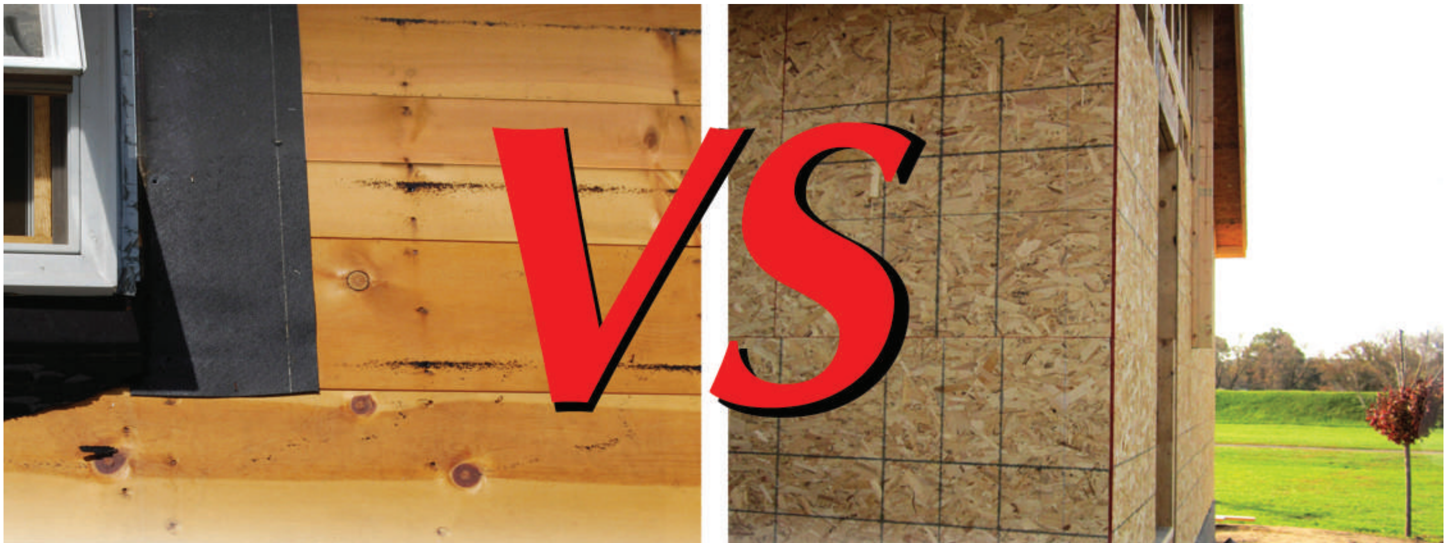


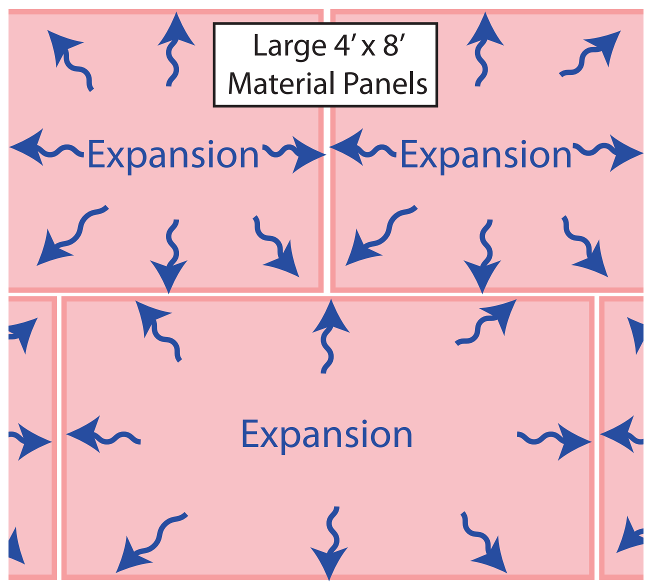
Living at the Edge

Large Dimension Material Panels Raise Exterior Building Envelope Moisture Management Concerns

by
John H. Koester

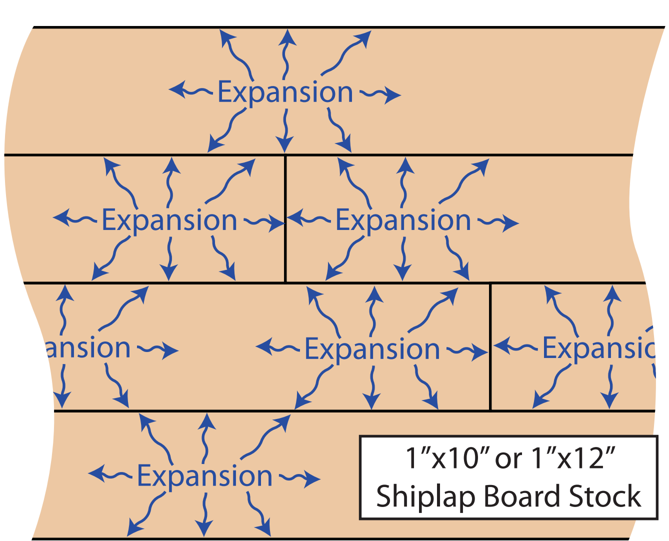
The construction industry has witnessed an ongoing trend towards large dimension material panels over the last 60 to 70 years. 4' x 8' sheets of OSB and plywood have replaced 1" x 10" or 1" x 12" shiplap board stock as the sheathing material of choice for the exterior building envelope. The factors driving this trend include labor savings, better utilization of materials and the positive structural characteristics of these larger panels. Sheet stock construction material sizing has also increased, and for the same reasons. The use of 9' to 10' wide rolls of synthetic WRB in place of 40" to 54" rolls of asphalt impregnated roll stock is increasingly common.

