A Study on Wetting Soil-Water Characteristic Curve of a Sandy Soil

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ABSTRACT

The determination of soil-water characteristic (SWCC) is of prime importance in unsaturated soil mechanics. For decades, experimental studies are performed to investigate the relationship between the soil suction and volumetric water content (SWCC). Most of the reported studies discuss about drying SWCC due to the simplicity of its measurement. It must be noted that wetting SWCC is equally important for situations like seepage through unsaturated soil. However, it is very difficult to determine wetting SWCC. A new approach has been discussed in this paper for developing wetting SWCC with the help of a column test set up. The methodology has been demonstrated by determining the wetting SWCC of a locally available sandy soil.

1. INTRODUCTION

Soil suction (matric suction, $\psi_m$, or total suction, $\psi$) and its relationship with water content (or degree of saturation), is termed as soil-water characteristic curve (SWCC) and it plays a pivotal role in understanding the behaviour of unsaturated soil (Fredlund & Rahardjo 1993: Sreedeep & Singh 2005; Gallage & Uchimura 2010; Rao & Singh 2010).

It can be noted that the drying and wetting SWCCs are different for the same soil, which is attributed to the phenomenon of hysteresis (Fredlund & Rahardjo 1993). It must also be noted that the use of wetting or drying SWCC is case specific, depending on the nature of study. Hysteresis information of soil helps to select the appropriate SWCC equation to be used for the SWCC parameter identification. Most of the researchers have used pressure membrane apparatus for obtaining wetting SWCC. However, this apparatus is costly and it does not simulate the field condition. Further, the boundary conditions can not be controlled fully. Gallage & Uchimura (2010) have used Tempe cells for developing wetting SWCC of sand. But Yang et al. (2004) have found that Tempe cells are not suitable for obtaining the wetting SWCC on coarse grained soils. This calls for the development of an alternative technique that can be employed for measuring wetting SWCC which is cost-effective and represents more realistic situation existing in the field.

With this in view, the present study attempts to develop a column test setup for studying the wetting behaviour of soil. The test setup has been demonstrated by determining drying and wetting SWCCs of a locally available soil. Details of the methodology adopted are presented in this paper.

Theoretical Background

A typical drying (desorption) and wetting (adsorption) SWCC is presented in Figure 1, which indicates a continuous ‘S’ shaped relationship which is hysteretic, that is, for a given water content, higher matric suction exists for drying than wetting process (Birle et al., 2008).

![Fig. 1: Idealized Soil-Water Characteristic Curves and its Details.](image)

2. MATERIAL DESCRIPTION

A locally available sandy soil was used in this study. According to IS classification (IS 1498: 1970) the soil is poorly graded sand.
3. DESCRIPTION OF THE COLUMN TESTING DEVICE

The experimental setup used in the present study, as depicted in Figure 2, essentially consists of one ECH₂O-TE volumetric water content probe connected to a data logger, one T5 tensiometer connected to a data logger, one computer for collecting experimental results, a flow regulator and a water reservoir, and the main perspex column into which soil is compacted. The EC-TE probe was installed horizontally along the soil specimen and placed at the same depth as the ceramic of the T5. A flow regulator was connected at the bottom of the column to control the flow of water from the reservoir into column specimen while performing wetting test.

Wetting Soil-water Characteristic Curve Using Column Test Setup

Drying test was performed on a soil specimen. At the end of drying test performed, the wetting process was simulated by operating the flow valve to enter the water into the soil gradually at a very slow rate. The corresponding change in suction and water content was recorded by the corresponding data loggers. When the specimen reached zero matric suction in the wetting process, the assembly was disconnected. The suction and volumetric water content values recorded during wetting process were used to obtain wetting soil-water characteristic curve.

4. RESULTS AND DISCUSSIONS

The data obtained from the T5 and ECH₂O-TE measurements carried out in the column testing device during drying and wetting process were used to plot the SWCCs corresponding to different compaction states for the soil SA, as depicted in Figure 3. It can be noted from the figure that the drying and wetting SWCCs are different and different initial paths are followed by the curves corresponding to different compaction state. The test results indicate that the hysteresis effect is significant for sand and wetting SWCCs coincide for matric suction, \( \psi_m < 10 \text{ kPa} \).

5. CONCLUSIONS

The study presents the details of a column test set up for determination of wetting soil-water characteristic curve (SWCC). The usefulness of the test setup has been demonstrated by determining the drying and wetting SWCCs of a locally available sandy soil. The study indicates that the hysteresis effect is significant for sand and wetting SWCCs coincide for matric suction, \( \psi_m < 10 \text{ kPa} \).

REFERENCES


