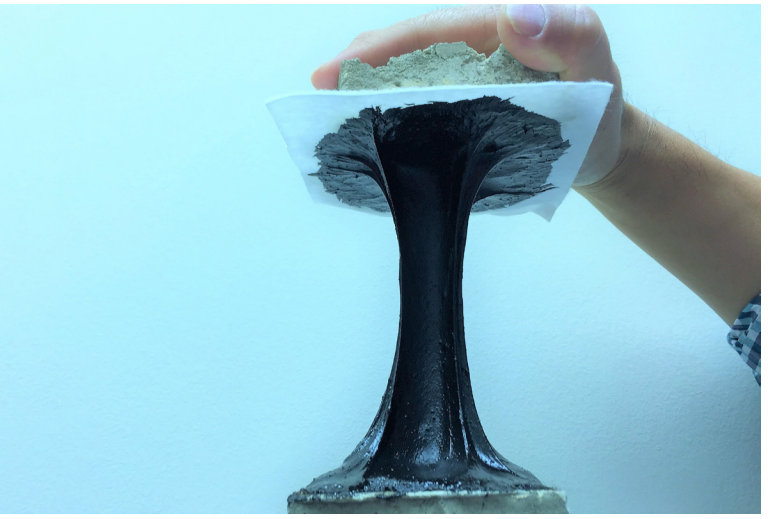
Polymer Rubber Gel Technology: High-Performance Waterproofing for Shotcrete and Blind-Side Applications

By John H. Huh



Using an innovative polymer rubber gel system (GTS) as provided by GelTechSystems for waterproofing underground structures is an effective solution that meets the unique challenges of underground construction. Key characteristics of the GTS waterproofing system includes adhesion to the substrate, responsiveness to substrate movement, non-curing, self-healing, chemical resistance, and environmental friendliness. This versatile technology, combined with a durable, flexible, fleece-reinforced HDPE laminate, creates a dynamically responsive composite waterproofing assembly that exhibits excellent waterproofing effectiveness for both shotcrete and blind-side applications. This technology has been successfully used for waterproofing large-scale subway stations in California. This article describes GTS's physical characteristics used as a composite waterproofing system and how it provides a high-performance solution for shotcrete and blind-side applications.

Selection of the waterproofing membrane system and appropriate engineering details are essential to the success of any tunnel or below-grade structural waterproofing application. Waterproofing poses distinct challenges in performance, design, and application. Two distinct methods of application are used for waterproofing structures: Positive Side and Blind Side applications.

- Positive Side Waterproofing: Applying waterproofing directly to the existing structure's concrete surface.
- Blind Side Waterproofing: Applying waterproofing to the support of excavation or outer lining and forming then casting concrete or spraying shotcrete against the waterproofing system.

Positive Side Waterproofing

Blind Side Waterproofing

For blind side applications, the final lining or structural wall is formed against the waterproofing membrane. This method reduces excavation and costs, particularly in urban environments where space constraints exist.

UNIQUE PHYSICAL CHARACTERISTICS OF THE GTS SYSTEM

GTS exhibits unique physical characteristics making it an ideal component of a dynamic waterproofing system:

- Adhesion to Concrete: Ensures no path for water migration.
- Responsiveness to Substrate Movement: Retains a waterproof seal during seismic events or joints that experience constant motion.
- Elongation: Ability to bridge cracks in concrete and construction joints without debonding or losing water tightness.
- Hydrostatic Pressure Resistance: Withstands continuous hydrostatic pressure without rupture.
- Self-Healing Capability: Self-heals small tears or punctures under direct hydrostatic pressure, mitigating common pre-construction waterproofing system damage.
- Chemical Resistance: Prevents degradation from aggressive soils.
- Environmental Friendliness: Made from non-toxic and recycled materials, with low VOCs during application and low odor.

GUIDELINES FOR EFFECTIVE WATERPROOFING

GENERAL DESIGN GUIDELINES AND WATERPROOFING SYSTEM SELECTION

Site factors must be considered for effective waterproofing of underground structures. A waterproofing system selection process should be based on the water tightness criteria, considering both physical site conditions and the type of construction chosen for the underground structure. The substrate for which the blind side waterproofing system is to be applied should be considered during the soil support of excavation design process.

Successful waterproofing of underground structures requires that the entire waterproofing system be continuous throughout the building envelope. Proper detailing for tie-backs to other structural systems, penetrations, protrusions, transitions, terminations, and seams within the waterproofing system are essential for maintaining the integrity of the continuous waterproofing envelope.

