

Probabilistic Analysis of Consolidation Considering Uncertainties of Geotechnical Parameters in the Plastic Board Drain Method

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ABSTRACT

Geotechnical performance at the soft ground is strongly dependent on the properties of the soil beneath and adjacent to the structure of interest. These soil properties can be described using deterministic and/or probabilistic models. Deterministic models typically use a single discrete descriptor for the parameter of interest. Probabilistic models describe parameters by using discrete statistical descriptors or probabilistic distribution density functions. The consolidation process depends on several uncertain parameters including the coefficients of consolidation and coefficients of permeability in vertical and horizontal directions. The implication of this uncertain parameter in the design of prefabricated vertical drains for soil improvement is discussed. A sensitivity analysis of the degree of consolidation and calculation of settlements to these uncertain parameters is presented for clayey deposits. In this study, it is revealed that probabilistic theoretical analysis method is necessary to minimize errors due to those uncertainties.

KEY WORDS: soft ground, deterministic model, probabilistic model, consolidation

INTRODUCTION

Geotechnical engineering has more or less uncertainties compared to other civil engineering fields. Hence, a judgment of an engineer is very important. There were so many attempts to apply probabilistic theoretical method to eliminate uncertainty for a decision of ground parameters. But it was inadequate. Consequently, confident design should be conducted through a combination of deterministic and probabilistic theoretical design method. In case of PBD method for designing soft ground improvement, the degree of consolidation is mainly affected by ground condition, construction condition and the drain board characteristics. Such factors which affect to the degree of consolidation are drainage capacity, smear zone, horizontal coefficient of permeability, and horizontal coefficient of consolidation and so on. However, because of insufficiency of data and uncertainties of input

parameters, which are required to consolidation analysis of soft ground improvement, might be resulted in low reliability with designing such as underestimation or overestimation of consolidation process. Barron's method(1948), Yoshikuni's method(1974), Hansbo's method(1981) and Onoue's method(1988) are used for the degree of consolidation analysis in vertical drain method. The deterministic analysis method assumed that influence factors are constant values. However, these factors which affect to the settlement of ground and duration of consolidation are variable depending on test method applied and transformation model of design parameter. Therefore the deterministic design method may include uncertain values and unreliable results when designing soft ground improvement.

In deterministic method which is based on concept of safety factor, safety is judged by not variance but only the representative value. Therefore, it is not possible to take account of uncertainty of influence factors with existing PBD design. On the other hand, it is more reasonable to consider uncertainty from variance of ground parameters and artificial error for probabilistic theoretical analysis method. In this study, the design process had been selected with assumption that the variable is ranged between constant values for analysis of ground consolidation behavior by using probabilistic theoretical method. Since ground parameters which affect settlement of ground and duration of consolidation are distributed according to the characteristics of variance, existing design methods have the problem that ground parameters are regarded as the fixed constant value. Investigated ground parameters had been statistically analyzed considering design parameters, which affect vertical drain method design. In addition, various design parameters investigated using probabilistic theoretical simulation method for more reasonable vertical drain design method.

RELIABILITY ANALYSIS THEORY

Concept of reliability

In existing deterministic method for provision against uncertainty, it is commonly assumed that there is no failure due to an empirical excessive safety factor. However, sometimes failures are happened actually. On the other hand, the estimation of safety in engineering problem