Three-dimensional petrographical investigations on borehole rock samples from Moutier tunnel, N16, Jura Mountains: a comparison with in situ convergence measurements and geomechanical behaviour of tectonized rock horizons.

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Technical difficulties associated with excavation works in tectonized geological settings are frequent. They comprise instantaneous and/or deferential convergence, sudden collapse of the walls and/or roof of the gallery, outpouring of fault-filling materials and water inflows. These phenomena have a negative impact on the construction sites as well as on its safety.

In order to optimize the project realization, preliminary studies on reliable rock material found on site are needed. This implies a regional site investigation (surface mapping, prospective drilling, water flow survey ...) as well as a local approach from laboratory investigations on rock samples (permeability determination, moisture and water content, mineralogy, petrography, geochemistry ...). A set of multiple parameters are then recorded which permit to gain better insights on the site conditions and its probable behavior during excavation.

Because rock formations are by nature heterogeneous, many uncertainties remain by extrapolating a large-scale behavior of the rock mass from analysis on samples order of magnitudes smaller (e.g. Bürgi et al., 2001; Habimana et al., 2002). Indirect large-scale field investigations (e.g. geophysical prospection) could help to better constrain the relationships between lithologies at depth. At a much smaller scale, indirect analytical methods are nowadays more widely used for material investigations, e.g. X-Ray Computed Tomography (XRCT, Ketcham & Carlson, 2001) and Neutron Tomography (NT, Lehmann et al., 1999), showing both promising results for 3D petrographical investigations of the internal structure of opaque materials (Figure 1). These techniques record contrasts inside a sample, which can be interpreted and quantified in terms of anisotropy. This approach has the advantage of combining genetic parameters (physico-chemical rock composition) with geometric parameters resulting from alteration or deformation processes (texture and structure). A critical analysis of such 3D models together with the realizations of mechanical tests could improve the prognostic regarding short- and long-term behavior of a rock unit.

Indirect methods have the advantage of being non-destructive. But as for large-scale geophysical prospection, XRCT and NT are affected by several error factors inherent to the interaction of a radiation modality (X-Ray or neutron beam) with the atomic structure of the investigated materials. Recorded signals are therefore in particular case not artifact-free and would need to be corrected in a stage of data processing.

In the case of the Moutier tunnel from N16 highway project in the Jura Mountains, accurate convergence measurements showed that acceleration of wall deformations in the lower tube are related first to advancement of the excavation in the upper tube but also to oblique fault structures of variable thickness and orientations. These tectonic horizons are composed of altered marls of the elsänder molasse formation that show mechanical properties that are transitional between rock and soil materials. A recognition and better characterization of such materials in a stage of preliminary project studies is crucial in order to avoid severe technical difficulties and project delay during effective project realization.

Figure 1. Picture of a tectonized marl sample from Moutier tunnel site in the Jura Mountains as recorded by XRCT (left) and NT (right) techniques.
REFERENCES


