ArGeTon®

Terracotta Rainscreens Cladding System
Test Data

Telling
Telling Architectural Systems, LLC
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Technical Report

Title	**Cyclic Load Testing for Shear Resistance on Argeton Samples for Telling Architectural Limited**
Report Number & Date of Issue	N950/08/14039 4 MARCH, 2009

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Abstract		

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Taylor Woodrow

CONTENTS

1. INTRODUCTION

This report describes tests carried out at the Taylor Woodrow Technology Centre at the request of Telling Architectural Limited, Primrose Avenue, Fordhouses, Wolverhampton, West Midlands, WV10 8AW.

The test samples consisted of an aluminium frame with Argeton tiles.

Taylor Woodrow is accredited by the United Kingdom Accreditation Service as UKAS Testing Laboratory No.0057 and is also approved with Lloyds Register of Quality Assurance for ad-hoc in-service inspections and tests to ISO 9001 2000.

The tests were carried out during December 2007 and were to determine the shear resistance of the test samples. The test method was in accordance with the ASTM standards – E2126-07 and E564-06.

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

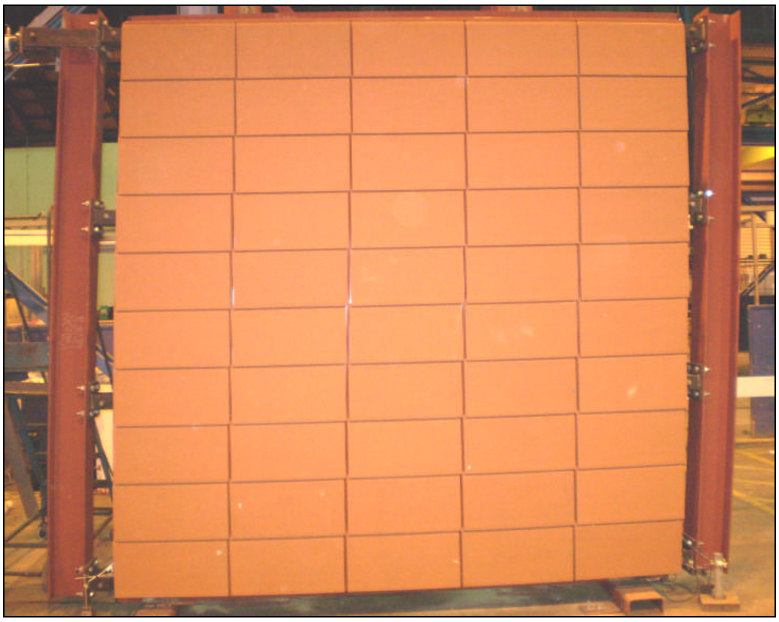
The results are valid only for the conditions under which the tests were conducted.

2. DESCRIPTION OF TEST SAMPLE

2.1 GENERAL ARRANGEMENT

There were four sample setups consisting of six vertical struts and clips and 50 ceramic tiles. The samples were as shown in the photo below.

Photo PC060040



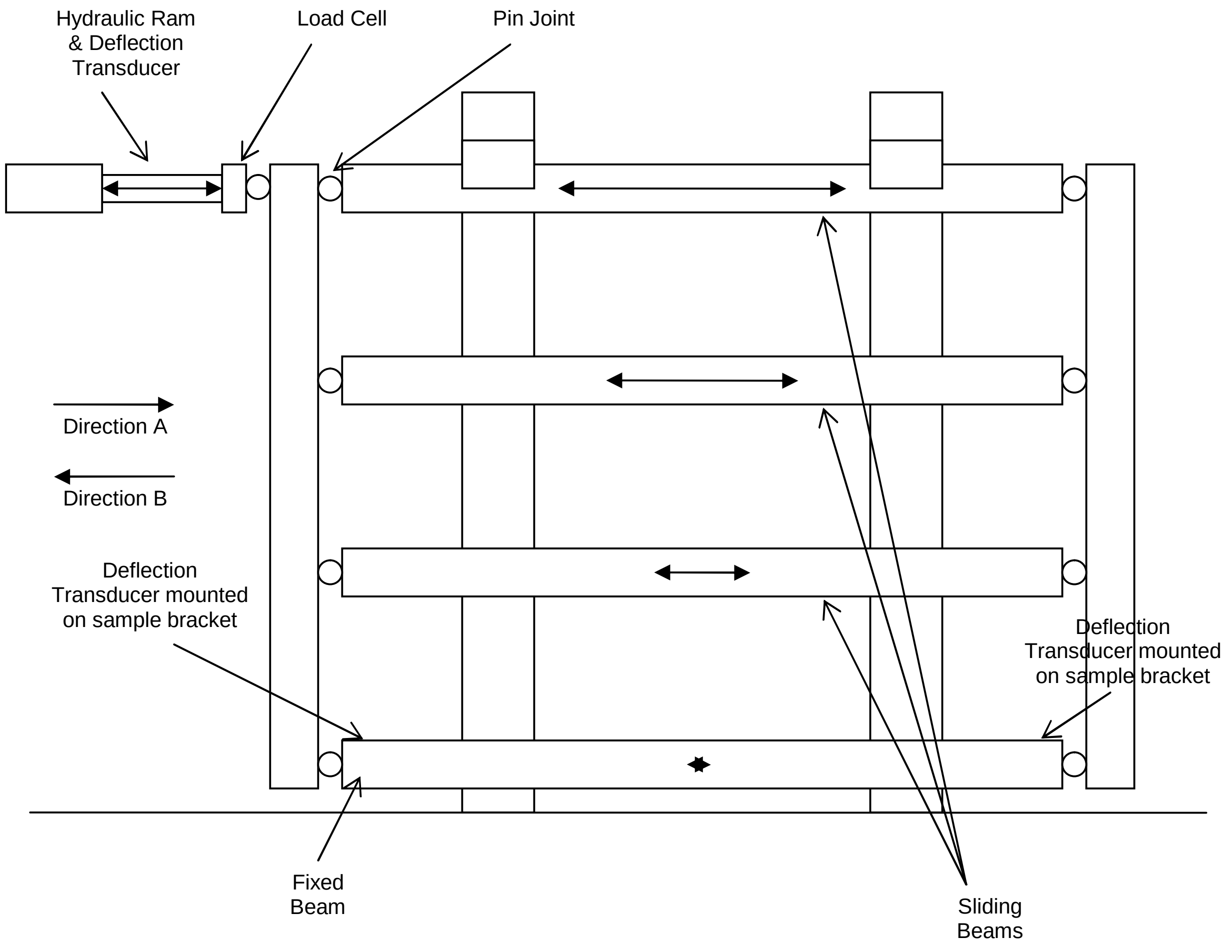
Argeton sample

3. TEST RIG GENERAL ARRANGEMENT

The test sample was mounted on a test rig with support steelwork designed to provide cyclic test conditions. The test rig comprised a pin-jointed steel frame, with a fixed beam at the foot of the rig which the frame was able to pivot on. A hydraulic ram was attached to the top of the frame to control its movement. Representatives of Telling Architectural Ltd installed the sample on the test rig. See Figure 1.

Figure 1

<u>TEST RIG & DEFLECTION GAUGE ARRANGEMENT</u>



4. TEST PROCEDURE

4.1 TEST SEQUENCE

The test sequence was as follows:

(1) Argeton Test 1: Single load to failure – Direction A

(2) Argeton Test 2: Single load to failure – Direction B

(3) Argeton – Sequential Phased Displacement (SPD) 1

(4) Argeton – Sequential Phased Displacement (SPD) 2

4.2 PROCEDURE

A new sample was built for each of the above tests.

The sample was subjected to two “load to failure” tests – one in Direction A and one in Direction B - to calculate average displacement failure. The load was applied at a constant rate of displacement to reach failure in no less than 5 minutes. The average displacement failure of the two tests was taken forward as the 100% figure for the SPD tests.

The samples were subjected to displacement cycles grouped in phases at incrementally increasing displacement levels. The cycles formed a triangular wave load pattern.

The SPD loading consists of two displacement patterns. The first consists of three phases, each containing three fully-reversing cycles of equal amplitude, at displacements representing 25%, 50% and 75% of anticipated failure. If the sample passed the first displacement pattern without failure it was subjected to the second pattern.

The second pattern consists of phases, each containing seven fully-reversing cycles of equal amplitude, displacement representing 100%, 100% + 5µ, 100% + 10µ, 100% + 20µ, 100% + 40µ continuing in 20µ increments until failure.

Testing was stopped as soon as failure occurred.

4.3 TEST PREPARATION

4.3.1 Datalogger

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

4.3.2 Deflection

Deflection transducers monitored movement at the top of the sample and at the base of the sample where the sample was fixed to the stationary beam. Movement was monitored throughout the test at positions shown in Figure 1.

4.3.3 Load

A load cell was fixed to the end of the hydraulic ram to measure load applied in both directions to the test sample.

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

5. TEST RESULTS

5.1 RESULTS SUMMERY

The following summarises the results of the tests carried out.

Table 1

Date	Test number	Test description	Displacement Failure (mm)	Failure Phase
6 December 07	1	Argeton Test 1: Single load to failure – Direction A	292	N/A
10 December 07	2	Argeton Test 2: Single load to failure – Direction B	339	N/A
19 December 07	3	Argeton – Sequential Phased Displacement (SPD) 1	N/A	Pattern 1 – Phase 3 75%
14 December 07	4	Argeton – Sequential Phased Displacement (SPD) 2	N/A	Pattern 1 – Phase 3 75%

5.2 SHEAR STRENGTH

A control test was carried out on the rig with no sample attached. The average maximum load required to cycle the frame was 1.2kN*. Therefore, this value was subtracted from the peak loads when calculating shear strength.

The formula below was used to calculate the shear strength of the samples:

$$v_{peak} = P_{peak} / L$$

where: V_{peak} = shear strength (kN/m)

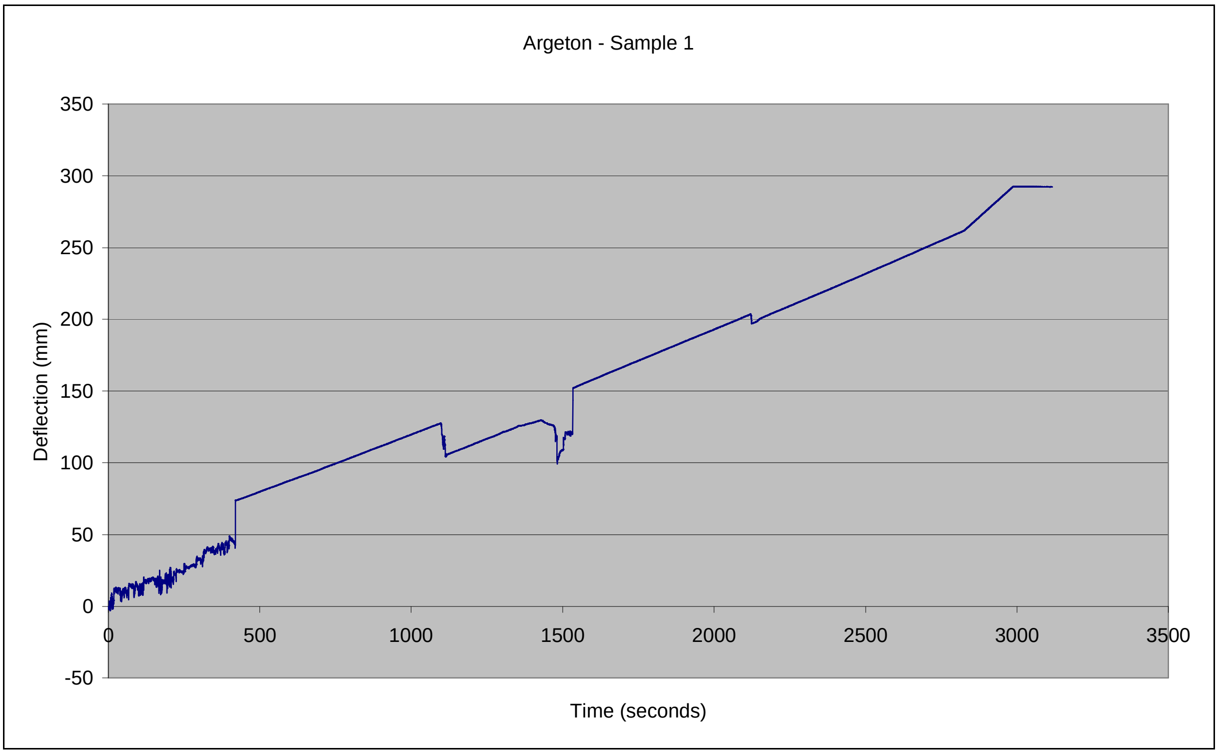
P_{peak} = maximum values of load resisted by the samples* (kN)

L = length of wall assembly (m)

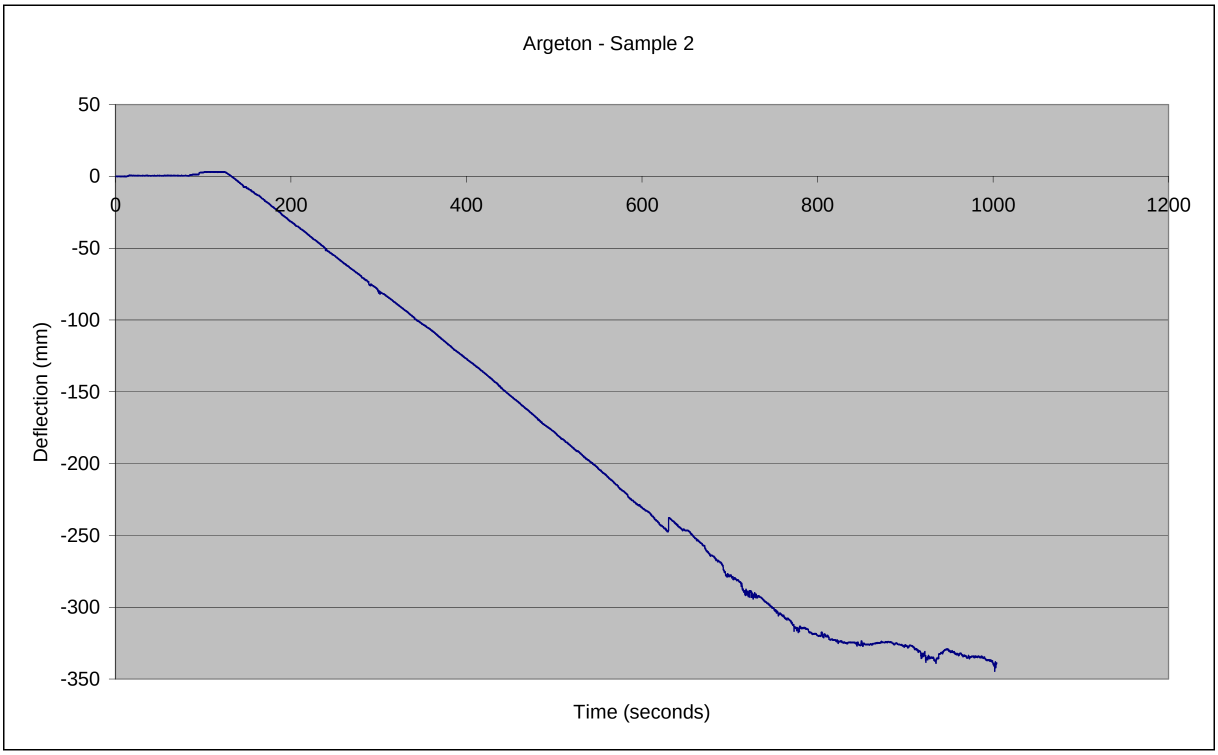
Sample Number	Shear Strength (kN/m)
Argeton 3	1.9
Argeton 4	1.8

5.3 ARGETON RESULTS

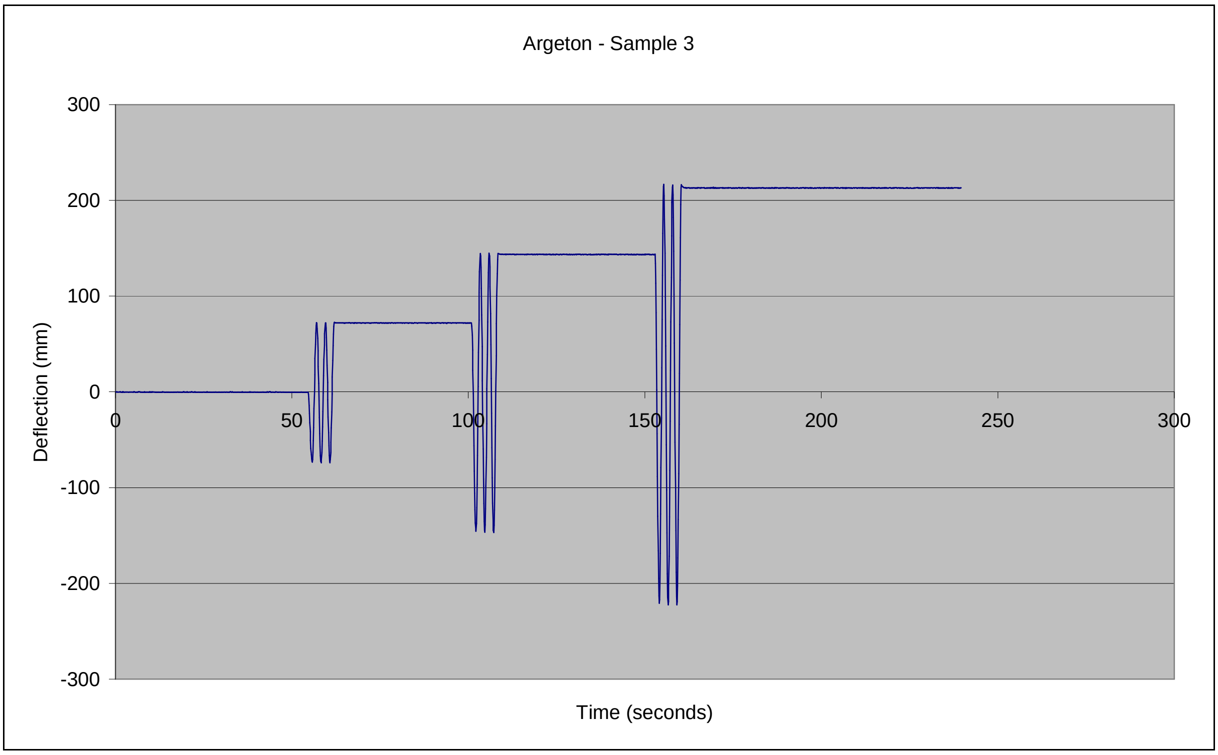
5.3.1 Sample 1 – Single Load to Failure



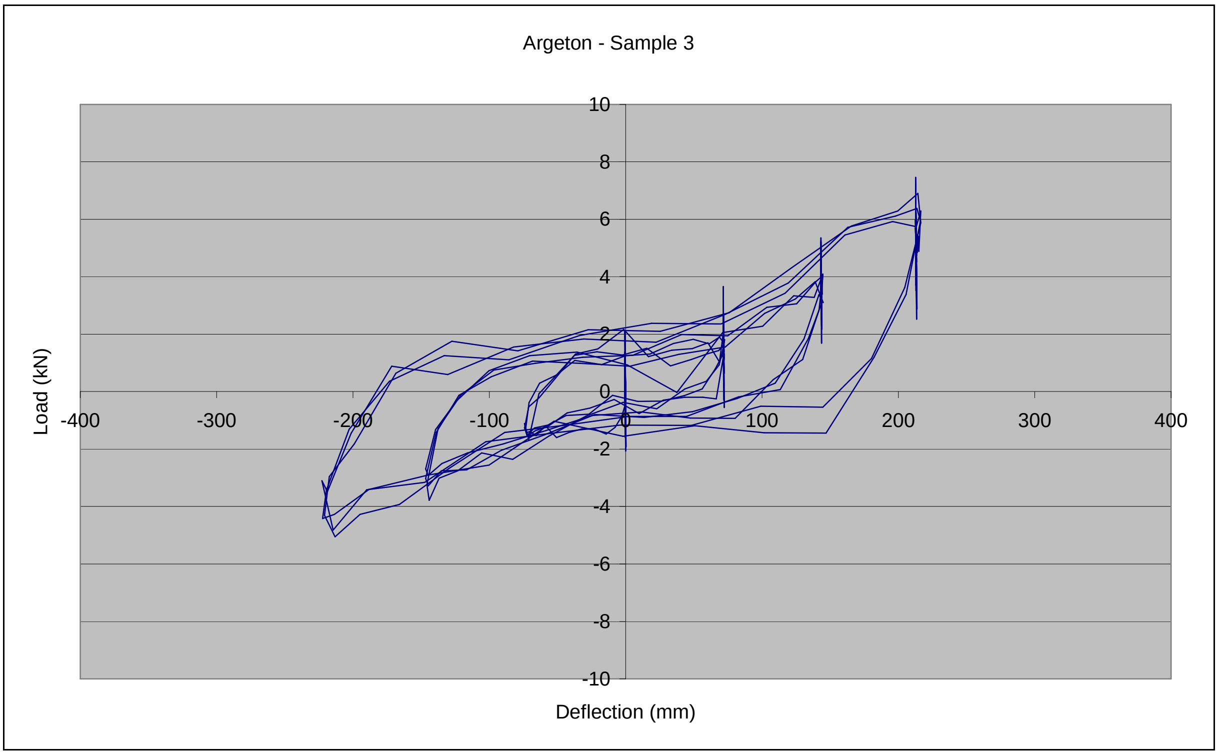
5.3.2 Sample 2 – Single Load to Failure



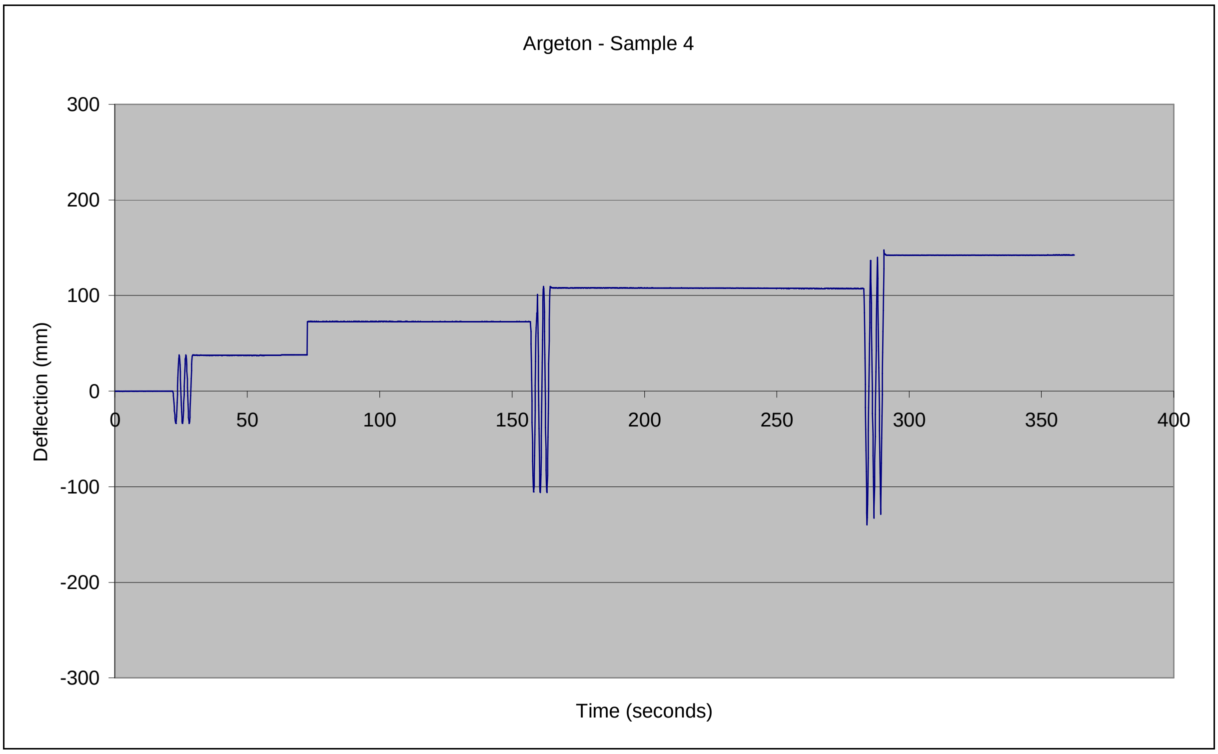
5.3.3 Sample 3 - Sequential Phased Displacement



