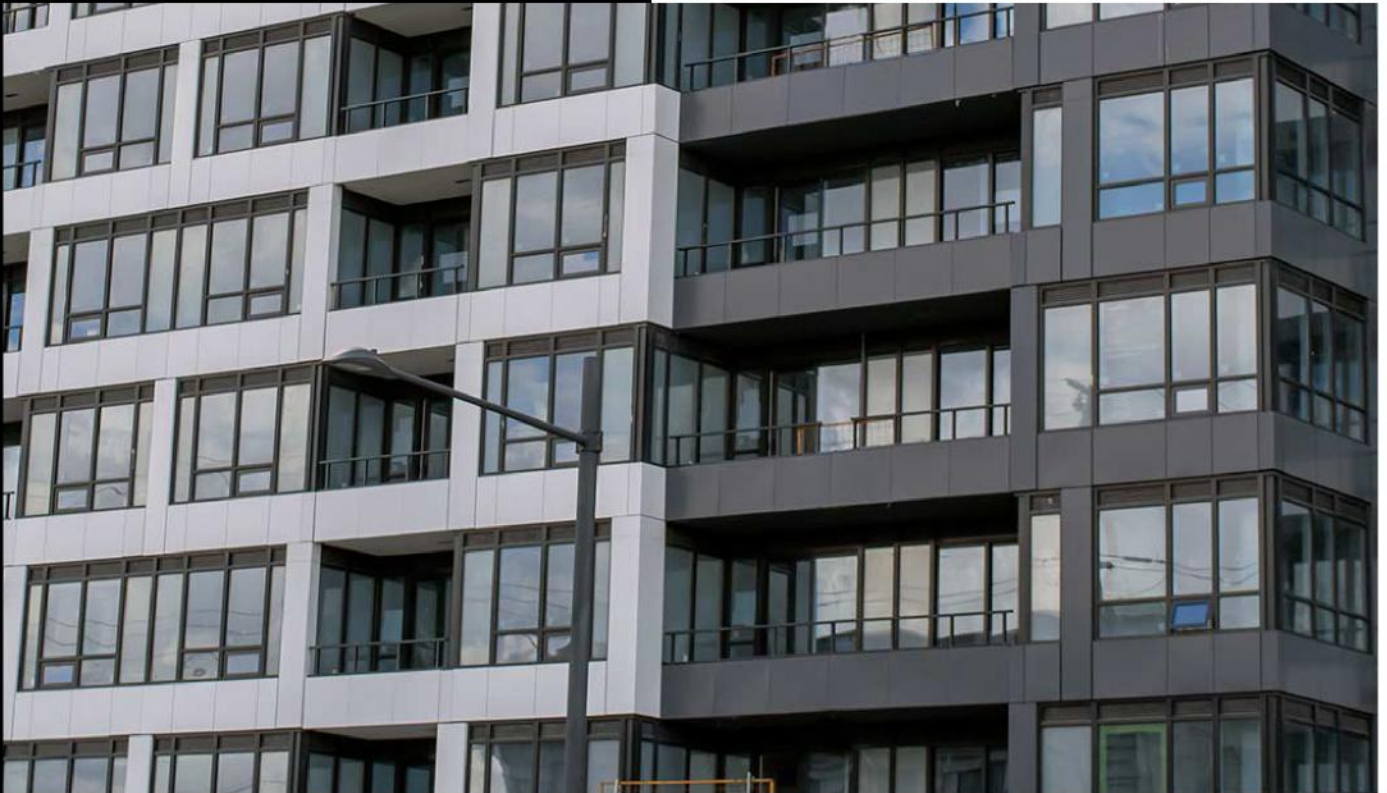




6500 Series Test Report

- PMU LAB REPORT
- THERMAL ANALYSIS OF BLACKLINE 6500 SERIES
- BULLETIN 19R. FIELD TEST



About Blackline Aluminum

Blackline Aluminum delivers innovative, high-performance window wall systems to high-rise developers by combining experienced industry leaders, modern designs, and a state-of-the-art facility to create windows of unmatched durability.

At Blackline Aluminum, process and consistency remain our guiding principles.

Each step of our manufacturing process, from product design to final installation, is carefully considered and reconsidered to ensure we seize on every opportunity to improve our design and execution. The result is a product with every innovation and solution available that can outperform and outlast any competing system available in the industry.

Our Mission

The mission of Blackline Aluminum is to design and produce window wall solutions of superior quality to create resilient buildings for the communities we serve.

TeamWork

Behind each success, there is a team of dedicated individuals coming together to a common end. At Blackline we reinforce our commitment to be an active partner in every client's project and to treat each other with integrity and respect.



Core Values

"The industry never stops innovating and we intend to compete with the best in the world when it comes to our product design, manufacturing process and delivery method."

