Quantifying the Quality of Cable Bolt Installation by Acoustic Testing

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ABSTRACT

As underground mines become more geotechnically challenging with increasing depth and excavation size, the requirement for ground support to be installed as per design becomes more critical. The verification of installation quality for cable bolts and grouted rock bolts is difficult to assess. Current methods to control quality have limitations; pull testing is largely inconclusive with only extremely poor installation being identifiable. Audits during installation can only capture a small percentage of installed bolts. Following large rock mass displacement from either squeezing ground or seismic events, even previously well installed bolts may have yielded and require replacement.

A method to provide an improved understanding of the reinforcement installation quality is Non-Destructive Testing (NDT) using acoustic reflection. To validate the accuracy of an NDT system, both plain and bulbed strand cable bolts were grouted in clear plastic tubes. The encapsulation grout quality was deliberately varied from full encapsulation through to partial encapsulation and a range of different size voids. The clear tubes allowed the ground encapsulation to be observed.

Cable bolts strands were cut at varying lengths and different water cement grout ratios were used. Acoustic testing of the cable bolt specimens was completed blind; the technicians were not aware of what was being tested. The NDT results correlated well with the grout encapsulation, with differences between full encapsulation, minor voids and major voids being determined. The different water cement ratio and bolt lengths (including when partially cut) were also identifiable but with some discrepancies.

Trials of the technology underground have also shown the data collection process to be relatively quick with each bolt taking 1-2 minutes to test, with interpretation of the results able to be completed soon after. The NDT results collected from the underground trial showed a wide variance in cable bolt grout encapsulation quality indicating that there were installation issues.