



Special Feature

On September 11, 2008, seven years after the terrorist attacks at the Pentagon, The Pentagon Memorial was dedicated to the people who lost their lives. The Memorial is structured chronologically based on the ages of the victims, with the 184 individual Memorials placed along Age Lines parallel to the trajectory of American Airlines Flight 77.

While the Memorial Units themselves are the central focus and at the heart of the project, when visitors traverse the grounds they notice the sound of crunching gravel and the feel of small stones moving underfoot. The audible nature of the gravel and the slight shifting were purposeful and intended in the design of the Pentagon Memorial. Along with rippled water, reflected light, and the tactile nature of the walls, the gravel was chosen to help visitors feel a part of the Memorial. The Designers of the Memorial, Julie Beckman and Keith Kaseman, KBAS Studios, Philadelphia, wanted to promote contemplation, feeling, and investigation without implicitly telling visitors what to think or feel. The gravel surface is unique compared to many of the granite, marble, and concrete walking surfaces at memorials and monuments in Washington, D. C..

For the sound, look, and feel they wanted, the designers chose a fifty-fifty mix of Cibola Gold and Cadet Black granite gravel imported from Texas. To facilitate the use of gravel in the design, Kaseman and Beckman used a product called Gravelpave2 to stabilize the loose aggregate and to allow for pedestrian, wheelchair and stroller access. Gravelpave2, manufactured by Invisible Structures, Golden, CO, is specifically designed as a surfacing material to contain gravel, allow for foot or vehicular traffic and to remain porous (drain water). Gravelpave2 is a series of one-inch high cylinders connected on a grid, with a geotextile fabric attached to the grid. Gravelpave2 is filled with decorative gravel and placed on a base course. Gravelpave2 is traditionally installed in parking lots, access roads, fire lanes, trails and walkways.

Beckman and Kaseman wanted the Memorial to be environmentally friendly. Gravelpave2 was not only chosen for the sound and feel of the gravel underfoot, but also because of its enhancements to the environment. Gravelpave2 is manufactured from 100% recycled plastic and has a 100% recycled/remnant geotextile fabric backing. The third party anchoring system is also manufactured from 100% recycled steel.

Gravelpave2 is a porous (permeable) pavement system. Rainwater is allowed to percolate through the system and back into the groundwater supply. Impermeable surfaces, such as asphalt and concrete, carry rainwater and pollutants such as; oil, gas, fertilizer and animal waste as runoff and contaminate our streams, rivers, reservoirs and ultimately, our water supply. Hydrocarbon drips, metals, nitrogen and many other pollutants are naturally

removed with the Gravelpave2 system – similar to undeveloped land.

Gravelpave2 also adds the benefit of urban heat island mitigation to the new Memorial. The colored gravel fill reduces the ambient air temperature associated with absorbed solar radiation. "Gravelpave2 can reduce air temperatures by as much as a few degrees, compared to asphalt and other building surfaces," states Kate Wright, Sales Engineer for Invisible Structures. "The gravel color, the angles on the surfaces of the stones, the number of surfaces, and the void space between the pieces, all contribute to the mitigation."



Gravelpave2 will also promote the growth of the newly planted Paperback Maple trees in the Memorial. Gravelpave2, as well as other permeable surfaces, allow water, carbon dioxide, oxygen and nutrients to transfer easily to and from the trees' root systems. "Promoting a healthy root system for new and existing vegetation is an advantage of Gravelpave2," says Wright. The Paperback Maples also benefit from a specially mixed bed they were planted in. For each tree there is a twenty-foot radius of a mixture of stone, sand and topsoil, extending out from the trunk, under the Gravelpave2. The unique bedding will help ensure a thriving plant. The Paperback Maple was chosen by Beckman and Kaseman for its unique red/brown paper-