All the components of the exterior building envelope are connected and have an impact on one another. While this impact may be slight, it's still a factor. In the case of material panels, the expansion-contraction characteristics of a 4' x 8' sheet of plywood or OSB need to be considered and the appropriate detail needs to be designed. The reason this new detail design is required is "not" because plywood or OSB expands or contracts that much more or that much less than shiplap board stock; it's because the expansion-contraction of the 4' x 8' sheet panels (32 sq. ft. area) is directed and occurs at the edges (joints) of the 4' x 8' panels. (see detail 1)



Detail 1

The same area of wall, roof or floor decking covered with the shiplap board stock may expand or contract a similar amount, but this expansion and contraction will not all accumulate and occur at the outside edge of the 32 sq. ft. area. Instead, it will be dispersed within this area between each 1" x 10" or 1" x 12" shiplap board stock. (see detail 2)

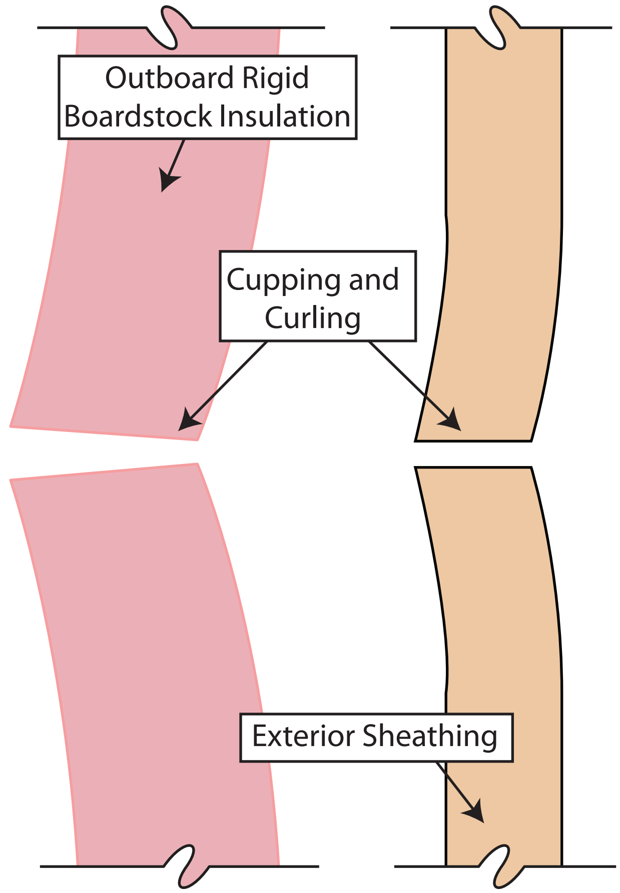


Detail 2

This dispersion minimizes the movement, and therefore, minimizes the stress at the joints. (see detail 2) This movement, and the stress it creates, impacts the other components of the exterior building envelope including the fastening mechanisms, structural members, covering membranes, coatings, etc.

There is another phenomenon that happens at the perimeter of the construction material panels; they curl up or down. When these panels of material experience a variance in moisture content and temperature (wet/dry, warm/cool) they expand and contract. This expansion and contraction creates stress patterns in the field of the panels. When the stress occurs in the center of the panels, there is adjoining material with similar stress patterns that oppose and neutralize the stress in the center. However, the perimeter doesn't have this oppositional stress on all sides, and this allows the edges to distort and curl up or down. (see detail 3)

The edges of these construction material panels are also exposed to a third phenomenon, moisture penetration. Even if there isn't any additional moisture at the perimeter of the panels, there is more surface for moisture to penetrate. (see detail 4) The surfaces of these edges may be more open to moisture because of saw cuts, exposure during shipping and poor storage methods at the job site. (see detail 5)



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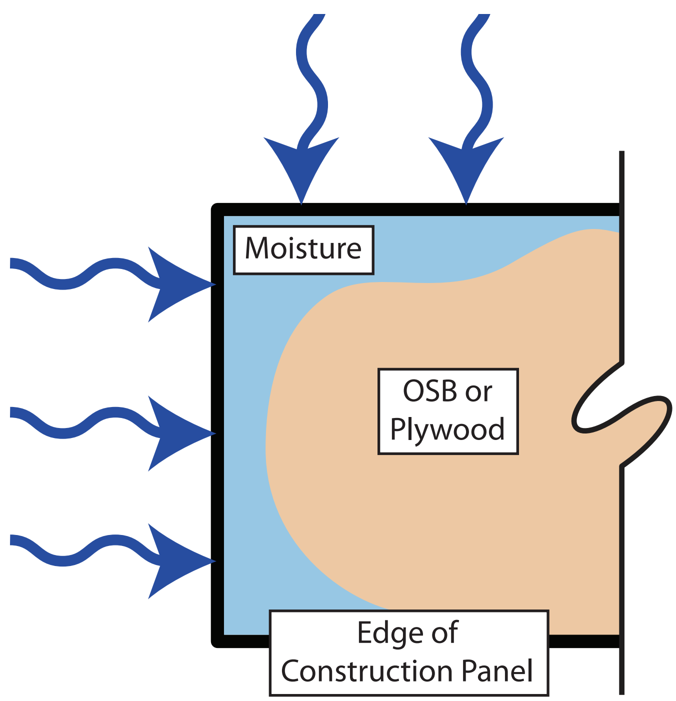

