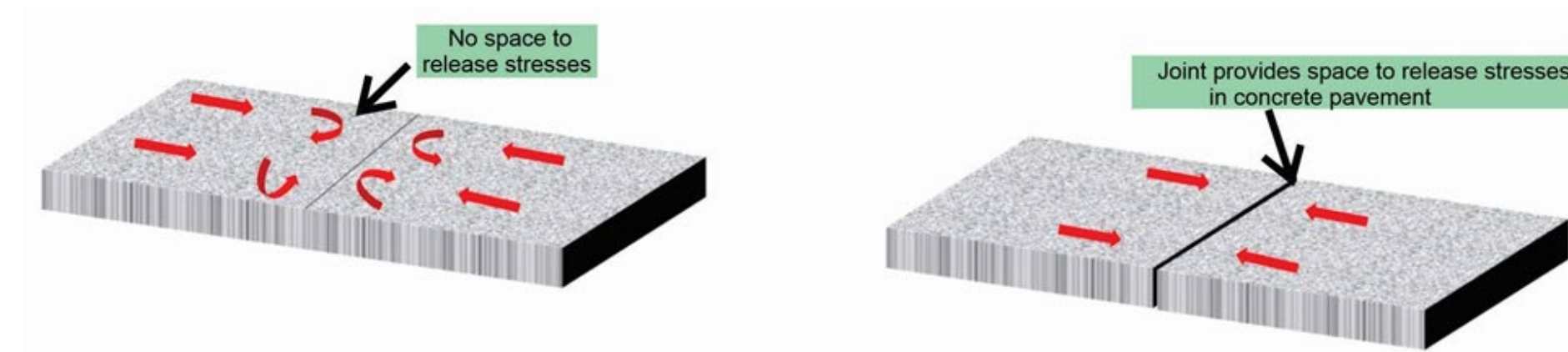


SELF-HEALABLE AND RECYCLABLE SEALANTS- A SUSTAINABLE SOLUTION FOR AGING INFRASTRUCTURE

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Introduction

- Joints in concrete pavements are formed to control cracking due to temperature changes.
- Sealants prevent infiltration of water and incompressible materials into the joint.



Joints in concrete pavements



Source: ACPA

Source: Wabo

Cold poured sealants

Preformed sealants

Motivation and Objective

- Within a few years, most sealants exhibit cohesive and/or adhesive failure.
- Maintenance often neglected, accelerated deterioration of infrastructure assets.



