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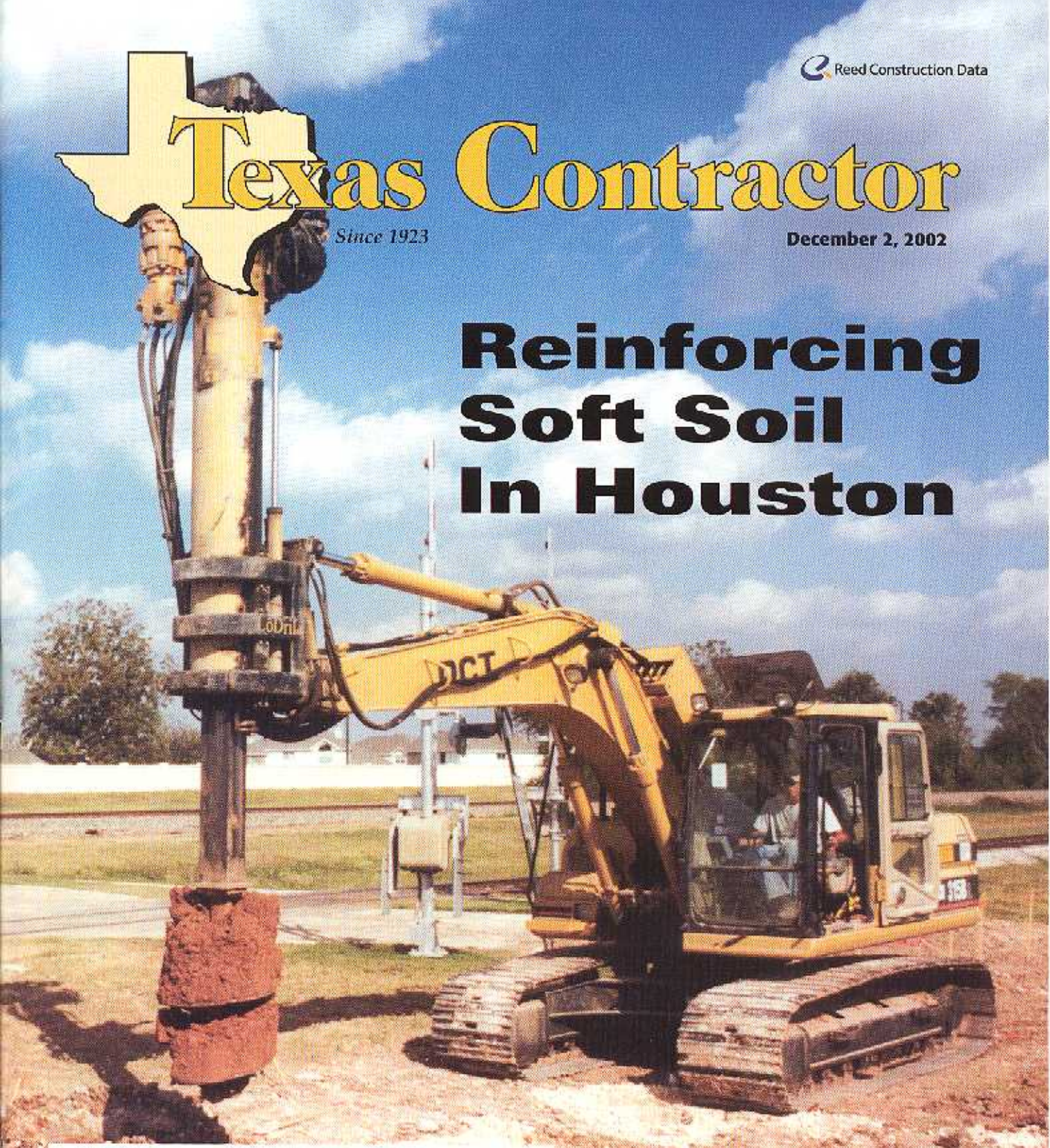
Reinforcing Soft Soil In Houston



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Soil Reinforcement Answer

Geopier Foundation Provides Solution for Soft Soil Along Houston's Westpark Tollway

By Carol Carder

On section 15 of Houston's new Westpark Tollway, two mechanically stabilized earthwall (MSE) embankments constructed over soft soils are being supported by an innovative intermediate foundation, Geopier® soil reinforcement.

