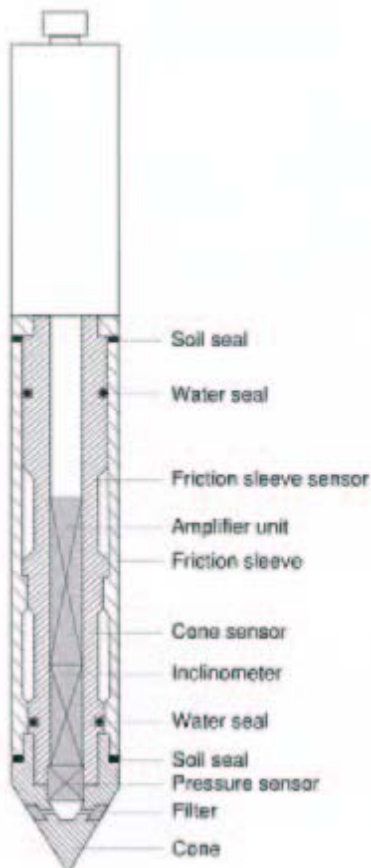
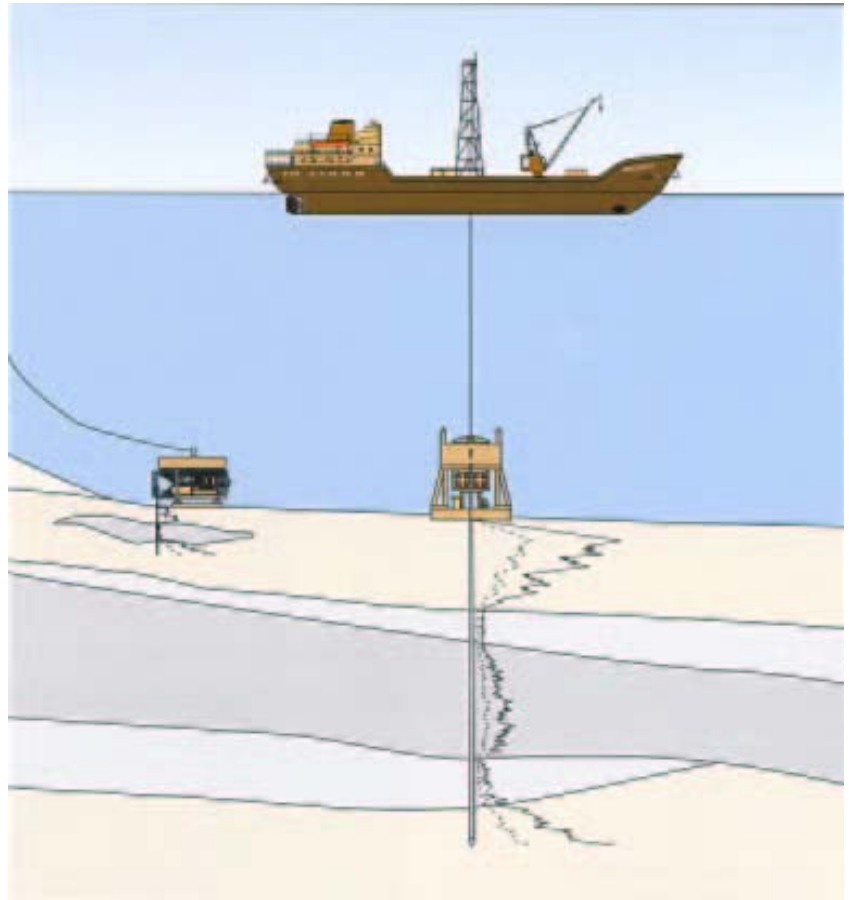