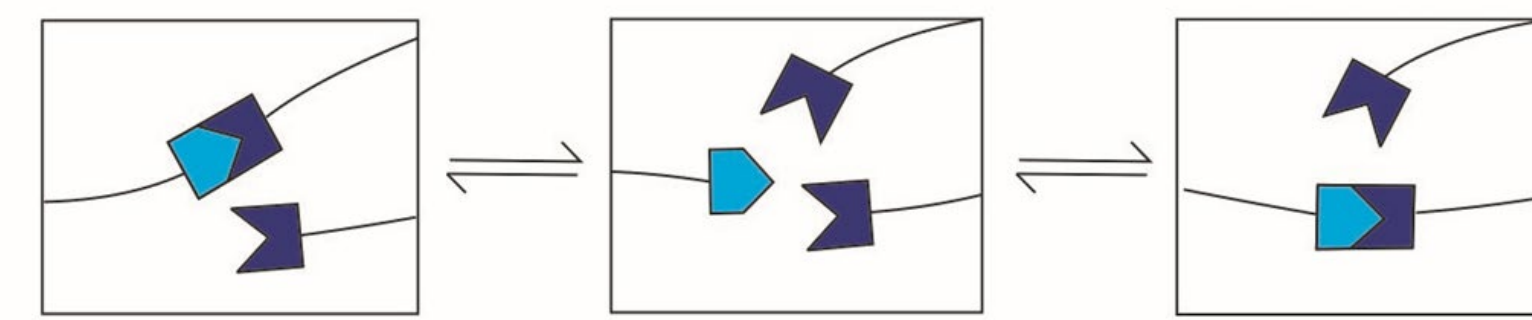
Debonding from concrete

Pavement cracking

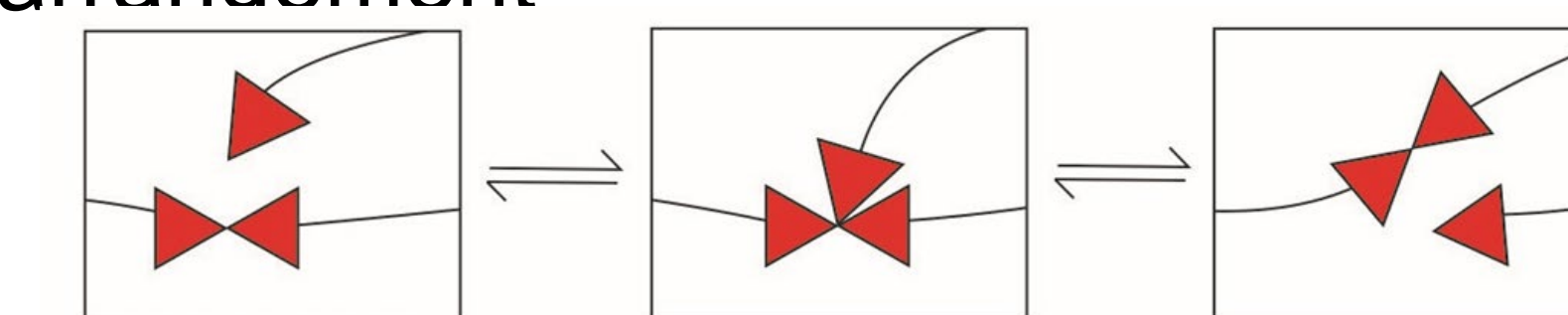
- Develop a self-healing sealant to extend the service life of concrete pavements.
- Evaluate the effect of compressive force on the self-healing of joints.

Covalent adaptable networks

- Polymer network can rearrange under external stimuli (temperature, UV, pH)
- Durable, processable, recyclable, and self-healable



Dissociative CANs: decreased network connectivity occurs during the network rearrangement



