The Effect of Organic Matter on Shrinkage and Water Retention Behaviour of Organic Dredged Sediments

Stephen Chin-a-Moei[1], Leon A. van Paassen[2], Nor Hazwani Md. Zain[1], Claire, Chassagne[1], Cristina Jommi[1]

[1]Delft Uinversity of Technology, Department of GeoScience & Engineering, Stevinweg 1, 2628CN Delft, The Netherlands.
[2]Arizona State University, Center for Bio-mediated and Bio-inspired Geotechnics P.O.Box 873005, 85287 Tempe, Arizona, United States.

Phone: +001-(480)-965-1075
E-mail: leon.vanpaassen@asu.edu

Introduction: Peatlands and organic soils in Delta areas suffer from continued surface subsidence, while at the same time accumulation of suspended sediments originating from these peatlands leads to poor water quality. Many researchers attribute the majority of surface subsidence of peatlands to decomposition of organic matter, particularly as a result of aerobic oxidation during periods of low groundwater level. The sediments which settle in the ditches and lakes are regularly dredged and deposited in depots on peatlands. Spreading these sediments on land may partially compensate for surface subsidence. To improve the understanding of the ripening behavior and to quantify the efficiency of using dredged sediments to mitigate subsidence, an experimental study was performed analyzing the effect of organic matter and initial water content on the shrinkage and water retention behavior. Additionally, the formation of gas during the ripening process is investigated.

Methods: From the peatland Wormer & Jisperveld in The Netherlands, dredged sediments were collected from a depot and core samples were taken over the course of three years. Soil characterization tests were carried out and a novel approach of combining the extended evaporation method using the HYPROP set-up with computed tomography was used. Experiments were varied by differing the organic and initial water contents, through chemical oxidation of organic matter using Hydrogen peroxide and fan drying prior to the evaporation tests, respectively. The initial water contents were prepared with consistency at or above liquid limit.

Results and Discussion: Chemical oxidation of the organic matter reduced the liquid and plastic limits of the sediment. The effect of organic matter on the shrinkage characteristics were not significant for the range of water contents relevant during the desiccation process observed in the field. Only normal shrinkage was observed at near saturated conditions, where the loss of water volume is equal to the loss of bulk soil volume. In contrast, the water retention characteristic curves were greatly influenced by the oxidation of organic matter: At any given suction level, the water content was significantly reduced after oxidation. Varying the initial water content changed the onset of the water retention characteristic. For the shrinkage behavior the lower initial water content only reduced the onset of the shrinkage curve. Computed tomography showed that the gas formation only occurred within the non-oxidized sediments. The first gas bubbles appeared at suction levels below 1 kPa. Gradual movement of the gas, aggregation, bubble growth and ebullition events were observed. The main mechanism of gas formation and type of gas could not be determined with the applied test methods. However, it is considered to have been caused by either exsolution of dissolved methane, oxidation of organic matter or a combination of both. Further research is needed for verification.

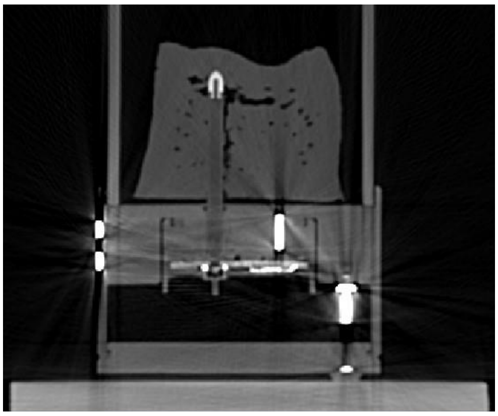

Fig. 1: An example image from CT-analysis, showing a section through the shrunken soil sample after significant mounted on the HYPROP sensor unit.

Acknowledgements:
This research is supported by the Dutch Technology Foundation STW, via the perspective program BioGeoCivil (grant 11344). The authors greatly acknowledge the support from technical staff at Delft University of Technology.