

Waterproofing Below-Grade Shotcrete Walls

An innovative combination of membrane and grout

By Jason Darling and Xia Cao

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Preapplied waterproofing systems for below-grade foundation wall construction at confined sites have traditionally been designed for use with cast-in-place concrete. This can pose challenges for traditional waterproofing systems when building owners and designers turn to shotcrete as an alternative to cast-in-place foundation wall construction. To address these challenges, designers, manufacturers, and installers have responded by modifying existing cast-in-place systems in an attempt to make these systems compatible with shotcrete wall applications. Yet the success of this approach has been limited, sometimes leading to damaging water infiltration.

The Foundation for a New System

In situations where water infiltration does occur, chemical grouts have long been used to repair all types of foundation walls, including shotcrete. Remediation typically consists of drilling holes in the wall in the proximity of the leak and injecting chemical grout to fill the voids and seal the leak. This approach has been successful and is the most widely used method of repairing leaks in shotcrete foundation walls.

The challenge with this approach is that, until the repair is completed successfully, there is a risk of continual water damage, downtime of the structure, liability concerns, and other costly consequences. Those tasked with the repair can't see the void patterns within the wall and, in many cases, must take a blind, trial-and-error approach. They often inject large amounts of grout with no way of knowing whether water intrusion pathways are being sealed effectively. Sometimes, they inject multiple times to trace the water leak. On large projects, remediation that impacts the construction schedule can result in liquidated damages. The overall result is a remediation process that is both time-consuming and extremely expensive, often costing hundreds of thousands or even millions of dollars.

Due to these realities, there has been strong demand from building owners and designers for a preapplied waterproofing system specifically designed for use with shotcrete foundation walls.

Leveraging a Proven Technology

Chemical grout injection has proven to be the most successful approach to repairing leaks in shotcrete foundation walls. Recognizing this, Grace Construction Products, a leader in membrane technology, and DeNeef Construction Chemicals, a leader in chemical grout technology, formed a partnership to develop a shotcrete-specific waterproofing solution. The goal was to develop a means to apply chemical grout proactively during the construction process. This approach offers the advantage of creating a waterproofing system designed to prevent water leaks before they occur, minimizing potential water damage, and reducing schedule interruptions and unknown cost liabilities associated with repairs.

"Together, we [Grace and DeNeef] saw that grout injection could be effective in stemming leaks if it could be successfully directed to cavities in the wall. We concluded that injecting grout proactively into a pre-defined cavity space behind the shotcrete wall could be an efficient way to create a seamless water barrier," explains Brian Iske, President of DeNeef Construction Chemicals. "The challenge was how to design and produce such a shotcrete-specific waterproofing system."

Integrated Solution

The research and development teams at Grace and DeNeef developed a system combining advanced waterproofing membrane technology with proven chemical grout technology. The result of a 3-year development process was the entirely unique system (shown in Fig. 1) designed specifically for waterproofing shotcrete walls in blindside applications: Preprufe® SCS (ShotCrete System).

Shotcrete Corner

The system is a fully-adhered, impermeable barrier against water. It consists of the three components shown in Fig. 2:

- A composite membrane that serves as a carrier for the post-injected chemical grout. Designed specifically to withstand the force of shotcrete application and to control the thickness of post-injected grout. The membrane consists of a polymer-mesh-reinforced cavity sandwiched between a plastic film and a nonwoven, semipermeable geotextile;
- Grout injection ports installed prior to shotcrete application to enable grout injection; and
- Hydrophilic grout specially formulated for the Preprufe® SCS system. The grout is post-injected into the membrane through the injection ports.

When the grout is injected through the ports, it fills the cavity created by the mesh layer in the membrane and permeates through the geotextile, filling any shotcrete voids and providing a waterproofing system that is fully adhered to and fully bonded with the shotcrete. The hydrophilic grout also has the ability to seal minor defects, cold joints, and interface defects in the presence of water. The result is a continuous waterproofing barrier with excellent resistance to up to 200 ft (60 m) of hydrostatic pressure.

The Preprufe® SCS system includes accessories, such as tieback covers, detail tape, and a hydrophilic sealant to ensure a complete waterproofing solution. The system is also designed to permit tie-in of the Preprufe® SCS Membrane with other Grace waterproofing products, including the Preprufe® 300R Underslab Waterproofing Membrane and Bituthene® or Procor® Waterproofing Membranes, to provide a continuous waterproofing system for the entire structure.