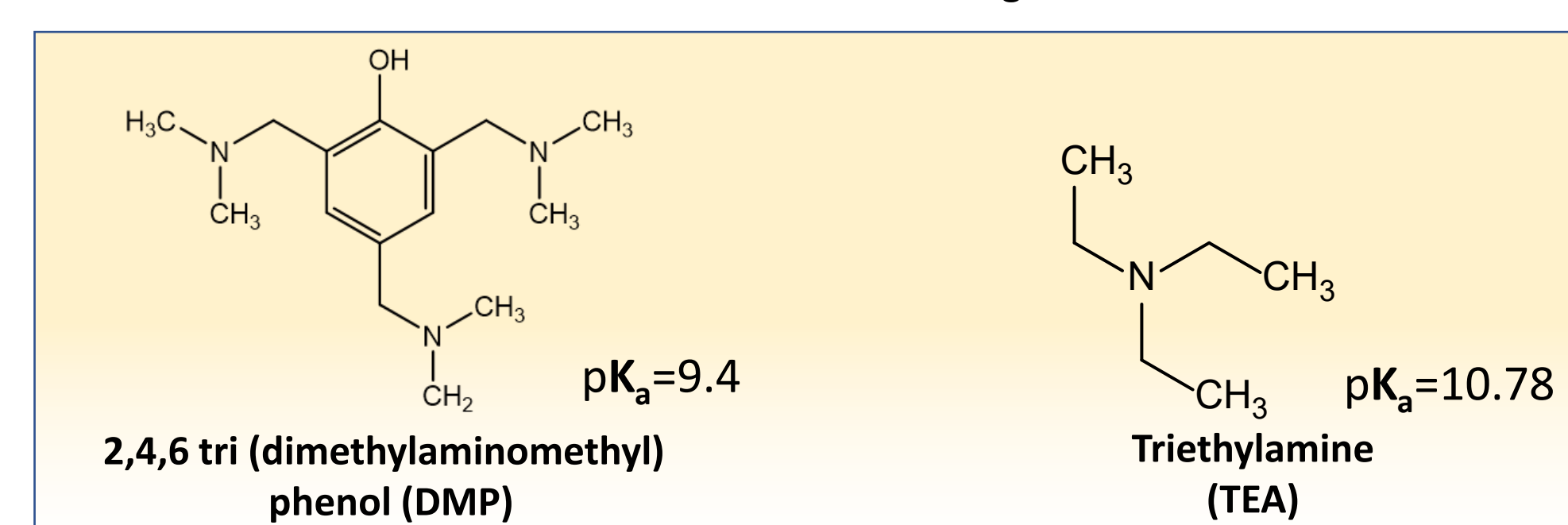
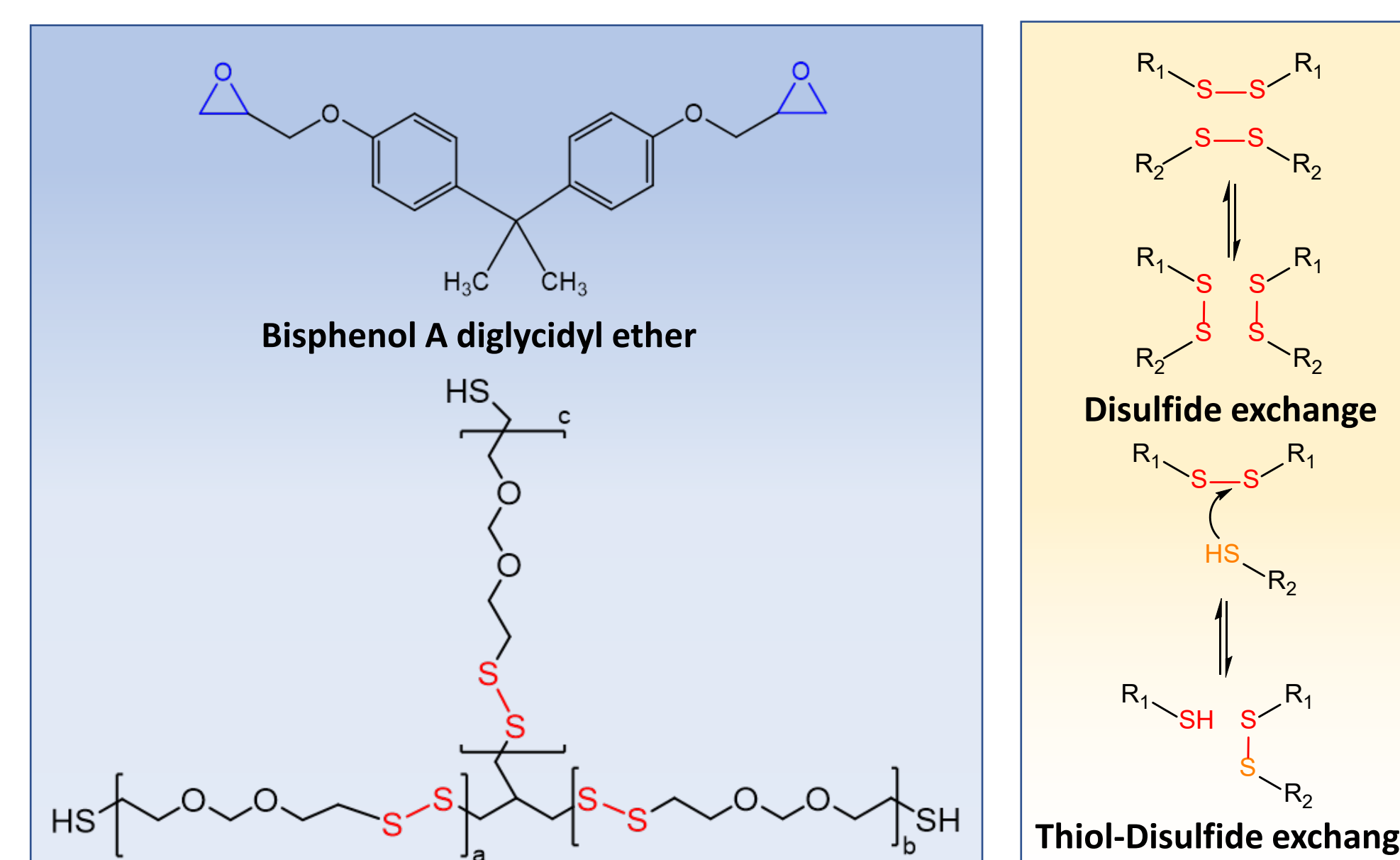
Kloxin(2013)

