GRL Engineers, Inc.

Sand Island Wastewater Treatment Plant

Project Details

Client: Hawaiian Dredging Construction Company, Inc.

Location: Honolulu, Hawaii

GRL Office: Hawaii & Central

GRL Services

- Bi-Directional Static Load Testing
- Thermal Integrity Profiling (TIP)

Challenge:

The city of Honolulu embarked on an expansion of the Sand Island wastewater treatment plant to account for residential growth. The $180.5 million expansion included construction of a second digester at the facility and raising the facility to account for rising sea levels. The Hawaiian Dredging Construction Company engaged GRL Engineers to provide foundation testing services, including Thermal Integrity Profiling and Bi-Directional Static Load Testing of augered-cast-in-place piles (ACIP).

Method:

The tested ACIP pile was installed 72 feet below ground surface with a nominal diameter of 18 inches. The Bi-Directional Static Load Test (BDSLT) was requested to determine the mobilized shaft, base, and total resistances from a single GRL-Cell installed within a non-production pile. The jack assembly consisted of a single 350-ton GRL-Cell with associated displacement instrumentation. The pile was drilled, grouted, and then the 66.2-foot-long reinforcing cage installed into the grout filled hole. The instrumented reinforcing cage terminated at a depth of 64.9 ft, resulting in a cage stick-up of 1.3 feet (16 inches) above ground level. The BDSLT was performed seven days after installation.

Thermal Wire® cables were instrumented on ACIP test pile to determine the Effective Radii over the instrumented length of the pile and to better ascertain the grout quality surrounding the GRL-Cell. Two Thermal Wire® cables were attached along the reinforcement cage. Following the placement of the reinforcement cage in the grout filled hole, a TAP-Edge and TAG were attached to the wires which initiated data acquisition. Every 15 minutes the TAP-Edge and TAG devices automatically recorded the measured temperature at each sensor location, generating a profile of temperature vs depth at each increment of time.

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Results:

Following the Bi-Directional Static Load Test, the design grout compressive strength was 4,000 pounds per square inch ("psi"). The average of two grout cubes uniaxial compressive strength test results performed on the day of the test was 8,295 psi. This compressive strength met the ASTM D8169 recommendations for grout strength to be at least 85% of the mix design compressive strength at the time of the test. Results can be viewed in **Figure 1**.

Full mobilization of shaft resistance was not exhibited at most evaluated pile segments above and below the jack assembly. Maximum mobilized shaft resistance was 15.5 ksf at approximately 0.05 inches of segmental foundation displacement on Segment A1. The t-z curves above and below the jack assembly are presented in **Figure 2**.

Negligible internal force and mobilized resistance at the pile base was indicated by the internal force profiles in the lowest pile segment. An equivalent top loading ("ETL") curve was constructed using the modified method and is presented in **Figure 3.** For an equivalent top load of 1,501 kips, pile head displacement is estimated to be approximately 0.32 inch.

Upward and downward jack assembly creep was determined from the change in displacements between the 4- and 8-minute elapsed time intervals and plotted versus gross test load in **Figure 4**. No appreciable upward or downward creep load was apparent for this test.

The TIP results are presented in Figures 5 and 6. Figure 5 presents the Measured Temperature (degrees Fahrenheit) vs. Depth (ft) on the left plot, and the Estimated Effective Radius (in) vs. Depth (ft) on the right plot. Temperature roll-off at the top of a pile is caused by heat loss due to the grout / air interface. It should be noted that the Effective Average Radii reduction computed at the location of the jack assembly is due to the amount of steel at this elevation which acts as a heat sink. Figure 6 presents the Estimated Effective Radius and a 3D model of the pile where adjustments in the temperature profile were applied to compensate for the temperature reductions at the jack assembly location.

Based on the thermal results, the Effective Average Radius is generally greater than the nominal 18-inch-diameter pile along the instrumented pile length. Please note that the reduction observed near the pile top may be due to grout settling after placement or the presence of lower quality grout in this region.

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

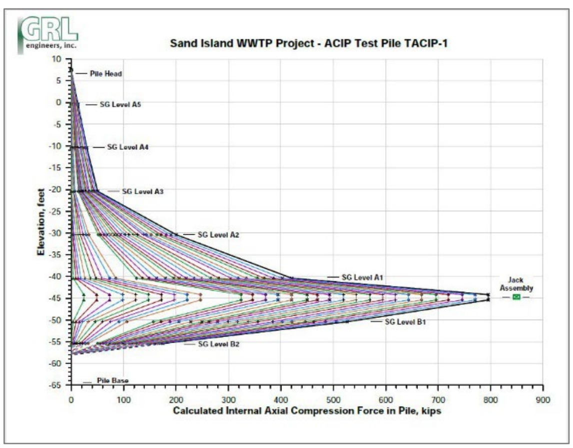

Figure 1. Internal Force vs Elevation

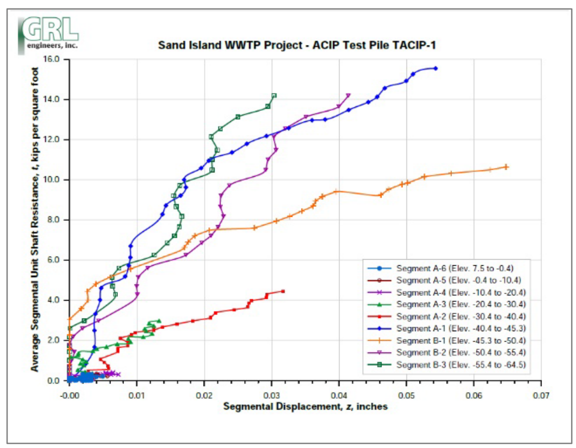

Figure 2. Average Segmental Unit Shaft Resistance vs. Segmental Displacement (t-z)

