FY 07/08 Research Initial Scope of Work

I. Project Title: **S075**

Development of Design Guidelines for CISS Piles

II. Background

Currently, Caltrans utilizes two classes of CISS piles (Class 400 and 625, Alternative "V"). These are standard pipe piles filled with concrete (details may be found in Caltrans' Standard Plans). The longitudinal reinforcement, when present, may or may not extend to the full height of the pile. Testing on such piles conducted at UCSD have shown that they may not perform in a ductile manner. However, these types of piles are typically used in a pile-with-pile-cap configuration and are designed to perform elastically per the Seismic Design Criteria (SDC). Consequently, ductility may not be required in these situations, and additional testing is necessary in order to determine the elastic capacity of CISS piles.

In addition to the 360 mm piles, Caltrans also utilizes other larger diameter CISS piles. CISS piles having a diameter greater than 2 meters have been used. These large diameter piles are subject to significant axial and transverse forces and are expected to perform in a ductile manner when used as pile column extensions. Currently, there is some limited information that will assist engineers in developing analytical models for such members. However, there are no design guidelines for the plastic design of the CISS pile-column itself. The proposed tests are intended to provide the information necessary to determine the capacities of CISS piles and pile-columns. In addition, the results of this project should improve analytical modeling.

III. Project Problem Statement:

Develop a series of tests (both physical and analytical) to determine the flexural behavior of CISS piles used in bridges. The proposed tests should identify the critical parameters that influence the composite behavior of these piles and lead to the development of design recommendations. That is, what are the critical parameters for modeling the flexural behavior of CISS piles, and can we improve design procedures?

IV. Objective:

The principle objective of the proposed testing is to develop guidelines for the design of small, medium and large diameter CISS piles. The guidelines should consider composite action in relation to flexural capacity, and incorporate

mechanisms to facilitate composite action as determined from previous axial load tests of CISS piles (See UCSD report # SSRP 06/16). The design guidelines should also include the following information:

a) Information on modeling CISS piles in the analytical model (including stiffness calculations) considering both composite and non-composite effects;
b) Estimating elastic and plastic flexural moment capacities;
c) Estimating ductility capacities including plastic-hinge length
d) Estimating shear capacity.

The composite flexural behavior of the CISS pile near the end of the casing should also be assessed.

V. Description of Work and Expected Deliverables:

Description of Work: The proposed test plan to facilitate the development of design guidelines for CISS piles and pile-columns is summarized in Table 1. The CISS piles used for the project should be categorized as follows:
(i) Small diameter - up to and including 460mm;
(ii) Medium diameter - from 610 mm to 900 mm
(iii) Large diameter - equal to or greater than 1060 mm

CISS pile type	Small dia.	Med. dia.	Large dia.
Fully composite with shear connectors to mobilize composite action	X	X	X
Non-composite (no shear connectors)	X	X	X
Full-length rebar cage	X	X	X
No rebar cage	X	X	X

Table 1

The test plan recommends that tests on small and large diameter CISS piles with standard D/t ratios (diameter-to-thickness of the shell) be conducted first. Tests on medium diameter CISS piles may be conducted if required. The tests shall incorporate axial tensile and axial compressive forces that are typically encountered on such piles.

Expected Deliverables: Upon completion of the project, a final report will be delivered. The report should include recommendations for quantifying critical parameters and procedures for modeling the composite flexural behavior of CISS piles.

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VI. Estimate of Duration:

24 months

VII. Related Research:

"Response of Standard Pile-to-Cap Connections under Simulated Seismic Loads" Researched by Prof. Silva, Seible, and Priestley, UCSD Report # SSRP-97/09.

"Axial Load Transfer Mechanism in Cast-In Steel-Shell Piles" Researched by Prof. Gebman, Ashford and Restrepo, UCSD Report #SSRP-06/16.

VIII. Deployment Potential:

As a result of this research new design procedures for CISS piles will be incorporated into Caltrans' design practice. These procedures will lead to improved safety and more cost effective designs of highway bridges in California.

IX. Date: July 18, 2007