GRL Engineers, Inc.

Replacement Bridge Over Buffington Road and NFS Railroad

Challenge:

South Carolina Department of Transportation (SCDOT) requested bids to replace an existing 60+ year old bridge over Buffington Road / Norfolk Southern Railroad in Spartanburg County, SC. The existing bridge was structurally deficient and did not meet the current SCDOT design standards. E.S. Wagner was contracted to replace the bridge and retained GRL Engineers to perform a specified bi-directional static load test on one of the 48-inch diameter by 89.1 ft long production shafts. The purpose of bi-directional load test was to determine the mobilized shaft resistance, base resistance, and total resistances on the load tested shaft for optimizing the production shafts as well as enhancing foundation design practice in similar subsurface conditions.

The boring log of the subsurface conditions near the test location indicated primarily sands and silty sands transitioning to partially weathered rock at approximately 79 feet below the ground surface. The partially weathered rock transitioned to a hard rock layer 80 to 83 feet below the ground surface before transitioning back to partially weathered rock.

Method:

A single GRL-Cell was installed within the jack assembly to apply the specified 2,000-kip unidirectional load. The jack assembly was located roughly 8.1 ft above the shaft base.

Following shaft excavation, the drilled shaft verticality and profile was evaluated using a Shaft Area Profile Evaluator (SHAPE®) to check that the shaft excavation was within SCDOT's specification requirement of ¼ inch per foot (2%) verticality. The base cleanliness was also checked using a Shaft Quantitative Inspection Device (SQUID™) to assess that the base cleanliness met SCDOT's requirement that a minimum of 50% of the base area have less than ½ inch of debris and that the maximum debris thickness at any location not exceed 1.5 inches.

The rebar cage included sister-bar mounted strain gages for load transfer evaluation and Thermal Wire® cables for concrete integrity and shaft profile. The thermal integrity profiling results were used to compute effective average radii. These results along with the SHAPE profile information were used to develop a model of shaft cross-sectional area versus depth.

Results:

The tested shaft was completed with an as-designed diameter of 48 inches. GRL Engineers assessed the shaft base cleanliness, which measured an average debris thickness of 0.43 inches. The maximum debris thickness measured was 0.94 inches. Thus, the SCDOT requirements for base cleanliness were met. The shaft verticality test resulted in 0.65% with an offset of 0.58 feet, meeting the SCDOT requirement.

Project Details

Client: E.S. Wagner Co.

Location: Spartanburg, SC

GRL Office: Central & North Carolina

GRL Services

- Bi-Directional Static Load Testing
- Drilled Shaft Verticality Assessment
- Drilled Shaft Cleanliness Evaluation
- Thermal Integrity Profiling

The bi-directional static load test applied a maximum unidirectional jack assembly load of 2,152 kips and a maximum test load of 4,304 kips. Measured strains were converted to internal forces using the Incremental Rigidity Method. These results, combined with the interpreted cross-sectional areas determined from Thermal Integrity Profiling, were used to assess the unit shaft resistance along the length of the tested shaft.

Full mobilization of shaft resistance along the embedded shaft length was exhibited from the t-z curves. The maximum average mobilized unit shaft resistance was 6.2 ksf immediately above the jack assembly. The calculated maximum mobilized unit base resistance was 145 ksf.

Conclusion:

Combined efforts by GRL Engineers and E.S. Wagner resulted in the installation and completion of a bi-directional static load test on a production shaft meeting the required project specifications. SHAPE® and SQUID™ equipment provided by GRL Engineers were used to evaluate the shaft excavation verticality and base cleanliness, prior to placing concrete. Thermal Integrity Profiling results were used to evaluate the concrete quality and shape of the shaft after concrete placement. Preliminary load test results were submitted within two business days and the final report was delivered within the project specified timeline.

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