

Self-healing (smart) concrete - Development and full scale application

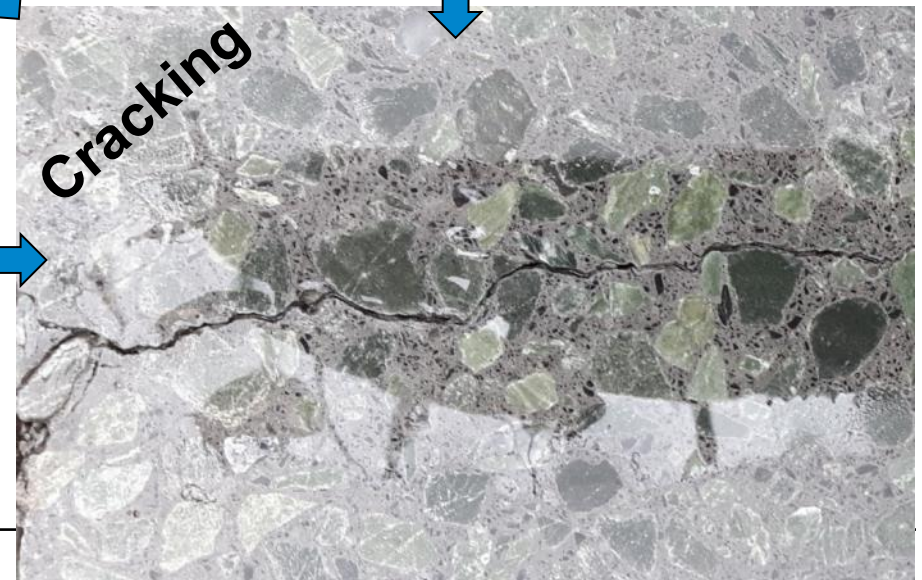


Development of self-healing concrete for Civil Engineering applications

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The problem



The problem

Cracks in concrete result in leakage problems



The problem

Cracks in concrete result in corrosion problems



The problem

Cracks in concrete result in limited service life and high costs for repair



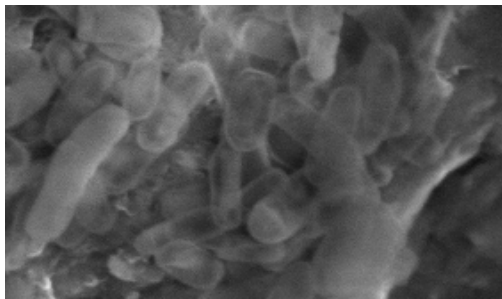
Solution: Smart self-healing concrete!

- **Reduced risk of failure**
- **Less repair actions required**
- **Less out-of-order occurrences**
- **Saves money!**
- **Increased performance and service life**

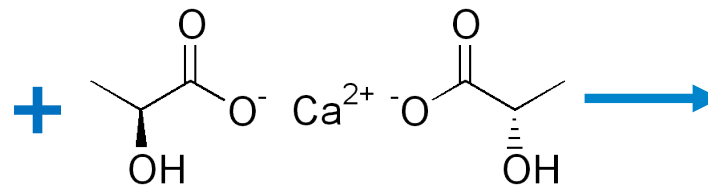


Self-healing concrete:

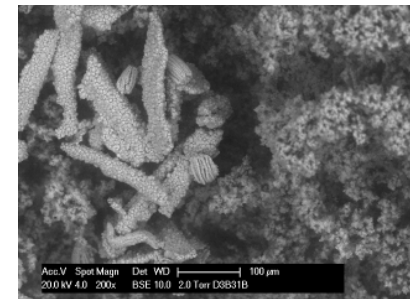
Solution: limestone producing bacteria!



