

IMPROVEMENT OF CLAY AND SAND LAMINATE LAYERS BY PVD-VACUUM METHOD COMBINED WITH CEMENT GROUTING

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1. Research background

PVD (Prefabricated Vertical Drain)-Vacuum method is proved to be effective in Vietnam soft soil condition in term of cost, construction time and environment. However, in this method, the thick sandy layer existing between two clay layers can reduce the effectiveness of PVD-Vacuum method significantly. Cement grouting method is proposed to overcome this weakness, and to minimize the damage caused by liquefaction of sandy layer during earthquake.

2. Methodology

2.1 Mixing sand with cement grouting

The procedure of mixing sand with cement grouting is following the hand-mixed method in Lois-Raymond research. The cement is mixed with water using a high-energy blender separately then mixing with coated sand using the same machine. After that, the mixture is gently poured into experiment chamber for permeability measurement.

2.2 Permeability experiment

The permeability experiment used in this research is water falling head type. The time for water falling is measured and based on this time; the permeability of each mixture can be determined.

2.3 Comparison with other researches

The result of this method is compared with Lois-Raymond research and Grouted Soil research. From different approaches of these methods, the permeability characteristic is concluded. After understanding the permeability characteristics of cement grouting soil, the mixing ratio is determined for the next experiment.

2.4 Consolidation experiment preparation

After the bottom of clay layer is poured into designed chamber, the sandy layer is mixed following the previous method. Then the top clay layer is poured into the chamber and surrounding water is poured to generate the hydraulic reaction in treated sandy layer. During this time, the settlement is measured by electrical gauge.

2.5 Consolidation experiment measurement

After 14 days of curing in water, the vacuum pressure is applied with 20kPa, 40kPa and 80kPa respectively. The amount of settlement is recorded and analyzed to obtain the optimum amount of cement.

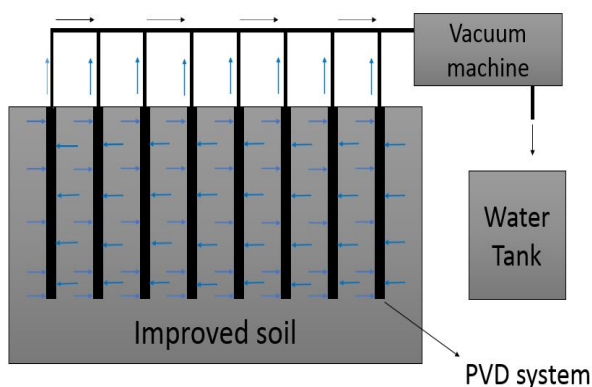


Fig.1 PVD-Vacuum method

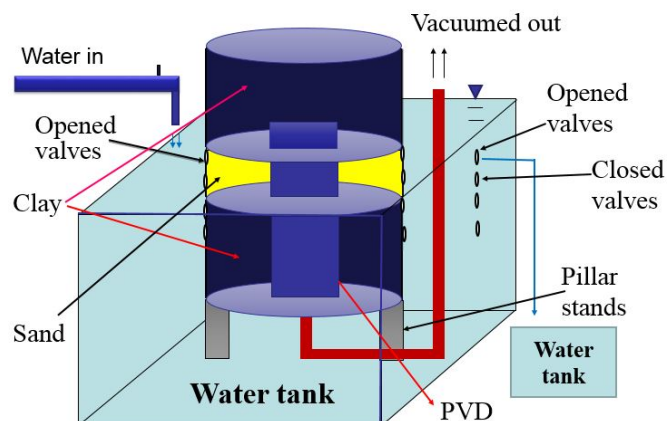


Fig.2 Experiment apparatus

Keywords: PVD-Vacuum method, sand-clay laminate layers, cement grouting

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3. Results and Discussion

The result shown in **Fig.3** illustrates that the influence of W_c/W_s (weight of cement/weight of sand) ratio and V_g/V_v (volume of cement grout/volume of sand void) ratio are equal in reducing the permeability of sandy soil, which are contradict to Lois-Raymond research. In the **Fig.4**, the permeability result for V_g/V_v of 100%, for ratio of W_c/W_s over 10%, the permeability degree keep decreasing significantly even after 14 days. In the **Fig.5**, the total settlement for each case is recorded and compared. From the chart, the failure of PVD-Vacuum method happened between W_c/W_s ratio of 4% and 10%. In Vietnam, 90% of total settlement is acceptable for construction, therefore, 90% line is indicated in **Fig.5** and **Fig.6**.

