Technical Report

Title: Weathertightness testing a rainscreen system for D & B Facades

Report No: N950-17-17368

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Title: Weathertightness testing a rainscreen system for D & B Facades

Customer: D & B Facades
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UKAS TESTING 0057

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CONTENTS

1 INTRODUCTION

This report describes tests carried out at VINCI Technology Centre UK Limited at the request of D & B Facades

The test sample consisted of a sample a sample of rainscreen cladding manufactured by D & B Facades.

The tests were carried out during February 2017 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.

Watertightness – static pressure, dynamic pressure and hose.

Wind resistance – serviceability & safety.

Impact resistance.

The testing was carried out in accordance with Technology Centre Method Statement C6298/MSrev0.

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

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

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

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

VINCI Technology Centre UK Limited is certified by BSI for:

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

The tests were witnessed wholly or in part by:

Shane Brown	-	D & B Facades
Ash Harsent	-	D & B Facades
Nick	-	Westcoast Windows

2 SUMMARY AND CLASSIFICATION OF TEST RESULTS

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

2.1 SUMMARY OF TEST RESULTS

TABLE 1

Date	Test number	Test description	Result
20 March 2017	2	Watertightness – static (pre-test)	Pass
22 March 2017	1	Air permeability	Pass
23 March 2017	2	Watertightness – static	Pass
23 March 2017	3	Wind resistance – serviceability	Pass
23 March 2017	4	Air permeability	Pass
23 March 2017	5	Watertightness – static	Pass
23 March 2017	6	Watertightness – dynamic	Pass
23 March 2017	7	Watertightness – hose	Pass
23 March 2017	8	Wind resistance – safety	Pass
24 March 2017	9	Impact resistance	Pass

2.2 CLASSIFICATION

TABLE 2

Test	Standard	Classification / Declared value
Air permeability	CWCT	A4
Watertightness	CWCT	R7
Wind resistance	CWCT	2400 pascals serviceability 3600 pascals safety
Impact resistance	CWCT TN76	Serviceability – Class 1 Safety –Negligible risk

3 DESCRIPTION OF TEST SAMPLE

3.1 GENERAL ARRANGEMENT

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

The sample contained two double glazed opeing vents and aluminium rainscreen panels mounted on an aluminium frame.

