The Presheared Flush Testing Procedure for Residual Shear Strength Measurement

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I. Introduction

In landslide slope stability evaluation, the determination of strength parameters (c and ϕ) is very important. For soil subjected to repetitive sliding, these parameters, reduced to their residual values (c_r and ϕ_r), are used in the calculation of the factor of safety. Currently, among the testing methods that permit the determination of these strength parameters, the torsion shear test through a ring shear apparatus is widely employed under numerous testing procedures. At the present time, four testing procedures have been proposed for the use of the Bromhead Ring Shear Apparatus. Stark and Vettel (1992) have shown that the Single Stage procedure provides a good estimation of the residual strength at effective normal stress less than 200 kPa. When the effective normal stress is greater than 200 kPa, consolidation of the specimen during the test causes settlement of the upper platen into the lower platen giving higher residual strength values. Wykehan-Farrance (1988) and Anayi et al. (1988) have also shown that in Presheared Test procedure, the preshearing facilitates the creation of a shear plane and reduces the length of the horizontal displacement required to reach the residual condition. However, this procedure causes the extrusions of a substantial amount of soil during the shear process. Stark and Vettel (1992) also concluded that in the Multistage Test procedure an additional strength, probably due to wall friction as the top platen settles into the specimen container, develops during consolidation and shear process, hence they proposed the "Flush" Test procedure in which increasing the thickness of the specimen prior to shear reduces the wall friction and therefore gives more trustworthy measured values. However, this procedure, when conducted at low rate of displacement, takes substantial time to reach the residual condition.

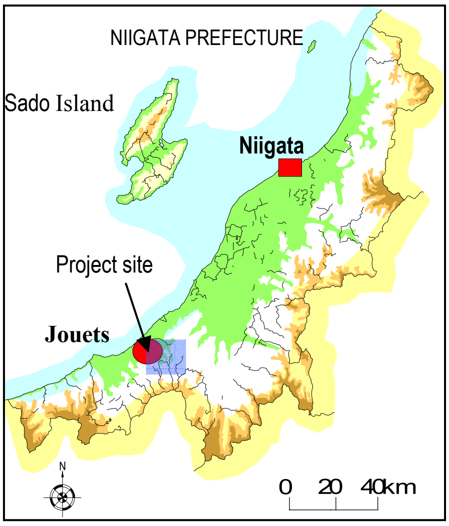

Fig.1: Location of the Drainage Project

II. The PFT Procedure

As the error due to the settlement of the upper platen into the specimen container is minimized in the "Flush" Test procedure, we propose the Presheared Flush Test (PFT) procedure in which the specimen is presheared prior to the use of the "Flush" Test procedure. This technique combines the merits of the Flush Test and the Presheared Test procedures. After the thickness was increased by 2 to 3mm (Δ H), the specimen was consolidated and later on presheared by hand on a horizontal displacement of about 5mm (see Fig. 2). Next, the system was left for about 2 to 3

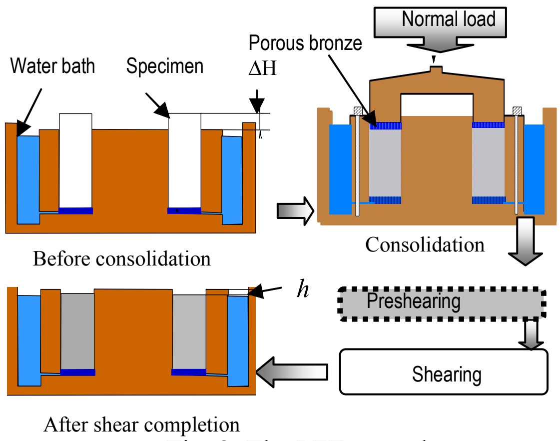

Fig. 2: The PFT procedure

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hours to allow the dissipation of pore pressure, and then sheared at a rate of displacement of 0.035mm per second. The natural specimens involved in this study were obtained from the interior of the tunnel of the Niigata Drainage Project (see Fig. 1). The consolidation of the specimen followed the procedure described by Stark and Vettel (1992) in the "Flush" Test procedure.

