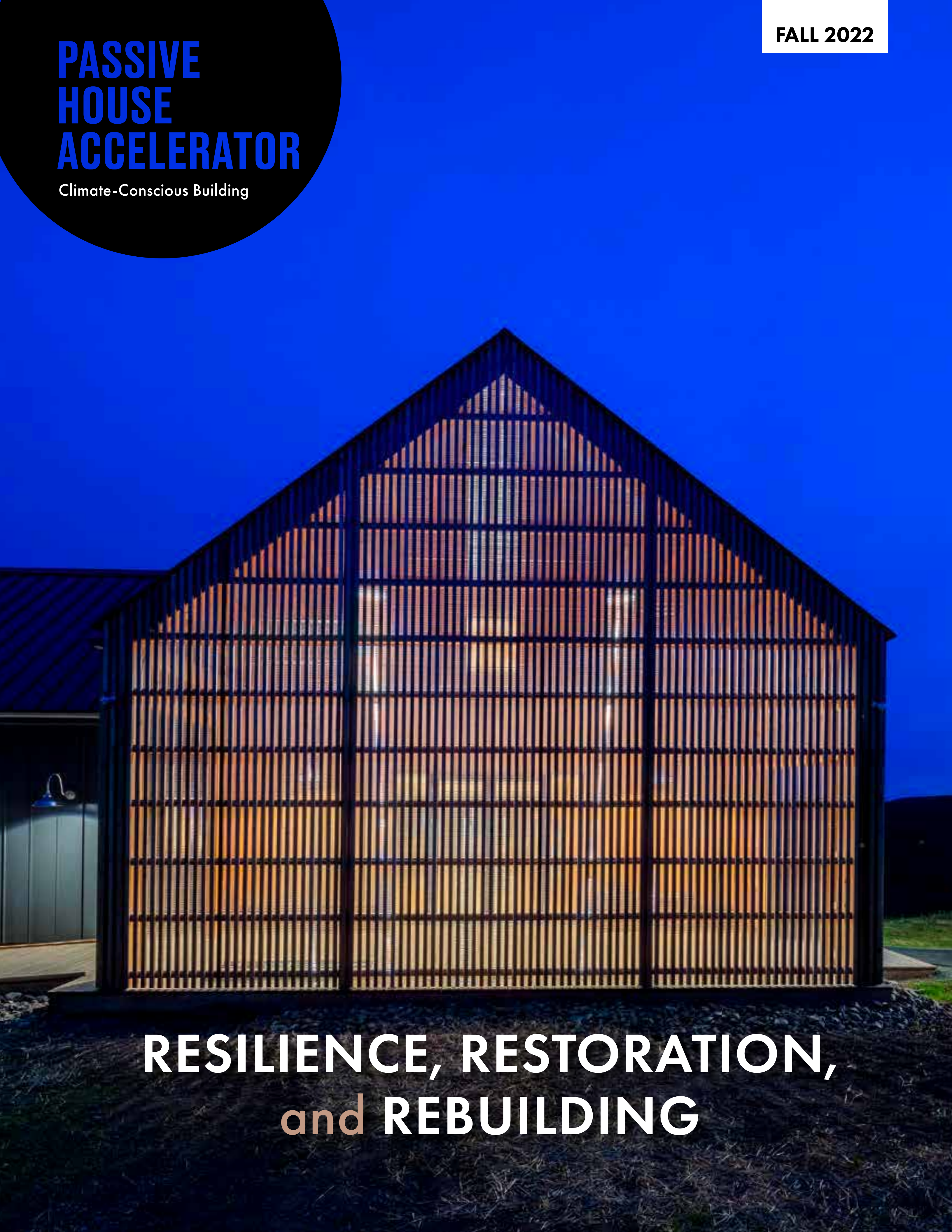
FALL 2022

PASSIVE HOUSE ACCELERATOR

Climate-Conscious Building



RESILIENCE, RESTORATION, and REBUILDING

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ROLLING UP: MODELING and FINE-TUNING OVERHEAD DOORS

Passive House (PH) certification is increasingly being sought and designed for in diverse non-residential building types, giving rise to specific complexities that don't commonly crop up in a standard single-family or multi-unit residential building. One such building type is the garage, which for a residential project would usually be modeled outside of the thermal envelope but can be an integral component of an office building, manufacturing facility, or other industrial facility. Garages' challenges stem mainly from the need for large overhead doors, which are a source of significant heat loss and air leakage. These losses pose a challenge for PH certification, as the stringent criteria for a heat demand of 15 kWh/m² and an airtightness of 0.6 ACH_{50} still need to be met.