PHOTO 4669

TEST SAMPLE ELEVATION

3.2 CONTROLLED DISMANTLING

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

TEST SAMPLE DURING DISMANTLE

PHOTO 0002

PHOTO 0003

TEST SAMPLE DURING DISMANTLE

PHOTO 0004

TEST SAMPLE DURING DISMANTLE

PHOTO 0005

TEST SAMPLE DURING DISMANTLE

PHOTO 0006

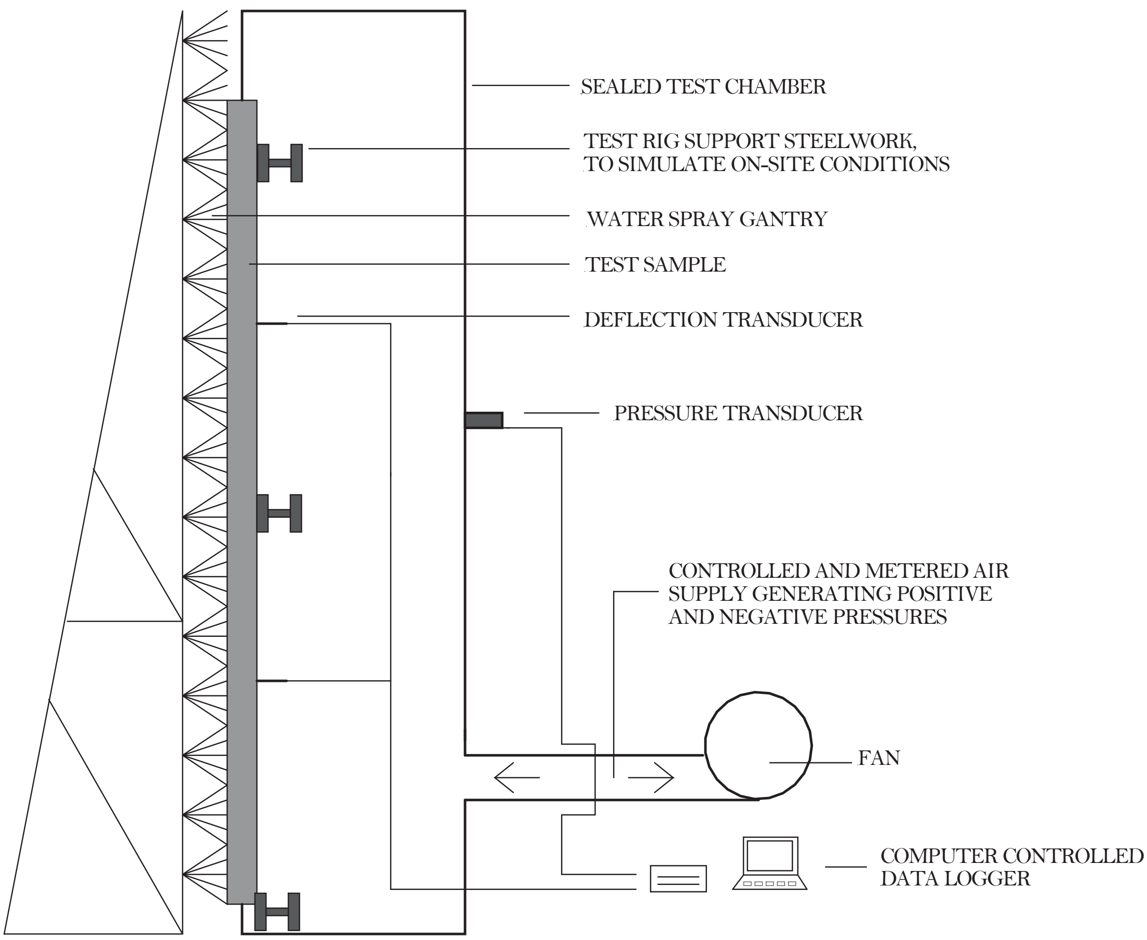
TEST SAMPLE DURING DISMANTLE

4 TEST RIG GENERAL ARRANGEMENT

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

FIGURE 1

TYPICAL TEST RIG SCHEMATIC ARRANGEMENT



SECTION THROUGH TEST RIG

5 TEST SEQUENCE

The test sequence was as follows:

(1) Air permeability

(2) Watertightness – static

(3) Wind resistance – serviceability

(4) Air permeability

(5) Watertightness – static

(6) Watertightness - dynamic

(7) Watertightness – hose

(8) Wind resistance – safety

(9) Impact – safety

Prior to starting the formal test sequence above, pre-testing using the static pressure watertightness test procedure (2) was carried out. See the relevant sections of this report for details.

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 recorded using a computer controlled data logger.

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

The air flow readings are reported in terms of flow at standard conditions.

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, 250, 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 sample with adhesive tape (polythene sheet as mentioned in CWCT clause 5.10.3.1 was not used on this occasion) and measuring the air flow at the pressures given above.

The test was then repeated with only the opening vent sections sealed and then with the complete sample unsealed; the difference between the readings being the rate of air flow through the vents and whole sample respectively.

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, and
2.0 m^3 per hour per m length of joint between the fixed frame and the frame enclosing the opening light when viewed from inside for opening lights.

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 sample was 14.7 m^2.

Length of openable joints was 9.2 m.

6.5 RESULTS

TABLE 3

Pressure differential (pascals)	Measured air flow through sample Test 1 Date: 22 March 2017			
	Infiltration		Exfiltration	
	Fixed panels (m^3/hour/m^2)	Opening vents (m^3/hour/m)	Fixed panels (m^3/hour/m^2)	Opening vents (m^3/hour/m)
50	0.04	0.02	0.03	0.04
100	0.14	0.02	0.00	0.08
150	0.02	0.04	0.12	0.00
200	0.04	0.10	0.01	0.13
250	0.12	0.08	0.05	0.01
300	0.13	0.34	0.09	0.00
450	0.07	0.09	0.11	0.05
600	0.18	0.09	0.15	0.10
Temperatures	Ambient = 6°C Chamber =7°C			

