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Characterization of the process of the strain localization in some porous rocks in plane strain condition using a new true triaxial apparatus

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Failure by strain localization is commonly observed in geomaterials. Generaly, experimental characterization of the localization in a porous sandstone are performed with classical axisymmetric triaxial compression tests. The effect of the confining pressure is observed on several aspects: onset of localization, pattern of localization, porosity evolution inside bands, grain scale mechanisms of deformation. Complex patterns of localization can be observed at high confining pressure in the transition between the brittle and ductile regime, showing several deformation bands in the specimens ([1]). However the history (time evolution) of the localization is not accessible because the observations are post-mortem.
Strain field measurement and evolution in time of the strain field are particularly useful to study the strain localization (initiation of the deformation bands) and the post-localization regime. Such tools have been developed for soils (e.g., sand specimens in plane strain condition [2] or in triaxial conditions using X-ray tomography [3]). Similar developments for rocks are still difficult, especially because the pertinent confining pressure to reproduce in situ stresses are higher than for soils.
We present here first results obtained in a new true triaxial apparatus that allows observation of the rock specimen under loading and especially the complex development of deformation bands and faults. As for [4] and [5], the three principal stresses are different, however the intermediate stress is controlled in order to impose a plane strain condition (zero strain in this direction). Observation of a specimen under load is possible as one surface of the prismatic specimen, which is orthogonal to the plane strain direction, is in contact with a hard transparent window. The deformation of this surface is representative of the deformation in the whole specimen, up to and beyond strain localization. Therefore the evolution of the strain field in the sample can be measured by digital image correlation (DIC) of photographs taken of this surface. It is noted that the cell can sustain a confining pressure up to 100 MPa and so the regime of deformation in soft rocks from brittle through to ductile can be studied. Furthermore, acoustic emission measurements and permeability measurement are also possible, which enriches the interpretation of the tests.

References

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