DESIGN

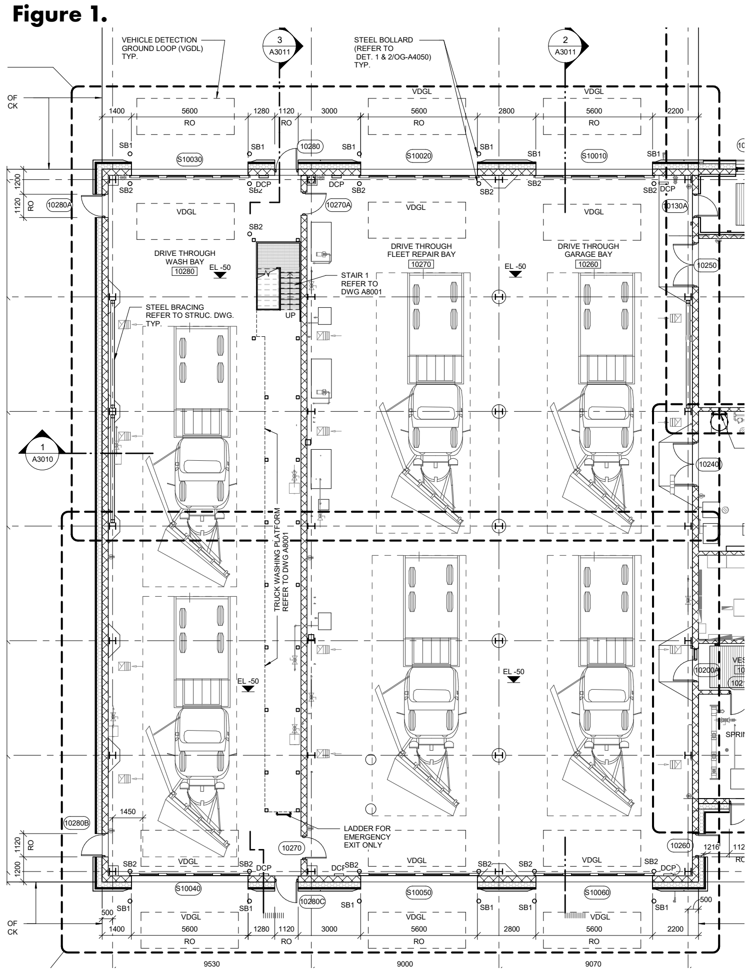
The design of the York Region Southeast District Maintenance Yard and Snow Management Facility in Markham, Ontario brought these exact complexities to IBI Group and Pretium Engineering, who were tasked with the design and Passive House certification of this building. The facility consists of an office connected to an industrial garage containing three bays—two vehicle bays and one wash bay—that are integral to the functionality and operations of the building (see Figure 1). Each of the bays needs to operate as a drive-through, requiring a total of six garage doors, two for each bay.

While carrying out the initial research to get this building to meet PH targets, the design team came up against a significant hurdle: there were no PH-certified overhead doors that were available on the market. This gap prompted a customized approach to the design, modeling, and detailing of this assembly. Several design assumptions, as well as calculation methods, had to be employed and verified to ensure reliable data could be input for the garage into the PHPP model.

INTERIOR ENVIRONMENT

The first decision, which heavily impacted the modeling outcome, revolved around establishing the realistic internal air temperature in the garage. Because of how the space is used—active snow ploughs and drivers in full winter gear coming into the space, completing their tasks, and leaving at irregular intervals—this type of facility does not typically require full heat in the winter, but rather is often heated to a minimum operating range of between 10°C and 18°C. With the overhead doors being open periodically (particularly when cross-ventilation occurs from the doors at each end of the garage being open simultaneously), heat loss and temperature drops are bound to occur consistently during the heating season. Because of this, reducing the minimum design air temperature in the model is an appropriate measure. However, because recently running vehicles are consistently entering the facility and giving off heat, some of this heat loss was assumed to be

Figure 1.



recovered, keeping the garage always above 10°C and, therefore, certifiable. The garage and office buildings were modeled separately in the PHPP to allow for these variations.

