REPORT 2014 - 02

VERMONT AGENCY OF TRANSPORTATION

Materials & Research Section
Research Report

ENNIS PAINT, INC. TYREGRIP HIGH FRICTION

SURFACE SYSTEM

Report 2014 – 02

March 2014

Ennis Paint, Inc. Tyregrip High Friction Surface System

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Reporting on Work Plan 2009-R-02

STATE OF VERMONT
AGENCY OF TRANSPORTATION

MATERIALS & RESEARCH SECTION

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16. Abstract

Unpredictable climatic conditions paired with the varying topography in Vermont have often resulted in dangerous roadway conditions. Statistics show that many fatalities occur in rural environments like Vermont. Federal Highway Administration (FHWA) has developed many strategies to address this issue. One experimental treatment that has been used is a high friction overlay known as Tyregrip. Key personnel at VTrans chose to evaluate the treatment at a high crash location along VT Route 9 in the town of Woodford, Vermont in 2009.

The treatment was placed on the westbound lane and shoulder at approximately MM 3.0, on October 8, 2009. Shortly after the installation Research personnel observed failures in the treatment, which required attention. In November 2009, the damaged sections were repaired by Ennis Paint, Inc and Total Highway Maintenance (THM). In July 2010, significant cracking and delamination failures were observed. It was determined a repair was needed however due to limited promoting weather conditions and inflexible schedules the repair was planned for the 2011 construction season. After an on-site meeting with VTrans Pavement Management, Materials and Research, and District 1 personnel it was determined that, the ideal repair would be to mill up and repave the section with asphalt pavement.

Based on the limited evaluation period it is recommended that the treatment be installed at a different location in Vermont. The new trial location would preferably be on new pavement, where underlying cracking and/or distresses are not of concern to the performance of the treatment.

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ABSTRACT

Unpredictable climatic conditions paired with the varying topography in Vermont have often resulted in dangerous roadway conditions. Statistics show that many fatalities occur in rural environments like Vermont. Federal Highway Administration (FHWA) has developed many strategies to address this issue. One experimental treatment that has been used is a high friction overlay known as Tyregrip. Key personnel at VTrans chose to evaluate the treatment at a high crash location along VT Route 9 in the town of Woodford, Vermont in 2009.

The treatment was placed on the westbound lane and shoulder at approximately MM 3.0, on October 8, 2009. Shortly after the installation, Research personnel observed failures in the treatment, which required attention. In November 2009, the damaged sections were repaired by Ennis Paint, Inc and Total Highway Maintenance (THM). In July 2010, significant cracking and delamination failures were observed. It was determined a repair was needed; however, due to prevailing weather conditions and inflexible schedules, the repair was planned for the 2011 construction season. After an on-site meeting with VTrans Pavement Management, Materials and Research, and District 1 personnel it was determined that, the ideal repair would be to mill up and repave the section with asphalt pavement.

Based on the limited evaluation period it is recommended that the treatment be installed at a different location in Vermont. The new trial location would preferably be on new pavement, where underlying cracking and/or distresses are not of concern to the performance of the treatment.

INTRODUCTION

The Vermont roadway network has an abundance of curves and steep inclines due to the varying topographic nature of the state. This coupled with many rural roads and inclement weather can create hazardous roadway conditions for all motorists. Injuries and fatalities along these dangerous locations are problematic not only in Vermont but nationwide. According to the, "Guide for Reducing Collisions on Horizontal Curves," 75 percent of all fatal crashes occur in rural areas and 25 percent are at curves. [FHWA] Many fatalities are from run-off-the road crashes involving single vehicles. In an effort to address these statistics, the FHWA developed various strategies for state transportation agencies to use as alternative countermeasures in an effort to decrease crashes. Basic strategies incorporate various pavement markings and other traffic control devices. Due to winter maintenance practices in Vermont, these basic treatments are often damaged and are not sufficient in many locations. Subsequently, innovative and experimental treatments are recommended, such as high friction surface overlays. (*1*)

The purpose of this evaluation was to apply an experimental roadway treatment manufactured by Ennis Paint, Inc. known as Tyregrip, a high friction safety overlay. This system consists of a highly modified exothermic epoxy resin two-part binder and calcinated bauxite aggregate. (*2*) Crash data prior to and following installation, as well as skid testing, was used to evaluate the effectiveness of the treatment in both clear and inclement conditions.

