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Poor-quality gunite can lead to severe cracking in swimming pools. Here's how to repair the damage.

Gunite Troubles

This featured project highlights the effects of poor-quality gunite, particularly when it meets expansive soil.

THE PROBLEM

This rectangular-shaped, gunite swimming pool was built in 2003. The following year, cracks began to develop in the sidewalls and benches. Within a few months, severe cracking had formed in all four pool walls, benches and steps as well as at the two skimmers and into the pool floor.

THE INVESTIGATION/CAUSE

The pool was built in an area with expansive clays, which wreaked havoc on other nearby pools and patio flatwork. Initially, we suspected that ground conditions had caused the damage. However, careful inspection of the pool cracks led us to another conclusion. Jagged, disjointed cracks that do not intersect the bond beam often are the telltale sign of poor gunite workmanship.

To confirm our suspicions, we collected eight core specimens from three locations throughout the pool: the walls, benches and steps. The samples were porous and had several layers of uncompacted sand, called lenses. This usually results from shoddy nozzling.

The cores were fractured and weathered at varying depths. One collected from

the sidewall consisted entirely of clean, cohesionless sand with no cement. The cement truck probably ran out of material or got jammed, while the sand truck continued to feed the hopper for a short period of time. We suspect the crew kept on shooting the material until they could get their cement feeding again. Though it was probably a small, isolated area, a large crack had developed.

We then visually graded the cores. This procedure assigns the core specimens a grade between 1 and 5, based on the quality of the material. Outlined by the American Concrete Institute, a grade of 1 corresponds to high-quality gunite that is relatively free of

imperfections. A grade of 5 signifies poor-quality gunite containing significant voids and sand lenses.

Five of the eight cores were classified as a grade of 5. The three remaining were rated a grade of 3. The average

grade of the eight cores was 4.25. ACI considers an average grade above 2.5 to be unacceptable.

Besides visually grading the cores, we measured the unit weights to determine density. Compressive strength



Poor workmanship: Cores taken from the pool (above) revealed poorly applied, weak concrete. Of the eight cores taken throughout the pool, five indicated shoddy nozzling during the gunite process. The cracks were repaired with epoxy injection (right), after which a layer of fiberglass was applied over the vessel's interior.

testing was performed on the core specimens. We could only test seven of the eight cores because one consisted entirely of clean, cohesionless sand. Twelve test samples were prepared from the seven remaining cores.

The project specifications required a minimum compressive strength of 2,500 psi. Compression test results varied from 810 to 3,130 psi, with eight of the 12 tests below 2,500 psi. An expected unit weight for high-quality gunite should be on the order of 135 pounds per cubic

foot. Unit weights ranged from 113 to 133 pcf. Low density generally indicates sand layers, voids or too much air, ultimately leading to low strength.

The testing also indicated that poor-quality gunite was not isolated to one specific area. It was present throughout the pool shell.

This project combined expansive soils and bad gunite. The shell couldn't withstand the stress of the soil. Therefore, as soon as the ground got wet and started to push on the pool, it began to

bust up because the pool had no structural integrity.

THE FIX

The gunite shell was weak and the soils in this area were expansive, so we concluded that the pool most likely would sustain additional cracking in the future. As a result, we developed a two-part repair.

First, we prescribed epoxy injection for the existing cracks. (For more about this process, see "Hazards of Loose Fill," Jan. 23, 2006, issue.) The pool was then resurfaced with a fiberglass coating. Fiberglass is more flexible than plaster, so any additional gunite cracking would be less likely to propagate through the surface. Two years after the repair, we have received no report of further problems.

THE LESSON

High-quality gunite depends on many factors. It begins with the skill of the nozzleman; the mix proportions of sand, cement and water; the equipment; and weather conditions at the time of placement. To avoid any problems, all gunite or shotcrete equipment should be calibrated at least once a year to ensure correct proportioning.

Mix designs also should be reviewed by a qualified materials testing laboratory. The material should follow ACI 506, the code that governs wet-mix and dry-mix shotcrete. It provides specifications for mixing, batching, proportioning, sand gradations and nozzling techniques. If someone is trying to evaluate a gunite job, he or she should turn to this standard.

Mixes should contain at least seven sacks of cement per cubic yard and have a cement-to-aggregate ratio of at least 1 to 5. Follow the ACI code's aggregate gradation specification. This outlines the range of aggregate sizes that the concrete should contain and in what proportions.

Apply the gunite so it compacts perfectly. It should have no sand lenses, voids or layering issues. All reinforcement must be completely encased. Remove and haul rebound off site; never throw it on steps, benches, waterfall pads and the like.

Make sure nozzle operators receive formal training. ACI collaborates with the American Shotcrete Institute to offer a Nozzleman Certification Program. Spanish-speaking instructors are available. The cost of the training program is the same for one student or 20, making it economical for several gunite applicators in a region to participate together. ■

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