

## 博士論文の要旨

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要旨(2,000字程度にまとめること。)

Methods for considering the effect of non-uniformity induced by consolidation process

(圧密過程に生じる地盤の不均一性の影響を考慮した圧密計算法)

Consolidation problem is an essential issue for geotechnical engineering. The current consolidation theories for both prefabricated vertical drains (PVD) induced horizontal radial consolidation and one-dimensional (1D) consolidation assumed that the coefficient of consolidation,  $c$  ( $c_v$  in vertical direction and  $c_h$  in the horizontal direction) of soil is a constant. However, for all soft clay deposits,  $c_v$  and/or  $c_h$  vary during the consolidation process. To consider this phenomenon, some researchers analyzed the consolidation problems incorporating the variation in compressibility and permeability ( $k$ ) with void ratio ( $e$ ), but

assumed the soil domain is uniform. While for any consolidation problem, the consolidation is not uniform and the existing solutions are not able to consider this effect of non-uniform consolidation on the average degree of consolidation DOC. New methods are proposed to predict the average DOC considering the effect of non-uniform consolidation.

The variation of the void ratio and permeability in a soil domain under consolidation have been studied based on the results of laboratory model tests and Finite element analysis (FEA). The results indicated that the consolidation in the zone near the drainage boundary is much faster than that in the zone away from the drainage boundary.

It has been confirmed that the non-uniform consolidation has a considerable effect on the rate of consolidation. The effect is more significant in the earlier stage of consolidation. The factors influencing the effect of non-uniform consolidation are (a) initial void ratio ( $e_0$ ), (b) compression index ( $C_c$ ), (c) loading conditions and (d) the rate of variation of permeability with void ratio, and they were

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investigated quantitatively.

In the method for PVD induced consolidation, a concept of equivalent ‘smear’ effect, has been proposed to consider the effect of non-uniform consolidation. The value of  $k_h/k_s)_e$  ( $k_h$  and  $k_s$  are the horizontal permeability in the undisturbed and smear zone of a PVD unit cell) can be evaluated quantitatively by a term,  $\Delta e/C_k$ .  $\Delta e$  is the stress increment induced relation of void ratio calculated using basic soil properties and loading conditions, and  $C_k$  is a constant in Taylor’s permeability ( $k$ )-void ratio ( $e$ ) relationship. In the method for 1D consolidation, the effect of non-uniform consolidation can be represented by a reduction factor,  $\alpha$  and  $\beta$  for one soil layer system and two-soil layer system, respectively.  $\alpha$  and  $\beta$  can be calculated using  $\Delta e/C_k$  and  $\Delta e_1/C_k$  respectively. And  $\Delta e_1$  is the stress induced reduction of void ratio in soil layer-1 which

contains the drainage boundary. The proposed methods yielded very good predictions of measured DOCs when applied to some reported cases. It is recommended the proposed method can be used to analysis the average degree of consolidation considering the effect of non-uniform consolidation.