Research & Development Highlights

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The Development of Test Procedures for Masonry Wall Air Barriers

Introduction

The National Building Code of Canada requires the use of "an effective air barrier" in exterior walls. Concrete blocks alone are not an effective air barrier. Construction details such as mortar and expansion joints, steel beams, and component interfaces also affect the air permeance of the masonry wall.

Recently, a number of air barrier systems have been developed for masonry applications. These systems are designed to significantly reduce the air leakage through masonry walls.

Unfortunately, there are currently no formal performance criteria, standards or test methods to qualify or evaluate these products. There is clearly a need to develop a standard procedure to evaluate the performance of the "as installed" air barrier system.

Test Program

The objectives of this project were to:

- establish performance criteria and test procedures to evaluate masonry air barrier systems with respect to air leakage and structural performance;
- assess the proposed evaluation process by using it to test a number of commercial air barrier systems; and
- recommend a prescriptive evaluation for masonry air barrier materials based on available test results provided by manufacturers and a review of current methods identified as applicable for air barrier components.

Eighteen air barrier systems were evaluated according to the following criteria.

Initial Air Leakage: Air leakage of each membrane was determined over a range of pressure differentials. Each air barrier was classified according to the levels proposed by the National Research Council of Canada.

Membrane Adhesion Under Gust Wind Load: Evaluation of delamination, deformation, or permanent damage when the membrane was subjected to a -3000 Pa pressure differential for 10 seconds. After the evaluation, the membrane's air leakage characteristics were re-checked and, where applicable, the percentage of membrane delaminated from the block substrate was calculated. Failure was deemed evident if air leakage at *75* Pa was greater than 0.15 14s/m2 or delamination was greater than *15%* of area.

Membrane Adhesion Under Sustained Wind Load: Evaluation of delamination, deformation and permanent damage to the membrane after undergoing a static pressure differential of 1000 Pa for one hour. Criteria for failure were the same as in the preceding test.

Membrane Under Stack Effect (Creep) Load: Creep, the progressive deformation of a material under a constant stress, was evaluated on membrane samples designed to bridge gaps on masonry construction by the application of a constant negative pressure differential of *250* Pa for 24 hours.

Membrane Uniformity: The thickness of each membrane was measured at a number of points to provide an indication of the variability and overall thickness of the membranes.

Prescriptive Data: A list of the prescriptive test data for each product supplied by manufacturers participating in the program was compiled. This list was used as an indicator of the type of prescriptive data available for air barriers, the variability of the type of data and the suitability of the information with respect to the use of the product.

Four torch-applied, four adhesive-applied, four trowel-applied, two mechanically fastened, and three spray-applied air barrier membranes were evaluated. Each sample membrane was applied to a plain block wall and to a block wall with brick ties. The torch- and adhesive-applied membranes were also applied to a block wall with a 50 x 910 mm gap to simulate bridging.

Test Results

The results of the testing show that the air leakage of the membranes was extremely low over the range of pressure differentials used. For the majority of the samples tested, the air leakage rates at a *75* Pa pressure differential were

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far lower than the proposed 0.05 *LIsfm2* maximum for Type III airbarriers.

The inclusion of brick ties had an effect on air leakage for all of themembranes evaluated (except the mechanically fastened and spray-on polyurethane systems). Air leakage rates were higher for most of the brick tie walls than for the plainwall substrates.

Membranes were,for the most part, unaffected by the gust load tests. Only one membrane failed to meet the Type III requirements with the remaining barriers showing no change, a marginal increase, or a decrease in measured air leakage rate.

The majority of walls were also unaffected by the sustained wind load test. One membrane failed to meet the air leakage requirements with the remaining barriers showing no change, a marginal increase, or a decrease in measured air leakage rate.

Both the gust and sustained wind load conditions selected were sufficient to demonstrate the effects of wind loading. In gust load testing, several of the membranes tested showed some evidence of delamination, ranging between 0.5% and *7.5%,* with an additional three of the membranes showing appreciable delamination *(15%).*

The results of the sustained wind load testing were much more dramatic than the gust load evaluation results. In this test, more than half of the membranes showed some evidence of delamination. Of these membranes, most showed delamination ranging between *0.5%* to 8% while a few failed the test with delamination ranging between 27%and60%.

The membrane creep load evaluation showed that none of the membranes tested were affected by the conditions employed. No evidence of permanent deformation, damage or delamination was observed.

The membrane uniformity assessment revealed that only one membrane was within the specified tolerance. Of the remaining membranes, 11 were above and four were below the thickness specified in the manufacturer's product literature.

The examination of the prescriptive data provided by the manufacturers was considered to be a cursory overview and requires further analysis.

Conclusions and Recommendations

The method employed for the evaluation for the determination of air leakage for masonry air barriers (ASTM E 283 *Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors)* was considered acceptable.

In the absence of an alternative means of classifying air barrier leakage, the Type 1,11 and III classification system proposed by the National Research Council of Canada was considered an appropriate means of rating masonry air barriers for air leakage.

ASTM E 330 *(Standard Test Method for Structural Peiformance of Exterior Windows, Curtain Walls and Doors by Uniform Static Pressure Difference)* was deemed an appropriate method to evaluate the structural and adhesive properties of the membranes under gust, sustained and stack load conditions.

The gust and sustained wind load conditions employed for the evaluation provided adequate means of assessing the comparative performance of masonry air barriers. To more adequately address actual field performance, further consideration should be given to the wind load levels.

The stack effect load conditions require further analysis to determine the suitability of the load period. Based on the results of this evaluation, the stack effect tests did not appear to affect the performance of masonry air barriers.

The review of the prescriptive data provided by the membrane manufacturers indicates an unacceptable degree of variability in information that exists in the industry. Further work is required to assess the applicability of the procedures listed.

There is a consensus that a performance standard for air barriers needs **to** be developed. This standard should include both performance and prescriptive requirements for masonry air barriers and could be written using the research information provided by this report.

We hope that the data produced in this report will be reviewed by a representative cross-section of the industry to assess its usefulness and identify areas of future work.

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Research Report: The Development of Test Procedures and Methods to Evaluate Air Barrier Membranes for Masonry Walls

Research Consultant: Building Performance Centre, Ortech International

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

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