ARORA and ASSOCIATES, PC
Consulting Engineers

ROUTE 49 BRIDGE OVER SALEM RIVER

Design of Large Diameter Drilled Shafts in Marine Deposits

Arora made this project a success by creating innovative foundation solutions to overcome undesirable geotechnical site conditions.

What can we do for your project?

Design of foundations and embankments in tidal waterways on soft, compressible marshlands is a challenging task for geotechnical and structural engineers. Arora and Associates' Geotechnical Department met this challenge on the $20 million replacement of the Route 49 Bridge over the Salem River. Arora recommended innovative foundation solutions and helped NJDOT to construct its largest bridge-supporting drilled shafts.

The Salem River, which runs between Mannington Lake and Delaware Bay, has six-foot tides and fast currents. The new three-span, steel-girder bridge was constructed next to the existing bascule bridge and port facilities, and the piers had to be designed to withstand large vessel collisions.

Arora recommended 125-foot deep, eight-foot diameter drilled shafts to support the piers after a thorough investigation and analysis. Extending the drilled shaft systems up to the bridge superstructure eliminated the need for expensive cofferdam construction. Construction involved partial casings with slurry-assisted excavation. Most of the foundation's capacity would be mobilized by skin friction so a two-layer Osterberg load cell test was conducted to confirm both skin friction and end bearing. Although this multi-level, O-cell testing is expensive to conduct and rarely implemented, Arora recommended it to assure the shaft would have adequate capacity to carry the bridge loads. The load-testing program verified an ultimate shaft capacity greater than 5,000 tons, which exceeded the required minimum value of 4,000 tons. Arora used the test results to reevaluate the design assumptions and reduce the production shaft length and lower NJDOT's construction cost.

A thorough subsurface investigation and laboratory testing program conducted by Arora revealed a 100-foot thick marsh deposit at the west side of the bridge. This cohesive deposit complicated the design of the west abutment and approach embankment. Arora recommended supporting the abutments on 18-inch diameter concrete-filled pipe piles. Arora anticipated that soil consolidation at the west abutment would cause significant negative skin friction. Preconsolidating the abutment area was the solution to mitigate the negative friction. The contract specifications called for fill plus eight feet of surcharge for primary consolidation to be placed for nine months with the wick drains. Then four additional feet surcharge should be placed for four more months. During construction the subsurface materials behaved as anticipated.

This thick layer of cohesive marsh deposits also posed a significant challenge for the west approach embankment design. Arora performed extensive global and local slope stability analyses that simulated the long-term and short-term subsurface conditions. Arora estimated the 11-foot high embankment would have a consolidation settlement of six feet. Over-excavating all the unsuitable cohesive materials was not feasible so Arora recommended installing a 100-foot deep wick drain system and eight to nine feet of surcharge to accelerate the consolidation process. To check the embankment settlement and slope stability; settlement plates, vibratory wire piezometers, inclinometers and observation wells were installed and monitored. Consolidation settlement occurred as predicted.

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