GEORGE HARMS CONSTRUCTION CO. INSTALLS 240-FOOT DRILLED SHAFTS

FOUNDATION DRILLING

APRIL 2022

SKANSKA
TEACHING AN OLD GIANT NEW TRICKS

BERKEL
MICROPILE SUPPORT OF HISTORIC STRUCTURES IN THE U.S. CAPITAL

DRIVING OUR MOVEMENT
MAKING PROGRESS IN OKLAHOMA

SUMMER MEETING 2022 PREVIEW

ADSC
The International Association of Foundation Drilling

FEATURE STORY

AWARD WINNING MICROPILE SUPPORT OF HISTORIC STRUCTURES IN THE U.S. CAPITAL

story structure with one basement level and was originally supported on a shallow foundation system.

The proposed construction consists of the renovation and upgrade of the existing structure. As part of this renovation, the upper level of the building was demolished and replaced by two new levels. In addition, the basement of the building was lowered approximately 4.5 to 20 feet at various locations. The challenge of the project was to support the existing structure and prevent excessive movement of the building during this excavation, renovation and new construction.

To date, BERKEL has performed the following phases of building support:

- Installation of permanent micropiles to support the existing columns
- Construction of a temporary, interior, masonry bearing wall support system and the subsequent load transfer activity
- Temporary internal support of the basement excavation
- Underpinning of the existing structure with lateral bracing

This article is focused on the means and methods used to shore the existing bearing wall.

SUBSURFACE PROFILE AND FOUNDATION SELECTION

The available geotechnical engineering report described subsurface conditions that are summarized as:

INTRODUCTION

National historic landmarks are designated as such for their undeniable importance in American history. This project involves the renovation of the Milken Center for Advancing the American Dream (MCAAD) building located at 1501-1505 Pennsylvania Ave NW. The existing structure (Figure 1) is listed in the National Register as an historic property. It was originally constructed in 1904 as a five-

• Man-made Fill: The lowest finished floor elevation of the existing building is at EL 40.45 feet and shallow foundation elevations change from approximately EL 33.5 feet at the southeast corner to approximately EL 37.8 feet. The largest areas of low-lying land were filled for building purposes (based on an examination of historical topographic maps). Fill and possible fill materials were encountered below the surface to depths ranging from about 8.5 to 23.5

feet. Standard Penetration Test (SPT) N-values in this material ranged from 0 to 7 blows per foot (bpf)

- Coastal Plain Terrace Deposits: This formation, comprised of elastic silt with sand (MH), is found irregularly between elevations of about El. 40 feet and El. 105 feet in elevation in a north-south running band of about two miles. On this site, the terrace deposits were encountered underlying the fill and possible fill to depths ranging from about 70 to 73.5 feet. SPT N-values ranging from 0 bpf to 50 blows per 4 inches of sampler penetration were recorded for the soils in this stratum.
- Potomac Formation: These deposits are described as variable gravel, sand, silt, and clay. The Potomac Formation soils were encountered below the terrace deposits. An average SPT N-value of 18 bpf was recorded for this stratum.
- Partially Weathered Rock (PWR): Locally, this material is defined as residual (weathered from the underlying bedrock) with SPT N-values greater than 60 blows per foot. The PWR underlies the Potomac Formation soils and is underlain by crystalline bedrock.

The lowest level of the building foundations is from approximately El. 33.5 feet at the southeast corner to approximately El. 37.8 feet at various other locations. The deepest level of the building will be lowered as much as 20 feet to provide an additional basement level below the existing basement, which will be converted to an auditorium. The additional construction of above- and below-grade levels will increase service loads on the existing foundation system. The interior bearing walls were required to be supported and stabilized by a new deep foundation system prior to the excavation required for the new basement.

Micropiles with outside diameters (OD) of 9-7/8 inches and 11 7/8 inches were selected to serve as the permanent foundation system for the new constructions and the temporary load transfer system from the existing foundations to the new support system. Permanent micropiles were utilized as trussed towers with needle beams and load transfer beams to temporarily support the existing bearing wall as shown in Figure 2.

