PLACEMENT OF AN EXPERIMENTAL BITUMINOUS CONCRETE MIXTURE UTILIZING AN ASPHALT ADDITIVE - "VERGLIMIT"

Prepared by
Frank Augeri

November 1987

Research Project HPR-1085
Report Number
1085-2-87-6

Dr. Charles E. Dougan
Director of Research and Materials

A Project in Cooperation With the U.S. Department of Transportation
Federal Highway Administration

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA - CT - RD 1085-2-87-6		1085-2-87-6

4. Title and Subtitle	5. Report Date
Placement of an Experimental Bituminous Concrete Mixture Utilizing an Asphalt Additive (Verglimit)	November 1987
	6. Performing Organization Code: HPR-1085
7. Author(s): Frank Augeri	8. Performing Organization Report No.: 1085-2-87-6
9. Performing Organization Name and Address: Connecticut Department of Transportation, Bureau of Highways, P.O. Drawer A, Wethersfield, Connecticut 06109	10. Work Unit No. (TRAIS): HPR-1085
	11. Contract or Grant No.: CT.HPR Study No.HPR-1085
12. Sponsoring Agency Name and Address: Connecticut Department of Transportation, Bureau of Highways, P.O. Drawer A, Wethersfield, Connecticut 06109	13. Type of Report and Period Covered: Construction, May - August 1987
	14. Sponsoring Agency Code: HPR-1085

15. Supplementary Notes

Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration from the study "Asphalt Additives"

16. Abstract

In response to Experimental Project No. 3 - Evaluation of Asphalt Additives, sponsored by the Federal Highway Administration, the Connecticut Department of Transportation has chosen to place an experimental bituminous concrete pavement, incorporating the additive "Verglimit." Composed of Calcium Chloride and Sodium Hydroxide encased in linseed oil, this capsule-like material is added to the bituminous mix during production. Once in place as pavement, the Verglimit is designed to retard the formation of ice on the friction surface, particularly on bridge decks.

ConnDOT has placed approximately 85 tons of Verglimit mix on one side of a newly constructed bridge, using the other as a control. Construction difficulties and material costs are addressed in this report. The pavement durability and ice-retardant capabilities of the Verglimit mix will be evaluated for a period of five years.

17. Key Words	18. Distribution Statement
Pavements, Bituminous Concrete, Asphalt Additives, Verglimit Ice-Retardant	No restrictions. This document is available to the public through the National Technical Information Service. Springfield, Virginia 22161

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

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

The contents of this report reflect the views of the author, who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

ACKNOWLEDGEMENTS

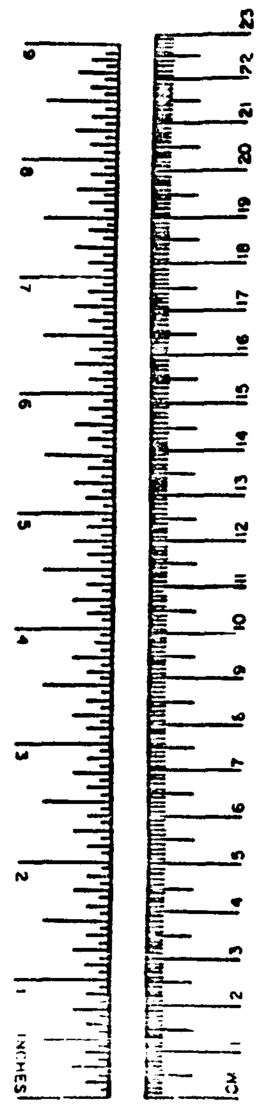
This work was performed by the Materials Testing Laboratory, Bureau of Highways in cooperation with the Division of Research, Bureau of Highways; Office of Maintenance, Bureau of Highways; and, the U.S. Department of Transportation, Federal Highway Administration.

The author gratefully acknowledges the assistance of ConnDOT's Laboratory Materials Technicians and the District 1 Construction personnel, who participated in this phase of the study.

METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS FROM METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons(2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS FROM METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares(10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

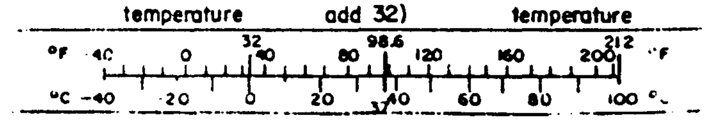


TABLE OF CONTENTS

PLACEMENT OF AN EXPERIMENTAL BITUMINOUS CONCRETE MIXTURE UTILIZING AN ASPHALT ADDITIVE - "VERGLIMIT"

INTRODUCTION

The Federal Highway Administration (FHWA) initiated experimental project No.3 to promote the systematic gathering and reporting of information on the design, construction cost, and performance of different asphalt additives. The Connecticut Department of Transportation (ConnDOT), in a continuing effort to develop improved bituminous concrete mixtures utilizing asphalt additives, selected "Verglimit" as an experimental material to test in accordance with stipulations governing work performed on Project No. 3.

One hazard confronting motorists is "preferential" bridge-deck icing that can occur under certain ambient conditions. A bridge deck, whose underside is exposed to the elements can glaze over with ice well in advance of the adjacent pavement, which is thermally insulated on three sides. This sudden transition from an unglazed to glazed surface can produce disasterous consequences for the unwary motorist.

The German Firm "Chemische Fabrik Kalk" (Cologne) produces the anti-icing agent "Verglimit", which when introduced to bituminous paving mixtures will reportedly eliminate hoarfrost, retard black-ice formation, and prevent adhesion between ice and the pavement. The Verglimit itself is composed of particles ranging in size from 0.1 to 5 mm. The particles consist of calcium chloride and sodium hydroxide and are coated with linseed oil. When mixed with bituminous concrete, the particles should be uniformly distributed and are protected from the asphalt and moisture by the linseed-oil coating. According to the information supplied by the producer, the Verglimit contained in the upper 5-10 mm of the pavement surface is active, depending on the void content. In this region, it is stored as a solution, which advances out of or retreats into the pores as a function of ambient humidity. As traffic passes over the pavement surface, fresh Verglimit particles are constantly being exposed through the abrasion process, and enter into solution with available moisture, lowering its freezing point.

In May 1987, ConnDOT placed a Verglimit-containing bituminous concrete surface course on the deck of a new bridge in the Town of Glastonbury (see Fig. 1). The material in question will be observed over a period of five years to ascertain its anti-icing characteristics and durability under traffic.

This report is devoted to the testing, production and placement of this experimental material.

DESCRIPTION OF TEST SITE

It had been initially planned to place the experimental material on a bridge deck in East Hartford. The bridge was to undergo in-service rehabilitation; however, the production logistics of the experimental mix would not have been favorable for this project. Instead of one day, production of the experimental material would have required scheduling over several different days.

Working in conjunction with the Office of Bridge Design, the Office of Research and Materials was provided with a substitute site, which would lend itself to a one-day production schedule. The site in question is the bridge deck that carries Rt 3 over Rt 2 in the newly constructed interchange between the two routes. The deck of the new bridge (No. 53-140-2) is divided into two roadways by a permanent Jersey barrier (see Fig. 2). The southbound lane of the bridge was selected for the Verglimit test application and the northbound lane as a control. The test section carries traffic southbound on Rt 3 from westbound Rt 2, and the control section traffic from northbound Rt 3 to westbound Rt 2.

