Recessed Thermoplastic Pavement Markings
Montpelier, Vermont

September 2002

Reporting on Work Plan 95-R-15
Final Report

State of Vermont
Agency of Transportation
Materials and Research

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16. Abstract

In 1995, the Vermont Agency of Transportation (VAOT) placed recessed thermoplastic pavement markings at an intersection in the City of Montpelier. The project involved grinding newly placed bituminous concrete pavement, creating a recess for thermoplastic markings.

All the markings were placed at 125 mils thickness, including adjacent thermoplastic markings, used for performance comparison. The markings were monitored to determine if recessing the marks increased the service life. Performance comparison focused on loss due to snowplow abrasion and wear.

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INTRODUCTION

Thermoplastic, the predominant durable marking material used in Vermont, has been used on new construction projects since 1992. During its use in the state, snowplow damage has been identified as the single most deleterious factor effecting the useful service life of this pavement marking material. Because of its high profile, thermoplastic is particularly susceptible to chipping from plow blades.

A proposed solution to alleviate the problem was to inlay the thermoplastic pavement markings into grooves cut into the pavement. While a modification of this method is done with pavement marking tape, it had not before been attempted with thermoplastic.

In 1995, the Vermont Agency of Transportation (VAOT) Construction Division proposed inlaying hot applied thermoplastic in the City of Montpelier, at the intersection of US Route 2 (Main St and Berlin St), Vermont Route 12 (Northfield St) and Memorial Drive, as part of the Montpelier NH 9530 project (Figure 1). The pavement markings selected included crosswalks, stop bars, and symbols.

This study investigates the field performance of inlaid thermoplastic pavement markings on a new bituminous concrete pavement.

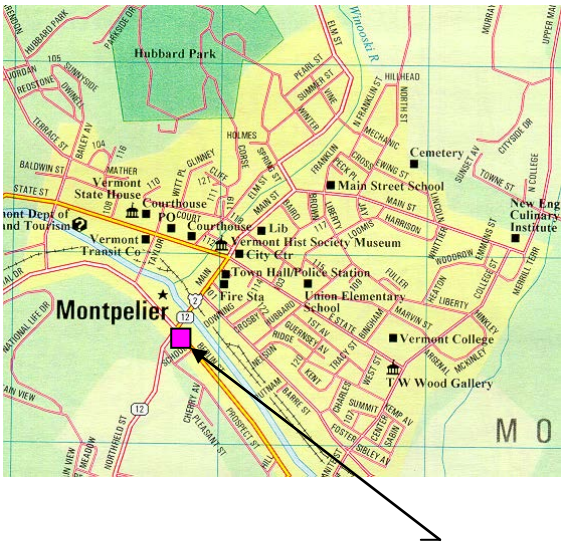

Figure 1. **Project Location** (DeLorme, VT Atlas & Gazetteer, 9th edition)

MATERIAL DESCRIPTION

The pavement marking material applied was Linear Dynamics, Inc. (LDI) SG-70 hydrocarbon thermoplastic. The material was applied by extrusion as a heated liquid with intermixed glass beads as well as additional glass beads dropped on to the surface.

TRAFFIC DATA

A summary of the average annual daily traffic (AADT) through the intersection of US Route 2 (Main St and Berlin St), Vermont Route 12 (Northfield St), and Memorial Drive is presented in Table 1. Data for 2000 was not available at the time of this report.

Year	AADT	Total Volume Increase
1994	21575	
1996	23203	1628 (7%)
1998	23894	2319 (10%)

Table 1. **Traffic Volume.**

CONSTRUCTION

The pavement marking contractor, L&D Safety Marking Corporation of Berlin, VT, contracted Techniques Routieres Avancees of Lavel, Province of Quebec, Canada, to perform the grinding for the inlaid thermoplastic markings.