Mohammad Ghadaki
Founder & President of Blackline Aluminum

"We are proud to be part of the Blackline equipment assembly and value the opportunity to work together with their committed team."

Jerry Schwabauer
VP Sales & Marketing for Azon

"We expect the quality of the Blackline Series 6500 window wall systems being installed at our sites to translate into major savings for future residents through reduced maintenance and longer life spans."

Ali Mesgarzadeh
President Life Construction Inc.

"We are impressed by the results of Blackline's series 6500 thermal performance and look forward to their future innovations. They are changing the way windows are designed and manufactured in Canada."

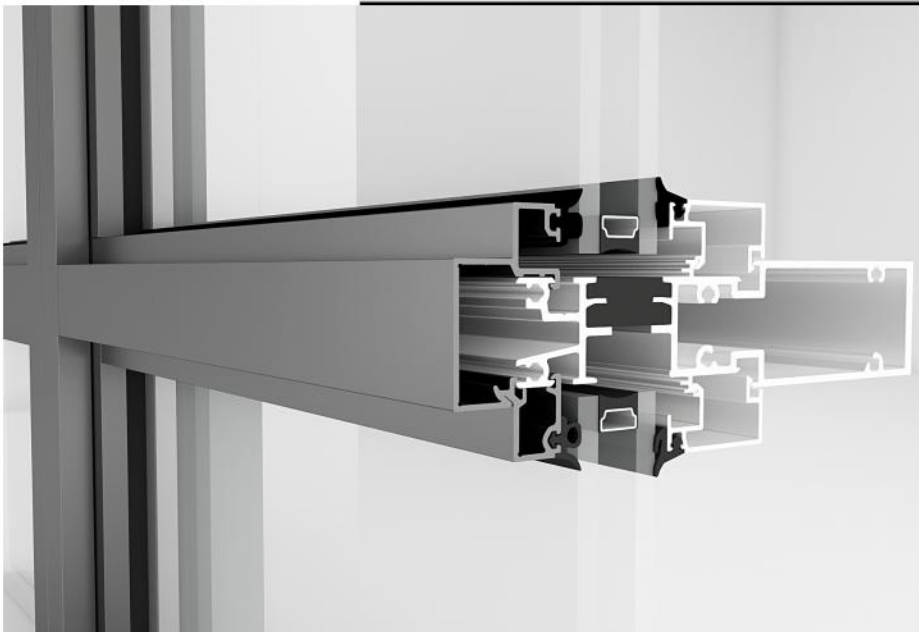
Shadi Aghaei
Vice-President, Times Group Corporation

The Blackline philosophy of innovation is careful, methodical implementation of improvements until the quality and performance of our product reflects our deep commitment to serve our clients, communities and changing needs and requirements of the industry. The pursuit for this new standard for our industry never rests.

