

**State Transportation Innovation Council (STIC)  
Final Report on CPT Peer Exchange  
MDOT Job Number 210968NI  
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**Submitted by:**

Ryan Snook, P.E.  
Geotechnical Services Section  
Bureau of Bridges and Structures  
Michigan Department of Transportation  
8885 Ricks Road  
Lansing, Michigan 48083

**Description of Project:**

MDOT is implementing the EDC – 5 initiative: Advanced Geotechnical Methods in Exploration (A-GaME) to better define the geotechnical conditions for project sites, which reduces risks to project schedules and budgets. As part of the A-GaME initiative, MDOT has purchased, with the help of STIC funds in 2019, Cone Penetration Test (CPT) equipment. We have begun using the CPT on projects and are evaluating how the results from the CPT compare to our current methods of subsurface exploration and characterization. As we continue to collect CPT data, we have begun assessing, interpreting, and using the CPT data for the design of our transportation infrastructure. It is here that we realized a need for training by experienced CPT professionals on how to use the data in our everyday practice, since we have very little experience using CPT data for design and construction. As we continue to develop our process and procedures for when, where, and how the CPT can best be utilized, MDOT needs to pass along our lessons learned to local agencies and the consulting community. This way the advantages that CPT can offer are being implemented throughout Michigan. This CPT training/peer exchange was held at the MDOT Construction and Technology Building on June 14 and 15, 2023.

**Overall Budget:**

The overall budget for this project was \$50,000 and the final expenses were well under budget (\$14,622.17).

**How the Work Specifically Meets the Program Criteria:**

The overall goals of the program were as follows:

- How to properly collect, assess, interpret, and use CPT data.
- How to use CPT data for design of spread footings, deep foundations, slopes, etc.
- Peer exchange between MDOT, FHWA, Dr. Paul Mayne, local agencies, and geotechnical consultants.
- CPT demonstration.

- Recommendations on what applications and in what geological profiles that MDOT finds CPT useful in Michigan.
- Updated MDOT guidance documents.
- Potential CPT data presentation templates for design plans.

### **Results of the project:**

On June 14 and 15, 2023, training on cone penetration testing was provided by Dr. Paul Mayne, who is an international expert on cone penetration testing. Dr. Mayne provided two days of cone penetration testing, which included data collection through design. MDOT provided a demonstration of CPT testing with the MDOT-owned Vertek S4 sounding system. The peer exchange noted that the participants from MDOT, FHWA, and geotechnical consultants possessed very little knowledge of cone penetration testing. Local agencies were not included since all of the local agency geotechnical engineering is performed by geotechnical consultants. As such, MDOT was able to share the experience that we have so far with CPT testing:

- CPT is suitable for a wide variety of soil conditions. The exceptions would be where shallow rock or where numerous cobbles/boulders are present.
- CPT is well suited for delineating poor soil conditions, such as peat, marl, and very soft clay.
- This technology is well suited for identifying sand lenses/layers that would be missed with traditional soil penetration test sampling.
- Groundwater levels from both unconfined as well as confined aquifers have been identified well with the pore water pressure transducer.

Some of the challenges MDOT has identified so far were also shared with participants:

- CPT provides a soil behavior type, not a soil classification. These are not necessarily the same, and MDOT needs to further evaluate the ramifications from that. There is potential for construction claims from providing a soil behavior type vs. a soil classification.
- The soil behavior type will lump together peat, marl, and very soft clay in the same classification. Further research is needed and is ongoing.
- The shear strength of cohesive soils derived from CPT data needs to be evaluated for Michigan soils. Some models appear to be adequate at higher shear strengths. However, at the lower shear strengths, some of the correlations from CPT data may not be as accurate. Further research in this area is needed and is ongoing.

MDOT currently owns and operates a CPT sounding system manufactured by Vertek. Other than that, there is currently only one other CPT rig in Michigan, which is owned by Mateco Drilling. SME has retrofitted one of their drill rigs in Cleveland, Ohio to be able to push CPT. Any other CPT equipment that geotechnical consultants will need must be subcontracted out to companies that are from out of state, which has occurred on some of the larger projects. The general consensus to date has been that CPT is beneficial for projects.



Figure 1. Cone Penetration Testing Training at Construction and Technology Building, June 14, 2023.



Figure 2. Cone Penetration Test Demonstration at the Construction and Technology Building on June 15, 2023.



