FINAL REPORT
CURTAIN WALL TESTING

STRUCTURAL GLAZING CURTAIN WALL (SG 50 SERIES)

SMART ARCHITECTURAL SYSTEMS FZC
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INTERNATIONAL CONSULTANTS

Issue Date: 7/15/21 12:36 PM
File: UK104

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Accreditation

Testing

ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories *with*

1. United Kingdom Accreditation Service (UKAS) - Testing Laboratory **: 4439**
2. GCC Accreditation Center (GAC) -Testing Laboratory : **ATL-0017**
   www.ukas.com www.gcc-accreditation.org

Memberships

Members of European Group of Organization for Fire Testing, Inspection and Certification

www.egolf.org.uk

Member of Association for Specialist Fire Protection

www.asfp.org.uk

Member of Centre for Window and Cladding Technology

www.cwct.co.uk

The work which is a subject of this document falls wholly or partly under the accreditation marked below:

ISO 17025 UKAS	☑
ISO 17025 GAC	☑
Non-accredited test	☐

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1. General Parameters

This Final Report of laboratory testing performed by Thomas Bell-Wright International Consultants located in Dubai UAE, determined the weather performance adequacy of a curtainwall specimen including all parts mentioned below, supplied and be installed by Smart Architectural Systems. The tests were carried out in conformance with the accredited test procedures of BS EN & AAMA Test Standards and according to the requirement of the client.

	Structural Glazing Curtainwall (SG50 Series)	
TEST SEQUENCE		
Test 1	Air Permeability Test	BS EN 12153:2000
Test 2	Air Permeability Test	BS EN 1026:2016
Test 3	Water Tightness Test	BS EN 12155:2000
Test 4	Water Tightness Test	BS EN 1027:2016
Test 5	Resistance to Wind Load Test	BS EN 12179:2000
Test 6	Air Permeability Test	BS EN 12153:2000
Test 7	Water Tightness Test	BS EN 12155:2000
Test 8	Dynamic Water Penetration Test	AAMA 501.1-17
Test 9	Resistance to Wind Load Test (Safety)	BS EN 12179:2000
Test 10	Impact Test	BS EN 14019

RELEVANT INFORMATION	
Type	Stick Curtain Wall with Window
Glass Type	Double glazed
Glass Thickness	30mm
Weatherstrip	--
Specimen Size	3.9m width x 7.2m height (Curtain Wall) 0.77m width x 1.17m height (Window Actual Size)
Flat/Curve	Flat/Vertical

Client	Smart Architectural Systems FZC
Main Contractor	--
Alum. Contractor	--
Consultant	--

2. Witnesses

NAME	COMPANY	TELEPHONE
Ahmed Ali Balhamer	Smart	+966-56 645 2222
Ibrahim Nasser	Smart	+966-50 626 3041
Khalid S.	Smart	+966-50 400 6250

3. Curtainwall Test Result

Testing results were all recorded as mentioned below with reference to the test sheets attached, witnessed by representatives listed above during the course of testing.

4. Test Summary

4.1. Test History

No.	TEST	DATE & TIME	PASS / FAIL
1	Air Permeability Test, BS EN 12153:2000	June 20, 2021 10:50 AM	PASSED

The specimen was blanked off with polyethylene sheet to achieve the extraneous leakage Q_E, often referred to as chamber leakage. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m3/hr. The achieved leakage for the chamber and the specimen is listed below:

- Differential test pressure = 750 Pascals
- Permitted leakage = 1.5 $m^3/hr/m^2$
- Specimen Area = 29.0 m^2
- Total allowable leakage = 43.50 m^3/hr

Results:

Test Pressure, Pa	50	100	150	200	250	300	450	600	750
Q_E m^3/hr	25.6	41.2	50.7	62.7	73.7	81.3	106	121	140
Q_T m^3/hr	25.8	41.4	52	64.7	75.7	83	108	127	144
Q_S m^3/hr	**0.2**	**0.2**	**1.3**	**2**	**2**	**1.7**	**2**	**3**	**4**

Specimen sealed with polyethylene sheet @ 750 Pa, Extraneous air leakage (Q_E) =140 m^3/hr

- Total air leakage (Q_T) for chamber plus specimen @ 750 Pa = 144 m^3/hr
- Specimen air leakage (Q_S) @ 750 Pa = 4 m^3/hr at standard condition, less than the Permissible (43.50 m^3/hr) and so the test was recorded passed.

2	Air Permeability Test, BS EN 1026:2016	June 20, 2021 11:15 AM	PASSED

The perimeter of the window of the curtain wall was sealed while taking the total leakage for the curtain wall specimen and hence the total leakage of the curtain wall is considered as the chamber leakage/extraneous leakage for the window specimen. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m3/hr. The achieved leakage for the chamber and the specimen is listed below:

- Differential test pressure = 750 Pascals
- Permitted leakage = 1 $m^3/hr/m^2$
- Specimen Area = 0.9 m^2
- Total allowable leakage = 0.9 m^3/hr

Results:

Test Pressure, Pa	50	100	150	200	250	300	450	600	750
Q_E m^3/hr	25.8	41.4	52	64.7	75.7	83	108	127	144
Q_T m^3/hr	25.8	41.5	52.1	64.9	75.8	83.2	108.1	127	144
Q_S m^3/hr	**0**	**0.1**	**0.1**	**0.2**	**0.1**	**0.2**	**0.1**	**0**	**0**

Specimen sealed with polyethylene sheet @ 750 Pa, Extraneous air leakage (Q_E) =144 m^3/hr

- Total air leakage (Q_T) for chamber plus specimen @ 750 Pa = 144 m^3/hr
- Specimen air leakage (Q_S) @ 750 Pa = 0 m^3/hr at standard condition, less than the Permissible (0.9 m^3/hr) and so the test was recorded passed.

3	Water Tightness Test, BS EN 12155:2000	June 20, 2021 11:29 AM	PASSED

The specimen was covered with 84 nozzles, producing a total of 16.8 gallons per minute of water volume flow (62.16 L/min) applied in the entire test specimen during the test**.**
Peak test pressure = 900 Pascals
Duration = 15 minutes at zero test pressure (access door opened)
= 5 minutes each at 50, 100, 150, 200, 250, 300, 450, 600, 750, 900 Pa (access door closed)
= Total time for water spray is 1 hour 5 minutes.
During the test, no water leakage was observed along internal side of the specimen and so the test was recorded passed.

4	Water Tightness Test, BS EN 1027: 2016	June 20, 2021 3:00 PM	PASSED

The specimen was covered with 1 row of 4 nozzles, producing a total of 2.11 gallons per minute of water volume flow (8 L/min) applied in the entire test specimen during the test**.**
Peak test pressure = 900 Pascals
Duration = 15 minutes at zero test pressure (access door opened)
= 5 minutes each at 50, 100, 150, 200, 250, 300, 450, 600, 750, 900 Pa (access door closed)
= Total time for water spray is 1 hour 5 minutes.
During the test, no water leakage was observed along internal side of the specimen and so the test was recorded passed.

5	Resistance to Wind Load Test - Serviceability	June 21, 2021 8:52 AM	PASSED

Six (6) linear displacement transducers (LDT) were positioned in place along internal side of the specimen to measure deflection values of horizontal and vertical members of the specimen.
Maximum deflection allowed was L/175, so obtained by deducting the average readings of the outermost gauges from the middle gauge of the member being measured.
The following transducers were positioned as follows:

LDT	LOCATION
1-2-3	Along the mullion
4-5-6	Along the transom

The test procedure mentioned in the method statement was followed. The test was initially carried out in the positive wind load direction, i.e. negative chamber pressure. Three positive air pressure pulses of 500 Pa were applied and maintained for 3 seconds each. Following the preparatory pressures, four steps of incremental positive air pressure that is 25% at 500 Pa; 50% at 1000 Pa; 75% at 1500 Pa, and 100% at 2000 Pa were then applied. In the process of each load application, the load was held for 15 ±5 seconds as the corresponding deflections were recorded. After a recovery period of 1-minute residual deformations were taken. There was no visual failure noted and the maximum deflection readings were found within the allowable limit. Test was recorded passed. The negative wind load

direction followed. Three negative air pressure pulses of 500 Pa were applied and maintained for 3 seconds each. Following the preparatory pressures, four steps of incremental negative air pressure that is 25% at 500 Pa; 50% at 1000 Pa; 75% at 1500 Pa, and 100% at 2000 Pa were then applied. In the process of each load application, the load was held for 15 ±5 seconds as the corresponding deflections were recorded. After a recovery period of 1-minute residual deformations were taken. There was no visual failure noted and the maximum deflection readings were found within the allowable limit. Test was recorded passed.

Applied Load, Pa	L value, mm		Allowable Deflection of L/175		Maximum net deflections recorded along member, mm	
	1-2-3	4-5-6	1-2-3	4-5-6	Mullion (1-2-3)	Transom (4-5-6)
(+) 500	3250	1190	18.6	6.8	2.0	0.0
(+) 1000					4.15	0.0
(+) 1500					6.15	0.0
(+) 2000					**8.35**	**0.1**
(-) 500					1.7	0.0
(-) 1000					3.75	0.05
(-) 1500					5.6	0.1
(-) 2000					**7.65**	**0.05**

6	Air Permeability Test, BS EN 12153:2000	June 21, 2021 10:00 AM	PASSED

The specimen was blanked off with polyethylene sheet to achieve the extraneous leakage Q_E, often referred to as chamber leakage. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m3/hr. The achieved leakage for the chamber and the specimen is listed below:

- Differential test pressure = 750 Pascals
- Permitted leakage = 1.5 $m^3/hr/m^2$
- Specimen Area = 29.0 m^2
- Total allowable leakage = 43.50 m^3/hr

Results:

Test Pressure, Pa	50	100	150	200	250	300	450	600	750
Q_E m^3/hr	34.3	51.9	66.8	78.3	90.9	102.7	130	152.4	171.2
Q_T m^3/hr	34.5	52.3	68.4	80	93.2	105.3	133	156	177
Q_S m^3/hr	**0.2**	**0.4**	**1.6**	**1.7**	**2.3**	**2.6**	**3.0**	**3.6**	**6**

Specimen sealed with polyethylene sheet @ 750 Pa, Extraneous air leakage (Q_E) =171.2 m^3/hr

- Total air leakage (Q_T) for chamber plus specimen @ 750 Pa = 177 m^3/hr
- Specimen air leakage (Q_S) @ 750 Pa = 6 m^3/hr at standard condition, less than the Permissible (43.50 m^3/hr) and so the test was recorded passed.

