HEALROAD Symposium

Promoting induction heating asphalt mixes
The self-healing technique

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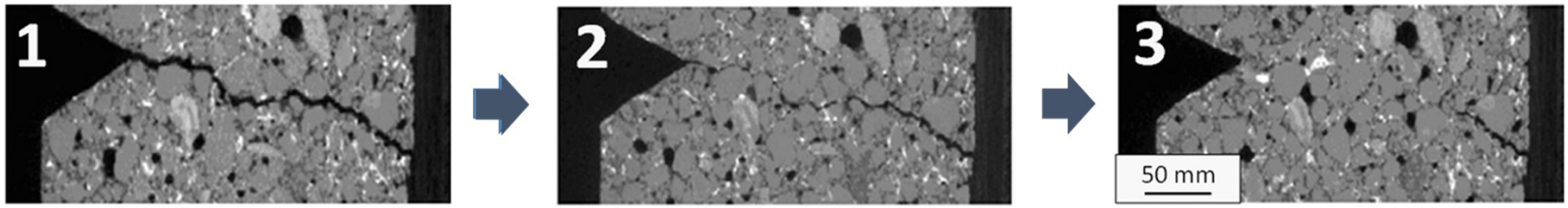
Background Concept of self-healing

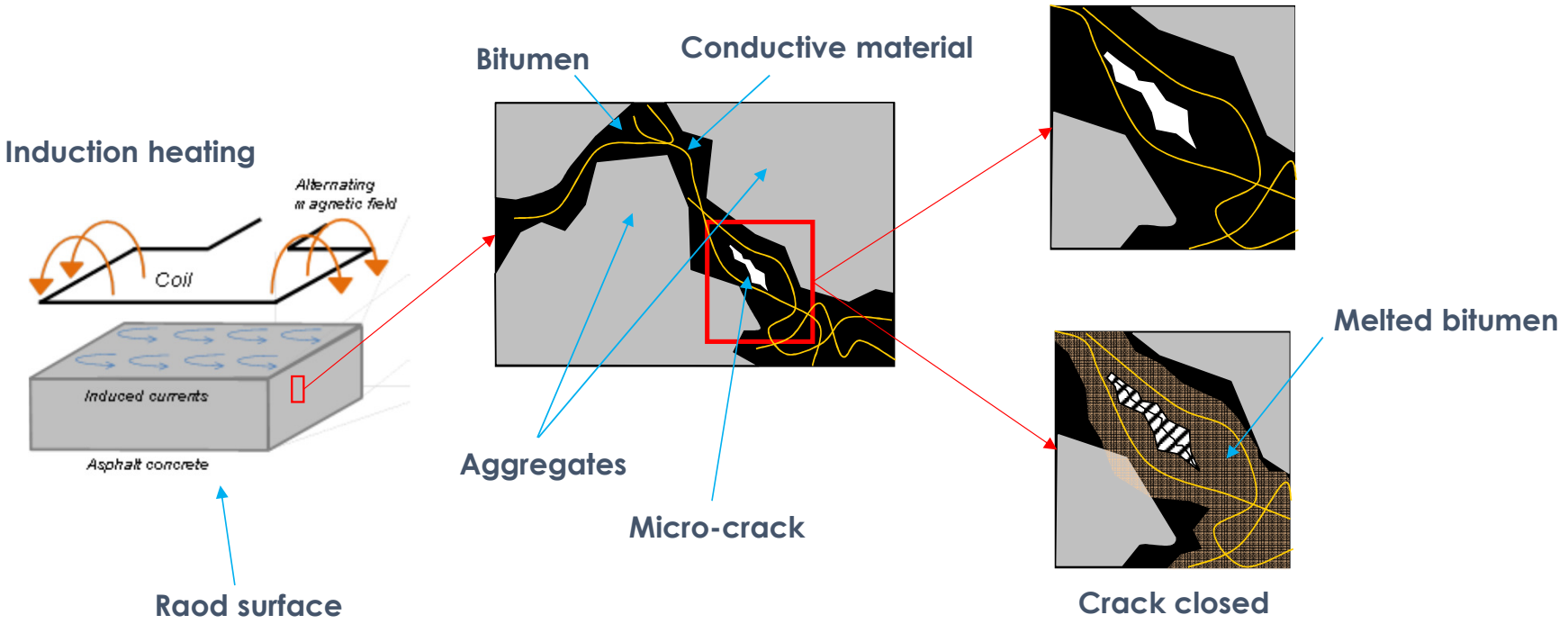
- Asphalt mixture is a **natural self-healing** material. When a crack is open in the road structure, it can close (heal) when enough temperature and time without traffic are provided.
- However, this process requires days for a complete healing, which in practice is impossible due to continual traffic flow.



