

Technical Report

Title: Product weathertightness testing of a sample of Living Wall rainscreen cladding

Report No: N950-15-17090



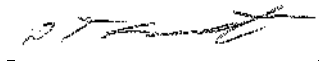
Technical Report


Title: Product weathertightness testing a sample of Living Wall rainscreen cladding


Customer: Biotecture Limited, The Old Dairy, Ham Farm, Bosham, West Sussex, PO18 8EH

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Distribution: 1 copy to Biotecture Limited
(confidential) 1 copy to project file

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1 INTRODUCTION

This report describes tests carried out at VINCI Technology Centre UK Limited at the request of Biotecture Limited.

The test sample consisted of a sample of Living Wall rainscreen cladding manufactured by Biotecture Limited.

The tests were carried out between September and November 2015 and were to determine the weathertightness of the test sample. The test methods were in accordance with the CWCT Standard Test Methods for building envelopes, 2005, for:

Wind resistance – serviceability & safety.

Watertightness – dynamic pressure.

Impact resistance.

The testing was carried out in accordance with Technology Centre Method Statement C5582/MS rev 0.

This test report relates only to the actual sample as tested and described herein.

The results are valid only for sample(s) tested and the conditions under which the tests were conducted.

The long-term durability of the façade system is not assessed by these test methods.

VINCI Technology Centre UK Limited is accredited to ISO/IEC 17025:2008 by the United Kingdom Accreditation Service as UKAS Testing Laboratory No. 0057.

VINCI Technology Centre UK Limited is Notified Body No. 1766.

VINCI Technology Centre UK Limited is certified by BSI for:

- ISO 9001:2008 Quality Management System,
- ISO 14001:2004 Environmental Management System,
- BS OHSAS 18001:2007 Occupational Health and Safety Management System.

The tests were witnessed by John Dyer of Biotecture Limited.

2 SUMMARY AND CLASSIFICATION OF TEST RESULTS

The following summarises the results of the tests carried out. For full details refer to Sections 6, 7 and 8.

2.1 SUMMARY OF TEST RESULTS

TABLE 1

Date	Test number	Test description	Result
22 September 2015	1	Wind resistance – serviceability	Fail
3 November 2015	1	Wind resistance – serviceability	Pass
3 November 2015	2	Watertightness – dynamic	Pass
3 November 2015	3	Wind resistance – safety	Pass
3 November 2015	4	Impact resistance	Pass

2.2 CLASSIFICATION

TABLE 2

Test	Standard	Classification / Declared value
Watertightness	CWCT	600 pascals dynamic
Wind resistance	CWCT	±2400 pascals serviceability ±3600 pascals safety
Impact resistance	CWCT TN75	Class 1 serviceability Negligible risk safety

3 DESCRIPTION OF TEST SAMPLE

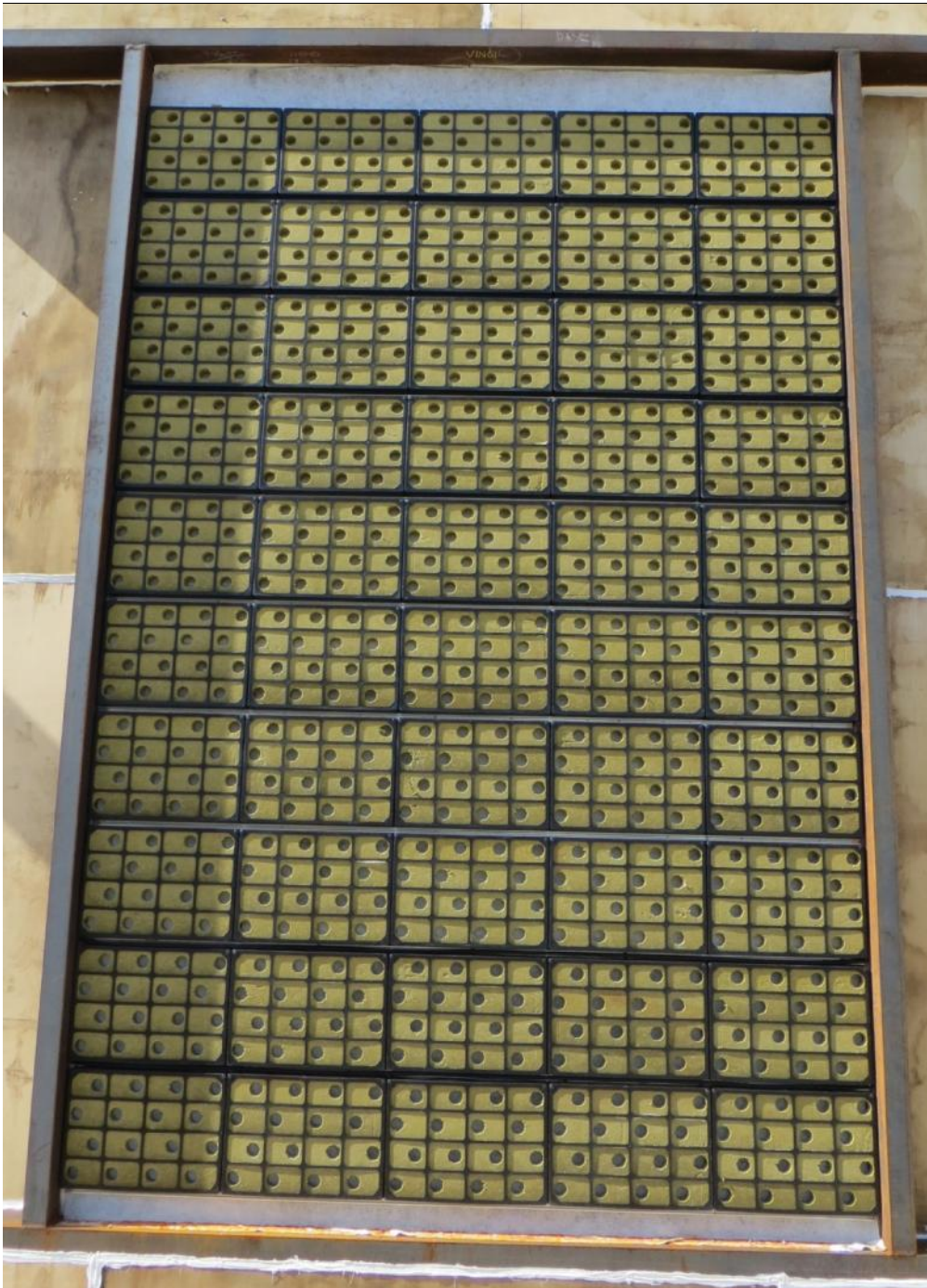
3.1 GENERAL ARRANGEMENT

The sample was as shown in the photo below and the drawings included as an appendix to this report. For details of any remedial work carried out refer to Section 7.

