An Analysis of the Performance of the Safelane™ Overlay during Winter 2005-06

Wilfrid Nixon, Ph.D., P.E.
Asset Insight Technologies

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Bob Persichetti
Cargill

Introduction

Prior to the 2005-06 winter season, a pavement overlay product, Safelane™ was installed at eight locations around the United States. In 2003, the overlay had been installed at one single location for lengthier testing. Table 1 lists these nine sites.

The overlay, which is based on technology described in US Patent Number 6,849,198 ("Anti-Icing coating and methods"), uses a special aggregate that acts, together with an adhesive, in a sponge-like manner such that when an anti-icing liquid is applied to the surface, it is retained for a significant portion of time (typically, many days) and remains effective as an anti-icing chemical during that time.

From a winter maintenance perspective, the purpose of the testing during the 2005-06 winter was twofold. The first goal was to determine the extent to which the overlay would extend anti-icing chemical effectiveness. In some of the installations, this goal was further refined to indicate a desire for reduction of accidents, a normal beneficial outcome of successful anti-icing activities. A second goal was to determine whether there were any unforeseen problems arising with the use of the product. The different locations allowed the product to be evaluated under a number of different conditions, including not only bridges, but also on- and off-ramps.

Site	Location	Type	Date of Installation
McLean Bridge, Texas	I-40, mile marker 144, 70 miles east of Amarillo	Two lane elevated bridge, westbound side only, 12,000 square feet	November 2005
Brecksville, Ohio	I-80, exit 173 on Ohio Turnpike	Exit ramp, incline with curve, 8,000 square feet	November 2005
Harrisonburg, Virginia	I-81, northbound, milepost 239.71	Two lane elevated bridge, northbound side only, 13,203 square feet	September 2005
Staunton, Virginia	I-81, southbound, milepost 219.78	Two lane elevated bridge, southbound side only, 7,164 square feet	September 2005
Ironwood Bridge, Indiana	Ironwood Overpass, South Bend, Indiana	Eastbound lane of the overpass, 11,790 square feet	May 2005
Blatnick Bridge On-ramp, Wisconsin	Blatnick bridge on Rt. 53 between Superior and Duluth	On-ramp for the bridge, 15,000 square feet	June 2005

Buffalo Creek Bridge, New York	Two Rod road over Buffalo Creek, near Buffalo, New York	Both lanes of a two lane bridge deck, 8,400 square feet	September 2005
Davis Bridge, New York	I-86 westbound over Rt. 430 East	Two lane elevated bridge, westbound only, 16,400 square feet	October 2005
Wolf River Bridge, Wisconsin	Rural bridge over the Wolf River, near Crandon Wisconsin	Two lane bridge, covered on both directions, 4,800 square feet	Summer 2003

Table 1: Site Locations

Site Descriptions

McLean Bridge, McLean, Texas

This site is located on Interstate 40 on the westbound bridge at mile marker 144. The location is about 70 miles East of Amarillo Texas, and is in a rural location. The bridge is prone to icing during winter weather, and the area of the bridge that was treated amounted to about 12,000 square feet. A primary concern for the operators of the structure was to reduce accidents. The bridge experiences “several accidents” each winter.

I-80 Eastbound, Brecksville Ohio

This site is located on Interstate 80 (the turnpike segment) on the eastbound side, at exit 173. The exit ramp, an incline with a tight curve, has been treated with the overlay. A total area of about 8,000 square feet was treated. The setting is rural, and a major concern for the location is to reduce accidents. Over the prior two years, 49 accidents had occurred.

Harrisonburg, Virginia

This overlay is placed on the northbound leg of structure 2024 on Interstate 81, at milepost 239.71. The setting is rural. The area treated was 13,203 square feet. Average daily traffic is approximately 24,000 vehicles (one way), with 26% of those being trucks. A primary concern for this structure is surface renewal and deck protection.

