THE EXTRACTION OF GEOTECHNICAL INFORMATION FROM HIGH-RESOLUTION SEISMIC REFLECTION DATA

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Abstract. There are strong empirical and theoretical correlations between the geotechnical and seismic properties of a marine sediment. With the development of modern digital acquisition techniques, and the advent of PC/workstation-based data processing methods it is becoming possible to extract geotechnical information from seismic data in a cost-effective manner.

In a collaborative project between U.C.N.W., Bangor and Applied Geology (NW) Ltd., attempts are being made to develop improved capabilities in high-resolution seismic data acquisition and processing for geotechnical site investigation purposes. The ultimate objective is the creation of a rapid and cost-effective method by which the physical properties of seafloor materials can be determined. The potential users of such a method might include offshore contractors working within the hydrocarbon industry (for rig-site surveys, investigation of pipeline routes, etc.), coastal engineers, dredging companies, and river and harbour authorities.

It is envisaged that via the development of robust computer programmes designed to extract a number of different seismic parameters (velocity, acoustic impedance, attenuation) it will be possible to produce depth profiles (to 20–30 metres below seabed surface) of a marine soil's bulk properties (e.g. density, void ratio, moisture content and grain size). Given this information, it is then theoretically possible to calculate order-of-magnitude estimates of parameters such as shear strength and permeability. Ultimately, with a limited amount of borehole control, it should be possible to improve upon these initial estimates and provide information on the spatial variability of the *in situ* geotechnical properties.

1. Introduction

A joint project between UCNW, Bangor and Applied Geology (NW) Ltd., Deeside, Clwyd, has been established as part of a SERC Teaching Company Scheme. The objective of the project is to develop methods to extract geotechnical information from high-resolution seismo-acoustic data obtained from underway sub-bottom

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profiling systems (for example, boomer, sparker, pinger systems). Such data are collected routinely, usually in the form of analogue paper records but increasingly in the form of digitally-stored records, during offshore site investigation studies.

The ultimate goal of the project is to create a rapid and moderately inexpensive methodology for investigating the physical properties of marine sediments. It is presently envisaged that such a method will be capable of investigating physical properties to depths of the order of 30–50 m and have a resolution of layer thickness to better than 0.5 m. The development of such a methodology offers large potential cost and technical benefits to the offshore industry.

To date, the major emphasis of the project has been on evaluating what is theoretically possible and what is presently technically feasible. This paper is a brief precis of what the authors believe can be expected realistically as regards the extraction of geotechnical information from seismo-acoustic data. The theoretical relationships between the geotechnical and acoustic properties of a marine sediment, and the strong empirical relationships between the two are discussed briefly. The important role of acoustic models is mentioned, before the implications of recent technological advances are discussed.

Recent developments in the processing of seismic data for the hydrocarbon industry and in the processing of basic sonar data have also led to methodologies which can be applied to the extraction of geotechnical information from acoustic data. However, one of the most important technological improvements has been the advent of moderately inexpensive but very powerful computers. This makes it possible (probably for the first time) to process the large amounts for acoustic data required to obtain useful geotechnical information quickly, cheaply and efficiently.

2. Geotechnical Relationships

The most important parameters that control the acoustic response of a marine sediment are given by Stoll (1989) as:

i. porosity,

ii. density,

iii. overburden stress,

iv. degree and type of lithification,

v. grain size and distribution,

vi. dynamic strain amplitude,

vii. material property of grains,

viii. sediment structure.