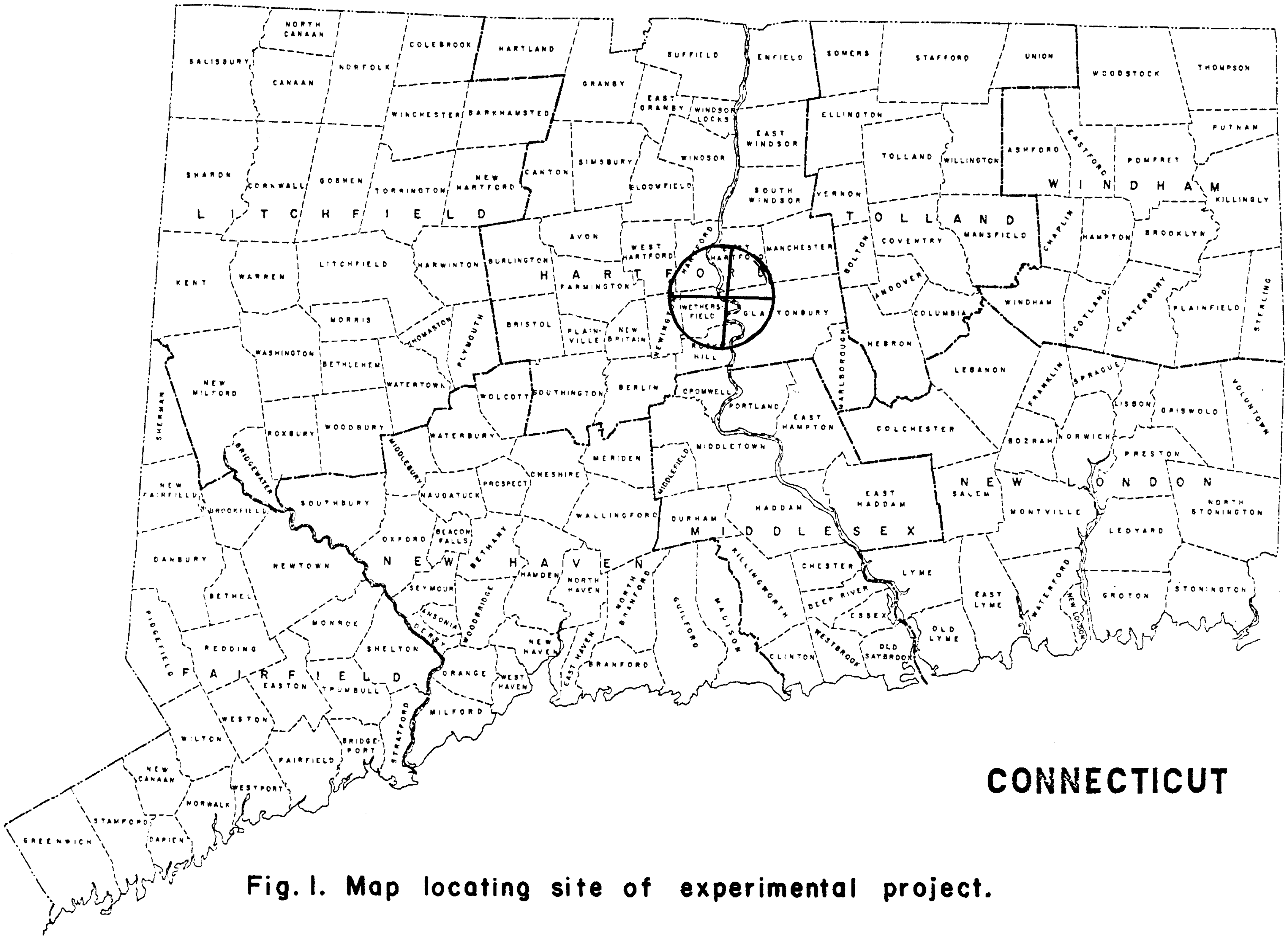


Fig. 1. Map locating site of experimental project.

