An evaluation of generated source signals from machinery in conventional tunnelling and their possible application in a tunnel seismic while drilling (TSWD) system

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Geological conditions and their uncertainties are a major risk factor in underground construction projects. To ensure a fast, smooth and save completion of the excavation, a prediction of the geological conditions in front of the working face during tunnelling is a topic of great importance.

Various geophysical methods for a prediction of the conditions ahead of the tunnel face have been developed over the past years, yet, most of them being seismic techniques, which require a short interruption of the excavation to minimise noise interference. However, there is also the approach with TSWD which uses the working TBM (Tunnel Boring Machine) as a source signal and can thus work simultaneously with the excavation. Up to now, this concept has been applied primarily in mechanised tunnelling and there are hardly any applications in conventional tunnelling.

In the course of several practical experiments at the “Zentrum am Berg” in Eisenerz (Austria), different concepts for a transfer of TSWD from mechanised to conventional tunnelling were developed and tested at scale in an underground research facility. Three machines were used for these tests, an excavator with a hydraulic hammer attached as well as two different drilling jumbos. The devices were equipped with an accelerometer to pick up the source signal at its origin (pilot signal). Different sensor positions were tested using a sledge hammer as a source and evaluated in detail. Moreover, omnidirectional geophones of different sensitivities (4.5 Hz and 27 Hz) were tested and compared as transducers in the adjacent rock mass.

An essential part of the experiment analysis consisted of the evaluation of the source characteristics as well as the generated spectral bandwidth of the source signal from typical construction machines in conventional tunnelling. Consequently, the outcomes will be another step forward in the development of a TSWD exploration system also applicable to conventional tunnelling projects.