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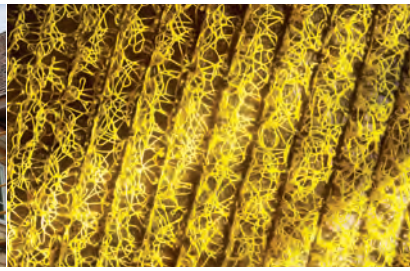
Managing Moisture in Low-Rise Building Enclosures

A Prescriptive Guide for Building Professionals on Proper Moisture Management Solutions.



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INTRODUCTION

Increasingly, builders, contractors and architects face the need to incorporate good moisture management solutions when designing and building structures to ward off problems such as mold and mildew damage and to help increase energy efficiency as heating and cooling costs escalate.

The compelling need for moisture management solutions across the walls of a structure are also driven by a series of other important factors, including:

- Averting the potential for callbacks, remediation and/or litigation costs when mold or structural damage occurs due to improper moisture management
- Managing moisture infiltration – especially in key coastal regions where experts predict more intense weather in future years;
- Preserving the life of exterior cladding, so that it dries optimally both on the inside and the outside of the cladding;
- Complying with growing federal requirements such as the International Residential Code (IRC) and the International Building Code (IBC), which requires a means of draining water that enters the assembly to the exterior. Some states in the US have added prescriptive measures to this language or are considering making their own modifications since the IRC does not describe how to achieve drainage. In Canada, since 2005 the National Building Code has required the use of "....a drained and vented air space not less than 10mm deep behind the cladding over the full height of the wall..." in areas that exceed a certain annual rainfall threshold. Coastal provinces have already adopted this provision while many of the inland provinces are actively considering it.

CONFUSION ABOUNDS

While the need for such solutions is clear, confusion abounds when it comes to how to select the right solution for each job. The starting point for clearing up the confusion lies in the terminology itself. Product names such as housewraps, building paper, and water resistive barriers are frequently used interchangeably, when in fact they can play distinctly different roles.

To add to the confusion, products such as housewraps and building papers are available in dozens of varieties, making it very difficult to choose the right product for each job. This is further complicated by the fact that there are currently no standards-based methods to compare the different types of moisture management solutions. The International Residential Code mandates the use of water resistive barriers. While most local building codes incorporate IRC guidelines, varying regional practices have led to widespread builder interpretation of the need for such solutions. At the same time, building experts continue to add to the existing body of knowledge in what is a relatively young science, with few existing absolutes.

One thing on which manufacturers, builders, contractors, architects and others concerned with building science can agree, however, is that no one solution is right for every climate. In fact, the building's location and its exterior cladding(s) are central to the decision on which building envelope solution is employed.

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So how do builders, contractors, architects and others make sense of the bewildering choice of moisture management solutions available today for walls in low-rise construction? And, more importantly, how can they understand when and where to use each solution?

Benjamin Obdyke, a leading provider of building products, commissioned independent research to help demystify the water resistive barrier and rainscreen system categories and provide basic guidelines to assist in determining when, where and how to make the best selections for each job. The study concludes that the biggest determinants are the amounts of rainfall and wind-driven rain to which the structure will be subjected and the choice of siding because each type of cladding responds differently to moisture. Naturally, project budgets and timetables also are key factors. Moreover, the study indicates that more data will be forthcoming as building science continues to add to the existing body of knowledge in this area.

WATER RESISTIVE BARRIERS

Water resistive barriers are part of a building's exterior wall system, designed to prevent air and water from entering the stud wall cavity from the outside. They also allow the free passage of water vapor to the outside of the building so that the framing and wall cavity can dry, reducing the threat of mold and rot. In effect, they perform like a shell for buildings—liquid water that has penetrated the exterior finish does not pass through, yet water vapor from the interior can escape. By keeping building materials dry, a water resistive barrier helps improve building durability, decreases maintenance costs and reduces the risk of moisture-related problems.

In addition, when installed as an air barrier that prevents hot and cold air movement through the wall cavity, water resistive barriers also help reduce utility costs and increase comfort by reducing air infiltration and potential drafts.

Water resistive barriers were originally referred to as weather resistant barriers, and today are called by a variety of other names such as WRBs or water resistant barriers; however, the preferred industry name seems to be water resistive barriers. There are three basic types of water resistive barriers on the market:

1. Building Papers and Felt

Building paper has been a staple for years. In fact, most building codes cite so-called Grade D Kraft building paper and/or #15 felt as a standard while allowing for substitutions of other equivalent materials. Building paper is a traditional paper sheet that is coated or impregnated with asphalt to increase its strength and resistance to water penetration. It's primarily used as a drainage barrier to protect against moisture. Grade D paper ratings are based on the amount of time it takes to wet their opposite side—the most common types are 10, 20, 30 and 60 minute, with the higher rating, the higher the moisture resistance.

