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Cradle-to-gate life cycle assessment of self-healing engineered cementitious composite with in-house developed (semi-)synthetic superabsorbent polymers

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Abstract

Autogenous crack healing can be stimulated with superabsorbent polymers (SAPs) in microfibre reinforced strain hardening engineered cementitious composite (ECC). Cradle-to-gate life cycle assessment was performed for self-healing ECC with 1 m% of three in-house developed (semi-)synthetic SAPs and 2 v% of polypropylene (PP) or polyvinyl alcohol (PVA) microfibre. Given the high cement content of this ECC (572 kg/m^3), CML-IA impacts of 1 m% SAP range between 4-52% of the cement impact. The highest impacts were recorded for semi-synthetic SAPs, due to high energy use during drying. Use of PVA microfibre should be avoided since addition of 2 v% (= 26 kg/m^3) can easily induce significantly higher CML-IA impacts than 572 kg cement. Nonetheless, if 100% crack healing efficiency could be assumed for slabs made of self-healing ECC, CML-IA impacts remain lower than those of a slab made of traditional concrete with inclusion of the required cover replacements within 100 years.

Keywords

Self-healing concrete; Autogenous crack healing; Superabsorbent polymers; Synthetic microfibres; Life cycle assessment

1. Introduction

Although concrete resides in the top five of most durable construction materials [1], its low tensile strength implies a high susceptibility to cracking. Evidently, harmful substances from the outside environment penetrate more easily via those cracks causing accelerated concrete degradation and corrosion of embedded reinforcing steel [2]. Since the policymakers of today are actively aiming at a higher sustainability of the construction industry, it is no surprise that research efforts overcoming this problem are being highly encouraged. One possibility in that