PROJECT LOCATION AND SUMMARY

The experimental feature was applied to the existing roadway surface within the westbound lane of VT Route 9 in the Town of Woodford at approximately MM 3.0. The roadway alignment is curved with a steep decline at a grade of 8% as shown in Figure 1, only further compounding the problems associated with wet and slippery roads. The estimated longitudinal length of the application is approximately 266' with a roadway width of 17', encompassing both the travel lane and shoulder, for a total area of approximately 4,522 ft2.

The location was selected due to a high rate of accidents reported by Highway Safety and Design personnel and local police enforcement. The VTrans' Crash Reporting System documented 13 injuries and 4 fatalities from mile marker (MM) 2.78 to MM 3.18 from 2000 to 2008 along this roadway segment. In addition, according to Mike Marvin from the Shaftsbury State Police Station, numerous accidents and incidents have been documented all of which are not currently reported within the VTrans' Crash Reporting System. Mike Marvin reported an increase of accidents during the winter months due to the accumulation of ice and snow resulting in a loss of traction. (*3*)

Figure 1 Overview of the site pre-construction

MATERIAL DESCRIPTION

Tyregrip was developed in the United Kingdom (UK) by the Greater London Council (GLC) and is licensed and marketed by Ennis Paint, Inc. of Ennis, Texas. Tyregrip is a patented pavement overlay composed of a highly modified epoxy two part resin binder and surfaced with calcinated bauxite, a reported extremely hard aggregate that retains sharp edges and facets over time. This mixture results in a minimum Polished Stone Value (PSV) of 70% for performance durability with high friction properties on wet or dry pavements. (*2*)

INSTALLATION

Manufacturer's Installation Requirements

In accordance with the manufacturers' instructions, the two-part modified base epoxy adheres to dry surfaces. The ambient surface temperature should be between 48ºF and 110ºF. All surfaces were cleaned by use of mechanical sweepers so that the surface was clean, dry, and free of all dust, oil, debris and any other material that might interfere with the bond between the epoxy binder material and existing surfaces. All existing pavement markings were removed and all joints and cracks greater than ¼" filled before placement. The treatment can be applied by either hand or mechanical mixing of the epoxy binder. Due to the physical nature of the site, the manufacturer suggests that the mechanical application be used. This method applies the epoxy by a truck mounted application machine onto the pavement section of widths up to 8 feet wide at a minimum coverage rate of 15 gallons per minute with a uniform thickness of 60 mils. Immediately following, the aggregate should be spread at a rate of 13 lbs +/- 2 lbs per square yard up to 8 foot widths. Compaction is not required. At an ambient temperature of 75ºF, the curing time is approximately 2 hours. Any excess aggregate should be removed by hand or suction sweeping before the pavement section is reopened to traffic. (*2*)

In an effort to highlight the new application method, manufacturer representatives chose to use the mechanized method. Due to mechanical difficulties during the initial installation, the hand method was eventually used to place the material. Although the aggregate was hand placed, the epoxy base binder was mixed mechanically and then poured into buckets and applied to the road surface and spread with squeegees. Both methods are summarized herein.

Hand Placement

The two parts of the epoxy base were mixed using a proportion ratio of 50:50 +/- 4% by weight using a low speed high torque drill fitted with a helical stirrer. Once properly proportioned, the mixed components were hand applied onto the pavement surface and spread uniformly using a serrated edged squeegee at a coverage rate of 2.5 lb +/- 0.5 per square yard. The aggregate was applied at a rate of 13 lb +/- 2 lbs per square yard immediately on top of the epoxy base binder. Once the overlay cures, the surface is swept with a vacuum truck to retrieve excess aggregate left over from the application. (*2*)

Mechanical Placement

The two parts of the epoxy base were mixed using the same proportional ratio of 50:50 +/- 4% by weight; however, it was heated to 112-115ºF and mixed using a four gun apparatus, which were located on the applicator truck. Once mixed, the epoxy was distributed onto the pavement surface through a series of eight hoses, which are attached to the mixing guns at a coverage rate of 15 gal/minute to achieve a uniform thickness of 60-70 mils. The aggregate is than spread directly onto the epoxy binder at a rate of 13 lb +/- 2 lbs per square yard. Once the overlay cures, the surface is swept with a vacuum truck to retrieve excess aggregate left over from the application. (*2*)