The felt variety is made of recycled paper products, rag felts, and sawdust and is frequently used in roofing construction, although many builders and contractors also apply it as a water resistive barrier. Grade D Kraft building paper, made of virgin paper

fibers, is lighter weight and more breathable than most felt papers. Felt as a product has evolved over the years. While once designated by weight – the 15-pound variety weighed 15 pounds per square (100 square feet) – modern-day equivalents are differentiated by number, i.e., #15 or #30, but weigh only 7.5 -12.5 pounds (#15) or 16-27 pounds (#30) per square. Because they weigh less, they also are less absorbent than earlier varieties, which may explain why some older felt-wrapped homes have better withstood the ravages of moisture over time.

These products do have a couple of unique features. One is they tend to improve their performance on the passage of moisture vapor (or MVTR - moisture vapor transmission rate) when they become wet. In addition, they tend to wrinkle when they are wetted. When installed in two layers, like in stucco or adhered masonry veneer, this wrinkling can create drainage gaps between the two layers. Both felt and Grade D building paper tend to be less durable than engineered, plastic housewraps (see below). Some building papers are not readily available in all areas of the country – they are widely used in Western U.S. and other areas where stucco cladding is favored, but less so in the Eastern U.S. and Canada.

2. Housewrap

Housewraps originated in the 1980s to serve as air barriers, and later evolved into moisture barrier products. Today they are becoming increasingly popular for their durability and ability to block water that has penetrated behind the exterior cladding from moving further into the exterior wall assembly. Housewraps are engineered plastic sheet membranes of varying sizes (typically .005-to-0.015 inches thick) that are wrapped around a house or other low-rise construction. They are specifically meant to resist the movement of water in the liquid state while allowing the movement of water in the vapor state.

Housewraps are designed to block water from reaching the sheathing and framing while allowing the free passage of water vapor so that wall cavities and framing lumber can dry to the outside of the building, reducing the possibility of mold and rot. Acting similar to a GORE-TEX® jacket, housewraps are water resistant on the outside, but also allow water vapor to pass through the building envelope in case moisture problems arise.

It is worth noting that housewraps are not designed to channel the direction of water movement. Since housewraps don't allow the selective passage of water in one direction or the other, moisture will move only in response to concentration or thermal gradients. While they resist liquid moisture movement toward the sheathing and framing, by themselves they do not create a drainage space to purposefully channel water out of the wall structure. In addition, the passage of moisture vapor is two-directional. While helpful when allowing moisture vapor from inside the structure to exit, it can also allow moisture vapor to be driven into the wall, for instance when a wet stucco wall is hit by sunlight (solar drive).

Also, as moisture moves through wood and stucco, it extracts surfactants, including detergent, oil, resin, plasticizer and colorant. Because these additives greatly reduce the surface tension of water, a housewrap can eventually lose its repellency and allow water to soak through to underlying sheathing.[1] For wood siding, some manufacturers recommend priming the back of the siding with a water-repellent primer to help combat the problem.

3. Enhanced Housewraps

While water resistive barriers keep water off of structural sheathing and framing, water resistive barriers can deteriorate if they remain wet or in contact with certain chemicals for extended periods of time. To avoid rot, water must be permitted to drain away from the sheathing surface.

To solve this problem, beginning in the mid-1990s, builders in wetter and more humid climates began to employ a third type of water resistive barrier, commonly referred to as a "textured," "drainable," or "enhanced" housewrap. The drainable barrier is intended to offer all the features of a housewrap or building paper but with one important addition – a drainage space – all combined in a single product.

Drainable housewraps were developed by benchmarking the performance of felt paper in a stucco assembly mentioned earlier, where code dictates the use of two layers of building paper or housewrap. Builders noticed that the layer applied closest to the stucco "crinkled" as it dried, in effect creating grooves in the paper that optimized moisture drainage.

Today's drainable housewraps are designed to use this same principle to promote bulk water drainage in wall systems, channeling moisture to the outside through channels or "wrinkles" engineered into the housewrap sheet, and according to some manufacturers, treated with a special preparation to enhance drainability. Moreover, drainable housewraps are designed to maintain a more constant drain rate than basic water resistive barriers, despite repeated wetting and drying cycles experienced in extremely wet and/or humid climates.

RAINSCREENS

While drainable housewraps are designed to do a better job of draining bulk water than most housewraps or building papers, they may not solve the problem of drying moisture that remains behind cladding even in climates that receive low or average rainfall. Solar-driven, trapped moisture, seeking a drier plane, can seep into interior assemblies, leading to mold and structural damage.