Air Permeability Test, BS EN 1026:2016 – Window

The perimeter of the window of the curtain wall was sealed while taking the total leakage for the curtain wall specimen and hence the total leakage of the curtain wall is considered as the chamber leakage/extraneous leakage for the window specimen. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m_3/hr. The achieved leakage for the chamber and the specimen is listed below:

- Differential test pressure = 750 Pascals
- Permitted leakage = 1 $m^3/hr/m^2$
- Specimen Area = 0.9 m^2
- Total allowable leakage = 0.9 m^3/hr

Results:

Test Pressure, Pa	50	100	150	200	250	300	450	600	750
Q_E m^3/hr	34.5	52.3	68.4	80	93.2	105.3	133	156	177
Q_T m^3/hr	34.6	52.4	68.6	80.3	93.6	105.6	133.6	156.5	177.5
Q_S m^3/hr	**0.1**	**0.1**	**0.2**	**0.3**	**0.4**	**0.3**	**0.6**	**0.5**	**0.5**

Specimen sealed with polyethylene sheet @ 750 Pa, Extraneous air leakage (Q_E) =177 m^3/hr

- Total air leakage (Q_T) for chamber plus specimen @ 750 Pa = 177.5 m^3/hr
- Specimen air leakage (Q_S) @ 750 Pa = 0.5 m^3/hr at standard condition, less than the Permissible (0.9 m^3/hr) and so the test was recorded passed.

7	Water Tightness Test, BS EN 12155:2000	June 21, 2021 10:35 AM	PASSED

The specimen was covered with 84 nozzles, producing a total of 16.8 gallons per minute of water volume flow (62.16 L/min) applied in the entire test specimen during the test**.**

Peak test pressure = 900 Pascals

Duration = 15 minutes at zero test pressure (access door opened)

= 5 minutes each at 50, 100, 150, 200, 250, 300, 450, 600, 750, 900 Pa (access door closed)

= Total time for water spray is 1 hour 5 minutes.

During the test, no water leakage was observed along internal side of the specimen and so the test was recorded passed.

8	Dynamic Water Penetration Test	June 21, 2021 12:04 PM	PASSED

The water spray rack remained the same as the water tightness test and the wind generator positioned along center width of the specimen.

- The dynamic pressure applied was 900 Pascal
- During the test duration, representatives stayed inside the chamber to observe the curtainwall until the test was completed for 15 minutes.

No water leakage was observed after the test. The test was recorded passed.

9	Resistance to Wind Load Test - Safety	June 21, 2021 3:00 PM	PASSED

Six (6) linear displacement transducers (LDT) were kept in the same position.
The maximum deformation allowed was L/500, so obtained by deducting the average readings of the outermost gauges from the middle gauge of the member being measured.

The following transducers were positioned the same as follows:

LDT	LOCATION
1-2-3	Along the mullion
4-5-6	Along the transom

The test was first carried out in the positive wind load direction, i.e. negative chamber pressure at 150 % =3000 Pascals. At the peak pressure of 150 % load, the pressure was held for 15 seconds and deflections were recorded. After a recovery period of 1minute residual deformations were taken. There was no visual failure noted and so the test was recorded passed.
The test procedures were followed with the negative wind load direction, 3000 Pascals at 150 % (i.e. positive chamber pressure). The test pressure at maximum 150% was sustained by the specimen without showing any breakage or adverse effect to constitute failure and the deformations of the framing members measured for reference.

Applied Load, Pa	L value, mm		Allowable Deformation of L/500, mm		Maximum net deformations recorded along member, mm	
	1-2-3	4-5-6	1-2-3	4-5-6	Mullion (1-2-3)	Transom (4-5-6)
(+) 3000	3250	1190	6.5	2.4	0.9	0
(-) 3000					0.15	0

No detrimental effects nor sign of distortion and breakage occurred as observed and all deformation readings were found within the allowable limit and so the test was recorded passed.

10	Impact Test, BS EN 14019:2016	June 21, 2021 3:35 PM	CLASS E5

A double tyre impactor weighing 50 kg was used for the test. A total of 4 external impact point locations was conducted on the specimen. The impactor was raised to drop height of 950mm drop height or Class E5 classification as per the requirement. All locations tested passed. No visual damage was observed. Refer to the drawing sketch for locations.

4.2. Description of Modification or Adjustments

No modification or rectification was done on the specimen.

4.3. Compliance Statement

The Stick curtain wall was tested as described in this document, in conformance with the accredited test procedures of BS EN & AAMA Test Standards according to the requirement of the client.
The effect of the test results relates only to the specimen tested and are valid under the ambient conditions during the test. No preconditioning of the specimen was required. The results apply to the sample as received.

This Final Report is respectfully submitted by:
Thomas Bell-Wright International Consultants

Prepared by:

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Assistant Testing Engineer

Tested by:

Joselito Adoan
Testing Engineer

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Façade Testing Manager

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This document has been revised as below. This revision supersedes the previous revisions.

Revision 1	*15th July 2021*	*Drawing received last 5 July 2021 has been added.*

5. Test Performance and Requirements

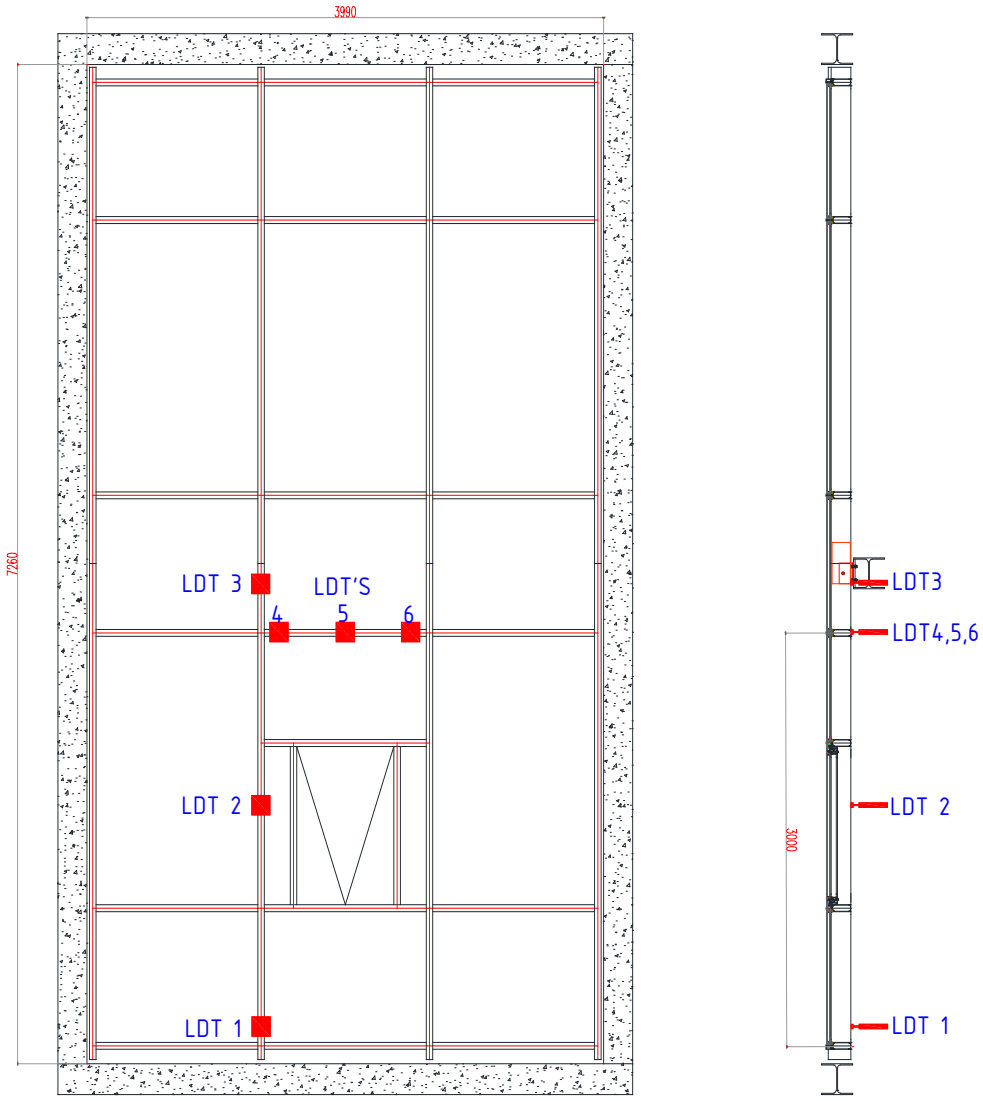
Test	Criteria	Reference
A. Test Briefing B. Visual Inspection		
Note: "No conclusions of any kind regarding the adequacy or inadequacy of the glass in the test specimen are to be drawn from the test"		
Structural Pre-Loading test	ASTM E-330-14 50% of design wing load	ASTM E-330-14
1. Air Permeability Test Test pressure - fixed element Permitted leakage - fixed element Permitted leakage – Operable element	BSEN 12153:2000 / BS EN 12152 750 Pa 1.5 $m^3/hr/m^2$ (Class AE) 0.5 $m^3/hr/m$ (Class AE)	Email received November 17, 2020 & May 9, 2021
2. Air Permeability Test Test pressure – fixed element Permitted leakage – fixed element Permitted leakage – Operable element	BSEN 1026:2016 / BS EN 12207 750 Pa 1 $m^3/hr/m^2$ (Class 4) 0.25 $m^3/hr/m$ (Class 4)	Email received November 17, 2020 & May 9, 2021 By client on the day of the test
3. Water tightness Test Test Pressure Leakage Details	BSEN 12155:2000 / BS EN 12154 900 Pa No Water leakage allowed (RE900)	Email received November 17, 2020
4. Water tightness Test Test Pressure Leakage Details	BSEN 1027:2016 / BS EN 12208 900 Pa No water leakage (Class E900)	Email received November 17, 2020 & May 9, 2021
5. Wind Resistance Test Test Pressure (inward and outward directions) Acceptable Deflection	BSEN 12179:2000 2 kPa inward & 2 kPa outward pressures Span L / 175	Email received November 17, 2020 By client on the day of the test
6. Repeat Air Permeability Test	Same as item 1	
7. Repeat Water tightness Test	Same as item 3	
8. Dynamic Water Penetration Test Test Pressure	AAMA 501.1-17 900 Pa	Email received November 17, 2020

