ROLE OF WRB in Open-joint Cladding Design

by Peter Barrett

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OPEN-JOINT CLADDING ENHANCES THE VISUAL APPEAL OF BUILDINGS. HOWEVER, IT EXPOSES THE EXTERIOR WALL TO WIND, WATER, AND ULTRAVIOLET (UV) RAYS, THEREBY RISKING HAVOC TO BUILDING PERFORMANCE AND CAUSING THE GROWTH OF MOLD AND ROT WITHIN THE WALL CAVITY. APPLYING THE RIGHT BARRIER IN THE APPROPRIATE PLACE CAN HELP BUILDING PROFESSIONALS PROTECT THEIR DESIGNS WELL INTO THE FUTURE AND IMPROVE THE OVERALL PERFORMANCE AS WELL AS THE APPEARANCE OF A STRUCTURE.

Water-resistive barriers (WRBs), specifically meant for open-joint cladding designs, are intended to be installed in front of the continuous insulation (ci) and behind the cladding itself. At this location, it does not replace the primary air barrier/WRB—these membranes are located in front of the structural sheathing and behind the ci (Figure 1).

Insulation protection

The primary role of a WRB designed for open-joint cladding systems is to channel bulk water from wind-driven rain (and snow) to the outside of the structure in order to keep it dry and maintain the insulation system's performance. In effect, the WRB functions as part of the primary cladding. It will also protect the insulation from the R-value-lowering effects of wind-washing, a phenomenon occurring when air blows through a permeable insulation, disturbing the otherwise inert gases that give the insulation thermal value.[1]

Some experts believe this bulk movement of air can increase heat loss and cause condensation as well as greater energy consumption. However, several contributing factors can alter the severity of these effects, including insulation type, product thickness, and building height. So, while there is still some discussion in the industry regarding the overall effects of wind-washing on insulation, the fact is, the membrane behind the cladding protects the insulation from elements like wind when installed correctly.

Proper installation

To ensure the effectiveness of the WRB in an open-joint cladding system, it is essential to install the membrane and its components in a manner that seals all potential leakage points, including:

- connections of the walls to the roof's air barrier and the building foundation;
- seismic and expansion joints;
- piping, conduit, duct, screws, bolts, and similar penetrations;
- changes in plane; and
- all other potential pathways for air and water leakage in the building enclosure.

Along with being water resistive, the right membrane should also be highly vapor permeable, allowing moisture within the cavity to escape swiftly through diffusion, while protecting the insulation from possible damage by moisture infiltration. Regardless of the type of membrane used, it is critical the moisture throttle should not be at this location as all interior moisture needs to move freely to the exterior.

Importance of UV stability

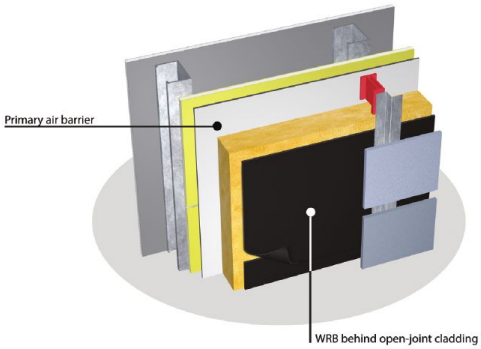
If wind, rain, and snow can get through the open joints, it goes without saying UV light can also do so because the wall assemblies are exposed. This increases the risk of degradation of wall components by UV light. It is important to note that regular membranes and even building paper might provide the desired water holdout but the aging process will accelerate due to excessive UV exposure. The assembly might only perform as expected for a few years, resulting in significant loss of performance over the life of a new building. However, design professionals can protect the exterior wall assembly by employing materials with UV-stabilized properties.

In the case of long-term UV exposure, there is no ASTM standard on which a manufacturer may base their claim of acceptable exposure time. There is a durability component to the International Code Council-Evaluation Services' (ICC-ES') acceptance criteria (AC) 38, "Water-resistive Barriers," but since it was designed to test any WRB, not just UV-stable membranes, it is not a meaningful measurement tool for membranes specifically designed for long-term open-joint exposure. However, using a UV-stable membrane, along with best practices in understanding and preventing excessive UV exposure, will help to prevent impact on performance. For example, one of the open-joint cladding WRBs available in the market are manufactured with special acrylic coatings to make them UV-resistant. These materials may be used in systems with up to 50-mm (2-in.) openings comprising up to 40 percent of the overall façade.

Durability and tear resistance

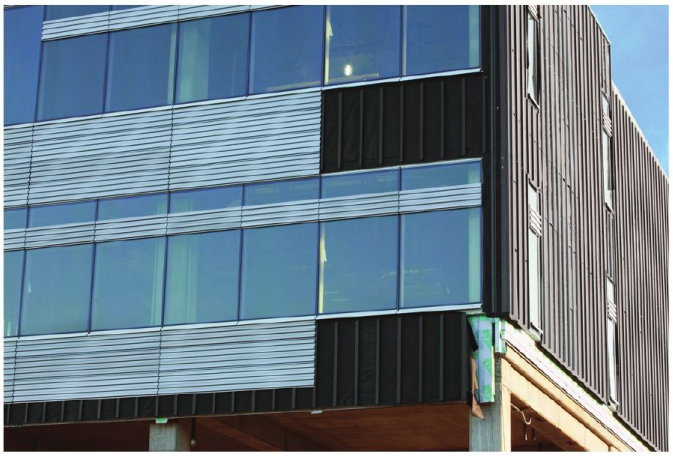
The ideal barrier for open-joint cladding is resistant to tears and can withstand the day-to-day environment of a construction site because the WRB is left uncovered prior to the installation of the cladding material. The durability is also a critical consideration for open-joint designs because some elements of the barrier will be left exposed even after the cladding is applied, as previously discussed.