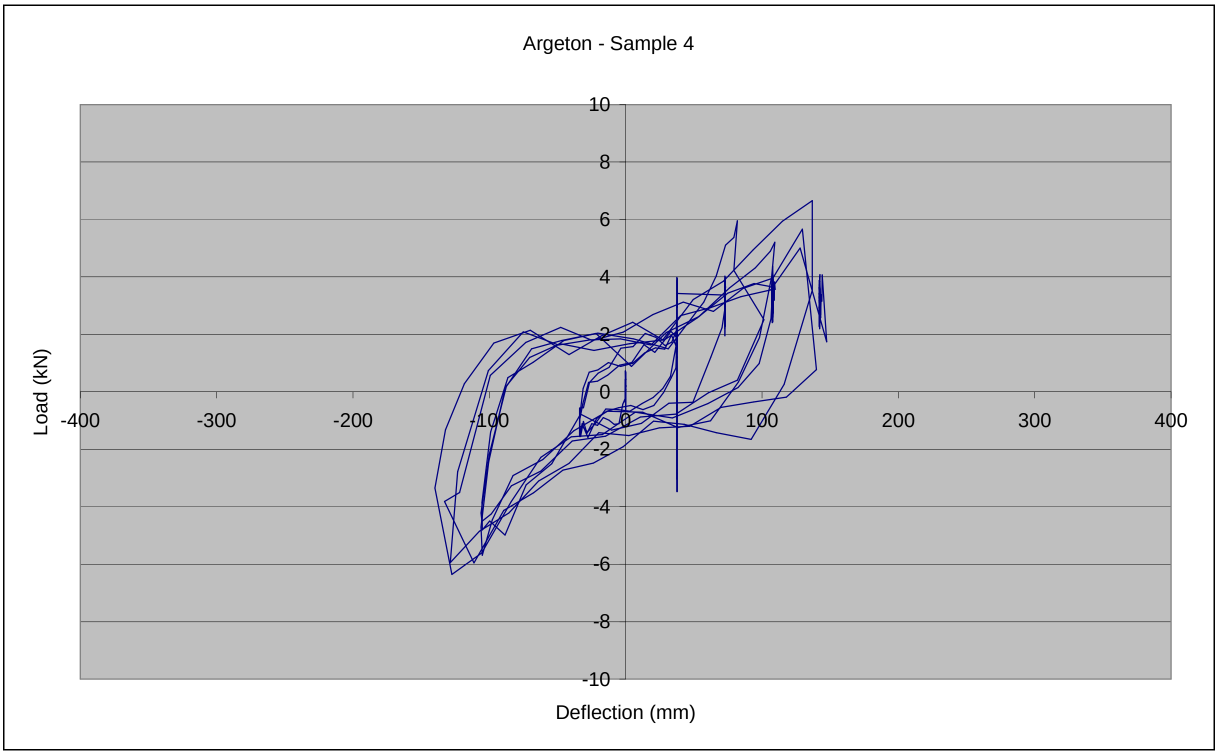
5.3.4 Sample 3 - Hysteresis Curve



5.3.5 Sample 4 – Sequential Phased Displacement



5.3.6 Sample 4 - Hysteresis Curve



6. PHOTOGRAPHIC RECORD

Photo PC060042

Argeton, sample 1 during testing

Photo PC060049

Argeton, sample 1 – Damaged clip and tile after testing

Photo PC102323

Argeton sample 2 during testing

Photo PC130023b

Argeton sample 3 failure after testing.

END OF REPORT

TECHNOLOGY CENTRE

Technical Report

Title: Product weathertightness testing of a sample of a Telling Architectural Rainspan ArGeTon System

Report No: N950-11-16372

Telling Architectural

VINCI CONSTRUCTION UK

Technical Report

Title: Product weathertightness testing of a sample of a Telling Architectural Rainspan ArGeTon System

Client: Telling Architectural Limited, 7 The Dell, Enterprise Drive, Four Ashes, Wolverhampton, WV10 7DF

Issue date: 22 July 2011

TC job number: TMV054-3PK5

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FS 95506

CONTENTS

1 INTRODUCTION

This report describes tests carried out at the Technology Centre at the request of Telling Architectural Limited.

The test sample consisted of a sample of rainscreen cladding using ArGeTon tiles mounted on a Eurobond composite panel backing wall.

The tests were carried out on 24 May 2011 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:

Air permeability.

Wind resistance – serviceability & safety.

Watertightness –dynamic pressure.

Impact resistance (BS 8200).

The testing was carried out in accordance with Technology Centre Method Statement C3878/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.

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

Technology Centre 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 wholly or in part by:

Dave Adams - Telling Architectural Limited
Huw Thomas - Eurobond Laminates Limited

2 DESCRIPTION OF TEST SAMPLE

2.1 GENERAL ARRANGEMENT

The sample was as shown in the photo below and the drawings included as an appendix to this report.

PHOTO 1000001

TEST SAMPLE ELEVATION

PHOTO 5100017

TEST SAMPLE DURING CONSTRUCTION

2.2 CONTROLLED DISMANTLING

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

PHOTO 1000084

TILE SUPPORT CLIP

PHOTO 1000087

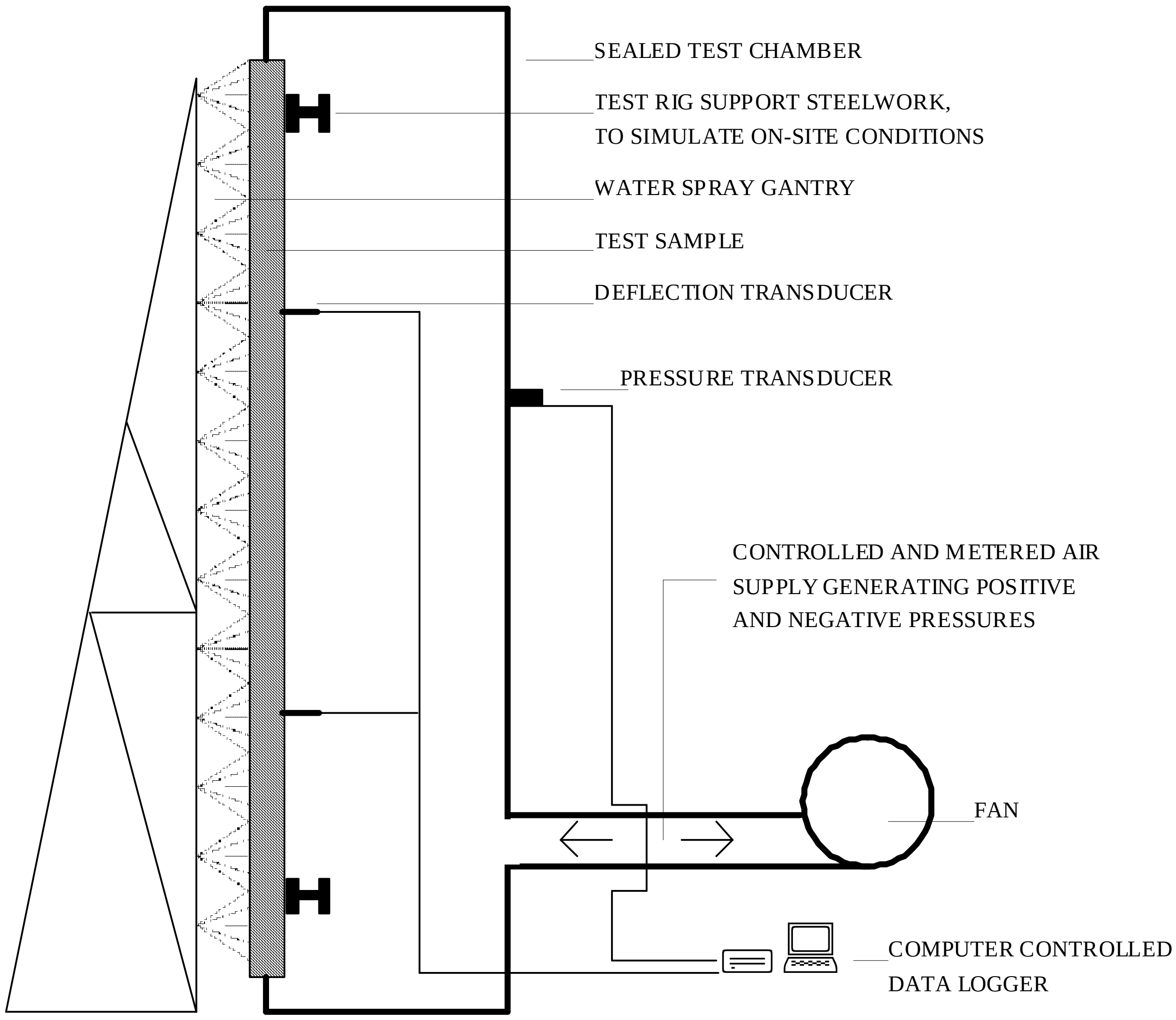
VERTICAL SUPPORT RAIL

3 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 Telling Architectural and Eurobond installed the sample on the test rig. See Figure 1.

FIGURE 1

TEST RIG SCHEMATIC ARRANGEMENT



SECTION THROUGH TEST RIG

4 TEST SEQUENCE

The test sequence was as follows:

(1) Air permeability

(2) Wind resistance – serviceability on backing wall

(3) Air permeability

(4) Wind resistance – safety on backing wall

(5) Wind resistance – serviceability on tiles

(6) Wind resistance – safety on tiles

(7) Watertightness – dynamic

(8) Impact resistance

5 SUMMARY AND CLASSIFICATION OF TEST RESULTS

The following summarises the results of the tests carried out. For full details refer to Sections 6, 7, 8 and 9.

5.1 SUMMARY OF TEST RESULTS

TABLE 1

Date	Test number	Test description	Result
24 May 2011	1	Air permeability	Pass
24 May 2011	2	Wind resistance – serviceability on backing wall	Pass
24 May 2011	3	Air permeability	Pass
24 May 2011	4	Wind resistance – safety on backing wall	Pass
24 May 2011	5	Wind resistance – serviceability on tiles	Pass
24 May 2011	6	Wind resistance – safety on tiles	Pass
24 May 2011	7	Watertightness – dynamic	Pass
24 May 2011	8	Impact resistance	Pass

5.2 CLASSIFICATION

TABLE 2

Test	Standard	Classification / Declared value
Air permeability	CWCT	A4 - backing wall
Wind resistance	CWCT	±2400 pascals serviceability ±3600 pascals safety
Impact resistance	BS8200	Category B

6 AIR PERMEABILITY 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 Air Flow

A laminar flow element mounted in the air system ductwork was used with a pressure transducer to measure the air flow into the chamber. This device was capable of measuring airflow through the sample to within 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

Three positive pressure pulses of 1200 pascals were applied to prepare the test sample.

The average air permeability was determined by measuring the rate of air flow through the chamber whilst subjecting the sample to positive pressure differentials of 50, 100, 150, 200, 300, 450 and 600 pascals. Each pressure increment was held for at least 10 seconds.

Extraneous leakage through the test chamber and the joints between the chamber and the test sample was determined by sealing the backing wall with adhesive tape and measuring the air flow at the pressures given above.

The test was then repeated with the sample unsealed; the difference between the readings being the rate of air flow through the backing wall.

The test was then repeated using negative pressure differentials.

6.4 PASS/FAIL CRITERIA

The permissible air flow rate, Q_o, at peak test pressure, p_o, could not exceed:

1.5 m^3 per hour per m^2 for fixed panels.

At intermediate pressures, p_n, flow rates, Q_n, were calculated using $Q_n = Q_o(p_n/p_o)^{2/3}$

The area of the backing wall was 27.2 m^2.

6.5 RESULTS

TABLE 3

Pressure differential (pascals)	Measured air flow through sample (m^3/hour/m^2)			
	Test 1 Date: 24 May 2011		Test 3 Date: 24 May 2011	
	Infiltration	Exfiltration	Infiltration	Exfiltration
50	0.02	0.00	0.01	0.00
100	0.12	0.06	0.14	0.18
150	0.11	0.15	0.13	0.35
200	0.20	0.22	0.25	0.32
300	0.23	0.31	0.35	0.37
450	0.43	0.33	0.43	0.50
600	0.39	0.48	0.41	0.72
Temperatures	Ambient = 12°C Chamber = 15°C		Ambient = 12°C Chamber = 15°C	

The results are shown graphically in Figures 2 and 3.

FIGURE 2

Air infiltration test results

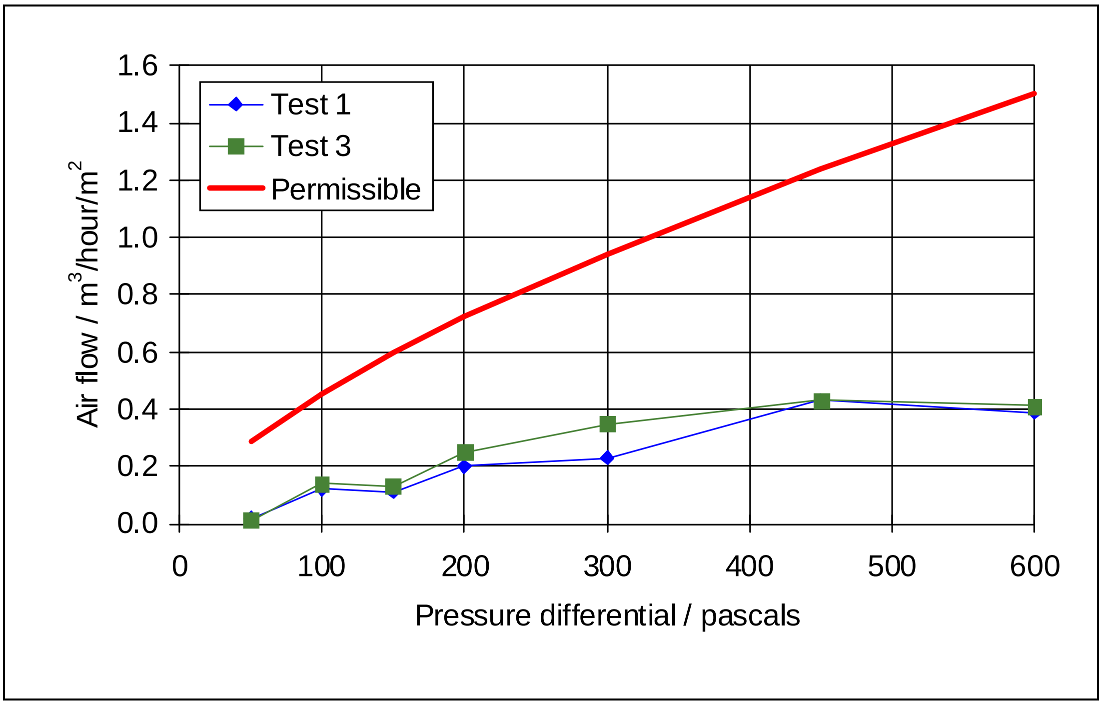
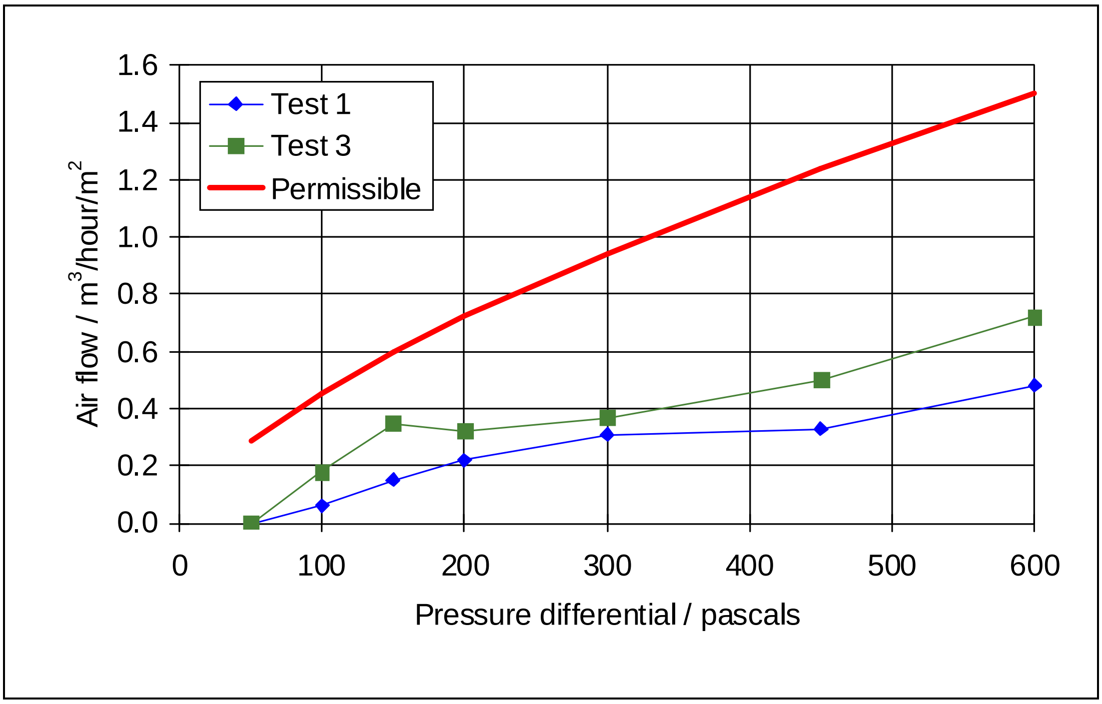


FIGURE 3

Air exfiltration test results



7 WIND RESISTANCE 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 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 4.

7.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air 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

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.

7.3 PROCEDURE

7.3.1 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.

7.3.2 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.

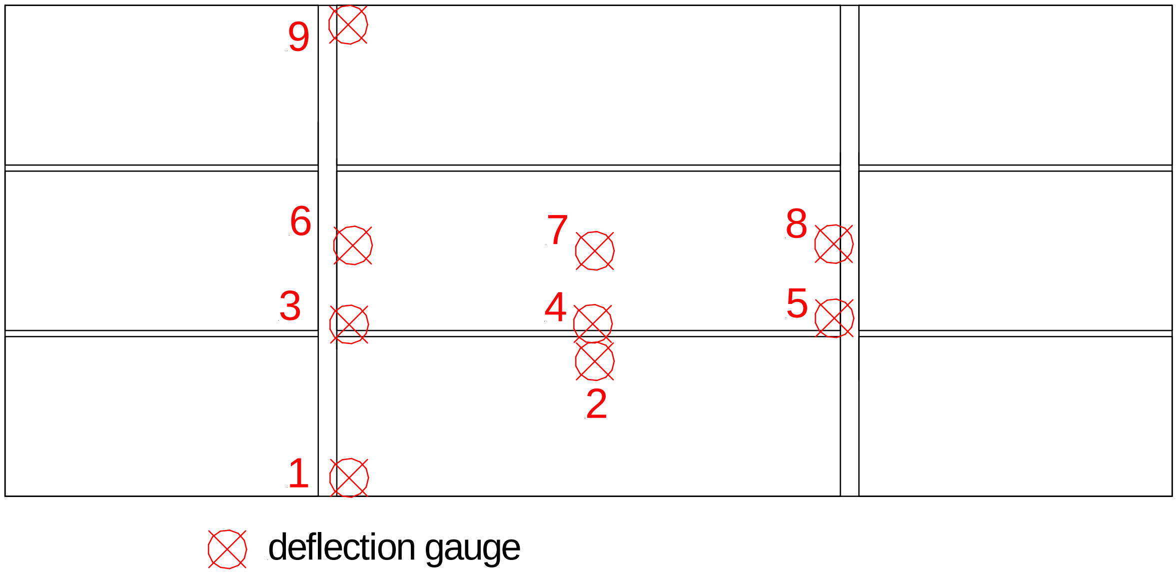
Any damage or functional defects were recorded.

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

FIGURE 4

<u>DEFLECTION GAUGE LOCATIONS</u>

<u>Internal View</u>



7.4 PASS/FAIL CRITERIA

7.4.1 Calculation of permissible deflection

Gauge number	Member	Span (L) (mm)	Permissible deflection (mm)	Permissible residual deformation
4	Base of panel	3800	L/300 + 5 mm = 17.6	1 mm
7	Centre of panel	3800	L/300 + 5 mm = 17.6	1 mm

7.5 RESULTS

<u>Test 2 (serviceability on backing wall)</u> Date: 24 May 2011

The deflections measured during the wind resistance test, at the positions shown in Figure 4, are shown in Tables 4 and 5.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
4	Base of panel	2417 -2433	4.1 -4.1	0.2 -0.3
7	Centre of panel	2417 -2433	4.5 -4.7	0.1 -0.2

No damage to the test sample was observed.

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

<u>Test 4 (safety on backing wall)</u> Date: 24 May 2011

The deflections measured during the structural safety test, at the positions shown in Figure 4, are shown in Table 6.

No damage to the sample was observed.

Ambient temperature = 13°C
Chamber temperature = 14°C

Note: For tests 5 and 6 the tile joints were sealed over and holes were opened into the top of the cavity between the backing and the tiles. No deflections were measured during these tests but the tiles were examined for damage.

Test 5 (serviceability on tiles) Date: 24 May 2011

No damage to the test sample was observed.

Ambient temperature = 14°C
Chamber temperature = 16°C

Test 6 (safety on tiles) Date: 24 May 2011

No damage to the sample was observed.

Ambient temperature = 14°C
Chamber temperature = 16°C

TABLE 4

WIND RESISTANCE – POSITIVE **SERVICEABILITY** TEST RESULTS ON BACKING WALL

Position	Pressure (pascals) / Deflection (mm)				
	607	1202	1804	2417	Residual
1	0.1	0.1	0.3	0.4	0.0
2	1.2	2.5	3.9	5.5	0.2
3	0.5	1.0	1.4	1.9	-0.1
4	1.1	2.5	4.1	5.8	0.2
5	0.3	0.6	1.0	1.4	0.0
6	0.6	1.2	1.8	2.5	0.0
7	1.4	3.0	4.7	6.5	0.2
8	0.3	0.7	1.1	1.5	0.0
9	0.0	0.1	0.1	0.1	0.0
4 *	0.7	1.7	2.9	4.1	0.2
7 *	1.0	2.0	3.2	4.5	0.1

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** TEST RESULTS ON BACKING WALL

Position	Pressure (pascals) / Deflection (mm)				
	-599	-1205	-1803	-2433	Residual
1	-0.1	-0.2	-0.3	-0.5	0.0
2	-1.2	-2.5	-4.1	-5.7	-0.3
3	-0.5	-1.0	-1.5	-2.0	-0.1
4	-1.2	-2.6	-4.2	-5.8	-0.3
5	-0.3	-0.6	-1.0	-1.4	0.0
6	-0.6	-1.2	-1.9	-2.5	0.0
7	-1.5	-3.1	-4.9	-6.7	-0.2
8	-0.3	-0.7	-1.1	-1.5	-0.1
9	0.0	0.0	-0.1	-0.2	0.0
4 *	-0.8	-1.8	-3.0	-4.1	-0.3
7 *	-1.0	-2.1	-3.4	-4.7	-0.2

* Mid-span reading adjusted between end support readings

TABLE 6

WIND RESISTANCE - **SAFETY** TEST RESULTS ON BACKING WALL

Position	Pressure (pascals) / Deflection (mm)			
	3647	Residual	-3595	Residual
1	0.9	-0.2	-0.7	-0.1
2	10.9	-0.1	-10.3	-0.9
3	4.0	-1.1	-2.3	0.2
4	11.5	-0.2	-10.8	-1.0
5	2.3	-0.6	-2.1	-0.1
6	4.9	-1.0	-3.5	0.1
7	13.6	0.2	-12.6	-1.2
8	1.3	-1.0	-1.6	0.1
9	-0.7	-0.2	-0.1	0.0
4 *	8.3	0.6	-8.6	-1.1
7 *	10.5	1.2	-10.1	-1.2

* Mid-span reading adjusted between end support readings

8 WATERTIGHTNESS TESTING

8.1 INSTRUMENTATION

8.1.1 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.

