Proving the effect of abiotic processes on the repair of cement composites with carbonates precipitated in the presence of bacteria

The formation of cracks in cementitious composites is one of the biggest drawbacks and threats to these materials. Constant search is being made for solutions to reduce the problem of crack formation and methods of repairing cracked structures that have the least impact on the environment while maintaining high repair efficiency. In recent years, the method of repairing cracks of cementitious composites with the products of the MICP process - Microbially Induced Carbonates Precipitation, is gaining popularity. The process is based on the use of selected strains of microorganisms that, under the appropriate microenvironment conditions and in presence of nutrients and precipitating precursors, are able to precipitate carbonate mineral phases that fill cement matrix cracks. Although this method is considered to be very effective, the cementitious matrix environment is highly unfavourable for microbial activity and all studies carried out up to now have indicated a reduction in cells capable of preserving viability under these conditions.

Due to the inconsistencies in the reported high rates of repair of cementitious composites with a drastic decrease in the viability of microorganisms in this particular environment, the project authors set out to prove the significant influence of abiotic processes (occurring without the involvement of microorganisms) in the formation of carbonate precipitation products in the environment of cementitious composites. The overall research plan is to analyse the products of carbonate precipitation in the presence of bacteria, both in a controlled environment and in a cement composite environment. The research will be carried out for different types of (bio-based) healing agents, which will include different types of bacteria, nutrients that initiate their activity and precursors of the precipitation reaction. A key task of the project will be the analysis of the solid phases - products resulting from microbial precipitation of carbonates. For this purpose, standard phase analysis methods will be applied, which will be further detailed by using synchrotron measurement techniques with diffraction and microscopic methods. As a final step, the energetics of the microbial carbonate precipitation process is planned to be modelled.

The research will lead to a complete study of the identification of the products of abiotic and biotic carbonate precipitation, the determination of the actual contribution of microorganisms to the precipitation of crystalline forms in the presence of cementitious composites, and the influence of (bio-based) healing agents on the changes occurring in their matrix. The subject matter of the project addresses an important and current research problem and the proposed project will provide new knowledge in the area.