Determining Field Conditions for Mine Impact Burial Studies

Robert D. Stoll
Lamont-Doherty Earth Observatory of Columbia University
Palisades, New York 10964
phone: (845) 365 8392 fax: (845) 365 8179 email: stoll@ldeo.columbia.edu

Award #: N00014-01-1-0275

LONG-TERM GOAL

The long-term goal of this work is to develop and deploy a set of tools that can be used to determine *insitu* values for certain sediment geotechnical properties that are needed when predicting the potential for burial when mines impact the sea bottom.

OBJECTIVES

The principal objective of this work has been to develop a set of mechanical, remote-sensing tools that will permit the determination of the main geotechnical variables that control mine embedment in the bottom. These properties include the porosity and undrained shear strength of soft, fine-grained cohesive sediments and the relative density of coarser granular sediment such as beach sand.

APPROACH

Over the past several years our field work in Sediment Acoustics (N00014-94-1-0258) has led to the development of a number of remote-sensing tools that have direct application to the problem of mine burial prediction. As an example, the penetration resistance measured by several different types of probe that we have developed is directly related to the bearing capacity of the sediment which is of prime importance in studies of mine burial in the seafloor. These probes include"XBP",an expendable bottom penetrometer, ☐PROBOS☐, a modified version of the Canadian ☐STING☐ penetrometer and a quasistatic penetrometer, ☐STATPEN☐ that measures both cone and sleeve penetration resistance to a depth of 2 meters into the sea floor. The XBP probes have been used to map critical areas in two recent NATO exercises aimed at ☐Rapid Environmental Assessment☐ (Stoll and Akal, 1999) and various versions of STATPEN have been built for NATO, Saclant Undersea Research Centre and for the Naval Research Lab, Stennis Space Center.

STATPEN utilizes a cone penetrometer of standard size and shape (i.e. Amer. Soc. Testing and Materials (ASTM) std 60 degree cone, 10 square centimeters of crosssectional area and a 2 cm/sec penetration rate) supported by a weighted, 4-legged frame that rests on the sea bottom during deployment of the cone. The penetrometer frame is first lowered to a depth about 1or 2 meters above the bottom to allow temperature and pressure transients to dissipate and then lowered the rest of the way at test time. Our basic unit is capable of pushing the cone to a depth of 2 m with a maximum thrust of 1000 lbs. The unit is easily dismantled for shipping and has been used in the Mediterranean and the Baltic for ☐ground-truthing☐ a number of acoustics experiments and in the waters around New York Harbor to measure the thickness of sand caps over dredge spoil areas. Because of the wealth of data available in the literature for tests performed with a standard ASTM cone penetrometer, in most

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2002		**00-00-2002 to 00-00-2002**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Determining Field Conditions for Mine Impact Burial Studies	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Lamont-Doherty Earth Observatory of Columbia University,,Palisades,,NY, 10964**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The long-term goal of this work is to develop and deploy a set of tools that can be used to determine insitu values for certain sediment geotechnical properties that are needed when predicting the potential for burial when mines impact the sea bottom.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**4**	

cases, undrained shear strength for fine-grained cohesive sediment can be directly estimated from the cone resistance using various correlations that have been published.

XBP is a system using expendable probes of the same size and shape as the standard XBT (Expendable Bathythermograph) that is extensively used by the Navy and other marine agencies to measure temperature.. However in the XBP, instead of temperature measurements in the water column, deceleration is measured during impact and penetration of the bottom and this data is then integrated to determine depth of penetration and the penetration resistance of the sediment. The characteristics of the impact signature are then analyzed to obtain shear strength, sediment type and other properties based on a large data base that has been collected over the past few years at SACLANT Center and Lamont-Doherty Earth Observatory (Stoll and Akal, 1999).

PROBOS is an improved version of the Canadian ☐STING☐ penetrometer with the same dimensions and shape as the STING but with additional capability of being able to display both the force on the tip as well as the deceleration of the unit without the necessity of recovering the probe and downloading the data with each deployment as is the case with the STING.

WORK COMPLETED

During FY 02 we participated in two mine burial cruises in the gulf of Mexico near Corpus Christi, Texas, Gyre 10 (01) in October 2001 and Gyre 06 (02) in May 2002. STATPEN, XBP and PROBOS were deployed during both cruises. The records from these deployments showed that there was a considerable amount of heterogeneity in the sediment at a number of the sites chosen for mine-drop experiments and that the sediment was somewhat stiffer than ideal for studying impact burial in most cases. As an example of the degree of heterogeneity and the general stiffness of the sediment, penetration resistance recorded by STATPEN in a number of deployments is shown in the figure below.

RESULTS

Results of the tests performed during the GYRE 10 and 06 cruises have been described in two preliminary reports (Stoll, Sun and Bitte, Nov. 2001 and Stoll, Sun and Bitte, Jul, 2002). In addition, numerical and graphical results have been posted for electronic downloading at the following site: ftp://ftp.ldeo.columbia.edu/pub/MBP

IMPACT/APPLICATION

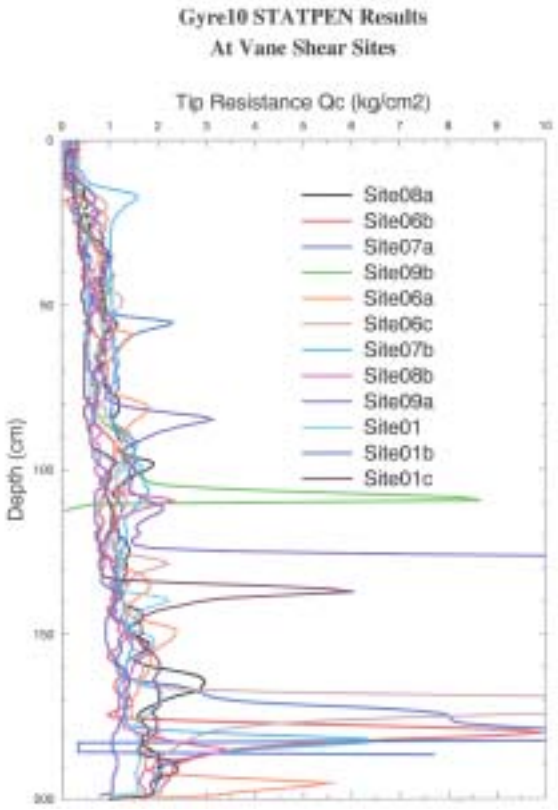
By running both quasi-static (STATPEN) and dynamic (XBP and PROBOS) penetration tests at most of the test sites we have developed a data base that allows the following studies to be made:

1. Estimates of insitu shear strength – based on correlation with quasi-static penetration resistance.

2. Estimates of strain-rate effect – based on comparisons of STATPEN and PROBOS penetration resistance at various depths in the sediment column.

TRANSITIONS

We prepared an XBP evaluation package for the Naval Oceanographic office composed of software, an electronic interface board and a user□s manual for use on board NAVO ships. As a result of their initial trials of the XBP they ordered eight addition systems for use on their survey vessels and on Navy mine hunting ships. We are currently working on a minor upgrade which will allow one-man deployment of the XBPs. We have built modified versions of the STATPEN for NATO, Saclant Undersea ResearchCenter and the Naval Research Lab, Stennis Space Center.



Penetration resistance as a function of depth as measured by STATPEN

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