WHITE PAPER
NEW SUSTAINABLE PROTECTIVE COATING – Sikagard®-5500

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EXTERNAL TECHNICAL DOCUMENT

BUILDING TRUST

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1 INTRODUCTION

After water, concrete is the second most consumed material in the world. Usually in the form of reinforced concrete, it is used all around the world for concrete houses, high-rise buildings, shopping malls, bridges, tunnels, jetties, cooling towers, etc.

But its popularity comes at an environmental cost – production of concrete, containing cement, is one of the largest producers of CO_2 emissions. The quantity of carbon dioxide needed to produce 1 m^3 of concrete is estimated at 410 kg of CO_2[1].

Another important impact on the environment is the use of aggregates which amount of ~80% by mass of concrete. On a global level, the quantity of aggregate and sand needed to produce concrete is estimated to be in the range of 10 to 11 billion tons per year[2]. This has a significant impact on rivers, seabed, landscape.

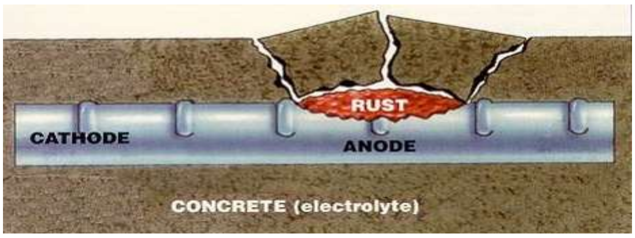
2 DURABILITY OF CONCRETE STRUCTURES

Concrete is a strong material, especially in compressive strength but weaker in tensile. To improve this property, reinforcing steel bars are added to create a composite material, reinforced concrete. This new composite material combines the resistance to both compressive and tensile load.

However, steel tends to corrode to revert back to its original oxide form. Embedded in the concrete, due to the high alkalinity of the surrounding cement paste, the steel bars are protected from corrosion.

These structures, built to last long time (e.g., 50 years for concrete buildings, minimum 100 years for bridges), are subjected to ageing with influences from pollution, water, and other deleterious elements such as chloride or carbon dioxide.

So, when chlorides or carbonation front reach the level of reinforcement, the passive layer is broken. The passivity of the steel is then lost, and corrosion is initiated. This phenomenon leads to the most common deterioration process of reinforced concrete due to subsequent volume expansion of the steel rebars.



It is estimated that every second, around 5 tons of steel are lost due to corrosion. According to NACE, 2016[3], the economic impact of corrosion is approximately 3.4 % of the global GDP ($2.5 trillion).

The corrosion of reinforced concrete in buildings or infrastructures may have severe economic consequences but may even lead to the collapse of these structures – in 2018, the Polcevera Viaduct in Genoa and in 2021 the Surfside Condo in Miami collapsed leaving behind many casualties.

Additionally, every time a structure is being renovated, there is some impact on the environment as some polluted concrete needs to be removed, new concrete/repair mortar has to be installed… these products have a certain carbon footprint. In response to this challenge, Sika has already in the last year launched a new range of repair mortars (Sika MonoTop®-1010, 4012 & 3020) with improved performance and lower carbon footprint.

3 CONCRETE PROTECTION

To prevent the penetration of the deleterious elements and then to extend the durability of concrete structures, various types of concrete protection can be used such as cement-based protective coatings, hydrophobic impregnations, or organic protective coatings.

Particularly effective against the progress of carbonation in concrete, organic protective coatings are available in different formulations, making them rigid or flexible even at very low temperatures. Effectively, concrete structures may be subjected to movements resulting in cracking in the protective coating used if this is not formulated appropriately. Elastic coatings should be able to resist either static or dynamic cracks.