On July 19, 1995, preparation for the inlaid markings began. The stencils for the markings were first marked out, as shown in Figure 2, for all four crosswalks, three stop bars, and four arrow symbols, after which the new bituminous pavement was ground as shown in Figure 2. The grounding was done in 5 ½" wide strips, 1/8" deep, in order to match the outline of the markings. Once these areas were ground to the proper depth, the locations were swept by hand and with a rotary sweeper, as shown in Figure 3. This process was completed within one 8-hour day.

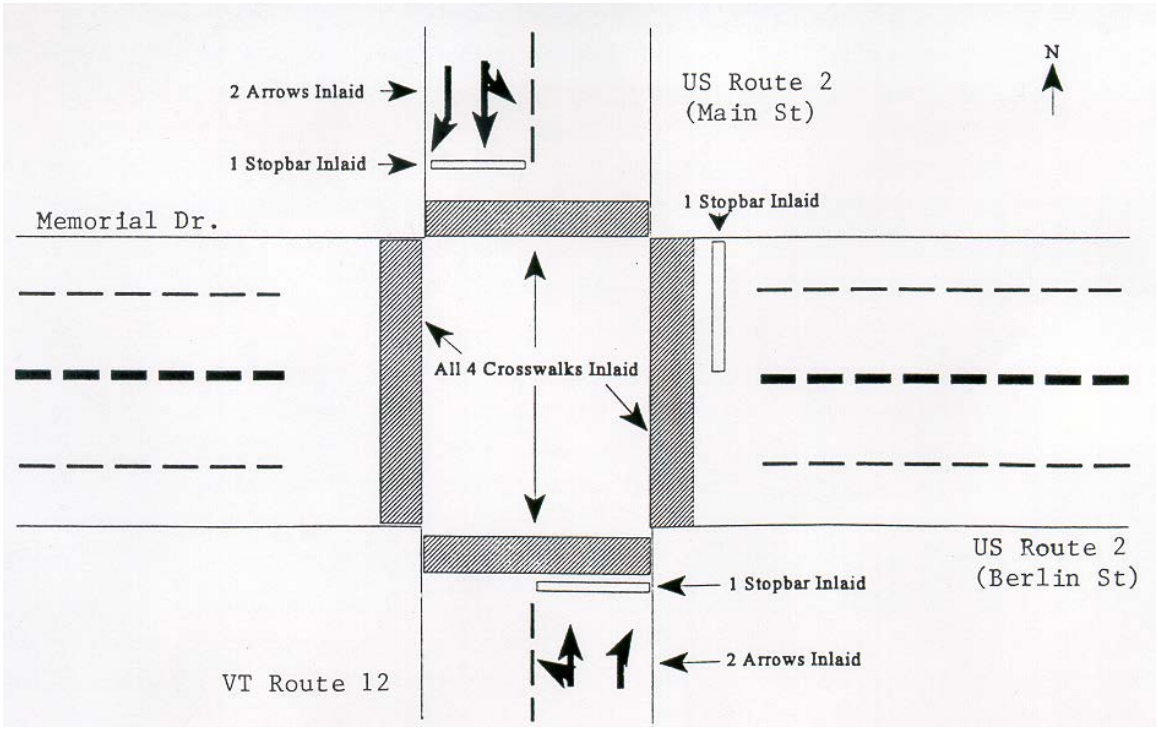

Figure 2. Project Layout.

The thermoplastic pavement markings were applied the following day. At the time of the application, the pavement surface was dry and the ambient air temperature was 70 degrees Fahrenheit. The material was applied with a handcart in the same manner as traditional surface-laid thermoplastic legends and symbols. Because the ground area was 5 ½" wide, and the die for the thermoplastic markings was 6" wide, a ¼" each side of the grooved area adhered to the pavement surface (Figure 4).

Figure 3. Ground out bituminous pavement.

Figure 4. Inlaying thermoplastic material in grooved areas.

COST

The table below presents the cost difference between the original contract bid price for applying surface-laid thermoplastic pavement markings on the Montpelier NH 9530 project and the actual price for inlaying the markings.