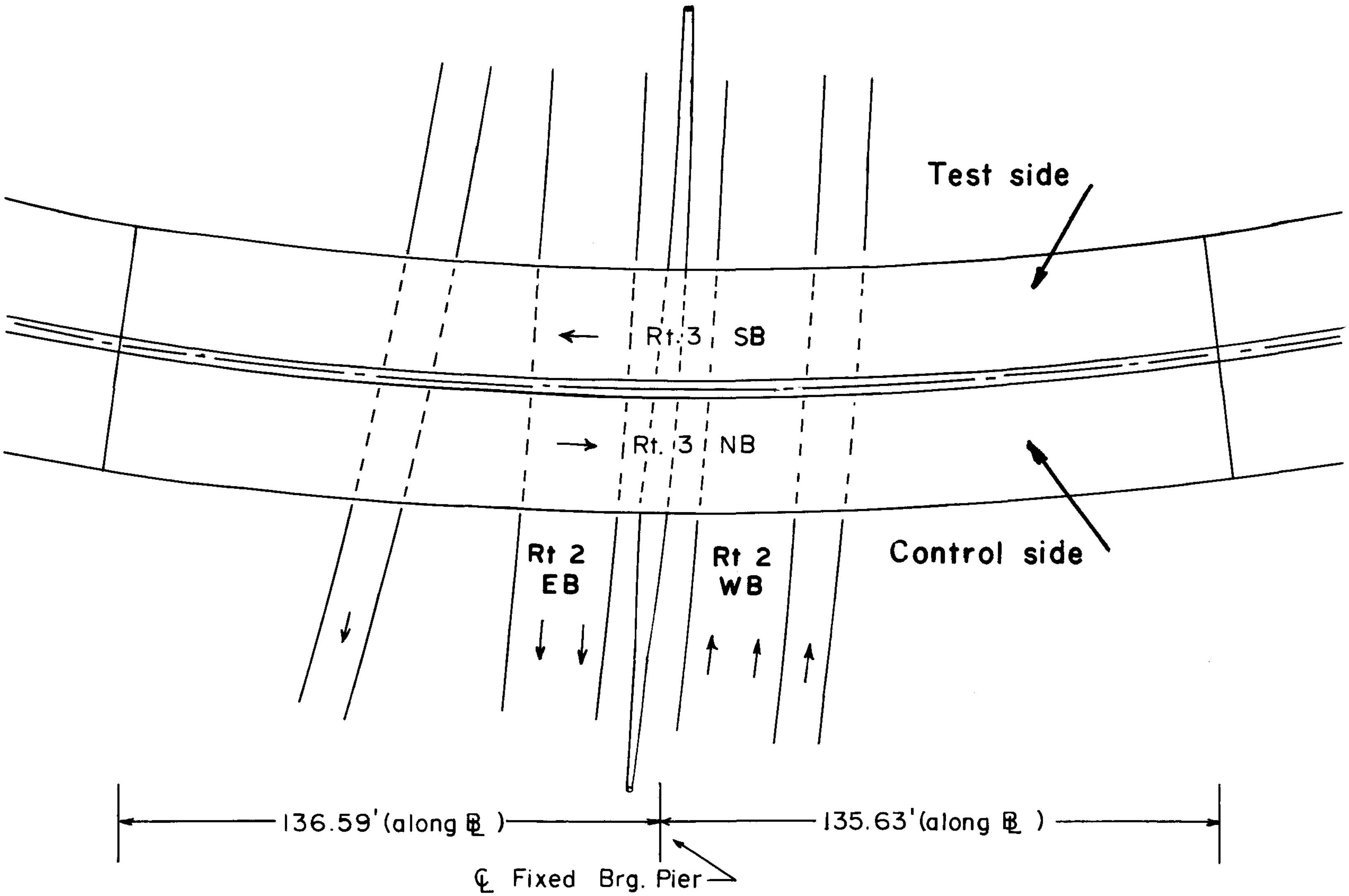


Fig. 2. Plan view of Rt 3 bridge incorporating experimental " Verglimit."

The bridge is approximately 272 ft in length and is in a horizontal curve with a radius of 1000 ft. It is divided into two nearly equal spans and employs steel box girders. The deck has an overall width of 62 ft and is superelevated at a rate of 0.0625 ft/ft. The test side of the bridge is 28 ft wide and the control side 30 ft wide. The median barrier is 4 ft wide. The actual travel lanes will be 12 ft on each side.

Original deck plans called for a waterproofing membrane topped by 3/4 in. of ConnDOT Class 12 and 2 in. of ConnDOT Class 1 (see Table 1). In this case, the latter course was modified to reflect the inclusion of 6% Verglimit.

TABLE 1 - SPECIFICATION FOR CLASS 1 BITUMINOUS CONCRETE

Screen Size	% Passing
#200	2-8
# 50	6-26
# 8	28-50
# 4	40-65
¼"	-----
3/8"	60-82
½"	70-100
1"	100
1-½"	---

Bitumen Percent (AC-20)	5-8
Bitumen Temperature (°F)	325 Max
Temperature of Mix (°F)	265-325
Aggregate Temperature (°F)	280-350
Voids (%)	3-6*
Stability (lb) Min.	1200
Flow (inches)	0.08-0.15

NOTES

a. 75-blow Marshall criteria utilized for void determination.

b. Coarse aggregate shall consist of clean, hard, tough, durable fragments of crushed stone or crushed gravel of uniform quality throughout. It shall not contain more that one percent (1%) of material such as crusher dust, sand, elongated or soft, disintegrated pieces. When tested by means of the Los Angeles Machine using AASHTO Method T96, the loss shall not exceed 40 percent.