The test sample measured 3.0 m wide by 4.8 m high and comprised 50 Biotecture 600 x 450 plant panels secured to an 8 mm thick rock panel backing wall.

PHOTO 9129

TEST SAMPLE ELEVATION



3.2 CONTROLLED DISMANTLING

During the dismantling of the sample no water penetration or discrepancies from the drawings were found.

PHOTO 9840

FRONT OF ALUMINIUM PEEL RIVET



PHOTO 9828

INTERNAL VIEW OF ALUMINIUM PEEL RIVET

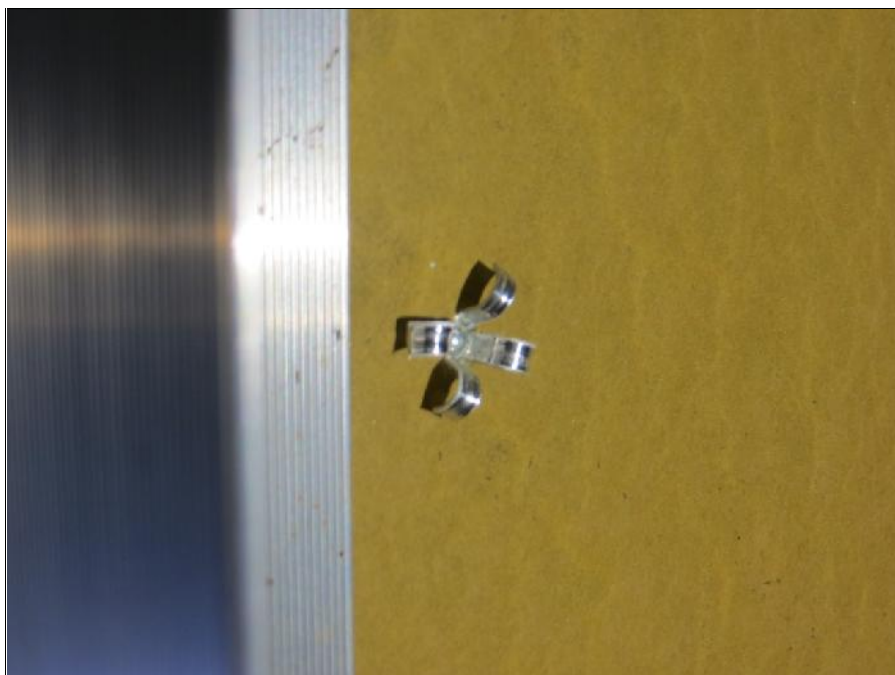


PHOTO 9833

SAMPLE WITH PLANT PANELS REMOVED



PHOTO 9834

PLANT PANELS



BACKING WALL

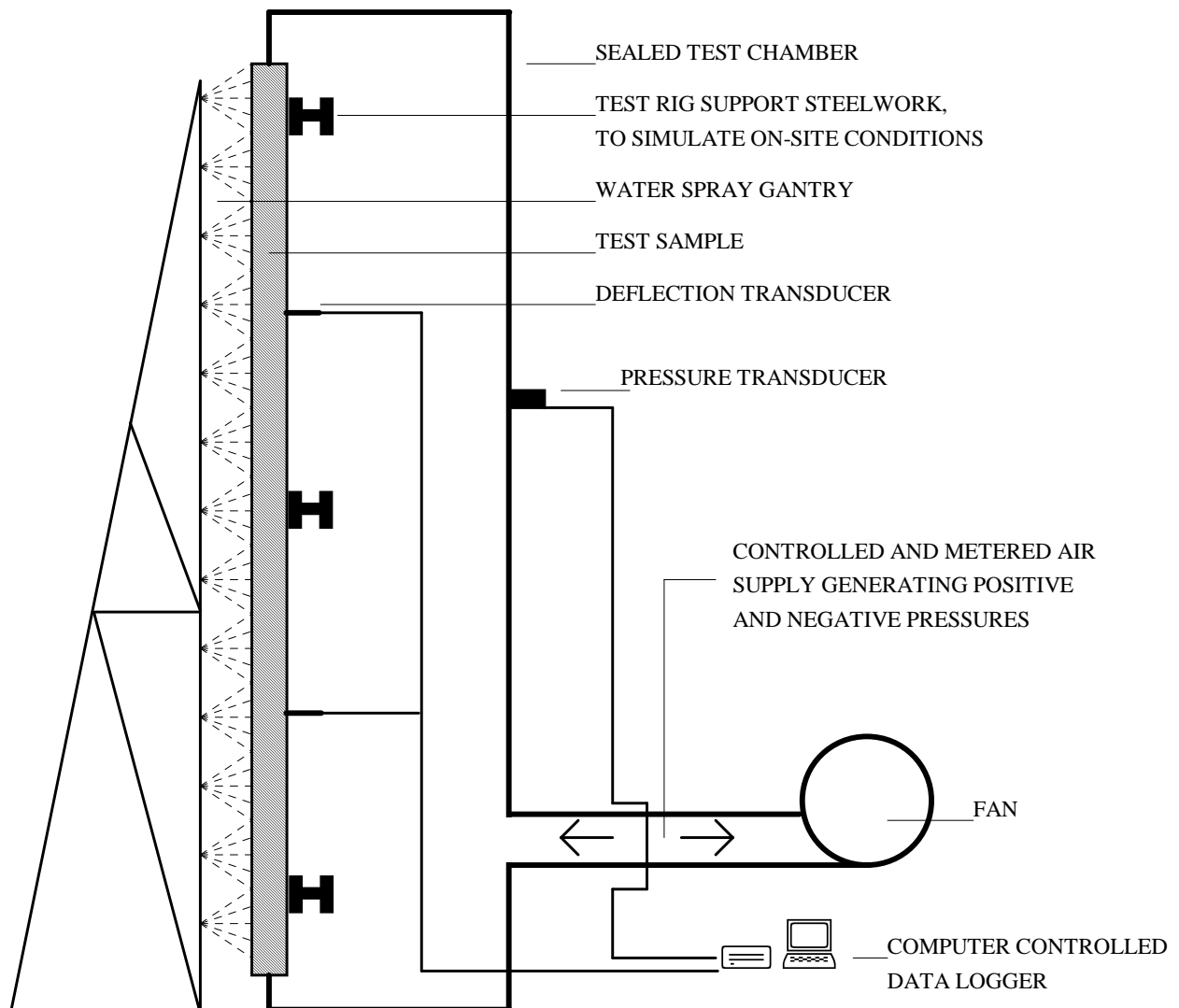


4 TEST RIG GENERAL ARRANGEMENT

The test sample was mounted on a rigid test rig with support steelwork designed to simulate the on-site/project conditions. The test rig comprised a well sealed chamber, fabricated from steel and plywood. A door was provided to allow access to the chamber. Representatives of Biotechure Limited installed the sample on the test rig. See Figure 1.

FIGURE 1

TYPICAL TEST RIG SCHEMATIC ARRANGEMENT



SECTION THROUGH TEST RIG

5 TEST SEQUENCE

The test sequence was as follows:

- (1) Wind resistance – serviceability
- (2) Watertightness – dynamic
- (3) Wind resistance – safety
- (4) Impact resistance

6 WIND RESISTANCE TESTING

6.1 INSTRUMENTATION

6.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

6.1.2 Deflection

Displacement transducers were used to measure the deflection of principle framing members to an accuracy of 0.1 mm. The gauges were set normal to the sample framework at mid-span and as near to the supports of the members as possible and installed in such a way that the measurements were not influenced by the application of pressure or other loading to the sample. The gauges were located at the positions shown in Figure 2.

6.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air temperatures to within 1°C.

6.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

6.2 FAN

The air supply system comprised a variable speed centrifugal fan and associated ducting and control valves to create positive and negative static pressure differentials. The fan provided essentially constant air flow at the fixed pressure for the period required by the tests and was capable of pressurising at a rate of approximately 600 pascals in one second.

6.3 PROCEDURE

6.3.1 Wind Resistance – serviceability

Three positive pressure differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 2400 pascals to 0. The pressure was increased in four equal increments each maintained for 15 ±5 seconds. Displacement readings were taken at each increment. Residual deformations were measured on the pressure returning to zero.

Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of -2400 pascals.

6.3.2 Wind Resistance – safety

Three positive pressure differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 3600 pascals to 0. The pressure was increased as rapidly as possible but not in less than 1 second and maintained for 15 ±5 seconds. Displacement readings were taken at peak pressure. Residual deformations were measured on the pressure returning to zero.

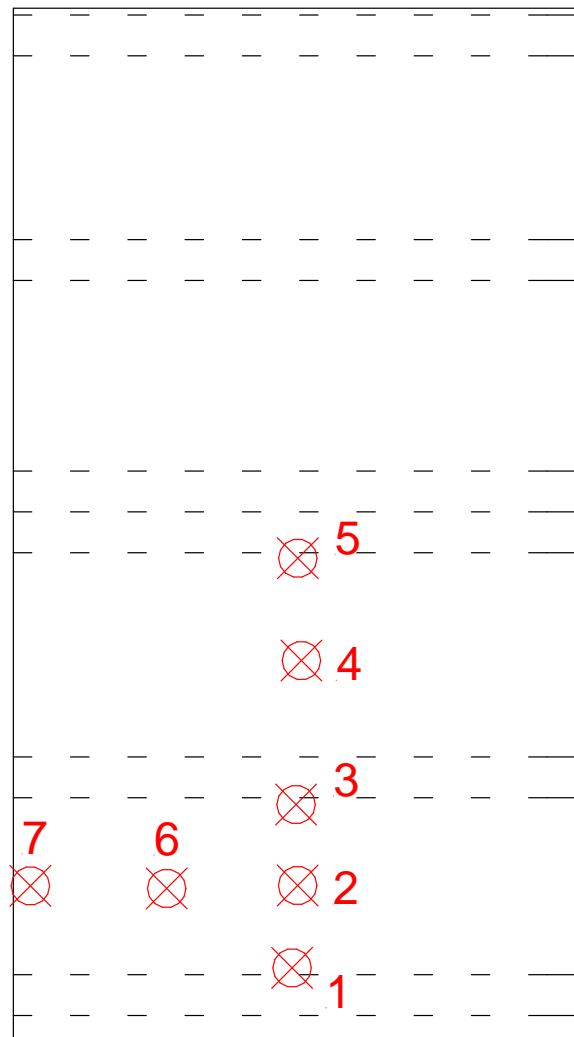
Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of –3600 pascals.

FIGURE 2

DEFLECTION GAUGE LOCATIONS

Internal View



 Deflection gauge

6.4 PASS/FAIL CRITERIA

6.4.1 Calculation of permissible deflection

Gauge number	Member	Span (L) (mm)	Permissible deflection (mm)	Permissible residual deformation
2	Internal panel	1000	$L/200 = 5.0$	1 mm
4	Internal panel	1000	$L/200 = 5.0$	1 mm
6	Internal panel	1500	$L/200 = 7.5$	1 mm

6.5 RESULTS

Test 1 (serviceability) Date: 22 September 2015

During the negative wind loading the panels started to pull away from the fixings.

Ambient temperature = 11°C
Chamber temperature = 12°C

Remedial work

The following remedial work was carried out by Biotechure Limited:

The 4.2 mm x 13 mm s/s screws holding the aluminium carrier rail to the backing board were replaced with 4.8 mm x 30 mm aluminium peel rivets.

The rivet effectively sandwiched the backing board between the carrier rail and the expanded and peeled back of the rivets.

Test 1 (serviceability) Date: 3 November 2015

The deflections measured during the wind resistance test, at the positions shown in Figure 2, are shown in Tables 3 and 4.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
2	Internal panel	2398	0.7	0.0
		-2392	-0.7	0.0
4	Internal panel	2398	0.2	0.0
		-2392	-0.1	0.1
6	Internal panel	2398	1.0	0.0
		-2392	-1.0	0.0

No damage to the test sample was observed.

Ambient temperature = 9°C
 Chamber temperature = 10°C

Test 3 (safety) Date: 3 November 2015

The deflections measured during the structural safety test, at the positions shown in Figure 2, are shown in Table 5.