8.1.2 Water Flow

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

8.1.3 Temperature

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

8.1.4 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.

8.2 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.

8.3 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.

8.4 PROCEDURE

Water was sprayed onto the sample using the method described above at a flow rate of at least 3.4 litres/m^2/minute.

The aero-engine was used to subject the sample to wind load equal to a static pressure differential of 600 pascals. These conditions were maintained for 15 minutes. Throughout the test the inside of the sample was examined for water penetration.

8.5 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.

8.6 RESULTS

Test 7 Date: 24 May 2011

No water penetration was observed throughout the test.

Chamber temperature= 20°C
Ambient temperature = 16°C
Water temperature = 15°C

9 IMPACT TESTING

9.1 IMPACTOR

9.1.1 Soft body

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.

9.1.2 Hard body

The hard body impactor was a solid steel ball of 50 mm or 62.5 mm diameter and approximate mass of 0.5 kg or 1.0 kg.

9.2 PROCEDURE (BS 8200)

9.2.1 Soft body

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 5. The impact energies were 120 Nm, 350 Nm and 500 Nm.

9.2.2 Hard body

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 6. The impact energies were 3 Nm, 6 Nm and 10 Nm.

9.3 PASS/FAIL CRITERIA

9.3.1 At impact energies for retention of performance

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

9.3.2 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.

9.4 RESULTS

<u>Test 8</u> Date: 24 May 2011

9.4.1 Soft Body Impacts

TABLE 7

Location	Energy (Nm)	Observation	Result
1	120	No damage observed.	Pass
1	350	No damage observed.	Pass
2	120	No damage observed.	Pass
2	350	Small crack in nib.	Pass
3	120	No damage observed.	Pass
3	350	No damage observed.	Pass
4	120	No damage observed.	Pass
4	350	No damage observed.	Pass
5	120	No damage observed.	Pass
5	350	No damage observed.	Pass
6	500	No damage observed.	Pass
7	500	No damage observed.	Pass
8	500	No damage observed.	Pass
9	500	No damage observed.	Pass
10	500	No damage observed.	Pass

Ambient temperature = 15°C

9.4.2 Hard Body Impacts

TABLE 8

Location	Energy (Nm)	Observation	Result
1	3	No damage observed.	Pass
2	3	No damage observed.	Pass
3	3	No damage observed.	Pass
4	6	No damage observed.	Pass
5	6	No damage observed.	Pass
6	6	No damage observed.	Pass
7	10	Small indent & hairline crack in tile.	Pass
8	10	Small dent in tile face.	Pass
9	10	Hairline crack in tile.	Pass

Ambient temperature = 15°C

FIGURE 5

SOFT BODY IMPACT TEST LOCATIONS

External View

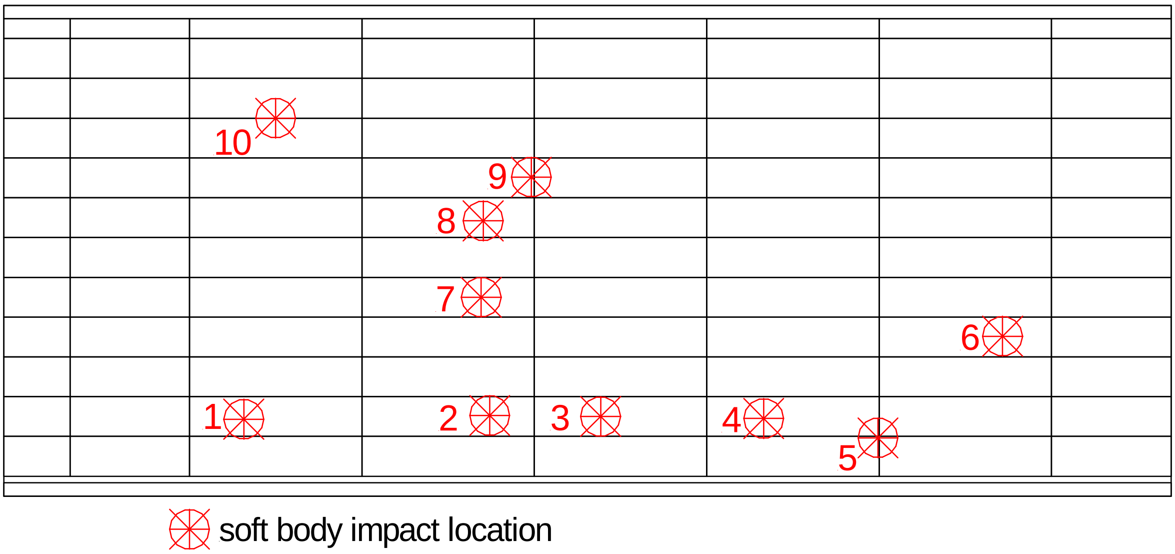


FIGURE 6

HARD BODY IMPACT TEST LOCATIONS

External View

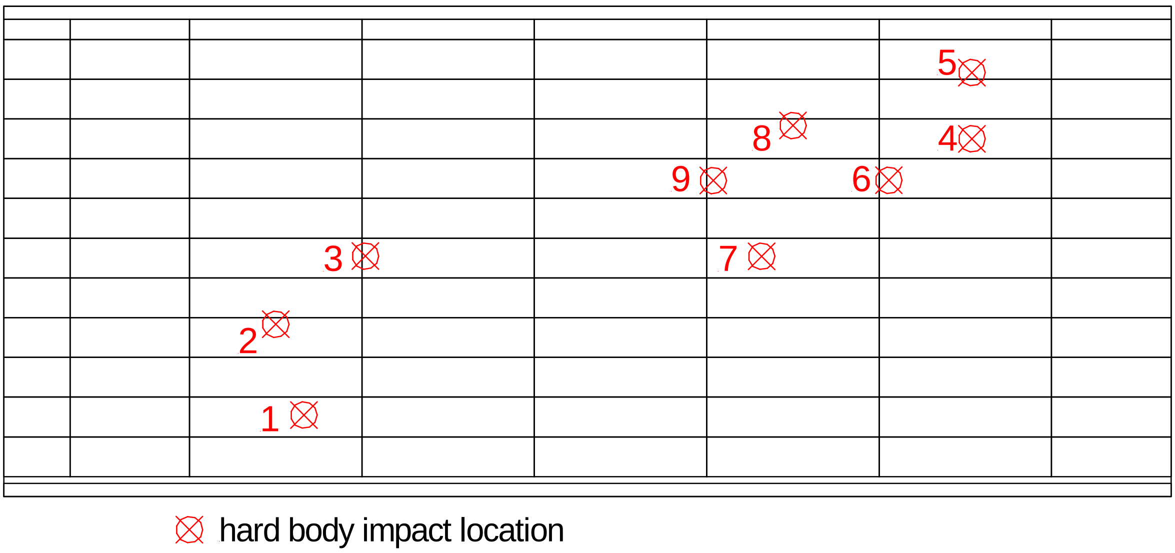


PHOTO 1000074

SOFT BODY IMPACTOR

PHOTO 1000078

HARD BODY IMPACTOR

PHOTO 1000078

LOCATION 7 AFTER HARD BODY IMPACT

10 APPENDIX - DRAWINGS

The following 5 unnumbered pages are copies of Telling Architectural Limited drawings numbered:

TESTEBL 01 Rev A,

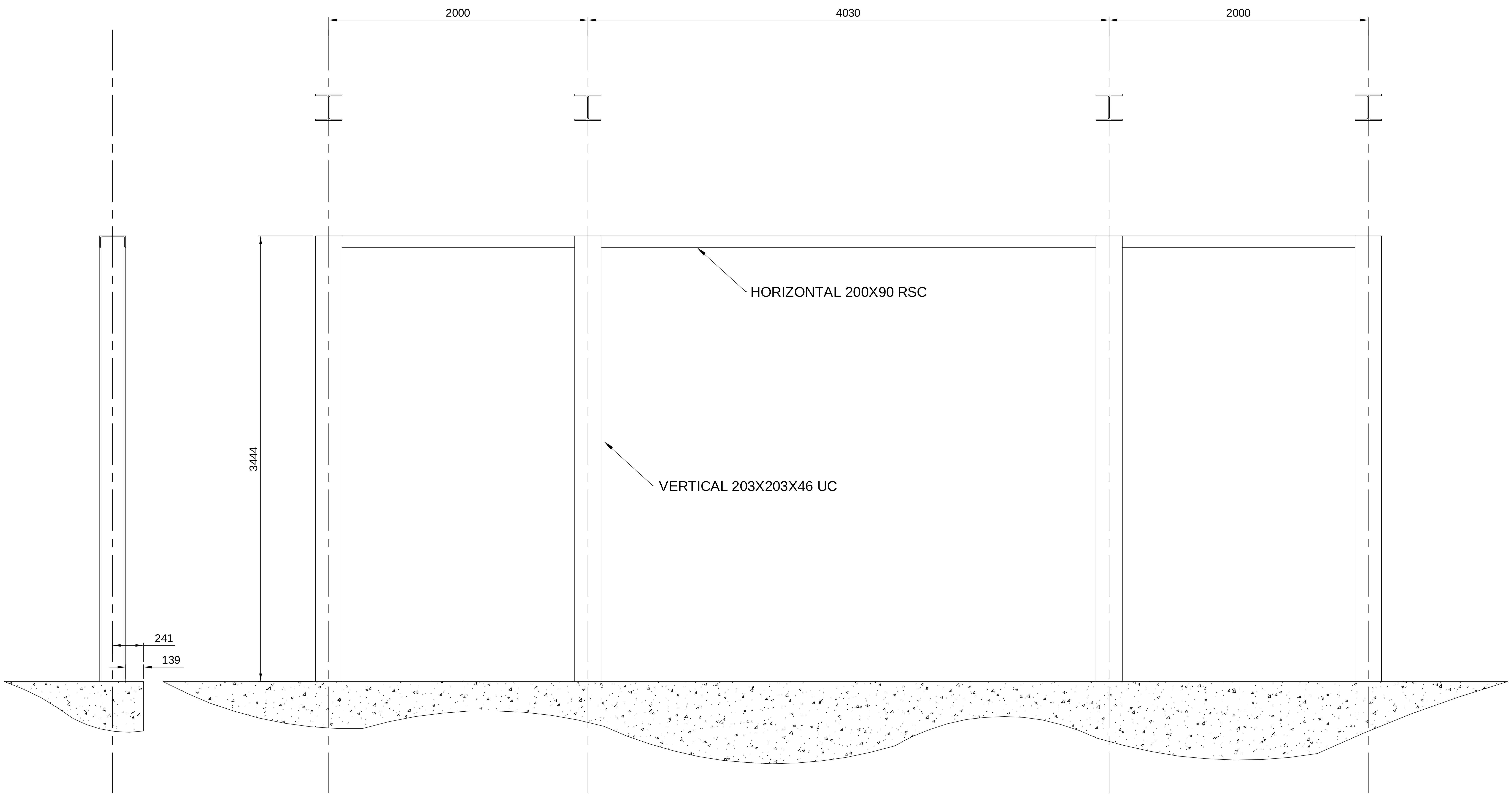
TESTEBL 02 Rev A,

TESTEBL 03 Rev B,

TESTEBL 04 Rev B,

TESTEBL 05 Rev -.

END OF REPORT



STEEL FRAME SETTING OUT

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

CONTRACT NUMBER: XXXX

DO NOT SCALE !!!

SPECIFICATION

TILE SYSTEM:

MODULE SIZE:

COLOUR:

DRAWING STATUS

FOR INFORMATION

REV	DATE	COMMENTS
A	24-03-11	AMEND STRUCTURE SETTING OUT

CONTRACT:

EUROBOND ARGETON TEST PANEL

Telling Architectural Ltd.
Unit 7, The Dell
Enterprise Drive, Four Ashes
Wolverhampton
WV10 7DF

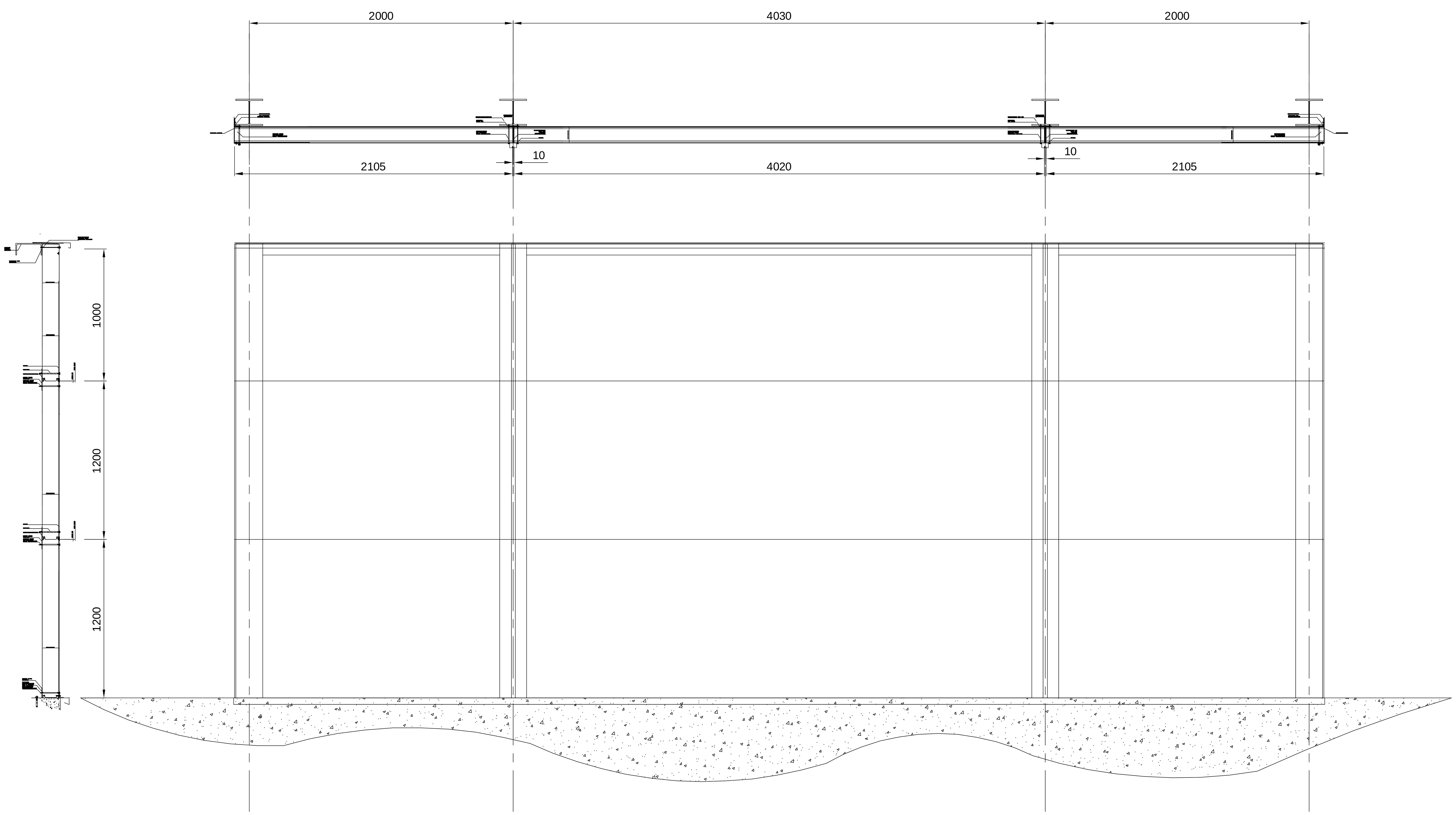
Tel : 01902 797700
Fax : 01902 797720

DRAWING TITLE :

STEEL STRUCTURE LAYOUT FOR TEST PANEL

SCALE A1	SCALE A2	SCALE A3
1:20	NTS	NTS

DRAWN	RAC	DRAWING No.	REV
DATE	23-03-11	TESTEBL 01	A



EUROBOND PANEL SETTING OUT

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

CONTRACT NUMBER: XXXX

DO NOT SCALE !!!

SPECIFICATION

TILE SYSTEM:

MODULE SIZE:

COLOUR:

DRAWING STATUS

FOR INFORMATION

REV	DATE	COMMENTS
A	24-03-11	AMEND STRUCTURE SETTING OUT

CONTRACT:

EUROBOND ARGETON TEST PANEL

Telling Architectural Ltd.
Unit 7, The Dell
Enterprise Drive, Four Ashes
Wolverhampton
WV10 7DF

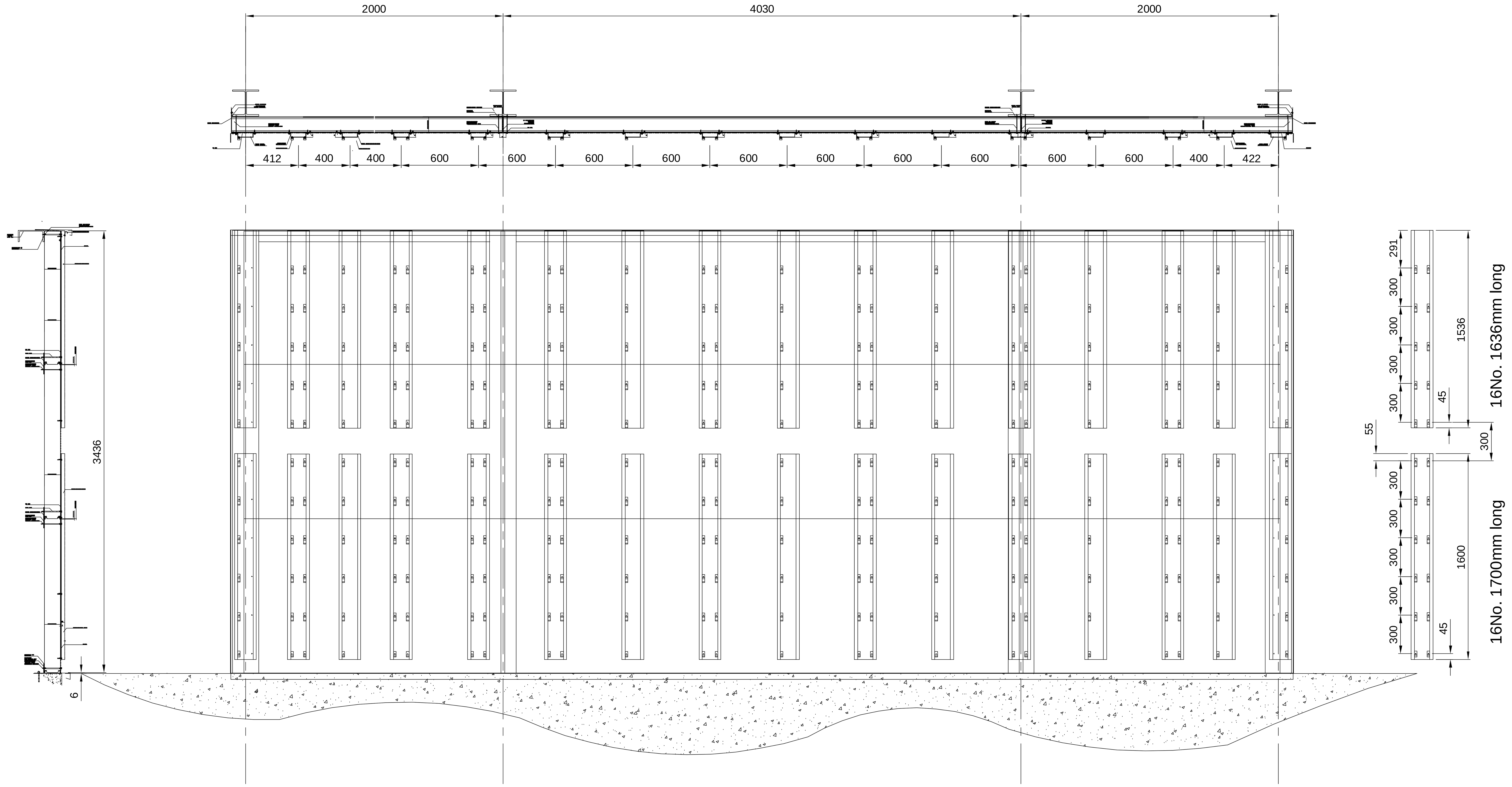
Tel : 01902 797700
Fax : 01902 797720

DRAWING TITLE :

EUROBOND PANEL SETOUT FOR TEST PANEL

SCALE A1	SCALE A2	SCALE A3
1:20	NTS	NTS

DRAWN	RAC	DRAWING No.	REV
DATE	23-03-11	TESTEBL 02	A



ARGETON TOPHAT SETTING OUT

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

CONTRACT NUMBER: XXXX

DO NOT SCALE !!!

