

Environmental criteria related to End of Waste legal framework for Recycled Aggregates from CDW

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Introduction

Leaching tests have proven to be an indispensable tool to evaluate the contaminant release from recycled aggregates (RA) as new construction materials. Leaching procedures simulate easily and at low cost the rain effect exposure on any type of material used in infrastructure: earthworks fillings, fill for drainage structures, road subbases or embankments. Therefore, based on leaching data, the prediction of polluting potential is possible by performing different leaching procedures at laboratory scale. However, Europe currently lacks a unified legal framework for the materials under study, specifically RA from Construction and Demolition Waste (CDW). The confusion resulting from the great variety of tests used to evaluate the environmental impact of RA makes it necessary to establish which procedures are the most appropriate for laboratory testing to closely replicate on-site conditions. This standardization is essential for ensuring that laboratory conditions closely mimic those in the actual environment.

The present work also compares the effect of different test procedures (UNE-EN 12457-4 and UNE-EN 12457-2) which are applied in the majority of European Member States, in order to evaluate the effect on heavy metals and anions listed by the Landfill Directive release from recycled aggregates.

Materials and methods

In Europe, 800 million tons of CDW were produced in 2020, most of which was produced in Germany and France. In Italy, Spain and The Netherlands there is also a high production of CDW (Eurostat, 2020). The 2008 European Waste Framework Directive set a target of 70% CDW recovery by 2020. Most European countries have reached this target. For example, The Netherlands recycles 100% of their waste, but also Italy, Spain, Germany have a high recycling rate. Some countries as Ireland, Poland, Portugal did not reach the target, being most of the waste destined for a reuse like backfilling and the rest are destined to landfill (Eurostat, 2020).

Obtaining good quality of RA is very important, but the quality of RA depends on the composition of CDW from which they derived. The European mean values about CDW composition are 25% concrete, 30% masonry, 15% asphalt, the rest divided between mixed CDW, other mineral waste, wood, plastic and metals (Monier, 2011). The composition of CDW varies in different European countries, as shown in Table 1.

Table 1. Composition of CDW in different European countries (Monier, 2011).

Component [%]	Italy	Spain	Ireland	The Netherlands	Belgium (Flanders)	France	Germany	Denmark
Concrete and masonry	80	66	80	65	-	11	70	-
Concrete	30	12	-	40	41	9	-	32
Masonry	50	54	-	25	43	2	-	8
Other mineral waste	6	9	0	2	-	51	-	0
Chalk	-	0.2	-	-	0.3	0.2	0.4	-
Asphalt	5	5	4	26	12	5	27	24
Wood	2.5	4	-	2	2	0.7	-	-
Plastic	2.5	2	-	-	0.1	0.3	-	-
Metals	3	3	4	1	0.2	1.3	-	-
C&D Mixed Waste	3.5	12	12	7	2	30.5	3	36

The 2008 European Waste Framework Directive contains a provision to define, at EU level, the "End of Waste" criteria according to which waste could cease to be waste and could be considered a freely traded material on the market. The purpose of the End of Waste criteria is to facilitate and promote recycling to achieve a Circular Economy, ensuring a high level of environmental protection, reducing the consumption of natural resources and the amount of waste sent for disposal. Article six of this Directive requires that RA produced from CDW are subjected to two different compatibility checks: technical compatibility and environmental compatibility.

Technical compatibility is necessary to put RA on the market by obtaining CE mark. Environmental compatibility can be verified through Leaching tests.

The environmental compatibility is important because RA in contact with water can release substances that are dangerous for the environment and human health. Leaching test simulate rain fall is used to estimate the potential release of these substances. The test consists of setting RA in contact with deionized water and then extracting the eluate chemical analysis to examine the substances released. There are different types of leaching tests, the most used is Compliance test. This test consists of putting the solid sample in contact with a leachant, usually deionized water, in a bottle, which is then stirred for 24 hours, and from which the eluate is extracted. There are four different European standards introduced in 2003 for Compliance test that differ for number of stages, liquid-solid ratio and grain size. The solid liquid ratio is ratio between the volume of liquid (in liters) and the weight of RA (in kilograms). Grain size is very important because it influence the leaching of substances. In some countries, such as Italy and Spain, the recycling of CDW is severely hampered by legislation and end-users' concerns about the chemical, physical and mechanical properties of materials. In Europe, only seven countries have adopted End of Waste criteria in national legislation for RA. These countries are Austria, Belgium, France, The Netherland, Ireland, Italy, United Kingdom.

The present study evaluates the different environmental testing procedures established by the environmental legislation of different Member states. It is confirmed that the compliance leaching test is the most used (by standards EN 12547- 2 or EN 12457- 4). In particular, part two is adoptive in Italy, Ireland, France and Germany, while part four in Spain, Austria, France, Czech Republic. In addition, for granular materials also percolation leaching tests are included on environmental criteria in some countries, as The Netherland, Belgium, Sweden, Finland. Table 2 shows leaching test adopted and main characteristics.

Table 2. Leaching test adopted for environmental compliance

Member State	ITALY	SPAIN	IRELAND	NETHERLANDS	AUSTRIA	FRANCE
Leaching test	CT	CT	PT	PT	CT	CT
Standard	EN 12457-2	EN 12457-4	EN 14405	EN 12457-2	EN 14405	EN 12457-4
L/S [l/kg]	10	10	0.1*	10	0.1*	10
Grain size	< 4 mm	< 10 mm	< 4 mm	< 4 mm	< 4 mm	< 10 mm

*C₀ first eluate; CT: Compliance Test; PT: Percolation Test

About the leachate pollutant limit values established in Spain, it has different limits for Compliance test and Percolation test. This is because in some cases, if the limits of some parameters obtained from the compliance test are not respected, it is possible to evaluate them through the Percolation test. Spanish limits introduced in 2020 Royal Decree came from limits for acceptable waste in landfills for inert waste of 2003 European directive. Dutch limits are more restrictive than Spanish limits, as these limits are introduced after studies on the Percolation test. Spanish legal limits for Compliance test are similar to French limits, but they are different respect to Italian limits.

Results and conclusions

Therefore, the present work concludes that Environmental compatibility is mandated by the European Directive as an End of Waste criteria for RA. For this reason, it is necessary to estimate the potential release of substances from RA through leaching tests. The main issue is that European states have adopted different type of leaching tests: Compliance test and Percolation test; these states are also adopted different leachate pollutant limit values. From a preliminary comparison of the results obtained with the execution of the Compliance test according to standards EN 12457-2 and EN 12457-4, it is possible to conclude that for most of the parameters the results are similar.

It can be concluded that it is necessary to unify leaching procedures at European level to be able to quantify the polluting potential of RA under the same criteria. This coordination will unify the environmental properties to be met by RA, increasing the recycling rate and meeting the guidelines set by the circular economy for European members.

References

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