Weather Barriers are a Must with Exterior Foam Sheathing

TECH TALK

Recent years have marked a significant growth of the "Green Building" movement. Specifically, this trend is focused on the efficient use of water, resources, and energy. In the case of residential construction, new codes and standards have been developed which suggest and prescribe how to build "green". Furthermore, the focus on conservation of energy has meant the increase of thermal resistance (R-value) in walls.

Traditionally in North America most residential wall system construction is built with 2 x 4 wood studs with an R-value of 13 obtained solely from cavity insulation. However, climate zones 3 through 8 now or will soon require that residential wood-framed wall systems achieve an R-value of 20. This can be achieved using different construction practices, including building walls with 2 x 6 studs and R-20 cavity insulation or continued use of 2x4 studs and R-13 cavity insulation with an additional R-5 attained through the use of continuous exterior foam insulation.

Exterior Foam Sheathing: Good Insulator, Bad Water Resistive Barrier

Exterior foam sheathing acts as a good insulator when added to walls. However, there are several issues with the use of foam sheathing as a water resistive barrier (WRB) and air barrier. Even though there are standards that if passed allow exterior foam sheathing to qualify as a WRB, problems with this installation method have been observed during laboratory testing and confirmed with issues observed in the field.

Foam sheathing used as a water resistive and air barrier can present the following problems:

Dimensional Instability

Extruded polystyrene (XPS), expanded polystyrene (EPS), and polyisocyanurate rigid foam boards have been observed to change size over time. Specifically, the material expands with extended heat exposure and shrinks with extended cold temperature exposure. Over time, each of the materials mentioned above have issues retaining their original dimensions. This phenomenon is known as DIMENSIONAL INSTABILITY.

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Dimensional Instability – What does this mean for the wall system?

XPS, EPS, and polyisocyanurate foam boards are typically installed in residential construction with butt joints which are then taped. As the XPS, EPS, and polyisocyanurate boards expand and contract over time, each of these materials has issues retaining their original dimensions. This means that the taped butt joint begins to be taxed which can cause the seam to fail. When a taped seam fails, water and air are allowed to easily penetrate into the wall cavity.

This increases the chances of mold growth, wood rot, and several other issues which will ultimately affect the structural integrity and performance of the wall system. Below is an observation by a third party:

> *"XPS and polyisocyanurate have commonly been utilized as a moisture barrier, but recent building science research has shown that these products may not be as dimensionally stable as initially thought. There is some evidence that the insulation boards shrink enough (up to 5/8") that simply taping the joints may not be sufficient to maintain the drainage plane long term."*
>
> *Energy Efficient and Green Technology Building Template Guide for the State of Maryland, prepared for Maryland Energy Administration – Energy Efficiency Programs by Steven Winter Associates, January 10, 2007*

This statement has been supported in recent laboratory aging studies which were performed in accordance with the Thermal Aging criteria described in AAMA 711-07 *(2007 Voluntary Specification for Self Adhering Flashing Used for Installation of Exterior Wall Fenestration Products)*, which simulates long term exposure to the elements.

Figure I: Polyisocyanurate, 70°C Thermal Exposure

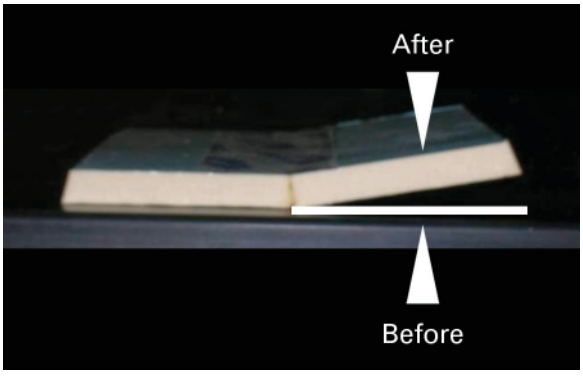
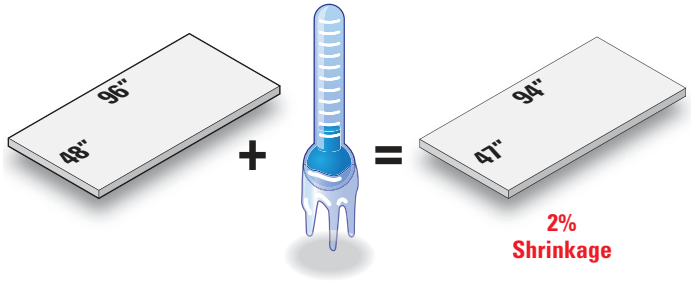


Figure I demonstrates (via buckling) how extended periods of heat exposure results in expansion of the foam board which places stress on the taped joints.

Furthermore, ASTM standard specifications C578, C591, and C1289 have thresholds of 1 to 4% expansion or contraction measured by Standard D-2126: *Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging*, before foam boards are deemed dimensionally unstable. In order to visualize what this means, consider a 2% dimensional change in a 4' x 8' sheet of foam sheathing subject to cold temperature as referenced in Figure II below.

Figure II: A Practical Example of Foam Shrinkage

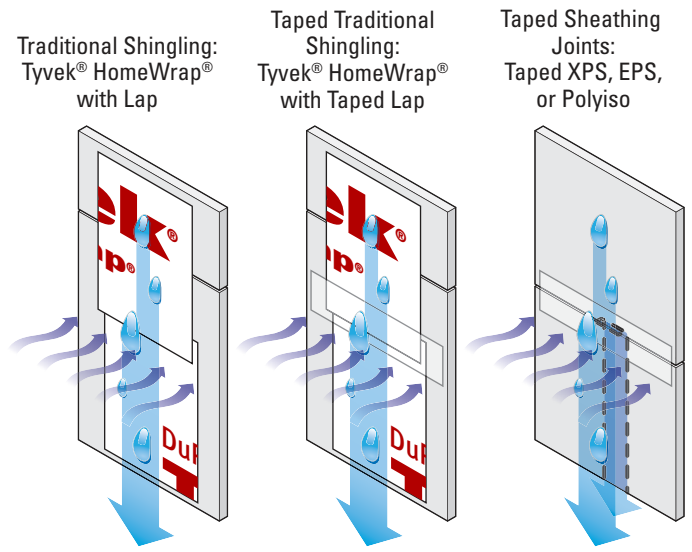


This means that seams which were butt joints, can retract anywhere from 1" – 2". This retraction strains the tape and allows for water and air to move freely through the wall.

Poor Water Management

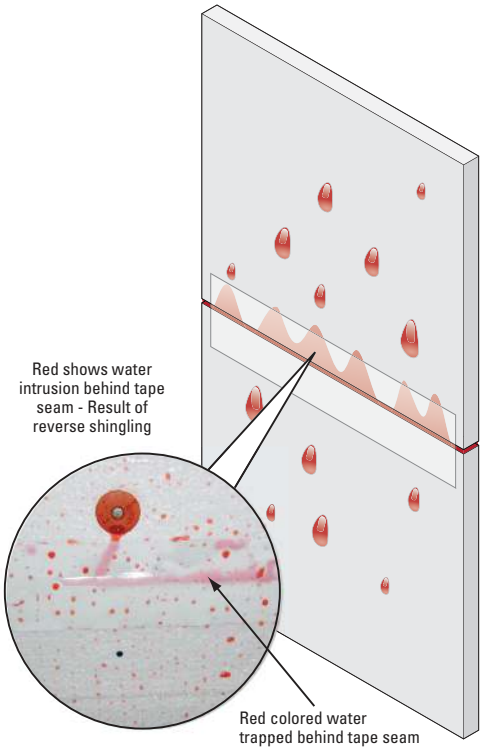
Another issue with the use of foam as a water resistive barrier is POOR WATER MANAGEMENT. This occurs with taped insulating sheathing panels because of the continual occurrence of reverse shingling at horizontal tape joints. Specifically, taped foam joints have an inherent issue known as reverse shingling. Unlike products such as Tyvek® HomeWrap®, taped foam joints cannot be lapped in order to properly shed water. Water can enter into the top of the taped seam and continue into the wall system, resulting in significant moisture-intrusion issues. See Figure III.

