RESEARCH HIGHLIGHT

Technical Series 00-119

Measured Pressure Equalized Performance of an Exterior Insulation Finish System (EIFS) Specimen

INTRODUCTION

A literature review conducted by the National Research Council of Canada in 1992 to determine design guidelines for pressure equalized rainscreen (PER) walls concluded that current guidelines were not comprehensive. As a result, a research and development project was initiated to generate design guidelines for PER walls. The project has three tasks, namely, computer modelling, experimental evaluation, and development of design guidelines. CMHC is jointly sponsoring the experimental evaluation task of the project with the Institute for Research in Construction (IRC). In addition, several wall system manufacturers are supplying test specimens and providing technical and practical information.

This Highlight summarizes the results of the sixth experiment - evaluation of a developmental exterior insulation finish system supplied by Sto Industries Canada Inc. Other experiments are summarized in Research Highlights 00-100, 00-101 and 00-102.

RESEARCH PROGRAM

Two specimens, each 2.43 m high by 1.12 m wide, (Figure 1) were installed side by side in a steel test frame which was mounted and sealed to IRC's Dynamic Wall Test Facility. The structural support for the EIFS specimens was provided by 16 ga and 18 ga, 89 mm steel studs. Lateral support was provided by 18 ga, 19 mm strapping that connected opposite corners of the test specimen. All the steelwork was welded together.

The steel stud frame was covered with 13 mm gypsum sheathing faced with glass fibre reinforcing. One coat of Sto Flexyl was applied by trowel to the exterior side of the sheathing and a reinforcing mesh was trowelled into the wet Flexyl. This material is used as a combination air and weather barrier. The insulation (Roxol Lamella) measured 63 mm by 152 mm by 2,440 mm, with a density of approximately 120 kg/m^3. It was applied vertically to the sheathing, using vertical ribbons of BTS-NC adhesive, such that there were

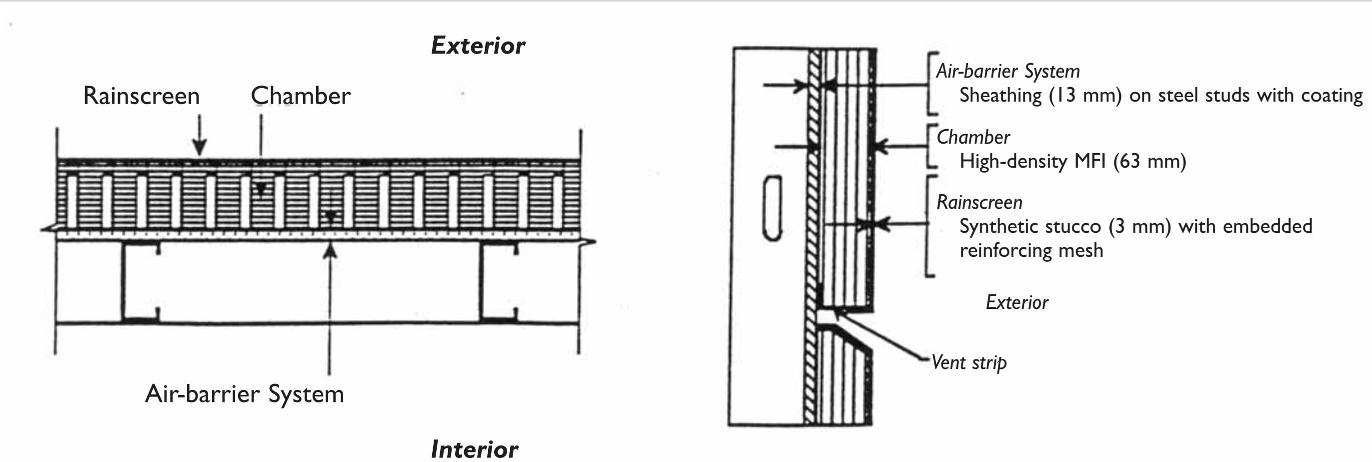

Figure 1 Test specimen horizontal and vertical section details

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12 mm gaps running the full height of one sample at 100 mm on centre and 6 mm gaps on the other. The two samples differed only with respect to the dimensions of the vertical gaps. The gaps were closed with field cut wedges of the insulation. One coat of BTS-NC Base Coat was applied directly onto the insulation and wrapped onto the perimeter of the steel frame. Standard Sto reinforcing mesh was embedded into the wet BTS-NC Base Coat and an additional coat was applied to ensure that the mesh was fully embedded. After the assembly was allowed to dry, Sto Silco Lit Finish was applied directly over the primer using a trowel. The specimens were allowed to cure for 30 days before the testing.

The test specimens had identical vent details, but different cross sections. The pressure-equalizing cavity was 1.178 m wide by 2.274 m high. Vents in both specimens were located at the same vertical height and had a vent area of 0.0294 m^2. The systems were evaluated for air leakage characteristics, pressure equalization response, and water penetration.

