High Performance Detailing

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ABSTRACT

Details are one of the most important, but sometimes overlooked portions of design. A detail that is good or poorly put together can derive success or failure for a project. Many of the details we utilize are repetitive such as a window flashing which occurs many times on a project. Thus, one or two details may have large consequences for the project as a whole if not well put together. High performance detailing is a method to not only more carefully review constructability issues, but also to take more care in defining sequence on a project. Carefully planned details will also allow design teams to review long-term maintenance considerations for the eventual end-user.

WHAT IS A DETAIL

In simpler terms, a drawing set can be viewed as a story, with each material playing the role of a character. Sometimes the characters are not compatible, do not fit well together, cause other problems when the details are left out and may be difficult to work with. Detailing in this analogy is the method by which to progress the story, and depending on how the detail is designed and constructed, the story can turn into a tragedy, a comedy, drama, or a very successful classic that stands the test of time. Details are small portions of the story that need to be successfully interwoven to create a beautiful story that designers and contractors will speak the laurels of over and over again.

A detail is a means to describe critical sequencing in construction, and clear communication of the intent of each material and layer needs to be provided. Although the "means and methods" of construction are left to the contractor team, manufacturer details and installation instructions and the installers, a detail missing large portions of the story may take a classic to a tragedy very quickly.

Detailing as provided in many sets of construction documents are lacking in information and clarity; this is not just the fault of designers, but of the industry as a whole. Owners have trimmed design fees, designers are expected in many cases to use the latest and greatest drafting and BIM tools, many which are more time consuming than simply drafting by hand, and fees for contractors and consultants have also been trimmed. Axonometric step by step details with well described critical sequencing are a better method of reviewing the constructability of details and verifying sufficient materials have been provided. Detailing in this way takes time and deep knowledge in the building technology, enclosure design and many times building science and the construction process to get right.

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Therefore a strategy has to be developed in the context of detailing to provide sufficient information in all details and additional information in critical details for the project. This is essential so that the design intent is clearly communicated to those in the field installing the building system and components.

HIGH-PERFORMANCE DETAILS

High-performance details are highly constructible, durable details and go above and beyond in controlling heat, air and moisture transfer. They are details that are easy to maintain over the life of the building and consider the contractor and end user in their design and construction. They allow items such as facilitating glass replacement on fenestration or re-roofing without removing significant wall components. They require forethought and a good understanding of building and material science to achieve success. They require clarity in the drawings and shop drawings. This creates a complex series of thoughts that must go into the creation of every detail in a design set. This requires verifying all required details are included within a set of drawings and will interface such that performance is predictable and not create problems like thermal bridging or water and air infiltration.

THE SCIENCE BEHIND THE DETAIL

In deriving details for a project, a deep understanding of the robustness, durability and technology behind the materials are needed. This requires well versed knowledge within the team on material science, waterproofing, roofing, air barriers, vapor retarders, insulation amongst the numerous other parameters of any building. An understanding of all aspects of building science, including building physics (heat, air and moisture transfer), acoustics, fire and smoke control, fenestration, lighting and daylighting, is also necessary to better determine the required materials for a successful detail that will perform its role for many years. Although bulk water entry (water infiltration) is still the leading cause of most owner complaints, especially with some portions of the United States seeing more extreme climate due to climate change, the other features outside of waterproofing cannot be ignored.

Design teams should not only invest time up front to develop the impressive renderings that sell a design. They should take time to run initial analytics on the building to determine what conditions each of the materials and systems can be expected to experience now and into the future. From this, durable overall systems can be selected for performance within the environment, and then through the stage of schematic design and design development, the details within a specific building system and at the ever critical interface between systems can be drawn and defined.

In looking at the building physics of details, we can subdivide the details into four major categories, each of which play a role in control of heat transfer, air flow and moisture control. These systems are:

- ***The waterproofing systems***, including roofing, flashings, below-grade and above grade water tightness layers. Main intent – bulk water control. Secondary intent – air tightness and sometimes diffusive vapor control.
- ***The air barrier systems***, including exterior planes of air tightness and interior planes of air tightness. Main intent – air flow control. Secondary intent – boundary condition for HVAC system and sometimes diffusive vapor control.
- ***Thermal barrier system***, including thermal breaks, insulation and glazing. Main intent – control of heat transfer.
- ***Diffusive vapor control system***, including all types and grades of vapor retarders. Main intent – control of moisture movement by diffusive vapor control.

