FY 16/17 Research Initial Scope of Work

I. Project Title:

Comparison of Embedded Data Collector (EDC) to the Pile Dynamic Analysis (PDA) for Precast Piles

II. Project Problem Statement:

Damages imposed to precast concrete piles during driving may result in long-term maintenance and repair costs if not detected and mitigated. This project investigates application of EDC as a new method (to Caltrans) for detection of damages developed during pile driving. Accuracy in estimation of geotechnical nominal resistance of precast piles using Gates formula (LRFD calibration) and PDA verification not been well documented and is questionable, therefore EDC can be used for this investigation.

III. Problem Statement Background/Context:

Precast pre-stressed concrete piles are frequently used as a cheap alternative, and mostly for slab bridges when recommended by Geotechnical Engineer. Precast concrete piles are also advantageous for Accelerated Bridge Construction (ABC) in wet lands. They offer a quick and inexpensive alternative when compared to CISS piles & drilled shafts. One of the prime advantages of precast concrete pile extensions is their ability to be partially free standing, thereby allowing the pile and column to form a single element (Pile extension). This is a common system in marine applications. Precast concrete piles can be square, octagonal or circular. Like any other type of piles, precast piles have their own pros and cons. One of the drawbacks of precast piles is the damages that may be imposed to the pile during driving and installation. Due to the nature of pile driving, cracks may develop specially at the driving tip and pile top where temporary driving shoe and cushion are located. The cracks initiated at portions of the pile buried in the soil may go un-attended and jeopardize structural performance of the piles, particularly when salty water and/or corrosive environment are encountered. Recently a few reports on the conditions of the piles delivered to the job site have indicated visible damages to the piles during fabrication and transportation (even before driving). If special attention is not given in monitoring the pile structural integrity during installation, spalling of concrete cover and subsequent corrosion of the rebars will adversely affect durability of the piles. Following illustrations are examples of damages to precast piles.



EDC can be also used for verification of geotechnical capacity of driven piles. Considering limitations of modified Gates formula as well as PDA, and high cost of Static Pile Load Tests (SPLT), EDC may provide an accurate and cost-effective technique to impact cost of deep foundations.

IV. Research Objectives:

Following are the main objectives of this study:

- Investigate the extent of the damages to precast concrete piles during driving, whether the damage is visible or hidden.
- Propose improvements to structural Quality Assurance of the department for precast piles to minimize damages specifically in low-redundancy foundations.
- Investigate adequacy of the Pile Dynamic Analysis (PDA) used by Caltrans in detection of damages to Standard Plan precast concrete piles.
- Investigate accuracy of modified Gates formula in prediction of nominal axial geotechnical resistance calculated based on AASHTO-CA LRFD (LRFD calibration).
- Investigate accuracy of PDA in prediction of axial geotechnical resistance of precast piles as well as structural integrity evaluations.

V. Support California Bridges & Structures Strategic Direction:

Application of EDC as a new technology will assist engineers to select a more economical system with confidence, and will improve Quality Assurance (QA) of the products used in construction. Therefore EDC application will meet objectives 3, 6, 8, and 12 of the Structures Strategic Direction for Bridges.

VI. Description of Work:

This project investigates application of Embedded Data Collectors (EDC) in detection of damages imposed to the precast piles during pile driving. Such damages may result in long-term maintenance and repair costs if not detected and mitigated.

Using EDC engineer may monitor axial strain and stress at different locations in the pile during driving to avoid any damages that may cause long-term performance problems.
Accuracy of nominal axial geotechnical resistance predictions by modified Gates formula or Pile Dynamic Analysis (PDA) currently used by Caltrans will be also verified by comparison to EDC results. The outcome of this research can be listed as:

- Provide/improve guidance on methods for structural integrity evaluation of precast concrete piles in California Amendments to AASHTO LRFD BDS, Seismic Design Criteria, and Caltrans Construction Specifications.
- Provide guidance in Geotechnical Manual for field verification of nominal axial geotechnical resistance of precast piles using EDC.
- Provide methods to minimize damages to the new precast concrete piles during driving.

VII. Related Research:

John F., Staton, Ph.D., P.E., "*Drilled & Driven piles in seismic region*", PCMAC Technical updates, November 2002.

Verbeek, G.E.H., & Gobles, G. "*Re-evaluation of the method to determine pile damage using the Beta Method*", VMS USA, & Goble Pile Test, USA.

Caltrans' Standard Plans, 2010.

AASHTO Innovative Initiative:
http://aii.transportation.org/Pages/EmbeddedDataCollector.aspx

VIII. Deliverables/Deployment Potential:

Design guidelines, construction specifications, and structural details (if needed) for Structural and Geotechnical NDE of precast piles using EDC.

IX. Sponsor: Office of State Bridge Engineer Support (OSBES)
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