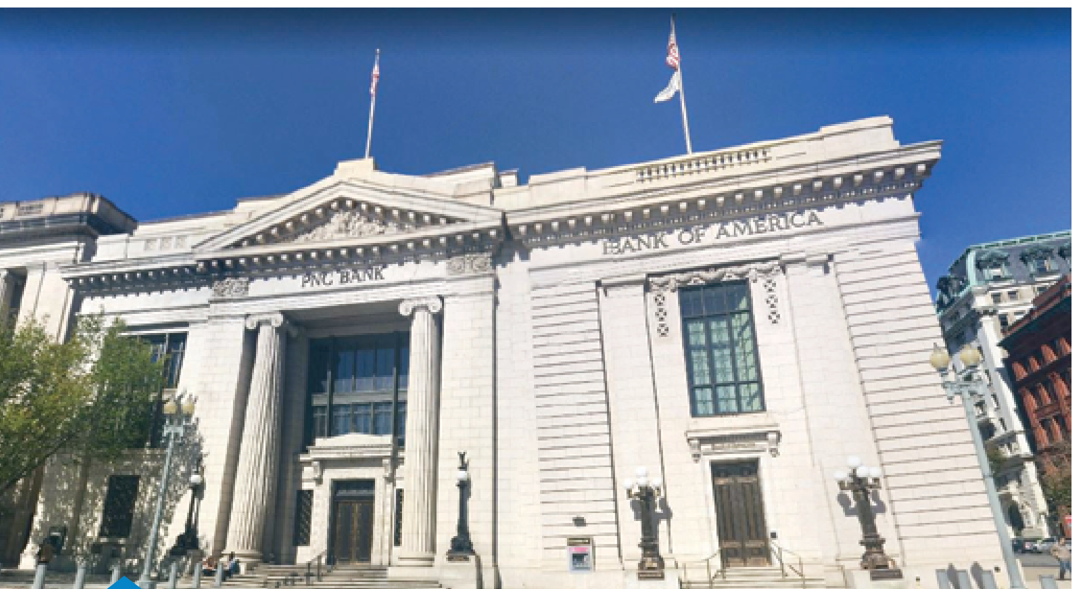


FIGURE 1: 1501-1505 PENNSYLVANIA AVENUE NW BUILDING (REFERENCED PHOTO BY GOOGLE MAPS)

FIGURE 2: MICROPILE TRUSS TOWER FOR INTERIOR BEARING WALL AND BANK VAULT DOOR SUPPORT

Construction material access was very limited and difficult. All construction materials and most of the equipment had to be hoisted from outside of the building with a tower crane to a small open area before being brought into the basement. Complicated steel erection work with long heavy steel beams (needle beams and load transfer beams) for shoring had to be performed under low head room conditions.

In addition to supporting the existing bearing walls, a 40-ton historic bank vault door was required to be stabilized and supported. Compression and tension micropiles with jacking beams were installed beneath the door to provide this support (Figure 2).

LOAD TEST

Two static compression load tests were performed in general accordance with ASTM D1143 Quick Load Test Procedures and Load Testing Setup requirements. The pile compression design load was 148 tons, and the piles were loaded to a maximum load of 296 tons (in increments of approximately 15 tons). The test piles were installed from the existing basement level at El. 41.8 feet by advancing

Continued on page 36

approximately 80 feet of 9.875-inch diameter (0.625 inch thickness, API N80) casing with a 15-ft rock socket that was 10.3 inches in diameter.

As shown in the Figure 3, the total displacement at the design load of 148 tons was about 0.4 inch. The net displacement at the conclusion of the test, after all load had been removed, was about 0.05 inch. Considering that the load and unload response of the micropile was primarily linear, elastic, and recoverable, the mobilized bond stresses in the rock sockets appear to be still within serviceable limits and do not represent ultimate or failure conditions. Per the load test results, it was confirmed that the installed test micropile could support the design compression load with a factor of safety of at least 2.

