** applications.



GCCMs: **Erosion Control**



GCCBs: **Containment**

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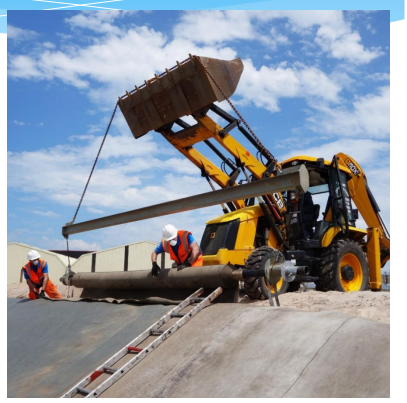
Typical Delivery Formats

CC Bulk Rolls
Up to 200sqm of concrete on a single pallet

CC Batched Rolls
Man portable batched rolls of 5 or 10sqm



CC Wide Rolls
Available in 2.2m and 3.3m widths

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GCCM Properties

ASTM D8364 Spec Standard for GCCMs		TYPE I	TYPE II	TYPE III
Thickness (mm) - *typical*	ASTM D5199	~5mm	~8mm	~13mm
Mass (kg/sqm) - *typical*	ASTM D5993	7kg	12kg	19kg
Flex Strength (N/m) – Initial (24hrs)	ASTM D8058	>625	>1500	>3750
Flex Strength (MPa) – Initial (24hrs)	ASTM D8058	>3.5MPa		
Flex Strength (MPa) – Final (24hrs)	ASTM D8058	>4.0MPa		
Compressive Strength (MPa) (28 days)	ASTM D8329	>40MPa	>50MPa	>60MPa
Abrasion Resistance (mm/1000c) 28 days	ASTM C1353	<0.3mm/ 1000 cycles		

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Typical Type I GCCM slope protection application
CC5™, Brunei, 2019

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GCCM Properties

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Abrasion Resistance (mm/1000c) 28 days	ASTM C1353		<0.3mm/ 1000 cycles	

Typical Type II GCCM channel lining application
CC8™, Myra Falls, Canada, 2016

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GCCM Properties

ASTM D8364 Spec Standard for GCCMs		TYPE I	TYPE II	TYPE III
Thickness (mm) - *typical*	ASTM D5199	~5mm	~8mm	~13mm
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Abrasion Resistance (mm/1000c) 28 days	ASTM C1353	<0.3mm/ 1000 cycles		

Typical Type III GCCM application over loose subgrade with high velocity flow. CC13™, Willow Creek, Canada, 2012

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GCCM Properties

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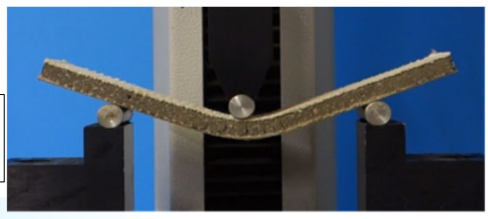

Flexural Strength testing

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GCCM Properties

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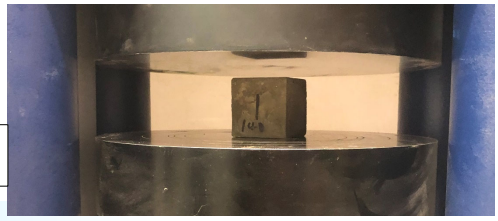
Compressive Strength of Cementitious Mix



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BBA Certification

Durability (GCCB / GCCM)	BBA	50yrs / 120yrs

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GCCM Core Applications

CHANNEL LINING

SLOPE PROTECTION

BUND LINING

CONCRETE REMEDIATION

WEED SUPPRESSION

Rapid lining of earth channels, ditches, gullies, canals and spillways.

