BROAD AGENCY ANNOUNCEMENT (BAA)

Material Uncertainties in Assessing Soil Strength from Geophysical Surveys

1.0 BACKGROUND

The Naval Facilities Engineering Service Center (NAVFAC ESC) provides ocean engineering program management and technical services to the U.S. Navy for matters regarding seafloor geotechnical engineering. This announcement seeks out laboratory test results and a preliminary analytical framework such that uncertainties in estimating soil strength from the results of geophysical tests can be quantified and reduced.

This task is part of a larger project titled "No-Touch Geophysical Strength Properties for Navy Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicle (ROV) Systems." It is relevant to note is that several sensors currently provide limited geotechnical information without requiring direct contact with the seafloor. Sub-Bottom Profiling, swath bathymetry, electro-resistivity, seismic refraction, and electromagnetic sensors are all examples of these techniques, several which are frequently utilized with Autonomous Underwater Vehicles (AUV's) and Remotely Operated Vehicles (ROV's). As site specific correlations between soil strength and various geophysical measurements can be achieved, the preliminary controlled laboratory study requested is intended to highlight variability in these correlations for a range of geotechnical materials anticipated to be encountered in the upper 5 m of the seafloor.

Proposals will be selected for award, consistent with the availability of Government funding and based on the evaluation criteria as described in Section 6.0. The availability of Government funding is dependent upon many factors. Currently, the estimated timeline for the subject award is somewhere in the period of the second quarter of FY-2012.

The Government understands the associated impacts, uncertainties, and changes that occur over time; and the potential that the proposals received may need to be updated for current cost information at the time of award.

2.0 DESCRIPTION

This announcement constitutes a Broad Agency Announcement (BAA) for the Naval Facilities Engineering Service Center (NAVFAC ESC) under FAR 6.102(d)(2). This announcement is open for 45 days from publication. There is no white paper phase within this BAA. Proposals must be submitted by 16 December 2011 at 12:00 pm Pacific Daylight Time (PDT). The award will be for no more than $70,000 and last up to 7 months in duration.

The evaluation of the responses to this announcement will be conducted in one (1) phase; the proposal submission, evaluation and award phase. A Government evaluation team will review all eligible proposals, and evaluate and rate each proposal against the evaluation criteria set forth in this announcement; see Section 6.0.

This announcement seeks out laboratory results and a preliminary analytical framework that can be used to assess the magnitude and uncertainty in geotechnical properties (e.g., void ratio, soil strength) estimated from the results of offshore geophysical surveys. The testing results and methodology shall address the performance areas cited in Section 3.0.

3.0 PERFORMANCE REQUIRMENTS

In Naval operations, sediments that may be encountered include:

- Terrigenous silty clays or muds
- Turbidites
- Slide deposits and volcanic ash
- Glacial marine soils
- Abyssal clays
- Authigenic deposits
- Biogenic Oozes

This BAA aims to quantify the magnitude and material uncertainty when characterizing the engineering properties (void ratio, porosity, water content, density, strength) of a variety of soils using geophysical methods. Fundamental research measuring engineering properties and geophysical parameters is needed to develop correlations and quantify uncertainty in these correlations. Sediments within 5 m of the seafloor are targeted for this investigation.

Note: specific information regarding the geotechnical parameters (including definitions, calculations, tests, and standards) can be found in the "*Handbook for Marine Geotechnical Engineering*" by the Naval Facilities Engineering Service Center [1]. The handbook is available for free download at www.dtic.mil.