Application

As part of the grant, Ennis Paint, Inc. provided all material and labor costs at no cost to VTrans. All parties arrived to the site at approximately 8 AM on Thursday, October 8. Total Highway Maintenance (THM), a contractor from Cedar Hill, Texas installed the Tyregrip overlay. At the time of installation, THM was the only contractor in the United States with a truck mounted applicator system. The truck, hydraulically driven at speeds 0-3 mph during application, was capable of applying both the epoxy base binder as well as the aggregate. To account for varying lane widths, the truck was equipped with different sized spreader bars, which extrude the binder onto the pavement. For this application, Tyregrip was to be applied to both the westbound lane and adjacent shoulder. The contractor fitted the applicator truck with an 8.5-foot long spreader bar and planned to apply the friction overlay in two passes.

The application process shown in Figure 2 and Figure 3 began at 10:49 am at which time, the pavement temperature was 51ºF and the air temperature was 52ºF. The operation was halted by the contractor after laying 60 feet down. The epoxy did not appear to be curing correctly and the truck did not appear to be moving smoothly and at the necessary slow speed required for the application, presumably due to the steep grade of the hill. At this time, the contractor cleaned and changed several distribution hoses to meet proper application requirements. After several attempts, the contractor told Research personnel that they would not be able to correct the problems and decided to apply the overlay by hand.

Figure 2: Epoxy truck application

Figure 3: Truck application

Hand application commenced at 12:58 PM, at which time the pavement temperature was 65ºF and the air temperature was 54ºF. District forces offered to assist the contractor as many of them were quite familiar with the procedure since they had installed a similar overlay called Cargill SafeLane Overlay two years ago in a similar manner shown in Figure 4. This process went rather quickly. Epoxy was ejected from the guns on the truck into 5 gallon pails and then poured onto the pavement surface and spread using the serrated squeegees. The aggregate was shoveled into buckets, applied onto the epoxy binder and spread with push brooms to achieve a uniform thickness. It should be noted: though the contractor generally uses the truck for applications, they also use hand application methods and has done so for several years. The operation was completed at 3:00 PM shown in Figure 5. After the overlay cured at the surface, THM drove their vacuum truck over the surface to recover any loose aggregate.

Figure 4: Hand application

Figure 5: Completed application

At the conclusion of the day, the contractor decided that the 60 feet of mechanical applied material previously placed was not curing properly due to improper mixing ratios of the two-part epoxy and needed to be removed and replaced. They proceeded to scrape the material off the roadway. Some of the material remained on the roadway surface. To rectify the issue, the contractor returned on Monday, October 12 to repair this section.

On October 12, 2009, THM, District 1, and Research personnel were once again, onsite to complete the removal of the improperly placed overlay and the subsequent replacement of new overlay within the 60-foot by 8.5-foot section. The operation began at approximately 9:20 AM at which time the pavement temperature was 31ºF and the air temperature was 43ºF. The errant material was removed by grinding the existing surface and a minor portion of the underlying bituminous pavement. Loose materials remaining on the surface were removed with a sweeper shown in Figure 6.

Figure 6: Repair area, after grinding and sweeping

At 10:35 AM, reapplication of the material commenced, at which time the pavement temperature was 51ºF and the air temperature was 43ºF. The mechanized epoxy mixer mounted to the truck was not working properly; therefore, to ensure a proper mixing ratio of the components, the mixing was done by hand using a drill and 5-gallon buckets as shown in Figure 7. Temperatures of each bucket of epoxy were recorded, which are provided in Table 1. Epoxy sets quicker in smaller batches; therefore, to ensure proper placement and curing, the process had to move quickly. Figure 8 and Figure 9 shows some of the steps in the placement. The aggregate was applied to the epoxy and once again spread. The repair completed at 12:12 PM shown in Figure 10. To speed the curing process, THM used a torch to heat the overlay and finished at 12:45 PM. Any loose aggregate was collected by the vacuum truck after the overlay cured.

