Scoring Big on Façade Without Skipping a Beat on Safety

Studio Bell, Home of the National Music Centre – Case Study

Nicole Parsons, Façade Specialist, Building Sciences
Scott Baxter, Project Manager, Building Sciences
Mike Carter, Director, Ice & Snow Consultant

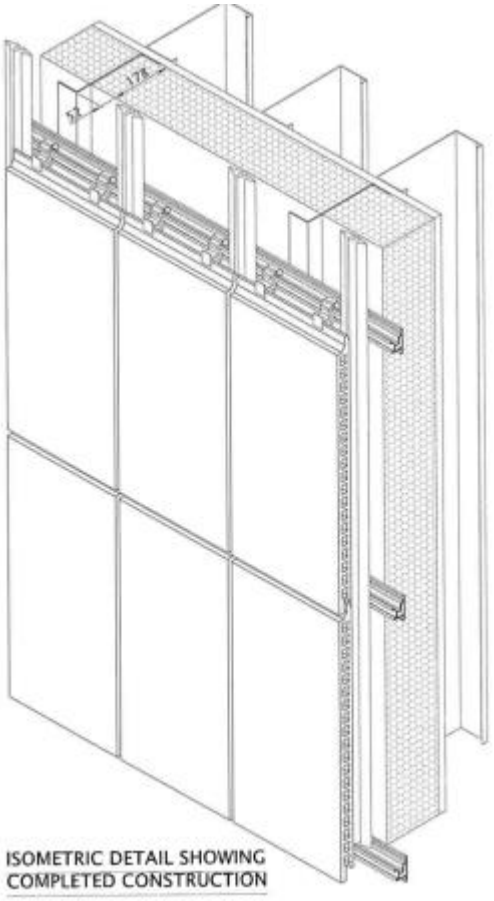
15th Canadian Conference on Building Science and Technology Vancouver, Canada

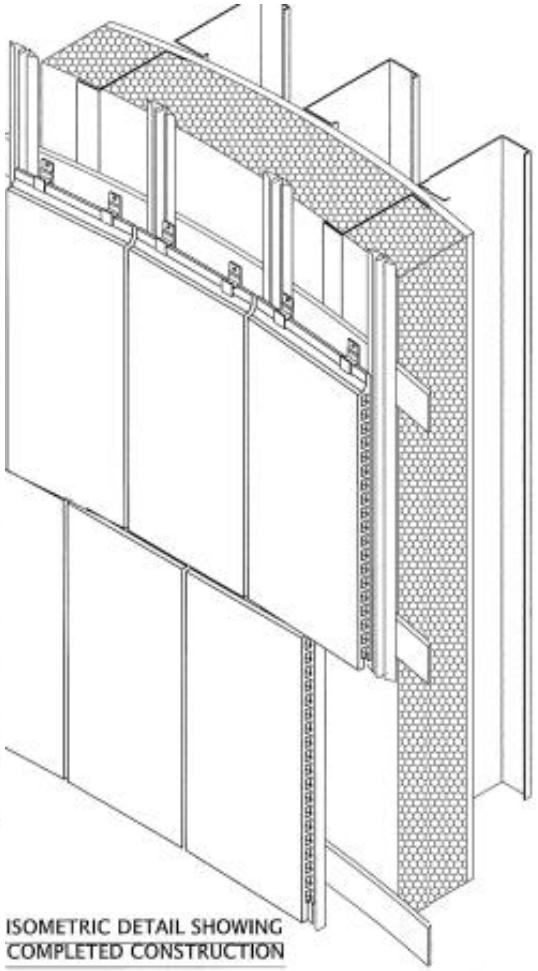
Outline

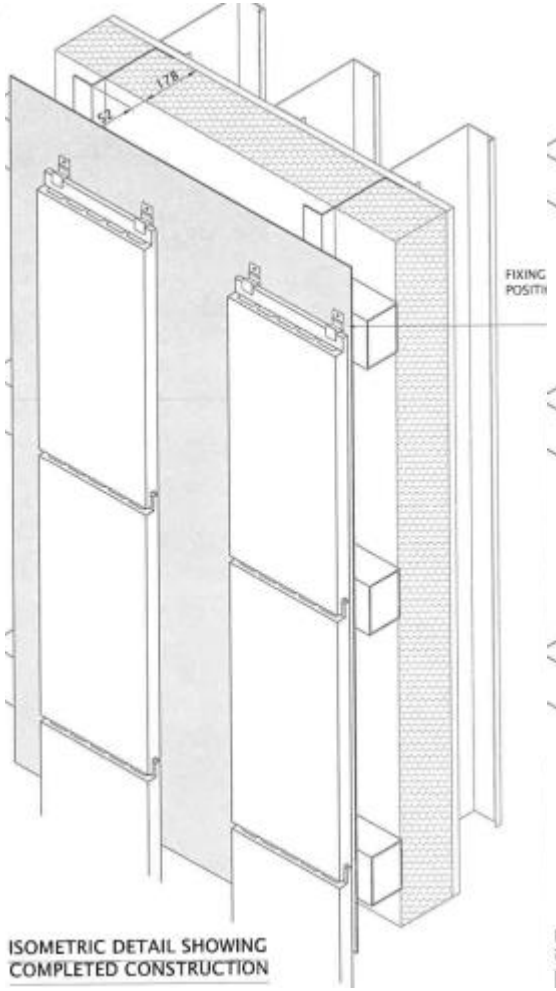
- Facility Overview
- Façade Assemblies
- Concerns and Unknowns
- Snow and Ice Study Process, Outcomes and Recommendations
- Construction implementation and challenges