Accession Number: ADA541417
Download URL: http://handle.dtic.mil/100.2/ADA541417

3.2 Laboratory Testing Equipment:

Soil testing should be performed under controlled 'triaxial' or simple shear conditions. Measurements should include:

- soil void ratio (e), porosity (n), water content (w), bulk density (γ)
- relationship between applied stress and strain (σ-ε)
- soil strength (τ_{max})
- 'Geophysical parameters'

Geophysical parameters of primary interest in this study include:

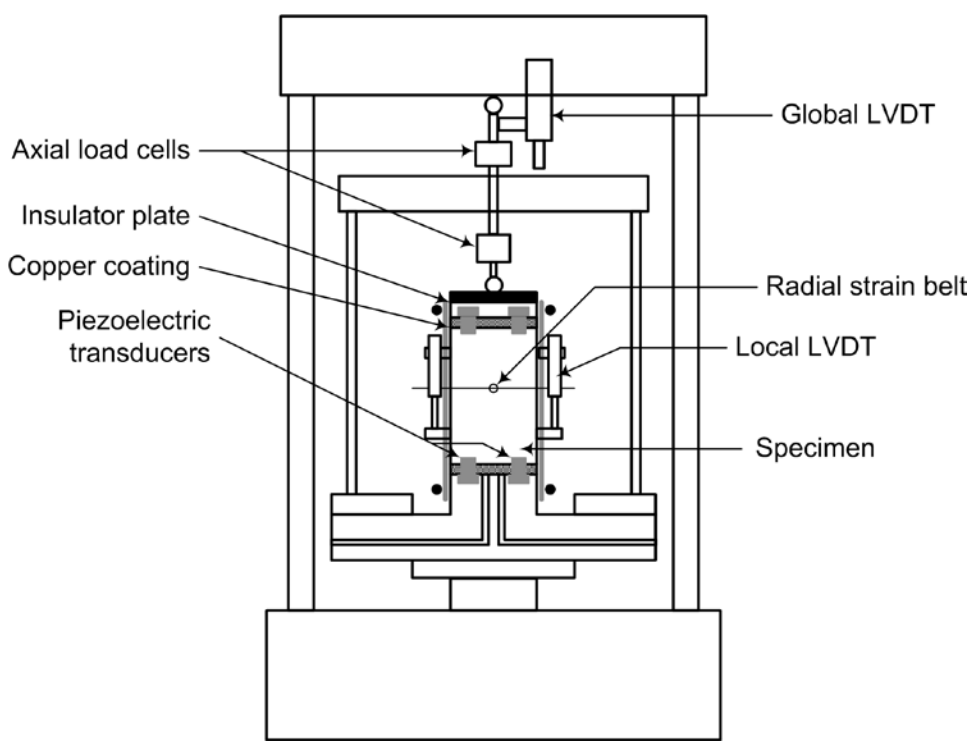
- P- wave velocity
- S- wave velocity

- Bulk resistivity (ρ_T) of the saturated material

It is desirable to have measurements of all three of the above the above mentioned geophysical parameters, but proposals will be considered provided that S-wave velocity is measured at a minimum.

The proposal shall provide a description and diagrams of laboratory equipment, including example results. Example Figure 1 illustrates some aspects of testing equipment that should be highlighted by the proposal. Additional electrical and mechanical details of systems to measure geophysical parameters should be included. Resolution of stress, strain, wave velocity, and resistivity measurements should be discussed.

Pore fluid characteristics can influence consistency limits, void ratio of formation, as well as geophysical measurements. The results of this study will be applied to seafloor sediments saturated with salt water. Testing shall be performed with soils formed and saturated with salt water (salinity ≈ 35 ppt). Testing programs which involve soils saturated with other pore fluids will be considered, provided the influence of salinity on geophysical measurements is discussed and can be rationally quantified.



Example Figure 1. Diagram of testing equipment

3.2 Proposed Minimum Testing Program:

A minimum potential laboratory program is outlined herein, however, other programs that meet the projects objectives will be considered. The initial testing program should consist of at least 2 predominantly sandy soils and 4 predominantly clayey soils with a range of “index properties”. Index properties within this study are considered as void ratio limits (maximum and minimum void ratio) for sandy soils and Atterberg Limits

(liquid limit, plastic limit, plasticity index) for clayey soils. The proposal should include a discussion of index properties and suppliers for anticipated soil types that will be used.

