地すべり土の残留強度と過圧密比の関係
―亀の瀬および廟湾地すべり―
Influence of Overconsolidation Ratio (OCR) on Residual Shear Strength of Miaowan & Kamenose Landslide Soils

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Introduction

Remoulding of an undisturbed soil sample changes the natural fabric of soil aggregates. Therefore, it raises the pertinent question of whether the disturbance of the natural overconsolidation ratio (OCR) of the could cause a significant effect on the test results. To this question, research literature provides contrasting opinions. Previous works of Skempton (1964), Kenney (1967), Lupini *et al.* (1981), Gibo *et al.* (1987), Tika (1999) and Moore (1991) have treated stress history (OCR) as a noncontributing factor to residual strength. Bishop *et al.* (1971) and Stark *et al* (2005) have indicated that the relationship of effective residual strength versus effective normal stress is independent of specimen preparation, stress history (OCR) and initial soil condition. Findings by Picarelli (1991 & 1998) and Leroueil (2001), show that the residual strength of reconstituted samples of Laviano clay shales and Eastern Canada sensitive clays was substantially lower than that of undisturbed samples. In 1996, Nakamori *et al* claimed that the true nature of a natural sample may not be represented by the use of remolded specimens and concluded that, upon shearing, undisturbed soil samples produce higher residual strengths than remolded samples. The present study investigates the effect of overconsolidation ratio (OCR) on residual strength of two landslide soils, namely, Miaowan and Kamenose from China and Japan, respectively.

Materials & Methods

Soil samples for mineralogical and ring shear analyses were collected from the landslides of Miaowan, China and Kamenose, Japan. The soils were made in to a slurry and packed into a shear box with 100 mm and 60 mm outer and inner diameters (Gibo *et al.* 1994), respectively. Ring shear tests were performed on the reconstituted specimens at a controlled displacement rate until a minimum drained shear resistance was achieved on a single shear plane. Soil slurry was vertically consolidated and in order to obtain several overconsolidation states, the initial effective normal stress was unloaded to a lower value and the samples were reconsolidated under the lower stress. The <2μm fraction clay constituents were determined by subjecting the samples to sonification-sedimentation-syphoning cycles. Mineralogical analysis was conducted by X-ray diffraction method.

Results & Discussion

Kamenose sample predominantly consists of clay (73.2%) and Miaowan sample is predominantly sandy (81.3%) in texture. The residual friction coefficient (τ_r/σ'_n) of Miaowan in the OCR=1 category (fig. 1a) appears to decrease as the normal consolidation pressure increases from 50 kN/m^2 to 400 kN/m^2. However, the visible

Table 1. Grain size distribution & mineralogical composition of <425 μm soil samples

Soil	Grain Size Distribution (%)			Mineralogical Composition (%)						
	Clay <2 μm	Silt <2-20 μm	Sand <20-425 μm	St	Ch	Mc	Kt	Qz	Fd	Other
Kamenose	73.2	17.8	9.0	77	0	2	1	14	3	3
Miaowan	18.7	30.9	50.4	1	6	15	1	56	21	0

[St-Smectite; Ch-Chlorite; Mc-Mica; Kt-Kaolinite; Qz-Quartz; Fd-Feldspar]

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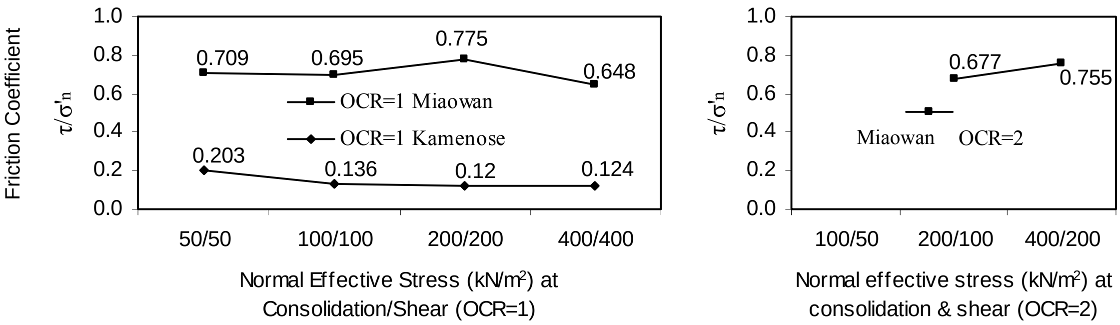
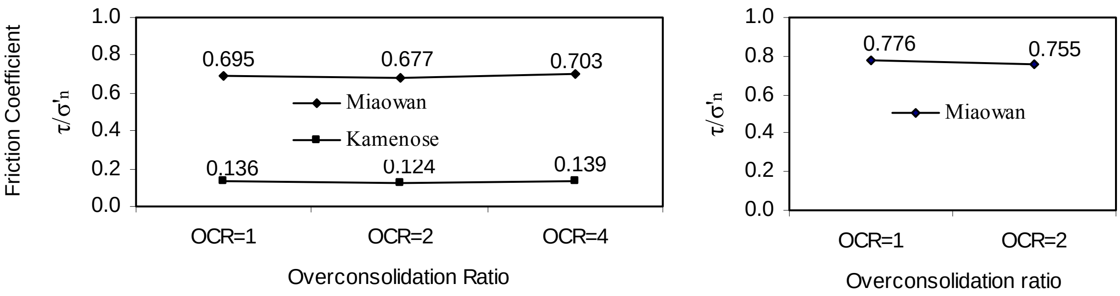


(a) (b)

Fig. 1. Variation of residual shear angle in OCR=1 & 2 against combinations of ENS at consolidation & shear



(a) (b)

Fig. 2. Variation of residual shear angle at 100 kN/m^2 (a), & 200 kN/m^2 (b), in OCR=1, OCR=2 & OCR=4

decrease in corresponding residual angle is minimal (the difference varying between 0.5^0 and 1.84^0). Similarly, in Kamenose sample, the same decreasing pattern of residual friction coefficient is evident from 50 kN/m^2 to 400 kN/m^2 in the OCR=1 bloc (Fig. 1a). The residual strength values for Kamenose soil are significantly lower than those of Miaowan soil, as expected with its smectite dominance of the mineralogy. The residual angle of Kamenose at 50 kN/m^2 is relatively higher by 4.64^0 than the minimum value among the rest of the rest of the values in OCR=1 bloc, which may be due to insufficient reorientation of platy clay minerals under the low effective normal stress. The friction coefficients of data points representing 100/100, 200/200 and 400/400 kN/m^2 for Kamenose differ only by 0.91^0 from each other at the maximum, which is assumed to be insignificant. The residual shear angle variation in Miaowan soil samples tested under OCR=2 too show no significance difference in the residual shear angles. In fig. 2 [a], though the three data points show a difference, the difference is in the range of 0.8^0-1.0^0 for Miaowan, which may be considered insignificant. Similarly, in Kamenose soil samples, too, the differences in shear angle are in the range of 0.16^0-0.84^0(fig. 2a). These results suggest that even when the OCR value is increased from 1 to 4, it has not changed the residual shear strength of the Miaowan and Kamenose soils.

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