Crax'n'Clay
The Analysis of Dessication Cracks

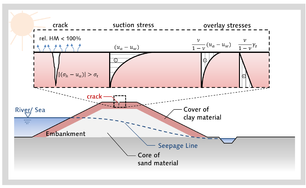

Figure 1: Cracking procedure in embankment cover through evaporation process

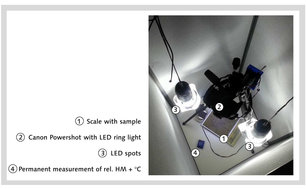

Figure 2: Experimental setup

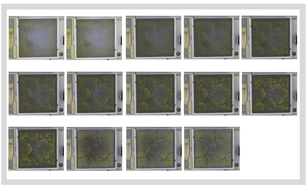

Figure 3: Original images with displacement vectors

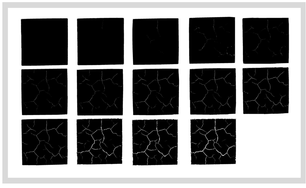

Figure 4: Binary images analyze of square sample

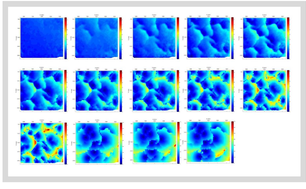

Figure 5: GeoPIV displacement analyze of the sqaure sample

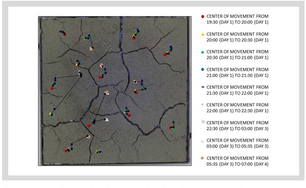

Figure 6: Results of trajectories of center location of the drying square sample

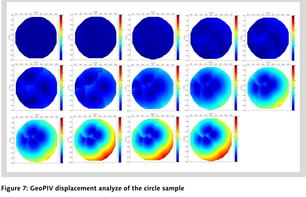

Figure 7: GeoPIV displacement analyze of the circle sample

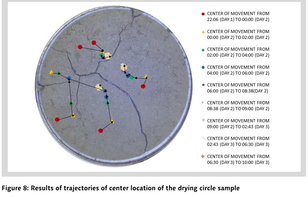

Figure 8: Results of trajectories of center location of the drying circle sample

MOTIVATION

In many geotechnical applications such as earth dam design and capping system of landfills, tensile failure of unsaturated cohesive soil caused by desiccation is important. This project used two different kinds of moulds (square and circle mould) to present two types of results of compacted clay sample with a certain initial parameter during the free shrinkage test. The results for each test include the displacements, volume changes, water contents over the whole shrinkage process and in particular at failure stages can be documented.

SOIL PROPERTIES AND PREPARATION

In this project, a soil with the main mineral Illite was chosen to make the samples. A certain point at an initial water content 36.9%, dry density 1.316 g/cm^3, saturation 94.27% was used. The sample was prepared in a specific procedure. This was essential to the quality and reproducibility of the results of the experiment.

At first, the clay powder was wetted to a water content of approximate 27%, thoroughly mixed and crushed in a cutter, and then stored in an airtight container for 5 days to allow the homogenization to occur. Secondly, the clay was dried to 14% water content in the oven at about 50 °C and was stored in an airtight container again for 5 days to allow for the homogenization. At the last, the material was wetted to the desired water content, 36.9%, again thoroughly mixed and crushed in a cutter. In this stage, the mixed clay was also stored in an airtight container for homogenization in 6 days. Until then, the clay was ready to be used.

SETUP AND EXPERIMENTAL PROCEDURE

During the free shrinkage test, two different kinds of moulds were used: square and circle mould. Size of the square mould is 19.97cm*19.97cm with a height of 1.00 cm. The diameter of the circle mould is 15.00 cm with a height of 1.00 cm.

The setup of the experiment consists four main components, which are (1) a clay sample in the certain mould (square or circle mould) which constrains up the clay during preparation. The sample is put on a electronic balance with a precision of 0.001g to measure the water content of the sample. The changes of the weight is recorded continuously on a computer. (2) A digital still camera (Canon PowerShot SX50 HS) to take images of the shrinkage test, (3) a LED ring light screwed directly with the lens and two LED spots which are used to prevent disturbing influence of shadows and provide the lights, and (4) a climate data logger to record temperature and humidity during the test.

At the beginning of the test, the clay sample with a certain weight was compacted into a corresponding mould. Relating to a square mould, the weight was 719.19 g. Otherwise, a clay sample of 318.37 g was used for a circle mould. The sample was left to dry in an enclosure space, which was controlled to a temperature and a relative humidity. The setup was placed on the electronic balance which recorded 5 values every minute. Every minute one image was taken and recorded by the digital camera. The environment condition around the setup was constant and recorded by the climate data logger. The drying period is 3-4 days for each type of mould.

To calculate the displacement during the desiccation, GeoPIV, a Particle Image Velocimetry (PIV, also known as image correlation) based on MATLAB was used. This code contains a digital image and compares the movement of texture through a series of images (White et al. 2003). Contrasting stochastic patterns were sprinkled randomly on the sample. For square mould, meshes of 50 by 50 pixels with path size of 3.8 mm by 3.8 mm (1 pixel ~ 0.077mm) are settled. For circle mould, the path size is 4.5 mm by 4.5 mm (1 pixel ~ 0.090 mm). From the GeoPIV software, displacements were determined.

To analyze the changes in the area the images were convent to binary pictures, based on MATLAB image processing. Geometric parameters were evaluated by the detected pixel information, which was provided by the software code. Changes of areas by square mould are presented in binary form.

EXPERIMENTAL RESULTS

The centers of the movement in each patch can be determined by analyzing the displacement vectors. As the friction between base and clay was changing all the time, the centers of movement moved from time to time. The trajectory of the movement can be found and used in equation below to get the suction stress,

$$\sigma^s(\theta) = -\frac{E(\theta)u_r(r,\theta)}{(1-\mu)r(\theta)} \qquad (1)$$

Where $\sigma^s(\theta)$ donates the suction stress at the water content θ, $u_r(r,\theta)$ donates the displacement of the center movement at a specific distance r from the center of the sample to the displacement field, $E(\theta)$ donates the elastic modulus at a current water content θ and μ stands for Poisson's ratio.

With the knowledge of $E(\theta)$, u_r and r, suction stress σ^s at each patch of the certain water content can be fully quantified by equation (1).

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