Figure 7: Mixing the epoxy

Table 1: Epoxy temperatures

Epoxy Temperatures		
Bucket	**Time**	**Temperature**
1st	11:34am	111ºF
3rd	11:40am	178ºF
5th	11:47am	110ºF
6th	11:53am	105ºF
7th	11:59am	91ºF
8th	12:05pm	80ºF
9th	12:10pm	82ºF

Figure 8: Pouring the epoxy

Figure 9: Spreading the aggregate

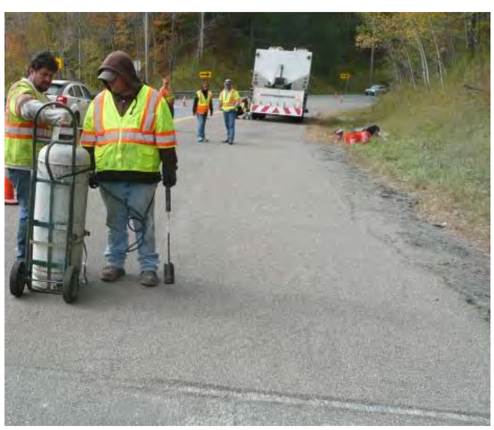

Figure 10: Completed repair

CRASH DATA

VTrans Highway Research Section has determined the subject stretch of highway in this study as a high crash location. For a highway section or intersection to be identified as a High Crash Location, two criteria must be satisfied:

- The location must have experienced five (5) or more crashes in a five year period, or the average of one (1) crash per year, and;
- The Actual/Critical ratio must be 1.000 or higher.

The crash data in the table in the appendix represents traffic accidents on US Route 9 approximately between MM 2.8 and MM 3.029. This crash data is between the years of 2006 and 2011. The data represents the number of crashes and fatalities in the three years prior to installation, as well as two years following. (*3*) In 2009 as well as 2011, no crashes were reported throughout this area. In the three years prior to installation, there were thirteen vehicle crashes, and in the three years following the installation there was only one crash. There were two fatalities in 2008 prior to the installation, but in the three years following installation, there have been no fatalities or injuries reported. (*3*)

PERFORMANCE AND OBSERVATIONS

During a routine visit on Tuesday, November 3, 2009, Research personnel noted some failures in the Tyregrip material. In the shoulder and near the shoulder in the westbound lane there were multiple spots where raveling seemed to have occurred. The underlying epoxy mix was apparent and caused some concern for the safety of motorists. The fear was that the visible epoxy surface would become slippery when wet and cause a potential safety hazard. Immediately following the inspection, Ennis Paint, Inc. was notified and asked about a solution. The damaged sections were repaired on Thursday, November 12, 2009. All associated costs were covered by Ennis Paint. Representatives from District 1 were on site for the repair and were satisfied with the repair. It appeared that no epoxy was visible and the concerns regarding the material being slippery in wet and dry conditions had been addressed.

During an inspection in July 2010, it was noted that the treatment had a significant amount of cracking. Some areas along the shoulder had delaminated from the underlying pavement. The product representative was contacted and a piece of the treatment was extracted by District personnel and sent to THM for analysis. Based on the condition of the overlay, it was determined that a repair would be necessary for optimum performance. Due to work schedules and limited ideal weather conditions, VTrans and the product representative jointly decided to postpone the repair until the following season. Research personnel requested an on-site meeting with District 1 and Pavement Management personnel on May 26, 2011 to discuss the condition of the treatment and future maintenance paving activities. Due to the performance and future paving projects it was determined that paving over the treatment in conjunction with a district-paving contract would be the best option for VTrans and roadway users. It was also decided to begin brainstorming different locations in the state to begin another trial with Tyregrip.

COST ANALYSIS

This research initiative was a joint effort between the VTrans' Highway Safety, the Design Section and the manufacturer, Ennis Paint, Inc. Ennis Paint, Inc. furnished all associated product relating to the patented system including the epoxy and calcinated bauxite aggregate. The manufacturer was responsible for the installation of the experimental feature and all associated labor costs. The Highway Safety and Design section supplied traffic control. Evaluation costs incurred were included in the Evaluation of Experimental Features budget within the Research Unit's program.

For future reference, Ennis Paint, Inc. quoted an approximate material cost of $14.64 per square yard. For this application, at a length of 266' and width of 17' this approximate to an approximate area of 503 square yards. Therefore, total material cost is approximately $7,370.000. With respect to the cost of installation, Ennis Paint, Inc. stated that a private contractor might charge approximately $26 per square yard for both the cost of materials and labor. Based on these figures, this application labor would cost approximately $5,700 for a total approximate project cost of $13,070. (2)

It is important to note that VTrans is under no current or future obligations to endorse or purchase this product. The intent of this experimental application was solely to examine product performance over time with respect to accident reduction and durability.