The results are shown graphically in Figure 2 & 3

FIGURE 2

Fixed panels - air permeability test results

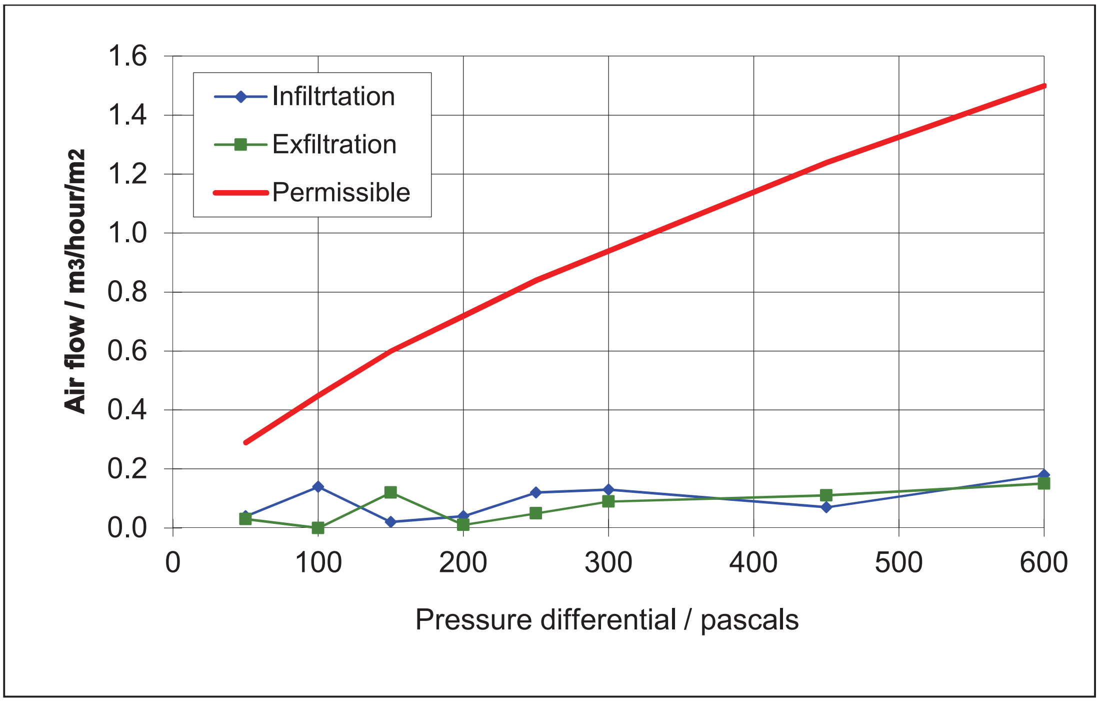
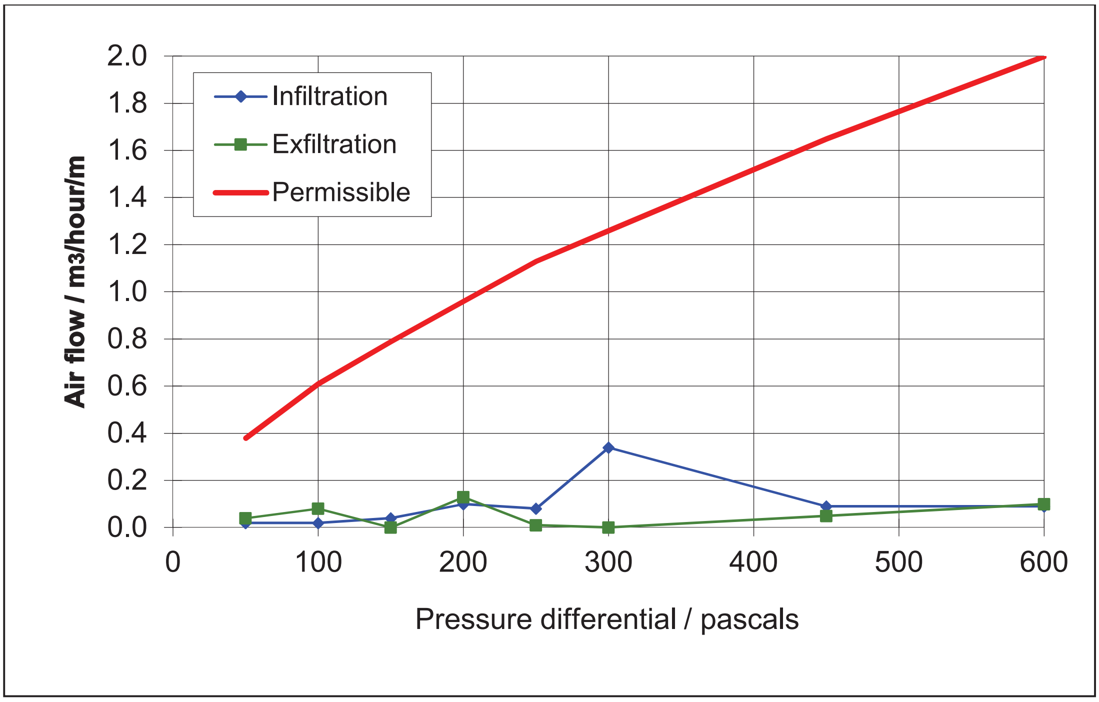


FIGURE 3

Opening vents - air permeability test results



Test 4 Date: 23 March 2017

Air flow readings were taken at ± 600 pascals. These showed no increase in air flow compared to those measures in test 1. Therefore a full set of readings was not taken.

