GRL Engineers, Inc.

Toombs County Bridge Replacement over the Altamaha River

Challenge:

Toombs County in Georgia took on a $60+ million-dollar bridge project to offer improved traffic flow over the Altamaha River. In 2020, GRL Engineers were brought on to perform bi-directional static load testing on a non-production drilled shaft that would help assess the load capacity of the replacement bridge.

Working with United Infrastructure Group, Inc. and Lee & Sims Drilling Services, Inc., GRL performed drilled shaft verticality assessment, shaft base cleanliness assessment, as well as bi-directional static load testing ("BDSLT") services. A multi-level jack assembly configuration increased the complexity of shaft installation requirements, load test execution, and test data analyses.

Method:

The test shaft was a drilled shaft with an embedded length of 125.1 feet, cased and uncased nominal diameters of 72 and 70 inches, respectively. The boring log indicated subsurface conditions consisting primarily of clay and sand, and partially weathered rock at 40-foot depth. The Shaft Area Profile Evaluator ("SHAPE") device was attached to a Kelly bar and lowered into the shaft to assess the foundation's excavation profile. The maximum eccentricity profile from SHAPE is shown in Figure 1. In addition to the verticality assessment, a shaft base cleanliness evaluation was performed with the Shaft Quantitative Inspection Device ("SQUID"). The SQUID was attached to the Kelly bar and lowered into the shaft where it encountered debris material at the shaft base. The device used force and displacement measurements on three penetrometers to assess debris thickness. The debris was within the specification requirements. Sample SQUID results are shown in Figure 2.

Thermal Integrity Profiling ("TIP") was implemented using six Thermal Wire cables instrumented along the longitudinal bars of the reinforcing cage to assess concrete quality and potential geometric deviations from the nominal casing and shaft diameters. During concrete curing, the hydrating cement generated heat which was measured every 15 minutes by the Thermal Wire cables. After reaching peak temperature, the data was downloaded and analyzed.

To perform the bi-directional static load test, two separate jack assemblies were installed at different elevations along the shaft's embedded length. Each jack assembly contained a single 2,200-kip **GRL-Cell**. The lower- and mid-level jack assemblies were located approximately 2.4 feet and 33.1 feet above the shaft base, respectively. Strain measurements were obtained at six strain-gauge levels above the mid-level jack assembly and three levels between the mid- and lower-jack assemblies. The measured strain was converted to internal force using the ACI method to estimate concrete modulus and using nominal foundation dimensions. Strain measurements in SG Levels C2 and C3 were combined for internal force computation above the lower-level jack assembly.

Project Details

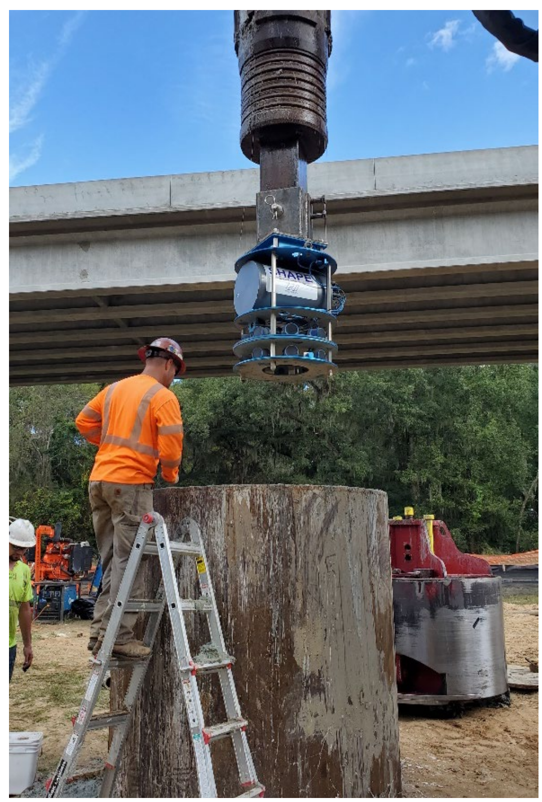
Client: United Infrastructure Group, Inc.

Location: Toombs County, GA

GRL Office: Georgia

GRL Services

- Bi-Directional Static Load Testing
- Drilled Shaft Verticality Assessment ("SHAPE")
- Drilled Shaft Base Cleanliness Evaluation ("SQUID")
- Thermal Integrity Profiling ("TIP")



Results:
The SHAPE test revealed consistent dimensions with the nominal shaft geometry prior to concrete placement. The maximum eccentricity was calculated as 0.62 feet from the ground surface to the bottom of the excavation, which equated to a verticality of 0.48%. Debris thickness for the shaft base ranged between 0.24 – 0.51 inches, with the maximum observed in the eastern location.

