Florida Department of Transportation Research

Prediction Model of Vibration-Induced Settlement Due to Pile Driving

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Project Manager
Larry Jones
Geotechnical Engineering

Principal Investigator
Boo Hyun
University of Central Florida

Current Situation

Impact pile driving is commonly used to install deep foundations that support structural loads. This method is especially effective in Florida's sandy soils. However, vibrations are generated in surrounding soils during installation that could disrupt them and cause damage to nearby infrastructure. Current design and construction standards set mathematical limits on construction-induced vibrations but further research is needed to determine the effects of pile-driving vibrations specifically in Florida's unique and varied soil compositions.

Research Objectives

This research project sought to better understand the mechanisms of pile driving-induced ground vibrations in loose to medium-loose soils. Additionally, the research team sought to develop a method for predicting ground deformations caused by impact pile driving, specifically for the characteristics of Central Florida soil conditions.

As part of a recent FDOT project, University of Central Florida researchers studied the impacts of pile-driving ground vibrations in various soils.

Project Activities

First, the University of Central Florida research team conducted a literature review of current methods for determining ground deformations from field tests and numerical methods. Next, the team surveyed practitioners and district geotechnical engineers who were familiar with ground deformations induced by pile driving. The team then recorded field measurements at 11 bridge construction sites, mostly in Central Florida, and conducted analyses to identify the most important pile-driving variables that trigger ground deformations. Those variables are peak particle velocities (PPVs), rated energy of impact hammers, distance away from the pile, and relative soil density.

The researchers also modeled different pile driving scenarios that reflect conditions commonly cited in surveys and observed during field tests. After analysis and modeling, they evaluated variables that influence pile driving-induced ground deformations.

Project Conclusions and Benefits

Approximately 60% of survey respondents had experienced construction problems associated with ground surface settlements induced by pile driving. Even if PPV ratings fell within FDOT standards, ground deformation development was still possible. The higher the rated energies were, the larger the potential ground deformations.

Larger settlements occurred when driving piles through loose soils than when driving them through medium-dense to dense soils. The team also discovered pre-drilling can help reduce ground deformations and vibrations.

The researchers presented equations and charts to help agencies estimate ground deformation envelopes caused by pile driving in similar soil conditions and potentially plan for deformations that may occur or prevent damage to existing structures. The Department is cautiously optimistic regarding the reliability of these predictions and is seeking comparisons with field data collected from additional sites.

For more information, please see fdot.gov/research.