SUMMARY AND RECOMMENDATIONS

Tyregrip, a high friction overlay, was placed on the westbound lane and shoulder of VT Route 9 in the Town of Woodford at approximately MM 3.0, on October 8, 2009. Shortly after the installation, Research personnel started to observe failures in the treatment, which required attention. In November 2009, the damaged sections were repaired by Ennis Paint, Inc. In July 2010, the treatment was observed to contain significant cracking and delamination failures. It was determined a repair was needed however due to limited promoting weather conditions and inflexible schedules the repair was planned for the 2011 construction season. After an on-site meeting with VTrans Pavement Management, Materials and Research, and District 1 personnel it was determined, the ideal repair would be to mill up and repave the section with asphalt pavement.

Prior to placing the overlay, the crash data showed that the average number of crashes per year were over two per year. After placement, the number of crashes over a three-year period was one. The overlay did show some promise in reducing crashes in the short time it was in use.

Based on the limited evaluation period, and its briefly demonstrated potential to reduce crashes, it is suggested that the treatment be installed at an alternate high crash location in Vermont. The new trial location would preferably be on new pavement or a section of pavement that has shown long-term durability. This product did not perform well where underlying cracking and/or distresses within the pavement structure is evident. Further, upon the advent of a new trial, it is recommended that every measure be taken by the applicator and the Agency, to ensure a mechanical mixing and application of the overlay. This would help limit the extraneous factors beyond that of a controlled application and the specified characteristics of the material, so a proper evaluation of the overlay can be made.

APPENDIX A

Crash Data from 2004 to October 8, 2009 - MM 2.8-3.029

Mile Marker	Date	Time	Weather	Accumulation (Inches)	Fog?	Contributing Circumstances	Direction of Collision	Number of Injuries	Number of fatalities	Direction
2.81	7/31/2007	5:35	Clear	N/A	N/A	Failure to keep in proper lane	Single Vehicle Crash	0	0	W
2.83	4/16/2008	13:41	Cloudy	0	N	No improper driving, operating vehicle in erratic, reckless, careless negligent or aggressive manner, disregarded traffic signs, signals, road markings	Head On	1	2	E
2.88	6/30/2006	22:07	Clear	N/A	N/A	No improper driving. Under the influence of medication/drugs/alcohol failure to keep in proper lane	Head On	5	0	E
2.88	2/14/2007	0:32	Blowing sand, soil, dirt, snow	N/A	N/A	Driving too fast for conditions	Single Vehicle Crash	0	0	W
2.88	6/30/2006	22:07	Clear	N/A	N/A	No improper driving, Under the influence of medication/drugs/alcohol failure to keep in proper lane.	Head On	5	0	E
2.88	4/22/2008	16:45	Clear	0	N	Driving too fast for conditions, failure to keep in proper lane	Single Vehicle Crash	1	0	
2.98	5/4/2006	6:20	Fog, Smog, Smoke	N/A	N/A	Exceeding authorized speed limit, driving too fast for conditions	Single Vehicle Crash	0	0	W
2.98	4/5/2006	6:20	Fog, Smog, Smoke	N/A	N/A	Exceeding authorized speed limit, driving too fast for conditions	Single Vehicle Crash	0	0	W
2.99	2/28/2006	21:00	Cloudy	N/A	N/A	Failure to keep in proper lane, driving too fast for conditions	Single Vehicle Crash	0	0	W
3	1/15/2004	14:57	Clear	N/A	N/A	Driving too fast for conditions	Single Vehicle Crash	0	0	E
3	12/2/2005	6:20	Snow	N/A	N/A	Driving too fast for conditions, failure to keep in proper lane	Single Vehicle Crash	0	0	W
3.01	8/4/2007	13:20	Clear	N/A	N/A	Failure to keep in proper lane	Single Vehicle Crash	1	0	N/A
3.02	8/27/2006	19:44	Rain	N/A	N/A	Exceeding authorized speed limit, driving too fast for conditions	Single Vehicle Crash	1	0	E

Crash Data from October 9, 2009 to 2011
MM 2.8-3.029

Mile Marker	Date	Time	Weather	Accumulation (Inches)	Fog?	Contributing Circumstances	Direction of Collision	Number of Injuries	Number of fatalities	Direction
2.98	8/20/2010	20:08	Clear	N/A	N/A	Swerving or avoiding due to wind, vehicle, object, non-motorist in roadway etc.	Single Vehicle Crash	0	0	E

REFERENCES

1. Federal Highway Administration. “Low-Cost Treatments for Horizontal Curve Safety.” December 2006.

2. Ennis Paint, Inc. *TyreGrip® by Ennis Paint, Inc.* *http://www.ennisflint.com/Products/High-Friction-Surfacing-Colorized-Lanes/Tyregrip.*

3. Highway Research Section. “*Highway Research Data Electronic Publications*.” Vermont Agency of Transportation. 2012. http://www.aot.state.vt.us/planning/documents/highresearch/publications/pub.htm.