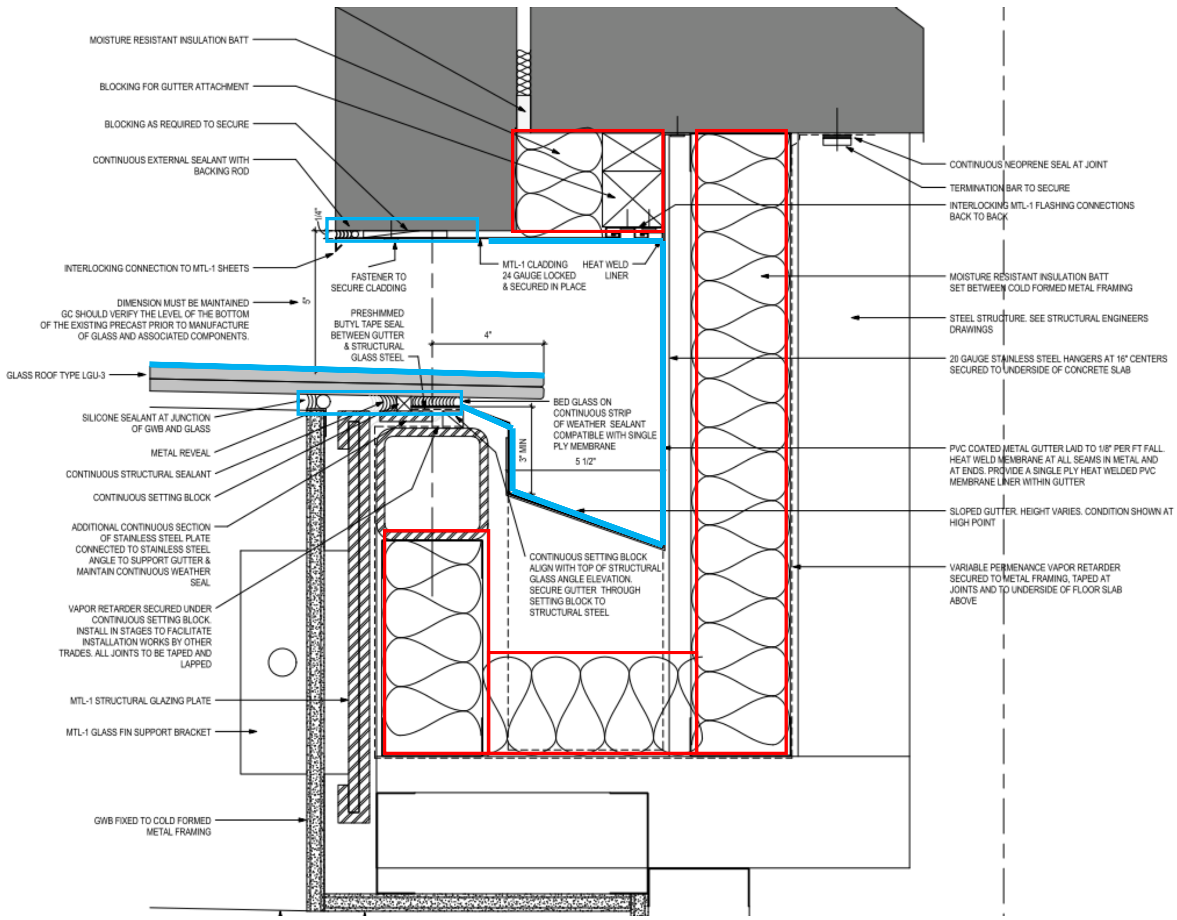
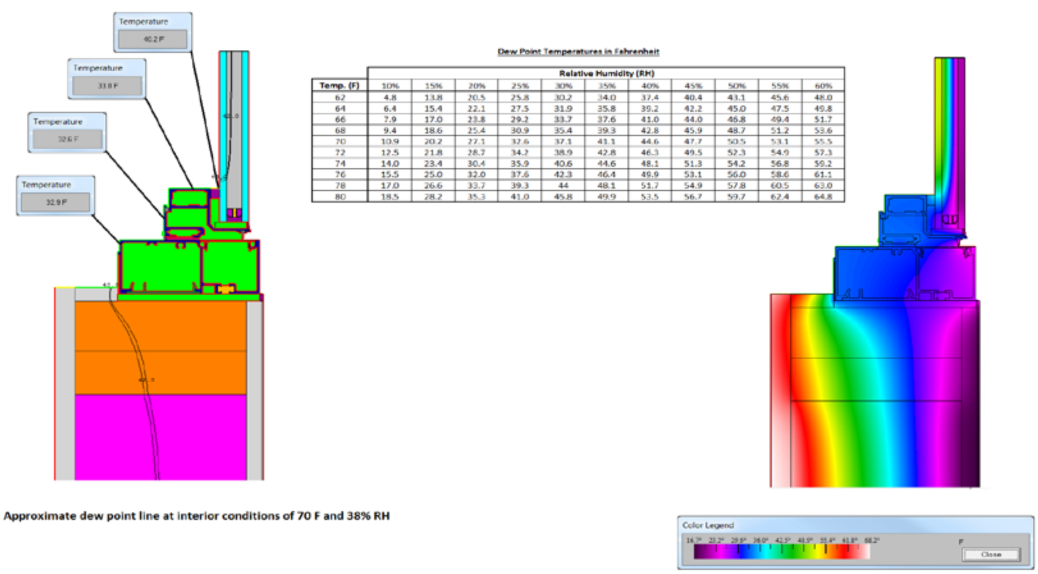