With this decision in mind, and an appropriate Passive House building envelope specified to surround the garage, the main component of interest was now the garage door. After much research, the design team found a workable option for this project, the Thermostop Sentinel Overhead Door.

THERMAL PERFORMANCE CRITERIA

The first challenge in finding suitable garage doors was identifying ones with sufficient insulation values. Several door manufacturers and door types (overhead and folding) were reviewed before landing on the Thermostop Sentinel doors, which provide an option that includes 100mm of polyurethane foam core insulation between steel panels. With this configuration the doors achieve a nominal thermal performance of approximately R-32.

The Thermostop doors also include an option for adding 600mm x 300mm (24 inch x12 inch) double-glazed fixed windows with a thermally broken aluminum frame, providing a thermal resistance of R-5. As the doors would be taking up most of the wall area on the north and south elevations of this part of the project, the option of placing windows within the door assemblies was very beneficial.

To appropriately model these doors in the PHPP, the basic door assembly was created in the U-Values tab, and the glazing and window frame components were input into the Components tab in accordance with the performance values provided by the manufacturer.

To optimize solar heat gains and minimize heat losses, while providing adequate daylighting into the garage area, the design decision was made to include four windows on each door along the north elevation and twelve windows, consisting of three rows of four, on each door along the south elevation (see Figures 2, 3, and 4).

THERMAL BRIDGING

The thermal bridging limitations of garage doors are difficult to overcome in Passive House projects, particularly in industrial applications, where heavy vehicles are expected to enter the garage multiple times a day. In the case of this project, steel sills were necessary at the door thresholds for durability. Thermal breaks were installed right at the outside edge of the door threshold to minimize thermal bridging. However, based on thermal modeling, the Psi-values were still found to be the highest at this location.

The detail at the overhead door sill was modeled using THERM to assess the impact of the steel threshold (see Figure 5). The thermal break material at the location of the door threshold stops a significant amount of thermal bridging (see Figures 6 and 7).

At the head of the overhead door, the greatest limitation was that the door had to be placed fully on

Figure 2.

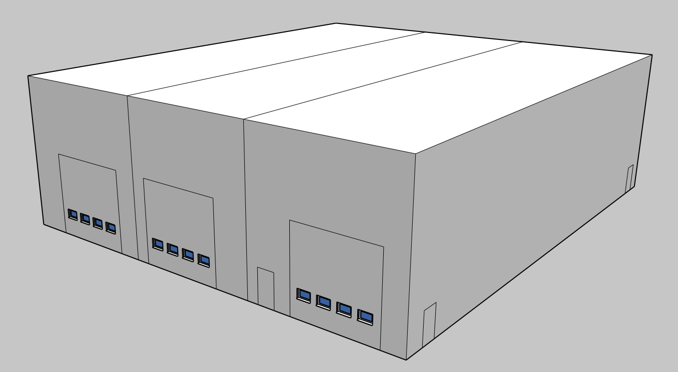


Figure 3.

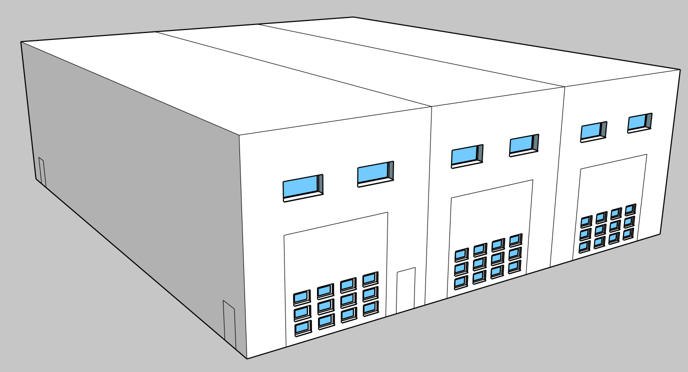
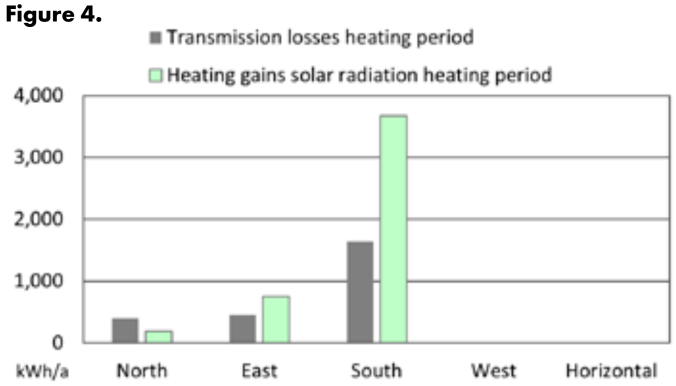


Figure 4.



