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A new approach to determine the soil particles arrangement by the digital image processing

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Abstract

Soil particle arrangement affects soil behavior. Determining the arrangement of soil particles is complex. In this paper, wavelet transformation based on digital image processing was developed to determine the soil particle arrangement. Soil image is decomposed to 512×512 pixels in small zones and is analyzed by wavelet transformation. For each analysis zone, an energy index is calculated. Since the energy can be calculated discretely for horizontal, vertical and diagonal directions, more data about the soil particle arrangement such as particles shape, particles orientation, and fabric can be acquired. For this purpose, the energy index is determined by comparing horizontal and vertical energies. Imaging of soils is done by sediment imaging test and flat surface test, and the energy index is calculated and compared for both methods. Energy index values greater than zero indicate that the particle are horizontally arranged, while the energy index values below zero represent the vertical arrangement of the particles. Therefore, the energy index is an appropriate indicator for determining the soil particle arrangement. Determination of particle arrangement by the digital image processing method reduces the operator and decreases errors.

Keywords: *Image processing, Particles arrangement, Wavelet transformation, MATLAB software*

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Extended Abstract:

1. Introduction

Particle arrangement of soils has a large effect on its engineering properties. A novel method to calculate soil arrangement from images of soil particle by digital image processing based on wavelet transformation (WT) is presented in this paper.

2. Wavelet transformation

WT technique uses WT for calculating the energy included at each level. Energy index (EI) is defined to compare the wavelet decomposition energies in the horizontal and vertical directions. EI amounts bigger than zero show that grains arranged horizontally, whereas EI amounts smaller than zero show vertical arrangement. The absolute value of EI is an indicator of overall particle sphericity with $|EI| \approx 1$ for very spherical particles. The EI has been calculated for SIT and FST models.

3. Tests results

The mean absolute amount of EI in the SIT is higher than the mean absolute amount of EI in the FST. These observations show that the mean of EI could be an index of grain arrangement or fabric, whereas the mean of absolute EI could be an indicator of particle shape or sphericity. Overall, the EI amounts obtained by the SIT could be an excellent indicator of particle shape and the potential for development of an oriented soil fabric.

4. Conclusion

This paper describes soil particles arrangement characterization based on WT. An EI is determined by comparing horizontal and vertical energies. Amounts of EI bigger than zero show grains arranged horizontally, whereas amounts smaller than zero show vertical arrangement. FST illustrates the EI amounts were distributed among positive and negative amounts displaying the isotropic arrangement. In SIT, the soil particles showed a strong tendency for EI amounts bigger than zero. So, EI can be utilized for measuring particles arrangement or fabric in the geotechnical laboratories.