Basilisk
self healing concrete

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Carbon footprint

Concrete construction leads to large CO_2 emissions. Not only through the cement, which contributes to 8% of the global CO_2 emission, but also through use of reinforcing steel, part of which is used for delivering tensile strength and part for crack-width control ensuring water tightness of the construction. Green-Basilisk Self-Healing Concrete (Basilisk SHC) contributes to the reduction of both cement and reinforcement, leading to a reduction of the CO_2 emissions for the concrete construction industry.

In Basilisk Info nr. 7, we show how the reduction in CO_2 emissions is calculated through various examples where Basilisk SHC can be used. The typical solution with standard concrete is compared to the new situation with Basilisk SHC. Of course, every project has its own characteristics, but using our standard situation you can easily estimate the CO_2 reduction for your project. In this fact sheet the reduction in CO_2 footprint is calculated in kg CO_2 per m3 of concrete (kg CO_2/m3) in order to allow comparison between the various examples.

The CO_2 footprint of standard concrete and Green-Basilisk Self-Healing Concrete

First, we determine the CO2 footprint (emission) per m3 of concrete. Data from IEA (1*) in 2017 showed 1.8 billion tons of CO2 per total market volume of 7.4 billion m3 concrete per year. This means that the average footprint is estimated at 240 kg CO2/m3 concrete. This is a value similar to the data for concrete given in the National Environmental Database of the Netherlands (NMD) (2*). For the production of Basilisk Self-Healing Concrete, a specific amount of Healing Agent is added to the concrete mix. As a consequence of this extra component addition, the total CO2 footprint of the concrete mix increases with (depending on the dosage) maximally 20 kg of CO2/m3 (3*). However, due to the specific healing agent properties this apparent increase can be offset what actually results in a significantly reduced footprint.

The following examples clarify the potential CO2 footprint reduction of Green-Basilisk Self-Healing Concrete in various applications.

Situation 1: Healing Agent application for service life extension by surface densification

The service life of a concrete structure is determined by durability characteristics. Durability of concrete is typically affected by the porosity of the concrete surface as reflected by water absorption (permeability). Addition of Healing Agent reduces water permeability by 30%. This potentially enables reduction of cement content and/or decreasing cover depth in line with NEN-EN 206 for performance-based concrete design (4*). Additionally, a 30% increase in service life would reduce necessity of casting new concrete to the same extend. A 30% reduction in concrete use would reduce its CO2 footprint by 72 kg CO2/m3.

Situation 2: Healing Agent for water tightness (alternative for membrane)

Making a watertight structure is quite complicated. Various methods can be recommended, which are for instance mentioned in the guidelines for design of structures of the Ministry of Transport of The Netherlands (ROK). One of the proposed options is making use of a foil or membrane around the structure, of PVC-P (> 1 mm thick) or LLDPE (>1.5 mm thick).

Besides difficulties during installation to guarantee water tightness, these membranes also have quite some environmental impact. For instance typically 2 kg of PVC-P per m2 of concrete is applied to ensure water tightness. According to the national environmental database of the Netherlands (NMD), the impact of PVC-P as a water barrier is 3 kg CO_2 per kg of PVC-P, thus 6 kg CO_2 per m2 of concrete structure. This equals 18 kg CO_2 per m3 of concrete for structures with a typical wall thickness of 30 cm. Choosing use of healing agent instead of a PVC-based membrane to ensure water tightness of constructions would thus further reduce the CO_2 footprint by 18 kg CO_2 per m3 of Self-Healing concrete. Moreover, ease of application of healing agent in comparison to instalment of the membrane would result in further reduction of CO_2 footprint due to reduction in construction time.

Situation 3: Healing Agent instead of crack width reducing reinforcement

A concrete structure typically contains steel reinforcement for both structural reasons and for crack width control. For watertight structures typically a lot of crack width reducing steel has to be applied. However, part of this particular crack width controlling steel can be replaced for healing agent to ensure water tightness of the construction. According to the European norm (NEN-EN 1992-1-1:2005) the minimum reinforcement required is 0.2 % of the volume of the concrete element. For crack width reduction however, typically 0.6 % of the element volume is required to ensure water tightness of constructions (ACI 224-01:2001). This extra steel typically amounts to 32 kg in addition to the 15 kg steel that is required for structural purposes.

For certain specific applications such as basement and diaphragm walls even more steel is often applied. Typically for a class C30/37 concrete wall with a thickness of 25 cm up to 80 kg steel per m3 is applied. The additional amount of steel has a large environmental impact. According to the Dutch National Environmental Database the CO_2 footprint of a kg reinforcement steel is about 2 kg CO_2. Use of healing agent instead of part of the crack width controlling steel can typically save 33 kg steel what amounts to a reduction of CO_2 footprint by 66 kg/m3 concrete.

This regards only material use, thus excluding additional benefits of easier and thus more efficient installation actions.

Resume

Adding Basilisk Healing Agent will lead to reduction of the CO2 footprint of concrete. Considering the volume of concrete for which water tightness and moisture related durability is required and therefore particularly suitable for Healing Agent application (660 million m3 yearly), a CO2 reduction potential **of 7 billion-ton CO2 per year** due to service life extension and **3 billion-ton CO2 per year** due to more effective crack control can be achieved.

(1*)IEA= International Energy Agency The IEA works with countries around the world to shape energy policies for a secure and sustainable future. The IEA analysis is built upon a foundation of activities and focus areas including data and statistics, training, innovation and international cooperation.

(2*) For the calculation of the environmental performance of buildings, structures and civil engineering works according to the determination method "Environmental performance of buildings and civil engineering works" it is customary to use guaranteed environmentally relevant material and product information from the NMD. Without the combination of the determination method and NMD, there is no uniformity in the calculation result. Designers, suppliers and clients therefore use the same information within a level playing field and hence speak the same language from now on. This information in the NMD has been supplied by the industry. The information consists of LCA data that covers the entire life cycle [cradle to grave]

(3*) This is based on the impact assessments of our suppliers, transport and production steps, we currently calculate with an impact of 2 kg of CO2 per kg of Healing Agent. Addition of Healing Agent is up to 10 kg per m3 of concrete, which makes that we currently add 20 kg of CO2 per m3 of concrete. However, this additional impact can be easily made undone by the beneficial effects of the Healing Agent on the concrete properties.

(4*) Each European Standard is identified by a unique reference code which contains the letters 'EN'. A European Standard is a standard that has been adopted by one of the three recognized European Standardization Organizations (ESOs): CEN, CENELEC or ETSI. It is produced by all interested parties through a transparent, open and consensus-based process.