Table 1: Summary of test results

Normal stress ((kPa)	Time to reach the residual state in (hours)		Total settlement of the upper platen in the container *h* (mm)		Residual stress in (kPa)	
	Flush	**PFT**	**Flush**	**PFT**	**Flush**	**PFT**
50	33.2	22.7	0.221	0.110	21	17
100	33.2	13.7	0.296	0.196	37	27
200	36.2	16.7	0.352	0.149	62.5	56.7
300	37.7	16.7	0.425	0.242	101.9	80
Total	140.3	69.8		$\phi_r=$	15.33°	15.48°

III. Test Results and Discussion

As shown in Table 1, it was found that in the PFT procedure, settlement of the upper platen into the specimen container was minimized compared to the "Flush" procedure. Another finding was that, in the PFT procedure, time to reach the residual state was reduced as shown in Fig. 3. The average reduction was in the order of 50 %. The results of the tests summarized in Fig. 4 and Table 1 show no significant difference in the internal friction angle ϕ_r of regression curves obtained from the Flush and the PFT procedures when the consolidation load is lower than 200 kPa. However, as has been already demonstrated by Stark and Vettel (1992), when the normal load is greater than 200 kPa the difference between the shear stress becomes noteworthy. This can be explained by the incidence of the wall friction between the lower and the upper platens.

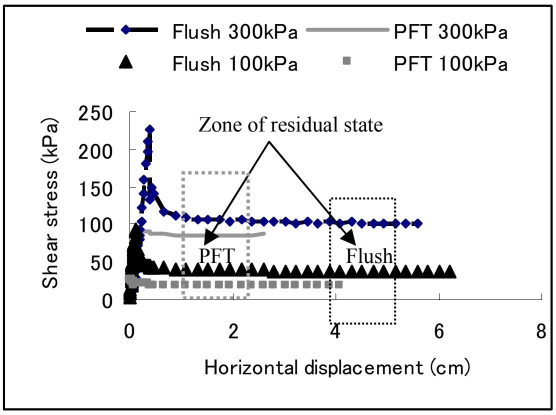

Fig. 3: Shear stress versus horizontal displacement

IV. Conclusion

The Presheared Flush Test procedure (PFT) is proposed as a short and effective procedure to obtain the residual shear parameters with a reduced amount of error due to metal friction. Tests conducted on clay samples using the proposed PFT procedure showed that in this procedure the total settlement of the upper platen into the specimen container was minimized. Furthermore, the elapsed time to reach the residual state was reduced by 50%. The residual internal friction angle ϕ_r obtained was close to the one measured using the Flush Testing procedure.

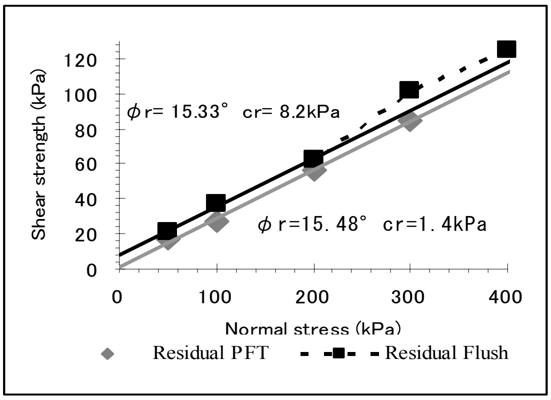

Fig.4: Failure envelopes

V. References

Anayi,T., Boyce, J. and Christopher, D.F.R. (1988), "Modified Bromhead ring shear apparatus", *Geotechnical Testing Journal*, Vol. 12, pp. 172-173.

Stark, T. D. and Vettel, J.J. (1992), "Bromhead ring shear test procedure", *Geotechnical Testing Journal*, Vol. 15, No.1, pp. 24-32.

Wykeham Farrance Engineering (1988), "Technical Literature WF25850".