Air and Water-Resistive Barriers

The latest advancement in the building enclosure.

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Building Science, Industry Relations & Compliance
March 2024

Introduction

One of the primary performance characteristics of the building enclosure is keeping water out of a building. We recognize that water comes in many forms–bulk water, capillary water, air-transported moisture, and water vapor. Building enclosures are designed with many lines of defense against the different forms of water.

Bulk water (i.e., rain and snow) is kept out of buildings with roof membranes and facades of all types. Capillary water is ground-based, and foundation and under-slab waterproofing membranes are used to keep this type of water out of buildings. Air-transported water, as the name suggests, is carried into a building by air intrusion through the building enclosure. Water vapor enters the building by diffusion through the enclosure materials.

Figure 1: 1) Bulk water, 2) Capillary water, 3) Air-transported water, 4) Vapor diffusion

The overall building and construction industry is really good at keeping bulk water out of buildings, as is true for underground capillary water. It's really been this millenia that the industry has made a more focused effort on keeping air-transported water out of buildings. As with many topics, the model codes can be slow to adopt new requirements. The first sighting of air-barrier requirements appeared in the 2012 International Energy Conservation Code (IECC). Not new, but not old, relatively speaking from a code and construction standpoint. Air barriers are used to prevent the loss of conditioned interior air (exfiltration) and to prevent the exterior air from infiltrating the building (infiltration). Both make the conditioned air less conditioned and mean the building owner potentially pays more for conditioned air. Preventing air intrusion and exfiltration also–importantly–means the interior relative humidity is maintained at the desired levels, both in the summer and in the winter. Conditioned air is air that is maintained at the desired temperature and relative humidity–they go hand in hand.

Building Enclosure

Let's start with a simple, performance-based definition for Building Enclosure. The building enclosure (aka, building envelope) is used for a number of reasons–primarily it is used to keep bulk water out of the building, to provide thermal resistance (i.e., insulation), and to prevent airflow (intrusion and extrusion) and moisture migration (aka, vapor) to/from the interior and the exterior. In other words, the building enclosure is used to protect the structure and the interior from air and water intrusion resulting from rain, snow, wind, and any other climatic conditions based on season and geographic location. A building enclosure, simply put, consists of the roof and the walls, as well as the surfaces that come in contact with the ground underneath the building–the foundation walls and bottommost slab.

Air Barriers

Air barriers are often still considered the "new thing" in the construction industry. Air barriers are used to significantly reduce airflow across the building enclosure. Sometimes airflow is from the interior to the exterior, and sometimes it's from the exterior to the interior. The direction of airflow is predominantly a climate-based issue, but also can greatly depend on the air pressure inside a building, stack effect, temperature variations, and internal HVAC pressurization.

An air barrier needs to be continuous around all 6 sides of the building. An air barrier is a combination of interconnected individual materials, systems, and assemblies that minimize air leakage into or out of the building enclosure. Air barriers are mandated in order to improve energy efficiency of the building enclosure. To put a point on it, air barriers have been required for commercial buildings by the International Energy Conservation Code (IECC) since 2012. Unfortunately, as of January 2023, there are still 4 states that have not yet adopted the IECC 2012 (or a later version), according to the International Code Council's website.

Vapor Retarders

Vapor retarders are materials that resist or stop (i.e., vapor barriers) the flow of water vapor. This characteristic is represented by the "perm rating" of a material. The lower the perm rating, the less vapor will move through it. The building industry defines three classes of vapor retarders, as shown in the figure below.

Class	Definition
I	0.1 perm or less
II	Greater than 0.1 perm to less than 1.0 perm
III	Greater than 1.0 perm to less than 10 perm

Class I is considered to be impermeable. Class II is considered vapor impermeable. Class III is considered to be vapor permeable. Any material with a perm rating above 10 is considered to be vapor open.

