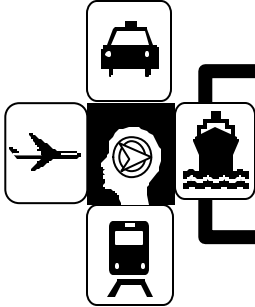


# JERSEY DOT'S

"Turning Problems into Solutions"



## Tech Brief

### Evaluation of Geotechnical Design Parameters Using the Seismic Piezocone (SCPTU)

FHWA-NJ-2001-032-TB

January 2002

SO, HERE'S THE PROBLEM...

- Site investigation is needed for almost all NJDOT related construction/reconstruction projects
- Typical practice is to use a drilling method (i.e. the Standard Penetration Test) for both soil classification and the determination of design parameters using the blowcount (N-value)
- Blowcount values have been found to vary due to the energy applied to the system. The applied energy is influenced by both the equipment and operator procedures
- Also, to conduct more advanced site characterization tests, such as seismic crosshole or downhole, after the Standard Penetration Test is conducted, casings must be installed and grouted around, adding further costs from materials and time.

AND, HERE'S OUR SOLUTION

- Utilize a fast and accurate device that can determine soil classification on a continuous profile, as well as determine the commonly used blowcount value
- Evaluate the accuracy of the device for soil classification and its ability to determine blowcounts
- The device must also be of some type of hybrid test equipment so seismic testing could also be conducted

We set out to evaluate the seismic piezocone's (SCPTU) ability to classify soil on a continuous profile, determine SPT blowcounts, and also evaluate its ability to be used as a means of determining shear wave velocity. SCPTU testing was carried out at a number of sites across New Jersey where current site investigations were on-going. This allowed for a direct comparison between SCPTU and laboratory results, as well as other field testing procedures, such as seismic crosshole and downhole testing.

HERE'S WHAT IT LOOKS LIKE... AIN'T IT A BEAUTY!!!



Figure 1 – Different Cone Penetrometers Used for Site Investigation

In the cone penetration test (CPT), a cone (Figure 1) on the end of a series of rods is pushed into the ground at a constant rate and continuous measurements are made of the resistance to penetration of the cone. Measurements are also made on the outer surface of a surface sleeve and also to pore water pressure that is generated during the pushing of the cone (Figure 2).

The seismic piezocone is the standard pore pressure measuring cone penetrometer modified to house a seismometer (Figure 3). The testing procedure is very similar to the downhole test, however, the pseudo-depth interval method is used to determine the shear wave velocity. The pseudo-interval method is determining the arrival time of the shear at depth  $x$ , then penetrate the penetrometer to depth  $y$  and again determine the shear wave arrival time. The distance between  $x$  and  $y$  is divided by the difference in time from  $x$  to  $y$  to determine the shear wave velocity (ft/sec or m/sec).

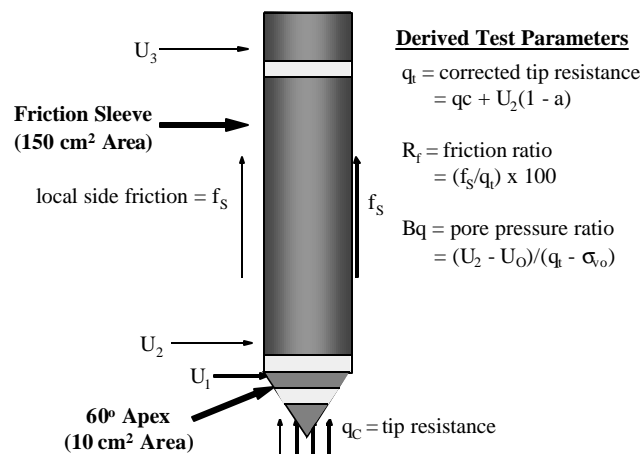


Figure 2 – Parameters Measured During the Cone Penetration Test

## THIS IS WHAT IT CAN DO

- 1) Provide fast, accurate and continuous data that is used to determine soil classification and also geotechnical design parameters, such as the Standard Penetration Test blowcount.
- 2) With a minimal amount of down time, the penetration can be stopped and a seismic downhole test can be conducted to determine the shear wave velocity. Also, correlations exist that can predict the shear wave velocity of the soil solely based on the SCPTU penetration data.

