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LMC proves a strong, economical choice for long-lasting bridge decks

Engineers from the Pennsylvania DOT discuss their use of latex-modified concrete in bridge decks around the district

The Pennsylvania Department of Transportation manages more than 25,000 state-owned bridges, which is third nationally. Those bridges see traffic anywhere from thousands to hundreds of thousands of vehicles each day. With all that traffic comes the need for regular maintenance to keep bridges structurally sound, as well as periodic inspections to comply with National Bridge Inspection Standards (NBIS) and keep travelers safe.

That's a lot of work for the Pennsylvania Department of Transportation (PennDOT). The District 11 Office, in the greater Pittsburgh area, has 1,800 bridges on their inventory and is responsible for inspections, maintenance, rehabilitations and replacements. Their district — which encompasses the Allegheny, Beaver and Lawrence Counties — also includes four tunnels, 500 sign structures and 1,100 retaining walls.

To keep bridges in working order, engineers at PennDOT need to think strategically about allocating funds, prioritizing projects, and specifying materials and methods of construction. When chosen correctly, the latter make all the difference in the time and cost of a project, the time between maintenance efforts, and the overall lifespan of a bridge.

PennDOT has successfully updated many bridges with latex-modified concrete (LMC), or concrete mixed with latex solids. LMC has been used for more than 50 years in bridge deck preservation projects as an overlay treatment to protect bridge decks, and PennDOT has used it for almost two decades.

For the engineers at PennDOT, LMC has been instrumental in achieving departmental objectives, and the Pittsburgh region in particular has been a big proponent of LMC in maintaining the district's bridges.

Deciding factors: Funds, priorities, materials

As part of their work in overseeing the maintenance of local bridges, PennDOT inspects and analyzes structures to decide how funding will be allocated. With all the structures in their purview, prioritizing projects can be challenging.

His team determines project priorities based on a combination of funding, the age of a structure, its current state of repair and the amount of traffic it carries, but there are always other factors at play, making priority a consistently difficult issue to address.

"Funding plays a huge role in prioritizing jobs, as well as any kind of metrics we may have to achieve based on state or federal guidelines," says Keith Cornelius, District 11 Assistant Bridge Engineer at PennDOT.

"There's also the amount of traffic on those structures. Interstates, for example, sometimes jump to the front of the list if the issues are big enough."

"According to a mandate from the Federal Highway Administration, we have to keep our bridges on the National Highway System in good condition," says Lou Ruzzi, District 11 Bridge Engineer at PennDOT. *"We're doing our best to keep that number down. We only have one poor bridge on the NHS at this point, which is very good."*

Of all the bridges on this system, which includes the interstate and other high-volume roads, only 5 percent or fewer may have a "poor" condition rating assigned to the bridge deck. As of April 2020, almost a quarter of Pennsylvania's bridges have a deck area in "good" condition, which is close to the state's target.

"Overall we try to keep a good balance of preservation, rehabilitation and replacement projects," says Ruzzi. *"We'd like to see bridge decks have at least a 60-year life, which would mean one deck replacement over the 100 or 120-year life of the structure."*

To keep bridge decks in good shape, PennDOT's engineers use a variety of construction techniques. They currently favor latex-modified concrete (LMC) as their go-to method, combined with hydrodemolition for concrete removal and surface preparation.

Though District 11 in Pennsylvania primarily uses latex, they keep an eye on new approaches, meet with other state DOTs and read studies to learn about alternative techniques. It's all about specifying the best approach for the situation.

The choice to keep returning to LMC has to do with its longer lifespan compared to other deck preservation methods. Other treatments have demonstrated a shorter lifespan in comparison to LMC.

"With deck preservation, our goal is to get at least 15 to 20 years out of a [latex treatment]. On newer decks, we'd like to see 20 to 25 years," Ruzzi says.

"In choosing the type of overlay, we have to take into account our funding situation and the bridge's lifespan," says Cornelius. *"When a lack of funding prevents deck replacement, LMC is sometimes used as a temporary solution to keep the bridge deck functional. "Preserving the deck is the number one thing. The deck is our frontline of defense against bridge corrosion, and it's the lifeblood that protects the super structure and the substructure of the bridge."*

PennDOT's engineers put a great deal of thought into the timing of treatments at specific points in a bridge's lifespan. They must prioritize "problem" bridges and high-traffic bridges, for instance. Preventative maintenance goes a long way towards keeping bridges in working order in a cost-effective way.

"If we don't take care of a bridge deck or make sure its cracks are sealed and protected, we're just not going to get that 60-year minimum lifespan we want," says Shane Szalankiewicz, District 11 Structure Control Engineer at PennDOT.

Bridge deck treatments are an essential part of that bridge management program, and things like joint repairs help extend the deck's life in other ways without having to perform extensive work on the substructure.

