

# SUBGRADE WATERPROOFING:

## *A Case Study in Selecting the Right Materials and Techniques for the Job*

**By Carter Pogue**

**S**evere weather can cause extensive damage to a structure's roof, foundation, interior, and more if they are not properly waterproofed. However, protecting a building's concrete foundation from potentially unforeseen water infiltration and other corrosive elements is one of the most important aspects of maintaining a structure's overall integrity.

Subgrade waterproofing plays an extremely important role in protecting every aspect of a structure's construction. Knowing which waterproofing coverage to specify for a particular structure is more than a science; it is an art form. Consulting with an experienced specialty contractor or waterproofing consultant for the best subgrade waterproofing options available will ensure a quality job that will extend the life of any structure.

Water is moved through a structure via any number of forces, including: hydrostatic pressure, capillary action, wind/air currents, surface tension, and natural gravity. If there is any breach in a structure's foundation, water is sure to find its way in.

Despite its physical resilience, concrete is a notably porous material. Moisture, chloride ions, pollutants, and other harsh chem-

icals can penetrate concrete materials and damage their surface if left unprotected and unsealed. Infiltration of these elements into the concrete primes the surface for greater damage and possible structural failure.

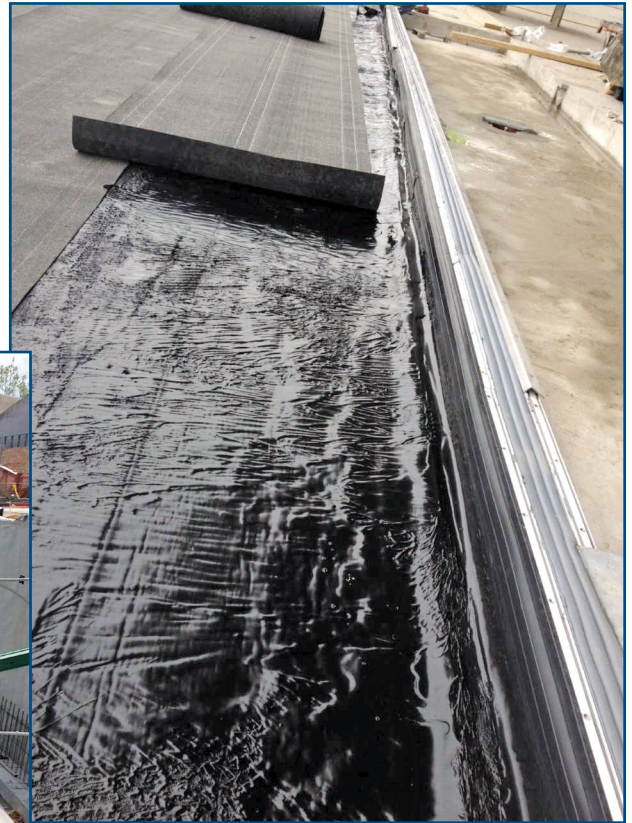
Waterproofing has come a long way since 1915, when the Ironite Company of Chicago invented a cost-effective product to waterproof concrete foundations from the inside called "Ironite." Painted onto the inside of basement walls, Ironite became a popular option because it could be applied quickly, and it was less expensive than the traditional, time-consuming waterproofing methods of the day, which required that the walls around the foundation be dug out, a membrane applied, and fill dirt put back in.

As the decades progressed, so did improvements in the materials and techniques used to waterproof subgrade surfaces. A number of excellent below-grade, exterior foundation waterproofing systems have become available within the last 20 years for preventing water penetration through foundations, concrete lids, pits, and other below-ground areas. These waterproofing materials may be applied to the inside or outside of the wall or foundation. Some examples of popular subgrade waterproofing materials and techniques are provided herein.

### **FLUID-APPLIED MEMBRANES**

Made of a liquid, rubber material that forms a continuous, monolithic membrane when applied via a sprayer, brush, or roller to the surface, a fluid-applied membrane is known for its ability to withstand abuse and high levels of hydrostatic pressure. This type of waterproofing, while not necessarily a new technology, can be compared to the rubberized coatings often applied to truck beds. Because of their fluid application, fluid-applied membranes are able to perfectly conform to any footers, transitions, or pipes present on the foundation to form a seamless cover. In order to apply a fluid-applied membrane, the concrete foundation, which naturally has flaws (i.e., air bubbles and deviations) must first be prepped for the waterproofing. This can be done by patching any imperfections to create a smooth surface that will accept the fluid waterproofing. When you have a two-part foundation system with a footing and a wall on top, the seam between those two pieces will need to be caulked to prevent any water infiltration between the seams. Once the prep work is completed, the fluid membrane can be applied, normally to a depth of 60 mil, which will dry to about a 30-mil finish, depending on the product.

