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研究テーマ－μフォーカスX線CTによる不飽和土の破壊メカニズムの解明

研究背景と目的

土粒子・水・空気から成る不飽和土は，土粒子接触点のメニスカス水に吸引圧 (サクション)が働くため強度・剛性が高くなるが，水の浸透やせん断によりサクションが消失するとせん断帯を伴い脆性破壊する．このような不飽和土の破壊メカニズムを解明するためには，土全体の変形を司る土粒子と間隙構造に着目した微視的研究が重要である．

本研究の目的は，不飽和土の破壊メカニズムを微視的観点から解明することである．特に，せん断帯発達過程における密度と飽和度の変化，メニスカス水の分布変化に着目した研究を行う．

研究手法

本研究では，不飽和珪砂を用いた三軸圧縮試験にマイクロフォーカス X 線 CT (KYOTOGEO-μXCT, TOSCANER-32250μHDK,東芝 IT 製)を適用し，微視構造を可視化する．本装置は，医療用・産業用 X 線 CT 装置と比べ焦点寸法が 4 μm と極めて微小であり，最高 5 μm の空間分解能で物体内部の観察が可能である．さらに，CT 画像解析によってせん断ひずみ場や局所的な密度，飽和度等を定量化する．

研究成果

Figure.1 は三軸圧縮過程で取得した供試体全体およびせん断帯を含む局所領域の鉛直断面 CT 画像であり，供試体中央と斜め方向へ帯状の密度低下が生じることを示す．Figure.2 は画像解析結果の一例である．画像相関法 (DIC)によって，せん断ひずみは Figure.1 の密度低下領域で集中することを明らかにした．また，三相分割を行うことで，局所的な間隙比と飽和度を議論することが可能となった．

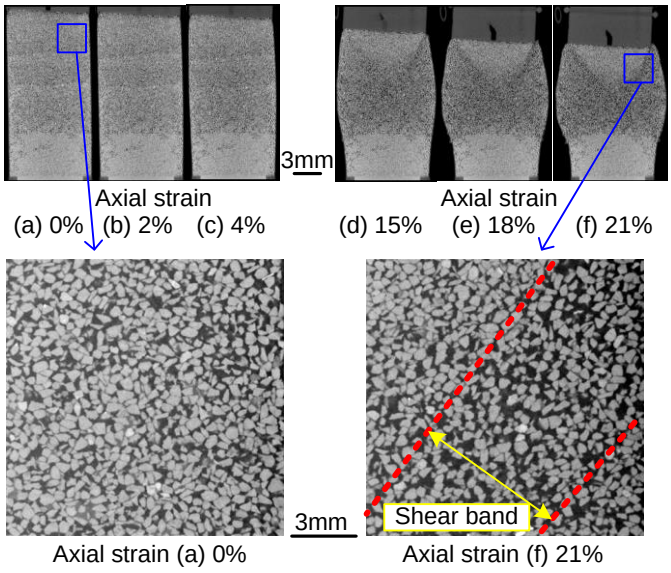


Figure.1 Vertical cross section of CT images obtained in triaxial compression test of partially saturated silica sand

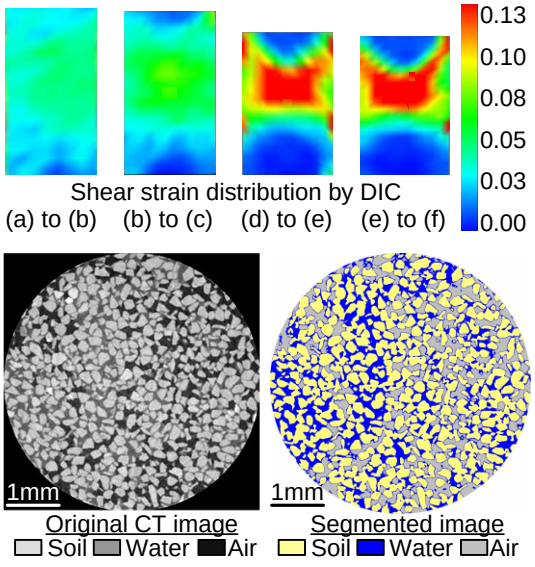


Figure.2 Results of Digital Image Correlation (DIC) and segmentation based on CT images

