Field Evaluation of an Experimental Bituminous Pavement Utilizing an Ice-Retardant Additive - Verglimit

FINAL REPORT

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16. Abstract

In response to the FHWA's Experimental Project No. 3, "Evaluation of Asphalt Additives," the Connecticut Department of Transportation (ConnDOT) has placed and evaluated a bituminous surface course, which contains the ice-retardant additive, Verglimit. The experimental section is located on half the deck area of a newly constructed bridge, with the other half serving as the control section. Both sections were subjected to a variety of performance and durability tests over a five (5)-year field-evaluation period.

This report describes the results of these tests and assesses the ice-retardant capabilities of the Verglimit. General conclusions are that the Verglimit pavement is as durable as the control, however, its ability to retard the formation and adherence of ice to the pavement surface has not been apparent since the first winter after placement.

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SI* (MODERN METRIC) CONVERSION FACTORS

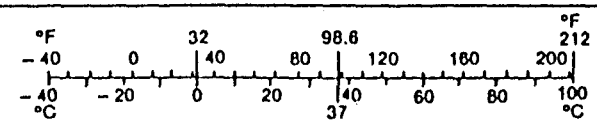
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

NOTE: Volumes greater than 1000 L shall be shown in m^3.

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement

(Revised April 1989)

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FINAL REPORT

Introduction

In response to the Federal Highway Administration's (FHWA) Experimental Project Number 3, Evaluation of Asphalt Additives, the Connecticut Department of Transportation (ConnDOT) has utilized two (2) different asphalt additives on separate paving projects. The first additive, Carbon Black, was incorporated into a bituminous pavement overlay in June 1985. The second, Verglimit, was placed as a part of a bituminous surface course of a newly-constructed bridge deck in May 1987. Because these two (2) products have dissimilar characteristics and require different evaluation techniques, separate reports have been prepared for each additive. The construction and field evaluation reports for the Carbon Black portion of the study are listed as References /1/ and /2/, respectively. For the Verglimit additive, a description of the mix design, batch-plant production and field placement is presented in Reference /3/, while results of the performance evaluation are contained herein.

Verglimit is a proprietary substance composed of approximately 95 percent calcium chloride ($CaCl_2$) and 5 percent sodium hydroxide (NaOH) encapsulated in a coating of linseed oil. The flake-like particles range is size from 0.004 to 0.200 in., and are added to a bituminous concrete mixture during production at the batch plant. When the modified mix is placed as the wearing surface of a roadway, the Verglimit flakes exposed at the pavement surface absorb and retain ambient moisture due to the hygroscopic nature of calcium chloride. This produces a mild brine on the surface that is intended to prevent the adhesion of snow pack and ice to

the pavement. Without a bond, snow and ice presents a much-reduced skidding hazard to motorists by allowing greater tire/pavement contact. In addition, it is claimed that plowing efficiency is increased due to the reduced snow-pack adhesion to the Verglimit-modified surface. When placed in selected problem areas, the additive is also intended to reduce or eliminate preferential icing, a condition in which a bridge deck or shady area freezes to a slick condition while adjacent sections remain ice-free. This includes the similar phenomenon known as "black ice." These conditions can readily occur well before a highway maintenance crew identifies the problem and treats it with a conventional salt application. It is postulated that with proper use of Verglimit, the rate of accidents related to these winter conditions may be reduced.

Experimentation with Verglimit has been going on for some time now. When it was first introduced in Europe, positive results had been realized for many types of special conditions, and expanded use of the product was recommended /4/. With these positive results, Verglimit was put on the market in North America. Dozens of locations in the United States and Canada were overlayed with experimental Verglimit mixes to evaluate its effectiveness and durability. Unlike the European experience, there have been mixed conclusions drawn from evaluation projects in North America. Studies in the State of New York and the Canadian Provinces of Ontario and New Brunswick showed positive ice-relardent capabilities with no detrimental side effects /5,6,7/. The conclusions of these studies were similar to those in Europe and resulted in recommendations for future use of Verglimit. However, several other states did not have positive experiences with the additive due to lack of noticeable ice-retardant capabilities or adverse side effects. D.O.T studies in Virginia and Colorado reported little to no apparent deicing benefits /8,9/. A Minnesota project in which Verglimit was utilized resulted in compaction