Bacteria



Calcium lactate

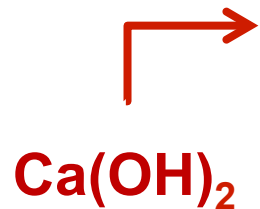
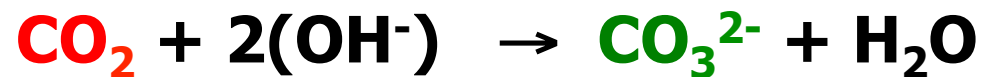


Limestone

Self-healing bacteria-based concrete:

Limestone production by bacteria in alkaline environments

Bacteria: convert organics into CO₂

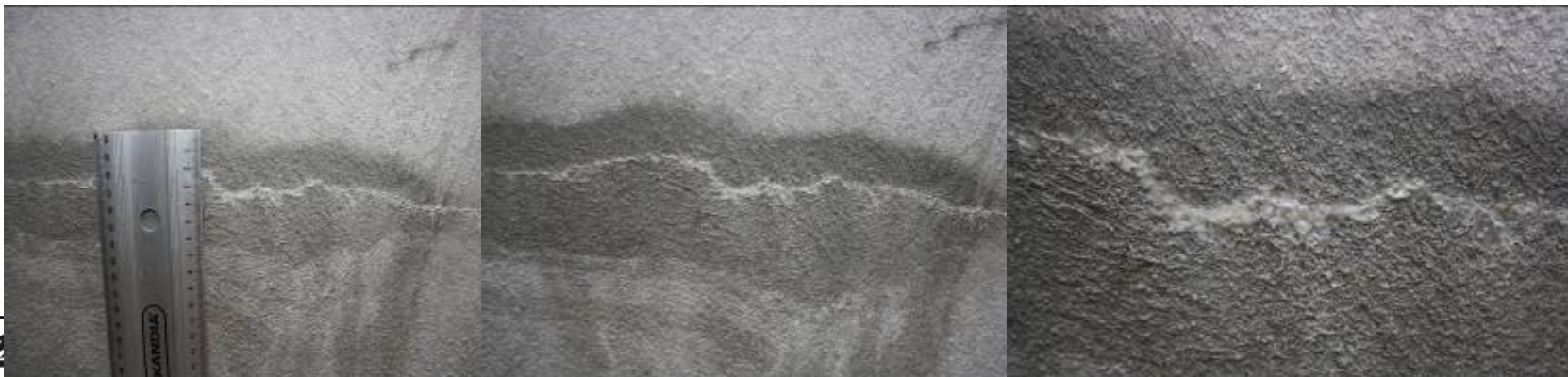


→ Two components required: bacteria + nutrients

Self-healing concrete:

Functionality:

1. Oxygen consumption: → protection steel corrosion
2. Limestone formation: → improving water tightness
3. “ → porosity decrease
4. “ → damage / wear resistance



Two-component self-healing agent:

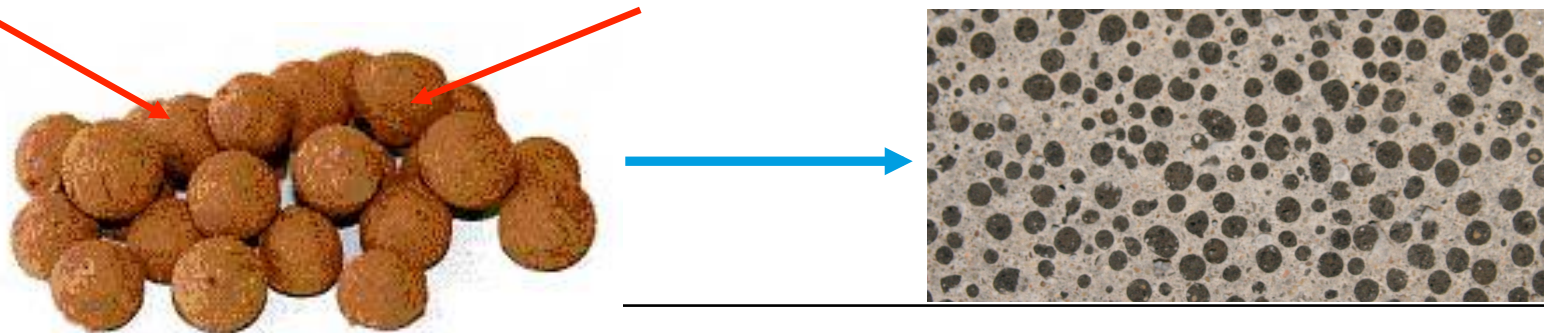
1. Bacteria (catalyst)
2. Mineral precursor compound (chemical / 'food')

