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Stereologically based 3D fabric analysis for geomaterials using X-ray CT images

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Under a microscope, materials are characterized by their three-dimensional (3D) microstructure formed by components such as pores, cracks, and particles; and their mechanical and hydrological properties are highly related to their microstructure. In order to discuss the mechanics of geomaterials based on their microstructure, details of the 3D microstructure are needed. X-ray CT, especially microfocus X-ray CT, is a powerful tool to detect microstructures using a non-destructive method. However, it is difficult to evaluate microstructures using reconstructed 3D images. In order to quantitatively determine three-dimensional structures from reconstructed 3D image data, voxel units have been used in the measurements. Voids in materials are used as measurement targets, and their geometrical characteristics are evaluated from the direction of the long axis in pores approximated by ellipsoids.However, difficulties are often encountered in extracting individual measurement targets because targets such as pores are constructed by voxels. In particular, it is extremely difficult to evaluate the anisotropy of fabrics associated with a long axis. In this study, in order to overcome this difficulty, we attempted to perform structural anisotropy measurements by inspecting three-dimensional structures using multidirectional scanning lines. In addition, anisotropy of obtained three-dimensional structures was expressed using a stereographic projection. We successfully evaluated 3D microstructural anisotropy of porous, granular, and fibrous materials using the multidirectional scanning line (MDSL) method based on simple image analysis. The stereo-net projection plotted using results of the MDSL method allowed visualization of structural anisotropy of such materials, and identified the principal axis of structural anisotropy.