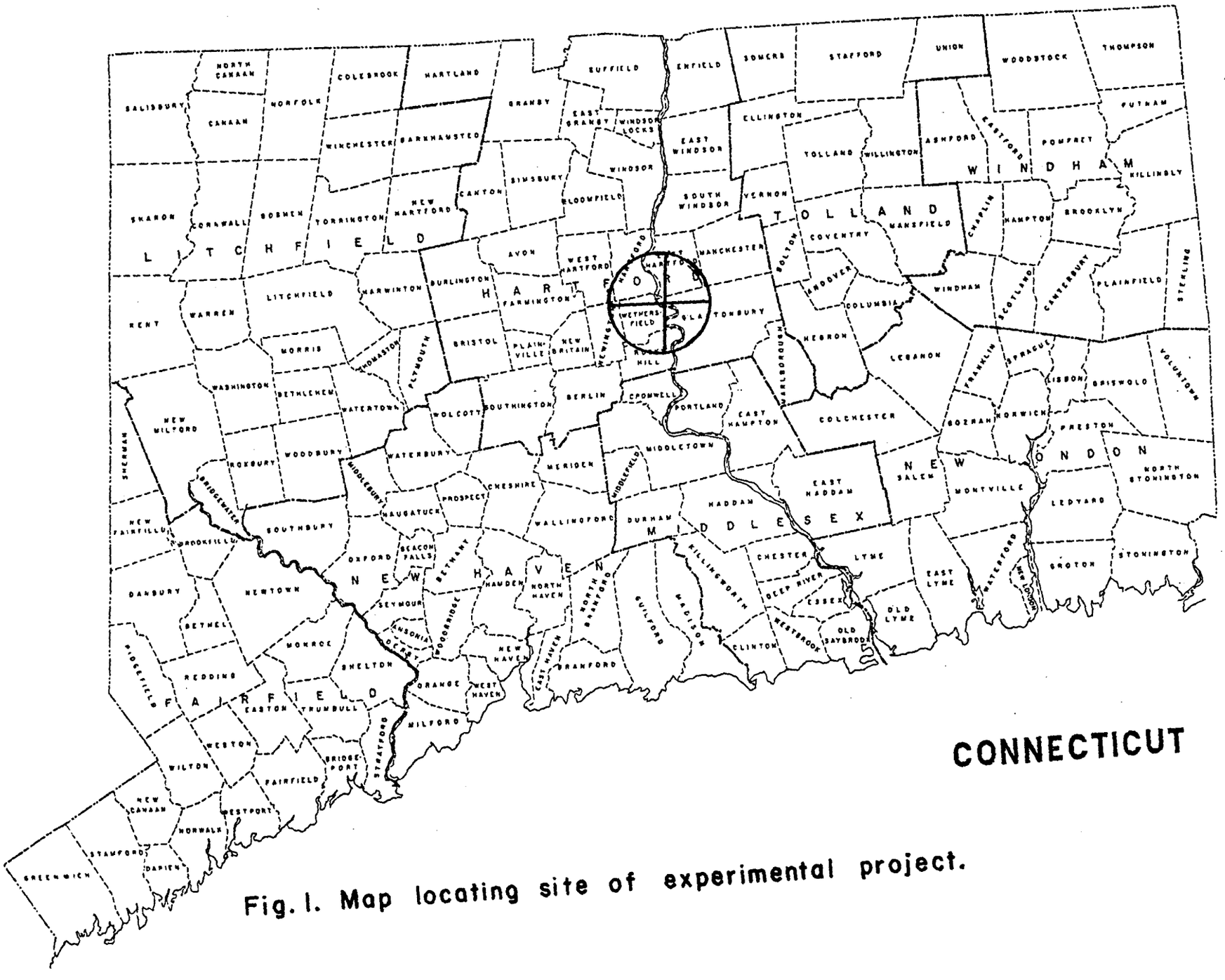

Fig. 1. Map locating site of experimental project.

