BIOSELANTE – Biocementation as Crack Sealing Technique Applied to Concrete Water Tanks

Summary

Water supply systems are vital infrastructures that provide an indispensable public service to society. An important percentage of water losses is caused by the development of cracks in water storage tanks, so efficient crack sealing repair works are necessary. Biocementation has been used with good results for sealing cracks in many construction concrete infrastructures (e.g., buildings), as an alternative to standard materials, such as polymeric resins and cement mortars. BIOSELANTE project aims at the experimental evaluation of biocimentation effectiveness in terms of watertightness for sealing cracks structures in contact with pressurized water, to be further applied to repair cracks in water storage tanks. Biocementation treatment was applied in cracks artificially created in small rectangular concrete plates 4 cm thick, with three crack widths (i.e., 0.1, 1 and 10 mm) to cover different real cases in which the repair with this technique is viable. The 10 mm width cracks were filled with sand before the treatment. A method to apply the treatment in vertical surfaces was developed (see Figure1) to simulate real conditions. Different rounds of bacteria Sporosarcina pasteurii were applied, being the efficiency of the treatment investigated by performing watertightness tests through variable water head tests starting at 10 kPa (1 m of water) (Figure 1). Dissolution was discarded through measurements of ultrasonic pulse velocities before and after the watertightness tests and the results were explained by images of thermographic camera (see Figure 2). The presence of biocement was confirmed by mineralogical analysis of the precipitate extracted from the cracks after breaking the plates through bending tests. Obtained results are very promising since the biocement precipitated can completely stop water flow in the 0.1 mm cracks and, for the cracks with 1 mm and 10 mm widths, the treatment can reduce the initial flow rate, on average, by 95% and 98%, respectively (Figure 3). The performance of the 10 mm width cracks previously filled with sand was similar to that of the 1 mm cracks, where no sand was used. The material strength recovered after the treatment is not as good as desirable: although a maximum recovery of 95.5% of the initial strength (average values) is found for the smallest crack width and it was almost null for the other two crack widths. These results demonstrate that the technique is effective when watertightness is required, but not when material strength must also be recovered. Further research is required to investigate the maximum water pressures that can be applied to each case, eventual effects of biocimentation on water quality and the durability of the treatment.

Outputs:
MSc Thesis:
Bonetti, L. (2022) - Biocimentação como técnica para selagem de fissuras em reservatórios de água em betão. MSc Thesis, Instituto Superior Técnico, University of Lisbon, Portugal

Journal paper submitted:
Cardoso, R, Bonetti, L., Pinto, M., Flores-Colen, I. and Covas, I. (---). Use of biocementation to seal joints in concrete water reservoirs. Construction and Building Materials, Q1. SUBMITTED

Project logo

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Project Reference

BIOSELANTE

Leading Institution

Civil Engineering Research and Innovation for Sustainability – CERIS (Portugal)

Partners

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Funding

Civil Engineering Research and Innovation for Sustainability – CERIS

Period

2021-2022

Total

7500€

CERIS

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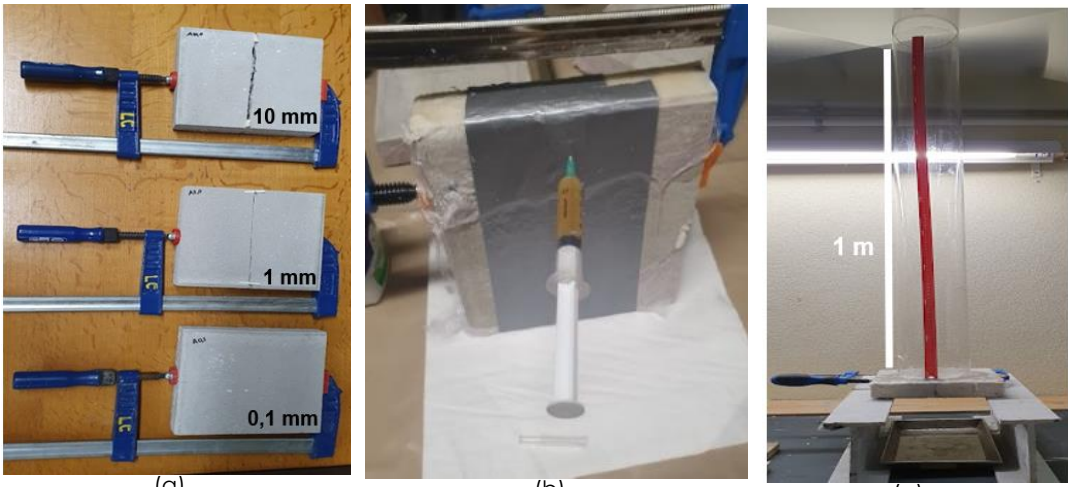
Project website

fenix.tecnico.ulisboa.pt/homepage/ist13977/projecto-bioselante



(a) (b) (c)

Figure 1. a) Different crack openings of the plates; b) Biocementation treatment in vertical surfaces, c) Watertightness test setup.