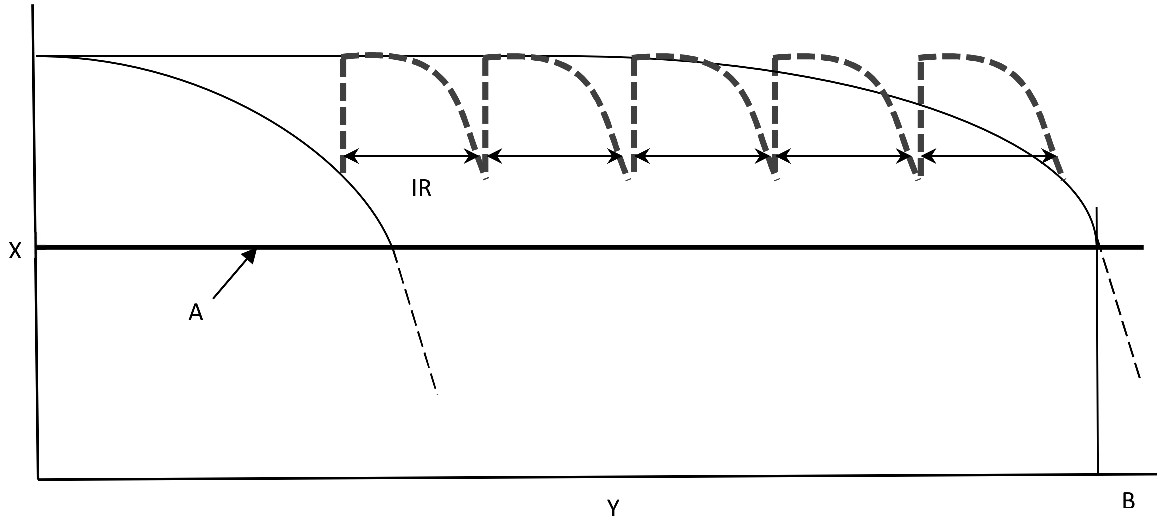
Static cracks' openings can be very large, up to more than 2.5 mm, while dynamic cracks are subjected to vibration as well as repetition of opening and closing. In Europe, testing to check the elastic coating crack bridging behavior is done based on EN 1062-7 (Method A, static, continuous opening of a crack; and Method B, cyclic opening of the cracks).

In recent years, the use of a water-based system in place of solvent containing material is becoming more and more popular, for health and safety for the workers at the workplace and to reduce the risk of fire hazard.

Some countries like the Netherlands even impose heavy fines when contractors use solvent-based material.

So, with the use of the relevant refurbishment strategy including these protective coatings, the service life of a structure can be significantly extended, increasing the time interval (IR) to the next refurbishment, reducing the number of refurbishment cycles needed to achieve the desired target life (refer to diagram below, where X is the asset condition, Y the life of the asset, A the critical condition and B the target life of the asset).

Therefore, the environmental impact can de facto be reduced.

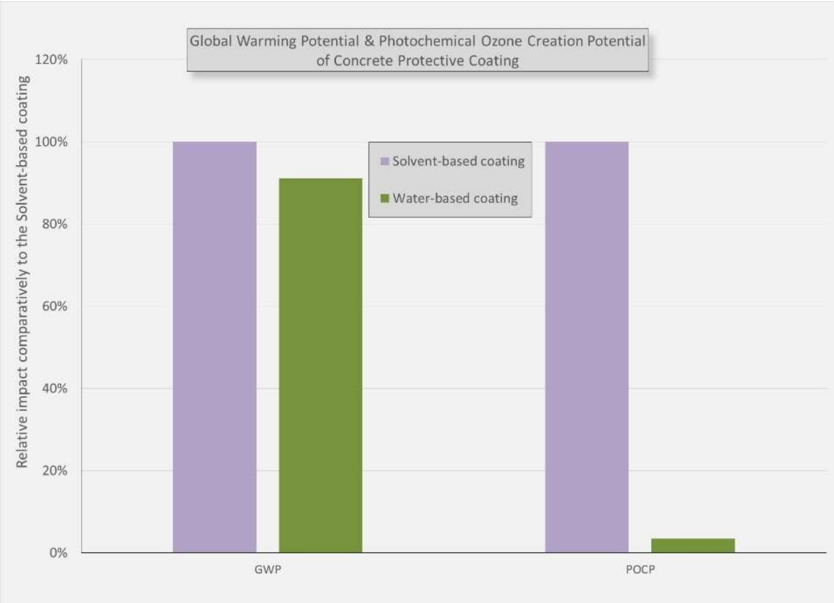


4 ARE WATER-BASED COATINGS SUSTAINABLE MATERIAL?

If we compare the ozone depletion of similar coatings, one solvent-based material and the second one water-based, the absence of solvent in the water-based coating is clearly shown in the strong reduction of this parameter. This has a strong positive impact on the reduction of the ozone layer.