Description	Quantity	Contract Bid Price		Actual Constructed Price	
		Unit Price	Total	Unit Price	Total
24" Stop Bar	75 lf	$3.80/lf	$285	$18.00/lf	$1350
Crosswalk	200 lf	$6.41/lf	$1282	$30.00/lf	$6000
Arrow	4 ea.	$47.50/ea.	$190	$180.00/lf	$720
TOTAL			**$1757**		**$8070**

Table 2. Cost Comparison.

It cost an additional $6313 to inlay the thermoplastic markings shown in Figure 2.

PERFORMANCE EVALUATION

Annual site visits were conducted to monitor the performance of the inlaid thermoplastic markings. Adjacent surface-laid thermoplastic pavement markings were used as a measure for comparison. All of the markings, both inlaid and surface-laid, were placed at a 125 mils thickness in July 1995. Observations made throughout the project's history is documented below.

October 1996

The inlaid thermoplastic markings remained completely intact while adjacent surface-laid thermoplastic markings began to exhibit some moderate to severe damage. The damage to the overlaid markings was attributed primarily to traffic wear.

July 1997

The inlaid thermoplastic markings continued to remain completely intact after two winter maintenance seasons. Adjacent surface-laid thermoplastic markings exhibited an estimated 45% of the total surface area had moderate to severe damage.

August 1998

After three years of performance, the inlaid markings began to deteriorate. The most significant loss occurred within the wheel paths of the stop bars and arrow symbols. Wear would be expected here since these areas are subjected more to the acceleration and deceleration of vehicles. All four crosswalks also exhibited signs of wear in the wheel paths, producing an estimated 10% loss of these markings, as shown in Figures 5 through 8.

In addition, the City of Montpelier reconfigured the lane assignments of the eastbound lane on Memorial Drive. The inlaid markings at this intersection were not compromised by this construction, but the surface-laid thermoplastic markings used for performance comparison were destroyed.

August 1999

Deterioration of all the markings continued, with damage occurring predominantly in the wheel paths and surrounding areas.

January 2001

After 4 ½ years, most of the inlaid thermoplastic markings exhibited significant deterioration. US Route 2, both Main and Berlin Streets, had undergone the most damage, with an estimated 40% loss of the crosswalks. Additionally, deterioration on VT Route 12 (Northfield St) and Memorial Drive continued with predominant wear in the wheel paths, as shown in Figures 9 through 12.

Though some of the inlaid pavement markings have worn away, the recessed areas created for these inlaid markings remained.

June 2002

After six years of service, all the markings at the intersection were remarked. Some of the markings were temporarily remarked with waterborne traffic paint in the Fall of 2001. In June 2002, all of the crosswalks were remarked with 90 mils of LDI SG-70 thermoplastic and the remaining arrows and stop bars received waterborne paint. Although some of the areas that had grooved pavement had a loss of material in heavily traveled areas, the recess was still intact for the new material to be placed within.

Figure 5. US Route 2 (Main St) – 1998.

Arrow symbols, stop bar and crosswalk are inlaid thermoplastic.

(Photo taken August, 1998)

Figure 6. US Route 2 (Berlin St) – 1998.

Crosswalk is inlaid thermoplastic.

(Photo taken August, 1998)

Figure 7. Memorial Drive – 1998.

Crosswalk is inlaid thermoplastic. Arrow symbols are surface laid.

(Photo taken August, 1998)

Figure 8. VT Route 12 (Northfield St) – 1998.

Arrow symbols, stop bar and crosswalk are inlaid thermoplastic.

(Photo taken August, 1998)

Figure 9. US Route 2 (Main St) – 2001.

Arrow symbols, stop bar and crosswalk are inlaid thermoplastic.

(Photo taken January, 2001)

Figure 10. US Route 2 (Berlin St) – 2001.

Crosswalk is inlaid thermoplastic.

(Photo taken January, 2001)

Figure 11. Memorial Drive – 2001.

Crosswalk is inlaid thermoplastic.

(Photo taken January, 2001)

Figure 12. VT Route 12 (Northfield St) – 2001.