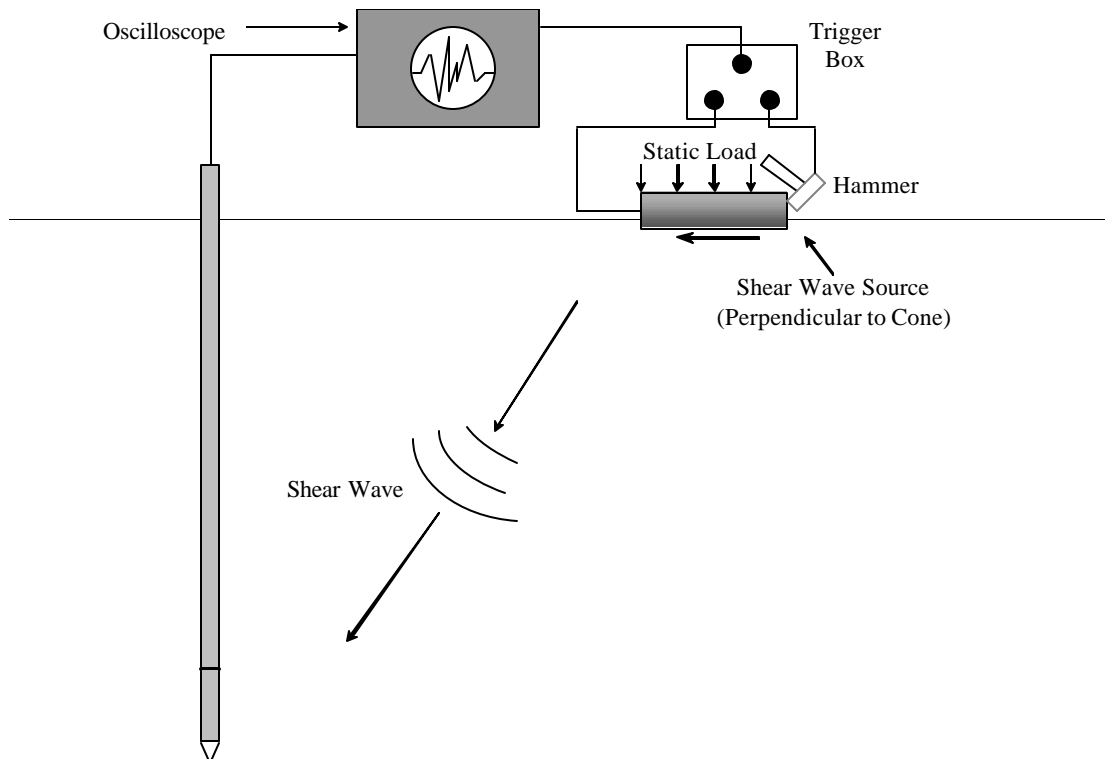


Figure 3 – Conducting the Seismic Piezocone Test

## ***HERE'S WHAT WE CAME UP WITH...***

SCPTU testing was carried out at a number of sites across New Jersey where current site investigations were on-going. This allowed for a direct comparison between SCTPU and laboratory results, as well as other field testing procedures. Results of the testing show that the device is in good agreement with laboratory soil classification procedures in identifying sands, clays, and silts; accurate over 80% of the time. Most discrepancies were due to the device not being able to differentiate between silty sand or sand with silt. However, this is something that even the most experienced drillers/inspectors would need laboratory testing to determine.

Comparisons between measured SPT N-values and estimated values show average to good agreement (Figure 4). The measured N-values must be corrected for the applied energy to the system, which is based on both the equipment and operator procedures. The disparity is most likely due to the lack of consistency of applied energy, which is typical of the measured SPT N-value by the drill rig operator.

