REPORT 2014 - 15

VERMONT AGENCY OF TRANSPORTATION

Research and Development Section
Research Report

AEXCEL ROADZILLA™ METHYL METHACRYLATE
PAVEMENT MARKING

Report 2014 – 15

December 2014

Aexcel Roadzilla™ Methyl Methacrylate Pavement Marking

Final Report 2014 – 15

December, 2014

Reporting on Work Plan 2009-R-1

STATE OF VERMONT
AGENCY OF TRANSPORTATION

RESEARCH & DEVELOPMENT SECTION

BRIAN R. SEARLES, SECRETARY OF TRANSPORTATION
CHRIS COLE, DIRECTOR OF POLICY, PLANNING AND INTERMODAL DEVELOPMENT
JOE SEGALE, P.E./PTP, PLANNING, POLICY & RESEARCH
WILLIAM E. AHEARN, P.E., RESEARCH & DEVELOPMENT

Prepared By:

Elise Coolbeth, Research Intern
Wendy Ellis, Research Technician

Reviewed By:

William E. Ahearn, P.E.,
Research Managing Engineer

Date: December 19, 2014

The information contained in this report was compiled for the use of the Vermont Agency of Transportation (VTrans). Conclusions and recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Agency policy. This report does not constitute a standard, specification, or regulation. VTrans assumes no liability for its contents or the use thereof.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
2014-15	- - -	- - -

4. Title and Subtitle Aexcel Roadzilla™ Methyl Methacrylate Pavement Marking	5. Report Date DECEMBER 2014 6. Performing Organization Code
7. Author(s) Elise Coolbeth Wendy Ellis	8. Performing Organization Report No. 2014-15
9. Performing Organization Name and Address Vermont Agency of Transportation Materials and Research Section 1 National Life Drive National Life Building Montpelier, VT 05633-5001	10. Work Unit No. 11. Contract or Grant No. 2009-R-01
12. Sponsoring Agency Name and Address Federal Highway Administration Division Office Federal Building Montpelier, VT 05602	13. Type of Report and Period Covered Final Report 2010 - 2013 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. The following report outlines the observations concerning the second application of an experimental pavement marking, known as Aexcel Roadzilla™ Methyl Methacrylate, with respect to long line application. In addition, the report contains information pertaining to field data collection to assess the luminance, durability, and the ability to uphold the retroreflectivity requirements over time.

The Aexcel Roadzilla™ Methyl Methacrylate was applied on the Chester Bridge #49 deck replacement BHF-ST 0134 (31) project, located along VT Route 11 at approximately mile marker (MM) 5.7 by the manufacturer, Aexcel Corporation of Mentor, Ohio. The rolled beam bridge structure has approximately an 82'-0" span. A total of 34 readings were taken on both the white edge lines and yellow centerlines on the concrete surface. On the bituminous concrete bridge approaches, 18 readings were taken on the white edge lines and 12 readings were taken on the yellow centerlines. Following the placement of the markings, retroreflectivity and wear readings were collected using uniform methods. Retroreflectivity readings were taken on each line (white edge, white skip, yellow edge) at five-foot intervals on both the bare concrete bridge deck surface and bituminous concrete bridge approaches using the LTL 2000 Retroreflectometer. Readings were collected four times over the course of the first year of the evaluation. At the fourth site visit, it was determined that due to the poor performance of the yellow centerline, it needed to be reapplied. All readings were taken after the reapplication of the yellow. The first year there were losses of retroreflectivity of 83% of the white on concrete and 93% of the white on asphalt. For the first application of the yellow markings, there was a loss of 89% on concrete and 94% on asphalt. For the reapplication, the yellow markings had losses of 92% on the concrete and 81% on the asphalt. The following report summarizes the application, performance and observations.

17. Key Words	18. Distribution Statement
Roadzilla™, Methyl Methacrylate, Pavement Markings	No Restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. Pages	22. Price
- - -	- - -		- - -

Form DOT F1700.7 (8-72) **Reproduction of completed pages authorized**

TABLE OF CONTENTS

ABSTRACT

Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. The following report outlines the observations concerning the second application of an experimental pavement marking, known as Aexcel Roadzilla™ Methyl Methacrylate, with respect to long line application. In addition, the report contains information pertaining to field data collection to assess the luminance, durability, and the ability to uphold the retroreflectivity requirements over time.