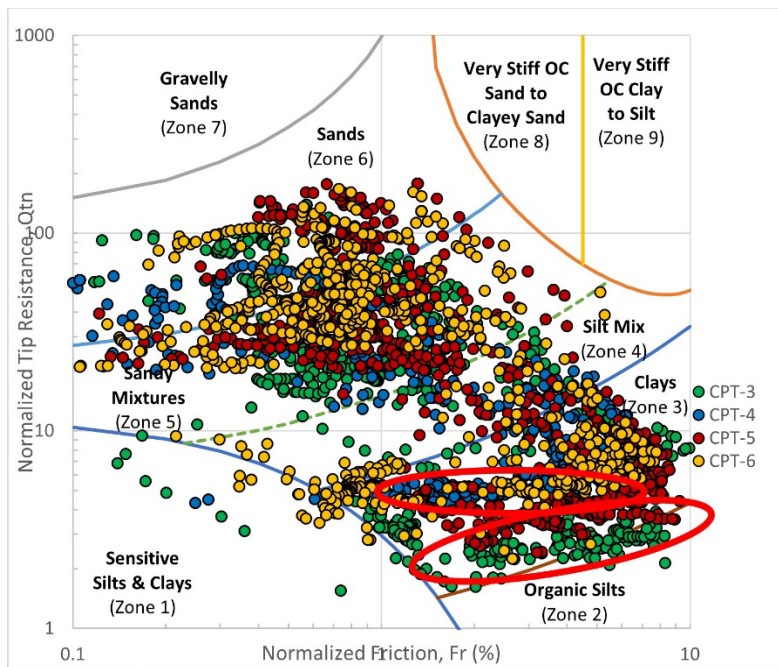


Figure 3. Example soil behavior type chart. The circled areas are where there have been issues with soil behavior type not matching soil classification.

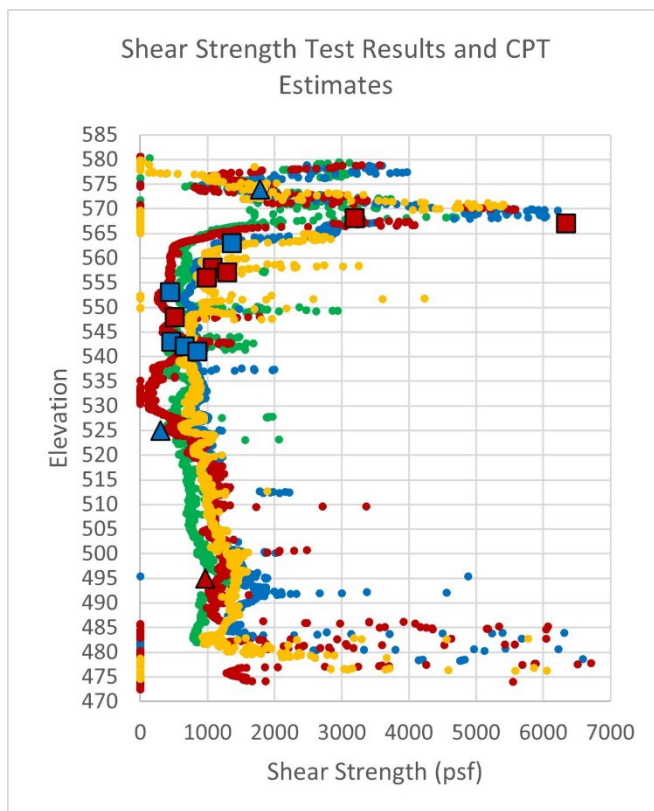


Figure 4. Example comparison between CPT data shear strength estimate (dots) vs lab testing data points (squares and triangles).

## **Future Goals:**

MDOT's goals for moving forward with Cone Penetration Testing are as follows:

- Continue to further evaluate how soil behavior type from CPT correlations compares to soil classification. Determine the best way of identifying poor soils (peat, marl, and very soft clay). This is being addressed in OR21-020 Michigan Cone Penetrometer Test Calibration, which is currently in progress.
- MDOT needs to evaluate the potential contractual issues with using soil behavior type versus soil classification. This has potential for affecting differing site condition claims. This should be discussed with MDOT Construction Field Services within the next six months.
- Continue to further evaluate the CPT correlations for shear strength of cohesive soil at low shear strengths (very soft to soft). This is being addressed in OR21-020 Michigan Cone Penetrometer Test Calibration, which is currently in progress.
- MDOT guidance documents currently allow the use of cone penetration testing with approval by the Geotechnical Services Section. However, guidance on how to use and present the data is needed. This is being developed as part of another ongoing research project. This is being addressed in OR21-020 Michigan Cone Penetrometer Test Calibration, which is currently in progress.
- CPT data presentation templates are needed. This is being developed as part of another ongoing research project. This has been complicated by a switch in software programs by Bentley. The current software (gINT) is being phased out and new software (OpenGround), is being rolled out. There has been roll out issues with OpenGround, which has slowed progress on this goal. This is being addressed in OR21-020 Michigan Cone Penetrometer Test Calibration, which is currently in progress.