the construction specifier

A Blindside Waterproofing Primer

Factors to consider when selecting the correct membrane

by Wendy Talarico, LEED AP

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THE PRIMARY PURPOSE OF BELOW-GRADE WATERPROOFING IS NOT TO KEEP WATER OUT OF THE BASEMENT, ALTHOUGH THAT IS AN IMPORTANT CONSIDERATION. RATHER, ITS ROLE IS TO PROTECT THE FOUNDATION AND THE ENTIRE BUILDING STRUCTURE FROM THE DAMAGING EFFECTS OF LIQUIDS AND VAPORS.

In his classic book, *The Manual of Below-Grade Waterproofing Systems*—published by John Wiley & Sons in 1999—Justin Henshell, FAIA, lists criteria for selecting the right waterproofing for the job. These include:

- the nature of the soil;
- hydrostatic pressure;
- the location of the water table;
- substrate stability;
- building occupancy; and
- the construction method to be used.

> Blindside, sometimes also called pre-applied, waterproofing is a term used to define the membrane type as well as the installation process.

USING BLINDSIDE AT THE ARIZONA CENTER FOR LAW AND SOCIETY

Shown on page 1, the new Arizona Center for Law and Society at Arizona State University (ASU)'s, Sandra Day O'Connor College of Law in Phoenix is situated on a full city block, bordered by busy streets. The six-story, 24,150-m² (260,000-sf) building, designed by Tomas Rossant of Ennead Architects in collaboration with Jones Studio, makes full use of its site with a large internal court, gardens, and two levels of below-grade parking. There is also some habitable below-grade space, including offices and support spaces.

The waterproofing system is "always a number one concern for us," said Ennead's associate partner, Gregory Clawson, AIA, LEED AP. "It is essential to the building's longevity."

With streets on all four sides, there was little room for staging materials, let alone excavating. The foundation extends 9 m (30 ft) below grade. While the slab is still far above the water table, it was necessary to waterproof the walls to protect them from storm runoff and sprinkler system moisture. The slab is protected by a vapor retarder.

The first challenge after the pit was dug was figuring an entry route and staging location for foundation materials. The excavator created a soil ramp on the south wall. All construction vehicles and cranes relied on the ramp for access. Since there was little room for staging, materials were brought only as needed.

The soil retention system is a layer of shotcrete. This was followed by a layer of drainage board, then a blindside membrane, which was selected for a number of reasons.

"When you only looked at the performance tests on the data sheets, all of the membranes that were considered were almost the same," says Ryan Olsen, project engineer for Firestop Southwest in Phoenix. "It was only when we all started talking about detailing that the differences became clear."

For example, there were more than 900 soil nails to detail. To protect these, some manufacturers require dome-like boots that protrude from the walls. Olsen was certain most of these costly boots would be damaged as the steel workers hoisted the rebar cages.

There were similar concerns about detailing the anchors used for hanging rebar. These are placed by drilling through waterproofing material, so it was essential the membrane be carefully repaired around these penetrations.

To solve this, standard nail-patching procedures provided by the company should be followed. The nail should be cleaned, liquid waterproofing material should be applied in caulk form around the edges of the nail plate, and this assembly should be covered with a layer of cold-applied liquid waterproofing embedded with detail fabric.

Again, redundancy is the solution for a watertight application. In the end, the team realized it was more cost-effective and faster to follow these steps at each of the nails than to install boots.

There were other cost advantages to the selected pre-applied membrane. The rolls are light enough for one installer to lift and carry and the peel-and-stick seams are easy to work with.

The foundation wall itself was composed of another layer of shotcrete. Not all membranes will accept shotcrete as it puts a lot of pressure on the seams and may cause them to split. It is best to discuss this with the manufacturer.

Transitioning the waterproofing from the foundation level to the plaza deck involved leaving an excess of 203 to 304 mm (8 to 12 in.) of waterproofing at the top of the wall and protecting it with layers of plastic.

"The below-grade waterproofing was done for almost a year before we started work on the plaza deck," Olsen says. "In the past, we've rolled the excess membrane onto polyvinyl chloride (PVC) pipe and covered it up. Both techniques work."

