Project Profile

Charleston's Landmark Citadel Goes Green With Low-Impact Porous Parking Lot

By Greg Northcutt

When the engineering firm of HLA Inc. in Charleston, SC, took on the job of renovating the alumni association's parking lot at The Citadel in the summer of 2009, it faced two challenges.

First, meeting the client's desire for a low-maintenance, environmentally friendly alternative to the existing surface—a macadam pavement that had become compacted over time and had developed alligator cracking and potholes—that would service pedestrians and support vehicle traffic; and second, protect a nearby saltwater marsh and open water tidal critical area from pollutants in stormwater runoff from the site, despite the lack of space and time for constructing a conventional stormwater detention pond in a low-lying area

The engineers met this challenge by selecting a unique porous pavement system designed specifically to confine and stabilize open-graded pervious aggregate infill inside a drainable structure. The strength of the confined mass of the aggregate supports the traffic load in concert with the load bearing wall of the high density polyethylene structure, while the voids in between the individual aggregate particles provide storage space for water, allowing runoff to infiltrate into the soil rather than flow off the parking lot, carrying pollutants. In this case, that ability to soak up runoff eliminated the need for a stormwater retention/detention pond that a concrete or asphalt pavement would have required. An additional benefit is that the aggregate infill stays cooler than traditional hard surface pavements.

A Package of Benefits

This green alternative to asphalt and concrete, called the GeoPave porous paving system, was developed by Presto Geosystems and is made from recycled polyethylene. It combines a herringbone pattern of cells for confining the aggregate with an integrated mesh bottom that prevents loss of infill through the bottom of the cells while contributing to the system's load distribution capacity. The individual paving units measures 20 inches wide, 40 inches long, and 2 inches deep. Structurally connected with clips, they are typically

arranged in, bricklayer or herringbone configuration.

When infilled with an open-graded aggregate for repeated traffic loads, the pavement performs to an H-20 rating. The system can also be used with an engineered topsoil/aggregate infill to provide a vegetated surface to perform to an H-10 rating and infrequent or occasional traffic loads.

Furthermore, this porous pavement system can help a commercial project achieve certification through the US Green Building Council's LEED (Leadership in Energy and Environmental Design), which has become the national standard for defining green buildings. This type of pavement can contribute to LEED credits in the areas of reduced site disturbance, the quality and quantity of stormwater management, reduced heat island effect, and recycled material content.

The demand for porous pavement continues to strengthen, reports Brandon Shaw of ACF Environmental, the product distributor in the Charleston area.

"This market is growing significantly, whether as a result of stormwater regulations or to capture the benefits from eco-friendly solutions, and developers and project owners are doing more green building projects," he says.

Most of that growth, he adds, has involved the use of porous pavement in parking areas used on a regular basis rather than vegetated applications, such as overflow parking sites, where traffic is limited to infrequent use.

The ability of the permeable GeoPave system to provide stormwater infiltration and to reduce stormwater runoff was especially valuable in this project, Shaw notes.

"Well known for its Corps of Cadets, the Citadel is located in downtown Charleston, which is at sea level," he says. "It doesn't take much of a rain event, maybe just an inch or two, for this area to flood. It helps reduce the impact on the parking lot by providing for underground storage of runoff."

In addition to its environmental benefits, this system is a less expensive alternative to concrete pavement, Shaw says. And, while construction costs are similar to that of an asphalt surface, the porous pavement is much more durable and doesn't require the periodic repairs needed to maintain asphalt pavement.

The GeoPave system offers several advantages over smaller unit porous pavement systems, he explains. "When filled with aggregate, the cells provide a decorative, randomized pattern design. The interconnected paving units hold up to repeated traffic and torsional loading and create a semi-rigid pavement surface that better resists subgrade undulations and imperfections than more flexible systems."

Because the stiffness and size of the paving units provides high structural strength and maximum load distribution, this system requires less depth of base material for all loading requirements than many other light-weight porous systems, Shaw notes. "That contributes to significant savings in material and construction costs," he says.

The monolithic mesh bottom creates a snowshoe effect, contributing to the system's maximum load distribution. Also, Shaw adds, because the molded mesh bottom holds infill in the cells, and because the system is designed with discontinuities in the walls of the grids, the system will not lift up like other systems causing infill to drop out of the bottom cells.