Figure 1: Complex internal gutter detail that provides for water and air tightness (blue line and boxes) and thermal improvement (red boxes). Tracing these out in design helps to facilitate continuity of barriers.

Each of these categories must be fully considered and implemented at each portion of the building enclosure, and at each detail. As a designer or detailer, you must be able trace the line corresponding to each enclosure system around your details and do some critical cross checks. These cross checks are as follows:

- Understand and check the location of dew point and where it is going to occur at varying times of day and at varying times of the year. Knowing this will allow you to pick the locations of the layers for air tightness. This is important especially for control of movement of moisture-laden air, to reduce the risk of this air flow stream crossing a point where the air temperature drops below dew point and results in condensation and moisture accumulation as well as the location of diffusive vapor flow control layers.
- Understand what the 2-dimensional detail is not indicating. This will help determine where axonometric drawings are needed, such as showing end dams and tie-ins at sill pan flashings, and interfaces for air and thermal barrier tie-ins.
- Understand how to show axonometric details in critical sequence, but more importantly, in a constructible sequence. This requires and understanding of the materials, but also the subcontracting trades that will install them.
- Understand that people must build this. That means details must leave room for someone to construct them, layer them and tie them into other details.
- Understand that each material has issues with compatibility – understand what can and cannot be put in contact with each other.
- Do not forget about tolerances. Windows and curtain walls and storefront have different construction tolerances than steel, concrete and many other materials we build with. If you want a ½-in. sealant joint around your window, request tighter tolerances with other materials or state ½-in minimum; contractor to verify other material tolerances will not undermine minimum dimension. Also state maximum acceptable size.
- Moisture and heat make many materials expand and contract; many times at different rates. Accommodate the rates of expansion and contraction in your details.



Dew Point Temperatures in Fahrenheit

Temp. (F)	Relative Humidity (RH)										
	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%
62	4.8	13.8	20.5	25.8	30.2	34.0	37.4	40.4	43.1	45.6	48.0
64	6.4	15.4	22.1	27.5	31.9	35.8	39.2	42.2	45.0	47.5	49.8
66	7.9	17.0	23.8	29.2	33.7	37.6	41.0	44.0	46.8	49.4	51.7
68	9.4	18.6	25.4	30.9	35.4	39.3	42.8	45.9	48.7	51.2	53.6
70	10.9	20.2	27.1	32.6	37.1	41.1	44.6	47.7	50.5	53.1	55.5
72	12.5	21.8	28.7	34.2	38.9	42.8	46.3	49.5	52.3	54.9	57.3
74	14.0	23.4	30.4	35.9	40.6	44.6	48.1	51.3	54.2	56.8	59.2
76	15.5	25.0	32.0	37.6	42.3	46.4	49.9	53.1	56.0	58.6	61.1
78	17.0	26.6	33.7	39.3	44	48.1	51.7	54.9	57.8	60.5	63.0
80	18.5	28.2	35.3	41.0	45.8	49.9	53.5	56.7	59.7	62.4	64.8

Figure 2: Two-dimensional heat transfer of an as-built window placement forensically investigated by the author. Understanding the location of the dew point should have led to better window placement by the original designer in this modernist home.

