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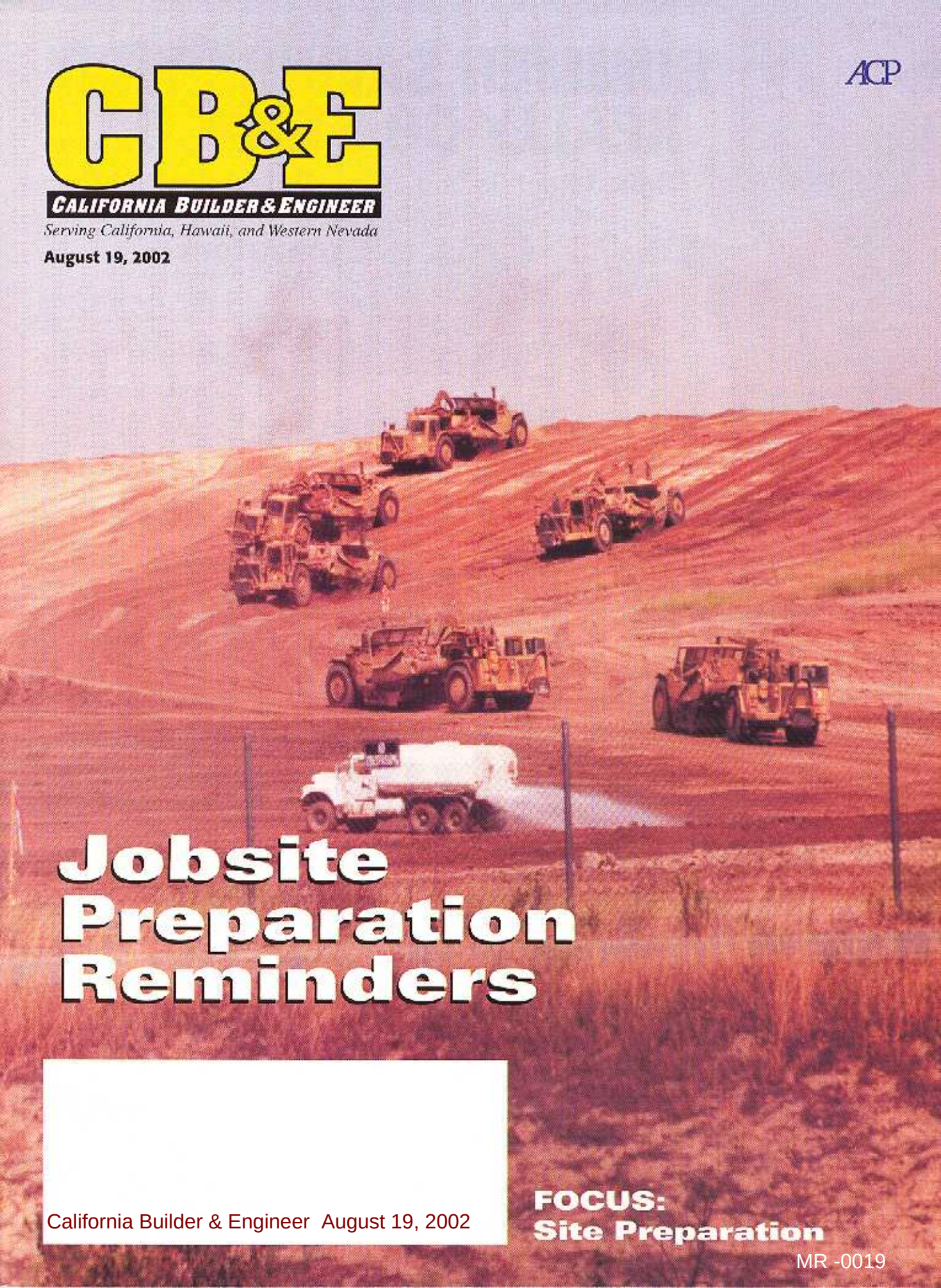


Jobsite Preparation Reminders

FOCUS:
Site Preparation

A Firm Footing

16th century Spanish Renaissance style building poses foundation challenge in San Diego.

By Carol Carder

The University of San Diego Center for Science and Technology Science is breaking ground in foundation technology with the first use of Geopier soil reinforcement in this southern California county. General contractor Rudolph & Sletten Inc. of San Diego is building this 16th century Spanish Renaissance style building notched into the hillside of Linda Vista above San Diego. Designer is San Diego Architect Carrier Johnson. Excavating contractor is West-Tech Contracting Inc, Escondido, and structural concrete contractor is Morely Construction Co., San Diego.

A Massive Concrete Structure

The challenge to the foundation design was not only soil conditions and location but the heavy concrete building itself. Cindy Blair, Carrier Johnson project manager, explains, "We chose cast-in-place concrete to dampen any vibrations and make this building a steady environment for all the research labs." According to Kris Specht, Rudolph & Sletten project senior superintendent, Rudolph & Sletten will be pouring 35,000 cubic yards of concrete in construction of this $43-million building. GFC–West designed for shear wall gravity loads up to 2,300 kips and interior column loads up to 1,100 kips. According to John Martin, P.E., Geopier Foundation Company-West, Hillsboro, Oregon, the design-builder of the patented foundation support system, a design static bearing pressure of 8,000 psf was allowed for proportioning the footings and design loads up to 130 kips per pier are utilized on the Geopier elements.