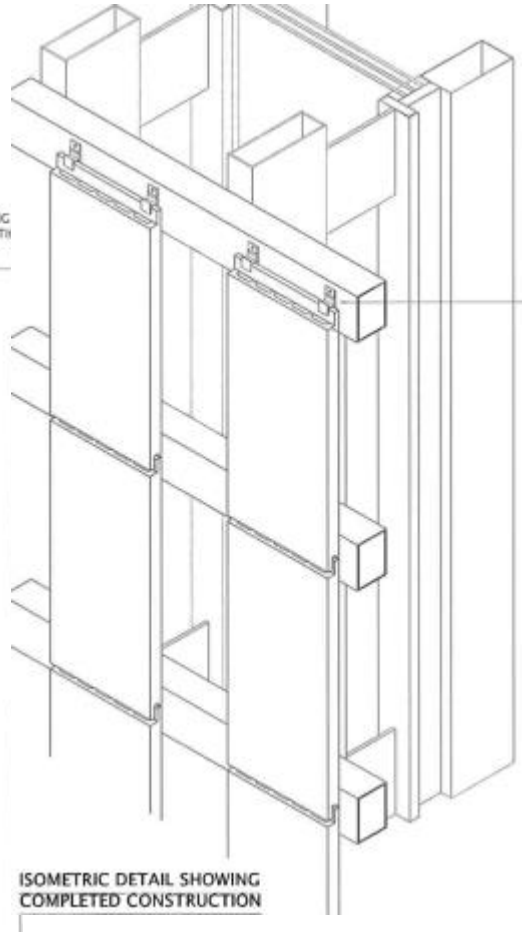
Facility Overview

Façade Assemblies

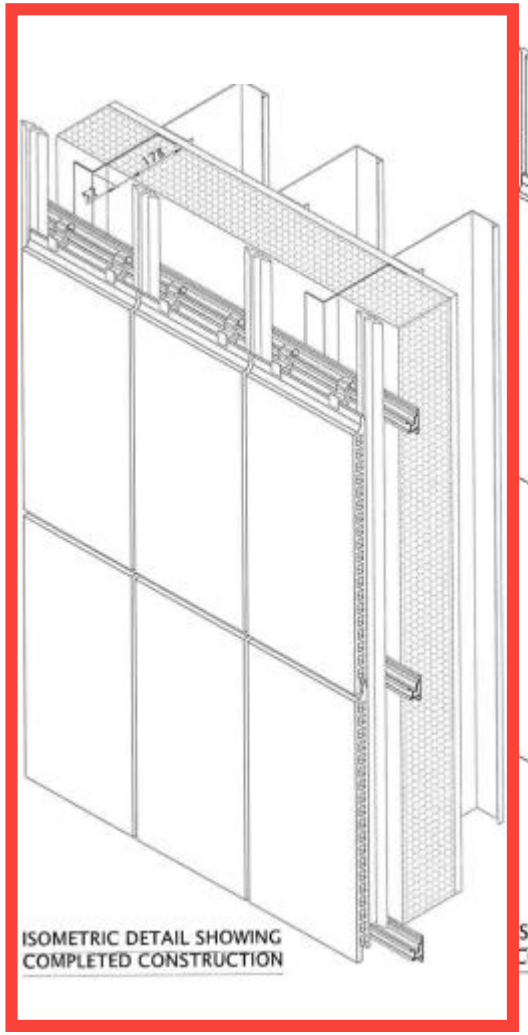


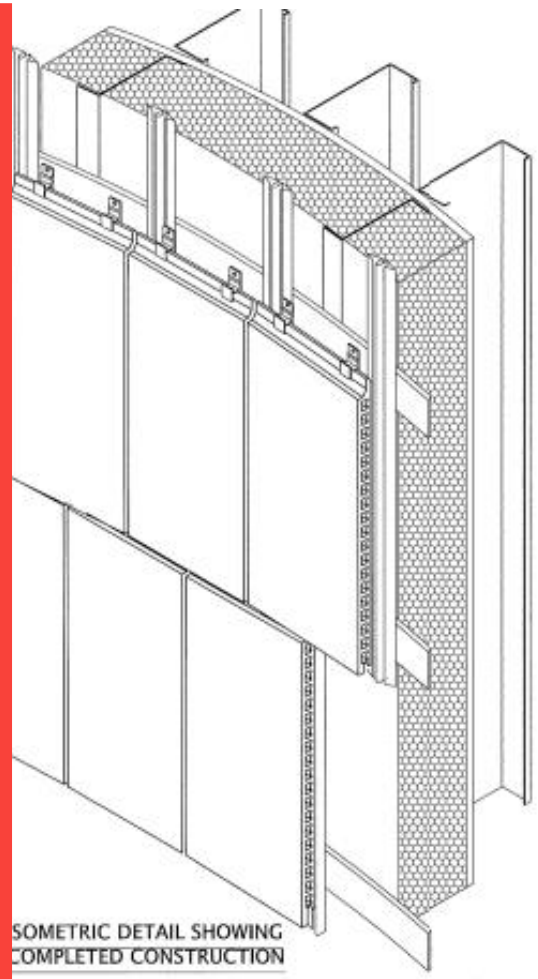


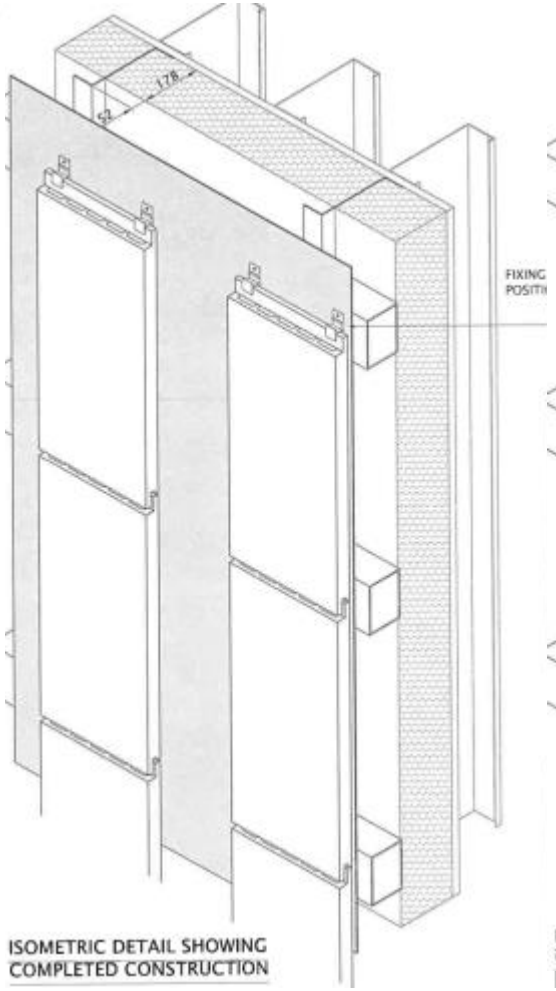


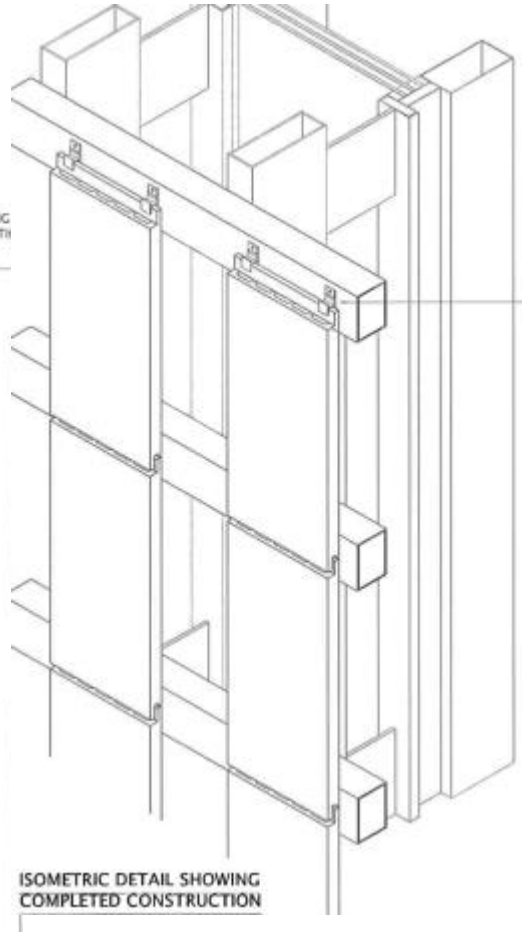


Façade Assemblies

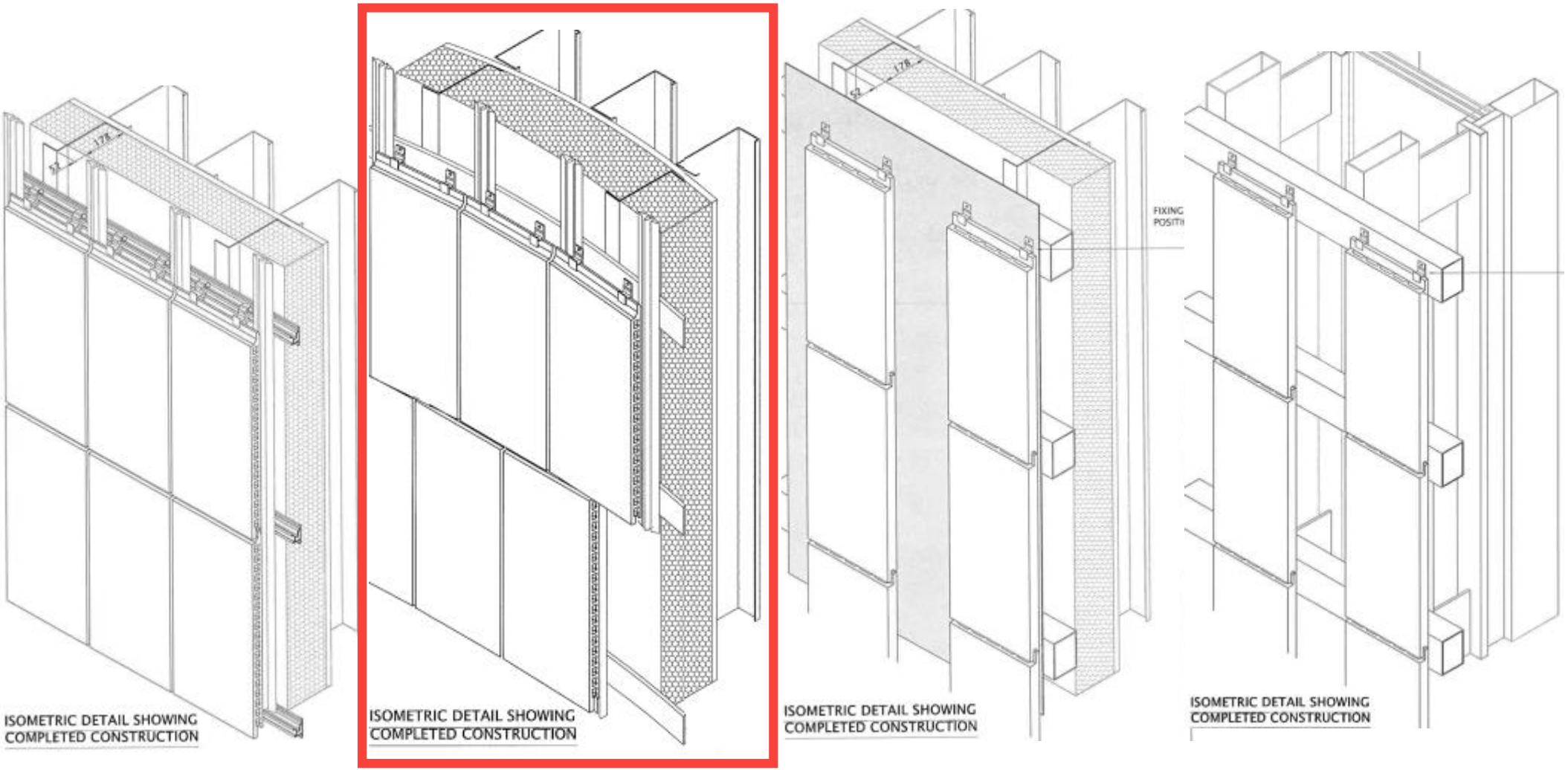




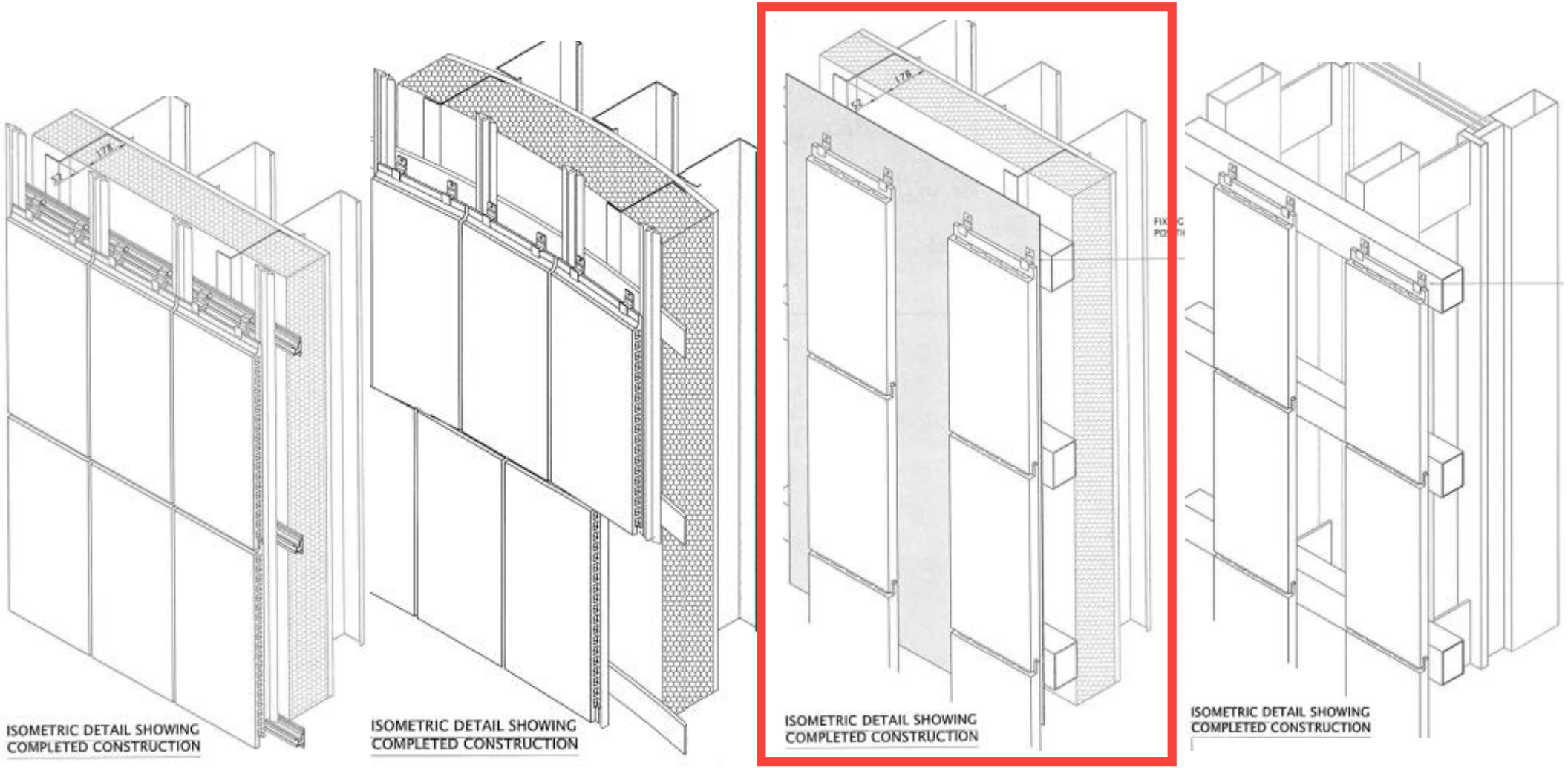




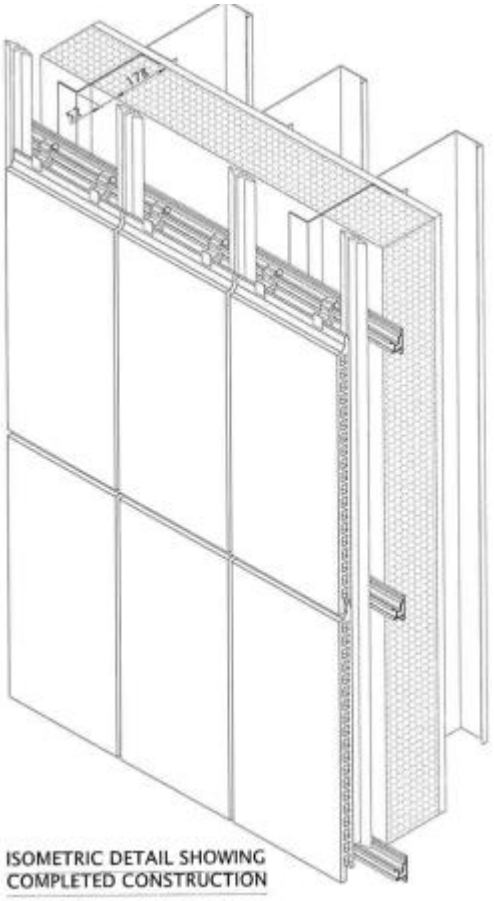
Façade Assemblies

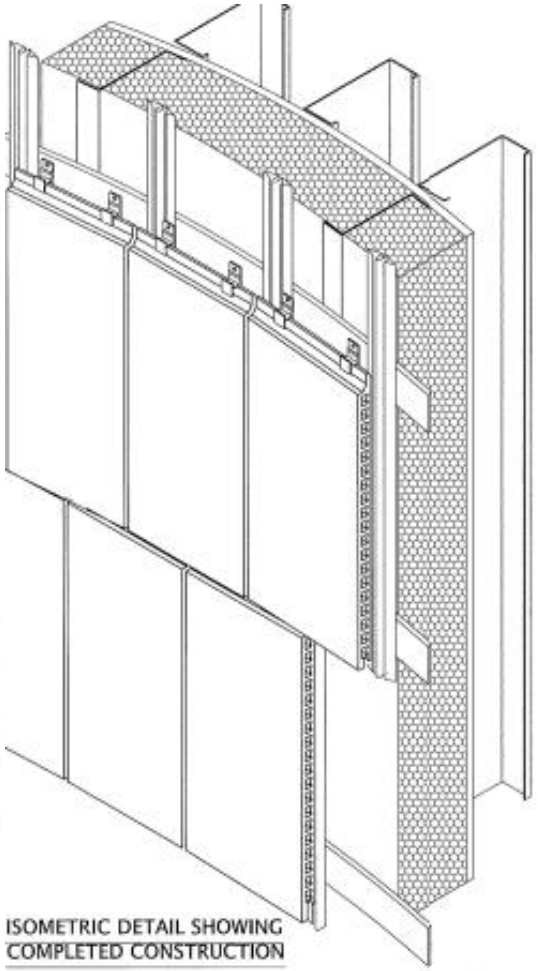