Associative CANs: crosslinks are exchanged such that there is no loss in connectivity in the network

Sealant formulation

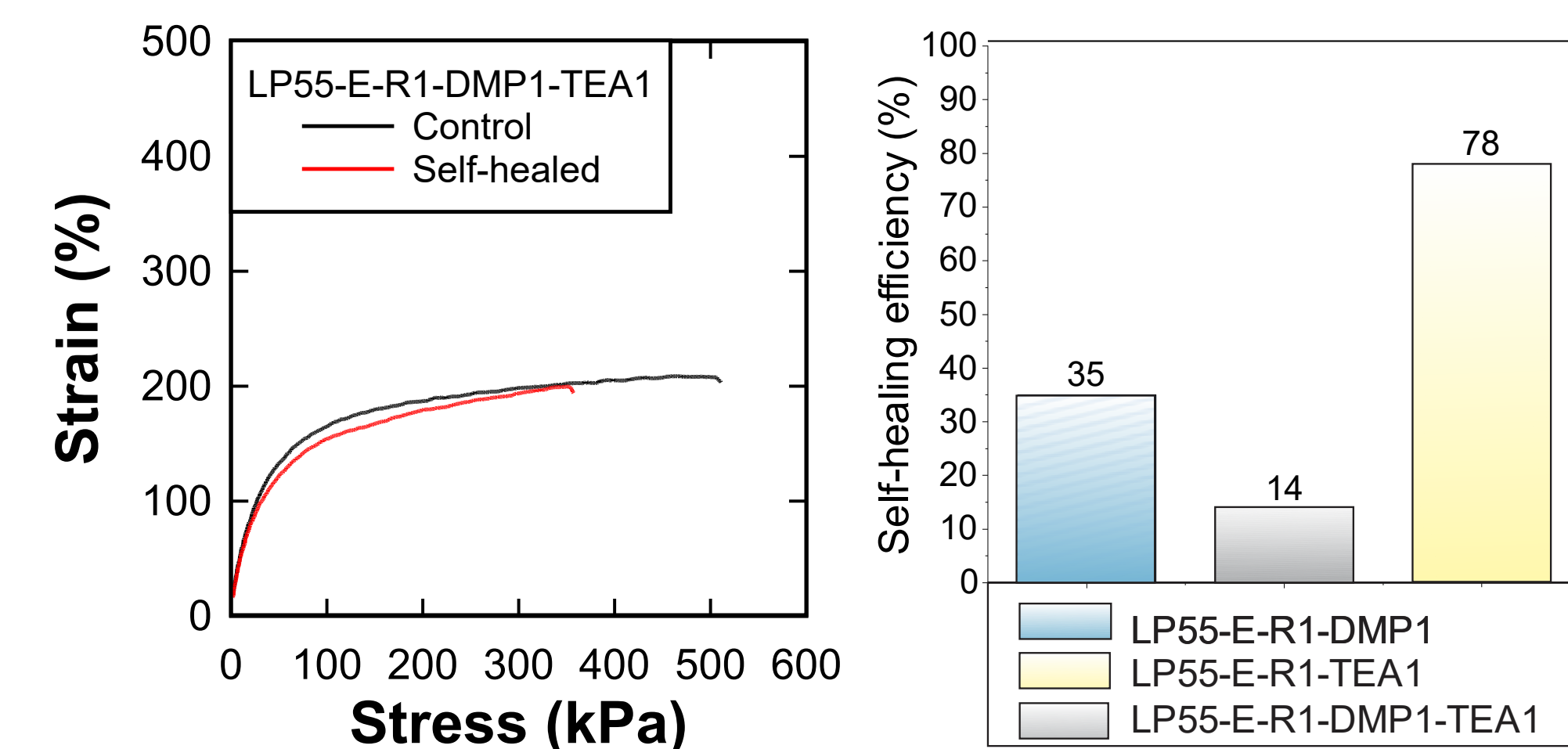
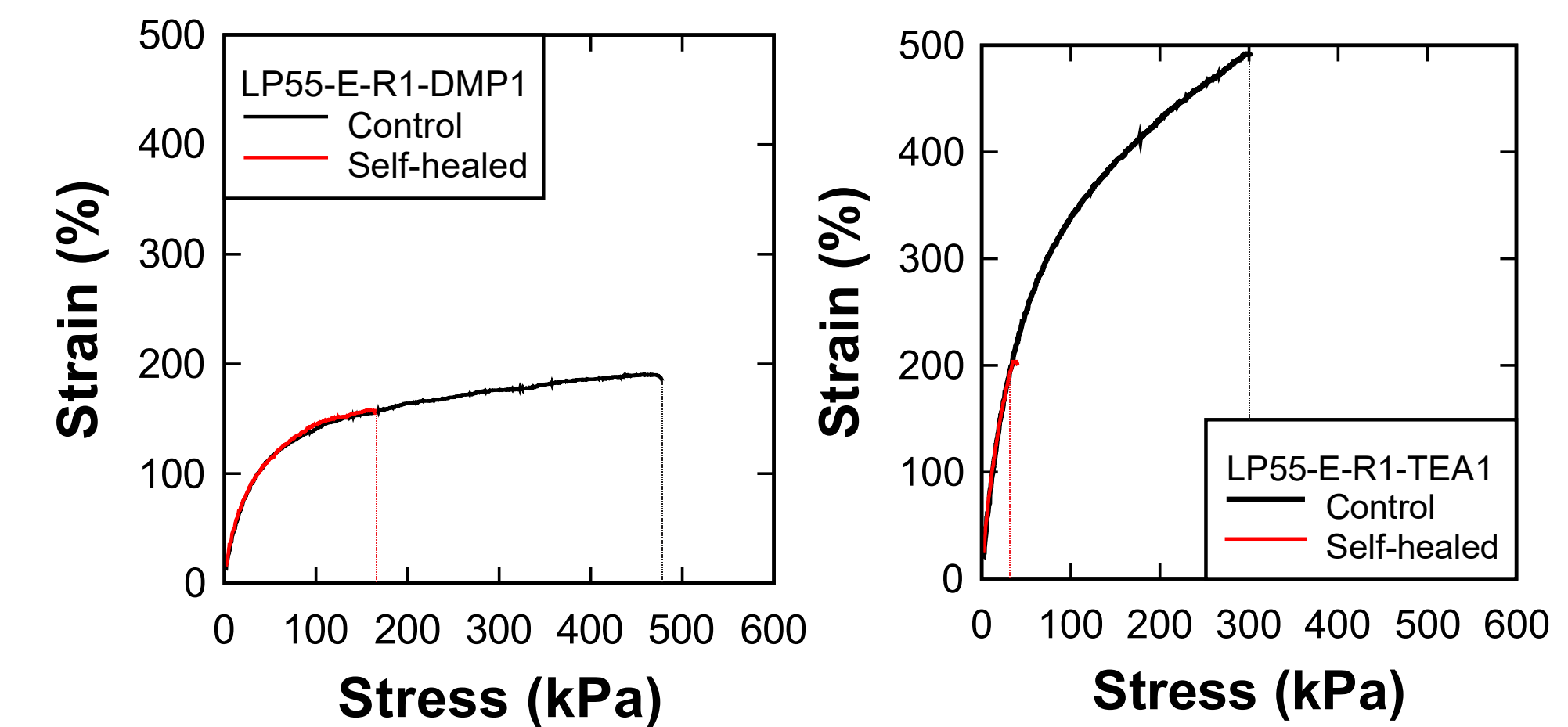
Effect of catalyst