Compared to conventional concrete lining:

- Faster
- Easier
- Less expensive
- Does not require specialist contractors or equipment
- Environmentally friendlier

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GCCM Core Applications

CHANNEL LINING

SLOPE PROTECTION

BUND LINING

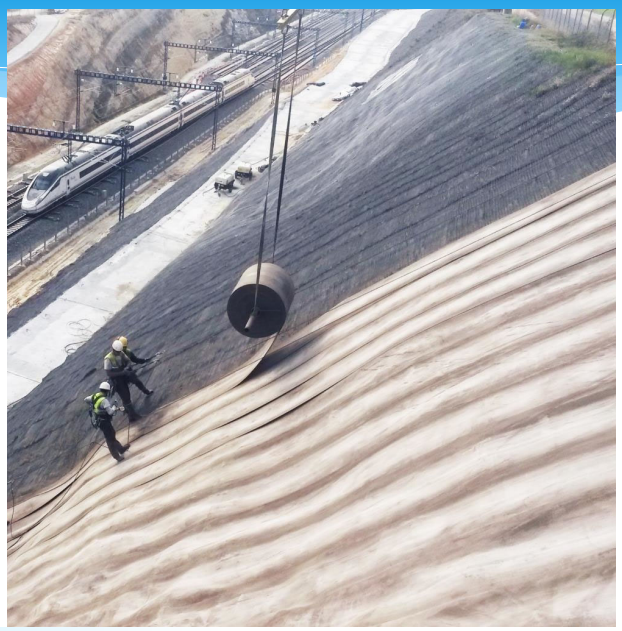
CONCRETE REMEDIATION

WEED SUPPRESSION

Hard armoured facing for slopes to mitigate weathering erosion and water ingress.

Compared to shotcrete:

- Typically faster to install
- More cost effective
- Does not require specialist contractors or equipment
- Eliminates the risk associated with rebound or debris



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GCCM Core Applications

CHANNEL LINING
SLOPE PROTECTION
BUND LINING
CONCRETE REMEDIATION
WEED SUPPRESSION

Encapsulation of typically trapezoidal earth or clay secondary containment berms.

- Provides protection against weathering erosion
- Effective weed suppression
- Protects against burrowing animals
- Reduce maintenance costs
- Provide additional level of impermeability

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GCCM Core Applications

CHANNEL LINING
SLOPE PROTECTION
BUND LINING
CONCRETE REMEDIATION
WEED SUPPRESSION

Reinstatement of existing assets, typically repairing cracked and dilapidated pre-cast concrete sections.

Compared to injection resins, in-situ pour or slab replacement:

- Swift return of asset to operation
- Maintain internal volume of structure to preserve capacity

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GCCM Core Applications

CHANNEL LINING
SLOPE PROTECTION
BUND LINING
CONCRETE REMEDIATION
WEED SUPPRESSION

Rapidly installed, effective vegetation control typically installed along road or rail structures, under pipe tracks and across easement areas of security fencing.

Compared to geotextiles and aggregate:

- Durable
- Reduce maintenance
- Protects against burrowing animals
- Effective against invasive species

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OTHER

- Culvert Repair
- Gabion Reinforcement
- Temporary Works
- Pipe Protection
- Mining Vent / Blast Walls
- Cable Covering / Protection