Successful detailing relies on the knowledge of the detailer, the quality control review during construction and an understanding of the limitations noted above.

MEANS AND METHODS VERSUS DESIGN INTENT

Unlike manufacturing where prototypes are developed and the process of assembly is refined for mass production, a set of construction documents are sometimes ambiguous. They define the "design intent" for the construction of a building system that is typically unique and one of a kind. The documents thus need to provide enough information to make the design intent clear, in a wide variety of conditions along with an understanding of how the materials can reasonably be assembled by the contractor or fabricator.

The "means and methods" is then the actual implementation of the design intent and focuses on how an assembly is to be built but not necessary why. While the assembly of a buildings element may take into account esthetics, it typically also has performance criteria which must be communicated via design intent. This is so that the contractor gains an understanding of the functional purpose of the assembly beyond just esthetics. This will also help inform them to a process of assembly that meets or exceeds the intent

That is not to say the design intent can simply be a profile of an assembly with the "how" of the fabrication left up to the contractor. This approach while expeditious invites a wide range of interpretations of the intent that may leave out critical performance features that once realized are missing, invites additional cost to the project via change orders. Design intent is far more than the big idea as its success is all in the details.

As with any good set of construction documents, the drawings can provide the design intent but they can only represent the graphical solution which has limitations. Here is where the specifications become critical to completing the design intent of the drawings as they provide the necessary technical criteria for the quality, properties, accessories, standards, finishes and other requirements common to the use of the material or assembly throughout the project. They supplement the details but are not a replacement for them. As an example, you don't want to rely on a narrative specification description for necessary end damming or flashing in an assembly and not actually show it in the drawings. It is likely to get missed in bidding, can lead to contentious architect/contractor relationships and does nothing to archive the goal of clearly communicating design intent supported by specification technical criteria. The two go hand in hand.

THE DIMENSIONS OF CHARACTER –
TWO-DIMENSIONAL VERSUS THREE-DIMENSIONAL DETAILS

Communication is an essential part of detailing and there are different ways of showing the details and annotating them. The performance of a detail can be impeded simply by the design intent being unclear. Two-dimensional details can communicate the spacing of components and general layering of materials, but are typically ineffective at communicating how the complexity of a detail is to be constructed. Having critical interfaces like corners shown in axonometric and with some guidance on critical sequencing is important to clarify the components needed to have the detail succeed. The three-dimensional detail can be better at showing the requirements that would mimic the look of the detail in actual construction.

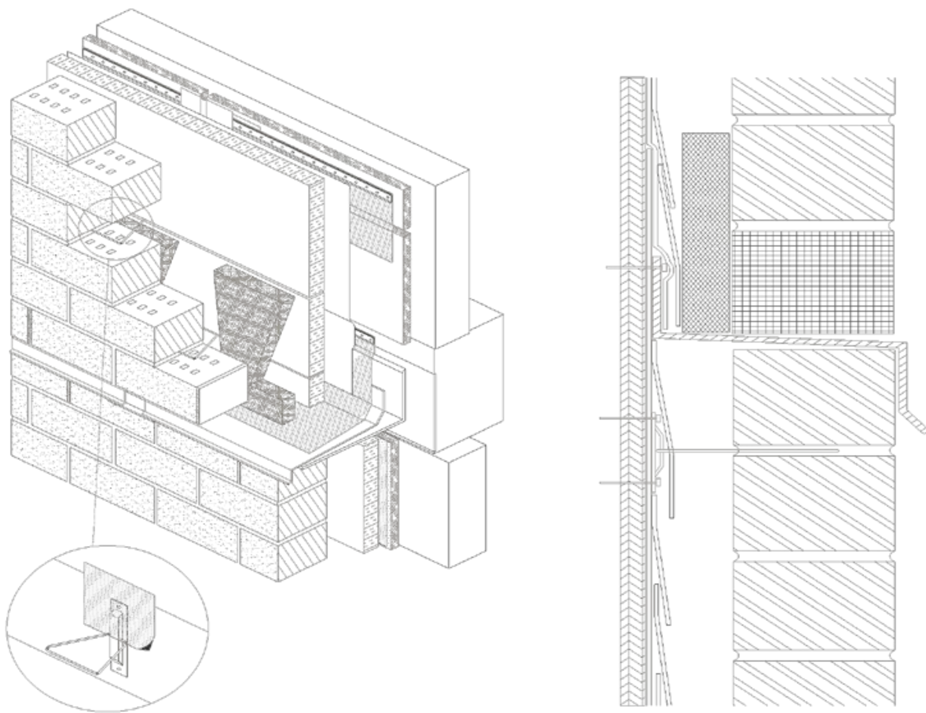


Figure 3: The two-dimensional detail on the right provides clarity in the line weights and hatching, but the fuller detail of counter flashing brick ties is easier to understand in the axonometric.

