Cone Penetration Testing COMES OF AGE

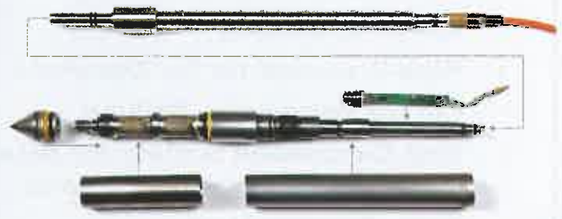
By Kevin Ewing

Since the recent earthquakes in New Zealand, CPT (Cone Penetration Testing) has become a more well-known method for obtaining accurate foundation engineering geotechnical information in building construction.

In its simplest form, CPT consists of pushing a conical shaped tool into the ground and measuring the resistance. These tests are especially good to locate the presence of clay, peat, sand etc. in the subsoil.

Most of the work originated in Holland: the original primitive tests were from essentially pushing a 'stick' into the ground to find the soft/hard layers. But with progress, buildings became relatively larger and more sophistication was needed. The 'modern' method is an off shoot of construction techniques, used several hundred years ago, driving (timber) piles in the Netherlands. The driving depth was calculated while the pile was being driven. Later, simple pile driving formulae were developed from the empirical data that had been collected. This then enabled the engineer to calculate the relation between driving depth and bearing capacity of the pile. If any of you have been to Amsterdam, and seen some of the odd angles of the seventeenth and eighteenth century buildings, you will understand why this information is so important to the Dutch.

It wasn't until the 1930s that Professor Barentsen - working at the Delft University in Holland (hence the alternate name Dutch Cone Test) - developed the modern CPT method. His groundbreaking work then enabled the pile length and bearing capacity to be determined prior to the pile installation. With the continuing more modern trend for larger structures, a better and more accurate understanding of foundations and the subsoil was required. The rapid development after 1945 was substantial and included the introduction of electronic measurements. Tooling changed to gather more information from a single cone. Sometimes it is written as CPTU, where the U is to indicate the equipment can do piezometer measurements and other tests followed. The interpretation of the CPT readings to predict load capacity of foundation piles replaced the old pile driving formulae completely, as well as the need to drive test piles. I understand that the methodology is so good, the Dutch now consider it intolerable to design a pile foundation without having sufficient CPT information. The technique was officially standardised in 1986 by ASTM International (American Society for Testing and Materials) as a recognised testing method.



Today, CPT is primarily used for:

- The determination of the sub soil and homogeneity of the in-situ ground
- Depth of firm strata and analysis of sub soil variation
- The recognition of the soil types
- Mechanical properties of the different strata
- Pile bearing capacity

With the advent of newer tooling the CPT methods can be used measure:

- Soil liquefaction
- Water Pressure information
- Vibratory load capacity
- Soil conductivity
- The location of unexploded ordinance (important in Europe)
- Some environmental information.

The 'modern' machines have developed from the early rack and pinion, either earth anchored to the ground, or weighted to give the reactive force to (and although there are small machines for difficult sites) the more modern truck or track machines we see today weighing between 15 and 25 tonnes. And while most of us will have seen a land based machine, specially designed units are able to work off shore in water depths of up to 4,000m.

Modern systems work with the aid of hydraulic cylinders pushing the specially shaped CPT cone into the ground at a constant (2cm per second) speed. The cone information is fed back to a computer, the data recorded and interpreted accordingly. Depending on what is required, different cones are used or a single cone is extended by adding modules to measure the various parameters.

Advantages for using CPTs over others sampling methods include:

- Continuous or almost continuous data generation
- Repeatable and reliable test data
- Real-time data generation
- Multiple parameters with one test
- High productivity compared to other methods
- No direct contact with the material being tested (contaminated soils)
- Lower operational costs compared to alternatives like SPT and sampling

Disadvantage in using CPT include:

- The initial investment is high compared to SPT (Standard Penetration test) and others
- A new skill set is required
- Maintaining/calibrating the tooling (depending on the use) can add to the operating costs

Due to structures being larger and located on what was once considered marginal ground, I can only see civil engineering using CPTs more often because they provide accurate information; and real-time data. In addition, new tooling is being developed for more information per test; and the OHS responsibilities of both the contractor and the engineer-consultant are fewer.

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