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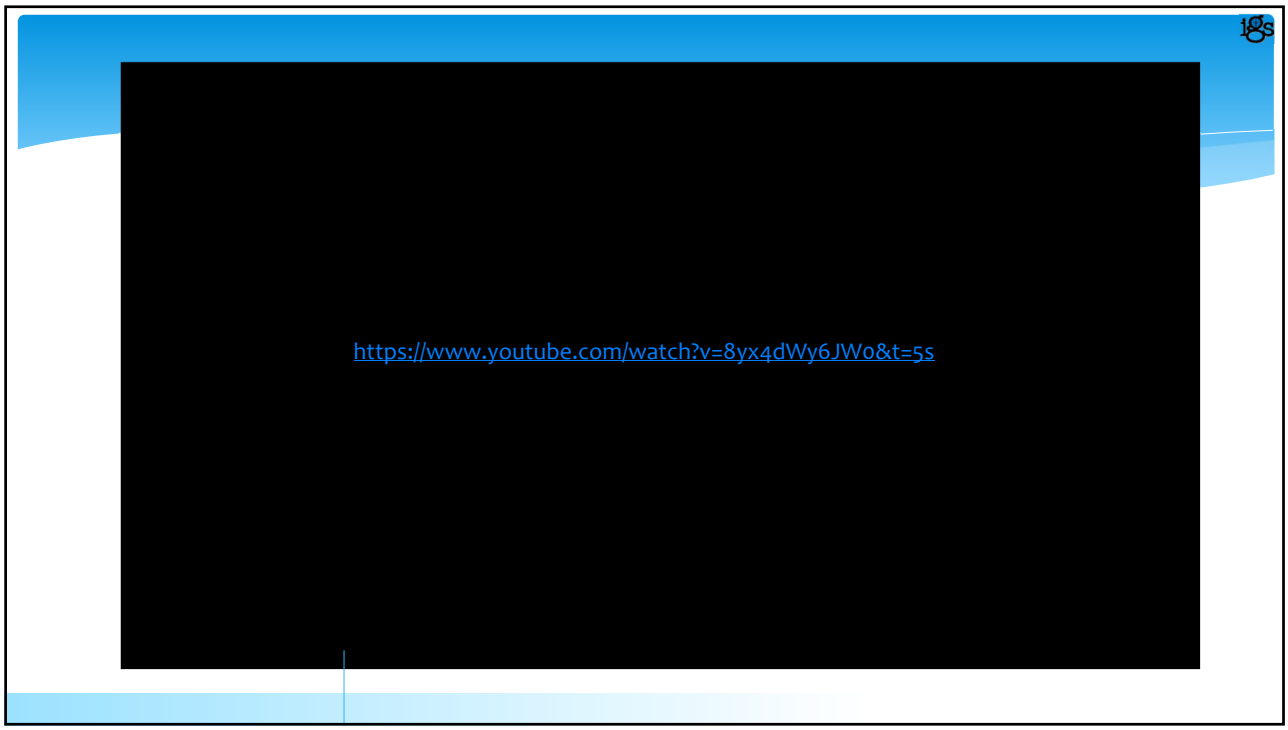
https://www.youtube.com/watch?v=8yx4dWy6JW0&t=5s

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NATURAL RESOURCES WALES
SLOPE PROTECTION
PONTYPRIDD, WALES
2017
PUBLIC WORKS
1,040SQM CC13™ BULK
RIVER TAFF BANK PROTECTION
Dilapidated grouted rip-rap embankment along river Taff threatening stability of adjacent factory site.
- Replacement of rip-rap
- Geotextile sub-layer
- Framework contractors
- Specified by environment body
River Taff, Slope Protection
https://www.youtube.com/watch?v=tUn5vBJ9xWc&t=3s
CONCRETE CANVAS

