A Feasibility Study: Use of Microwave-Assisted Opening of Epoxy Resin-Filled Alginate Capsules

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Introduction

The transport infrastructure is the basis for mobility and the associated economic success of a society. The concretes used so far in transport infrastructure are neither adaptive nor multifunctional, which is why they cannot be the basis for modern mobility. The aim of this research project is to find possible solutions for a concrete that is capable of meeting future requirements. This adaptive and multifunctional concrete 2.0 should be able to recognize damage and repair it itself by being functionalized with for example capsules filled with a reaction resin. The capsule needs to be able to release the reaction resin on demand when damage in the microstructure of the concrete occurred.

Results and discussion

Concept

- Design a core-shell capsule whose shell is made of a renewable material and functionalised with an internal switch to be opened on demand and release the contained epoxy resin.

Proof of concept

- Core-shell capsules with a core of epoxy resin, the shell is made of alginate and functionalised with Fe-particiles.

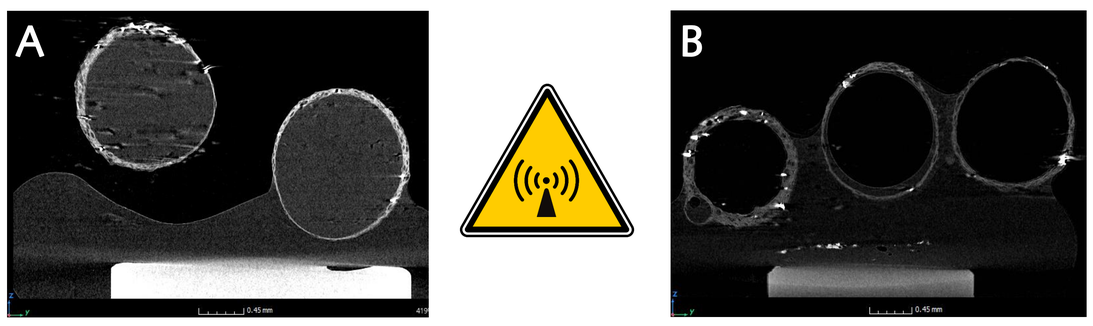

Figure 1: Nano-CT scans of the alginate capsules with a functionalised shell before (**A**) and after (**B**) irradiation with microwaves for 2 minutes and a power output of 800 watts.

- Figure 1 shows the computer tomography (CT) scans of the capsules, it is to bee seen that the irradiation with microwaves leads to the release of the epoxy resin.

- Does the opening mechanism work in mortar or concrete ?

Opening of the capsules in a mortar matrix

- Using a mortar with a w/c ratio of 0.5 to prepare specimens, which get irradiated for 10 minutes with a power output of 800 watts.

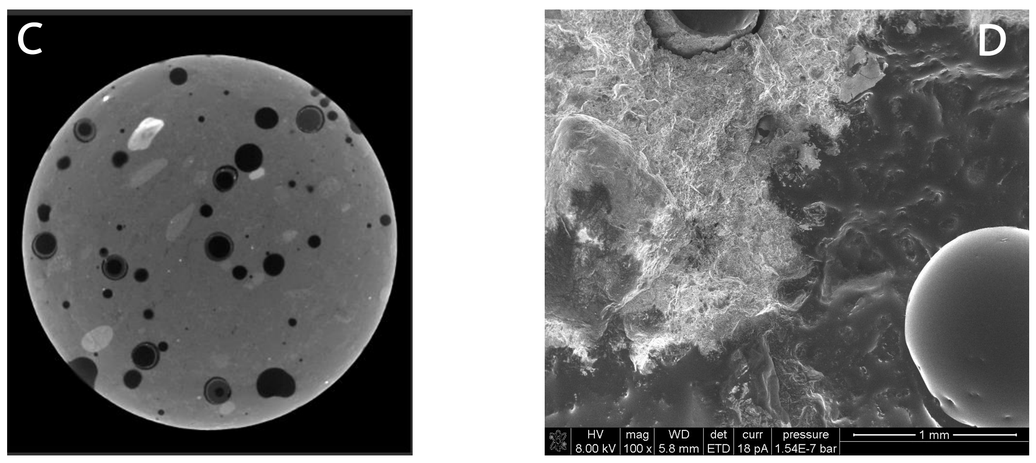

Figure 2: Nano-CT scan (**C**) and an SEM-picture (**D**) of a drill core which is exposed with microwave radiation to release the reaction resin.

- Figure 2 shows the top-down (**C**) view from the CT-scan of a drill core made from the specimen that has been irradiated with microwaves.

- It can be seen that the epoxy resin left the capsules.

- To be seen where the epoxy resin has gone SEM recordings (**D**) has been made, the resin left the capsules forced by capillary forces.

Conclusion

This studies show the possibility of designing a core-shell capsule with a shell formed of a renewable material. It was shown that the capsule could be opened on demand in a mortar matrix. The capsules are able to release an amount of reaction resin to fill cracks in the microstructure of the mortar matrix. In further investigations it needs to be clarified if it is possible to open capsules in a small area of the specimen to be able to fill detected cracks while the other capsules stay intact.

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