Application of polymeric capsules in concrete beams: survival during mixing and sealing ability of cracks

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Within the M-ERA.Net project CAPDESIGN, polymeric tubular capsules have been developed by the University of Mons for use in self-healing concrete. Their applicability in mortar/concrete has been tested at Ghent University and tests revealed that PMMA capsules (∅ 6.5 mm; L 50 mm; wall thickness 0.6-0.7 mm) can survive the concrete mixing process and break upon appearance of a crack of approximately 120 µm, showing their suitability to be used in self-healing concrete.

As small scale tests do not completely represent realistic applications, it was decided to test the capsules at a larger scale. Therefore, reference and self-healing concrete beams (2.5 x 0.4 x 0.2 m^3) were cast. Both polymeric and glass capsules were tested and all capsules were filled with a water repellent agent (Sikagard 705L). In order to be able to assess the dispersion of the agent in the cracks, fluorescent dye was added. The capsules (22 capsules / liter concrete) were added to a self-compacting concrete mix during the last 2 minutes of the mixing process, for which a vertical shaft mixer with a rotating pan and a capacity of 200 l was used. The concrete was poured into the moulds and no further compaction methods were applied. Fresh and hardened concrete properties were determined. Results showed that the compressive strength of the self-healing concrete is slightly lower than the compressive strength of the reference concrete (10-15% reduction).

From the age of 14 days, six cracks were successively created in the beams via separate three-point bending tests. Cracks appeared at the position of the notches sawn at the corners of the beam. Cracks were kept open by filling the notches with a repair mortar (Master Emaco T1100 TIX) and unloading was postponed until the repair mortar was sufficiently hardened. In that way cracks with a residual width at

the crack mouth of 0.2 till 0.4 mm were created. During loading, it was clear that capsules broke inside the concrete, as at some places water repellent agent was visible at the concrete surface. Water permeability tests show to which extent these cracks were sealed.

To assess the sealing efficiency obtained in these self-healing concrete beams, the beams are exposed to 6 cycles of NaCl exposure. Therefore, a solution of 3 wt% NaCl flows over the beams for 24 hours each week. Afterwards, the performance of the beams is evaluated by:

- Measurement of the chloride ingress via the cracks
- Measurement of the dispersion of the water repellent agent in the crack via fluorescence microscopy
- Determination of the distribution of the capsules in the concrete via X-ray tomography

The results will be further described in the 3 page paper.

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