Installing Weather-Resistive Barriers: A General Contractor's Perspective

By Brian Lenz

Figure 1. Walsh Construction Co. typically builds project mock-ups as "tiny houses," which are subsequently donated to the Low-Income Housing Institute, one of Walsh's longtime nonprofit clients. (Window testing performed by QED Lab, Troutdale, Ore.)

To improve performance outcomes and construction efficiency, Walsh Construction Co. employs a rigorous quality assurance/quality control (QA/QC) program focused on the building enclosure and, specifically, weather-resistive barrier (WRB) and air-barrier construction. Walsh's quality process uses constructability reviews, site inspections, mock-ups, material and process testing, installer training, and employee continuing education (**Figs. 1** and **2**). Walsh's self-performed work subsidiary, RDF Builders, executes approximately 80% of the company's window and WRB installations, working closely with the QA/QC department.

EXPERIENCE

Over the past 15 years, Walsh and RDF Builders have installed mechanically attached, self-adhered, and liquid-applied WRBs in the Pacific Northwest (Oregon and Washington), with the system being specified by the architect and building enclosure consultant during the design phase. The design team's selection of system and products takes into account multiple factors, including performance, constructability, cost, potential schedule impacts, projected weather conditions, and anticipated installer

Figure 2. A building-enclosure coordination meeting involves everyone working on the building enclosure, including owners, architects/designers, consultants, product manufacturers, and the entire Walsh Construction Co. team.

availability. Approximately 80% of the completed installations have been mechanically attached WRBs (including hybrid systems using some liquid or self-adhered flashing at rough openings, penetrations, or specific substrates), with the remainder evenly split between liquid-applied and fully adhered WRBs.

CODE REQUIREMENTS

In 2005, Washington State enacted a law[1] that requires, with very few exceptions, the party applying for a building permit for new multifamily construction and rehabilitation to have a design professional perform design review and observe/document the WRB and window installation and testing, with the documentation reported to the authority having jurisdiction over permits. Buildings completed by Walsh in Washington have been tested for air leakage since the adoption of the *2009 Seattle Energy Code*[2] and the *2012 Washington State Energy Code*.[3] The allowable threshold for leakage was 0.40 cfm/ft^2 (2.0 L/s·m^2) of building enclosure area in the 2009 Seattle code and 2012 Washington State code; in 2018, the Seattle[4] and Washington[5] codes both reduced the rate to 0.25 cfm/ft^2 (1.2 L/s·m^2). In Oregon, testing will be a requirement in the *2021 Oregon Energy Efficiency Specialty Code*[6] for the first time, with a target threshold of 0.40 cfm/ft^2. To date, Walsh has had more than 70 completed projects tested across both states, with results continuing to improve and landing well below even the tightened code threshold requirements (**Fig. 3**).

Figure 3. A typical blower door setup for the code-required whole-building air-leakage test, which is usually performed a few weeks prior to building turnover on most Walsh Construction Co. projects.

MECHANICALLY ATTACHED WRBS

The least expensive system to install has been the mechanically attached WRB, where large wall areas can quickly be covered to start the dry-out process, leaving the detailing at flashings, penetrations, and rough openings to follow. The 10-ft (3-m) roll width available from some manufacturers works out neatly to one course per floor on most projects, with the laps occurring at the window head, which is the most common location for through-wall flashings (**Fig. 4**). The installers can shingle lap their way up the building, leaving the laps open just enough at each course to allow the cladding subcontractor to install the flashings and the rainscreen furring, which is then used to securely tie the WRB to the wall sheathing (**Fig. 5**).

Figure 4. Mercy Housing's Mt. Baker Family Housing in Seattle, Wash., with a mechanically attached weather-resistive barrier.

Figure 5. Rainscreen furring and flashings installed at the Tony Lee Apartments–Lake City Family Housing in Seattle, Wash.

Walsh History, Values, and Mission

Walsh Construction Co. is a company of builders whose mission is working to build relationships, quality, and value on every project. Formed in Portland, Ore., in 1961, with the Seattle, Wash., office opening in 1986, Walsh focuses on customer service, safety, teamwork, and cooperative problem-solving, resulting in many repeat-client relationships.