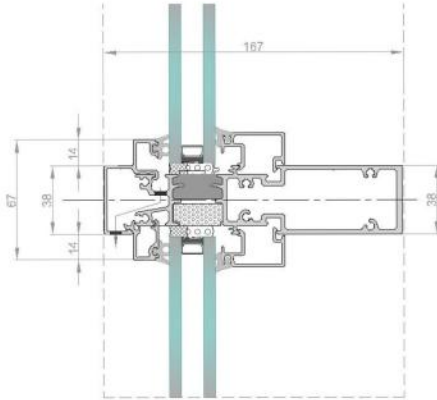


TEST REPORT

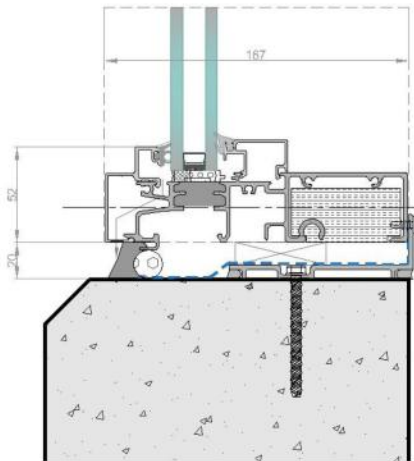
Product



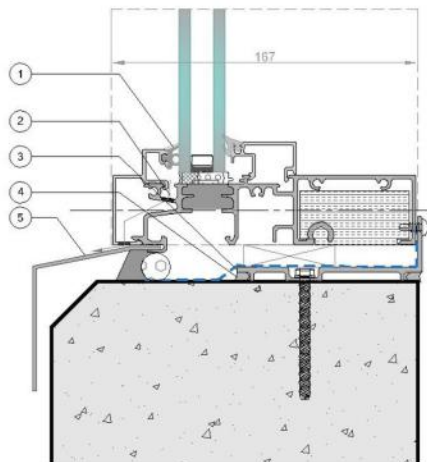
6500 Series



Transom Detail @Vision Glass



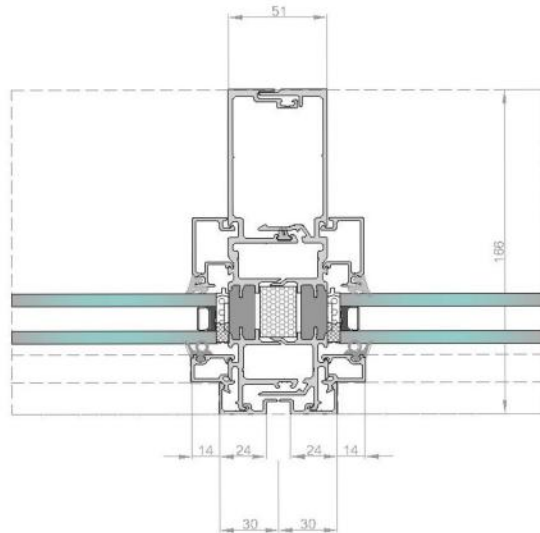
Sill Detail with Starter (No Sill Flashing)



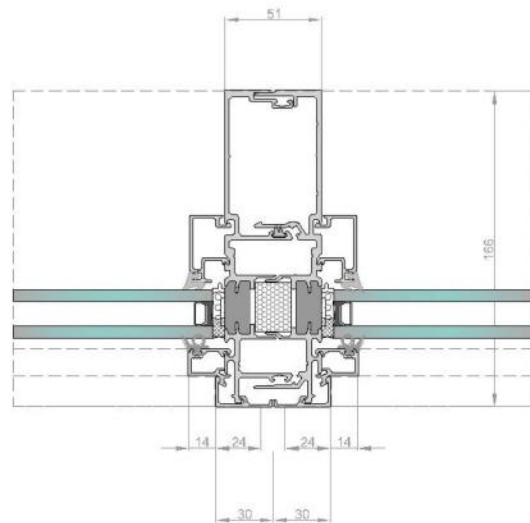
Sill Detail with Starter Track & Sill Flashing

Featured

- 1- Extruded EPDM and Silicone gaskets
- 2- Rain Screen Principle.
- 3- Extruded Starter sill track to guarantee continuity seal in all panels.
- 4- Continuous Silicone sealants applied to the face and under the track.
- 5- Extruded sill flashing if required.



Split Mullion Detail Reveal Cap



Split Mullion Detail Flush Caps

RESULTS AND OBSERVATIONS

This report covers the laboratory performance mock-up (PMU) testing performed on March 16th, 2022 of the 6500 Series Window Wall system. Project located in Toronto, Ontario, Canada. Testing was conducted on a window wall assembly. The overall nominal dimensions are approximately 3.4 m (11 ft) wide (unfolded) and 6.6 m (21-1/2 ft) high.

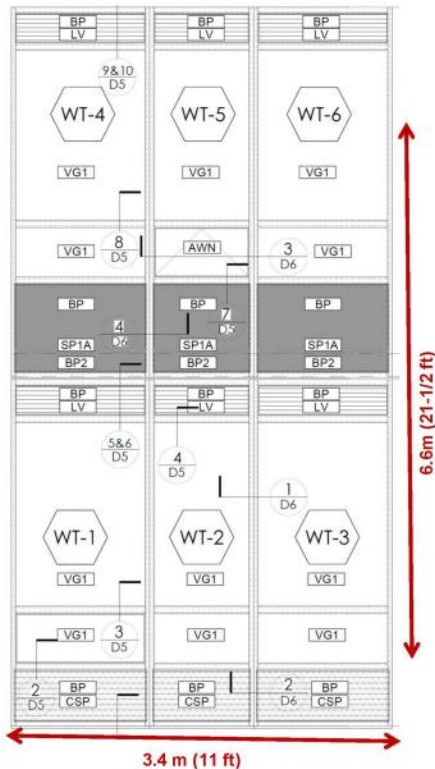


Figure 1 : Dimensions of the prototype (Elevation view)



The numbers below are referring to the testing procedure in categories as follow:

A - (2.1) Vent Operation

(2.2) Pre-load 50% of design (2.3) Air inf/exf. test

(2.4) Water penetration test (Static) @ 574Pa (12PSF)

B - (2.5) Structural performance at 100% of design pressure

(2.6) Air inf/exf. test

(2.7) Water penetration test (Static) @ 574Pa (12PSF)

C - (2.8) Interstory Vertical Movement Test (UP/DOWN)

(2.9) Air inf/exf. test

(2.10) Water penetration test (Static) @ 574Pa (12PSF) (2.11) Water penetration test (Static) @ 720Pa (15PSF)

D - (2.12) Structural performance test at 150% design pressure

STRUCTURAL TESTING RESULTS

AT 150% OF DESIGN LOAD – RESIDUAL (METRIC)

