



# Improving Design Phase Evaluations for High Pile Rebound Sites

May 2016

## Project Number

BDV28-977-01

## Project Manager

David Horhota  
FDOT Materials Office

## Principal Investigator

Paul Cosentino  
Florida Institute of Technology

### Current Situation

In Florida, many structures are built on driven piles. Though it seems straightforward, pile driving involves complex interactions between the pile, the hammer, the soil, and driving procedures. Soils can even rebound, or push back, after each hammer blow. Some rebound is expected, but when it is beyond certain limits, it is referred to as high pile rebound (HPR). Piles designed for new construction in areas of the state that have historically encountered HPR require additional hammer blows to drive the pile to the desired depth. These additional blows risk damage to the pile and a loss of supportive capacity. Predicting HPR requires a better understanding of the engineering properties of various Florida soils.

### Research Objectives

Florida Institute of Technology researchers conducted a testing program to help engineers determine typical properties of soils encountered during pile installation when HPR occurs.

### Project Activities

The researchers reviewed the literature related to rebound, including the causes of rebound, methods of measuring rebound, and methods of determining the engineering properties of soil. The researchers also reviewed seven case studies covering soil types in Florida, Canada, Washington State, North Carolina, and the North Sea.

For field research, the researchers chose nine Florida Department of Transportation (FDOT) construction projects identified as sites where high pile rebound had occurred. Most sites were in Central Florida, but one was in the Panhandle, and another was in Jacksonville.

For each site, soil was collected for laboratory testing, and field tests were performed. Because the field sites were established FDOT construction sites, data collected through the Pile Driving Analyzer (PDA) software was available. These data were matched to field data collected by the researchers. Factors such as unit weight, moisture content, permeability, silt content, clay content, and shear strength were used to characterize soils. Standard penetration tests (SPT) and cone penetration tests (CPT) were conducted at each site. Fine particle content was determined using sieves, and silt/clay contents were determined using hydrometer analyses.

The researchers examined the correlations between rebound and the wide range of soil data they collected, with promising results. A correlation in an earlier, more limited study between certain values produced by SPT and fine particle content of soil samples was not supported by the findings of this project. The researchers provided a flowchart to summarize their results and to aid in categorizing HPR during the design phase of the project when alternatives can be provided to minimize its effect.

### Project Benefits

The ability to predict whether a site will cause high pile rebound will save time and money by allowing engineers to design piles and procedures that will help ensure projects proceed efficiently and according to designs.

For more information, please see [dot.state.fl.us/research-center](http://dot.state.fl.us/research-center)



*This bridge over Biscayne Bay is one of many transportation structures in Florida founded on driven piles.*