A Time- and Space-Saving Design

Senior project manager Ron Felkel, P.L.S., with HLA Inc., was in charge of the Citadel parking lot renovation project. The firm viewed it as an opportunity to use cutting edge technology to provide an all-weather traffic surface without increasing runoff as a concrete or asphalt pavement would, he recalls. A porous pavement also offered a way to complete construction, which began in July, in time for the start of the football season the following month.

Surfacing the lot with hard pavement, like asphalt, would have required building a stormwater retention/detention pond, constructing an outflow control structure to control runoff flows from a two-year, a 10-year, a 25-year, and a 100-year storm. It would also have meant providing more vegetated areas to slow and help remove pollutants from the runoff before it entered the marsh. "To gain the necessary space for this, we would have had to reduce the size of the parking lot, which was not an option," says Felkel. "We didn't have a lot of time to get this site permitted and constructed. The GeoPave product, by its design, reduces the amount of stormwater design work required, which saves agency review time in obtaining the necessary permits."

The engineering firm selected the GeoPave porous pavement system for this project after thoroughly researching its specifications and engineering criteria. To minimize the amount of land disturbance of the project and maintain the existing direction of drainage flow, the new parking lot design kept the original grade.

The design of the 57,064-square-foot project included hard pavement for driving lanes and porous pavement for the actual parking areas. The 20- to 23-foot-wide driving lanes, covering a total of 25,352 square feet, would be surfaced with hot laid asphaltic pavement. The idea was to eliminate any need to replace gravel infill that might be kicked out of the porous pavement system from changes in wheel direction as vehicles enter and exit a parking space.

The porous pavement system was specified for the 22,738 square feet of parking stalls to provide a permeable, stabilized surface for the vehicles and foot traffic. By making more efficient use of the parking lot space, the redesign increased the number of parking stalls from 80 to 117 and provided more grassed areas for treating runoff.

Runoff from the impervious driving lanes flows across and seeps into the porous pavement system before reaching the grassed areas and grassed swales, Felkel notes. "This increase in the time that runoff is exposed to the gravel surface helps improve water-quality treatment," he says. "The open porous texture also slows down the flow to aid water in soaking into the soil. Our calculations show that the post-renovation runoff for two-, 10-, 25-, and 100-year storm events is less than before."

Construction Details

Charleston contractor Arthur Schirmer, a civil engineering graduate of The Citadel and president of Landscape Pavers LLC, assisted in the design of the project and directed the work to renovate the parking lot.

The first parking area was completed in mid-August 2009, six weeks after construction began. The second parking area, also done in six weeks, was finished in February 2010. To prepare the site, his crew removed the original recycled asphaltic pavement material to a depth of 8 to 12 inches, replacing it with new compacted granular fill to the

Crews place GeoPave units on a mesh bottom (left). At right, the cells are ready to be filled with aggregate.

same elevation. Next, they covered this subgrade with a nonwoven geotextile to filter water and prevent fines in the subgrade from migrating up into the porous pavement system.

After the asphalt driveways were laid, the crew then placed the GeoPave system by connecting GeoPave units using metal clips and a hammer to secure one to another. In all, they installed 4,090 units.

"Installing and clipping them together was very easy," says Schirmer. "We could cover an 18- by 100-foot area in a day and a half. Because this system is designed to be held in place by the weight of the infill, there was no need to anchor the units for this project.

Using a front-end loader to place the open-graded aggregate—a 789 gravel (one-half- to three-fourth-inch, or 8-mm stone)—and a motor grader to spread it, the crew filled the cells with a total of 532 tons of infill.

"For the final step, we ran an asphalt paving roller over the entire parking area as an extra precaution to prevent any waves in the surface," says Schirmer. "When we were done, the top of the parking stalls was flush with the surface of the driving lanes for a nice, neat appearance."

Positive Results

The ease of construction wasn't the only aspect of this project that Schirmer enjoyed.

"It's exciting to work on a project like this, which was in a high-visibility area of the campus next to the football stadium, knowing that you're doing some really good things for the environment."

Felkel has been pleased with the results of this project. "It's met our requirements in terms of reducing stormwater runoff, and there hasn't been any ponding in the parking lot."

In fact, he expects to see increased use of porous pavement systems like the one used at this parking lot in the future. "We're doing more and more low-impact development projects, and this permeable type of pavement helps slows down runoff while also helping to clean it up," he says. "Even if a porous pavement system doesn't catch all the runoff; it can reduce the size of any stormwater retention/detention ponds that might be needed."

It's fitting that The Citadel, nationally recognized for developing leaders, is using a leading technology to protect the environment in Charleston.