LMC and hydrodemolition

In PennDOT's case, latex-modified concrete often works best in tandem with the concrete removal method of hydrodemolition. Using an automated system of high-pressure water jets, hydrodemolition removes layers of damaged concrete in a controlled manner. It prepares the surface of the bridge deck for LMC application by selectively removing deteriorated or weakened concrete while also providing a very roughened surface, which allows for a stronger bond between the latex and the deck surface.

The Veterans Bridge in Pittsburgh, PA was completed in 1988 and recently updated with LMC.

"Over the years, our process with latex has evolved," says Szalankiewicz. ***There was a learning process involved in the amount of material removed by hydrodemolition, as well as consultations with other districts to learn about their methods. "Now we're a hydro district. Hydro is cheap insurance to ensure you get a better bond, and we're going to use it almost every time with an LMC overlay."***

Szalankiewicz has perfected the calibration specifications through the years, using a combination of scarification and hydrodemolition to achieve a more effective and uniform removal of deteriorated deck.

"When you have a hydro surface with peaks and valleys, you get more surface area," he explains. ***"It's rough and opens up the pores of the concrete, where latex and slurry can get in and bond really well. So we feel a lot more confident that it will last longer and gives us that monolithic deck placement."***

In the 20 years that PennDOT has used LMC, they have used hydrodemolition for the majority of bridge preservation projects. The department recently updated its standard specifications with some of those best practices.

LMC in Pittsburgh bridges

PennDOT recently used latex-modified concrete on the Veterans Bridge, a steel welded plate girder bridge that carries Interstate 579 over the Allegheny River. Completed in 1988, the bridge deck began to see issues more than two decades later.

"Somewhere along the line — about 10–15 miles up the I-279 into the North Hills of Pittsburgh — there was some bad aggregate on the job," says Ruzzi. ***"We started to get these round pop-outs, about four to six inches, on the bridge decks. The main span of the Veteran's Bridge was no different."***

"That one turned out well — we haven't had any issues since it was done," Ruzzi says. ***"We also did some in-depth latex repairs on the Fort Duquesne and Neville Island Bridges."***

The Fort Duquesne Bridge was much older, having opened to traffic in 1969. The steel bowstring arch bridge spanning the Allegheny River had a latex surface applied in 1985, and then it was stripped down and latex re-applied again in the mid-2000s. In a similar example, the Neville Island Bridge, a tied arch bridge built in 1976, had many deck repairs surfacing in 2001. After numerous repairs, PennDOT programmed a hydrodemolition and latex overlay project a few years later.

Pittsburgh's Fort Duquesne Bridge has had multiple latex jobs since it opened to traffic in 1969.

For the PennDOT engineers, these bridges serve as examples of the importance of regular maintenance work done with proper surface treatment and materials. Szalankiewicz offers a more modern example of the Regis R. Malady Bridge, also known as the Elizabeth Bridge, that crosses the Monongahela River.

"The Elizabeth Bridge was much different from the others. The deck was placed new in 1985. It had minimal damage, which made it a good candidate for latex," he explains. *"It should last a very long time because its substrate is in good shape, and we had a contractor who is experienced with latex to put those down."*

The work of Szalankiewicz and his team has narrowed down some of the best practices it takes to get the LMC to bond properly and last longer. In general, the PennDOT team is satisfied with the choice to use LMC consistently on several projects.

"We're getting up to around the 18-year mark on some of the earliest latex jobs we did, and the most we usually see is some cracking here and there," says Ruzzi. *"For the most part, it's doing its job — extending the life of bridge decks."*

A reliable, long-lasting bridge preservation method

Considering all the careful planning, strategy and money that goes into bridge deck preservation, the use of a high-quality LMC mix is paramount. A concrete modifier produced by BASF called STYROFAN® 1186 is designed to extend the longevity of concrete bridge decks.

STYROFAN 1186, a styrene-butadiene emulsion polymer, mixes with concrete onsite to create an LMC that cures with greater flexural strength. It has demonstrated strong bonding, excellent durability and reduced permeability, which is important where bridges are treated with high chlorides, such as the harsh environment in the Pittsburgh area. Its high flexural strength helps minimize cracking as temperatures change.

Latex: The 'bread and butter' for PennDOT

PennDOT reports high satisfaction with the use of LMC overall.

"For the most part, we've been happy with how LMC has performed," says Cornelius. *"We have many different products to turn to now, but LMC fills a pretty big void in bridge preservation."*

He adds that LMC often comes in handy with the many high-traffic structures that need work in their district.

"We need something that can be applied quickly, will last a long time and be cost-effective. LMC has been a good tool in the toolbox."

For Szalankiewicz, cost-effectiveness and familiarity with the method make LMC an all-around strong choice. It's important to have experienced contractors who know how to work with the product. If everything is scoped, prepared and placed correctly, the bridge deck will last longer.

"As a deck rehabilitation strategy, latex has been the bread and butter for us," Szalankiewicz says. *"Latex is more economical from a material standpoint because it's been around for a while, and our region is used to it. Overall, it's been a very good product for our region."*

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