For example, Siplast's WALLcontrol Reinforced Aluminum Butyl Adhered AWB has a perm rating less than 0.01, so it is considered to be essentially vapor impermeable. In contrast, Siplast's WALLcontrol STPE Liquid AWB – at 20 mil thickness – has a perm rating of 9 or 15 (ASTM E96 Method A [dry cup] and ASTM E96 [wet cup], respectively).

Air Barriers or Vapor Retarders

Here's a very important point–all vapor retarders block air, but not all air barriers block vapor. This is a critical point when it comes to designing and building the building enclosure.

The other critical piece of information that designers need to know about vapor retarders and air barriers is the total amount of moisture that can enter (or leave) a building differs greatly from vapor diffusion and from air leakage. Let's compare vapor diffusion and air-leakage from the perspective of how much water is transported for each process. In a warm climate, air transports approximately 10 times more water than diffusion, and in a cold climate, air transports approximately 100 times more water than diffusion. This is why air-transported moisture is much more critical to control than water vapor that enters a building by diffusion.

Environmental Building News (Nov 2012) suggested that air infiltration and exfiltration make up 25 to 40 percent of the total heat loss in a building in a cold climate and 10 to 15 percent of total heat gain in a hot climate. This is surely why the IECC has air-barrier requirements but does not have any significant vapor retarder requirements for building envelopes. In other words, air barriers can help save energy and money.*

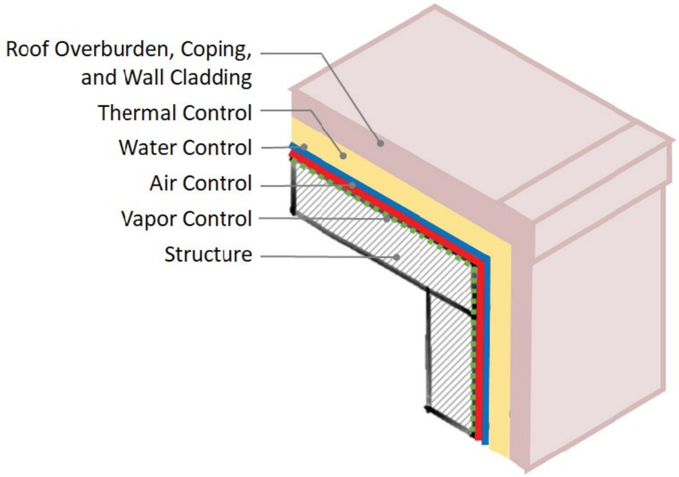
Water-Resistive Barriers

Controlling bulk water is the job of a building facade, and more and more commonly, with a water-resistive layer behind the facade. A water-resistive layer is positioned behind the facade and on the exterior of wall sheathing. There are many types of walls–cavity, mass, and curtain walls, for example–and each type can be constructed from different material types. With wall construction, which often differs greatly from roof construction, the exterior material may not be the primary bulk-water control layer–consider a rainscreen facade system.