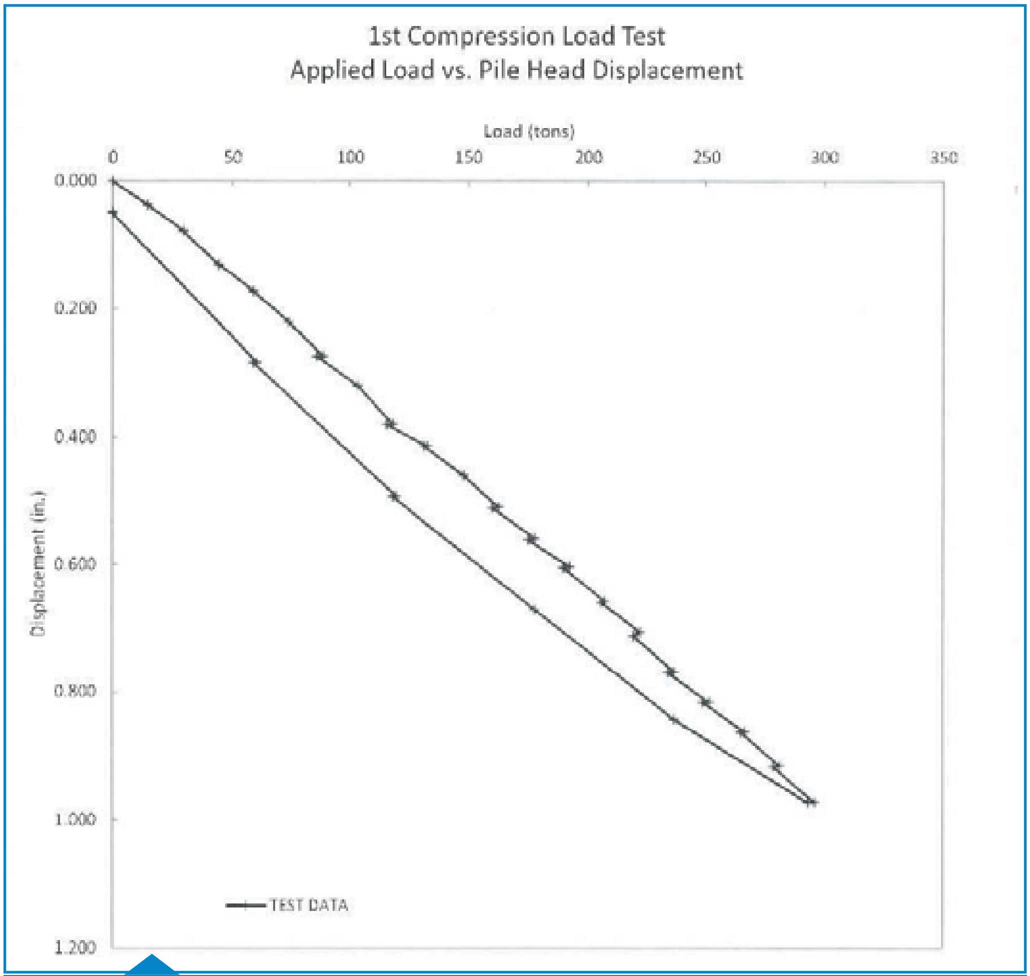


FIGURE 3: LOAD SETTLEMENT CURVE IN LOAD TEST REPORT BY BERKEL

SUPPORT OF INTERIOR BEARING WALL

More than three hundred micropiles with 9 7/8-inch casing, with section lengths of 3 feet to 5 feet, were installed with about 8.5 feet of headroom. These micropiles were installed along the two bearing walls and were utilized as shoring towers as shown in Figure 4.

Each shoring tower consisted of four micropiles called jacking piles and a supporting bracket was constructed on top of each jacking pile. The supporting bracket was designed to apply preloading in the existing bearing wall with low-height hydraulic jacks prior to the new pile cap and bearing wall construction.

Transfer beams were then erected on top of the supporting brackets. Then needle beams were installed between transfer beams. The spacing of needle beams was limited to a maximum of 3 feet by the bearing stress in the contact surface between the existing masonry bearing wall and the flange of needle beams.

LOAD TRANSFER

The service loads of the existing bearing wall were estimated and updated during the construction. A structural analysis model was created to determine allowable jacking loads. Preloading of the new bearing wall supports was deemed necessary to limit elastic settlements, which could damage the existing building. Four low-height hydraulic jacks were utilized at each micropile tower to preload the existing bearing wall and transfer the load to the new foundation system. The jacking of the trussed tower was sequential to avoid load concentration in certain areas of the existing bearing wall.

Four hydraulic jacks were placed in the supporting brackets. Reference beams and two monitoring gauges (one each side of the existing bearing wall) were installed at midspan between jacking piles. Construction activities were strictly controlled during the entire jacking procedure.

Preloading was applied simultaneously to all installed jacks in increments of five percent of the target jacking load. The jacking process was monitored to limit the upward movement to less than 1/16 inch or the maximum target jacking load to ensure that the target service load of the new bearing wall had been transferred to the existing bearing wall (Figure 5).