   Fine aggregate shall consist of natural sand or of sand prepared from stone, slag or gravel, or combinations thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam, or other deleterious substances. If manufactured stone is utilized as fine aggregate, voids shall be 3-8 percent.*

MIX DESIGN AND FIELD-TRIAL TESTING

As was previously mentioned, the location was changed for the placement of the Verglimit mix. The originally selected bridge deck was to be paved with 6.2 percent Verglimit on the basis of laboratory design trials. Because the plant that was to have supplied the mix for the original location was also to supply the mix for the new location, it was decided to forego further laboratory trials and proceed with essentially the same mix design for the Glastonbury bridge. The only exception was a reduction in Verglimit content from 6.2 to 6.0 percent.

Field trials were run on May 12, 1987 at the Balf Co. Plant in Newington, Conn. In this case, the batch plant had a maximum batch capacity of five tons and was totally automated. It would be the same plant that would supply the experimental site in Glastonbury.

A target of 6.0 percent Verglimit was established for the trial 5-ton batch. The Verglimit would therefore replace 600 lbs of fine aggregate (minus 4 mm material). It was delivered to the plant in sealed 55-lb bags. A total of 11 bags (11 x 55 = 605 lb) were used for the trial batching. These bags were placed near the pugmill and remained sealed until their contents were actually charged into the mill.

The procedure employed for the actual trial batch was as follows:

1) Charge aggregate (course and fine) into pugmill and dry mix for 5 sec;
2) place Verglimit into weigh box by hand, first passing it through a 1-in. screen to break up any lumps that might have formed during storage;
3) add asphalt cement (AC 20 viscosity-graded);
4) mix asphalt and aggregate for 30 sec;

5) charge Verglimit into pugmill;

6) mix Verglimit, aggregate and asphalt for 15 sec; and,

7) discharge batch into truck.

The truck containing the 5-ton batch was then driven to a sampling platform where the temperature of the mix was checked and samples were taken for extraction-gradation tests and the molding of Marshall specimens. The latter were molded at the plant using an automatic compactor, and were transported the same day to the central laboratory in Rocky Hill for Marshall tests (flow, stability, and voids). The extraction - gradation tests were performed at the plant laboratory. The mixture was also checked for uncoated particles.

The results of the laboratory tests conducted on the trial batch are presented in Table 2. All mix properties were within the range of acceptable values for ConnDOT Class 1, with the exception of the voids. The latter were out of tolerance, because of the hydrophilic nature of the Verglimit. (See Table 2).

The trial batch was placed in a parking lot near the plant and rolled. The material will be observed periodically for durability.

TABLE 2. RESULTS OF TESTS CONDUCTED ON TRIAL BATCH

Mix temperature (in truck)	-	280°F
Avg. stability	-	2315 lb
Avg. flow	-	0.15 in.
Voids*		

GRADATION

Sieve	% Passing	JMF**	Class I Master Range
200	3.8	5.0	2 - 8
50	11.0	16.0	6 - 26
8	32.2	44.0	28 - 50
4	48.8	54.0	40 - 65
3/8	74.4	74.0	60 - 82
1/2	95.2	92.0	70 - 100
3/4	100.0	95.0	90 - 100
Bitumen	5.9%	5.5%	5 - 8

* During the period between molding of the specimens and their actual testing (20^+ hours), the molds apparently absorbed atmospheric water, showing a negative void content in both cases.

** Job Mix Formula

FIELD PRODUCTION AND PLACEMENT

Placement of both the Class 12 and experimental Class 1 materials was carried out on the same day - May 13, 1987. The total weight of the Verglimit-containing bituminous concrete placed at the jobsite was 85 tons.

Both materials were produced at the same plant as the trial batch: Balf Co., Newington. The batching procedure used for the Verglimit mix was the same as that developed for the trial batch. Due to the hand work involved in passing the Verglimit through the 1-in. screen, the plant manager elected to produce all 85 tons in consecutive batches. Thus, all four trucks carrying the experimental mix to the jobsite - about 10 miles - were loaded one after the other.