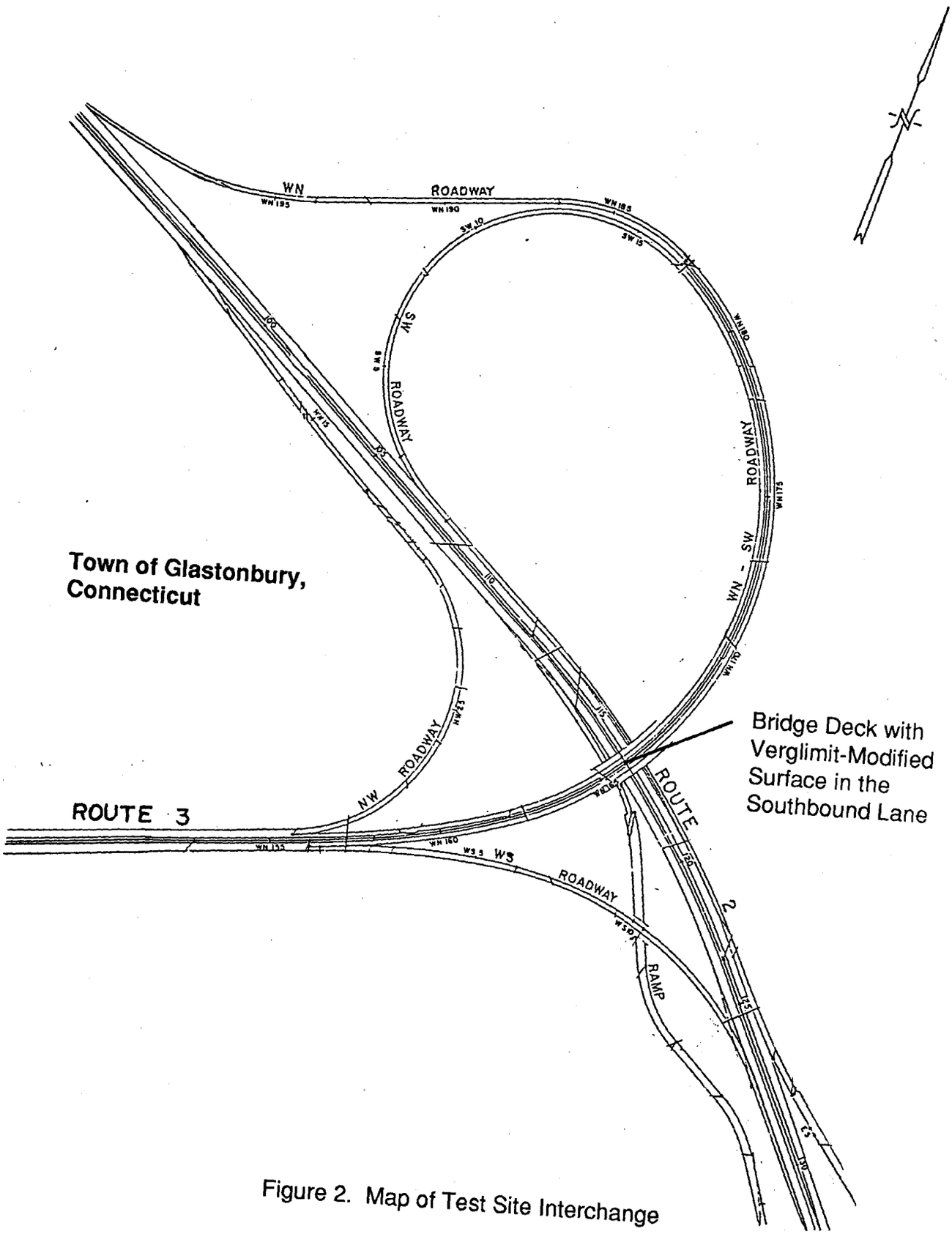

Figure 2. Map of Test Site Interchange

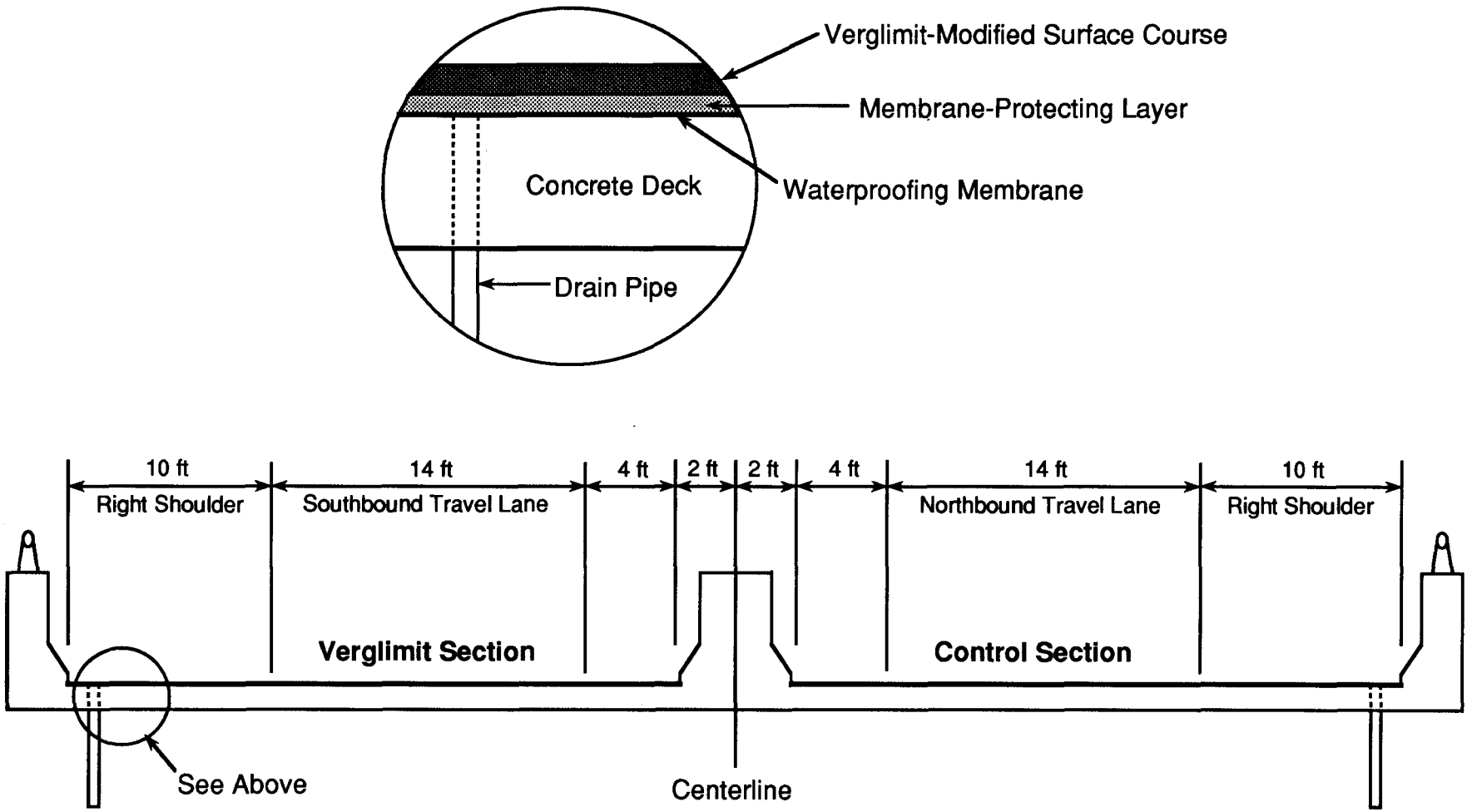

Figure 3. Cross Section of Bridge, Looking North

Although the Verglimit and control sections are adjacent to each other, the operating characteristics of each traffic stream are somewhat different. On the Verglimit section (Rt 3, southbound), traffic tends to be accelerating after traversing the looped ramp from Rt 2, westbound. The traffic on the control section tends to be braking as it enters the curved ramp to Rt 2, westbound. Rt 3, south of the study location is a divided expressway with a design speed of 60-mph. The design speed of the ramps is 45-mph, with posted advisory speed plates showing 35-mph. Because the test location was new construction, accident trends had not been established prior to the start of the evaluation period.

The Average Daily Directional Traffic (ADDT) through each section, expressed in vehicles per day (vpd), was as follows:

Year	Verglimit Section	Control Section
1987	7700 vpd	4200 vpd
1988	8400 vpd	4900 vpd
1989	9000 vpd	5400 vpd
1990	10000 vpd	5800 vpd

Due to the arrangement of the interchange between Routes 2 and 3, the traffic volume is significantly higher on the Verglimit section. All test-section traffic volumes are well above the recommended minimum of 5000 vpd/lane for the use of Verglimit.

Test Mix, Placement and Costs

