Geophysical Research Abstracts
Vol. 12, EGU2010-8535-1, 2010
EGU General Assembly 2010

Relevance of pore fluid composition for the drained strength of clays

Giovanni Spagnoli (1), Tomás Fernández-Steeger (1), Christian Arnhardt (1), Helge Stanjek (2), Rafig Azzam (1), and Martin Feinendegen (3)

(1) Department of Engineering Geology and Hydrogeology, RWTH Aachen University, Lochnerstraße 4-20, 52064 Aachen (Germany) (spagnoli@lih.rwth-aachen.de/+4924180-96777)., (2) Clays and Interface Mineralogy, RWTH Aachen University, Wüllnerstr. 2, 52056, Aachen (Germany), (3) Chair of Geotechnical Engineering, RWTH Aachen University, Mies-van-der-Rohe-Straße 1, 52074 Aachen (Germany)

Classical soil mechanics based on the effective stress concept with water as second phase does not apply anymore for fine-grained materials. Since clays particles are per definition colloidal in size, their properties are determined and dominated by their large surface area and hence, by their surface forces. Therefore, other mechanism plays a role. Geotechnical properties of soils with different pore fluid are especially important for clays used in hydraulic barriers for landfills. Also in the petroleum engineering or in tunnelling engineering the mechanical properties of clays with different pore fluids could be very useful.
Since for clays physical and chemical interactions are decisive, the pure mechanical model (e.g. shearing and contact among the particles) is coupled by other forces, typical for colloidal sized materials. If the diffuse double layer develops from the surface of the clay particles, the interactions of the layers should develop a repulsion. That would resist part of the normal stress and producing no shearing resistance. However, the clays show different properties, dependent on their mineralogy, which complicates their behaviour.
Several drained shear stress with shear box have been performed on pure Kaolinite, Illite, Na-Smectite and Ca-smectite. Since the shear behaviour of clays is also controlled by chemical interactions, the clays were mixed with pore fluids with different dielectric constant (water, ethanol), electrolyte concentration (NaCl and CaCl2) and pH (ranging from 3 to 8).
Different consolidation pressures (from 15 kPa to 400 kPa) have been used in order to better understand the influence of the pore fluids on the drained cohesion (c') and on friction angle (ϕ').
The materials were mixed with different consistency to form a paste. The consistency ranges from 0.65 to 0.85.
The results show how the sensitive the clays to different pore fluids are. Besides, Kaolinite and Illite shows a shearing behaviour almost entirely controlled by mechanical forces between the particles independent on the water content and stress state, while on the other hand, smectite (Na and Ca) shows strong dependence on the variation of diffuse double layer (DDL). In order to be able to manipulate the material behaviour of clays, it is important to understand the interaction and significance of the different parameters.
This project is funded by the German Federal Ministry of Education and Research (BMBF) in the frame of the programme GEOTECHNOLOGIEN.