4. Policy, Planning and Intermodal Development Division Highway Research Section. “*High Crash Location Report: Sections and Intersections.*” Vermont Agency of Transportation. Years 2006-2011. Pg 53. http://www.aot.state.vt.us/planning/documents/highresearch/publications/2006-2010%20High%20Crash%20Location%20Report.pdf

WORK PLAN

Prepared By: Wendy Kipp
Date: 6-25-2009

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH SECTION

WORK PLAN FOR
RESEARCH INVESTIGATION
Ennis Paint, Inc. Tyregrip High Friction Surface System
Work Plan No. WP 2009-2

OBJECTIVE OF STUDY:

The Vermont roadway network has an abundance of curves and steep inclines due to the varying topographic nature of the state. This coupled with many rural roads and inclement weather can create hazardous roadway conditions for all motorists. Injuries and fatalities along these dangerous locations are problematic not only in Vermont but nationwide. According to the, "Guide for Reducing Collisions on Horizontal Curves," 75 percent of all fatal crashes occur in rural areas and 25 percent are at curves. [FHWA] Many fatalities are from run-off-the road crashes involving single vehicles. In an effort to combat these disheartening statistics, the Federal Highway Administration (FHWA) developed various strategies for state transportation agencies to use as alternative countermeasures in an effort to decrease crashes. Basic strategies incorporate various pavement markings and other traffic control devices. However, in Vermont, due to winter maintenance practices, these basic treatments are often damaged during winter months and are not sufficient in many locations. Subsequently, innovative and experimental treatments are recommended, such as high friction surface overlays.

The purpose of this evaluation is to apply an experimental roadway treatment manufactured by Ennis Paint, Inc. known as Tyregrip, a high friction safety overlay. This system consists of a highly modified exothermic epoxy resin two-part binder that is top dressed with a calcinated bauxite aggregate. Crash data prior to and following installation, as well as skid testing, will be used to evaluate the effectiveness of the treatment with regards to both clear and inclement conditions.

LOCATION:

The experimental feature is to be applied to the existing roadway surface within the west bound lane of VT Route 9 in the Town of Woodford at approximately MM 3.0. The roadway alignment is curved with a steep decline at a grade of 8% as shown in Figure 11, only further compounding the problems associated with wet and slippery roads. The estimated longitudinal length of the application is approximately 266' with a roadway width of 17', encompassing both the travel lane and shoulder, for a total area of approximately 4522 ft2.

Figure 11: Overview of site

This location was selected for this project due to a high rate of accidents reported by Highway Safety and Design personnel and local police enforcement. The VTrans' Crash Reporting System documented 13 injuries and 4 fatalities from mile marker (MM) 2.78 to MM 3.18 from 2000 to 2008 along this roadway segment. In addition, according to Mike Marvin from the Shaftsbury State Police Station, numerous accidents and incidents have been documented all of which are not currently reported within the VTrans's Crash Reporting System. Mike Marvin reported an increase of accidents during the winter months due to the accumulation of ice and snow resulting in a loss of traction.

MATERIAL:

Tyregrip was developed in the United Kingdom (UK) by the Greater London Council (GLC) and is licensed and marketed by Ennis Paint, Inc. of Ennis, Texas. Tyregrip is a patented pavement overlay composed of a highly modified epoxy two part resin binder and surfaced with calcined bauxite, a reported extremely hard aggregate that retains sharp edges and facets over time. This mixture results in a minimum Polished Stone Value (PSV) of 70% for performance durability with high friction properties on wet or dry pavements.

INSTALLATION REQUIREMENTS:

In accordance with the manufacturers' instructions, the two-part modified base epoxy shall to a dry surface. The ambient surface temperature should be between 48ºF and 110ºF. All surfaces shall be cleaned by use of mechanical sweepers so that the surface is clean, dry, and free of all dust, oil, debris and any other material that might interfere with the bond between the epoxy binder material and existing surfaces. Surfaces may need to be washed with a mild detergent, rinsed, and dried using a hot compressed air lance. All existing pavement markings shall be removed and all joints and cracks greater than ¼" filled before placement. The treatment can be applied by either hand mixing or mechanical mixing of the epoxy binder. Due to the physical nature of the site, the manufacturer suggests that the mechanical application be used. This method applies the epoxy by a truck mounted application machine onto the pavement section of widths up to 8 feet wide at a minimum coverage rate of 15 gallons per minute with a uniform thickness of 60 mils. Immediately following, the aggregate should be spread at a rate of 13 lbs +/- 2 lbs per square yard up to 8 foot widths. Compaction is not required. At an ambient temperature of 75ºF, the curing time is approximately 2 hours. Any excess aggregate should be removed by hand or suction sweeping before the pavement section is reopened to traffic.

COST:

This research initiative is to be a joint effort between the VTrans' Highway Safety and Design Section and manufacturer, Ennis Paint, Inc. Ennis Paint, Inc. is to furnish all associated product relating to the patented system including the epoxy and calcined bauxite aggregate. The manufacturer will also be responsible for the installation of the experimental feature and all associated labor costs. The Highway Safety and Design section is to supply traffic control.

For future reference, Ennis Paint quoted an approximate material cost of $14.64 per square yard. For this application, at a length of 266' and width of 17' this approximate to an approximate area of 503 square yards. Therefore total material cost is approximately $7370. With respect to the cost of installation, Ennis Paint stated that a private contractor may charge somewhere in the vicinity of $26 per square yard for both the cost of materials and labor. Therefore for this application, labor would cost approximately $5700 for a total approximate project cost of $13,070.

It is important to note that VTrans is under no current or future obligations to endorse or purchase this product. The intent of this experimental application is solely to examine product performance over time with respect to accident reduction and durability.

SURVEILLANCE AND TESTING:

In an effort to reduce vehicular accidents due to roadway design, Research personnel will assess the roadway surface overlay in the following manner:

1. Research personnel will monitor and observe all installation activities. This may include any preparation activities as well as application efforts. The time for installation and return of traffic is to be recorded.
2. An annual collection of IRI (international roughness index) is to be collected through the Pavement Management Section.
3. All crash data from 2000 to the present day and throughout the study period is to be collected from the Traffic Research Section and local police records.
4. Visual inspections of the roadway surface, prior to and following application, are to be conducted annually to examine any potential product delamination following application.
5. Two 1' by 1' squares are to be delineated on the surface of the experimental substrate through the use of traffic paint following installation. One is to be identified within a wheel path and one is not to be located in a wheel path. Photographs are to be taken on

an annual basis and compared to previous years to determine any loss of aggregate due to vehicle tires or wintertime maintenance activities.

6. Photographs of the overall site are to be collected on an annual basis and any other pertinent information is to be recorded.
7. If feasible, the Standard Method of Test for Frictional Properties of Paved Surfaces Using a Full-Scale Tire (AASHTO T 242-96) is to be performed at several intervals during the experiment. In correlation with this test, the Standard Method of Test for Surface Frictional Properties using the British Pendulum Tester (AASHTO T 278-90) will be utilized to test skid resistance. Five swings per test will be conducted and results averaged to produce a British Pendulum Number (BPN) that may be used to determine the relative effects of skid resistance materials. The BPN will be compared each year to monitor any loss in skid resistance over time.
8. Ennis Paint will be requested to supply a representative sample of the parent aggregate material for testing in accordance with ASTM C 131-06, "Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine." Mass lost through this test method will be compared to other aggregates throughout the state.

DURATION OF THE STUDY:

The duration of this study will be no more than three years or until final conclusions can be drawn from the observations and results from data collection.

REPORTS:

An initial report will be prepared to include the installation of the materials and preliminary observations, with a subsequent final report at the conclusion of the study. Interim reports will be prepared and submitted as needed. These reports will be authored by Research staff.

Agency of Transportation Reviewed By:
Materials and Research Section

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William Ahearn P.E.
Materials and Research Engineer
Date:

REFERENCES:

Federal Highway Administration. “Low-Cost Treatments for Horizontal Curve Safety.” December 2006.