SPECIFICATION

TILE SYSTEM:
MODULE SIZE:
COLOUR:

DRAWING STATUS

FOR INFORMATION

REV	DATE	COMMENTS
B	27-04-11	AMEND STRUCTURE SETTING OUT
A	24-03-11	AMEND STRUCTURE SETTING OUT

CONTRACT:

EUROBOND ARGETON TEST PANEL

Telling Architectural Ltd.
Unit 7, The Dell
Enterprise Drive, Four Ashes
Wolverhampton
WV10 7DF

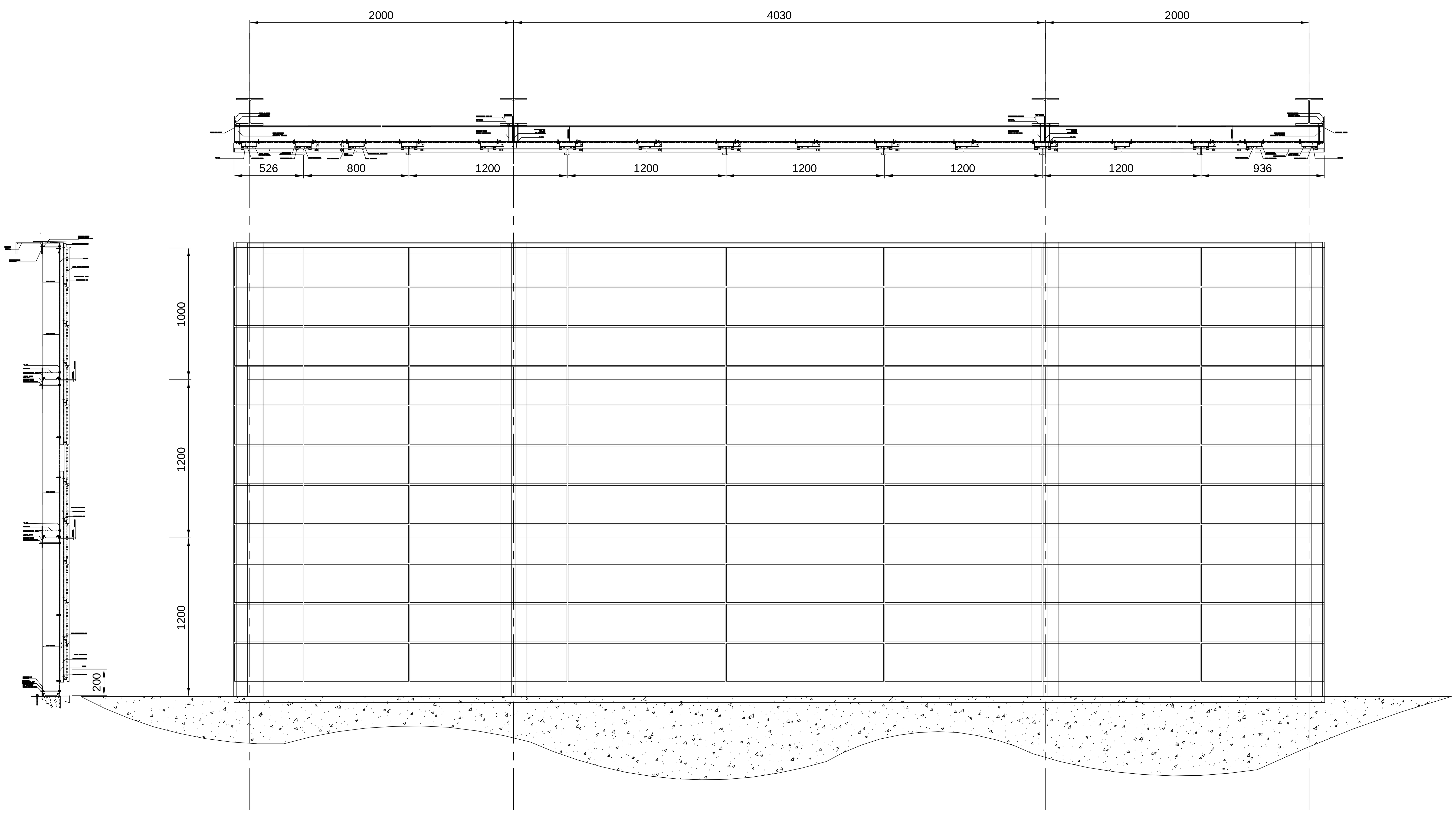
Tel : 01902 797700
Fax : 01902 797720

DRAWING TITLE :

ARGETON TOPHAT SETOUT FOR TEST PANEL

SCALE A1	SCALE A2	SCALE A3
1:20	NTS	NTS

DRAWN	RAC	DRAWING No.	REV
DATE	23-03-11	TESTEBL 03	B



ARGETON TILE SETTING OUT

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

CONTRACT NUMBER: XXXX

DO NOT SCALE !!!

SPECIFICATION

TILE SYSTEM:

MODULE SIZE:

COLOUR:

DRAWING STATUS

FOR INFORMATION

REV	DATE	COMMENTS
B	27-04-11	AMEND STRUCTURE SETTING OUT
A	24-03-11	AMEND STRUCTURE SETTING OUT

CONTRACT:

EUROBOND ARGETON TEST PANEL

Telling Architectural Ltd.
Unit 7, The Dell
Enterprise Drive, Four Ashes
Wolverhampton
WV10 7DF

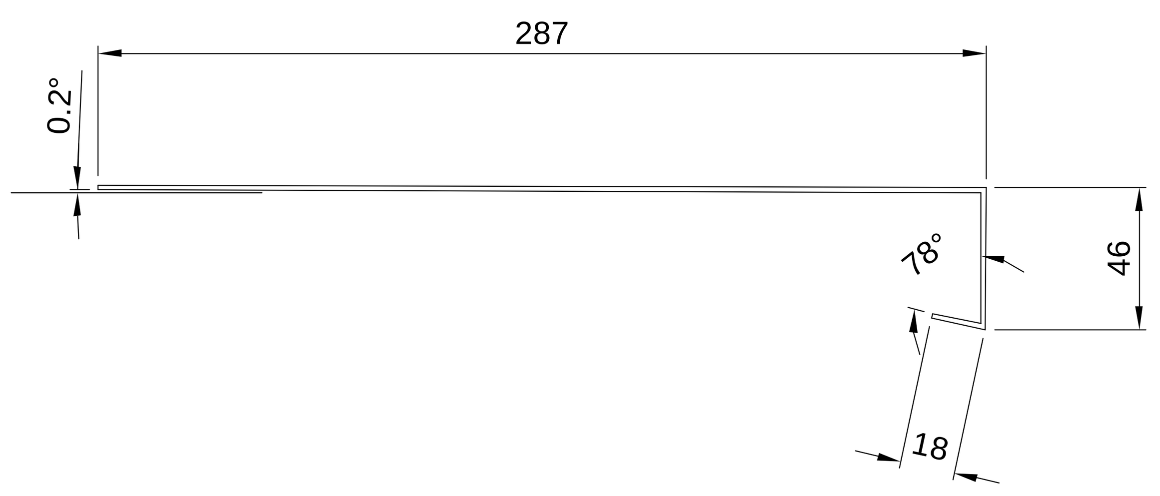
Tel : 01902 797700
Fax : 01902 797720

DRAWING TITLE :

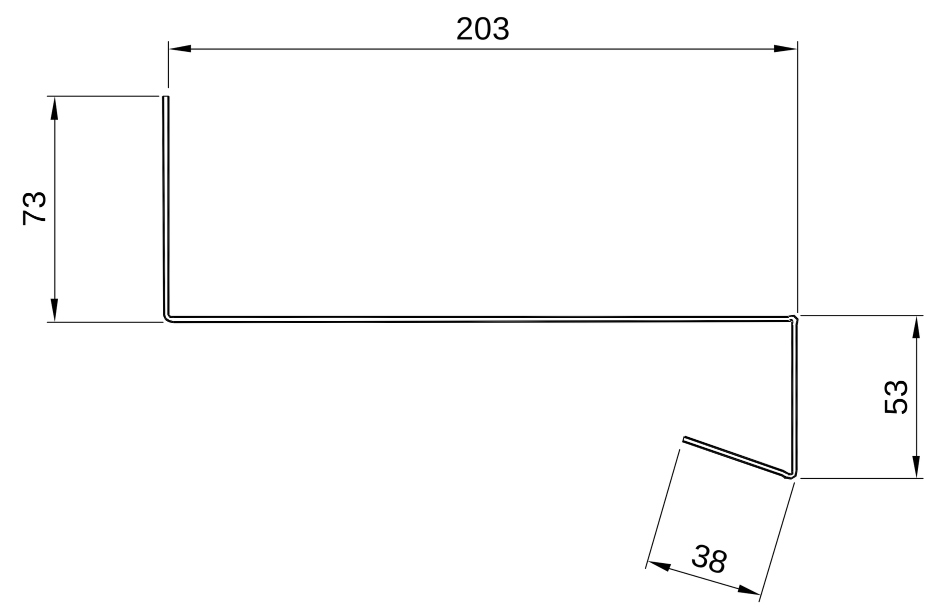
ARGETON TILE SETOUT FOR TEST PANEL

SCALE A1	SCALE A2	SCALE A3
1:20	NTS	NTS

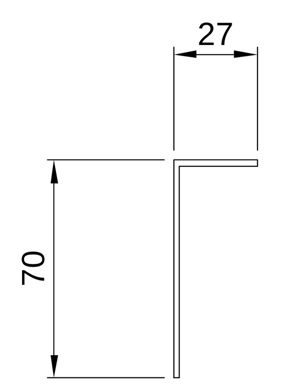
DRAWN	RAC	DRAWING No.	REV
DATE	23-03-11	TESTEBL 04	B



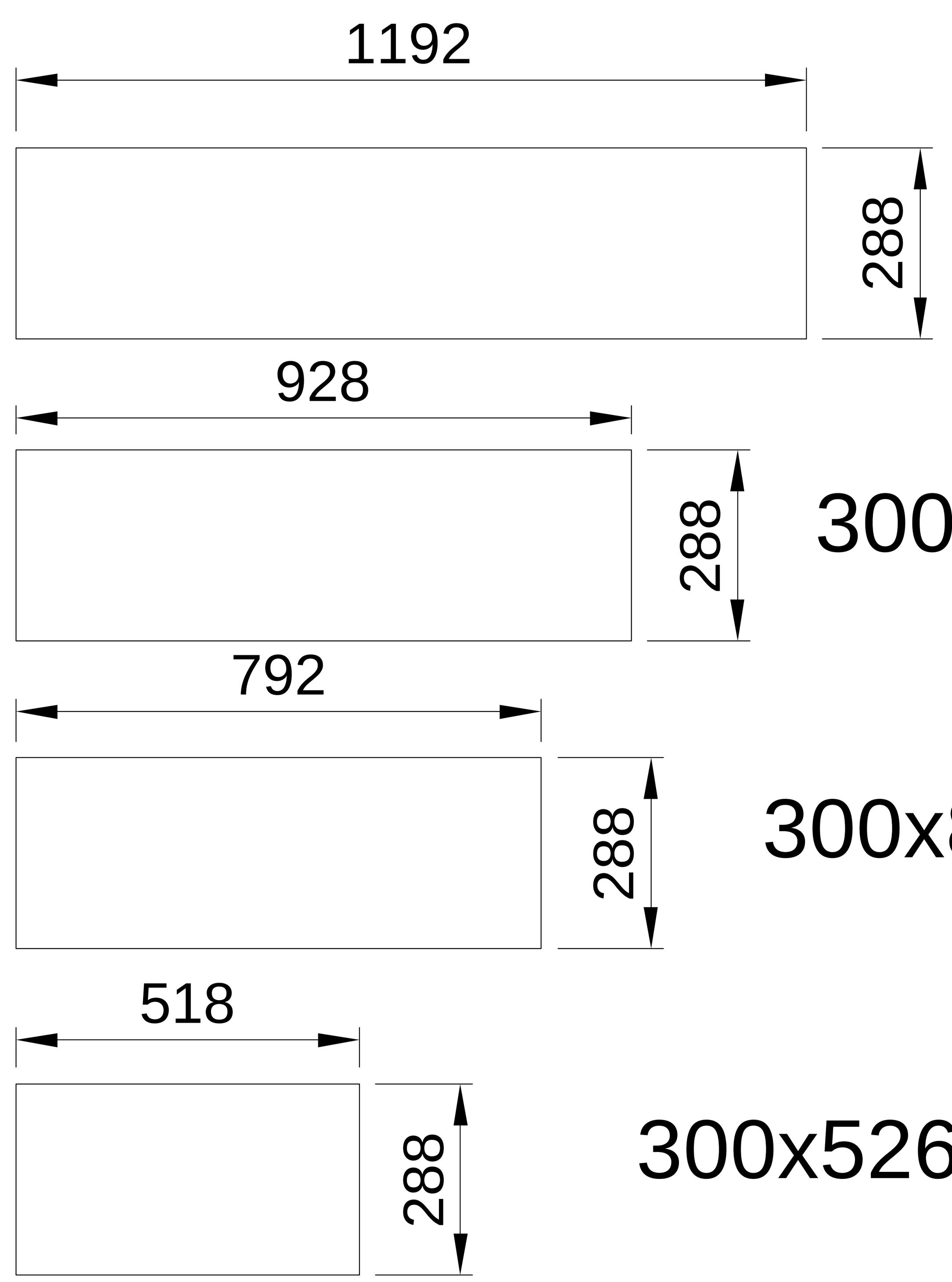
2No. 3000mm lengths
1No. 2255mm length
with 2 No. loose butt straps



2No. 3000mm lengths
1No. 2255mm length
with 2 No. loose butt straps



2No. 1700mm lengths
with 1 No. loose butt strap

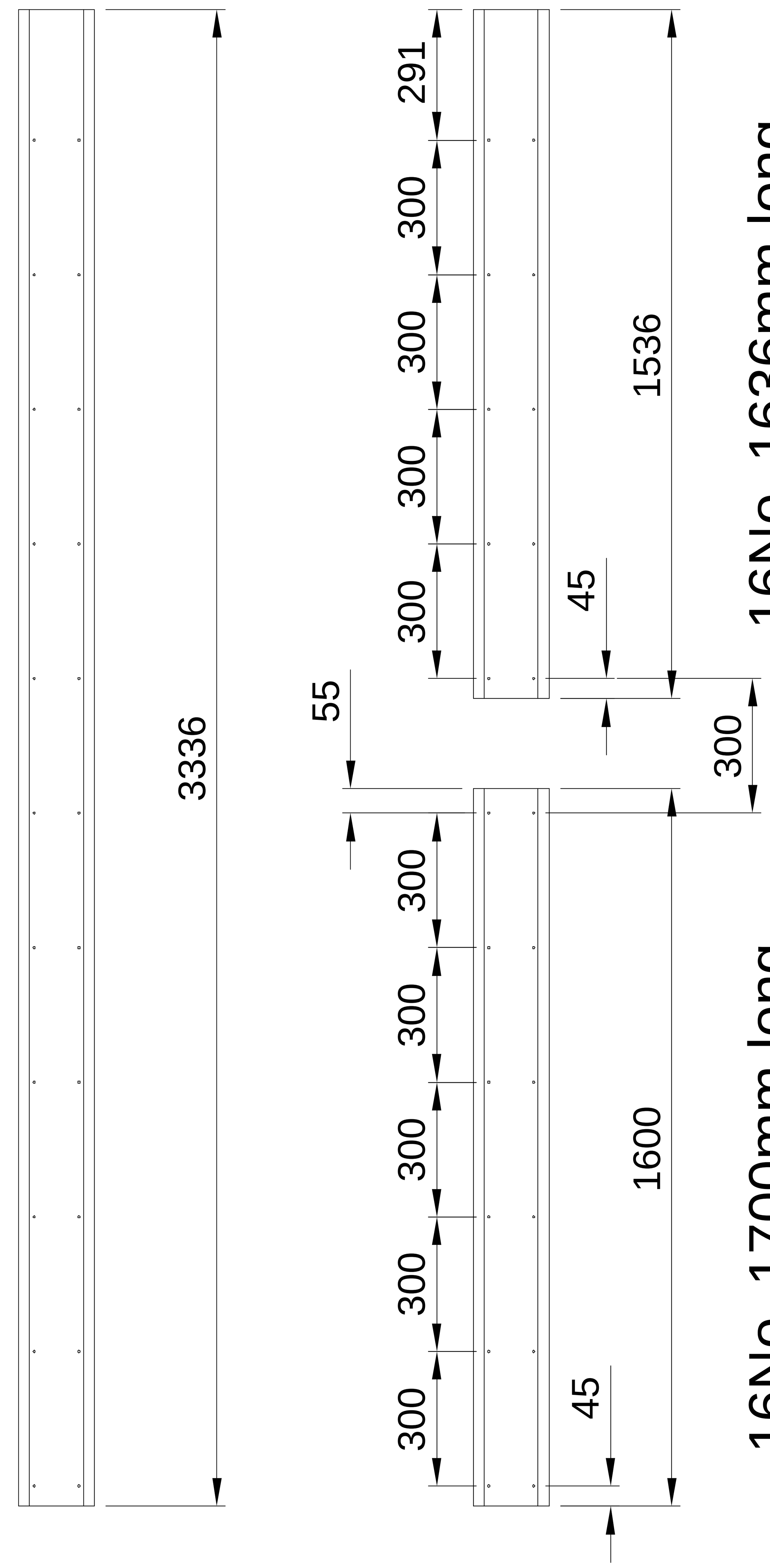


300x1200 module - 55No. Tiles

300x936 module 11No. Tiles

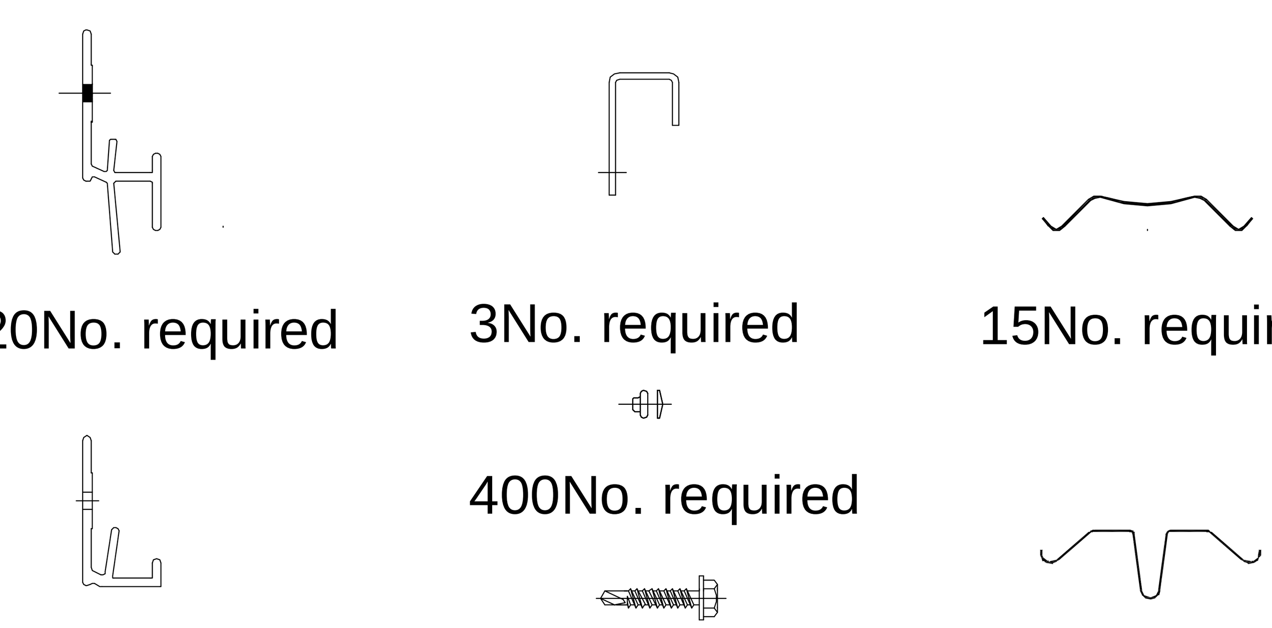
300x800 module 11No. Tiles

300x526 module 11No. Tiles



16No. 1636mm long

16No. 1700mm long



320No. required

40No. required

3No. required

400No. required

300No. required

15No. required

12No. required

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

CONTRACT NUMBER: XXXX

DO NOT SCALE !!!

SPECIFICATION

TILE SYSTEM:
MODULE SIZE:
COLOUR:

DRAWING STATUS

FOR INFORMATION

REV	DATE	COMMENTS

CONTRACT:

EUROBOND ARGETON
TEST PANEL

Telling Architectural Ltd.
Unit 7, The Dell
Enterprise Drive, Four Ashes
Wolverhampton
WV10 7DF

Tel : 01902 797700
Fax : 01902 797720

DRAWING TITLE :

COMPONENT REQUIREMENTS
FOR TEST PANEL

SCALE A1	SCALE A2	SCALE A3
NTS	NTS	NTS

DRAWN	RAC	DRAWING No.	REV
DATE	23-03-11	TESTEBL 05	-

TECHNOLOGY CENTRE

Technology Centre
VINCI Construction UK Limited
Stanbridge Road
Leighton Buzzard
Bedfordshire
LU7 4QH
UK

01525 859000

technologycentre@vinciconstruction.co.uk

www.vinciconstruction.co.uk/technologycentre

VINCI CONSTRUCTION | UK

Client: Telling Architectural Ltd
10 Worthington Road
Suite K
Cranston
RI 02920
p. 401/632-4577
c. 401/787-8551
Job Number: 11-0045E
Test Date(s): 6/30-7/1/11
Report Date: 7/22/11

Test Procedures:

AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure

AAMA 501.5 Test Method for Thermal Cycling of Exterior Walls

ASTM E283-04 Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen

ASTM E331-00(2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E330-02(2010) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

Test Specimen Description:

Stud wall:

A freestanding test buck in 12"wide steel 'C' channel was prepared by MT Group, 10'-0" in height and 10'-0" wide. A load bearing panel was constructed with 6"deep x 16 gauge studs fitted in to a tracks at the top and base of the panel. The tracks were fastened to the buck with 3/32"thick x ¾" long stainless steel hex head screws 12" centers. Studs were fixed to the tracks at 16" centers. 5/8" plywood sheathing boards was screwed to the vertical studs at 12" centers with 1 5/8" board screws. A priming agent EXOAIR 5 agent was applied to the plywood and EXOAIR110 air/vapor barrier was applied.

Rain Screen System: **ArGeTon MTE System**
(4) rows of 9 gauge extruded MTE aluminum brackets 5 1/2" deep x 6 5/16" long x 1/8" thick were fastened to the 16 gauge studs through the sheathing board at 32" on center with (2#) 1/4" thick x 2" long stainless steel hexagon head coarse thread screws. The bottom row of the helping hand brackets were located approximately 6" from the base of the buck and were spaced at 36" vertically centers staggering each stud to evenly spread the stud loading.
A 9 gauge extruded aluminum horizontal 'Z' was fastened to the rows of MTE brackets using 1/4" x 2" stainless steel screws starting six inches from the bottom of the buck and 3' centers.
Three 12 gauge extruded aluminum top hat sections were fastened to the horizontal aluminum 'Z' at 4'-0" centers with 1/4" x 2" screws. The top hat had two vertical rows of 3/16" holes pre-punched @ 12" centers to suit the tile size. Argeton anodized aluminum tile clips were fixed with st/st alu rivets in to the pre-punched holes. The Argeton powder coated drainage profile was placed on the central tile joint and the Argeton mill finish spring profiles on the outer top hats inserted behind the tiles. The top row of tiles were

held in place with a 16 gauge continuous aluminum closer clip. The test wall had (18#) terracotta tiles 4'-0" long and 12" high mounted upon it.

Test Results:

Air infiltration

ASTM E 283	
@ 1.57 psf (25 MPH)	>.01 cfm/ft^2
@ 6.24 psf (50 MPH)	> .01 cfm/ft^2
@ 25 psf (100 MPH)	.01 cfm/ft^2

Water Penetration

ASTM E547 (Four (4) five minute cycles)	
@ 25 psf	No leakage or visible water
ASTM E331 (15 minute continuous)	
@25 psf	No leakage or visible water
AAMA 501.1 Dynamic	
@ 25psf (100 MPH)	No leakage or visible water

Uniform Load Structural

ASTM E330

Design Pressure

+60 psf (27.5" Span between anchors)	0.022"
-60 psf (27.5" Span between anchors)	0.011"

Uniform Load Structural

ASTM E330 (cont')

Overload

+90 psf (27.5" Span between anchors)	0.005"
-90 psf (27.5" Span between anchors)	0.005"

Thermal Cycling

AAMA 501.5 (Three (3) cycles -40°F – +140°F)

Phase 1: During the first hour, the temperature was increased on the weather side condition to the specified high temperature conditions of 140°F. These conditions were maintained for two hours.

