EFFECTIVENESS AND EFFICIENCY OF CONSTRUCTION AND DEMOLITION WASTE RECYCLING IN LOMBARDY: A LIFE CYCLE BASED EVALUATION

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The establishment of effective and sustainable waste management is nowadays regarded as a milestone by local authorities on a path for green growth and circular economy. Particularly, Construction and Demolition Waste (CDW) management has been identified by the European Commission (COM 2014) among priority areas where strategic measures and investments are required to move away from a linear economic model towards a circular one. Indeed, CDW accounts for approximatively 30-35% of the total waste generated in Europe per year (i.e. 851 million tonnes in the EU in 2014 according to Eurostat data).

The local government of Lombardy Region (Italy) has selected the Life Cycle Assessment (LCA) methodology as a strategic support decision tool in the planning of its own CDW management system, commissioning the present research project. The aim of the project was the identification and evaluation of improving solutions that are expected to support the whole CDW recycling chain and to maximize the resource recovery from waste.

In the study here presented the focus is on the mixed mineral CDW and the gypsum-based waste (GW), mainly regarded as plasterboard.

In 2014, in Lombardy, 91% of the mixed waste was sent to recycling (Borghi et al., 2018). Nevertheless, the LCA of the current mixed mineral CDW management system showed that the induced environmental impacts are in general higher than the benefits arising from recycling activities. The biggest environmental burdens come from waste transportation and are not balanced by the small avoided impacts associated with the use of recycled aggregates in the actual applications. Recycled aggregates, which correspond to the 99.4% of the input of the recycling plants, due to their low quality, can only in fact be used in low grade applications in the construction of road embankment body, sub-bases layers and for environmental reclamations, in substitution of the unprocessed natural raw material. Moreover, the study pointed out that not all the produced recycled aggregates are really used; reasons for that are, on the one hand, the limited knowledge and general diffidence in their technical characteristics by the potential users and, on the other hand, the low cost and wide availability of natural raw materials. Consequently, on average, only 67% of the produced recycled aggregates was actually used. Starting from the current scenario, a certain number of sensitivity and scenario analyses were performed to understand which parameters and assumptions influence mostly the LCA results. Based on these comparative analyses, a best-case scenario was defined and recommendations were formulated. In particular, it is crucial to increase the demand of recycled aggregates,

supporting their use in the construction sector; it is necessary to improve the quality of recycled aggregates to create a more widespread use and to achieve suitable properties for high grade application (e.g. concrete production); and it is important to minimize waste transportation by localizing the recycling plants properly across the regional territory, and promoting the connection between recyclers and constructors.

The mixed mineral CDW mainly include concrete, bricks, tiles, ceramics, but also gypsum waste (GW). Even when GW is segregated at source, the prevalent current option for GW recycling in Lombardy (in 2014) was the mixing with the mineral CDW fractions; indeed, only a very small percentage (0.5%) of GW was sent to dedicated recycling (Borghi et al., 2018). After adequate recycling, the materials were recovered consisting of about 83.9% gypsum, 15.2% cardboard/paper, and 0.02% metals (Pantini et al., 2019). Different scenarios related to technically feasible end-uses of the recovered gypsum were analysed in the LCA: 1) use in the construction sector as raw material in the manufacturing of new plasterboards; 2) use in the cement sector as additive to the clinker for retarding the setting time of cement; 3) use in sewage sludge treatment as additive for the chemical stabilization of the sewage sludge and the production of an organic-rich fertilizer; and 4) use in agriculture as a soil amendment. Results from the LCA indicated that the recycling of the GW in dedicated plants is much more beneficial than its recovery by mixing with other CDW, for all the applications considered. The dedicated recycling of GW provides benefits for most impact categories, which are, however, mainly ascribed to the recovery of the cardboard/paper. Comparing the different uses of recycled gypsum, it was found that the highest environmental benefits are associated with the use of the recycled gypsum in agriculture: this is mainly due to the avoided energy consumptions for lime production (i.e. the avoided primary product). Based on these results, recommendations were formulated to improve the effectiveness of the recycling chain: optimizing the GW management system through a strategic localization of future GW recycling plants to minimize transport distances of both waste and secondary materials based on local markets; promoting the recycling of GW in dedicated plants and the adoption of adequate technologies able to achieve high-quality recovered gypsum and to separate cardboard/paper sufficiently pure to be destined to paper factories; sustaining the development of current (i.e. cement production and sludge treatment) and new (i.e. agriculture) markets for the recycled gypsum.

References

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