

# Swimming Pool Penetrations

By Jonathan E. Dongell

**S**hotcrete swimming pools, spas, and water features require a proper mixture design and attention to detail in application that ensures watertightness. A good shotcrete structure, enhanced with a good interior finish coating, should not leak water. While the shotcrete can be engineered and placed in a manner that creates a structure that is watertight, it is an unrealistic expectation that shotcrete will be watertight at penetrations or where it butts up to a dissimilar material. Swimming pools are typically shot monolithically, meaning one continuous application, with no relief joints. Therefore, it is logical that some separation will develop at penetrations, primarily as a result of normal shrinkage that occurs during the setting of hydraulic cement in shotcrete. While the function of an experienced shotcrete nozzleman is to fully encapsulate piping, light niches, and other penetrations within shot-

crete, a certain amount of shrinkage and separation around penetrations subsequent to application is inevitable for most monolithic structures.

Therefore, all penetrations should be sealed or plugged. Some interior finishes that are continually trowelled to a hard, smooth finish may be capable of sealing around penetrations. Others, such as exposed-aggregate finishes, may require that a sealant or plugging material be applied prior to applying the interior finish coating. It is common practice to dig out (“cup out” or “box out”) the shotcrete around some or all penetrations. Typically, dig outs for return lines are a nominal 1.5 to 2 in. (38 to 50 mm) in depth by a nominal 3 to 4 in. (75 to 100 mm) around the piping. Suction lines may require a much larger dig out, depending on the type of main drain base ring and cover that will be installed.

Dig outs allow better access to the piping, making it easier to cut the pipe far enough back to ensure that fittings will be flush with the anticipated surface of interior finish coating. Dig outs also allow access and space to apply a sealant or plugging material around the penetrations, ensuring they will be watertight. Other penetrations that require no other adjustment or work to be done prior to the application of the interior finish coating may often have little or no dig out. The burden of ensuring penetrations are sealed and/or plugged may fall to the builder, plasterer, or the pre-plaster prep crew depending on which party is given the responsibility. Ideally, the engineer or architect should stipulate the sealing or plugging of penetrations in a manner that ensures all are watertight.



*Fig. 1: Water intrusion at penetrations from behind structure*



*Fig. 2: Piping with and without fitting prior to sealing*



*Fig. 3: Piping with fittings and sealed*



Fig. 4: Improper sealing at pipe-shotcrete transition, leaving unsealed areas. Applying a sealant to the entire dig out area that is not compatible with cementitious materials



Fig. 5: Hydration issue due to variation in plaster thickness at dig outs

The following considerations, as to the type of material and method of installation, are suggested for sealing or plugging penetrations:

1. The use of non-shrinking or low-shrinkage cementitious plugging material;
2. Non-sanded cementitious materials should be used only as a thin slurry coating within the dig out, as per manufacturer's recommendations, and should not be used as a method of filling the entire dig out;
3. The inclusion of a polymeric fortifier, proven stable underwater, with the cementitious plugging material, as per manufacturer's recommendations;
4. The use of sealants that are not compatible with cementitious materials should be confined to sealing only the immediate area at the interface of the penetration and the shotcrete and should not be used to seal or coat the interior of the dig out, piping, or other fixtures;
5. The removal of any loose material or debris and thorough washing around penetrations to ensure a good adhesion bond or "keying" of the interior finish coating with the shotcrete;
6. Plugging or filling dig outs flush with the overall shotcrete surface, as opposed to using finish coating material while plastering, may help to prevent differential hydration discoloration caused by the interior finish coating's increased thickness at dig outs; and
7. Plugging material should be allowed to thoroughly dry or cure, as per the manufacturer's recommendations, prior to applying the interior finish coating.

## Sealing of Other Cracks

The use of a good shotcrete mixture design and limiting of the water-cement ratio can reduce the amount and size of shrinkage cracks that develop in shotcrete. Proper engineering, shotcrete materials, and trade practices should ensure that the hardened structure will have no structural cracks. Plastic and autogenous cracks may be visible on

the surface of a monolithic shotcrete structure; however, these will be sealed shut with the application of the cementitious interior finish coating. Structural movement cracks may not. Continued movement of the structure can reopen existing cracks or create new cracks.



**Jonathan E. Dongell** is Director of Research & Development, Pebble Technologies, Scottsdale, AZ. Dongell has worked in concrete construction and with cementitious materials spanning over 30 years. His roles have included Technician, Superintendent, Manager, Contractor, and President. He is Past President, Whitestone Cement Company, Scottsdale, AZ (1998-2005), and Universal White Cement Co, Inc., Glendale, AZ (1992-1998). He is a member and past Chair of ACI Committee 524, Plastering, and is a member of ACI Committees 201, Durability of Concrete; 225, Hydraulic Cements; 232, Fly Ash in Concrete; 308, Curing Concrete; 350, Environmental Engineering Concrete Structures; and 555, Concrete with Recycled Materials. Dongell also currently serves on the Concrete Research Council (CRC). He is a member of several ASA Committees, including the ASA Pool & Recreational Shotcrete Committee. He is a member of several ASTM International committees and subcommittees. Dongell is the author of several books, including *The Durability of Cementitious Materials in a Water Contact Environment*. He is an inventor and holds three patents on cementitious materials. He is a designated expert witness in the fields of cement, concrete, stucco/plaster, and water chemistry. He was the recipient of the ACI Delmar L. Bloem Distinguished Service Award in 2007.