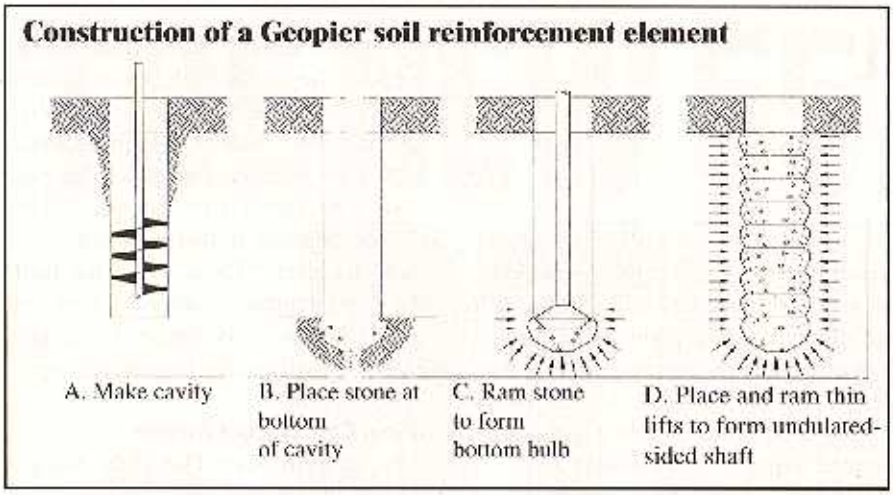
Challenging Soil Conditions

"Saying the site is challenging is an understatement," said Martin. The main concern of the structural engineering firm, Hope Engineering, and the geotechnical firm, Kleinfelder Inc., both of San Diego, was the potential for differential settlement. A portion of this 160,000-square-foot four-story cast-in-place concrete building is cut into the hillside, while a portion rests on undocumented fill placed on the site years ago from excavation for a parking lot on the mesa above.

"The two alternatives initially specified by the San Diego Building department of either over-excavation and replacement with engineered fill or a deep foundation system anchored in bedrock were not feasible," said Kraig Klausen, S.E., Hope Engineering. "With the hillside location, over-excavation and replacement of fill would have been difficult, as well as too time consuming, in this fast-track project," observes Kris Specht, Rudolph & Sletten project senior superintendent. In addition, GFC–West estimates cost of an over-excavation and replacement would have been about $500,000.

Hope Engineering considered caissons anchored in bedrock with belled bottoms to resist any uplift. However,

Rendering of massive 160,000-square-foot Center for Science and Technology.



Left: Construction of a Geopier soil reinforcement element.
Below: Geopier foundation system being installed at U.C. San Diego

since some of the building's columns were only 9 feet apart, the bells of the caissons bells would have overlapped, according to Klausen. Then one of Hope's engineers suggested Geopier elements as the solution. An added bonus was savings on construction costs. Mark Kelly of Campbell-Anderson Associates Inc., San Diego, the construction cost estimating firm, calculated the use of the Geopier foundation system saved 32 percent over a belled caisson foundation system.

Martin explained how the system works, "Geopier elements are densely compacted columns of crushed rock placed in clusters beneath footings to reinforce the otherwise unsuitable soils. This permits the use of conventional spread footings."

To form a Geopier element, the construction crew, licensed by Geopier Foundation Company Inc., drills a 30-inch-diameter shaft to the design depth with an auger. Then the beveled head of an Okada 312 modified hydraulic pavement breaker rams in 12-inch-thick layers of highway base course gravel at 1.7 million foot-pounds of energy per minute. The aggregate pushes outward into the surrounding soil increasing lateral strength as well as providing vertical support for the foundation footing.

Working with soil analysis information from Kevin Crennan, G.E., at Kleinfelder, and load information from Hope Engineering, Martin produced a design-build plan addressing the site conditions and structure bearing requirements. Before construction began, GFC installed a test pier element, then subjected it to modulus testing to measure its stiffness in the on-site soils. After the pier passed the test, GFC's certified installer, working as a subcontractor to the general contractor, installed the 336 piers in the foundation footprint in just eight days time, a week ahead of schedule.

Because the wedge of fill tapered on the site from 25 feet deep to less than a foot, the piers varied in length from 4 feet to 25 feet.

Specht commented, "This project has tremendous variety such as two 2,000-gallon sea water tanks for the aquarium lab, a 2,500-square-foot greenhouse on the roof, an NMR room, 150 fume hoods, 1,000-kW emergency generator, four different cold rooms, Vivarium, and sophisticated audio visual equipment throughout."

Rudolph & Sletten started construction May 25, 2001, and is on schedule to finish in 21 months on April 3, 2003. ❑