GRL Engineers, Inc.

Rigid Inclusion Test Piles for Retaining Walls

Project Details

Client: L.G. Barcus and Sons, Inc.

Location: Kansas City, KS

GRL Office: Illinois

GRL Services

- Thermal Integrity Profiling (TIP™)
- Dynamic Load Testing with APPLE Systems
- CAPWAP® Analyses

Challenge:

A railroad track extension project in Kansas City necessitated the construction of three retaining walls. Soil improvements required precast retaining walls initially designed as rammed aggregate piers. The contractor proposed rigid inclusions (non-reinforced auger-cast-in place piles (ACIP)) as an alternative foundation type. The initial design included 24-inch diameter ACIP piles, extending to approximately 60 feet deep. However, soil conditions suggested that the piles could be shortened and still achieve the required capacity. As part of the investigation, two test piles with internal strain gages, accelerometers and Thermal Wire® cables were installed.

Method:

Test piles utilized Thermal Integrity Profiling (TIP) with a full-length center bar. Each center bar accommodated the shaft instrumentation. Thermal Wire® cables were attached to TAP-Edge data loggers that collected and remotely transmitted stored data to a secure cloud database in real-time. TIP analysis assessed the effective diameter of the pile along the full length of the retaining walls.

Dynamic Load Testing was utilized to determine pile capacity. For drilled foundations, this is performed with a drop weight with strain measurements taken on a transducer and pile acceleration measured near the pile top. The test method is suitable for total capacity, but the shaft resistance and end bearing capacity is not always easily separated. To refine the pile resistance resolution, the test piles were also instrumented with strain gauges and accelerometers near the pile toe.

Results:

Two test piles with embedded instrumentation were installed and dynamically tested. GRL utilized a 16 kip drop weight to mobilize the required capacity of approximately 450 kips under dynamic loading conditions. Between four and six impacts were delivered with drop heights up to 3.5 feet. The test piles had sets per applied blow between zero movement and ⅜ inches, with cumulative sets of approximately ⅝ and ⅞ inches.

TIP results, presenting cross-sectional area versus depth, were incorporated into CAPWAP Analyses. **Figure 1** offers an example of the effective area that was indicated by the TIP results. CAPWAP analyses were performed for every blow to generate a cumulative load-set curve, see **Figure 2**. One blow was selected for detailed CAPWAP® analysis from the internal strain and acceleration measurements. This analysis allowed for a more accurate determination of end bearing capacity. With the end bearing capacity determined, the top of pile analysis output presented the shaft resistance values and distribution with a high level of confidence. The unit shaft resistances indicate a significantly higher resistance in the shale bedrock layer, as expected. The unit resistances as a function of depth are presented in **Figure 3**. The test pile results confirmed that the pile length could be reduced and still achieve the required pile capacity.

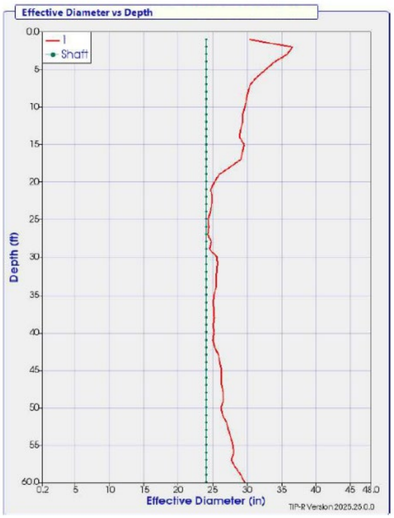

Figure 1. Effective Diameter vs Depth

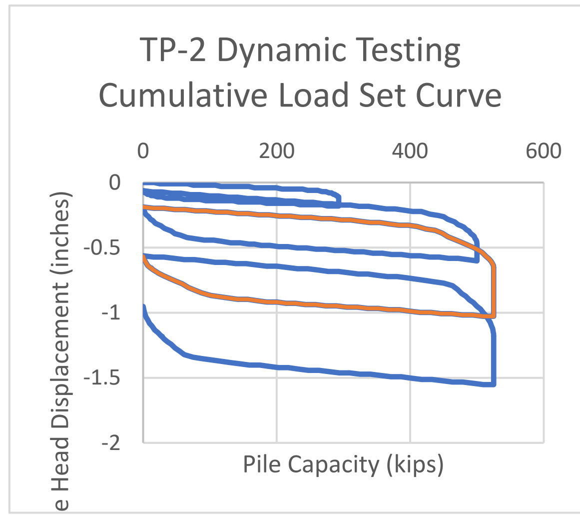

Figure 2. Cumulative Load Set Curve

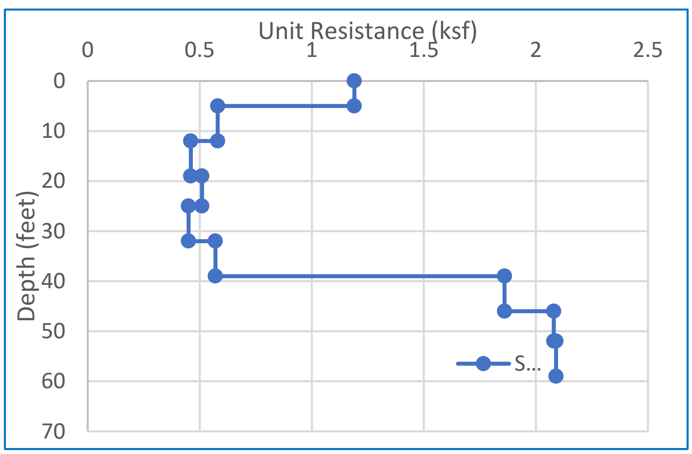

Figure 3. Unit Shaft Resistance vs. Depth for a Test Pile

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