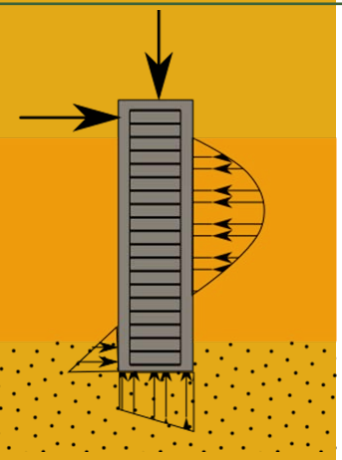
Performance of Drilled Shaft under Combination of Complicated Loads under Hurricane Event



Evaluates the performance of drilled shafts through expiremental study and numerical simulation

This study jointly uses experimental testing and numerical analysis to investigate the performance of drilled shafts subjected to combined lateral and vertical loads. The experimental study involves designing, building and testing drilled shafts in a large-scale facility, while the numerical study includes calibrating a numerical model and then utilizing it to assess the versatile vertical and lateral loading combinations.

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Background

Drilled shafts have been widely used to support transportation infrastructures, such as bridges and retaining walls. Usually, these drilled shafts are designed to sustain different loads, including vertical and lateral forces independently. Namely, it is assumed that the interactional effect between different loads are ignored. Studies have indicated that this assumption works reasonably well under normal service conditions under which only limited lateral deflection occurs. However, it is concerned that the interaction between lateral and vertical loads may be too significant to be neglected during a hurricane event. As a strong swirled wind, hurricane generates fast moving turbulent airflow with a velocity as high as 150 mph, leading to very high lateral forces. Combined with the vertical load on the structure, this lateral force may lead to a resultant force that has a line of action outside the footprint of the drilled shaft, which will significantly deteriorate its vertical capacity. Meanwhile, the lateral load will aslo be affected, since additional moments from the eccentricity of the vertical load will act as a secondary force for lateral movement. Such strong interaction will lead to non-recoverable movement and even collapse of structures if not appropriately addressed. The technical challenge of the problem lies in the plastoelastic behavior of soils, which makes the force-displacement relationship non-linear and cannot be analyzed by existing methods.

Project Summary

Given the missing information to permit a rational analysis and design that accounts for the interaction between vertical and lateral loads, this study shall focus on assessing how a vertically loaded drilled shaft performs when a sudden, high magnitude lateral load is applied. This scenario represents the drilled shafts supporting bridges are subjected to hurricane loads. The ultimate objective of this project is to quantify the effect of vertical loads on the lateral response of a drilled shaft during a hurricane event to allow a rational design and analysis of bridge foundation under hurricane events. The study includes two components: experimental study and numerical simulation. The technical phase encompasses a large-scale testing and numerical simulation to scrutinize the effect of vertical loads when a lateral load is applied thereafter, while the implementation is focused on incorporating the effect of vertical loads into existing p-y curves, which can be used to design and analyze drilled shaft accordingly.

Status Update

The team has calibrated a numerical model to assess the effect of lateral loading on the performance of a drilled shaft. It has been found that under repetitive lateral loading, the deflection of drilled shaft increases gradually and becomes stable after a number of cycles. An experimental testing assembly has been designed and will be built to test the drilled shaft soon.

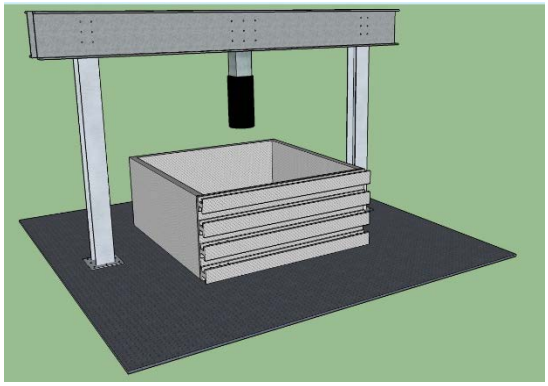

Figure 1. Schematic of experimental set-up to test performance of drilled shaft.

Impacts

Due to the climate change, extreme weather events have become more and more frequent. Addressing this issue in the design phase is necessary. This project will provide urgently needed information to address the safety and sustainability of critical transportation infrastructures, as drilled shafts are widely used to support bridges and retaining walls.

The objective of this study is alignment with the practice of local, state, and federal transportation authorities, and the study can be extended to embrace many drilled shaft configurations that will be investigated in this study. The overarching goal of the study will be developing an inclusive design guideline in the long run, which can be easily used in design.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

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