Leakage Details	No water leakage allowed	
9. Wind Resistance Test – Safety Test Pressure (inward and outward directions) Acceptable Deformation	BSEN 12179:2000 3 kPa inward & 3 kPa outward pressures Span L / 500	Email received November 17, 2020
10. Impact Test A. Impactor B. Curtainwall Internal / External Impact classification <u>Soft Body</u> Impact load positions a. Center mullion height between fixings (external only) b. Center width of transom of component, (external, internal) at sill height or at spandrel height. c. End of transom, 150 mm from junction with mullion (external, internal) d. Center of infill panel (external, internal).	BS EN 14019: 2016 I5 / E5 (drop height = 950mm) The curtain wall shall safely absorb the impact loads and shall retain its integrity fulfilling the following criteria: 1. No part exceeding the mass of 50 grams shall fall down. 2. No holing shall occur permitting a test block E2 according to with EN 1630 (ellipse) to be passed through it. 3. Permanent deformation of curtain wall framing members including their connections and fixings shall be accepted as far as no fracturing or rupturing that separates any framing member, connection, or fixing into two or more fragments shall occur. 4. The test specimen shall not detach or dislodge. 5. Any infill panel shall not detach or dislodge. 6. Glass products used as or incorporated in infill components shall be classified in accordance with EN 12600.	Email received November 17, 2020

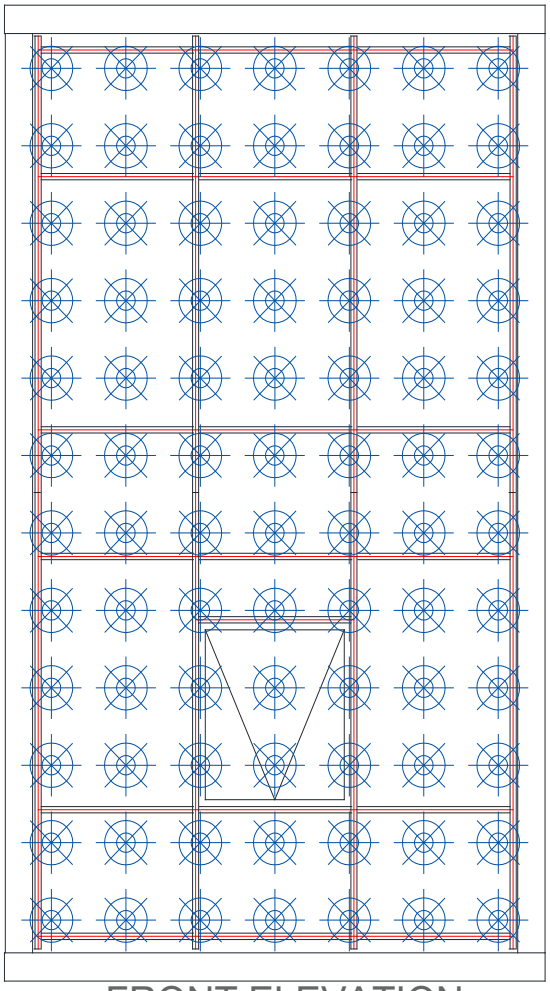
Note: The testing criteria were taken from the project specification or as approved by the client/ consultant.

6. Mock-up Diagram

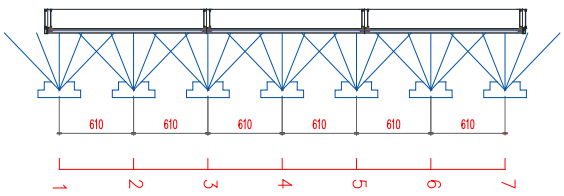
Note: Drawing has been provided by the customer



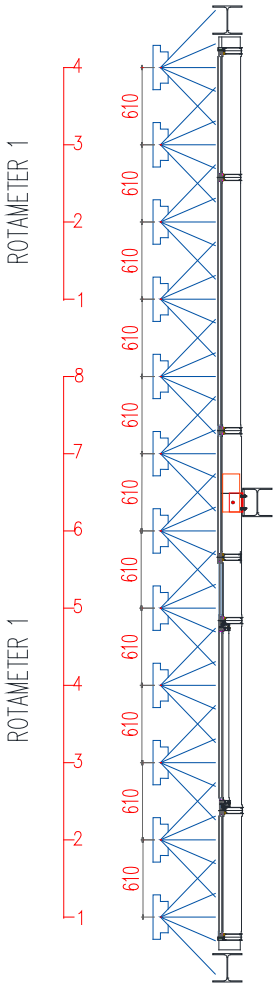
LDT Number	Location
1-2-3	Along Mullion
4-5-6	Along Transom