Champagne-Webber Inc. of Houston had already begun construction on Section 15 when Tricon Precast Inc. of Houston and its structural firm Robertson & Associates of Weatherford turned in its bearing pressures for the 23-foot-tall MSE walls that lead to an elevated portion of roadway. When the engineer of record, VandeWehl of Houston, rejected the figures, it became apparent that the existing soils were unsuitable for both bearing and settlement of the embankments, according to Wally Burns, Turner Collie & Braden (TC&B).

TC&B considered taking out the poor material and replacing it with cement stabilized sand, but opening a pit in the restricted construction area wasn't feasible. Temporary shoring would have been required for an exiting embankment adjacent to the area plus temporary supports would be needed for a fiber optic line and an 8-inch gas line. TC&B requested Tolunay-Wong Engineers, the geotechnical engineer for the engineer of record, provide an alternate solution.

The geotechnical investigation indicated a compressible layer consisting of 13 feet of clay soils with sand partings

A hydraulic tamper rams aggregate at 1.3 million foot pounds energy per minute to form a Geopier element as a skid loader with custom bucket brings aggregate to shaft. Photo by Tommy Williamson.

underlain by 6 feet of stiff gray clay with sand pockets, and 34 feet of fine sand and silt. Daniel Wong, Ph.D., P.E., recommended soil reinforcement to reduce the settlement to a tolerable range and to increase allowable bearing pressures.

Jim White, Champagne Webber project manager, solicited bids from Geopier Foundation Company (GFC) – Houston for its Geopier elements and Hayward Baker for stone column reinforcement. The owner Harris County Toll Road Authority (HCTRA) selected GFC's bid that used approximately half the number of piers compared to the stone columns and was nearly half the cost at $162,075.

So what's a Geopier element?

To the layperson, Geopier elements resemble shafts of aggregate. However the patented design/build system is a precise engineered product custom designed to the site conditions and desired load-bearing capacity. To build each of the Geopier elements, Peterson Contractors Inc. (PCI), the licensed installer, Reinbeck, Iowa, drilled a 30-inch shaft to the design depth ranging from 12 feet to 18 feet below the existing ground surface. Then a modified hydraulic pavement tamper rammed 12-inch lifts of clean fractured aggregate without fines into the ground at 1.3 million foot pounds energy per minute. The undulating layers of aggregate reinforce the surrounding soil enabling it to support the anticipated loads.

On Sienna Parkway installation PCI's modified hydraulic tamper completes installation of a pier while LoDril attachment augers hole for adjacent pier. Photo by Milstead Photography, Houston.

Basic equipment with modifications is used to install Geopier elements: a CAT 315 excavator with Lo-Dril attachment to auger and a skid loader with custom bucket to bring aggregate to the shaft. To ram the aggregate, the crew uses a CAT 315 excavator with a CAT 120 hydraulic demolition hammer, modified with a downhole extension.

After the Geopier design had passed peer review at GFC's design office, Design Associate Tommy Williamson, submitted the design to TC&B who plotted in the location of the gas line and fiber optic line. Then Williamson refined the design to move the dozen piers that conflicted with the utilities. GFC stands behind its design and installation that will control any settlement to 2 inches maximum.

Catching up the schedule

Between August 26 and September 9, PCI installed 395 Geopier elements to stabilize the 17,577-square-foot 42-foot-wide main lane embankment and the 3,864-square-foot 28-foot-wide Ramp O embankment. The drilling was hard, according to Bob Menuey, PCI foreman, as the crew encountered lots of conduit from abandoned utilities, but PCI persevered finishing the job in nine and a half work days.

White says, "They did a great job, came in, got the work done and got out without any problems." Delays such as finding a remedy for the poor soil under the embankments and waiting on utility relocations have put Section 15 behind schedule. Section 15 started December 2001, and White expects to complete this work by the end of April 2003 if construction proceeds without further complications.

Overall the critical path is on schedule for the planned opening in the first quarter of 2004, according to Lisa Gonzales, HCTRA engineering manager. In an era when public works projects often exceed budget and time schedules, HCTRA has compiled an enviable record in building the first three sections of the Sam Houston Tollway and Hardy Toll Road. Forty percent of the 86 construction contracts were completed ahead of schedule; 98 percent completed under estimated cost, and 42 percent completed both ahead of schedule and under estimated cost.