The Aexcel Roadzilla™ Methyl Methacrylate was applied on the Chester Bridge #49 deck replacement BHF-ST 0134 (31) project, located along VT Route 11 at approximately mile marker (MM) 5.7 by the manufacturer, Aexcel Corporation of Mentor, Ohio. The rolled beam bridge structure has approximately an 82’-0” span. A total of 34 readings were taken on both the white edge lines and yellow centerlines on the concrete surface. On the bituminous concrete bridge approaches, 18 readings were taken on the white edge lines and 12 readings were taken on the yellow centerlines. Following the placement of the markings, retroreflectivity and wear readings were collected using uniform methods. Retroreflectivity readings were taken on each line (white edge, white skip, yellow edge) at five-foot intervals on both the bare concrete bridge deck surface and bituminous concrete bridge approaches using the LTL 2000 Retroreflectometer. Readings were collected four times over the course of the first year of the evaluation. At the fourth site visit, it was determined that due to the poor performance of the yellow centerline, it needed to be reapplied. All readings were taken after the reapplication of the yellow. The first year there were losses of retroreflectivity of 83% of the white on concrete and 93% of the white on asphalt. For the first application of the yellow markings, there was a loss of 89% on concrete and 94% on asphalt. For the reapplication, the yellow markings had losses of 92% on the concrete and 81% on the asphalt. The following report summarizes the application, performance and observations.

The rapid deterioration of the MMA after the initial and second application does not support the use of this product as a durable marking without further modification.

INTRODUCTION

Pavement markings provide an important mean of communicating how a driver must use a roadway safely. Pavement markings must be capable of conveying information during inclement weather and evening hours when there may be little to no illumination from overhead lighting. However, traffic markings are often subject to abrasion from vehicle tires and winter maintenance practices as well as ultraviolet sunlight and fading pigments following application. These deterioration mechanisms result in a loss of binder and reflective elements. Durable markings are often applied to newly constructed pavements in the state of Vermont and restriped with waterborne paint when markings no longer adequately delineate the roadway. In accordance with both the 2006 and 2011 Standard Specification for Construction, "durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, polyurea paint and methyl-methacrylate." Each of the referenced markings, comprised of various elements, has displayed unique characteristics and varying life cycles (*1*).

The following report outlines and compares the final observations and data collection used to assess the retroreflectivity and durability over time of pavement markings using Roadzilla™ Methyl Methacrylate, manufactured by Aexcel Corporation.

PROJECT LOCATION SUMMARY

The Roadzilla™ Methyl Methacrylate (MMA) was applied on the Chester project, BHF-ST 0134 (31), in conjunction with the Bridge #49 bare bridge deck replacement project located along VT Route 11 at approximately mile marker (MM) 5.7 in Chester, Vermont by the manufacturer, Aexcel Corporation of Mentor, Ohio. The rolled beam bridge structure has an approximate span of 82'-0", with no alignment issues. The average annual daily traffic (AADT) is 3,900. This is considered a moderate to low AADT for Vermont. There is a District #2 maintenance garage located near the bridge (*2*).

MATERIAL DESCRIPTION

Binder

According to the manufacturer, Roadzilla™ MMA Pavement Marking Material is a durable and versatile two-component polymer pavement marking system that improves visibility and motorist safety under both wet and dry conditions. Common applications include lane lines, edge lines, channelizing lines, gore markings, symbols, and legends. The two component system reportedly has exceptional adhesion characteristics due to the reactive resin produced by Evonik Industries. The system is chemically activated without heating, allowing the product to be applied at colder temperatures. It is catalyzed at 2% with benzoyl peroxide and applied as a structural marking that provides wet-night reflectivity. With the addition of reflective glass beads, the product provides excellent retroreflectivity under normal conditions and at night when it is raining. In addition, it provides excellent durability with a 3-5 year lifespan with minimum snowplow degradation. MMA may also be applied in a uniform manner consistent with other durable markings such as thermoplastic and polyurea however, the splatter effect of the Roadzilla™ MMA creates valleys in the application and is quoted to provide high visibility in wet and dry conditions (*3*).

In accordance with the manufacturer's specifications, the application surface should be dry with ambient air temperatures between 40˚F to 110˚F. The product may be applied using extrusion or spray methods by a self-propelled vehicle, pushcart, drag box and trowel. An application thickness of 90 mils is recommended for optimum performance (*3).*

Beads

The retroreflective beads used in conjunction with the MMA were Duralux and Megalux, both manufactured by Swarco America, Inc. of Columbia, TN. The manufacturer's description of the beads is summarized below. Duralux was developed to address the demand by transportation agencies worldwide for better performance and longer lasting visibility levels from their pavement markings. Swarco has responded with the development of a more durable glass bead that is better able to withstand today's traffic environment and provide higher reflectivity levels similar to high index glass beads (+1.90) throughout the lifetime of the road marking. Duralux glass beads are produced and properly coated in a wide range of sizes for use on all kinds of pavement marking binders including thermoplastic, MMA, epoxy, modified urethanes or other durable marking binders.(*4*)