Walsh specializes in affordable housing and mixed-use construction. Its expertise also includes supportive, senior, and student housing as well as academic, healthcare, hospitality, expansion, and renovation projects; all of which involve a broad range of construction types, such as wood frame, masonry, concrete, and structural steel. Throughout the company's history, Walsh has partnered with mission-driven clients to create affordable, comfortable, and well-crafted homes across the Pacific Northwest. Thirty-five housing authorities and affordable housing developers have worked with Walsh as repeat clients. These partnerships have resulted in the delivery of over 56,000 affordable homes in Washington and Oregon. In the past 10 years, Walsh has built more than 4500 units and approximately 4.8 million ft^2 of multifamily housing in Washington alone.

A typical Walsh Construction Co. project, the Low Income Housing Institute's Tony Lee Apartments–Lake City Family Housing in Seattle, Wash., includes five stories of wood framing over a post-tensioned concrete deck.

Most Walsh projects are wood framed, and getting the building wrapped quickly, even in inclement weather, is critical in starting the dry-out process. The mechanically attached approach is a favorite among Pacific Northwest superintendents who need to strictly adhere to critical path schedules. Moisture readings are taken weekly at representative locations on each floor to determine when the walls can be insulated, and finishes installed.

Figure 6. Ainsworth & Dunn Building in Seattle, Wash., with a self-adhered weather-resistive barrier.

Figure 7. Liquid flashing around penetrations over a self-adhered weather-resistive barrier.

A downside to the mechanically attached system is the large number of laps and transitions to other materials that need to be completed. The mechanical, electrical, and plumbing penetrations, as well as any steel knife plates and other anchors, are designed to all be in place before the WRB install, but this is seldom the case. Achieving proper lapping at penetrations added out of sequence is time consuming and often requires additional sealants and transition membranes. Mechanically attached WRBs rely on a combination of integral or surface-applied tapes and sealant at laps, and quality control of these tapes and sealants can be difficult. Furthermore, the long-term performance of these components is challenging to verify once they are concealed beneath cladding.

Each of the sheet WRBs is only compatible with certain types of sealants, membranes, and primers. This limitation places considerable responsibility on the design team to clearly communicate the details, and the installer to properly execute those details. An often overlooked challenge to using a mechanically attached system is potential exposure to wind and the resultant damage and replacement if there is a delay in the cladding installation. Multiple sections requiring some degree of repair after a stormy weekend can be a common and unpleasant Monday morning discovery.

SELF-ADHERED WRBS

The use of self-adhered WRBs can lead to improved airtightness performance by providing a complete bond to 100% of the wall area, which eliminates reliance on tapes or sealant at laps, and by requiring less use of transition membranes than is needed for mechanically attached systems. The self-adhered material can be rolled out and installed vertically, which may make the work manageable for a small crew. Also, the vertical installation results in fewer wrinkles and potential breaches in the building enclosure compared to a mechanically attached system (**Fig. 6**). Many of the self-adhered WRBs make excellent substrates for liquid-applied flashings, which can simplify the detailing around penetrations and at window and door rough openings (**Fig. 7**). Another major benefit of self-adhered WRBs is their durability when exposed to the elements during construction. The risk of damage to the WRB during exposure prior to cladding is almost eliminated.

In the Pacific Northwest market, the installed cost of self-adhered WRBs has typically been 40% to 50% greater than that for mechanically attached systems, when the detailing around the rough openings is excluded. The self-adhered material can be between two and four times as expensive as mechanically attached sheet products, and narrower roll widths are typical of self-adhered materials, which means more courses are required to cover the same amount of wall area. The simple method of leaving laps open for the cladding that exists with mechanically attached WRBs is not available to the same degree with self-adhered WRBs because the release film has to be gently slit and a strip of it left temporarily in place. Lastly, self-adhered WRBs require a very dry substrate for proper adhesion, which can pose a significant challenge during the wet-weather months in the Pacific Northwest.

