



## Seismic source characterisation of a Tunnel Boring Machine (TBM)

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The Tunnel Seismic While Drilling (TSWD) method aims at predicting continuously the geological situation ahead of the tunnel without disturbing the construction work. Thereby the Tunnel Boring Machine (TBM) itself is used as seismic source. The cutting process generates seismic waves radiating into the rock mass and vibrations propagating to the main bearing of the cutter head. These vibrations are monitored and used as pilot signal. For the processing and interpretation it was hypothesized so far that the TBM acts like a single force. To prove this assumption the radiation pattern of several TBM's under construction were investigated. Therefore 3-components geophones were installed at the surface, which were situated directly above the tunnel axes and also with lateral offset. Additional, borehole geophones were placed in the wall of one tube of a two-tube tunnel. The geophones collected the forward and backward radiated wave field, as the TBM, operating in the other tube, passed their positions. The obtained seismic data contains continuous records over a range of 600 m of the TBM position. The offsets vary from 25 m to 400 m and the frequency ranges from 20-250 Hertz. The polarisation of the p-wave and the s-wave and their amplitude ratio were determined and compared with modelled seismograms with different source mechanism. The results show that the description of the source mechanism by a single force can be used as a first order approximation. More complex radiation pattern including tensile forces and several source locations like the transmission of reaction forces over the gripper to the tunnel wall are further tested and addressed.