GUSSASPHALT BRIDGE DECK PROTECTIVE SYSTEM

FINAL REPORT 76 - 2
October, 1976

VERMONT DEPARTMENT OF HIGHWAYS

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STATE OF VERMONT
DEPARTMENT OF HIGHWAYS
MONTPELIER
05602

May 23, 1978

Mr. David B. Kelley, Division Administrator
Federal Highway Administration
Federal Building
Montpelier, Vermont 05602

Att: D. J. Philbrick

Dear Mr. Kelley:

Re: Failure of Category II Experimental Feature on US Rte. 302 Bridge over I 91 in Newbury

Problems have been experienced with the pavement on the U.S. Route 302 eastbound lane over I 91 in Newbury since construction in October, 1973. The pavement distress has occurred in the form of migration or cracking. Repairs carried out in 1974 and 1975 included an area of 68 s.y. or 8% of the deck area. Distress is currently visible at five additional locations which encompass an area of approximately 130 s.y. or 13% of the deck surface.

The major cause of failure was believed due to the absence of the normal impregnated coating on the fiberglass reinforcement which resulted in shear failures of the membrane along the reinforcement.

We do not believe further temporary repair of the pavement and membrane is a viable solution to the problem. We propose that the existing pavement and membrane be removed and replaced under a Force Account project with the membrane application carried out by an experienced waterproofing contractor.

Since the membrane system was installed as a Category II experimental feature, we respectfully request that Federal-Aid Interstate funds be made eligible for repair of the failure as covered under the Federal-Aid Highway Program Manual, Volume 6 Chapter 4, Section 2, Subsection 4, Transmittal 249, September 15, 1977.

An estimate of the cost would be as follows:

Traffic Control
Pavement & Membrane Removal
Surface Preparation
Membrane (840 s.y. @ $ 5.00)
Pavement (93 tons @ $40.00)

Total

Enclosed also, please find a layout and photos showing the present condition of the pavement.

ACKNOWLEDGMENT

This experiment was performed in cooperation with The Demonstration Projects Division, Region 15, of the Federal Highway Administration, under negotiated Contract DOT FH-15-137.

The information contained in this report was compiled exclusively for the use of the Vermont Department of Highways and the Federal Highway Administration. Recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Department or FHWA policy.

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INTRODUCTION

In August, 1974, a mastic asphalt membrane and Gussasphalt pavement was placed on east and westbound spans of Vermont Rte. 62 over Blackwell Street in Barre, Vermont. The experiment was conducted in cooperation with the Federal Highway Administration, Region No. 15 Demonstration Projects Division, as part of Demonstration Project No. 22, "Demonstration of Paving Mastic Asphalt Protective Systems for Bridge Decks".

Detailed information on the production and application of the materials was recorded and reported in Vermont Department of Highways Report No. 74-7 entitled, "Gussasphalt Bridge Deck Protective System". Initial observation and test results indicated that the production and application of the system were successful considering the experimental nature of the trial. However, the cost of the system was excessive at $62.35 per square yard.

OBSERVATIONS AND FOLLOW UP EVALUATIONS

Evaluation of the Gussasphalt system during the first winter's installation was limited to visual observations and a check of moisture sensors which had been placed at four locations on the concrete surface. An in-depth evaluation of the system was made in June, 1975. There were no signs of distress or cracking in the Gussasphalt nor was there any indication that the material had pulled away from the granite curb lines. Good surface textures were noted, although chips had begun to wear off the westbound lane. Chips were also missing at several small areas on the eastbound roadway but the shape of the areas suggests that the loss was due to a lack of adhesion during construction rather than wear from traffic. Indentations were visible on the westerly end of the westbound lane where a tractor tired vehicle had parked along the curb line. Transverse cracks were noted on the westerly end of both lanes where the bituminous pavement butted the Gussasphalt. The cracks were due to stresses which developed when the joints between the bituminous pavement and Gussasphalt were not sawed directly over the end of the spans. Electrical resistivity tests were taken at 64 locations over a two-hour period. All readings were recorded at infinity indicating the system was impermeable. Readings taken on the moisture sensors (copper foil strips) revealed resistance values between 250 and 800 ohms. Such low readings suggest a short-circuiting effect caused by the flow of a chloride solution between sensors. However, since the resistivity readings on the system were high and the curb lines appeared to be properly sealed, the validity of the readings were considered suspect.