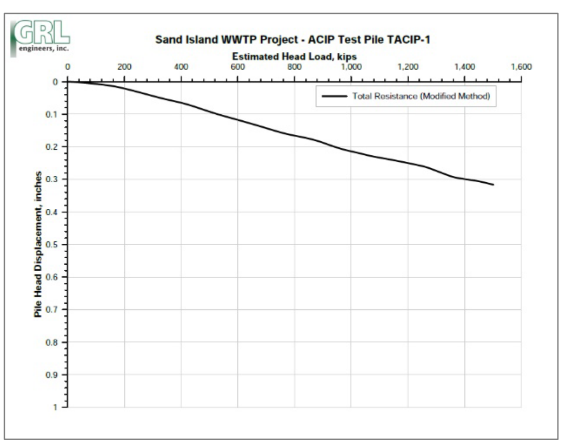

Figure 3. Equivalent Top-Loading ("ETL") Curve

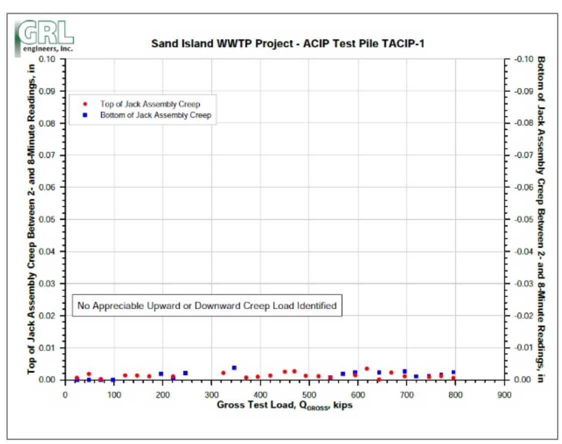

Figure 4. Top and Bottom of Jack Assembly Creep vs. Gross Test Load

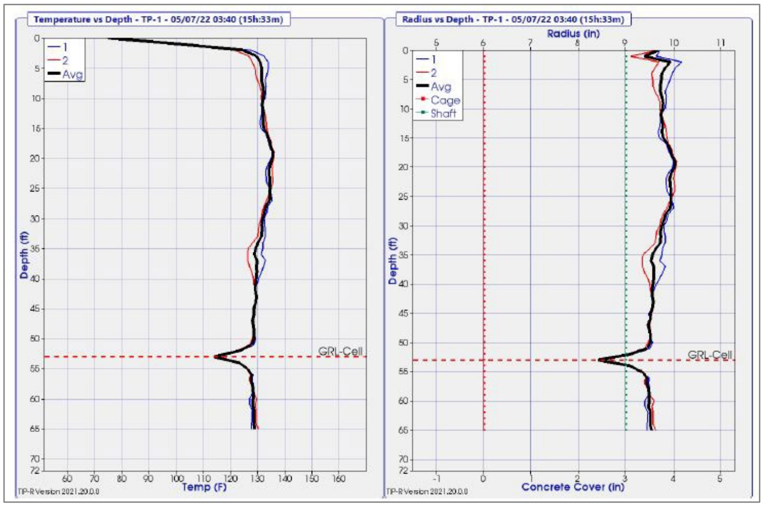

Figure 5. Measured Temperature vs Depth (left) and Estimated Radius vs Depth (right)

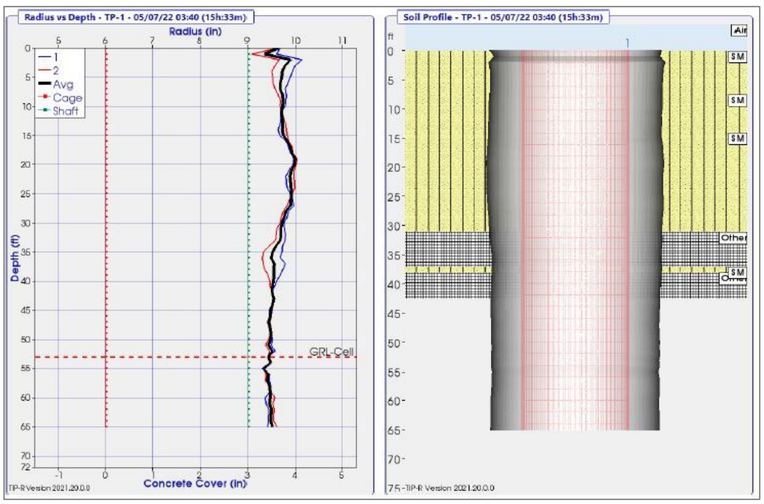

Figure 6. Estimated Radius vs Depth with Mid-Shaft Adjustments Applied at the Jack Assembly (left), 3D Interpretation (right)