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A Comparative Study on Geotechnical Characteristics of Marine Soil Deposits Worldwide

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ABSTRACT

A comprehensive study has been made of the geotechnical characteristics of marine soils deposited across the world. One of the distinguishing features of this study is that all the soil samples used in it were recovered by using a single type of sampling technique (that is, by following the Japanese standard sampling method), and all the samples were transported to and tested in a single laboratory under the guidance and supervision of the author. Thus, it is considered that all data obtained in this study are free from differences in sample quality as well as testing method and subjectivity of interpretation. Many established empirical relations, especially relations to the plasticity index (I_p), were carefully examined using the soil data obtained. The study has revealed that many of the well-known empirical relations, based on the I_p, are not always applicable to soils across the world.

INTRODUCTION

As a large proportion of the land in Japan is occupied by mountains, coastal areas have been highly utilized since ancient times. A typical example of such a development is the Kansai International Airport (KIA). Its first phase was completed in 1994, and the second phase is under construction (as of 2001). In this project, to avoid the noise problem and to make available the huge space required for the airport, the airport was constructed 5 km offshore. The water at this site is as deep as 20 m, and the weight of the fill material is as heavy as 600 kPa in the ongoing second-phase construction.

For development in coastal areas, soft marine clays usually are thickly deposited. At the KIA construction site, layers deeper than 200 m are compressed by the weight of the land. It is impossible in practice to apply improvement techniques, such as the sand drain method, to such a great depth in order to reduce the residual settlement. Instead of adopting soil improvement techniques, the facilities should be designed with the capabilities for adjustment or remediation against residual settlement after their utilization. In such cases, an accurate prediction of the ground movement is an essential work for foundation design.

Due to the great advancements in computer technology, it has become easy to predict ground behavior by using numerical methods, based on the constituted rules to follow real soil behavior. Unlike products in the manufacturing industries, however, soil is naturally formed. Its properties vary not only with the constituents of soil particles, including clay minerals and grading, but also with the environment during and after sedimentation. Thus, the roles of site investigation as well as laboratory testing are of extreme importance when determining soil parameters for the numerical methods. In real practice, however, it is quite rare to obtain the required soil parameters from such site investigation. Instead, they are estimated by using empirical correlations, especially based on the plasticity index (I_p).

We should remember that modern geotechnical engineering has evolved through the experiences gained in relatively small and restricted areas in the world, i.e., Northern Europe and North America. Inevitably, the well-known empirical relations are mostly derived from data measured in these regions. It should be borne in mind that in most parts of these regions, ground formations were quite strongly influenced by glacier activities in the Ice Age.

It is then an urgent task for geotechnical researchers to establish a global correlation of soil parameters, valid for all types of clays in the world. We have to recognize, however, that the variability of measuring techniques for soil parameters is very large compared with other industrial disciplines. We do not yet have an international standard for the soil sampling method, which strongly affects the soil parameters derived from laboratory tests (e.g., Tanaka, 2000). Thus, the data published from different sources are not usually comparable.

The author's geotechnical group has carried out a comprehensive site investigation at various sites across the world by the same sampling technique, using the Japanese standard fixed piston sampler. Soil samples were transported to the author's laboratory, and all tests were run under the identical testing standards. It is then considered that accumulated data through these tests are free from differences in sample quality or testing methods. Based on this database, the paper will discuss the comprehensive soil parameters that are valid to various worldwide marine clays.

IMPORTANCE OF SAMPLE QUALITY

Although every geotechnical engineer understands the importance of sample quality, in practice, soil samples are not always recovered using a proper method. For example, a borehole is drilled by wash boring and the soil sample is recovered by an open-drive Shelby tube without using a piston. On the other hand, large-diameter samplers such as Sherbrooke and Laval samplers are used for research purposes. The superiority of these samplers was proved by the comparative study at the Bothkennar site, in the U.K., by Hight et al. (1992). Since the sampling cost using

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