The performance of the detail can be more readily reviewed for completeness for air tightness, water tightness, and thermal efficiency when shown in three dimensions. Understanding the materials that will be used, the thickness of the materials and the ability for the material to form the detail is then critical to understanding its constructability, as well as the number of trades needed to put the detail together. Each additional trade required increases construction time, but may also increase risk of additional human error in the building of the detail. By using some step-by-step critical sequencing details, some of this can be thought through more precisely.

Although this may increase cost to prepare the design, it will usually result in improved efficiency in construction and durability in the eventual building. The same level of clarity should also be requested in shop drawings. As shop drawings show the intended fabrication of the building and all of its parts, the drawings should be seen in a way that facilitates construction and clearly identifies what trade is responsible for components not supplied or installed by the trade responsible for the shop drawings. “By others” does not facilitate that understanding.

LINE WEIGHT AND SPACING

In this age of digitally modeling our buildings, we have the ability to literally “build” our designs electronically. While this may be technically more accurate, it does not translate well in some instances where the concept of how materials are sequentially put together needs to be communicated to those trades putting the building together. We need to regain the lost art of graphically communicating ideas in how we detail. Those who literally hand drew walls sections and details learned this well. They were creating drawings that communicated ideals with a simple set of line weights, a clear definition of each material and an exaggerated approach to demonstrating each of the various materials within an assembly.

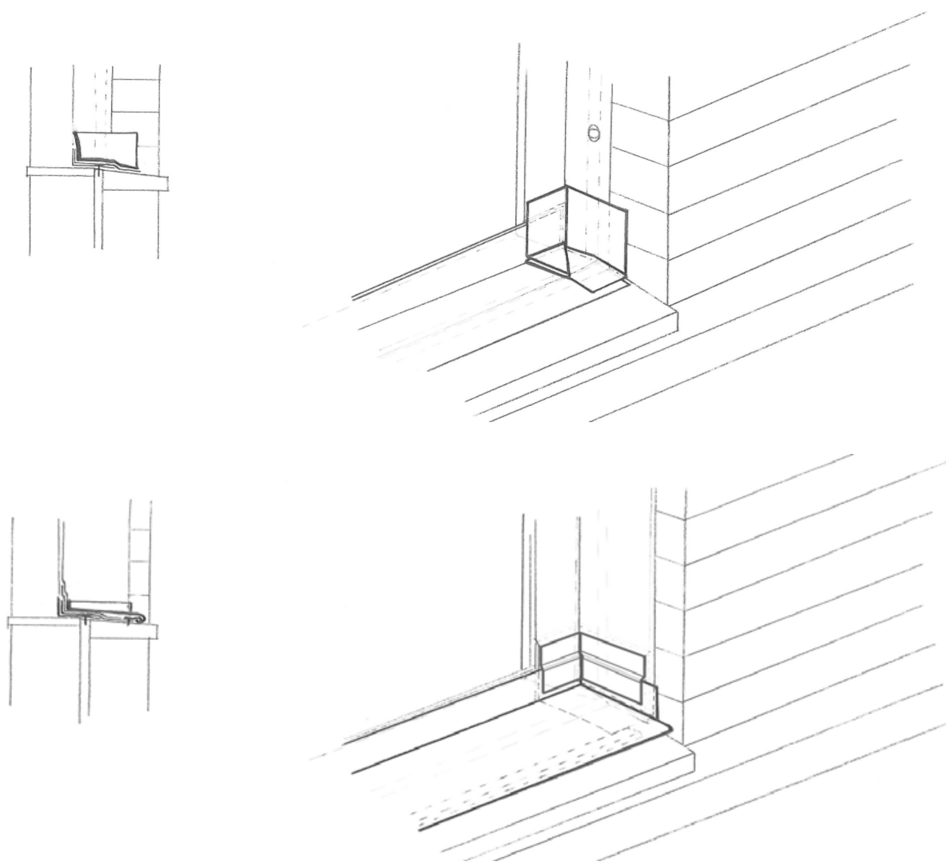


Figure 4: These hand sketch concepts of window flashings allows a designer to think about critical sequencing and components needed for air and water tightness. On this historic building, a low profile sill pan was required.