Figures 1-4 – This Springfield, IL project included fluid-applied waterproofing to more than 31,000 square feet of below-grade concrete foundation and 13,000 square feet of below-grade dampproofing on two new building additions.



Western Specialty Contractors used this type of subsurface waterproofing to restore Memorial Stadium at the University of Illinois Urbana-Champaign (Figures 1-4). Western was contracted to repair deteriorated vertical and horizontal concrete, both partial and full depth, as well as replace expansion joints at the south and west elevations of the bleacher areas. When the repairs were completed, Western crews applied a heavy-duty deck coating system to protect the surface from future water penetration. The 86-year-old stadium was returned to like-new condition and will remain protected for many more years to come.

#### HOT-APPLIED RUBBERIZED ASPHALT

This type of waterproofing application is ideal for providing a durable, monolithic seal to prevent water from penetrating concrete subsurfaces. Made of a blend of refined asphalts, synthetic rubber, and

mineral stabilizers, hot-applied rubberized asphalt waterproofing is ideal for bridging nonworking foundation cracks and conforming to surface irregularities. The initial step of applying this type of system involves first spraying the concrete surface with primer, then melting rubberized asphalt bricks to a liquid state by heating them to

400°F (204°C) in an agitated melter. The rubberized asphalt is then poured out or applied while it is still hot and in its liquid state to evenly coat the surface area. Care must be taken not to spread the asphalt too heavily or too thinly.

This type of waterproofing was utilized on the 750,000-square-foot concrete park-

Figures 5-7 – Crews used hot-applied rubberized asphalt to waterproof the parking garage beneath Maggie Daley Park in downtown Chicago, IL. The project required seven layers, including over 1.3 million pounds of rubberized asphalt.



installation of the waterproofing system began.

The waterproofing system consisted of seven layers, which each serve an important function in the overall operation of the system. First the concrete deck was sprayed with primer, next the hot, liquid rubberized asphalt was poured out onto the concrete, and then spread out to evenly coat the area. In total, this project required over 1.3 million pounds of rubberized asphalt applied by multiple crews consisting of 40 workers per day.

Constant measurements were taken during the process to confirm that the

material was not being spread too heavily or too thinly along the deck. After the first layer of rubberized asphalt was spread out, workers rolled reinforcing felt fabric onto the layer of melted rubber while it was still in its liquid state. Another layer of melted rubber was then poured and spread out over the area. The next

ing garage beneath Maggie Daley Park in downtown Chicago, IL.

The concrete parking structure, originally constructed and waterproofed in the 1970s, had become compromised from years of wear and tear and groundwater infiltration. Ensuring proper waterproofing of the large parking structure was key to maintaining the structural integrity of the garage beneath the park.

The scope of the parking garage project included structural repairs to the existing concrete roof slab, full removal and reinstallation of a new waterproofing system, and major drainage improvements.

After the existing park (Daley Bicentennial Plaza) was completely demolished and removed from the site, work began to prepare the 750,000-square-foot surface for application of the new waterproofing system. The entire surface of the concrete roof was power-washed and then shot-blasted to achieve the proper surface profile required by the waterproofing manufacturer. Next,

step required workers to roll out sheets of heavy-duty, rubberized asphalt protection board, which was specially made to prevent tree roots from puncturing the waterproofing. The final layers of the system included a drainage mat, filter fabric, and approximately 400,000 cubic feet of gravel overburden. (See Figures 5-7.)





Figure 8 – A two-ply modified-bitumen sheet waterproofing membrane, an electronic leak detection system, and a permanent leak-detection grid system were installed on the museum roof beneath the historic Gateway Arch in St. Louis, MO.

### SHEET-APPLIED WATERPROOFING MEMBRANES

Sheet-applied waterproofing membranes are ideal for simple, flat-wall applications, such as basements, elevator pits, or underground garages, and come in a variety of materials, including rubberized asphalt, ethylene propylene diene terpolymer (EPDM) synthetic rubber, polyvinyl chloride (PVC), chlorinated polyethylene (CPE), chlorosulfonated polyethylene (CSPE), butyl rubber, and neoprene. Sheet-applied waterproofing is typically applied after the concrete pour has cured and may be used in many vertical and horizontal applications. Adhering tightly and permanently to concrete, sheet-applied membranes are strong and provide a continuous barrier to water and moisture vapor entry.