Control Layers

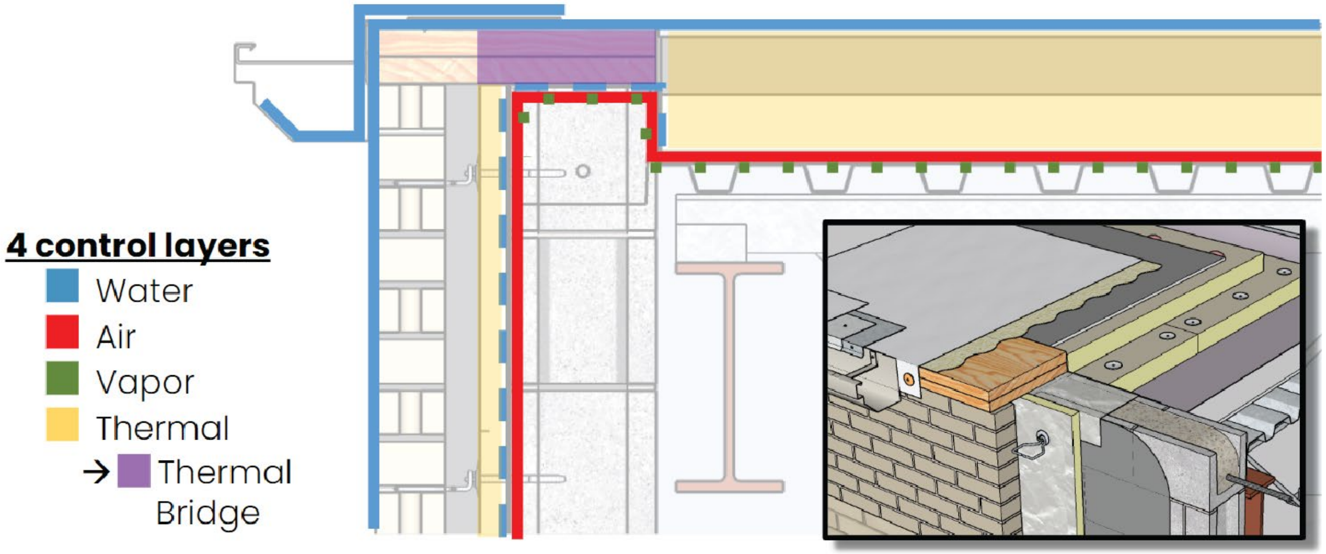
When it comes to the building enclosure, the design and construction industries are speaking in terms of "control layers" now. Essentially, these are the various layers within a building enclosure, each with a specific purpose. There are four control layers, and they align with the performance requirements of the building enclosure–water, air, thermal, and vapor. From a building science perspective, and from an overall efficiency perspective, the control layers need to be continuous. How the control layers connect at openings (e.g., windows), interfaces of differing materials (e.g., curtain wall to masonry), and angle changes (e.g., roof-to-wall) is critical to their performance. In other words, the details make all the difference.

**Energy cost savings are not guaranteed and the amount of savings may vary based on climate zone, utility rates, radiative properties of roofing and wall products, insulation levels, HVAC equipment efficiency and other factors.*



From a roof to a wall, the four control layers–ideally–will transition from vertical to horizontal at a 90-degree corner, but this is often never the case. The roof would need to be an inverted roof membrane with the membrane below the insulation, and there couldn't be wood blocking on the edge of the roof, nor could there be a parapet of any kind. The figure to the left shows an "ideal" roof to wall transition.

Roofs most commonly have the membrane above the insulation, and there is generally wood blocking at the edges and/or some version of a parapet. To that end, the real-world transition from roof to wall is often quite a tricky detail. The graphic below shows a relatively simple real-world example of a method to construct the 4 control layers when transitioning from a roof to a wall.



Looking a bit closer at this detail, the first thing to notice is that the wood blocking is a thermal bridge. While wood does provide some thermal resistance, it is a location of some amount of thermal loss. Second, while the air barrier is continuous, the vapor retarder (dashed green line) appears to stop at the top of the front side of the wall, and the water-resistive layer (dashed blue line) stops at the top of the back side of the wall. These are not discontinuous control layers. Rather, a single component is performing the function of more than one control layer. For example, the dashed blue line is a single component performing the role of the secondary water control layer, the air barrier, and the vapor retarder. Combining functions, as long as the material/system is appropriately placed within the wall, reduces labor and helps with job sequencing.

Air and Water-Resistive Barriers

The water-resistive layer and the air-control layer are often one component. This layer is commonly known as the AWB–the air and water-resistive barrier. An AWB needs to be continuous to minimize unwanted air and water movement through a building enclosure. A high-quality AWB will maintain its integrity and remain stable in high heat conditions and under UV exposure. An AWB will have appropriate tensile strength, elongation capabilities, and tear resistance.