FRONT ELEVATION



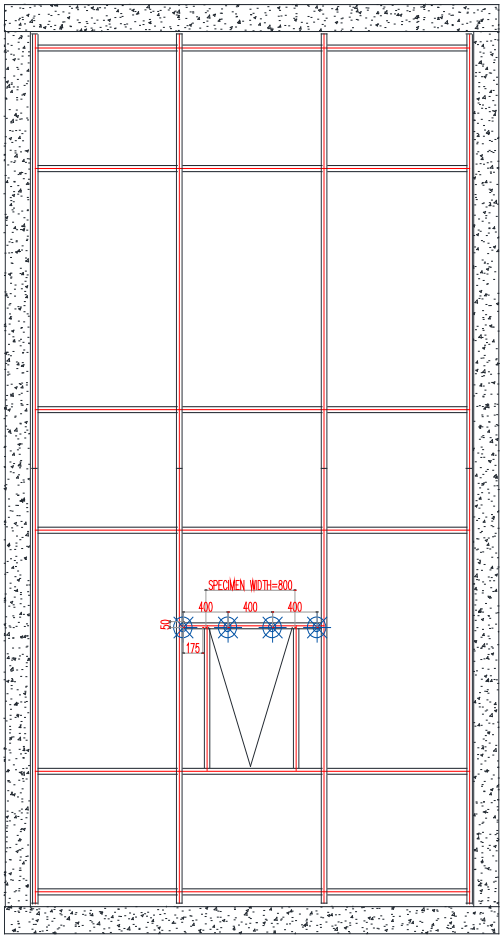
ELEVATION



SECTION

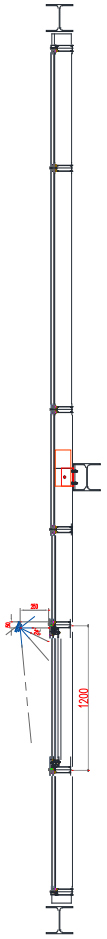
BS EN 12155– WATER TIGHTNESS TEST SET–UP FOR CURTAINWALL

Water Spray rack set-up

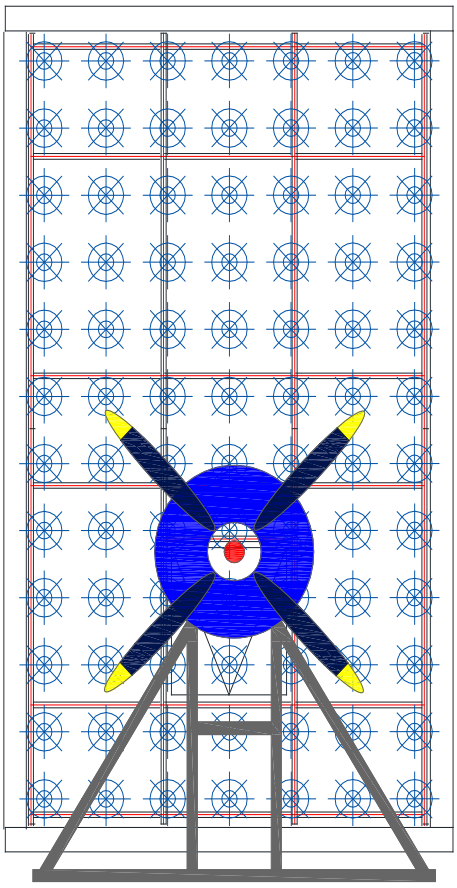


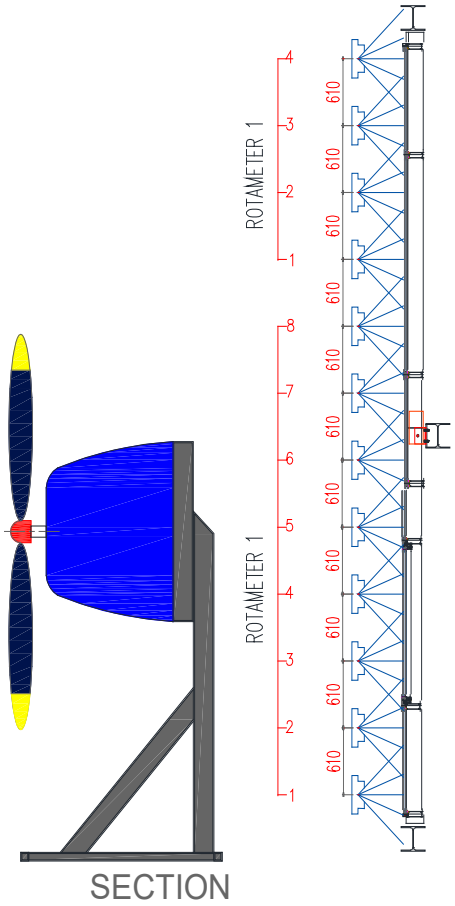
ELEVATION

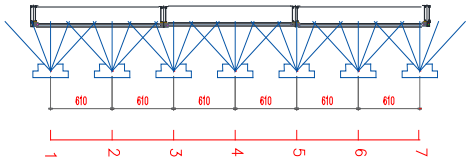
BS EN 1027- WATER TIGHTNESS TEST SET-UP
FOR WINDOW / FACADE WINDOWS

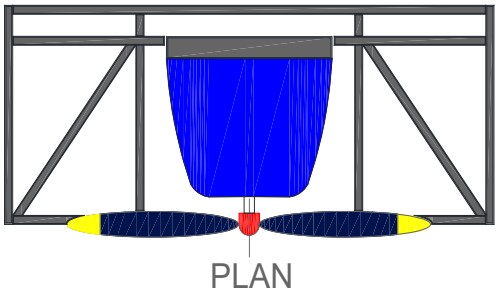


SECTION

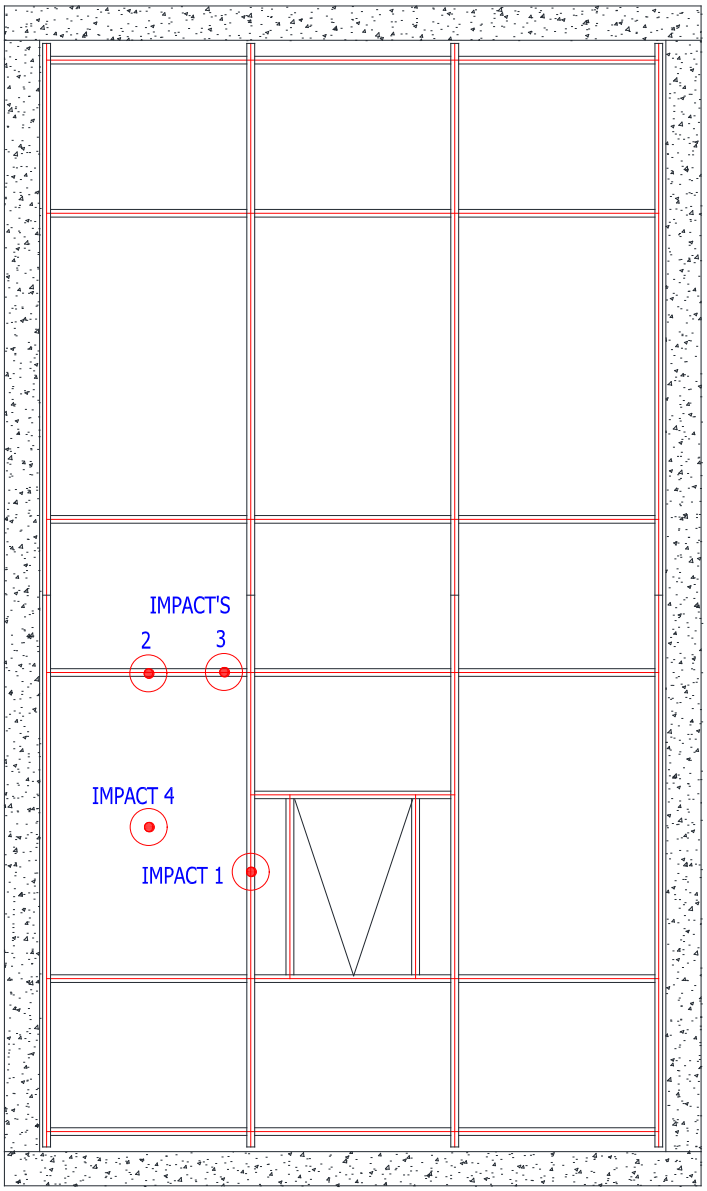








Dynamic Water Spray rack set-up



Impact Location

1	Centre of mullion or component height between fixings (external only).
2	Centre width of transom of component (external, internal) at sill height and/or at spandrel height.
3	End of transom, 150 mm from junction with mullion (external, internal).
4	Centre of infill panel (external, internal)

7. Specification Compliance

Testing will be carried out under the direction of the Testing Engineers of TBWIC in compliance with the requirements of the Client

8. Test Procedures

Specimen verification: Prior to start of the test, the Testing Engineer shall verify to the witnesses that the mock-up has the correct file number label stuck on the test chamber similar to the file number identified on the Method Statement.

8.1. Air Permeability test, BS EN 12153:2000

Determine the air permeability of curtain walling, both fixed and openable parts.

8.1.1. CHAMBER CALIBRATION

Determine the chamber air permeability excluding the effect of test specimen, to be made in the following procedures.

a. Ensure the specimen is properly secured in the test chamber.
b. Seal the specimen with plastic and tape on the outside. Openable joints will be sealed with non-permeable tapes.
c. Apply three pulses of positive pressure equal to 500 Pa or 10% greater than the maximum test pressure whichever is greater. The maximum pressure for each pulse should be reached in not less than 1 second and should be maintained for not less than 3 seconds.
d. The pressures shall be applied in increments of 50 Pascals up to 300 and in increments of 150 Pascals up to the maximum test pressure.
e. Determine the air permeability of the chamber (Qc) and record respectively up to the maximum test pressure.
f. Measure the air permeability of the test chamber as above under the appropriate negative test pressures when the specimen is to be tested in the negative test pressures.

8.1.2. PREPARATION

a. Calculate the area of the fixed panels (A) and measure the overall length (Lo) of the openable joints if there are any.
b. Connect the three-phase blower, the conical inlet nozzle and the pressure sensor to the chamber.

8.1.3. TEST PROCEDURE

a. Record temperature, humidity and barometric pressure.
b. Apply three air pressure pulses equal to 10 % greater than the peak test pressure in less than one second and the pressure shall be maintained for at least three seconds.
c. Apply positive pressure in increments of every 50 Pascals up to 300 and every 150 up to the peak test pressure. At each pressure level, the differential pressure and air flow (Qfc) shall be recorded.
d. The seal of the openable joints shall be removed and the whole of the pressure sequence described above repeated. At each pressure level the differential pressure and air flow (Qtc) shall be recorded.
e. Determine the air permeability of the fixed panels (Qf) and the openable joints (Qj) at each test pressure in cubic meters per hour (m3/hr) as follows:
    i. For fixed panels, $Qf = Qfc - Qc$
    ii. For openable panels, $Qj = Qtc - Qfc$
f. Calculate the air permeability per unit area of fixed panels (Qf/A) at each test pressure and plot a graph of the results against the test pressures.

g. Calculate the air permeability per unit length of openable joint (Qj/Lo) at each pressure and plot a graph of the results against the test pressures.

8.2. Air Permeability test, BS EN 1026: 2016

8.2.1. Terms and Definitions

a. Closing Condition

   i. Closed – movable part rest in or at the fixed part in a way in which they may be fastened (latched and / or locked).

   ii. Fastened – where the movable part is restrained at one or more points an shall be described by at least one or the two as listed below:

   iii. Latched – movable part is returned to its closed position and restrained by either self-engaging fastener or roller catch or latch.

   iv. Locked – movable part is further restrained in the closed position by additional operations to engage integrated locking devices which will affect the products characteristics.

b. Opening joint – line of discontinuity between either a frame and its matched component or two components which can be opened by means of their building hardware.

c. Length of Opening joint – length of the line of discontinuity as defined above (opening joint), should be expressed in meters, m.

d. Overall area – area of the test specimen measured parallel to the glazing of the leaf, expressed in m^2.

8.2.2. Preparation

a. Install the specimen as intended for use in the actual condition without any variation which may affect the result of the test.

b. The specimen shall be fully operable, cleaned and dry.

c. Ventilation devices if any shall be taped over except when it is required to determine the amount of air flow through such devices.

d. The ambient temperature and humidity shall be within the range of 10 degrees to 30, and 25% to 75 RH, measured adjacent to the sample. The specimen shall be conditioned for at least 4 hours before the testing.

e. Ensure customers are aware that ambient temperatures may be outside the required range and report as a deviation when this is the case.

8.2.3. Test Procedure

a. The air permeability of the chamber will be regarded zero if it is less than 5% of the maximum air permeability throughout the range of the classification that is attributed to the test specimen. When this is not so, the air permeability of the chamber must be measured in positive test pressures (static air pressure on the external side is higher than the internal), and shall not exceed 30% of the overall air permeability of both specimen and chamber.

b. For test chamber with unknown air permeability, seal all joints of the specimen with adhesive tape or cover the whole specimen with an air tight sheet.

c. Apply three air pressure pulses of 500 Pascals or 10% greater than the maximum test pressure whichever is higher in not less than one second and maintain for at least three seconds.

d. Apply positive test pressures in steps of 50 Pascals up to 300 Pascals and 150 Pascals thereafter and let stabilize for some time before recording the air permeability at each step.

e. If so, required in the negative test pressures, perform the same procedures and record air permeability at each step.

f. Remove all seals of the test specimen and allow to open and close all opening parts of the test specimen at least once before securing them in the locked position.

g. Measure the combined air permeability in positive pressure levels the same as when the specimen was covered.

h. Perform the negative test when specifically required.

8.2.4. TEST RESULT

a. Adjust the result of the airflow measurements of the test specimen (Q_x) at each step, to calculate the airflow (Q_o) at normal conditions (T_o = 293 K, p_o= 101.3 Kpa), considering the actual temperature T_x expressed in °C and atmospheric pressure P_x expressed in Kpa, during the test.

$$Q_o = Q_x \cdot \frac{293}{273 + T_x} \cdot \frac{P_x}{101.3}$$ where:

Q_o = airflow in cubic meters per hour, cph (m^3/hr)

Q_x = airflow measurements of the test specimen, in cph (m^3/hr)

T_x = actual temperature in degrees Celsius (°C)

P_x = atmospheric pressure in kilo Pascal (KPa)

b. Test specimen: the air permeability at each step is equal to the overall air permeability adjusted in accordance with (a) above less the air permeability of the chamber, when not zero, adjusted in accordance with (a).

c. Using the length of the opening joint and the overall area, calculate the air permeability in terms of m^3/(hr.m) and m^3/(hr.m^2), expressing the results to two significant figures.

d. Record on a graph the air permeability (Q_o) related to the length of joint (Q_t) and the overall area (Q_A), for each pressure step.

8.3. Watertightness Test, BS EN 12155:2000

8.3.1. PREPARATION

a. A spray rack will be deployed on the exterior not more than 40 cm from the surface of the specimen nor closer than 25 cm. It will consist of a vertical feeder pipe attached to an arrangement of row pipes with nozzles spaced 610 mm apart vertically. The flow rate of the spray rack for the test is to apply 0.5 gpm.m^2 (2.0 lpm.m^2) depends on the total count of the nozzles used for the test. Each nozzle will produce 0.2 US gpm of water and the total amount of water spray required for the test is controlled by rotameter gauges in terms of volume flow. To limit the pressure difference between the top and bottom nozzles, the spray arrays are limited in height to a maximum of 5 meters. This ensures the maximum flow at the bottom and the minimum at the top are within the limits prescribed in the standard. The entire specimen will be covered with 7 columns of nozzles and 12 rows of nozzle pipes. A total of 16.8 gpm (62.16 lpm) of water spray will be applied to cover the entire specimen.

8.3.2. Test Procedure

a. Record temperature, humidity and barometric pressure.
b. Apply three air pressure pulses equal to 10 % greater than the peak test pressure in less than one second and the pressure shall be maintained for at least three seconds.
c. The exterior of the test specimen shall be sprayed with water using the above spraying method for 15 minutes with zero air pressure difference.
d. While the water spray continuously running, apply positive pressure in increments of every 50 Pascals up to 300 and every 150 up to the peak test pressure, each pressure level lasting 5 minutes.
e. Return the pressure to zero in one step and turn off the water spray.
f. Inspect the internal side of the specimen for any water leaks.

8.3.3. Leakage

If there would be an emergence of water leakage, it shall be recorded at which test pressure leveler has occurred, the location and the extent amount shall be noted on a drawing of the specimen.

8.4. Watertightness Test, BS EN 1027: 2016

This test method determines the watertightness of completely assembled windows and doorsets of any material. Constant spraying of a specified quantity of water onto the external surface of the test specimen while increments of positive test pressure are applied at regular intervals during which details are recorded of test pressure and location of water penetration.

