

Immersed Adhesion Dynamics

Assessing Liquid-Applied Waterproofing Membranes through Immersed Installation

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In high-performance building enclosures, the water control layer is a critical defense against environmental degradation. While an assembly may be continuous at the time of installation, the inevitable stresses of building aging, thermal cycling, and structural movement can introduce stresses into the system over time. In comparing waterproofing system types, below-grade waterproofing represents a higher risk profile, and product selection to mitigate these risks should be based on performance and not initial material first-costs.

Below-grade enclosure systems are subjected to a relentless battery of unseen stresses: hydrostatic pressure from groundwater continuously exerting force against the structure, structural dynamics and movement, and environmental degradation from constant exposure to the site's sub-grade environment. Because these waterproofing systems are physically inaccessible once the building is complete, designers require more than just a specified product; they require robust assurance that the selected waterproofing chemistry is engineered to withstand the unique, subterranean rigors of the site for the life of the structure.

Liquid-Applied Waterproofing: Advantages and Material Profiles

Liquid-applied membranes are commonly specified for post-applied scenarios where the exterior foundation remains accessible during construction, and prior to backfilling the excavation. Advantages to using these liquid systems include the ability to create a monolithic, seamless barrier and restrict lateral water migration or bypass that is often associated with sheet-good laps or seams. Because the membrane is fully adhered to the substrate, it can prevent water breaches from migrating between the membrane and the concrete structure, localizing a potential leak. The fluid nature of the material also allows for precise detailing around complex geometries, such as pipe penetrations and structural corners, details which can be difficult to seal with prefabricated sheets.

Liquid-applied waterproofing ranges from legacy solvent-heavy asphaltic emulsions to high-solids polymer formulations, each offering distinct performance profiles. Traditional solvent-heavy liquid systems are often selected for cost-efficiency and ease of use, yet the liquid formulation that relies on drying solvents out to create the final membrane may also risk emulsification during prolonged submersion. In contrast, high-solids polymer systems utilizing silane-terminated polymers (STP) or silicones are engineered for the dynamic realities of the built environment, offering advanced crack-bridging and moisture-cure capabilities.

Specify for Long-term Success:

To manage risk when selecting a below-grade liquid membrane, designers should consider specifying beyond the basic minimum standard performance and prioritize comprehensive third-party validation. To ensure long-term performance and reduce project risk, consider the following three guiding criteria:

1. **Prioritize Immersed Adhesion Performance Over Dry Data:** Dry concrete adhesion data alone (ASTM C794) can be misleading. A material that sticks well in a dry lab may lose over 70% of its bond strength once buried in saturated soil. Designers should specifically require immersed adhesion data to ensure the membrane remains a monolithic part of the foundation for the life of the building.
2. **Clarify Inverted Wet-Cup Permeance (ASTM E96BW) Value Requirement:** Standard wet-cup tests (E96B) may show low vapor drive, but the inverted method (E96BW) better replicates the osmotic pressure of standing water against a membrane. High-performance non-asphaltic STP formulations can maintain low permeance under these conditions, whereas traditional asphaltic-modified STP can shift from vapor-impermeable to semi-permeable when comparing ASTM E96 testing methods (B vs BW) of the same material. Choosing a material that stays below the recommended 0.1 perm threshold under E96BW testing can help resist "blister dynamics" that lead to system failure.
3. **Verify Permeance at Specific Application Thickness:** Fluid waterproofing membrane performance can be based on the installed thickness, and designers should ask for permeance values—the absolute measure of the product at the required 60-mil, 120-mil, or specified thickness—rather than relying on general permeability. Because permeability is calculated from thickness, manufacturers can report numbers that appear better than they actually are. Ensuring a low permeance at the actual thickness used on-site is the only way to ensure the specified performance will be present on the jobsite.

