MEANINGFUL TESTING OF FIBRE REINFORCED SHOTCRETE FOR LINING DESIGNS

Ralf Winterberg, Group Chief Engineer, BarChip Inc., Japan
rwinterberg@barchip.com
Des Vlietstra, Technical Consultant, BarChip Australia Pty Ltd, Japan

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The routine use of Fibre Reinforced Shotcrete (FRS) as an integral component of ground support systems is well-established. FRS, employing steel or macro synthetic fibres, is used worldwide in service conditions ranging from low stress friable ground to high stress hard rock, and over a wide range of exposure conditions, often harsh, such as at high temperature, chemically aggressive ground or waters, static stresses and dynamic loadings, etc.

Shotcrete linings require a rotation capacity in order to follow ground movements while the arching effect in the surrounding rock mass develops. The fibre reinforcement within the shotcrete overcomes the brittleness of concrete and provides the necessary ductility after the shotcrete cracks, to prevent a sudden failure. The ductility or toughness provided by the fibres is determined by experimental testing.

Testing of FRS is carried out either routinely, as a mechanism in establishing quality control in an ongoing project, or when dedicated testing is required to confirm efficacy, properties and performance levels of FRS proposed for use in a system or application. For test results to be meaningful to the assessment of performance it is of vital importance that the test methods employed are reliable, repeatable and relevant.

Two types of test methodologies are standardized and in use, i.e. beam tests and panel tests. When evaluating FRS it is very important to use a test methodology that is at least representative of the loading mechanism, the load-bearing mechanism and reflects the full capabilities of the FRS. Beam tests are low deformation test (up to 4mm) and so cannot adequately represent larger deformations that can be found in typical underground environments. For sprayed concrete linings, panel tests, which measure energy absorption, are the more relevant test methods to represent a shotcrete lining failure mechanism. Panel tests are statically indeterminate (hyperstatic), just as the shotcrete lining itself is, and thus, represent the structural behaviour of the lining best.

This paper discusses the commonly employed standardized test methods for fibre reinforced concrete and shotcrete, examines the referring results, and discusses how those results are interpreted. Further, it informs how those results can be influenced by external factors and exposes the potential of some results to misinterpretation.

The aim of this paper is to assist those currently assessing FRS in existing ground support systems and those developing new systems in understanding which testing is “meaningful or meaningless” in its capacity to provide data employable in ongoing systems assessment, or in the selection and nomination of values required in developing efficient, safe, economical and durable FRS mixes in new works.