8.4.1. Terms and Definitions

a. Closing Condition
    i. Closed – movable part rest in or at the fixed part in a way in which they may be fastened (latched and / or locked).
    ii. Fastened – where the movable part is restrained at one or more points an shall be described by at least one or the two as listed below:
    iii. Latched – movable part is returned to its closed position and restrained by either self-engaging fastener or roller catch or latch.
    iv. Locked – movable part is further restrained in the closed position by additional operations to engage integrated locking devices which will affect the products characteristics.
b. Watertightness – ability of the test specimen to resist water penetration under the test conditions up to a pressure (P_{max} = limit of the watertightness).
c. Water penetration – continuous or repeated wetting of:
    i. Parts of the inside face of the test specimen, or
    ii. Any parts of the test specimen intended to remain dry, not being part of the water drainage system to the outside, or
    iii. Any part of the test specimen where water does not drain to the outside in a controlled way.
d. Limit of watertightness – maximum test pressure P_{max} up to which the test specimen remains watertight under the test conditions for the specified time.

8.4.2. PREPARATION

a. Install the specimen as intended for use in the actual condition without any variation which may affect the result of the test.

b. The specimen shall be fully operable, cleaned and dry.

c. Ventilation devices if any shall be taped over except when it is required to let the air flow through such devices.

d. The ambient temperature and humidity shall be within the range of 10 degrees to 30, and 25% to 75 RH. The specimen shall be conditioned for at least 4 hours before the testing.

e. Open and close all opening parts of the test specimen at least once before securing them in the closed condition.

f. The configuration of the specimen shall be taken into account to select the spraying method and be tested in one method alone.

g. Arrange a single row of spray rack nozzles equidistant 400 mm apart (+/- 10 mm) and positioned 250 mm from the surface of the test specimen with the outer most nozzles at the sides inset not less than 50 mm nor greater than 250 mm from the sides of the specimen, (refer to the "c" value in the mock up diagram). The nozzle line shall be located not more than 150 mm above the topmost horizontal joint line of any moving frame or the glazing line of any fixed glazing.

h. The nozzle axis shall be tilted in an angle $24^{o\ +2}$ below the horizontal line for test according to Method 1A and 84^{o} +/- 2^{o} for test according to Method 1B.

i. Use a single row of nozzle with each will spray an average 2 liters/minute spray for Method 1A and 1B, if the height of the specimen is not more than 2500 mm.

j. For specimen with heights more than 2500 mm, the upper row of nozzles shall be added with another row at intervals of 1500 mm below (+/- 150 mm). The flow of each nozzle shall be on average 1 liter/minute spray for Method 2A and 2 liters/minute spray for Method 2B.

k. Ensure customers are aware that ambient temperatures may be outside the required range and report as a deviation when this is the case.

8.4.3. TEST PROCEDURE

a. Apply three pressure pulses with the duration of increase in test pressure shall not be less than 1 second and maintained for at least three (3) seconds, 10% greater than the maximum test pressure required for the test, without however being less than 500 Pascals.

b. Spray the water at 0 pressure for the first 15 minutes and increase in an interval of 50 Pascals each lasting 5 minutes up to 300 Pascals, and from thereafter 150 Pascals interval until water emergence occurs along the internal side of the specimen. Note, the duration of each pressure step shall be within a tolerance of +1/-0 minute.

8.4.4. LEAKAGE

If there would be an emergence of any water on the inside face, it shall be recorded at which test pressure level it has occurred, the location and extent of the leakage shall be noted on a drawing of the specimen.

8.5. Resistance to Wind load, BS EN 12179:2000

This test method determines the resistance of curtain walling, both the fixed and openable parts to wind load under positive and negative static air pressure. Test direction is initially carried out in the positive direction.

8.5.1. Preparation

a. Install the linear transducers on the internal side of the specimen neat two successive anchorages on a typical mullion and midway between, and on a transom.
b. Measure the outermost distance and this will be recorded as the value of "L" and will be divided by the allowable deflection ratio to arrive at the permitted deflection.
c. Open and close each openable part of the test unit for five times prior to testing.

8.5.2. Test Procedure

a. Record the temperature, humidity and barometric pressure.
b. Apply three air pressure pulses equivalent to 50% of the wind resistance serviceability test peak pressure or 500 Pascals whichever is higher. The pressure rise time shall not be less than one second and the pressure shall be maintained for at least 3 seconds.
c. Reset the reading of the transducer to zero.
d. Subject the test specimen to the test pressures in 4 steps for a minimum period of 15 seconds +/- 5 seconds at each stage up to the design wind load, that is 25%, 50%, 75% and 100%
e. Record the residual deformation after 1 minute.
f. Repeat the above test procedure for the negative pressure test, and after completion of the test. The deflection gauges will be kept in place for the safety test.
g. Report any damage condition.

8.6. Dynamic Water Penetration test, AAMA 501.1-17

The required wind velocity to be developed by the wind generator shall be taken from the calibrated results established, equating the engine speed to the specified test pressure. (Note: the equivalent velocity pressure shall be calculated using the Ensewiler formula, P = 0.613 V^2, where V = wind velocity in m/s and P = the equivalent velocity pressure in Pascals.) The same spray rack set-up and flow adjustment as the one used for the static water penetration shall be used for the test.

8.6.1. Preparation

a. Install spray rack as for static test.
b. Locate wind generator and install restraint cables.
c. Issue hearing protectors and cordon off area in front of propeller.
d. One digital hand-held anemometer will be set ready to check/measure wind speed going to be generated.
e. Ensure PMU elevation with view from inside is with TBWIC representative for marking record if water leakage occurs during the test.

8.6.2. Test Procedure

a. Record temperature.
b. The wind generator will be started and warmed up approximately 10 minutes or as deemed necessary prior to the testing.
c. The test chamber door will be open and witnesses may enter or leave the chamber during the test, as they wish.
d. The engine running speed will be increased until it reaches the rpm value given in the calibration.

e. With the engine running, the same method of water spray in the static test will be started and adjusted as above.
f. After 15 minutes, the engine will be slowed to idle, and the water stopped.
g. The specimen will be inspected for leaks.

8.7. Impact test, BS EN 14019:2016

8.7.1. SCOPE

a. The Standard defines performance requirements of curtain walling under impact load.
b. The mode of breakage of the glass has to be already assessed according to EN 12600.
c. Its criteria are targeted to safety in use and integrity of curtain walling in the event of sudden impact forces.
d. It does not set out to define performance requirements of impact under exceptional circumstances such as acts of vandalisms, vehicular collision, firearm projectiles, etc.

8.7.2. PREPARATION

e. Though the standard requires storage and testing shall be done in a non-destructive environment within the range of 5 degrees C to 30 degrees C and relative humidity of 25 % to 75%. [test to be done under the prevailing ambient conditions outside the required range shall be recorded as a deviation from the Standards].
f. Fix the specimen on a rigid structure of the chamber using the same method of fixing as proposed for site installation. The sample used for water tightness test will normally be suitable.
g. Mark the location of the impact points to be stricken as per the required location indicated in Sec 5 of the test Standard,
h. For every impact location and prior to testing, set the impactor in rest position and align the largest diameter of the impactor closest to the target point.
i. Weigh impactor for verification purposes and check impact lines are free from obstructions. The impactor should be hanging at free state aligning with the impact point and cable lines taut at the required drop height. Drop heights and reference lines are measured with a calibrated measuring tape.

8.7.3. TEST PROCEDURE

a. Record temperature, humidity and barometric pressure.
b. Attach the release hook mechanism to the impactor and raise by means of adjusting device until the required drop height is correctly set. Assure the suspension cable to be taut and the axis of the impactor and cable shall be in line with the target.
c. Testing may start at the lowest drop height and increase up to the drop height required or a failure occurs, or straight to the specified classification. The drop height shall be set to an accuracy of +/- 10 mm.
d. With the impact point defined, mark the required drop height in the sample with a calibrated measuring tape and project this line to the center of the impactor using a laser pointer.
e. Once ready, disengage the release hook allowing the impactor to swing freely until it strikes the test specimen perpendicular to the infill. The metal part of the impactor shall not make contact with the test piece during the impact. After impact, follow with once 100 mm drop height impact. Separate test positions could be used for the external and internal impacts.
f. Inspect the test piece after each impact and note whether it complies with the requirements given in the failure criteria.
g. For each test position identified, the classification impact is applied once followed by an impact of 100 mm drop height.
h. If failure of an infill panel occurs, the test may be repeated with a replacement infill panel once.

9. Testing Equipment

Equipment used for the test as enumerated below which requires calibration are all covered by valid calibration certificates.

a. A 3-phase high pressure centrifugal blower with speed controller and damper to control the pressure within the chamber. This will be connected to the chamber via a transition piece and 2 meters of 20 cm flexible duct. Speed is controlled by varying the frequency in steps of 0.1 Hz at the controller and by a remote knob control.
b. Conical inlet nozzles for measurement of air flow.
c. Data acquisition electronic equipment. Consists of 3 electronic manometers, 6 displacement transducers and software to read data, all are integrated into the excel sheet forms included herein.
d. Double tyre impactor with mass equivalent to 50 Kg. according to EN 12600.
e. Standard test frame/Impactor release mechanism
f. Measuring tape.
g. Ellipse according to EN 1630.
h. Laser Pointer
i. Water spray rack.

