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Soil compaction: Evaluation of stress transmission and resulting soil structure

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Accurate estimation of stress transmission and resultant deformation in soil profiles is a prerequisite for the development of predictive models and decision support tools for preventing soil compaction. Numerous studies have been carried out on the effects of soil compaction, whilst relatively few studies have focused on the cause (mode of stress transmission in the soil). We have coupled both cause and effects together in the present study by carrying out partially confined compression tests on (1) wet aggregates, (2) air dry aggregates, and (3) intact soils to quantify stress transmission and compaction-resulted soil structure at the same time. Stress transmission was quantified using both X-ray CT and Tactilus sensor mat, and soil-pore structure was quantified using X-ray CT. Our results imply that stress transmission through soil highly depends on the magnitude of applied load and aggregate strength. As soon as the applied load is lower than the aggregate strength, the mode of stress transmission is discrete as stresses were mainly transmitted through chain of aggregates. With increasing applied load soil aggregates start deforming that transformed heterogeneous soil into homogenous, as a result stress transmission mode was shifted from discrete towards more like a continuum. Continuum-like stress transmission mode was better simulated with Boussinesq (1885) model based on theory of elasticity compared to discrete. The soil-pore structure was greatly affected by increasing applied stresses. Total porosity was reduced 5-16% and macroporosity 50-85% at 620 kPa applied stress for the intact soils. Similarly, significant changes in the morphological indices of the macropore space were also observed with increasing applied stresses.