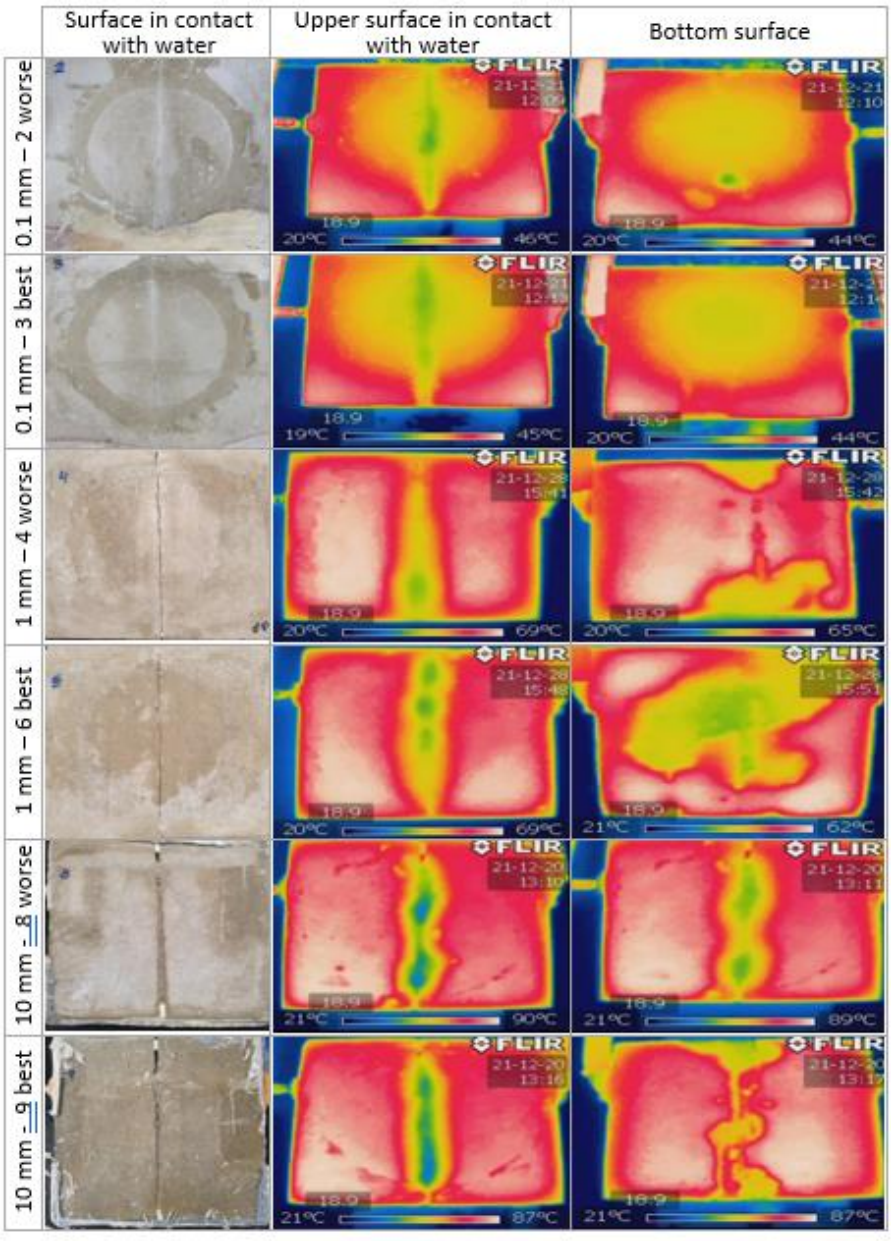


Figure 2. Thermal images of the plates after the treatment showing the zones without filling around the openings.

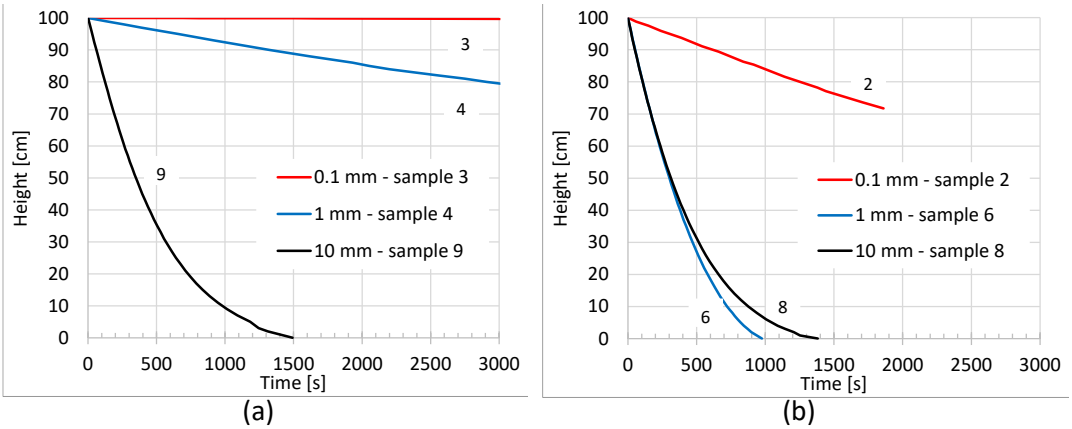


Figure 3. Comparison between the different widths after treatment for the samples with the best (a) and worst (b) sealing performance.