FY 07/08 Research Initial Scope of Work

I. Project Title: **S129**

Required Embedment Length of Column Rebar Cage into Type II Shafts

II. Background:

All Caltrans pile shafts have been classified as Type I or Type II shafts. For Type I shafts, the plastic hinges will form a certain distance below the ground surface. In order to estimate the plastic hinge length, plastic hinge depth, and plastic hinge modeling, etc, the investigations on the behavior of Type I pile shafts have attracted a significant research attention. Due to a clear location of plastic hinge (bottom of column / top of shaft), the studies are much less for Type II pile shafts than those for Type I shafts. During the development of Seismic Design Criteria (SDC) 8.2.4, the data to verify the required embedment length of column rebar to Type II shafts was lacking. Based on the similarity of column main bars extending into bent caps, a conservative recommendation of extending column longitudinal bars into shaft for three column diameters was adopted. Recently, Caltrans has updated HDM Index 110.12, which requires complying Cal-OSHA's Tunnel Safety Order for construction of any CIDH pile shafts. Specifically, more stringent Cal-OSHA standards have to be followed if any human entry occurs in the CIDH pile shaft below the depth of 20 feet from the top of shaft. To this purpose, a new Standard Special Provision (SSP) S5-800 has also been developed. Obviously, the construction cost will be increased for any Type II pile shafts with column diameter larger than 7 feet due to the current SDC 8.2.4 requirement. Therefore, it becomes urgent for Caltrans to verify and update SDC 8.2.4.

A preliminary investigation on the connection of column and Type II pile shafts was performed at Washington State University in 1997 and the recommendations from this study have been adopted by WSDOT. Extensive research for Type I pile shafts can be found in the literature.

III. Project Problem Statement:

Seismic Design Criteria (SDC) 8.2.4 requires that the column rebar cage be embedded into the Type II shaft a distance equal to three times the column diameter to ensure adequate anchorage of column reinforcement after a plastic hinge forms at the bottom of column. Based on this requirement, any column with diameter larger than 7 feet, the column rebar cage has to be extended into the pile shaft at least 21 feet. The Association of Drilled Shaft Contractors (ADSC) has requested that a construction joint be placed in the Type II shaft below the embedded column cage, this would allow for the shaft to be constructed without supporting the column cage. If this joint can be located within twenty feet of the ground surface, then Cal-OSHA standards are less stringent for allowing people to enter the shaft. Less stringent Cal-OSHA standards equate to cost savings and safer conditions for the workers. It

is very important to verify SDC 8.2.4 requirement, and if needed, to improve this requirement. What is needed to determine the minimum length that a column rebar cage should be embedded into a Type II pile shaft?

IV. Objective:

The objective of this study is to develop the improved design criteria for a column rebar cage embedded into Type II pile shafts.

V. Description of Work and Expected Deliverables:

This study will include analytical modeling, laboratory scaled model testing or full scale field testing. For Type I pile shafts, various analytical and experimental studies have been performed. Those procedures should be followed here to accomplish Type II pile shafts study.

It is anticipated a minimum embedment length requirement for column rebar cage into Type II pile shafts will be developed through this study.

VI. Estimate of Duration:

24 Months

VII. Related Research:

1. McLean, D. I., and Smith, C. L., (1997). *Noncontact Lap Splices in Bridge Column-Shaft Connections*, Research Report, WA-RD 417.1, Washington State Department of Transportation, July, 1997.
2. WSDOT. (2006). *Bridge Design Manual*, Washington State Department of Transportation, November, 2006.

VIII. Deployment Potential:

The DES Substructure Committee is submitting this research proposal and accepts responsibility for deploying the product. The products will be a report on which to modify policy.

IX. Date: July 18, 2007