At the plant, the first truck was signaled to the sampling platform, where the temperature of the mix was checked and samples taken for extraction/gradation and Marshall specimens. The results of tests performed on these specimens are presented in Table 3.

The temperatures of the batches in the truck ranged from 305 to 310°F, indicating that the mix temperature in the pugmill was well below the recommended maximum of 337° for bituminous concrete containing Verglimit.

When the first truck arrived at the project site, the contractor was still placing the Class 12 material over the waterproofing membrane (Fig. 3). Before he had finished placing the Class 12, all four heated trucks containing the Verglimit mix had arrived at the site.

Once the Class 12 had been completed, the contractor immediately began to place the experimental surface course. It should be noted that after rolling, and before application of the surface course, the Class 12 material felt unusually soft under foot; this may have been due to the fact that the

TABLE 3. RESULTS OF TESTS CONDUCTED ON PRODUCTION CLASS 1 WITH VERGLIMIT

Seive	% Passing		Target
	Test 1	Test 2	
200	3.0	3.0	5
50	13	12	16
30	22	21	27
8	40	36	44
4	52	58	54
3/8	73	74	74
1/2	95	95	92
3/4	100	100	95
Bit.	6.39%	6.15%	

MARSHALL RESULTS

Flow, in.	12	14
Voids, %	1.39	1.41
Stability, lb	1965	2109

Fig. 3. Placing Class 12 material over waterproofing membrane on bridge deck.

Fig. 4. View of deck on test side of bridge. Top course containing Verglimit has just been completed.

roller was used in the static mode (no vibration). The Verglimit mix was placed in two 14-ft passes (Fig. 4). The paver used is a Blaw Knox PF180N. Two rollers were used for compaction - a Blaw Knox PF18011 (8 tons) and a Hyster R46 (10 tons). Both rollers were used in the static mode for the surface course also. The Verglimit manufacturer recommends the initial pass be made with a hot and dry roller, but a damp, not wet, wheel may be used if necessary. This is to prevent the Verglimit from retaining excess water. For this job, a damp roller was used, and no water retension problems were observed.

The manufacturer of the Verglimit also recommends that about 1 kg of sand, whose particles range from 0.1 to 3 mm, be applied and rolled into each square meter of surface to improve surface texture and increase skid resistance during the initial wear-in period. This sand should be spread before the final roller pass, and when the surface is still hot (no less than 195°F). In our case, however, it was decided to eliminate the sand application based on the fact that the bridge would not be opened to traffic for several months.

Paving of the experimental section proceeded smoothly and was completed in several hours. Some additional Verglimit mix remaining in the last of the four trucks was placed in the shoulder lane just north of the deck. This strip of material is approximately 12 ft wide and 116 ft long.

The temperature of the experimental mix at the paver ranged from 300°F to 275°F for the first and last trucks, respectively. The ambient temperature dropped from 79°F at 3:00 pm to 71°F at 4:50 pm, the approximate period in which the Verglimit was placed. The relative humidity was a rather low 30-34 percent over the same period.

The control side (northbound lane) of the deck received the same materials in the same sequence and thicknesses, with the exception that the

Class-1 surface course contains no Verglimit. This side was paved approximately three weeks prior to the test side. The same plant was used for both the Class 12 and Class 1 - Balf Co., Newington.

DENSITY TESTS

On May 14, 1987, the day after the Verglimit had been placed, personnel from the ConnDOT Central Laboratory measured the density of the experimental Class 1 material using a Campbell Pacific® ML-3 nuclear gage. Density measurements are not normally taken on bridge decks, i.e., there is no ConnDOT specification governing compaction of bituminous concrete over a concrete deck. In this case, measurements were taken at 10 random locations along the length of the bridge.

The results of these measurements indicated an average surface-course density of 93.2 percent of the theoretical density of 154 pcf as determined at the Laboratory. ConnDOT specifications governing the density of bituminous concrete placed as a surface course require a density of at least 91 percent and not more than 97 percent of the theoretical density. The average value obtained for the Verglimit (93.2 percent) was therefore approximately at the center of the allowable range. No density tests were taken on the control section at the time of placement.