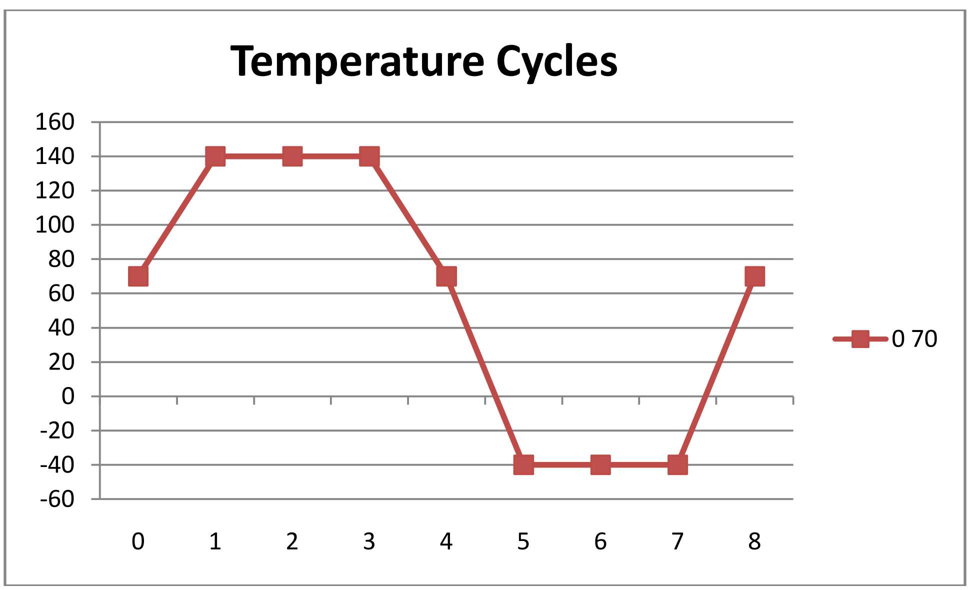
Phase 2: Weather side temperature decreased to 75°F in one hour.

Phase: 3 Weather side conditions were lowered to specified low temperature conditions -40°F over the next hour. These conditions were maintained for two hours.

Phase: 4 Weather side temperature increased to 75°F in one hour.

(The temperatures were average readings based on thermocouples placed six (6) inches from the top, center and six (6) inches from the bottom.)

Cycle 1	No permanent damage due to expansion and contraction
Cycle 2	No permanent damage due to expansion and contraction
Cycle 3	No permanent damage due to expansion and contraction



This report is prepared for the convenience of our customers and endeavors to provide accurate and timely project information. It contains a summary of observation made by a qualified representative of Materials Testing Lab, Inc. This report is intended to help in your Quality Assurance Program, but it does not represent a continuous nor exhaustive evaluation. The statements made herein do not constitute approval, disapproval, certification or acceptance of performance or materials.

A copy of this report will be retained by Materials Testing Lab, Inc, for a period of seven years.
This report is the exclusive property of the client so named herein.

MT Group

VP- Window/Curtain Wall Division

Client: Telling Architectural Ltd
7 The Dell
Enterprise Drive
Four Ashes
Wolverhampton, England WV10 7DF
Job Number: 11-0045A
Test Date(s): 6/30-7/1/11
Report Date: 7/22/11

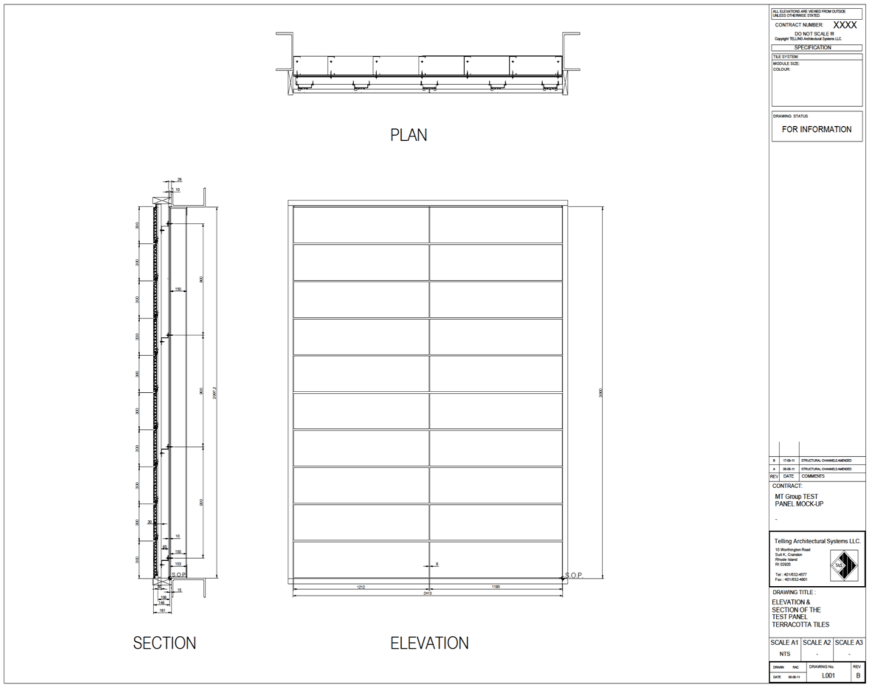
Test Procedures:

AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure
AAMA 501.5	Standard Test Method for Thermal Cycling
AAMA 508-07	Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
ASTM E283-04	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331-00(2009)	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E330-02(2010)	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

Test Specimen Description:

Stud wall:
A 12" 'C' channel test buck was supplied by MT Group. A load bearing wall was constructed with 2 x 6 x 1-1/2 galvanized studs fastened to the buck with 3/32" x ¾" SS hex head screws 12" centers. Studs were placed on 16" centers. 5/8 plywood sheathing boards were screwed to the vertical studs on 12" centers. A sealing agent was applied to the plywood and a peal/stick vapor membrane was applied.
Rain Screen System: **ArGeTon with Horizontal Rails and Vertical Top Hats**
Aluminum Horizontal 'Z' was fastened to the helping hand brackets using 1/4" x 2" screws starting six inches from the bottom of the buck and 3' centers.
Aluminum Top Hat was fastened to the aluminum 'Z' with 1/4" x 2" screws. The top hat employed 3/16" holes pre-punched through the face @ 6" centers. The tiles bottom edges were placed into base clips. The drainage profile is located on the central tile joint and the spring profiles on the outer edge of the tiles were inserted behind the tiles. The top of the tiles were held in place with intermediate clips. These clips were pop riveted in place. The system included (18) terracotta tiles.


TREMCO
EXOAIR



Test Results:

Air infiltration

ASTM E 283	
@ 1.57 psf (25 MPH)	>.01 cfm/ft^2
@ 6.24 psf (50 MPH)	> .01 cfm/ft^2
@ 25 psf (100 MPH)	.01 cfm/ft^2

Water Penetration

ASTM E547 (Four (4) five minute cycles)	
@ 25 psf	No leakage or visible water
ASTM E331 (15 minute continuous)	
@25 psf	No leakage or visible water
AAMA 501.1 Dynamic	
@ 25psf (100 MPH)	No leakage or visible water

Uniform Load Structural

The pressure differential across the test specimen at the time of testing for deflection measurements was 60.0 psf, first applied in a negative, then positive load. The pressure differential across the test specimen for permanent deformation measurement was 90.0 psf, first applied in a negative, then positive load. ASTM E330. The defection was taken from the longest unsupported span using a straight edge and dial calipers.

ASTM E330

Design Pressure

+60 psf	L/175
-60 psf	L/175

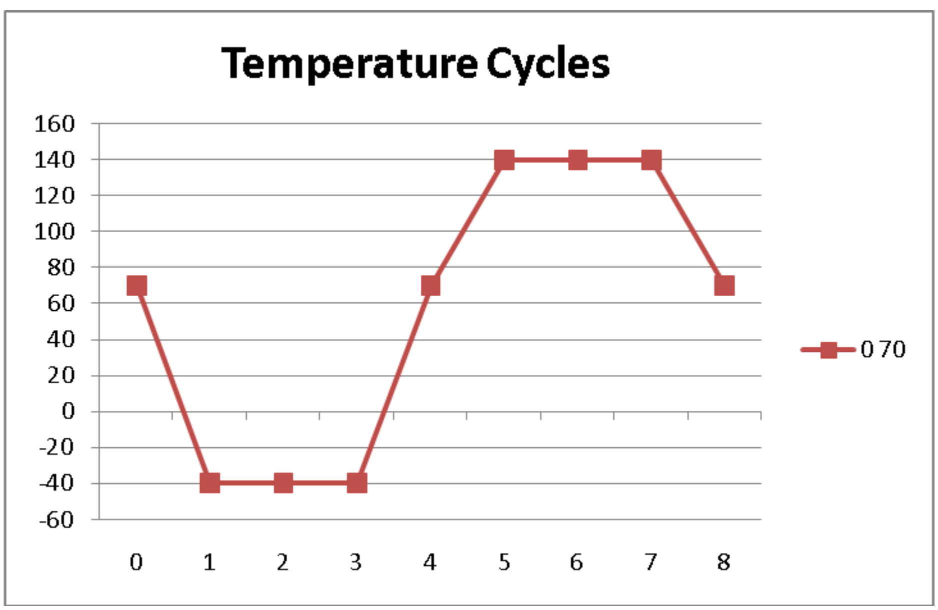
Overload

+90 psf	Perm set
-90 psf	Perm Set

Thermal Cycling

AAMA 501.5 (Three(3) cycles -40^{o}F – +140^{o}F)

Cycle 1	No damage, deformation, cracking
Cycle 2	No damage, deformation, cracking
Cycle 3	No damage, deformation, cracking



Test Witnesses (All or partial):

Davy Adams	Telling Architectural LTD
Wayne Breighner	MT Group
Michael Wood	Telling Architectural LTD
Mike Hendrick	MT Group
Ed Armellio	MT Group
Wayne Breighner Jr.	MT Group

The system tested performed as indicated in this report using components advised as being standard for the ArGeTon system mounted on a backing wall built to withstand the forces that were to be tested.This report is prepared for the convenience of our customers and endeavors to provide accurate and timely project information. It contains a summary of observation made by a qualified representative of Materials Testing Lab, Inc. This report is intended to help in your Quality Assurance Program, but it does not represent a continuous nor exhaustive evaluation. The statements made herein do not constitute approval, disapproval, certification or acceptance of performance or materials.

A copy of this report will be retained by Materials Testing Lab, Inc, for a period of seven years.
This report is the exclusive property of the client so named herein.

MT Group

VP- Window/Curtain Wall Division

Client: Telling Architectural Ltd
10 Worthington Road
Suite K
Cranston
RI 02920
p. 401/632-4577
c. 401/787-8551

Job Number: 11-0045C
Test Date(s): 6/30-7/1/11
Report Date: 7/22/11

Test Procedures:

AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure

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ASTM E331-00(2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E330-02(2010) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

Test Specimen Description:

Stud wall:

A freestanding test buck in 12"wide steel 'C' channel was prepared by MT Group, 10'-0" in height and 10'-0" wide. A load bearing panel was constructed with 6"deep x 16 gauge studs fitted in to a tracks at the top and base of the panel. The tracks were fastened to the buck with 3/32"thick x ¾" long stainless steel hex head screws 12" centers. Studs were fixed to the tracks at 16" centers. 5/8" plywood sheathing boards was screwed to the vertical studs at 12" centers with 1 5/8" board screws. A priming agent EXOAIR 5 agent was applied to the plywood and EXOAIR110 air/vapor barrier was applied.

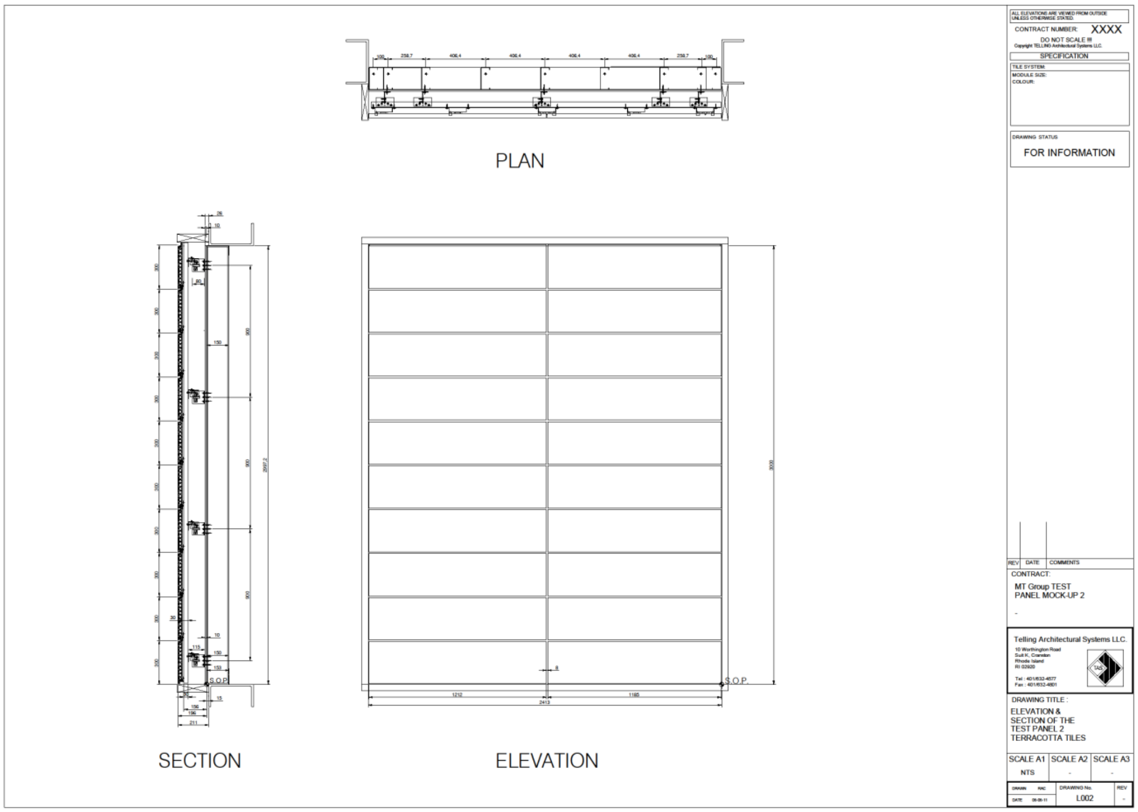
Rain Screen System: **ArGeTon Bracket and T Section for Masonry**

Three rows of (4) 1/8" thick aluminum 'helping hand brackets were aligned vertically on the test panel at 3' centers vertically. The helping hand brackets measured 5 1/2" deep x 3 3/8" long were fastened to the panel with (2) 1/4" x 2" stainless steel hexagon head/coarse thread screws. The lower bracket was fixed approx. 6" from bottom of buck. At the top a larger helping hand bracket measuring 5 1/2" x 6 5/16" fastened fixed with (2) 1/4" x 2" stainless steel hexagon head/coarse thread screws. (3) lengths of vertical extruded aluminum 'T' sections measuring 4 3/4" face x 1 3/4" depth x 9' 9 3/4" high were fastened with 3/16" x 1"long stainless steel hexagon headed coarse thread screws placed into slots of each bracket. 3/16" pre punched holes to the face were placed at 6" centers, every 2nd hole used a 12" tile base clip. The larger bracket located at the top of the panel received a dead hole fixing. The drainage profile is located on the central tile joint and the spring profiles on the outer aluminum 'T' sections behind the tiles.
Rain Screen System: **ArGeTon Bracket and T Section for Masonry**

Rain Screen System: **ArGeTon Bracket and T Section for Masonry (cont')**

The 'T' sections had two vertical rows of 3/16" holes pre-punched @ 12" centers to suit the tile size and were spaced at 4'-0" centers. Aluminum clips were riveted in to the pre-punched holes. The drainage profile was placed on the central tile joint and the spring profiles on the outer edge of the tiles were inserted behind the tiles. The top rows of tiles were held in place with a continuous aluminum closer clip. The test wall had (18) terracotta tiles 4'-0" long and 12" high mounted upon it.


TREMCO



Test Results:

Air infiltration

ASTM E 283

@ 1.57 psf (25 MPH)	>.01 cfm/ft^2
@ 6.24 psf (50 MPH)	> .01 cfm/ft^2
@ 25 psf (100 MPH)	.01 cfm/ft^2

Water Penetration

ASTM E547 (Four (4) five minute cycles) @ 25 psf	No leakage or visible water
ASTM E331 (15 minute continuous) @25 psf	No leakage or visible water
AAMA 501.1 Dynamic @ 25psf (100 MPH)	No leakage or visible water

Uniform Load Structural

The pressure differential across the test specimen at the time of testing for deflection measurements was 60.0 psf, first applied in a negative, then positive load. The pressure differential across the test specimen for permanent deformation measurement was 90.0 psf, first applied in a negative, then positive load. ASTM E330. The defection was taken from the longest unsupported span using a straight edge and dial calipers.

ASTM E330

Design Pressure

+60 psf (27.5" Span between anchors)	0.022"
-60 psf (27.5" Span between anchors)	0.011"

Uniform Load Structural

ASTM E330 (cont')

Overload

+90 psf (27.5" Span between anchors)	0.005"
-90 psf (27.5" Span between anchors)	0.005"

Thermal Cycling

AAMA 501.5 (Three (3) cycles -40^{o}F – +140^{o}F)

Phase 1: During the first hour, the temperature was increased on the weather side condition to the specified high temperature conditions of 140^{o}F. These conditions were maintained for two hours.

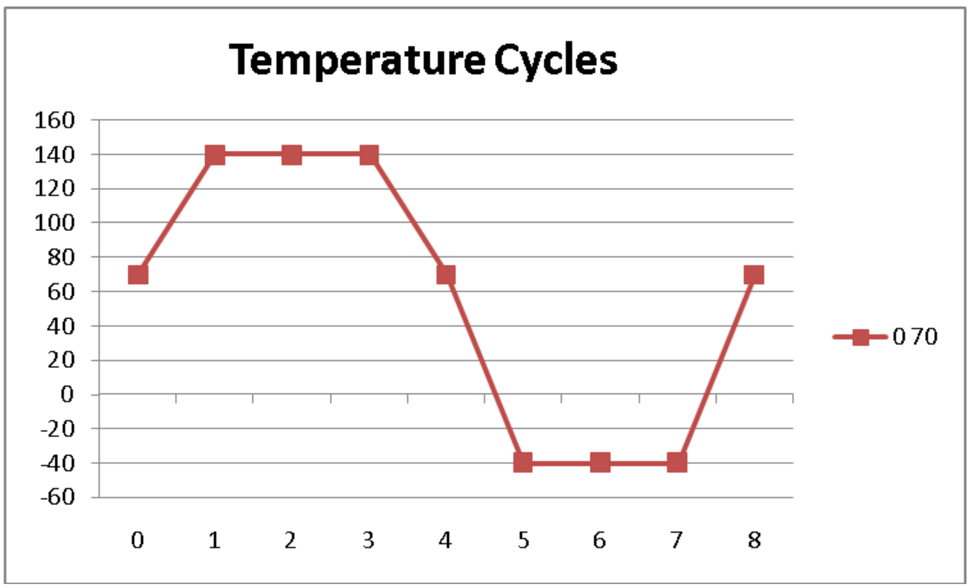
Phase 2: Weather side temperature decreased to 75°F in one hour.

Phase: 3 Weather side conditions were lowered to specified low temperature conditions -40°F over the next hour. These conditions were maintained for two hours.

Phase: 4 Weather side temperature increased to 75°F in one hour.

(The temperatures were average readings based on thermocouples placed six (6) inches from the top, center and six (6) inches from the bottom.)

Cycle 1	No permanent damage due to expansion and contraction
Cycle 2	No permanent damage due to expansion and contraction
Cycle 3	No permanent damage due to expansion and contraction



Test Witnesses (All or partial):

Davy Adams	Telling Architectural LTD
Wayne Breighner	MT Group
Michael Wood	Telling Architectural LTD
Mike Hendrick	MT Group
Ed Armellio	MT Group
Wayne Breighner Jr.	MT Group

The system tested performed as indicated in this report using components advised as being standard for the ArgeTon system mounted on a backing wall built to withstand the forces that were to be tested. This report is prepared for the convenience of our customers and endeavors to provide accurate and timely project information. It contains a summary of observation made by a qualified representative of Materials Testing Lab, Inc. This report is intended to help in your Quality Assurance Program, but it does not represent a continuous nor exhaustive evaluation. The statements made herein do not constitute approval, disapproval, certification or acceptance of performance or materials.

A copy of this report will be retained by Materials Testing Lab, Inc, for a period of seven years.
This report is the exclusive property of the client so named herein.

MT Group

VP- Window/Curtain Wall Division

Test Report No. 080961

1st English copy of 13th March 2012

Ordering party	ArGeTon GmbH Oldenburger Allee 26 30659 Hannover
Order date	7th Apr. 2008 - Mr. I. Lehnardt
Content of order	Acid resistance and base resistance test as well as surface scratch test according to DIN V 105-100 to brick facade sheeting

The Test Report includes 3 pages.

In case of any dispute, the original German version is decisive.

Materialprüfanstalt für das Bauwesen Hannover MPA BAU HANNOVER

Prepared by: Dr. Schnatzke
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D-30167 Hannover
GERMANY

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MPA BAU HANNOVER

1. Delivery of samples

A pallet with samples was delivered to the Institute of Material Testing on 11th Apr. 2008 by forwarding agent.

Details:

1. 12 pc. of brick facade sheeting, 'Tampa natural red'; dimensions (approx.): L: 49 cm, W: 21 cm, thickness: 3 cm; identification: none

   Internal sample No.: 0929/08

2. Test job

Acid resistance and base resistance test as well as surface scratch test according to DIN V 105-100 to brick facade sheeting.

3. Tests and test results

3.1 Surface scratch test

The surface of the brick facade sheeting was tested according to DIN V 105-100.

The surface has a scratch hardness of 6 – 7.

3.2 Acid resistance and base resistance test

The resistance of the brick facade sheeting towards acid and base was tested according to DIN V 105-100. For this purpose, 6 specimens per test liquid were sawed from the longitudinal side with the top overlap fold. The specimens were subsequently dried at 105°C and tested according to DIN EN ISO 10545-13 – Low concentration (L) and DIN EN ISO 10545-13 – High concentration (H).

Test liquids for acid and base resistance – Low concentration (L):

1) Hydrochloric acid solution HCl (3% (V/V))
2) Citric acid (100g/l)
3) Potassium hydrate solution KOH (30g/l)

Test liquids for acid and base resistance – High concentration (H):

1) Hydrochloric acid solution HCl (18% (V/V))
2) Lactic acid (5% (V/V))
3) Potassium hydrate solution KOH (100g/l)

<u>Result: Testing of acid and base resistance – Low concentration (L)</u>

No flaking or separation of material occurred to the surfaces of the specimens. Also, no other visible changes occurred to the surfaces or the cut or uncut edges.

<u>Result: Testing of acid and base resistance – High concentration (H)</u>

No flaking or separation of material occurred to the surfaces of the specimens after testing. Due to the storage in the hydrochloric acid and in the potassium hydrate solution, white salt spots occurred to the surface of the bricks, however, they are of no relevance for the assessment according to DIN V 105-100.