Figure 9 – The area around the Lincoln vault was excavated in preparation for waterproofing.

When prepping concrete for this type of waterproofing application, the foundation must be clean of any loose materials, dust, or sharp edges. A primer is then usually applied that provides a tacky surface for the membrane to adhere to. The sheets can be cut to any manageable size. The release paper covering the adhe-

sive side of the membrane sheet is simply pulled off and the sticky side of the sheet pressed up to the primed concrete surface. The sheet will bond on contact, so it is very difficult to reposition. Next, the membrane should be smoothed out to remove wrinkles or air pockets and rolled out over the entire surface to create a continuous bond. The membrane should then be covered with extruded polystyrene insulation to protect it from tears during the backfill process.



Figure 10 – The walls on the exterior of the vault were in very poor condition.

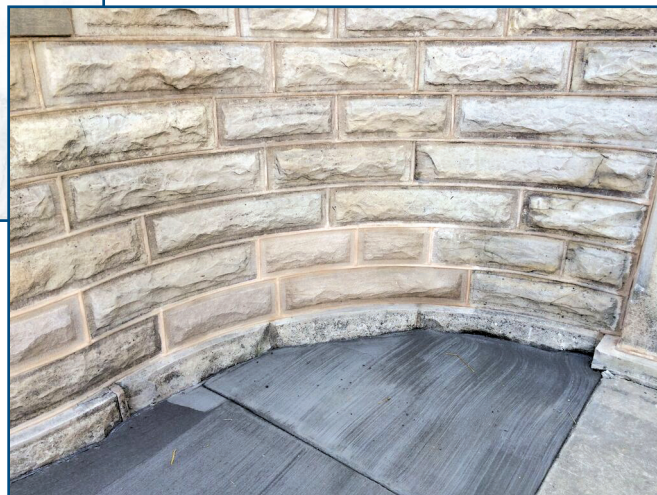


Figure 11 – Once the bentonite sheet waterproofing was applied, crews worked to restore the vault's stone façade and serpentine retaining walls.

This type of waterproofing was used to restore and waterproof the museum roof beneath the historic Gateway Arch in St. Louis, Missouri. Work on the 100,000-square-foot museum roof started by removing 16 to 18 inches of sod and sandy soil, 10 to 28 inches of Elastizell

engineered fill, and the existing waterproofing membrane, down to the structural deck. Once the subsurface concrete roof was exposed, crews identified and repaired any leaks before installing a 2-ply modified-bitumen sheet waterproofing covered with protection board (Figure 8). An electronic leak detection system and a permanent leak-detection grid system were installed over the protection board. Crews then installed a layer of 1½-in., 60-psi extruded polystyrene with an additional layer of protection board and a drainage mat.

The next phase of the project involved waterproofing the 42,000-sq.-ft. horizontal lid and 37,000 sq. ft. of vertical walls for the museum addition. The scope of work included installing two-ply modified-bitumen sheet waterproofing covered with protection board, and installing an electronic leak detection system, along with two layers of 1½-in., 60-psi extruded polystyrene. A layer of 1½-in., 60-psi extruded polystyrene was installed on the vertical walls, as well as a drainage mat on both horizontal and vertical surfaces.

Additional waterproofing of the north and south museum entrances (approximately 13,800 sq. ft.), which included approximately 5,000 sq. ft. of deck around each arch leg, was also completed.

#### BENTONITE WATERPROOFING

First widely used in the 1960s as a below-grade waterproofing material, bentonite is a type of powdered clay that naturally expands and contracts based on the amount of moisture that it extracts from the surrounding soil. The natural hydrating action of bentonite forms an impenetrable barrier capable of absorbing water and chemicals, like acids and salts, up to ten times its own weight. Bentonite waterproofing comes in several forms, and is applied based on specific conditions. When mixed with sand, bentonite may be used for such water-containment applications as lining ponds, sewer lagoons, irrigation canals, and landfills. Bentonite waterproofing panels that contain bentonite clay granules between two layers of fabric can be used for below-grade slabs and vertical walls and as a blindside waterproofing membrane. Bentonite waterproofing panels that consist of bentonite clay granules infused in paper boards are ideal for waterproofing split-slab construction, blindside waterproofing, backfill concrete, and masonry walls. For below-grade slabs and vertical

walls, a spray-applied bentonite waterproofing membrane, combined with an asphalt binder or enhanced with a polymer, is recommended.