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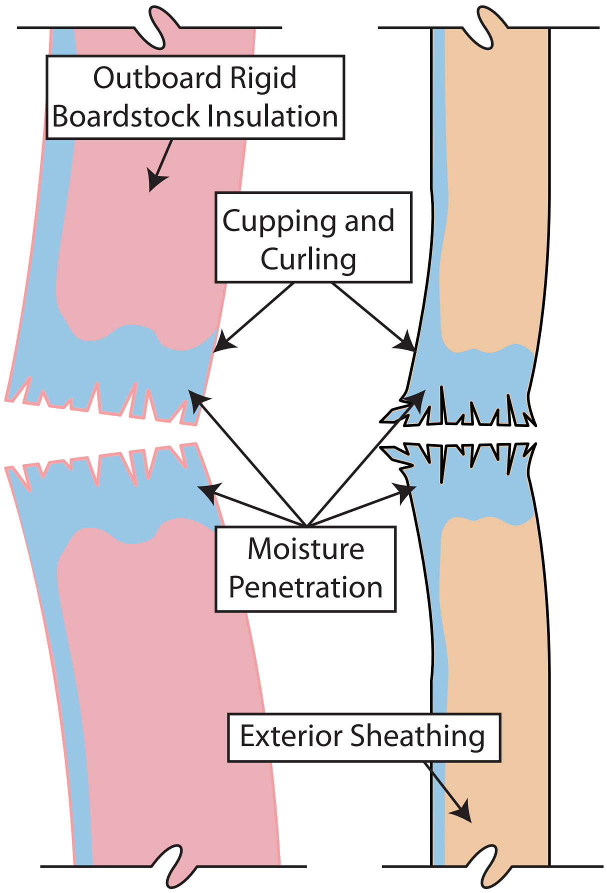

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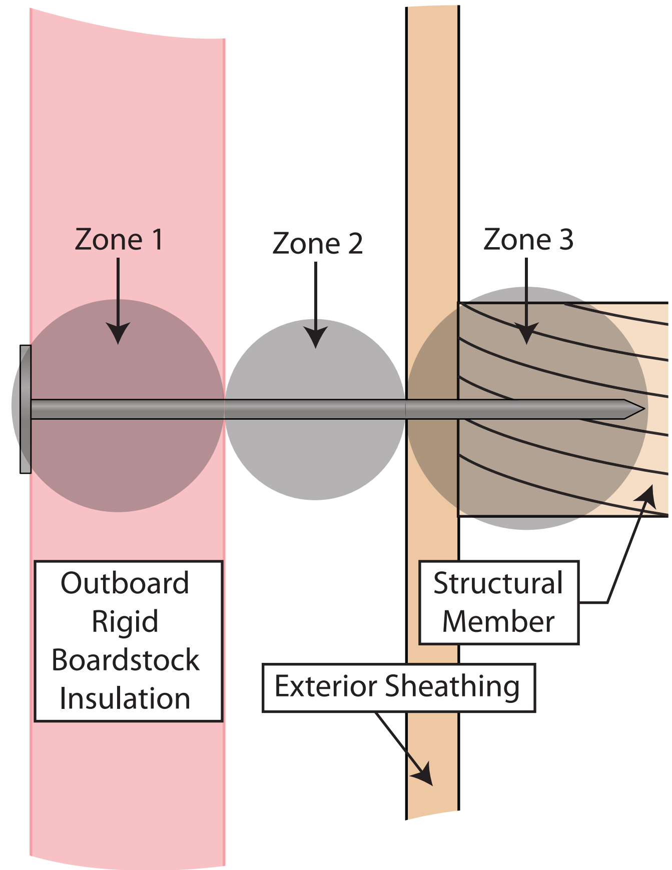

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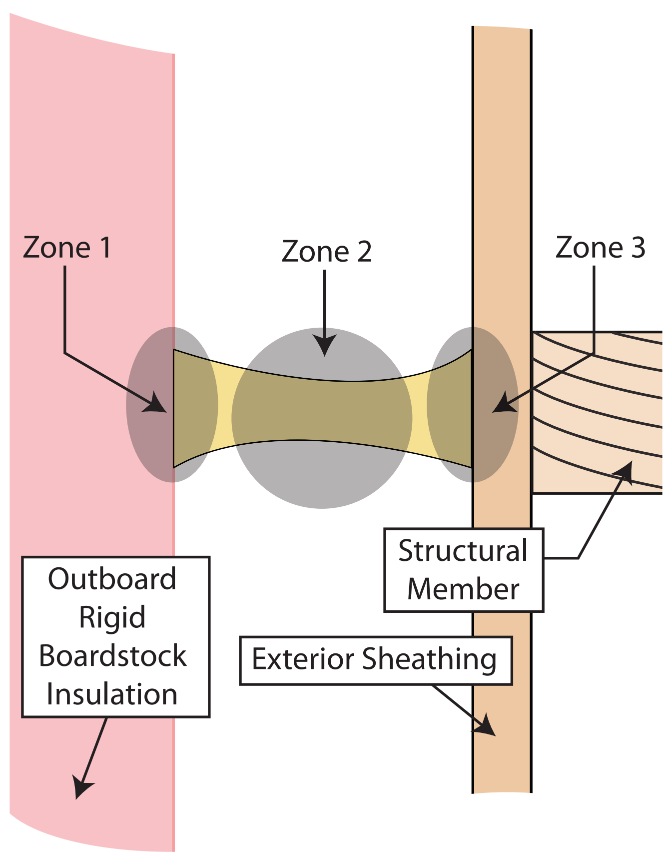
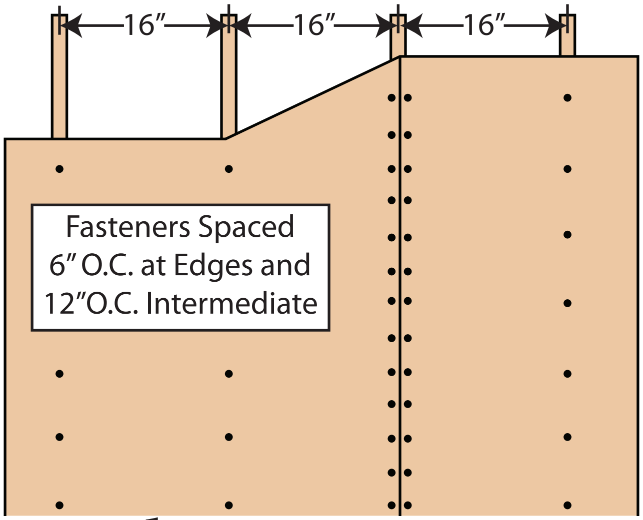