No damage to the sample was observed.

Ambient temperature = 11°C
 Chamber temperature = 12°C

TABLE 3

WIND RESISTANCE – POSITIVE SERVICEABILITY TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	595	1198	1795	2398	Residual
1	0.0	0.0	0.0	0.0	0.0
2	0.2	0.5	0.7	1.0	0.0
3	0.1	0.2	0.4	0.5	0.0
4	0.2	0.3	0.5	0.6	0.0
5	0.1	0.2	0.3	0.4	0.0
6	0.4	0.8	1.2	1.6	0.1
7	0.1	0.1	0.2	0.3	0.0
2 *	0.2	0.4	0.5	0.7	0.0
4 *	0.1	0.1	0.2	0.2	0.0
6 *	0.3	0.5	0.8	1.0	0.0

* Mid-span reading adjusted between end support readings

TABLE 4

WIND RESISTANCE – NEGATIVE SERVICEABILITY TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	-600	-1215	-1812	-2392	Residual
1	0.0	0.1	0.1	0.2	0.0
2	-0.2	-0.4	-0.7	-0.9	0.0
3	-0.2	-0.3	-0.5	-0.7	-0.1
4	-0.1	-0.3	-0.4	-0.6	0.0
5	-0.1	-0.2	-0.3	-0.3	0.0
6	-0.4	-0.8	-1.3	-1.8	0.0
7	-0.1	-0.2	-0.4	-0.6	0.0
2 *	-0.1	-0.3	-0.5	-0.7	0.0
4 *	0.0	0.0	-0.1	-0.1	0.1
6 *	-0.2	-0.5	-0.8	-1.0	0.0

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE - SAFETY TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)			
	3605	Residual	-3598	Residual
1	0.1	-0.1	0.4	0.0
2	1.5	0.1	-1.4	0.0
3	0.8	0.0	-1.0	0.0
4	0.9	0.0	-0.9	0.0
5	0.6	0.0	-0.6	0.0
6	2.5	0.1	-2.5	0.0
7	0.3	0.0	-1.0	0.0
2 *	-0.9	0.1	-0.9	0.0
4 *	-0.1	0.0	-0.1	0.1
6 *	-1.2	0.1	-1.2	0.0

* Mid-span reading adjusted between end support readings

7 WATERTIGHTNESS TESTING

7.1 INSTRUMENTATION

7.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

7.1.2 Water Flow

An in-line water flow meter was used to measure water supplied to the spray gantry to within 5%.

7.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air and water temperatures to within 1°C.

7.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

7.2 FAN

A wind generator was mounted adjacent to the external face of the sample and used to create positive pressure differentials during dynamic testing. The wind generator comprised a piston type aero-engine fitted with 4 m diameter contra-rotating propellers.

7.3 WATER SPRAY

The water spray system comprised nozzles spaced on a uniform grid not more than 700 mm apart and mounted approximately 400 mm from the face of the sample. The nozzles provided a full-cone pattern with a spray angle between 90° and 120°. The spray system delivered water uniformly against the exterior surface of the sample.

7.4 PROCEDURE

Water was sprayed onto the sample using the method described above at a flow rate of at least 3.4 litres/m²/minute.

The aero-engine was used to subject the sample to wind of sufficient velocity to produce average deflections in the principle framing members equal to those produced by a static pressure differential of 600 pascals. Suction was applied to the inside of the specimen to achieve the required test deflections but was limited to 25% of the peak static pressure. These conditions were maintained for 15 minutes. Throughout the test the inside of the sample was examined for water penetration.

DYNAMIC WIND GENERATOR



7.5 PASS/FAIL CRITERIA

There shall be no water penetration to the internal face of the sample throughout testing. At the completion of the test there shall be no standing water in locations intended to remain dry.

7.6 RESULTS

Test 2

Date: 3 November 2015

No water penetration was observed through the backing wall throughout the test.

Chamber temperature= 12°C
Ambient temperature = 11°C
Water temperature = 11°C

8 IMPACT TESTING

8.1 IMPACTOR

The soft body impactor comprised a canvas spherical/conical bag 400 mm in diameter filled with 3 mm diameter glass spheres with a total mass of approximately 50 kg suspended from a cord at least 3 m long.

8.2 PROCEDURE

The impactor almost touched the face of the sample when at rest. It was swung in a pendular movement to hit the sample normal to its face. The test was performed at the locations shown in Figure 3. The impact energies were 120 Nm for serviceability and 350 Nm and 500 Nm for safety.

8.3 PASS/FAIL CRITERIA

8.3.1 At impact energies for retention of performance

There shall be no failure, significant damage to surface finish or significant indentation.

8.3.2 At impact energies for safety

The structural safety of the building shall not be put at risk, no parts shall be made liable to fall or to cause serious injury to people inside or outside the building. The soft body impactor shall not pass through the wall. Damage to the finish and permanent deformation on the far side of the wall may occur.

