RESEARCH HIGHLIGHTS

Technical Series Issue 00-101

MEASURED PRESSURE-EQUALIZED PERFORMANCE OF A BRICK VENEER/STEEL STUD ASSEMBLY

Introduction

A literature review conducted by the National Research Council in 1992 to determine design guidelines for pressure-equalized rainscreen (PER) walls concluded that current guidelines were not comprehensive. As a consequence, 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 experimental evaluation of a brick veneer steel stud (BVSS) test specimen.

Research Program

The specimen, 2.44 m high by 2.44 m wide (Figure 1), was installed in a steel test frame which was mounted and sealed to IRC's Dynamic Wall Test Facility with the air barrier facing the laboratory. The system was evaluated for air leakage characteristics, pressure equalization response, deflection and water penetration. Previous research has shown that in the field the gypsum sheathing can be very leaky; so, intentional holes were cut in the gypsum to ensure that it offered little resistance to air flow and that the plywood acted as the air barrier.

Air Leakage Characteristics

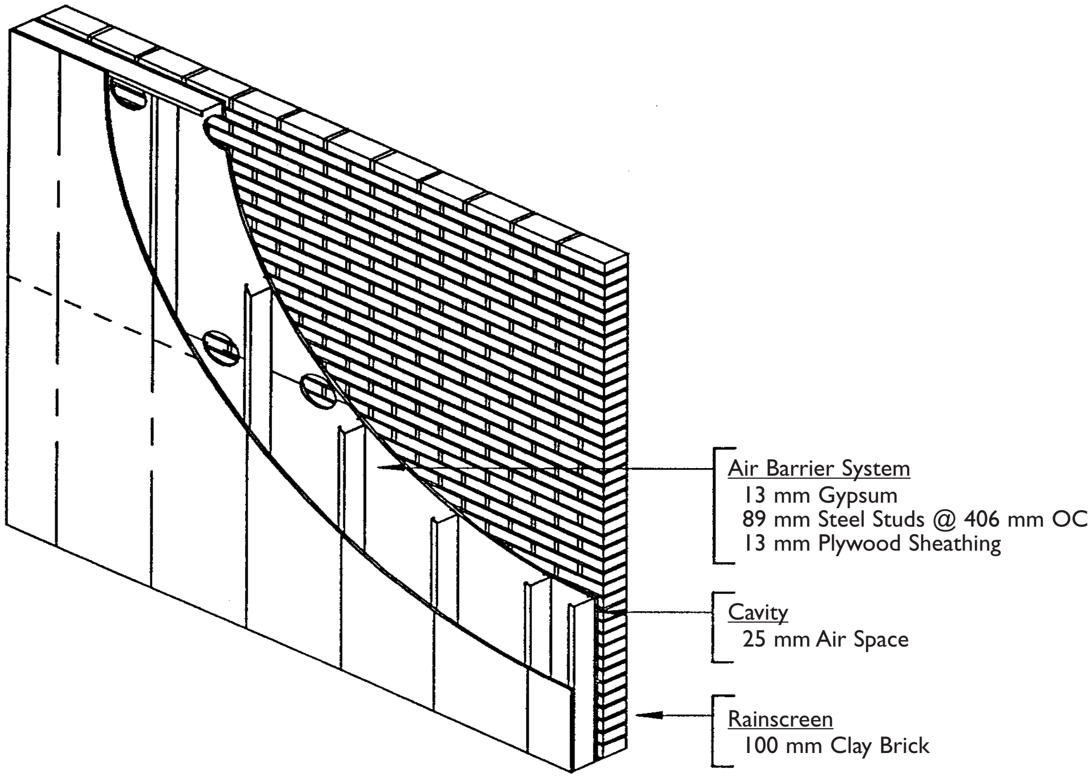
Air leakage through the assembly was measured at static pressure differences ranging up to 1 000 Pa. Extraneous leakage and specimen perimeter leakage were first determined. The effect of a defect in the air barrier was then examined by intentionally opening two, four and six 6-mm leakage holes in the air barrier, 100 mm apart and 70 mm from the top.

CMHC SCHL

HOME TO CANADIANS

Canada

Figure 1: Details of Construction of the Brick Veneer/Steel Stud Test Specimen



Pressure Equalization Response

The pressure equalization response of the system was measured by subjecting the wall to sinusoidal pressure loadings, with varying frequencies (0.05 Hz to 5 Hz) and amplitudes (500 and 1 000 Pa). The leakage in the air barrier was also varied by opening none, two, four and six of the leakage holes. The vent area was also varied. Pressure taps were strategically located to record pressure differences across the air barrier. The pressure difference across the rainscreen was calculated by subtracting the pressure measured across the air barrier from the pressure across the wall.