SITE CONDITIONS, CONSTRUCTABILITY, AND INSTALLATION

Site conditions and constructability play a strong factor in the waterproofing system design process. Often, waterproofing systems used on large-scale applications will be exposed to the elements for extended periods prior to concrete placement. Preconstruction meetings with the waterproofing applicator and project general contractor should be conducted to ensure proper work staging to limit exposure to potential damage.

KEY PHYSICAL GUIDELINES OF THE WATERPROOFING SYSTEM

After successful installation and proper detailing, a waterproofing system must perform based on the physical attributes of the product. Key performance criteria include adhesion to concrete, responsiveness to substrate movement, elongation, hydrostatic pressure resistance, self-healing capability, chemical resistance, and environmental friendliness.

ADDITIONAL WATER MITIGATING COMPONENTS

In addition to a primary waterproofing system, accessory components such as prefabricated drainage composites and various types of waterstops should be considered. For underground structures not below the water table, prefabricated drainage composites may be a suitable addition to remove direct hydrostatic pressure from the waterproofing membrane.

GTS COMPOSITE SHOTCRETE AND BLINDSIDE WATERPROOFING

THE CHALLENGES OF SHOTCRETE ASSEMBLY AND BLINDSIDE ASSEMBLY

For underground construction, shotcrete and blindside waterproofing systems play a significant role in protecting against water intrusion. The challenge in this type of construction is that the waterproofing must endure exposure to adverse environments and withstand the force of the shotcrete placement. Additionally, reinforcing bar must be supported, so the waterproofing will generally have numerous penetrations from tie-backs and supports for reinforcing bar, making these areas susceptible to water leakage. Most importantly, it is critical that the shotcreted concrete bonds to the waterproofing after placement, ensuring that water does not migrate between the membrane and the concrete. Inspection and monitoring during application are critical since the waterproofing will be inaccessible once the concrete is in place.

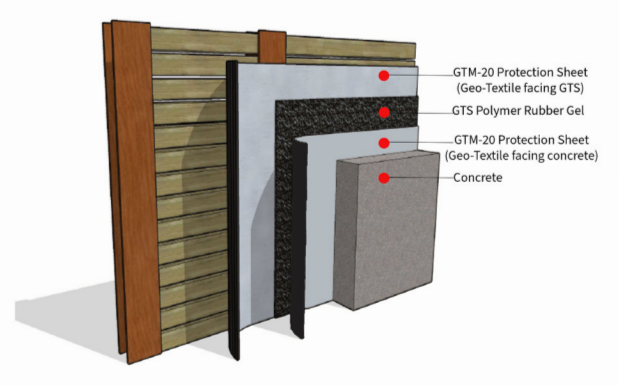


Fig. 1 Polymer rubber gel blindside Assembly

THE GTS POLYMER RUBBER GEL SHOTCRETE OR BLINDSIDE SYSTEM

The waterproofing system consists of a composite system of two layers of 20 mil HDPE fleece reinforced sheets sandwiched with a spray-applied 100 mil-110 mil thick polymer rubber gel layer in the center (Fig. 1). The durability and chemical resistance of the HDPE sheets combined with the flexibility of the gel create the dynamically responsive waterproofing system. The final layer of 20 mil HDPE is applied to the negative face of the system with the fleece facing the installer to protect the waterproofing system from job site contamination, weather, or damage (Fig. 2). The fleece layer forms a mechanical bond to the concrete. This three-layered GTS waterproofing system allows greater flexibility for timing of pours during construction.

Preparation of the soil support or excavation substrate for blind side application of the GTS system may require placing a plywood protection board or a shotcrete smoothing layer to create a sufficiently rigid and smooth substrate for the mechanical attachment of the waterproofing sheet. Typical applications where this would be necessary are for sheet pile walls or some types of deep soil mix walls. Care must be taken to prevent the possibility of protrusions from the wall or cavities that could damage the waterproofing assembly either during assembly or at the time of concrete pour or shotcrete placement.

The principal design concept with a GTS waterproofing system is to achieve a complete monolithic building envelope of the gel system. This requires proper detailing of the transitions from base slab to walls and walls to ceiling. Once the first layer of 20 mil HDPE is installed and penetrations and transitional details are in place, a layer of polymer rubber gel is sprayed (Fig. 3) creating a monolithic non-curing, self-healing membrane.

Once the GTS spray layer is in place, a final layer of fleece reinforced HDPE is installed with the fleece layer facing the rebar. This layer bonds to the GTS and creates a mechanical bond with the shotcrete or cast concrete. Due to the self-healing aspect of the GTS waterproofing assembly, the risk of damage during rebar installation is mitigated.