10. Test Worksheets

Air permeability test sheet for Curtain wall

Project name:	SMART ARCHITECTURAL SYSTEM										
Air Permeability Test BS EN 12153:2000										June 20, 2021	
File No.	UK104	Thomas Bell-Wright International Consultants, Dubai								10:50:30 AM	
Ambient condition											
Air Temperature	38	°C	Bar. Press.	1001	mb	RH	45	%	DATE		

Test criteria							
Specimen height	7.26	m					
Specimen width	3.99	m	Inlet nozzle size	56	mm	0	Chamber
Specimen area	29.0	m²	Nozzle Connection	A- PT L1		0.0	Nozzle
Test pressure	750	Pa	Chamber Connection	B- PT L2		0.0	Flow
Length of opening joint	0.0	m					
Permitted leakage fixed area	1.5	m³/hr/m²					
Permitted leakage(opening joint)	0.0	m³/hr/m	Joe Adoan				
Total permitted leakage	43.50	m³/hr	Testing Engineer				

Air Infiltration Test

Chamber Leakage

Test Pressure	50	100	150	200	250	300	450	600	750	
Chamber Pressure	50	99	151	199	250	305	454	599	749	Pa
Nozzle pressure	5.8	15	22.7	34.6	47.7	58	98.7	135.3	171.4	Pa
Flow	25.6	41.2	50.7	62.7	73.7	81.3	106	124	140	m³/hr

Chamber and Specimen Leakage

Test Pressure	50	100	150	200	250	300	450	600	750	
Chamber Pressure	52	101	153	200	252	303	455	601	744	Pa
Nozzle pressure	5.9	15.1	23.8	36.8	50.4	60.5	102.2	141.4	180.2	Pa
Flow	25.8	41.4	52	64.7	75.7	83	108	127	144	m³/hr
	0.2	0.2	1.3	2.0	2.0	1.7	2.0	3.0	4	m³/hr

Air permeability test sheet for Windows

Project name:	SMART ARCHITECTURAL SYSTEM										
Air Permeability Test BS EN 1026:2016										June 20, 2021	
File No.	UK104	Thomas Bell-Wright International Consultants, Dubai								11:15:30 AM	
Ambient condition											
Air Temperature	38	°C	Bar. Press.	1001	mb	RH	45	%	DATE		

Test criteria							
Specimen height	1.17	m					
Specimen width	0.77	m	Inlet nozzle size	56	mm	0	Chamber
Specimen area	0.9	m²	Nozzle Connection	A- PT L1		0.0	Nozzle
Test pressure	750	Pa	Chamber Connection	B- PT L2		0.0	Flow
Length of opening joint	0.0	m					
Permitted leakage fixed area	1.0	m³/hr/m²					
Permitted leakage(opening joint)	0.0	m³/hr/m	Joe Adoan				
Total permitted leakage	0.90	m³/hr	Testing Engineer				

Air Infiltration Test

Chamber Leakage

Test Pressure	50	100	150	200	250	300	450	600	750	
Chamber Pressure	52	101	153	200	252	303	455	601	744	Pa
Nozzle pressure	5.9	15.1	23.8	36.8	50.4	60.5	102.2	141.4	180.2	Pa
Flow	25.8	41.4	52	64.7	75.7	83	108	127	144	m³/hr

Chamber and Specimen Leakage

Test Pressure	50	100	150	200	250	300	450	600	750	
Chamber Pressure	52	101	153	200	252	303	455	601	744	Pa
Nozzle pressure	5.9	15.2	23.9	37	50.5	60.7	102.3	141.4	180.2	Pa
Flow	25.8	41.5	52.1	64.9	75.8	83.2	108.1	127	144	m³/hr
	0.0	0.1	0.1	0.2	0.1	0.2	0.1	0.0	0.0	m³/hr

Water Tightness Test sheet for curtain wall

Project Name	SMART ARCHITECTURAL SYSTEM	See Input Data
Water Tightness BS EN 12155:2000		Sunday, June 20, 2021
File No.: UK104	Thomas Bell-Wright International Consultants, Dubai	11:29:53 AM

AMBIENT CONDITION

Air Temperature 33 °C — Barometric Pressure 1001 mb — Relative Humidity 44% %

Water Temperature 33 °C

TEST CRITERIA — Update — CLEAR DATA

Width 4.0 m — Height 7.3 m

Chamber Connection B- PT L2 — The spray rack will consist of 7 rows of 12 nozzles

US gallon / minute 28.0 — Test Pressure 900 Pa

STOP — Conclusion Pass

TIMER		
HOUR	MINUTES	SECONDS
1	5	14

CHAMBER PRESSURE

900

Start/reset timer 11:30 AM

	0	50	100	150	200	250	300	450	600	750	900
TIME	11:45 AM	11:50 AM	11:55 AM	12:00 PM	12:05 PM	12:10 PM	12:15 PM	12:20 PM	12:25 PM	12:30 PM	12:35 PM
PRESSURE	4	50	98	149	205	251	297	497	612	749	888
Minutes	0:15	0:20	0:25	0:30	0:35	0:40	0:45	0:50	0:55	1:00	1:05

RECORD

Joe Adoan
Testing Engineer

TBW-CW-46 - Issue 1 - Issue Date - March 2015

Water Tightness Test sheet for windows

Project Name	SMART ARCHITECTURAL SYSTEM	See Input Data
Water Tightness BS EN 1027:2016		Sunday, June 20, 2021
File No.: UK104	Thomas Bell-Wright International Consultants, Dubai	3:00:45 PM

AMBIENT CONDITION

Air Temperature 36 °C — Barometric Pressure 1001 mb — Relative Humidity 44% %

Water Temperature 33 °C

TEST CRITERIA — Update — CLEAR DATA

Width 0.8 m — Height 1.2 m

Chamber Connection B- PT L2 — The spray rack will consist of 1 rows of 4 nozzles

US gallon / minute 1.3 — Test Pressure 900 Pa

STOP — Conclusion Pass

TIMER		
HOUR	MINUTES	SECONDS
1	5	2

CHAMBER PRESSURE

900

Start/reset timer 3:00 PM

	0	50	100	150	200	250	300	450	600	750	900
TIME	3:15 PM	3:20 PM	3:25 PM	3:30 PM	3:35 PM	3:40 PM	3:45 PM	3:50 PM	3:55 PM	4:00 PM	4:05 PM
PRESSURE	1	52	101	150	206	252	303	453	601	750	904
Minutes	0:15	0:20	0:25	0:30	0:35	0:40	0:45	0:50	0:55	1:00	1:05

RECORD

Joe Adoan
Testing Engineer

TBW-CW-46 - Issue 1 - Issue Date - March 2015

Resistance to wind load test sheet (Positive wind load)

SMART ARCHITECTURAL SYSTEM

Resistance to Wind Load - Serviceability BS EN 12179:2000 — **File No.: UK104**

THOMAS BELL-WRIGHT *INTERNATIONAL CONSULTANTS*

Joselito Adoan
Testing Engineer

June 21, 2021
8:52 AM

Ambient Condition

Ambient Temperature	35	°C
Barometric Pressure	1000	mb
Relative Humidity	49%	%
Bedding Pulses	750	Pa

Test Criteria

Design wind load	2000	Pa
Mullion length to be tested	3.25	m
Transom length to be tested	1.2	m
Max. allowable deflection - mullion	18.6	mm
Max. allowable deflection - transom	6.8	mm

POSITIVE TEST PRESSURE

2000 **Pa**

LDT MOVEMENT **49.3 42.8 46.0 48.6 45.8 51.9**

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	25%	0.7	2.5	0.3	0.8	0.8	0.8														
2nd	50%	1.4	5.2	0.7	1.7	1.8	1.9														
3rd	75%	2.2	7.8	1.1	2.6	2.7	2.8														
4th	100%	2.9	10.6	1.6	3.7	3.7	3.9														
Record bracket movement LDT No:																					

C

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Residual	0.3	0.9	0.4	0.6	0.5	0.4														

C

Mixmum Deflection

LDT	1	2	3	NET		4	5	6	NET		7	8		NET		
1st pulse	0.7	2.5	0.3	2	PASS	0.8	0.8	0.8	0	###					PASS	**LIVE READING**
2nd pulse	1.4	5.2	0.7	4.15	PASS	1.7	1.8	1.9	0	###					PASS	
3rd pulse	2.2	7.8	1.1	6.15	PASS	2.6	2.7	2.8	0	###					PASS	2000 **Pa**
4th pulse	2.9	10.6	1.6	8.35	PASS	3.7	3.7	3.9	-0.1	###					PASS	

Time Finish 2:38:24 PM

BW-CW-47 - Issue 1 - Issue Date - March 201

Resistance to wind load test sheet (Negative wind load)

SMART ARCHITECTURAL SYSTEM

Resistance to Wind Load - Serviceability BS EN 12179:2000 — **File No.: UK104**

THOMAS BELL-WRIGHT *INTERNATIONAL CONSULTANTS*

Joselito Adoan
Testing Engineer

June 21, 2021
9:07 AM

Ambient Condition

Ambient Temperature	35	°C
Barometric Pressure	1000	mb
Relative Humidity	44%	%
Bedding Pulses	0	Pa

Test Criteria

Design wind load	2000	Pa
Mullion length to be tested	3.25	m
Transom length to be tested	1.2	m
Max. allowable deflection - mullion	18.6	mm
Max. allowable deflection - transom	6.8	mm

NEGATIVE TEST PRESSURE

2000 **Pa**

LDT MOVEMENT **49.3 42.8 46.0 48.6 45.8 51.9**

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	25%	-0.8	-2.3	-0.4	-0.9	-0.9	-0.9														
2nd	50%	-1.5	-4.9	-0.8	-1.8	-1.9	-1.9														
3rd	75%	-2.3	-7.4	-1.3	-2.7	-2.9	-2.9														
4th	100%	-3.1	-10.1	-1.8	-3.9	-4.1	-4.2														
Record bracket movement LDT No:																					

C

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Residual	-0.4	-0.8	-0.3	-0.4	-0.5	-0.5														

C

Mixmum Deflection

LDT	1	2	3	NET		4	5	6	NET		7	8		NET		
1st pulse	-0.8	-2.3	-0.4	-1.7		-0.9	-0.9	-0.9	0							**LIVE READING**
2nd pulse	-1.5	-4.9	-0.8	-3.75		-1.8	-1.9	-1.9	-0.05							
3rd pulse	-2.3	-7.4	-1.3	-5.6		-2.7	-2.9	-2.9	-0.1							2000 **Pa**
4th pulse	-3.1	-10.1	-1.8	-7.65		-3.9	-4.1	-4.2	-0.05							

Time Finish 2:38:24 PM

TBW-CW-48 - Issue 1 - Issue Date - March 2015

Repeat Air permeability test for Curtain wall

Project name:	SMART ARCHITECTURAL SYSTEM									
Air Permeability Test BS EN 12153:2000									June 21, 2021	
File No.	**UK104**	**Thomas Bell-Wright International Consultants, Dubai**							10:00:30 AM	
Ambient condition										
Air Temperature	38	ºC	Bar. Press.	1001	mb	RH	45	%	DATE	

Test criteria						
Specimen height	7.26	m				
Specimen width	3.99	m	Inlet nozzle size	56	mm	0 Chamber
Specimen area	29.0	m²	Nozzle Connection	A- PT L1		0.0 Nozzle
Test pressure	750	Pa	Chamber Connection	B- PT L2		0.0 Flow
Length of opening joint	0.0	m				
Permitted leakage fixed area	1.5	m³/hr/m²				
Permitted leakage(opening joint)	0.0	m³/hr/m	**Joe Adoan**			
Total permitted leakage	43.50	m³/hr	Testing Engineer			

Air Infiltration Test

Chamber Leakage

Test Pressure	**50**	**100**	**150**	**200**	**250**	**300**	**450**	**600**	**750**	
Chamber Pressure	50	101	149	202	250	300	454	600	750	Pa
Nozzle pressure	10.4	23.7	39.2	53.9	72.5	92.4	146.9	202.8	255.7	Pa
Flow	34.3	51.9	66.8	78.3	90.9	102.7	130	152.4	171.2	m³/hr

