Characterization of aggregates from construction and demolition waste in relation to Italian and Spanish regulations

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Introduction

This study compares the chemical and environmental characteristics of construction and demolition waste (CDW) and recycled aggregates (RA) in compliance with the requirements established by the recent Italian End of Waste Regulation (M.D. 152/2022) for inert waste, and the Spanish legislation Royal Decree 646/2020 "regulations for the management of waste disposal through landfilling," and Law 7/2022 “wastes and contaminated soils for a circular economy” which set analytical limits and criteria for the verification of the environmental compliance of CDW.

The M.D. 152/2022 (EoW for inert waste), officially published and set to come into force on 4th November 2023, has introduced more restrictive limits and additional analyses on RA produced in treatment plants, causing numerous disputes among operators in the sector, while as regards the introduction of a national End of Waste decree in Spain, this has not yet been taken into consideration and each situation is still being evaluated individually.

It should be noted that at the European level, Italy ranks fourth in the production of these wastes with about 60 million tons produced each year, and at the same time, Spain with about 40 million tons is ranks sixth, recovered respectively with percentages of 76% and 84% of the total produced (European Commission, 2017).

The use of RA would result in a high saving of raw materials, but the findings are discouraging, primarily due to the environmental incompatibility of specific materials. CDW as well as RA are composed by different substances consisting of various components such as concrete, bricks, wood, plastic, metal, and other materials (Bianchini et al, 2020) and unfortunately, some of these materials have the potential to release pollutants into the environment.

As previously mentioned, the possibility of using these aggregates is hindered by compliance with the limits set out in the new regulations. The objective of this study is to compare the chemical and leaching characteristics of CDW with the ones performed on RA; the Italian and Spanish situations will be reported.

Materials and methods

The data collected and analyzed in this work derives from Italian and Spanish CDW treatment facilities. The information was collected both for CDW that enters the treatment plants, and the RA obtained from their treatment. The data were grouped into four categories:

- chemical analysis on CDW;
- chemical analysis on RA;
- leaching test on CDW;
- leaching test on RA.

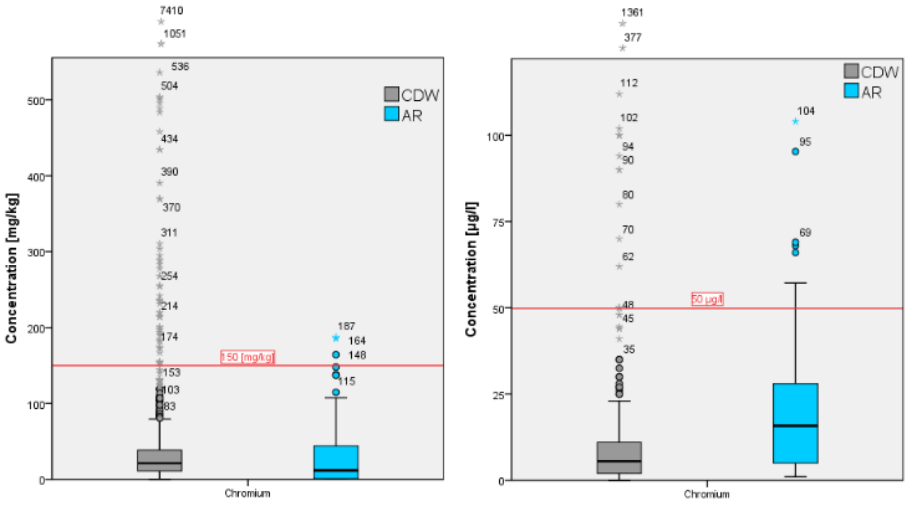
The results obtained from chemical analysis and leaching test were compared to the limit values provided for Italian and Spanish regulations.

Results

As concerns the regulations, the main differences between the Italian and Spanish frameworks is the absence of the evaluation of heavy metals in chemical analysis on RA in the Italian EoW decree; unlike the Spanish decree requires the analysis of these substances according to leaching bath tests UNE-EN 12457- 4 and UNE-EN 14405. Additionally, regarding the leaching tests, the main difference lies in the use of different methodologies for carrying out the tests. The Italian EoW decree provides for the implementation of the UNI EN 12457-2 standard, while in Spain, the UNI EN 12457-3 methodology is used.

In Italy, the most critical parameters for chemical analysis on CDW are PCBs, asbestos, benzene, phenols, and heavy hydrocarbons (C>12) (Sorlini *et al*, 2023). For leaching tests performed on CDW, COD, nickel, mercury, total chromium, and copper are critical. RA, on the other hand, is less critical compared to CDW in terms of chemical composition and leaching tests due to fewer available analyses and the origin of the aggregates mainly from excavation materials and rocks. The criticalities for RA are still lower than those for CDW and concern total

chromium, COD, and copper for a limited number of samples. Figure 1 illustrates the content of chromium and its release using the box-plot methodology for both chemical analysis and leaching test on CDW and RA as an example.



(a) **(b)**

Figure 1: (a) Chromium content: comparison between CDW and RA; **(b)** Leached concentrations of Chromium: comparison between CDW and RA compared to the maximum allowable concentration in in the leachate for waste reuse

With regard to the critical components and pollutants released the origin are mainly related to the different origin of the incoming waste. As regards the presence of benzene, PCBs, and Chromium VI other components and the release of total chromium, for example, are mainly associated with the presence of cementitious fractions (EWC 170101) in the incoming waste and produced RA. At the same time, the bituminous fractions (EWC 170302) and the mixed CDW (EWC 170904) could lead to the presence and the release of different pollutants including COD, copper, phenols, etc.

At Spanish level, GEAR project analysed RA from a wide number of treatment plants in Spain and detected Cr and sulphate as more critical components on RA. It was also studied by GIASA project which identified the key RA compounds that pose environmental risks (mainly ceramic materials bricks and tiles, gypsum and plaster). The current challenge and a large field of work is focused on evaluating the legal limit applied and the inclusion of the real physical conditions in the environmental criteria of the recycled materials when they are applied on site.

Future perspectives

The research highlighted that the high heterogeneity of CDW can influence the quality of RA and their properties I terms of leaching behavior. Some pollutants released in the leachate can be a critical issue compared to the regulation for waste reuse in construction applications. Moreover, some novelties introduced with the recent EoW criteria in Italy will require further investigation on the quality of RA.

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