Table C13: Vertical Mullion (Upper Row)

Table C13: Vertical Mullion (Upper Row)

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	A	B	C				
3806	0.22	0.38	0.27	0.14	0.2%	5.90	2950
-3806	0.46	0.57	0.52	0.08			

Table C14: Vertical Mullion (Lower Row)

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	D	E	F				
3806	0.61	0.49	0.51	0.07	0.2%	5.90	2950
-3806	0.16	0.63	0.66	0.22			

Table C15: Operable Vent (Sash, non hinged side)

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	G	H	I				
3806	0.35	0.31	0.30	0.01	0.2%	1.51	755
-3806	0.42	0.54	0.40	0.13			

Table C16: Center of Glass (Double Glazed, Short Side)

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	J	K	L				
3806	0.76	0.44	0.41	0.14	0.2%	2.20	1100
-3806	0.61	0.43	0.10	0.07			

Table C17: Center of Glass (Triple Glazed, Short Side)

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	M	N	O				
3806	0.81	0.83	0.69	0.08	0.2%	2.20	1100
-3806	0.56	1.07	1.51	0.04			

Table C18: Backpan

Pressure (Pa)	Displacement			Deflection (mm)	Allowed deflection (mm)		Span (mm)
	P	Q	R				
3806	0.22	0.24	0.05	0.11	0.2%	2.20	1100
-3806	0.47	0.29	0.05	0.02			

TEST REPORT

TEST	REQUIREMENTS	RESULTS
A - (2.1) Vent Operation Date: March 16 th , 2022	Open and close the vent unit ten (10) times.	CONDUCTED
(2.2) Pre-load 50% of design pressure ASTM E330-14 50 % DP: +1,269 Pa (+26.50 PSF) 50 % DP: -1,269 Pa (-26.50 PSF) Date: March 16 th , 2022	The uniform load will be maintained for 10 seconds. There shall be no visible signs of failure.	PASSED
(2.3) Air inf./exf. test ASTM E283-19 Flow meter: EQ-FM-25 Manometer: EQ-EM-43 Date: March 16 th , 2022	Fixed: $Q_{inf/exf} = 0.30 \text{ L/s.m}^2 (0.06 \text{ cfm/ft}^2)$ @ 300 Pa (6.24 psf) Operable Vent: $Q_{inf/exf} = 0.50 \text{ L/s.m}^2 (0.10 \text{ cfm/ft}^2)$ @ 300 Pa (6.24 psf)	Fixed: $Q_{inf} = 0.072 \text{ L/s.m}^2 (0.014 \text{ cfm/ft}^2)$ $Q_{exf} = 0.075 \text{ L/s.m}^2 (0.015 \text{ cfm/ft}^2)$ @ 300 Pa (6.24 psf) Operable Vent: $Q_{inf} = 0.005 \text{ L/s.m}^2 (0.001 \text{ cfm/ft}^2)$ $Q_{exf} = 0.007 \text{ L/s.m}^2 (0.001 \text{ cfm/ft}^2)$ @ 300 Pa (6.24 psf) PASSED
TEST	REQUIREMENTS	RESULTS
(2.4.a) Water penetration test (static) ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43 Date: March 16 th , 2022	No water leakage allowed under a pressure differential of 574 Pa (12.00 psf). No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)	No water infiltration FAILED
<u>Water Penetration Observations:</u> Water leakage was observed at the bottom right jamb mullion groove at the sill (viewed from interior side) (See Appendix B, Photo B4).		
<u>Remediation:</u> The bottom right jamb at the sill was resealed with sealant.		
(2.4.b) Water penetration test (static) ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43 Date: March 16 th , 2022	No water leakage allowed under a pressure differential of 574 Pa (12.00 psf). No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)	No water infiltration PASSED
B - (2.5) Structural Service Load test at 100% design pressure (DP) ASTM E330-14 Data acquisition: EQ-DM-04 50% DP: 1,269 Pa (26.50 PSF) 100% DP: 2,538 Pa (53.00 PSF) 50% DP: -1,269 Pa (-26.50 PSF) 100% DP: -2,538 Pa (-53.00 PSF) Date: March 16 th , 2022	The uniform load shall be maintained for 60 seconds. Allowed deflections: <ul style="list-style-type: none">• Aluminum members: L/175• Vents: L/175• Metal back pans: L/120 or 19.1mm (0.75 in), whichever is less• Glass center: L/60 or 19.1 mm (0.75 in), whichever is less	See Appendix C for results PASSED