Benchmarking Performance

Evaluating and comparing liquid-applied below-grade waterproofing requires moving beyond basic data sheets to analyzing how a membrane interacts with the environment and the substrate over time. Specifying and design professionals can consider three primary standards (*Figure 1*) when comparing and evaluating liquid-applied products for below-grade applications:

- ASTM C836 (*Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course*)
- ASTM C8463 (*Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric, Silyl-Terminated Polymer-Based Waterproofing Membrane for Use with Separate Wearing Course*)
- ICC-ES AC29 (*Acceptance Criteria for Cold, Liquid, Applied, Below-grade, Exterior Dampproofing and Waterproofing Materials*)

Each standard focuses on three critical pillars for waterproofing performance: environmental interaction, substrate bonding, and chemical composition. Because these factors define the functional needs of a project, professionals should favor products with comprehensive testing data to de-risk the waterproofing selection process.

Performance Property	ASTM C836	ASTM C8463	ICC-ES AC29
Resistance to decay		●	●
Resistance to water	●	●	●
Remain in place during application	●	●	●
Adhesion Strength	●	●	●
Hydrostatic Pressure		●	●
Low Temperature Crack Bridging	●	●	●
Extensibility after heat aging		●	●
Hardness	●	●	
Weight loss	●	●	
Cure-through		●	
Water vapor transmission		●	●
Stability	●	●	●

Figure 1

All testing criteria are based on current ASTM and ICC-ES acceptance criteria for cold liquid-applied elastomeric waterproofing membranes. Blank cells indicate properties not specifically addressed by that standard.

A critical, often overlooked factor for long-term durability in saturated soil is the prevention of osmotic blistering in liquid-applied membranes. Recent research¹ suggests that standard dry-adhesion tests (ASTM C794) do not accurately predict performance in the field. Therefore, designers should consider immersed adhesion data to ensure the membrane remains bonded in saturated soil. While ASTM C836 provides a baseline for elastomeric properties, more rigorous analysis is required to understand a material’s resistance to the impacts of water, such as blistering, moisture drive, and continued adhesion.

Quantifying Immersed Durability

Recent publication¹ by Henderson et al. highlights a significant gap in our understanding of "blister dynamics" of waterproofing membranes, noting that standard dry-adhesion tests and traditional wet-cup permeability (ASTM E96B) do not accurately predict how a membrane will behave under a standing head of

water. To mitigate the risk of system failure, the paper recommends evaluating materials using the inverted wet-cup method ASTM E96BW, as it serves as a superior proxy for real-world osmotic flow and long-term water absorption. This is because in a standard wet-cup test, the membrane only faces vapor; in the inverted test, the material is in direct contact with the liquid, which more accurately simulates the "standing head of water" found in saturated soils

When comparing these technical metrics, it is vital to distinguish between permeance and permeability. Permeance is the absolute measure of a material's performance at a specific thickness, whereas permeability is a calculation of permeance multiplied by thickness. Manufacturers often interchange these terms, but for a reliable design, specifiers should request the permeance value specifically at the thickness intended on the job site.

For high-performance concrete structures, the research¹ suggests a target permeance of less than 0.1 g/m²/day to ensure the membrane remains stable and prevents water from migrating into the slab. By prioritizing products that can achieve the low-permeance benchmarks of ASTM E96BW for demonstrating stable immersed adhesion, professionals can de-risk their waterproofing selection against the forces of the below-grade environment.

Comparative Case Study: Validating Performance

To move from theoretical standards to practical application, an in-house evaluation compared four liquid-applied materials: one non-asphaltic STP (a) and three asphaltic-modified STPs (b-d). By isolating variables like immersed adhesion and inverted wet-cup permeance, the study demonstrates that while traditional data sheets may provide acceptable values under the given test methods, they certainly fail to reflect how these materials may actually perform once they are actually in the ground.