Detail 7

We stated earlier that all things in the building envelope are connected. So what's the cumulative effect of moisture penetration and the expansion/contraction phenomena and the stress they create on the other components of the building envelope? The primary area of concern is the fastening mechanism (i.e. adhesives, welds or mechanical fasteners). If everything is known and the appropriate design details are correctly engineered and executed, the fastening details will withstand the stress put on them. If the fastening details are incorrectly designed or poorly executed, they will be overwhelmed by these stressors and the holistic synergy of the building envelope will be compromised. Additionally, the fastening mechanisms can fail at these general locations: Zone 1, Zone 2 and Zone 3. (see details 6 and 7)

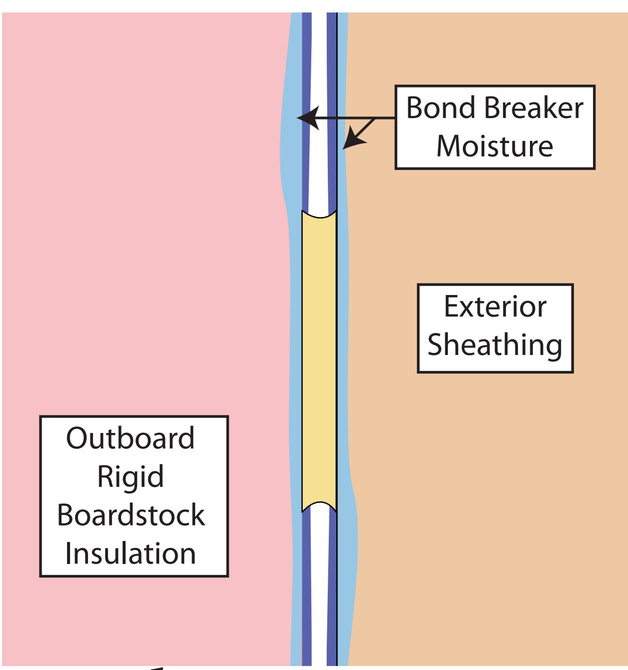
Fastening mechanisms are required to hold materials in place. They are also required to do so following a certain "fastening pattern," and that fastening pattern needs to be correctly engineered. (see detail 8)



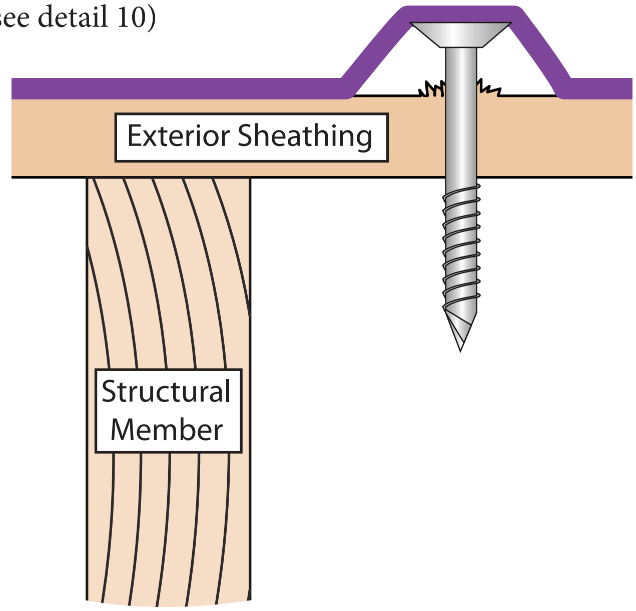
Detail 8

Most fastening mechanism failures follow a "zipper-like" pattern. Stress is incorrectly compensated for and one or more fastening mechanisms stress to failure causing the released stress to transfer to the adjoining fastening mechanisms that in turn are overstressed to failure. This ultimately leads to overall system failure.

Fasteners are also affected by poor or improper installation techniques. Improper installation issues include adhesives that are installed on contaminated surfaces and do not bond (see detail 9) and mechanical fasteners that are carelessly installed causing them to miss the structural members, leaving them with little, if any, holding ability. These mechanical fasteners (screws, nails, staples, etc.) if not seated into structural members, tend to float and back out. This can cause point-pressure stress that may damage other components of the exterior building envelope such as moisture resistant materials and/or waterproof coatings. (see detail 10)

