Florida Department of Transportation Research

Design Phase Evaluations of High Pile Rebound Soils with an Emphasis on Standard Penetration Testing

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Current Situation

The Florida peninsula was created over millions of years as seashells were converted to limestone and as changing sea levels deposited layers of sand. In many areas of the state, this created distinctive patterns of soil layering, some of which can present a special difficulty during the installation of driven pile foundations. Given the size and scale of piles and the power of pile drivers, this difficulty, called rebound, might be surprising. Generally, when the pile driving hammer strikes a pile and drives it further into the ground, the ground pushes back a small amount, usually a fraction of an inch, which causes no problems. But soil layering in certain areas of Florida makes pile driving prone to especially high rebound, which can require much more time and energy to drive piles and increase the chances of pile damage during the process. High pile rebound (HPR) has become more significant because changes in Florida building standards specify wider piles to make structures more resistant to hurricanes. A good understanding of the possibility of high pile rebound (HPR) is important during the design phase.

Alum Bluff in NW Florida has complex soil layers that can cause high pile rebound.

Research Objectives

Florida Institute of Technology researchers investigated the use of standard geotechnical tests to determine areas prone to HPR. Test results were used in conjunction with a decision tree the researchers had developed in a previous project.

Project Activities

In a previous research project (BDV28-977-01), the research team created a set of decision trees to aid designers in determining the level of concern about rebounding for construction sites. Respectively, the Levels I, II, and III are based on basic site characteristics, laboratory tests, and field tests.

Data for the decision trees were taken from 11 sites in northwest, northeast, north central, and central Florida. Working with FDOT State Materials Office engineers, the researchers reviewed numerous sites to be used in extending the database and in the decision tree. They identified six additional sites in northeast, north central, and central Florida that met the study criteria.

Acquiring data from the six new sites took considerable time because of travel time, instrument setup, and coordination with construction schedules. Data included standard geotechnical tests – the cone penetration text (CPT) and the Standard Penetration Test (SPT) – as well as data from the Pile Driver Analyzer (PDA) system which directly monitors the pile driving process.

The new data were added to the database, and the complete dataset was examined to determine trends. The Level I decision tree was updated, and a series of recommendations were provided for additional guidance for designers.

Project Benefits

Improved tools for site evaluation can help prevent inappropriate design decisions and costly corrections or damage during construction.

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