

Solutions@Mecmesin

Shotcrete Early Strength Calibration Studies

Specification

[Multicrete Systems Inc.](#) are specialists in project solutions for the mining and tunneling industries. Based in Canada, the company operates globally and provides leading-edge technical assistance through expertise with concrete materials and equipment, including construction programs using shotcrete. The development of new shotcrete products—aggregate materials and mix specifications, accelerator additives—and the selection of the most suitable product for a particular solution are areas of expertise which have built Multicrete's reputation. A mining project raised the opportunity to use a new shotcrete mix for NATM/SEM tunnel design, but had an additional logistical challenge of assessing the early strength with a faster turnaround. Quick evaluation of the strength enables time, and hence cost, efficiencies, but is also safety-critical in determining when the workforce may re-enter the mine. The existing Field Early Strength Shotcrete Testing (FESST) and End-Beam Tester processes involve partial beam compression testing, which was labor-intensive and time consuming, and the equipment was cumbersome to transport, although accurate up to 4 MPa (FESST) and 35 MPa (End Beam). Thus, there was the requirement to speed up this component of the process whilst maintaining accuracy of readings and confidence that the new mix was delivering the desired performance improvements. Multicrete embarked on a thorough, controlled, calibration program at their Flin Flon facility to evaluate how a digital [Mecmesin shotcrete penetrometer](#) could help accomplish these objectives.

Solution

The team prepared a set of trial batches with variations of water source, mix concentration and accelerator percentages for the new and existing products. The material was then sprayed into two standard-sized test panels, four end-beam molds and 18 FESST beams for back-to-back comparison. For each trial batch, the early compressive strength was calculated. For the penetrometer method, 10 needle penetration force readings were recorded and a strength value returned via calibration curves. The team used a Mecmesin BFG digital penetrometer and a standard mechanical penetrometer for direct comparison. Graphs were plotted for all 4 test methods. The Mecmesin instrument was found to give comparably accurate results within the 1 MPa range, while dependency on the sharpness and life expectancy of the needles was also established. This information enables Multicrete to take advantage of the speed and portability benefits of the penetrometer instrument and additionally specify the usage recommendations for future projects. This methodology also allowed these improvements to be established alongside the optimization of the shotcrete product for sprayability, pumpability, workability, maximum adhesion and minimal clogging characteristics—a mix of quality and efficiency for which Multicrete are renowned.



Shotcrete pump and accelerator pump



Spraying a sample and early strength testing with a digital penetrometer

System

- BFG digital force gauge, now replaced by AFG digital force gauge
- Shotcrete penetrometer accessories: dual handle, probe adapter and needle kit

Testimonial

"The Mecmesin penetrometer provides accurate low strength data (up to 1 MPa) as soon as you can start testing. This data can immediately be shared with the Shotcrete crews working underground. The instrument and accessories have brought benefits through easy transportation and has the ability to be used for shotcrete trials, where the samples are shot to be cored at a later date. This has eliminated the need to transport additional samples."

Adam O'Ray, Quality Control Manager, Multicrete Systems Inc.

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