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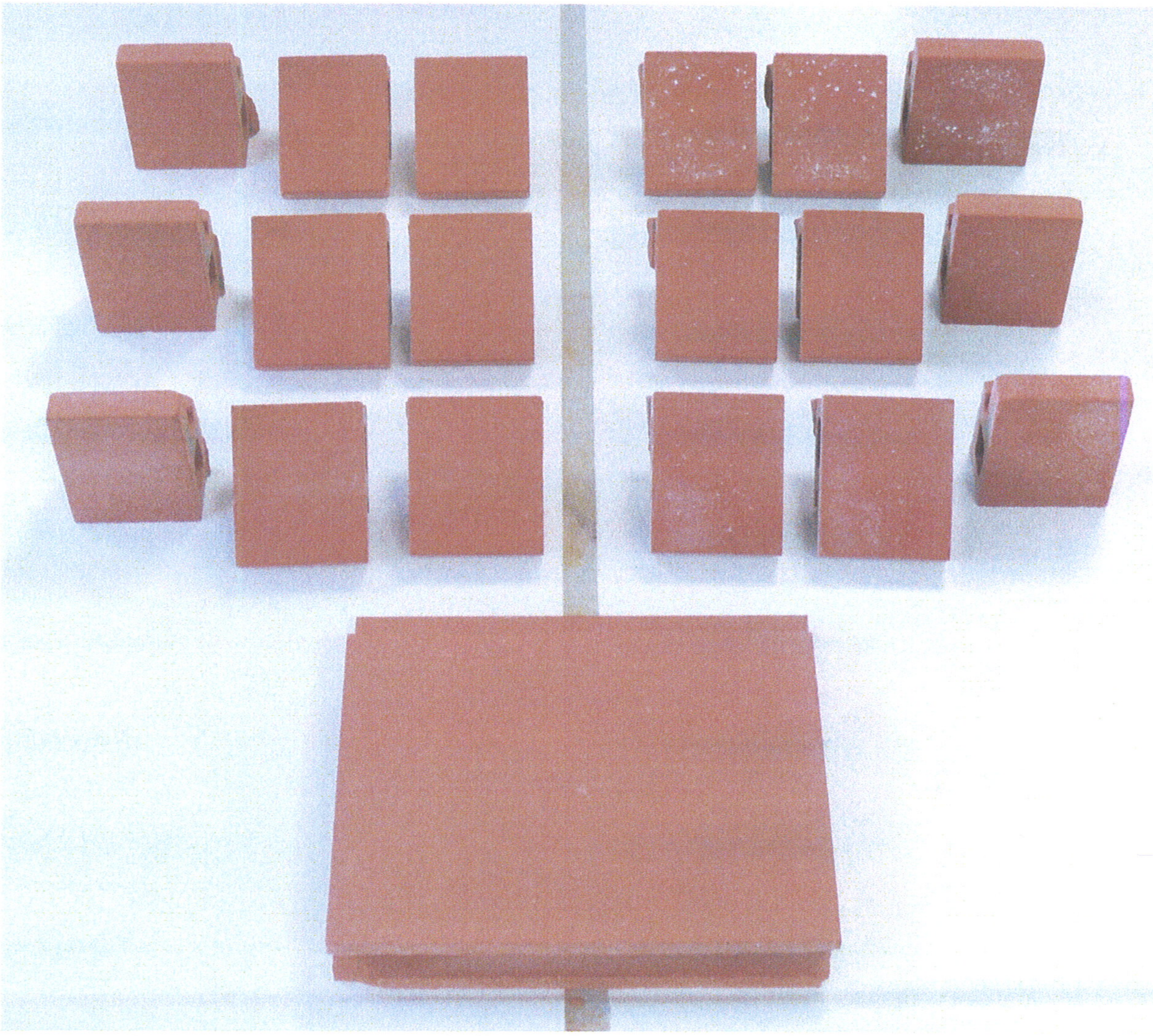

Fig. 1: Each 3 of the 6 specimens from the resistance tests
Left side: "low concentration (L)", from top to bottom, test run 1, 2, 3
Right side: "high concentration (H)", from top to bottom, test run 1, 2, 3
Bottom: untreated reference block

Summary:

The brick samples tested according to DIN EN ISO 10545-13 with "low concentration (L)" and with "high concentration (H)" comply with the requirements of DIN V 105-100 with regard to acid resistance and base resistance.

Hannover, 13th March 2012
Head of Test Centre

(RD Dipl.-Ing. Suhr)

Materialprüfanstalt für das Bauwesen Hannover
MPA BAU HANNOVER

Head of Chemical Laboratory

(Dr. rer. nat. Schnatzke)

BAUTEST DRESDEN GmbH
former dept. for building materials and metals of MPA Dresden

Test Report

Client

ArGeTon GmbH

Oldenburger Allee 26
30659 Hannover

Contract no.:

DD 1636 / 2007

Task:	Testing of cladding tiles from ArGeTon Toskana Tampa PM 592 mm 300 x 600 mm
Order date:	08 August 2007
Testing laboratory:	BAUTEST DRESDEN GmbH

Dresden, 21 December 2007

Head of test unit	Testing Agency Manager
i. A. Pohle	i. A. Müller
p.p. Dipl.-Ing. Pohle	p.p. Dipl.-Ing. Müller

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BAUTEST DRESDEN GmbH
Georg-Schumann-Straße 7
01187 Dresden
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www.bautest.de

This test report contains 2 text and 7 attachment pages.

1 Task

The client delivered to the testing laboratory BAUTEST DRESDEN GmbH 28 off ArGeTon cladding tiles of the size K 300x600mm TOSKANA TAMPA PM 592 mm in two lots for testing.
These tests were carried out following to DIN EN ISO 10545, with the exception of the freezing test as per DIN EN 539-2. Apart from the basic dimensions, the manufacturer provided no other target specifications.
The surfaces of the cladding tiles are flat and free from cracking.

2 Test performance and results

2.1 Dimensions and surface quality

The test was carried out as per DIN EN ISO 10545-2 (1997-12) "Ceramic tiles, Part 2: Determination of dimensions and surface quality"

The dimensions (length, width, thickness), straightness, squareness were measured and an assessment of the surface quality was made.

All measured values and the required test values are represented in the Attachment 1 as a summary.

2.2 Water absorption

The test was carried out as per DIN EN ISO 10545-3 (1997-12) "Ceramic tiles, Part 3: Determination of water absorption, apparent porosity, apparent relative density and bulk density".

The water absorption was determined on the basis of the "cooking method" and "vacuum method".

All measured values and the required test values are represented in the Attachment 2 as a summary.

2.3 Flexural strength

The test was carried out as per DIN EN ISO 10545-4 (1997-12) "Ceramic tiles, Part 4: Determination of modulus of rupture and breaking strength". To this end, the breaking loads were determined on cladding tiles with and without prior freezing.

The load was introduced centrally at a span of 570mm.

All measured values and the required test values are represented in the Attachment 3 as a summary.

2.4 Moisture expansion

The test was carried out as per DIN EN ISO 10545-10 (1997-12) "Ceramic tiles, Part 10: Determination of moisture expansion".

All measured values and the required test values are represented in the Attachment 4 as a summary.

2.5 Frost resistance

The test was carried out according to DIN EN 539-2 (2006-10), method C "Clay roofing tiles for discontinuous laying - Determination of physical characteristics, Part 2: Test for frost resistance".

Attachment 5 documents the losses of weight after alternating frost and dew stress cycles and a description of the PK condition after the test.

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ATTACHMENT 1

2.1 Dimensions and surface quality of cladding tiles as per DIN EN ISO 10545-2 (1997-12)

2.1.1 Determination of dimensions

Test Specification: DIN EN ISO 10545-2 (1997-12) "Ceramic tiles, Part 2: Determination of dimensions and surface quality"
Number of samples ≥ **10** (each 2x length; 2x width; 4x thickness)

2.1.1.1 Length		11	12	13	14	15	16	17	18	19	20				**Requirement:**
1. Measurement	[mm]	592,3	592,3	592,2	591,8	591,8	591,9	591,9	591,8	591,9	591,8	**Mean value**	**Minimum**	**Maximum**	- Factory dimension
2. Measurement	[mm]	592,2	592,1	592,1	591,7	591,7	591,7	591,7	591,7	591,7	591,8	**591,9**	591,7	592,3	**592,0**
Mean value	**[mm]**	**592,3**	**592,2**	**592,2**	**591,8**	**591,8**	**591,8**	**591,8**	**591,8**	**591,8**	**591,8**	bs. Mean val	Abs. Min.	Abs. Max.	
Deviation from the side length Φ	[%]	0,06	0,05	0,04	-0,03	-0,03	-0,02	-0,02	-0,03	-0,02	-0,02	**0,03**	0,02	0,06	
Deviation from the factory dimension	[%]	0,04	0,03	0,03	-0,04	-0,04	-0,03	-0,03	-0,04	-0,03	-0,03	**0,04**	0,03	0,04	

2.1.1.2 Width		11	12	13	14	15	16	17	18	19	20				**Requirement:**
1. Measurement	[mm]	314,6	313,9	314,3	313,3	313,5	313,6	313,5	314,1	314,6	313,6	**Mean value**	**Minimum**	**Maximum**	- Factory dimension
2. Measurement	[mm]	313,8	314,7	314,3	313,7	314,5	313,6	313,8	315,2	315,5	313,5	**314,1**	313,3	315,5	**313,5**
Mean value	**[mm]**	**314,2**	**314,3**	**314,3**	**313,5**	**314,0**	**313,6**	**313,7**	**314,7**	**315,1**	**313,6**	bs. Mean val	Abs. Min.	Abs. Max.	
Deviation from the side width Φ	[%]	0,04	0,07	0,07	-0,18	-0,03	-0,15	-0,14	0,18	0,31	-0,17	**0,13**	0,03	0,31	
Deviation from the factory dimension	[%]	0,22	0,26	0,26	0,00	0,16	0,03	0,05	0,37	0,49	0,02	**0,19**	0,00	0,49	

2.1.1.3 Thickness		11	12	13	14	15	16	17	18	19	20				**Requirement:**
1. Measurement	[mm]	29,8	29,5	29,7	30,0	30,0	30,3	30,0	30,2	29,8	29,9				
2. Measurement	[mm]	29,8	29,7	30,1	29,6	29,9	29,7	30,0	29,8	30,0	30,2				
3. Measurement	[mm]	29,7	29,9	29,7	29,8	29,6	29,9	29,7	30,6	30,8	29,8	**Mean value**	**Minimum**	**Maximum**	- Factory dimension (assumed)
4. Measurement	[mm]	29,7	29,8	29,9	30,2	29,7	29,9	30,2	29,8	30,3	30,3	**29,9**	29,5	30,8	**30,0**
Mean value	**[mm]**	**29,8**	**29,7**	**29,9**	**29,9**	**29,8**	**30,0**	**30,0**	**30,1**	**30,2**	**30,1**	bs. Mean val	Abs. Min.	Abs. Max.	
Deviation from the factory dimension	[mm]	-0,25	-0,28	-0,15	-0,10	-0,20	-0,05	-0,02	0,10	0,22	0,05	**0,14**	0,02	0,28	
Deviation from the factory dimension	[%]	-0,83	-0,92	-0,50	-0,33	-0,67	-0,17	-0,08	0,33	0,75	0,17	**0,47**	0,08	0,92	

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ATTACHMENT 1

2.1 Dimensions and surface quality of cladding tiles as per DIN EN ISO 10545-2 (1997-12)

2.1.2 Determination of straightness

Test Specification: DIN EN ISO 10545-2 (1997-12) "Ceramic tiles, Part 2: Determination of dimensions and surface quality"
Number of samples ≥ **10** (each 2x length; 2x width)

2.1.2.1 Longitudinal sides			**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**				**Requirement:**
1. Measurement	"-C"	[mm]	-1,0	-0,3	-0,1		-1,1	-1,0	-0,9	-0,5	-0,8	-0,5				
	"+C"	[mm]				0,0										
2. Measurement	"-C"	[mm]		-0,3	-0,3	-0,7							**Mean value**	**Minimum**	**Maximum**	- Factory dimension
	"+C"	[mm]	1,0				1,1	1,1	0,2	0,5	0,7	0,1		**-1,1**	**1,1**	**592,0**
Abs. Maximum		**[mm]**	**1,0**	**0,3**	**0,3**	**0,7**	**1,1**	**1,1**	**0,9**	**0,5**	**0,8**	**0,5**	s. Mean val	Abs. Min.	Abs. Max.	
Max. deviation from the factory dimension		[%]	0,17	0,05	0,05	0,12	0,19	0,19	0,15	0,08	0,14	0,08	0,12	0,05	**0,19**	

2.1.3 Determination of squareness

Test Specification: DIN EN ISO 10545-2 (1997-12) "Ceramic tiles, Part 2: Determination of dimensions and surface quality"
Number of samples ≥ **10** (each 2x length; 2x width)

2.1.3.1 Longitudinal sides			**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**				**Requirement:**
1. Measurement	"-δ"	[mm]				-0,3				-0,7						
	"+δ"	[mm]	1,5	0,3	0,0		1,9	0,0	0,0	0,7	0,0	0,0				
2. Measurement	"-δ"	[mm]		-1,3				-1,1			-0,7		**Mean value**	**Minimum**	**Maximum**	- Factory dimension
	"+δ"	[mm]	1,5		0,3	1,0	3,0		1,1	1,4		0,7		**-1,3**	**3,0**	**592,0**
Abs. Maximum		**[mm]**	**1,5**	**1,3**	**0,3**	**1,0**	**3,0**	**1,1**	**1,1**	**1,4**	**0,7**	**0,7**	s. Mean val	Abs. Min.	Abs. Max.	
Max. deviation from the factory dimension		[%]	0,25	0,22	0,05	0,17	0,51	0,19	0,19	0,24	0,12	0,12	0,20	0,05	**0,51**	

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ATTACHMENT 1

2.1 Dimensions and surface quality of cladding tiles as per DIN EN ISO 10545-2 (1997-12)

2.1.5 Determination of surface quality

Test Specification: DIN EN ISO 10545-2 (1997-12) "Ceramic tiles, Part 2: Determination of dimensions and surface quality"

Requirement:		**Tested:**	
Test area:	≥ 1 m²	Test area:	approx. 5 m²
Number of samples	≥ 30 pcs	Number of samples	28 pcs

Found surface flaws	**Number**	**Flaw portion [%]**		**Number**	**Flaw portion [%]**	**Requirement:**
- Fragment cracks	0	0,0	- Crazes	0	0,0	
- Unglazed spots	0	0,0	- Roughs	0	0,0	
- Pin hole	0	0,0	- Devitrification of glazing	0	0,0	
- Stains	0	0,0	- Flaws under the glazing	0	0,0	
- Decoration flaws	0	0,0	- Splinters	0	0,0	
- Bubbles	0	0,0	- Rough edge	0	0,0	
- Glazing projection	0	0,0			0,0	
Flawed tiles				0	0,0	
Flaw-free tiles				28	100,0	

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ATTACHMENT 2

2.2 Water absorption of cladding tiles - as per DIN EN ISO 10545-3 (1997-12)

Test Specification: DIN EN ISO 10545-3 (1997-12) "Ceramic tiles, Part 3: Determination of water absorption, apparent porosity, apparent relative density and bulk density"
Number of samples ≥ **10** if visible tile area is ≤ 0.04m²; single weight of sample: ≥ 50 g
Number of samples ≥ **5** if visible tile area is > 0.04m²

2.2.1 Cooking test		**Sample no.**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	With halved tiles			**Requirement:**
													Mean value	**Minimum**	**Maximum**	
m_1	Dry weight	[g]	4279	4226	3814	3308	3738	3533	4636	3560	3828	3575				
m_{2b}	Weight after cooking test	[g]	4495	4441	4006	3493	3944	3731	4896	3762	4030	3776				
E_b	**WA cooking test**	**[M-%]**	**5,0**	**5,1**	**5,0**	**5,6**	**5,5**	**5,6**	**5,6**	**5,7**	**5,3**	**5,6**	**5,4**	5,0	**5,7**	

2.2.2 Vacuum method		**Sample no.**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	With full tiles			**Requirement:**
													Mean value	**Minimum**	**Maximum**	
m_1	Dry weight	[g]	7766	7773	7783	7474	7474	7473	7473	7455	7477	7477				
m_{2v}	Weight after vacuum test	[g]	8271	8277	8285	7987	7987	7990	7987	7971	7979	7987				
E_v	**WA vacuum test**	**[M-%]**	**6,5**	**6,5**	**6,4**	**6,9**	**6,9**	**6,9**	**6,9**	**6,9**	**6,7**	**6,8**	**6,7**	6,4	**6,9**	

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ATTACHMENT 3

2.3 Flexural strength of cladding tiles - as per DIN EN ISO 10545-4 (1997-12)

Test Specification: DIN EN ISO 10545-4 (1997-12) "Ceramic tiles, Part 4: Determination of modulus of rupture and breaking strength"
Number of samples ≥ **10** if tile dimensions are < 48mm, but ≥ 18mm
Number of samples ≥ **7** if tile dimensions are ≥ 48mm

Samples without freezing stress

		Sample no.	11	12	13	14	15	16	17	18	19	20	With full tiles			Requirement:
													Mean value	Minimum	Maximum	
b	Tile width	[mm]	314,2	314,3	314,3	313,5	314,0	313,6	313,7	314,7	315,1	313,6				
F	Breaking force	[N]	1980	1920	2280	1800	2040	1860	1920	1860	1740	2340	**1974**	1740	2340	
L	Span	[mm]	570	570	570	570	570	570	570	570	570	570				
l	Projection	[mm]														
S	Breaking load (calc.) [1]	[N]	3592	3482	4135	3273	3703	3381	3489	3369	3148	4254	**3583**	3148	4254	
h	Min. thickness along breaking	[mm]	29,8	29,7	29,9	29,9	29,8	30,0	30,0	30,1	30,2	30,1				
R	**Flexural strength [2]**	**[N/mm²]**	**6,1**	**5,9**	**7,0**	**5,5**	**6,3**	**5,7**	**5,8**	**5,6**	**5,2**	**7,1**	**6,0**	**5,2**	7,1	

Testing after test for frost resistance as per DIN EN 539-2 (2006-10), method C

		Sample no.	1	2	3	4	5	6	7	8	9	10	With full tiles			Requirement:
													Mean value	Minimum	Maximum	
b	Tile width	[mm]	314,3	314,4	313,8	313,4	314,5	314,5	314,6	314,0	314,5	314,5				
F	Breaking force	[N]	2040	1740	1980	1920	2400	1680	2100	1980	2220	1800	**1986**	1680	2400	
L	Span	[mm]	570	570	570	570	570	570	570	570	570	570				
l	Projection	[mm]														
S	Breaking load (calc.) [1]	[N]	3700	3155	3597	3492	4350	3044	3805	3594	4023	3262	**3602**	3044	4350	
h	Min. thickness along breaking	[mm]	29,8	30,1	29,7	30,2	29,8	30,0	30,1	29,8	29,8	29,9				
R	**Flexural strength [2]**	**[N/mm²]**	**6,2**	**5,2**	**6,1**	**5,7**	**7,3**	**5,1**	**6,3**	**6,1**	**6,8**	**5,5**	**6,0**	**5,1**	7,3	

Result: **Complies with DIN EN 14411, App. A**

1) Breaking load idealized calculated with total tile width
2) Flexural strength idealized calculated with existing cladding tile height and total tile width

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ATTACHMENT 4

2.4 Moisture expansion of cladding tiles following to DIN EN ISO 10545-10 (1997-12)

Test Specification: following to DIN EN ISO 10545-10 (1997-12) "Ceramic tiles, Part 10: Determination of moisture expansion"
Number of samples ≥ 5 pcs
Heating: to approx. 500°C

Sample no.	A	B	C	D	E						On sections			Requirement:
Moisture expansion [mm/m]											Mean value	Minimum	Maximum	
[%]	0,033	0,025	0,032	0,034	0,031						0,031	0,025	0,034	

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ATTACHMENT 5

2.5 Frost resistance of cladding tiles - as per DIN EN 539-2 (2006-10), method C

Test Specification: DIN EN 539-2 (2006-10) "Clay roofing tiles for discontinuous laying - Determination of physical characteristics, Part 2: Test for frost resistance", Method C

Laboratory samples: ≥ **13** off non-damaged tiles
Number of samples ≥ **10** pcs
Absolute pressure: **61,300 Pa** = 61.3 kPa = ~600 mbar

2.5.1 Losses of weight (after frost-dew cycle)

	Sample no.		1	2	3	4	5	6	7	8	9	10	With full tiles			Requirement:
M	Starting dry weight	[g]	7773	7765	7756	7764	7756	7744	7752	7769	7774	7761	Mean value	Minimum	Maximum	
M'	Weight after 50 frost-dew cy	[g]	7772	7765	7755	7764	7756	7745	7752	7769	7775	7761				
	Loss of weight	**[M-%]**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	0,0	0,0	**0,0**	

2.5.2 Condition of the tiles after 50 frost-dew cycles

After 50 frost-dew cycles, no damages such as
- Flaking
- Fractures
- Separation of one or more ribs
- Cracks
- Peelings and
- Crazing were found on the tested tiles.

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NY Metropolitan Regional Office / Corporate Headquarters
145 Sherwood Avenue, Farmingdale, NY 11735 (631) 815-1900 FAX (631) 815-1901
www.materials-testing.com

Client:	Telling Architectural Systems LLC 68 Fox Run Cranston RI 02921	**Report #:** **Lab #:** **Date:** **Work Order #:**	11TA-001 10702 8/19/2001 **185432**

Project: Tiles
Sample: Five ArGeTon Terracotta Tiles

Submitted For: Flexural Strength Test
Procedure: ASTM C 880-09

Reference

Sample Conditioning: Dry, 48 hours at 60°C.

Span Length : 12.5

Results

Sample #	Width in.	Detph in.	Maximun Load lbs	Flexural Strength psi
1	4.01	1.22	1470	2310
2	4.05	1.21	1430	2260
3	4.05	1.20	1470	2360
4	4.06	1.20	1590	2550
5	4.05	1.21	1490	2360

Average Flexural Strength, psi: 2370

Reported To: William Smith

Submitted By: Materials Testing Lab, In

STATE OF NEW YORK
PAUL J. HESSE
No. 059484
LICENSED PROFESSIONAL ENGINEER

MT Group

MT GROUP

NY Metropolitan Regional Office / Corporate Headquarters
145 Sherwood Avenue, Farmingdale, NY 11735 (631) 815-1900 FAX (631) 815-1901
www.materials-testing.com

Client:	Telling Architectural Systems LLC 68 Fox Run Cranston RI 02921	Report #:	11TAS-003
		Lab #:	10702
		Date:	10/7/2011
		Work Order #:	188445

Sample: Five ArGeTon Terracotta Tiles
Submitted For: Compressive Strength
Procedure: ASTM C 67-09

Results

Sample #	Compressive Strength psi
1	11400
2	13100
3	11900
4	12700
5	12100

Average Compressive Strength, psi: 12200

Reported To: Mike Wood

Submitted By: Materials Testing Lab, Inc.

STATE OF NEW YORK ★ PAUL J. HESSEL ★ LICENSED PROFESSIONAL ENGINEER No. 059484

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Client: Telling Architectural Systems LLC
68 Fox Run
Cranston RI 02921

Report #: 11TAS-003
Lab # 10702
Date: 10/4/2011
Work Order #: 188033

Submitted For: ASTM C 67 - Freezing and Thawing

Material Identification

ArGeTon Terracotta Tiles

1.) Freezing and Thawing

Procedure: The test was conducted in accordance with ASTM C 67 on five specimens.

The specimens were exposed to 25 cycles of freezing and thawing. Each cycle consisted of 20 hours (+/- 1h) of freezing in a chamber maintained at a setting that did not allow the temperature to exceed 16°F one hour after introducing the test specimens into the chamber , followed by 4 hours (+/-0.5 h) of thawing by totally submerging in water at 75°F (+/- 10°F)

Results

Sample #	Initial Weight, g	Final Weight, g	Weight Loss %
1	552.5	552.2	0.05
2	557.0	556.8	0.04
3	531.1	530.9	0.04
4	536.9	535.1	0.34
5	528.3	527.8	0.09

Remarks : No cracks or breakage was observed in any of the 5 samples tested

Reported To: Mike Wood

Submitted By: **Materials Testing Lab, Inc.**

STATE OF NEW YORK
PAUL J. HESSEL
No. 059484
LICENSED PROFESSIONAL ENGINEER

MT Group

MT GROUP

NY Metropolitan Regional Office / Corporate Headquarters
145 Sherwood Avenue, Farmingdale, NY 11735 (631) 815-1900 FAX (631) 815-1901
www.materials-testing.com

Client:	Telling Architectural Systems LLC 68 Fox Run Cranston RI 02921	**Report #:**	11TAS-002
		Lab #:	10702
		Date:	9/12/2011
		Work Order #:	**186593**
Project:	Tiles Argenton		
Submitted For:	ASTM C 67 - Efflorescence		

Material Identification

ArGeTon Terracotta Tiles

1.) Efflorescence

Procedure: ASTM C 67 , ten representative samples were taken from the submitted tiles and tested for efflorescence.