Megalux beads are a state-of-art solution for consistent and optimal retroreflection for all kinds of binder systems. The physical properties of Megalux beads make them the first choice for brighter road markings. Megalux beads are characterized by crystal clear color, up to 95% roundness, increased daytime, nighttime and wet-night retroreflectivity, custom coatings for performance binders, excellent results in long-term reflectivity test, and uniform quality. Megalux glass beads are particularly suited for high performance road marking systems requiting optimum retroreflectivity and durability: thermoplastic, coldplastic, profiled, structured and 2-component marking systems. (*4*)

CONSTRUCTION

The exposed concrete bridge deck reached the 21-day concrete cure point on October 22, 2010. The bridge was immediately opened to traffic. The following day Aexcel Corporation primed the bridge deck surface with a clear acrylic solution which is used in cases where the MMA is being applied within 30 days after the deck is cured. After the primer had set, peroxide, the system adhesion activator, was added in a 5-gallon pail which initiated the chemical heating process. The amount of peroxide needed is dependent upon ambient conditions and the temperature of the application surface. Typically, 4 ounces of peroxide per gallon of MMA is used. Once the system was mixed, the markings were applied using a push handcart (see Figure 1.) A spiked bar on the handcart was used to create a splatter effect as the markings were applied to the bridge deck (see Figure 2.)

Figure 1: Push handcart applicator.

Figure 2: Spiked bar located on the handcart.

After the handcart passed, the optics were dropped onto the marking substrate (see Figure 3.) White markings typically provide higher retroreflective values due to the nature of pigments in white paint as compared to yellow. Because of this, the yellow markings used strictly Duralux beads whereas the white markings received a 50/50 blend of Duralux and Megalux beads. The white markings did not use strictly Duralux beads because these beads are much more expensive. Approximately 10 to 12 lbs of beads per gallon of MMA paint were applied. Figures 4-7 show the markings immediately following application (*2*).

Figure 3: Bead applicator.

Figure 4: White edgeline on concrete

Figure 5: White edgeline on asphalt

Figure 6: Yellow centerline on concrete

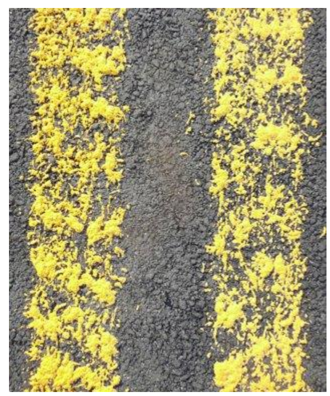

Figure 7: Yellow centerline on asphalt

PERFORMANCE AND OBSERVATIONS

The initial site visit was conducted on November 10, 18 days after the MMA markings were applied because the Delta Retroreflectometer LTL 2000 was being serviced and calibrated. Figure 8 below shows an overview of the markings.

Figure 8: Bridge overview looking eastbound.

Retroreflectivity readings were taken on each line (white edge and yellow centerline) on both eastbound and westbound sides with the LTL 2000 Retroreflectometer and the results are displayed in Table 1.

All markings were noted to be in excellent condition and far above the FHWA recommended minimum retroreflective values which are 85 mcdl/lx/m^2 for white and 55 mcdl/lx/m^2 for yellow for non-freeway roads when the speed limit is less than or equal to 40 miles per hour. The average initial readings of the white edgelines on concrete (WC) and asphalt (WA) were 950 mcdl/lx/m^2 and 1185 mcdl/lx/m^2 respectively. The yellow centerline readings averaged 330 mcdl/lx/m^2 on concrete (YC) and 208 mcdl/lx/m^2 on asphalt (YA).

It was noted that dirt had accumulated in and around the markings shown in Figures 9-12 below. This paired with the irregular surface of the concrete deck could have caused some inconsistency of the retroreflectivity values.

Included in Table 1 are the average retroreflective values for each line over the course of the first year and the percentages of how much retroreflectivity was lost. On February 23, 2011, the average readings showed a loss of retroreflectivity from the previous site visit readings. In May after the spring rains essentially cleansed the markings, the white markings increased in reflectivity after the winter visit but were still below the initial readings. The yellow readings however increased by only 3 mcdl/lx/m^2 on concrete and further decreased on asphalt. At the site visit on August 27, 2011, retroreflectivity averages continued to decrease. Overall, the white markings had a higher reflectivity than the yellow readings, which is a normal occurrence. The WC lost 77% of reflectivity and WA lost 86% of reflectivity. The yellow lines lost more reflectivity with YC losing 89% and YA losing 94% of its reflectivity.