See climatic conditions, deicing chemical applications, and traffic data on page 11.

No further evaluations of the system were made in 1975 with the exception of visual observations. On February 22, 1976, a visual inspection of the Gussasphalt pavements revealed the existance of a network of connected random cracks in both spans (see crack layout on page 7). Approximately 170 lineal feet of cracks were noted on each span but the total footage could not be initially determinded due to the existance of snow banks along three of the four curb lines. The exposed curb line revealed that a number of the cracks extended towards the curb line but all stopped short of the curb face. The average width of the cracks at the riding surface was 1/16 inch while the maximum width was measured at 3/16th inch. The cracks extended through the full depth of the Gussasphalt and mastic asphalt membrane as evidenced by cores taken through four crack locations and chloride concentrations recorded on ice and water samples taken from curb line drain tubes. The latter may also have been due in part to leakage at the curb line since inspection of such areas after the snow had melted revealed a definite loss of adhesion between the Gussasphalt and granite at numerous locations. The formation of an additional crack was noted in each span on March 18, 1976.

Repair of the system was carried out in April, 1976. The procedure included routing of the cracks, burning to remove moisture and sealing with a hot poured joint sealer which was certified to meet Federal Specification SS-S-1401A. The routing was done with 1/2 inch bits for an average depth of 5/8 inch. The sealing procedure along the outer curb lines included removal of the Gussasphalt along a 2 inch wide by 2 inch deep area. Treatment along the median curb lines consisted of cutting a 1 1/2 inch wide by 2 inch deep groove which was then filled with joint sealer. The transverse cracks which had ocurred the first year along the westerly end of both spans were also sealed. The cost of the repairs totaled $1,103.84.

The second evaluation of the system was made on September 14, 1976. Little, if any, change was noted in the texture of the riding surface. Infinite electrical resistance readings were recorded on the Gussasphalt with the exception of readings between 8 million and 25 million ohms obtained over sealed crack locations. Pulverized concrete core samples were taken from three representative areas in order that the level of chloride contamination could be determined and compared with any possible future increase due to either Gussasphalt or crack filler leakage. All three cores disclosed high chloride levels at both 0 - 1 inch and 1 - 2 inch depths (see chloride levels on page 12). The highest contamination, recorded at approximately 3 pounds chloride per cubic yard of concrete, occured in the top inch at a location 1.5 feet down grade from a crack in the Gussasphalt. However, chloride levels from 1 - 2 pounds were also detected in cores taken 1 foot off the curbline and at a location 7 to 13 feet away from adjacent cracks where chloride ingress had not been anticipated. The widspread contamination may have been due in part to a wicking action provided by the fiberglass mesh and cloth vapor release layer beneath the membrane.