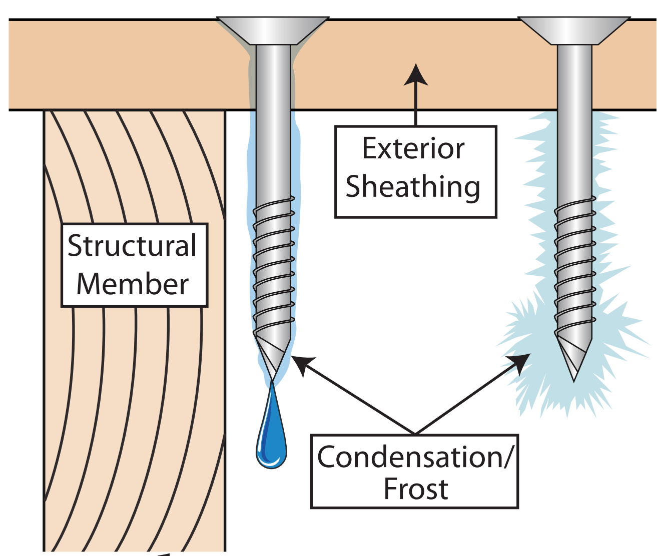


Detail 9



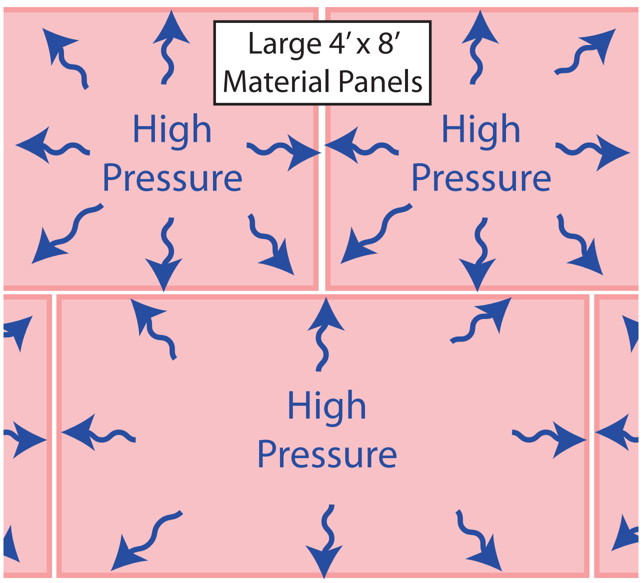
Detail 10

They also create unnecessary penetrations through the WRBs and act as thermo conductors through the sheeting and into stud, rafter and joist cavities. If these exposed fastener shafts or heads convey a dew point temperature, they may accumulate condensed moisture in the form of water droplets or frost. (see detail 11)

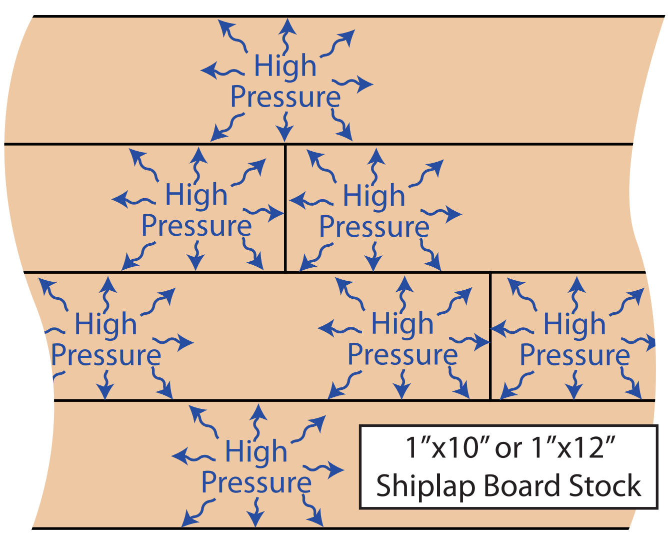


Detail 11

Large panels of construction materials also impact the exterior building envelope by directing air pressure equalization requirements to their perimeters. (see detail 13) This is generally true with all materials of any dimension, small or large, (see detail 14) but similar to the expansion-contraction movement of larger panels of material, it is directed and accumulates at the edges. (see detail 13) As with the expansion-contraction movement, there aren't necessarily more or fewer pressure equalization requirements, it's that they all occur at the perimeters of the larger area. This concentration in a smaller, more restricted area causes a unique phenomenon.



Detail 13

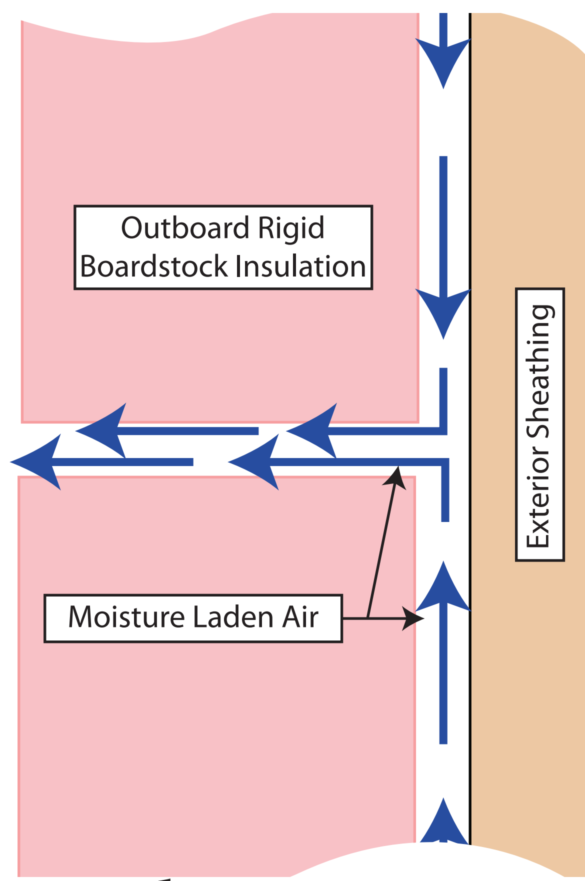


Detail 14

The negative results of a contaminant (in this case moisture) are directly connected to its physical form and its amount of concentration in a material or location. An example would be a gallon of water in vapor form dispersed throughout a house as opposed to a gallon of water in liquid form concentrated in a single window sill detail.