The test section was paved with Class 1 bituminous mix, which is ConnDOT's standard dense-graded friction course. Verglimit was added to make up 6.0 percent of the total mix by weight, and it replaced the same amount of fine aggregate. A total of Eighty-five (85)-tons of Verglimit mix was produced and placed in one (1)-day, May 13, 1987. Two (2) separate samples were taken for extraction/gradation and Marshall testing. The results of these tests are shown in Table 1. All gradation and Marshall test results were within the Job Mix Formula (JMF) targets with the

Table 1 - Production Test Data for the Verglimit-Modified Mixture

Gradation: Screen Size	**Sample 1** Percent Passing	**Sample 2** Percent Passing	**Job Mix Formula** (Class 1 - Target) Percent Passing
#200	3	3	5
# 50	13	12	16
# 30	22	21	27
# 8	40	36	44
# 4	52	58	54
3/8 in.	73	74	74
1/2 in.	95	95	92
3/4 in.	100	100	95
Extraction:			
Bitumen Content (AC - 20)	6.39 %	6.15 %	5.5 %
Marshall Mold:			
Stability	1965 lbs.	2109 lbs.	1200 lbs., min.
Flow	0.12 in.	0.14 in.	0.08 - 0.15 in.
Voids	1.39 %	1.41 %	3 - 6 %
Maximum Theoretical Density	154.0 lb/cu. ft	-----	-----
Other Data:			
Mix Temperature	305°F	310°F	265 - 325°F

exception of the void content. Due to the hygroscopic nature of the Verglimit, the Marshall molds absorbed some atmospheric moisture, thus influencing void content measurements. It is believed that the void contents would be in the target range had no moisture collected in the molds prior to testing.