Today we have the ability to represent the thickness of various materials laid upon one another in an assembly. While this leads to greater accuracy in the digital model, it does little to communicate the design intent of various assembles.

When detailing, think more closely about the graphic communication of the details intent to the trades fabricating and installing the material. Represent membranes with a single think line or dash line. Separate it from other material with sufficient space so that it's recognized as a single material. Remember to create hierarchy in your line weights (three to four is sufficient). A heavy line to represent the exterior outline edges of an assembly, another line to represent the outline of substantial materials, a third for pouches or hatching to distinguish various materials from one another. And a fourth line weight for special materials or conditions that might otherwise get lost in a detail.

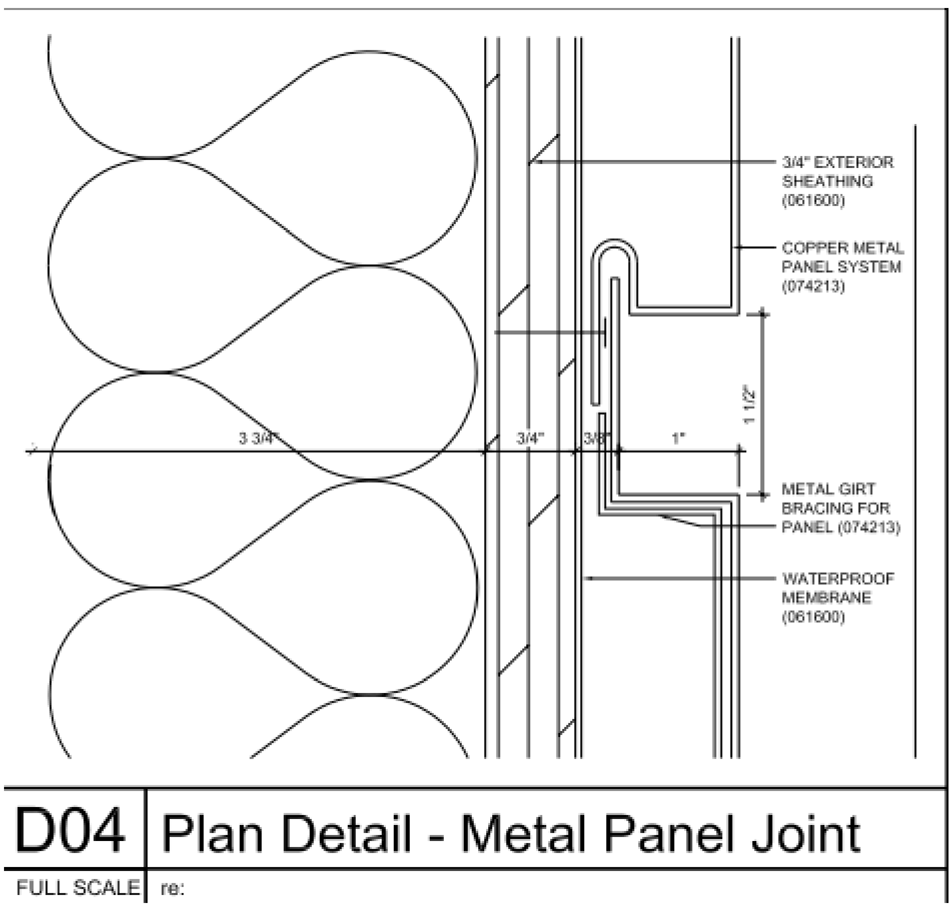


Figure 5: The exaggerated gaps between the metal components provide for a better understanding of the necessary components and interlocks that will be further refined in shop drawings.

This will not result, in some cases, in a detail that is dimensionally accurate (override the dimensioning as needed) but will provide the necessary clarity to communicate clearly your design intent.

