GRL Engineers, Inc.

Seattle Center Arena Net Zero Project

Challenge:

The Seattle Center Arena, recently renamed the Climate Pledge Arena, underwent a complete renovation with the exception of keeping the original roof. The center was originally built in 1962 to host the Seattle World's Fair. This renovation marked the arena as the first net zero certified arena in the world, and serves as a reminder of the Climate Pledge Commitment to be net zero by 2040. During the construction of the new foundation, GRL Engineers was retained to assess the drilled shaft integrity using the Thermal Integrity Profiling (TIP) method following concrete placement.

GRL tested and analyzed the collected thermal data for 21 drilled shafts. The tested shafts were either 36 or 78 inches in diameter with shaft lengths from 80 to 93 feet. Some shafts were constructed with permanent casings, some had temporary casings, and some had no casings. The 78-inch diameter shafts were designed with full length reinforcing cages. However, the 36-inch diameter shaft design only required a cage in approximately the upper 50 feet of the shaft.

Method:

For the 72-inch diameter shafts selected for integrity testing, the 60-inch O.D. reinforcing cages contained six evenly spaced thermal wire cables attached to the longitudinal rebar. For the 36-inch shafts, the 30-inch O.D. cage contained four evenly spaced thermal wire cables. In order to assess the integrity in the lower portion of the 36-inch diameter shafts, an additional thermal wire was attached to a center bar that was installed full length. The center bar data and cage data were compared with each other, adding confidence to the integrity assessment in the lower portion of the shaft below the reinforcing cage. Per ASTM D7949, a 36-inch diameter shaft is at the upper end of the shaft diameter where a single wire on a center bar can be utilized with the Thermal Integrity Profiling method.

Results:

The test results provided valuable information regarding the shaft installation methods, as well as each shaft's ability to fulfill its intended structural and geotechnical purpose. The soil contained layers of sand interspersed with layers of silt, and lean clay. This led to non-uniform shaft profiles in some instances. Engineers could compare TIP results with soil boring and the shaft pour logs. If modified installation techniques were used, the resulting trends in shaft profiles could also be observed and evaluated. Figures 1 and 2 provide TIP data from an uncased 36-inch diameter shaft. TIP data from the thermal wire cables on the both the cage and the center bar indicate an oversize section (i.e., a bulge) from depths of approximately 28 to 33 feet. If solely the cage data was acquired, there may be integrity concerns in the lower non-instrumented depths. Having the additional center bar data (Figures 3 and 4) below the reinforcing cage depth provided a means of checking the concrete integrity as well as the shaft's ability to perform its function in the foundation.

Project Details

Client: Malcolm Drilling Company, Inc.