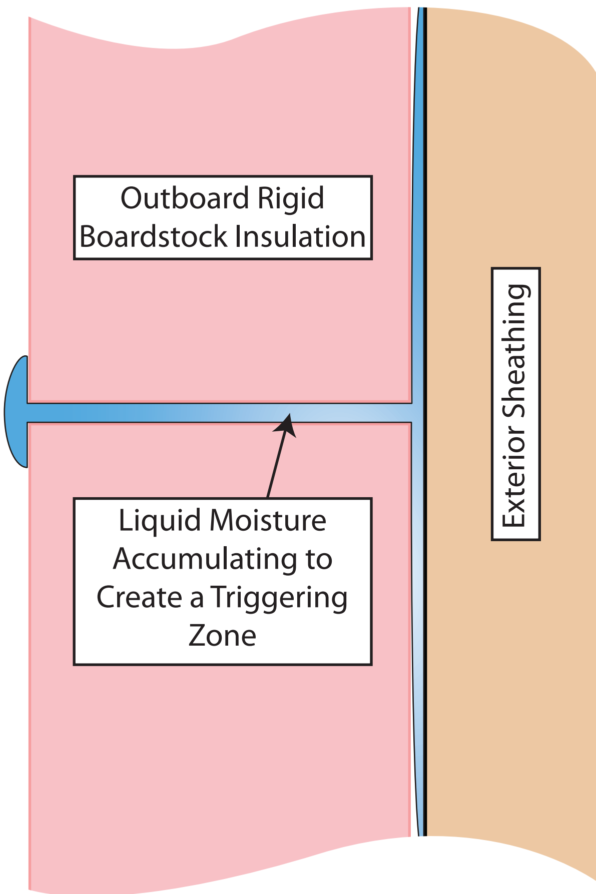
This phenomenon starts to occur immediately upon placement of a large dimension construction panel. The surfaces that are covered by these panels will have some degree of moisture concentration. Upon placement, a large construction panel begins restricting free air movement over a large area, and impacts the pressure of that volume of area. If the encompassed area holds high pressure, the high pressure will attempt to equalize with a lower pressure. If this lower pressure is located outside the perimeter of this construction panel, air from the high pressure area will move to the low pressure area and will take some moisture with it.
(see detail 13 and 14)

This pressurized air, moving to a lower pressure and carrying moisture with it, is funneled through the perimeter edge joints of the large construction panels. (see detail 15)



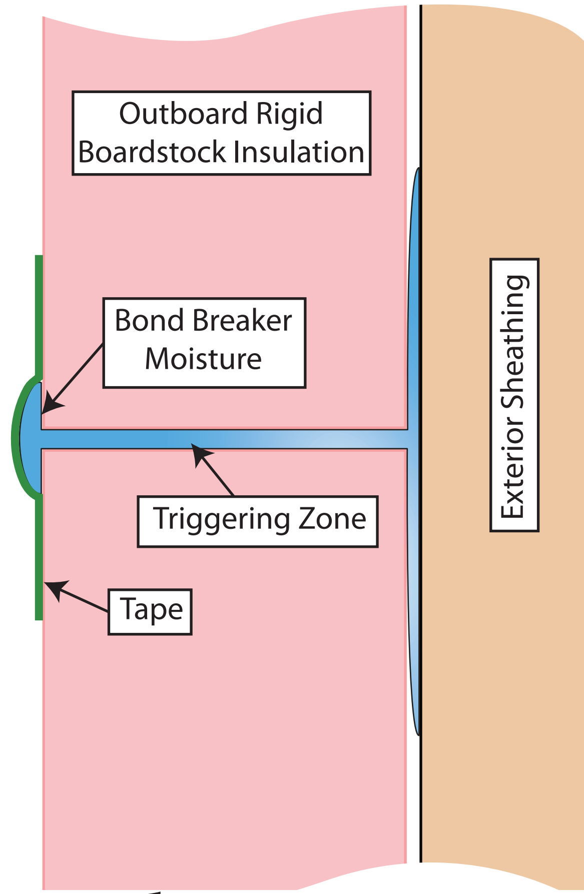
Detail 15

When certain conditions prevail, such as dew points caused by the temperature of the ambient air or temperatures on the surfaces of material that the moisture-laden air moves past, water vapor may condense on and accumulate in the panel joints and on the surface adjacent to these joints. (see detail 16)

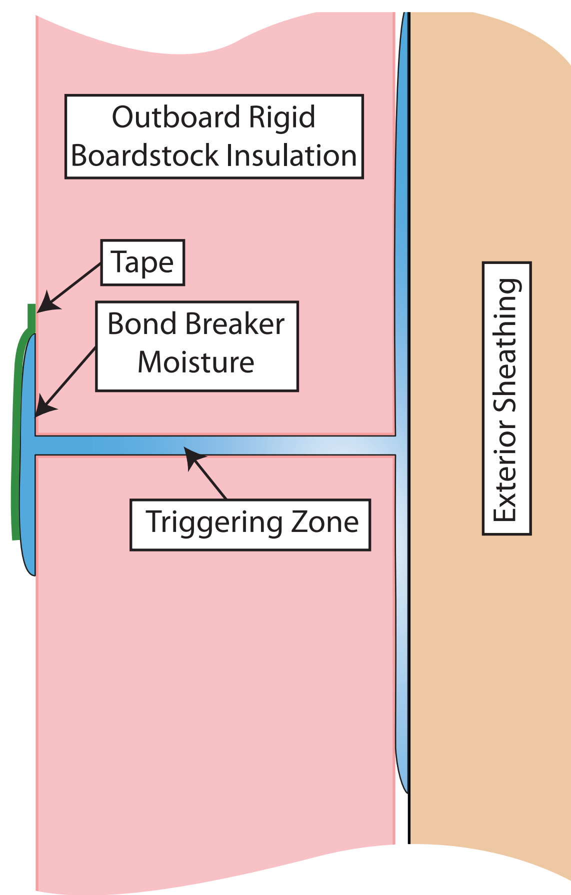


Detail 16

This liquid water will wet the surfaces in these joints and will absorb into their edges and into materials adjacent to the edges of the construction panels. This wetted material will, in turn, conduct temperature more readily than dry material thereby amplifying the negative condition. The failure of tape at the taped joints of large construction material panels may be attributed to this phenomenon. The joints are contaminated with moisture (a very good bond-breaker) before the tape is applied, and the tape's ability to bond is degraded from the inside out. (see details 17 and 18) This condition is exacerbated when the taped seams (joints) fail and moisture is allowed into and behind the large construction panels from the outside in.