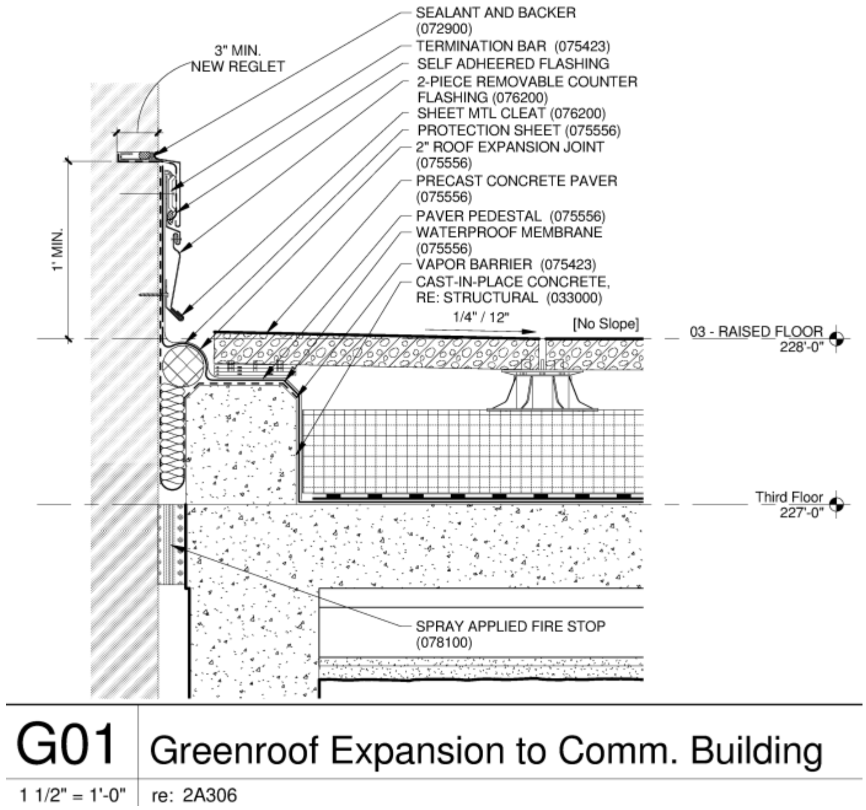


Figure 6: The notes and cross references to the specifications provide clearer guidance to the contractor and installer on the expectations on the project.

CLEAR AND CONCISE NOTES

Notes on drawings that are hard to understand can be seen in two ways:

- concise, but not clear as to what should be done with a material;
- or verbose, and thus the intent lost in the verbiage such that it is also not clear.

Designers are often worried about violating the separation between design and construction (means and methods) and thus tend to err on the side of less is more. However, some components of a detail actually require some guidance. For example, on flashing details, indicating if one component must be installed before another component is an important part of design intent and critical sequencing for details. The notes can offer guidance like lap the membrane onto the sheet metal and give expected dimensions of the lap. It will allow the contractor to better understand the expectations.