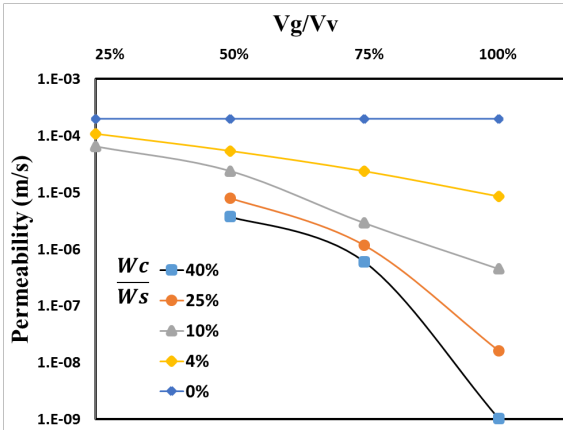


Fig.3 Permeability comparison after 14 days

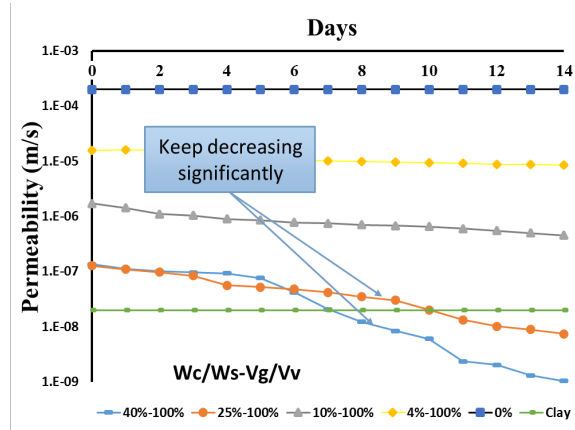


Fig.4 Permeability result for V_g/V_v 100%

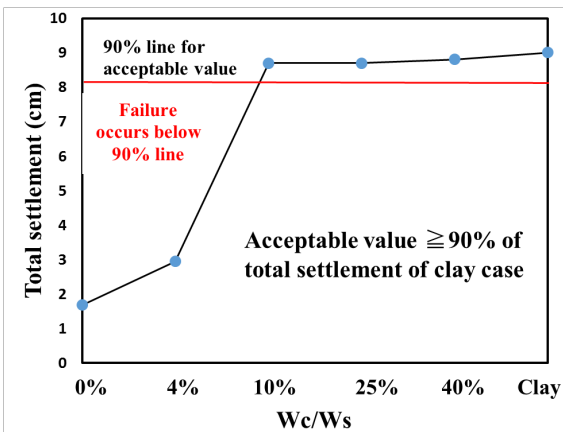


Fig.5 Total settlement for each case

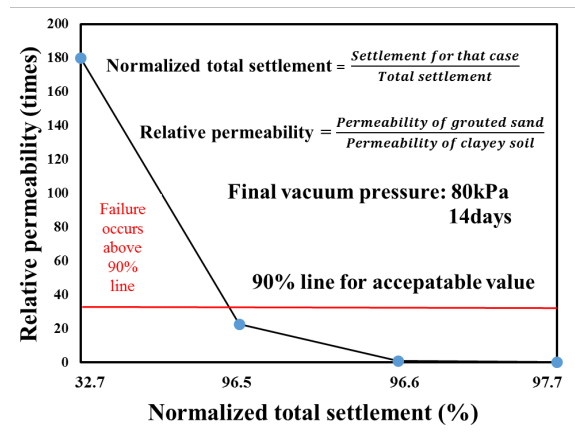


Fig.6 Relative permeability

Fig.6 generalized the result by calculating the relative permeability. The failure of PVD-Vacuum method happens between the value of 20 and 150 times of relative permeability.

4. Conclusions

This research proposes a different approach in mixing cement grout and sandy soil using W_c/W_s ratio and V_g/V_v ratio. By comparison with other researches, it illustrated the similarity and difference between these researches and proved that W_c/W_s and V_g/V_v ratio have equal roles in reducing the permeability of grouted sand. For the consolidation test, it proposes a new approach in investigating laminate layers as well as the combination of laminate layers and PVD-Vacuum method. Finally, it proves that if the value of relative permeability of treated sandy layer is below 35 times, the PVD-Vacuum method works effectively in Vietnamese condition.

Reference

- [1] Schwarz, L. G. and Krizek, R. J., (2015), "Effect of preparation technique on permeability and strength of cement-grouted sand", Geotechnical Testing Journal, GTJODJ, Vol. 17, No. 4, December 1994, pp. 434-443.

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