ANALYSIS OF PORE STRUCTURAL PARAMETERS WITH MICROFOCUS X-RAY COMPUTED TOMOGRAPHY AND GAS TRANSPORT MEASURMENTS

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Understanding of gas transport in porous media has wide applications, particularly in contaminates transport at polluted sites, emission of greenhouse gases from solid waste landfill site and decomposition process of waste layer. Gas transport are controlled through the pore structure parameters (i.e. pore size distribution, porosity, pore connectivity and tortuosity). Nowadays micro-focus X-ray computed tomography (MFXCT) has been proven to be a valuable non-destructive tool for the direct visualization and better understand soil pore geometry. However, there have been few studies on visualization and quantification of soil pore network and soil pore networks linked to indirect pore parameters for gas flow based on measured gas diffusion coefficient and air permeability. The study aimed to identify the effect of moisture content on pore structural parameters based on MFXCT analysis and compare the MFXCT derived parameters to indirectly-estimated parameters from soil gas diffusion coefficient and air permeability such as pore tortuosity-connectivity factor (X_G) and equivalent pore diameter (d_G) for gas flow. Undisturbed and repacked samples taken from a solid waste landfill site located in Saitama prefecture Japan was used in this study. For repacked soil samples, particle size (d<2mm) with field water content were used with different dry bulk densities by hand compaction. A hanging water suction method and pressure plate apparatus were used for maintaining the different moisture content inside the soil sample. Finally, all the samples were prepared in air dry conditions (AD) at the constant room temperature of 20°C and relative humidity of 60%. Soil samples were scanned by MFXCT system with different scanning resolutions of 12, 30 and 50 μm/voxels. Then, 3-dimensional models were reconstructed with different regions of interest (ROI) of 50, 100, 200 and 300 voxels. Finally, soil pore-structural parameters such as effective pore diameter (d_{MFXCT}), pore coordination number (C_{MFXCT}), and pore tortuosity (T_{MFXCT}) were analyzed. Results showed with increasing ROI, the pore structure parameters of both undisturbed and repacked samples showed less variation. Moisture content affected clearly pore structural parameters, T_{MFXCT} and C_{MFXCT} decreased with increasing soil air filled porosity, however, measured d_{MFXCT} were independent on the moisture content. The pore connectivity-tortuosity factors derived from MFXCT were well correlated with the indirect connectivity tortuosities from measured soil gas diffusion. However, it was observed that there were some variations between effective pore diameters from MFXCT and equivalent pore diameters for gas flow estimated by gas transport parameters depending on scanning resolutions (ranging from 1:4 to 2:1 for SR =12 μm/voxels and 1:1.5 to 5:1 for SR = 30 μm/voxels).

Keywords: Micro-focus X-ray computed tomography (MFXCT), Pore structural parameters, Gas transport parameters

