



## Benefits of Performing a Bi-Directional Test on a Drilled Shaft in Sand, Gravel, and Cobble Deposits

### Challenge:

Inland Foundation Specialties contacted GRL Engineers to help predict displacement on a drilled shaft in sand, gravel and cobble deposits. GRL conducted a bi-directional static load test using calculated geotechnical nominal resistances through foundation testing

### Method:

A bi-directional static load test (BDSLTL) was performed on June 6th, 2018. Fifty-four test load increments of approximately 200 kips each were applied, with each load increment held for ten minutes. This resulted in a maximum test load of 10,707 kips. The 200-kip test load increments were selected to provide a reasonable number of load increments based on the pre-test estimate of the nominal resistance. The large number of test load increments resulted from the mobilized nominal resistance exceeding the pre-test estimate. The average unit shaft resistance versus segmental midpoint displacement was calculated for each foundation segment.

In accordance with LRFD design methodologies, a higher resistance factor can be used if top loading or bi-directional static load testing is performed. Without static load testing, the LRFD resistance factors for drilled shafts in sand are 0.55 and 0.50 for shaft and base resistance, respectively. GRL Engineers performed a bi-directional static load test (BDSLTL), with a resistance factor of 0.70, for this project.

Crosshole sonic logging (CSL) was performed by the Montana DOT on each of the northbound structure's four river shafts. Testing results indicated varying degrees of anomalies at the base of three shafts which were characterized as the potential for weak or soft concrete. Following receipt of the CSL results from the first shaft with an indicated anomaly, the extent of the possible anomaly and its potential impact on the shaft's available base resistance to support design loads was evaluated. Since the apparent anomaly was at the base, it was decided as a first step to review the bi-directional static load test data to determine if shaft resistance alone (ignoring any base resistance) was sufficient to support design loads.

### Project Details

**Client:** Inland Foundation Specialties

**Location:** Missoula, Montana

**GRL Office:** Central

### GRL Services

- Bi-Directional Static Load Test (BDSLTL)

# 4 Days

Construction Time Saved



## Results:

When CSL testing indicated potential anomalies near shaft bases, BDSLT results were used to demonstrate that shaft resistance alone (ignoring base resistance) was sufficient to support design loads in three shafts, thereby precluding the need to core or remediate. Because a bi-directional static load test was performed at the beginning of this project, data were available to re-evaluate drilled shaft resistances and avoid having to potentially core and/or grout up to three large-diameter drilled shafts, which could have taken three to four weeks or more of project schedule to complete.

In the case history presented, bi-directional static load testing permitted the use of a higher resistance factor than would have been used in the absence of testing. This resulted in saving 16 feet of embedded length on each of eight river shafts for a new bridge structure. After accounting for the total cost of testing, a **net savings of \$25,260** in construction cost was realized, demonstrating that bi-directional static load testing can save more money than it costs. Additionally, it is estimated that the decreased required footage saved four days of construction schedule.

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