TEST REPORT

TEST	REQUIREMENTS	RESULTS
<p>(2.6) Air inf./exf. test <small>ASTM E283-19 Flow meter: EQ-FM-25 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>Fixed: $Q_{inf/exf} = 0.30 \text{ L/s.m}^2$ (0.06 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>Operable Vent: $Q_{inf/exf} = 0.50 \text{ L/s.m}^2$ (0.10 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p>	<p>Fixed: $Q_{inf} = 0.074 \text{ L/s.m}^2$ (0.014 cfm/ft²)</p> <p>$Q_{exf} = 0.015 \text{ cfm/ft}^2$ (0.075 L/s.m²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>Operable Vent: $Q_{inf} = 0.005 \text{ L/s.m}^2$ (0.001 cfm/ft²)</p> <p>$Q_{exf} = 0.009 \text{ L/s.m}^2$ (0.002 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>PASSED</p>
<p>(2.7) Water penetration test (static) <small>ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>No water leakage allowed under a pressure differential of 574 Pa (12.00 psf).</p> <p>No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)</p>	<p>Water infiltration observed</p> <p>PASSED</p>
<p>C - (2.8) Interstory vertical displament test (3 cycles) <small>AAMA 501.7-09</small></p> <ul style="list-style-type: none"> - 9.5 mm (0.375") upward - Back to initial position - 9.5 mm (0.375") downward - Back to initial position <p>Date: March 16th, 2022</p>	<p>The sequence will be repeated three (3) times. Visual inspection of the specimen will be made at each displacement.</p> <p>There shall be no glass breakage and no permanent damage to panels, fasteners anchors, gaskets or weatherstrip, and there shall be no other damage rendering the system unfit for its intended purpose(s).</p>	<p>See Appendix B for pictures</p> <p>PASSED</p>
TEST	REQUIREMENTS	RESULTS
<p>(2.9) Air inf./exf. test <small>ASTM E283-19 Flow meter: EQ-FM-25 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>Fixed: $Q_{inf/exf} = 0.30 \text{ L/s.m}^2$ (0.06 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>Operable Vent: $Q_{inf/exf} = 0.50 \text{ L/s.m}^2$ (0.10 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p>	<p>Fixed: $Q_{inf} = 0.080 \text{ L/s.m}^2$ (0.016 cfm/ft²)</p> <p>$Q_{exf} = 0.085 \text{ L/s.m}^2$ (0.017 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>Operable Vent: $Q_{inf} = 0.009 \text{ L/s.m}^2$ (0.002 cfm/ft²)</p> <p>$Q_{exf} = 0.009 \text{ L/s.m}^2$ (0.002 cfm/ft²)</p> <p>@ 300 Pa (6.24 psf)</p> <p>PASSED</p>
<p>(2.10) Water penetration test (static) <small>ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>No water leakage allowed under a pressure differential of 574 Pa (12.00 psf).</p> <p>No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)</p>	<p>Water infiltration observed</p> <p>PASSED</p>

TEST REPORT

TEST	REQUIREMENTS	RESULTS
<p>(2.11.a) Water penetration test (static) <small>ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>No water leakage allowed under a pressure differential of 720 Pa (15.00 psf).</p> <p>No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)</p>	<p>No water infiltration</p> <p>FAILED</p>
<p><u>Water Penetration Observations:</u> Water leakage was observed at the bottom right jamb mullion groove at the sill (viewed from interior side) (See Appendix B, Photo B4).</p> <p><u>Remediation:</u> The bottom right jamb at the sill was resealed with sealant.</p> <p><u>Final Inspection Observations:</u> Upon the completion of all test and full inspection of mock-up, it was observed that the bottom drain slots were covered by backer rod and excessive sealant application (See Appendix B, Photo B6).</p>		
<p>(2.11.b) Water penetration test (static) <small>ASTM E331-00 Reapproved 2016 Manometer: EQ-EM-43</small></p> <p>Date: March 16th, 2022</p>	<p>No water leakage allowed under a pressure differential of 720 Pa (15.00 psf).</p> <p>No water leakage permitted on the interior face of wall or trim (water infiltration is defined by water that is found on an inner surface of the prototype that is not contained or drained to the exterior)</p>	<p>No water infiltration</p> <p>PASSED</p>
TEST	REQUIREMENTS	RESULTS
<p>D - (2.11) Structural performance test at 150% design pressure (DP) <small>ASTM E330-14 Data acquisition: EQ-DM-03</small></p> <p>75% DP: 1,906 Pa (39.80 PSF) 150% DP: 3,806 Pa (79.50 PSF) 75% DP: -1,906 Pa (-39.80 PSF) 150% DP: -3,806 Pa (-79.50 PSF)</p> <p>Date: March 16th, 2022</p>	<p>The uniform load 150% design load shall be maintained for 10 seconds</p> <p>Allowable permanent deflection:</p> <ul style="list-style-type: none"> Permanent deformation will be recorded 1 minute after both positive and negative loading. No glass breakage, weld, or fastener failures, component disengagement or breakage. The permanent set shall not exceed 0.2% of the clear span 	<p>See Appendix C for results</p> <p>PASSED</p>

