Experimental risk assessment of Extensive Green Roofs with fine fraction of mixed recycled aggregates from construction and demolition waste.

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1. Introduction

The rise of green roofs due to their potential with multiple benefits is a fact widely studied (Getter and Rowe, 2006). Extensive Green Roofs are those which are partially or fully covered by a thin and light layer with vegetation and a growing medium over a waterproofing membrane (Santamouris, 2014).

An experimental extensive green roof has been carried out in the University of Córdoba (south of Spain). There were built two piece of grounds over a building roof (Figure 1); each one occupied 14 meters squared, covered by a waterproofing and root barrier membrane, an egg-cup shaped drainage layer, a nonwoven filter fabric and a coir-based erosion control blanket. 12 Autochthonous Mediterranean plants, selected by their adaptation to withstand drought stress, intense lighting and extreme heat, shallow and poor substrates due to harsh conditions in urban Mediterranean ecosystems, were distributed to almost 16 plants per meter squared, following the recommendation of the German Guideline of green Roofs execution and maintenance (FLL, 2008).

Figure 1. Piece of grounds of the Extensive Green Roof in University of Córdoba

As the growing medium for vegetation, mixes with different proportions of a fine mixed recycled aggregate (FMRA), from a nearby construction and demolition waste treatment plant, and a commercial vegetable substrate (CVS) were used. In this experimental Extensive Green Roof Experience, among other issues, the environmental evaluation of these mixes used as growing medium for vegetation has been analysed.

Due to the total content of a pollutant is not the decisive factor but its capacity to be incorporated into the water; leaching tests are the experimental procedures used for developing the environmental assessment. Landfill Directive (Council Decision DC/2003/33/CE, 2002) lays down criteria and procedures for the acceptance of waste at landfills, and these limit values are used as reference for comparison with the results obtained with leaching tests. Furthermore, it was conducted a long-term “in situ” leaching test motivated by the point that the European Committee for Standardization (CEN / TC 292) proposes, in addition to basic characterization and conformity tests, an on-site verification test for long-term prediction to verify the behaviour material.

2. Materials and methods

The FMRA and the CVS used presented a maximum size of 4 mm. The FMRA presented water absorption after 24 hours of 3.64%; and a dry density, saturated surface dry density and bulk density of 2.49 g/cm^3, 2.58 g/cm^3 and 1.4 g/cm^3 respectively. The CVS presented water absorption after 24 hours of 41.35%; and a dry density, saturated surface dry density and bulk density of 1.06 g/cm^3, 1.49 g/cm^3 and 0.6 g/cm^3 respectively.

The mixes, here presented, were S100, used as reference, 100% composed by CVS; and S50, with a 50% (in volume) of FMRA incorporation rate and a 50% of CVS.

The different leaching test methods used were: the Compliance Test (UNE-EN 12457-3:2003) and the Column test (NEN 7343:1994), both required by the Landfill Directive; and as a long-term “in situ” column test, it was carried out a system to collect the leachate from the different green roof piece of grounds in a deposit (Figure 2) from the samples analysed were extracted. It was determined the first six liquid to solid ratios of the Column test: 0.1, 0.2, 0.5, 1, 2 and 5 l/kg, in similar way to NEN 7343:1994.

Figure 2. Deposit to collect leaching from green roofs

3. Results and discussion

The classification according to Landfill Directive limits, Compliance Test and the first extraction of the Column Test at an L/S of 0.1 L/kg, of the materials used were: FMRA as Non-hazardous due to the sulphate content, in agreement to Butera *et al* (2014), who found the sulphate anion as a critical element; and in CVS case, Non-hazardous due to the sulphate and chloride content obtained. Figure 3 shows the chloride and sulphate content results in the Column Test and Compliance Test for S100 and S50. Chrolide content in S50 complied with the Landfill Directive limit, otherwise, chloride and sulphate content in S100, and sulphate content in S100 and S50 did not comply with Landfill Directive to be classified inert. So S100 and S50 are classified as non-hazardous materials.