Figures courtesy of IBI Group (left, top, and middle) and Pretium Engineering, Inc. (bottom)

Figure 5.

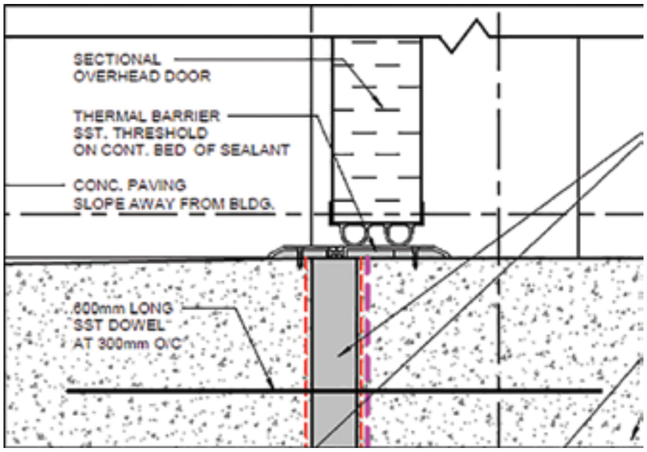


Figure 6.

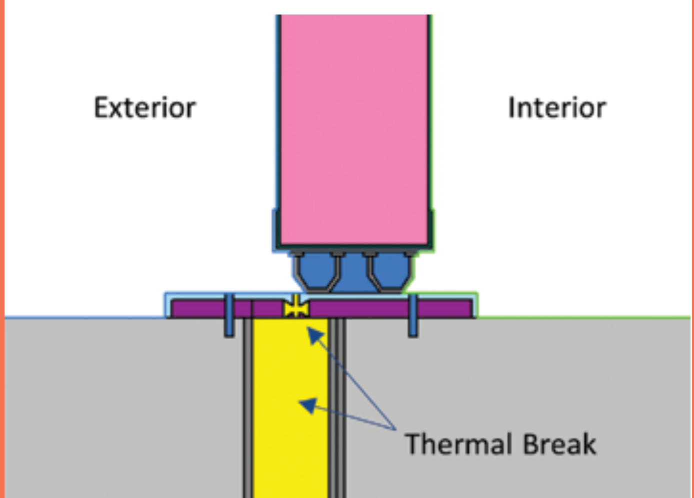


Figure 7.

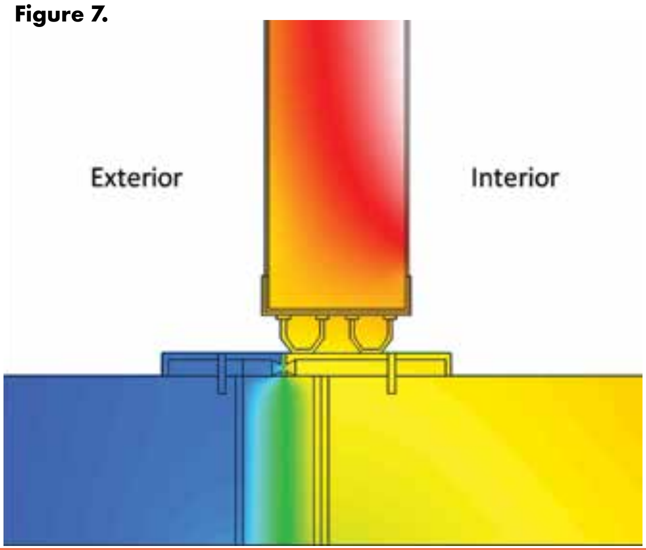


Table 1. OVERHEAD DOOR PSI-INSTALL (W/mK)

Sill	Head	Jambs
0.344	0.185	0.185

the interior side of the wall to permit gliding upwards. This placement is not thermally optimal. However, insulation, weatherstripping, and a thermal break material are being installed at the exterior side of the sliding door to decrease the thermal bridge at this location (see Figures 8 and 9). Similar to the head, the jamb of the overhead door also relies on a thermal break and a weather seal at the location between the wall and overhead door to decrease thermal bridging. The resultant thermal bridging values (Psi-install) based on the modeling of the details at the sill, head, and jambs of the overhead door are shown in Table 1.