The Verglimit mix was placed on the bridge deck in two (2) 14-ft-wide passes. Two (2) rollers (8 and 10 tons) were used in the static (no vibration) mode for field compaction. For the first roller pass, a slightly damp, not wet, drum was used to prevent the Verglimit from retaining excess water, which can cause a skidding hazard on newly placed Verglimit pavements. Also, to avoid this condition, the Verglimit section was washed once per day for the first week after placement, and twice per week for six (6) weeks thereafter. These washings were recommended by the manufacturer to flush away excess Verglimit exposed by the compaction process. Because the test section was part of a larger construction project, it was not opened to traffic until four (4) months after placement. This was ample time for the Verglimit surface to be adequately flushed to prevent a slick condition.

The day following placement, the density of the Verglimit surface course was measured with a nuclear gage. The average of ten (10) readings was 143.6 pcf, which represents a compaction of 93.2 percent of the maximum theoretical density of 154.0 pcf. Although there is no ConnDOT specification governing the compaction of bituminous concrete over a concrete bridge deck, the average compaction obtained is well within the acceptable range of 92 to 97 percent for compaction on grade.

For this project, the contract price per ton of conventional Class 1, in place, was $33.00. The cost of the Verglimit-modified mix was an additional $92.80/ton, for a total of $125.80/ton in place. This represents a Verglimit pavement cost 3.8 times higher than the conventional surface.

Description of Performance Evaluation Tests and Results

Accident Analysis - The principle goal of utilizing Verglimit is to reduce vehicular accidents caused by the early freeze-up of a pavement, occurring prior to conventional treatment such as sanding and salting. Since these freezing conditions can be very localized and not readily apparent, it is very difficult to determine when, and to what extent the Verglimit prevented icing during appropriate weather conditions. For this reason, many of the previously-mentioned evaluation projects were based on accident rates before and after placement of Verglimit /5,6/. Unfortunately, our Verglimit test site is on a newly constructed roadway with no prior accident history. Subsequent to placement of the Verglimit, accident data is available from the interchange opening date, September 1, 1987, to December 31, 1990. In order to thoroughly analyze the accident records and their relevance to the study, data on accidents occurring within a quarter (1/4)-mi, either direction from the bridge, have been considered. This basically expands the control section to include the roadway before and after the bridge, and supplies a section of conventional pavement that has the same alignment and operating characteristics as the test section.

The data show that a vast majority of all accidents occurred in the northbound lane. As stated, the northbound traffic coming from the Rt 3 expressway must slow down for the ramp to Rt 2, westbound. The snow- and ice-related accidents also follow this pattern. Over the period in which data is available, there were six (6) snow- and ice-related accidents in the overall vicinity described. One (1) of the six (6) was in the southbound lane, approximately 1000-ft south of the Verglimit section. The remaining five (5) were in the northbound lane, one (1) of which was right

on the bridge (control section). Although there were snow- and ice-related accidents in the "control" areas, and none in the test section, it cannot be concluded that the Verglimit prevented any accidents.

Winter Observations - Since it was expected from the beginning that accident data would not provide enough information on the effectiveness of Verglimit, an on-site observation plan was developed. Prior to and during frozen precipitation, research personnel were sent to observe the Verglimit and control sections in an attempt to detect differences in surface conditions. Snow- and ice-control personnel were instructed to halt salt application 100-ft before and on the Verglimit section, until it was deemed essential. This allowed a short period of time, early in a storm, to observe ice-retardant capabilities of the Verglimit. A majority of the observations were simply visual. A few times, we tried to subjectively quantify the traction supplied by the pavement sections. This was done by controlled skids at approximately 25 mph with a regular automobiles and also by feeling under foot. Although these are very unconventional and subjective test methods, they were the only evaluation techniques available. Table 2 summarizes the observation program.

The first winter after placement (1987-88), the Verglimit pavement seemed slightly more resistant to skidding and adhesion of snow pack than the control. The differences between the sections were very subtle, and could have been due to other circumstances, in addition to the presence of Verglimit. Figure 4 shows the Verglimit section to be slightly clearer during a moderate snow storm in the first winter. When the Verglimit seemed to be somewhat effective, the ambient temperature was at or near $32^{\circ}F$. At temperatures below $25^{\circ}F$, the Verglimit's influence on surface condition was not apparent (See Figure 5). This is consistent with the product literature and reports from other Verglimit users.