The proposals shall include a discussion of sample preparation methods and testing procedures. Slurry consolidation from 1.5 to twice the liquid limit is anticipated for clayey soils. Air pluviation is anticipated for sandy soils, and sands should be tested at two densities which are representative of (1) loose and (2) dense to very dense conditions. Soils should be tested under at least four effective stress states representative of conditions within 5 m of the seafloor. A separate sample should be prepared for each stress level; no multi-stage testing will be accepted for this research. Duplicate testing for at least one stress level should be performed for each material type in relation to quality control.

Test matrices that summarize materials to be tested, frequency of parameters to be measured, and stress conditions for each test shall be included in the proposal. Example test matrices are shown in Example Table 1 and Example Table 2.

Example Table 1. Soil index properties and interval for measurements

Soil[1]	e_{max}	e_{min}	LL	PI	Test Drainage	e, n, w, γ [2]	σ-ε[2,3]	P-wave[2]	S-wave[2]	ρ_T[2]
S1	1.15	0.75	-	-	Drained	BA	BCSA	BA	BA	BA
S2	0.85	0.50	-	-	Drained	BA	BCSA	BA	BA	BA
K	-	-	55	25	Undrained	BA	BCSA	BA	BA	BA
K-D	-	-	75	20	Undrained	BA	BCSA	BA	BA	BA
K-SF	-	-	35	15	Undrained	BA	BCSA	BA	BA	BA
CM2	-	-	75	35	Undrained	BA	BCSA	BA	BA	BA

[1] S1 = angular crushed sand; S2 = rounded ASTM graded sand; K = Kaolin Clay; K-D = Kaolin clay mixed with 50% diatoms; K-SF = Kaolin clay mixed with 60% silica flour; CM2 = Non kaolin clay with a liquid limit equal to K-D mixture or K-SF mixture
[2] B = measurement before testing; A = measurement at end of testing; BA = measurement before and after testing; BCA = measurement before and after testing, as well as relatively continuous during sample consolidation; BSA = measurement before and after testing, as well as relatively continuous during sample shearing; BCSA = measurement before and after testing, as well as relatively continuous during sample consolidation and shearing;
[3] specify whether axial and radial strains will be measured and how they will be measured

Example Table 2. Proposed stress levels for sample consolidation and testing

Test ID	$\sigma'_{1c,max}$ (kPa)	$\sigma'_{3c,max}$ (kPa)	$\sigma'_{1,0}$ (kPa)	$\sigma'_{3,0}$ (kPa)
1	5	2.5	5	2.5
2	15	7.5	15	7.5
3	30	15	30	15
4	45	22.5	5	7.5

$\sigma'_{1c,max}$ = maximum vertical effective stress for initial sample consolidation
$\sigma'_{3c,max}$ = maximum radial effective stress for initial sample consolidation
$\sigma'_{1,0}$ = vertical effective stress for final sample consolidation prior to shearing
$\sigma'_{3,0}$ = radial effective stress for final sample consolidation prior to shearing

3.3 Reports and Testing Schedule

Two draft and one final report are required for this project. The initial draft report shall present details of testing procedures and preliminary results from one sandy soil and one clayey soil, due within two months of contract award. The final draft report and electronic copies of laboratory data (i.e., Excel or text file) are required within five months of contract award, with the final report due within one month of receipt of comments on the draft final report. The proposal shall include a schedule for testing and report preparation.

3.4 Analysis Framework:

An analysis framework will be necessary to extrapolate the results of this study to other expected offshore soil conditions, as well as provide a way to quantify uncertainty in application of the results. A brief overview of the theoretical background of a framework that will be used to link geophysical measurements to soil strength should be outlined. If uncertainties in correlations are to be quantified using databases compiled as part of this study, the anticipated size and characteristics of those databases should be discussed in the proposal.

