

How Dense Are You?

by Bill Drakeley

Webster's Dictionary provides three basic definitions for "denseness": (1) closely together or compact; (2) thick or impenetrable; and (3) slow to understand or stupid. In my experience, the pool industry is represented by all three definitions (me included). What I have learned and relearned is that this term is not given enough thought when shotcrete placement occurs. I propose that we installers take a good, hard look at why density is so important to the pool and shotcrete industry.

The American Concrete Institute (ACI) certification manual for nozzle men teaches us that "shotcrete is a method of shooting concrete at sufficient velocity to ensure proper compaction." A good final product in concrete placement using the shotcrete process is a function of its mixture proportions and compaction achieved. Proper compaction and density are paramount for good

quality shotcrete. How do we get good compaction? Velocity, velocity, velocity. And, by the way, there is no such thing as low-velocity shotcrete. High velocity is required for a successful project. This means your compressor size, hoses, and equipment need to have the means to shoot shotcrete that ensures proper steel encapsulation and limits porosity in the mixture.

My recommendation for proper sizing of air equipment is a compressor with at least 250 ft³/minute (7.1 m³/minute) capacity for wet-mix shotcrete. Our company uses a 375 ft³/minute (10.6 m³/minute) unit on all pool projects. On occasion, we have employed a unit that, at best, had a capacity of 185 ft³/minute (5.2 m³/minute), probably less with use. The smaller unit did not apply shotcrete in a fine spray like cone onto the substrate. It was clumpy and uneven. By upsizing the compressor capacity, one could really see the ridges on the reinforcing bar during



Shooting for exact tolerances on walls and edges creates ease of movement for water in transit. Shooting in tight tolerances also reduces preparation for the installation of the finish material (tile)

Technical Tip

shooting and how the shotcrete encapsulated the reinforcing bar from the back of the substrate forward and toward the nozzle.

By using different velocities, a nozzleman can really see the difference, not only in steel encapsulation, but also in the porosity of the mixture. The more porosity (capable of being permeated by fluid) the installed shotcrete has, the weaker it will be. Voids, shadowing, and poor encapsulation of the reinforcement obviously have adverse effects on shotcrete strength and durability. I have actually attended lectures where the instructors had advocated sealing the newly installed pool shell with some type of hydraulic cement-based sealer. This whole step is basically an attempt to cover up the problem. With good velocity and compaction of the shotcrete, sealing is a non-issue. With proper mixture design, velocity, and shotcrete techniques, you can expect 4000 psi (27.6 MPa) compressive strength from properly cured shotcrete (curing is a subject for another Technical Tip).

Review your equipment and understand the shotcrete process. High velocity of material is defined by the American Shotcrete Association and ACI. By practicing these guidelines, you will not be assigned denseness definition Number 3.



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This picture depicts the denseness of the concrete. Thickness, tolerance, and uniformity of the shotcrete are shown, as well as the encapsulation of the reinforcement bar