Testing Results

Extensive laboratory and field testing of the Preprufe® SCS system have confirmed that it performs as designed. Cores of test walls, such as the one shown in Fig. 3, prove that the system not only provides a durable, continuous grout layer, but that it also effectively fills voids that may occur in the shotcrete.

While developing the system, Grace and DeNeef also focused on designing the product to work with current waterproofing and shotcrete application practices. To help facilitate this, they designed grout injection ports with a simple push-and-turn connection to the membrane and flexible tubing to accommodate various reinforcing bar configurations. This ensures that proactive grouting can be achieved without holding up project schedules (Fig. 4).



Fig 1: The Preprufe® SCS membrane (gray) is installed over the soldier piles and lagging (see insert). Preprufe® tieback covers (white) are installed over the wall's tie-back anchorages to ensure a continuous barrier. After the basement wall's reinforcing bars are installed, grout tubes are inserted through the bars and attached to the Preprufe® SCS membrane (photos courtesy of Johnson Western Gunite Company)

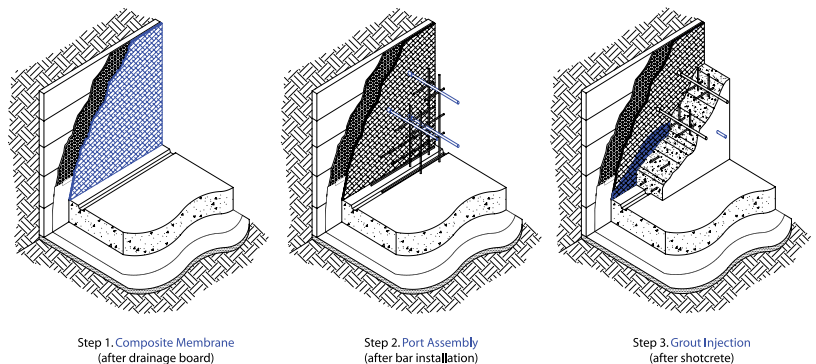


Fig. 2: Schematic representation of the three-step installation process for Preprufe® SCS

“Initially, we were not sure how the grout ports would affect the process of applying shotcrete,” says Larry Totten, President of Johnson Western Gunite Company of San Leandro, CA, shotcrete contractor on one of the first Preprufe® SCS projects. “As it turned out, the system did not impact our process in any way, shape, or form.”

Totten also points out that Preprufe® SCS helps address another common issue impacting waterproofing membranes: damage to the membrane caused during installation of the reinforcing steel.

“With the Preprufe® SCS system, this is less of an issue because the membrane serves as a receptacle for the grout,” he says. “If a hole is punched in the

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Fig. 3: Core through a shotcrete wall where Preprufe® SCS was used, showing effective grout sealing of voids in shotcrete (photo courtesy of Grace Construction Products)



Fig. 4: The shotcrete is placed and finished over the Preprufe® SCS membrane. The completed wall includes grout tubes that are later used to inject the hydrophilic grout for the Preprufe® SCS system (photo courtesy of Johnson Western Gunite Company)

membrane, it is less likely to affect its waterproofing performance once the grout is injected.”

Success in the Field

Since its introduction, the Preprufe® SCS system has been used on blindside projects on the west coast of the U.S., where shotcrete foundations are common. “We have been extremely pleased with the in-place performance of the system,” states Tony Vitale, Business Director for Grace Specialty Building Materials North America. “This new system has created a lot of excitement, and feedback from the design and contracting community has been extremely positive.”



Selected for reader interest by the editors.



Jason Darling is Marketing Manager for Below Grade Systems at Grace Construction Products. He received a BS in civil engineering from Duke University and an MBA from the Fuqua School of Business at Duke University. He has more than 9 years of experience in building design and building materials for the construction industry. Over the course of his career, he has managed the design and installation of waterproofing and air barrier systems for roofing, exterior walls, and below-grade areas on major construction projects.



Xia Cao is a Senior R&D Chemist at Grace Construction Products. She received a PhD in chemical engineering from Ohio State University. She has more than 10 years of academic and industry experience in material and process design, as well as more than 3 years of experience in building design and building materials, including one published patent, and three pending patent applications. She has authored more than 20 technical publications and has been the technical reviewer for Industrial & Engineering Chemistry Research and the Journal of Applied Polymer Science.

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