FY 07/08 Research Initial Scope of Work

I. Project Title: **S038**

Development of a Highly Ductile Axially Yielding Pile to Pile-Cap Connection

II. Background:

Current Caltrans practice is to design foundations to remain linear under seismic loading. Studies by Gajan et al. have demonstrated the possible reduction in structural load that can be achieved by allowing spread footings to rock. A similar reduction may be achievable by letting piled foundations rock in a controlled fashion by designing the pile to pile-cap connection yield both in tension and compression. This yielding would reduce structural forces allowing for smaller columns and reduced footing size.

III. Project Problem Statement:

Reduced construction cost and improved seismic performance would result from the "controlled yielding" of the pile to pile-cap connection. To be viable for design practice, however, the system would need to be relatively inexpensive, reliable, and maintenance free. The connection would need to transfer shear loads while top of pile rotation could either be restrained or unrestrained. Can a special pile to pile-cap connection be developed that would absorb energy such that pile and column load demands will be reduced without damage to the pile?

IV. Objective:

The objective of the project is to develop a new pile to pile-cap connection that is highly ductile in both compressive and tensile yielding. These connections would be installed in the perimeter piles of pile groups in single column bents to enable energy absorption through "controlled rocking". The new connections would need to be maintenance free and reliable for the life of the structure (approximately 75 years).

V. Description of Work and Expected Deliverables:

The first phase of the project will be to develop and evaluate possible energy absorbing connection schemes. The most promising of these will be evaluated in a second phase through full scale testing under earthquake loading in the laboratory. The final prototype would be evaluated as it supports a test structure loaded by shake-table. During the second phase, design aids would be developed so that the reduction in force levels stemming from the new pile connection could be accounted for in design.

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VI. Estimate of Duration:

2 years (Phase 1: development and evaluation of possible systems)
2 years (Phase 2: detailed development of a single system)

VII. Related Research:

Gajan, S., Phalen, J. D., Kutter, B. L., Hutchinson, T. C. and Martin, G. (2005), "Centrifuge modeling of load-deformation behavior of rocking shallow foundations," Journal of Soil Dynamics and Earthquake Engineering. Vol. 25 (7-10), 2005, pp. 773-783.

VIII. Deployment Potential:

At the conclusion of the project, the design and supporting test data will be available for Caltrans to "approve" the system as an allowable alternative. Design aids will be provided to estimate the modified structural response of the bridge.

IX. Date: July 18, 2007