In-Situ Soil Testing in the Central Indian Ocean Basin at 5462-m Water Depth

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ABSTRACT

The optimum design of an integrated mining system for polymetallic nodule mining is mainly dictated by the soil properties of soft seabed at 5000-6000 m depth. The entire weight distribution and traction of the mining machine depends mainly on the bearing strength and shear strength parameters of the soil. The shear strength of the soil also provides useful information for the maneuverability of the mining machine. Also, it is imperative that the mining area be delineated to eliminate vulnerable areas of low strength where the equipment may sink suddenly beyond recovery leading to anchoring of the machine. A remotely operable in-situ soil tester has been developed for 6000m operations with a cone tester and a shear vane tester and tested for operations. This paper describes the methodology used for soil property measurements and equipment’s performance at 5462 m water depth in the Central Indian Ocean Basin (CIOB)

KEY WORDS: In-situ soil tester, Underwater mining machine, Polymetallic Nodules, Shear strength Bearing strength.

INTRODUCTION

India has been involved in the exploration and technology development for exploitation of polymetallic nodules under the Polymetallic Nodule program (PMN) of the Ministry of Earth Sciences (MoES). The Indian polymetallic nodule area lies in the Central Indian Ocean Basin and extensive surveys have been carried out in that area. India has been involved in mining technology development using the Flexible Riser Concept. An underwater mining system with a crawler based mining machine and flexible riser system has been developed and tested for operations upto 512 m depth. The same concept is being extended for 6000 m operations and to design underwater mining machine for such depths and soft sea floor operations, it has become imperative to measure soil properties in-situ to get more reliable data. The available soil property data have been obtained so far using conventional soil sampling methods like box corers and gravity corers [9] wherein the soil is likely to disturbed during sampling and transport. In order to have accurate data in the top layers - which influences the performance of underwater mining machine, in-situ soil property measurements is required. This paved way for the development of a Remotely Operable Subsea In-situ Soil testing (ROSIS-6000) equipment which can measure the soil property in-situ at 5000-6000 m depth where polymetallic nodules are found in the CIOB region. The configuration of the system, methodology of measurements, testing and performance of the system in the CIOB are described in the sections below.

DESCRIPTION OF THE SYSTEM

Brief overview

The Remotely Operable In-situ Soil Tester is one of the supporting systems used for the design and development of underwater mining machine. The equipment is designed to operate on soft sea bed and has a cone tester and a shear vane tester mounted on it specially developed to operate in the deep oceans.

Fig.1. Conceptual Scheme of Remotely Operable In-situ soil tester system

The Cone and Shear Vane sensor assemblies are mounted on a mechanical structural arrangement. The system can be remotely