Staunton, Virginia

This overlay is placed on the southbound leg of structure 2037 on Interstate 81, at milepost 219.78 (about 20 miles from the Harrisonburg bridge above). The area treated on this bridge is 7,164 square feet. Average daily traffic is approximately 22,000 vehicles (one way), with 32% of those being trucks. As for the Harrisonburg bridge above, a primary concern for this structure is surface renewal and deck protection.

Ironwood Bridge, South Bend, Indiana

This bridge is located on the Ironwood Bridge overpass (on the US 20 bypass), near South Bend Indiana, specifically on the eastbound lane of the overpass. The setting is urban. The area of bridge deck that was treated was 11,790 square feet. Average daily traffic is 30,000 vehicles. A primary concern for this installation was the reduction of accidents.

Blatnick Bridge On-Ramp, Superior, Wisconsin

This structure is the on ramp for Route 53. It is in an urban setting, onto the bridge linking the cities of Superior, Wisconsin and Duluth, Minnesota. The area of deck treated was 18,000 square feet. Average daily traffic is 15,000 vehicles. The primary concern for this on ramp was to reduce accidents, of which there have been twenty over the past four years.

Buffalo Creek Bridge, New York

This is a rural bridge on Two Rod road, near to Buffalo. The deck was treated in both directions, with a total treated area of 8,400 square feet. Average daily traffic was 2,145. The primary concern at this location was extending bridge life.

Davis Bridge, New York

This bridge is on Interstate 86, on the westbound lanes. The bridge passes over Route 430 East, fairly close to the state line with Pennsylvania. The setting is rural. The area of bridge treated was two lanes wide, with total area of 16,400 square feet. Average daily traffic is 10,845.

Wolf River Bridge, Crandon, Wisconsin

This is a rural bridge about 120 feet long. The whole deck (both lanes) was treated in the summer of 2003. Average daily traffic is in the range of 5,000 to 8,000. One concern about this bridge was that prior to treatment there had been three to four wintertime accidents each year.

Observations of Site Performance

McLean Bridge, McLean, Texas

The standard treatment for the structure was to apply magnesium chloride brine at a rate of 30 gallons per lane mile. In terms of results, the primary information for this site comes from a three day ice storm in the middle of December. During the storm, temperatures (presumably air temperatures, although this was not specified) ranged between 26 and 28 degrees Fahrenheit. The structure (the westbound side of a bridge on I-40) was treated once prior to the storm start, with 30 gallons per lane mile of magnesium chloride, a standard application. The test site received no further treatment throughout the whole storm. The test site never iced over, and no accidents occurred at that location.

In contrast, other locations experienced significant problems with ice accumulations, and there were numerous accidents “up and down the interstate.” Further, one accident occurred on the eastbound bridge adjacent to the test section. The clear implication is that in this circumstance, the SafeLane™ overlay was extremely effective both in preventing the accumulation of ice on the highway and in preserving the safety and mobility of the highway for the traveling public.

I-80 Eastbound, Brecksville Ohio

No formal records of chemical applications and overlay performance were available for this test sections. Discussions with the chief maintenance engineer, Tim Ujvari, indicated three primary results from the winter of testing. First, no problems were encountered with the overlay during the winter season. Second, fewer slide-offs (vehicles leaving the exit ramp in an uncontrolled skid) occurred this winter, with the caveat that some (but not all) of the reduction may be due to a somewhat milder winter than normal. Third, Mr. Ujvari indicated that the lifetime performance of the overlay will be an important consideration, and of course, one winter does not provide information on the expected lifetime of the overlay.

The two key factors here are that a reduction in accidents was observed, and that no problems with the overlay were encountered.

Harrisonburg, Virginia and Staunton, Virginia

For these test sections, detailed information was provided on the initial application of liquid to both the test sections and the control section. A spray truck applied salt brine at a rate of 30 gallons per lane mile, and made two passes per lane. Each pass was nine to ten feet wide, and there was thus a four to five foot overlap in the center of each lane. Further, a two foot overlap occurred at the centerline.