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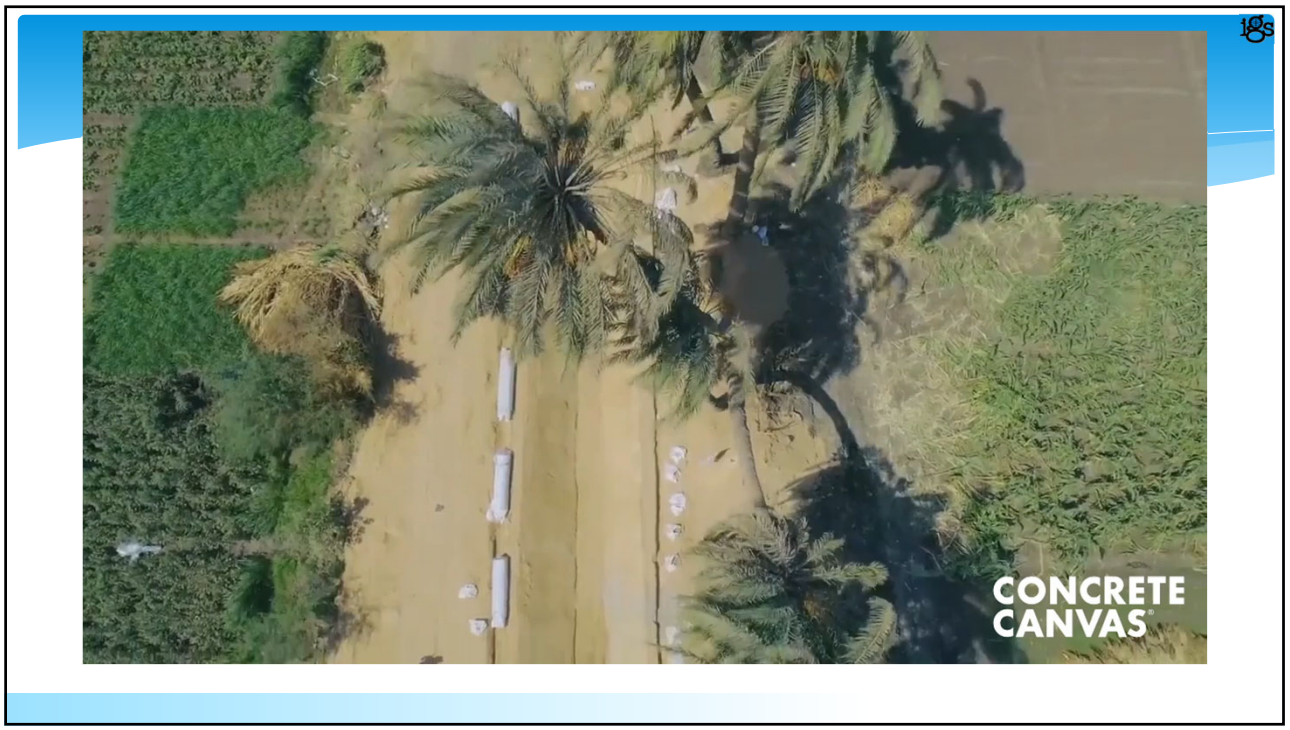

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GCCMs : for **Erosion Control**
GCCBs : for **Seepage Control**

- Speed of Installation
- Ease of Installation
- Durable
- Lower Carbon

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William Crawford (Meng MA DIC)
Director
will.crawford@concretecanvas.com

Thank You

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ASTM D8364 TABLE 1

GCCM Property	Test Method	State of GCCM	Unit	Minimum Values Unless Specified		
				Type I	Type II	Type III
Thickness	ASTM D5199	uncured	mm	4.5	7.0	7.0
Thickness	ASTM D5199	cured - 24 hrs	mm	4.5	7.0	7.0
Mass per Unit Area	ASTM D5993	uncured	kg/m^2	6.5	10.5	10.5
Density	ASTM D5993/D5199	uncured	kg/m^3	1250	1250	1250
Flexural Strength - Initial Breaking Load	ASTM D8058	cured - 24 hrs	N/m	625	1500	3750
Flexural Strength- Initial Flexural Strength	ASTM D8058	cured - 24 hrs	MPa	3.5	3.5	3.5
Flexural Strength- Final Flexural Strength	ASTM D8058	cured - 24 hrs	MPa	4	4	4
Compressive Strength of Cementitious Mix	ASTM D8329	cured - 28 days	MPa	40	50	60
Pyramid Puncture Resistance	ASTM D5494 Type B	cured - 28 days	kN	2.0	3.5	4.5
Abrasion Resistance (maximum value)	ASTM C1353	cured - 28 days	mm/1000 Cycles	0.3	0.3	0.3
Tensile Strength - Final	ASTM D6768	uncured	kN/m	8	8	8
Tensile Strength - Initial	ASTM D4885	cured - 28 days	kN/m	3.5	6.5	9
Tensile Strength - Final	ASTM D4885	cured - 28 days	kN/m	10	19	19
Freeze - Thaw (residual Initial Flexural Strength after 200 cycles)	ASTM C1185	cured - 28 days	%	80	80	80

