Influence of Sample Conditions in Leaching Tests on Pollutant Release of Recycled Aggregates from C&DW

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Abstract

The field of construction materials is in continuous movement, they are continually created and destroyed in infrastructure or buildings, generating a tremendous impact. The materials sector is in continuous transformation due to the great challenge it faces. It is a sector responsible for 50% of the natural resources used, 40% of the energy consumed (including the energy in use) and 50% of the total waste generated. The objective of companies producing construction materials is to achieve a circular economy where products, materials and resources are kept for as long as possible in a circle of production and use, and for this it is essential to recycle and minimize the generation of waste.

In this sense, the role of Construction and Demolition Waste (C&DW) treatment plants is key. Increasingly, the search for quality Recycled Aggregates (RA) is becoming increasingly important in the construction sector, hence the growing importance in recent years. More and more construction companies and developers are aware of the need to have recycled products in their high-quality constructions capable of competing with natural aggregates.

The present research work is focused on the study of different RA produced in the south of Spain (Andalusia region). Different RA commercial typologies have been characterized at the level of physical and the leaching behaviour. For this purpose, different leaching tests have been carried out on a laboratory scale on RA studying the sample condition. The study aims to determine the influence of the sample size of the leaching performance in RA from C&DW.

Introduction

The construction sector continues to be one of the least sustainable in the world: it generates 36% of CO_2 emissions and 39% of energy and process-related carbon dioxide (CO_2) emissions. Annually, 3 billion tons of raw materials are used to manufacture construction products worldwide. Such waste involves a significant loss of valuable minerals, metals and organic materials. Considering such values, even slight improvements in the construction industry will have a significant impact on sustainability (ANEFA, 2023).

In Spain, 45 million tons of CD&D are generated per year, with RA accounting for 10% of the total production of aggregates (CEPCO, 2023). The main challenge faced by RA at national level is the heterogeneity of the quality of C&DW source. The need to obtain a cleaner product is challenging since in many RA we can find non-stone remains or high gypsum content, which may make its use impossible for some construction activities.

The main materials obtained after recycling in the treatment plant are mainly used for road surfaces, tread layers, as a sand bed under pipes or drainage layers (Cardoso et al., 2016, Reis et al., 2021).

To quantify the environmental impact of RA, leaching tests have demonstrated to be a useful tool at laboratory scale. These tests allow obtaining the levels of release of polluting substances present in the solid material, simulating what happens when a rain episode occurs. At a laboratory scale, water-solid contact is simulated and through this procedure contaminants are transported by migration through the water. The conditions of leaching tests affect the results. This research has focused on examining the influence of sample conditions when testing RA from C&DW. It aims to determine whether these RA pose harm to the environment and whether there is an overestimation of their potential harmfulness. The proposed sample conditions are designed to mimic on-site conditions of RA.

Materials and test methods

Different samples were collected from two different C&DW treatment plants (1 and 2). The samples were two Mixed Recycled Aggregates (MRA), two Recycled Concrete Aggregates (RCA), two Recycled Sands (RSand), two Recycled Soils (RSoil) and one Recycled Gravel (RG). Two different batch leaching tests were performed: UNE-EN 12457-4:2003 and UNE-EN 12457-2:2003. Both are the proposed batch test for leaching of granular waste materials and sludges at Compliance Level. The extractions are obtained at L/S of 10 l/kg. The contact time with deionised water is 24 ± 0.5 h respectively. The difference between them yields on the fact that UNE-EN 12457-4 standard stablishes and maximum size of the sample of 10 mm, while UNE-EN 12457-4 standard does it at 4 mm. In a similar way, to compare the affection of the sample size, the first eluate (with a L/S ratio of 0.1) for the leaching Up-flow percolation test UNE-EN 14405:2017 and the same eluate from a new method for testing samples with bigger size than 4 mm (maximum size for UNE-EN 14405:2017 standard) were carried out.

Results and Conclusions

This abstract presents the results of comparison the standard UNE-EN12457 part 4 and part 2 for sulphate and chloride anions (Figure 1). The expectation was that the Part 2 test would leach more as the aggregate size is smaller, but the results did not show a clear trend. For the case of sulfates, comparing Part 4 with Part 2, there was a reduction of more than 50% for RSand2, while there was an increase for RG1 of 29%. For the case of chlorides, there was an increase of 57% for MRA1, while sample MRA2 experienced a reduction of 32%.

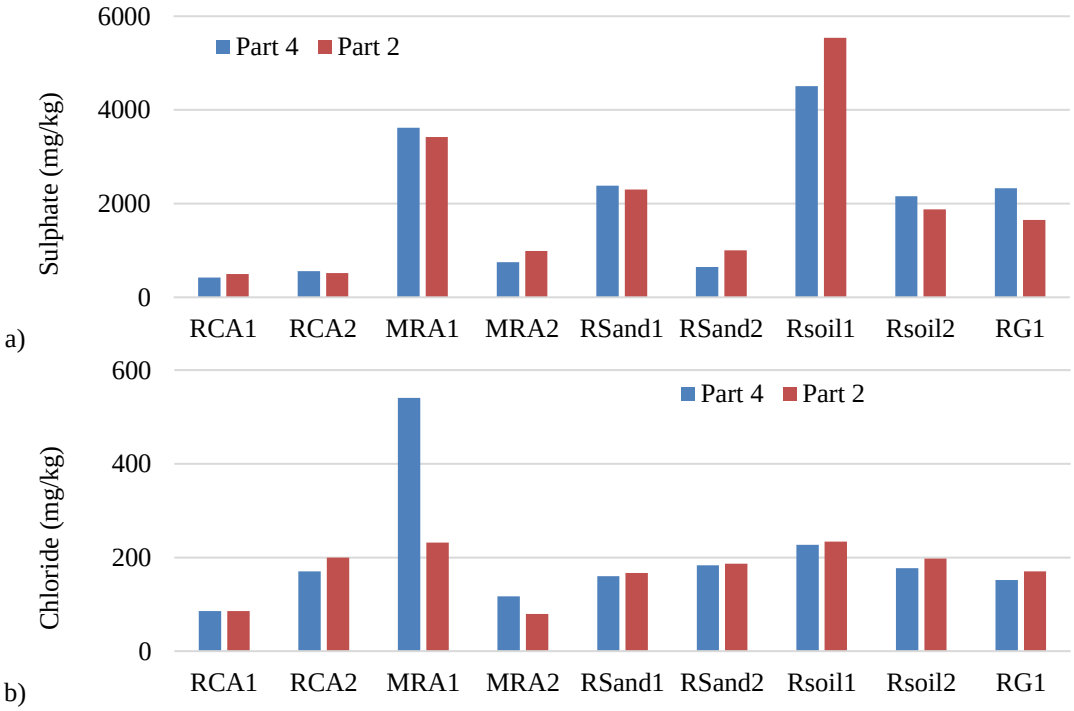

Figure 1. a) Sulphate and b) Chloride anions release in mg/kg for Standard UNE-EN 12457 part 4 and part 2

Pending verification is whether this premise, that there is no influence on the aggregate size, can be extrapolated to the percolation test. This research focusses on the influence of sample conditions testing RA from C&DW, with the purpose of detecting whether they pose harm to the environment and if it is overestimated potential harmfulness, since the proposed sample conditions are more similar to the RA on-site conditions.

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