- A high-performance AWB can provide a number of benefits:
- Manage incidental moisture, which reduces the potential for mold within the building enclosure and protects the building structure
- Reduces the loss of conditioned air, which maintains a more comfortable indoor environment
- Can help lower energy use by keeping conditioned air where it is intended to be
- Reducing air leakage, when combined with proper ventilation, helps maintain consistent indoor temperature and humidity which can help reduce the potential for indoor mold growth.
- Potentially reduce initial cost of HVAC systems which is possible with a more airtight building design

There are two main types of air and water-resistive barriers: self-adhered sheets and fluid-applied membranes. Adhered systems have advantages over mechanically attached systems, and it is not uncommon to use self-adhered and fluid-applied membranes on the same project.

Designing a high-performance AWB System

An air and water-resistive system includes a number of building enclosure components, and therefore, a number of trades that require appropriate coordination from design to installation. To help alleviate a common concern during design and construction is the use of a single manufacturer for the air and water-resistive barriers. And even better, specify a single manufacturer, like Siplast, that provides AWBs and roofing systems. While the wall itself can be complicated, the intersection of wall systems with roof systems can require complex details and sequencing. And this detail circumscribes the entire building–so it's quite important! Using materials from a single manufacturer who has knowledge and experience with compatibility issues and sells materials that specifically alleviate compatibility concerns make this critical detail considerably more manageable.

Choosing the correct AWB system for a specific building should take into account a number of considerations.

- Climate Zone. ASHRAE divides North America into 8 climate zones, which differ based on heating and cooling degree days. The climate zones are also subdivided by moisture levels–Marine, Dry, and Moist.
- Wall Assembly Design. Construction type, type of substrate, finishes, and methods of attachment the cladding vary from project to project and the AWB should be appropriate.
- Code requirements. IBC, IECC, NFPA, and ASCE include various requirements for building construction. Notably for walls, NFPA 285, which tests fire propagation of walls, can also affect AWB selection.
- Intended Use of the Building. Interior RH and usage pattern can inform AWB selection. Is the building used seasonally (a school closed for the summer), full-time (a residential building), or daily (office building).

Why Siplast Air and Water-Resistive Barriers?

Siplast delivers high-performance building enclosure solutions and unparalleled levels of service and partnership, setting industry standards for the future of building design and construction. Siplast WALLcontrol AWB systems provide high-performance solutions for vertical walls to create a continuous air and water-resistive barrier for commercial buildings and enable complex transitions from roofing and waterproofing systems.

- Siplast air and water-resistive barrier systems are compatible with other Siplast systems, including roofing and waterproofing systems.
- Siplast products are evaluated for high-temperature performance, which is particularly vital at the roof and wall interface.
- To accommodate the commercial walls of new and retrofit building enclosures, Siplast offers consultant-grade air and water barrier solutions.
- Siplast offers a line of high-performing, moisture-cure liquid air barrier products with high solids content and high elongation. The moisture curing process reacts with moisture in the air to cure after application, to limit shrinking, pin-holing, and to help resist washing off the substrate.
- The Siplast complete building enclosure solution for an air and water-resistive barrier system, along with Siplast roofing and waterproofing systems, comes with a limited warranty/guarantee.
- Resiliency. Sustainability. These terms get tossed around a lot in the roofing industry. These terms, to most of us, are more nebulous than practical when it comes to buildings and roofing. Of course, dictionary definitions trend to the common uses of the words. Simply put, resilience is the ability to bounce back, and sustainability is the ability to continue over time.

For more information about all of Siplast's Air Barrier Systems, click here, or simply go to www.Siplast.com.

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Jim Kirby, AIA, is an architect for Siplast. His focus is Building Science, Industry Relations, and Compliance. He has a Masters of Architecture—Structures Option and is a licensed architect. His 30+ years in the roofing industry have covered low-slope, steep-slope, metal, and SPF roofing, as well as green roofs and rooftop solar. Jim writes and speaks about building science topics related to roofing, represents Siplast across numerous segments of the roofing industry, and helps manage Siplast's compliance documents and information. He is a board member for CRRC and SPRI, an active committee member for ARMA and ASTM, and a member of AIA, ICC, IIBEC, NRCA, and WSRCA.

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