→ Packing of agents in particles / capsules

Reservoir for healing agents (bacteria + chemicals)

Bacteria

food



Development of concrete healing agents

Two-component self-healing agent:

→ **Development since 2006:**

1. Direct addition to concrete mixture

Jonkers (2007) In: S. van der Zwaag / SHM: an introduction. Springer

Jonkers et al. (2010) *Ecol. Eng.* 36(2): 230-235

2. Encapsulation in LW aggregate

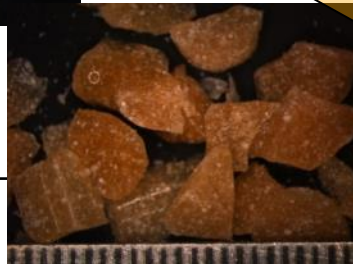
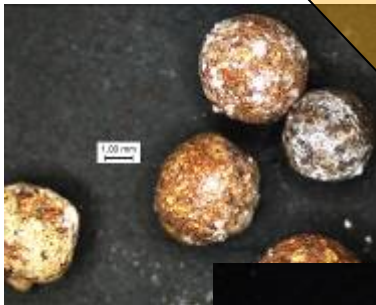
Jonkers (2011) *Heron* 56:1-12

Wiktor & Jonkers (2011) *Cem Conc Comp* 33:763-770

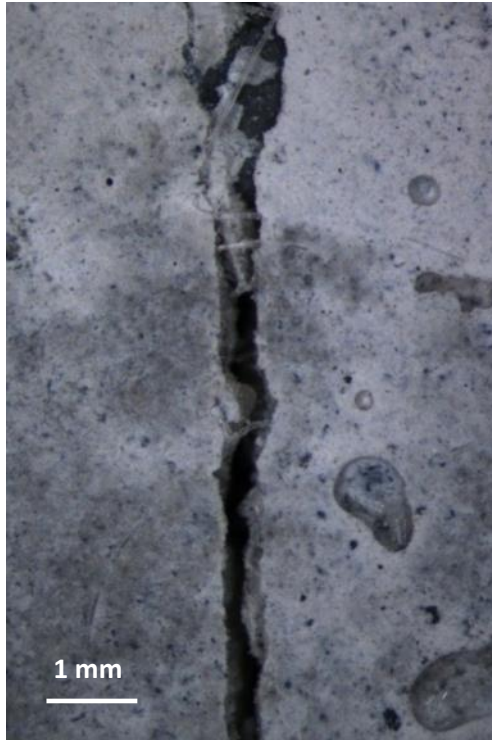
3. Encapsulation in polymer particles

Jonkers et al. (2015) SHM S. van der Zwaag IOS Press

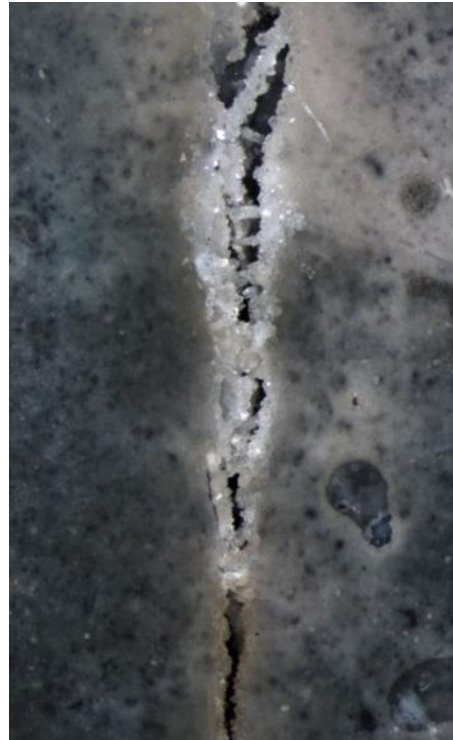
Development



Self-healing concrete:



t=0



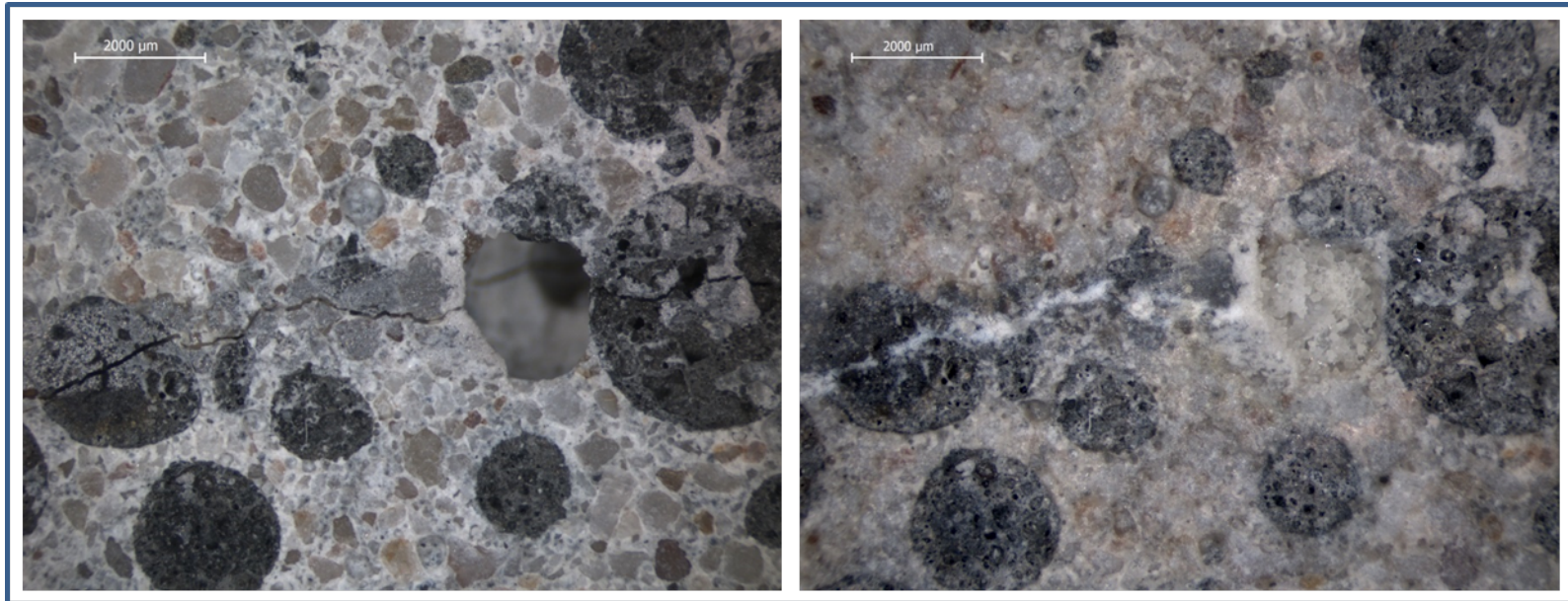
t=24d



t=58d

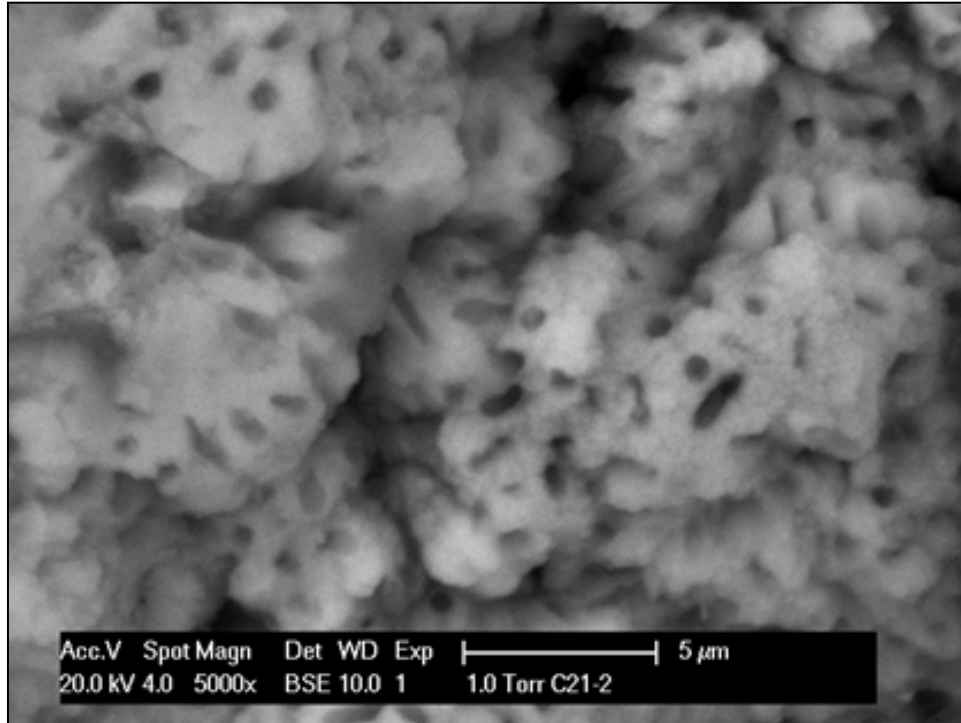
Crack healing in water

Self-healing concrete:

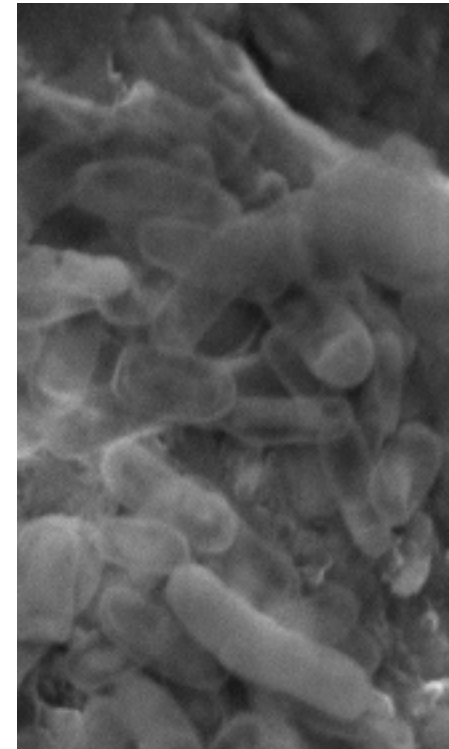


Crack healing in water

Self-healing concrete:



Bacterial limestone



2 μ m

Self-healing products

1. Self-healing concrete
2. Self-healing repair mortar
3. Liquid repair system



Self-healing concrete

- 'Self-healing agent'
- Based on granular additive
- Seals up to 1mm wide cracks



Self-healing concrete

Healing agent easily added to the concrete mix



'Healing agent'