Air Leakage Characteristics

Air leakage through the assemblies was measured at static pressure differences ranging up to 1,000 Pa. Extraneous leakage and specimen perimeter leakage were first determined to allow the leakage through the specimen to be calculated.

Pressure Equalization Response

The pressure equalization response of the system was measured by subjecting the wall to sinusoidal pressure loadings, with varying frequencies and amplitudes. The leakage in the air barrier was also varied by opening up to three intentional 6 mm diameter leakage holes in the air barrier. Pressure taps were strategically located to record pressure differences across the air barrier at five locations over the height of the specimen and at four locations across the width of the specimen. Some pressure taps were located in the centre of the insulation and in the vertical channels. The pressure difference across the rainscreen was calculated by subtracting the pressure measured across the air barrier from the pressure across the wall.

Water Penetration

Water penetration was measured under both static and dynamic pressure, with and without an intentional defect in the rainscreen (measuring 500 mm long, 1 mm high and 3 mm deep, located 300 mm from the top), with and without the vents open, and with and without defects in the air barrier. Water was applied to the wall at a rate of 4.2 L/min/m^2 for a period of 60 minutes and any water that penetrated the wall was collected and recorded. In addition, a series of moisture pins were installed through the air barrier system to approximately the mid-depth of the insulation.

RESULTS

Air Leakage

The specimen air leakage was found to be significantly less than 0.10 L/s/m^2 at a 75 Pa pressure difference, which is the maximum flow rate recommended for air barrier assemblies by the Technical Guide for Air Barrier Systems published by the Canadian Construction Materials Centre.

Pressure Equalization Response

Pressure equalization response refers to how well the cavity pressure matches the pressure applied to the wall, in terms of both magnitude and time lag. The pressure equalization response was found to improve as the air leakage across the air barrier decreased. The pressure difference across the rainscreen was found to vary along the height of the specimen. In general, the further from the vent location, the greater the pressure difference across the rainscreen, likely due to the resistance to air flow in the channels. The effect becomes amplified as both the air leakage and the test frequency increases. The test specimen with the 12 mm vertical channels performed better than the specimen with the 6 mm vertical channels. The pressure across the rainscreen did not vary significantly across the width of the specimens.

As the frequency increased, the pressure equalization response became worse. It was found that without adequate dynamic pressure equalization response, a significant difference could be imposed on the rainscreen as the frequency increases. Further, above 2 Hz, the 12 mm vertical channels exhibited resonance behaviour.

Water Penetration

Under static conditions, the amount of water that passed through the system increased as the pressure across the specimen increased. With no pressure difference across either specimen, the amount of water through the system with the defective rainscreen was slightly greater than for the non-defective specimen. At higher pressures, the rate of water penetration increased for both the defective and the non-defective specimens. However, at 500 Pa, the water penetration rate was approximately 0.10 L/min greater for the defective specimen than for the non-defective specimen, leading to the conclusion that the majority of water collected during the water penetration tests came through the lamina or around the perimeter seal. The penetrating water was collected at the vent location, as expected, and no water penetration occurred inbound of the air barrier.

The amount of water entering both specimens was significantly lower when the vent area was open and the system was acting like a pressure-equalized system. When the air barrier was compromised, the rate of water penetration was significantly increased for both specimens.

The moisture pins did not indicate any moisture. However, as moisture pins are a point method of measurement, moisture may not always be detected using this measurement approach. In addition, the mineral insulation is hydrophobic and resists water penetration up to 1 kPa pressure. Moisture pins in the insulation would not have detected water.

Post Test Inspection

The panels were returned to Sto for inspection upon conclusion of the testing. Sto reported that no visible cracks were present and there was no apparent penetration point in the panel face. In addition, it was discovered that some of the lamella wedges used to close the surface gaps in the insulation had collapsed. In these areas the gaps were partially or completely closed with the mineral wool wedge and base coat material. This would have adversely affected the PER performance. Current design for the Sto Plus 1 RS system require that the notches be routed into the middle of the vertical edge of the insulation to avoid this.

IMPLICATIONS FOR THE HOUSING INDUSTRY

A wall designed to PER principles is better able to resist rain penetration, as demonstrated in this work. However, as the pressure equalization response is poorer further from the vent locations, the location and spacing of the vent locations must be carefully considered in the design of the wall. The results showed that flaws in both the air barrier and the rain screen could significantly impact the amount of rain penetration. These results suggest that guidelines should be determined for the optimum spacing of vents and joints in the EIFS wall. Further, when these results are compared to the results of other EIFS wall designs, it is clear that not all EIFS walls perform in a similar fashion. The development of guidelines should take this factor into consideration.

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Housing Research at CMHC

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