LIQUID-APPLIED WRBS

The use of liquid-applied WRBs, at a cost premium of 10% to 20% over self-adhered WRBs, presents the opportunity for a monolithic system with improved airtightness and simplified detailing at rough openings, substrate transitions, changes in plane, and penetrations. Liquid-applied WRBs can allow room

Figure 8. The Asian Health and Service Center in Portland, Ore., with a liquid-applied weather-resistive barrier.

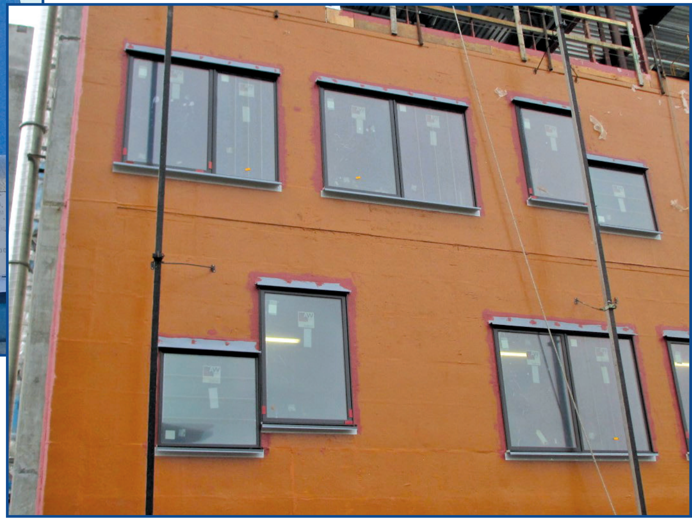

Figure 9. The building enclosure for the Greenfire Campus in Seattle, Wash., includes a liquid-applied weather-resistive barrier and liquid flashing over sheet metal head flashings.

for flexibility in sequencing because reverse lapping is not a concern, and work on the building can proceed from the top down or the bottom up, as required (**Fig. 8**). If waterproofing at rough openings is also done in a liquid membrane, the waterproofing can be installed before, after, or concurrent with the work on the adjacent wall surfaces. The integration of sheet metal flashings into sheet-applied WRBs generally requires tapes, sealant, and often a transition membrane, all of which can be eliminated when using a liquid membrane (**Fig. 9**).

The challenges faced when using liquid-applied WRBs on Walsh projects generally center around weather and attaining a dry substrate. For the silyl-terminated polyether (STPE) products, the substrate can be slightly damp, but not wet, and it can be very difficult in the winter months to hit an acceptable window of opportunity that aligns with the pace of a project schedule. With water-based membranes, it is imperative that precipitation does not closely follow installation of the product.

Though roller application seems intuitively slower than spray application in terms of production, most of the liquid-applied WRB installations on our projects have been by roller application. The spray equipment for STPE and silicone products is more specialized and costly than most of the airless sprayers typically used for painting, and, compared to using rollers, the spray application generally requires more start-up and cleanup time, which does not lend itself well to doing work in small sections (**Fig. 10**).

Figure 10. Spray application of liquid-applied weather-resistive barrier was used on the A to Z Wineworks project in Newburg, Ore.

Figure 11. An installer using a roller to apply a liquid-applied weather-resistive barrier with liquid flashing into the door and window rough openings.

Also, if the project does not have enclosed scaffolding, drifting overspray can be a concern, making roller application the better option (**Fig. 11**).

SELECTION CRITERIA

When choosing among the three types of WRBs, the design team and the other project stakeholders consider construction materials, installer qualifications, an array of project-specific factors, and lessons learned from past projects. All three types of WRBs work equally well on oriented strand board, plywood, or gypsum sheathing that is dry and free of large gaps and voids, so the factors discussed in the previous sections of this paper tend to influence the choice of a particular WRB type for projects using these materials. With smooth concrete and steel, both liquid-applied or self-adhered WRBs have been used on many of Walsh's projects, but there have been some issues with concrete (without an architectural "meant-to-be-seen" finish) requiring a substantial amount of surface preparation to achieve a void-free coating application. With masonry, specifically concrete masonry units, the use of the liquid membranes has almost always been the choice.

Factors that must be emphasized in the current market conditions are installer qualifications and the available labor pool. Although the application of the liquid membranes, particularly with spray equipment, requires specific training and experience, Walsh's experience has been that installers need a much broader skillset to install sheet WRB systems. As the number of different materials and the transitions from one material to the other increase, the likelihood that less-experienced installers may deviate from the manufacturer's instructions or the details in the project documents also increases. Walsh has had success in overcoming this limitation by having close relationships with all of their installers, who have become highly valued collaborative partners in the QA/QC process.

During the preconstruction phase, the design team and owners make decisions based on what best serves the project. Factors influencing those decisions include the project schedule, operational building performance, occupant comfort, durability, ease of maintenance, and expenses (up-front, long-term maintenance, and replacement costs). A building that is fairly simple in form may lend itself well to a mechanically attached WRB system, constructed by skilled installers, and this choice could free up budget for enhancing other enclosure components, such as a more robust roofing assembly, triple-pane windows, or specialty cladding. Buildings with highly articulated facades and a multitude of decks, slab projections, and atypical window and door rough opening details make the use of a liquid-applied WRB system a more attractive and potentially cost-effective option.

In many recent projects, the stakeholders

Figure 12. An example of a "hybrid" installation, which uses mechanically fastened and self-adhered weather-resistive barriers as well as liquid flashing applied over vinyl window flanges.

have settled on a hybrid approach of mechanically attached WRB for the field areas of plywood or gypsum sheathing, and a combination of self-adhered and liquid-applied WRBs at rough openings, penetrations, horizontal soffits, concrete, and masonry (**Fig. 12**). This hybrid strategy essentially reserves the more expensive materials and systems with simpler installation procedures for the areas of higher risk and greater complexity. As mentioned previously, projects with an increased number of enclosure components require installers with a higher skill level, but the hybrid approach still allows some flexibility in terms of how the work is sequenced among the different trades.

Walsh puts a great deal of effort into capturing the "lessons learned" during debriefs at the end of each project, with each team member generating their own list of challenges faced, what was done well, and what could be improved upon. The quality team drills deeply into the building enclosure process of the project, and a qualitative analysis of how the WRB installation was executed always involves a lengthy and spirited discussion. There are usually four or five key takeaway points that can immediately be applied to the WRB installations of current and future projects. Based upon this experience, Walsh project teams and the QA/QC department often prefer the use of liquid-applied or self-adhered WRBs if the anticipated schedule will place the installation within the drier months of the year—which in the Pacific Northwest can be a very short window! Of course, the design team must choose the systems very early in preconstruction, and rarely can they wait and make a "game-time" decision since the construction documents need be completed in time for final bidding. The potential for delayed start dates will often steer the design team and other stakeholders to select a mechanically attached WRB as a conservative hedge against a lengthier dry-out period.

Lastly, in a slight twist of irony, the consistently excellent air-leakage test results achieved on completed projects have made many of Walsh's longtime clients, architects, and enclosure consultants comfortable specifying a mechanically attached WRB system in an effort to earmark some potential budget savings for other building components.

CONCLUSION

In the end, what really matters to the entire project team is that Walsh turns over a well-crafted, comfortable, airtight, energy-efficient, durable, and low-maintenance building to their clients. This task is made much easier by a passion for clean execution of every step in the process of completing the building enclosure—one that the entire team brings to work each morning.

Please address reader comments to elorenz@iibec.org, including "Letter to Editor" in the subject line, or IIBEC,* IIBEC Interface Journal*, 434 Fayetteville St., Suite 2400, Raleigh, NC 27601.

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Brian Lenz has worked as a quality assurance manager for 10 years with Walsh Construction Company in Seattle, Wash. He performs constructability reviews, construction-phase site inspections, infrared imagery, qualitative blower door testing, in-house material testing, and oversight of project mock-ups. He leads installer and employee training sessions and has presented to industry groups on strategies for constructing airtight buildings. Prior to joining Walsh, he had more than 20 years of hands-on experience in residential construction. Brian earned his bachelor of arts from Northwestern University and a master of architecture from the University of Washington.