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X-ray μCT and 3D digital image correlation to study localised deformation in geomaterials under triaxial compression

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Deformation in geomaterials (soils, rocks, concrete, etc.) is often localised, e.g., in the form of shear bands or fractures. In experimental analysis of materials exhibiting such behaviour standard laboratory methods are insufficient as the majority of measurements are made at the sample scale and rarely at a “local” scale. X-ray tomography monitoring during triaxial compression tests allows high-resolution full-field observation of the development of deformation. However, such images only indicate clearly the deformation when there are significant changes in material density that produce a change in x-ray absorption. As such 3D Volumetric Digital Image Correlation approaches have been developed that allow quantification of the full strain tensor field throughout the imaged volume. We will present results from a set of triaxial compression tests on specimens of a stiff natural clay (Beaucaire Marl) and a granular material (Hostun sand) recently performed at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, using an original experimental set-up developed at Laboratoire 3S-R, Grenoble. Complete 3D images of the specimens were recorded several stages throughout each test using X-ray micro tomography. The images were subsequently analyzed using an in house 3D Volumetric Digital Image Correlation software. Full-field incremental strain measurements were obtained, which allow detection of the onset of shear strain localization and its timing relative to the load peak. Furthermore different features of localized deformation, including fractures, can be identified and their spatial and temporal development characterised.