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FINAL TEST REPORT

Performance Mock-Up Testing Alpine LedgeGuard-Bar and LedgeGuard-12" System

Project # M18-23

Alpine LedgeGuard-Bar System



Prepared For:

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Introduction

Microclimate Ice & Snow Inc. (MI&S) was retained by Alpine SnowGuards® (Alpine) to conduct Performance Mock-Up (PMU) tests for their proprietary LedgeGuard-12” and LedgeGuard-Bar snow and ice retention systems. The purpose of the requested testing was to investigate and evaluate the performance of the Alpine LedgeGuard System products on typical exterior details of a **thermally correct metal and glazing curtain wall system that was designed and constructed by a commercial curtain wall firm.**

To accomplish this request a PMU was specified and commissioned by MI&S, on behalf of Alpine, in the form of a 10’ x 12’ curtain wall facade and support frame with an adjoining insulated and temperature controlled rear box intended to simulate a conditioned building interior, approximating thermally correct facade skin temperature (refer to Figures 1 and 2). The curtain wall was designed and manufactured by **New Hudson Facades of Linwood, Pennsylvania** and the PMU support frame was designed and manufactured by **Steelworks Design Incorporated of Peterborough, Ontario**. To accommodate the environmental testing, the Large Climatic Chamber (LCC) at the **Ontario Tech University (formally known as the University of Ontario Institute of Technology – UOIT) located in Oshawa, Ontario, Canada** was employed (<https://ace.ontariotechu.ca/testing-chambers/large-climatic-chamber.php>). The performance mock-up assembly and installation was completed by the technicians at the Ontario Tech University.