Performance Property	Siplast TeraPROOF STP (non-asphaltic STP)	Material B (asphaltic-modified STP)	Material C (asphaltic-modified STP)	Material D (asphaltic-modified STP)
Reported Standards	ASTM C836, ASTM C8463, ICC-ES AC29	ASTM C836, ASTM C8436	ASTM C836	ASTM C836
Dry Concrete Adhesion, ASTM C794, [pli]	12	14	8.3	3.4
Immersed Concrete Adhesion, ASTM C794, [pli]	13	1.8	0.79	0.21
Permeance at 60 mils, ASTM E96B, [perm]	0.70	0.10	2.6	0.20
Permeability, ASTM E96B, [perm*inch]	0.040	0.0060	0.16	0.012
Permeance at 60 mils, ASTM E96BW, [perm]	0.4	3.1	2.1	2.4
Permeability, ASTM E96B, [perm*inch]	0.024	0.19	0.13	0.14

Figure 2

Table demonstrating several performance properties of Siplast TeraPROOF STP (non-asphaltic STP) membrane vs asphaltic-modified STP membranes found on the market today.

Values shown derived from Siplast in-house laboratory testing. All testing performed according to the applicable ASTM standard listed for each property.

The data from this analysis² reveal three critical takeaways for comparing membrane performances (Figure 2). First, dry concrete adhesion (ASTM C794) is an unreliable predictor of field performance; while all materials adhered well initially, the asphalt-modified STP materials saw a significant loss of bond strength under immersed conditions.

Second, while several materials showed low permeance in the standard wet-cup test (E96B), their performance shifted toward "semi-vapor-permeable" when subjected to the inverted wet-cup method (E96BW)—the method most relevant to below-grade structures.

Finally, the study confirms that permeability is an inconsistent indicator vs permeance for water migration within a below-grade (immersed) application. Designers should evaluate permeance values based on the project-specified thickness, ensuring the installed barrier meets the intended thresholds for long-term moisture resistance.

We can see this when we look at a projection of the weight of water seen permeating through the membranes over time when there is a standing head of water (*Figure 3*). Using the data collected over the 240 hours of testing to project linearly over time, we see that the asphaltic-modified STPs will allow a considerable amount of water through per square foot of membrane; – while the non-asphaltic STP shows a marginal amount of water permeating through.

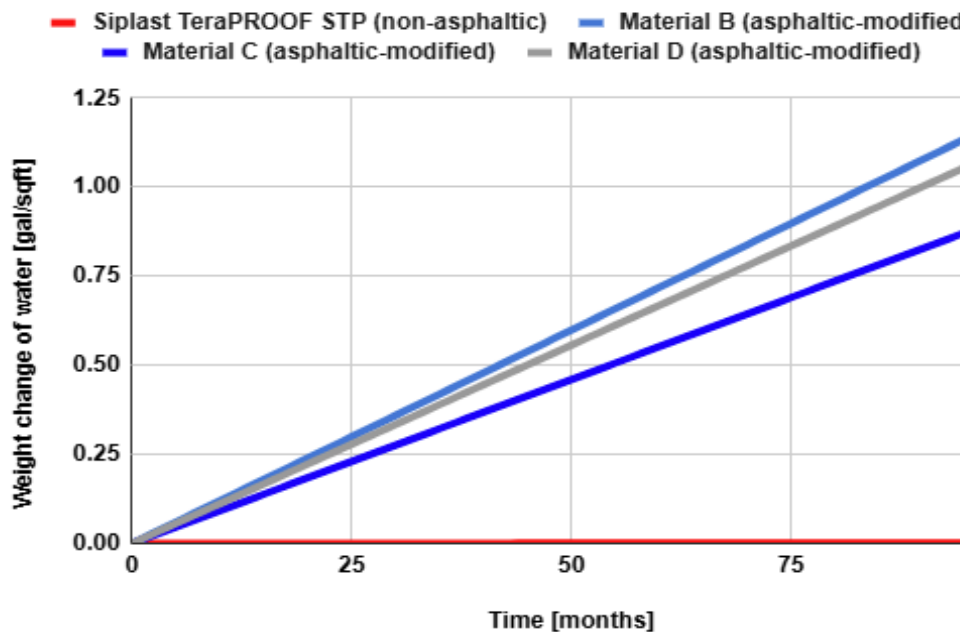


Figure 3

Projected volume of water per square foot of membrane for asphaltic-modified STP membranes versus a non-asphaltic STP membrane. Projection is a linear extrapolation of data derived from 240 hours of testing completed on the materials in accordance with ASTM E96BW.

