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## Reuse of by-products coming from blasting of unstable rock elements.

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The improvement of safety conditions of unstable rock slopes can be achieved through the use of explosives, for the removal of unstable rock elements. This technique is often applied because, most of time, drill and blast operations, where they can be used, are cheaper and faster than other techniques and require less subsequent maintenance interventions.

When the activity is performed in an area that can be reached by vehicles (quarry area, slope above a road, etc...) it is possible to recover the blasted material.

Depending on the size of the unstable element to be removed, this kind of operations often lead to the production of large quantities of blasted rocks, which most often ends up at landfill or is marginally reused in unqualified manner (construction of temporary tracks, filling voids left by extractive activity, etc...).

Reusing blasted rocks can offer several benefits: more sustainable engineering practices, economic, environmental and social benefits; in particular, this way of operating can preserve natural resources and prevent the production of unwanted waste. As a rule, on-site and nearby-site reuse is preferred to meet sustainable goals. Specific cases where blasted material has been adopted for both slope protection and final rehabilitation works, in a quarry area, can be mentioned.

Unfortunately, due to unclear legislation, lack of technical data and extreme variability of the materials produced (for instance quantity, size and physical properties), the use of blasted material is not common: It can be estimated that only 20-30% of these materials are currently reused properly.

To improve this practice, the type of reuse must be a design goal since the beginning of the planning phase.

According to the quality of the rock mass and the type of blasting, different by-products can be obtained, i.e. armour stones to be applied in hydraulic engineering works, gabion stones, drainage stones and crusher run as a mix of different types of aggregates, that can be employed as paver

layer on road construction.

When ornamental stone quarries are involved, hard rock fragments are obtained for high mechanical performances.

The main purpose of blasting demolition of unstable rock elements, as mentioned, is to improve the safety conditions of the site, depending on local features, as well as by the safety of the workers, that can force the blasting scheme geometry and firing and impose important limitations on the operating techniques.

Two case studies will be presented, both in the Verbano-Cusio-Ossola (VCO; Piemonte - NW Italy) extractive area; they show how the blast design can be arranged to obtain different fragmentation and greater quantities of a specific by-product, according to the local needs and specific reuse.

**Key words:** by products, blasting, muck reuse, solid waste, slope protection.