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August 16, 2002 • Since 1893 • \$4.00 Per Issue



Bonus Coverage: Winter Preparedness

**FOCUS:
Site Preparation**

Geopier

Soil Reinforcement System

A pair of Tri-State Region construction projects are utilizing Geopier to provide solutions to soil problems

■ *By Carol Carder*

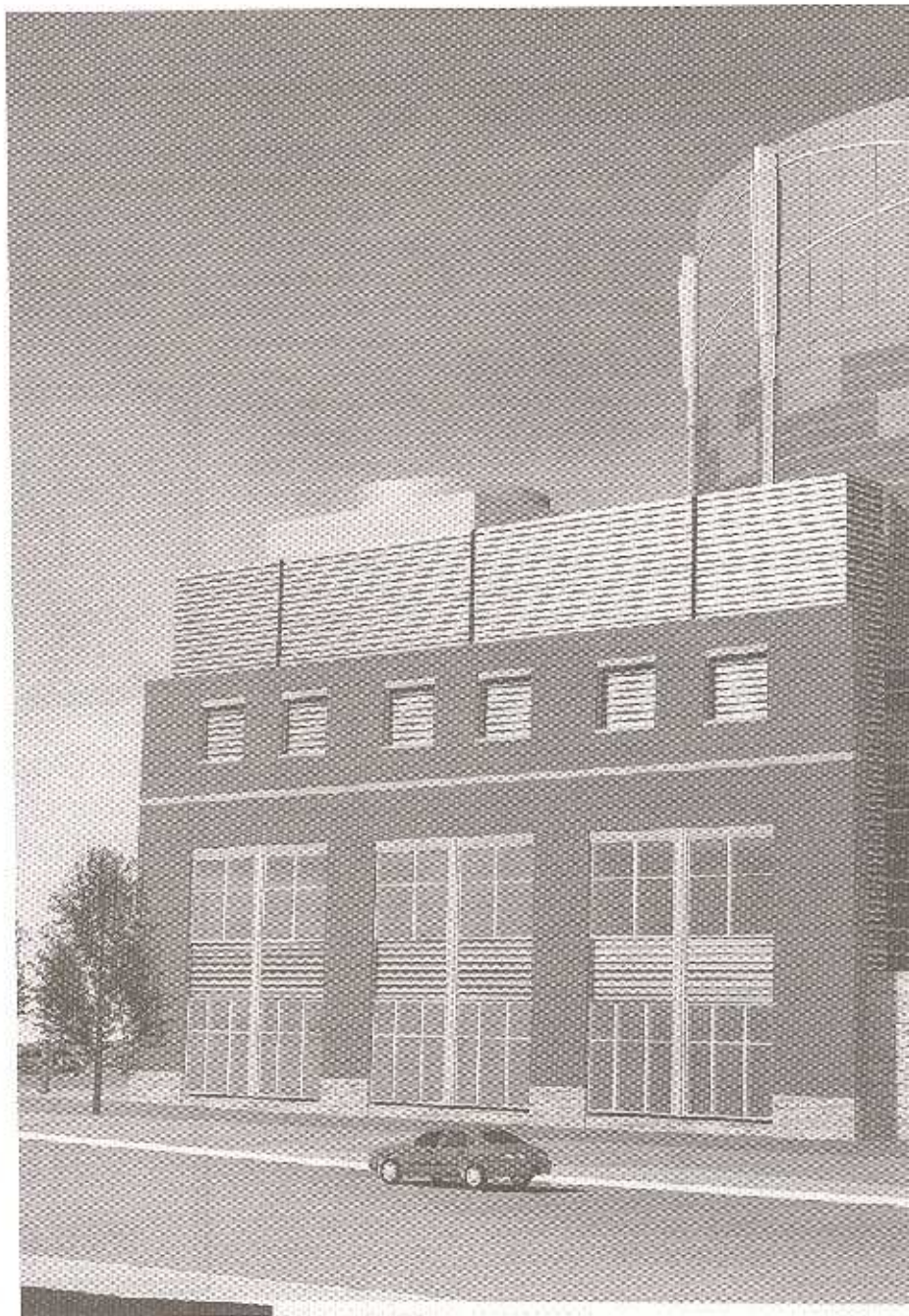
In Groton, S.D. (near Aberdeen), Broin & Associates, Sioux Falls, is building a 45-million-gallon-per-year, state-of-the-art ethanol plant on a 110-acre site.

According to Bruce Culler, vice chairman of the James Valley ethanol plant board, to produce the "home grown" energy, the facility will purchase 16 million bushels of corn annually and will maintain a local payroll of \$1.3 million.

