GEMS

The GEMS Group was founded in 2003 by Andrew Wright and was formely known as the hydrographic department of Decloet (Dec), Silt and Medida. GEMS (Geotechnical Engineering and Marine Surveys) is an independent survey company with its headquarters based in Belgium. The group has expanded rapidly around the globe, opening offices in the UK (Bath and Devizes), Nigeria (Lagos), Egypt (Giza) and the United Arab Emirates (Abu Dhabi).<P>

Currently, GEMS offers a broad range of services, such as geophysical surveys, all types of bathymetric surveys, cable and pipeline route surveys, offshore windfarm site surveys, posÂitioning, mapping and charting, envirÂonmental and oceanographic survey services, and geotechnical operations (web reference 1).

The main clients, based around the globe, include gas and oil companÂies, dredging companies, and port and waterway authorities. In addition, GEMS has a specialist division that provides surveys of the United Nations Convention on Law of the Seas (UNCLOS) continental margin and extended boundary exclusive economic zone.

GEMS operate their own fleet of vessels and are committed to delivering projects to the highest possible standards. GEMS has achieved ISO 9001 accreditation.
In terms of long-term survey serÂvice contracts around the world, the situation at Zeebrugge port is unique as GEMS has been offering a competitive service to the Flemish community, which is part of the Belgian Government, since 1984. During this period, GEMS has become a leading expert on dealing with dredged materials when offering hydrographic and oceanographic survey services to ports and harbours. GEMS has transformed itself from a traditional survey company into an industry leader and innovative service provider.

The port of Zeebrugge is located on the coast of Belgium and is a very important port for the European Community in terms of cars, fruit, and paper. In order to offer safety to the vessels in the access channels and in the port, a minimum margin (the "keel clearance") between the hull and seabed has to be taken into account. This is more complex with a fluid mud bottom. For example, detecting water depth is easy with hard seabed conditions, but in the case of dealing with cohesive sediment (as in the port of Zeebrugge), specific tools and expert opinion are required.

Many ports around the world have a similar problem to Zeebrugge with suspended material: as the material is transported down the rivers or brought in from the sea, it arrives as suspended material and then consolidates at a rapid tempo. The consolidated material can act as a whole (cohesive sediment), moving over the hard bottom. A continuous behaviour of sedimentation and re-suspension makes it even more complex. When dealing with both river water and seawater, the flocculation of suspended material increases the amount of consolidation.

The suspended particles consist of fine sand, clay, silt (mainly quartz) and organic material. The mixture of these suspended and consolidated components results in very complex behaviour. Up to a certain concentration, the suspended material can rheologically be observed as a Newtonian fluid. As the material gets more dense during sedimentation and consolidation, it becomes a dense cohesive sediment. Within this cohesive sediment, inter-particle forces start to play and the material rheology differs from the Newtonian fluid. The sediment (when containing mainly clay) starts to behave as a thixotropic 'non-ideal Bingham fluid' with a true yield stress (Toorman,1997).

Because of the complexity of rheological behaviour, GEMS does not only need to collect information at a detected water depth, but also on sediment characteristics. The top of the waterbed is detected with an area-covering technique, namely multi-beam echosounding. The area is then surveyed with a dual-frequency echosounder (with a high frequency around 200kHz and a low frequency around 33kHz), providing information on the cross section, showing the soft top and hard bottom of the sediment package.

Both types of systems must be used to collect the data because the recorded depth of a seabed can easily vary caused by changing weather conditions, increasing sediment input or re-suspension (erosion).

The high frequency of the echosounder is influenced in the same way as a multi-beam system and will record water depth by reflection of the beams on top of the 'fluid mud'. The 33kHz echosounder beam will reflect on an impedance (density) contrast between two layers, which should indicate the depth of highly consolidated sediment or the seabed.

In shallow areas, it is vital to find out to what depth ships can safely manoeuvre through the suspended material or just above it. By using the Navitracker, it is possible to detect the density of silt in real-time. The Navitracker is a patented back-scatter gamma probe, which has been in use since 1985. The device records and provides information on depth versus density and will show a sharp increase in density as fluid properties change to become solid. This level is known as the nautical depth and is described by PIANC as: "the level where physical characteristics of the bottom reach a critical limit beyond which contact with a ship's keel causes either damage or unacceptable effects on controllability and manoeuvrability".
Although other parameters such as viscosity and yield stress should be taken into account for a non-discussable determination of nautical depth, the density information can be used in combination with acoustic sources.

Nautical depth is determined at densities between 1,150kg/m³ and 1,270kg/m³. This range in density is related to the demanded safety margin and rheological properties of mud. This density property of the sediment has been accepted by pilotage worldwide as a leading parameter. At the port of Zeebrugge, the nautical depth is determined at a density of 1,200kg/m³.

Not only is it important to determine and measure nautical depth but also, of equal importance, is finding out which parameters influence the consolidation process and what measures can be taken to reduce the process. For this reason, GEMS has participated in a wide range of studies for the Belgian government, focussing on the relationship between currents in the dock area and the way in which the solid silt builds up.

Based on turbidity studies, GEMS has developed an in-house, on-line, underwater, remote sensing tool, called Sedimon, to determine the behaviour of suspended particles. Further studies have been carried out focussing on spill monitoring and environmental impact studies related to the dredging activities in the port of Zeebrugge.

Recently, GEMS has been awarded a contract to conduct a study for the Flanders Hydraulics Research, a department of the Belgian government. This study will compare and evaluate systems that claim to measure rheological parameters in real time. For this study, Flanders Hydraulics Research will invest in building a sludge test tank. After filling and conditioning this tank with in-situ dredged sediment and water, it will be used as a platform for a variety of tests focussing on sedimentation and consolidation. Third parties will be invited to test the on-line measuring techniques they use to obtain nautical depth, based on rheology.

Reference

Toorman, E.A., 1997: Modelling the thixotropic behaviour of dense cohesive sediment suspensions, Rheologica Acta, 36(1), 56-65.