Truck mixer

Self-healing concrete

Prefab elements applications



Self-healing concrete

Prefab elements applications



Wastewater treatment tank

Self-healing concrete

In situ concrete applications



Self-healing concrete

In situ concrete applications



Water reservoir

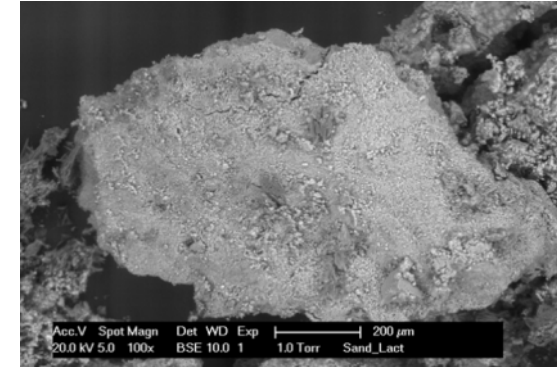
Self-healing products

2. Self-healing repair mortar

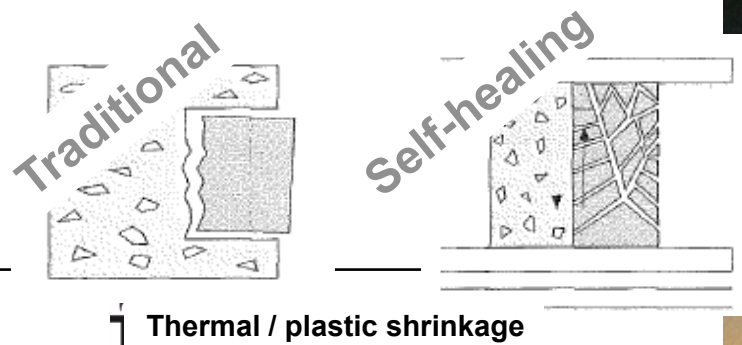


2. Self-healing repair mortar

- Based on granular healing agent
- Based on PVA fibers
- Low shrinkage
- Ductile behaviour
- Strong bonding



Healing agent
+
PVA fibres



Self-healing repair mortar - Projects



Structural repairs

Self-healing repair mortar - Projects



Waterproofing leaking cracks in basement / tunnel walls

Self-healing repair mortar - Projects



Liner for repair / durability improvement

Self-healing repair mortar - Projects



<https://youtu.be/LRCMyPxTWtw>

BAM Groningen, applied as shotcrete on leaking basement walls

Self-healing products

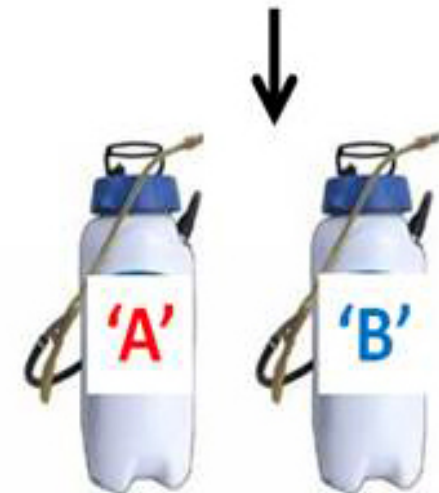
3. Liquid repair system



Practical applications bacteria-based SHC

3. Liquid repair system

- Two-component liquid spray
- Forms firm gel, converted in time to limestone
- Fast application (6000 m² in 4 hours)
- Increases frost resistance
- Seals 0.2 mm cracks in 1 treatment
- Seals 0.2 – 0.6 mm cracks in 2-3 treatments