Ambient temperature =7°C
Chamber temperature = 8°C

7 WATERTIGHTNESS TESTING

7.1 INSTRUMENTATION

7.1.1 Pressure

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

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

7.1.2 Water Flow

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

7.1.3 Temperature

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

7.1.4 General

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

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

7.2 FAN

7.2.1 Static Pressure Testing

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.

7.2.2 Dynamic Pressure Testing

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.

PHOTO 4689

DYNAMIC WIND GENERATOR

7.3 WATER SPRAY

7.3.1 Spray Gantry

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.

7.3.2 Hose test

The water was applied using a brass nozzle that produced a full-cone of water droplets with a nominal spray angle of 30▪. The nozzle was used with a ¾" hose and provided with a control valve and a pressure gauge between the valve and nozzle.

7.4 PROCEDURE

7.4.1 Watertightness – static

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

The opening vents were then opened and locked closed five times.

Water was sprayed onto the sample using the method described above at a rate of at least 3.4 litres/m^2/minute for 15 minutes at zero pressure differential. With the water spray continuing the pressure differential across the sample was then increased in increments of: 50, 100, 150, 200, 300, 450 and 600 pascals, each held for 5 minutes.

Throughout the test the interior face of the sample was examined for water penetration.

7.4.2 Watertightness – dynamic

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 average deflections in the principle framing members equal to those produced by 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.

7.4.3 Watertightness – hose

Working from the exterior, the selected area was wetted progressing from the lowest horizontal joint, then the intersecting vertical joints, then the next horizontal joint above, etc. The water was directed at the joint and perpendicular to the face of the sample. The nozzle was moved slowly back and forth above the joint at a distance of 0.3 metres from it for a period of 5 minutes for each 1.5 metres of joint. Shorter or slightly longer joints were tested pro rata. The water flow to the nozzle was adjusted to produce 22, ±2 litres per minute when the water pressure at the nozzle inlet was 220, ±20 kPa.

Throughout the test the interior face of the sample was examined for water penetration. The perimeter of the right hand opening vent was tested..

7.5 PASS/FAIL CRITERIA

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

7.6 RESULTS

<u>Test 2 (Static pressure pre-test)</u> Date: 20 March 2017

No water penetration was observed throughout the test.

Chamber temperature= 13°C
Ambient temperature = 12°C
Water temperature = 10°C

<u>Test 2 (Static pressure)</u> Date: : 23 March 2017

No water penetration was observed throughout the test.

Chamber temperature= 8°C
Ambient temperature = 6°C
Water temperature = 9°C

<u>Test 5 (Static pressure)</u> Date: : 23 March 2017

No water penetration was observed throughout the test.

Chamber temperature= 9°C
Ambient temperature = 7°C
Water temperature = 9°C

<u>Test 6 (Dynamic pressure)</u> Date: : 23 March 2017

No water penetration was observed throughout the test.

Chamber temperature= 10°C
Ambient temperature = 8°C
Water temperature = 9°C

<u>Test 7 (Hose)</u> Date: : 23 March 2017

No water penetration was observed throughout the test.

Chamber temperature= 10°C
Ambient temperature = 8°C
Water temperature = 9°C

8 WIND RESISTANCE 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 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.

8.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air 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

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.

8.3 PROCEDURE

Note: *Wind loading was first carried out on the backing wall and then on the rainscreen panels.*

8.3.1 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. Operable components were opened and closed five times and any change in ease of operation noted.

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

8.3.2 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.

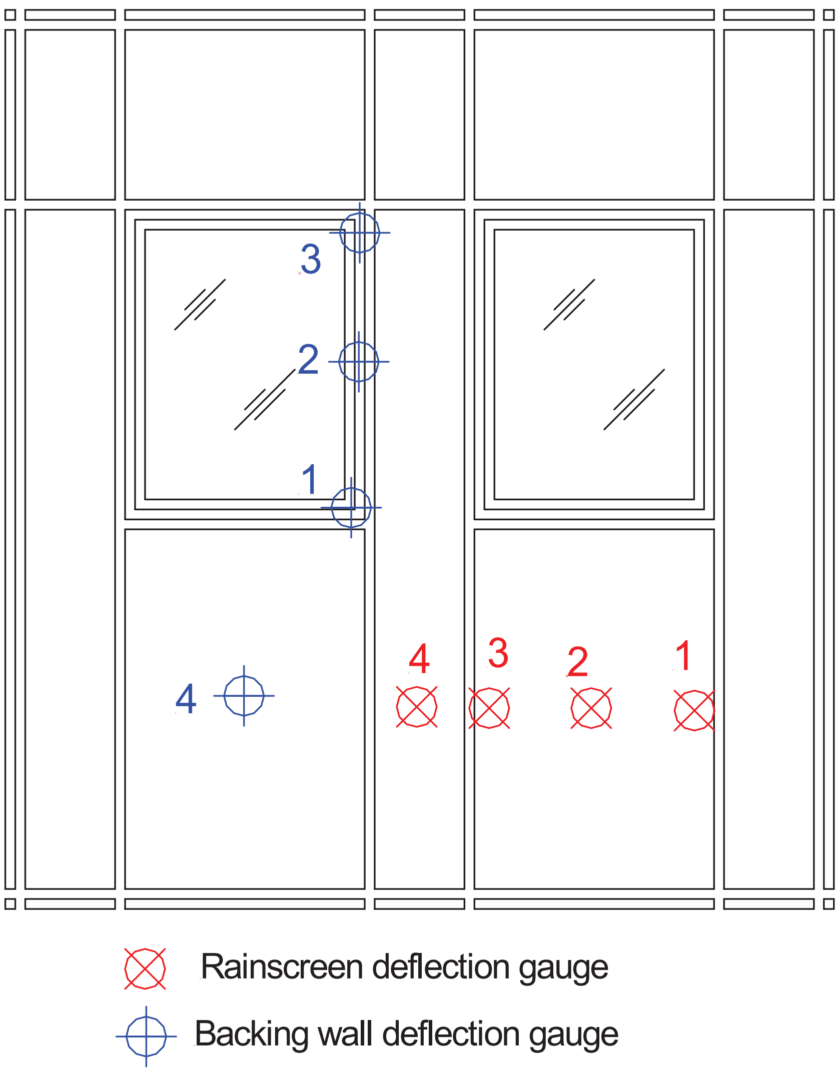
Any damage or functional defects were recorded.

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

FIGURE 4

DEFLECTION GAUGE LOCATIONS

External View



8.4 PASS/FAIL CRITERIA

8.4.1 Calculation of permissible deflection

Gauge number	Member	Span (L) (mm)	Permissible deflection (mm)	Permissible residual deformation
2 2	Mullion Rainscreen	1470 1156	L/200 = 7.3 L/90 = 12.8	1 mm 1 mm

8.5 RESULTS

<u>Test 3 (serviceability)</u> Date: 23 March 2017

The deflections measured during the wind resistance test, at the positions shown in Figure 4, are shown in Tables 4 and 5 for the backing wall and Tables 7 and 8 for the rainscreen.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
2	Mullion	2420 -2395	0.0 0.3	0.1 0.0

No damage to the test sample was observed.

Ambient temperature = 7°C
Chamber temperature = 6°C

<u>Test 8 (safety)</u> Date: 23 March 2017

The deflections measured during the structural safety test, at the positions shown in Figure 4, are shown in Table 6 for the backing wall and Table 9 for the rainscreen.

No damage to the sample was observed.

Ambient temperature = 6°C
Chamber temperature = 7°C

TABLE 4

WIND RESISTANCE – POSITIVE **SERVICEABILITY** (Backing Wall)TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	605	**1201**	**1819**	**2420**	**Residual**
1	1.2	2.6	4.1	5.8	0.3
2	1.1	2.2	3.6	5.3	0.4
3	0.9	2.0	3.3	4.8	0.4
4	2.3	2.9	3.5	4.1	0.2
2 *	0.0	0.0	-0.1	0.0	0.1

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE – NEGATIVE **SERVICEABILITY**(Backing Wall) TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	-607	**-1205**	**-1814**	**-2395**	**Residual**
1	-1.1	-2.0	-3.0	-4.1	-0.3
2	-0.8	-1.5	-2.4	-3.4	-0.3
3	-0.7	-1.4	-2.4	-3.4	-0.4
4	-5.9	-10.9	-16.3	-23.3	-2.2
2 *	0.1	0.2	0.3	0.3	0.0

