

Shotcrete for Underground Support: a State-of-the-art Report with Focus on Steel-fibre Reinforcement

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Abstract—This paper reviews current trends in shotcreting, primarily based on the Status Report of a Working Group of the International Tunnelling Association and the most recent U.S. Engineering Foundation conference on the same field in Uppsala, Sweden, in 1990. Of special interest is the increasing use of fibre reinforcement, which implies increased safety and substantial cost savings. The need for scientific collaboration and exchange of ideas between concrete and rock mechanics specialists is emphasized as a tool for a better understanding of the support behaviour of shotcrete linings.

Résumé—Ce rapport passe en revue les tendances actuelles des techniques de béton projeté, principalement fondées sur un rapport du Groupe de Travail de l'Association Internationale des Travaux en Souterrain et de la plus récente conférence de la Fondation Américaine d'Ingénierie sur le thème (détenue en Uppsala, Suède, en 1990). Ce qui présente un intérêt particulier, est l'utilisation croissante du fibre renforcement, qui entraîne une meilleure sécurité et des économies en coût considérables. On insistera sur la nécessité d'une collaboration scientifique et d'un échange d'idées entre les spécialistes en béton et en mécanique des roches pour une meilleure compréhension des comportements en tant que support des revêtements en béton projeté.

1. Introduction

Shotcrete for ground support is a very wide-ranging subject. Apart from typical questions related to general concrete technology, e.g., regarding mix design, the effects of additives, etc., it is also important to use suitable equipment for efficient and environmentally sound production of the lining. And, of course, contractual arrangements are essential to achieving a correct and economically justified use of this important element in rock tunnelling and mining. However, this paper deals primarily with the structural behaviour of shotcrete linings in different applications.

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1.1. ITA Working Group on Shotcrete

The wide range of topics within the field of shotcrete was brought into discussion a few years ago at a meeting of the International Tunnelling Association (ITA), when it was proposed that a working group on shotcrete should be formed. Many countries showed a strong interest in the subject from various viewpoints and depending on their involvement in the technology. In 1988, the ITA established a Working Group on the Use of Shotcrete in Tunnelling.

Because active development of topics through international working groups is a difficult task, we started simply, with the compilation of some general information. The group has now published a Status Report on the use of shotcrete in tunnelling (Franzén 1991). The report includes national contributions in a comprehensible format, demonstrating today's technology in some fifteen countries and including references and abstracts of some important papers. The primary aim of the report was to review current activity in the field of shotcreting and to make it easy to find references and establish contacts with people or organizations active in this field.

The next task of the working group is to review guidelines or recommendations of various status that exist in some countries. A final draft report, (Malmborg 1992), which was discussed by the group in May 1992, may be used

as a basis for some general and common guidelines. It is not altogether obvious, however, that such a document would serve totally beneficial purpose, as it might have a conservative effect on the development of the technology. In other words, the aim and format of such a document have to be thoroughly considered, at least before it is given any official status.

This report is largely based on the work of the ITA working group, as well as on information gained at the U.S. Engineering Foundation conference on shotcrete held in Uppsala, Sweden, in 1990 (Sharp 1992). In addition to these sources, several papers from journals and other conferences have been reviewed.

1.2. Few Scientific References on Shotcrete Support

In trying to concentrate on the role of shotcrete as support, and more or less omitting other aspects (e.g., equipment and environmental issues), it is interesting to note that there is very little published in scientific journals on the real core of this problem, namely: *What is the actual supporting effect or behaviour of a shotcrete lining in cases where it is not evidently designed or functioning as an ordinary structural component, e.g., as an ideal arch or a beam with well-defined end supports and calculable loads?*

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