

## Water Penetration Testing of an Adhered Masonry Veneer Wall Assembly Installed Over Rainscreen Systems

### INTRODUCTION

This investigation explored the effect of simulated wind-driven rain conditions on several wall assemblies related to adhered masonry veneer cladding installed over a rainscreen system. For the purposes of this study a rainscreen is defined as: a construction technique or rainscreen product that creates a capillary break/air space between the cladding and the primary water resistive barrier. The assemblies tested the “field of the wall”. The parameters investigated were water-resistive barrier (WRB) of #15 felt combined with commercially available rainscreen systems.

The testing protocol was to evaluate wall assembly performance with WRB, five different rainscreen systems, lath, and a mortar scratch coat layer. The intent was to show that the addition of a rainscreen system does not negatively affect test results, and compare the results to similar testing by MVMA without the rainscreen systems incorporated into the wall assembly. The testing ultimately demonstrated the combination of WRB, rainscreen, lath, & scratch coat was effective at preventing water penetration.

### EXPERIMENTAL APPROACH

A common, laboratory-based test for building envelope water penetration is ASTM E 331 – *Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*. This test involves the placement of a pressurized, wetted condition on the exterior side of the wall assembly, which simulates wind-driven rain, and the observation of water penetration on the interior side of the wall assembly (i.e., the sheathing-framing interface).

The pressure differential, water flow rate, test duration, and wall assemblies were derived from the 2006 International Residential Code, Section R703.1. It specifies that a wall assembly must pass ASTM E 331 at a pressure of 6.24 lb/ft<sup>2</sup> for a 2-hour duration. ASTM E 331 requires a minimum water flow rate of 5 gal/ft<sup>2</sup>-hr. The pressure differential of 6.24 lb/ft<sup>2</sup> is equivalent to a 50 mph wind, and the water flow rate of 5 gal/ft<sup>2</sup>-hr is equivalent to 8 inches of rain per hour, which creates a continuous film of water on the surface.

### WALL CONSTRUCTION

**Framing & Sheathing** – Each wall assembly was 4' wide by 8' high and constructed from 2x4 wood framing spaced 16" on center (Fig. 1). The framing was sheathed with four pieces of APA-rated 7/16" oriented-strand board (OSB) – two were 32" by 48" and two were 16" by 48". These sheathing sections were secured to the wood studs in a staggered pattern with an 1/8" gap between the sheets to simulate a typical offset stacked joint (Fig. 1).

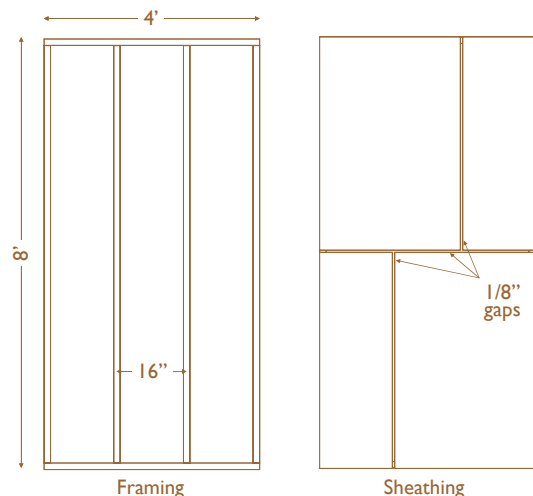


Fig. 1 – Framing & sheathing configurations.

**WRB** – In all 5 samples the water resistive barrier was a layer of #15 felt (ASTM D 226, Type I) with a vertical seam located in the center of the wall for one of the courses, and the felt lapped 6” at this seam. All other courses of felt were continuous across the width lapped 2” at horizontal joints. The fastener type was a staple with 3/8” crown (T50) and 3/8” length and spaced 16” on center both horizontally and vertically. A second layer of WRB was installed either in contact with the first layer of WRB or on the exterior side of the rainscreen system.

**Rainscreen systems-** A construction industry review of the current methods and products for creating a rainscreen system identified 5 general categories. This

study evaluated one product or method to represent each category. A description of the 5 systems tested is as follows.