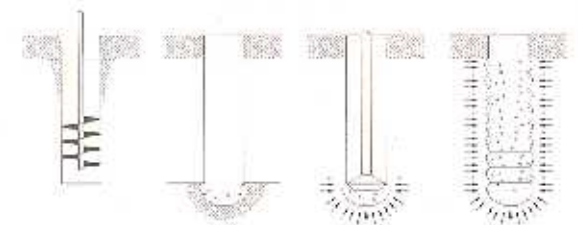
Broin & Associates, established in 1991, is a design-build contractor producing, then managing, its turn-key operations. When this plant starts producing in 2003, Broin Companies and affiliates' ethanol production will exceed 400 million gallons annually.

When Karl Liester of American Technical Services Inc., Sioux Falls, conducted the geotechnical investigation of the site, he found soft silt and sandy silt soils in the upper 30 feet to 35 feet with a consistency ranging from soft to very soft. He also found wet soils at a depth of 3 feet on the flat site.

Right: BWBR Architects, St. Paul, designed a residential scale brick-faced building and graduated matching colors for the tank's insulating panels to blend the facility into the new urban developments in downtown St. Paul. This rendering is by BWBR Architects.



Construction of a Geopier soil reinforcement element



A. Make cavity. B. Place stone at bottom of cavity. C. Ram stone to form bottom bulb. D. Place and ram thin lifts to form unbalanced shaft.



He suggested several foundation options to support the loading ranging from 2,500 psf (pounds per square foot) for buildings on up to a minimum of 4,000 psf for the fermenting tanks and grain storage bins.

Rich Victor, Broin & Associates director of projects, priced out augur cast piles to a depth of 50 feet to 80 feet paired with structural slabs for the heaviest loads, and over excavation to an 8-foot depth and replacement with engineered fill for the 2,500-psf load areas of the 40 acres being developed. The option of pre-loading the site and letting it settle to equilibrium wasn't feasible because of the construction timeframe.

Liester, who had worked with the Geopier soil reinforcement system on a Vermillion, S.D., project on similar soils, suggested the design engineers at Broin check out this intermediate foundation system. Victor determined it was the solution for the site conditions saving both dollars and time compared to the alternatives.

To the layperson, Geopier elements resemble underground 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.

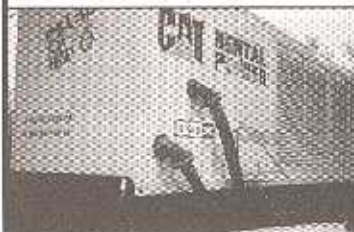
To build each of the Geopier elements, Peterson Construction Inc., the licensed installer from Reinbeck, Iowa, drilled a 30-inch shaft to the design depth ranging from 7 feet to 11 feet below the

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Geopier Reinforcement

foundations level. Then a modified hydraulic pavement tamper rammed in 12-inch lifts of clean fractured aggregate without fines into the ground at 1.7-million-foot-pounds energy a minute. The undulating layers of aggregate reinforced the surrounding soil allowing normal spread foundations and floor slabs to support the anticipated loads.

Two Peterson Construction crews installed the 1,965 piers underlying the 40 developed acres in five weeks' time starting in June. The Geopier elements fortify the soil beneath concrete ring walls and the sand pads supporting the four 1/2-million-gallon metal fermenting tanks that require a uniform bearing of 3,500 to 4,000 psf.

Piers also underlie the grain receiving and storage system built by Broin's design-build subcontractor J&D Construction Inc., Montevideo, Minn. This consists of two 430,000-bushel, 90-foot-diameter by 100-foot-tall grain storage bins, the 55,000-bushel storage bin and the 130-foot-tall by 12-foot by 24-foot square (14,500-square-

Right: New Strata-Therm chilled water tank will help further improve DCSP's energy efficiency and reduce need for additional regional power plants.

Below: DESP heats and cools much of downtown St. Paul from a central energy plant.



foot) grain receiving structure that handles 30,000 bushels an hour.

Long pits built in the road permit belly dump semis to discharge two hoppers filled with corn in three minutes. From there the tower elevator transfers the corn vertically 130 feet, then distributes the corn to the storage bins by conveyors.



This tall, slender structure subject to tremendous wind loads rests on spread foundations supported by Geopier elements.

The bins are built with bolted steel panels manufactured by GSI, Assumption, Ill. Concrete ring walls under girded by Geopier elements support the 28-million-pound loaded bins that exert up to 5,000-psf bearing pressure.

According to Doug Nelson, J&D chief executive officer, Peterson Construction installed approximately 1,000 piers, many

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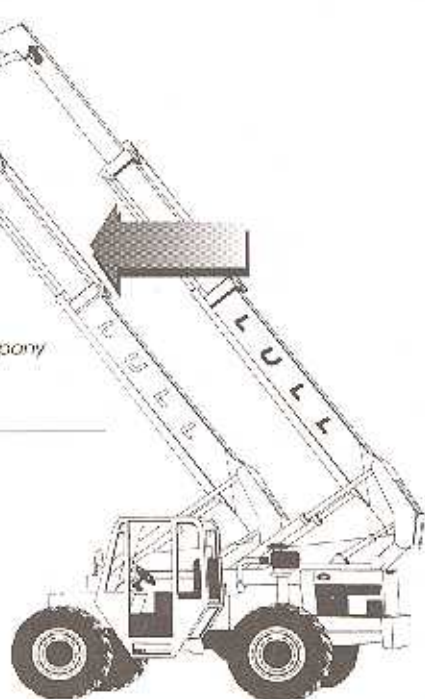
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For information circle 6

5 feet on center, under the grain receiving and storage system.

