Art der studentischen Arbeit: ***Type of study work:***	Master's thesis
Teilprojekt: ***Sub-Project:***	**A5 + A6**
Kategorie: ***Category:***	**Theoretical + Experimental**

Name des Betreuers: (Name, Raum, Telefon) ***Name of Supervisor/(s):*** *(Name, Room, phone number)*	Chenyang Zhao / Zdenek Zizka / Arash Alimardani Lavasan / Britta Schößer / Wiebke Baille
Start:	As soon as possible

Aufgabenstellung:
Task formulation:

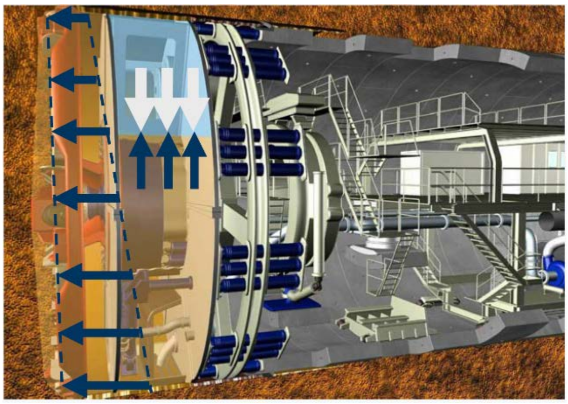

Fig. 1: Slurry shield

Slurry shields (Fig. 1) represent a well proven technology for excavation within water bearing soft soils. Granular soils, starting from silty sands and terminating at sandy gravels, are the main application range of the slurry shields.
Slurry shields make use of bentonite suspension as support medium of the tunnel face. The function of the suspension is to stabilize the subsoil by creating a zone of reduced permeability in the ground and thereby transfer the slurry pressure on soil grains. This pressure transfer can be achieved in two ways (Fig. 2): (a) a penetration zone and (b) with a membrane. The membrane, also called filter cake, creates a thin impermeable layer directly on the tunnel face, and enables a transformation of excess slurry pressure into effective support stress. In the case of a penetration zone formation, the excess slurry pressure is transferred into the soil skeleton along the entire penetration depth by shear stresses between suspension and soil grains.
The most recent research shows that the factors of the time-dependent penetration process or filter cake formation, which have not yet been studied thoroughly, are very important within slurry shield excavation.

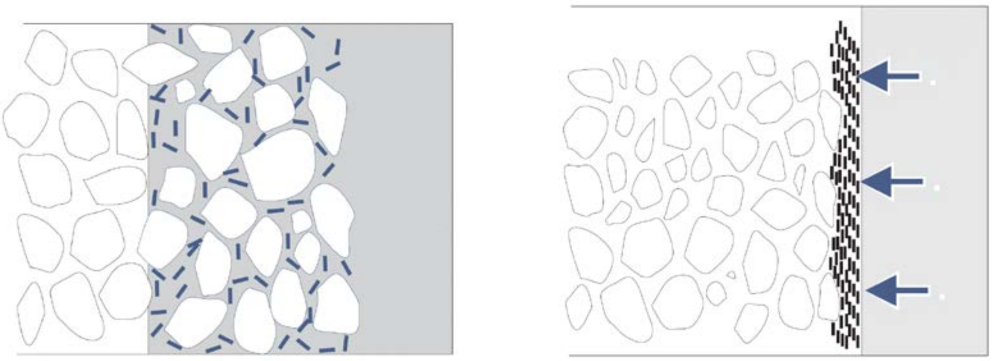

Fig. 2: Two basic pressure transfer mechanisms on the tunnel face – a) penetration zone b) filter cake

Masini, Rampello and Soga (2014) gave the analytical solution to obtain the thickness of filter cake with respect to time by considering the loss of water under constant pressure. Their model is

validated based on the 1D filtration test. Schaufler, Becker and Steeb (2012) proposed the evolution of void ratio and permeability with respect to time by considering the movement of fine particles. It is necessary to summarize the current methods which can be employed to calculate the penetration depth with respect to time. Thereafter, model validation should be conducted based on the designed experiments.
Since the realistic tunnel excavation is difficult to investigate in the lab scale, numerical simulation has become a powerful tool to simulate the tunneling process, and it is able to consider the effect of filter cake or penetration zone. Based on the validated analytical solution, hydraulic properties of soil and slurry can be updated in the numerical model and manually coupled with the system mechanical behavior. By doing so, the influence of slurry shield on the model responses, such as pore water pressure distribution and surface settlement, can be evaluated.

Zielstellung:
Aim of the work:
1. Validation of the analytical solution of time-dependent penetration depth based on the experiments. A statement about the suitability of the theoretical approaches should be made.
2. Generate a Finite element model using PLAXIS and take into account the time-dependent penetration depth, its effect on the model responses should be evaluated.

Arbeitspakete/Umfang:
Working packages/Scope of the work:

AP1: Literature review
AP2: Implementation of the theoretical approaches for filter cake formation or slurry penetration into chosen calculation program (e.g. Excel, Mathcad). Following approaches should be considered in particular: Schaufler, Becker and Steeb (2012); Masini, Rampello and Soga (2014); Lemppenau (2015); Talmon, Mastbergen and Huisman (2013)
AP3: Choosing suitable combinations of soil and bentonite suspension based on the experimental data of the Institute for Tunneling
AP4: Performing the calculations for chosen slurry type, soil type and slurry excess pressure
AP5: Performing verification experiments in the lab of Institute of Tunneling (if needed)
AP6: Apply PLAXIS to generate the Finite Element model which has the same size as the experimental device and conduct model validation based on the experimental results
AP7: Generate real scale tunneling model and take into account the time-dependent penetration depth to evaluate its influence on the model responses