Reuse of aggregates from recycled construction and demolition waste commonly disposed in landfill

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Keywords: Recycled mixed aggregates, recycling process, sulphate content, environmental assessment

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1. Introduction

The waste reuse and recycling are among modern society's environmental priorities and hence areas to which considerable effort is being devoted today. Directive 2008/98/CE of the European Parliament on waste, regulates, among other matters, the pressing need for measures aimed at reducing the use of resources, and favouring the practical application of the waste hierarchy.
The waste recycling of construction and demolition (C&DW) has been a practical pathway to prevent pollution and reduce the impact of the extraction of natural aggregates in developed countries. The recycling rate of C&DW in Europe shows significant variations among the countries. Some countries showed recycling rates below 10% while others showed recycling rates over 90% (Waste statistics. Eurostat web)
There have been several studies to apply recycled aggregates (RA) from demolition and construction waste in concrete or road (Agrela et. al 2012; Pasandín, A.R.& Pérez, I.; Poon C.S & Chan D. 2006.).
Generally, the recycling process involves a selection of the material before being processed in the recycling plant and also during the production process of the aggregate. In the present work, the main objective of the study is to value through an exhaustive comparison of recycled mixed aggregates (RMA-I), low quality Recycled Aggregates (RMA-II) and other commonly refused (RMA-III) produced in the recycling plant (fig.1). The confirmation of material aptitude in civil infrastructures allows the sale of a by-product that is currently discarded by plants. Thus, the results suggest the application of the material. This application would prevent a large amount of waste from being deposited in landfills and would not provide any economic advantages and environmental

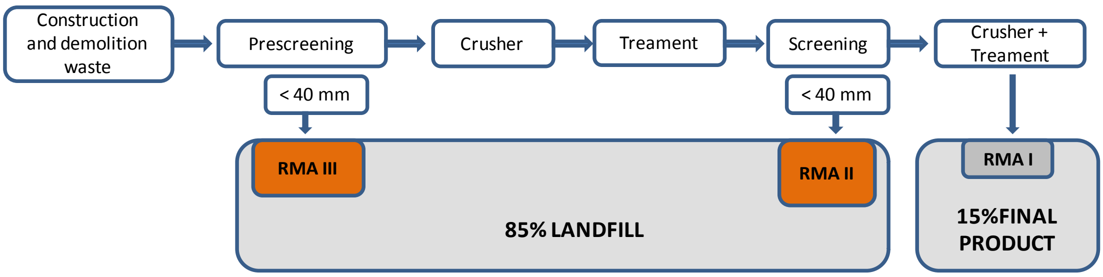

Figure 1: Diagram the process of obtaining recycled aggregate

2. Materials and methods

Recycled mixed aggregates (RMA) are composed by different materials: asphalt, ceramic, concrete and mortar, natural aggregates, gypsum and impurities (wood, glass, plastic, metal). RMAs were obtained from a recycling plant at the Gecorsa Company located in Córdoba, Spain.
Three recycled aggregates were tested in the laboratory: recycled mixed aggregates (RMA-I, RMA-II and RMA-III), the physical, chemical and mechanical performance were tested (Fig. 2).

