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Application of Electric Cone Penetration Test in Unconsolidated and Consolidated Sediments

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Abstract

Landfill areas have received significant emphasis by the geo-technical community in the recent years as large structures are being built in these sensitive areas due to the scarcity of land in the urban area. The high cost of these structures has dictated the need for accurate and precise strength measurement as a basis for improving foundation design, efficiency, safety and sediment stability analyses. Specific analyses of shear strength of the soil and ground improvement methods are necessary to stabilize the ground more economically, prior to the early stage of construction especially if it is done in a reclamated land. During past two decades, Cone Penetration Test (CPT) gained importance as a preferred versatile device for carrying in-situ sub-surface investigations and for characterization of soils. CPT readings which are continuous in nature are best considered than conventional rotary drilling, which allows clear delineation of the strata, depth, thickness, and extent of the soil. In certain conditions, the cone penetrometer technology is used in delineating and detecting anomalous conditions or features which are present on the surface in unusual condition. This can be penetrated in most of the soil types, which ranging from soft clays to hard clays to greater depth beneath the surface. CPT provides data for estimating engineering properties of soil which intended to help with the design and construction of earthworks, foundation for structures, and the behaviour of soils under static and dynamic loads. This conveys the advantage of electric cone penetration test in the reclaimed land, and highly recommendable in unconsolidated and consolidated sediments. In the present investigation, electric cone penetration test carried out in the unconsolidated sediments of reclamated land in Dubai, UAE.

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Keywords: Electric Cone Penetration Test; Unconsolidated sediments; Shear strength; Reclamated land

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1. Introduction

Constructions on the reclaimed land needs prior knowledge on the strength, hydraulic, deformability, acoustic, thermal, acoustic, and seismic characteristics of the area for identifying the safer environment for designing proper functioning of the structures, pipelines, etc. at designated location. Core Penetration Testing (CPT) is widely used tool which offers modern approach for soil exploration, especially for the in-situ investigations and it is widely used over several decades in several number of ways. CPT is one of the fastest and reliable methods for conducting investigations such as soil exploration and soft ground for the support of embankments, pavement upgrades, retaining walls, and for foundations of bridges. With CPT results available immediately, it is very handy for the Geologists or field engineers for assessing the real time data. Soundings up to a depth of 10 m (30 feet) can be easily completed in 15 to 20 minutes time, while conventional soil boring instrument may take around 60 to 90 minutes. Therefore, CPTs are more advantageous for carrying investigations pertaining to the areas which are environmentally very sensitive and/or the sites which are contaminated.

A number of geo-technical agencies and highway departments mostly depend on the Standard Penetration Test (SPT) for getting soil borings which is the primary source of data for designing bridges, walls, and roads. The estimation of the soils by means of a dynamic test is inherently unsatisfactory, largely because of the differentiating pore water stresses. More reliable results are obtained from static penetration test of which the commonly used is the Dutch cone penetrometer [1]. The CPT resistance helps to discrete the values from the SPT at the location of the site itself, and in turn helps to define the interface between the layers like thicknesses, and relative consistencies of the stratum. To ascertain more realistic evaluation of soil behavior, additional sensors which give up to five more additional readings with respect to the depth are available. There are certain critical zones or soft layers beneath the subsurface which need keen detection and identification. The ability of the CPT to collect multiple and simultaneous readings spontaneously with respect to depth is a valuable asset in screening the subsurface conditions and for evaluating the natural foundation bearing materials.

Cone penetration test (CPT) has gained importance during the past two decades as an in-situ tool for investigations pertaining to sub-surface and characterization of soils. While, for piles which bear the establishment for lower foundation, CPT is the best test for identifying the depth of the pile bottom for fitting operations without knowing the soil parameters. The CPT is basically performed by putting a cylindrical shaped rod with a conical tip dipped down into the surface. The CPT is equipped with electrical, electronic, mechanical, hydraulic units and a coil system. Depending up on the depth of the investigation of the sediment sample, length of the coil can be fixed. The tip of the coil which is conical at its apex is at an angle of 60° and with a diameter of 35.7 millimeters, which is pressed into the sediment using a hydraulic unit which is at a rate of 2 cm/sec. According to the cone penetrometer [2], measurements pertaining to static resistance are not provided, whereas it records the resistance where penetration rates are standardized to 20 mm/s. At high cone resistance, loads as high as 10 tones might be required to apply on the cone. The diameter of the coil and the cone should be same. Generally, depending upon the type of