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Influence of Overconsolidation Ratio on Residual Shear Strength of Miaowan & Kamenose Landslide Soils under Laboratory Conditions

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ABSTRACT

Two landslide-associated clay soils, namely from Kamenose, Japan and Miaowan, China, were tested under laboratory conditions to determine the influence of overburden stress history on their residual shear behaviour. Landslide soil samples were reconstituted and re-consolidated using a ring shear box and sheared for long displacements to achieve residual conditions at differing OCR levels. Preliminary results show that there is no significant difference in the residual shear strengths recorded for the Kamenose and Miaowan soils at three levels of OCR tested.

KEY WORDS: Landslide soil; OCR; Reconstituted soil; Residual Shear Strength; Ring Shear Test

INTRODUCTION

Overconsolidation, widely researched in the field of soil mechanics, is a process leading to a tighter particle arrangement and structural deformations of the soil matrix during geological development. Overburden stress history of a clayey landmass, as defined by the overconsolidation ratio (OCR), holds much significance in the studies of strain softening and corresponding shear behaviour of landslide soils. The OCR is theoretically defined as the ratio of maximum preconsolidation pressure recorded in the stress history of a soil mass to the current overconsolidation pressure of the same. The accepted method of soil sample testing using a ring shear apparatus to investigate shear behaviour of landslide soils involves reconstituting of undisturbed soil core samples obtained from a landslide site. The manual disintegration of the natural sample in the laboratory, thus, changes the natural fabric of soil aggregates and structure and allows for the remoulding of the soil to fit into the shear box of the ring shear apparatus, which is then re-consolidated using external loading to make an annular soil ring. Subsequently, the apparatus, simulating natural in situ landslide conditions, shears the soil ring for long displacements. On the other hand, though the testing of undisturbed soil specimens in its intact condition is actually possible, it is difficult, as obtaining a specimen from the actual slip surface of a landslide and aligning the sample in the ring shear apparatus is cumbersome. Thus, the fact that the testing conditions are achieved by disturbing the natural structure of soil gives rise to the pertinent question of whether the disturbance of the natural OCR condition of the soil in the laboratory could have a significant effect on the test results, which may cause the results to deviate from what it might have been, had the soil sample been sheared without disturbance and reconstitution. To this question, landslide and soil mechanics related research literature provides contrasting opinions, which can be briefly outlined as follows. Pioneering among them was Skempton (1964), who concluded that despite dilatation, the post-softening particle arrangement of an overconsolidated soil mass is still denser than a normally consolidated soil at the same normal stress. However, Skempton also concluded that residual strength is, independent of stress history (OCR) and mainly affected by the clay fraction of the soil. Skempton (1964), Kenney (1967), Lupini *et al*. (1981), Gibo *et al*. (1987), Tika (1999) and Moore (1991) have showed that the residual strength of soils depends on factors such as normal effective stress, clay mineralogy, particle shape and size distribution, pore water chemistry and rate of displacement, yet they have all excluded stress history (OCR) as a contributing factor to residual strength. Based on ring shear tests on Brown London Clay, Bishop *et al*. (1971) indicated that the relationship of effective residual strength versus effective normal stress is independent of specimen preparation, stress history (OCR) and initial soil condition. Stark *et al* (2005) too stated that the residual shear strength is not a function of sample preparation (hence not a function of OCR) because the aggregated particles are broken down during the continuous shearing in one direction in the field and the laboratory. Accordingly, since many other authors too have acknowledged the effect of OCR only as a contributing factor to peak shear strength and strain softening (Henkel 1956, Parry 1960), almost all previous work on soil shear strength before the '90's, has treated overconsolidation as a factor that does not influence residual shear strength of a soil. However, disputation of this fact is not absent in research literature, however, with much less prominence. Findings by Picarelli (1991 & 1998), referenced in the 39th Rankine lecture by Leroueil (2001), has showed a considerable deviation from the results produced by past researches in that the residual strength of reconstituted samples of Laviano clay shales and Eastern Canada sensitive clays had turned out to be substantially lower than that of undisturbed samples of the same. Picarelli suggested that the internal fissure structure and the presence of 'lithorelicts' (clay lumps) as the reason for his observation, which, he argued, significantly affects the residual strength of clay shales in its undisturbed condition. In 1996, Nakamori *et al* also reported similar observations regarding natural soil structure and the residual shear strength. They found that the distinct microstructural characteristics that exist in shear surface soil