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ASTM D8364 TABLE 1

CONCRETE CANVAS®

CC SPEC SHEET TO ASTM D8364

Concrete Canvas® (CC) Classification Properties to ASTM D8364 'Standard Specifcation for GCCM Materials' 2103.01.EN

GCCM Property	Test Method	State of GCCM	Unit	Minimum Values Unless Specified					
				Type I Specification	CC5™	Type II Specification	CC8™	Type III Specification	CC13™
Thickness	ASTM D5199	uncured	mm	4.5	>5.0	7.0	>7.5	7.0	>11.5
Thickness	ASTM D5199	cured - 24 hrs	mm	4.5	>5.0	7.0	>7.5	7.0	>11.5
Mass per Unit Area	ASTM D5993	uncured	kg/m²	6.5	>6.5	10.5	>10.5	10.5	>16.5
Density	ASTM D5993/D5199	uncured	kg/m³	1250	>1250	1250	>1250	1250	>1250
Flexural Strength - Initial Breaking Load * (1st crack in cementitious material)	ASTM D8058	cured - 24 hrs	N/m	625	>625	1500	>1500	3750	>3750
Flexural Strength- Initial Flexural Strength * (1st crack in cementitious material)	ASTM D8058	cured - 24 hrs	MPa	3.5	>3.5	3.5	>3.5	3.5	>3.5
Flexural Strength- Final Flexural Strength *	ASTM D8058	cured - 24 hrs	MPa	4	>4	4	>4	4	>4
Compressive Strength of Cementitious Mix (water/cementitious materials ratio to ASTM D8329)	ASTM D8329	cured - 28 days	MPa	40	>70	50	>70	60	>70
Pyramid Puncture Resistance	ASTM D5494 Type B	cured - 28 days	kN	2.0	>3.5	3.5	>8.0	4.5	>10
Abrasion Resistance (cementitious barrier depth of wear - maximum value)	ASTM C1353	cured - 28 days	mm/1000 Cycles	0.3	<0.25	0.3	<0.25	0.3	<0.25
Tensile Strength - Final *	ASTM D6768	uncured	kN/m²	8	>8	8	>8	8	>8
Tensile Strength - Initial ** (1st crack in cementitious material)	ASTM D4885	cured - 28 days	kN/m²	3.5	>6	6.5	>7	9	>9
Tensile Strength - Final **	ASTM D4885	cured - 28 days	kN/m²	10	>17	19	>19	19	>19
Freeze - Thaw (residual Initial Flexural Strength to ASTM D8058 after 200 cycles)	ASTM C1185	cured - 28 days	%	80	>80	80	>80	80	>80
GCCM Classification	ASTM D8364		Type	CC5™ = Type I GCCM		CC8™ = Type II GCCM		CC13™ = Type III GCCM	

* GCCM materials are non-isotropic and the values for flexural strength, tensile strength, and initial breaking load are reported as the lower of the material machine production direction (length of roll) or material cross-machine production direction (width of roll).
** When using CC tensile strength properties for design purposes, please contact Concrete Canvas Ltd for advice on the appropriate data to use.

For independent laboratory test results please consult the CC5™ ASTM D8364 Type I, CC8™ ASTM D8364 Type II and CC13™ ASTM Type III reports by BICS Laboratories Ltd