Hanging black waterproofing on a wall in the Arizona heat was trying for workers and for the materials used. Temperatures reached upward of 43 C (110 F).

"That means the material was 65 C (150 F)," Olsen says. The solution for the contractors was to work nights and early mornings, but extreme heat may cause problems with any waterproofing membrane—conventional or blindside. Once again, one should check with the manufacturer.

Perhaps the trickiest part of the job was transitioning from blindside to conventional waterproofing along the south wall, where there was just enough room for cast-in-place concrete. Still it was tight—with only 3 m (10 ft) to work with, the concrete was poured in lifts of about 1.5 m (5 ft), the waterproofing installed, then another 1.5 m of concrete, and so on until the wall was complete.

Once again, the contractors left a skirt of the blindside membrane—about 304 mm (12 in.) long—from either side of the east and west walls. The membrane was pulled around the concrete and lapped under the conventional waterproofing.

The Arizona Center for Law and Society is not the typical law school or the typical law school building. Its goal is to connect with the local residents and make legal processes transparent and accessible. The building design supports this with an open park-like plaza, an upturned 'come on in' entry, and other features. The waterproofing system is not as visible as the curtain wall assembly, for example, but it is just as complex, interesting, and important. **CS**

The soil retention system is a layer of shotcrete. This was followed by a layer of drainage board, then by a blindside membrane.

Photos courtesy W.R. Meadows

One more criteria can be added to that list: access. On most new construction projects where there is plenty of land, a site is excavated, the foundation is poured, and traditional waterproofing is applied to the outside of the foundation wall. There is maneuvering room for heavy equipment and space for staging building materials. However, this is not always possible where space is limited or where sites are hemmed in by other buildings, infrastructure, or tight lot lines. The solution in many of these circumstances is blindside waterproofing.[1]

Blindside, sometimes called pre-applied, is a term used to define the membrane type as well as the installation process. It reverses the typical application—the waterproofing is installed before the foundation is poured. The membrane is applied to the soil support (*i.e.* shoring, sheet pile, slurry wall, rock, or the structure of the neighboring building) and then concrete or shotcrete is applied against the membrane. In short, the concrete is applied to the waterproofing. Attachment to the soil support system is temporary. The real goal of blindside is to adhere to the concrete.

Various pre-applied applications have been around since the advent of the zero lot line in urban settings. Around 1900, brick and stone foundations were typically waterproofed—usually parged—with bituminous materials. Concrete was a rare material at that time, but had already started to make its way into the foundation wall.

According to *Kidder Parker Architects' and Builders' Handbook*, the first blindside membranes were "multiple layers of burlap or felt swabbed with hot pitch or asphalt… applied over the [drainage] tile and covered with bricks." Foundation walls were then erected against this system.

As buildings moved toward concrete foundations that incorporated more steel, keeping moisture out became a priority. This is even more important now as foundations go deeper and more purposes are assigned to these below-grade spaces.

Within the past 50 years, soil retention systems have become more sophisticated, thanks to better:

- technology;
- construction techniques;
- soil nailing and anchoring; and
- excavation supports.

The geotechnical engineer may work hand-in-hand with the structural engineer and the architect to create a foundation as complex as any other building systems.

The most typical use for below grade space is likely the parking garage, though there is no official statistical data on the subject. Hospitality projects, for example, employ underground square footage for exercise rooms, information technology (IT), record storage, conference rooms, and even 'wine cellar' restaurants. Medical projects may use this space imaging equipment in order to help shield radiation and minimize vibration.

Another reason some are designing deeper foundations is to increase the allowable glass above. Updates to the *International Energy Conservation Code* (*IECC*) are limiting the amount of permissible glass on buildings. The 2015 code calls for a 30 to 40 percent window to wall ratio. The easiest way for a designer to meet this requirement while maximizing the amount of permissible glass, is to follow the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 90.1, *Energy Standard for Buildings Except Low-rise Residential Buildings*. This standard allows the architects to factor in all the building wall surface areas, including those located below-grade, when calculating the window-to-wall ratio.