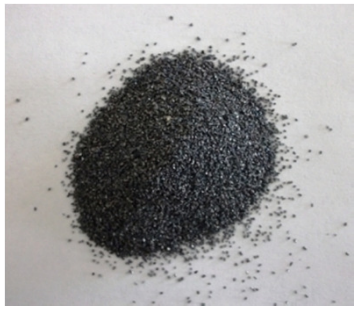
Source: A.García (UoN)

- Self-healing of asphalt mixes can be accelerated by means of induction heating, a technique used to increase the temperature of electrically conductive and magnetic susceptible materials.

Background Self-healing by induction heating



Source: A.García et al. (TU Delf)



Background Self-healing in lab

- The feasibility of the self-healing by induction heating has been studied by means of laboratory tests using several materials and variables:

Magnetic Materials	Variables
Steel wool fibers	% of magnetic materials
	Material properties (length, diameter, etc.)
	Induction heating time
Cast steel particles	Healing temperature
	Resting time
	Damage level

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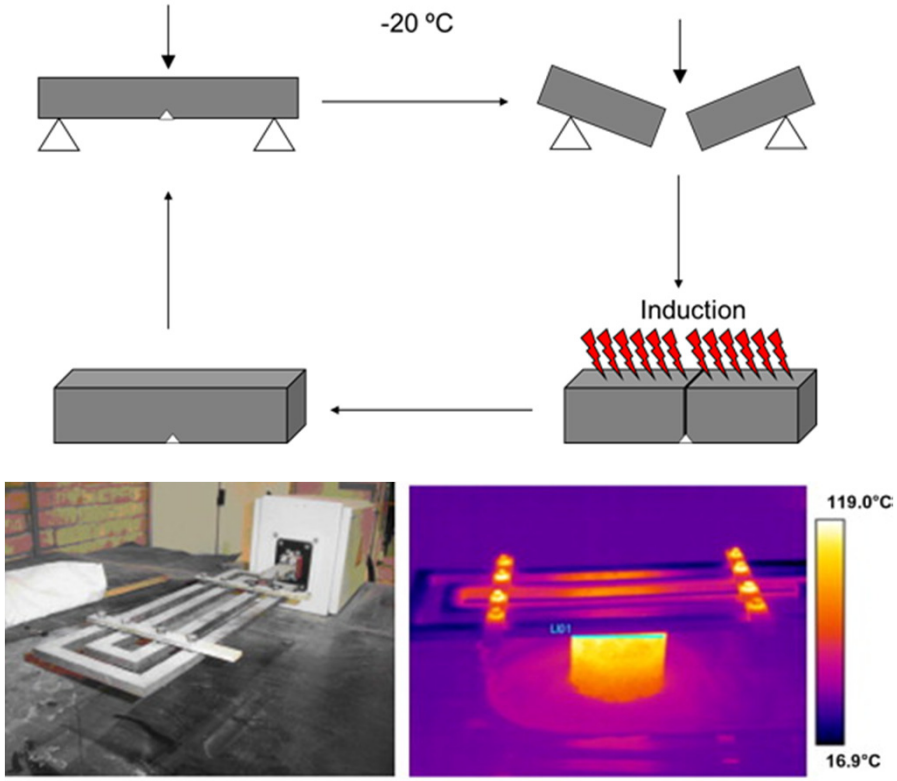
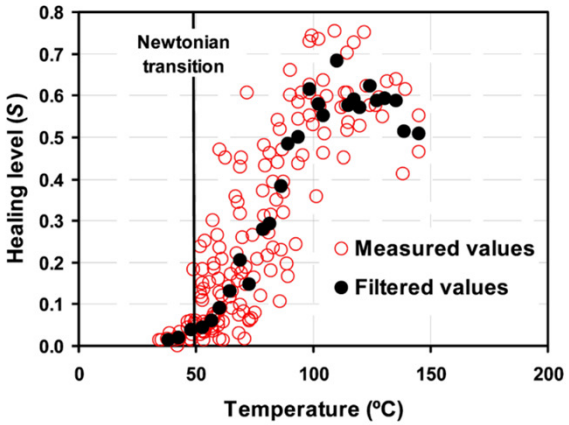
Background Self-healing in lab