- The effect of two tertiary amines on polymer network formation, mechanical properties, and self-healing was evaluated.
- Interest in triethylamine as an effective catalyst for disulfide exchange or thiol-disulfide exchange



Tensile properties and self-healing efficiency

- Sealant formulations prepared with TEA exhibited higher tensile strength (~500 kPa) and tensile modulus (740 kPa) compared to the formulations with DMP (~150 kPa and 370 kPa, respectively).

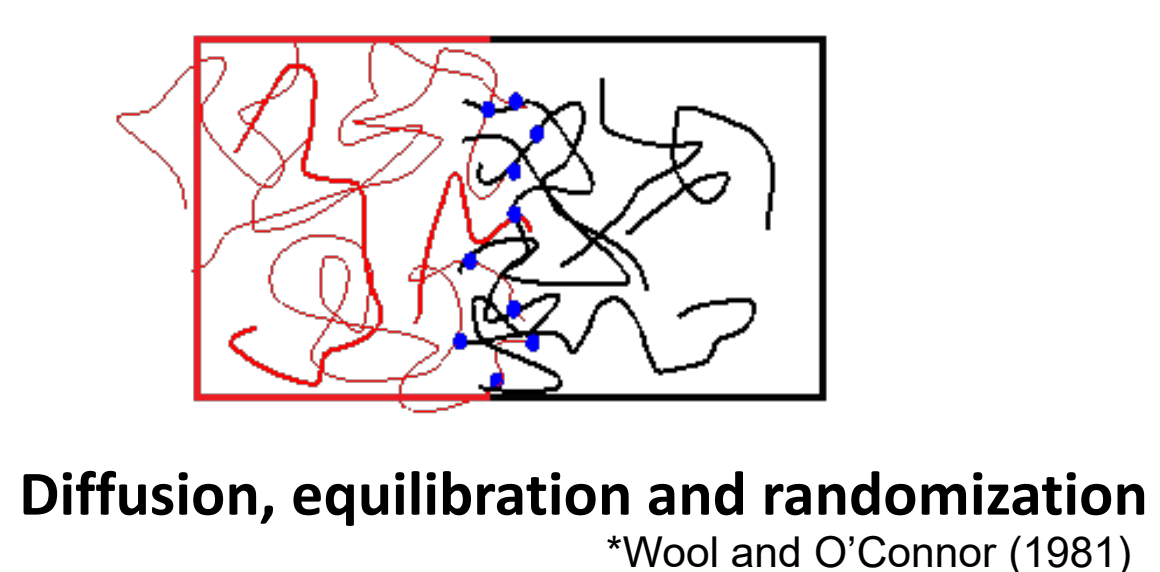
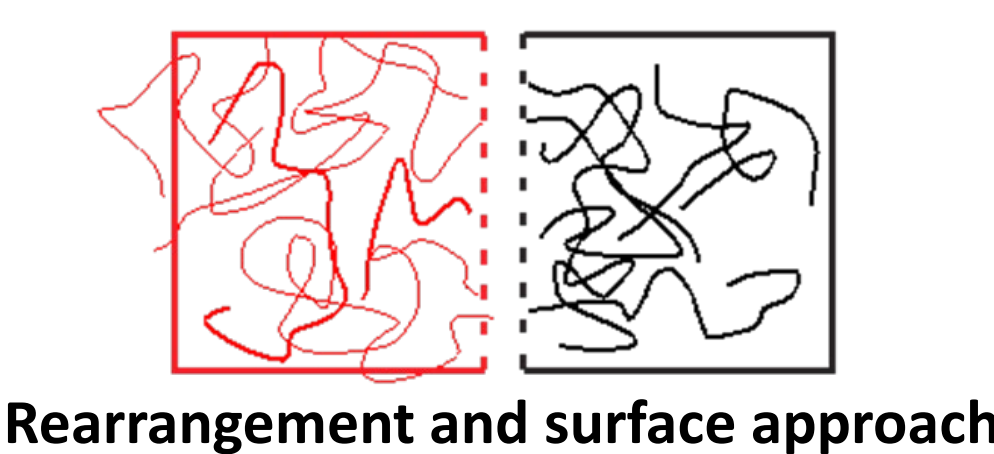


- 78 % of the initial elongation and 100% of tensile strength were restored in the sealant prepared with DMP and TEA.