There was no spray or mist caused by traffic during the application process. Within five minutes of application, the surface in the wheel track area was dry. Between the wheel tracks dried out in about 20 minutes. The weather was clear and sunny. Surface temperatures were between 51 and 39 degrees Fahrenheit at time of application, which is somewhat significant. There is concern that if ice-control liquids are applied at relatively high surface temperatures (above 40 degrees seems to be the accepted limit) there is a possibility that as the liquids penetrate the road surface and dry out, they may pass through a state in which they can be very slippery or slick. It is clear from the observations in Virginia that this did not happen.

The winter in Virginia was very mild in 2005-06, thus relatively few events (snow storms or frosts) occurred in which the performance of the overlay could be compared with the control section. Indeed, when significant winter events did occur (e.g. December 8 and December 15 2005), maintenance personnel plowed and applied chemicals equally to both the test and the control sections. No difference in performance between the test and controls was observed. However, this is to be expected, given that the benefit of the SafeLane™ overlay lies in the persistence of the ice control chemical within the overlay, and winter conditions for the Virginia test sites were such that the benefits of this ability were not tested.

Ironwood Bridge, South Bend, Indiana

Data for the Ironwood Bridge comprises both data sheets and anecdotal reports. The bridge has been treated with a salt (sodium chloride) brine during the winter. The first anecdotal report is dated December 1, 2005, and notes (explanatory comments added in parentheses):

> "The bridge westbound (control section) was slushy and a little slippery. The new bridge eastbound (test section) was just wet. Nothing Stuck. We anti-iced Tuesday (two days prior to event). The bridge worked this time."

The next anecdotal report stems from a meeting on December 13, 2005. At this meeting, it was noted they had three documented cases where the test section performed better in a winter event than the surrounding roads and structures. This included one instance where the temperature dropped to 8 degrees Fahrenheit (it is not clear if this is a surface or an air temperature, but it is likely an air temperature) and everything except the test section froze, while the test section remained wet. The one comment from this meeting that was not totally positive was that the bridge was a little rough to drive over.

A further anecdotal report is dated December 14, 2005. This notes:

> "A little bit of snow just fell and stated to turn things a little snotty. We shot the westbound side (control section) and by the time we were going to shoot the eastbound side (test section) it was already melting off."

The note further explains that only a matter of a few minutes separated the truck from the westbound and eastbound sites.

Tabulated data are available for this test site for December 13 and 14, January 23 and 24, February 9 and 12, and February 17. Table 2 presents the information from these events.

Date and Time	Road and Weather Conditions	Applications	Condition of Test and Control Sites
12/13/05 @ 12 p.m.	No snow and Pavement Temperature (PT) = 32º	35 gallons a lane mile of salt brine applied in anti-icing mode	Pre-treatment, so no precipitation at this point
12/14/05 @9:40 a.m.	Light snow, PT = 26º	200 lbs per lane mile of salt	Test section clear, control section slushy
Same @ 12:40 p.m.	Freezing rain, PT = 29º	200 lbs per lane mile on control section only	Control section had ice, test section was wet
Same @ 1:40 p.m.	Freezing rain and snow, PT = 30º	250 lbs per lane mile on control, 230 on test	No report
Same @ 3:15 p.m.	Freezing rain, PT = 31º	200 lbs per lane mile on both	Control section had ice, test section was wet
Same @ 4:05 p.m.	Freezing rain, PT = 29º	200 lbs on control section only	No report on control section, test section still wet
Same @ 5:25 p.m.	Freezing rain, PT = 29º	250 lbs per lane mile on control section, 230 on test	Control section had only wheeltracks bare, test section still wet.
1/23/06 @ 9:00 a.m.	No snow, PT = 30º	Anti-icing at 40 gallons per lane mile	Snow and frost were in the forecast
1/24/06 @ 9:00 a.m.	Light snow, PT = 30º	200 lbs per lane mile of salt on control section	Control section was snow covered prior to treatment, test section did not need treatment
2/9/06 @ 9:00 a.m.	No snow, PT = 21º	Anti-icing at 40	No report

