SHARP Report Summary
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Final Report Summary - SHARP (Self Healing Asphalt for Road Pavements)
Self Healing Asphalt for Road Pavements (SHARP) FINAL REPORT
Research Team:
Researcher: Dr. Amir Tabaković
Project Supervisor: Professor Erik Schlangen

1. PROJEKT OBJECTIVE
The key objective of the SHARP project was: ‘To develop an effective, sustainable and environmentally friendly self-healing system for asphalt pavements’.

2. RESEARCH OUTCOMES
• Successful development of alginate compartmented fibre as rejuvenator (healing agent) delivery and triggering mechanism.
• Successful development of microcapsule/fibre packing numerical model – the model is used for optimisation of amount (volume) of microcapsules/fibres in the asphalt mix.
• Successful development of rejuvenator and aged asphalt binder diffusion model using Matlab software.
• Successful design of pours asphalt (PA) mix containing compartmented alginate fibres encapsulating rejuvenator – optimum fibre content in the PA is 5%.

3. RESEARCH FINDINGS
• Rejuvenator encapsulation in compartmented sodium alginate fibres is a suitable mechanism for delivery of self-healing agent (rejuvenator) for asphalt pavement self-healing system.
• The best suitable rejuvenator is the real rejuvenator (Modiseal R20 – product by Latexfalt B.V.) as it modifies the aged binder and recovers the bitumen molecular structure.
• Optimum fibre design is Rejuvenator: Alginate ratio 70:30.
• The experimental analysis on the alginate fibres showed that fibres have good thermal and mechanical strength, to survive asphalt mixing and compaction processes. Furthermore the fibres can increase asphalt mortar mix strength by up to 36%.
• The healing system showed very good healing capacity (strength and elastic modulus recovery) at small damage (healing micro cracks) though limited at large damage (large cracks – full failure). The solution to this problem is by combining the rejuvenator encapsulation system with induction heating system to create a self-healing system that will allow rapid and effective asphalt pavement repair. The idea behind this approach is that induction heating will heal the asphalt damage, i.e. cracking, and encapsulated rejuvenator to rejuvenate the aged binder. This combined system is currently in process of development as part of Mr. Shi Xu PhD study at TUDelft, for which Dr. Amir Tabaković is member of supervisory team together with Professor Erik Schlangen.

4. TRAINING OUTCOMES
• Following in house training has been received:
i. Safety in the laboratory, Microlab and NOVA (chemical laboratory),
ii. Alginate microcapsules and compartmented fibres production procedure,
iii. Use of fibre spinning machine – wet spinning line,
iv. Use of testing equipment in the TU Delft Microlab, such as: micro testing machine, optical microscope, the Environmental Scanning Electron Microscope (ESEM), micro CT scanner and image analysis.
• Matlab training was provided by Dr. Daniel Cantero Lauer from Norwegian University of Science and Technology, Trondheim, Norway.
• Proposal (ERC grant) writing training, provided by ‘Yellow Research B.V.’ (http://www.yellowresearch.nl/)
• Researcher was assigned duty of daily supervisor to a PhD candidate (Mr. Shi Xu), where Professor Erik Schlangen is the project promoter. Researcher continues to act as advisory supervisor on the project.

5. OUTREACH
• Conference proceedings and presentations:
  ii. The Eight International Conference on Maintenance and Rehabilitation of Pavements (MAIRE PAV 8th), ‘Compartmented alginate fibres as a healing agent (rejuvenator) delivery system and reinforcement for asphalt pavements’, Singapore, 27th - 29th July 2016. This paper was awarded the best conference paper award.
• Talks:
  i. On 29th September 2016 Dr. Tabaković presented on Self-healing Technology for Asphalt Pavements to members of the International RILEM committee, Montreal, Quebec, Canada.
  ii. Dr. Tabaković was invited speaker at Institute of Asphalt Technology Seminar ‘Road Maintenance Matters’, Athlone, Ireland, 12th April 2016. He presented on use of Self-healing Technology in Road Maintenance.
  iii. On 13th April 2016 Dr. Tabaković presented on Self-healing Technology for Asphalt Pavements to staff and students of University College Dublin, Department of Civil Engineering.
  iv. Dr. Tabaković was invited speaker at TU Delft at Microlab colloquium on self-healing material for asphalt pavements, 31st March 2016 and 22nd December 2016.
  v. On 20th January 2016 Dr. Tabaković presented SHARP research findings to staff and students of Trinity College Dublin, Department of Civil Engineering.

6. ADDITIONAL INFORMATION
Plan for continuation of the project, outstanding tasks:
• Rejuvenator diffusion model, the model (task) will be fully completed as part of Mr. Shi Xu PhD study, due date: September 2017.
• Fracture model, the model development will continue as ongoing collaboration between Dr. Tabaković (TU Delft) and Professor Aleksandar Karač (University of Zenica), due date: N/A.
• Technology transfer model, the technology transfer from TL 3 – TL 6 (from the laboratory to site) has not been achieved as the technology requires further development. It is anticipated that technology transfer model will be developed after the successful development of combined induction heating and rejuvenation self healing system as a part of the Shi Xu PhD project. Due date: December 2019.