CASE STUDY: TRIAXIAL AUTOMATED SYSTEM

USER: DR.-ING. WILFRIED HÜLS, SACHVERSTÄNDIGER FÜR GEOTECHNIK, G.U.B. INGENIEUR AG

The G.U.B. Ingenieur AG *was founded in 1991 as an engineering company in Zwickau, located in the Free State of Saxony. Within the next few years a number of subsidiaries were established, which merged in 2007, into the G.U.B. Ingenieur AG. The company is mainly active in the fields of geotechnical, environmental and construction engineering, including various supplementary services.*

The operating engineers, scientists and technicians within the G.U.B. Ingenieur AG have many years of professional experience in the fields of geotechnics, geology, hydrology, hydrogeology, environmental engineering, geophysics, engineering seismology, construction engineering, transport planning, landscape design/landscape architecture, hydraulic engineering, surveying and geoinformatics.

Useful Link:
http://www.gub-ing.de/

GDS Instruments
Unit 32 Murrell Green Business Park
London Road
Hook
Hampshire RG27 9GR
UK

T: +44 (0)1256 382450
F: +44 (0)1256 382451
E: info@gdsinstruments.com
W: www.gdsinstruments.com

THE PROBLEM

The quantity of land affected in the extraction of lignite in opencast mines is vast. Former mining activities leave behind numerous mine voids, which will mostly remain as artificial lakes from rising groundwater and flooding. Overburden dumps are stretched over large areas. These areas present themselves as often uninhabitable and difficult areas for construction without further site investigation and understanding.

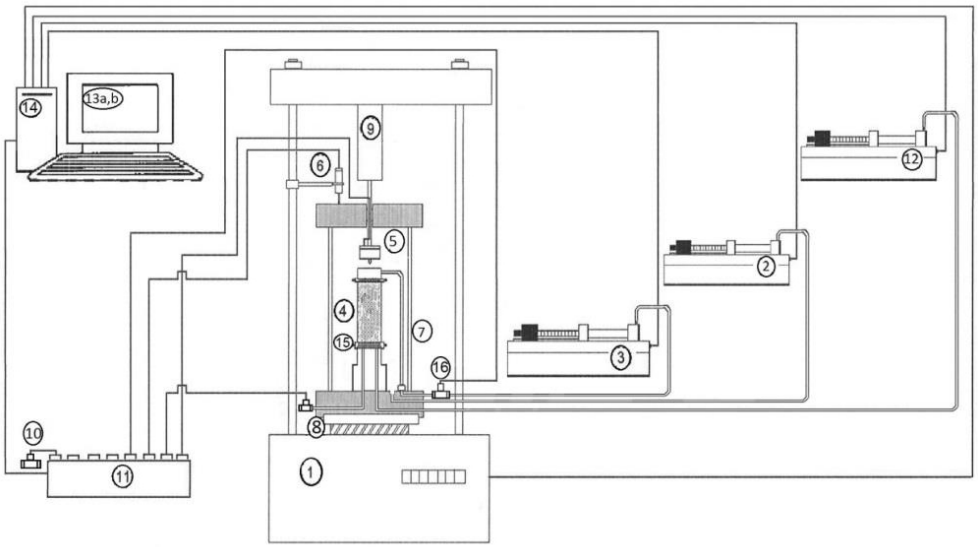
For the successful rehabilitation it is necessary to accurately determine the movements and deformations of the dump masses, that occur over time. The non-cohesive soils in particular, are susceptible to liquefaction when exposed to groundwater impact.

There is a requirement for the pit slopes and overburden dumps at the Central German Lignite District, which remain since 1990, to be secured to provide usable land. This enormous project asks for a scientific foundation based on planning and rehabilitation, as well as an engineering verification.

GUB AG is one of the consulting partners of the LMBV Ltd., the mining company which is the owner and responsible for the affected areas, it was their responsibility to come up with a solution to resolve the complex geotechnical problems and ensure the area becomes safe and parameters assessed, such that decisions can be made on how to stabilise the area for the future.

THE SOLUTION

The ground failures caused by liquefaction occurring away from the slopes, which are connected to the large scale rise in groundwater conditions, cannot be described using the classical soil mechanics calculation methods alone. A micromechanical-hydraulic modelling of non cohesive soil is considered a possible approach. After analysis of the initial research, a testing schedule was devised to take into consideration three key characteristics of the soil. These characteristics were the changes in liquid, gas and density of the soil, which are



(1) Load Frame	(5) Submersible Load Cell	(9) Pressure Cylinder	(13) Controlling Software
(2) Cell Pressure Controller	(6) Displacement Transducer	(10) Pressure Sensor for Atmospheric Pressure	(14) Controlling Computer
(3) Pore Air Controller	(7) Triaxial Cell	(11) Data Logger	(15) HAEPD Filter Stones
(4) Sample	(8) Pore Pressure Sensor	(12) Saturation Pressure Controller	(16) Pore Pressure Sensor (air)

Fig 1: Schematic diagram of GDS Instruments Triaxial Automated System upgraded to perform Unsaturated Testing

in turn deemed responsible for the sudden base failures that have been observed. Each characteristic needed to be measured, controlled and evaluated by the testing regime. The chosen apparatus for performing the tests was the GDS Instruments Triaxial Automated System (GDSTAS), upgraded to perform Unsaturated Testing (UNSAT), see Fig 2. The UNSAT part of the system provides gas (generally air) pressure control, allowing the user complete control of all three characteristics, whilst at the same time monitoring the results through the automated software. The UNSAT system itself was chosen for its ability to be customisable for most test situations, whilst providing highly accurate test results.