- **Wood Strapping-** Nominal 1" x 2" treated wood strapping ( $\frac{3}{4}$ " x 1 $\frac{1}{2}$ ") fastened in a vertical position every 8" on center with 8 penny galvanized nails every 12". The second WRB layer of #15 felt was installed over the wood strapping as a mortar block.
- **Polymer entangled mesh drainage mat-**  $\frac{1}{4}$ " thick mat fastened with a staple of  $\frac{3}{8}$ " crown (T50) and  $\frac{3}{8}$ " length and spaced 12" on center horizontally at framing locations and 6" at the perimeter. The second WRB layer of #15 felt was installed in contact with the primary WRB.
- **Dual cavity drainage and ventilation mat (3-D structured polymer, non-perforated)-**  $\frac{5}{16}$ " thick mat fastened with 1  $\frac{1}{4}$ " roofing nails spaced 16" on center into framing in both horizontal and vertical direction. The second WRB layer of #15 felt was installed on the exterior side of the mat as a mortar block.
- **Perforated, channel formed polymer sheet drainage mat-**  $\frac{3}{16}$ " thick mat fastened with a staple of  $\frac{3}{8}$ " crown (T50) and  $\frac{3}{8}$ " length and spaced 12" on center on framing and 6" on center at the perimeter. The second WRB layer of #15 felt was installed in contact with the primary WRB.
- **Formed expanded polystyrene (XPS) drainage mat-**  $\frac{1}{4}$ " thick mat, fastened with 1" plastic-cap nails  $\frac{1}{4}$ " length into framing 16" on center in both horizontal and vertical direction. The second WRB layer of #15 felt was installed on the exterior side of the mat as a mortar block.

**Lath** – Galvanized, self-furred, expanded metal lath (2.5-lb.) was installed over the WRB and rainscreen systems using 16-gauge staples with 1" crowns and 2" length. Lath fastening horizontally was 16" on center into framing and 8" on center between framing. Fasteners were spaced 6" on center vertically.

**Scratch Coat** –Premixed Type S mortar was installed at a nominal thickness of  $\frac{1}{2}$ -inch and allowed to cure for a minimum of 28 days prior to water penetration testing.

**Wall Sill** (foundation termination) – The bottom edge of the wall was terminated with a foundation weep screed (No. 7), and the WRB was lapped over the weep screed flange (see Fig. 2). Sealant, tape, or self-adhered flashing (SAF) was not used at the interface of the weep screed with the sheathing or at the interface of the WRB

with the weep screed. The rainscreen system terminated at the weep screed and a weeped metal casing bead or other weeped trim channel was installed at the bottom of the rainscreen system (Fig. 3).



Fig. 2 – Wall sill detail



Fig. 3 – Weeped casing bead detail.

## RESULTS

The test details and results are summarized in Table I.

### **WRB (#15 felt) + Wood Strapping +WRB (#15 felt) + Lath + Scratch Coat**

Test Result: No water was observed on the interior of any of the test wall assembly for the 2-hour test duration.

### **WRB (#15 felt) +WRB (#15 felt) + Polymer Entangled Mesh Drainage Mat + Lath + Scratch Coat**

Test Result: No water was observed on the interior of any of the test wall assembly for the 2-hour test duration.

### **WRB (#15 felt) + Non-Perforated, Dimple Formed Polymer Sheet Drainage Mat +WRB (#15 felt) + Lath + Scratch Coat**

Test Result: No water was observed on the interior of any of the test wall assembly for the 2-hour test duration.

### **WRB (#15 felt) +WRB (#15 felt) + Perforated, Channel Formed Polymer Sheet Drainage Mat + Lath + Scratch Coat**

Test Result: No water was observed on the interior of any of the test wall assembly for the 2-hour test duration.

### **WRB (#15 felt) + Formed XPS drainage mat +WRB (#15 felt) + Lath + Scratch Coat**

Test Result: No water was observed on the interior of any of the test wall assembly for the 2-hour test duration.

## CONCLUSIONS

The results of this study compliments previous testing completed by MVMA covering a range of WRB combinations, lath fastening schedules, penetrations and terminations. This study shows that these wall assemblies

related to adhered veneer installation which incorporate rainscreen systems meet the pass criteria of ASTM E 331. This testing was conducted by Architectural Testing, Incorporated and can be referenced from their report numbers shown in Table I.

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**Table I – Summary of water penetration testing.**

**Test Method:** ASTM E 331-00 - *Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.*

**Test Conditions:** pressure difference: 6.24 lb/ft<sup>2</sup>  
 water flow rate: 5.0 U.S. gal/ft<sup>2</sup> · h  
 duration: 2 hours

Report Number	Description of Wall Assembly				Test Result
	Rainscreen	WRB Combinations	Lath Fasteners	Mortar Block	
85958.04-201-44	1x2 nominal (3/4" x 1 1/2") Wood Strapping	No. 15 Felt	into framing and between framing	No. 15 Felt	Pass
85958.02-201-44	Polymer Entangled Mesh Drainage Mat	No. 15 Felt + No. 15 Felt	into framing and between framing	Included on rainscreen product	Pass
85958.03-201-44	Non-Perforated, Dimple Formed Polymer Sheet Drainage Mat	No. 15 Felt	into framing and between framing	No. 15 Felt	Pass
85958.05-201-44	Perforated, Channel Formed Polymer Sheet Drainage Mat	No. 15 Felt + No. 15 Felt	into framing and between framing	Included on rainscreen product	Pass
85958.01-201-44	Formed XPS drainage mat	No. 15 Felt	into framing and between framing	No. 15 Felt	Pass