SKID RESISTANCE

Once a Verglimit pavement is placed, the surface must be monitored before traffic is allowed to pass on it. Low skid resistance can occur as a result of the compaction operation which crushes the Verglimit particles in the upper 1-3 mm of the surface. These crushed particles absorb moisture, creating a damp surface. Combined with small amounts of excess linseed oil, the moisture causes a potential lack of adequate skid resistance during periods of high humidity.

In addition to the sand application mentioned, the Verglimit manufacturer recommends washing the newly placed pavement for several weeks. This is intended to flush the excess crushed Verglimit out of the pavement texture. Arrangements were made with the Division of Maintenance to utilize a water truck for this washing operation. They washed the Verglimit section every day for the first week after paving. Subsequent to the first week, the section was washed twice per week, and approximately 500 gallons of water were used in each application.

Pavement skid resistance was measured in both the test and control sections approximately two weeks after the Verglimit was placed. During this interim period the Verglimit section had been washed seven times. One skid test was performed on each section. The Verglimit had a skid number of 43.8, and the control had a skid number of 54.7. Although the skid resistance in the control section was significantly higher, that in the Verglimit section wasn't critically low, and would be expected to increase after additional washing. As mentioned, the Verglimit section was not to be opened for several months, thus washing twice per week continued for approximately six weeks. Skid testing is planned to be a major part of the evaluation phase of the project.

OBSERVATIONS

The Class 1 bituminous concrete containing the Verglimit was placed in the same manner and with the same machinery as the standard Class 1 bituminous concrete placed on the control section. The only problem that developed during placement stemmed from the fumes given off by the mixture, which aggravated some of the laborers, and especially the paver operator. The odor liberated was that of linseed oil. Complaints were registered, but no one actually got sick. In the future, some type of protective breathing apparatus could be worn by those objecting to the fumes.

Another problem that arose occurred in the laboratory with the Marshall specimens. Normally, Marshall specimens are molded in the field and returned to the central laboratory in Rocky Hill for testing. These tests may be run the same day or the next working day, depending on the time that the cores arrive at the laboratory. In our case, the specimens were brought to the lab on May 12, and were tested the next day - May 13. On standing overnight, the specimens apparently absorbed moisture from the air, primarily through the calcium chloride in the mixture. In testing for void content, the determinations indicated negative voids. If Verglimit is proven to be effective, and additional sites are selected for its application in the future, some change in the method of void determination will be required.

COST

A comparison was made between the cost of the conventional Class 1 bituminous concrete and the Class 1 with the Verglimit. The contract price for the Class 1 material placed on the control section was $33.00/ton in place. The additional per-ton cost for the test material amounted to the following:

Cost of Verglimit (187 bags @ $36.76 per bag)	=	$6875.00
Cost of Mixing (4 additional men & storage)	=	$ 997.60
		$7872.60
Estimated Quantity of Experimental Mix	=	84.83 tons
Additional cost per ton = $7872/84.83 ton	=	$92.80/ton

Summing the additional cost and the conventional cost for Class 1, we obtain

$$\$92.80 + \$33.00 = \$125.80/\text{ton}$$

for the total in-place cost of the Verglimit material. This figure is about 3.8 times higher than the per ton cost for the conventional material. The only possible way to reduce this cost in the future would be to automate the introduction of Verglimit to the pugmill, thereby reducing the labor intensity of the process.

CONCLUSIONS

From a construction point of view, the inclusion of Verglimit into a bituminous mix posed some, but no major problems. The difficulty in determining the percent voids was the only testing problem. For future Verglimit projects, this problem can be overcome by keeping the Marshall mold dry, and running the test sooner to prevent excessive water absorption.

For cost savings, a revised method for adding the Verglimit to the mix batches can be developed. Instead of manually screening, and charging the pugmill, some mechanized system can be substituted. This will result in significant savings if larger amounts of Verglimit mix are produced.

The washing of the test section also increased costs compared to the conventional pavement. This procedure can not be eliminated because of the loss of skid resistance. Our skid testing, conducted 2 weeks after placement, showed the Verglimit to have lower skid resistance than the control, but still adequate for normal driving conditions. For this project, the section was not opened until September 1, 1987. This was an advantage because the Verglimit was fully washed before traffic passed over it. Overall, the inclusion of Verglimit into the bituminous mix had no major adverse effects on the production and placement operations.