Blast vibration prediction

Trabi, Bernd; Bleibinhaus, Florian

Chair of Applied Geophysics, Montanuniversität Leoben, Peter-Tunner-Straße 25, A-8700 Leoben, Austria.

In order to limit ground vibrations to sensitive areas in the vicinity of a mine, it is essential to predict peak ground velocity (PGV) for production blasts. A general formula can be used to relate the PGV to the offset between sensor and production blast with a spatial decay exponent b and the maximum charge weight per delay (q) with a charge exponent c. To calibrate this equation a wide variation of offsets as well as a wide variation of maximum charge weights is desirable. Both parameters are often limited in mines due to the size of the mine or to production constraints. Therefore, the inversion can be very unstable. To get around this problem, mining operators use the scaled distance (SD) approach. The SD is the offset divided by some power of q. There are various empirical formulas and they are just distinguished by the exponent m of q. This exponent m typically ranges between 1/3 and 2/3. In the SD approach the charge exponent c becomes some ratio of the exponent b. This ratio seems to be arbitrary and we did not see a physical justification for that. In mining practice this does not matter if just the accuracy of the prediction is important. The mining operator in the particular mine for this study uses the USBM SD approach with a ratio of m = 0.5. We explored other strategies to calibrate the general equation and, we compare them with some key performance indicators like the root mean square (rms) residual and the coefficient of determination (R^2). One of the strategies are subset inversions where we are able to drop one of the exponents as a constant and invert for the remaining exponent. As an alternative to subset inversions we also jointly invert all data to constrain global b and c values. For this study we used data of 55 regular production blasts recorded with an array of 81 seismic three-component stations at 119 different receiver sites. Half of the stations are located on top of the loose sediments of the valley fill and hillside slides. The remaining stations are located within the mine on hard rock. The sensors are acceleration MEMS with a flat amplitude response function that we integrated to get ground velocities. The final derived decay exponent b was higher than expected due to spherical spreading of the wavefronts. The complexities of the subsurface and topography make it difficult to ascertain b to a physically reasonable range. The derived charge exponent c was close to the expected value of 0.5, assuming that charge weight is proportional to seismic energy. This value could be suggested as a global value, independent of the specific site. Both exponents are not correlated with each other. Overall, the used USBM SD method was not very suitable in terms of data fit. This research was partially funded by the European Union's Horizon 2020 research and innovation programme under grant agreement 730294: Sustainable Low Impact Mining (SLIM). Peter Schimek from the mine operator VAE Erzberg provided crucial support for the station deployments and the coordination with the blasters.