J&D Construction has specialized in grain handling and storage facilities for the past 22 years. Last year the company built a 500,000-bushel grain storage bin for the farmers coop in Jasper, Minn. This 90-foot-diameter, 115-foot-tall bin with a total filled weight of 30 million pounds also rests on a concrete ring wall supported by Geopier reinforced soil.

Piers also reinforce the soil under the spread foundations of the six-story distilling building, process and a mechanical building spreading over 51,000 square feet. Beyond the ethanol plant buildings, Broin & Associates is also developing the roadways, paving and rail spur lines.

Meanwhile, in downtown St. Paul, design-build contractor CBI Services Inc., a subsidiary of Chicago Bridge & Iron Company (CB&I), of The Woodlands, Texas, needed a 5,600-psf subgrade bearing capacity for the four-million-

gallon Strata-Therm chilled water tank it is building perched near a sloped exit off I-94.

A Geopier soil reinforcement system is providing a solution for the 90-foot-tall, 90-foot-diameter thermal energy storage (TES) tank and attached 14,400-square-foot chiller plant. CB&I, with its subcontractor excavator Marcy Construction Company, Minneapolis, is building the TES tank. General Contractor Kraus Anderson Construction Company of St. Paul is building the chiller plant. TKDA Inc., St. Paul, is the structural engineer for the chiller plant.

Currently District Cooling St. Paul (DCSP) Inc. provides chilled water for air conditioning to 60 downtown buildings or approximately 55 percent of the available market. For the past 20 years its affiliate District Energy St. Paul Inc. has provided hot water for heating to commercial customers and currently serves 160 downtown buildings comprising 80 percent of the market. In 1993, when the chilled water system started operation, demand hovered around 3,000 tons. A few years later, DCSP had CB&I build its first TES tank on the waterfront, and since then demand has grown to 20,000 tons, according to Doug Maust of DCSP.

The new tank and chiller building will increase cooling capacity by 50 percent. DCSP uses less expensive electricity to chill the water at night and store it in the TES tank, then circulates it through its under-street pipe network to businesses during the day.

Last year President George W. Bush hailed this district energy facility as a "model of energy efficiency, diversity and affordability" when he chose the plant location to present his U.S. National Energy Policy Plan.

"DCSP provides chilled water for air conditioning to 60 downtown buildings."



District Cooling St. Paul (DCSP) Inc., an affiliate company of District Energy St. Paul (DESP), currently is expanding the energy system operated by DCSP.

Pipe Logic 103

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Charles Hubbard of Braun Intertec, St. Paul, in his geotechnical investigation found 4 feet to 7 feet of existing fill, alluvial soils to depths of 21 feet to 32 feet and glacial soils below.

The existing sand and silt fill was poorly compacted, and the alluvial soils consisting of sand, silt and clay were rather loose. He predicted the existing soils

would compress and cause unacceptable settlement.

CB&I required a tilting settlement across the tank to be limited to less than 5 inches and differential settlement between the tank center and edges to be less than 4-1/2 inches, and out of plane settlement along the tank shell to be less than 3/8-inch over a 30-foot arc.

With the proximity to the interstate freeway and the slope, excavations to 30 feet (or deeper) would have been impractical and a deep foundation such as concrete-filled steel pipes would need to be driven into the glacial soils far below.

In May, Foundation Service Corporation, licensed installer from Reinbeck, Iowa, began installation of 340 piers to support the tank concrete ring wall foundation and 148 pier elements to support the spread foundations for the chiller building.

Estimates place the dead and live loads transferred to the ring wall 3,320 psf of circumference, and the grade-supported bottom exerting a uniform pressure on the subgrade of 5,600 psf. Column loads for the building will be 1,300 kips and floor slab loads will be approximately 500 psf.

Geopier element installation concluded in June. DCSP expects the tank to be completed this December and the chiller building to be completed in April of next year.

The Geopier design associate working with both the TES tank and the ethanol plant is Charles Allgood, Geopier Foundation Company - Midwest, Minneapolis. Currently Geopier elements support more than 800 major structures in the United States and in eight foreign countries. Additional information on Geopier systems and projects may be found at www.geopiers.com. □

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Vehicles whiz by on nearby I-94. Proximity to the interstate as well as slope posed problems for engineers.