



## Overhead Shooting against PVC Membrane

By Frank E. Townsend III and Dennis Rubi



Overhead shotcrete application against any substrate is challenging. Shooting against a polyvinyl chloride (PVC) membrane waterproofing system increases the difficulty and danger of the process. This requires the use of alkali-free liquid set accelerator introduced to the mixture at the nozzle to provide rapid accelerated hydration, thus allowing increased layer thickness and reduced sagging. The PVC membrane is a flexible PVC sheeting that can be

easily welded and repaired and can be applied efficiently on most wet and uneven substrates.

Creating the overhead shotcrete section starts with the substrate and anchoring system. A combination of rock-bolts, BA anchors, and reinforcement mats greatly assists as an anchorage system to support freshly applied concrete in place. It is critical that the reinforcing bar mats are rigid and adequately spaced. Also, the spacing of the reinforcement is important because if it is too tight, other means of form-and-pour should be used. If the reinforcement is not supported adequately, the shotcrete may collapse after placement as the reinforcement flexes with the weight of the concrete. Rigidity impacts the ability to properly encase the reinforcing steel because if the steel is loose, it will vibrate, leading to poor encapsulation.

The malleable nature of the PVC membrane against uneven surfaces, coupled with large BA anchor spacing, causes the sheeting to pillow in areas not tight against the substrate. More anchors in a tighter pattern will help hold the membrane closer to the substrate and thus create less pillowing. Shotcrete against the combination of this pillowing effect and the smooth surface of the PVC sheeting exacerbates the difficulty of shooting overhead. Plastic-tipped reinforcing bar slab bolsters are often used to put pressure on the areas of PVC membrane that sag.

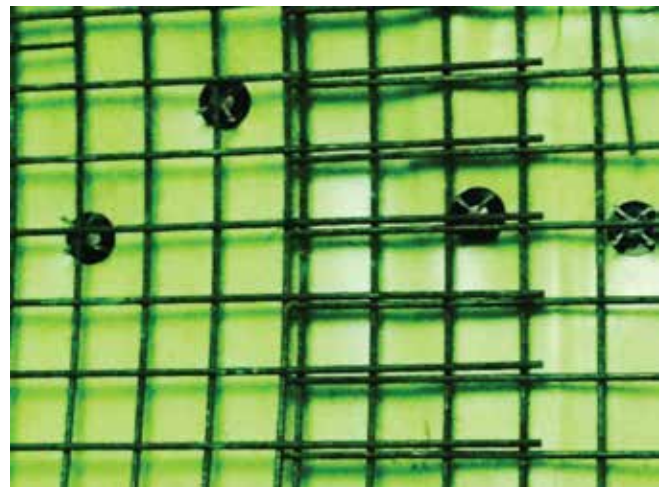
The overhead shotcrete application against the PVC waterproofing membrane is undertaken on scaffold or lifts



PVC membrane waterproofing system



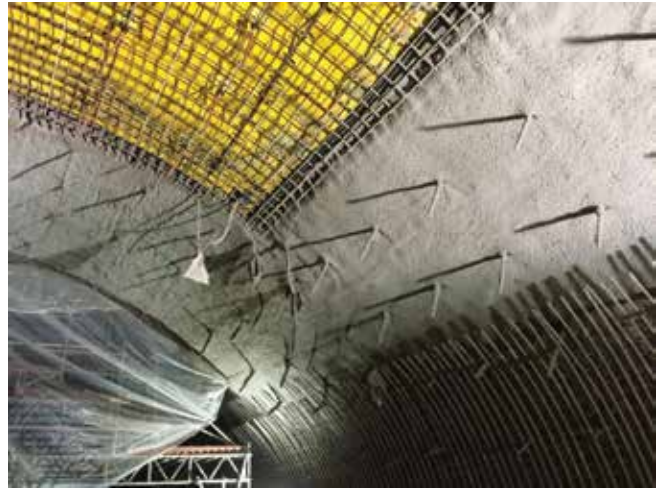
Anchorage system



Reinforcing bar spacers



*Shotcrete application building up from wall*



*Adjacent surfaces cleaned of debris*



*Scratch finish between layers*



*Second-layer reinforcement mat*

to provide proper access for the nozzle to ensure it is within effective range for good encapsulation. With the nozzle pointed perpendicular to the receiving surface, and rotating to assure you get slightly different angles within 3.2 ft (1 m) of the back surface. The concrete material is applied in thin layers building up from the more vertical section of the walls to the overhead arch. Doing so minimizes the rebound as you approach the overhead sections. As you build up the concrete, focus is placed on building around the rock bolts to act as a bridge to support the load of the final lining. Reinforcing steel is encased by a combination of the workability of the material, distance of the nozzle, and high impact velocity, causing the concrete to flow around the bar, creating full encasement of the reinforcing bar and compaction of the concrete.

For the initial layer against the water barrier, shotcrete placement must be applied from joint to joint. The layout for the water barrier joints are identified and approved by the

engineer and laid out on the contract drawings. With exception of final linings, the initial layer and subsequent layers can be shot at a thickness of up to 12 in. (300 mm), given a rough, scratched finish, and will not be treated with curing compound. Curing compounds and bonding agents impair the bond between shotcrete layers.

Prior to application of the subsequent initial layer, placement must be cleaned by employing jet-wash cleaning to remove loose and foreign materials, as well as fume condensates, and to bring the surface to a saturated surface-dry condition (SSD).

Upon completion of an initial layer, another layer of pre-fabricated reinforcement mats will be installed to complete either a second layer or the final lining.

With exception of being restricted to placing shotcrete from joint-to-joint, required by the water barrier, subsequent layers can be stopped wherever it is necessary. These subsequent layers are completed in a similar fashion described in the sequence for the initial layer, and because shotcrete does not have cold joints produces a monolithic concrete section.

## | GOIN' UNDERGROUND

Once the liner is complete and finished, grouting must be performed to fully fill the back surface, especially in arch applications. The pillowing waterproofing-created air pockets must be filled with a thorough grout program between the PVC waterproofing membrane and shotcrete liner.



Final product



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