LABORATORY TESTS PERFORMANCE

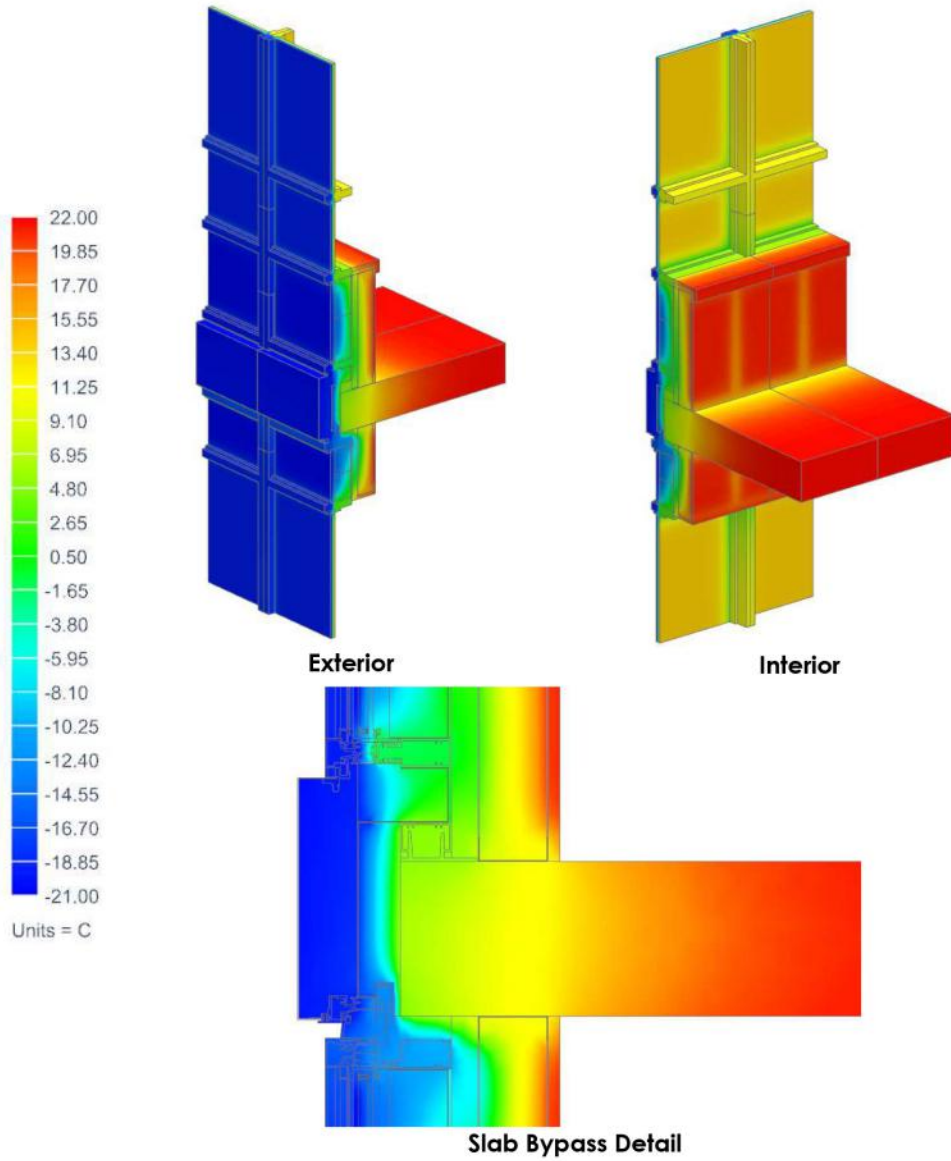
TEST	REQUIREMENTS	RESULTS
(2.1) Vent Operation	Open and close the vent unit ten (10) times.	Not Applicable
(2.2) Pre-load 50% of design pressure <i>ASTM E330-14</i>	Pre-load Pressure: $\pm 1,269$ Pa (± 26.50 psf)	Not Applicable
(2.3) Air inf./exf. test <i>ASTM E283-04 Reapproved 2012</i>	Test pressure: 300 Pa (6.24 psf) Fixed allowable: 0.30 L/s.m ² (0.06 cfm/ft ²) Vent allowable: 0.50 L/s.m ² (0.10 cfm/ft ²)	PASSED
(2.4) Water penetration test (static) <i>ASTM E331-00 Reapproved 2016</i>	Test pressure: 547 Pa (12.0 psf)	PASSED
(2.5) Structural performance test at 100% design pressure (DP) <i>ASTM E330-14</i>	- 50% DP: +1,269 Pa (+26.50 psf) - 100% DP: +2,538 Pa (+53.0 psf) - 50% DP: -1,269 Pa (-26.50 psf) - 100% DP: -2,538 Pa (-53.0 psf)	PASSED
(2.6) Air inf./exf. test <i>ASTM E283-04 Reapproved 2012</i>	Test pressure: 300 Pa (6.24 psf) Fixed allowable: 0.30 L/s.m ² (0.06 cfm/ft ²) Vent allowable: 0.50 L/s.m ² (0.10 cfm/ft ²)	PASSED
(2.7) Water penetration test (static) <i>ASTM E331-00 Reapproved 2016</i>	Test pressure: 547 Pa (12.0 psf)	PASSED