But a big part of these protective coatings is organic compounds where the resin is made from non-renewable sources. If we compare the carbon footprint impact of similar coatings, one solvent-based material and the other water-based, we can see they are close to each other as both are produced with similar organic resin.

So, on one hand there is a clear benefit of using a water-based coating instead of a solvent containing coating but no such big difference in the CO_2 footprint.



Comparison of Global Warming Potential (GWP) and Photochemical Ozone Creation Potential (POCP) between a solvent-based and a water-based protective coating[4]

5 Sikagard®-5500

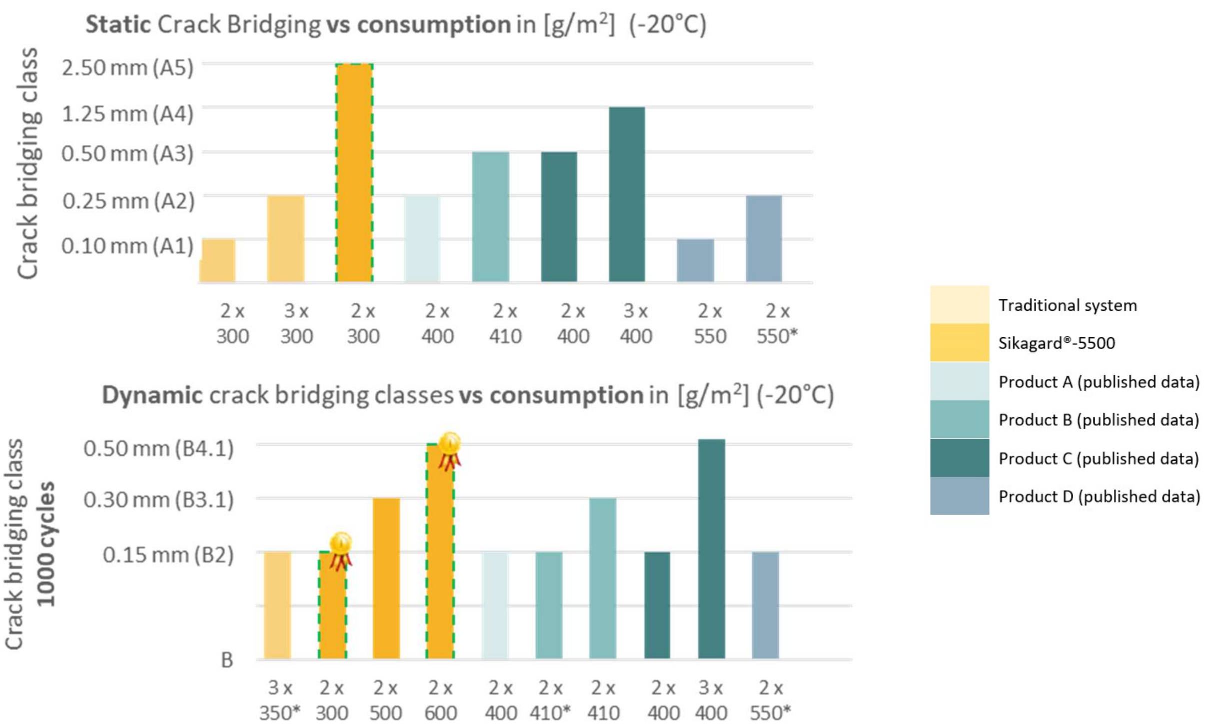
Sika recently launched a new concrete protective coating with a reduced footprint and using dispersion based on renewable feedstocks. Sikagard®-5500 is a 1-part, water-based, elastic protective coating for concrete. It has very high static and dynamic crack-bridging abilities in a wide temperature range.