Research theme – Investigation of failure mechanism of partially saturated soil by microfocus X-ray CT

Research background and objective

Partially saturated soil is composed of soil particle, water and air. Strength and stiffness of it are enhanced by suction which exists at the contact points of soil particles; however, it exhibits brittle mode of failure with clear shear band due to loss of suction caused by water infiltration or shearing. It is important to clarify the failure mechanism of partially saturated soil to investigate microstructures such as soil particle and pores.

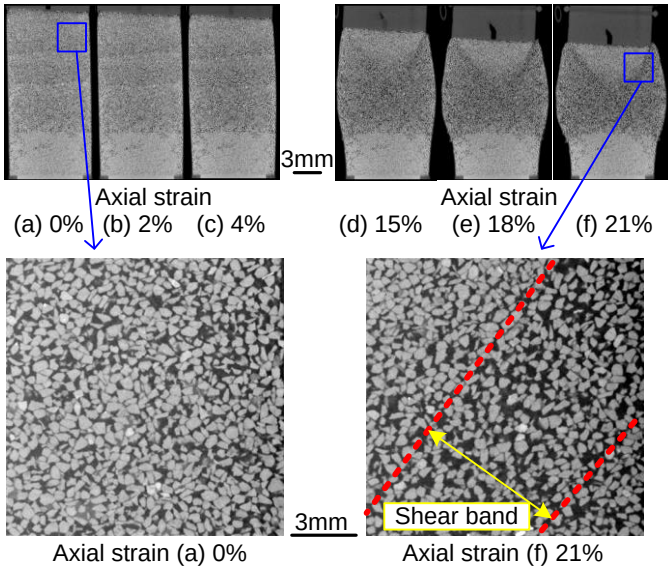
Objective of this study is to clarify the failure mechanism of partially saturated soil microscopically. Changes in density, degree of saturation and distribution of meniscus water during shearing are investigated.

Research method

Three-phase microstructure during triaxial compression test of partially saturated silica sand is observed by microfocus X-ray CT equipment (KYOTOGEO-μXCT, TOSCANER-32250μHDK, THOSHIBA-IT), which makes it possible to observe with highest spatial resolution of 5 μm. Shear strain distribution, local void ratio and degree of saturation also can be quantified by image processing.

Results & Discussion

Figure.1 shows CT images scanning whole specimen and shear band obtained in triaxial compression test. Figure.2 shows results of image processing. It is found that density decreases in the middle of specimen and in diagonal direction. DIC reveals that shear band occurs in loose region where is shown in Figure.1. Segmentation makes it possible to discuss the changes in void ratio and degree of saturation due to shearing.



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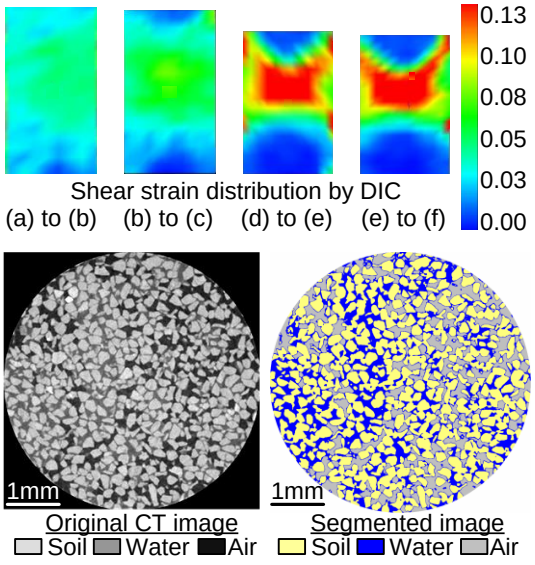

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