TIP indicated the post-concreted Effective Average Radius was generally greater than the nominal 70-inch-diameter shaft to a depth of 45 feet (within the 72-inch diameter casing). A reduction in average temperature was observed from 45 – 70 feet below the shaft head. The reduction in temperature models a reduction in Effective Average Radii slightly below nominal. From 70 feet to 119.6 feet, the calculated radius was above nominal.

Two levels of jack assemblies on the BDSLT permitted staged testing with the intent of maximizing mobilized resistance in specific portions of the test shaft. Stage 1 consisted of pressurizing the lower-level **GRL-Cell** while the mid-level **GRL-Cell** remained welded closed. Stage 2 consisted of pressurizing the mid-level **GRL-Cell** with the hydraulic lines to the lower-level jack open, allowing the lower-level **GRL-Cell** to drain and retract. Stage 3 consisted of pressurizing the mid-level **GRL-Cell** with the hydraulic lines to the lower-level **GRL-Cell** closed, rendering the lower-level **GRL-Cell** locked (unable to drain). The maximum jack assembly force achieved was 1,987 kips, 2,194 kips, and 2,193 kips for Stages 1, 2, and 3, respectively. For each stage, unloading was accomplished in decrements equal to approximately 20% of the maximum jack force achieved. Figure 5 represents Stage 1, Figure 6 represents Stage 2, and Figure 7 represents Stage 3 results.