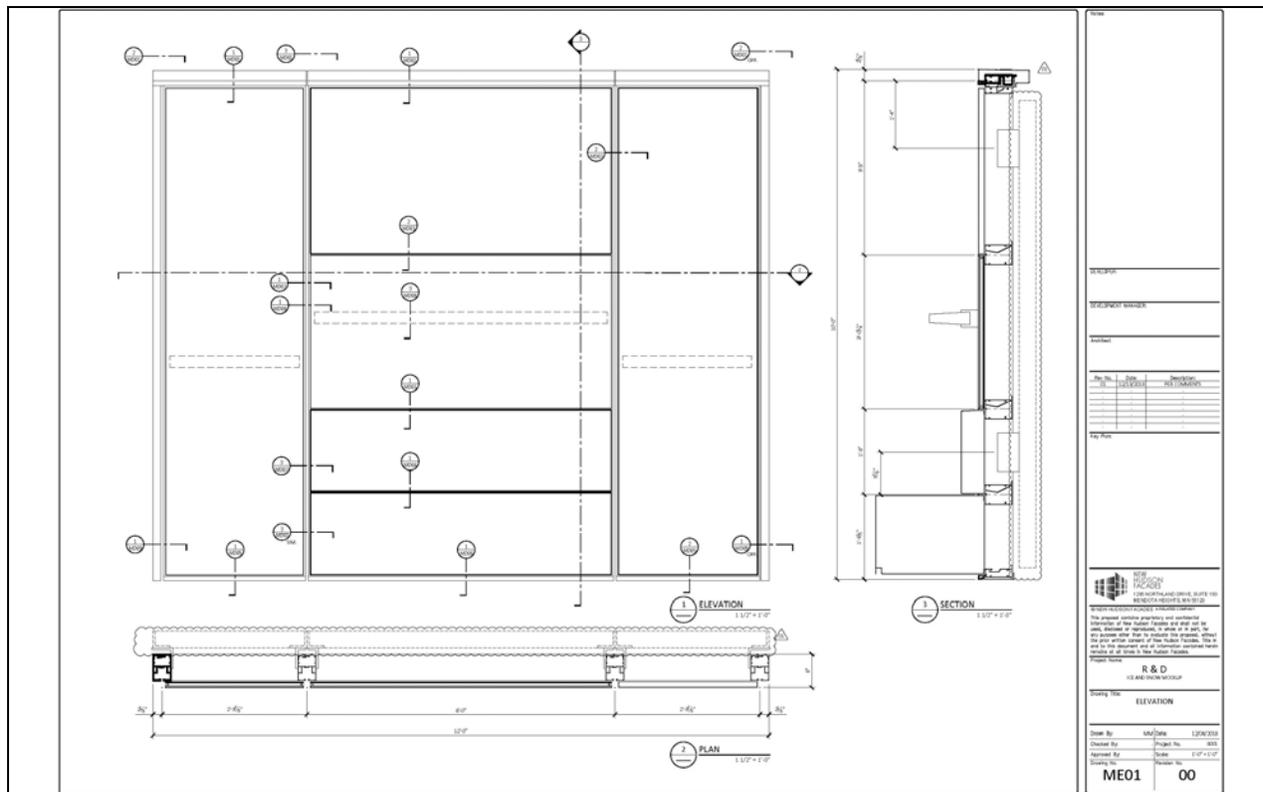


Figure 1 – New Hudson Facades Curtain Wall Design

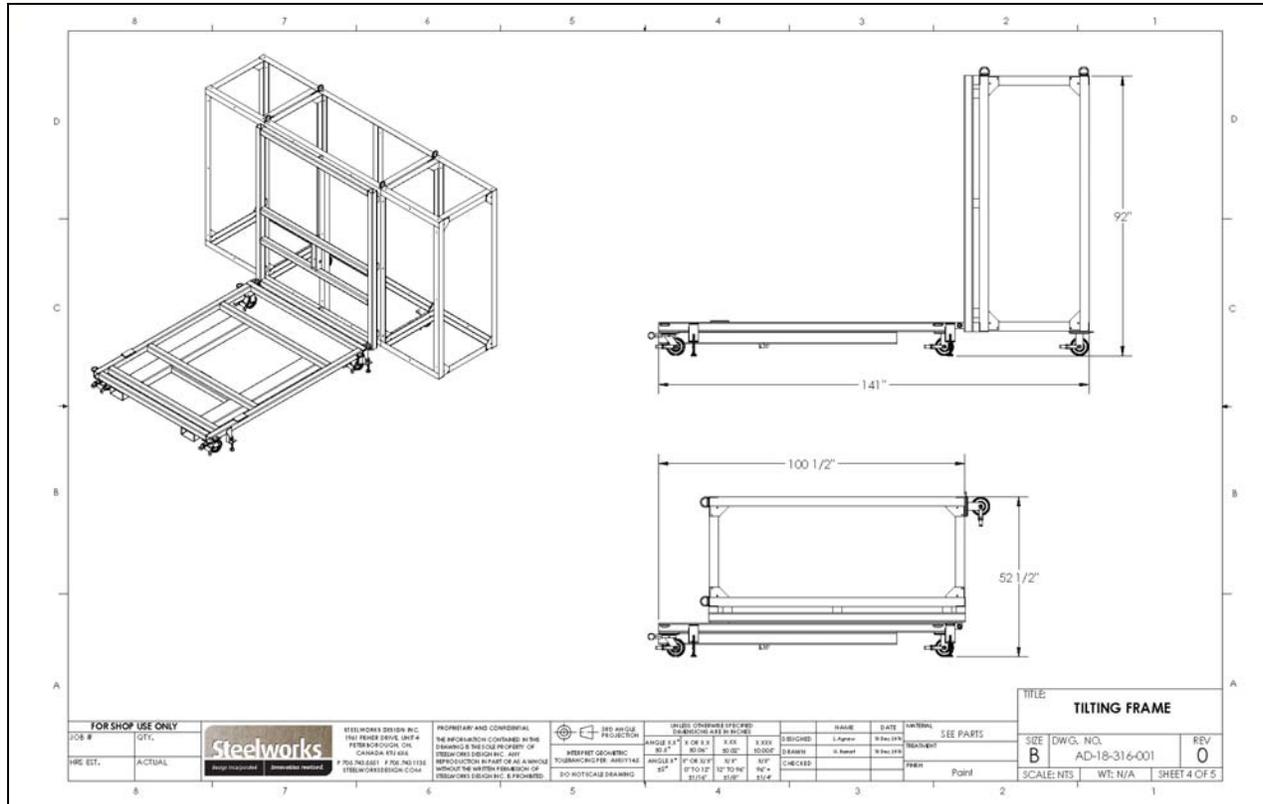


Figure 2 – Steelworks PMU Support Frame with Rear Heat Box

Performance Mock-Up and Test Configurations

Details regarding the performance mock-up design, curtain wall design, Alpine LedgeGuard test configurations and winter weather simulation, as well as the test results and recommendations from the June 26 through 28 tests are provided below. A summary of the information contained in this report, along with additional photographs and video test results are also provided within an accompanying video report titled: 2019-09-09 Ice & Snow Performance Testing Report-MIS.