Chamber and Specimen Leakage

Test Pressure	**50**	**100**	**150**	**200**	**250**	**300**	**450**	**600**	**750**	
Chamber Pressure	54	103	156	204	251	305	450	602	752	Pa
Nozzle pressure	10.5	24.1	41.1	56.2	76.2	97.1	155.3	211.8	274.2	Pa
Flow	34.5	52.3	68.4	80	93.2	105.3	133	156	177	m³/hr
	0.2	**0.4**	**1.6**	**1.7**	**2.3**	**2.6**	**3.0**	**3.6**	**6**	m³/hr

Repeat Air permeability test sheet for Windows

Project name:	SMART ARCHITECTURAL SYSTEM									
Air Permeability Test BS EN 1026:2016									June 21, 2021	
File No.	**UK104**	**Thomas Bell-Wright International Consultants, Dubai**							10:15:30 AM	
Ambient condition										
Air Temperature	38	ºC	Bar. Press.	1001	mb	RH	45	%	DATE	

Test criteria						
Specimen height	1.17	m				
Specimen width	0.77	m	Inlet nozzle size	56	mm	0 Chamber
Specimen area	0.9	m²	Nozzle Connection	A- PT L1		0.0 Nozzle
Test pressure	750	Pa	Chamber Connection	B- PT L2		0.0 Flow
Length of opening joint	0.0	m				
Permitted leakage fixed area	1.0	m³/hr/m²				
Permitted leakage(opening joint)	0.0	m³/hr/m	**Joe Adoan**			
Total permitted leakage	0.90	m³/hr	Testing Engineer			

Air Infiltration Test

Chamber Leakage

Test Pressure	**50**	**100**	**150**	**200**	**250**	**300**	**450**	**600**	**750**	
Chamber Pressure	54	103	156	204	251	305	450	602	752	Pa
Nozzle pressure	10.5	24.1	41.1	56.2	76.2	97.1	155.3	211.8	274.2	Pa
Flow	34.5	52.3	68.4	80	93.2	105.3	133	156	177	m³/hr

Chamber and Specimen Leakage

Test Pressure	**50**	**100**	**150**	**200**	**250**	**300**	**450**	**600**	**750**	
Chamber Pressure	50	101	155	200	255	305	464	611	750	Pa
Nozzle pressure	10.6	24.2	41.4	56.6	76.9	97.7	156.1	213.8	274.7	Pa
Flow	34.6	52.4	68.6	80.3	93.6	105.6	133.6	156.5	177.5	m³/hr
	0.1	**0.1**	**0.2**	**0.3**	**0.4**	**0.3**	**0.6**	**0.5**	**0.5**	m³/hr

Repeat Water Tightness Test sheet for curtain wall

Project Name	**SMART ARCHITECTURAL SYSTEM**										See Input Data -
Water Tightness BS EN 12155:2000											Monday, June 21, 2021
File No.: UK104	**Thomas Bell-Wright International Consultants, Dubai**										10:35:45 AM
AMBIENT CONDITION											
Air Temperature 36 °C	Barometric Pressure 1001 mb						Relative Humidity 44% %				
Water Temperature 33 °C											
							TEST CRITERIA		Update		CLEAR DATA
							Width 4.0 m			Height 7.3 m	
Chamber Connection B- PT L2							The spray rack will consist of 7 rows of 12 nozzles				
US gallon / minute 28.0							Test Pressure 900 Pa				
TIMER							**STOP**		Conclusion Pass		
HOUR		**MINUTES**		**SECONDS**							
1		5		2							
CHAMBER PRESSURE									Start/reset timer 10:35 AM		
900											

	0	50	100	150	200	250	300	450	600	750	900
TIME	10:50 AM	10:55 AM	11:00 AM	11:05 AM	11:10 AM	11:15 AM	11:21 AM	11:25 AM	11:30 AM	11:36 AM	11:40 AM
PRESSURE	1	53	95	150	206	243	303	442	584	750	904
Minutes	0:15	0:20	0:25	0:30	0:35	0:40	0:45	0:50	0:55	1:00	1:05

RECORD

Joe Adoan
Testing Engineer

TBW-CW-46 - Issue 1 - Issue Date - March 2015

Dynamic water penetration test sheet

Dynamic Water Penetration Test AAMA 501.1-05 **Project Name:** SMART ARCHITECTURAL SYSTEM

This is the eighth test in sequence, and the initial running of this test **Client:** SMART ARCHITECTURAL SYSTEM **File:** UK104

Thomas Bell-Wright International Consultants, Dubai

TEST CRITERIA		
Specimen height	7.260	m
Specimen width	3.990	m
Specimen area	29.00	m²
Test pressure	750	Pa
Accuracy ±	12	Pa

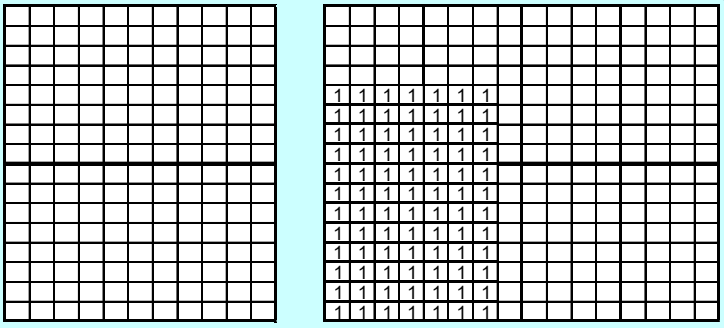
INSTANTANEOUS VALUES		
Ambient Temperature	28.0	°C
Barometric Pressure	1.014	mb
Relative Humidity	55%	
Dynamic Pressure	900	Pa
Uncertainty ±	2.8	Pa

TIMER DATA	
Start Time	12:04:24
Current Time	12:19:38
Elapsed Time	15:00
Time to Go	00:00
Finish Time	
Test Duration	15.0 Min
	15:00

The diagrams below represent the two main types of spray racks plus one free-form (for irregular areas). Each square is 61cm and the nozzle delivers one third of a US gallon per minute. A one has been placed in the squares where nozzles will be activated. Totals for the flow rates for the upper and lower portions of the spray racks are shown below the diagrams.

PRESSURE UNCERTAINTY		
Pressure Tdr. Range	750	Pa
Pressure Tdr. Uncertainty	2.8	Pa

0.00 US gpm



After completion of the testing, the data was saved at 12.19, in C:\Documents and Settings\user\Desktop\Project 2019\Marina Rise Tower\[Marina.xls]St. Water

Upper Half: 0.00 US gpm
Lower Half: 0.00 US gpm

Upper Half: 5.33 4.00 0.00 0.00 US gpm
Lower Half: 10.67 8.00 0.00 0.00 US gpm

Observations: No water leakage

Date: 21-Jun-21

Resistance to wind load test sheet (Positive wind load)- Safety

Project Name: SMART ARCHITECTURAL SYSTEM

Resistance to Wind Load - Safety BS EN 12179:2000 — **File No.:** UK104

THOMAS BELL-WRIGHT *INTERNATIONAL CONSULTANTS*

Joselito Adoan
Testing Engineer

June 21, 2021
3:21 PM

Ambient Condition

Ambient Temperature	35	°C
Barometric Pressure	1000	mb
Relative Humidity	44%	%

Test Criteria

Design wind load	3000	Pa
Mullion length to be tested	3.25	m
Transom length to be tested	1.2	m
Max. allowable deformation - mullion	6.5	mm
Max. allowable deformation - transom	2.40	mm

NEGATIVE TEST PRESSURE

LDT MOVEMENT **49.3 42.8 46.0 48.6 45.8 51.9**

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Max Load	4.4	16.9	2.2	5.8	6.0	6.3														

C

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Residual	0.5	1.4	0.5	0.8	0.8	0.8														

C

Maximum Deformation

LDT	1	2	3	NET		4	5	6	NET		7	8	9	NET		
1st pulse	0.5	1.4	0.5	0.9	PASS	0.8	0.8	0.8	0	PASS				0	FAIL	**LIVE READING**
																3000 Pa

2:52:48 PM

TBW-CW-49 - Issue 1 - Issue Date - March 2015

Resistance to wind load test sheet (Negative wind load)

Project Name: SMART ARCHITECTURAL SYSTEM

Resistance to Wind Load - Safety BS EN 12179:2000 — **File No.:** UK104

THOMAS BELL-WRIGHT *INTERNATIONAL CONSULTANTS*

Joselito Adoan
Testing Engineer

June 21, 2021
3:28 PM

Ambient Condition

Ambient Temperature	36	°C
Barometric Pressure	1000	mb
Relative Humidity	43%	%

Test Criteria

Design wind load	3000	Pa
Mullion length to be tested	3.25	m
Transom length to be tested	1.2	m
Max. allowable deformation - mullion	6.5	mm
Max. allowable deformation - transom	2.40	mm

NEGATIVE TEST PRESSURE

LDT MOVEMENT **49.3 42.8 46.0 48.6 45.8 51.9**

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Max Load	-4.8	-18.6	-3.0	-7.1	-7.4	-7.6														

C

LDT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st	Residual	-0.8	-0.7	-0.9	-0.6	-0.7	-0.8														

C

Maximum Deflection

LDT	1	2	3	NET		4	5	6	NET		7	8	9	NET		
1st pulse	-0.8	-0.7	-0.9	0.15	###	-0.6	-0.7	-0.8	0	####					###	**LIVE READING**
																Chamber Pressure
																3000 Pa

Time Finish 2:52:48 PM

TBW-CW-50 - Issue 1 - Issue Date - March 2015

THOMAS BELL-WRIGHT
INTERNATIONAL CONSULTANTS

File No: UK104

BS EN 14019:2016 – CURTAIN WALLING IMPACT RESISTANCE TEST SHEET

Project Name	SMART ARCHITECTURAL	Testing Date	June 21, 2021
Client	SMART ARCH.	Testing Location	TBWIC LAB
Manufacturer	-	Alum. Contractor	-

Curtainwall Type	STICK CW		
Glass Type/Thickness	30 mm	Mock-up Size	7.26x3.99
Framing System Manufacturer		Temperature and Humidity	38°C / 45%

Platform Scale ID	AAH01	Impactor Weight	50kg
Pressure Gauge ID	AMH24	Tyre pressure	3.5 Bar
Drop Height Class	E5	Drop Height	950 mm
Electronic Balance ID	AOI04	Measuring Tape ID	ANH050

Note: Tyre pressure to be checked at each change in drop height.