Challenges ahead

Blindside projects take planning and forethought. Things quickly get complex because applying and detailing waterproofing ahead of the foundation pour is a matter of anticipating problems and weak spots.

However, this approach also means sites with little access—often valuable urban infill locations—can be made usable. It is ideal for:

- buildings on office, medical, or college campuses;
- tunnels and other transportation venues;
- pits; and
- additions to existing buildings where access is blocked by parking garages, roads, or other infrastructure.

Pre-applied can be used throughout, forming a 'bathtub' encasing the entire foundation in waterproof material. This means water and, in most cases, vapor from beneath the foundation is also controlled, which can be significant to the building's health and longevity.

However, many jobs use blindside along one or two walls and then combine with vapor retarders at the slab or to conventional waterproofing along walls with greater access. Blindside can also be used for renovation projects. How it is used depends on site conditions and regional practices. In the Southwest, for example, the practice may be used on the walls, but a vapor retarder is considered adequate where the water table is low. (See "Using Blindside at the Arizona Center for Law and Society".)

Even where there is plenty of space, excavating large areas means disturbing the existing ecosystem more than necessary. Use of blindside waterproofing means less excavation and potential to benefit from Leadership in Energy and Environmental (LEED) credits for minimizing site disturbance. Even for projects not pursuing LEED, it may be a priority of the landholders to preserve plantings and animal habitats.

Alternatively, a site may be close to an old landfill, industrial waste area, or other source of contamination. Churning the soil in these areas may mean digging into hazardous chemical locations. The U.S. Environmental Protection Agency (EPA) estimates there are more than 450,000 brownfields in the country.

Waterproofing a true brownfield site is beyond the scope of this article, but it is not unusual to work at a site near a brownfield. In these cases, the geotechnical engineer will provide guidance—which may include steering the project away from excessive excavation and toward blindside methods.

Choosing a membrane

A blindside membrane must, first and foremost, adhere tightly to the concrete. Since it goes in early, it must also be tough enough to withstand foot and even truck traffic. While it relies upon the soil retention system to form a substrate for its application, the membrane must stay put once that system falls apart, sags, and reacts to the pressures of soil and water. This is a tall order.

Detailing the anchors used for hanging rebar are placed by drilling through waterproofing material, so it was essential that the membrane be carefully repaired around these penetrations.

There are many choices for membrane materials, but they fall into roughly two categories: bentonite and composites. These adhere to the concrete either mechanically or chemically, depending on the materials used.

Bentonites

Bentonite is a group of clays that, when in contact with moisture, expand and seal to irregular surfaces, penetrations, cracks, and voids in concrete. It is a good choice for blindside applications due to its ability to repair itself, but it also has a tendency to migrate away from the foundation if there is enough water.

It is essential to keep bentonite confined and compressed against the foundation walls. In the past, installers relied on the soil retention system to accomplish this. However, these systems shift and degrade, so manufacturers are now placing the clay between multi-layered sheets of geotextiles or plastics to add tenacity and strength. These sheets may also function as vapor barriers, as bentonite alone is not effective in this regard.

Composites

Composites are proprietary mixtures that include layers of bituminous materials and/or plastics laminated for strength and durability. A common ingredient is polymer-modified

The entry route and staging location for foundation materials was created by the excavator as a dirt ramp on the south wall for vehicles and cranes to access the pit.

asphalt. This is asphalt with performance-boosting additives, such as styrene-butadiene-styrene (SBS).

Some membranes incorporate high-density polyethylene (HDPE), polyvinyl chloride (PVC), butyl rubber, or thermoplastic polyolefin (TPO). Others include woven and non-woven geotextiles. Every manufacturer offers its own proprietary formula.

Membranes are tested based on a series of ASTM standards that include tests for resistance to hydrostatic head, elongation, tensile strength, and puncture resistance. Some manufacturers have modified the standard tests to create their own performance criteria. There is some debate over whether this is valid. Regardless, ASTM tests provide an unbiased platform for the evaluation of performance.

Testing is just part of the picture when it comes to evaluating a manufacturer and a membrane. The potential for problems is present regardless of which membrane is used. There is no single blindside product or brand right for every jobsite.

