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## Quarry waste for the production of sustainable and innovative constructional materials

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In Canton Ticino, Switzerland, the exploitation of natural stone, mostly gneisses, is an important activity of valley's economies but in the last decades the local quarries are facing severe economic difficulties. The current rules on the disposal of quarry wastes and the territorial planning that regulates the structure of quarries and inert landfills, is putting pressure on the economy and profitability of quarries, as the wastes represent up to 40% of the extracted material and disposal costs are huge given the important volumes. Therefore, the sustainable development of the quarry sector needs new and effective strategies, in particular in the management of quarry waste to reduce its disposal costs and possibly to re-enhance this material. Here, we propose an example of an environmentally friendly circular economy based on crushed aggregates of quarry waste for the building of high added value constructional elements.

In this applied study, we characterized the waste materials (different types of gneisses) and evaluated the crushed aggregates for their use in traditional concretes and in innovative geopolymers to use in 3D printing systems. The results showed that the concretes produced with 100% quarry waste (crushed aggregate) have good mechanical properties but moderate durability. However, it has been observed that even by simply mixing these crushed aggregates with a part of fluvial sand (allochthonous) it is possible to improve the performance of the concrete in all respects. Hence, this environmentally friendly material is suitable for many applications in the concrete industry. The aggregates were also tested for powder bed 3D printing that uses geopolymers as a binder. The first tests with this printed geopolymer suggest that this innovative constructional material may be used in non-structural architectural elements, however, further investigation is needed.

In this project it has been mapped, within the construction industry, how the economic supply chain could be configured for the reuse of this material. In particular, the usability in the production of concretes, geopolymers and mortars was highlighted, both in traditional

applications and with innovative applications such as 3D printing. The analysis was carried out with particular attention to the concepts of circular economy and sustainability, identifying the main actors and their potential interests within the supply chain.