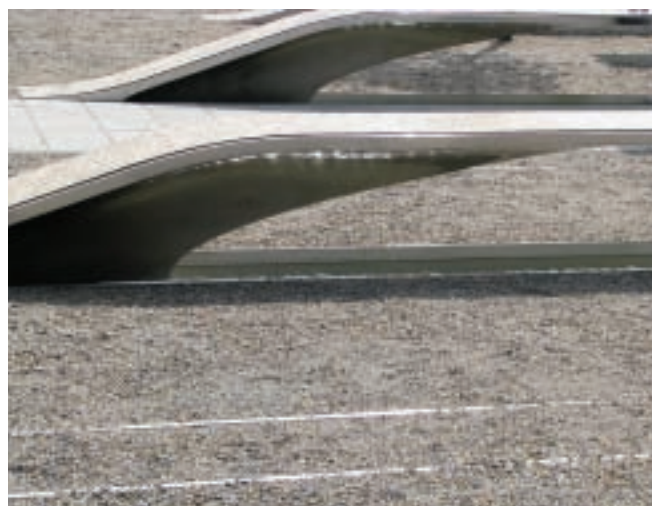
Unique surfacing adds sound and feel to the Pentagon Memorial

Environmentally friendly aesthetic surface placed at D.C.'s newest memorial



textured bark and for the fact that the tree is late to lose leaves in the fall. The bark will add contrasting color and texture to a gray winter day.

The Gravelpave2 system was augmented with a cement binder to stabilize the aggregate inside the ring and grid matrix, and then topped off with up to a half-inch of the unbound Cibola Gold and Cadet Black colored granite gravel. No binder is necessary for ordinary Gravelpave2 installations. The binder was added at the request of the United States Access Board, a federal agency dedicated to seeing that the disabled and wheelchair bound have equal access to public buildings.



Beckman, Kaseman, and The Pentagon Memorial Fund Members invited the United States Access Board to collaborate in the design process on the aspects of accessibility. Modifications to the design were also made at the request of the Access Board regarding the width of the hard surface granite-paver paths and height and placement of

the walls. Prior to the Memorial installation, many Access Board Members were on-site for field testing of a small installed bed of the Gravelpave2 system. Gravelpave2 has been independently tested to meet ADA (Americans with Disabilities Act) accessibility requirements.

"Originally, the designers were looking at a custom colored Gravelpave2," says Kevin Cobaugh, Vice President of Sales at Invisible Structures. Invisible Structures investigated speckled coloring and a pattern that would match the imported decorative gravel fill. Once the test bed was installed, the design team decided there was not enough of the Gravelpave2 rings that would show and therefore a custom color was not necessary. Ultimately, gray colored Gravelpave2 was installed. "The gray looks great," continues Cobaugh, "It blends in with the aggregate chosen for the Memorial."

"It [Gravelpave2] works great for what it's supposed to do," says John Dingus, Jr of Davey Tree Expert Company, Site Installer for the Memorial. "Under the product is a 57 stone base course for drainage and under all of what you see is 12,000 tons of material."

56,000 square feet of Gravelpave2 was installed at the Pentagon Memorial by Davey Tree Experts Company. "Some of the Gravelpave2 was precut at our yard [Chantilly, VA] but most of it was fit onsite. Custom fit," says Dingus.

"The most difficult part was the ten percent cement mixture," Says Dingus. "We couldn't premix it. It had to be done on site." Dubrook Concrete, also of Chantilly, VA, was brought in to mix the gravel, water, and cement to fill the Gravelpave2 rings level to the top. The surface was then topped off with up to one-half inch of the loose gravel.

The 10% cement binder mix and the base course were not the only unique installation aspects to this design. Under the Age Lines sections of the Memorial Units, the base course of the Gravelpave2 is concrete. Normal anchors (eight inch ring shank nails and washer) were not sufficient – the Gravelpave2 was anchored down with threaded bolts and secured to the concrete base. The areas not in the Age Lines, used the aforementioned 57 stone as a base and the normal eight inch ring shank nails and washers.

Invisible Structures has two more unique installations at the Pentagon: A small patch of Gravelpave2 as the utility road for a ceremonial cannon, and 22,000 square feet of Grasspave2 (a grass surfaced porous pavement) for the helicopter landing pads on top of the Pentagon's Remote Delivery Facility.

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