Rating : " not effloresced"

Reported To: **Michael Wood**

Submitted By: **Materials Testing Lab, Inc.**

STATE OF NEW YORK
PAUL J. HESSEL
No. 059484
LICENSED PROFESSIONAL ENGINEER

MT GROUP
NY Metropolitan Regional Office / Corporate Headquarters
145 Sherwood Avenue, Farmingdale, NY 11735 (631) 815-1900 FAX (631) 815-1901
www.materials-testing.com

Client: Telling Architectural Systems LLC
68 Fox Run
Cranston RI 02921

Report #: 11TAS-001
Lab #: 10702
Date: 8/19/2011
Work Order #: 185432

Project: Tiles
Submitted For: Material Evaluation

Material Identification

ArGeTon Terracotta Tiles

1.) Absorption

Procedure: ASTM C 67 , five representative samples were taken from the submitted tiles.

RESULTS:

Sample No.	1	2	3	4	5
Dry Weight, g	539.1	540.7	548.4	545.2	541.5
Saturated Weight, after 5 h submersion, g	562.5	564.7	572.7	568.9	565.1
Saturated Weight, after 24 h submersion, g	564.2	566.5	574.5	571.1	567.8
Cold Water Absorption, after 5 h submersion, %	4.3	4.4	4.4	4.3	4.4
Cold Water Absorption, after 24 h submersion, %	4.7	4.8	4.8	4.8	4.9
Saturated Weight after 5 h boiling in water, g	575.5	578.1	586.8	583.0	580.1
Boiling Water Absorption, after 5 h submersion, %	6.8	6.9	7.0	6.9	7.1
Saturation Coefficient	0.69	0.69	0.68	0.69	0.68

Averge Cold Water Absorption, after 5 h submersion, %	4.4
Average Cold Water Absorption, after 24 h submersion, %	4.8
Average Saturation Coefficient	0.69

Reported To: Mike Wood

Submitted By: Materials Testing Lab, Inc.

STATE OF NEW YORK
PAUL J. HESSEL
No. 059484
LICENSED PROFESSIONAL ENGINEER

Certificate of Test

Title: Impact testing on a Terracotta Rainscreen cladding sample

Certificate of Test Number: 7546

Client's Name & Address:

Telling Architectural Ltd
Primrose Avenue
Fordhouses
Wolverhampton
West Midlands
WV10 8AW

Our Ref: N950/T473

TW Job No: 3ET2

Your Ref:

Date: 12 July 2005

Date sample(s) received: 5 January 2005

Sample(s) received from: Telling

Sample No: C1116-B

This Certificate and the results shown are based upon the information drawings samples and tests referred to herein

Taylor Woodrow accepts no liability for any damages, charges, costs (including, but not limited to, legal costs) or expenses in respect of or in relation to any damage to any property or other loss (save for death or personal injury occasioned by reason of any negligence on the part of Taylor Woodrow) whatsoever arising directly or indirectly from the use of this Certificate of Test, or the use of any goods or materials referred to in this Certificate of Test.

Tested by: ....
D. Bennett (position: Technician)

Authorised by: ....
N. McDonald (position: Principal Engineer)

Taylor Woodrow Technology,
Stanbridge Road, Leighton Buzzard, Bedfordshire, LU7 4QH

Tel No. 01525 859111 **Fax No. 01525 859112**
Registered Office Watford Registered No.1090601 England

UKAS TESTING
0057

Taylor Woodrow

1. INTRODUCTION

This certificate of test describes impact testing on a sample of Terracotta Rainscreen Cladding. Testing was carried out on the 5th January 2005 at the request of Telling Architectural Limited and was conducted at Taylor Woodrow's Cladding test facility at Leighton Buzzard, Bedfordshire.

Testing was carried out generally in accordance with the BS8200: 1985 section 7 and appendix G test procedure for soft body impacting.

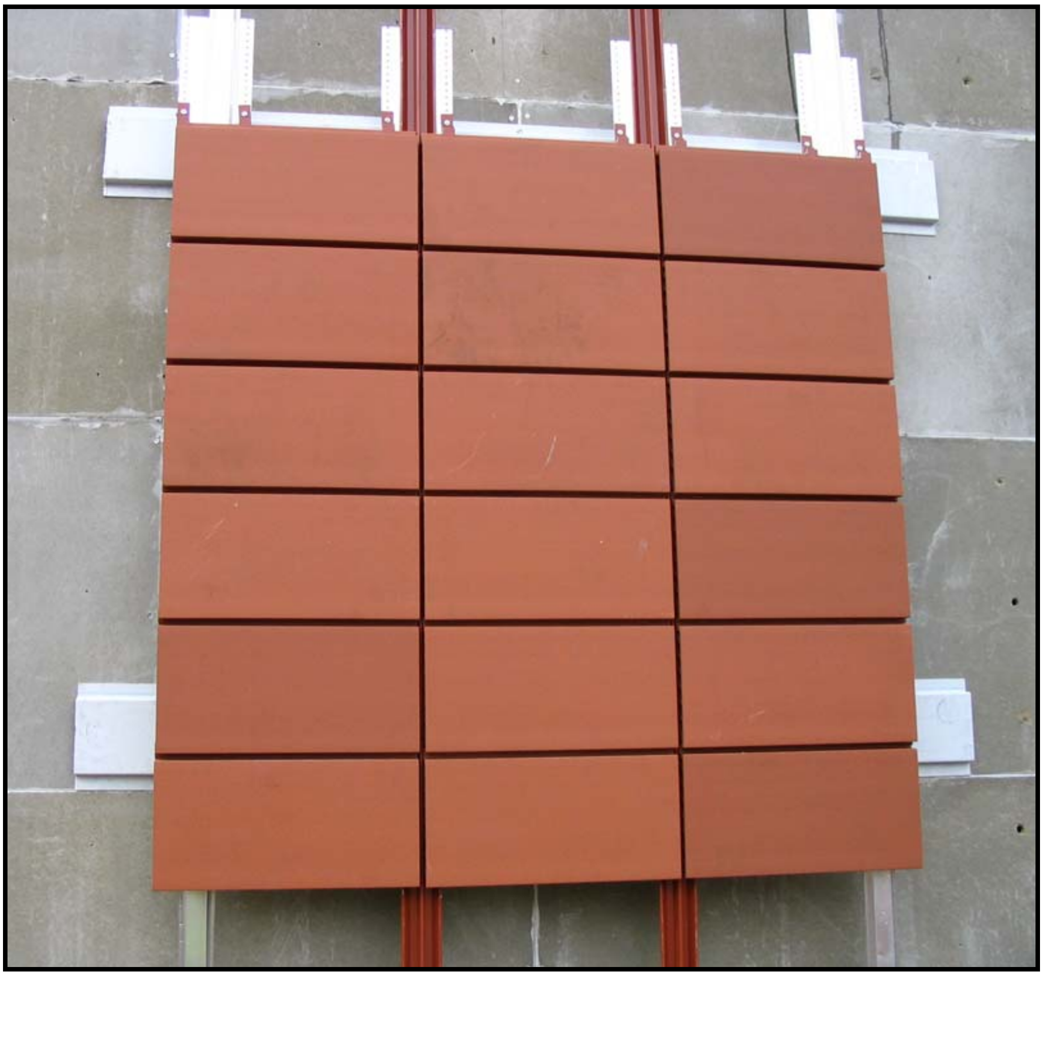
The test were witnessed by:

Russell Clark	-	Telling Architectural Ltd
Craig Boddice	-	Telling Architectural Ltd
Andrew Wood	-	Telling Architectural Ltd

2. SAMPLE DESCRIPTION

The test sample comprised of a Terracotta Rainsreen Cladding System as detailed in the drawing included at the end of this certificate and shown in photograph below.

PHOTO 0219



3. TEST ARRANGEMENT

3.1 Soft body

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.

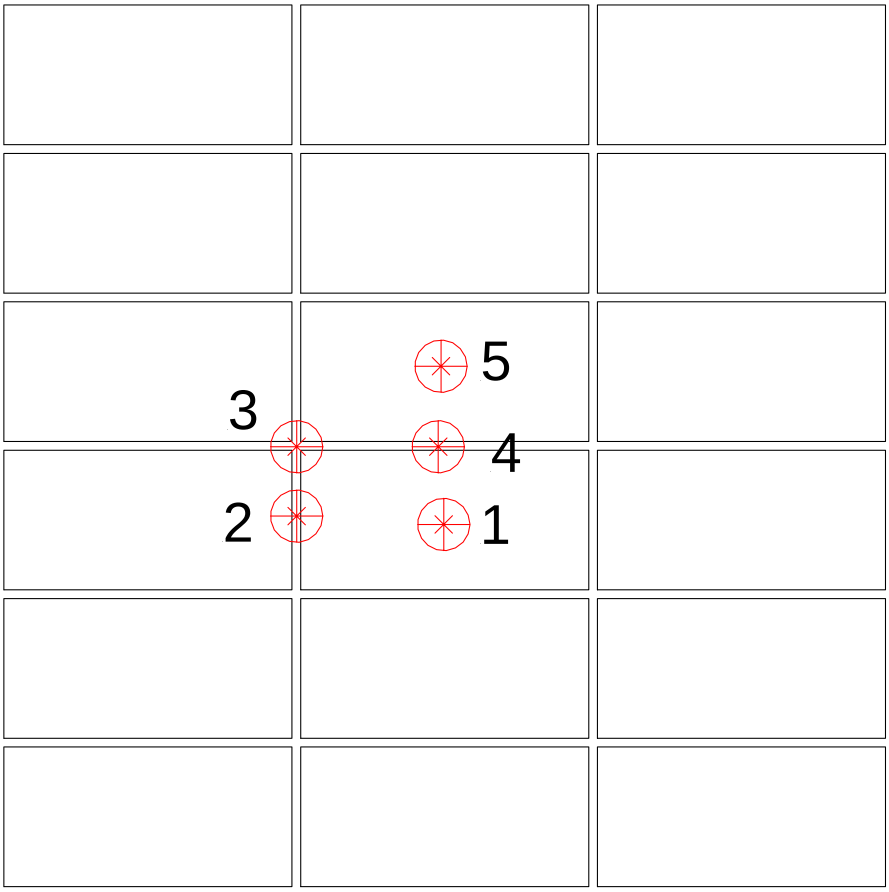
3.2 Hard body

The hard body impactors were solid steel balls of 50 mm and 65 mm diameters and approximate mass of 0.5 kg and 1.0 kg respectively.

4. TEST 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 locations shown in Figure 1. The impact energies were 120 Nm, 350 Nm and 500 Nm for the soft body and 3 Nm, 6 Nm and 10 Nm for the hard body.

FIGURE 1



5. TEST RESULTS

5.1 Soft Body

LOCATION	ENERGY (Nm)	RESULT
1	120, 350	No damage observed.
2	120, 350	No damage observed.
3	120, 350	No damage observed.
4	120, 350	No damage observed.
5	500	No damage observed to tiles. The vertical support rail moved in due to the buckling of the horizontal behind it.

PHOTO 0224

SUPPORT RAILS AFTER TESTING

5.2 Hard Body

Note: *These tests were carried out on a similar system using the same tiles and fixings, but on horizontal support rails.*

LOCATION	ENERGY (Nm)	RESULT
Centre of tile	3	Vertical hairline crack from top of impact point. Tile stayed secure on wall.
Short edge between tiles	3	No damage observed.
Long edge between tiles	3	Vertical crack across tile. Tile stayed secure on wall.
Centre of tile	6	3-way crack across tile. Tile stayed secure on wall.
Long edge between tiles	6	Vertical hairline crack from top of impact point. Tile stayed secure on wall.
Centre of tile	10	3-way crack across tile. Tile stayed secure on wall.

6. DRAWING

The following un-numbered page is a copy of Telling Architectural Ltd. drawing numbered T006.

END OF CERTIFICATE

Certificate of Test

Title: Impact testing a sample of a Telling Architectural Limited Terracotta Facade System

Certificate of Test Number: 13914

Client's Name & Address:

Telling Architectural Limited
7 The Dell
Enterprise Drive
Four Ashes
Wolverhampton
WV10 7DF

Our Ref: N950/V054

TC Job No: C3733

Your Ref:

Date: 28 January 2011

Date sample(s) received: 14 December 2010

Sample(s) received from: Telling Architectural Ltd.

Sample No: 1

Tested by: ....
D. Bennett (position: Technician)

Authorised by: S.R. Mox..
S.R. Moxon (position: Manager)

Technology Centre
Stanbridge Road, Leighton Buzzard, Bedfordshire, LU7 4QH

Tel No. 01525 859111 **Fax No. 01525 859112**
Registered Office, Watford Registered No. 2295904 England

TECHNOLOGY CENTRE

This Certificate and the results shown are based upon the information drawings samples and tests referred to herein

Technology Centre accepts no liability for any damages, charges, costs (including, but not limited to, legal costs) or expenses in respect of or in relation to any damage to any property or other loss (save for death or personal injury occasioned by reason of any negligence on the part of Technology Centre) whatsoever arising directly or indirectly from the use of this Certificate of Test, or the use of any goods or materials referred to in this Certificate of Test.

1. INTRODUCTION

This certificate of test describes impact tests carried out at the request of Telling Architectural Limited on 15 December 2010 at the Technology Centre in Leighton Buzzard.

The test was carried out in accordance with BS8200:1985.

The tests were witnessed by Dave Adams of Telling Architectural Limited.

2. SAMPLE DESCRIPTION

The test sample is shown in the photo below and the drawing included at the back of this certificate.

The terracotta tiles measured 1500 mm high and 300 mm wide.

The aluminium support frame was mounted vertically onto a rigid concrete test wall.

PHOTO 240010

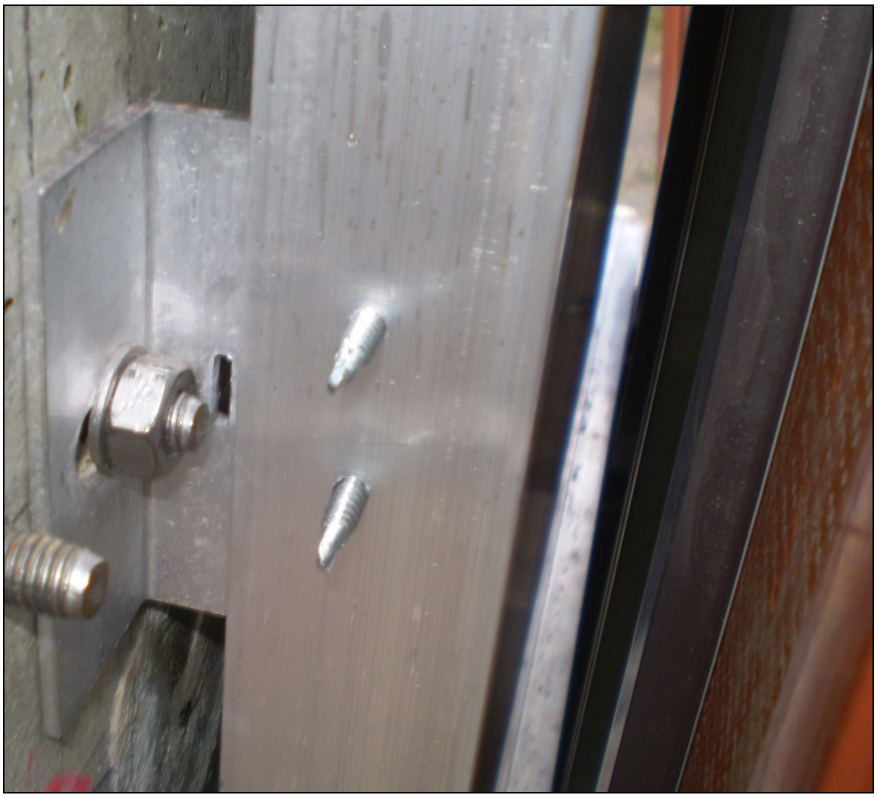
TEST SAMPLE FRONT ELEVATION

PHOTO 240011

END OF HORIZONTAL SUPPORT RAIL

PHOTO 240013

VERTICAL RAIL SUPPORT BRACKET



3. TEST PROCEDURE

4. IMPACTOR

4.1.1 Soft body

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.

4.1.2 Hard body

The hard body impactor was a solid steel ball of 62.5 mm and 50 mm diameter and approximate mass of 1.0 kg and 0.5 kg respectively.

5. PROCEDURE

5.1.1 Soft body

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 location 1 shown in Figure 1. The impact energies were 120 Nm, 350 Nm and 500 Nm.

5.1.2 Hard body

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 location 2 shown in Figure 1. The impact energies were 3 Nm, 6 Nm and 10 Nm.

6. PASS/FAIL CRITERIA

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.

The following two tables are taken directly from BS8200: 1985.

BS8200:1985 Table 2 – Categories associated with impacts on surfaces of the vertical enclosure to buildings

Category	Description	Examples	
A	Readily accessible to public and others with little incentive to exercise care. Prone to vandalism and abnormally rough use	External walls of housing and public buildings in vandal prone areas	Zone of wall up to 1.5 m above pedestrian or floor level
B	Readily accessible to public and others with little incentive to exercise care. Chances of accident occurring and of misuse	Walls adjacent to pedestrian thoroughfares or playing fields when not in category A	
C	Accessible primarily to those with some incentive to exercise care. Some chance of accident occurring and of misuse	Walls adjacent to private open gardens. Back walls of balconies	
D	Only accessible, but not near a common route, to those with high incentive to exercise care. Small chance of accident occurring or misuse	Walls adjacent to small fenced decorative garden with no through paths	
E	Above zone of normal impacts from people but liable to impacts from thrown or kicked objects	1.5 m to 6 m above pedestrian or floor level at location categories A and B	
F	Above zone of normal impacts from people and not liable to impacts from thrown or kicked objects	Wall surfaces at higher positions than those defined in E above	

BS8200:1985 Table 4 – Test impacts to ensure safety to persons

Wall category (see Table 2)	**Test impact energy for impactor shown**	
	H1	**S1**
	Nm	Nm
A	(see note 1 to Table 3)	
B and C external and indoor surfaces	10	500
D	(see note 2 to Table 3)	
E external and indoor surface	10	
E and F external surface if access is required for regular cleaning and maintenance		350

7. TEST RESULTS

Test date: 16 December 2010

7.1 Location 1

Soft body impacts at energies of 120 Nm and 350 Nm.

No damage observed.

7.2 Location 2

Soft body impacts at energies of 120 Nm and 350 Nm.

No damage observed.

7.3 Location 3

Soft body impact at an energy of 120 Nm.

No damage observed.

Soft body impact at an energy of 350 Nm.

Two tiles cracked horizontally but remained securely on wall (see photo 240015).

7.4 Location 4

Soft body impact at an energy of 500 Nm.

Two tiles cracked horizontally but remained securely on wall (see photo 240018).

7.5 Location 5

Hard body impacts at energies of 3 Nm and 6 Nm.

No damage observed.

7.6 Location 6

Hard body impact at an energy of 10 Nm.

Minor indent observed in face of tile, less than 1 mm in depth(see photo 240017).

8. SUMMARY OF TEST RESULTS

The sample passed the impact test for category B.