* Mid-span reading adjusted between end support readings

TABLE 6

WIND RESISTANCE – **SAFETY** (Backing Wall) TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)			
	3582	Residual	-3591	Residual
1	9.0	0.6	-5.3	-0.7
2	8.3	0.8	-4.5	-0.7
3	7.5	0.7	-4.3	-0.7
4	6.2	0.5	-30.7	-3.7
2 *	0.1	0.1	0.3	0.0

* Mid-span reading adjusted between end support readings

TABLE 7

WIND RESISTANCE – POSITIVE **SERVICEABILITY** (Rainscreen)TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	593	1192	1779	2394	Residual
1	1.4	3.0	4.8	6.7	0.3
2	4.2	8.3	12.6	16.5	0.3
3	1.8	3.5	5.8	7.7	0.3
4	2.3	5.0	8.4	11.6	0.4
2 *	2.6	5.0	7.3	9.3	0.1

* Mid-span reading adjusted between end support readings

TABLE 8

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** (Rainscreen) TEST RESULTS

Position	**Pressure (pascals) / Deflection (mm)**				
	-585	**-1213**	**-1803**	**-2392**	**Residual**
1	-1.5	-3.1	-4.7	-7.2	-1.3
2	-4.2	-8.4	-12.00	-16.6	-1.4
3	-1.7	-3.6	-5.4	-8.4	-1.3
4	-2.4	-5.4	-8.5	-12.7	-1.6
2 *	-2.5	-5.0	-7.0	-8.8	-0.1

* Mid-span reading adjusted between end support readings

TABLE 9

WIND RESISTANCE – **SAFETY** (Rainscreen) TEST RESULTS

Position	**Pressure (pascals) / Deflection (mm)**			
	3631	**Residual**	**-3597**	**Residual**
1	11.4	1.4	-10.2	-1.1
2	24.4	1.0	-23.4	-1.4
3	11.5	0.0	-12.2	-1.1
4	17.9	0.3	-19.5	-2.1
2 *	12.9	0.3	-12.2	-0.3

* Mid-span reading adjusted between end support readings

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.

PHOTO 4701

SOFT BODY IMPACTOR

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.

PHOTO 4696

HARD BODY IMPACTOR

9.2 PROCEDURE

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 for serviceability and 500 Nm for safety.

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

9.3 PASS/FAIL CRITERIA

Note: Tables 1 to 2 are taken from CWCT TN76.

Table 1 - Classes for serviceability performance

Class	Definition	Explanation/Examples
1	No damage.	No damage visible from 1m, and Any damage visible from closer then 1m unlikely to lead to significant deterioration.
2	Surface damage of an aesthetic nature which is unlikely to require remedial action.	Dents or distortion of panels not visible from more than 5m (note visibility of damage will depend on surface finish and lighting conditions – damage will generally be more visible on reflective surfaces), and Any damage visible from closer than 5m unlikely to lead to significant deterioration.
3	Damage that may require remedial action or replacement of components to maintain appearance or long term performance but does not require immediate action.	Dents or distortion of panels visible from more than 5m, or Spalling of edges of panels of brittle materials, or Damage to finishes that may lead to deterioration of the substrate.
4	Damage requiring immediate action to maintain appearance or performance. Remedial action may include replacement of a panel but does not require dismantling or replacement of supporting structure.	Significant cracks in brittle materials e.g. cracks that may lead to parts of tile falling away subsequent to test, or Fracture of panels causing significant amounts of material to fall away during test.
5	Damage requiring more extensive replacement than 4.	Buckling of support rails.

Table 2 - Classes for safety performance

Class	Explanation/examples
Negligible risk	No material dislodged during test, and No damage likely to lead to materials falling subsequent to test, and No sharp edges produced that would be likely to cause severe injury to a person during impact, and Cladding not penetrated by impactor.
Low risk	Maximum mass of falling particle 50g, and Maximum mass of particle that may fall subsequent to impact 50g, and No sharp edges produced that would be likely to cause severe injury during impact.
Moderate risk	Maximum mass of falling particle less than 500g, and Maximum mass of particle that may fall subsequent to impact less than 500g, and Cladding not penetrated by impact, and No sharp edges produced that would be likely to cause severe injury during impact.
High risk	Maximum mass of falling particle greater than 500g, or Cladding penetrated by impact, or Sharp edges produced that would be likely to cause severe injury during impact.

9.4 RESULTS

Test 9 Date: 24 March 2017

No damage to the sample was observed during soft body impact testing and the 3 Nm hard body impacts.

Minor indents at 6 Nm and 10 Nm impact energies using the hard body impactors.