As referred to previously, Figure 1 shows the curtain wall that was design and provided by New Hudson Facades to include typical materials, paint and glass properties of a high performance modern facade. The typical design geometries included in the facade design were:

- a large low sloped box-out ledge;
- a low slope window sill;
- a horizontal mullion with low slope sunshade; and,
- a wall parapet (note: the designed wall parapet cap was incomplete for testing and thus was not considered with the test results).

Figure 2 also shows the PMU Support Frame with the 4 foot deep thermally controlled heated box that was attached and sealed to the rear of the curtain wall to simulate appropriate facade skin temperatures. Once the support frame, heated box and curtain wall were assembled and installed in the LCC, the air temperature was lowered to 16°F (-9°C) and the PMU was left to acclimatize. A total of three (3) PMU configurations were planned and tested during a 3 day testing schedule. The completed test configurations included:

- Test #1 - Problem Condition (No Ice and Snow Retention Applied – refer to Figure 3)
- Test #2 – Alpine LedgeGuard-12 Inch (LedgeGuard 12” Applied at 24” O.C. – refer to Figure 4)
- Test #3 – Alpine LedgeGuard (LedgeGuard Applied Continuously – refer to Figure 5)



Figure 3 – Test #1
(No Ice and Snow Retention)
Figure 4 – Test #2
(LedgeGuard 12” @ 24” o.c.)
Figure 5 – Test #3
(LedgeGuard Continuous)

Once the test chamber and PMU had acclimatized snowfall was produced within the test chamber by a snow gun calibrated and positioned appropriately to produce an application of wet heavy snow on all curtain wall surfaces (refer to Figure 6). To produce snow pressurized water and air are expelled from the snow gun, mixing and traveling in an arc trajectory ultimately travelling in a downward angle toward the curtain wall, simulating windblown snowfall. The maximum snow depths for each test were achieved through 3 separate snow making applications separated by time periods required for equipment defrost cycles. Each test configuration was documented through both digital and manual measurements as well as video recording and still photography (refer to Figure 7).



Figure 6 – Snow Making

Figure 7 – Example of Test Data

Test #1 Results, Conclusions and Recommendations

Test Results (refer to Figures 8 through 11)

- After 3 applications of snow within the climatic test chamber, the low sloped surfaces of the curtain wall facade collected 7 to 10 Inches of wet heavy snow (refer to Figure 8).
- Wind action deposited falling snow onto vertical facade surfaces in smaller quantities, however the vertical facade also deflected wind and therefore directed additional snow fall downward onto the low sloped surfaces where the largest volumes collected.
- As temperatures fluctuated during snow production, caused by the snow making process as well as equipment defrost cycles, the accumulated snow pack experienced some densification and ice production similar to what would occur naturally over time in the outdoor environment with the influences of sun and daily air temperature fluctuations.
- Once snow production was complete and air temperatures were raised above 32°F (0°C) within the climatic test chamber, melt water produced within the collected snow migrated downward, saturating the frozen connection of snow to the low sloped metal surfaces. As a result, shortly after melting began, masses of snow started to release, slide and fall from the low sloped surfaces, creating a potential hazard for people and property that exists below (refer to Figures 9, 10 and 11).



Figure 8 – Test #1
Accumulated Ice and Snow

Figure 9 – Test #1
Falling Ice and Snow

Conclusions

- Strategies for Ice, Snow and Meltwater retention are required for low sloped, protruding or recessed elements of a vertical curtain wall facade to avoid falling ice and snow. This conclusion

extends to sloped or curved facades, and facades with complex forms and geometries, including double or rainscreen facades.



Figure 10 – Test #1
Falling Ice and Snow

Figure 11 – Test #1
Falling Ice and Snow

Recommendations

- To alleviate this potential hazard on an existing or completed building design, mitigation in the form of ice and snow retention barriers is typically recommended to retain ice and snow formations, implementing a melt in place strategy. In-progress building design projects have a further option of design modification to mitigate hazard potential.
- In general, buildings and building facades that are situated in icing and / or snowfall climates are recommended to be assessed for the potential of hazardous ice and snow formation and release.
- It is further recommend that buildings situated in icing and / or snowfall climates adopt and maintain building specific winter operational procedures for the inspection, observation, management and implementation of restricted access for the prediction and prevention of a potential hazard.

