Experiments with settling columns to evaluate changes in physical behaviour of drying sediments

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Introduction: The Netherlands produces each year more than 100,000,000 m^3 of dredged sediments. The reuse of dredged material has been proposed as alternative means of sediment disposal. However, in order to recycle dredged material in civil engineering applications, the mechanical behaviour of these sediments, especially regarding their low stress performance, their desiccation and volume change behaviour, needs to be defined.
Volume change behaviour in soils is of importance because of its direct relationship with settlements under compression, heave due to expansion, and deformations arising from shear stresses.
The mechanical behaviour of dredged sediments depends on many environmental and compositional factors, such as the type and amount of organic material. Also the degradation of organic material by biological processes in the subsurface will change the material properties over time. So far the knowledge about the interaction between biological processes and the physical behaviour of dredged sediment is limited or spread over various disciplines.
The main aim of this study is to quantify the volume change behaviour and changes in physical properties due to dewatering of dredged sediments, including self-weight consolidation and ripening for a wide range sediment compositions.

Methods: In order to characterize the mechanical behavior of sediments, columns of circular cross section were used in order to measure the evolution of density, suction stress, moisture content and volume change. The columns also incorporated tensiometers at different heights to measure the development of suction in the soil during drying.
Initially, various column diameters from different materials were tested to determine the optimal size and material. This was done to minimize the boundary effects on the tested samples. After the optimal diameter was established, different configurations for the tensiometers were investigated. The adequate arrangement was found to minimize the disturbance on the tested samples.
The following step was to establish a benchmark for the change in volume, suction stress, moisture content and density. This was carried out using a commercially available clay (illite) that was settled from liquid suspension (mud) in the columns. Later, experiments were conducted using a mix of the clay with different flocculants to evaluate the differences in performance of various soil mixtures.
For all these experiments, measurements of suction, moisture content through time (using destructive testing), changes in density using CT-scanning (Fig. 1) and changes in volume were carried out.

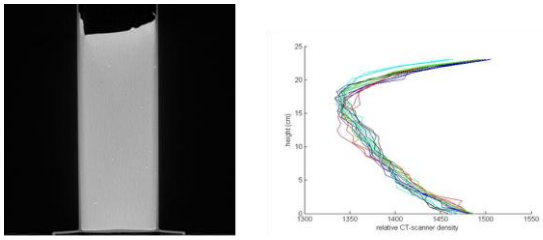

Fig. 1: CT-scanning (left) was used to measure the density profiles over the height (right) at various time intervals in column experiments.

Results: The changes in volume, density, suction stress and moisture content of sediments with time were successfully measured for different soil mixtures. Preliminary results show that the columns provide reliable data regarding the physical changes in the sediment during the drying process.
Clays with flocculants develop a different density profile with time compared to a clay without additives.

Discussion: As a result of these investigations, it is expected that new knowledge and guidelines for the use of dredge sediments will emerge, providing practical solutions for the sediment reuse.

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