

# NHDOT SPR2 PROGRAM

## RESEARCH PROGRESS REPORT

<b>Project #</b> SPR 42372F		<b>Report Period</b> Year 2022 X Q1 (Jan-Mar) <input type="checkbox"/> Q2 (Apr-Jun) <input type="checkbox"/> Q3 (Jul-Sep) <input type="checkbox"/> Q4 (Oct-Dec)	
<b>Project Title:</b> Use of Drilling Parameters for Enhancing Geotechnical Site Investigations			
<b>Project Investigator:</b> Jean Benoit, PhD		<b>E-mail:</b> jean.benoit@unh.edu	
<b>Phone:</b>			
<b>Project Start Date:</b> May 05, 2021	<b>Project End Date:</b> August 31, 2023	<b>Project schedule status:</b> X On schedule <input type="checkbox"/> Ahead of schedule <input type="checkbox"/> Behind schedule	

### Brief Project Description:

The standard penetration test (SPT) is a proven tool widely used in providing disturbed soil samples to aid in geotechnical site characterization and estimating soil properties for the design of DOT projects. Testing and sampling are typically done at 5 to 10 feet intervals, and thus between these samples, the use of engineering judgment identifies changes in stratigraphy and the soil's respective properties. The results from these tests are used to develop recommendations and aid in designing the NHDOT Department projects. Continuously performing the SPT is time-consuming, labor-intensive, and not well-suited for many of the soils encountered in New Hampshire and cannot be used to characterize rock. Soils containing large particles such as gravel lead to poor sampling recovery and unreliable results. A technique known as Monitoring-While-Drilling (MWD) makes use of the mechanical response of the drill rig and cutting tools while advancing a borehole. MWD can be used to explore the subsurface in any geological conditions. With such data combined with SPT testing, a continuous quantitative drilling record is produced, and the correlated parameters can be applied more reliably to the design process. Additionally, data to objectively assess site variability is obtained. The drilling parameters collected can provide quality assurance for the soil classifications provided by incomplete testing and sampling exclusively performed by the SPT.

The objectives of this research are as follows:

1. Provide MWD as a tool for geotechnical site characterization to result in a more thorough and accurate representation of subsurface conditions leading to safer and more economical designs. The MWD is an underutilized tool in the process of site characterization for infrastructure projects and is recognized by the Federal Highway Administration EDC-5: Advanced Geotechnical Methods in Exploration (A-GaME) initiative:  
[https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_5/geotech\\_methods.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/geotech_methods.cfm)
2. Support more efficient use of design and construction resources and reduce the chance of delays due to unexpected subsurface conditions. This effort will contribute to the overall goal of improving the efficiency of the NHDOT by increasing the delivery time of subsurface conditions and decreasing the time it takes to complete.
3. Provide data to other efforts: a) depth of bedrock which is of interest to other parties for mapping efforts and water quality studies, b) rock properties and joint orientations to support rock slope stability efforts with the Smart Rock technology and, c) estimates of relative permeabilities to support efforts with the Permeafor.

### Scope of Work:

The proposed research will assess the use of MWD to be used on roadway and bridge foundation projects for the NHDOT. The scope of work includes the following tasks:

#### *Task 1- UNH MWD update:*

Update the existing UNH MWD system with the latest generation Lutz equipment. This will require the purchase of a new control and recording unit, junction box, and associated software.

#### *Task 2 – MWD installation:*

Install MWD system on one of the NHDOT drill rigs and perform an initial evaluation on a site with both soil and rock.

# NHDOT SPR2 PROGRAM

## RESEARCH PROGRESS REPORT

### *Task 3 – Torque sensor design:*

Design or purchase a torque sensor to be fitted to the mechanically driven drill rig operated by the NHDOT. This design will collaborate with the Montana DOT, the University of Florida, and the Jean Lutz company.

### *Task 4 – MWD testing:*

Using project sites determined with a NHDOT technical advisory group, drilling parameters recorded will be compared to measurements traditionally collected by SPT and the associated soil samples, along with rock cores for deep foundations. The following parameters will be collected: thrust on drilling tool, rotation rate, drilling fluid rate, advance rate, torque, fluid injection pressure, and drilling fluid return rate. In addition, other non-controlled parameters will be documented to include tool wear and changes in drilling fluid composition.