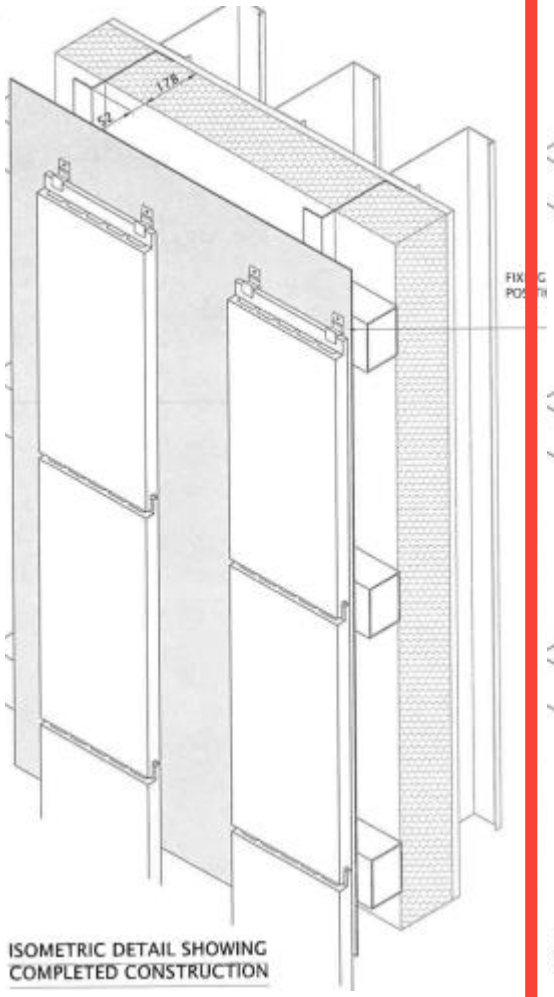
Façade Assemblies

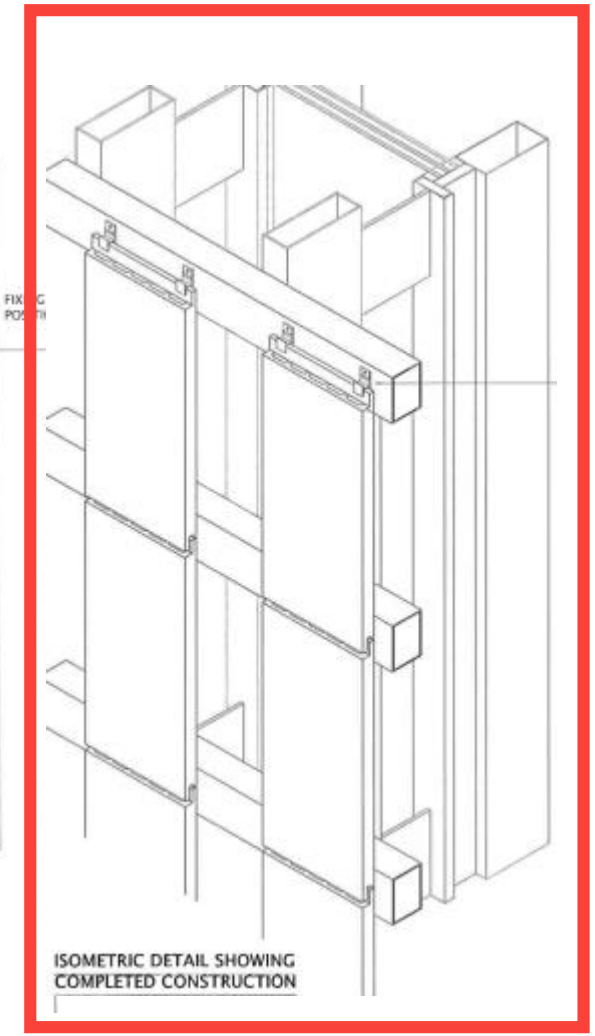


Façade Assemblies





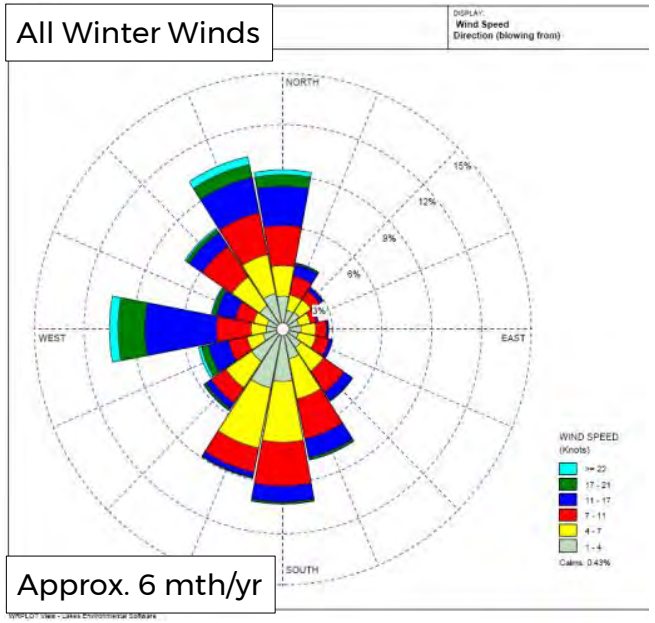




Concerns and Unknowns

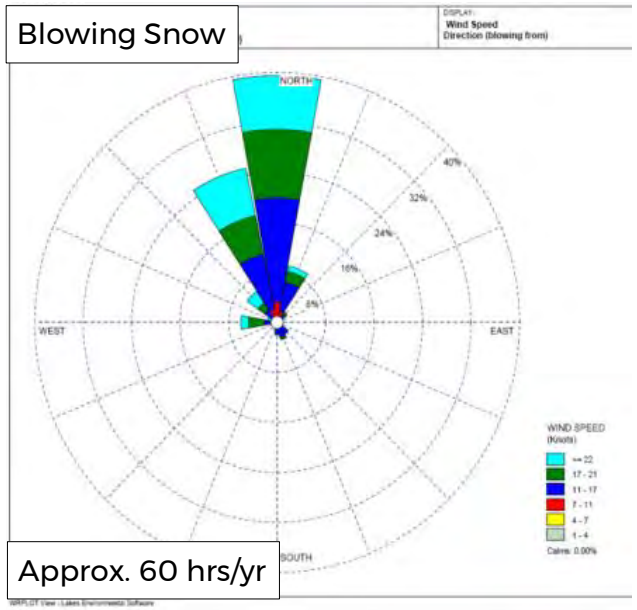
Winter Winds with Snowfall

All Winter Winds



Approx. 6 mth/yr

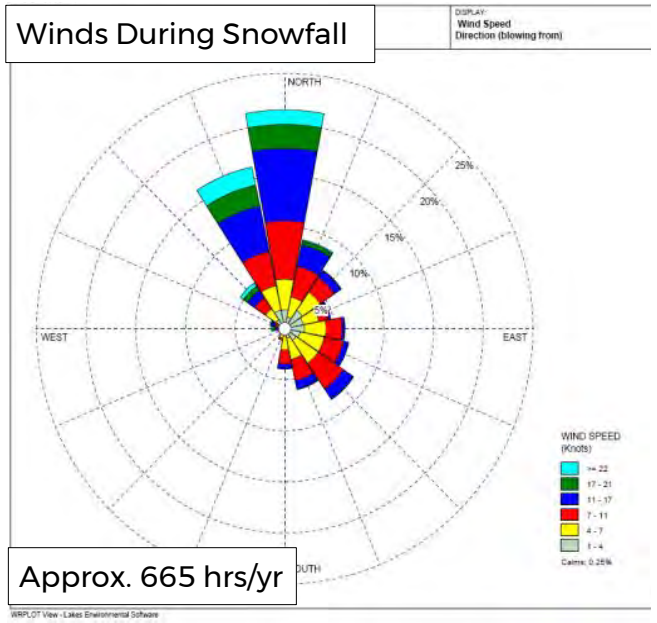
Blowing Snow



Approx. 60 hrs/yr

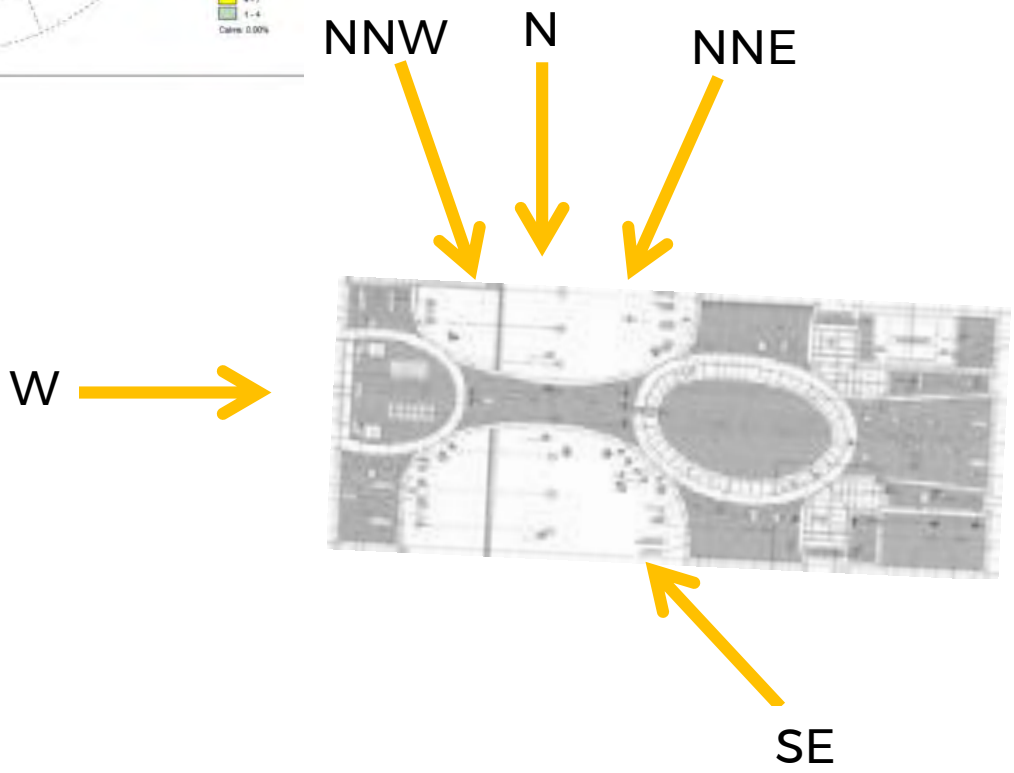
Approx. 30 years of data from Calgary International Airport

