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Experimental and analytical investigation of the relation between B-value and degree of saturation

(Experimentelle und analytische Untersuchung des Zusammenhangs zwischen B-Wert und Sättigungsgrad)

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Introduction

Saturation degree of soil plays a significant role in soil mechanics. Among other things, it highly affects the undrained behavior of granular material. In order to model the behavior of soil, it is usually necessary to determine its actual saturation degree. For some laboratory tests, it is indispensable to first either evaluate saturation degree or to guarantee that the soil material taken into the consideration, is fully saturated.

Both, the saturation degree (Sr), as well as the compressibility modulus of the air-water mixture (Kf) can be related and specified by the use of Skempton B parameter, which bonds at the same time relationships of the compressibility modules of soil skeleton, water and air respectively. Therefore the Skempton B-value and its correlations, will be given the main focus of this research work. Material chosen for the analysis is coarse and fine sand. Load of the present work includes also some additional criteria that might affect (either delayed or speed up) saturation of soil i.e. considering different fluids (different types of water) along with different methods of soil installation.

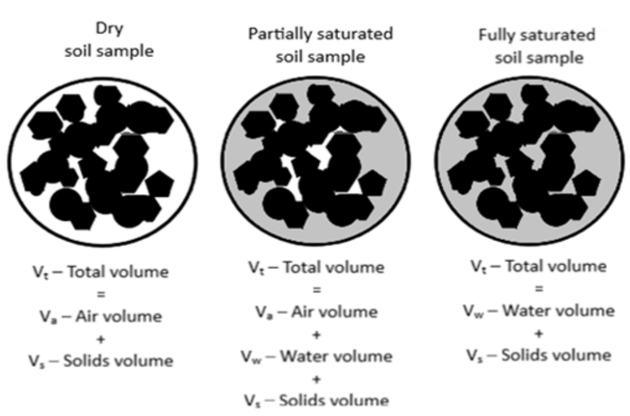

Fig 1: Soil saturation states.

Motive

The main purpose of the research is to investigate the time needed to obtain a sufficient soil saturation. Another insight is given towards the most effective method of sand installation in order to achieve the highest possible saturation of the specimen, in the shortest time. Furthermore, the analysis are aimed to state what kind of water should be used for the saturation experiments. Above and beyond, it is important to find whether constant B- value and B-value of 0.95 is a good indicator of a full soil saturation. For this reason few installation possibilities are checked together with a performed B-Tests afterwards. The findings can improve the prediction of time needed for a sufficient soil saturation as well as to investigate how saturation degree can be achieved faster due to some changes within the process of sample preparation and by using different water types. The analysis is done within the fine **(2018_29_F)** and coarse **(2018_29_C)** sand of loose and dense packing.

No	Sand type	φ [°]	e_{min} [-]	e_{max} [-]	ρ_s [g/cm³]	D_{50} [mm]	C_u [kPa]
1	2018_29_C	30	0,579	0,865	2,65	0,943	1,37
2	2018_29_F	30	0,674	1,105	2,65	0,171	1,44

Table 1:1 Sand properties

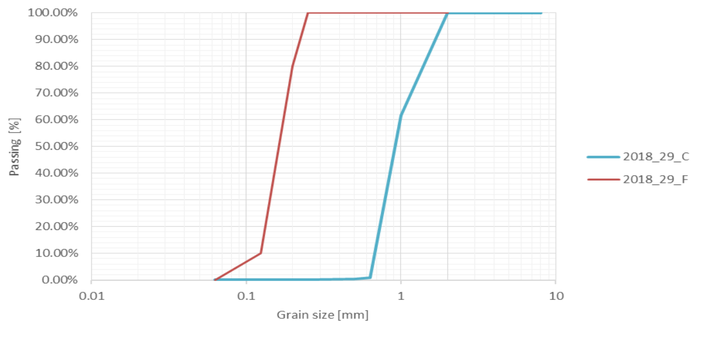

Fig. 1: Grain size distribution curves of coarse **(2018_29_C)** and fine sand **(2018_29_F)** .

Types of investigated sand installation methods

The meaning standing behind the method of a sample installation is, in other words, the procedure of preparing the soil specimen for the test, in order to regulate its packing, as well as, to influence its initial saturation degree. Methods investigated for the present research are divided into three categories which are further subdivided as follows:

1. Dry funnel installation for:

a) dense sand;
b) loose sand.

2. Moist tamping for:

a) loose sand.

3. Installation under water for:

a) dense sand;
b) loose sand.

Types of investigated water

There are three types of water which are examined in this research work. Water type may influence to certain extend the initial saturation degree of a soil sample and therefore is tested, in order to select such fluid which gives the best saturation results. The following types of water are chosen for the experiments:

a) Demineralized water
b) Deaerated water
c) Mineral water

Demineralized water finds its appreciation in the laboratory works. Within this research, it is checked whether demineralized water has the greatest influence on high initial soil saturation degree, when compared with deaerated and mineral water.

Saturation with CO_2

In order to check the impact of CO_2 on the saturation progress, three more test are done based on flushing of the pore space with CO_2. Fine sand and only demineralized water is used for these three experiments.

Results

Each method applied for the installation was checked with all three types of water, in order to compare the efficiency of every method and chosen water type. Results analysis contain graphs with B-value and saturation degree correlations, as well as, graphs with the B-value and time correlation. Time refers to the moment in time when B-value check was done on the specimen and is counted in hours.

