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# A Practical Construction Technique to Enhance the Performance of Rock Bolts in Tunnels

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**Abstract :** In Swedish tunnel construction, a critical issue that has been repeatedly acknowledged is corrosion and, consequently, failure of the rock bolts in rock support systems. The defective installation of rock bolts results in the formation of cavities in the cement mortar that is regularly used to fill the area under the dome plates. These voids allow for water-ingress to the rock bolt assembly, which results in corrosion of rock bolt components and eventually failure. In addition, the current installation technique consists of several manual steps with intense labor works that are usually done in uncomfortable and exhausting conditions, e.g., under the roof of the tunnels. Such intense tasks also lead to a considerable waste of materials and execution errors. Moreover, adequate quality control of the execution is hardly possible with the current technique. To overcome these issues, a non-shrinking/expansive cement-based mortar filled in the paper packaging has been developed in this study which properly fills the area under the dome plates without or with the least remaining cavities, ultimately that diminishes the potential of corrosion. This article summarizes the development process and the experimental evaluation of this technique for the installation of rock bolts. In the development process, the cementitious mortar was first developed using specific cement and shrinkage reducing/expansive additives. The mechanical and flow properties of the mortar were then evaluated using compressive strength, density, and slump flow measurement methods. In addition, isothermal calorimetry and shrinkage/expansion measurements were used to elucidate the hydration and durability attributes of the mortar. After obtaining the desired properties in both fresh and hardened conditions, the developed dry mortar was filled in specific permeable paper packaging and then submerged in water bath for specific intervals before the installation. The tests were enhanced progressively by optimizing different parameters such as shape and size of the packaging, characteristics of the paper used, immersion time in water and even some minor characteristics of the mortar. Finally, the developed prototype was tested in a lab-scale rock bolt assembly with various angles to analyze the efficiency of the method in real life scenario. The results showed that the new technique improves the performance of the rock bolts by reducing the material wastage, improving environmental performance, facilitating and accelerating the labor works, and finally enhancing the durability of the whole system. Accordingly, this approach provides an efficient alternative for the traditional way of tunnel bolt installation with considerable advantages for the Swedish tunneling industry.

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