CONCRETE BRIDGE PRESERVATION

CBP

Preserving Our Infrastructure by Using Modified Silica Gel

by Mario Baggio, Alchemco

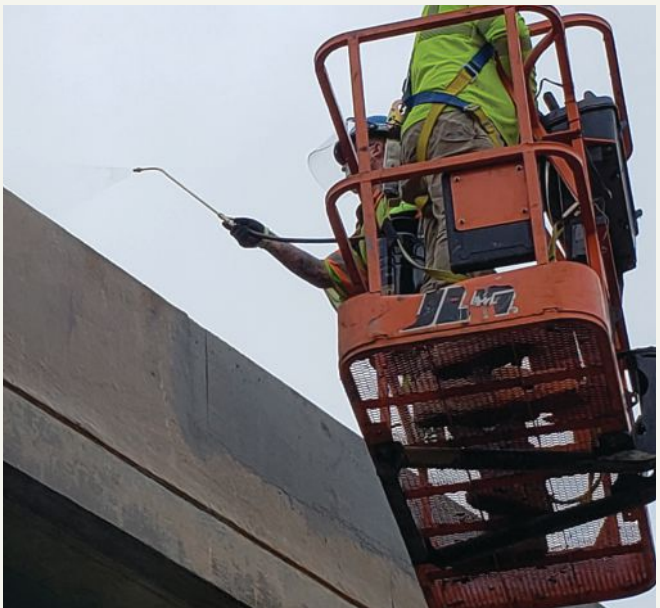
The bridge infrastructure in the United States is aging. Maintaining our bridges is crucial to our transportation system, and yet while department of transportation agencies around the country are focusing on bridge preservation and preventive maintenance, many of those same state agencies are faced with budget cuts year after year. According to a 2015 report by Purdue University for the Indiana Department of Transportation,[1] more than 50% of the national bridge inventory has exceeded a 50-year service life, and 25% of existing bridges are rated as structurally deficient or functionally obsolete. New bridge preservation technologies will help the United States and many other countries make their infrastructure last decades longer.

Key Factors in Bridge Preservation

Regularly preserving and maintaining bridges has been shown to be more effective than performing intensive and expensive repairs. When agencies are making choices on how best to spend their limited bridge maintenance and repair budgets, there are a few key things to think about.

In particular, a protection system for concrete surfaces of bridges should ideally fulfill several criteria. It should be durable and not rely solely on external protection, which can delaminate or wear away. A product that protects a bridge deck in summertime but gets scraped off by snowplows in winter or is worn off by year-round traffic is a poor choice for long-term protection. The system should also protect steel reinforcement from corrosion.

A protection system that is not porous will help prevent graffiti from adhering, but it should still be possible to paint over the system (for example, for striping). A system that seals cracks, thereby preventing premature deterioration of concrete, is advantageous. It is also important to get the bridge back in service quickly.



Spray application of modified silica gel on a bridge barrier for a Delaware Department of Transportation project. All photos: Alchemco.

Water is applied to activate modified silica gel that was previously applied on a bridge barrier for a Delaware Department of Transportation project.

A penetrating sealer and waterproofing product is a good choice to fulfill these criteria. Cracks need to be sealed against chloride ions to protect the steel reinforcement. But applying a product on the outside to seal the cracks may not be the best option, because an external protective surface can wear away and still leave the problem on the inside.

Bridge Preservation Using Silanes and Siloxanes

Silane- and siloxane-based sealers penetrate the concrete surface and chemically react to form a hydrophobic (water-repellent) barrier within the pores. The barrier, once formed, will last five to seven years. These sealers reduce concrete damage and deterioration caused by the absorption of surface water, such as cracking, spalling, pitting, mold and mildew, and efflorescence.

Silane-based products are increasingly being used for a variety of reasons. Silane molecules are slightly smaller than siloxane molecules and will penetrate more deeply, but the smaller molecule size also makes silane more volatile than siloxane (with a greater potential to evaporate after application).

Either silane or siloxane is appropriate for new bridges or reapplications on existing bridges. But, while they do create a hydrophobic surface to prevent water intrusion and damage over time, silane and siloxane do not seal cracks, which is the main concern for long-term durability.

Bridge Preservation Using Modified Silica Gel

Modified silica gel products are sprayable liquids that penetrate into the concrete using water as a transport mechanism. The products are sprayed on the surface of the structure and travel ½ to ¾ in. deep into the concrete by the process of diffusion. Properly prepared concrete surfaces that are clean, dry, dust free, and at least 28 days old are necessary to ensure success of the system.

When installed, these products form an impermeable and flexible waterproof structure inside the concrete. The gel interacts with calcium hydroxide and other by-products from the hydration process, which form as the concrete cures, to block capillaries, cracks, microfractures, and the like.

Modified silica gel can be used on new or existing concrete. In this application, the transport water is an ally, not an enemy, because the active ingredients of the gel use available water to migrate through the cracks and pores to penetrate deep into the concrete.

The organic ingredients in the modified silica gel, once they have been absorbed into the concrete and have been activated by water, give the concrete the ability to seal a surface crack whenever one may occur, which essentially gives the concrete "self-healing" properties. The active ingredients react with water to chemically change into a hydrophilic gel that seals cracks already in existence. The gel is absorbed into the concrete and remains present but dormant until it is reactivated by water. It subsequently undergoes the same chemical reaction again when future water penetrates the concrete and heals cracks as soon as they form. This attribute persists over the life of the concrete. Modified silica gel can heal potential future cracks that are up to 0.08 in. wide (about the width of a car key). Lab tests have shown that modified silica gel also acts as a densifier, increasing the hardness and compressive strength of the penetrated area of the concrete surface. When the gel is applied to a concrete deck at an early age, it can reduce the number of cracks and seal any future cracks that form.

Modified silica gel is being applied to seal individual cracks in a bridge deck for the Illinois Department of Transportation.

Penetrating sealers cannot be damaged or deteriorate like surface coatings. Moisture is not trapped in the concrete. The sealer allows moisture vapor outgassing while preventing ingress of water molecules and other deleterious materials. Modified silica gel is nontoxic, with no volatile organic compounds, and allows the concrete to be completely recycled after demolition. Also, it can be used over other integral waterproofing systems (like crystalline admixtures).

Conclusion

Protecting concrete bridge decks is an important part of bridge preservation. Modified silica gel is a durable waterproofing system that can extend the service life of our concrete infrastructure. Other systems, such as silanes and siloxanes, can and do protect against water, but they do not provide a long-term solution for the most common problem with concrete: cracking. Because of the unique crack self-sealing and waterproofing properties of silica gel, its use can reduce the direct cost for maintenance and repair.

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Reference

1. Bowman, M. D., and L. M. Moran. 2015. *Bridge Preservation Treatments and Best Practices*. FHWA/IN/JTRP-2015/22. West Lafayette, IN: Purdue University. https://doi.org/10.5703/1288284316007.

A spraying rig that can cover up to 100,000 ft² per hour applies modified silica gel to a bridge deck for the South Dakota Department of Transportation.