SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2010

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I. PROBLEM NUMBER

GHE-10-02

II. PROBLEM TITLE

Analysis and Design of Pipe Ramming Installations

III. RESEARCH PROBLEM STATEMENT

Large diameter steel culverts (pipes) are often installed beneath fills or embankments using trenchless technology techniques such as pipe ramming. Pipe ramming has the advantage of not producing measurable settlements and not impacting the flow of traffic on the highway above. Pipe ramming involves installing the new pipe sections using hydraulic/ pneumatic hammers, conceptually similar to the driving of bridge foundation piles.

The most authoritative resource on pipe ramming is the US Army Corps of Engineers' guidelines. This guide is completely silent on the selection of the impact hammer and simply puts forward pipe sizes types and lengths that have been used successful. A great deal of emphasis is place on simply selecting an experienced contractor.

While there has been adequate research into aspects of pipe ramming such as settlement, much of the process is based on doing what worked on the last job. There is a need to develop a reliable method to evaluate the actual site, design the diameter, wall thickness and length characteristics of the pipe for a specific job, and design and specify the pipe ramming operation accordingly.

IV. RESEARCH OBJECTIVES

The objective of this research is to develop more detailed, data and theory supported methods to design and specify the installation of culverts using pipe ramming. The research will develop procedures and guidelines to assist designers in specifying steel pipe culverts and associated installation equipment to the optimum for a safe and successful pipe ramming installation.

V. WORK TASKS, COST ESTIMATE AND DURATION

There is a paucity of information published about the particulars of designing and specifying pipe ramming installations. The first task would be to attempt to gather information, especially quantitative data, from DOT pipe ramming projects around the country. It is anticipated that a significant amount of this type of data has been collected but remains unpublished.

After the published material and unpublished state DOT project files have been mined for all available information, the geotechnical dynamics of pipe ramming will be rigorously assessed. Various forms of modeling would be used as part of this task. This process will be constrained and informed by the data that has been collected. While superficially pipe ramming seems very similar to the process of driving a vertical pile, the stress fields encountered, the types of materials penetrated (especially for DOT projects), the ground water conditions and the ability to clean out the pipe all result in important differences in the overall behavior of a rammed pipe as compared to a pipe pile. This carefully assessment, grounded with measured data should increase our understanding of the actual geo-mechanics of pipe ramming.

The next task will be to collect additional data on the dynamic hammer force characteristics and combine them with the advance rates and the installation behavior of the ram. It is possible that we will wish to collect strain gauge data at various distances along the pipe from the ram to capture the stress fall off within the pipe in front of the ram. This would help decide when or whether a sacrificial length of pipe is needed next to the ram to protect the installed pipe. Pile driving analysis equipment seemed to provide useful information during the installation of the Perham

Creek-Interstate 84 crossing pipe ramming project. Additional data of this type might be needed, depending on what was available from other DOTs. Measurements of the soil volume increases within the pipe and external to the pipe due to the disturbance during ramming and the use of driving shoes to create annular gaps seems to be a data gap that might need to be explored as well.

Additional data to separate face resistance from frictional resistance so that more accurate driving requirements can be understood will likely be needed. These additional data needs will be addressed by both monitoring of regular pipe ramming projects and conducting test pipe rammings under controlled conditions.

It is estimated that this research project will take 30 months to complete at a cost of $328,000.

VI. IMPLEMENTATION

The resulting recommended procedures and guidelines would be incorporated into the documents and procedures used by the Region Tech Centers to design and specify pipe ramming installations.

VII. POTENTIAL BENEFITS

Significant cost savings could be realized by being able to design and specify steel pipe culverts for pipe ramming projects with the optimum pipe properties necessary for safe, undamaged installation. Likewise, quick and problem free installations should result from applying the optimum equipment and operations to the installation for the specific conditions at any given project sites. If the Region Tech Centers have clearer design and specification guidance in which they have confidence, ODOT may reap direct and indirect cost savings by more frequently using pipe ramming with its associated advantages.

VIII. SUBMITTED BY

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