FIGURE 4: MICROPILE TRUSS TOWER CONSTRUCTION DURING EXCAVATION IN PROGRESS

After the completion of all load transfer sequences, the supporting brackets were welded to lock off the applied load, the demolition of the wall below supporting level (at the top of the needle beam) and excavations to the new sub-grade elevation proceeded to allow construction of new footings and bearing walls below the existing basement.

To transfer the foundation loads through the new bearing wall to the installed pile cap and piles, steel stud shear connectors were welded to the micropiles. Sixteen- or twenty-headed studs (1-inch diameter and 3-3/4 inches long) were welded to the micropile casing as the load transfer connection between the micropiles and the new pile caps as shown in the Figure 6.

SUMMARY AND CONCLUSION

The major challenge of the project was to stabilize the existing bearing walls and control settlement of the existing building during demolition and construction of interior renovations and new sub-grade basement. The

Continued on page 38

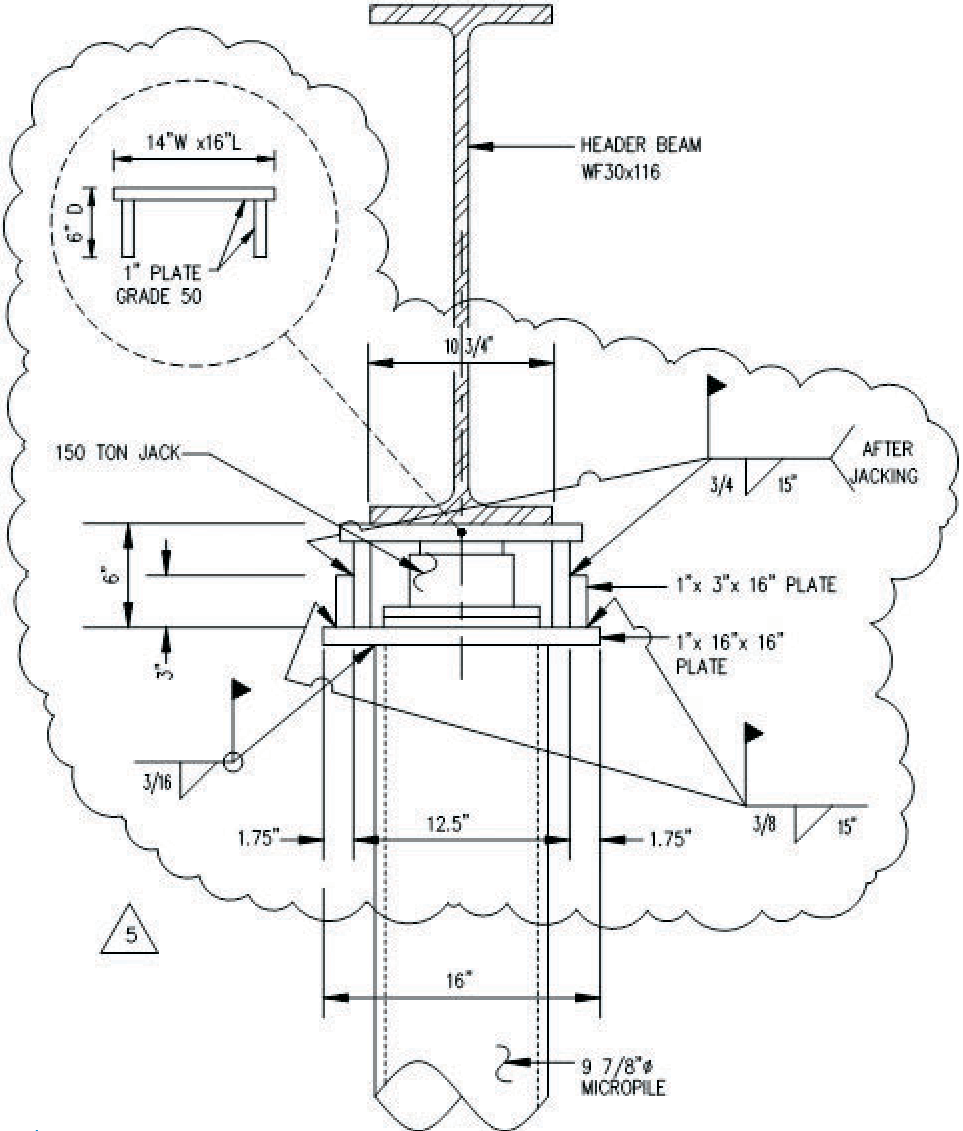
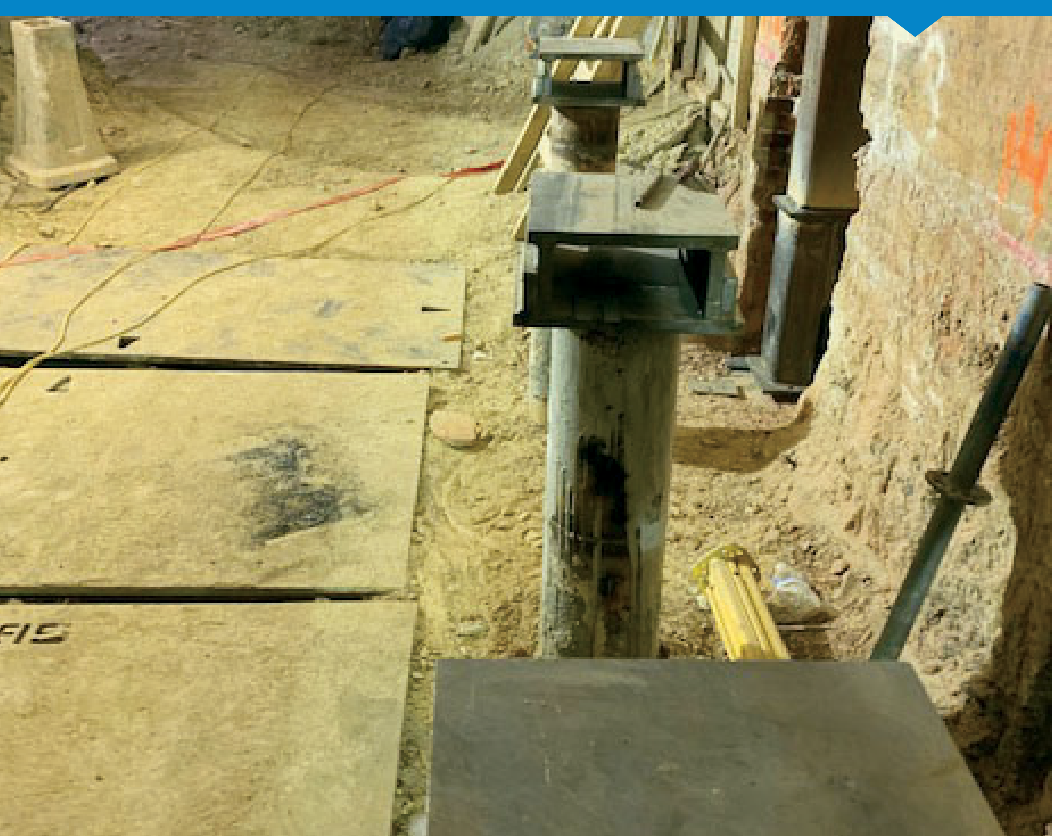