Construction and Building Materials 25 (2011), 3746-3752

- The performance evaluation of the self-healed asphalt materials was done by: (1) damaging specimens, (2) repairing them through induction heating and (3) damaging again for evaluating their healing level.



$$\text{Healing level} = \frac{S}{S_0}$$

S= Strength of asphalt concrete after healing
S_0= Strength of asphalt concrete before healing

Journal of Testing and Evaluation (2014), 42(5)

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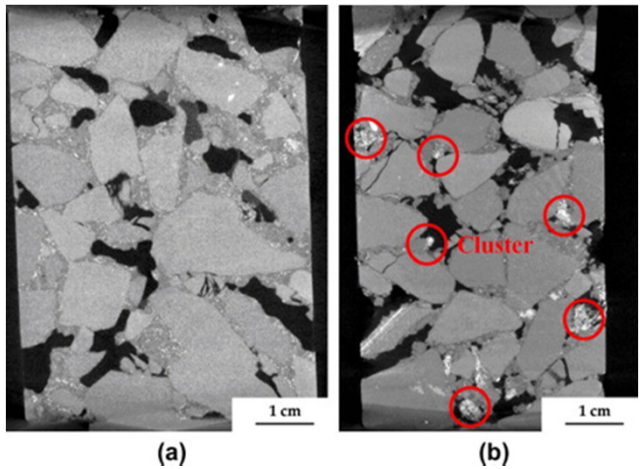
Background Self-healing in lab

- When using steel fibers, **clusters** appeared during the mixing process.
- The **amount of clusters** grows depends on the amount of fibers, their diameter and length.
- Many **clusters** of fibers appear during the first moments of **mixing** and the mixing process itself serves for **dissolving** the clusters.
- The **maximum temperature reached changed** with the diameter and percentage of fibers in the mixture.
- There is a minimum temperature below which asphalt cannot be healed.



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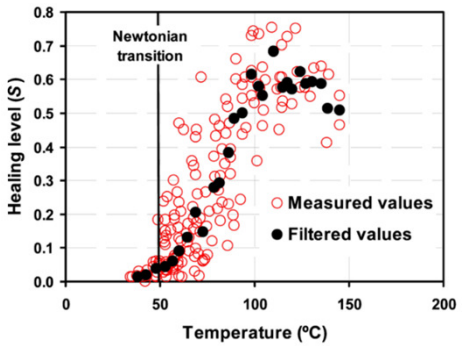

Journal of Testing and Evaluation (2014), 42(5)

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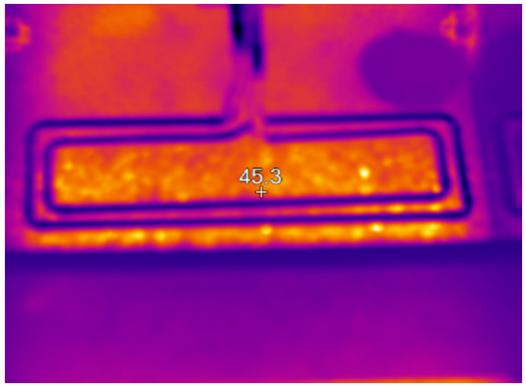
Background Self-healing in lab

- The **lifetime** of the test samples subjected to **fatigue** damage **were extended up to 30%** by means of induction heating.
- Induction healing can only heal **cracks of a certain width**. There is an optimum moment for healing cracks in asphalt mixture.
- Induction heating can only **repair cracks** in asphalt mixture, **not permanent deformations**.