Figure 9: White edgeline on concrete.

Figure 10: White edgeline on bituminous concrete.

Figure 11: Yellow centerline on concrete.

Figure 12: Yellow centerline on bituminous concrete

The retroreflectivity values depict severe plow damage and a more gradual reduction throughout the summer. After speaking with product representatives from Aexcel Corporation, the marking manufacturer and Evonik Degussa, the resin supplier, the premature wear was presumably due to the roughness of the bare concrete bridge deck and the fact that not enough time may have elapsed between deck and asphalt approaches placement and marking application. Product representatives originally believed a 21 day curing time for the concrete was adequate (which was observed prior to marking placement), but after this failure reassessed this belief. Due to the unexpected wear and loss of reflectivity, Aexcel Corporation agreed to reapply the centerline markings. The reapplication was completed on Tuesday, October 11, 2011. Research personnel were onsite to document the process and take retroreflectivity readings. Figures 13 through 17 show the application and initial as-applied condition of the markings.

Figure 13: Push handcart applicator.

Figure 14: Spiked bar located on the handcart.

Figure 15: Bead applicator

Figure 16: Yellow centerline on concrete

Figure 17: Yellow centerline on asphalt

Included in Table 1 are the average retroreflective values for each line over the course of the year after the reapplication and the percentages of how much retroreflectivity was lost. On October 11, 2011, the WC readings averaged 280 mcdl/m²/lx and WA was 177 mcdl/m²/lx. The newly applied YC was 529 mcdl/m²/lx and the YA was 374 mcdl/m²/lx. Readings were taken again 22 days after application (November 2, 2011) and the YC had already decreased 78% and YA 66%. There was a storm with some snow between October 29 and 30; therefore, some plowing, salting or sanding activities likely occurred, affecting the quality of the lines. As of the visit on February 5, all of the readings had continued to decrease as an effect of the winter season. The WC reading was 115 mcdl/m²/lx and the WA reading was 97 mcdl/m²/lx. The YC readings were 55 mcdl/m²/lx and 76 for YA readings. On the next site visit on June 5, the white readings regained some reflectivity while the yellow readings declined again. The WC and WA readings were 150 mcdl/m²/lx and 103 mcdl/m²/lx. The YC and YA readings were 43 mcdl/m²/lx and 55 mcdl/m²/lx. Following this visit, the lines were subsequently repainted with waterborne paint, ending the evaluation period of the MMA.

Overall, the white markings had a higher reflectivity than the yellow readings, which is a normal occurrence. While only the yellow centerlines were restriped, the white markings were also tested throughout the process. After the testing was completed, the data was used to compare how much reflectivity was lost throughout the testing period. The WC and WA lost 84% and 91%. Before the reapplication, the YC and YA markings lost 89% and 97%. Then after the reapplication, the YC and YA lost 92% and 81%. At the end of the first year evaluation, it was observed that a few of the readings did fall under the minimum requirements but all other averages were above those requirements. Table 1 includes the average retroreflective values for each line over the course of evaluation including the reapplication of the yellow centerline.

Table 1: Average Readings for Retroflectivity

	Days		White Edgeline		Yellow Edgeline	
Date	**White**	**Yellow**	**Concrete**	**Asphalt**	**Concrete**	**Asphalt**
11/10/2010	19	19	950	1185	330	208
2/23/2011	105	105	82	N/A	45	48
5/11/2011	182	182	547	430	48	17
9/27/2011	321	321	220	168	36	6
Reflectivity Lost in Year			**77%**	**86%**	**89%**	**97%**
10/11/2011	335	0	280	177	529	374
11/2/2011	357	22	137	98	118	128
2/15/2012	468	133	115	97	55	76
6/5/2012	573	238	150	103	43	55
Reflectivity Lost Since Install			**84%**	**91%**	**92%**	**81%**

SUMMARY AND RECOMMENDATIONS

In an effort to explore the durable and retroreflective capabilities of Aexcel Roadzilla™ Methyl Methacrylate (MMA) was applied on October 22, 2010 to the Bridge #49 deck replacement project (BHF-St 0134 (21)) on VT Route 11 at approximately MM 5.7 in Chester, Vermont by the manufacturer. Following the placement of the markings, retroreflectivity and wear readings were collected using ASTM 1710-11 Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer uniform methods. MMA markings have rarely been used on Vermont Agency of Transportation projects and this project afforded the Agency the opportunity to evaluate not only this particular MMA, but also MMA markings in general.