FIGURE 5: DETAIL OF SUPPORTING BRACKET ON TOP OF MICROPILE



spread of COVID-19 impacted the project schedule by delaying and halting construction activities. Limited ventilation in the enclosed basement under the existing building required continuous forced air ventilation with fresh outside air to provide a safe work environment during the heavy construction activity.

The new deep foundations required not only the support of excavation, but also load transfer structures to support the excavation and construction of the new basement as well as renovations of the upper structure. Also, the sequential load transfer and jacking procedures were scheduled and successfully performed to transfer the existing building load during the entire construction sequences.

ACKNOWLEDGMENT

The author would like to acknowledge the excellent cooperation, support and contribution throughout the project from the general contractor, Grunley Construction Company, the structural engineer, Thorton Tomasetti, and ECS Ltd., the geotechnical engineer.

Daniel S. Stevenson, P.E., is a chief structural engineer in Berkel and Company Contractors, Inc. He has more than 33 years of experience with deep foundation engineering and an active member of DFI, ACI and IBC.

Robert W. Bergwall, P.E., is a senior foundation manager in Berkel and Company Contractors, Inc. He is a licensed engineer in the District of Columbia, Maryland and Virginia. He has more than 35 years of experience with the design and management of sheeting and shoring projects.

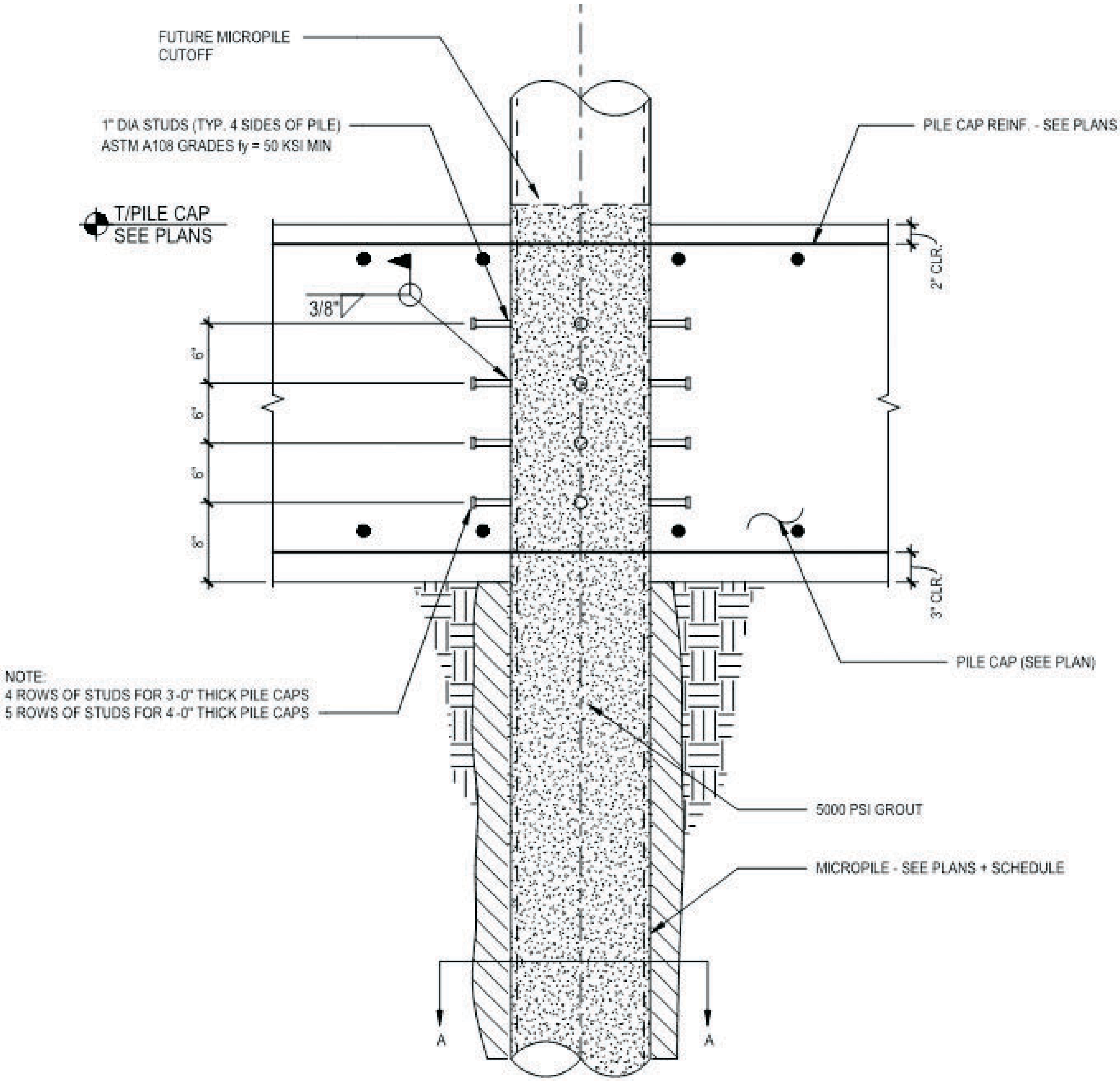


FIGURE 6: DETAIL OF SHEAR CONNECTORS IN NEW PILE CAPS AND NEW BEARING WALL CONSTRUCTION

about our
AUTHOR

SungJe Chi is a structural engineer for the design of deep foundations and excavation support systems with Berkel and Company Contractors, Inc. (BERKEL). He has over 13 years of experience in the design of geotechnical solutions and has previously published a technical paper for the DFI Annual Conference.