Performances

From the performance aspect, this new coating brings the crack bridging behavior to a new level. Compared with the traditional system used previously, higher performance is achieved with a lower quantity of material needed

TRADITIONAL AND NEW SYSTEMS FOR SPECIFIC CRACK BRIDGING CLASSES						
	Crack bridging class	Pore sealer	Primer	Coat 1	Coat 2	Coat 3
Number of application steps		1	2	3	4	5
Example 1 (number indicate the typical consumption of the coating and primer in g/m² per layer)						
Traditional system	A2 (-20°C)		150	300	300	300
Sikagard®-5500	A5 (-20°C)		125	300	300	
Example 2 (number indicate the typical consumption of the coating and primer in g/m² per layer)						
Traditional system	B2 (-15°C)		110	350	350	350
Sikagard®-5500	B2 (-20°C)		125	300	300	

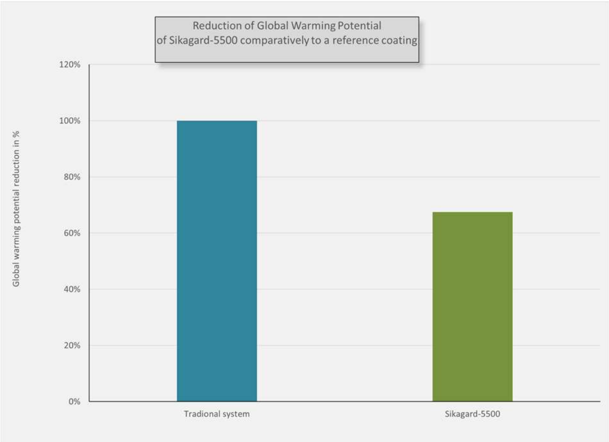
And compared with different products in the market, either the new Sikagard®-5500 outperforms them or yields a similar result but with fewer application steps.



6 ENVIRONMENTAL IMPACT

CLIMATE: REDUCED CARBON FOOTPRINT

Sikagard®-5500 has a reduced carbon footprint because of the replacement of fossil-based dispersions with dispersions based on renewable feedstocks in its formulation, among other optimizations. When compared with a reference water-based elastic protective coating, Sikagard®-5500 shows an approx. 30% reduction in Global Warming Potential (GWP). Assuming a typical consumption of 2x300 g/m^2 for a typical project size of 1,000 m^2, this corresponds to approx. 250 kg of CO_2 saved – this is equivalent to the saving of the CO_2 released from a ride of a fully loaded truck from Paris to Naples (~1,600 km).



Reduction of carbon footprint[5]

RESOURCES AND CIRCULAR ECONOMY: DISPERSIONS BASED ON RENEWABLE FEEDSTOCKS

Sikagard®-5500 contains raw materials derived from renewable resources. When compared with a reference water-based elastic coating, the formulation of Sikagard®-5500 entails a 100% substitution of fossil-based dispersion with an alternative dispersion based on renewable feedstocks, via biomass balance.

- When compared with a reference water-based elastic protective coating, fossil resources are saved with Sikagard®-5500 due to the use of sustainably certified renewable raw materials.

In summary, as environmental impact, by applying 1,000 m^2 of Sikagard-5500 using typical consumption, customers benefit from:

- approx. 250 kg CO_2-eq savings
- dispersion based on 100% renewable feedstocks.

For more information, please visit our webpage and download the Sustainability Factsheet.

7 CONCLUSION

The Owner's benefit from using the higher performing Sikagard®-5500, will be extending maintenance frequency time interval between refurbishments.

And using this sustainable coating will have a long-term positive impact on the environment because of the reduced carbon footprint.

MORE **PERFORMANCE**
MORE **SUSTAINABLE**

8 REFERENCES

[1] Environmental impact of concrete - Wikipedia

[2] P. Kumar Mehta, Reducing the environmental impact of concrete, Concrete International, October 2001

[3] G Koch et a~~l~~l~~–~~, International measures of prevention, application, and economics of corrosion technologies study, ~~–~~NACE international, 2016

[4] Data extracted from internal LCA performed by Sika comparing ~~solvent~~ solvent-based and ~~water~~ water-based concrete protective coatings

[5] Data extracted from internal LCA performed during the SPM Evaluation ~~in~~ at Sika~~.~~

9 LEGAL NOTE

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