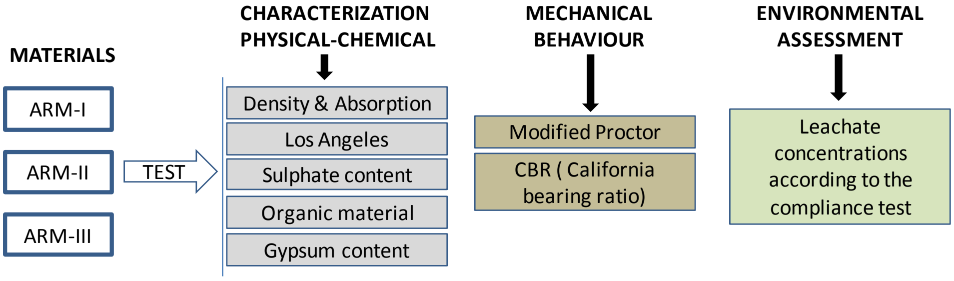

Figure 2: Experimental program

3. Results and discussion

Table 1. Summary of results chemical and physical

PROPERTIES	RMA-I	RMA-II	RMA-III	TEST METHOD
Water-soluble sulphate content (% SO_3)	0.5	2.3	2.21	UNE - EN 1744-1
Acid-soluble sulphate content (% SO_3)	0.79	1.4	2.44	UNE - EN 1744-1
Water- soluble salts (%)	1.47	3.22	2.45	UNE - EN 1744-1
Gypsum content (%)	0.64	1.78	0.81	NLT-115/99
Organic material (%)	0.33	0.93	1.07	UNE 103204
Density-SSD (kg/m^3)				UNE - EN 1097 - 6
0-4 mm	2.32	2.42	2.12	
4-31.5 mm	2.21	2.25	2.28	
Water absorption (%)				UNE - EN 1097 - 6
0-4 mm	6.12	6.47	11.51	
4-31.5 mm	10.75	8.58	10.23	
Resistance to fragmentacion	34	36	41	UNE - EN 1097 - 2

The sulphate contents are included in Table 1 to compare the values obtained in the different materials. In Spain, the regulation of reference set a limit of 0.8% for the acid-soluble sulphate content and 1% for the total sulphur content. According to the results, the RMA-II and RMA-III mixtures not meet these limits. It is observed that the density of the fine fraction is greater than that of the coarse fraction because it has less void space, which increases the density. By comparing the absorption data, it can be observed that the materials with the highest percentage of ceramic particles showed higher values.

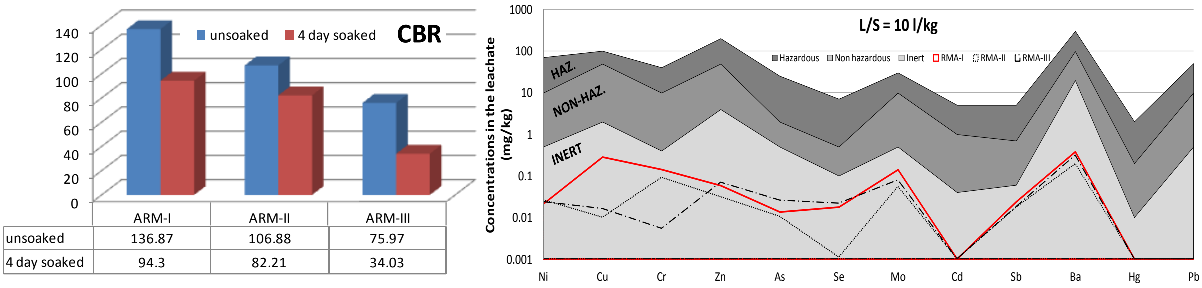

Figure 3: Results of CBR (left) and Concentrations in the leachate (right)

According to the results (Fig. 3), under unsoaked conditions, the RMA-I sample presented the highest value of CBR (163.87%) followed by the RMA-II sample (106.88%). Otherwise, the RMA-III sample showed the lowest bearing capacity (75.97%). The measured values are consistent with the data obtained by previous authors which characterized recycled aggregates for be applied in civil infrastructures. Based on the results of the compliance test, thus, the environmental benefit will be shown in addition to checking that these materials can be applied as construction materials

4. Conclusions

Based on the results obtained, we present the following conclusions:

- The main limitation for the use of RMA-II and RMA-III is the high content of soluble sulfates present.
- From the comparison between CBR data unsoaked and after 4 day soaked it can be concluded that the influence of the soaked period was worse on the CBR values for all cases. However, the samples presented a high value of CBR.
- The compliance test data revealed the sulphates a contaminant in of the samples analyzed.

The valorization of this product (RMA-II and RMA-III) instead of exploiting the natural resources can eliminate the negative impact associated with the indiscriminate disposal of this by-product in landfill.

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