TEST	REQUIREMENTS	RESULTS
(2.8) Interstory vertical up and down movement (3 cycles) <i>AAMA 501.7-09</i>	- 9.5 mm (0.375") upward - Back to initial position - 9.5 mm (0.375") downward - Back to initial position	PASSED
(2.9) Air inf./exf. test <i>ASTM E283-04 Reapproved 2012</i>	Test pressure: 300 Pa (6.24 psf) Fixed allowable: 0.30 L/s.m ² (0.06 cfm/ft ²) Vent allowable: 0.50 L/s.m ² (0.10 cfm/ft ²)	PASSED
(2.10) Water penetration test (static) <i>ASTM E331-00 Reapproved 2016</i>	Test pressure: 547 Pa (12.0 psf)	PASSED
(2.11) Water penetration test (static) <i>ASTM E331-00 Reapproved 2016</i>	Test pressure: 720 Pa (15.0 psf)	PASSED
(2.12) Structural performance test at 150% design pressure (DP) <i>ASTM E330-14</i>	- 75% DP: +1,906 Pa (+39.80 psf) - 150% DP: +3,808 Pa (+79.50 psf) - 75% DP: -1,906 Pa (-39.80 psf) - 150% DP: -3,806 Pa (-79.50 psf)	PASSED



THERMAL ANALYSIS OF 6500 SERIES

The following figure illustrates the temperature distribution in one of the six scenarios for the Blackline 6500 Series Window Wall System. The full test result is provided upon request.



FIELD TEST



This report has been prepared in accordance with the requirements of the Tarion Warranty Corporation (Tarion) Builder Bulletin 19R (Bulletin 19R).

Report Items:

Item ID Type Status Company Date Created

FT.01.01 For Information Only None N/A 17 Apr 2021

Subject: Water Penetration and Air Leakage Testing - General

Location: General

Description: Scope and Test Locations Summary

Field water penetration and air leakage testing were conducted at specified window wall locations. Tests were carried out in accordance with project specifications and ASTM E 1105 (for water penetration) and ASTM E783 (for air leakage).

The following window wall areas were part of the field tests:

1. Unit 409 - master bedroom slab bypass windows (See FT.01.02)

1) Water test = PASSED

2. Unit 511 - bedroom awning window (See FT.01.03)

1) Air test = PASSED

2) Water test = PASSED

3. Unit 512 - master bedroom sliding door (See FT.01.04)

1) Air test = PASSED

2) Water test = PASSED

4. Unit 512 - bedroom fixed window (See FT.01.05)

1) Air test = PASSED

2) Water test = CONDITIONAL PASSED

Field Test



MORRISON HERSHFIELD



FT.01.02.A - Outside Suite 409: View of spray rack on the slab bypass area between level 3 and level 4.



FT.01.03.B - View of interior test chamber.

Field Test



MORRISON HERSHFIELD



FT.01.04.A - View of spray rack on sliding doors during water penetration test.



FT.01.04.C - View of interior test chamber.



This 6500 system creates the lowest U-Value in its comparable class and the strongest bounding, making it the only structural thermally broken system in the industry.

R-VALUE U -VALUE



MORRISON HERSHFIELD

Scenario		UCOG Btu/h ft ² °F (W/m ² K)	Uvision Btu/h ft ² °F (W/m ² K)	Spandrel Nominal R-value h ft ² °F/Btu (m ² K/W)	Spandrel + Slab		Total System (Vision + Spandrel + Slab)	
					Us Btu/h ft ² °F (W/m ² K)	Rs h ft ² °F/ Btu (m ² K/W)	UT Btu/h ft ² °F (W/m ² K)	RT h ft ² °F/ Btu (m ² K/W)
1	ACM Panel	0.252 (1.43)	0.380 (2.16)	R-34.5 (6.07)	0.231 (1.31)	R-4.3 (0.76)	0.320 (1.82)	R-3.1 (0.55)
2	Glazed IGU				0.226 (1.28)	R-4.4 (0.78)	0.318 (1.81)	R-3.1 (0.55)
1a	ACM Panel (Modified)	0.214 (1.22)	0.347 (1.97)	R-42.0 (RSI-7.39)	0.201 (1.14)	R-5.0 (RSI-0.87)	0.289 (1.64)	R-3.5 (RSI-0.61)
2b	Glazed IGU (Modified)				0.199 (1.13)	R-5.0 (RSI-0.88)	0.288 (1.64)	R-3.5 (RSI-0.61)



What Makes 6500 Unique?