Effect of compressive force on self-healing of joints

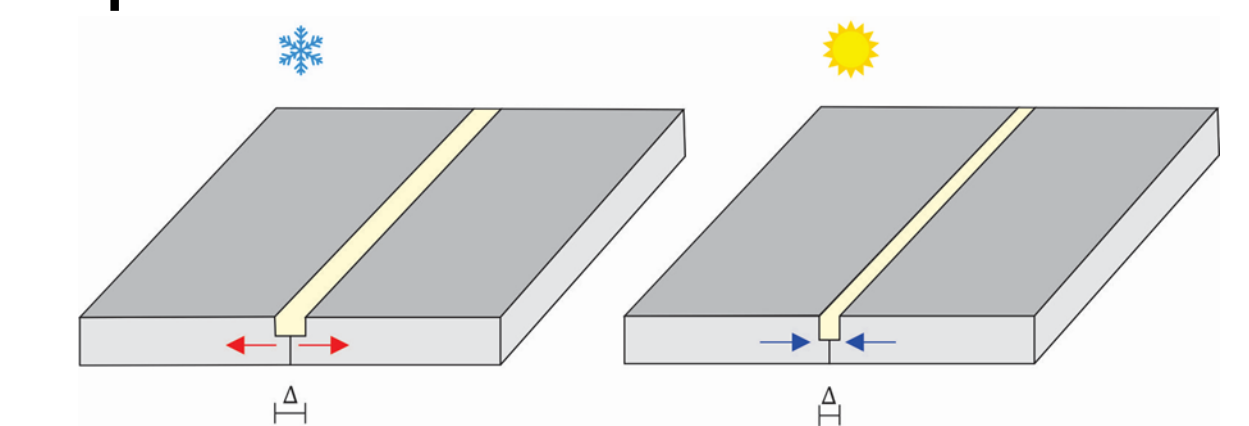
The broken polymer chains in the vicinity of the crack diffuse and come into contact with each other.

Compression enhances the contact between the damaged surfaces and increases diffusion, accelerating self-healing.