Table 2 - Winter Observations

Date	Temperature Range (°F)	Precipitation	Section Comparison (Verglimit vs. Control)
11/10/87	33 - 35	Wet Snow	Same Condition (Both Wet)
12/15/87	30 - 32	Moderate Snow	Same Condition
12/29/87	21 - 23	Light-Mod. Snow	Verglimit Lane Slightly Clearer
1/4/88	26 - 29	Light Snow	Snow-pack Adherence Less on Verglimit Section
1/5/88	25 - 28	Snow Squall	Better Traction Felt on Verglimit (Controlled Skid)
1/8/88	11 - 13	Mod.-Heavy Snow	Same Condition
1/25/88	33 - 35	Wet Snow	Better Traction Felt on Verglimit (Under Foot)
1/27/88	18 - 20	None	Frozen Snowpack Stuck Solid to Both Sections
2/4/88	25 - 28	Moderate Snow	Better Traction Felt on Verglimit (Controlled Skid)
1/6/89	20 - 22	Light-Mod. Snow	Same Condition
1/12/89	30 - 35	Freezing Rain	Same Condition
1/26/89	30 - 35	Light Snow/Rain	Same Condition
2/26/89	28 - 30	Light Snow	Same Condition
1/9/90	25 - 27	After Snow	Same Condition
1/22/90	30 - 32	After Snow	Same Condition
3/6/90	30 - 32	Light Snow	Same Condition

Verglimit Section Control Section

Figure 4. Section Comparison at Temperature Near Freezing

Verglimit Section Control Section

Figure 5. Section Comparison at Temperature Well Below Freezing

Subsequent to the first winter after placement, there have been no perceptible ice-retardant capabilities of the Verglimit pavement. The slight effectiveness observed initially, ceased. After two (2) years of not observing Verglimit benefits, even in appropriate conditions, the on-site monitoring program was discontinued.

Runoff Water Analysis - It was decided to analyze runoff water from the Verglimit and control sections in an attempt to estimate the amount of $CaCl_2$ leaching from the Verglimit pavement. The test-site bridge has a waterproofing membrane between its concrete deck and the bituminous surface. In order to drain the roadway, 1-1/2-in. diameter pipes were installed extending through the deck with the inlet on top of the waterproofing membrane (See Figure 3). With this configuration, water that permeates through the bituminous overlay runs along the top of the membrane and exits through the pipes to the underside of the bridge. This was an ideal set up to collect runoff water that had passed through the Verglimit-modified pavement. In July 1988, a water collection system was placed on drain pipes in both sections (See Figure 6). The water samples were retrieved periodically when the one-liter bottles were full. Table 3 presents the results of tests performed on the samples to determine $CaCl_2$ content. The data show that significant amounts of $CaCl_2$ were leaching out of the Verglimit pavement for approximately 1-1/2-years after placement. Entries with large sample sizes were collected after rainfall. The first two (2) samples were collected during periods of high humidity with no rain, and were produced by the Verglimit's absorpition of atmospheric moisture.

From these data, it is concluded that the Verglimit pavement was releasing significant amounts of $CaCl_2$ for the first 1-1/2-years. After December 1988, however, the amount of leachate from the Verglimit section