8.4 RESULTS

Test 4

Date: 3 November 2015

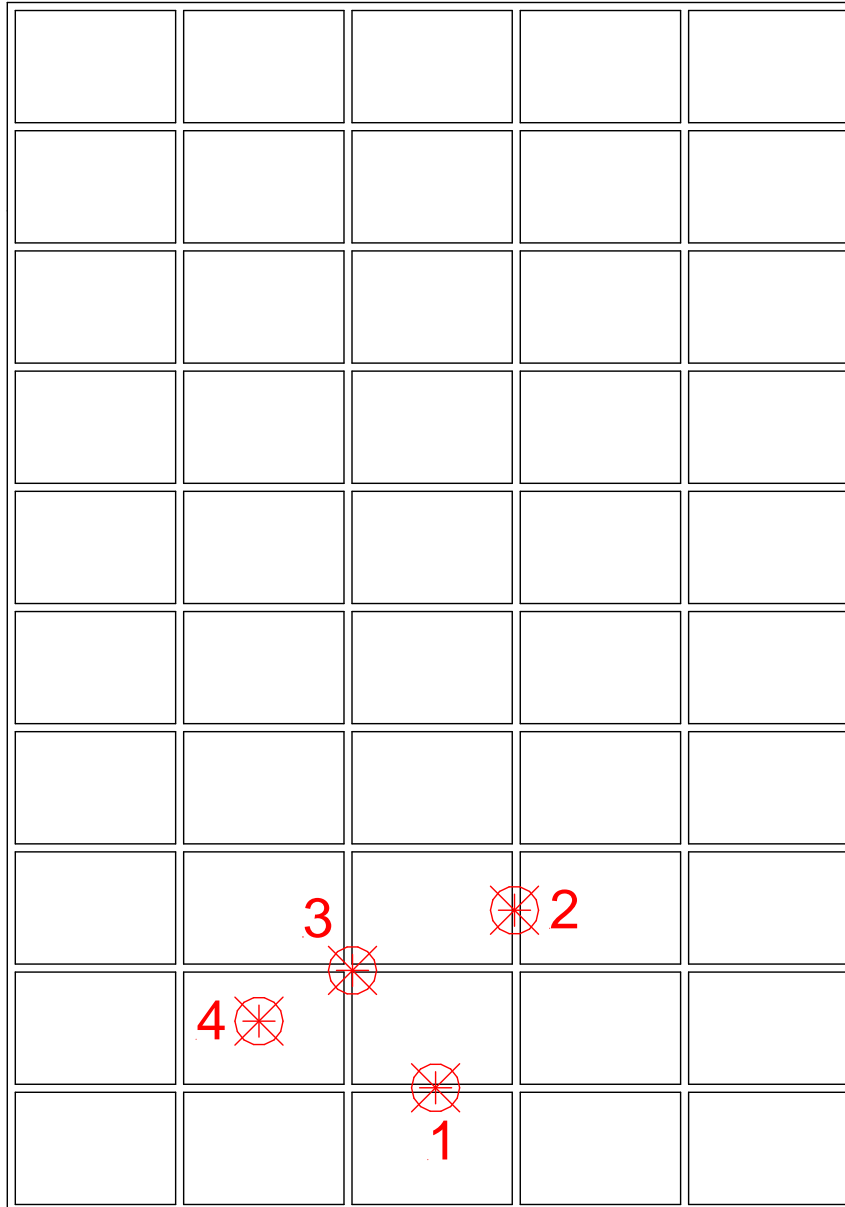
No damage to the sample was observed.