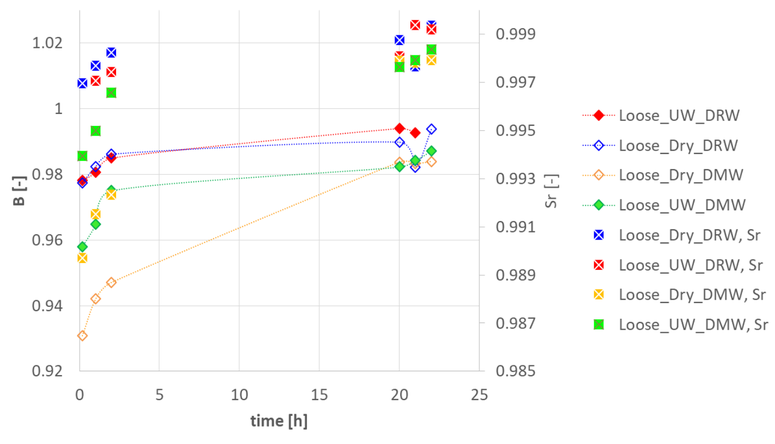

Fig. 2: Installation method comparison.

Method of underwater installation contributes to the initially higher attained parameter B for the most of the cases. Therefore, the underwater method of installation can be considered as more efficient than a dry method of installation.

Deaerated water ensures the highest initial saturation and exhibits only slight increase in saturation degree of soil when the saturation phase lasts longer.

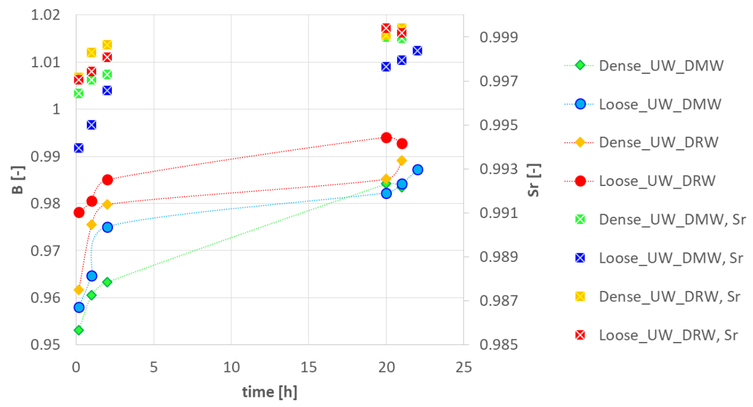

Fig. 3: Water type comparison

The full saturation state is achieved at very early stage of saturation process. Deaerated water is more efficient than demineralized water, for both, loose and dense specimens

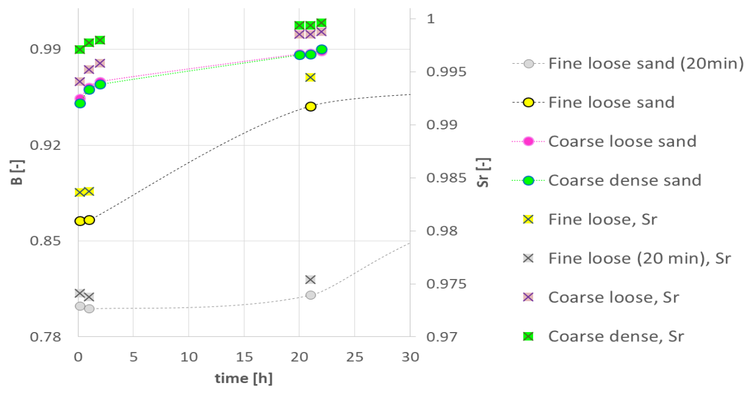

Fig. 4: Saturation Time analysis

It is hard to estimate one B parameter indicator of full soil saturation. That coefficient varies even for the same soil type depending on its packing, density, particles sizes and distribution, what consequently affects the bulk modulus of soil skeleton.

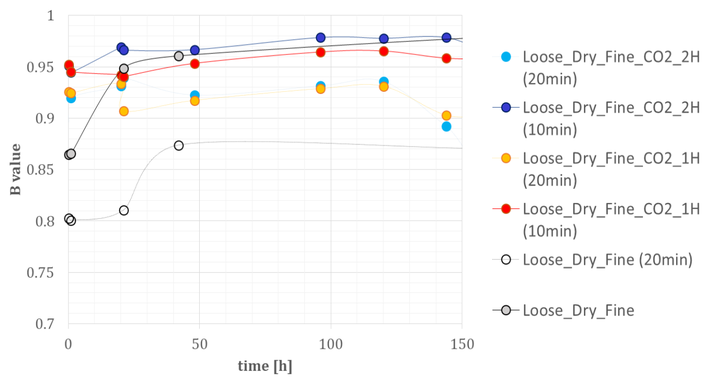

Fig. 5: Saturation Time analysis

Impact of CO_2 on the saturation progress is checked on a fine sand, because its full saturation state, when not enhanced with CO_2, was highly time demanding. CO_2 is found to have a positive effect on saturating the soil, decreasing the time needed for a sufficient soil saturation.

Conclusions

Laboratory tests performed to evaluate the saturation degree showed that:

- Installation under water provides a higher saturation degree in a shorter time over a dry funnel pluviation method.
- Deaerated water is more efficient than a demineralized water.
- Soil saturation can be enhanced by flushing a specimen first with a carbon dioxide. Specimens injected with CO_2 shows a spectacularly higher B-values within first days of saturation phase.

Projekt
Project Work

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Submission
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