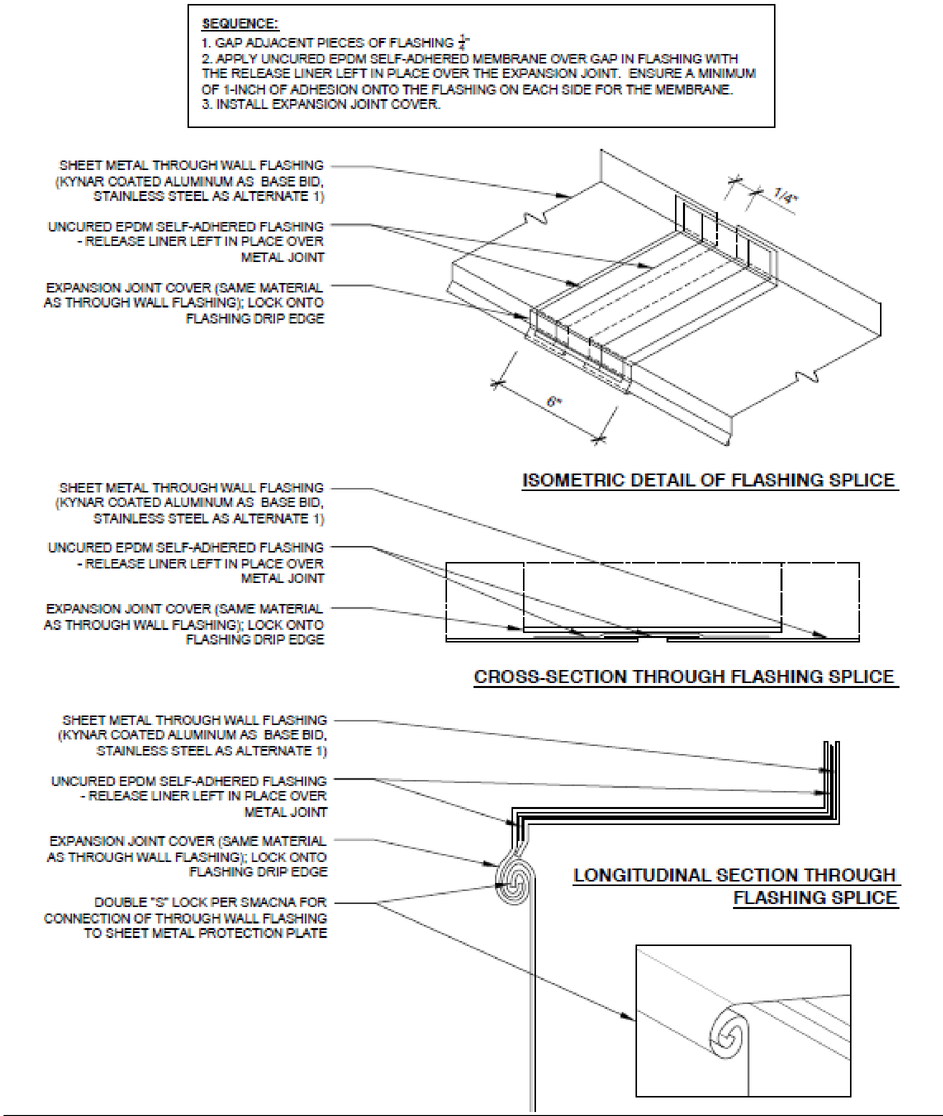


Figure 7: The critical sequence of this detail and the use a variety of graphical representations provide the contractor a better understanding of this flashing splice joint and sheet metal interlocks.

COMPLEXITY MAY NOT BE BEST

The more complex a detail is, the more challenging it will be to construct and thus the higher the chance for errors in the construction. Making the detail simple does not mean simply removing parts, but rather finding ways to meet the intent of that component being removed by possibly utilizing a material already within the detail that addresses that intent, or with a little more effort, can meet the intent. It may mean more carefully picking the materials that will be used to reduce the complexity. Note that some details will still be more complex to construct just because of the geometry or interface condition, but these should be the rarity and not the norm on the project.

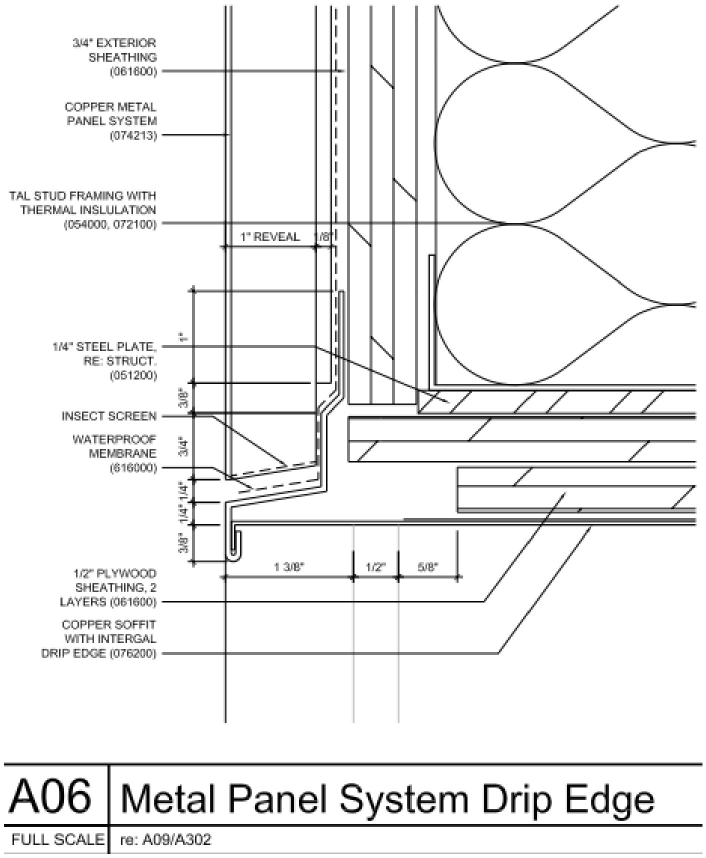


Figure 8: Careful review of the materials provides for a drip edge that also acts as securement for the soffit panel.

By combining building science and technology with well thought through easy to understand details, projects will benefit from less risk of misunderstanding during construction and a more fluid process through building fabrication.

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