

Field Instrumentation Monitoring of Soft Soil in An Offshore Land Reclamation Project

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ABSTRACT

The Changi East Reclamation Project in the Republic of Singapore necessitated offshore land reclamation for the future airport and associated facilities. Ground improvement works in the project comprises the installation of prefabricated vertical drains and the subsequent placement of sand surcharge to accelerate the consolidation of the underlying soft marine clay. In such ground improvement projects in soft soil, the degree of improvement attained by the marine clay has to be ascertained to confirm whether the soil has achieved the required degree of consolidation to enable surcharge removal. This analysis can be carried out by means of observational methods for which continuous records of ground behavior can be monitored from the date of instrument installation. A Pilot Test Site was conducted in the reclamation site comprising of a vertical drains installation as well as a control site where no drains were installed. At the Pilot Test Site the areas with vertical drain were fully instrumented and monitored to compare the degree of consolidation of the areas close to the surcharge removal period. Instruments installed, monitored and analyzed in the Case Study Area include settlement plates, deep settlement gauges, pneumatic piezometers, electric piezometers and water-standpipes. Assessment of the field instrumentation data from vertical drain areas in the Pilot Tests Site were back-analysed by the Asaoka, Hyperbolic methods and also using pore pressure data from piezometers.

KEY WORDS: Instrumentation, Ground Improvement, Piezometer, Settlement Plates, Land Reclamation, Deformation.

INTRODUCTION

The Changi East Reclamation Project in the Republic of Singapore is a multi-phase reclamation project, which includes a vast quantity of soil improvement works. Since prefabricated vertical drains were used for acceleration of consolidation process, several geotechnical instruments were required to monitor the settlement and pore pressure dissipation hence effective stress gain. Edges of newly reclaimed land are either retained by vertical retaining structure or coastal shore protection rock bund with suitable slopes and berms. Therefore sufficient monitoring and measurement of magnitudes and rates of movement were essential in order to complete the construction of retaining structures without

stability problem. During the implementation of 5 phases of land reclamation and soil improvement projects, several thousands geotechnical instruments such as settlement plates, deep settlement gauges, multi-level settlement gauges, liquid settlement gauges, pneumatic piezometers, vibrating wire piezometers, Casagrande open type piezometers, water stand pipe, inclinometers and earth pressure cells were installed to monitor the behaviors of ground movement. Some brief description on instrumentation and monitoring of soil instrument can be found in Bo et al. (1998). This paper presents the field instrumentation and monitoring of soft soil deformation in the Changi East Land Reclamation and Ground improvement Project.

TYPE OF GEOTECHNICAL INSTRUMENTS INSTALLED IN AN OFFSHORE LAND RECLAMATION PROJECT

There are two types of geotechnical instruments used in land reclamation and soil improvement projects. The first type measures ground behavior during construction whereas the second type measures performance of ground during loading, unloading and soil improvement. However the types of instrument used for these two purposes are more or less similar, which measures ground deformation, and status of pore pressure during deformation of ground.

Instruments were installed at the platform level where vertical drains were going to be installed or on the special platform erected at the offshore. Majority of the instruments were installed at platform level during or before installation of vertical drain since magnitude of settlement occurred before vertical drains were small and installation and protection of instruments installed at offshore condition were difficult and costly.

Only very few instrument clusters were installed in offshore condition with proper protection in order to monitor the settlement occurred during reclamation. Normally instruments were installed in instrument cluster which commonly include the following types of instruments:

- Deep Reference Point
- Settlement Plate
- Liquid Settlement Gauge
- Multi-Level Settlement Gauge
- Piezometers