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Effects of Dehydration on the Residual Shear Strength of Hydrous Material in High-velocity Shearing

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The residual shear strength of materials on the shear surface is a crucial parameter influencing the movement of landslides. This parameter exhibits varying behavior with changes in shear velocity, refer as positive, neutral, or negative rate effects, where residual shear strength increases, remains constant, or decreases, respectively. Among them, the negative rate effect has attracted more attention. Previous research has shown that when the shear velocity exceeds 0.01 m/s and reaches several meters per second, a significant reduction in the coefficient of friction is observed in some shear tests, even with values dropping as low as 0.1. However, the mechanism of strength weakening during high-velocity friction tests is still unclear. Recently, frictional heat generation has been inferred as a potential factor contributing to this phenomenon. During high-speed shearing, frictional heat generation becomes pronounced, potentially causing the material to undergo decomposition, melting, dehydration, and more. To investigate the potential effect of dehydration on the shear behavior of hydrous material, a series of ring shear tests were conducted using a hydrous material (halloysite nanoparticles, ADH_{orig}), and the same material pre-dried at 500 ℃ (ADH_{500}). These tests were performed under a normal stress of 200 kPa and varying shear velocities. Results represent that for both ADH_{orig} and ADH_{500}, their residual shear strengths (τ_r) increase slightly with shear velocity (V) at low velocities (0.1 ~ 10 cm/s), but decrease with a further increase of V beyond 10 cm/s. It is noticed that a sharp decrease in τ_r when V reaches about 210 cm/s, with τ_r for ADH_{orig} being half of that of ADH_{500}. The results of XRD on the sample after testing and estimates of shear surface temperatures suggest that during high-velocity shearing, interlayer water in ADH_{orig} is dehydrated. Under high-temperature conditions, the interlayer water is inferred to be released as a vapor phase, contributing to the observed reduction in shear strength. In contrast, due to the ADH_{500} being dried at 500°C, the interlayer water was fully lost before the test. Therefore, during high-velocity shearing, ADH_{500} does not undergo dehydration, and any dehydration that does occur is negligible.