Ambient temperature = 6°C

FIGURE 6

IMPACT TEST LOCATIONS

External View

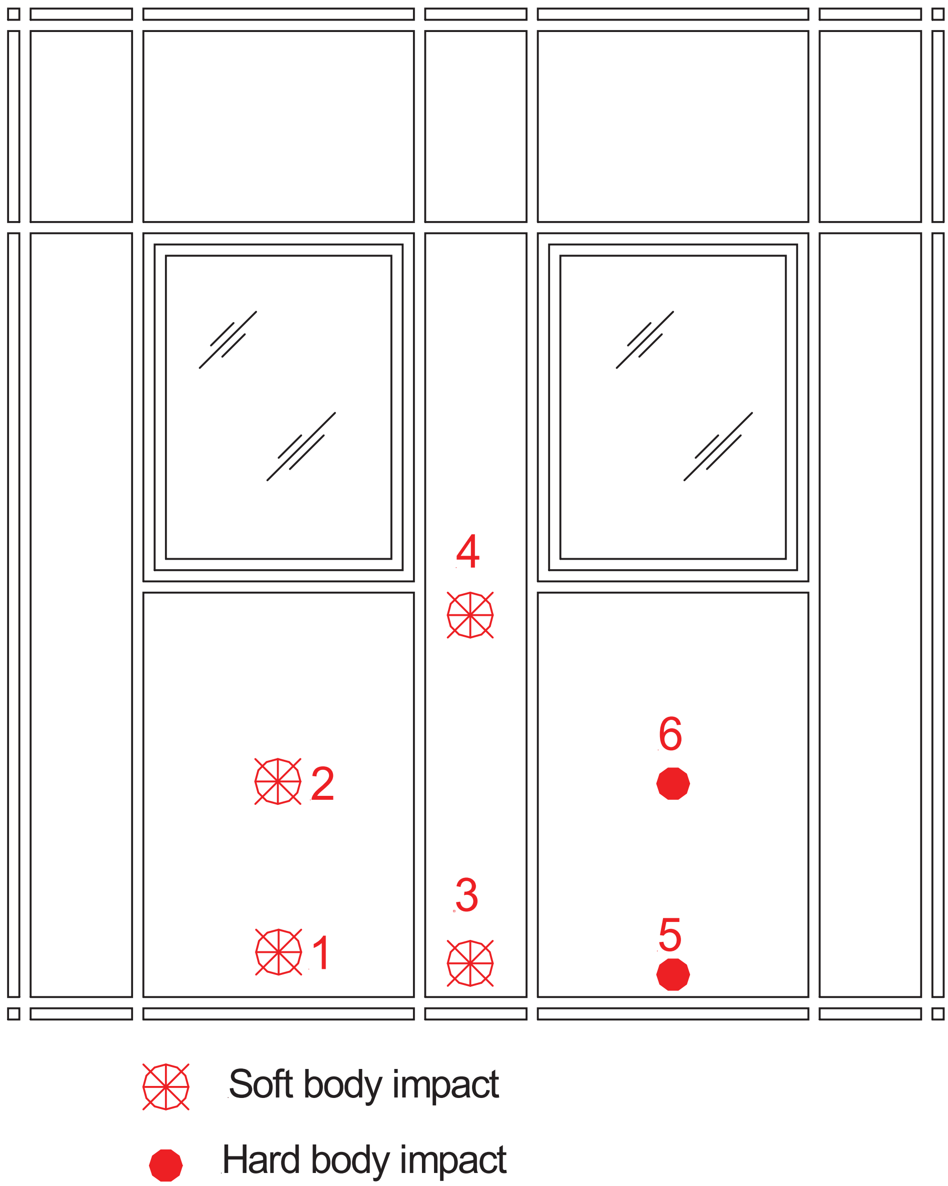


PHOTO 4698

LOCATION 6 HARD BODY IMPACTS