Winds During Snowfall



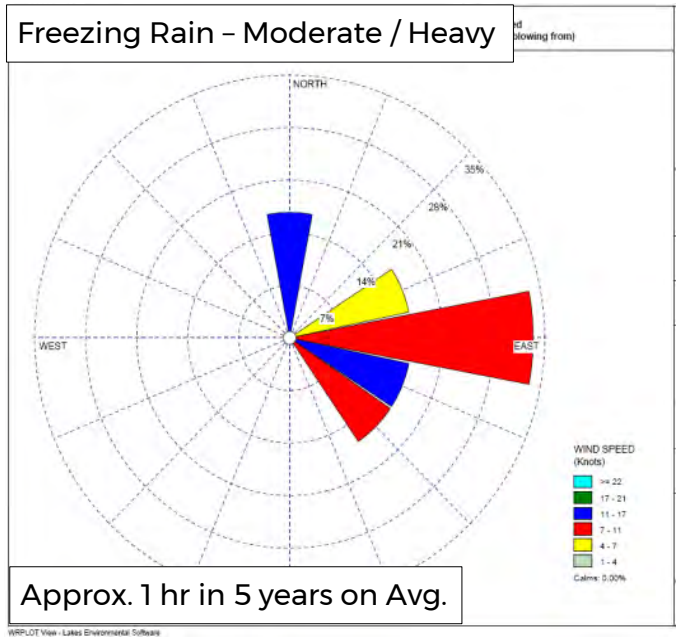
Approx. 665 hrs/yr

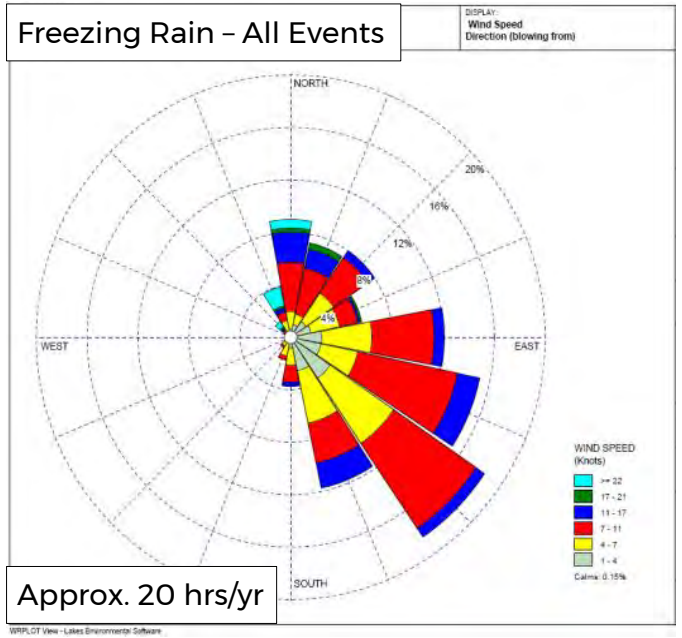
Summary: Wind blown snow and ice will be focused towards the bridge walls.



Note: Meteorological data courtesy of Novus Environmental Inc. and plots produced with Lakes Environmental Software

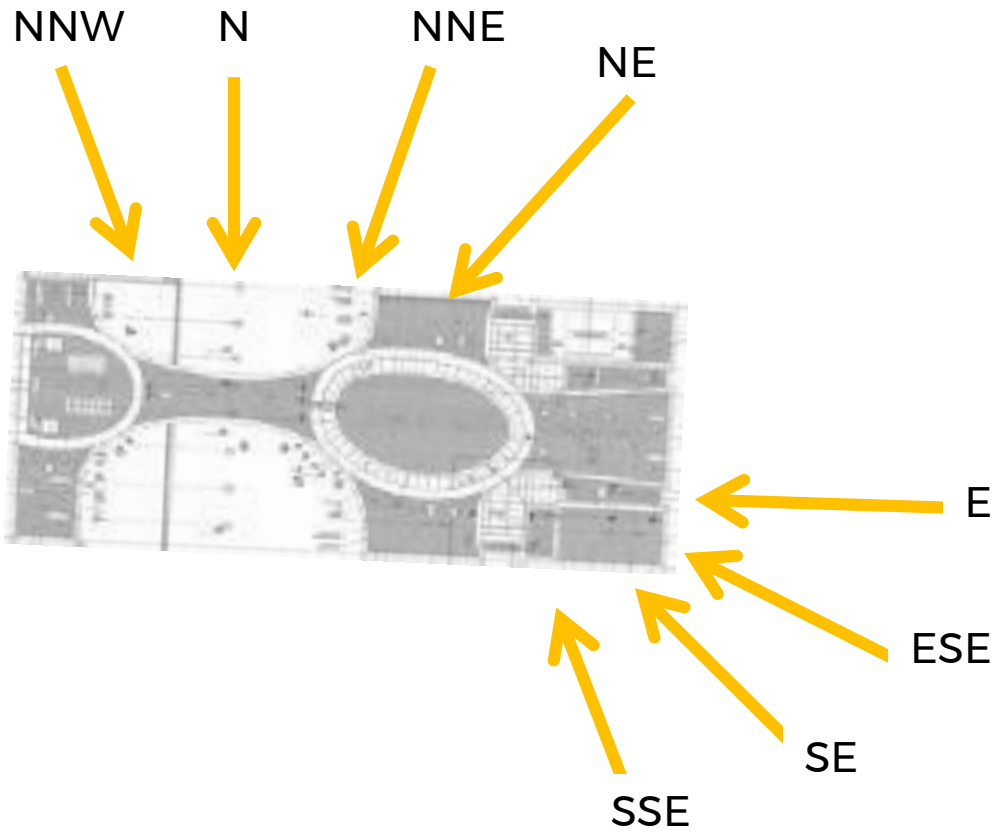
Winter Winds with Freezing Rain





Moderate / Heavy Freezing Rain is rare. The analysis (left upper Wind-Rose) indicates only 6 hrs of occurrence over the 30 year record.

Light Freezing Rain events are much more common, averaging approximately 20 hrs per year.



Summary: Wind blown freezing rain can impact the bridge walls as well as North and South building facades.

Note: Meteorological data courtesy of Novus Environmental Inc. and plots produced with Lakes Environmental Software

Calgary Winter Statistics

Days with: Snowfall

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Above 0.2 cm	10	8	9	6	2	0	0	0	2	4	8	8
Above 5 cm	0	1	1	1	1	0	0	0	0	1	1	1
Above 10 cm	0	0	0	0	0	0	0	0	0	0		0

7 Days on Average

Days with:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Freezing rain or freezing drizzle	1	1	2	1	0	0	0	0	0	0	2	1
Thunderstorms	0	0	0	1	3	7	8	6	2	0		
Hail	0	0	0	0	1	1	1	1	0	0	0	0
Fog, ice fog, or freezing fog	2	2	3	2	1	0	0	1	1	2	3	2
Haze or smoke	2	3	2	1	1	0	0	1	0	1		
Blowing dust	0	0	0	0	1	0	0	0	0	0	0	0
Blowing snow	2	1	1	0	0	0	0	0	0	0	1	2

8 Days on Average

19 Days on Average

7 Days on Average

Snow depth

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean daily snow depth (cm)	6	4	3	1	0	0	0	0	0	0	2	4
Median daily Snow depth (cm)	5	4	2	0	0	0	0	0	0	0	1	4
Extreme daily Snow depth (cm)	36	37	38	33	20	0	0	0	10	23	25	30
Mean monthly end snow depth cm	5	3	2	0	0	0	0	0	0	1	4	5

Extreme Daily Snow Depth = 30+ cm

Precipitation

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Single day record snowfall (cm)	25	28	24	46	48	25	0	6	23	30	36	22
Date	Jan 03 1913	Feb 10 1951	Mar 13 1889	Apr 21 1932	May 06 1981	Jun 06 1951	Jul 23 1918	Aug 25 1900	Sep 19 1895	Oct 04 1914	Nov 13 1914	Dec 11 1889
Single day record precipitation (mm)	25	28	25	46	65	79	95	81	93	46	36	22
Date	Jan 03 1913	Feb 10 1951	Mar 16 1998	Apr 21 1932	May 18 1902	Jun 01 1932	Jul 15 1927	Aug 25 1945	Sep 12 1985	Oct 01 1915	Nov 13 1914	Dec 11 1889
Extreme daily Snow depth (cm)	36	37	38	33	20	0	0	0	10	23	25	30
Date	Jan 10 1997	Feb 13 1978	Mar 18 1998	Apr 27 1966	May 01 1966	Jun 01 1955	Jul 01 1955	Aug 01 1955	Sep 26 1965	Oct 22 1957	Nov 15 1965	Dec 30 1996

Single Day Snowfall Record = 48 cm

Note: Statistics from The Weather Network

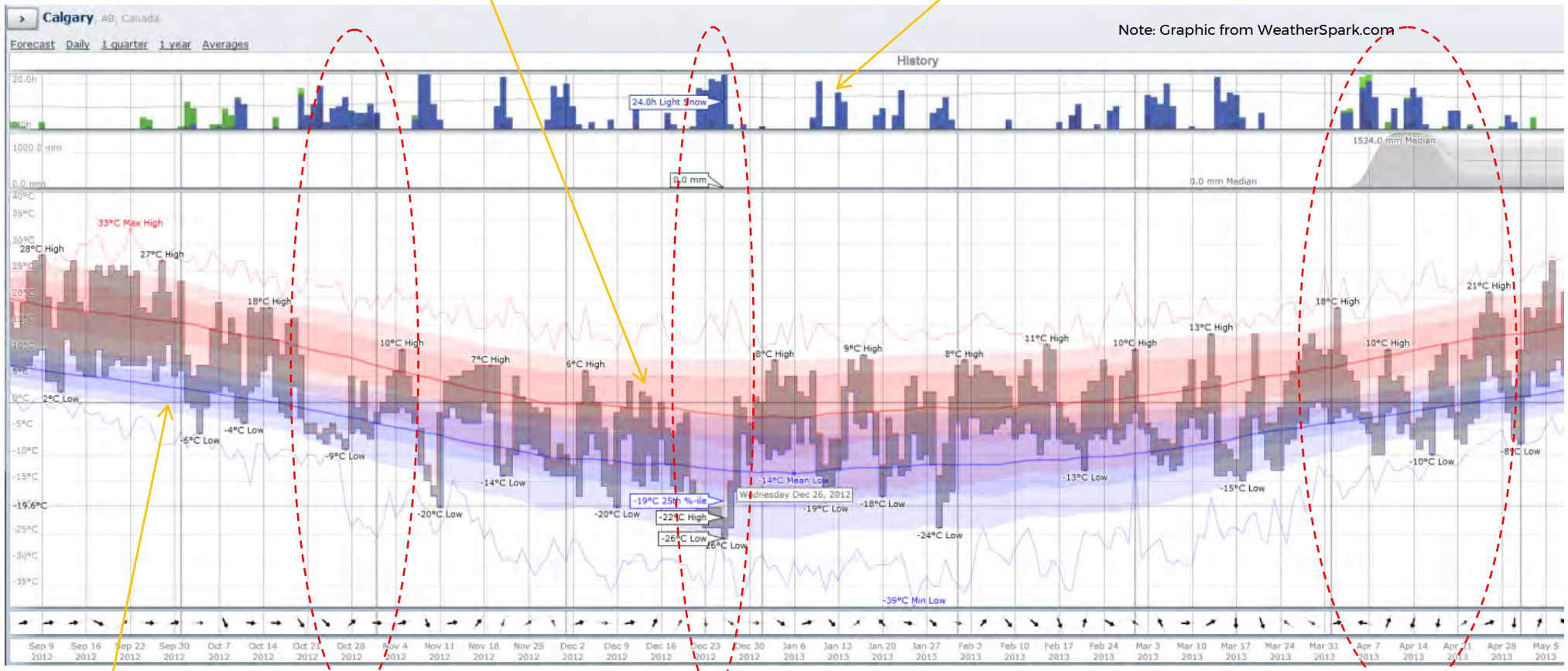
Station: Calgary Int'l A, AB, Canada | **Latitude:** 51.1° | **Longitude:** -114.0° | **Altitude:** -9999 m

Typical Storm Events

A timeline graphic of the 2012-2013 winter season, showing temperature fluctuations and forecasted snow records

Gray bars show maximum and minimum daily temperatures.

Blue bars show hours of light moderate or heavy snowfall predictions.