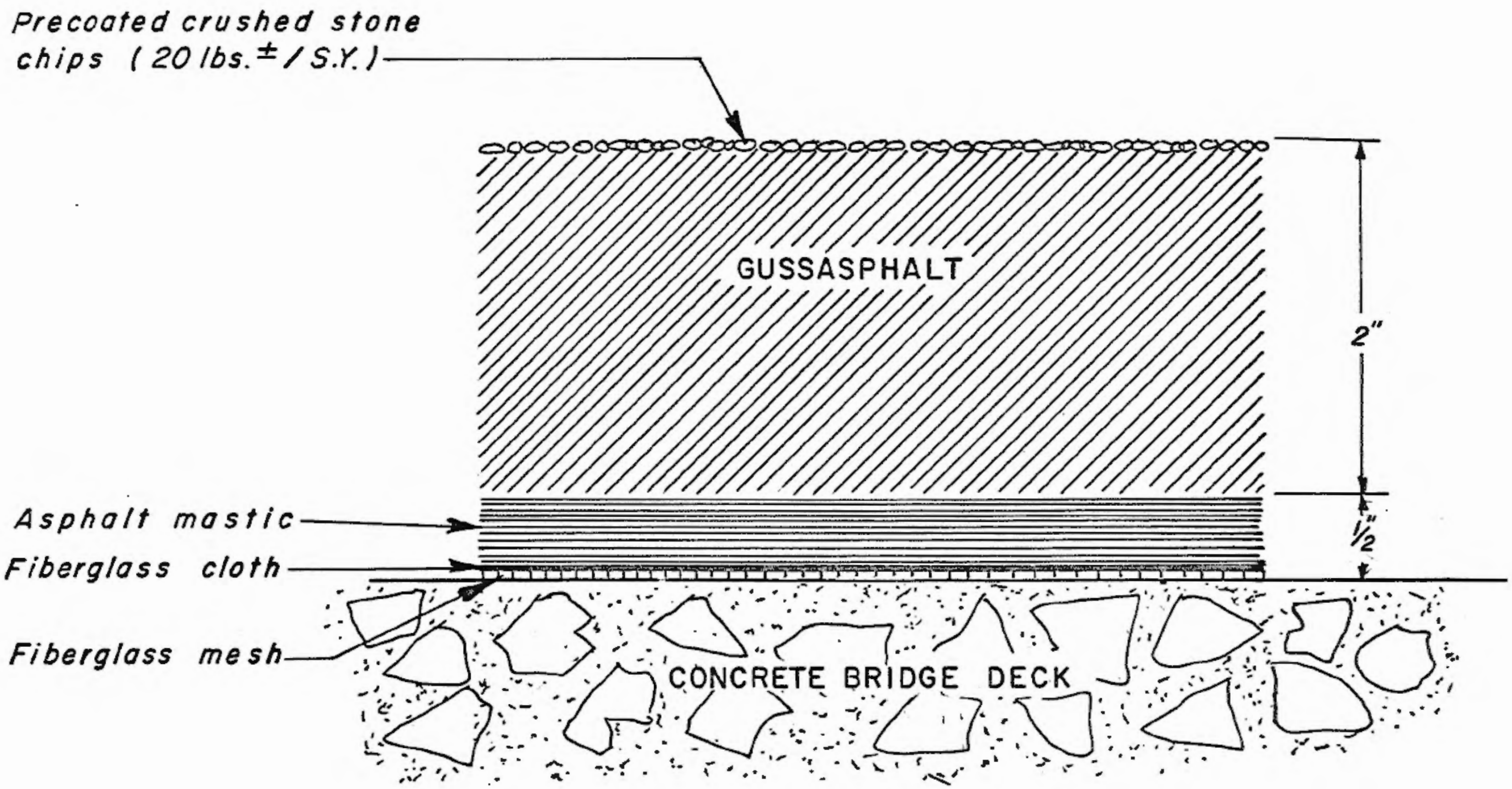
SUMMARY

The unsatisfactory performance of the Gussasphalt system was no doubt due to a number of factors with the ultimate crack failure brought on by low temperatures. Although the material was generally not heated to the 420°F - 450°F recommended range, a high percentage of it was heated at 350°F to 390°F for an extended period of time. The extended heating period may have damaged some of the mix by hardening the asphalt, as indicated by variations in viscosity and penetration values obtained on recovered asphalt samples. Leakage of the system at the curb line may have been prevented if the curb surface had been primed with material capable of promoting adhesion of the mastic asphalt to the substrate.

Pulverized core samples taken from the WB deck after the overlay failure revealed chloride levels of 284 to 755 ppm in the top inch as compared to initial levels of 49 to 66 ppm.

Inspection of the system will continue with emphasis on the performance of the crack filler since failure of the latter will result in further chloride contamination which will bring chloride levels above acceptable limits.

