PROJECT PROFILE

EVALUATION OF DISTRESSED PIERS AT 14TH STREET BRIDGE, WASHINGTON, DC

D'Appolonia provided geotechnical engineering services as a subconsultant to Modjeski & Masters, Inc. (M&M) for a geotechnical and structural evaluation of unusual cracking in masonry-faced, pile-supported, reinforced-concrete piers supporting the 14th Street Bridge over the Potomac River in Washington, D.C. M&M was working under contract with the District Department of Transportation (DDOT), the owner of the bridge. D'Appolonia's responsibilities included:

- Planning and assisting M&M with the development and monitoring of subsurface exploration and laboratory testing programs to characterize the soil and rock conditions in the vicinity of the distressed piers.
- Evaluating the results of the subsurface exploration and laboratory testing programs and developing recommended soil and rock parameters for foundation evaluation and design.
- Analyzing the structural and geotechnical conditions associated with the existing driven piles relative to the potential effects of damage during in-service loading, downdrag (negative skin friction) during driving, load distribution, and corrosion, particularly as these conditions might relate to differential displacements between piles.

Geotechnical borings were drilled at two of the distressed bridge piers. For each pier, test borings were drilled at the upstream end, center and downstream end. The borings were advanced using a track-mounted drill rig set on a barge held in place with four "spud piles." The test borings were advanced through soil and highly weathered rock using an auger and a 4-inch-ID casing advancer. Standard Penetration Tests (SPTs) were performed continuously through the soil to auger refusal. Undisturbed samples of fine-grained soils were recovered using 3-inch-OD thin-walled steel tubes. Geotechnical laboratory testing was performed on disturbed and undisturbed soil and rock samples to classify and characterize their engineering behavior.

Pier at the 14th Street Bridge in Washington, DC.

Drilling activities adjacent to bridge pier.

The generalized soil profile used for analysis was:

- 60 feet of very soft, fine-grained (silty to clayey) and very loose sandy alluvial soils subdivided into two zones based on undrained shear strength
- 24 feet of hard sandy clay
- 13 feet of very dense sand and gravel with some cobbles and weathered gneiss
- Competent gneiss

The static geotechnical axial pile capacity was estimated using the program DRIVEN. A dynamic analysis simulating conditions during driving of the piles was performed using GRLWEAP.

Based on the results of subsurface exploration, laboratory testing, and engineering analysis, the following was concluded:

- The piles supporting the explored bridge piers were not overstressed during driving, but may have been damaged or deformed near their tips due to difficult driving conditions in very dense gravel, weathered gneiss, and refusal at the top of competent gneiss.
- Based upon an estimated potential total corrosion loss of 0.09 inches (1.5×10^{-3} in/yr for 60 years) over all surfaces, the structural capacity of an individual pile is 110 kips; therefore, adequate capacity still exists to provide the design-basis service (allowable) load of 100 kips per pile.
- Unacceptable axial pile loads due to downdrag are unlikely under current conditions, but a reasonable margin of safety for structural capacity is available even if all piles in a group are subjected to the maximum estimated potential downdrag load.

Because the piles are founded on a non-yielding bearing stratum, the potential for settlement of the piles due to downdrag is negligible, and it is unlikely that differential settlement of the piles would occur.