Ambient temperature = 13°C

FIGURE 3

IMPACT TEST LOCATIONS

External View



 Impact location

PHOTO 9827

IMPACTOR

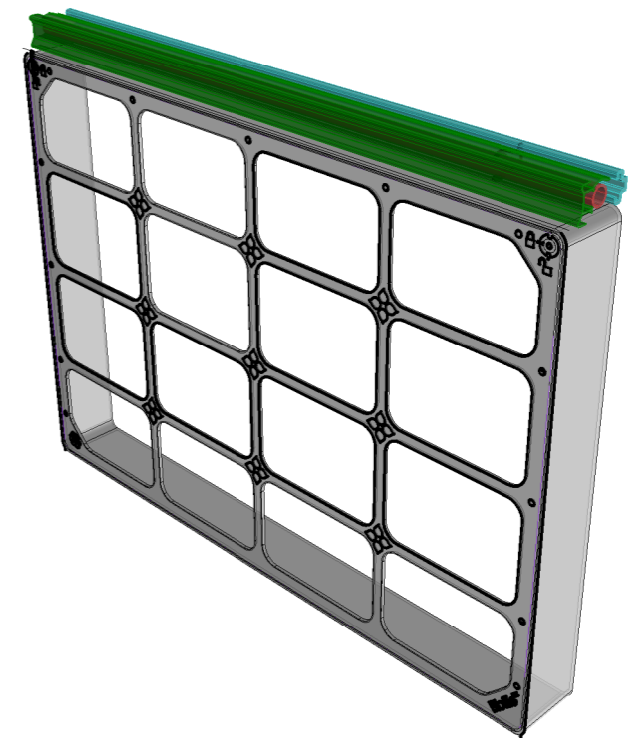
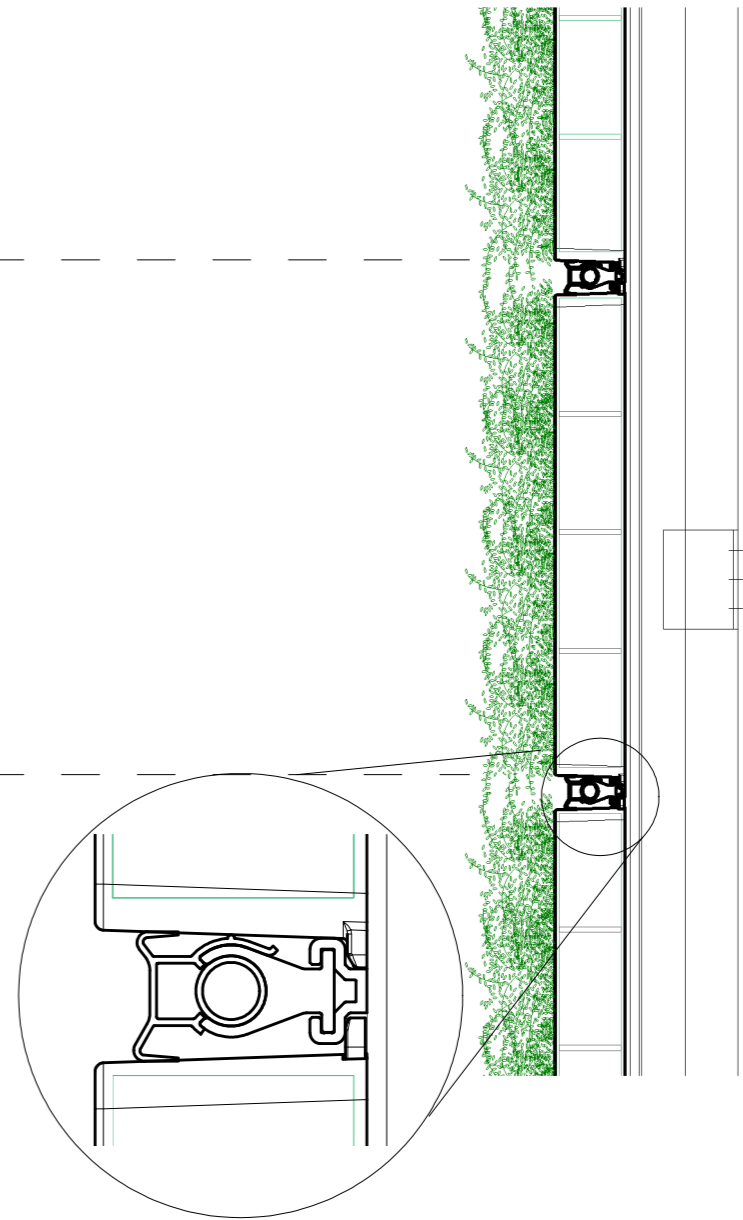
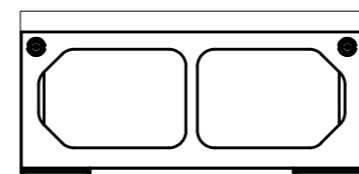
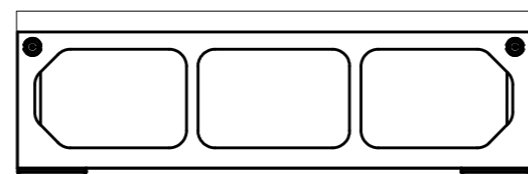
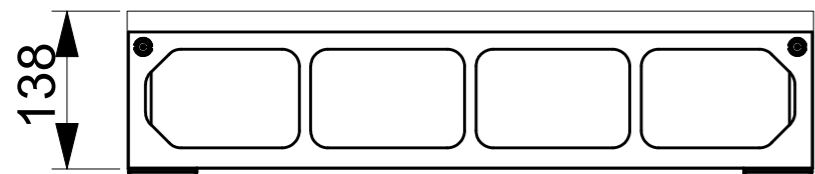
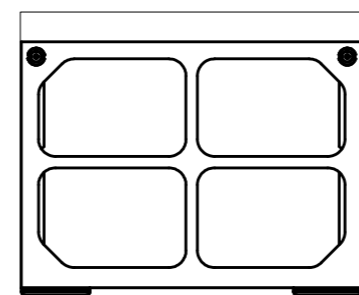