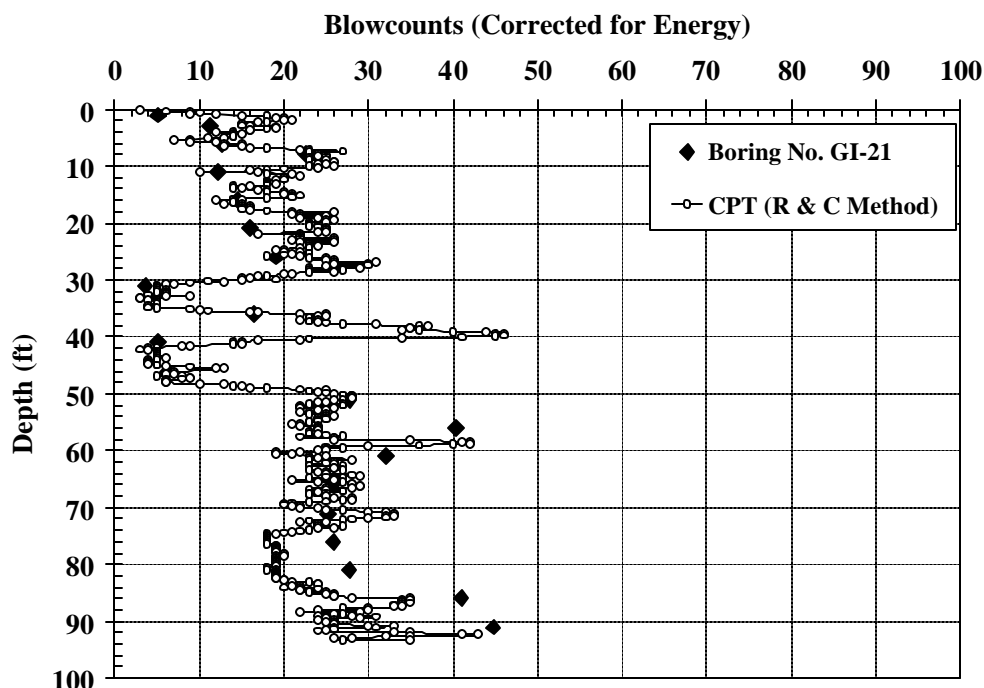


Figure 4 – Comparison of the Standard Penetration Test and the CPT Correlations

The SCPTU was also used as a seismic tool and compared to traditional seismic testing procedures (downhole and crosshole) testing. The results showed that there was extremely good agreement between the traditional downhole testing and the SCPTU measured values. However, only average agreement was shown with the traditional crosshole method. This is most likely due to differences in wave propagation. Correlations used to determine shear wave velocity from the CPT data showed excellent agreement (Figure 5), as long as the correlations were used for their respective soil type (i.e. clay or sand).

### **THE BOTTOM LINE...**

The seismic piezocone (SCPTU) was evaluated to determine its ability to 1) classify soil, 2) determine blowcounts, and 3) be used as a seismic evaluation tool. All three abilities were proven using a number of test sites across New Jersey and parts of New York. For optimal site characterization, it is recommended to first conduct the cone penetration test and then come back later to sample it needed. The CPT would provide a continuous soil profile decisions could be made as whether to sample troubled layers. The CPT data could also be used to determine design parameters, such as SPT blowocount.

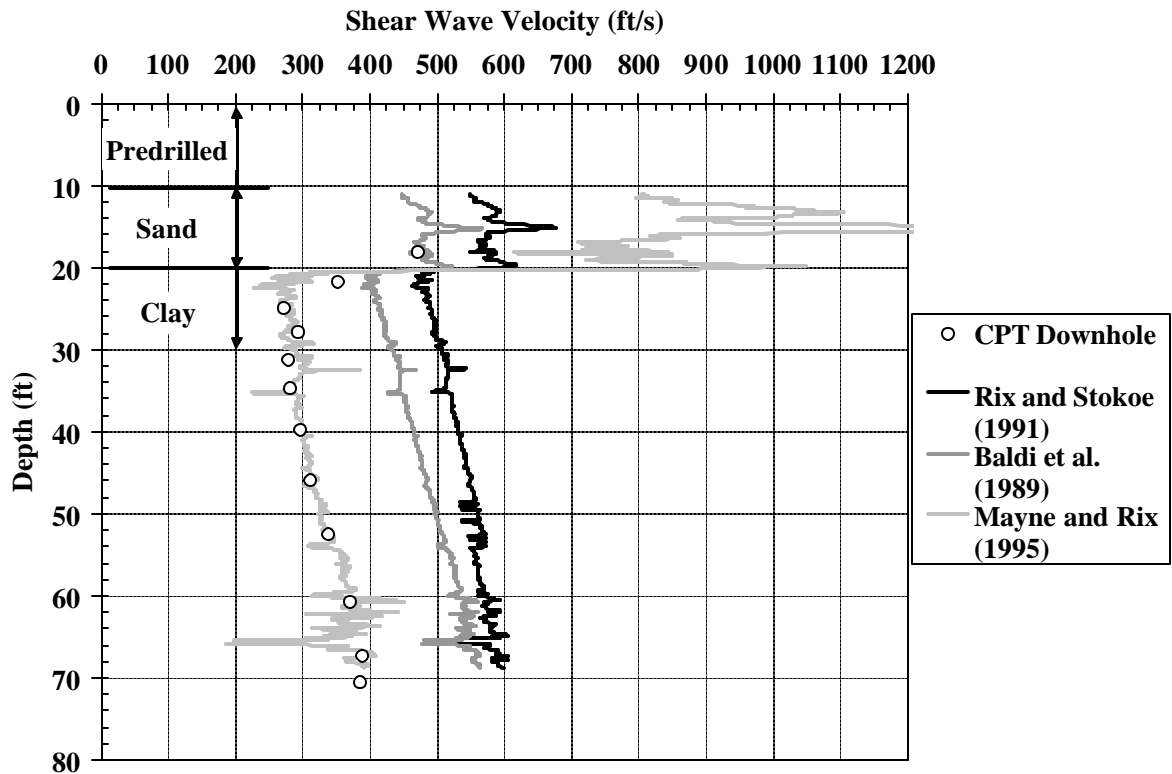


Figure 5 – Measured Shear Wave Velocity Compared to CPT Correlated Values

While this study illustrated that the SCPTU can be a valuable tool in determining the soil classification, blowcounts, and shear wave velocity, it should be noted that there are other parameters that can be determined and should be further evaluated:

- strength properties of soils (friction angle for sands and undrained shear strength for fine-grained soils)
- consolidation and permeability properties of fine-grained soils
- use of the device for direct design procedures, such as pile and wick drain design

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A final report is available online at  
<http://www.state.nj.us/transportation/research/research.html>

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to [Research.Bureau@dot.state.nj.us](mailto:Research.Bureau@dot.state.nj.us) and ask for:

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