Test Results					
Impact No.	Location	Drop Height,mm (internal)	Drop Height,mm (external)	100 mm Drop Height	Remarks
1	CENTER MULLION	-	3090	-	OK
2	CENTER TRANSOM	-	2420	-	OK
3	150mm MULLION/TRANSOM JOINT	-	2420	-	OK
4	CENTER OF GLASS PANEL		3420	-	OK

Name of Witness	Company/Contact

Test sheet completed by:	Signed	Date	Test sheet checked by:	Signed	Date
JOE ADAMO		6/21/21	CPF.		21/06/21

TBW-CW 064- Issue No: 1 Issue Date: April 2021
U:\CWT\Resources\CW Forms\TBW-CW 64a BS EN 14019 Impact Test Sheet Issue No. 3 Issued April 2021.docx

THOMAS BELL-WRIGHT
INTERNATIONAL CONSULTANTS

File No: UK104

Verification of Weighing Scale

Check Repetition	Weights			Checked by Name / Signature	Date	Verified by
	20 Kg	40 Kg	60 Kg			
1st	20	40	60		June 21, 2021	
2nd	20	40	60			
Result						

Equipment ID / Asset No: **AAH01**
Name: **Platform Balance** (Cardinal Detecto)

Verifying Weights: 3 Test Weights (T01, T02, T03), 20 Kg each.
Verification to be reviewed by the Testing Engineer

Procedures:

1. Put ON the power of the Electronic Platform Balance and re-set to zero "0".
2. Load one (1) 20-kg weight and compare/ record readout display of the Platform Balance, and then remove the weight.
3. Load two (2) 20-kg weight and compare/ record readout display of the Platform Balance, and then remove the weights.
4. Load three (3) 20-kg weight and compare/ record readout display of the Platform Balance, and then remove the weights.
5. Repeat the procedures 2 to 4 for the second time.
6. Conclude workability of the Platform Balance for usage.

THOMAS BELL-WRIGHT
INTERNATIONAL CONSULTANTS

File No: UK104

Verification of Electronic Balance

Check Repetition	Weights			Checked by Name / Signature	Date	Verified by
	10 Gms	20 Gms	50 Gms			
1st	10	20	50		June 21, 2021	
2nd	10	20	50			
Result						

Equipment ID / Asset No: **AO104**

Name: **Endel Electronic Precision Balance**

Verifying Weights: 3 Test Weights (10 gms, 20 gms, 50 gms).

Verification to be reviewed by the Testing Engineer

Procedures:

1. Put ON the power of the Electronic Balance and re-set to zero "0".
2. Load the 10 Grams weight and compare, record readout display then remove the weight.
3. Load the 20 Grams weight and compare, record readout display then remove the weights.
4. Load the 50 Grams weight and compare, record readout display and then remove the weights.
5. Repeat the procedures 2 to 4 for the second time.
6. Conclude workability of the Electronic Balance for usage.

11. Photos

Air Permeability Test set-up for curtain wall & windows

Water Tightness Test set-up

Dynamic water penetration test set-up

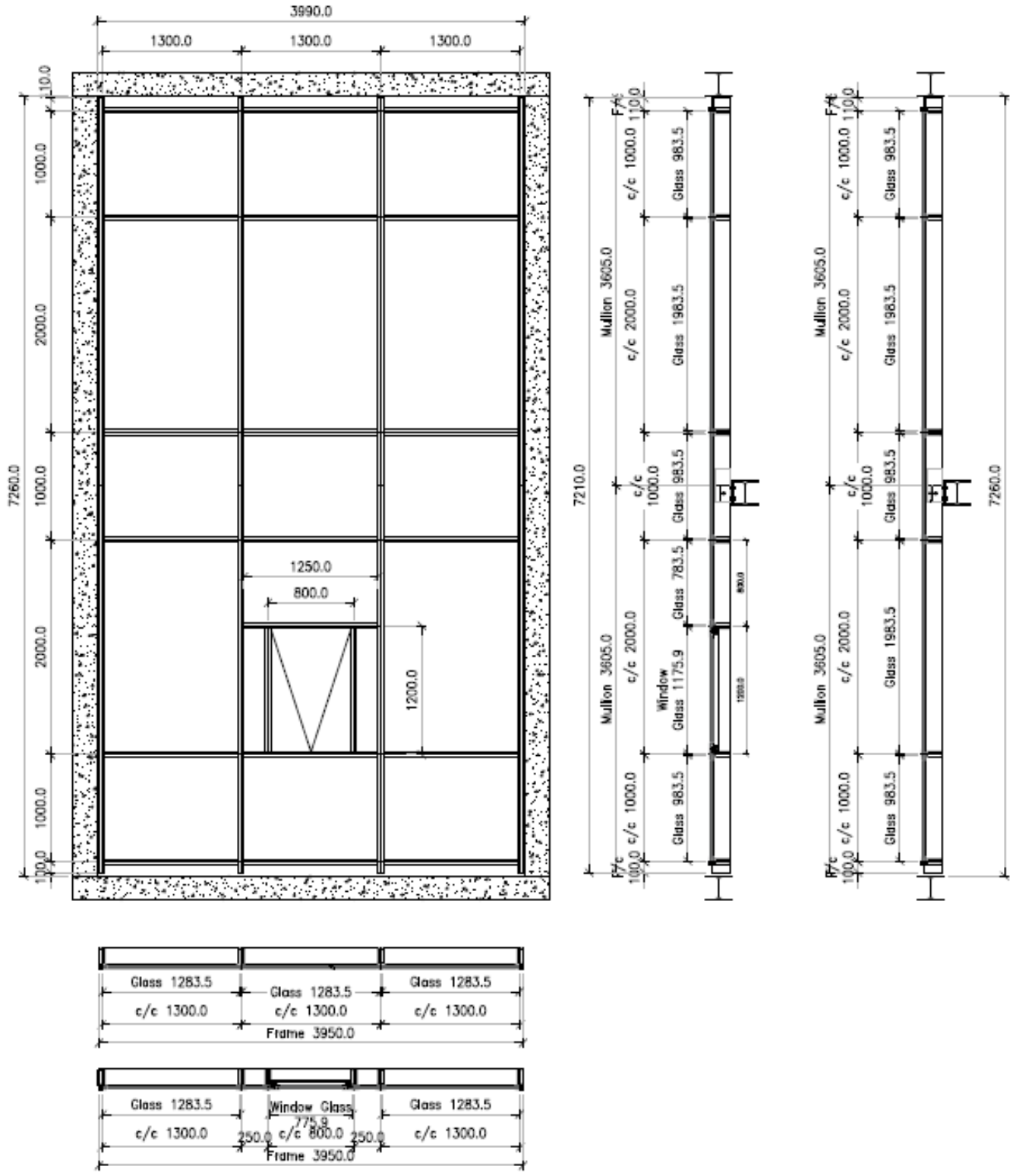
Impact Test set-up BS EN 4019

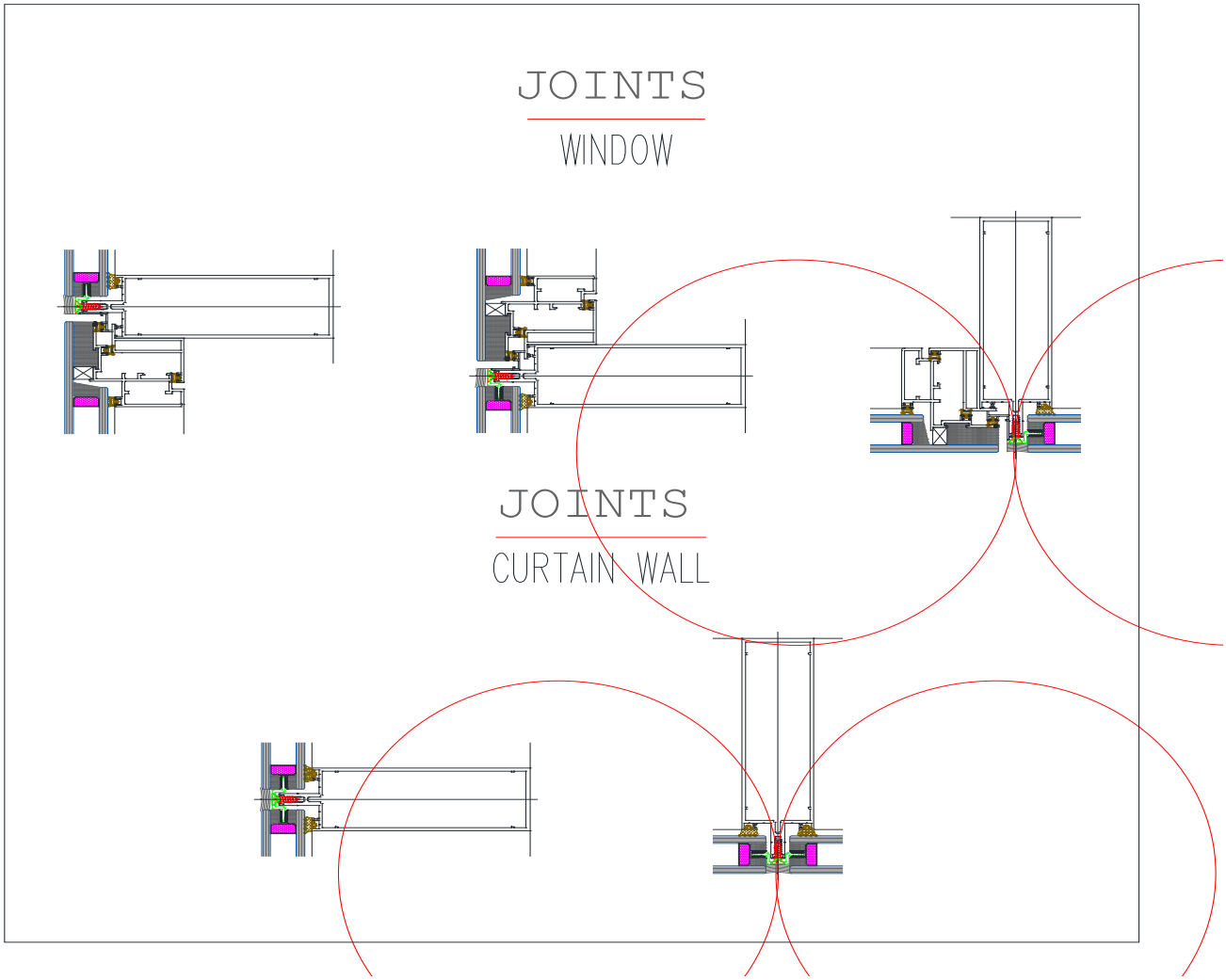
Arrangement of LDT's for Resistance to Wind Load Test – Serviceability & Safety

12. Drawings

(Drawings received on July 5, 2021)

No drawing number provided





-End of Final Report-