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The Influence of Uniaxial Compression upon Pore Size Distribution in Bi-modal Soils

M. Kutilek (1), L. Jendele (2) and K.P. Panayiotopoulos (3)

1. Emeritus Professor, Czech Technical University, Nad Patankou 34, 160 00 Prague 6, Czech Republic, (2) Cervenka Consulting, Prague, Czech Republic, (3) Aristotle University of Thessaloniki, Greece

(1) kutilek@ecn.cz

Abstract

Transport of water, of dissolved and non dissolved chemicals, of gas, the rooting of plants and the conditions for all soil biota are influenced by the soil porous system and by the soil pore size distribution. We have analyzed the change of the soil porous system due to the short time compression in ranges from 0 to 300 kPa in Entisols, Alfisols, Vertisols and at compression stress 50 and 1000 kPa in Oxisols. The procedure was based upon the evaluation of the soil water retention curves. The equation of log-normal pore size distribution in bi-modal soils was applied for the analysis. The obtained physical parameters describe the soil porous system and its change due to the compression. The minimum pressure head h_A between two peaks of pore size distribution represents the boundary between the structural and matrix domains of the soil porous system. The value of h_A was in broad ranges between h_A = -136 cm and h_A = - 585 cm, corresponding to equivalent radius r = 10.9 μm and r = 2.5 μm. Its change due to the applied compression was not the same in all examined soils, h_A was decreasing in some soil taxons, in others it was slightly increasing with the increase of the compression stress. It follows that the boundaries between the soil pore categories can not be taken as a fixed value for all soils and for all compression stresses. The increase of the compression stress caused a decrease of the total porosity, but the decrease of the structural porosity was much more expressed. The ratio of the decrease of structural porosity due to compression was in ranges between 0.91 and 0.48. The change of the matrix porosity has not the same tendency in all soils. In majority of instances it was increasing, but in two soils it was slightly decreasing with the increase of compression stress. The characteristics of the pore size distribution did not change in a uniform way either. The pore size distribution curve is more flat and more broadly distributed due to compression in the structural domain. The tendency is opposite in the matrix domain. A generally valid rule on the change of the pore size distribution due to compression does not exist for all soil taxons. The change was great in both domains of soils with a low stability of aggregates. The change was relatively small in soils with a well developed structure where it was more related to the structural domain. The log-normal model does not fit in all instances to pore size distribution in the structural domain. A profound study of the soil micromorphology may result in a better description of the soil porous system and its internal change during compression.

Keywords: Pore size distribution; Soil compression; Bi-modal soils; Structural porosity; Matrix porosity; Soil water retention