0˚C - Freezing

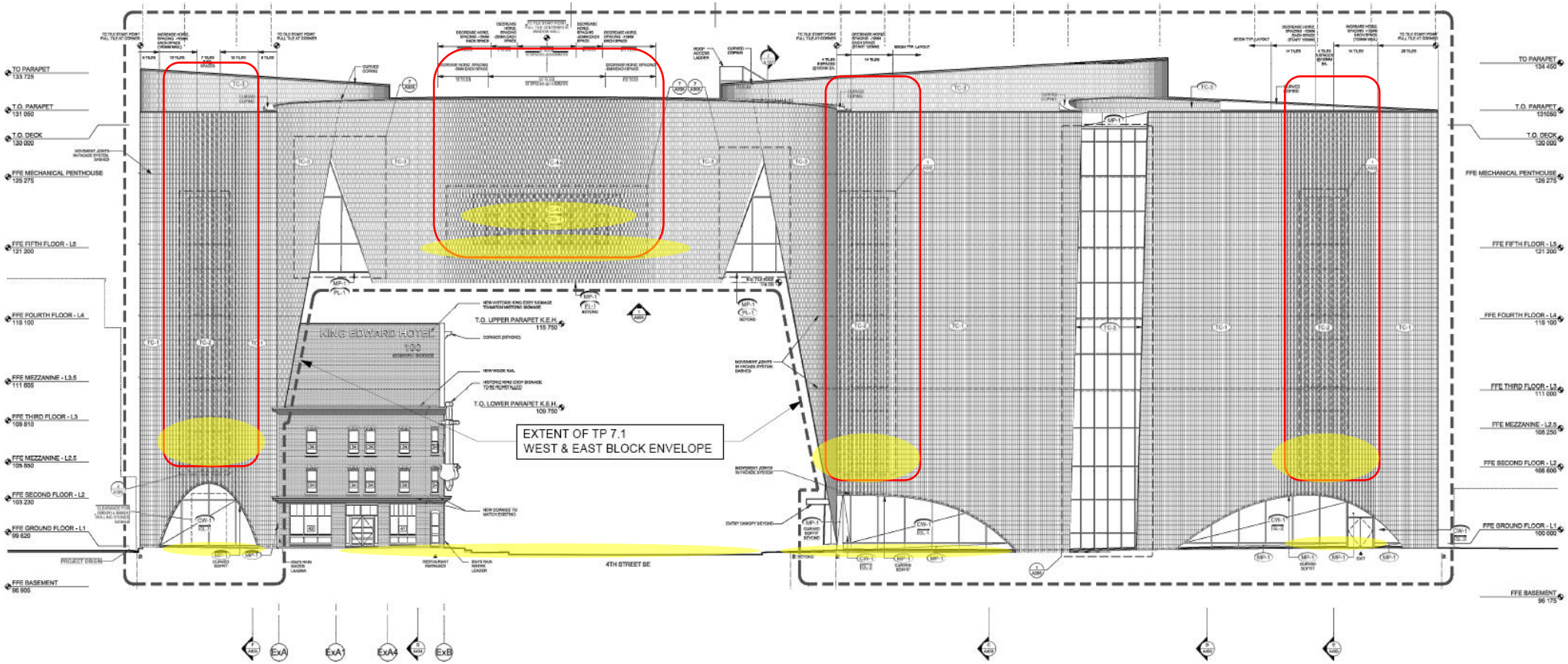
Cold period followed by a warming trend with below freezing nights.

Very cold period with snowfall.

Likely wet snowfall during cycles of daytime melting, then freezing at night.

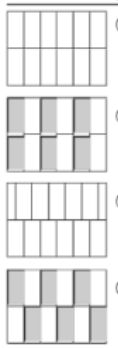
Note: Weather graphic courtesy of WeatherSpark.com

Winter Performance Concerns Identified



SOUTH ELEVATION

SYSTEM TYPES



TC-1 TERRA COTTA
- SOLID / STACKED PATTERN
- FLAT SURFACE
- DARK COLOR GLAZE

TC-2 TERRA COTTA
- "SCREEN" PATTERN
- FLAT SURFACE
- DARK COLOR GLAZE

TC-3 TERRA COTTA
- SOLID / RUNNING BOND PATTERN
- CURVED SURFACE
- LIGHT COLOR GLAZE

TC-4 TERRA COTTA
- "SCREEN" PATTERN (4.a, 4.b or 4.c)
- CURVED SURFACE
- LIGHT COLOR GLAZE

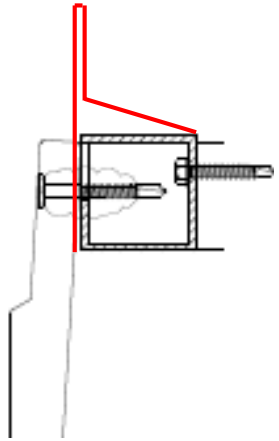
Summary of Concerns:
The porosity of the Terra Cotta Wall Systems will promote snow collection behind and between tiles, creating a need to control water migration, falling ice and icicle potential.

Legend:

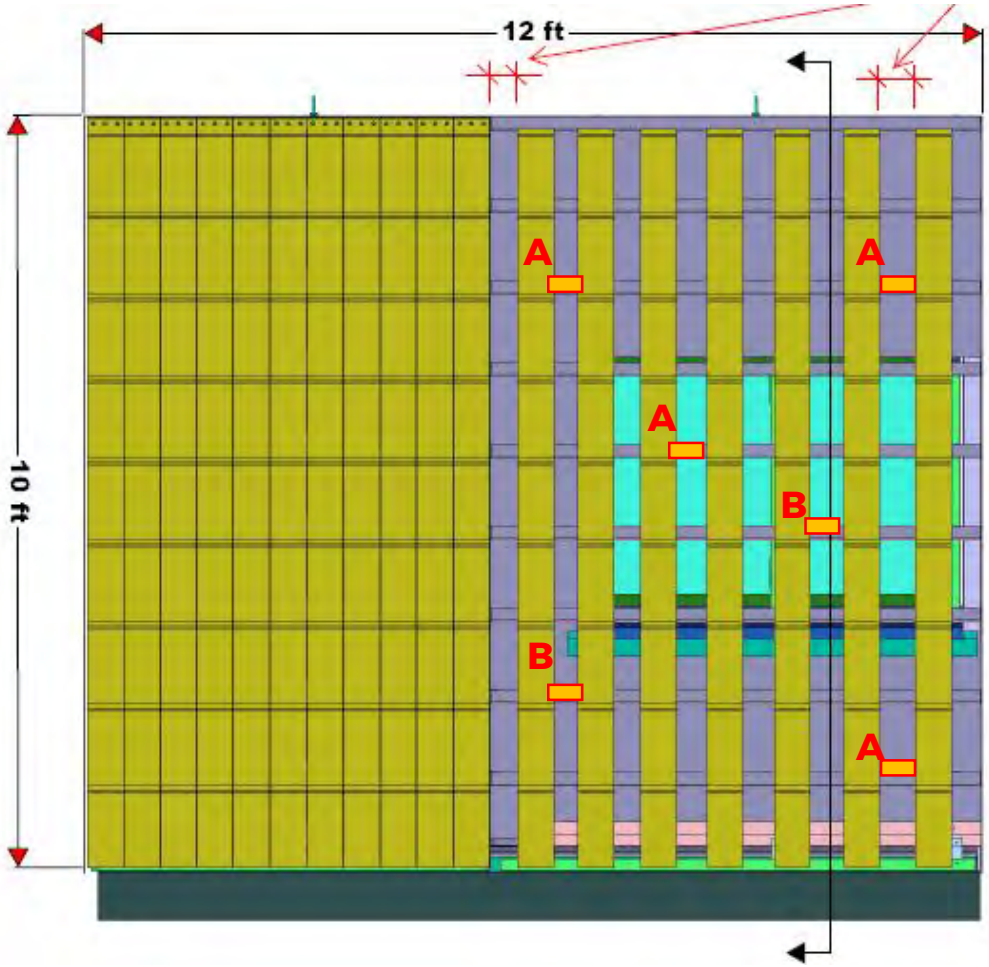
Area of Concern

Area of Potential Icing

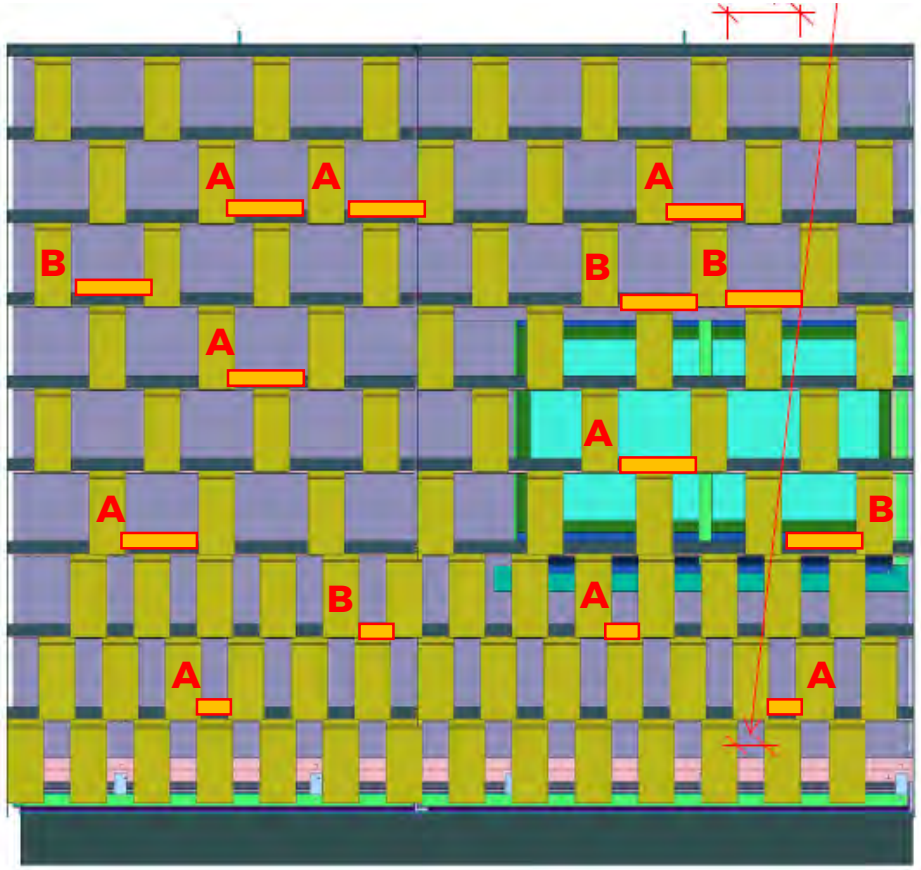
Mock-Ups with Mitigation Locations



Section Sketch: Exposed Metal Support Rail between tiles with mitigation.