Deflection

Deflections were measured at the centre and outer edge of the air barrier at mid-height, and at the top centre of the rainscreen. Deflections were measured with zero and six leakage holes, four vent holes, and for a sinusoidal loading with an amplitude of 1 000 Pa, roughly equivalent to a 150 km/h wind or 100 kg/m^2, and frequencies of 0.5 Hz and 1.0 Hz.

Water Penetration

Water penetration through the wall was measured under both static and dynamic pressure, with and without leakage openings in the air barrier, and with and without the vents open. In essence, tests were conducted to simulate a face-sealed wall (with a leaky air barrier), a cavity wall (i.e., one with an airtight air barrier to achieve static pressure equalization but insufficient venting for dynamic pressure equalization response) and a pressure-equalized system. Water was applied to the wall at a rate of 3.42 L/min/m^2 and any water that penetrated the wall was collected and recorded.

Results

Air Leakage

The specimen perimeter leakage was found to be less than 10 per cent of that measured through the leakage holes. The leakage created by two leakage holes was approximately equal to 0.1 L/s/m^2, which is the maximum flow rate recommended for air barriers 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 be unaffected by the airtightness of the air barrier system, suggesting that the governing criteria for air leakage with respect to rain penetration control may be that required for static pressure equalization rather than that required for dynamic pressure equalization. The pressure difference across the rainscreen did not change significantly with the height or width of the specimen.

Pressure equalization response became worse as the frequency increased and a significant pressure difference was imposed on the rainscreen. It was also shown that the dynamic pressure equalization response of the specimen was directly related to the cavity volume-to-vent ratio. A volume-to-vent ratio of approximately 100 m was provided with eight vent holes; however, at 5 Hz, the pressure equalization response was not adequate. This result suggests that a maximum volume-to-vent ratio of about 50 m (i.e., a smaller cavity or more vent openings) might have to be considered for adequate dynamic response of brick veneer steel stud systems.

Deflection

Deflections of the air barrier may adversely affect the pressure equalization response of the cavity, while deflections of the rainscreen may improve the pressure equalization response. The composite action of the air barrier and the rainscreen, given that steel brick ties join them, made distinguishing between the two deflections difficult. However, it appeared that the air barrier was somewhat more flexible than the rainscreen, which may have a negative effect on the pressure equalization response of the wall.

Water Penetration

For the face-sealed system without an applied pressure difference, the water penetrating the wall was small, but for a pressure difference of 500 Pa, equivalent to a 75 km/h wind or 50 kg/m^2, the leakage through the rainscreen was 0.44 L/min/m^2. Under dynamic conditions, the penetration of the face-sealed wall dropped to about one-third of that at a static pressure of 500 Pa. A similar amount of penetration occurred for the cavity wall configuration. Under dynamic conditions, the pressure equalized wall experienced water penetration approximately equal to that which was experienced with no pressure difference, or about half of that of the face-sealed and cavity walls.

Implications for the Housing Industry

A wall designed to pressure-equalized rainscreen principles is better able to resist rain penetration, as demonstrated in this experimental work. For best results for BVSS walls, the air barrier must be sufficiently airtight to achieve static pressure equalization and there must be sufficient venting to achieve dynamic pressure equalization. Similar results were obtained from research conducted on other wall systems. For the BVSS wall system, however, the air barrier is more flexible than the rainscreen, having a negative effect on pressure equalization response.

CMHC Project Manager: Jacques Rousseau

Research Report: Determination of Water Vapour Diffusion Across Brick Masonry Treated With Water Repellent Sealers, 2000

Research Consultant: Armand Patenaude, Patenaude Consultants Inc.

A full report on this project is available from the Canadian Housing Information Centre at the address below.

Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

This **Research Highlights** fact sheet is one of a wide variety of housing-related publications produced by CMHC.

For a complete list of **Research Highlights**, or for more information on CMHC housing research and information, please contact:

The Canadian Housing Information Centre
Canada Mortgage and Housing Corporation
700 Montreal Road
Ottawa, ON K1A 0P7

Telephone: 1 800 668-2642
FAX: 1 800 245-9274

OUR WEB SITE ADDRESS: www.cmhc-schl.gc.ca/Research