"We're going to open everything from section 4 to 16 at once," she says. That's because this section contains a major interchange.

To build the Westpark Tollway HCTRA purchased a 50-foot-width of land on the north side from the Metro Transportation Group. On the south side HCTRA has acquired hundreds of parcels and a big stretch from Reliant Houston Power & Light (HP&L). Because the 12-mile toll road passes through a developed area, HCTRA has

Working around utilities challenges both Geopier installers, Peterson Contractors Inc. (PCI), and Champagne-Webber, general contractor for Section 15 of Houston's Westpark Tollway. Photo by Tommy Williamson.

wrestled with the planning and costs associated with moving utilities for this 5-year project. Millions have already been paid for utility relocations. The current plan is to extend the toll road through Fort Bend County to connect with the new Fort Bend Tollway. Construction cost estimates for Westpark Tollway are projected between $240 and $260 million.

In this heavy traffic area, HCTRA forecasts 80,000 vehicles a day will be using the Westpark Tollway. HCTRA's toll road system was serving 5.6 million motorists each week as of mid-year 2002. The tollway will be completely automated and restricted to EZ TAG users only. HCTRA plans to launch an extensive promotional campaign prior to the system opening in 2004 to inform the public of how the automated system works and to encourage motorists to enroll in the EZ TAG program well in advance.

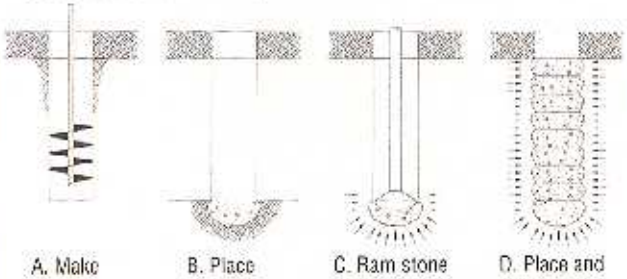
Other transportation applications of Geopier soil reinforcement

In the Houston suburb Missouri City, Geopier elements support an MSE wall and embankment to a bridge passing over an existing railroad track. The limited 160-foot-wide right-of-way wouldn't permit an embankment with sloped sides. Daniel Wong, Ph.D., P.E., Tolunay-Wong Engineers, Houston, who performed the geotechnical investigation, predicted the weight of the fill for the 400-foot long, 32-feet high MSE walls could cause settlement of up to 15 inches in the soft compressible soil. He recommended the Geopier solution to both control settlement and increase slope stability. In November of 2001 PCI installed 490 Geopier elements, each 16 feet long. Then NBG Constructors Inc. of Houston built the 180-foot long, 90-foot wide bridge finishing in August 1, 2002.

In the Midwest Iowa Department of Transportation (IDOT) has used the Geopier system to solve a number of problematic site conditions. In August 2001 near Council Bluffs, Iowa PCI installed 276 piers to support a 48-meter long poured-in-place box culvert replacing a bridge on Route 191. In Dallas County, Iowa nine rows of 22-foot long Geopier elements installed in the spring of 2001 are halting a reoccurring landslide that plagued IDOT and county officials for 32 years. Earthwork Contractor Tom Kueter Construction, Peosta, Iowa value engineered Geopier support for twin embankments for bridge approaches over the Union Pacific Railroad on the Highway 30 realignment. The recommendation saved IDOT $110,000 and a month in construction time compared to the original over excavation and backfill design.

On-going research on Geopier soil reinforcement in transportation applications continues at the University of Utah, Virginia Tech and at Iowa State University (ISU), Ames, Iowa. At ISU David White, associate professor civil engineering, is monitoring the settlement plates installed by ISU to measure any future movements of the Iowa culvert. Today Geopier soil reinforcing elements support more than 500 structures in 37 states and in 5 foreign countries. ❑

Construction of a Geopier soil reinforcement element



To the lay person, Geopier elements resemble underground columns of gravel. However, this patented design/build system is a precise engineered product custom designed to the site conditions and desired load-bearing capacity. To build Geopier elements, the licensed installer drills the required shaft as specified for that location. Then a modified hydraulic pavement tamper rams 12-inch lifts of aggregate into the ground at 1.3 million foot pounds energy a minute. The aggregate undulates horizontally into the ground, reinforcing the surrounding soil.