		gallons per lane mile	
2/12/06 @ 9:20 a.m.	Light snow, PT = 28º	200 lbs per lane mile to control section	Control section was snow covered prior to treatment, test section did not need treatment
Same @ 10:30 a.m.	Light snow, PT not recorded	200 lbs per lane mile to control section, 100 lbs to test section	Control section had snow present prior to spreading, test section was still wet
Same @ 12:00 p.m.	Light snow, PT = 32º	200 lbs per lane mile to control section, 100 lbs to test section	Control section had snow present prior to spreading, test section was still wet
2/17/06 @ 2:00 a.m.	Light snow, PT not recorded	220 lbs per lane mile to both sections	Both sections had snow prior to treatment – rain in previous days may have removed chemical residual
Same @ 4:00 a.m.	Light snow, PT = 27º	200 lbs per lane mile to control section, none to test section	Test section was still clear from prior treatment, control section had icy film prior to this application

Table 2: Field Data for the Ironwood Bridge

Blatnick Bridge On-Ramp, Superior, Wisconsin

The primary concern for this structure was to address the issue of accidents. During the four years prior to installation of the overlay, about 20 accidents had occurred. During this past winter, no accidents occurred. A summary comment, provided by Jeffrey Hall of Minnesota DOT is: “The area where the SafeLane™ was applied holds the chemical longer and when it does become snow covered it seems to still have more traction than the surrounding area.”

Data sheets for treatment of the structure are available for January and February 2006. The information on these sheets is presented in summary form in table 2 below. In general terms, typical chemical applications for this area would be in the range of 300-400 lbs per lane mile of solid chemicals (and granular salt), and 20 gallons per lane mile of magnesium chloride brine (in anti-icing mode). The structure was “charged” about every two weeks with an application of about 15 gallons per lane mile of magnesium chloride brine.

Date and Time	Road and Weather Conditions	Applications	Condition of Test and Control Sites
1/6/06 @ 4:00 a.m.	No precipitation, pavement temperature (PT) = 31º	21 gallons per lane mile, liquid, anti-icing	Both were clear and dry
1/11/06 @ 4:00 a.m.	No precipitation, PT = 27º	18 gallons per lane mile, liquid, anti-icing	Clear and dry
1/19/06 @ 4:00 a.m.	No precipitation, PT = 24º	25 gallons per lane mile, liquid, anti-icing	No report
1/22/06 @ 11:00 a.m.	Freezing rain and sleet, PT = 29º	Solid chemicals applied twice, at 200 lbs per lane mile each time	Test site was clear and wet, and was not slippery
1/26/06 @ 4:00 a.m.	No precipitation, PT = 17º	27 gallons per lane mile, liquid, anti-icing	Clear and dry
1/30/06 @ 4:00 a.m.	No precipitation, PT = 21º	23 gallons per lane mile, liquid, anti-icing	Clear and dry
2/9/06 @ 8:00 a.m.	Wet, heavy snow, about 2-4 inches, PT =18º	3 applications of solid chemicals at 200 lbs per lane mile each time	Slush present on test site, but it remained clear longer than control site.
2/10/06 @ 7:30 a.m.	Snow, air temperature = 22º	2 applications of solid chemicals at 400 lbs per lane mile each time	Slush present on both test and control site. No differences between the two were noted
2/20/06 @ 7:00 p.m.	Normal snow, PT = 17º	1 application of solid chemicals at 200 lbs per lane mile	Test site was clear and wet. Accumulation of snow on test site was delayed in comparison to control
2/21/06 @ 6:00 p.m.	Wet snow, 1-3 inches, PT =20º	1 application of solid chemicals at 200 lbs per lane mile (pre-wet)	Test site was clear and wet. Able to be kept that way with less chemical than control sections.
2/22/06 @ 5:45 p.m.	Snow, 1-2 inches, PT= 27º	1 application of solid chemicals at 200 lbs per lane mile (pre-wet)	Test site clear and wet, and "holding" longer than control sections.