Background Self-healing in lab

A test track using this concept was built in a motorway (A58) in The Netherlands in 2010, and tested in 2014. Some problems were found that need to be faced:

- Steel wool fibers used presented mixing difficulties and formed **undesirable clusters**.
- The **optimum moment** for healing in the lifetime of the road was **not identified**.
- The **total energy** needed for the asphalt self-healing **was unclear**.
- The optimum time and temperature were also unknown.



Source: Heijmans

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HEALROAD Problems addressed

- Temperature at which optimal self-healing is obtained.
- When to apply self-healing?
- Quantification of service life extention
- Adequate use of the induction healing device (parameters).
- Impact of aging in healing performance.
- Quantification of the energy needed.
- Solve the clusters when upscaling.

HEALROAD Main Goal

The overall objective of the project is the further development and the technical, economic and environmental validation of healable asphalt mixes via induction heating to overcome the technical barriers for the future industrialization and market uptake.

HEALROAD Consortium / partners

UNIVERSIDAD DE CANTABRIA

PROJECT COORDINATOR
UNIVERSIDAD DE CANTABRIA (UC)

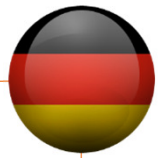
EUROPEAN UNION ROAD FEDERATION

EUROPEAN UNION ROAD FEDERATION (ERF)

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

UNIVERSITY OF NOTTINGHAM (UoN)

bast
Federal Highway Research Institute



BUNDESANSTALT FÜR STRAßENWESEN (BAST)

heijmans

HEIJMANS INFRA B.V. (HEIJMANS)

SGS

SGS INTRON B.V. (SGS)

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HEALROAD Scientific & Technical Objectives

1. Understand the main chemical and rheological factors influencing the movement of bitumen through cracks in order to identify the most suitable bitumen for this application.
2. Optimize from the technical, economic and environmental point of view the parameters that most influence the induction heating of the asphalt mixture: magnetic material and air voids.
3. Optimal design of asphalt mixes from the healing capacity and durability point of view.
4. Ensure the recyclability of the HEALROAD mixes by defining the amount of virgin material needed to restore the asphalt mixture properties, including its healing capacity.

HEALROAD Scientific & Technical Objectives

5. Scaling up the production of HEALROAD mixes in a real asphalt plant.
6. Demonstration of the solution proposed:
   - Demonstrating the healing capacity of a real scale test section through and Accelerated Loading Test.
   - Economic and environmental feasibility through a LCA and LCC analysis.

HEALROAD Main outcomes

Description of factors in the chemical composition and the rheology of the bitumen that affect the healing properties the most.

Assessment of the influence of the air voids content and the type, size and amount of electrically conductive materials in the healing and the mechanical properties of the mixture.

Two asphalt mixes (PA and AC) with optimal healing capacity and durability.