Figure III: Traditional versus Reverse Shingling



The issue highlighted in Figure III was also observed during laboratory experiments, where a wall was sheathed with foam. Butt joints were created and then taped. Water entered in through the top edge (i.e. the reverse shingle) of the tape and then went into the wall cavity. See Figure IV.

Figure IV: Laboratory Wall Test of Taped Foam Sheathing



From these observations, it can be concluded that insulating sheathing, such as foam panels, cannot be used as a reliable water resistive barrier or drainage plane.

Other issues with using foam sheathing as a water resistive barrier or air barrier arise when flashing windows and other penetrations. The 2009 IRC states, "Approved corrosion-resistant flashing shall be applied shingle-fashion in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components." Foam sheathing, because of its thickness, however, creates a "reverse shingle" at the head of the window. These details will be entirely dependent on the quality of the adhesion of the tape or self-adhered flashing to the surface of the panel material. The ability to maintain continuity at these details is also subject to issues relating to dimensional stability of the foam sheathing.

The Solution: DuPont™ Tyvek® HomeWrap®, Tyvek® DrainWrap®, StuccoWrap®, or CommercialWrap® D

Laboratory experiments and field observations point out foam sheathing is a good insulator, but a poor water resistive and air barrier. The dimensional stability and water management issues intrinsic with foam products can be remedied by using a wrap product as the water resistive barrier and to provide continuity at air barrier details. The use of DuPont™ Tyvek® Weatherization system products in conjunction with exterior continuous insulation, provides both higher R-value walls and a more durable and superior water resistive and air barrier.

DuPont™ Tyvek® wraps can be installed UNDER or OVER exterior foam insulation. The DuPont™ Tyvek® wrap should be installed on the same plane as the window flanges to allow for the most effective installation. DuPont does not recommend taping the foam seams regardless of whether the Tyvek® is installed under or over the foam. Not taping the seams will have very little effect on the foam R-value, and because of the low permeability of the foam, the open seams will help the wall breathe.

When a DuPont™ Tyvek® wrap is installed UNDER exterior foam insulation, it's recommended that DuPont™ Tyvek® DrainWrap™, StuccoWrap®, or CommercialWrap® D be used for enhanced drainage. DuPont™ Tyvek® DrainWrap™, StuccoWrap®, or CommercialWrap® D are creped, mechanically fastened wrap products developed for enhanced drainage. DuPont™ Tyvek® DrainWrap™, StuccoWrap®, or CommercialWrap® D are water resistive barriers with long established dimensional stability. Additionally, these water resistive barriers can be easily installed with the proper shingling, thus providing the correct water shedding properties. For these reasons, foam should be paired with DuPont™ Tyvek® DrainWrap™, StuccoWrap®, or CommercialWrap® D when the foam is installed over the Tyvek® wrap. See Figure V below for an example of DuPont™ Tyvek® DrainWrap™ installed UNDER exterior foam insulation.

Figure V: DuPont™ Tyvek® DrainWrap™ Under Foam Sheathing

Photo courtesy of Cold Climate Housing Research Center

When a DuPont™ Tyvek® wrap is installed OVER exterior foam insulation, DuPont™ Tyvek® HomeWrap® can be used for the application. Additionally, DuPont™ Tyvek® DrainWrap™, StuccoWrap®, or CommercialWrap® D could also be used in place of the Tyvek® HomeWrap® for this application if enhanced drainage is desired. All of these products are water resistive barriers with long established dimensional stability, and can be easily installed with the proper shingling to provide the correct water shedding properties.

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Limited Warranty

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DuPont™ FlexWrap™ NF
DuPont™ StraightFlash™
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