Concrete-Based and Mixed Waste Aggregates in Rendering Mortars

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Version received: 27 April 2020

The construction industry is considered the biggest waste producer in Europe. In order to encourage recycling, European Parliament decreed through the Waste Framework Directive 2008/98/EC, that at least 70% of construction and demolition waste should be recycled by 2020. From recycling plants, three types of recycled aggregates are produced. Recycled Concrete Aggregate, mainly from cementitious waste, as such as concrete and mortars residues; Recycled Masonry Aggregates mainly composed by recycled ceramic materials, as such as tiles and bricks residues; Mixed Recycled Aggregates based on rubble residues, from heterogenous materials waste. This research evaluated the technical feasibility of rendering mortars with Recycled Concrete Aggregates and Mixed Recycled Aggregates, in different volume incorporation of 0%, 20%, 50% and 100%. The experimental programme comprised an analyse of the fresh and hardened properties, regarding the water and mechanical behaviour of the mortars. From the results, it was noticed that the modified mortars presented a reduction in the modulus of elasticity, which its correlated to a less susceptibility to cracking. Regarding mechanical performance, the modified mortars obtained reduction of the flexural and compressive strength over time. However, it was not a significant harmful criterion. Therefore, the incorporation of recycled aggregates in cementitious materials is considered a technical and sustainable solution.

The analysis of the incorporation of recycled aggregates in rendering mortar is the main objective of this research. Two types of recycled aggregates from construction and demolition waste were used as a replacement of natural aggregate. Recycled Concrete Aggregate, mainly composed by cementitious materials waste and Mixed Recycled Aggregate from rubble residue. The latter is considered a heterogenous waste, due to different quantities of each construction materials. This research provides a feasible solution to manage the waste from construction sector.

Regarding the results, it was concluded that the type of recycled aggregate used, and the volume incorporated have a different influence concerning the mortars behaviour.

To achieve the same workability, the modified mortars required more water when compared to the traditional mortar. This is attributed to the greater surface area and the shape of the recycled aggregates and also, for the presence of non-hydrated cement particles, which can hydrate with the kneading water. Recycled aggregates are more porous than the natural ones, which can demand higher content of kneading water.

Due to a more porous microstructure of the recycled aggregate and their lower particle density, the fresh and hardened bulk density of the modified mortars presented a decrease. It was verified that a decrease trend as the volume of recycled aggregate increased.

The incorporation of recycled aggregates in mortars improved the ability to withstand the deformations without fracture, due to a lower dynamic modulus of elasticity. Mortars with Mixed Recycled Aggregates presented a lower modulus of elasticity than that of the Recycled Concrete Aggregates mortars.

Regarding the mechanical strength of the mortars, it was shown that the incorporation of recycled aggregates reduced the flexural and compressive strength over time. Although, at 28 days, the total replacement of natural aggregates for Recycled Concrete Aggregates presented an increase in both mechanical strengths.

In general, recycled aggregates are more porous than natural one. It depends mainly of its composition. This feature of the aggregate influence the water absorption of the mortars. Thus, modified mortars showed a higher water absorption by capillarity when compared to the control mortar. It was observed a linear trend as the recycled aggregate volume was increased. Recycled Concrete Aggregates mortars presented a better water behaviour compared to the Mixed Recycled Aggregate mortars, due to the water absorption capacity of the particles, the pore microstructure and the connectivity of the pore channels inside the mortars.

The incorporation of recycled aggregate in rendering mortars improved the adherence strength between the mortar and substrate. This is attributed to the presence of non-hydrated cement particles, which hydrates inside the substrate's pores and, strengthening the interlock in the interfacial transition zone.

It can be seen that the heterogeneity of the recycled aggregates influence all the results obtained of modified mortars.

According to the results obtained in this study, it can be considered that the incorporation of recycled aggregate in rendering mortars presents an adequate technical performance. Additionally, the use of recycled aggregates from construction and demolition waste provide a reduction of their deposit in landfills and a replacement of the natural resources used.

Keywords

eco-mortars; rendering mortars; Construction and demolition waste; recycle; reuse; CO2 reduction