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Abstract

The Use of Tunnel Demolition Rocks to Produce Shotcrete for a Railway Infrastructure †

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Abstract: Environmental issues are a main concern for society. The construction field largely affects the consumption of energy and the environment. In this concern, infrastructure, in particular streets, bridges and tunnels, is a necessity for life today. It links people, increasing their meeting capability. Tunnels have continuously gained relevant importance to shorten the travel distances and to save the landscape surface. In this work, demolished rock materials from the construction of part of a 50 km long tunnel through the alps were characterized and used to produce shotcrete to secure the tunnel walls. Several samples of demolished aggregates were investigated with respect to the granulometric curves. They needed to match with the reference curves in the content and amount of stone aggregates. This was particularly difficult in some cases because of the different mineralogy encountered. The type and form of the aggregates were also evaluated. These latter parameters have an influence on the workability and on the mechanical properties. In particular, the angular and subangular aggregates needed special attention. Then, the material was mixed by adding silica fume. This enabled a more dense microstructure by reducing the porosity at a later stage. The steel fibers were also added to the mixtures in different amounts to produce the shotcrete. The fresh concrete properties were measured directly on site. Furthermore, the hardened state was controlled on site and in the laboratory. The compression strength exhibited variable values, which could be related to the mixing proportion of the ingredients. The punch tests indicated similar fracture behaviors but were very important for the safety of the worker inside the tunnel, in particular where material enrichment was present on the roofing parts. The steel fiber content generally increased the ductility of the specimens. The porosity and the water permeability were controlled, as well as the freeze/thaw resistance. The mixtures were continuously optimized by keeping the water/cement ratio and the superplasticizer dosage under control. All these adaptations allowed for the reuse of a large amount of the tunnel demolition material. The concrete was produced in a special mixing plant on site. This reduced the transportation and increased the environmental sustainability of such a long infrastructure.

Keywords: tunnel; demolition; rock; aggregates; shotcrete

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