Arrow symbols, stop bar and crosswalk are inlaid thermoplastic.

(Photo taken January, 2001)

SUMMARY

In 1995, thermoplastic markings in Vermont were commonly placed at 125 mils, as was the case in this study. As of 1997, the Vermont Agency of Transportation specification changed to a 90 mils thickness. The change came about for a few reasons, one of which, was due in part to safety concerns raised by cyclists, many of whom found that the high profile of thermoplastic jarred the two-wheeled vehicles when crossing the line. It was also learned that some other states had been using less than 125 mils for thermoplastic marking material and that a lower profile marking may be less susceptible to snowplow damage.

The inlaying of thermoplastic markings can aid to lessen the safety concerns of cyclists by the elimination of a high profile marking. Other added benefits to this method include better quality markings during initial years, and less susceptibility to damage caused by snowplows. In addition, the recess in the pavement remains even after the marking has worn, hence, allowing some protection for future maintenance markings.

The downside to the use of this method is the cost. The additional cost incurred on this project raised the price of the pavement markings by more than 3.5 times the original bid price. This was in large part due to the limited availability of the equipment needed for grinding the pavement at the time of the project. As this equipment becomes more readily available this process will likely become more feasible.

The performance of the inlaid thermoplastic pavement markings in this study revealed that the short-term quality of the markings were better than the surface laid pavement markings. Two years after installation the inlaid markings showed little to no significant deterioration. Hence, due to the inlaid process, it was determined that these markings were less affected by the early failure typically associated with snowplow abrasion.

The long-term performance of the inlaid markings appeared to increase as well. After 4 ½ years, the integrity of the inlaid marks were better than the surface laid marks placed at the same time.

Overall, it appeared that the effects of snowplow abrasion were not the primary mechanism for failure for either the inlaid or surface-laid markings at this location, but rather wear due traffic movements. Though the inlaid markings had the added protection of being recessed, these markings were still exposed to common wearing mechanisms such as acceleration, deceleration, and turning movements caused by traffic. The wear introduced by moving vehicles contributed significantly to the overall deterioration of both the inlaid and surface laid pavement markings.

Based on this study, the use of inlaid thermoplastic pavement markings has presented some benefits. In considering this method of placement, items such as location and traffic patterns should be considered. Due to the cost of this process, it may not be suitable for areas with low traffic volumes or aged pavements.

Appendix A

Prepared By: C. Graham
Date: 5/19/95

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

WORK PLAN FOR
CATEGORY II EXPERIMENTAL PROJECT

RECESSED THERMOPLASTIC PAVEMENT MARKINGS
WORK PLAN 95-R-15

OBJECTIVE OF EXPERIMENT

To evaluate the performance of recessed thermoplastic pavement markings.

PROJECT:

Montpelier NH 9530 (1)

EXPERIMENTAL WORK LOCATION

All crosswalks and stopbars, as well as arrows associated with stopbars at the intersection of US 2 and VT 12 in Montpelier (Station 115+26 to 116+32).

MATERIALS TO BE USED

LDI SG70 hydrocarbon thermoplastic pavement markings will be applied by L&D Safety Marking Company of Barre, VT.

CONTROL:

The control markings will be those letter and symbol markings, not specified above, that will be applied on the rest of the contract.

APPLICATION PROCEDURE

Installation will be accomplished by the marking subcontractors. The material will be recessed by first grinding out a section of pavement to a depth of 1/8". Thermoplastic markings will then be placed into this recessed area and be flush with the pavement surface.

ESTIMATED COST

The cost is estimated at approximately $0.30/lf to $0.80/lf.

DATE OF INSTALLATION

By June 15, 1995.

DURATION OF STUDY

The project will be evaluated for the length of time required to obtain valid conclusions on the performance of this experimental procedure. Both control and experimental materials will be monitored for durability and overall performance.

REPORTS

The final report will be issued when valid conclusions can drawn.

Materials & Research Division
Agency of Transportation

Date: 5/20/95

Reviewed By:

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