NMC_PERFORMANCE MOCKUP #2 14 JAN 2014



NMC_PERFORMANCE MOCKUP #1_17JAN2014

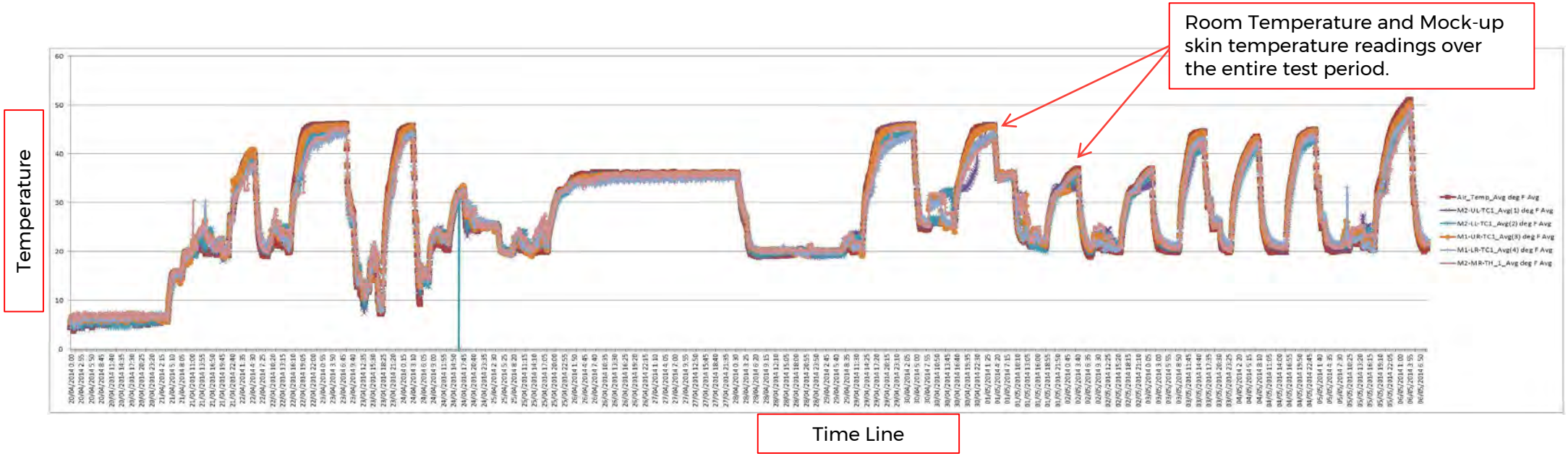
Completed Mock-Ups

Test Plan

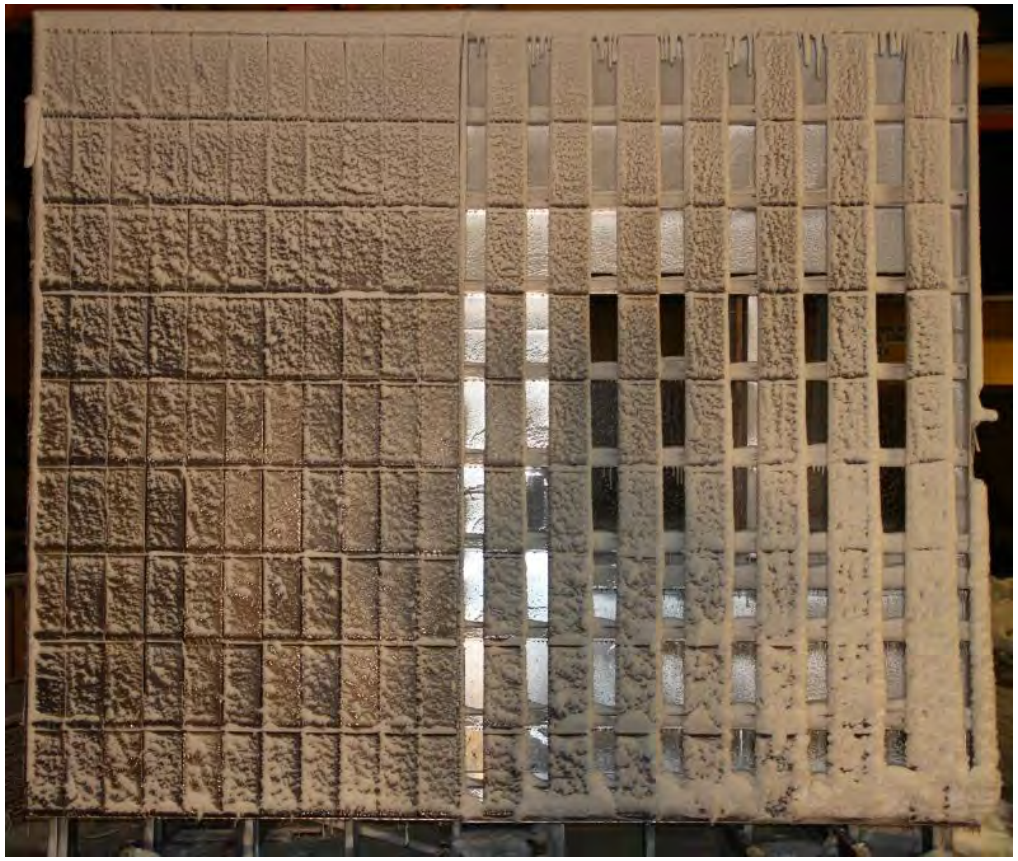
Testing Summary:

1. 14 freeze/thaw cycles were completed.
2. 3 separate applications of radian heaters were introduced, producing ice and icicle potential.
3. Multiple variations of wind, snow, and rain.
4. Most common melt out scenarios investigated.

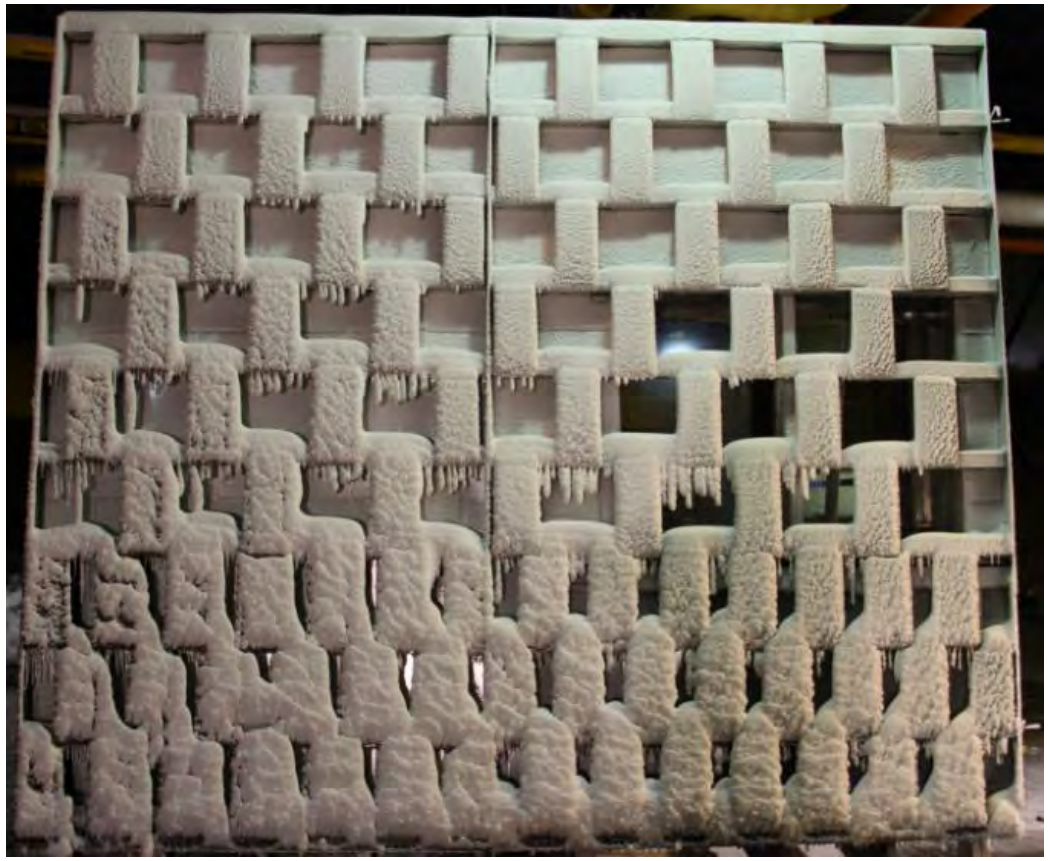
Test #	Based Condition
Test 1	Moderate Snow
Test 2	Wet Snow
Test 3	Dry Snow
Test 4	Wet Heavy Snow
Test 4	Additional Wet
Weekend	**Mitigation Configuration**
No Testing	Mitigation Added
Test 5	Wet Heavy Snow
Test 6	Clear Ice
Test 7	Clear Ice
Test 8	Wet Snow with Freeze/Thaw Cycles
Test 9	Wet Heavy Snow



Mock-Ups Exposed to Snow



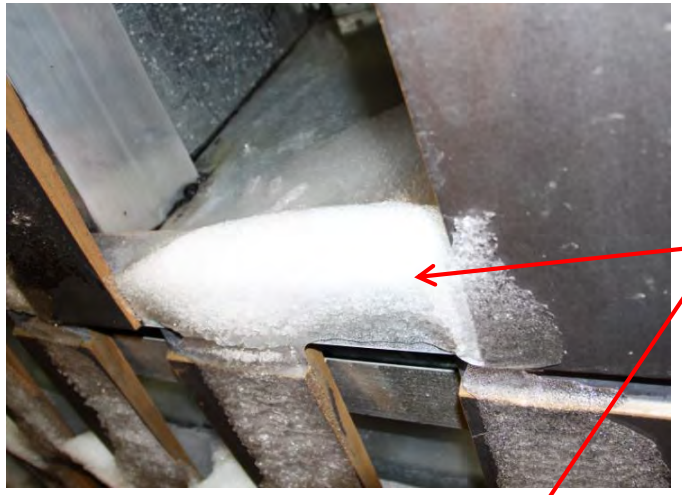
Mock-up #2



Mock-up #1

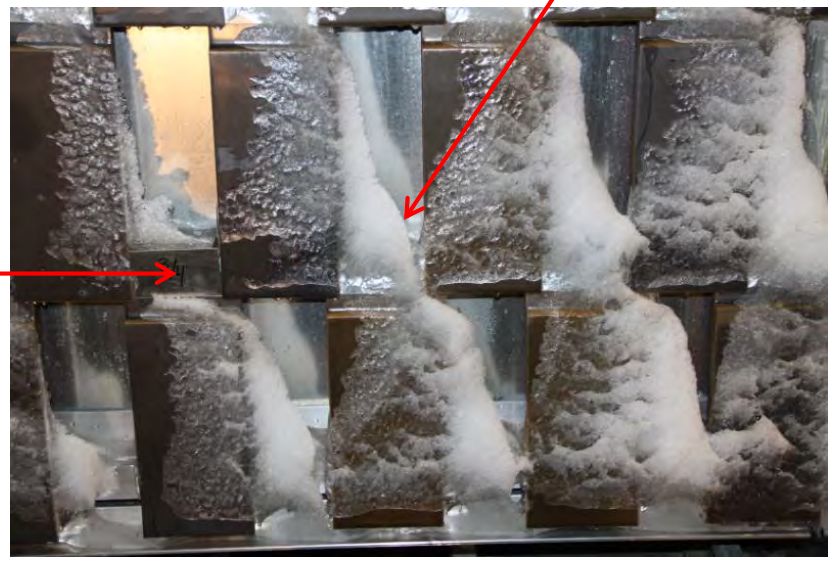
Test Results

Examples of ice that could release or slide from the base of wall assembly.



Example of ice/snow on the un-protected Metal Support Rail and Window Sill.

Example of Mitigation

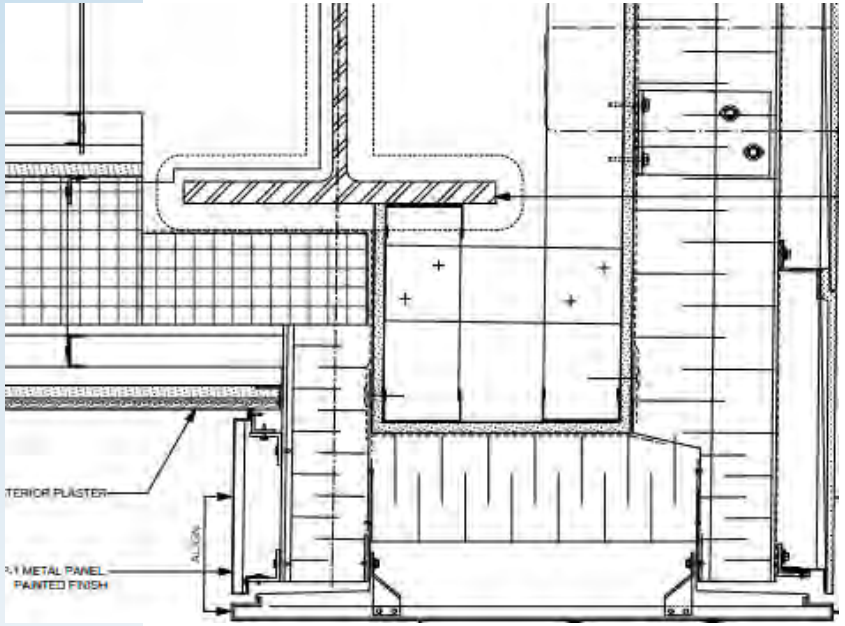


Recommendations

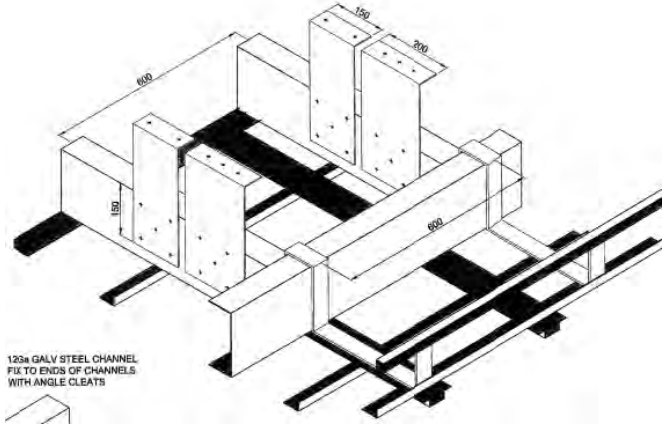
- Modify the tile support rail assembly to reduce snow and ice release between tiles.
- Add a heated gutter assembly to the base of bridge façade.
- Add ice and snow retention to roof parapets where drifting snow was a identified to be a concern.
- Modify the wall internal drainage path to reduce freeze and icicle potential.