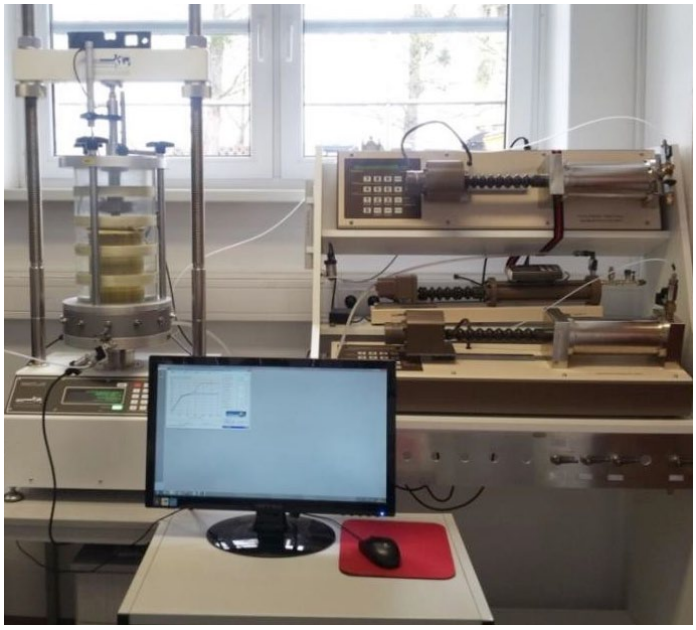


Fig 2: Triaxial Automated System with UNSAT upgrade in GUB AG laboratory

THE RESULTS

The UNSAT system allowed GUB AG to re-create the complex test conditions of the mine by independently controlling the liquid and gas phases within the soil. Initial results identified sands with a particular size grain and shape as the problematic material. Results concluded an increase in axial load wasn't necessarily the catalyst for failure; a rise in groundwater alone could cause the sands to fail. This meant the collapse could happen before the mechanical limits of the soil are reached. The abandoned mines were therefore at risk to damping soil slope failures, and liquefaction within flatter damping areas. Not only were homogeneous areas affected, but also changing layers (permeable and not permeable) at risk due to remaining air bubbles during ground water rise. The results from the GDS UNSAT apparatus provided data for the first time that could be compared and used within numerical models. (Fig 3 shows the development of axial load and pore air pressure. Fig 4 shows the development of axial displacement and grade of saturation during an injection).

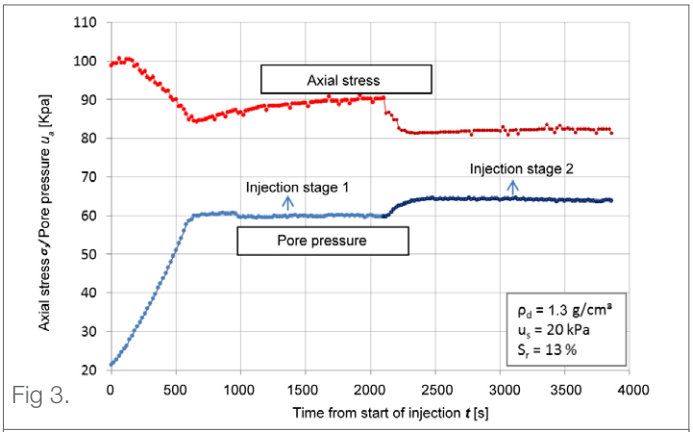


Fig 3.

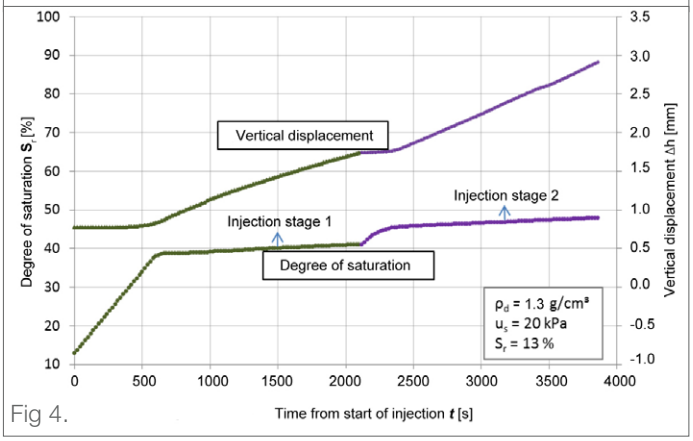


Fig 4.

TESTIMONIAL AND ACKNOWLEDGEMENTS

"We at GUB AG are extremely satisfied with our GDS Triaxial Automated System with UNSAT upgrade. It was possible to simulate all described difficult circumstances for the first time under lab conditions. Thanks to the GDS equipment we now have an additional tool in favour of a solid strategy for the rehabilitation of these areas. They (GDS) provided good service, well working equipment and good cooperation." Wilfried Huels from GUB Ingenieur AG.

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