

Total Performance of the Building Envelope

By Laverne Dalglish

We have done our research, we surfed the internet (anything on the internet has to be true), we have talked to other contractors, we tried the material ourselves and we are now convinced that the material we want to install is absolutely the best material ever made.

Maybe I am pushing it a bit here, but we also install material that we like. The reasons we like it is why we have chosen it. As this material is the best, we will never have a warranty claim, be sued for a building non-performing or anything else. Now we have slipped back into la-la land.

The problem we run into is that the ultimate performance of the material depends on things outside our control. Material are put together with accessories into assemblies which they form the whole building system. Many of the reasons why a material is deemed not to perform is beyond our control. Or is it?

Decades ago, we built very simple buildings that were very forgiving, and the owner and occupants were also very forgiving. The house that I grew up in was insulated with sawdust in the walls and shavings in the attic. That was because my dad owned and operated a planning mill. We also heated the house with wood – slabs cut from the logs. That home did not have the problems we face today in our buildings. Now we had single pane check rail windows so when it was -20° F and below, we had frost build up on the glass to $\frac{3}{4}$ inch thick in absolutely beautiful patterns. When the sun came out, that frost melted, turned to liquid water and ran down on the window sill. We place a towel there to sop up the water.

Now build a building like that today and you will be sued before you finish the sentence. What happened? We went from simple designed buildings with simple material to complex buildings using complex materials, which meant the building is not forgiving. Water does not get absorbed by the building materials to be later released later back into the air. Today that moisture, whether caused by liquid water ingress or by the condensation of water vapor because of air leakage, shows up in a building or is hidden to cause rot, mold, corrosion and other bad things.

Today, building performance is dictated by the design, the details of the constructed assemblies, the outdoor environment, the indoor environment and the quality of the installation.

As a contractor, some of these things you cannot do anything about, but some of these things you can. You need to accept that you have to move from being material focused to building assembly focused. You need to understand how your material works in a building assembly when combined with other materials, many of them installed by others. You need to apply building science when looking at where you are installing your material and you need to look at the complete building assembly.

Let me give you an example. The project you are bidding on calls for medium density closed cell rigid spray polyurethane foam. You know the physics involved here, the material is an air barrier, a vapor retarder, a water resistive barrier and it is a thermal insulation. You should have everything covered when you use this material.

As you read deeper into the project specification and as you examine the plans, you realize that the project calls for the material to be installed from the interior onto the back of the exterior sheathing. As you pour through the project specifications, you realize that the spray foam is the designated air barrier and the specifications do not list any other material to be the water resistive barrier or the vapor barrier. As you look

at the physics of heat, air and moisture flow, you realize that this building assembly could not perform as intended.

Now there is no question that spray foam is an excellent insulation, but it is installed between framing members and there is a lot of structural steel in this project (or a lot of wood framing) so the high performing spray polyurethane foam is compromised by the thermal bridges. What may have started out as more than enough insulation on the project, turns out to be much lower once you factor in the thermal bridging. In some building assemblies you are not even meeting the minimum code requirements and this could lead to cold surfaces which then can cause condensation.

Spray foam also makes an excellent air barrier material. However, for the project, it is installed between framing members from the interior. Now as the project calls for the spray foam to be the designated air barrier, you now have to factor into your bid, the caulking and sealing of all the areas not covered with spray foam. These areas include, sealing the stud ends to the bottom plate / track, sealing the bottom plate/track to the subfloor, sealing between the two top plates together, sealing between the stud and cripple on each side of the window, sealing the header to the stud and cripple, and the list just keeps going on. As you calculate all of this, you realize that the cost to do all this additional sealing to make the building assembly airtight can almost cost more than the spray foam. If you do not do all this sealing, then there is no all barrier system.

Medium density spray foam installed at two inches will provide a class two vapor retarder and for this project, that's all that is needed. Now vapor retarders are not required by code to be installed free of holes, overlapped, etc., so the spray foam can provide the function as a vapor retarder.

For this project, the exterior sheathing is a gypsum based material. The manufacturer's technical data sheet seems to indicate that it is water resistant, but you cannot find and testing that was done on the material. You are left with a dilemma that if the project expects your material to stop liquid water from coming into the building, you may or may not be able to provide that function with your spray foam material. You know the material is water resistant and where the material is, there will be no water leakage. You are concerned that the gypsum based sheathing may not be water resistant and may absorb water. In addition, if water gets through the sheathing through joints or fastener holes and it falls on a joint in the framing material, the spray foam material is not there to stop it.

You now have completed your review of the project. You understand building science and the physics of heat, air and moisture flow. The project is a high profile one and you know that the work will be closely scrutinized. You put your bid together, making sure what is clear in the project specs is covered and you give additional pricing for what should be done to ensure building performance, but is not specifically listed in the project specifications.

You turn your bid in on time, a bit apprehensive about the project. You are not the low bidder, so your bid gets rejected. You are disappointed, but somewhat relieved.

Six months pass and you get a call from the general contractor. He needs you to come and fix the project. He tells you don't worry about pricing it, just fix it at any cost. You do all the things you had originally proposed, and the building performs. As this is rework, your final bill comes to four times your original bid.

You play back the whole chain of events as you sit on the beach in the Bahamas, and then you think about how you are going to enjoy the new boat that you just purchased. You also remember to thank the contract who simply looks at the material and installs the material in isolation to the building assemblies and the whole building.

This scenario will repeat itself time and again. We are building more and more complex buildings. As we move to net zero buildings, the materials will perform, but the assemblies may not perform. As we add more and more insulation in a building assembly, the insulation does its job. But now the energy that transported the moisture through the insulation to the exterior is no longer there and now there is a moisture problem.

Contractors need to move from their comfort zone and look at material performance as part of an assembly and not just how their material performs in isolation. Contractors who do this will prosper and grow.