Although none of the door perimeters were able to achieve the Passive House recommended maximum of 0.04 W/mK, accounting for them ensured that other design decisions could be made to mitigate their impact on the building's overall performance.

One location, however, that was able to achieve excellent thermal bridging values was the installation of the windows within the garage doors. Due to pre-fabrication, the detail at these areas is optimally designed and consistent, with little margin for error in installation. As a result, the window installation Psi-value was able to be minimized to 0.01 W/mK.

AIRTIGHTNESS

One of the difficulties of using local products in Passive House buildings in general is the disconnect between the testing standards that have to be met for local fabrication and for PHPP input. In this case, the garage doors were tested for airtightness by a third-party testing company to ASTM E-283 "Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors". The results of this testing were 0.061 cfm/ft^2 at 27.7 Pa and 0.127 cfm/ft^2 at 75 Pa.

To generate a conservative estimate of the effect of the doors on the overall airtightness of the garage, the leakage rate at 75 Pa was used. Based on the size and number of doors planned, the total leakage was calculated as approximately 230 cfm, which equates to roughly 25% of the total leakage allowed for the garage to achieve the PH requirement of 0.6 ACH_{50}. This informed the airtightness allowance for the remaining sections of the building envelope, as they could now meet a maximum of 0.45 ACH_{50}.

The major component in these overhead doors providing adequate airtightness is the seal at the base, which is a double U-shaped, flexible PVC weather seal. The double seal provides a layer of protection, both thermally and from air leakage, while the flexible material allows for compression, which allows for more

Figure 8.

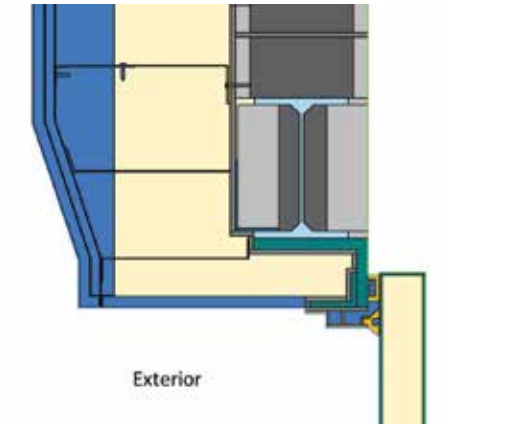
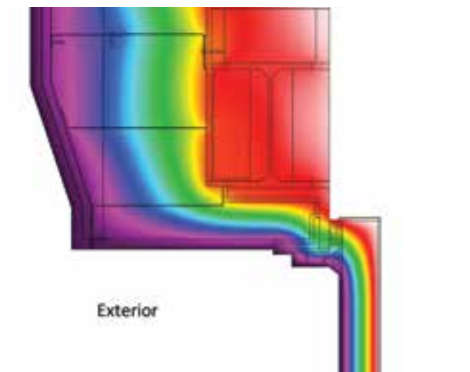


Figure 9.



Figures courtesy of IBI Group (top left) and Pretium Engineering, Inc. (middle and bottom left and above)

sealing while maintaining durability. The remaining perimeter of the doors has a 3-lip flexible PVC weather seal, allowing also for sufficient compression to prevent air flow and increase thermal resistance.

SUMMARY

In summary, garages, when they are a part of the thermal envelope, pose a unique challenge to Passive House certification, mostly due to the need for overhead garage doors. Although there are limitations to how the negative impact of garage doors can be mitigated, there are multiple models, calculations, and estimates that can be used to understand how the doors impact the building envelope. As a result, design decisions for the remainder of the garage can be made with these impacts in mind, allowing the garage, and building, to successfully achieve Passive House certification. Our hope is that the lessons learned from the design of the garage space in this case study will better enable Passive House designers in applying PH standards and principles to industrial space types.

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