FIGURE 1

IMPACT TEST LOCATIONS

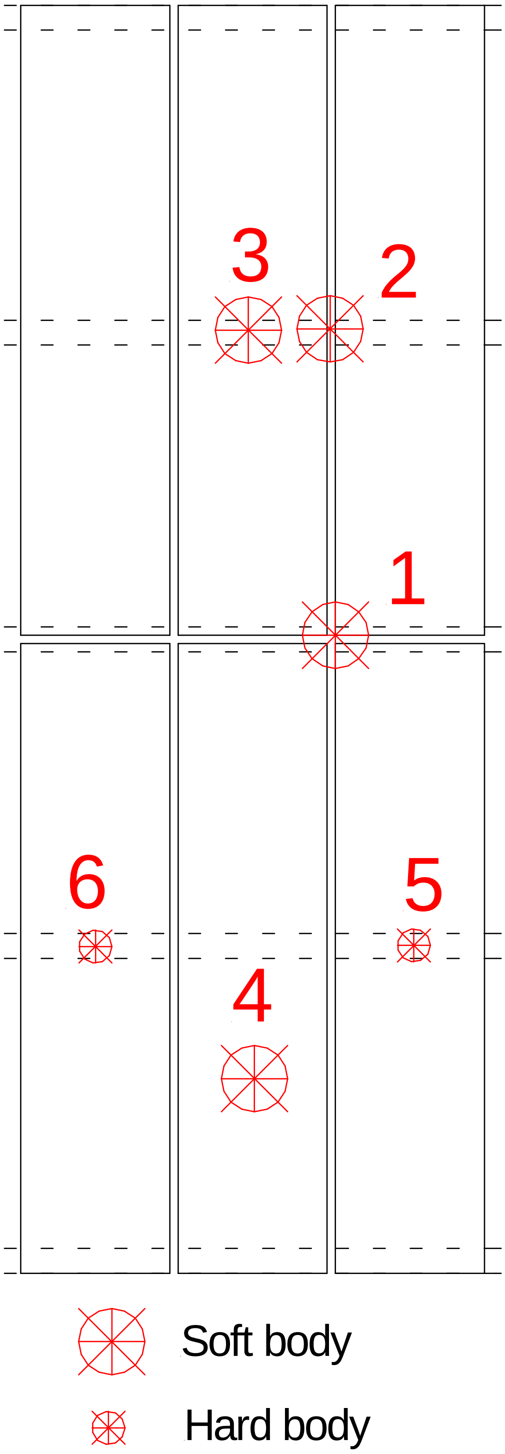


PHOTO 240017

SAMPLE AFTER 10 Nm HARD BODY IMPACT TEST

PHOTO 240015

SAMPLE AFTER 350 Nm SOFT BODY IMPACT TEST

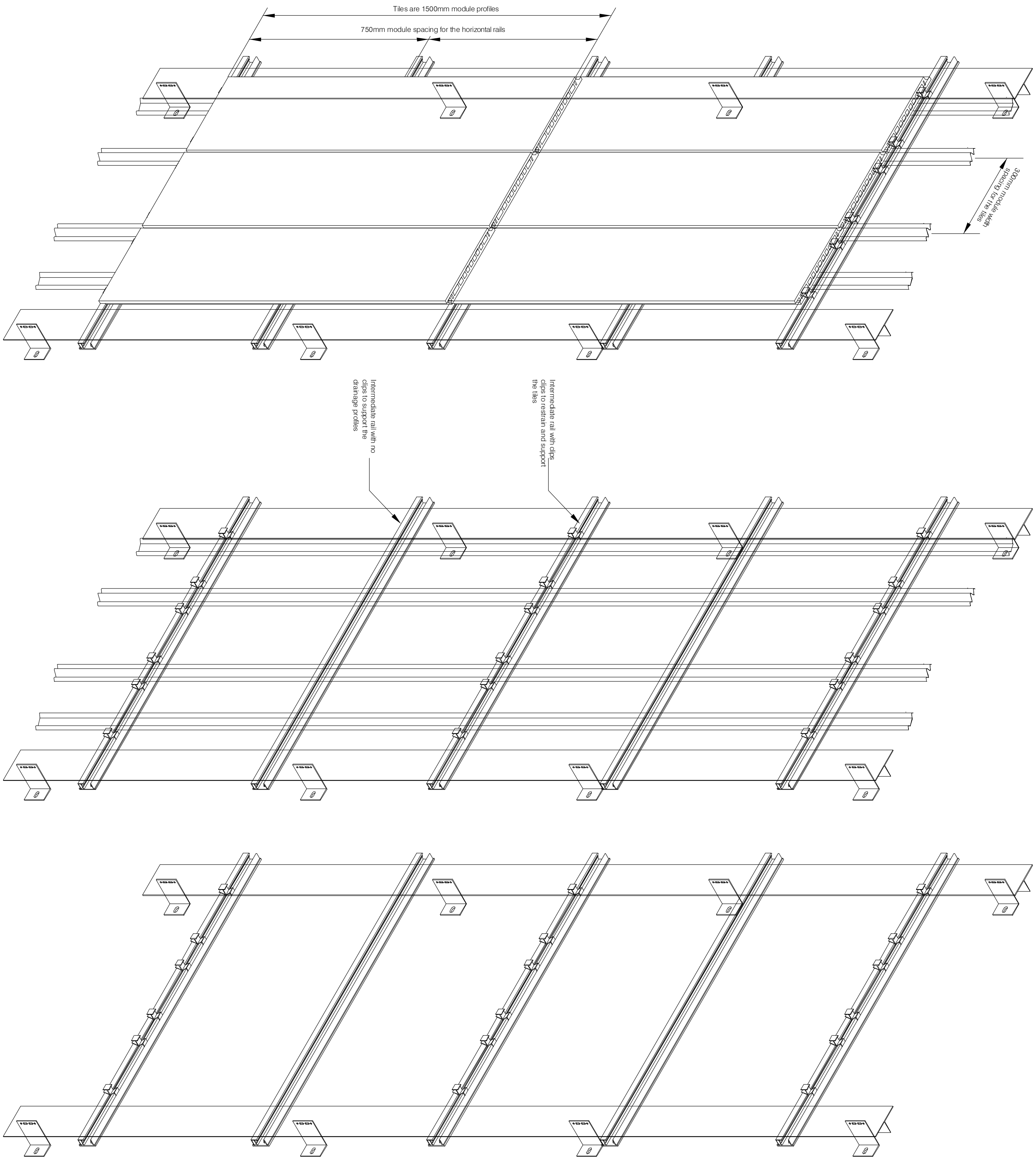
PHOTO 240018

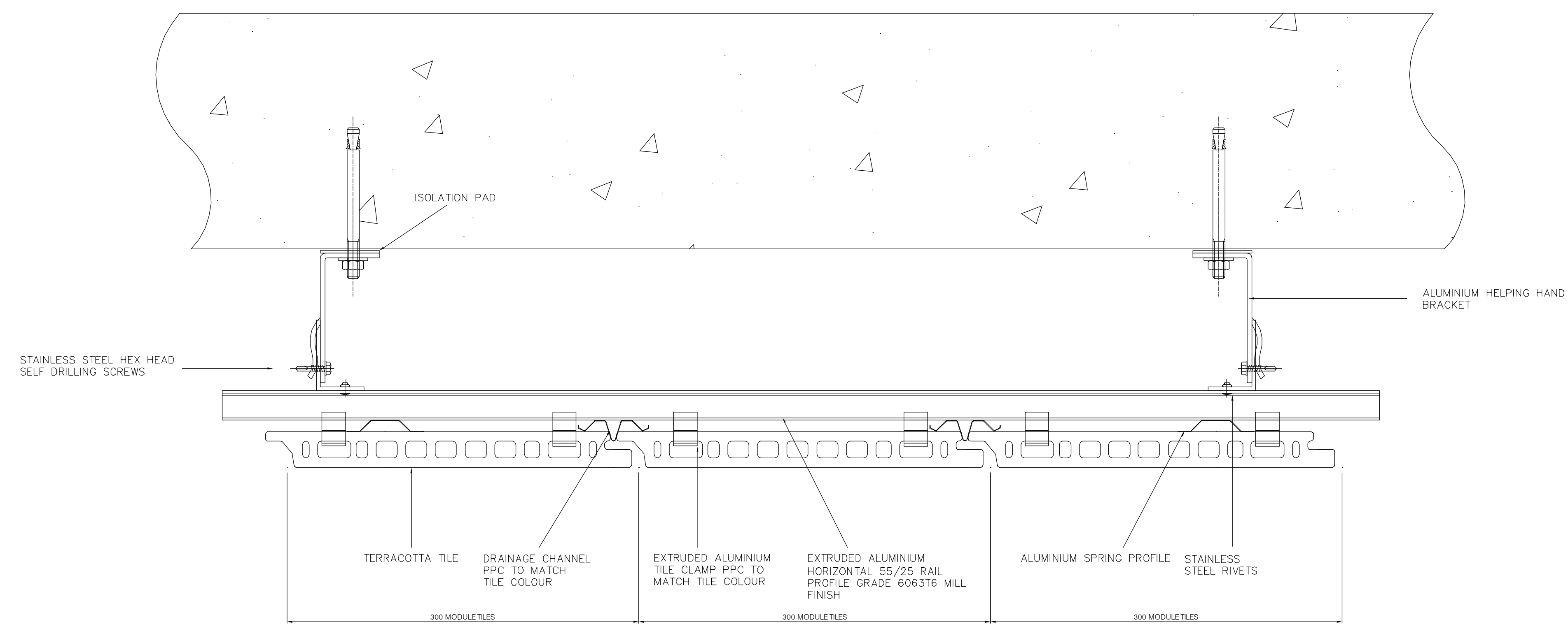
SAMPLE AFTER 500 Nm SOFT BODY IMPACT TEST

9. DRAWING

The following un-numbered page is a copy of a Telling Architectural Ltd. drawing numbered TEST02.

END OF CERTIFICATE





DATE	DRAWN	DRAWING No.	REV
02-04-10	RAC	TEST02	

SCALE A1	SCALE A2	SCALE A
NTS	NTS	NTS

DRAWING TITLE :
ISOMETRIC VIEW OF HORIZONTAL TILE SUPPORT SYSTEM

Telling Architectural Ltd.
Primrose Avenue
Fordhouses
Wolverhampton
WV10 8AW
Tel : 01902 789777
Fax : 01902 398777

CONTRACT:
TEST WALL AT TAYWOOD FOR IMPACT TESTING IN ACCORDANCE WITH BS8200

REV	DATE	COMMENTS

DRAWING STATUS
AS BUILT

TILE SYSTEM:
MODULE SIZE:
COLOUR:

SPECIFICATION

DO NOT SCALE !!!

CONTRACT NUMBER: XXXX

ALL ELEVATIONS ARE VIEWED FROM OUTSIDE UNLESS OTHERWISE STATED.

Technical Report

Title

Weathertightness testing an Argeton Rainscreen system of terracotta

Report Number & Date of Issue

N950/07/13946/REV01
16 OCTOBER, 2007

Author: D. Bennett Position: Technician	**TW Job No.** 3HE8/C1994
Author's signature:	
Checked by: N. McDonald Position: Principal Engineer	
Authorised by: S. R. Moxon S. R. Mox Position: Manager	
Distribution (confidential) - 1 copy to TW central area for archive - 1 copy to TW project file - 3 copies to Telling	
Abstract	

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UKAS TESTING
0057

Taylor Woodrow

CONTENTS

1. INTRODUCTION

This report describes tests carried out at the Taylor Woodrow Technology Centre at the request of Telling Architectural Limited, Primrose Avenue, Fordhouses, Wolverhampton, West Midlands, WV10 8AW.

The test sample consisted of an Argeton Rainscreen system of terracotta manufactured by Telling.

Taylor Woodrow is accredited by the United Kingdom Accreditation Service as UKAS Testing Laboratory No.0057 and is also approved with Lloyds Register of Quality Assurance for ad-hoc in-service inspections and tests to ISO 9001 2000.

The tests were carried out on the 11th and 12th September 2007 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:

Watertightness – dynamic pressure

Wind resistance – serviceability & safety.

The sample was also subjected to the following non UKAS accredited tests in accordance with the Taylor Woodrow Quality System:

Impact resistance. (BS 8200)

Seismic movement. (AAMA 501.4-00)

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

The results are valid only for the conditions under which the tests were conducted.

2. DESCRIPTION OF TEST SAMPLE

2.1 GENERAL ARRANGEMENT

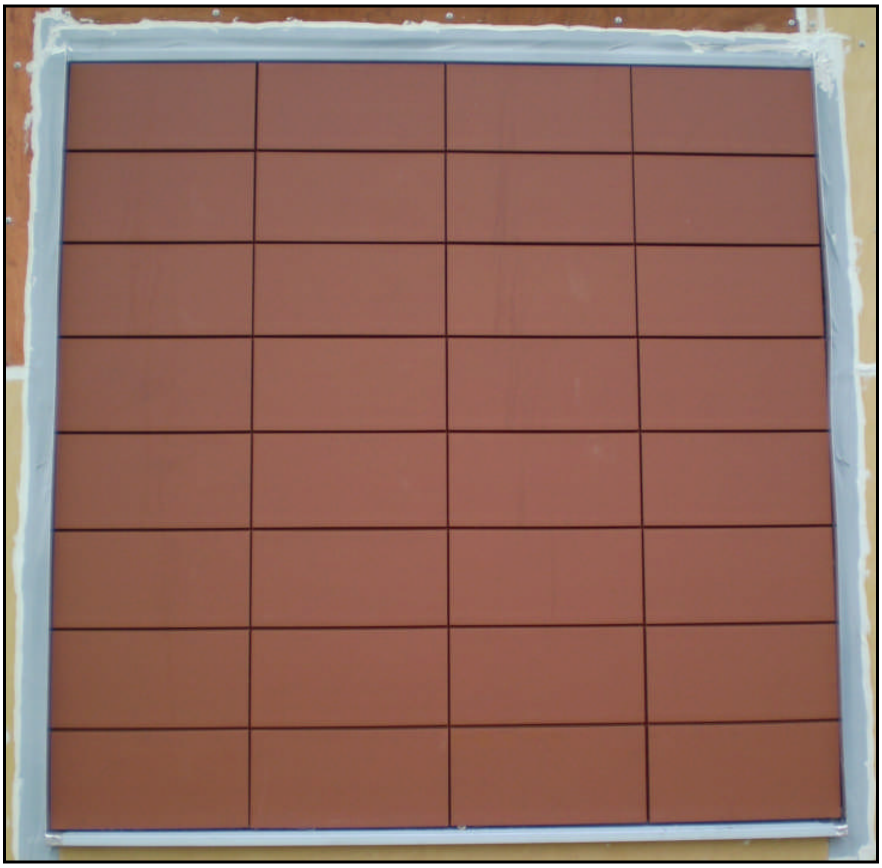
The sample was as shown in the photo below and the drawings included as an appendix to this report.

The tiles measured 600 mm wide by 300 mm high and were supported by vertical rails at 600 mm centres.

The aluminium rainscreen carrier frame was secured to the backing wall framework with 2 coarse thread self drilling Tek screws at each fixing position.

PHOTO 00013

TEST SAMPLE ELEVATION



2.2 CONTROLLED DISMANTLING

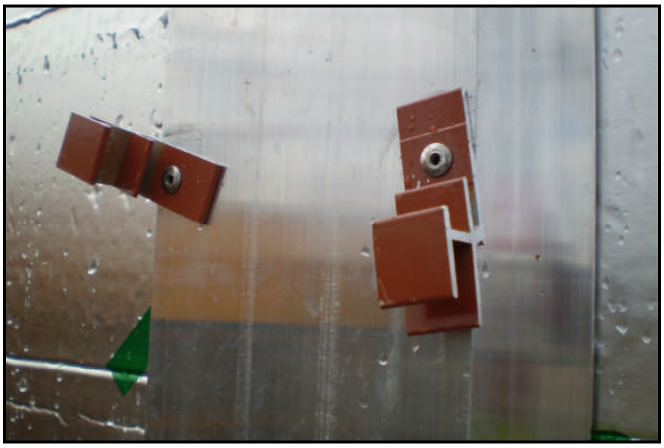
During the dismantling of the sample no discrepancies from the drawings were found.

PHOTO 20027

VERTICAL SUPPORT RAILS

PHOTO 20028

TILE SUPPORT CLIPS

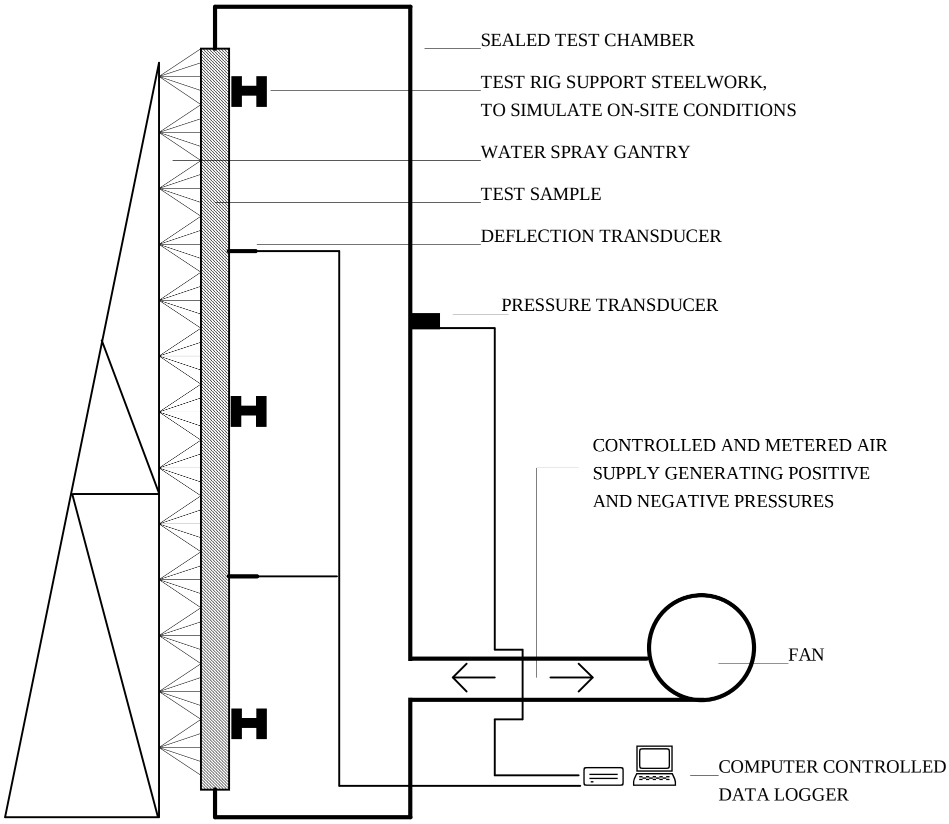


3. TEST RIG GENERAL ARRANGEMENT

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 Telling installed the sample on the test rig. See Figure 1.

FIGURE 1

TYPICAL TEST RIG GENERAL ARRANGEMENT



SECTION THROUGH TEST RIG

4. TEST SEQUENCE

The test sequence was as follows:

(1) Wind resistance – serviceability

(2) Wind resistance – safety

(3) Watertightness – dynamic

(4) Impact resistance

(5) Seismic movement

5. SUMMARY AND CLASSIFICATION OF TEST RESULTS

The following summarises the results of the tests carried out. For full details refer to Sections 6, 7, 8 and 9.

TABLE 1

Date	Test number	Test description	Result
11 September 2007	1	Wind resistance – serviceability	Pass
11 September 2007	2	Wind resistance – safety	Pass
12 September 2007	3	Watertightness – dynamic	Pass
12 September 2007	4	Impact resistance	Pass
12 September 2007	5	Seismic movement	Pass

TABLE 2

Test	Standard	Classification / Declared value
Wind resistance	CWCT	2400 pascals

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

Holes were introduced in the backing wall and insulation to enable the pressure to reach the tiles. During these tests the joints between the tiles were taped over.

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 -1200 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.

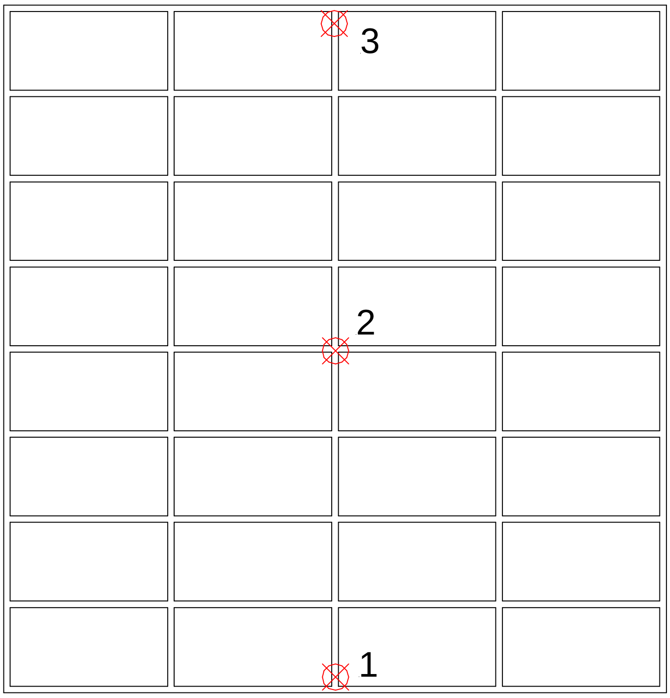
Any damage or functional defects were recorded.

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

FIGURE 2

DEFLECTION GAUGE LOCATIONS

External View



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	Vertical support rail	2400	L/200 = 12.0	1 mm

6.5 RESULTS

Test 1 (serviceability) Date: 11 September 2007

The deflections measured during the wind resistance test, at the positions shown in Figure 2, are shown in Tables 4 and 5.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
2	Vertical support rail	2440 -2417	6.4 -7.1	0.1 -0.7

No damage to the test sample was observed.

Ambient temperature = 20°C
Chamber temperature = 22°C

Test 2 (safety) Date: 11 September 2007

The deflections measured during the structural safety test, at the positions shown in Figure 2, are shown in Table 6.

No damage to the sample was observed.

Ambient temperature = 20°C
Chamber temperature = 22°C

TABLE 4

WIND RESISTANCE – POSITIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	609	1181	1780	2440	Residual
1	0.8	1.5	2.2	2.8	0.1
2	3.7	6.3	8.6	10.6	0.2
3	3.0	4.0	4.8	5.5	0.1
2 *	1.8	3.5	5.1	6.4	0.1

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	-621	-1228	-1855	-2417	Residual
1	-0.9	-2.0	-3.6	-5.3	-0.4
2	-2.8	-5.7	-8.8	-11.8	-0.9
3	-1.0	-2.0	-3.0	-4.1	-0.2
2 *	-1.9	-3.7	-5.5	-7.1	-0.7

* Mid-span reading adjusted between end support readings

TABLE 6

WIND RESISTANCE - **SAFETY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)			
	3588	**Residual**	**-3582**	**Residual**
1	4.3	0.4	-8.1	-0.6
2	14.6	0.5	-16.6	-1.1
3	6.6	0.2	-6.2	-0.8
2 *	9.1	0.2	-9.5	-0.4

* Mid-span reading adjusted between end support readings

7. WATERTIGHTNESS TESTING

7.1 INSTRUMENTATION

7.1.1 Water Flow

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

7.1.2 Temperature

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

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/m^2/minute.

The aero-engine was used to subject the sample to wind of sufficient velocity to produce a pressure differential of 600 pascals. These conditions were maintained for 15 minutes. Throughout the test the inside of the sample was examined for water penetration.

7.5 PASS/FAIL CRITERIA

There shall be no water penetration to the internal face of the sample throughout testing.

7.6 RESULTS

<u>Test 3</u> Date: 12 September 2007

No water penetration was observed throughout the test.

Chamber temperature= 12°C
Ambient temperature = 9°C
Water temperature = 14°C

8. IMPACT TESTING

8.1 IMPACTOR

8.1.1 Soft body

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.

8.1.2 Hard body

The hard body impactor was a solid steel ball of 50 mm or 62.5 mm diameter and approximate mass of 0.5 kg or 1.0 kg.

8.2 PROCEDURE (BS 8200)

8.2.1 Soft body

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, 350 and 500 Nm.

8.2.2 Hard body

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 3, 6 and 10 Nm.

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

<u>Test 4</u> Date: 12 September 2007

Location 1.

120 Nm soft body. No damage to the sample was observed.

Location 2.

120 and 350 Nm soft body. No damage to the sample was observed.

500 Nm. The impact cracked the top of the tiles below. The tiles remained secure. See photo 20018.

Location 3.

120, 350 and 500 Nm soft body. No damage to the sample was observed.

Location 4.

500 Nm soft body. No damage to the sample was observed.

Location 5.

500 Nm soft body. No damage to the sample was observed.

6 Nm hard body. No damage to the sample was observed.

Location 6.

3 Nm hard body. No damage to the sample was observed.

Location 7.

10 Nm hard body. The tile cracked but remained secure. See photo 20025.

Ambient temperature = 13°C

FIGURE 3

IMPACT TEST LOACTIONS

External View

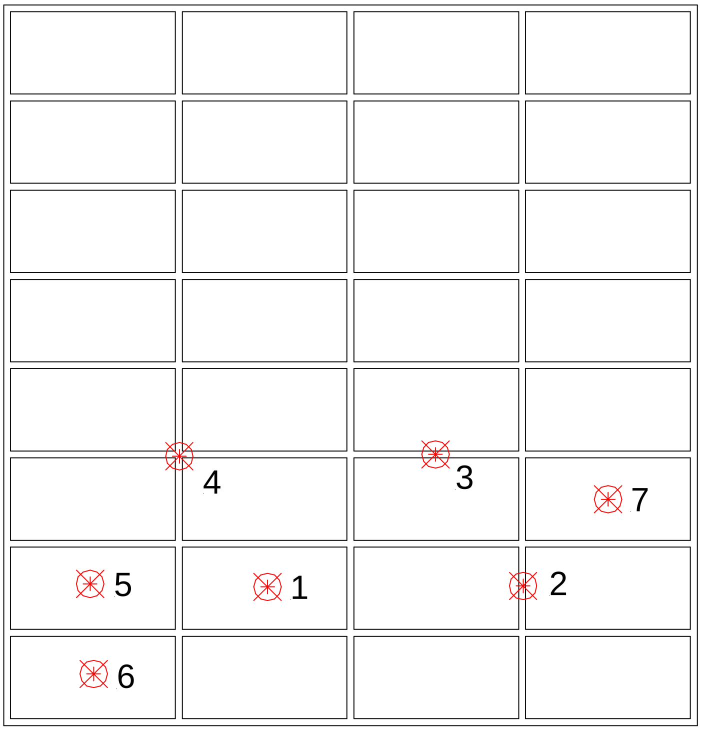


PHOTO 20018

LOCATION 2 IMPACT

PHOTO 20025

LOCATION 7 IMPACT

9. SEISMIC MOVEMENT

9.1 PROCEDURE (AAMA 501.4-00)

Seismic serviceability.

The top horizontal support beam was moved sideways by 24 mm in each direction three times.

Seismic safety

The test was then repeated once in each direction but the movement was increased to 36 mm.

9.2 RESULTS

Test 5 Date: 12 September 2007

No damage to the sample was observed.

Ambient temperature = 15°C

10. APPENDIX - DRAWINGS

The following 14 unnumbered pages are copies of Telling Architectural Aluminium drawings numbered:

L001,

L002,

L003,

L004,

M001,

M002,

M003,

M004,

M005,

M006,

M007,

M008,

M009 rev A,

M010.

END OF REPORT

Taylor Woodrow