4.0 NOTIONAL PROJECT PLAN

The notional project plan is anticipated to be funded in incremental phases that potentially correlate to a base period with subsequent optional periods. These phases parallel field testing equipment development and interpretation covered through a separate BAA. These periods are anticipated to correlate to demonstrated technology readiness levels (TRLs). The following is a notional outline of potential phases:

- Base Period 1 (TRL 4): Proof of concept laboratory testing and preliminary data analysis framework.
- Optional Period 2 (TRL 5-6): Database expansion and improved interpretation framework.
- Optional Period 3 (TRL 7): Database expansion and final interpretation framework.

This BAA covers Base Period 1 (TRL4).

5.0 PROPOSAL SUBMITTALS

PROPOSAL SUBMITTALS TO THIS BAA CAN BE MADE USING THE INSTRUCTIONS ASSOCIATED WITH THIS SOLICITATION:

Submit the proposals to james.a.schneider1@navy.mil, timothy.petro@navy.mil, blake.jung@navy.mil and lynn.torres@navy.mil. The proposals shall be evaluated according to the CRITERIA stated in this announcement, see Section 6.0. Proposals will be evaluated on their own merits and will not be evaluated against each other. A peer review board will evaluate the proposals for this BAA.

6.0 EVALUATION CRITERIA

The full proposals will be evaluated based on the following CRITERIA (listed in descending order of importance):

1. The contractor's capabilities related experience, techniques, existing equipment, or unique combination of these that are integral factors in achieving the proposed objectives.
2. The qualifications, capabilities, and experience of the principal investigator, team leader, or key personnel who are critical in achieving the objectives of the white paper.
3. The ability of the contractor to meet the rapid schedule of this project.
4. The cost relative to the proposed scientific/technical approach. Once accepted into the program, the proposals will be shared with appropriate DON personnel for consideration.

NOTE: An eligible proposal does not guarantee a contract. Multiple contracts may result.

CRITICAL NOTE: A contractor is required to register with the Department of Defense Central Contractor Registration (CCR). No contract award will be made to any contractor that is not registered with the DOD CCR. The DOD CCR may be reached at (888) 227-2423, OR WEBSITE WWW.CCR.GOV.

NOTES:
1. The preceding data should be sufficient for completing the proposal form.
2. There are no solicitation documents applying to this BAA beyond what is attached to this synopsis. Request for a solicitation package will not be acknowledged. Those interested in participating in the BAA program must follow the instructions of this solicitation for submitting a white paper.
3. There is no commitment by the Navy to either make any contract awards or to be responsible for any money expended by the contractor for contract award.
4. As no funding for contracts has been reserved in advance, NAVFAC ESC will be sharing qualified abstracts with other Federal Government activities to seek funding. Some Federal Government activities may employ civilian contractors to determine the applicability of an offered technology to specific environmental projects. Any information that may be sensitive to review by such personnel should not be submitted.
5. Eligibility notification will be sent to all contractors who have submitted a white paper, after the Technical Evaluation Board (TEB) has reviewed all white papers submitted the defined cut-off date.
6. For technical questions regarding this BAA, contact NAVFAC ESC at (805) 982-5577 or via these e-mail addresses: james.a.schneider1@navy.mil, timothy.petro@navy.mil and blake.jung@navy.mil.
7. Direct contractual questions to lynn.torres@navy.mil, (805) 982-4720.
8. The contractor should expect a receipt notification of the full proposal by the Government within one week of submission. If the contractor does not receive a notification of white paper or full proposal receipt, the contractor should call or e-mail NAVFAC ESC by using the phone number or e-mail address provided above.
9. Historically Black Colleges/Universities and Minority Institutions will be recognized according to DFARS 226.7002.

REFERENCE (1): *SP-2209-OCN, Handbook of Geotechnical Engineering, March 2011*, NAVAL FACILITIES ENGINEERING COMMAND, PORT HUENEME, CA

Download the Handbook at: *http://handle.dtic.mil/100.2/ADA541417*