### *Task 5 – MWD data evaluation:*

MWD data obtained in conjunction with key NHDOT projects identified as high-risk projects will be evaluated to determine direct methods to correlate values to specific design parameters and be documented for use on future NHDOT projects.

### *Task 6 – Collaboration with other users:*

Collaborate with other DOT MWD users to develop a database of information for best practices for drilling under various soil and rock conditions.

### *Task 7- Final report:*

Provide a final report summarizing the research and recommendations for implementing the MWD in the everyday site and soil exploration. The information will be summarized to be included in the DOT Geotechnical Manual.

### **Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):**

An initial Technical Advisory Group (TAG) meeting was held over Zoom on June 16, 2021, at 10:30 am. The following items were discussed: 1) Review of the research program and implementation strategy; 2) Review of research needs; 3) Review of project.

Instead of updating the MWD system at the University of New Hampshire, a new MWD system was purchased from Jean Lutz and installed on the NHDOT drill rig in late May. Preliminary testing then followed the MWD installation in Merrimack on June 2. Since then, improvements have been made to improve the measurements. We have requested an amendment to our CPA to obtain a newly developed torque sensor by Jean Lutz which will be capable of measuring torque directly at the top of the drill string. It will also measure down pressure and rotation rate directly, all done wirelessly. This will facilitate the use of the MWD system in the field. More importantly the torque data is essential to the MWD measurements to properly characterize the in-place materials.

During the Summer and Fall, initial MWD tests were performed in Dover, NH, and Orford, NH. During these recent tests, NHDOT personnel have been trained in the use of the equipment so that they can start collecting drilling data in the field on all projects drilled with the MWD equipped drill rig. Maintenance required by the MWD drill rig did not allow additional testing to occur in the past quarter. However, future MWD testing in Newington during the month of April has been planned.

The results of these first tests are currently being analyzed in terms of drilling and compound parameters. The factors of highest interest in this data analysis include comparing the drilling data to Standard Penetration Test results and comparing the efficiency and effectiveness of the MWD in subsurface investigations. In addition, the effect of tool wear will also be investigated as more profiles are recorded.

A portable, hand drill has also been purchased in order to perform laboratory and field MWD measurements at shallow depths. This system will be used next Summer, and results will be compared to the conventional MWD system installed on the NHDOT drill rig.

In parallel, we have also been working on the MWD Users Group in collaboration with FHWA. The kickoff meeting took place on October 28, 2021, and the following meetings have been held on the third Wednesdays of each month. This has been an excellent opportunity to exchange experiences, analysis approaches and testing equipment, innovations, and standards with other users across the United States and worldwide, with nearly 100 participants in every meeting.

# NHDOT SPR2 PROGRAM

## RESEARCH PROGRESS REPORT

**Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc.):**

We need to modify the original CPA to include the purchase of the newly developed TICOR torque sensor essential to the success of this research effort. In addition, we need to collect more MWD data from daily drilling activities in the field, as well as any relevant additional testing results (SPT, grain size distribution, RQD, strength, etc.). The drill rig that the NHDOT is currently planning to purchase should also be equipped with the TICOR wireless torque sensor.

**Anticipated research next three (3) months:**

Anticipated work for the next quarter includes additional MWD tests in Newington, NH, at the beginning of April, as well as continue to perform data analysis and evaluation. Our collaboration with other users will also continue through the MWD Users Group.

**Circumstances affecting project:** None.

<b>Tasks (from Work Plan)</b>	<b>Planned % Complete</b>	<b>Actual % Complete</b>
<i>Task 1- UNH MWD update:</i>	100	100
<i>Task 2 – MWD installation:</i>	100	80
<i>Task 3 – Torque sensor design:</i>	10	10
<i>Task 4 – MWD testing:</i>	20	5
<i>Task 5 – MWD data evaluation:</i>	10	10
<i>Task 6 – Collaboration with other users:</i>	30	30
<i>Task 7- Final report:</i>	0	0

**Barriers or constraints to implementing research results** None.