

# The use of tunnel demolition rocks to produce shotcrete for a railway infrastructure

C. Paglia, G. Frigeri, S. Antonietti

Institute of Materials and Construction, Supsi, V. Flora Ruchat 15, CH-6850 Mendrisio, Switzerland.

Email corresponding author: [christian.paglia@supsi.ch](mailto:christian.paglia@supsi.ch)

Researchgate: <https://www.researchgate.net/profile/C-Paglia>

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## ABSTRACT

Environmental issues are a main concern for the society. The construction field largely affects the consumption of energy and the environment. In this concern, the infrastructure, in particular streets, bridges and tunnels are a common needs for today life. They link people speeding up the meeting capability. Tunnels continuously gained a relevant importance to shorten the travel distances and to save the landscape surface. In this work, the demolished rock materials coming from the construction of part of a 50 km long tunnel through the alps, was 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 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 evaluated as well. These latter parameters have an influence on the workability and on the mechanical properties. Especially angular and subangular aggregates needed a special attention. Then, the material was mixed by adding silica fume. This enabled a more dense microstructure by closing the porosity at a later stage. The steel fibres 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 laboratory. The compression strength exhibited variable values, which could be related to the mixing proportion on the ingredients. The punch tests indicated a similar fracture behavior 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 fibre 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 taking the water / cement ratio and the superplasticizer dosage under control. All these adaptations allowed to reuse the big amount of tunnel demolition material. The concrete was produced in a special mixing plant on site. This fact reduced the transportation and increased the environmental sustainability of such a long infrastructure.