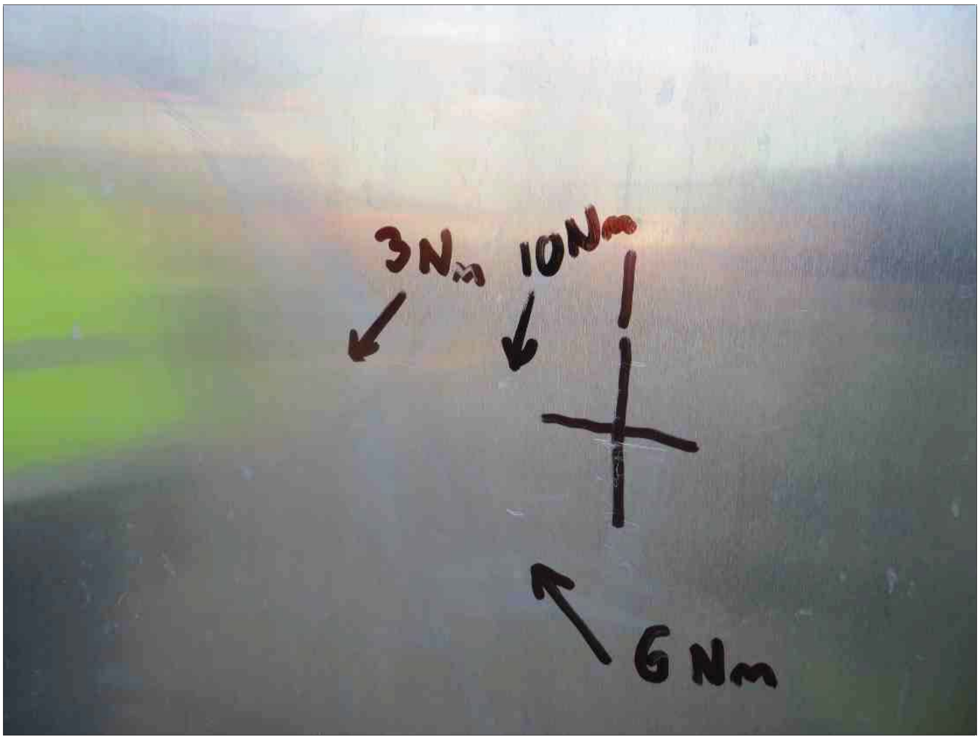
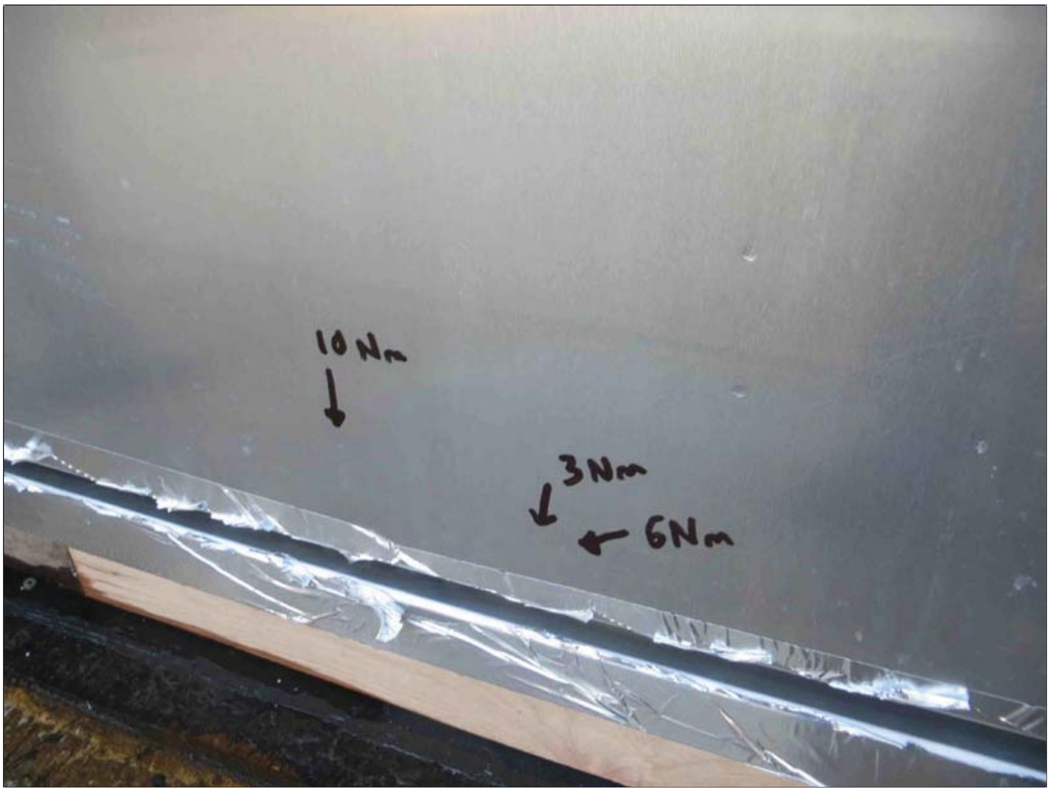


PHOTO 4699

LOCATION 5 HARD BODY IMPACTS



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