This type of waterproofing was utilized to restore the historic receiving vault that once held the bodies of President Abraham Lincoln and his son Willie in 1865. The receiving vault, which is located at the base of a hill in Oak Ridge Cemetery in Springfield, Illinois, was subjected to water penetration, which resulted in major dete-

rioration. The initial phase of the project involved channeling water away from the vault. The area around the vault was excavated in preparation for waterproofing (Figure 9), drain installation, repairs to the stone façade, and restoration of the marble and iron gates. Crews encountered more extensive deterioration of the vault than they had originally anticipated.

The walls making up the exterior of the vault were in such poor condition that waterproofing could not be applied directly

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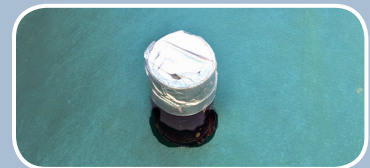


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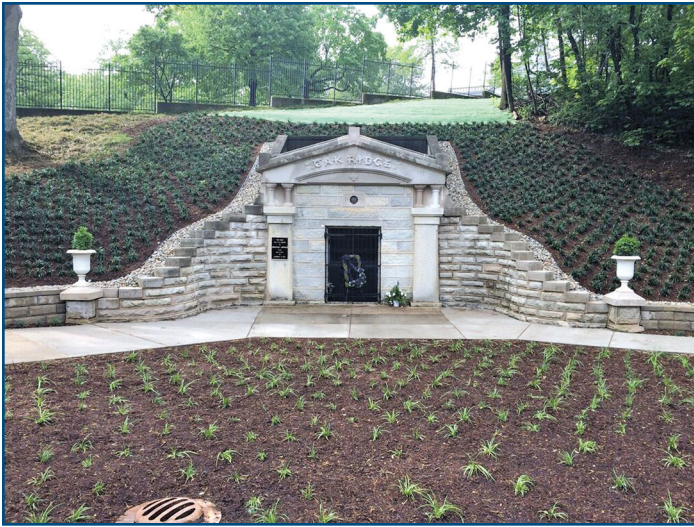



Figure 12 – Finished Lincoln vault project.

to the surface (Figure 10). A scope of work that would repair the walls without compromising the integrity of the historic structure was needed. Crews formulated a system of using a low-cement-ratio mortar and brick infill in areas where the brick had deteriorated away from the wall. After infilling the voids in the walls, crews applied a layer of the low-cement-ratio mortar to the entire wall surface to create a smooth surface with no protrusions that could penetrate through

the bentonite sheet waterproofing that would be used. Once the bentonite sheet waterproofing was applied, crews worked to restore the vault's stone façade and serpentine retaining walls (Figure 11). Great care was taken to respectfully preserve not only the look of the receiving vault, but also the method by which it was originally constructed. With the restoration and waterproofing in place, the historic vault is now preserved for future generations to appreciate (Figure 12).

With all of the new materials and techniques available today for subgrade waterproofing, remember that there is never a one-size-fits-all solution for every project. Just as an architect designs each structure differently, the same can be said for the specialty contractor when determin-

ing the optimal subgrade waterproofing for that structure. A customized waterproofing approach for each individual structure and its unique set of circumstances will help to ensure maximum moisture protection for years to come. 



Carter Pogue

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## AR HEADGEAR: *Not Your Father's Hardhat*

Augmented reality (AR) headgear may one day be standard issue for architects, engineers, and building envelope consultants on construction sites. The headsets could overlay digital information from building information modeling (BIM) so that someone looking at a wall or a roof through the AR headset visor could see imagery of the systems beneath. It could also be used as a thermographic tool to check heat and moisture in building envelope systems.

DAQRI, an AR company based in Los Angeles, has introduced the Smart Helmet, which includes a high-speed wide-angle tracking camera, a thermal camera, multiple sensors, and Intel Core processors.

Microsoft Corp., which produced a pair of mixed reality smartglasses called HoloLens, is working with Trimble Inc. to integrate Trimble's 3-D modeling and collaboration software with HoloLens for use in the architecture, engineering, construction, and operations industries. Other companies are also working toward industrial uses of AR headgear.

DAQRI's Smart Helmet uses a combination of cameras and sensors to capture and record real-time information about the user's surroundings, from valve readings to thermal data. It can also show the wearer stored information such as safety guidelines and worker instructions. This video shows how the helmet works: [https://www.youtube.com/watch?time\\_continue=32&v=BmqmgsAYJil](https://www.youtube.com/watch?time_continue=32&v=BmqmgsAYJil).



*Man wearing DAQRI's Smart Helmet on a worksite. Photo courtesy of DAQRI.*

— Dezeen.com