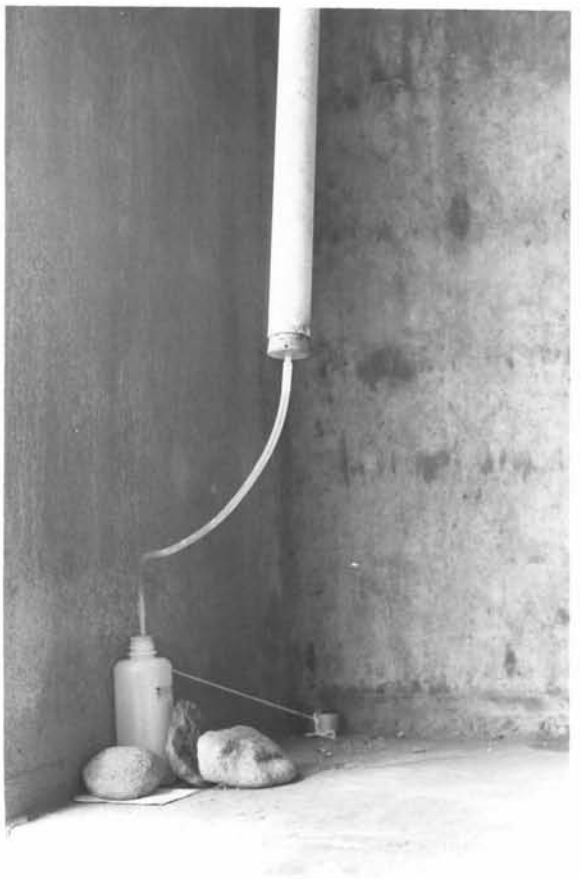

Figure 6. Water Collection Apparatus

Table 3 - Runoff Water Analysis

Date	Verglimit Section		Control Section	
	Calcium Chloride Concentration (lbs / gal)	Sample Size (ml)	Calcium Chloride Concentration (lbs / gal)	Sample Size (ml)
7/18/88	1.080	650 #	No Sample	No Sample
7/20/88	1.070	625 #	No Sample	No Sample
7/22/88	0.170	650	0.006	650
7/25/88	0.622	400	0.010	700
8/23/88	1.070	1000	0.013	1000
9/2/88	0.681	1000	0.011	1000
9/16/88	0.920	1000	0.015	1000
9/29/88	1.090	700	0.007	900
10/11/88	0.210	1000	0.009	1000
11/3/88	0.160	1000	0.011	1000
11/23/88	0.117	1000	0.019	1000
12/6/88	0.199	1000	0.013	1000
1/6/89	0.016	1000	0.002	1000
1/26/89	0.044	900	0.004	900
2/27/89	0.009	950	0.003	950
4/10/89	0.018	1000	0.007	250 *
7/25/89	No Sample *	No Sample *	< 0.001	900
8/14/89	0.035	1000	< 0.001	1000
8/30/89	No Sample *	No Sample *	< 0.001	850
9/18/89	0.019	950	< 0.001	950
9/22/89	0.012	950	< 0.001	950
9/25/89	0.022	150 *	0.001	950
10/23/89	0.036	950	< 0.001	950
1/9/90	0.018	1000	0.016	1000

* Small or No Sample due to Overturned Collection Bottle

Sample Obtained from the Absorbtion of Atmospheric Moisture

had dropped to nearly the level of the control. This is consistent with the effectiveness observations described earlier. It seems that most of the Verglimit has leached out, or the remainder is locked into the pavement. Because we have not experienced ravelling or other forms of pavement deterioration, it is believed that a portion of the Verglimit is still in the pavement, but is tightly bound by bitumen, unable to be released. During January 1990, the water collection system had been vandalized/stolen for the second time, and was not replaced.

Pavement Friction Tests - Immediately after placement, a Verglimit surface can create a slick condition for motorists, which has been a problem for some of its users. During compaction, a relatively large amount of Verglimit particles are crushed, allowing them to attract atmospheric moisture from the air. Combined with NaOH and linseed oil, the moisture produces a greasy brine on the pavement surface, which can cause a hazardous condition. The situation is worse when traffic must be directed on to the new pavement immediately after placement, not allowing sufficient time to flush the excess Verglimit from the surface. For our project, the Verglimit section was not opened to traffic for four (4) months after placement, which allowed ample time for the surface to stabilize.

In order to monitor this condition, pavement friction tests were performed on both sections throughout the evaluation period. The tests were conducted in conformance with the Standard ASTM Test Method for "Skid Resistance of Paved Surfaces Using a Full-Scale Tire," Designation E274-85. The data are contained in Table 4. The first tests were performed two (2) weeks after placement, and show a lower level of skid resistance on the Verglimit section, although it was considered adequate. By the time the sections were opened to traffic in September 1987, the skid resistance of the Verglimit had risen to nearly the level of the control.

Table 4 - Pavement Friction Data

	Average Skid Number (SN40)	
Test Date	**Verglimit Section**	**Control Section**
6/1/87	43.8	54.7
No. of Tests	1	1
9/10/87	50.2	55.0
No. of Tests	2	6
10/13/87	47.0	51.6
No. of Tests	4	4
12/10/87	50.6	52.4
No. of Tests	2	3
2/1/88	50.6	53.2
No. of Tests	4	4
6/14/88	47.9	52.0
No. of Tests	4	5
7/15/88	48.8	49.1
No. of Tests	3	3
9/28/88	47.4	47.1
No. of Tests	4	4
11/14/88	47.1	46.8
No. of Tests	4	4
5/23/89	53.9	50.0
No. of Tests	4	4
10/13/89	43.9	46.5
No. of Tests	4	4
11/28/89	48.6	47.6
No. of Tests	2	2
6/25/90	46.1	45.5
No. of Tests	3	3

This is attributed to the flushing of the Verglimit pavement, described earlier. For the remainder of the project, the skid resistance on the Verglimit pavement was very near that of the control, and no skidding hazards were experienced.

Distress Surveys - Pavement durability is an important consideration when using an experimental additive in a bituminous mix. Once a year, the Verglimit and control sections were visually surveyed for pavement distress such as cracking, ravelling, wear, flushing, and delamination. Because the sections are on a new bridge deck, pavement deterioration was not expected to be a problem within the five (5)-year evaluation period. This turned out to be the case, no pavement distress developed on either section. The good pavement durability is attributed to compliance with the mix design parameters and the compaction recommendations of the Verglimit manufacturer.