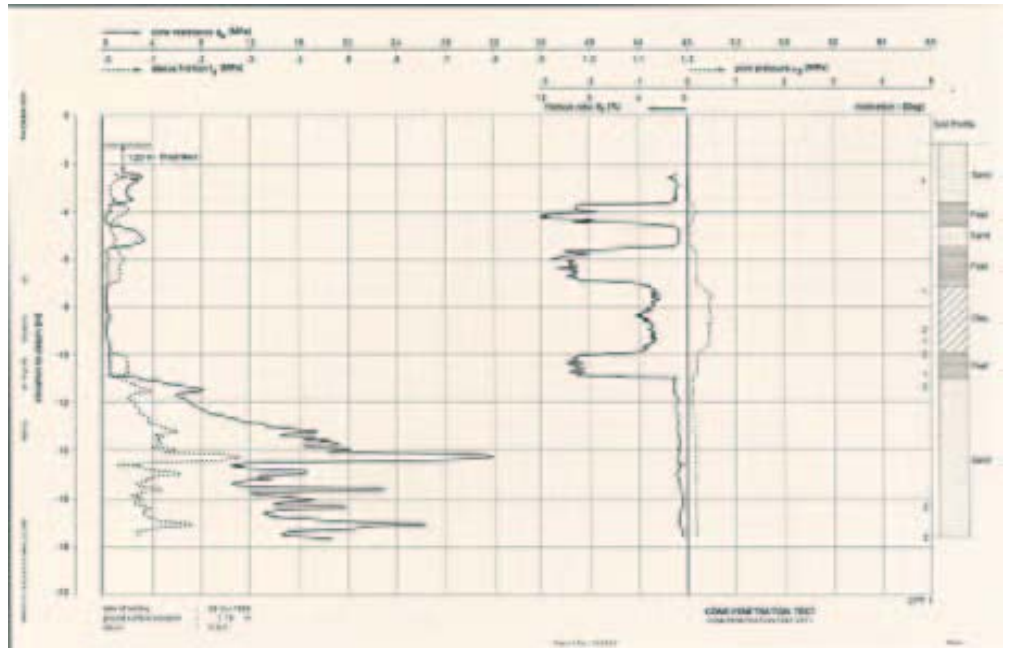
ELECTRIC CONE PENETRATION TEST



Since 1964 Fugro have successfully developed and modified the electric cone penetration as an in-situ testing techniques for use in site investigations. The cone penetrometer forms the basis of a variety of tools and equipment used by Fugro for soil surveys both onshore and offshore. The electric cone penetrometer supersedes the mechanical cone penetrometer, such as the Delft or Begemann types. It offers a number of advantages: namely that continuous and direct recording of cone resistance, sleeve friction and pore pressure is obtained with a high degree of resolution, accuracy and reliability. The method whether employed onshore or offshore provides a fast and efficient investigation technique.



The operational technique to perform cone penetration tests (CPT) is basically similar for the various types of penetrometers. Penetration is achieved by a hydraulic jacking system while the cone resistance is measured by means of electrical strain gauges located inside the cone penetrometer. The electrical signals are transmitted via a cable to a data acquisition unit in the operations control unit. Data are stored on magnetic media and simultaneously graphically displayed on a computer.



3

Some of the most important and widely used application of the system is stratigraphic profiling, since an accurate knowledge of soil layering is essential to any geotechnical study. The continuous penetration record together with the high resolution (logging rate of 1 Hz) means that thin layers can be identified which might be missed using conventional investigation methods. Because of the speed of operation of the testing system, the data can be acquired both quickly and economically. In addition, cone penetration test results can be used to indicate the optimum locations of boreholes and the most suitable depths for taking undisturbed samples.



4

Extensive research has indicated that that ratio of sleeve friction and of pore pressure to cone resistance (Friction resp. Pore pressure Ratio) assists greatly in identifying soil type. These ratios vary, depending upon whether it applies to cohesive or granular soils. Therefore it is possible to interpret soil type as a function of cone resistance and the ratios. In addition, empirical relationships have been established between cone resistance and other in-situ soil properties. These include

undrained shear strength of cohesive soils and relative density of cohesion less soils. Similarly, direct empirical correlations have been developed between cone penetration test data and foundation design parameters such as friction and end bearing of piles.

3 Results obtained using the piezocone penetrometer at an onshore site

4 Truck-mounted CPT unit at Amsterdam Airport

To enable tests to be performed in the wide variety of soils and soft rocks encountered in site investigations, Fugro has developed a range of electric cone penetrometers:

- 150 kN capacity, generally for use in very dense granular soils/soft rocks
- 100 kN capacity, generally used in dense granular soils
- 50 kN capacity, for use in clayey soils and medium dense granular soils

For readings in soft and very soft soils above cone penetrometers can be fitted with sensitive electronics for highest resolutions. Other special sizes have been built to fit non-standard areas of applications. In addition cone penetrometers have been developed for special in-situ measurements and include:

- Pore water pressure measurements using piezo-electric transducers built into the cone penetrometer (PCPT). The piezo-cone penetrometer allows measurement of the pore pressures generated during penetration and the dissipation of this pressure while the cone is stationary.
- Shear wave measurements using a dual array seismic piezo-cone penetrometer, allowing the measurement of the dynamic shear modulus, G_{max} (SCPT)
- Electrical resistivity (conductivity) measurements (ECPT)
- Soil temperature measurements.