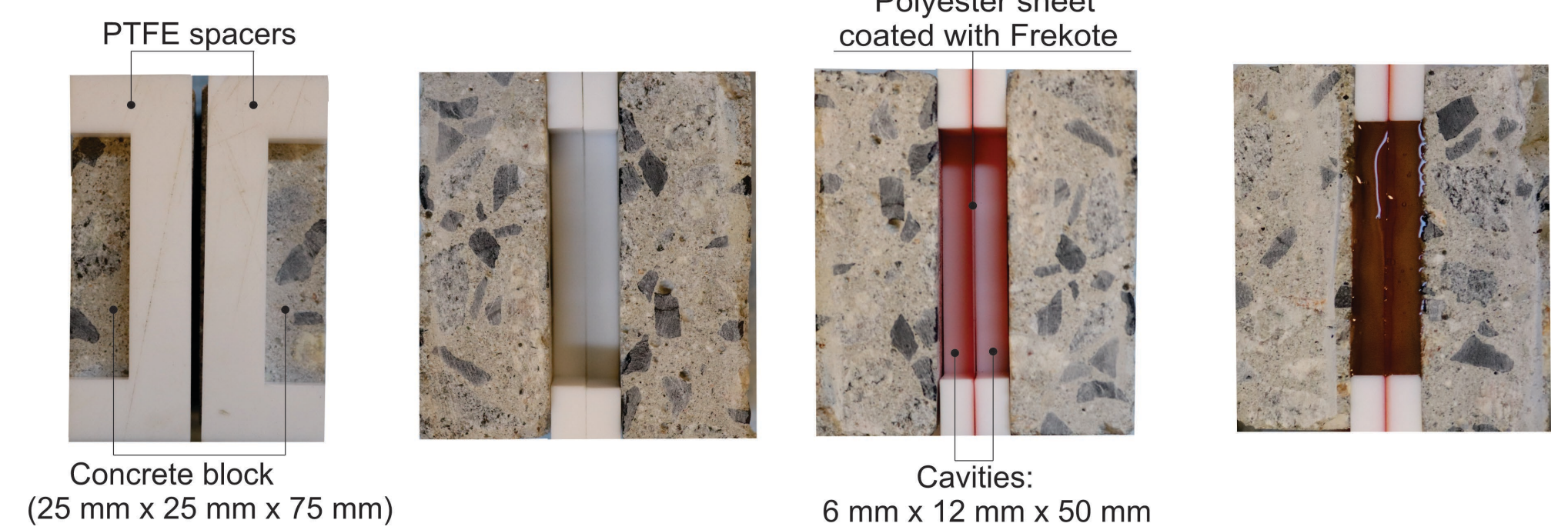


Effect of compressive force on self-healing of joints

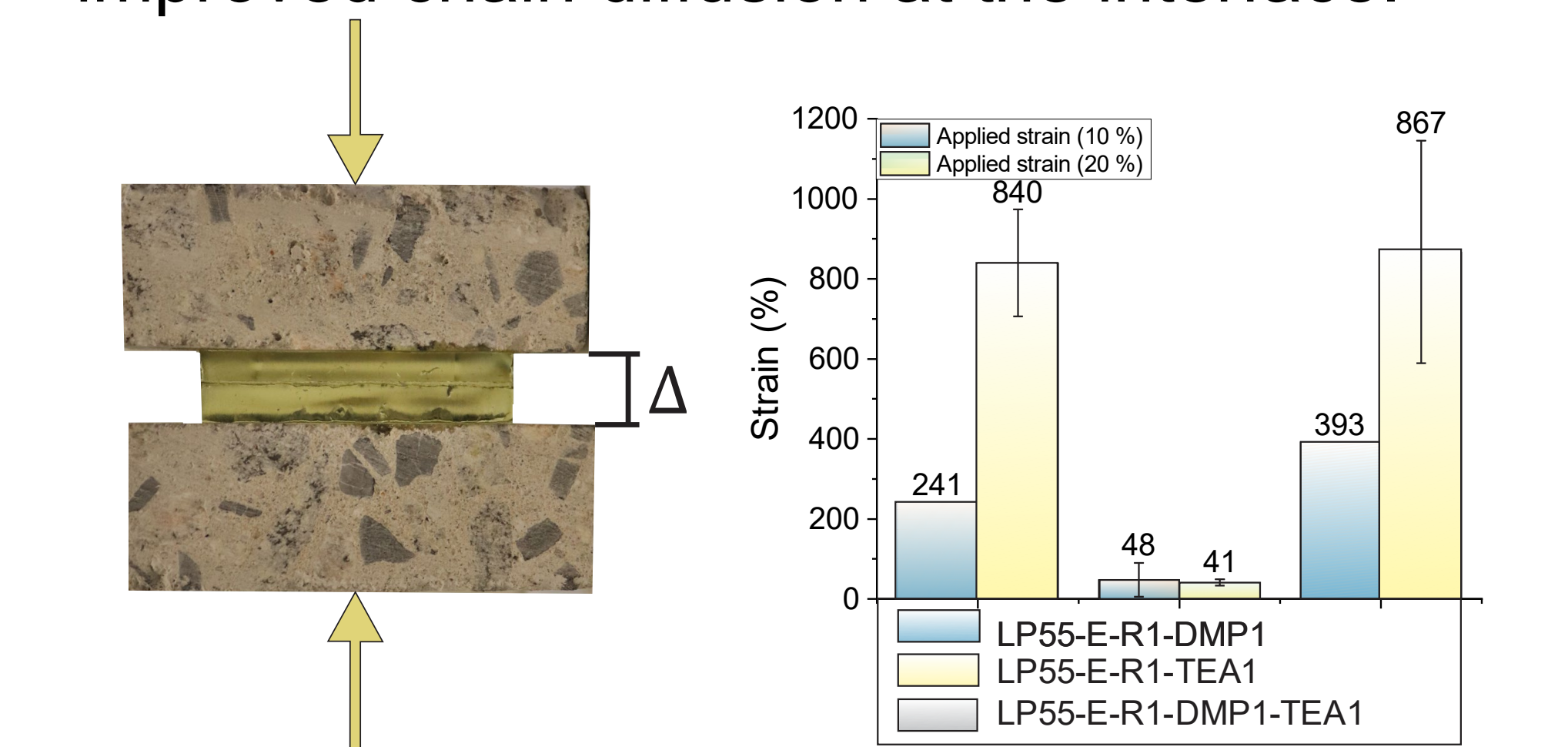
The joint is more open during winter than during summer when higher temperatures cause the expansion of concrete pavement (and compression of the sealant in the joint).



Controlled displacement of: ~ 1 mm and ~2 mm was applied over a 12.5 mm wide joint.



Compressive strain enhanced self-healing in the joint by more than 100 % due to improved chain diffusion at the interface.



Conclusion

After 24 h of self-healing at room temperature, 78 % of elongation was restored in the sealant prepared using DMP and TEA.

Substantial increase in self-healing efficiency-when the applied displacement was increased from 10% to 20%

Acknowledgements

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