To put this in perspective, consider a 10,000-square-foot membrane-protected area continuously immersed in at least 3 inches of water over a 24-month period. Within two years, 15 to 20 gallons of water can permeate through the asphaltic-modified membrane systems (*Figure 4*). Permeation of this much water through a waterproofing system designed to keep water out, and with limited drying potential, could lead to membrane blistering, structural corrosion, or deterioration of critical building components over the building's life. Continuous immersed conditions – combined with the multitude of extreme pressures from building movement and potential deterioration from soil contaminants – only compound the potential for this volume of water intrusion to increase.

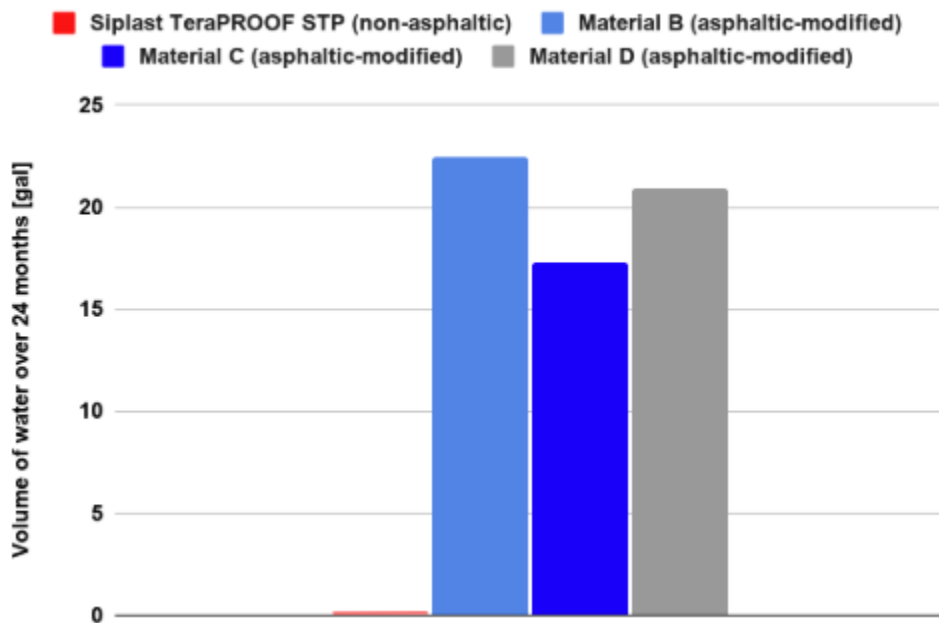


Figure 4

Projected volume of water in a 10,000 square foot area of membrane-protected surface below grade for asphaltic-modified STP membranes versus a non-asphaltic STP membrane. Virtually no value is shown for the non-asphaltic STP (estimated to allow 1/10 of a gallon of water through the membrane). Projection is a linear extrapolation of data derived from 240 hours of testing completed on the materials in accordance with ASTM E96BW.

A resilient design is built on data that reflects what should be relevant to the application on the job site rather than the ideal conditions of a laboratory. Understanding the application, material options, and performance values provided by manufacturers can enable the project specification to perform as designed, even in the most challenging of applications, like below-grade waterproofing.

References

¹Henderson et al., *Understanding Blister Dynamics in Below-Grade Waterproofing*, 10.1520/STP161720180085.

²Siplast laboratory testing conducted between June 2023 and June 2025. See testing footnotes.

Testing Footnotes

All testing referenced was conducted by Siplast in accordance with the ASTM standard or ICC-ES criteria referenced, using three samples of each material. The tables and graphs included throughout this document represent typical samples from the testing. For material selection and analysis, three key asphaltic-modified STP products, and one non-asphaltic STP product currently available in the market were evaluated. These products are all listed with a passing adhesion peel rating after membrane immersion and testing in accordance with ASTM C836 (C794).

Disclosure

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