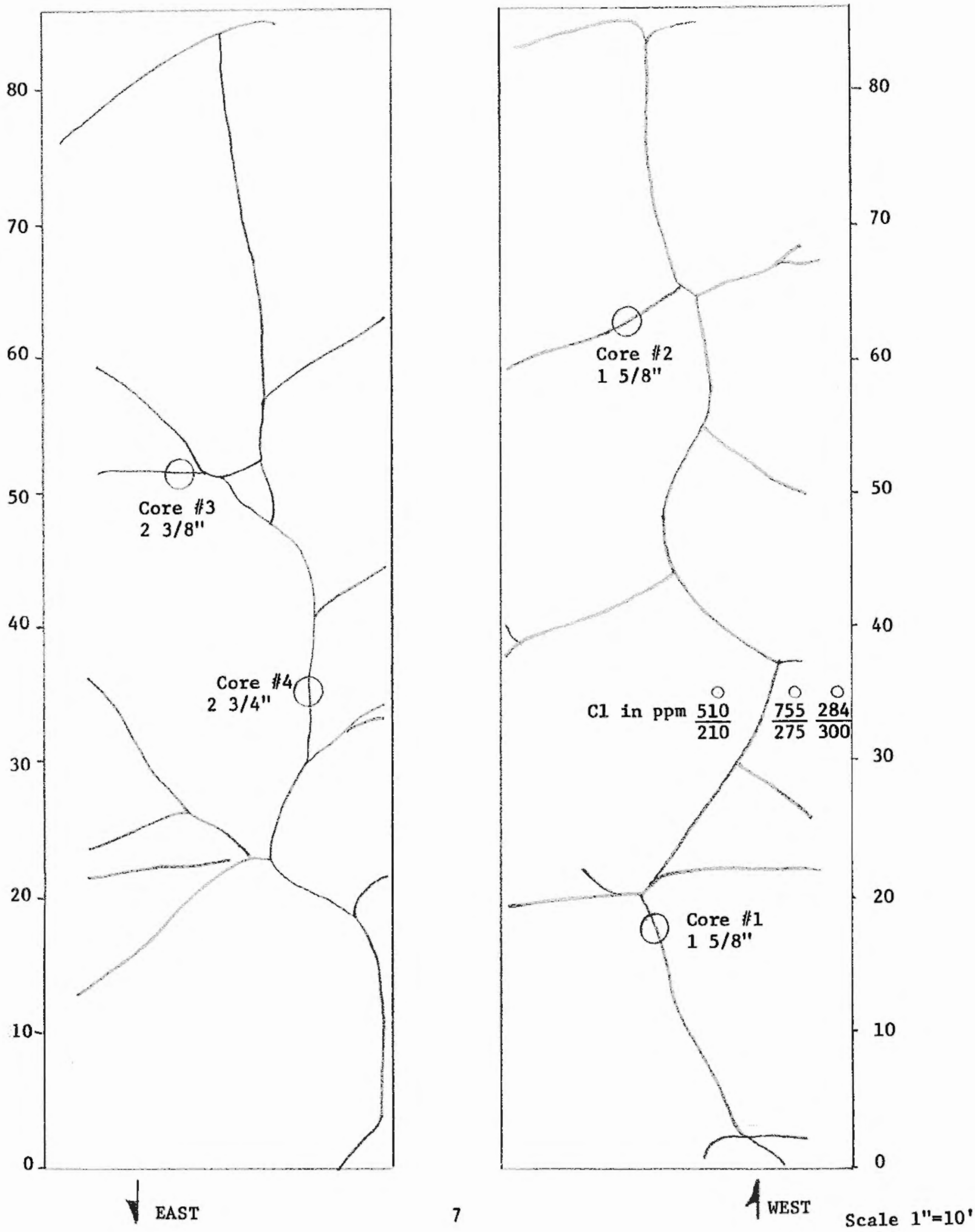
REG.	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
#1	Vt	Demo 22.	1	1