Table 3: Field Data for the Blatnik Bridge

Buffalo Creek Bridge, New York and Davis Bridge, New York

For both New York structures selected to partake in this study, the New York DOT has decided that they will produce their own internal reports. Early results from the two bridges indicated that the overlay was meeting their specified goal "to evaluate the use of thin polymer overlays to extend the service of life of structural concrete decks. Secondary goals are product cost, ease of installation, material availability, and riding surface wear."

The limited data provided from early in the winter suggest that the overlay on the two New York bridges performed well. In particular, events in early December when some light snow storms (in the range of 2 to 4 inches of snow) occurred, indicated that the overlay treated parts of the bridges stayed clear of sticking snow, and was not slick. Further results will be presented in the New York DOT report.

Wolf River Bridge, Crandon, Wisconsin

This bridge has had the overlay in place for three consecutive winters, and thus provides a longer history of operation than the other structures considered in this report. While the data for this structure is primarily anecdotal, it nonetheless has significant value. Typical treatments of the whole structure require 8 to 10 gallons of anti-icing liquid at most. There are no problems with slickness unless "way too much" liquid is applied (it is surmised that this means significantly more than the 8-10 gallons on the whole structure).

In typical winter weather, a single treatment or application of liquid has been effective against frost for two to three weeks. This is for a bridge that prior to the overlay being placed almost always exhibited frost if conditions were right. Thus, by a single application at a regular time of day every two to three weeks, the agency charged with maintaining the bridge has avoided early morning phone calls from local law enforcement officials saying "the bridge is icy" for the three winters since the overlay was installed. This, of course, represents a significant savings in overtime.

In addition to these savings in labor and equipment, there have been no wintertime accidents on the bridge since it was treated with the overlay in summer 2003. This compares with 3 to 4 accidents each winter prior to treatment. Two comments by the person charged with maintenance for the bridge (Ron Cole) indicate the value of the overlay. In the first instance he noted: "When the sun went down in the winter, the bridge used to freeze up – it just doesn't do that anymore." And as a summative comment on the overlay he noted" "It just does its job real well."

Implications of Observations

Four important implications are clear from the field observations reported from the 2005-06 winter season. In making these observations, the author has attempted to take a prudent and conservative approach, noting that the results are based on only one winter of testing for the bridges discussed in detail herein. Given how winters vary not only from location to location but also from year to year, it would be foolhardy to attempt to generalize the results from one season's testing to all winters in all possible winter weather locations. Notwithstanding these cautions, the following implications are noteworthy.

First, the SafeLane™ overlay caused no problems with winter maintenance operations. A particular concern here is that the overlay needs to be "charged" occasionally with liquid chemicals. As noted above, under certain circumstances, these liquids may, in the process of drying out, create a slick or slippery condition. There were no reports of such slickness occurring on any of the test sections. It is noteworthy that in some cases, again as noted above, liquids were applied when temperatures were such that slickness might well have occurred. On the basis of these observations, it would appear, that for the chemicals used in the 2005-06 season (primarily sodium chloride brine and magnesium chloride brine) there is not a problem of slickness associated with their placement.

Second, in a number of instances the SafeLane™ treated test sections were observed to be clear of snow and/or ice when control sections had snow or ice on them. This observation is well documented for both the Blatnik installation and the Ironwood Bridge. In addition, anecdotal reports for both the Ironwood Bridge and for the McLean Bridge in Texas indicate that the test sections in both cases performed significantly better than the control sections. Specifically, the test sections remained clear of snow or ice under weather conditions when snow and ice were accumulating on control sections, and further, in the case of the McLean Bridge, were causing accidents.