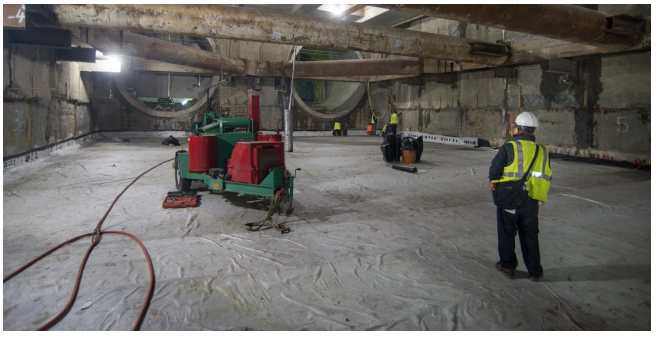
Fig. 2 Installation of the outer fleece reinforced HDPE sheet

Fig. 3 Spray application of GTS gel on fleece reinforced HDPE

CASE STUDY: CENTRAL SUBWAY AND PRESIDIO PARKWAY, SAN FRANCISCO, CA

Central Subway Application Photo

Central Subway Application Photo



Central Subway Application Photo

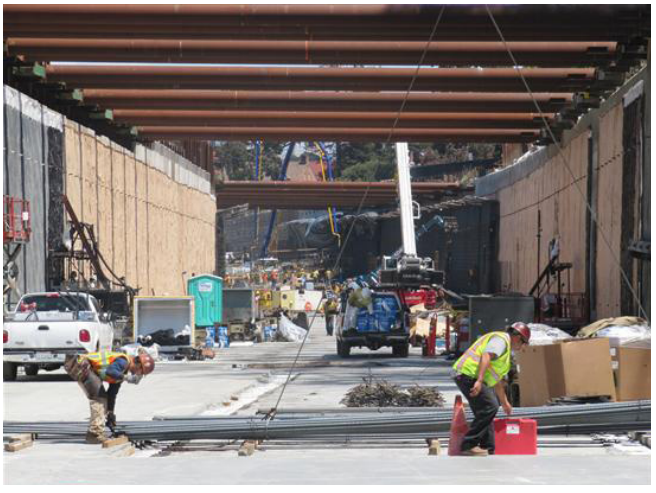
The **Central Subway Project** extends the Muni Metro T Third Line through SoMa, Union Square, and Chinatown, vastly improving transportation in some of San Francisco's busiest areas. The project includes the construction of four subway stations using top-down construction methods, incorporating GTS waterproofing systems. The design utilized GTS due to its superior flexibility, self-healing characteristics, and seismic performance.

The **Presidio Parkway Project** was designed to improve the seismic, structural, and traffic safety of the historic Doyle Drive route connecting San Francisco to the Golden Gate Bridge. The project succeeded in improving the roadway through the addition of new tunnels and more access points while improving views from within the National Historic Landmark District.

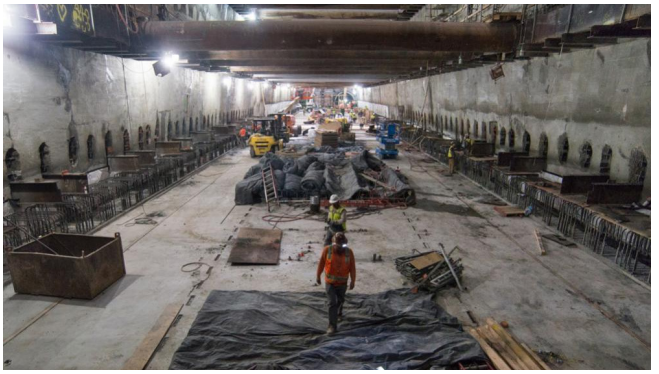
The Polymer Rubber Gel, Gel-Tech 500 blind side system was specified for the entire cut and cover highway tunnel box structure. Structural engineers were particularly concerned with improving seismic performance of the construction.

Presidio Parkway Application Photo

Presidio Parkway Application Photo



Presidio Parkway Application Photo



Conclusion

The innovative GTS Polymer Rubber Gel waterproofing systems are proven and effective for underground construction applications. The unique physical characteristics of polymer rubber gel combined with HDPE membrane sheets create composite waterproofing assemblies, advancing state-of-the-art cut-and-cover construction within the industry. Given proper design consideration and specification of composite GTS waterproofing assemblies, this provides excellent waterproofing performance along with enhanced methane/chemical protection for underground structures.

John H. Huh *is the CEO and founder of RE-Systems Group Americas Inc., a company specializing in waterproofing solutions for challenging underground construction. Huh has over two decades of experience in the industry. RE-Systems Group Americas led by Huh has been instrumental in major infrastructure projects across North America, showcasing their expertise and commitment to advancing waterproofing practices.*