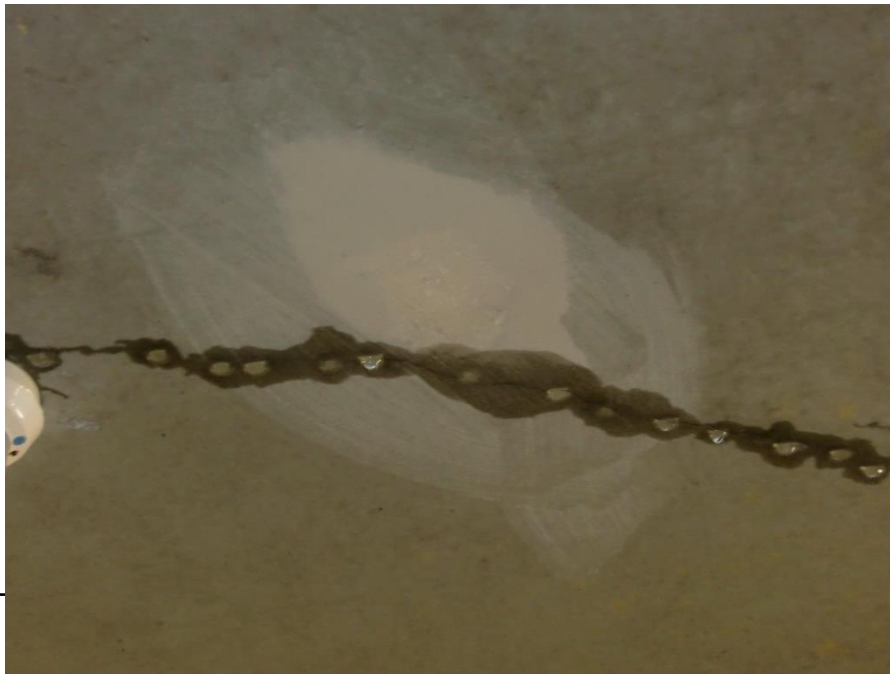


Practical applications bacteria-based SHC

3. Liquid repair system - Projects

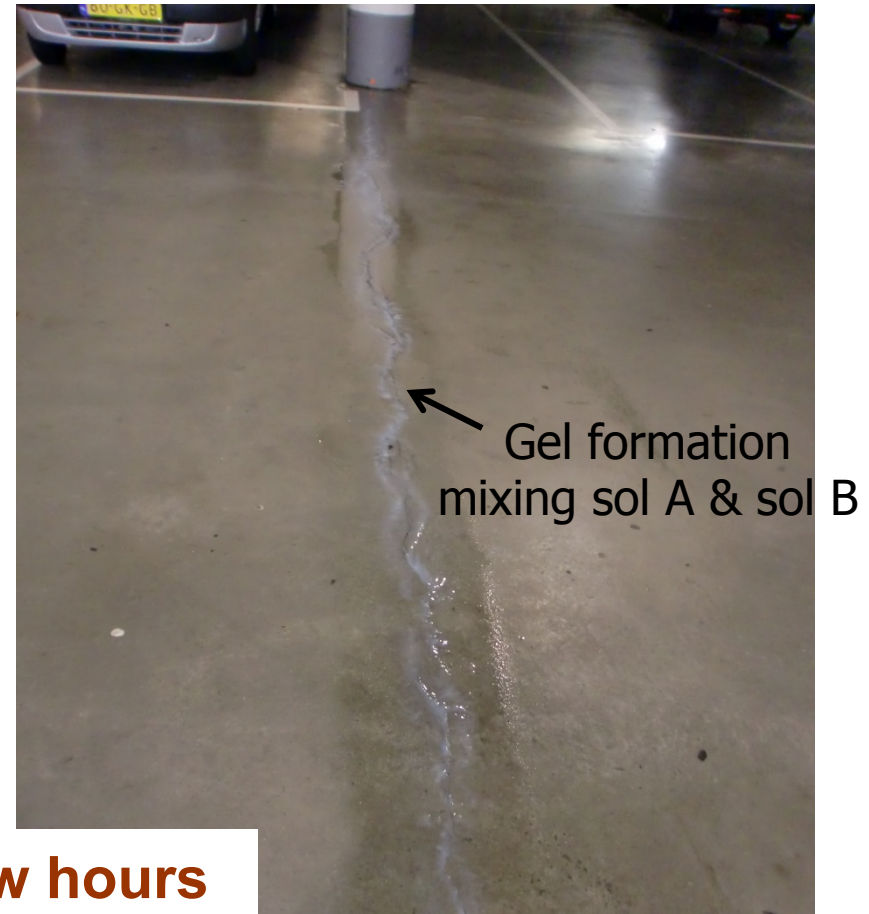


Sealing of cracks in parking decks



Practical applications bacteria-based SHC

3. Liquid repair system - Projects



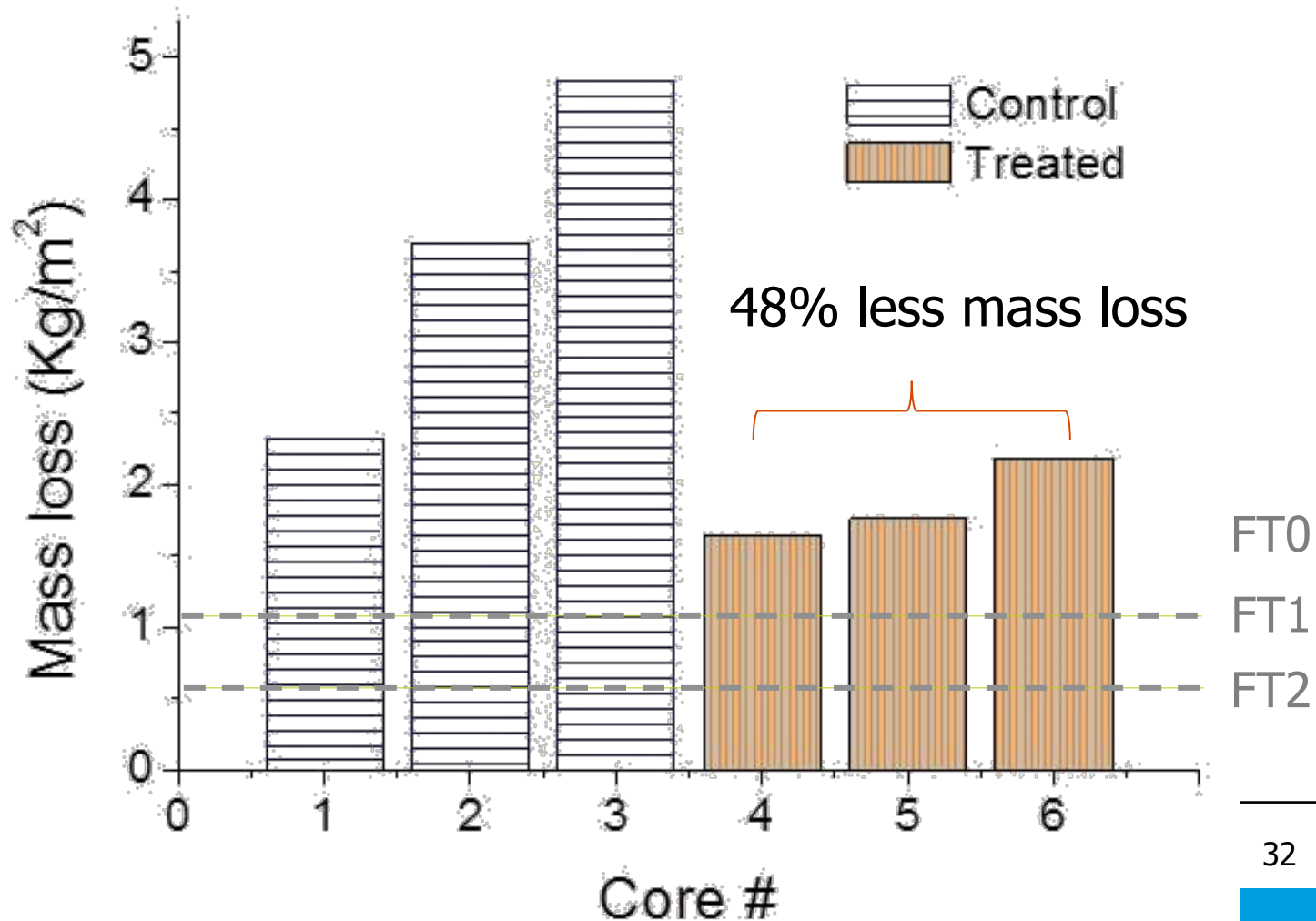
Application is done within few hours

Structure/parking garage can re-opened after application

Self-healing concrete products

Lab results on drilled cores

Resistance to freeze/thaw with de-icing salt





**Green-Basilisk B.V.
Self Healing Concrete**



basiliskconcrete.com

Self-healing concrete products

Self Healing Agent

Basilisk self-healing agent
for concrete mixtures



Self Healing Repair Mortar MR3

Basilisk self-healing repair mortar
for existing concrete structures



Liquid Repair System ER7

Basilisk liquid
repair solution



Links to self-healing concrete movies

Link to CNN website self-healing concrete documentary:

<http://edition.cnn.com/2015/05/14/tech/bioconcrete-delft-jonkers/index.html>

EPO finalist 2015:

<https://www.youtube.com/watch?t=44&v=OXkW1q9HpFA>

Shotcrete application of repair mortar MR3

<https://youtu.be/LRCMyPxTWtw>

Aanleg bluswaterreservoir Hoogvliet (in Dutch):

https://youtu.be/M7i_Xv9tWnw



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Basilisk
self healing concrete



EPO finalist 2015:

