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Effect of Normal Pressure and Width of Geosynthetic Horizontal Drain in Pullout Test Using Soft Clay

Yokohama National University, Tej B. S. Pradhan
Yokohama National University, O Dinesh R. Shiwakoti
Yokohama National University, S. Ikedo
Yokohama National University, Goro Imai

1. Introduction

Various researchers have pointed out the possibilities of utilizing high water content clay and other low grade cohesive soils to construct earth structures in conjunction with appropriate geosynthetic having high transmissivity, permittivity and tensile strength. This paper examines the consolidation and subsequent pullout behaviour of Geosynthetic Horizontal Drain (GHD) using reconstituted Tokyo Bay Clay. The effects of normal pressure and GHD width have been investigated.

2. Test Materials

Soft clay recovered from Tokyo Bay was completely reconstituted by seiving through 75 micron seives, making slurry from the fines with consistency of twice the liquid limit and mechanically consolidating at 50 kPa normal pressure using 3t method. Liquid limit, plasticity index and specific gravity of the clay are 74%, 44, and 2.65 respectively.

Geosynthetic having wavy core and non-woven filter cover with total nominal thickness 10 mm and width varying from 50 mm to 150 mm were tested. Filtration capacity and transmissivity of the GHD used were sufficient enough to expel the water squeezed out as a result of consolidation.

3. Test Procedure

Test was carried out using pullout apparatus having inner dimensions of 250 mm length, 160 mm width and 100 mm thickness. Above the rectangular block of soil sample of thickness 55 mm, GHD was placed. Another soil block of 45 mm was placed above the GHD. Normal pressures varying from 30 kPa to 150 kPa were applied using two load cells. Before conducting pullout test, the sample was consolidated at the applied normal pressure until the end of primary consolidation was observed in the time-settlement curve. Pullout was conducted at the strain rate of 1 mm/min. Elongation at various sections of GHD was monitored by four wires embedded along its length. Also the total displacement of GHD was recorded by displacement transducer located at front face of pullout apparatus. Details of testing apparatus and method are explained in Ikedo (1994) and Okamoto et. al.(1994).

4. Results and Discussions

Fig. 1 shows the variation of water contents across the mid-section of the sample before and after the test. Effects of variation in consolidation pressure is remarkable in reducing the water content, thereby causing the shear strength gain. It may also be noted that in the vicinity of GHD, water content reduction is higher.

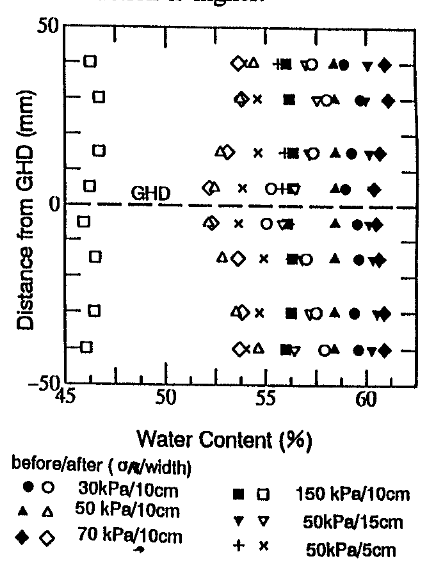

Fig. 1 Variation of water content

Variation of consolidation time with GHD width is depicted in Fig. 2. The effectiveness of GHD and the role of its width in reducing consolidation time is apparent from Fig. 2. With the increase in GHD width, contact area of soil and GHD increases which causes the reduction of the drainage path.

Influence of normal pressure in pullout resistance is shown in Fig.3. Increase in pullout resistance with increase in normal pressure is reasonable because as a result of higher pressure, more water is expelled out of the soil, thereby increasing the shear strength of soil. Consequently the pullout resistance increases.

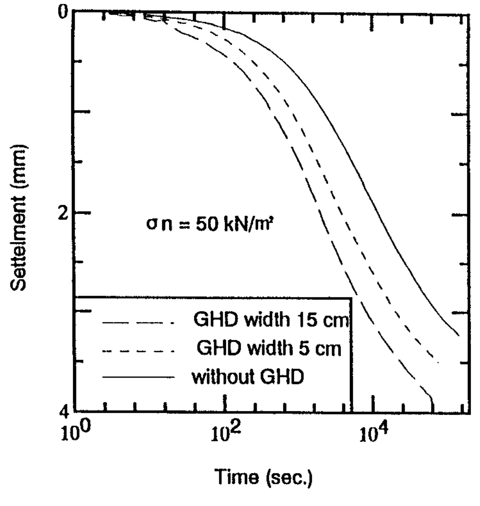

Fig. 2 Effect of GHD in consolidation duration

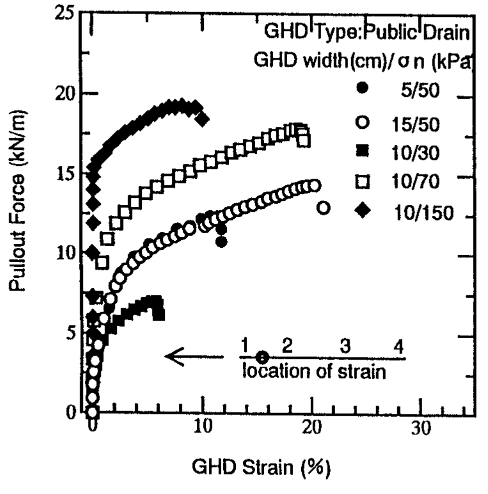

Fig. 3 Influence of normal pressure & GHD width in pullout resistance

Also compared in Fig. 3 is the effect of width of GHD in pullout behaviour. The test result of 10 cm wide GHD at 50 kPa normal pressure could not be included in the figure because the displacement measurement at location 1 did not function during the pullout test. Fig. 4 compares the pullout resistance against total strain of GHD for various widths. It is evident from Figs 3–4 that the path followed at various GHD widths is more or less the same. However, higher ultimate resistances have been observed for greater widths. This result indicates that GHD width may

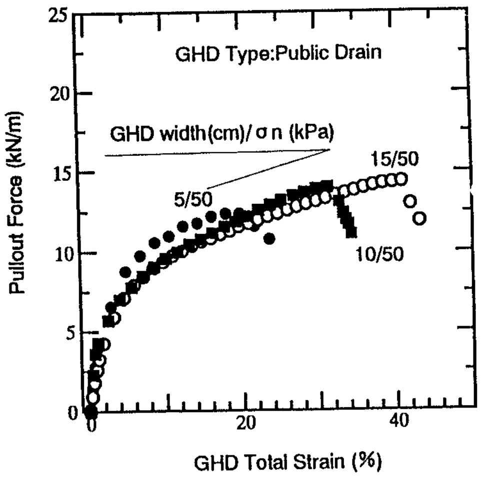

Fig. 4 Influence of GHD width in pullout resistance

not be significant in so far as stress–strain relation at design strain (generally within 10%) is concerned. This result observed from these figures are not conclusive but preliminary and more tests are necessary to confirm it.

5. Conclusion

Effects of normal pressures and widths of GHD in consolidation and subsequent pullout resistance using reconstituted Tokyo Bay Clay have been investigated. Larger pullout resistances for higher normal pressures have been observed. At various widths of GHD, the pullout resistance–strain curves follow the same path regardless of variation in width of GHD, however more such test results are required to confirm this behaviour.

6. References

IKEDO, S., (1994). Pullout Resistance of Geotextiles in Clay, B. Engg. Thesis, Yokohama National University.

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