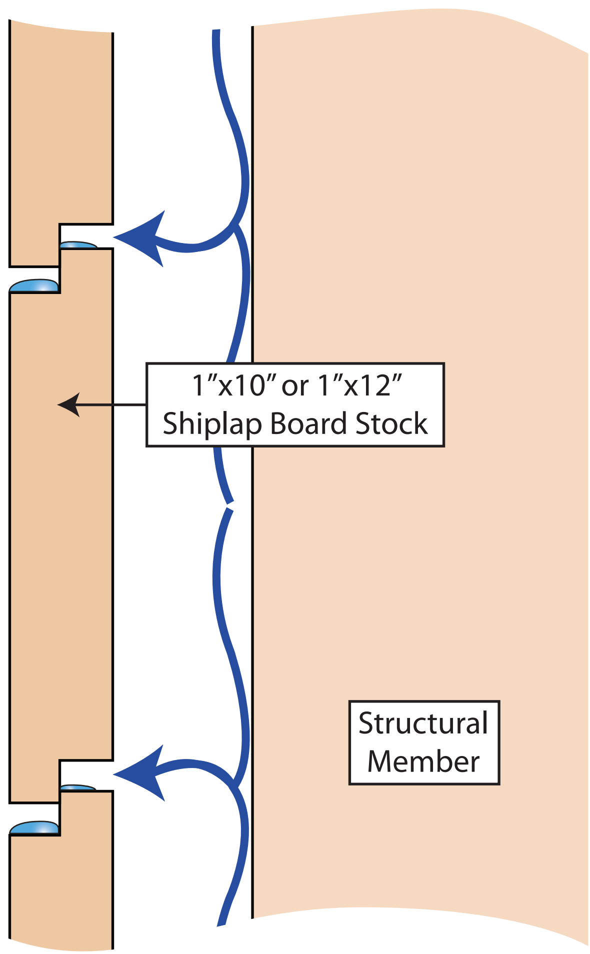


Detail 17

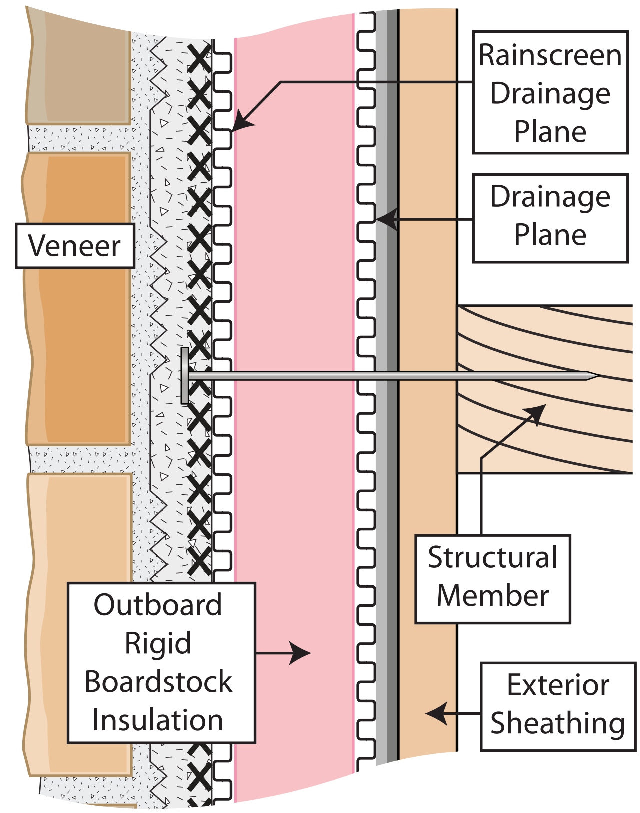


Detail 18

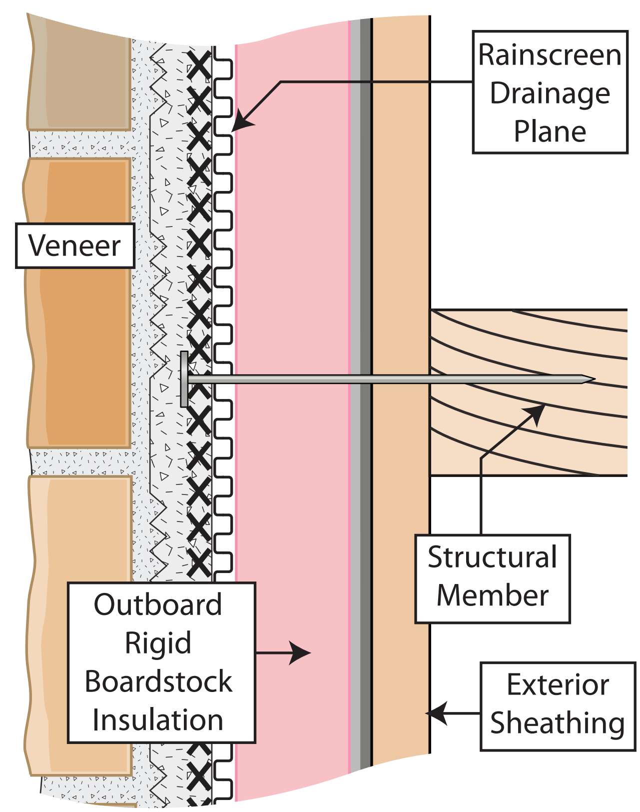
Smaller dimension sheeting and decking materials of the past (1" x 10" and 1" x 12" shiplap boardstock) had more seams (joints) to help disperse both expansion-contraction stresses and air pressure equalization requirements. (see detail 19)