In regions of the country prone to wind-driven rain, excessive amounts of rainfall, or high temperature and humidity, a more robust water management solution is often called for – a rainscreen wall system. Originally developed for use in masonry construction, the technology is based on the simple scientific fact that water will infiltrate all exterior cladding over time and therefore a more "forgiving" water management assembly must be deployed in wet climates.

A rainscreen is a technique for controlling rain entry in an exterior wall that involves locating a pressure-moderated air space immediately behind exterior cladding[2] in addition to employing a water resistive barrier. The 1/4-to-3/4-inch air space between the back of the cladding and the face of the water resistive barrier is designed to reduce the forces that draw water into the assembly. Water that does reach the back of the cladding is permitted to drain from the wall assembly via the space created by the rainscreen. At the same time, a rainscreen offers accelerated drying of moisture-laden air

(vapor) that accumulates in the interior wall assembly by moving air in a convective fashion throughout the cavity.

The laws of physics demand that the air space be at least 3/16-inch or 4.75 millimeters in depth to provide the necessary capillary break that will prevent water from bridging from the back of the cladding onto the water resistive barrier's drainage plane. Both the top and bottom of the cavity also should be ventilated to allow moisture to escape and increase the drying rate. Proper detailed flashings around all penetrations are also critical to the success of any moisture management system.

There are two ways to construct an air space as part of a rainscreen system. The traditional method incorporates nailing wood furring strips – also called strapping – over wall studs and sheathing after applying a building paper or housewrap. In recent years, building product manufacturers have developed "void space" products that achieve the same effect by using a three-dimensional plastic matrix to create a vented continuous rainscreen on a roll. Builders can choose from several different manufactured varieties – a plastic matrix that can be applied directly over a water resistant barrier or special bonded products that combine the plastic matrix with a water resistive barrier for a one-step installation.

The chief advantage of strapping is the savings in material costs – wood furring strips are much less expensive than manufactured rainscreen systems. In recent years, plastic furring strips have been developed and priced at a premium over traditional wood furring strips. However, installing these wood or plastic strips is labor-intensive and therefore strapping is ultimately more costly than using void space products. Other drawbacks of strapping include the creation of hot spots along stud locations and trapped moisture as a function of wood-to-wood contact, which can lead to reduced air movement and a greater potential for mold buildup. Because manufactured products are applied continuously, the entire surface area of the wall is protected from water infiltration and continuous air movement is optimized. The combination manufactured systems also are faster to install because they are a unified assembly, employing the rainscreen and WRB in one step.

SELECTING THE RIGHT PRODUCT FOR THE JOB

Because building science experts point to rain as the single most important factor to control in order to optimize durability, deciding which building envelope product to use must be predicated on climate conditions to which the building will be exposed. A wall assembly that is trouble-free in one area of the country may not perform adequately in another.[3]

Wind-driven rain is an especially powerful foe, forcing its way into small penetrations in cladding materials at joints, laps, settlement cracks, hose-bibs, vents, utility cut-outs, electrical outlets and nail holes. Wind can also blow rain horizontally into cracks and holes in the exterior wall. And wind blowing around a building can create a negative pressure within the wall assembly that literally siphons rainwater up and in to the assembly; "reservoir" style cladding such as stucco is particularly sensitive to this type of phenomenon. Wet wood in turn creates a food source for mold leading to potential health hazards. It is estimated that 90% of all mold cases are related to water leaking through exterior

finishes.[4] This moisture can also lead to structural damage to the sheathing and framing meaning costly repairs. The main rule, therefore, in selecting a moisture management strategy is that the amount of rain will determine the amount of rain control needed.

In areas like the Southwest that receive low rainfall (less than 20 inches annually), a housewrap or building paper should offer sufficient water resistance protection, according to most building experts. In areas that experience moderate amounts of rainfall (20 to 40 inches annually), protection against rain penetration should include an enhanced housewrap. And for wet and/or humid climates, coastal areas and hilltop exposures receiving high (40 to 60 inches annually) or extreme (60 inches or more annually) rainfall, a ventilated rainscreen assembly is recommended; a rainscreen system is also advised for areas that receive high winds in addition to rain. Rainscreen systems are recognized by leading building trade associations for their effectiveness in controlling rain water intrusion into wall assemblies in areas of high and extreme rainfall.[5]

Even in dry, less demanding climates, however, builders and designers seeking optimum drying and drainage capability may wish to install a rainscreen or drainable housewrap as added insurance against moisture problems. The cost of using these methods up front during construction is small in comparison to fixing moisture-related problems later. As always, budget and schedule will be key factors in builders' and architects' ultimate choices. Also, new product alternatives are starting to come on the market – for example, wraps that can be sprayed or painted on sheathing – which bear watching.

