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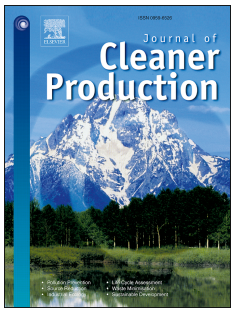

Microbial carbonate precipitation for the improvement of quality of recycled aggregates

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Microbial carbonate precipitation improves the quality of recycled aggregates for sustainable concrete production

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Abstract

High water absorption is the main drawback of recycled aggregates which greatly hinders the re-use of them in concrete production. In this study, bio-deposition treatment, based on bacterially induced $CaCO_3$ precipitation, was applied to improve the quality of the recycled aggregates. Two representative recycled aggregates, recycled concrete aggregates (CA) and mixed aggregates (MA) were used. The bacterial $CaCO_3$ precipitated on the surface and in the pores of the recycled aggregate worked as a barrier for the penetration of water, and hence the water absorption of the aggregates can be decreased. Firstly, the optimal treatment method was determined by screening among spraying and several immersion strategies. It was found that the two times immersion treatment was the best method. Samples subjected to this method had a high weight increase (2% for CA and 2.5% for MA) and largest extent of water absorption decrease (one percentage point drop for CA and two percentage points drop for MA). Furthermore, The biogenic $CaCO_3$ had a good cohesion and strong bond with the aggregate surface. Very limited (<0.1%) mass loss occurred on the bio-treated samples while the mass loss of the untreated aggregates was much higher (0.2% for CA and 0.5% for MA). This indicated that the surface of the aggregates was strengthened by the biogenic $CaCO_3$ as well. After using the bio-treated aggregates, the compressive strength was increased by 40% for CA concrete and 16% for MA; the water absorption was decreased by 27% for CA concrete and 20% for MA concrete.

Keywords: Recycled aggregates, water absorption, porosity, biogenic $CaCO_3$, immersion

1. Introduction

Construction and demolition waste (C&DW) is the waste materials generated by construction, renovation and demolition of buildings. From the viewpoint of sustainable resource management, concrete and demolition waste is sorted and reduced to applicable sizes. Mostly, the coarse fraction is investigated for secondary use. One of the most often used applications is as coarse aggregate. Ossa et al. (2016) made asphalt concrete specimens with different percentages of recycled aggregates and found that it was feasible to use construction and demolition waste aggregates up to 20% for paving urban roads. Rodríguez et al. (2016) applied recycled mixed aggregates in non-structural concrete precast pieces. However, around 95% of the aggregates from construction and demolition waste is used in low quality applications (foundations of roads, rip-rap,…). This is due to the questions raised regarding the performance of these aggregates. The main issue with recycled aggregates designated for