Detail 19



Detail 20

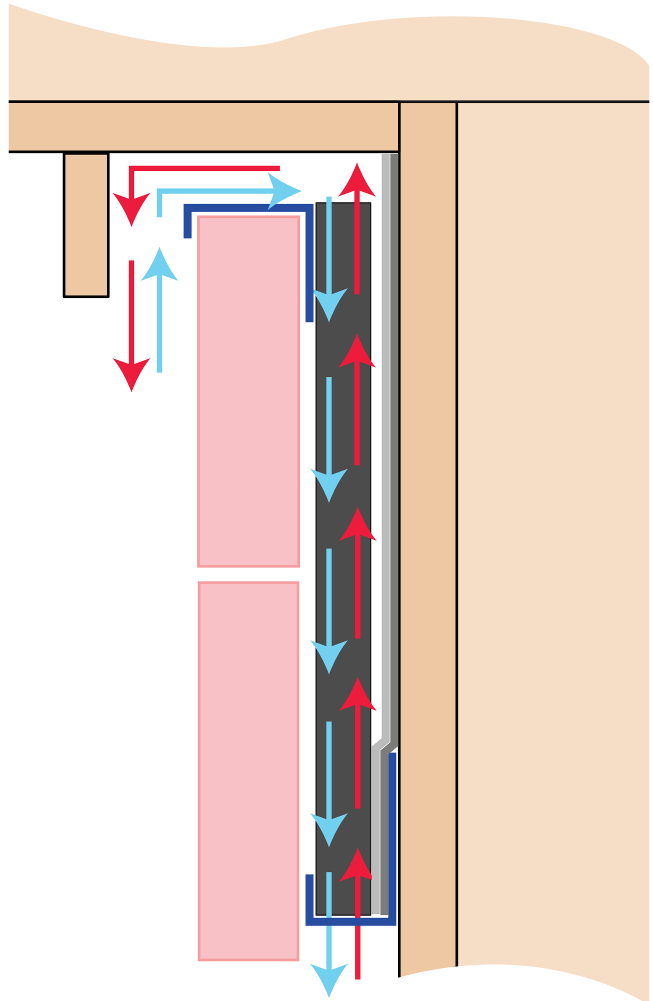


Detail 21

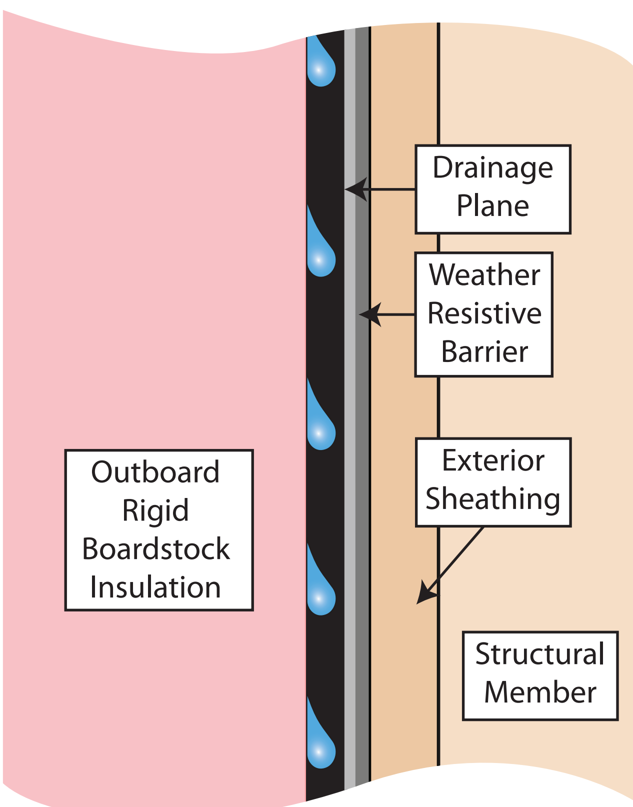
Today's larger construction panels need assistive technology to help them achieve maximal performance. This technology comes from drainage planes and rainscreen drainage planes, technology that has a twofold benefit. (see details 20 and 21) First, the void (or separation) that this technology creates between the layers of the exterior building envelope (exterior sheathing, outbound rigid boardstock insulation and exterior veneers) has, to a small degree, had a positive impact on expansion-contraction characteristics by allowing the movement to be smoother and more evenly dispersed. (They act as slip-sheets.)

The more important impact is that they are designed pathways for moisture that may attempt to accumulate between these layers of construction materials in the exterior building envelope to exit the system in a timely manner. (see detail 22) The design of the rainscreen drainage planes and drainage planes gives fluids (air and water) a more convenient pathway to follow past and away from the more vulnerable construction joints. (see detail 23)

No one can turn back those proverbial "hands of time," and in the case of large dimension material panels used in the exterior building envelope, it's neither possible nor necessary. It is possible and necessary that the construction industry understands that whenever a new material with either a new dimension or composition is introduced into any system, it may (and often will) have a negligible impact on the other materials used with it. We must focus on "holistic" building if we truly want to achieve "sustainable" buildings!



Detail 23



Detail 22