Implementation of Recommendations During Construction

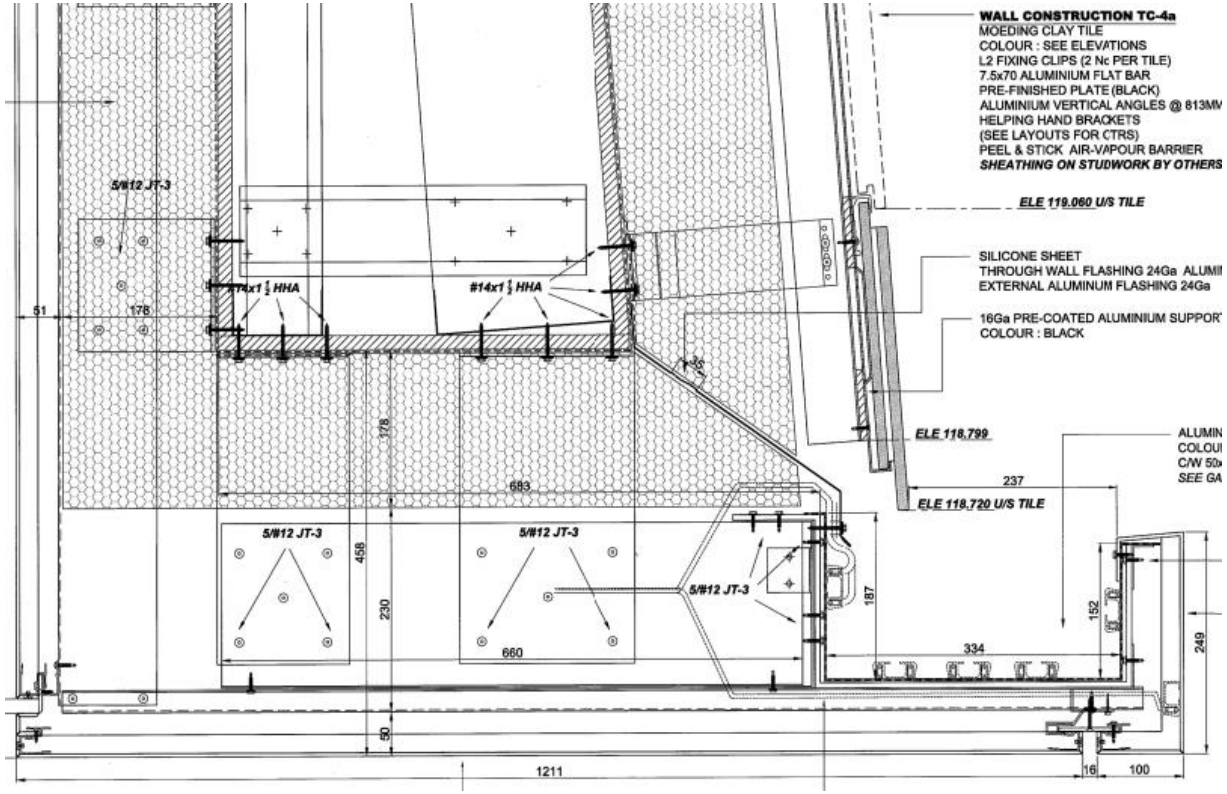
Heated Gutter at Base of Bridge Façade



Architectural Detail:
Base of Bridge Façade



Final Shop Drawing Showing The Heated Gutter

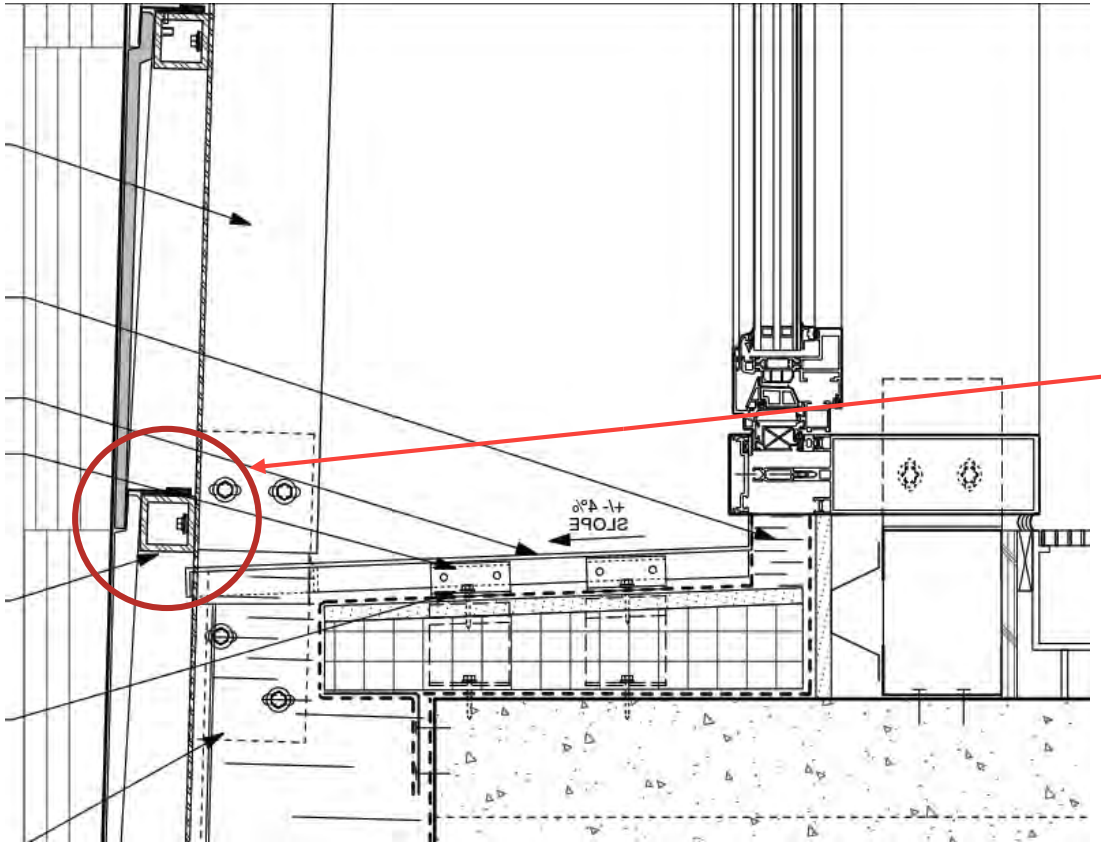


Heated Gutter at Base of Bridge Façade

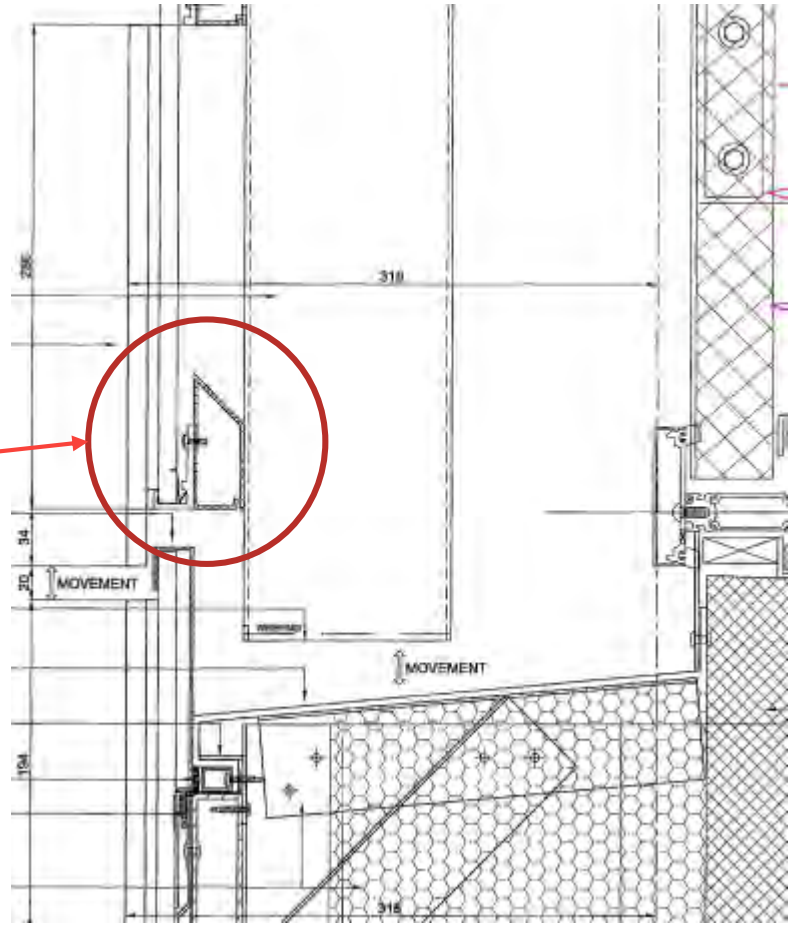
Heated Gutter at Base of Bridge Façade

Heated Gutter at Base of Bridge Façade

Back Sloped Horizontal Rail



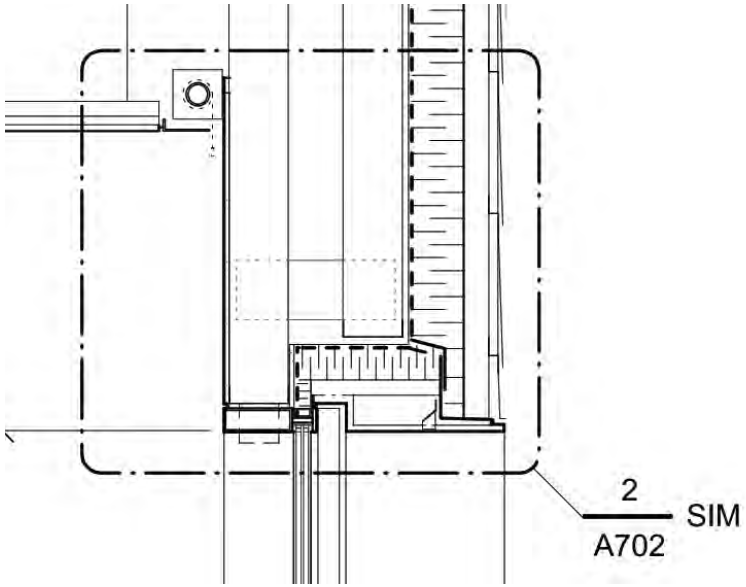
Architectural Detail:
Horizontal Rails at TC2