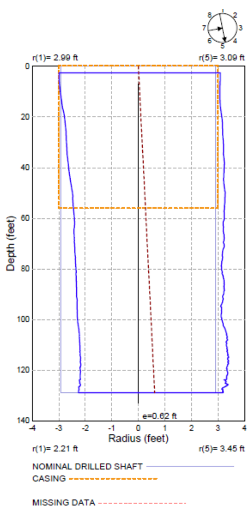


Figure 1: SHAPE Maximum Eccentricity Profile

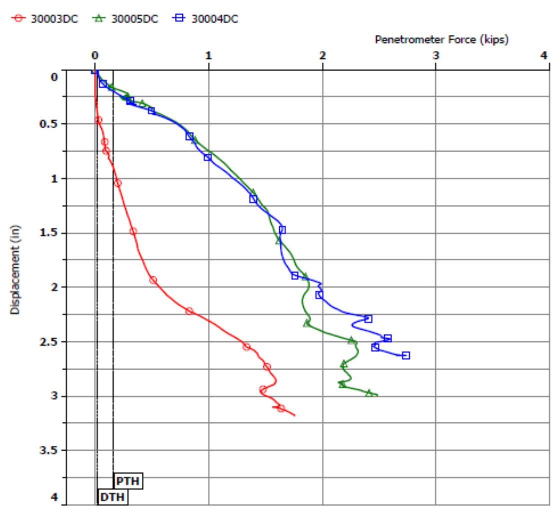


Figure 2: Sample SQUID Debris Thickness Results

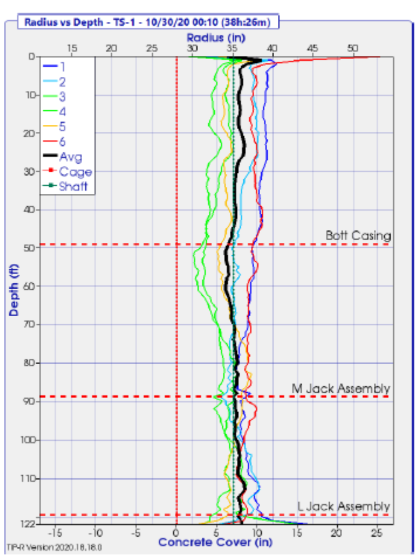


Figure 3: TIP Estimated Radius Vs Depth

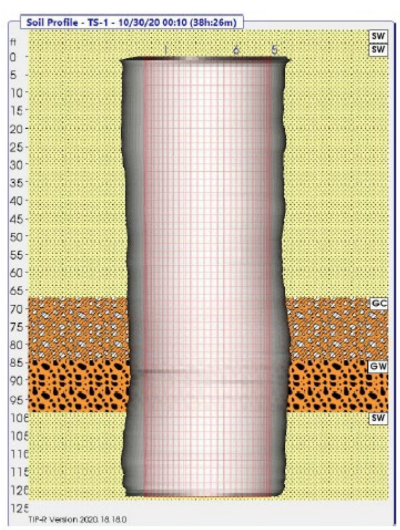


Figure 4: TIP 3D Interpretation of the Test Shaft

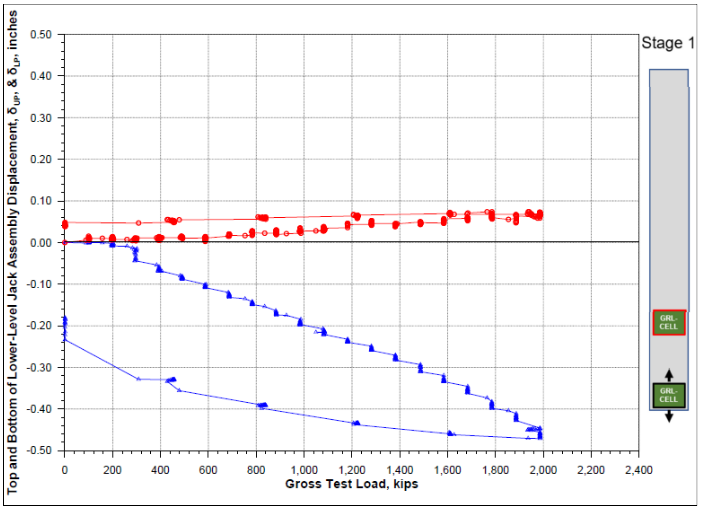


Figure 5: Jack Assembly Bearing Plate Displacement vs
Gross Test Load - Stage 1

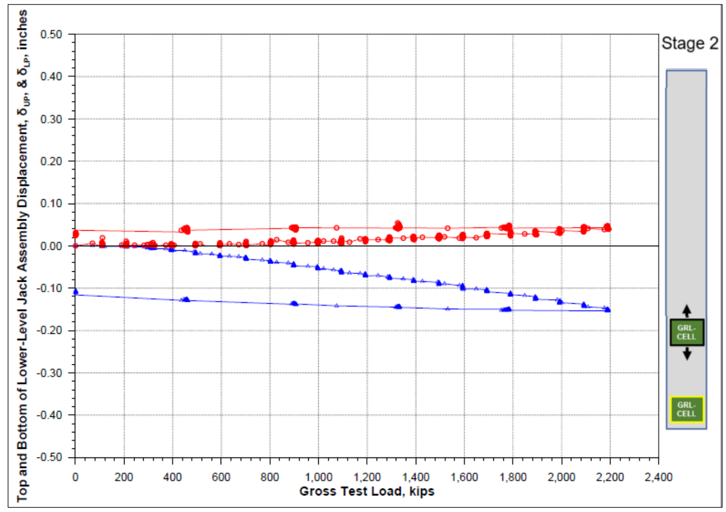


Figure 6: Jack Assembly Bearing Plate Displacement vs
Gross Test Load - Stage 2

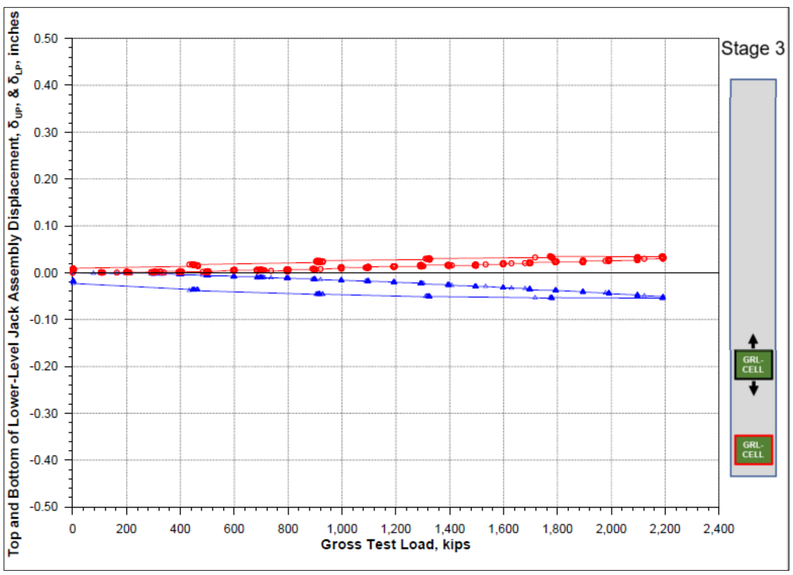


Figure7: Jack Assembly Bearing Plate Displacement vs
Gross Test Load - Stage 3

To learn more about GRL Engineers, visit www.grlengineers.com or email us at info@grlengineers.com.