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Based on information from the U.S. Department of Agriculture and Environment Canada

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CLADDING IS A FACTOR, TOO

At the same time, the choice of exterior cladding must be taken into account, as some claddings are more moisture absorbent than others, and thus could benefit from drainable housewraps or rainscreen systems. The following chart offers suggested guidelines from building science experts for selecting a water resistive barrier or rainscreen depending on the type of siding that will be used:

GUIDELINES FOR BEST BUILDING PRACTICES

SIDING MATERIAL	BUILDING ENCLOSURE PROTECTION OPTION	REASON
Wood cladding	Rainscreen system	All woods are highly susceptible to moisture penetration and absorption and require air space protection
Stucco or stone masonry	Rainscreen system or enhanced housewrap	Porous nature of stucco and stone absorbs water and therefore benefits from air space protection. Drainable housewrap may suffice in certain dry climates, but not all enhanced housewraps optimize drying; over time, small cracks will appear in stucco, requiring water drainage behind cladding.
Fiber cement	Rainscreen system or enhanced housewrap	Less susceptible to moisture infiltration and absorption than wood, but can trap water like stucco (see Stucco above)
Vinyl siding	Housewrap or building paper	Non-absorbent, does not trap water, low potential for rot. Good-performing building paper or housewrap is recommended to optimize long-term performance
Brick	"Knuckle" space and mortar deflection product	Nature of brick construction practice creates sufficient moisture protection and air movement with 1" or 2" air space; however, clear drainage at weep areas must be maintained.

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CONCLUSION

Advances in building construction and technology have vastly broadened the range of solutions for builders and architects to incorporate effective moisture management systems in designing and building new low-rise homes and buildings. Those systems today can be tailored to fit the particular circumstances for each new building to help guard against the effects of water damage over sustained periods of time.

Selecting the right system remains a complex issue – due in part to a general lack of standards-based methods to evaluate the optimum solution for each structure. In addition, factors such as the type of cladding to be used – stucco, stone, wood, fiber cement or vinyl, for example – add another layer in the decision-making process because each responds differently to moisture. Project budgets and timetables are determinants, too.

Ultimately, one of the most crucial deciding factors is the environment. A continuum ranging from the most arid environment to areas where rain and wind are frequent will dictate the level of protection needed. That can range from simple building paper to housewrap along with rainscreen protection. Each of these products should be carefully evaluated before use for their ability to drain bulk water and dry remaining moisture so other building components are not compromised. When in doubt, it is probably better to err on the side of applying a higher level of protection for a small incremental cost, compared to the cost of solving a problem in the future.

With a solid understanding of the differences in the roles and performance characteristics of rainscreen systems and the distinct types of water resistive barriers, making the right product selection can be greatly simplified. As the state of building science progresses, more data will be available to builders and architects to guide them in this decision-making process.

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1. Fisette, Paul, *"Housewraps, Felt Paper and Weather Penetration Barriers,"* University of Massachusetts, 2001
2. *Lstiburek, Joseph W. and Carmody, John, "Moisture Control Handbook:* Principles and Practices for Residential and Small Commercial Buildings," John Wiley & Sons, New York, NY 1994, pp 1
3. Cornick S. and Rousseau, M.Z., *"Understanding the Severity of Climate Loads for Moisture-related Design of Walls,"* IRC Building Science Insight 2003 Seminar Series, Toronto, CA Oct. 2003, pp.1.
4. *Builder Magazine*, May, 2002.
5. *"To Build a Better Home,"* published by the APA-Engineered Wood Association, 2002.

BENJAMIN OBDYKE

FUNCTION COMPARISON OF WATER RESISTIVE BARRIERS AND RAINSCREEN SYSTEMS

FUNCTION	WATER RESISTIVE BARRIERS		RAINSCREEN WALL SYSTEM
	HOUSEWRAP OR BUILDING PAPER	ENHANCED HOUSEWRAP	
Water resistive barrier to keep water off structural sheathing and framing	X	X	X
Allows water vapor in framing or insulation to escape, avoiding mold and rot	X	X	X
Air barrier to stop hot and cold air movement through wall cavity, reducing utility costs	X	X	X
Promotes bulk water drainage in wall systems by channeling moisture through channels, grooves or wrinkles to the outside		X	X
Incorporates air space between the exterior cladding and drainage plane to enhance drainage and promote drying			X

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For more information about our line of moisture management products, including the Home Slicker® family of moisture-eliminating rainscreens, call 800.346.7655 or visit www.homeslicker.com.

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