The foundation wall was composed of shotcrete. Not all membranes will accept shotcrete as it puts a lot of pressure on the seams and may cause them to split and it is best to discuss this with the manufacturer.

Adhesion and seams

Two types of adhesion are utilized in creating the blindside bond to the concrete: chemical and mechanical. Chemical adhesion means a proprietary adhesive is applied to the face of the membrane and protected with release paper. When that paper is removed and the concrete is poured, there is a chemical reaction bonding the two.

Mechanical adhesion involves the penetration of the concrete into a fleecy layer of membrane. Some manufacturers say the heat of hydration also plays into this, allowing inner layers of material to melt and bond to the concrete.

Both systems work when installation is done properly. Special attention needs to be paid to the horizontal application. All membranes must be cleaned by vacuum and blower before the concrete pour or a protection slab, which must be monolithic with the structural pour. Standing water has to be removed. This is essential to create a clean ‘canvas’ and facilitate full bond at the slab and lower corners.

According to energy codes, the waterproofing should meet the air barrier at the sill or above grade, usually via some type of transition membrane.

The Arizona Center for Law and Society, designed by Tomas Rossant of Ennead Architects in collaboration with Jones Studio, is a 24,154 m² (260,000 sf) structure in the heart of Phoenix.

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Standing and stormwater is especially problematic with bentonite as both will cause premature hydration. In other words, the clay absorbs the water and swells ahead of the installation of the foundation. There are differing opinions on how detrimental this is. Some manufacturers say this hydration is not harmful to the performance of the membrane, as long as the clay is still tightly sandwiched between the protective sheets and is undamaged.

There has to be a good system for seaming the sheets and accomplishing end laps. Most manufacturers offer a peel-and-stick adhesive along the selvedge, while others rely on adhesive tape. Many offer a caulk-type product for covering end laps (which must overlap the adjacent sheet by several inches) or covering seams. Some designers say it is best to specify the peel and stick seam and top it with tape or the caulk-type material—the belt and suspenders approach. It is imperative these detail materials offer the same opportunity to bond with the concrete as the rest of the membrane. Redundancy is always a good idea below grade.

Numerous penetrations, protrusions, and cuts will have to be detailed on even the simplest jobs. According to energy codes, the waterproofing should meet the air barrier at the sill or above grade, usually via some type of transition membrane. Manufacturers should provide a suite of materials to accomplish all these requirements, such as:

- termination bars;
- preformed boots to cover anchors;
- liquid detailing materials;
- reinforcing mesh; and
- transition membranes of various widths.

Most manufacturers also provide standard details that show how to trim out penetrations and cuts.

Hitting the wall

Soil retention systems are rarely flat and smooth. They usually have step backs, and changes in grade, materials, thicknesses, or angles. Yet, they form the substrate for the waterproofing. The concrete will conform to the wall and so the pre-applied membrane must flex as needed.

The backup wall needs to be as smooth and sound as possible. This is especially true for some of the stiffer plastic sheets that offer limited flexibility. Achieving a smooth wall is accomplished by covering the substrate with plywood and filling voids with patching compounds. Additionally, protection board and insulation will help and may provide a slip plane as the retention system shifts. Drainage boards help alleviate hydrostatic pressure, thereby contributing to the longevity of the system. It also helps make the backup wall smoother.

The horizontal base must be similarly level and even. Gravel has to be properly sized and compacted, and a mud slab is always a good idea.

The prep work does not end there. Installers may have soil nails, ties, and anchors—which stabilize retaining walls—with which to contend. Additionally, there is likely a ‘thicket’ of rebar to detail. Each manufacturer offers

The new $130-million, six-story Arizona Center for Law and Society opens itself up to the public as a place where society and the study and practice of law converge.

slightly different detailing techniques, but redundancy is common. Typically, some type of liquid membrane is applied, followed by a layer of membrane or reinforcing tape, all topped with more liquid.

Corners, changes in plane, backup wall material, joints, and transitions also require additional detailing. This is a good time to talk to the manufacturer and find out what it recommends. Those details should be clearly drawn and included in drawing sets. Leaving it up to contractors can be disastrous, no matter how experienced they are.