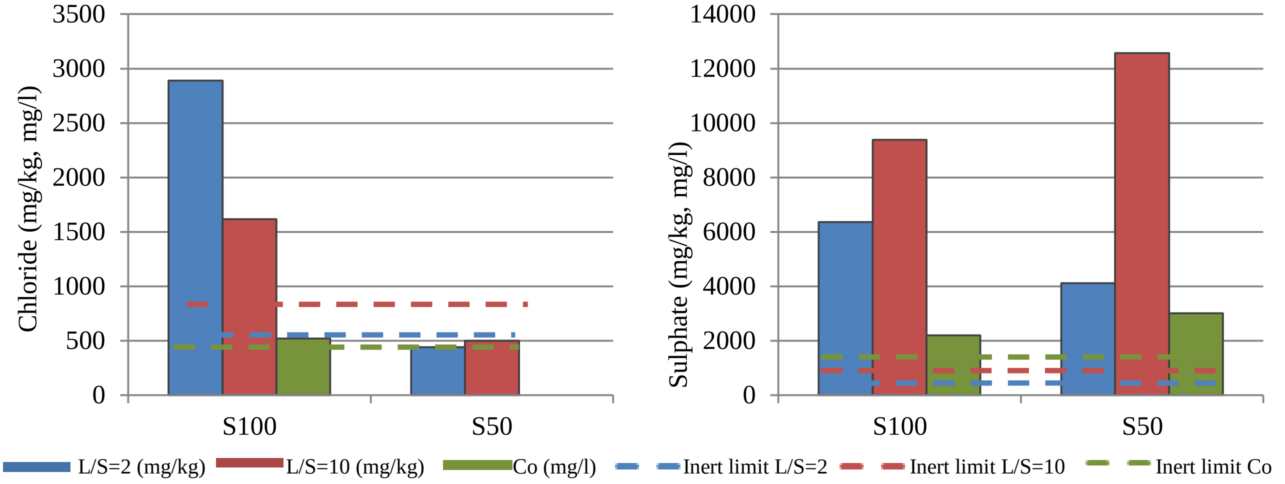

Figure 3. Comparison between the results of Column Test in Laboratory and Compliance Test and the Landfill Directive limit between inert and non-hazardous.

Figure 4 shows the comparison between the results of Test Column in Laboratory (Lab) and "in situ" in S100 and S50. It can be observed that the cumulative sulphate and anion content levels in the Column Test are reduced in "in situ" results respect to laboratory data. This is can be explained due to the confinement effect and the total contact of the material with the leachant that takes place in the laboratory, in comparison to "in situ" conditions.

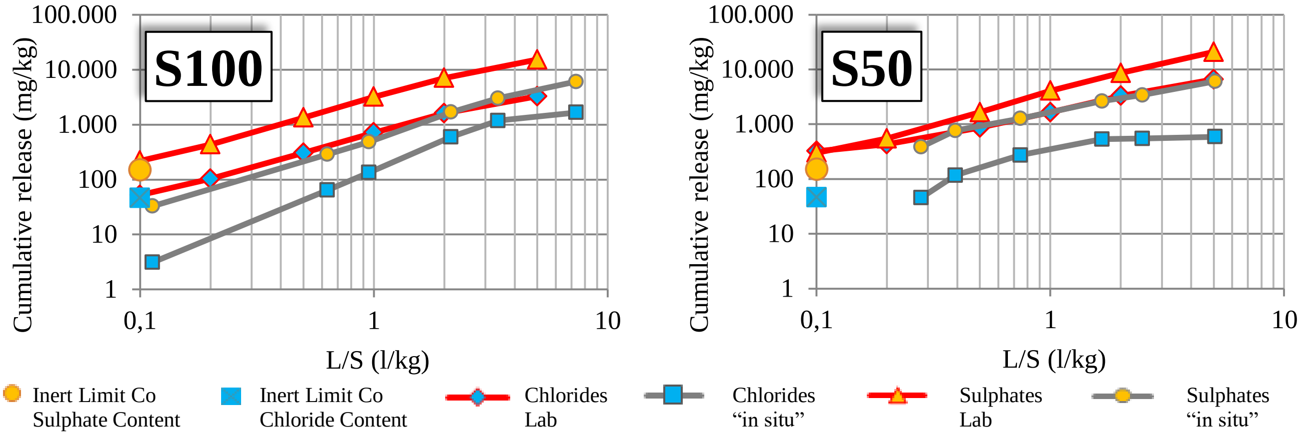

Figure 3. Comparison between of Test Column in Laboratory (Lab) and "in situ" in S100 and S50 for the cumulative results of sulphate and chloride anions, and Landfill Directive Inert Limit for first extraction of the Column Test (Co).

4. Conclusions

This risk assessment of Extensive Green Roofs with FMRA presents that the difference between the results of column test in laboratory, required by the available regulatory limits, and "in situ" results, indicates that real application of FMRA with CVS release less amount of pollutants, in particular sulphate and chloride anions are diminished. It implies that the effect of laboratory conditions can overestimate the potential pollutant of these materials.

5. References

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