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Shearing rate effect on residual strength of slip soils and its influence on the deformation characteristics of landslides

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During a landslide event, the shearing rate in the sliding zone is expected to be very low, whilst during dynamic events such as changes of reservoir water level or earthquakes, the shearing rate can be orders of magnitude higher than during general conditions[1,2]. The response of the residual strength of slip soils varies significantly with the corresponding shearing rate. Thus, there is a need for an improved understanding of shearing rate effect on residual strength of slip soils in order to improve the level of stability analysis and design of countermeasures against the reactivation of landslides.

The Huangliangshu reactivated landslide in the Three Gorges Reservoir area was triggered by the fluctuation of reservoir water level. It kept moving since 2008, showing accelerating and decelerating movement during the fluctuation of reservoir water level. The response relationship between the horizontal displacement of the landslide and the reservoir water level was noticeable. The slip soils were taken from the back edge of the landslide. Using ring-shear testing on reconstituted soil samples over a wide shearing rate varied in a range of 0.2mm/min-20mm/min, this paper examined the impact of shearing rates on the residual strength of slip soils (Figure 1). The influences of moisture content and normal stress on shearing rate effect were analysed. The relation between the shearing rate effect and the deformation characteristic of the landslide was explored by the numerical simulation technology. The test results revealed that the residual strength of slip soils increased linearly with an increase in the logarithm of shearing rates. Further, the equation which quantitatively assessed three types of shearing rate effect was presented: τ_r=ALn(ν)+B, where A was the rate effect coefficient. The residual strength of slip soils would display different effects of shearing rate, accompanying A. The value of A reached the minimum value with the maximum moisture content and the minimum normal stress in the positive rate effect. Based on the equation, the deformation process of the Huangliangshu landslide was clarified by FLAC3D. Due to the positive rate effect, the residual strength of slip soils had a noticeable fluctuation and the activated landslide gradually tended to become stable. The simulated results agreed well with the monitoring results and could provide an explanation for the continuous accelerating–decelerating process of landsliding [3]. In summary, the shearing rate effects on residual strength of slip soils play a decisive role in the deformation process. In addition, the results indicate there is a one-to-one correspondence between the types of shearing rate effect and the deformation characteristics of landslides.

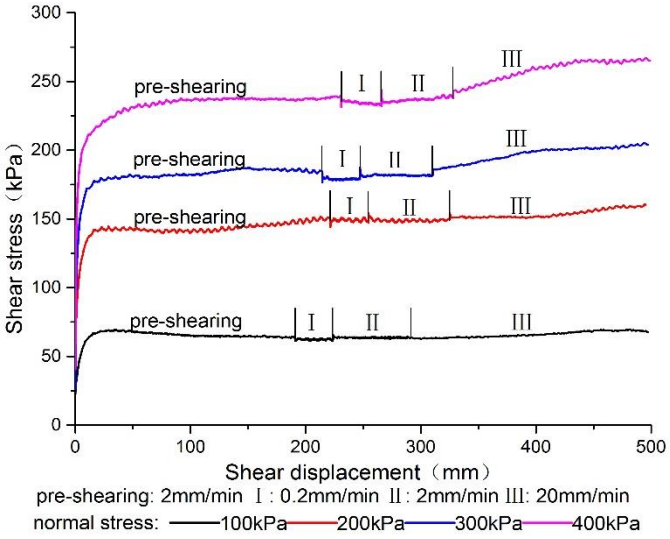

Figure 1: Typical results of various shearing rate

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[3]Wang G and Suemine A and Schulz W H (2010) Earth Surface Processes and Landforms 35(4): 407-416