Going onsite

All of this is great advice, but it is what occurs onsite that really matters. Waterproofing contractors require good instructions. Installation processes should be clear, easy to understand, systematic, and as simple as possible. 'Think like a contractor,' should, perhaps, be the mantra when it comes to product development.

For example, many designers will select material that comes on a wide roll thinking it will mean fewer seams, which are one of the areas of vulnerability on any job. However, wide rolls are hard to kick out as they are heavy and bulky. They get dragged around a lot because installers do not always work in pairs. They are slow to install, and contractors want to finish their work quickly.

There are other various site conditions to consider.

Skill of the installers

It used to be manufacturers required trained certified installers to work with their membrane. This is still true for some products, but many owners are recognizing the best training is done on the jobsite with the people who will actually be doing the work.

Often, the managers receive the training, not the actual workers that would benefit most from the instructions. This requires a manufacturer's representative to do the training in situ. It is even better if that person is able to communicate well. Regular appearances at the site are the best approach—maybe not every day, but certainly at these critical junctions:

- the day the work commences;
- the first day the membrane is hung from the backup wall;
- the day the detailing starts;
- before the concrete is poured; and
- during the pours.

One should meet with the representative and anyone else who will touch the foundation wall to iron this out ahead of time. Of course, a consultant can be hired to 'babysit' the job, this is not a bad idea if the contractors are unproven and the site is problematic.

Availability and price

There is huge variation in the costs of the different membranes when the variables of the installation are taken into account. One membrane may require expensive tapes; another may rely on preformed boots to cover anchors, while another may require cant strips at every plane change. Sometimes, the expense is worthwhile. Regardless, getting the full story, and finding out if the membrane is available for delivery when it is needed, is the best practice. Supply can sometimes be an issue.

Warranties

This is a huge subject that requires its own article. Labor and materials coverage gets expensive fast because it means a full-time representative at the site and maybe even regular testing during the install. This is a sticky subject, but it may be better to invest time in good in-situ training rather than long warranties.

Compatibility

Mixing and matching different materials can be problematic and will likely void warranties. Some examples of mismatched products include:

- vapor retarders with blindside membranes;
- blindside membranes with conventional membranes; or
- one manufacturer's tape with another manufacturer's transition strips.

There may also be compatibility issues with the pre-applied membrane and surrounding materials, such as the form release on the soil retention wall. Manufacturers should be able to assist.

Other special concerns

There are low-temperature formulations of some products. These will ensure the membrane is still pliable when temperatures fall below manufacturer's installation recommendations. Similarly, most membranes contain plasticizers that may be compromised by ultraviolet (UV) exposure. One should check the data sheets to ensure the material will not be sitting in the sun for longer than recommended.

Unusual details require the manufacturer's expertise, or even advice from a waterproofing consultant. The best manufacturer's representatives will admit when they are unsure and ask for help from the higher-ups.

Finally, no concrete should be poured against a membrane that has not been carefully inspected. Once the concrete is poured, it is virtually impossible to go back and make repairs. Carpenters have a saying: 'Measure twice, cut once.' When it comes to blindside waterproofing, a similar maxim might be: 'Inspect twice, and pour.' **CS**

Notes

[1] Blindside is a positive-side application—meaning it goes on the outside or the soil side of the foundation wall. Negative side waterproofing is on the inside of the wall.

ADDITIONAL **INFORMATION**

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Abstract

Blindside, or pre-applied, is a relatively new approach to waterproofing that allows the membrane to be applied to a backup wall, lagging, or even rock, and the concrete for the foundation walls poured against it. The membrane adheres to the concrete in a variety of ways—mechanical and chemical. Ideal for urban spaces, campuses, brownfields (to minimize site disturbance) and greenfields (to preserve native flora/fauna), the technique comes with many considerations and challenges for design professionals.

MasterFormat No.

07 17 00–Bentonite Waterproofing
07 16 13–Polymer-modified Cement Waterproofing

UniFormat No.

A9010–Substructure Excavation
A9020–Construction Dewatering

Key Words

Division 07
Below-grade
Bentonites
Blindside
Waterproofing

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