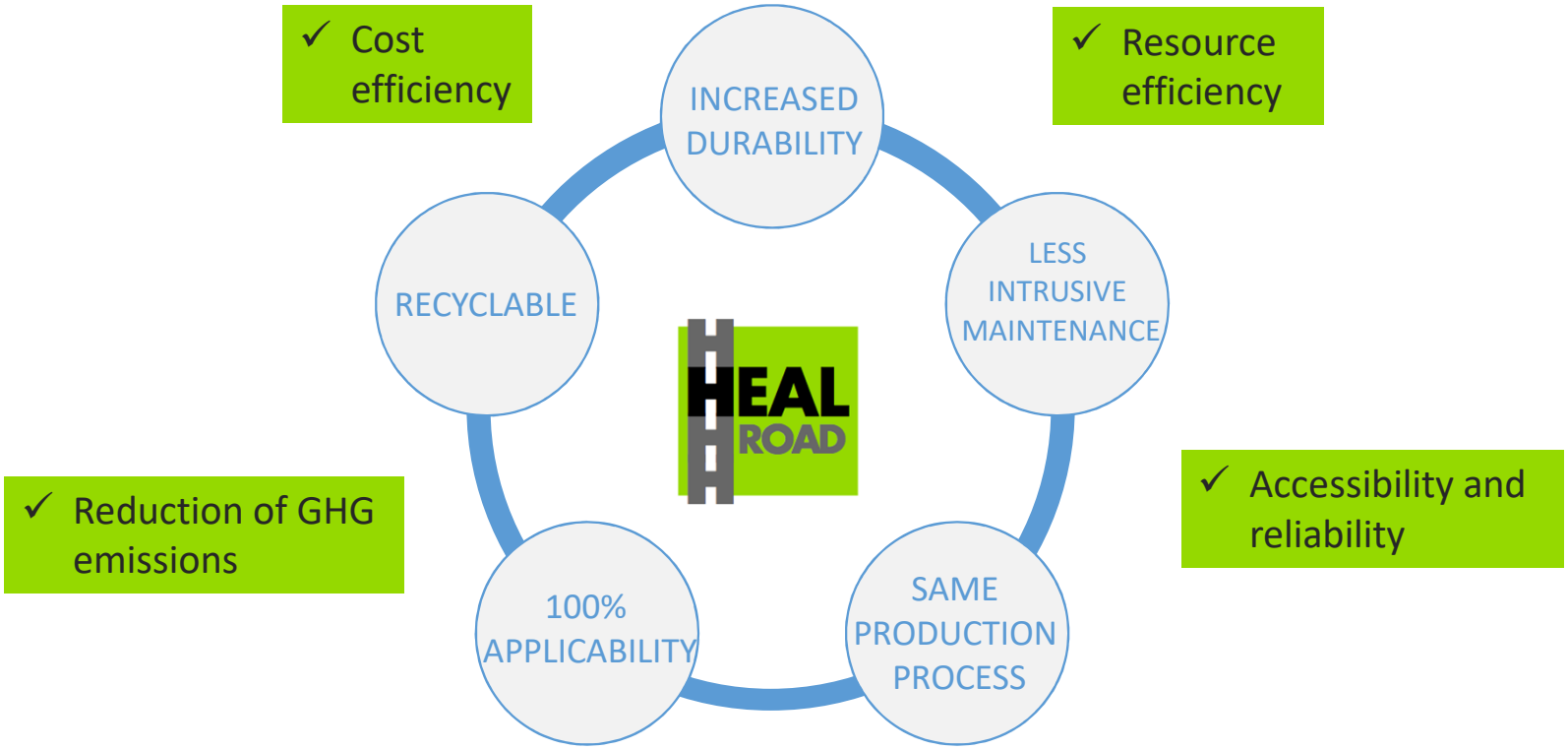
Quantification of unknown parameters related to the self-healing of the asphalt mixes

- Maximum lifetime extension of the asphalt mixture.
- Effect of aging on the healing capacity of the asphalt mixes.
- Identification of the optimum time for healing in the lifetime of the road.

Up-scaling of the production process of the mixes

Technical, economic and environmental validation of the technology.

HEALROAD Expected results and Impacts



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FUNDERS

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TRANSNATIONAL COLLABORATION OF 11 COUNTRIES AND THE EC ON ROAD INFRASTRUCTURE INNOVATION

An ERA-NET Plus Call to support development of advanced systems, materials and techniques for road infrastructure under seven defined challenges:

An ERA-NET Plus with funding from the European Union under grant agreement no 618109.

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30 Months (01/10/2015 - 31/03/2018)
Challenge B: Enhanced durability and life-time extension
Challenge D: Keeping freight routes open through zero-intrusive maintenance

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