During the initial site visit, all markings were noted to be in excellent condition; however, over the first winter the markings experienced an exceptional amount of wear. White edgelines on concrete lost 77% of its reflectivity and 86% of their reflectivity on asphalt. The yellow centerlines on concrete lost 89% reflectivity and lost 94% on asphalt. After one year the readings for white edgelines were above the FHWA recommended minimum retroreflective value which is 85 $mcdl/lx/m^2$ for white on non-freeway roads when the speed limit is less than or equal to 40 miles per hour, while yellow centerlines fell below the recommended minimum of 55 $mcdl/lx/m^2$ for yellow. Due to the unexpected wear described above, the Aexcel Corporation agreed to reapply the centerline markings at no cost to the Agency in the fall of 2011.

After the reapplication of the yellow centerline markings, a site visit was conducted on October 11, 2011. White markings averaged 280 $mcdl/m^2/lx$ and 216 $mcdl/m^2/lx$ on concrete and asphalt, while yellow values were 529 $mcdl/m^2/lx$ on concrete and 289 $mcdl/m^2/lx$ on asphalt. Similar to the first year observations, readings were very low during the winter visit and then increased after the spring, however readings overall continued to decrease over the course of the second year. The final white readings were 150 $mcdl/m^2/lx$ and 103 $mcdl/m^2/lx$ on the concrete and asphalt. The yellow markings were 43 $mcdl/m^2/lx$ on concrete and 55 $mcdl/m^2/lx$ on asphalt for the final readings. For white this was an 84% and 91% reduction from the initial readings in October 2010. For yellow, this was a 92% and 81% decrease from the reapplication in October 2011.

Readings for both colors on the concrete were at or above the FHWA recommended minimum retroreflective values which are 85 $mcdl/m^2/lx$ for white and 55 $mcdl/m^2/lx$ for yellow for non-freeway roads when the speed limit is less than or equal to 40 miles per hour.

After speaking with product representatives from Aexcel Corporation, the marking manufacturer and Evonik Degussa, the resin supplier, the premature wear following the first year was presumably due to the roughness of the bare concrete bridge deck and the fact that not enough time had elapsed between deck and asphalt approach placement and marking application.

It is also recognized that severe plow damage occurred on these surface applied markings. A contributing factor appears to be a high frequency of plowing as a direct result of proximity to the VTrans garage. The manufacturer now recommends that markings should not be applied before 30-45 days for concrete and 14 days for asphalt, rather than the original 21-day recommendation for concrete. These new recommendations do not address the performance issues following the second application though, as the yellow markings faired nearly identical the second time when applied to one-year-old surfaces. While the roughness of the concrete bridge deck could easily have contributed to excessive or accelerated wear on the markings, similar wear and reduction in retroreflectivity was recorded on the smoother asphalt approaches as well. A likely aspect that may have affected the lines was the fact that a district garage is adjacent to the bridge deck and the bridge may receive far more plowing activity than a normal stretch of road may. It is unclear if this greater amount of plowing on this thicker, structured marking is solely responsible for the excessive wear or if something else is in play.

Given only the data in this study, the overall performance of the structured Aexcel Roadzilla™ Methyl Methacrylate marking was unsatisfactory in this application. There are enough reported successful applications of MMA in the country, and enough question marks about the placement location and substrates in this study, that another trial of these marking types should be afforded before final decisions or recommendations are made. A trial with a thin film MMA marking has since been initiated, the results of which will guide further trials and deployment of the marking type. Pending the outcome of that and future applications of thin film MMA lines, a trial of the Aexcel Roadzilla™ structured marking may be performed again in the future. The use of a recess for the marking should be a component of any subsequent trial for this material.

REFERENCES

1. Vermont Agency of Transportation. (2011). *2011 Standard Specifications for Construction.* Montpelier, VT.

2. Ellis, Wendy. Site Visit Report for Research Investigation Methyl Methacrylate Pavement Marking Evaluation. November 10, 2010

3. "Roadzilla™ White Methyl-Methacrylate (MMA) Pathfinder 100:1 Beading Two Component Traffic Marking Paint White-Part "A". Product Data Sheet" Aexcel Corporation. 7373 Production Drive, Mentor, Ohio 44060

4. "Swarco North America: Glass Beads, Duralux." http://www.swarco.com/northamerica/Products-Services/Glass-Beads/Traffic-Beads/DURALUX ." 27 Oct. 2014.

5. Vermont State Statutes, *Title 23, Chapter 13, Sub-Chapter 3, Section 1031: Driving to right.* Vermont State Government.

   http://www.leg.state.vt.us/statutes/fullchapter.cfm?Title=23&Chapter=013. May 2014