Figure 1



This illustration shows that water-resistive barriers (WRBs) for open-joint cladding systems are installed in front of the continuous insulation (ci) and do not replace the primary air barrier/WRB, located in front of the structural sheathing.

The exterior of the Collaborative Life Sciences Building (CLSB) in Portland is made up of prefinished perforated panels of aluminum, engineered in a corrugated profile.



Addition of the barrier membrane to CLSB's exterior wall.

The WRB is a part of the wall system but its location makes it quite vulnerable and exposed. Therefore, it is a poor idea to designate the membrane at this location as the primary air barrier. Though both the air and water-resistive barriers are expected to be durable and tear resistant, it is important to note that their location is also critical to their long-term performance.

As building industry experts John Straube and Joe Lstiburek recommend in the Perfect Wall concept, critical performance layers, such as the air barrier, should be placed in a protected location to prevent damage.[2] Barriers—exposed or actually performing as cladding—such as those seen in an open-joint design, would not be considered protected in the Perfect Wall concept. Therefore, the designated air barrier should always be placed behind the ci, to the interior, to prevent damage.

Adds to innovative design

Most architects and designers choose open-joint cladding to enhance the overall visual appeal of their buildings. When not using a WRB directly behind the cladding, there can be concerns around the appearance of the wall elements. For example, if the uncovered insulation shows through in such designs, a beautiful concept might miss the mark. However, when the right barrier is employed in the proper manner, it can provide a 3D effect to enhance the visual appearance of the building. This concept is applied by the world's most advanced building professionals designing some of the most cutting-edge buildings.

Bringing the concept to life

Recognizing the need for protection and getting ahead of building challenges were the drivers behind the development of the Collaborative Life Sciences Building (CLSB) in Portland. The project brought together three of the state's top universities to create a landmark facility. The project combined the resources of the Oregon Health & Science University (OHSU), Oregon State University (OSU), and Portland State University (PSU) to provide 46,452 m^2 (500,000 sf) of instructional and research space for life sciences, pharmacy, medical, and dental programs.

One of the unique features of this new build was the enclosure design. The exterior of the CLSB is comprised of prefinished perforated panels of aluminum, engineered in a corrugated profile. While this specific feature provided the academic building with enhanced visual interest, one technical challenge was wind and water intrusion. It was important the design meets the project's stringent water intrusion goals. Open-joint cladding systems specifically require extreme water and wind protection. If the WRB is not durable enough to withstand extreme weather conditions or stable when exposed to prolonged periods of UV light, the system will fail. With the CLSB building exposed to strong winds off Puget Sound, the concern was the constant positive and negative pressure of blowing wind could damage the membrane, particularly at fastening points.

Designing the assembly

When determining what would go underneath the panels, it was critical to choose a water-shedding membrane suitable for the conditions in Oregon, as CLSB is situated in an area where high winds and wet weather are common. The team considered using a black sheet metal for the weather barrier, but then looked to a WRB solution that could provide strong weather protection and UV resistance. The

neutral black color of the product also provided a suitable background to give the perforated panels the desired visual depth. However, questions arose about durability because of the building height and local weather conditions.

Testing

Special testing was required for the application, as the building is subject to extraordinary wind conditions. As explained, the concern was the durability of the membrane since it would be subject to the cyclic action of wind pressures. The testing was a collaborative effort and was critical to measure the WRB's structural strength and durability. The testing was done over the span of two days, where the lab put the membrane through 9000 cycles of pressure differential, each consisting of three seconds of pressure followed by three seconds of rest. To fully observe the condition and performance of the membrane, testing was done in increments—7000 cycles with a positive pressure differential of 575 Pa (12 psf), followed by 2000 cycles of negative pressure differential at 575 Pa. Since no test exists for this kind of design previously, the laboratory created a test method that was based on ASTM E1233, *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Cyclic Air Pressure Differential*.

The results of the test showed no measurable wear, indicating that the WRB was quite durable. However, given the severity of the Oregon weather, the team wanted to dig further. Therefore, after the initial testing, the team attempted a five-minute cycle at higher wind velocity pressures, up to 193 km/h (120 mph) and performed destructive testing on the wall system. Rips or tears were not seen on the membrane but the z-girts gave out before the membrane.

For a building with an exterior cladding full of holes, using a suitable WRB proved to be the best solution to preserve the structure's performance and enhance its aesthetics.

Conclusion

Protecting open-joint buildings from water, wind, and UV is extremely important since they tend to expose the inner parts of the performing walls to extreme weather conditions. The CLSB case study reiterates the importance of installing a membrane that is water- and wind-resistant in open-joint cladding systems. With a durable and effective WRB in place, building professionals can be confident their projects and aesthetic visions are well protected and will be an enduring legacy. **CS**

Notes

[1] Wind-washing refers to wind-driven flow of cold outdoor air through low-density insulation or air gaps in exterior continuous insulation (ci). This phenomenon can cool the interior side of the enclosure, thereby resulting in condensation.

[2] For more information, visit www.buildingscience.com/documents/insights/bsi-001-the-perfect-wall.

ADDITIONAL **INFORMATION**

Author

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Abstract

While open-joint cladding enhances the visual appeal of buildings, they expose the inner parts of the performing walls to extreme weather conditions. The exterior of the Collaborative Life Sciences Building in Portland is made up of prefinished perforated panels of aluminum, fabricated in a corrugated profile. While visually interesting, the design highlights the need to implement measures to ensure the building envelope's durability. This project underlines the importance of incorporating an ultraviolet (UV)-stable, water-resistive barrier (WRB) in order to avoid failure of the wall system without sacrificing aesthetics in buildings with open-joint cladding.

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