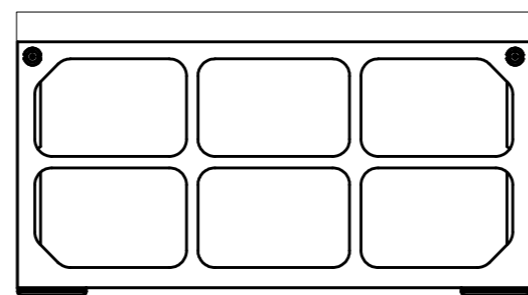
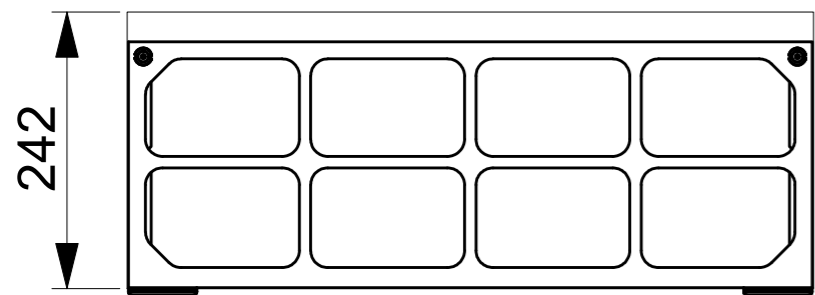
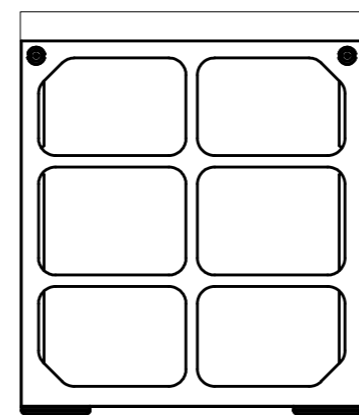
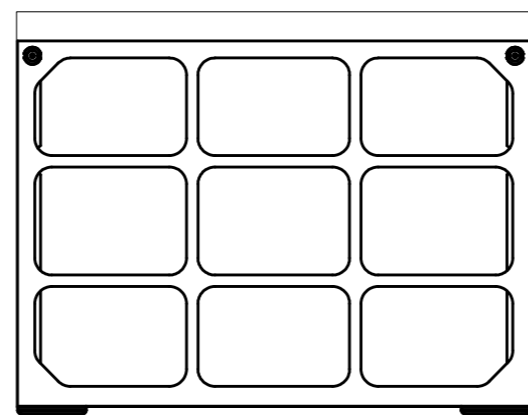
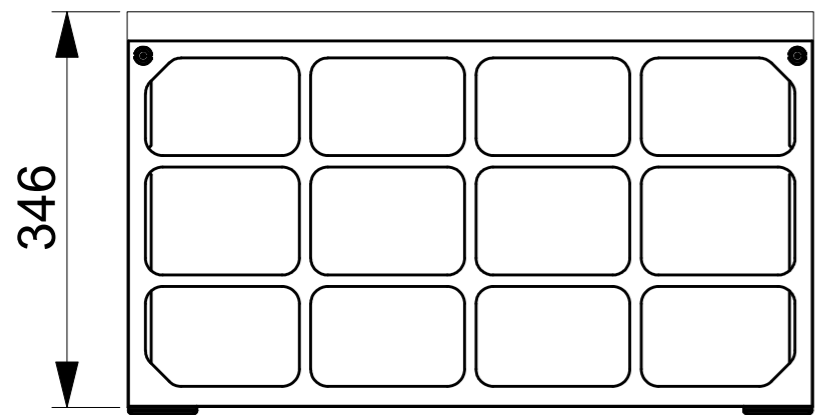
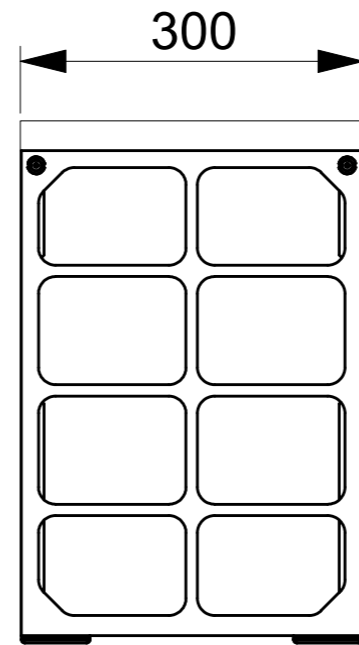
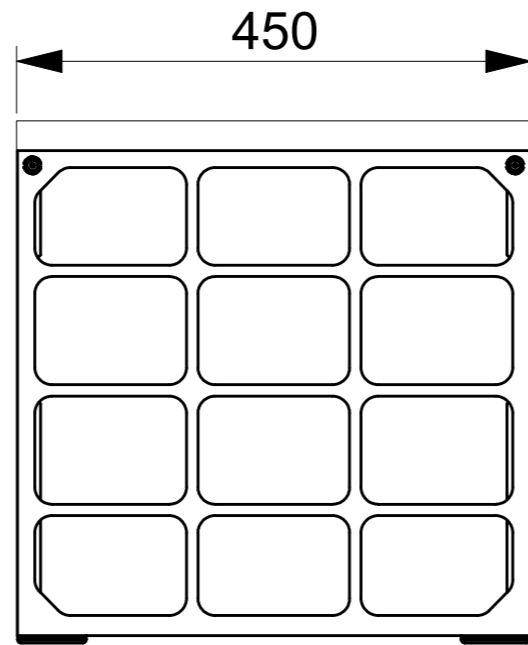
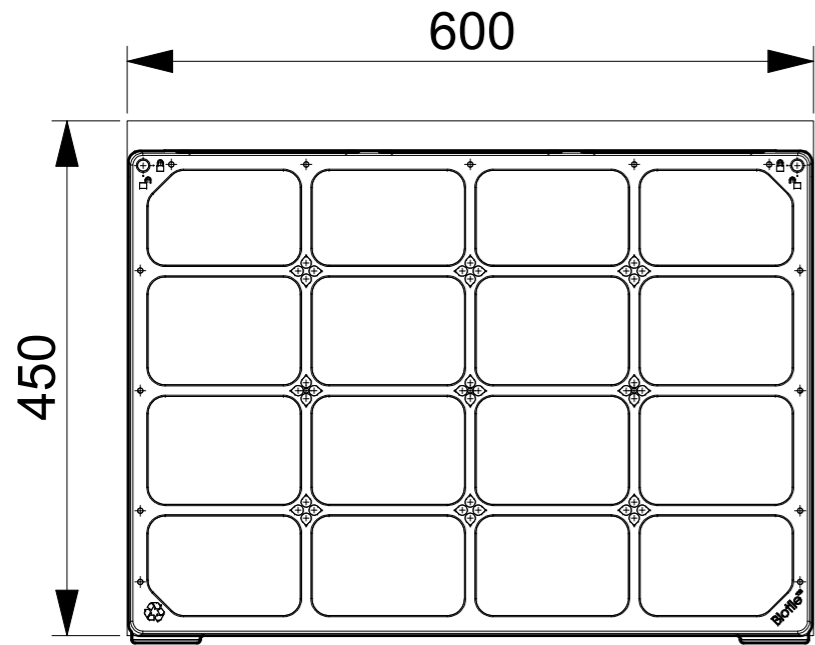