Third, in cases where sufficient snow was falling that some accumulation was inevitable, it was observed that the SafeLane™ treated test sections could be kept clear with lower applications of chemicals, and that these applications prevented bonding as well as, and in some cases better than, the larger applications on the control sections. Specifically, for the Ironwood Bridge, there were a number of occasions on which lower applications of chemicals were made to the test sections and suitable response was obtained. This occurred with two applications on December 14, 2005 and two applications on February 12, 2006.

These latter two points are very significant for winter maintenance in two ways. First, one of two primary goals in winter maintenance is to ensure mobility on the highway during and after a storm. The SafeLane™ treated test sections did this on numerous occasions when untreated segments of highway allowed accumulations of snow and/or ice to occur. For example, for 11 in-storm treatments at the Ironwood Bridge, (as opposed to anti-icing pre-treatments), the test section was clear of snow and ice without treatment for 10 of the 11 treatments. That means that traffic on the test section was unhindered by snow on the road for almost all the time. In contrast, for 10 of the 11 treatments the control section was reported as having either snow, slush or ice present. No report was given for the 11th treatment occasion.

Further, the superior performance of the test section was achieved with significantly less chemicals than those applied to the control sections. Again, from the Ironwood Bridge, the test section for all reported treatments had liquid applied at the same rate as the control section, but while the control section had solid chemicals applied in total at a rate of 2,520 lbs per lane mile, the test section had chemicals applied at a rate of 1,260 lbs per lane mile. Thus superior performance was achieved on the test section with only 50% of the chemical used on the control section. This is a significant saving of chemicals, and will have both cost benefits and environmental benefits.

The final major implication of the reported observations from the 2005-06 winter concerns safety, the other primary goal of winter maintenance. In this regard, reports from the McLean Bridge reported significant safety benefits during one winter event (specifically no accidents on the test section, while there were numerous accidents occurring elsewhere on the road). Of course, crashes occur in unpredictable patterns, so this observation in and of itself is not conclusive. However, it is bolstered by season-long observations at two other sites. At the Blatnik Bridge, which had observed about 20 crashes over the previous four years, no crashes were observed. At the Interstate exit in Brecksville Ohio, it was noted that fewer crashes occurred on the exit this winter than in previous winters. For statistically significant results, safety studies need to be conducted over a number of years, but these observations suggest that the improved performance of the overlay under winter conditions discussed above does indeed translate into safety improvements for the traveling public.

Conclusions

The SafeLane™ overlay system was applied to a number of sites for evaluation during the 2005-06 winter season. Observations at these sites allow the following preliminary conclusions to be made:

- ✓ The SafeLane™ overlay did not cause any problems with winter maintenance. In particular, no concerns with chemical slickness or slipperiness arose even though chemical was applied on some occasions under weather conditions where such slickness might have been a concern.
- ✓ Test sections remained clear of snow or ice under weather conditions when snow and ice were accumulating on control sections. In some circumstances these accumulations on control sections were sufficient to contribute to crashes.
- ✓ When accumulation did occur on the test sections, bonding of snow and ice to the pavement was not observed, and the accumulation could be controlled by plowing and application of chemicals. Further, the quantity of chemicals needed to obtain these good conditions was less on the test sections than on the control sections.
- ✓ One implication of the above two points is that SafeLane™ treated segments of the highway infrastructure maintained mobility for longer, and could be returned to full mobility more easily than non-treated sections.
- ✓ A second implication of these two points is that bare pavement conditions could be maintained on the test sections with approximately 50% of the chemicals applied to control sections.
- ✓ Finally, while the data are preliminary, there is evidence that the improved performance of the SafeLane™ overlay under winter conditions discussed above does indeed translate into safety improvements for the traveling public.

Thus in conclusion it appears, on the basis of the observations made during the 2005-06 winter that the SafeLane™ overlay provides benefits in both safety and mobility under winter storm conditions, and that those benefits may be attained with less chemical than would be needed for highway segments without the overlay.

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