Geopiers: An Intermediate Foundation Type

First use in Colorado at Ballpark Lofts

by Carol Carder

A SAVINGS of more than a half million dollars on a $36-million project and shaving 100 days off the construction schedule convinced the owner and designers of Ballpark Lofts that Geopier foundations offered a viable and attractive alternative to drilled shaft foundations, according to Tommy Williamson, president of Geopier Foundation Co's. (GFC) Houston, Tex., division.

Ballpark Lofts, Colorado's first Geopier-supported project, begins construction in May at 24th and Blake streets, Denver. Target completion date is the end of November 2002. Players include: Legacy Partners, Denver, owner; J.E. Dunn Construction, Denver, general contractor; Peterson Contractors Inc., Reinback, Iowa, Geopier licensed installer; Davis Partnership, Denver, architect; Terracon Consultants Western Inc., Wheat Ridge, Colo., geotechnical engineering, and Martin Design Inc., Denver, structural engineering.

Williamson explains that traditionally when the soil conditions are too poor to support a structure on spread foundations, the architect and engineers designing the project either specify over-excavation and replacement of fill with aggregate roadbase grade material or drilled shafts to bedrock. The Geopier system offers an intermediate proven foundation system, according to Dr. Nathaniel Fox, GFC president. The system developed by Dr. Fox, a consultant with a Ph.D. in geotechnical engineering from Iowa State, and Dr. Evert Lawton, then at the University of Miami (Fla.), in 1988 now supports structures in more than 30 states and three other countries. Varied structures the system supports include buildings, parking garages, retaining walls, mechanically stabilized earthwalls, grain elevators, bridge abutments, bridge approaches, pipelines and storage tanks. The system may also be used to stabilize landslide areas and soil embankments.

Auger mounted on an excavator bores hole for Geopier installation.

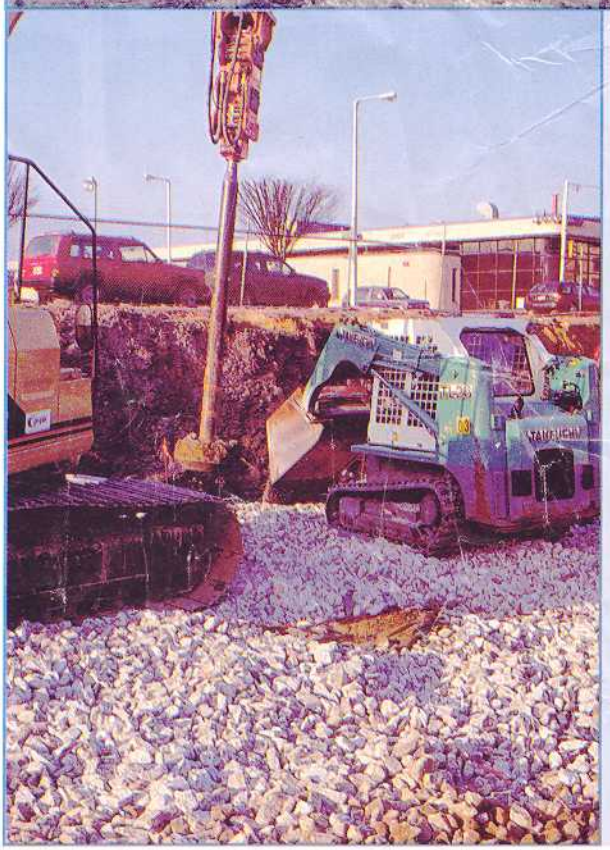
Simply speaking, Geopier(T) elements are medium depth holes filled with compacted aggregate (rammed aggregate piers). From the engineering viewpoint, it's a fine-tuned engineered product calculated to carry the loads from the spread footing foundations. GFC, acting in a

design-build mode, is so confident of the performance, the company gives the owner a written warranty guaranteeing any settlement at a maximum of one inch and at one and a half inches for parking structures, according to Williamson. "No other foundation companies warranty their products. They may guarantee the materials and workmanship, but they do not address settlement," he adds.

Geopier engineers design the width, depth and placement of the rammed aggregate elements to support one and a half times the calculated loads, according to Williamson. In the Ballpark Lofts project, an average of four to six piers 30 inches in diameter and 11 to 18 feet deep support the 8-square-foot standard spread footing under each load-supporting column. Support capacity of each pier is 100 kips or 50 tons. The five/six story, 388,000-square-foot building and 152,000-square-foot, six-level parking garage project will rest on 1,353 piers that Peterson Contractors, the Colorado Geopier licensee, will install in 35 working days.

Curtis Tanner, P.E., Geopier representative for Colorado and Utah, observes, "The installation uses easily mobilized small equipment such as a backhoe-mounted auger, a small loader such as a Bobcat to place aggregate and a pavement breaker to tamp down the aggregate. We're using inexpensive material and are fast averaging 40 to 60 piers a day."

Williamson describes the construction of a Geopier element: "We drill the hole to the design depth, 17 feet deep in this case. Then, we build the bottom bulb with clean stone that is 30 inches deep and composed of 4- to 6-inch aggregate without fines. We tamp it at 2,200 foot-pounds with the beveled head of a pavement breaker. Then, we come up the shaft in 12-inch lifts using normal highway grade base with some fines. Each lift is tamped with 2,200 foot-pounds of pressure that bulges the aggregate into the surrounding soil, increasing the load-bearing capacity of the soil. A concrete foundation slab seals the tops of the piers."



Tampers attached to hydraulic breakers on either an excavator or a skid-steer loader are used to compact the lifts of aggregate that make up the Geopier.

