Riding with the tide

A geotechnical driller in deep water takes advantage of a combination of diamond coring and sonic drilling

When substrates need to be characterised in an underwater marine environment, several challenges can emerge versus a more traditional geotechnical project.

First, the soils can change dramatically from the mudline down to bedrock. Additionally, tidal fluctuations complicate the water depth and the depth to which soils and bedrock need to be tested.

However, when soil and bedrock near Prince Rupert in British Columbia, Canada, required investigation for a liquefied natural gas (LNG) marine terminal, Mud Bay Drilling adapted a Terra Sonic diamond coring option to its sonic rig.

According to Gordon Gibbons, Mud Bay president, "the water depths at the work site ranged from 15m to 67m, with 7m of tidal fluctuations over a 24-hour period. The scope of work entailed continuous sonic soil sampling with geotechnical sampling (Shelby piston samples, standard penetration test and cone penetration test in-situ soils investigations) utilising a sonic drill rig mounted on a rubber-tracked carrier".

The plan was to characterise the soils below the mudline using sonic drilling, then switch to HQ diamond coring for the bedrock.

To avoid having to remove the sonic rig from the barge and replace it with a diamond coring rig, a cost-savings component to the plan was to adapt Terra Sonic's diamond coring option to the sonic rig. Before the project began, the diamond coring option was installed at the client's shop location in Surrey, British Columbia. All hydraulic hose connections and quick coupled hydraulic connections were tested at that time. This preparatory work enabled an installation in 15-20 minutes at the project site, and coring began immediately.

PROJECT PROGRESSION

Since no previous drilling was carried out in this area of the Prince Rupert marine environment, bathymetric surveys (marine equivalent to topography) were used to estimate what might exist below the mudline.

To add to the uncertainty, logging operations had existed in the area for over a century, so there was a strong likelihood of drilling into logs, steel cables or sunken boats.

With a plan in place, work began with the sonic drill head. Sonic coring was conducted at depths greater than 200ft (61m) below the mudline. Before bedrock was encountered, where the substrate was not as hard and the wear and tear on the equipment would not be as great, sonic technology was used. Once bedrock was reached, the sonic drill was used to either prove the bedrock, or the diamond coring option was used to HQ core at 10-15m into the rock.

The sonic and diamond coring work resulted in valuable data despite the challenges of the marine environment. It was then decided to expand the initial scope of five holes to ten. The barge company, with its experienced crews, also helped the job go smoothly.

IN COMBINATION

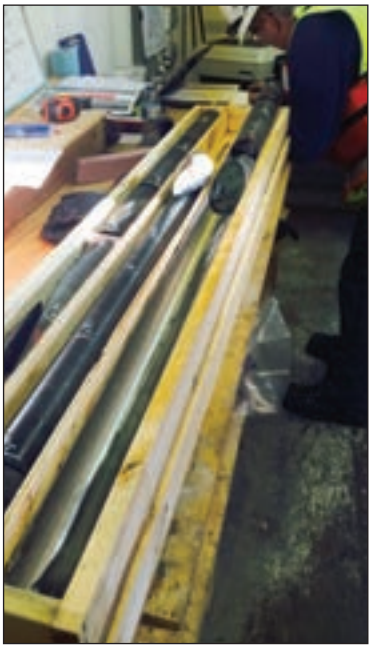
The Prince Rupert project offered a suitable opportunity for combining sonic drilling and Terra Sonic's diamond coring capabilities. The diamond coring option was best suited for extracting the hard rock cores at greater depths, and unlike speed multipliers used to increase rpm of the sonic head rotation, it consists of a dual-speed motor that operates in the 0-600rpm range with 1,623ft-lb (2,200N-m) of continuous torque and 0-1,000rpm with 811ft-lb (1,100N-m) of continuous torque. When used with a Terra Sonic International sonic drill rig, the coring option also includes a frequency control dial that can be used to fine-tune the rpm of the dual-speed motor.

The Terra Sonic International coring head

Sonic drilling is incerasingly becoming the methodology of choice for soil characterisation. There are several reasons for this growing trend. ►

First, sonic drilling is fast. Depending on the formation, the sonic method can be two to three times faster than conventional drilling. This increased speed is because of the sustained vibratory energy that lies at the heart of the technology. The fluidisation of the soil around the drill bit reduces the amount of friction and thus maximises the speed at which drilling occurs.

A second advantage of sonic drilling over conventional methods is the ability to create continuous core samples. Again, this can in part be attributed to the fluidisation of the soil it creates. Once the formation is fluidised, the sonic drill can pass easily through the substrate and provide a nearly in-situ core sample.



Finally, sonic drilling is advantageous because it increases safety and efficiency. It reduces the amount of investigative derived waste (IDW) by around 80% compared to conventional drilling methods. This not only creates fewer opportunities for accidents, but it also reduces time required for materials handling and associated disposal costs, as well as environmental impact and permitting issues.

Terra Sonic International states that by using its sonic drill rigs there will be fewer equipment breakdown issues, fewer incomplete or defective core samples, and fewer boreholes that fail to meet specifications. The rigs' design also reduces the number of drillers needed for each project, and the flat platform on the rig creates a sturdy, stable foundation on which the drillers can stand and work.

All told, the combination of sonic technology with the diamond coring option worked well for this project. Gibbons notes: "Everything worked very well and the client was pleased. Good geotechnical soil and rock information was retrieved, and the drilling set-up was efficient, even in the challenging marine tidal fluctuations and water depths."

Left: core samples obtained from the bedrock beneath the mudline