Test #2 and #3 Results, Conclusions and Recommendations

Test Results (refer to Figures 12 through 15)

- Similar to Test #1, after 3 applications of snow within the climatic test chamber, the low sloped surfaces of the curtain wall facade collected 7 to 10 inches of wet heavy snow (Ledges, sills, horizontal mullions or sun shades – refer to Figures 12 and 14).

- Similar to Test #1, wind action deposited snow onto vertical facade surfaces in smaller quantities, however the vertical facade deflected wind and therefore directed additional snow fall downward onto the low sloped surfaces where the largest volumes collected.
- Similar to Test #1, as air temperatures fluctuated during snow production and equipment defrost cycles, the accumulated snow experienced some densification and ice production similar to what would occur naturally over time in the outdoor environment.
- Similar to Test #1, once air temperatures within the climatic test chamber rose above 32°F (0°C), melt water that was produced within the collected snow, migrated downward saturating and melting the frozen connection to the metal of the low sloped facade surface.
- However, different than Test #1, in both Test #2 and Test #3, snow that collected behind the LedgeGuard system products (i.e. ice and snow barriers) experienced resistance to movement and therefore did not release and fall from the low sloped surfaces, significantly reducing the potential of a falling ice and snow hazard for people and property that exists below (refer to Figures 13 and 15).



Figure 12 – Test #2
Accumulated Ice and Snow



Figure 13 – Test #2
Ice and Snow Melting in Place

Conclusions

- The specification and application of an ice and snow retention system that has been proven through environmental performance testing to retain and manage the movement and release potential of ice, snow and melt water in heavy snow and icing conditions will significantly reduce risk of a falling ice and snow incident.
- Conducting environmental performance testing of a custom ice and snow retention system or system layout on a proposed curtain wall, facade or roof design performance mock-up (PMU) on a project specific basis can:
 1. allow for the refinement of systems to promote alignment with the project design aesthetic / intent;

2. validate system performance in the various extreme winter weather conditions;
3. investigate constructability and assembly of systems;
4. allow for the integration of ice and snow retention with various aspects of design modification to improve performance while minimizing the impact on cost and aesthetics;
5. educate building ownership of anticipated future performance and requirements for winter operational procedures (i.e., design + operations = risk management); and,
6. demonstrate design due diligence.



Figure 14 – Test #3
Accumulated Ice and Snow



Figure 15 – Test #3
Ice and Snow Melting in Place

Recommendations

- In general, buildings and building facades that are situated in icing and / or snowfall climates are recommended to be assessed for the potential of hazardous ice and snow formation and release.
- Planning for ice and snow performance mock-up (PMU) testing during design is recommended to refine, validate and integrate ice and snow retention and management strategies; thereby, reducing risk and aesthetic impact while demonstrating due diligence.
- The application and layout of an ice and snow retention system, such as the Alpine LedgeGuard, is recommended to be specified by an ice and snow specialist; as the consideration of the local winter microclimate, the construction and dimensions of the building detail, as well as the detail's exposure and geometry need to be considered.
- ***As the application of an ice and snow retention system such as the Alpine LedgeGuard cannot completely eliminate the potential for falling ice and snow in all winter weather conditions, it is recommended that buildings situated in icing and / or snowfall climates adopt and maintain building***

specific winter operational procedures for the inspection, observation, management and implementation of restricted access in order to predict and prevent a potential hazard.

Applicability of Results

Mock-up performance testing in an environmental laboratory cannot simulate or replicate all external variables, conditions and combinations thereof exactly in a single set of tests. As such, confidence and accuracy is typically obtained through an extended program of investigation and repetitive testing. ***Consequently, all test results provided within this report require analysis, interpretation, and judgement in their application. It is therefore recommended that all results be reviewed in a conservative manor, with final designs incorporating some magnitude of conservatism (e.g., safety factor). It is further important to coordinate the decision to retain ice and snow on a building or structure with the structural design of that building or structure (existing or proposed), to verify that the retention of ice and snow can be accommodated by or factored into the structural (i.e. snow load) design.***

Closing

We trust that the services provided by MI&S have met your current needs and expectations. Should you have any questions regarding the recommendations or guidance provided within this report, or you require clarification of any aspect of the recommendations presented, please feel free to contact us at any time in the future.

End