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On The Cover: Crews install structural supports for covers over the pervious concrete of a 3.4-acre park-and-ride lot being built at Glendale Avenue and Loop 101 near the Arizona Cardinals' gleaming new stadium in the Phoenix suburb of Glendale. The lot is by far the largest use of pervious concrete ever in the Southwest. Photo by Terry Ertter

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Pervious Concrete: The Water Just Disappears

Absence of fine aggregates allows pervious concrete to drain, making it ideal for parking lots

BY TERRY ERTTER

There's a little demonstration Stew Waller enjoys running whenever he gets a chance to demonstrate pervious concrete to a group that's unfamiliar with the product. "Anytime we start a new job, we have a water truck come out on-site," he says. "We just open that water truck hose on the pavement and let it flow."

Waller says groups are always amazed. The water just disappears. There's no ponding and no runoff – just dry concrete and plenty of stunned observers. Where did all that water go?

Welcome to the world of pervious concrete, the material being used to pave a 3.4-acre park-and-ride lot being built at Glendale Avenue and Loop 101 near the Arizona Cardinals' gleaming new stadium in the Phoenix suburb of Glendale. The lot is by far the largest use of pervious concrete ever in the Southwest, and it's garnering lots of attention.

What is it?

According to Waller, executive director of the Arizona Cement Association, pervious concrete has been widely used in Florida for more than 25 years. "It's sometimes called no-fines concrete," Waller explains. "Normal concrete contains cement, water, coarse aggregate, and fine aggregate. The fine aggregate in that mix is sand. In pervious concrete, we take the sand out of the mix, and that creates voids. That allows the water to pass through the pavement into whatever material is below the pavement. Those voids are actually interconnected channels that allow the water to pass though."

How much water can pass through? Brand-new pervious concrete can handle anywhere from 200 inches to 400 inches of rain per hour. That assumes, of course, that the water has somewhere to go after it passes through the concrete.

Above: Looking south and slightly east at the pervious concrete park-and-ride lot being built in Glendale, Ariz. The roof of University of Phoenix Stadium, home of the Arizona Cardinals, is visible on the other side of Loop 101 from the lot. Photos by Terry Ertter except as noted

The water-handling capabilities of the material open up a whole new world of possibilities for designers planning projects that call for paving large swaths of ground. The slopes, gutters and retention basins required to manage storm water drainage in conventional projects can be eliminated or scaled back. Dramatically reducing the size of a retention basin – as was done with the Glendale lot – allows for a more efficient use of the property.

Glendale might have been able to dispense with the pond entirely if the

ground under the new lot contained less clay to block the absorption of the water coming through the concrete. Designers called for construction of an underground drainage system to prevent the soil under the lot from swelling after a heavy rain.

The parking areas of the new lot have a 6-inch layer of pervious concrete sitting on a 6-inch layer of loose 3/4-inch rock. "The rock is not a structural feature," says Waller. "It's a storage reservoir. Pervious concrete is 20-percent to 25-percent voids. The rock is about 30-percent voids. If the soil beneath will accept the water, you can have it flow right through, and you don't even need that reservoir. The soil below this job has some clay, so they do have a subdrainage system to handle any excess drainage needs. There will be some groundwater recharge on this job."

Environmental benefits

The groundwater recharge capability is one of the many environmental plusses of pervious concrete. The Phoenix area – much like other arid Western communities – has a strong desire to get water back into the water table. Every gallon that leaves the city on its way to Yuma is a lost gallon of an increasingly precious resource. Every gallon that sits on the surface and evaporates is a loss.

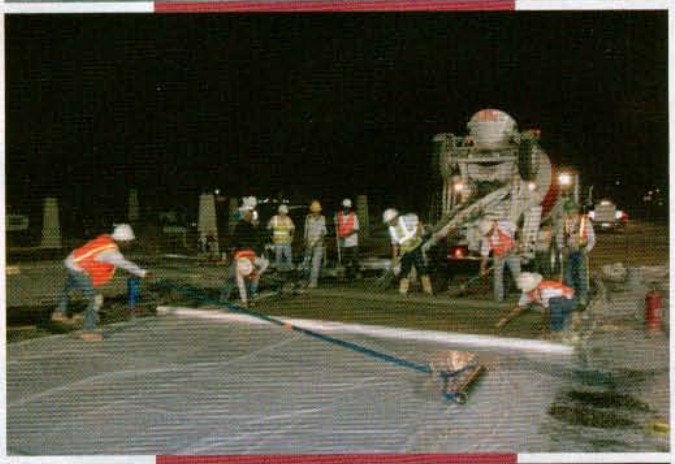
Simply dumping storm water into the city's storm drains is not an option. "Environmental issues in construction are gaining momentum all the time," Stew Waller points out. "Storm water management has become a big issue. What's the most economical way to treat our storm water?

"You can't just release it into storm drains. Storm water is dirty. You have dust and car oils that accumulate over time. That first rain after an extended dry spell is called first flush, and it is very dirty, so we want to treat that first flush. Pervious pavement actually filters that. There's a microbial action that goes on inside the voids that digests some of the hydrocarbons from the oil."