9 APPENDIX - DRAWINGS

The following 3 unnumbered pages are copies of Biotecture Limited drawings numbered:

BIO-PL-01 rev A and 2 unnumbered pages.

END OF REPORT



NOTES:

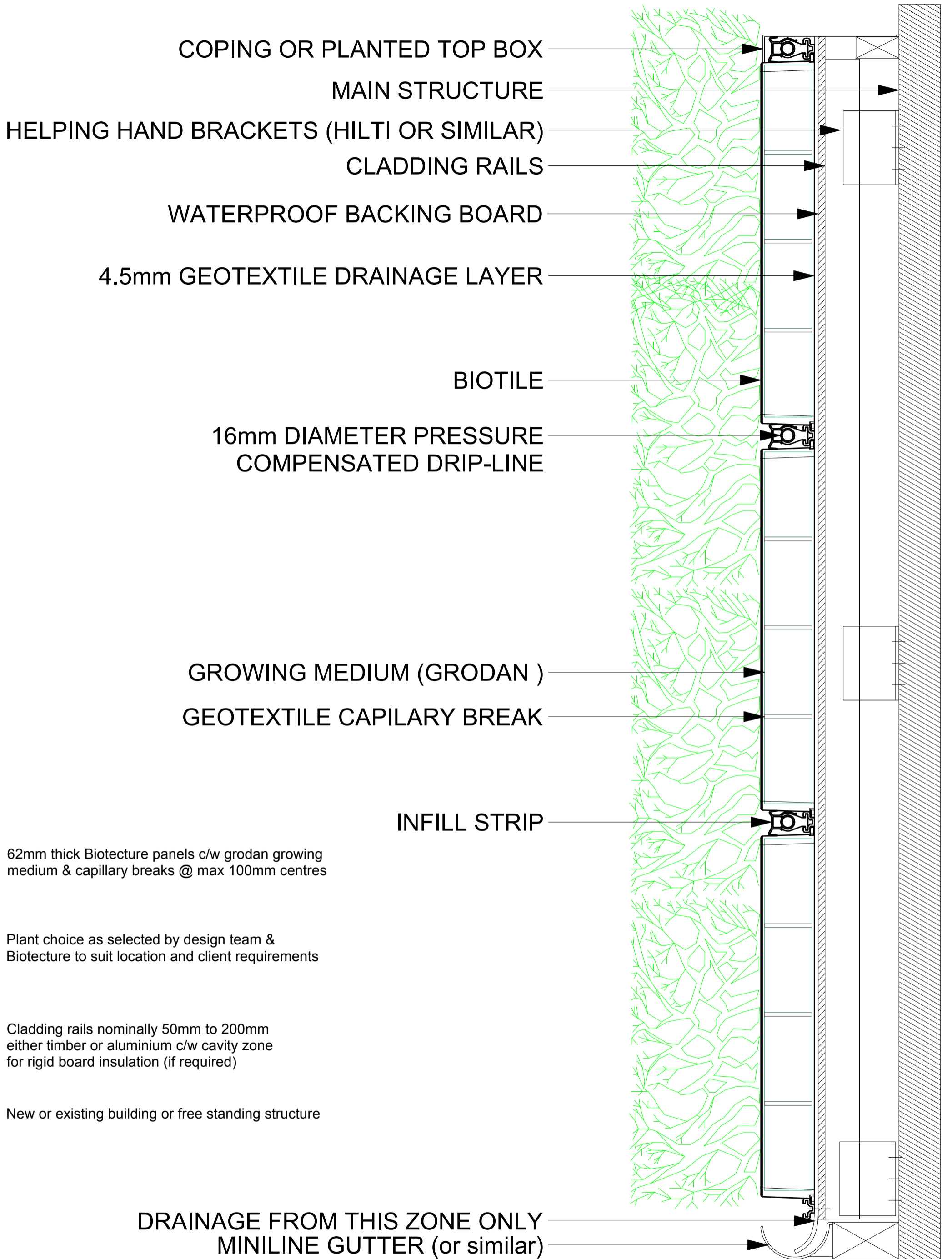
REVISIONS:

KEY: GA - General Assembly
 PL - Panel Layout
 BS - Backing Board Layout
 IS - Irrigation System



Client: BIOTECTURE
 Project:
 Title: BIOTILE STANDARD PANEL SIZES

Date: 21/04/15
 Drawn: SB
 Checked:
 Drawing No: BIO-PL-01
 Revision: A

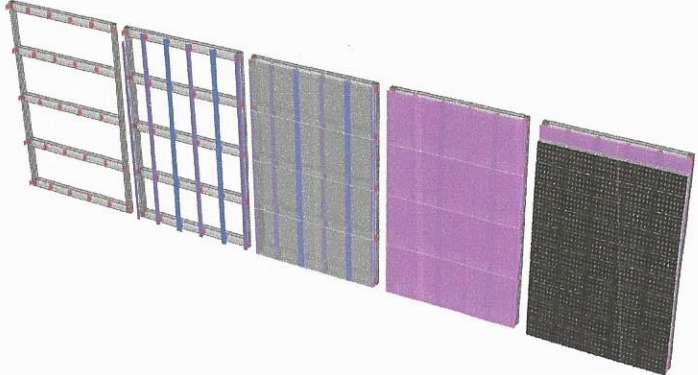


62mm thick Biotecture panels c/w grodan growing medium & capillary breaks @ max 100mm centres

Plant choice as selected by design team & Biotecture to suit location and client requirements

Cladding rails nominally 50mm to 200mm either timber or aluminium c/w cavity zone for rigid board insulation (if required)

New or existing building or free standing structure



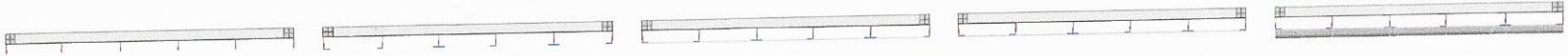
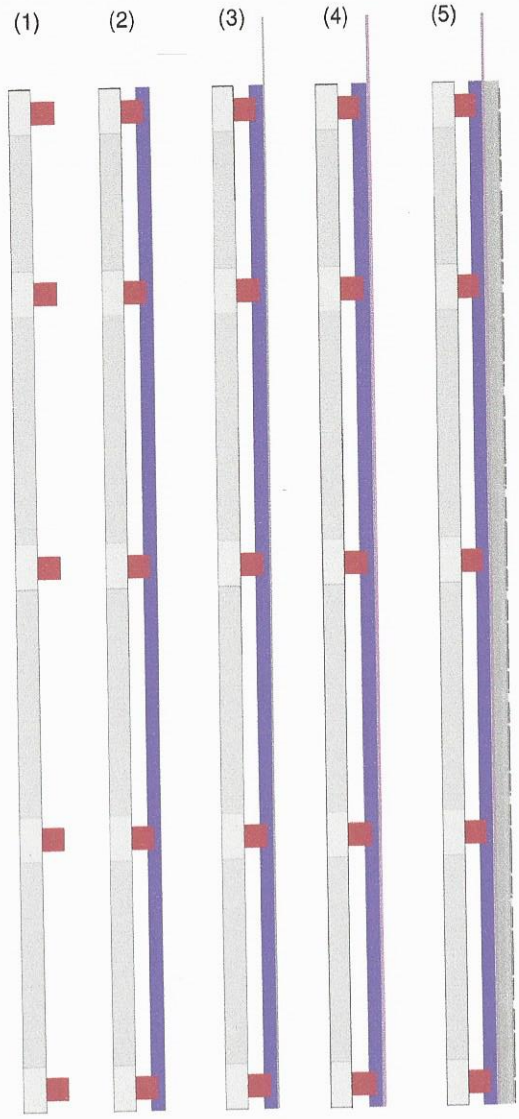
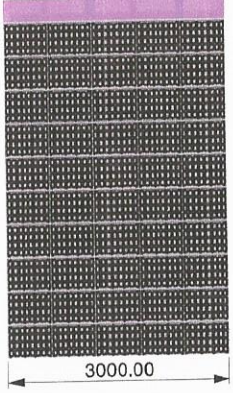
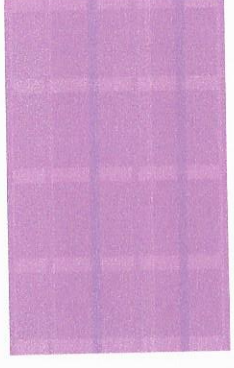
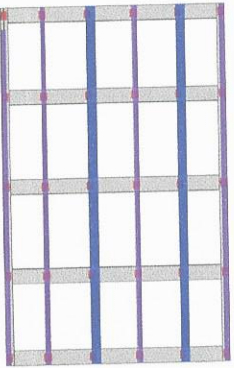
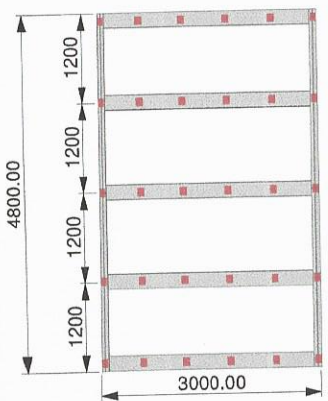
HELPING HAND BARACKETS
(1)

HILITI 'L' AND 'T' PROFILE
(2)

8MM ROCK PANEL (3000X1200MM)
(3)

4MM VOID FORMER
(4)

BIOTECHTURE 600X450
PLANTED PANELS
(5)



NOTES:

REVISIONS:

KEY: GA - General Assembly
PL - Panel Layout
BB - Backing Board L
IS - Irrigation System
PD - Plant Design

Client:
WIND TESTING
Project:
WIND TESTING
Title:
ELEVATION

Date:
9/7/2015
Drawn:
MF
Drawing No.:

Check
Rev



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