CONCRETE CANVAS®
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GEOSYNTHETICS TEST RESULTS
CONCRETE CANVAS LTD

Contract Ref: N/A
Material: Concrete Canvas

Report Ref No: BS-8364a
Dates Tested: 19/03/2020-15/03/2021

TEST METHOD	TEST SPECIMEN NUMBER										MEAN	MIN	Std Dev
	1	2	3	4	5	6	7	8	9	10			
Sample ID: CC5								BICS Sample Ref: 1					
Thickness (ASTM D5199-12(2019))													
Thickness Uncured mm	5.36	5.40	5.46	5.36	5.36	5.27	5.36	5.31	5.27	5.35	5.36	5.27	0.06
Thickness Cured mm	5.18	5.16	5.10	5.13	5.21	5.02	5.16	5.36	5.36	5.36	5.19	5.02	0.11
Mass Per Unit Area (ASTM D5993-18)													
Mass/Unit Area kg/m²	7.76	7.57	7.39	6.83	6.75	7.09	6.94	7.61	7.90	8.07	7.47	6.75	0.48
Density (ASTM D5993-ASTM D5199)													
Density kg/m³	1448	1403	1354	1270	1259	1407	1290	1434	1469	1516	1397	1259	56
Flexural Strength (ASTM D8058-19*)													
Machine Direction													
Initial Flexural Strength MPa	7.52	7.63	7.71	8.81	7.22	7.28	7.22	7.30	7.54	7.30	7.34	6.81	0.25
Initial Breaking Load N	54.62	54.06	54.88	49.91	50.28	53.44	51.56	52.61	54.56	51.32	52.72	49.91	1.86
Initial Breaking Load N/m	1366	1352	1372	1248	1257	1336	1289	1315	1364	1283	1318	1248	47
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	0.29	0.10
Final Flexural Strength MPa	13.02	13.79	13.25	14.03	13.72	13.27	13.51	13.66	13.77	14.02	13.69	13.25	0.26
Final Breaking Load N	94.00	97.00	92.00	102.00	99.00	95.00	99.00	98.00	99.00	95.00	96.40	92.00	3.03
Final Breaking Load N/m	2350	2425	2300	2550	2450	2375	2325	2450	2475	2400	2410.00	2300.00	75.83
Deflection at Final Break mm	21.60	24.00	24.40	25.50	23.00	23.80	23.40	23.00	21.60	22.50	23.37	21.60	1.25
Initial Modulus of Elasticity MPa	7764	8040	8304	9480	8763	7788	7957	9186	9294	8877	8365	6480	849
Cross Direction													
Initial Flexural Strength MPa	6.83	5.50	5.81	6.83	5.94	6.64	6.05	6.43	5.60	6.45	6.19	5.50	0.47
Initial Breaking Load N	52.63	41.61	43.30	50.94	45.13	49.69	43.59	46.30	41.55	47.29	46.27	41.55	3.83
Initial Breaking Load N/m	1316	1040	1083	1366	1153	1242	1090	1159	1039	1182	1157	1039	96
Deflection at Initial Break mm	0.53	0.56	0.61	0.93	0.60	0.61	0.90	0.73	0.73	0.84	0.71	0.53	0.13
Final Flexural Strength MPa	5.10	5.90	5.58	6.07	6.46	5.90	5.37	5.19	5.29	5.67	5.55	5.10	0.36
Final Breaking Load N	40.00	43.00	34.50	36.40	39.60	42.50	38.60	37.30	33.20	41.40	38.63	33.20	3.33
Final Breaking Load N/m	1000	1075	863	910	973	1063	965	933	830	1046	965.75	830.00	83.33
Deflection at Final Break mm	4.80	5.30	7.80	7.10	8.50	7.60	5.20	5.20	9.60	5.10	6.64	4.80	1.73
Initial Modulus of Elasticity MPa	7333	5894	5572	6151	5615	7590	6235	6759	5602	6752	6361	5515	743
Compressive Strength - (ASTM D8329C1596) (28 days Cured @ 20°C)													
Compressive Strength N/mm²	72.9	85.1	80.1	79.4	81.4	80.1					79.7	72.9	4.9
Pyramid Puncture Resistance (ASTM D5494-93*)													
Method B - with Aluminium Plate as the Underlying Medium													
Puncture Resistance N	4672	4456	5214	4731	4441	4274	4103	4095	4268	4230	4444	4095	345

Atmospheric Conditions at Test: 21 ± 2 °C, Relative Humidity: 65 ± 5 % RH

BICS Laboratories Ltd, neither accepts responsibility for nor makes claim as to the final use and purpose of the material. Unless otherwise detailed sample sizes and related test items comply with the listed test method. Test results relate only to the sample(s) supplied. The company also observes and maintains client confidentiality.

CONFIDENTIAL TEST REPORT

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