Dolphin In Situ Sampling and Testing System

An inexpensive and reliable method for geotechnical data acquisition.

A Versatile Geotechnical Solution

Cost effective design of offshore foundations requires high quality samples and in situ geotechnical test data. The Dolphin system offers a simple wireline method for acquiring this information in water depths up to 3,000 meters or more. The Dolphin system provides: Cone penetrometer data, vane shear data, high-quality piston samples, push samples, hydraulic fracture test data, and temperature data. The Dolphin is a remotely operated system of downhole geotechnical tools.

Capabilities:

• Versatile deployment from most types of drilling spreads
• Remote wireline data gathering
• Mobilization by land, sea or air transport
• Reliability and reduced operating time
• Quick interchangeability of sampling/testing components
• Quick turnaround of test results onsite

Method of Deployment

Sampling or in situ testing tools either free-fall or are lowered down the drill pipe; retrieval requires only an overshot on a sand line. Tools that require controlled thrust for operation, such as the cone penetrometer and piston sampler, use a shear pin system powered by mud pressure. Vane testing and push sampling do not require controlled thrust for operation. The system is compact and transportable by air freight for quick mobilization. It can be used with essentially any drill rig suitable for geotechnical site investigations, including large rigs normally used for oil exploration.
Cone Penetrometer Testing (CPT) and Piezocone Penetrometer Testing (PCPT) are excellent methods for obtaining soil property information for most soil types. In addition, these techniques allow extremely detailed profiling to be accomplished. The cone penetrometer probe contains load cells which measure the compressive force on the tip of the probe and the frictional force over a known cylindrical area along the side of the probe. The Piezocone also allows the measurement of pore water pressure during probe penetration.

Fugro’s CPT/PCPT is a component of its Dolphin In Situ Sampling and Testing System. To conduct a test, the unit is lowered into the drill pipe until it reaches the Bottomhole Assembly (BHA). Mud pressure is then applied to the drillstring and the flow-rate controlled shear pin system pushes the cone penetrometer into the soil at the ASTM standard rate of 2 cm/sec. The stroke length is 3.0m or until refusal is met. During the push, the Dolphin Remote Memory collects and stores pertinent data from the test. Upon test completion, the CPT unit is recovered using an overshot and wireline. Once on deck, data is transferred from the Remote Memory Unit (RMU to a PC for processing and display.

Information which can be obtained from CPT/PCPT tests include:

- detailed stratigraphy
- soil type
- undrained shear strength (in clays)
- relative density (in sands and silts)
In situ testing of cohesive soils is accomplished using the Remote Vane Shear device. Use of this technique mitigates the mechanical disturbance effects of sampling and also the stress relief experienced from recovering soil samples from great depths. In situ vane testing is also an excellent means to measure the shear strength of very soft cohesive soils near the seafloor and highly underconsolidated soils such as delta deposits.

Fugro’s Remote Vane is a component of its Dolphin In Situ Sampling and Testing System. To measure the shear strength of clays, the vane is inserted into the soil and then rotated at a speed of 15°/min as per ASTM. The torque is measured during rotation by a torque transducer, and the data is stored in the Remote Memory Unit (RMU). A vane constant, derived from the area of the sheared cylinder, is applied to the torque measurement to produce the undrained shear strength of the soil.

The Remove Vane Shear tool can be used downhole as well as mounted to a seafloor-resting template. The latter, nicknamed the Halibut, is useful for obtaining shear strength profiles at 2-ft intervals to a penetration down to 28 feet below the seafloor.
Technical Information

Dolphin provides sophisticated data but remains simple to operate. Cone penetrometer testing is performed as follows:

1. The data acquisition system is pre-programmed on deck.
2. The tool either free-falls or is lowered down the drill pipe and lands in the thruster unit.
3. Tool penetration is started by increasing mud pressure.
4. The test is terminated when the mud pressure reaches a pre-determined level.
5. An overshot retrieves the tool using a high speed winch.
6. Test data is transferred on deck to a personal computer.

The procedure for piston sampling operations is similar. Remote vane testing and push sampling do not require pressurizing of the drill string.

Data Acquisition

In situ test data is digitally recorded by the Remote Memory Unit. Once Dolphin has been retrieved, the data is processed by onboard computers. Preliminary data is plotted within minutes after completing a test.

Onboard Requirements

Electrical
- 220/240v or 110v
- 50 or 60 Hz

Drill Pipe
- 114 or 127mm (4.5 or 5-in) IF API
- 97mm (3.8-in) ID minimum

Mud System Pressure
- 11.0 MPa (1600 psi) maximum auxiliary mud pump available for small rig applications

Drill Rig
- Conventional drill rig on semi, jack-up, etc.
- Adaptable to most skid-mounted rig systems

Motion Compensation*
- Use either existing system onboard drill vessel or available bolt-on system

Deck Requirements
- Any sheltered work space 3.7m x 3.7m (12 ft x 12 ft)

Handling
- Sand line retrievable with 26.7 kN (6000-lb) force

Reaction Mass*
- Jaw system adaptable to temporary guide base or complete system may be fabricated at site
*Not required for Remote Vane or push sampler

Equipment Specification

Vane Rotation
- 15 ±3 degrees per minute, 34 N-m (300 in-lb) maximum torque

Thrust
- 80 kN (18,000 lb)

Samples
- 76mm (3 in) diameter, 0.6 or 1m (24 or 39 in) long

Water Depth
- 3000m (9,800 ft)

Tool Selection
- Cone Penetrometer (CPT)
- Piezocone Penetrometer (PCPT)
- Remote Vane Shear (downhole and template-mounted)
- Plezoprobe
- Temperature Probe
- Piston Sampler
- Piston Liner Sampler
- Push Sampler