Pervious concrete is also much cooler than asphalt or conventional concrete. The light color reflects ultraviolet rays that would be absorbed by asphalt, and the void structure lets the material breathe, preventing it from storing heat the way conventional concrete does. Engineers, including Arizona State University's NCE SMART group (National Center of Excellence for Sustainable Materials And Renewable Technology) are actively seeking ways to minimize the urban heat-island effect. The group has recommended use of pervious concrete at ASU.

Tucson's Reed Park Zoo is counting on pervious concrete to keep zoo goers a little more comfortable on warm days. The zoo plans to install new sidewalks, a plaza and parking lots built with pervious concrete this winter.

Waller notes one other advantage he expects to see builders employ soon. "A designer could easily incorporate shade trees into a parking lot without having the issues usually associated with the concept," he states. "Getting water and oxygen to the roots is easy, and the roots won't need to come to the surface, breaking up the pavement in search of the water and oxygen."



Night shots showing the pouring of the 3.4-acre park-and-ride lot being built of pervious concrete at Glendale Avenue and Loop 101 in Glendale, Ariz. Three photos courtesy Stew Waller

Factoring in the cost

Like any new technology, pervious concrete costs more now than it will as the adoption rate increases. Waller estimates the pervious concrete portion of the Glendale job is nearly twice as high as it would be for the same work in Florida. The lack of certified contractors plus the lack of suppliers equals a lack of competition. Despite its higher initial cost, the pervious concrete actually became economically feasible when viewed over time.

"The consulting engineer performed a formal least cost analysis," says Waller. "The study used a 20-year design life. Up front, the pervious concrete didn't pencil out, but over 20

Recently poured concrete is covered with plastic and carefully sealed during the curing process.

View of surface texture looking straight down.

A section of rock sub-base ready to have pervious concrete poured onto it.

Sidewalks are built using conventional concrete and elevated slightly to drain onto the pervious concrete.

Cross section showing 6 inches of pervious concrete atop 6 inches of rock. The rock layer works as a storage reservoir for rainwater.

years, it's a push, and that's without considering the environmental benefits."

Asphalt has the lowest up-front costs, but patching, slurry sealing and other maintenance costs are much higher with asphalt as years go by. With the 20-year costs being roughly equal, the environmental benefits of pervious concrete became an important positive.

The long-term costs sold Glendale project manager Mike Johnson. The design decisions had all been made by the time the job was assigned to him, and he had some concerns when he first heard the project used pervious concrete. "I was very skeptical at first, because I didn't know anything about it when I got the project," Johnson states. "Since then, I've had the training, and I'm certified, and now I'm comfortable with it. I've seen the tests. It's all about longevity."

Installation and maintenance

A contractor experienced with conventional concrete can't expect to simply switch to pervious concrete without training. Installation and curing are critical. "Pervious is a zero-slump mix," says Waller. "It's a very dry mix with a low water-to-cement ratio. It has to be dry, because if it's too wet, you'll get a wet paste rising to the surface. That will clog your openings and defeat the whole purpose."

Waller continues, "Pervious concrete cures very rapidly, and controlling that is the biggest challenge in Arizona. The guideline for us is to put plastic sheeting on top of the concrete within 20 minutes after it's poured and rolled. Otherwise, you may get raveling (top surface loosening)." It's absolutely essential for the contractor to make sure the fresh

Above: Crews installing structural supports for covered parking.

Closer view of supports for covered parking.

pour is completely covered and wind is not allowed to get under the plastic.

Another consideration that must be taken into account is that pervious concrete does require a thicker pour than conventional concrete to reach load-bearing equivalency. The 6-inch pour at the Glendale lot will have the same load-bearing characteristics as a 5-inch pour of conventional material. "Standard practice is to add 20 percent to what would be needed for conventional," according to Waller.

Crews working with pervious concrete for the first time are always surprised by how slowly the mix comes out of the truck. A crew person typically needs to help the mix along through the chute. However, this flow rate can be greatly improved by proper use of chemical admixtures. Once the mix is in the form, there's very little of the hand smoothing and shaping needed with conventional concrete. "Place the material, rake it out and run a roller screed over it," Waller says.

Compaction is another critical area. Too little reduces structural integrity. Too much removes voids. Removing voids is good with conventional concrete, but it's not at all desirable with pervious.

Maintenance needs for pervious concrete are minimal. "There are jobs in Florida that have been in place for 25 years and have not been cleaned once," Waller notes. "That causes clogging, but even on those jobs the worst flow rate is still better than 4 inches per hour. We recommend vacuuming or power washing once a year to minimize clogging. Assuming installation was done properly and loads are kept within design parameters, a good annual cleaning should be sufficient maintenance."

Future uses

Progress at the Glendale park-and-ride lot is being watched closely by contractors and others in the construction industry. The environmental benefits make pervious concrete an attractive option, and the word has begun to spread. Waller anticipates considerable growth in the number of certified contractors and suppliers in the next couple of years. ■

Job Facts

Project name: Glendale Avenue and Loop 101 Park-and-Ride
Owner: city of Glendale
Specs: 12.7 acres
392 parking spaces in Phase One, another 254 in Phase Two
3,000 square yards pervious concrete (140,000 square feet)
Website: http://www.ekglendaleaz.com/parkandride.htm
General Contractor: Banicki Construction
Concrete Contractor: Progressive Concrete
Concrete Supplier: CEMEX
Consulting Engineer: Jacobs Edwards and Kelcey