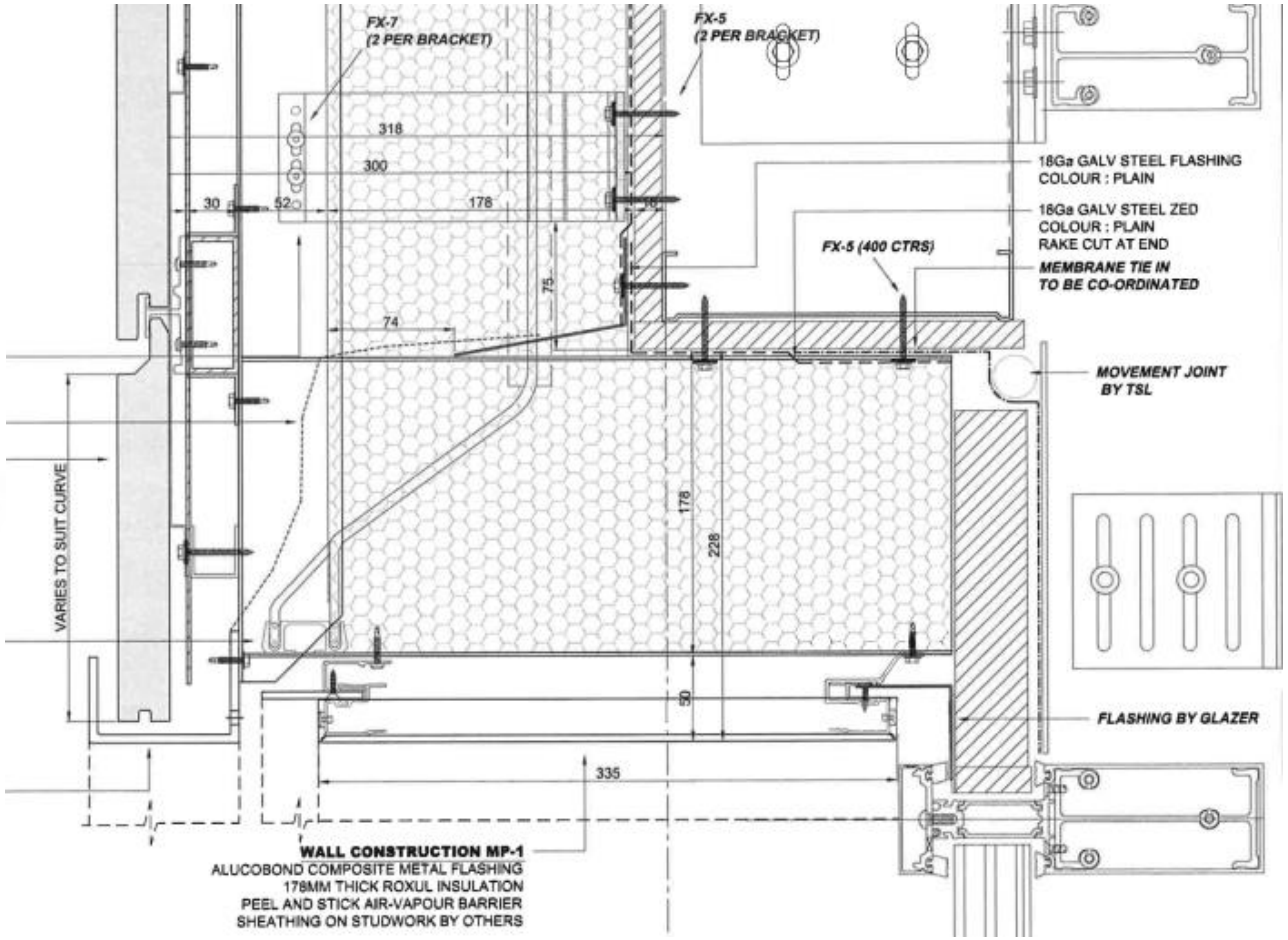
Final Shop Drawing
Showing the Sloped
Horizontal Rail at TC2

Back Sloped Horizontal Rail

Gutter At Arched Windows

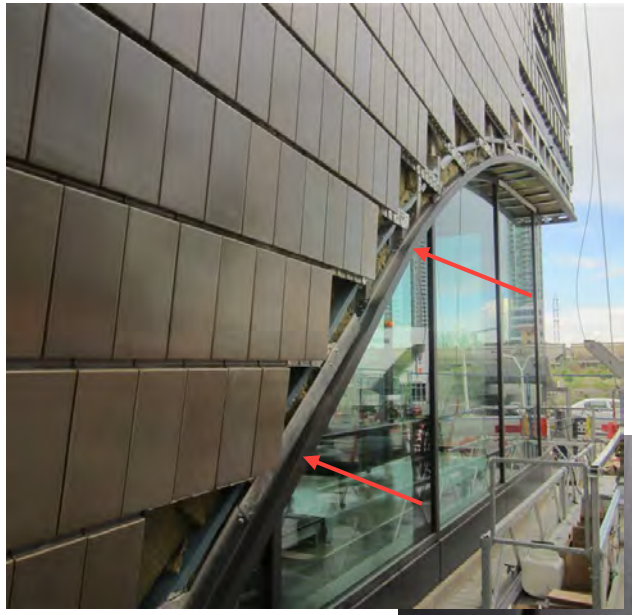


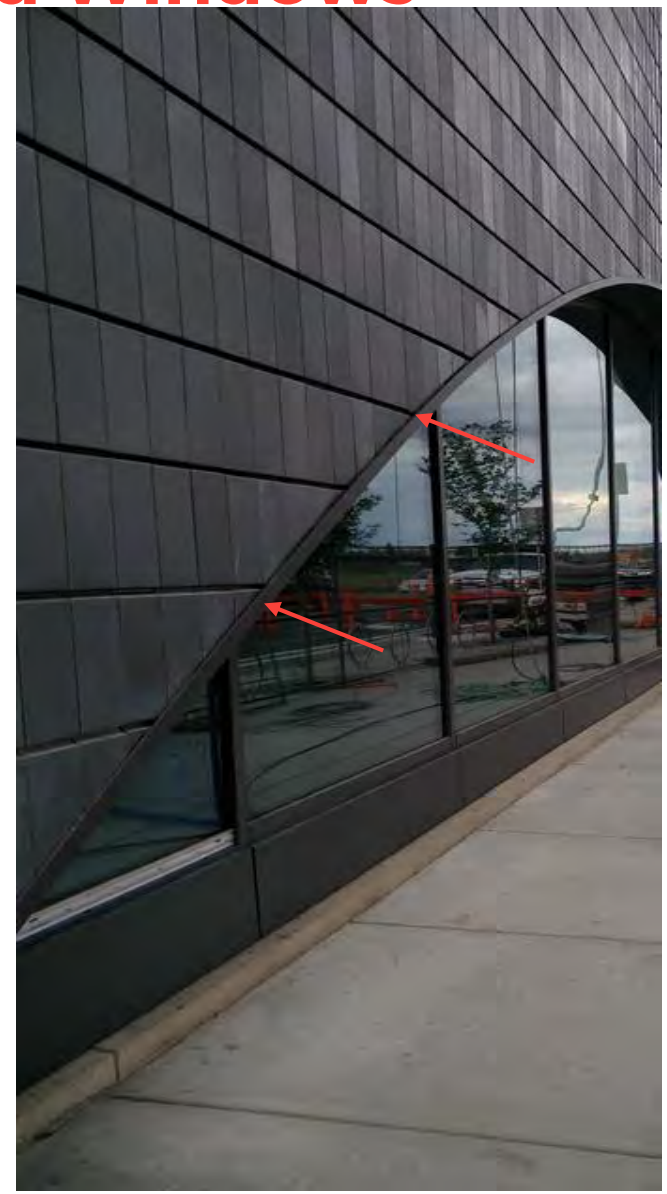
Architectural Detail: Base of Façade at Arched Windows



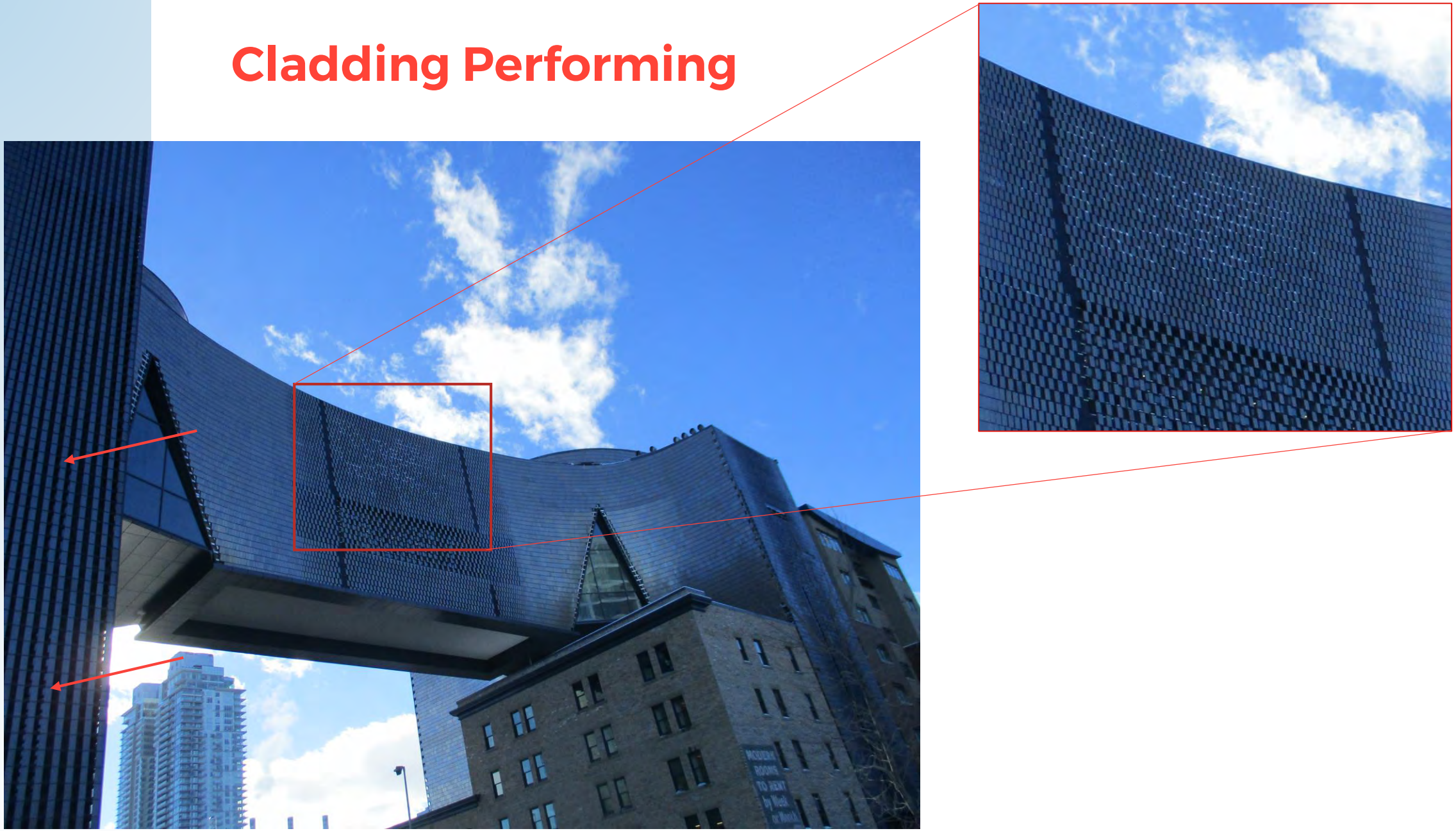
Final Shop Drawing Showing the Addition of the Gutter at the Base of the Façade at Arched Windows

Additional Drainage At Arched Windows





Cladding Performing



Thank you!

Nicole Parsons
Senior Project Manager
Building Sciences, WSP
Hamilton, Ontario
905-529-4414
nicole.parsons@wsp.com

Mike Carter
Director,
Microclimate Ice & Snow
Cambridge, Ontario
226-887-3580
mcarter@icesnowconsult.com

Scott Baxter
Project Manager,
Building Sciences, WSP
Calgary, Alberta
403-390-2094
scott.baxter@wsp.com

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microclimateiceandsnow.com

wsp.com