Master Thesis

Topic:

Improving the sample quality from soft sensitive clay deposits by the use of biodegradable synthetic polymers in drilling fluids

Description:

Figure: Use of the type Mini-block Sampler (Black Insitu Testing, Australia) as an example of advanced sampling techniques

Soil mechanical properties like stiffness, shear strength, soil viscosity and permeability of natural clays as well as their anisotropic behavior is a result of the processes during diagenesis. Related to the stiffness and shear strength the term structural strength is used to summarize mainly the effects rising form bonding and fabric at the scale of individual clay particles (nano-scale) and the scale of the particle assembly (micro-scale) which in the case of lacustrine clays as well comprises decisive contents of silt and fine sand. The structural strength at least at small strains i.e. $< 10^{-5}$ is well measurable by comparing the results from in situ tests by e.g. applying non-destructive methods like the analysis of seismic waves and the corresponding results obtained on so-called remoulded samples prepared in the laboratory comprising an ideally amorphous arrangement and orientation of the soil particles with only limited unavoidable instantaneously forming of bonding by chemical forces at the clay particles. So far so-called element tests for examining the constitutive behavior of soil at compared to seismic waves significant higher strain i.e. $> 10^{-4}$ are only possible by taking samples from the field and performing experiments like the oedometer test, triaxial test and resonant column test the in the laboratory. Hence to preserve the natural structural strength of the samples is of major interest. In the last decades considerable effort was undertaken to improve and establish sampling techniques suitable for soft sensitive clay deposits. Despite the advances even the most advanced sampling technologies still cannot prevent disturbance by the stress relief once a sample is cut from the soil and lifted up from the bore hole. This stress relief causes instantaneously undrained shear deformation and subsequent volumentric expansion governed by the delayed flow of water and possibly air into the pores of the sample. If the negative pore pressure within a sample reaches the tensile strength of the pore water cavitation may occur associated with volumentric strain that as well leads to sample disturbance. One approach to reduce the volumetric expansion of the sample is the use of specially designed of biodegradable synthetic polymers in drilling fluids. The aim of this fluids is to prevent the penetration of water, air and other liquid materials into the pores of the sample. If full saturation of the pores of the sample by ground water is assumed and cavitation is not taking place e.g. by providing lateral support during sampling the volumentric

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strain will be eventually reduced to zero by the use of the proposed drilling fluids. The reduction of volumetric strains during sampling will improve sample quality enhancing the meaningfulness of element tests conducted in the laboratory.

Scope of work:

This study aims to investigate the advantages of biodegradable synthetic polymers in drilling fluids for the sampling at soft sensitive clay deposits. The works are carried out in cooperation with the company of GEO-BOHRTECHNIK GmbH. A first suggestion is to investigate a polymer called AMC BIO VIS XTRA, a high-viscous mixture of natural polymers formulated for mixing low-solid drilling fluids for use in water wells. Moreover, other biodegradable synthetic polymers in drilling fluids have to be searched by a literature review and evaluated considering the scope of the application. If possible the laboratory tests should comprise at least 3 different drilling fluids. As a reference water as a drilling fluid has to be examined. For the proposed laboratory tests samples of Rosenheim Seeton a soft lacustrine clay will be consolidated under isotropic pressure. After consolidation the samples will be exposed to the different drilling fluids and their volumentric change will be measured. A suitable evaluation of the carried out experiments is necessary to draw a conclusion for future field tests. These tests on a test site close to Rosenheim as well as future laboratory tests can be accompanied by the applicant as a research assistant after completing the master thesis.

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