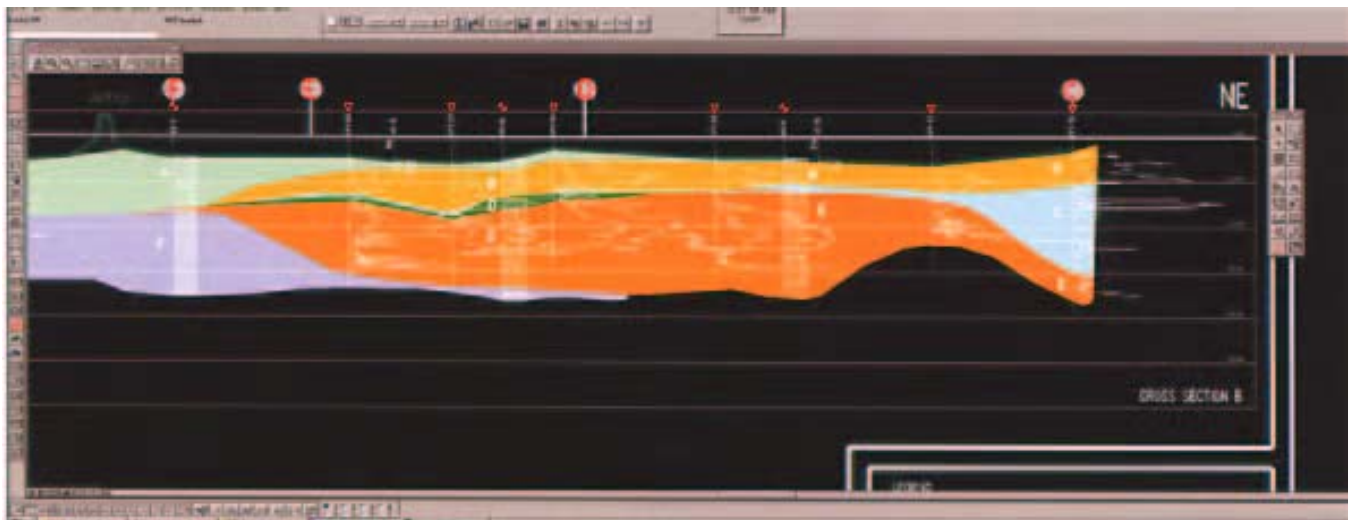
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Other probes include:

- Heat flow: soil temperature and conductivity
- Pressuremeter testing combined with a cone penetrometer (CPMT)
- Hydrocarbon detection systems.

5 Selection of cone penetrometers

6 Interpretive cross section



6

All cone penetrometers are calibrated in the Fugro laboratory and regular checks on performance are made in the field prior and after testing.

Fugro has incorporated electric cone penetrometer equipment into a variety of operational units to suit the required depth of investigation and terrain conditions:

- CPT trucks and rigs of various sizes (1.5 kN-300 kN)
- Sensitive apparatus for investigations in very soft soils
- A variety of vehicles/craft ranging from all-terrain vehicles for sites with poor accessibility to floating craft for inland waterways, coastal waters etc.
- Wireline cone penetration test system (WISON) for use from the bottom of a borehole either on land or offshore, in water depths up to 650 m.
- Remote cone penetration test system (DOLPHIN and WISON XP) for use from the bottom of a borehole either on land or offshore, for water depths up to 2000 m
- Remote controlled cone penetration test systems (SEABED WISON, SEASCOUT, WHEELDRIVE SEACALF, STARFISH, SEASPRITE) for performing tests from the seabed in water depths up to 600 m.
- A ballasted tower system for performing tests from the seabed in shallow water



7 SEASCOUT seabed cone penetration test system

8 Quality control of electric cone load cell before final assembly

Cone penetration tests performed by Fugro are carried out in general accordance with standards, such as those published by the American Society for Testing and Materials (ASTM), the British Standards Institute (BSI), and the International Society for Soil Mechanics and Foundation Engineering.

The specification of the equipment in this data sheet may be subjected to modifications without prior notice.

Fugro Singapore Pte Ltd

159 Sin Ming Road
 #06-07 Amtech Building
 Singapore 575625
 Tel: (65) 65528600, Fax: (65) 65528900/65528911
 E-mail: fsininfo@fugro.nl; www.fugro-singapore.com.sg

Fugro Engineers B.V.

10 Veurse Achterweg
 P.O. Box 250, 2260 AG Leidschendam
 The Netherlands
 Tel: 31-70-3111444, Fax: 31-70-3203640
 E-mail: febinfo@fugro.nl; www.fugro.com

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