Location: Seattle, Washington

GRL Office: Washington

GRL Services

Thermal Integrity Profiling (TIP) Instrumentation and Analysis

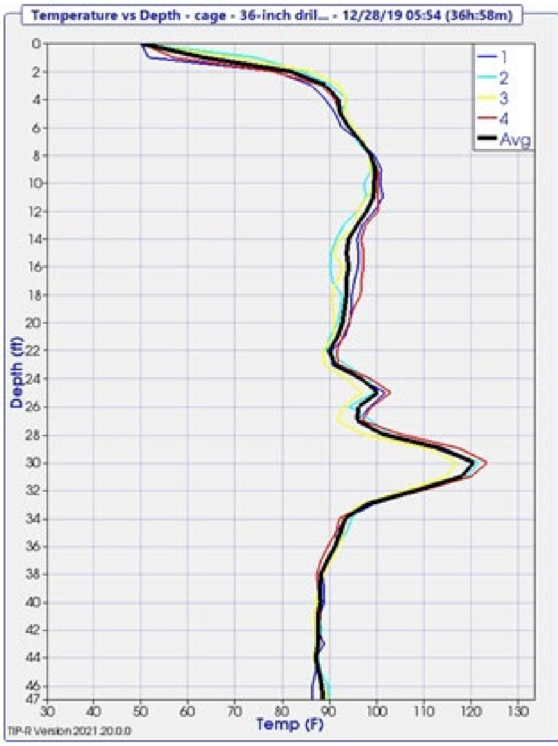

Figure 1: TIP Temperature vs Depth Rebar Cage Results

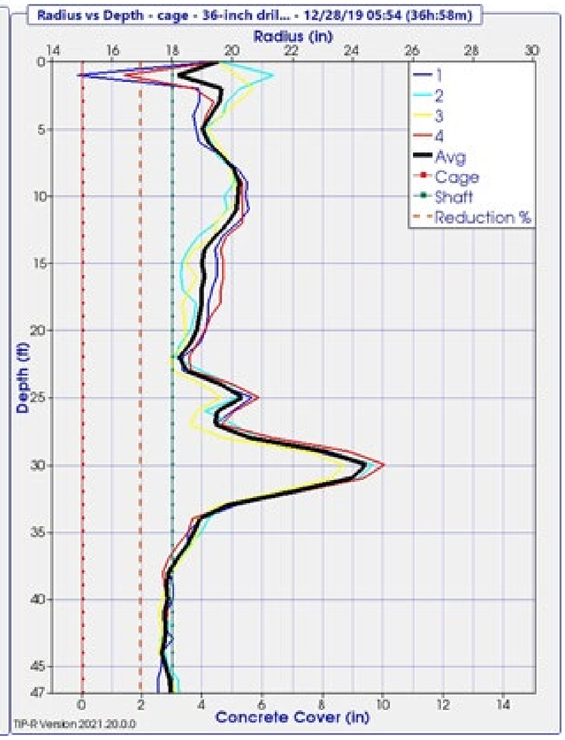

Figure 2: TIP Effective Radius vs Depth Rebar Cage Results

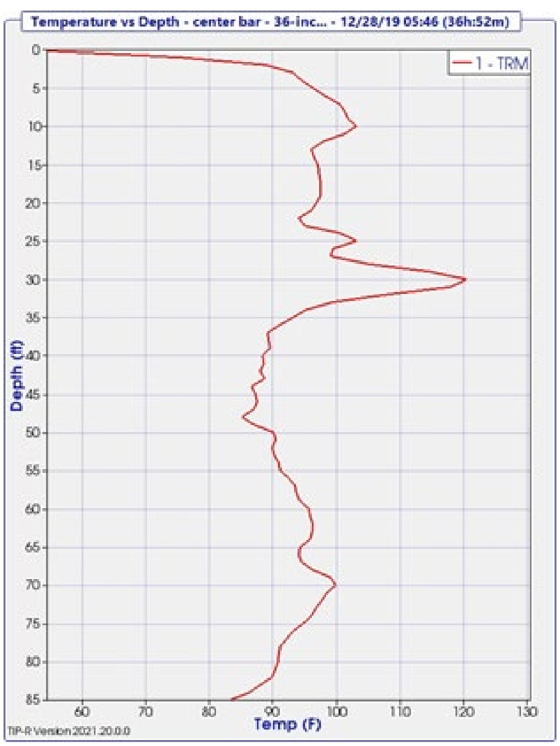

Figure 3: TIP Temperature vs Depth Center Bar Results

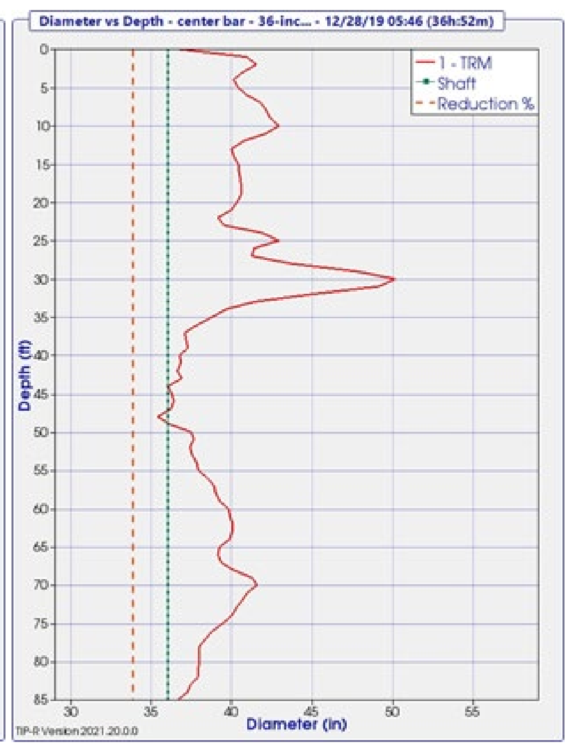

Figure 4: TIP Effective Diameter vs Depth Center Bar Results

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