Conclusions

This study was conducted to evaluate the effectiveness of an ice-retardant asphalt additive, Verglimit, and determine if there are any detrimental side effects associated with its use. It was not excessively difficult to incorporate the Verglimit particles into the bituminous mixture. It is simply added at the pugmill as a replacement for an equal amount of fine aggregate. An initial hinderance to the use of Verglimit is the high cost. Nearly four (4) times the "in place" cost of a conventional surface course, the Verglimit pavement must exhibit substantial benefits to be economical.

It is believed that the most important factor determining the behavior of a Verglimit pavement is density and compaction. The pavement's winter performance and overall durability are dependent on the rate at which the Verglimit is released, which is very sensitive to the compaction of the mixture. If too dense, the Verglimit pavement will be over active

initially, due to an excess of crushed particles, and inactive later because the action of traffic will not be sufficient to expose new particles over time. With inadequate compaction, it is believed that the Verglimit would be flushed out prematurely, leaving the pavement ineffective and vulnerable to deterioration. We have concluded that our Verglimit pavement may be too dense. This is based on the pattern established by the winter observations and the runoff water analysis. The amount of $CaCl_2$ released by the test pavement had dropped to nearly the level of the control section runoff after 1-1/2 years. This substantiated the lack of perceptible winter effectiveness after the first winter. Since the pavement is still in excellent condition, it is believed that a large portion of the Verglimit particles are still in the pavement, locked into the dense mixture. Had a majority of the Verglimit been flushed out after 1-1/2 years due to inadequate compaction, the pavement probably would have ravelled. The Verglimit mix was produced and placed in conformance with standard procedures, and compacted to a density within ConnDOT limits. It is not known what action could have been taken to produce a more effective Verglimit surface.

During the evaluation of Verglimit in Connecticut, we did not experience any detrimental side effects such as difficulty working with the material, poor skid resistance or premature pavement failure. However, the winter weather benefits reported by other Verglimit users, were not experienced to an extent sufficient enough to offset the high cost of the material.

Recommendations

Based on the test results obtained from this study, it is not recommended, at this time, that Verglimit be utilized on future paving projects in Connecticut. There are no known mix design alterations or construction techniques that would guarantee the ideal conditions required

for the Verglimit to perform as intended. If the effectiveness of Verglimit was not so sensitive to outside factors, there would probably be more consistent results obtained from the evaluation projects conducted to date.

For agencies that wish to try Verglimit for themselves, it is recommended that a test site be chosen where a high winter accident rate already exists. Then, a drastic reduction of ice- and snow-related accidents would positively verify the effectiveness of Verglimit. Also, it would be favorable to keep traffic off the fresh surface until excess Verglimit could be adequately washed off. This was the case with our project, and we didn't experience the skidding problems that occurred in other states.

References

1. Augeri, F., "Pavement of an Experimental Bituminous Concrete Mixture Utilizing an Asphalt Additive - Carbon Black, "Report No. 1085-1-86-1, January 1986.

2. Lohrey, E.C., "Field Evaluation of an Experimental Bituminous Pavement Utilizing an Asphalt Additive - Carbon Black, FINAL REPORT," Report No. 1085-3-91-6, October 1991.

3. Augeri, F., "Placement of an Experimental Bituminous Concrete Mixture Utilizing an Asphalt Additive - Verglimit," Report No. 1085-2-87-6, November 1987.

4. Johannes, H., "Verglimit - Progress Report on the Use of Ice-Inhibiting Additives in Road Surfacings," Documentation of the IX:th IRF World Meeting on Road Maintenance, Stockholm, Sweden, 1-5 June 1981.

5. Tanski, J.H., "Performance of Two Ice-Retardant Overlays," Report No. FHWA-NY-RR-86-132, May 1986.

6. Fromm, H.J., "Anti-Icing Compound for Bridge Decks and Road Surfaces," Ontario Ministry of Transportation and Communications, September 1979.

7. Dohaney, W.J. "Verglimit/Asphalt Concrete Performance Analysis," ISBN 0-919868-16-9, Proceedings of the 26th Annual Conference of Canadian Technical Asphalt Association, 1981.

8. Maupin, G.W., Jr., "Final Report - Field Investigation of Verglimit," Report No. VHTRC 87-R2, July 1986.

9. Kiljan, J., "Verglimit Evaluation (Boulder)," Report No. CDOH-DTD-R-89-4, February 1989.

10. Turgeon, C.M., "Evaluation of Verglimit (A De-Icing Additive in Plant Mixed Bituminous Surface) - Final Report," Report No. FHWA-MN-RD-89-02, July 1989.