In working with Rick Ehlert, structural engineer at Martin Design, Denver, Williamson compared the cost and time schedule with both the previously considered concrete drilled pier system and driven H-piles. He also conducted load testing using basic ASTM procedure 1143 and demonstrated settlement of less than an inch at one and a half times the design load.

Addressing Problem Soils

Minimizing excavation of lead-contaminated soil is a concern in the Townpointe condominium project in Park City, Utah. Since Park City was a mining site before it became a ski town, 10 to 15 feet of mining fill underlays the area. Developer/contractor Summit Point Construction, Park City, Utah, has decided Geopier installation, instead of over

excavation and replacement fill, solves the problem.

"Using piers will produce only 15 percent of the potentially contaminated material that would have been produced with over-excavation," explains James Johnson, P.E., president of Geopier Foundation Co. (GFC) Inc. Northwest division, Bellevue, Wash.

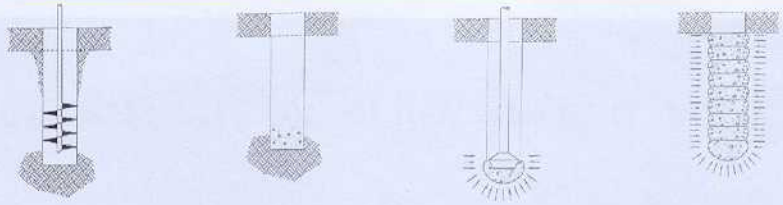
Installation of 375 piers supporting the three four-story buildings and the parking garage is beginning at the end of May and will be completed within two weeks. Johnson observes that the actual timeframe is shortened for subsequent construction sequencing. The construction division of GFC Northwest will complete the rammed aggregate elements for one building at a time, moving on to the next building while the construction crew pouring the foundations will move in right behind them.

"Our actual timeframe is three to four days a building, so we sequence well into other construction activities," Johnson says.

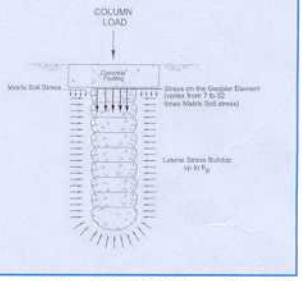
The Geopier foundation system also protects against liquefaction (soils turning into a liquid state) resulting from seismic activity. In Olympia, Wash., where the Feb. 28 Richter 6.8 earthquake caused an estimated $1 to 2 billion in damage, 32 Geopier-supported buildings rode out the quake intact. Johnson inspected the buildings several days after the earthquake and observed that not a single crack or any evidence of damage could be detected. Several of these structures are next to areas of high building damage and landslides.

"We have no way of knowing if the Geopier-supported buildings would have been damaged or destroyed if they had not been protected by Geopier soil reinforcement. But one thing we do know is that Geopier-supported buildings can undergo even larger and more damaging earthquakes without experiencing serious damage," Fox exclaims.

"Geopier soil reinforcement substantially limits or prevents potential damage from earthquake-induced liquefaction and earthquake ground displacements," explains Dr. Kord Wissmann, chief engineer with GFC Inc.



Above: Schematic construction of a Geopier: drilling the hole, adding lifts of aggregate, and compacting each lift to create the finished foundation pier.



Right: Diagram of completed Geopier showing stresses.

Dr. Evert Lawton, now professor of Civil Engineering at the University of Utah, has authored an extensive report examining the performance of Geopier-supported foundations on simulated seismic tests on a northbound Interstate 15 bridge over South Temple Street in Salt Lake City, Utah, in December 2000. This documentation on the testing of this bridge, slated for demolition with the expansion of I-15 in preparation for the 2002 Winter Olympics, may be obtained through Geopier Foundation Co. Inc.

In Washington, D.C., the Washington Suburban Sanitary Commission (WSSC) recently authorized installation of Geopier rammed aggregate piers to support several hundred feet of sanitary sewer pipe that had settled as a result of consolidation of an embankment.

In February 2000, GFC completed installation of piers supporting 10 80,000-barrel tanks at the Houston Fuel Oil Terminal Co.'s tank farm. Each tank has a footprint of 7,850 square feet and exerts approximately 3,700-psf pressure. Williamson says each of the 30-inch-diameter and 14.5-foot-deep pier elements supports 50 tons while the pier with the strengthened adjacent soil will support 60 tons. A total of 3,354 piers were installed; 315 support each fuel tank for a total of 3,150 for the 10 tanks, while 204 support the pipe racks.

In Virginia's Shenandoah Valley, the Staunton site for a parking garage lay adjacent to a historic high-rise masonry structure and contained buried basements, debris-laden fill and abandoned utilities from many previous in-town developments. Over-excavation wasn't an option. Underlying limestone with voids and sinkhole potential made caissons financially risky. GeoConstructors, a Geopier licensee, eliminated the potential risks with an on-time on-budget installation of piers.

In Maryland, the Maryland State Highway Administration (MSHA) successfully used piers to support a 13-foot-high retaining wall built on Route 5 in swampy soil. The 185 36-inch-diameter piers are10 to18 feet deep.

Williamson fully expects before the Ballpark Lofts installation is completed in Denver, he will have another project lined up locally. "We're growing 80 to 100 percent a year now. The system has really taken off since Dr. Fox began licensing installers. We're going all over the world." Within the past year Dr. Fox has taken the Geopier story to Russia, Germany, Italy, India and the Philippines. As this issue of ROCKY closes, he's in Tokyo. ■