Structurally Superior

A new Polyurethane pour and de-bridge thermal break mean industry-leading strength and durability. No support is needed up to 14 ft. and minimal support is needed up to 16 ft high windows. Proving its superior design, strength, and quality. This Strength allows to install 6500 series up to 75 storeys.



A Neat Façade & More Interior Space

Due to the unique design of the 6500 series the glass sits further out in the frame thus achieving one plain of view from the exterior. The benefits of this design don't end there, according to BOMA standards we are able to achieve more interior space which can be beneficial both for the builders and future consumers.



Higher Energy Efficiency

The system allows up to 4" rigid insulation in select locations to meet or beat OBC specifications as needed. 6500 can be spaced Showbox, double glaze and even triple glaze to meet all required energy models based on project requirements.



Easy Maintenance & Repair On-Site

The unique design of profiles and pressure caps accompanied with EPDM and Silicone gaskets allow the 6500 Series to be glazed and de-glazed from the interior or exterior.



Greater Design Freedom

The innovative exterior pressure-plate covers on the 6500 Series can be extruded in any desired shape to accommodate any design style further than ever before



Keep Your Projects on Schedule

A fully equipped vertical glass line with a 120-pack storage system and an ultramodern panel department mean faster production times, higher quality, and superior performance specifications. Our facility is modelled to be automated and our vertically intergrated line allows for high efficiency output.

OUR CURRENT, COMPLETED/FUTURE PROJECTS



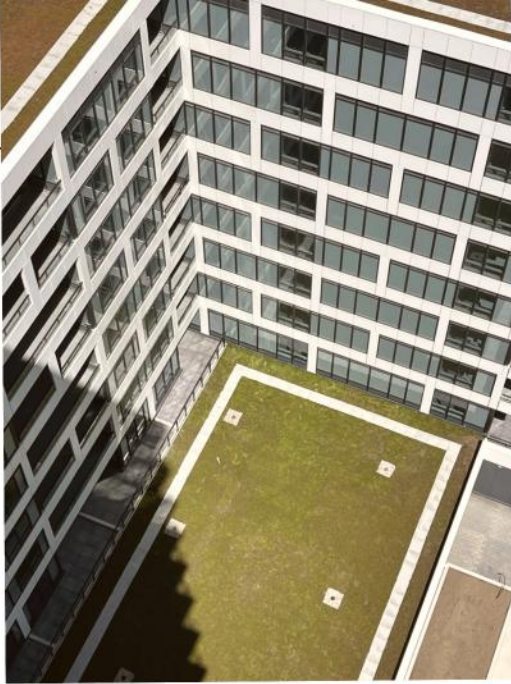
RIVERVIEW
TOWERS



PAVILIA
TOWERS



SIXTY FIVE BROADWAY
TOWERS



Riverview Towers

Location: Hwy 7 & Verclaire Gate South, Markham, Ontario

Architect: Kirkor Architects + Planners

Units: 1,042

Status: Under Construction

Type: High-Rise Residential

Completion Date: Building C - 2022

Building A and B - 2024*



Pavilia Towers

Location: Hwy 7 & South Park Road, Thornhill, Ontario

Architect: Icke Brochu Architects Inc.

Units: 769

Status: Under Construction

Type: High-Rise Residential

Completion Date: Building A - 2022

Building B - 2023*



Future Project:

65 Broadway Condos

Location: 65 Broadway Avenue, Toronto, Ontario

Architect: Wallman Architects

Units: 778

Status: Under Construction

Type: High-Rise Residential

Completion Date: 2025*



Future Project

5800 Yonge Street

Location: 5800 Yonge Street, North York, Ontario

Category: Residential Condominium

Status: Pre-Construction

Units: 2000

Storeys: 46, 48 (Residential) 52,54 (Rental)



Future Project

The Dylan

Location: 831 Glencairn Avenue, Toronto, Ontario

Category: Residential

Status: Pre-Construction

Units: 218, 5, 4

Number of Buildings 1

Storeys: 10



Future Project

4569 Kingston Road

Location: 4569 Kingston Road, Toronto, Ontario

Category: Residential

Status: Pre-Construction

Number of Buildings: 1

Storeys: 11



Blackline Head Office:

110 Cochrane Drive, Unit A, Markham, ON L3R 9S1

Manufacturing Plant:

400 Cochrane Drive, Unit 3, Markham, ON L3R 8E3

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@blacklinealuminum

