FY 16/17 Research Initial Scope of Work

I. Project Title:

Deployment of Post Grouting Technique to improve Drilled Shaft End-Bearing Resistance

II. Project Problem Statement

In spite of benefits to cost of the projects, application of tip grouting in Caltrans has been very limited due to lack of construction specifications and Quality Assurance/Quality Control (QA/QC) measures that meet departments' standards, as well as lack of non-proprietary tip-grouting system that can be evaluated and certified by Caltrans or FHWA.

III. Problem Statement Background/Context:

Although numerous case-histories and supporting research have documented substantial increase in drilled shaft axial geotechnical nominal resistance resulting from post grouting, Caltrans has been reluctant to embrace this technology due to concerns related to reliability and repeatability of the technique and lack of FHWA construction standards and Caltrans specifications for Quality Control and Quality Assurance. A recent position paper prepared by the Substructure Committee characterized use of post grouting before developing such information (through research and pilot study) as “risky, unreliable, and unverifiable” therefore limiting the application to redundant systems that may have little benefit to offer. Furthermore, in-house research and pilot project applications were recommended before full adoption of the technology for non-redundant deep foundation systems.

IV. Research Objectives:

The research objective is the development of a guidance document on estimating post-grouted shaft capacity using instrumentation as well as QC/QA measures to increase confidence in performance of the production shafts that are not instrumented. The proposed approach will include quantification of foundation reliability, taking into consideration variability in instrumentation readings and uncertainty in their interpretation.

V. Support California Bridges & Structure Strategic Direction:

Deployment of Tip Grouting to Caltrans’ projects will directly benefit the cost by using an innovative technique, therefore it meets objectives 8 and 12 of the Strategic Direction for California Bridges and Structures.

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VI. Description of Work:

Guidance will be developed on the use of instrumentation to quantify reliability of the post-grouted shaft. Presumably, the recommended instrumentation will be some combination of strain gauges placed near the shaft tip, telltales, and measurement of top of shaft displacement. Other options can be considered if shown to be effective and economical. Detailed protocols will be provided for the amount of each type of instrumentation, instrumentation placement, and monitoring procedures. These protocols will depend on the level of redundancy in the foundation. Instrumentation data from past projects will be collected. This data will be used to develop comprehensive data interpretation procedures that **include estimates of uncertainty in the inferred capacity**.

VII. Related Research:

Gray Mullins, University of Southern Florida, published 2 papers on post grouting, based on research supported by Florida DOT.

Mullins, G., Dapp, S.D., Lai, P., 2000, Pressure Grouting of Drilled Shaft tips in Sand.
New Technological and Design Developments in Deep Foundations. American Society of Civil Engineers, Geotechnical Special Publication Number 100, pp 1-17.

Mullins, G., Winters D., Dapp, S., 2006, Predicting End Bearing Capacity of Post Grouted Drilled Shaft in Cohesionless Soils, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 132, No. 4, April 2006, pp. 478-487.

In 2005, Caltrans funded research at University Nevada-Reno focused on the development of a numerical model to predict the capacity of post grouted shafts. This work was documented in a 2010 final report.

VIII. Deliverables/Deployment Potential:

Guidance document on verification of post grouted shaft capacity that can be incorporated into Caltrans specifications, as well as recommendations on QC and QA measures that can be used as a baseline to develop construction specifications and design guidance for Caltrans' engineers.

IX. Sponsor: Office of State Bridge Engineer Support
Date: January 2016

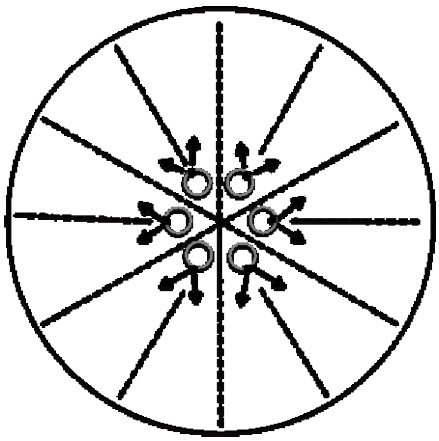

Figure 1: Plan view of grout channelization device concept. Dashed lines represent approximately 4-inch deep metal strips welded to the bottom of a round steel plate. The round metal plate is connected to the bottom of CIDH rebar cage. Gray circles represent grout pipes that extend to the top of shaft. As shown, each pipe fills 1/6 of the void space beneath the tip. Grout pipe and channelizer design will be refined as part of the project.