Typical Cross Section of Gussasphalt Waterproofing Membrane

VERMONT DEPARTMENT OF HIGHWAYS - MATERIALS DIVISION

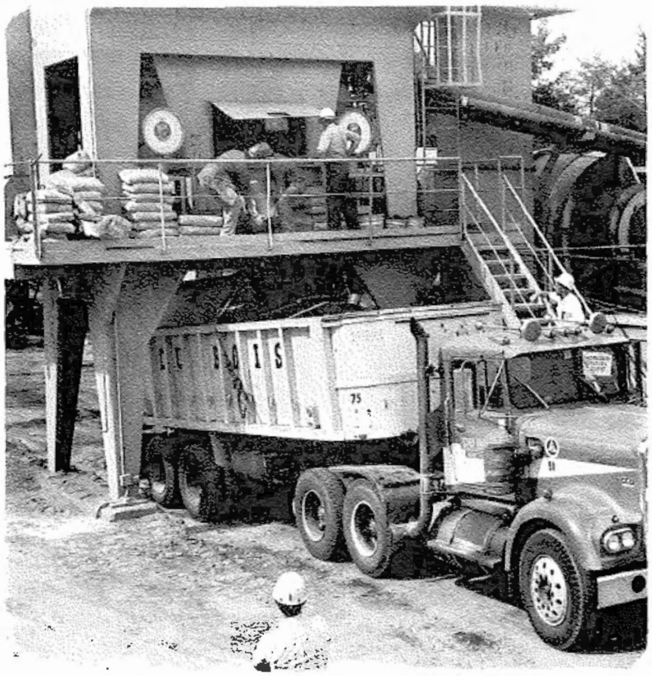
CRACKS IN GUSSASPHALT PROTECTIVE SYSTEM
ROUTE 62/BLACKWELL STREET, BARRE



GUSSASPHALT BRIDGE DECK

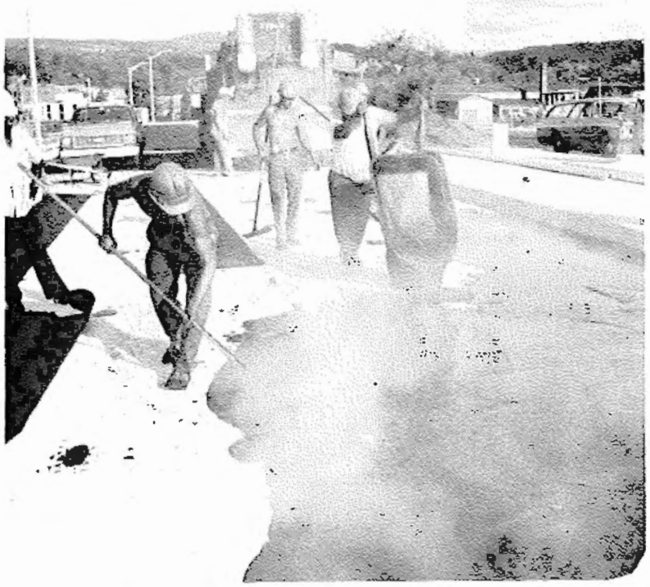
PROTECTIVE SYSTEM

August 1974



Adding the mineral filler into the pugmill by hand.

Fiberglass vapor release system. Note extension of system over drain tube near curb face.



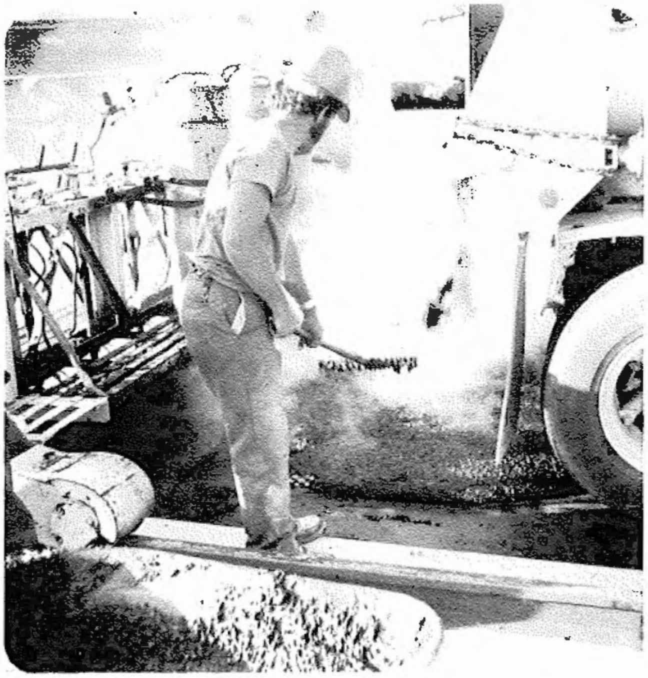
Placing and spreading mastic asphalt with squeegees.

Voids in mastic asphalt prior to touch-up.

GUSSASPHALT BRIDGE DECK

PROTECTIVE SYSTEM

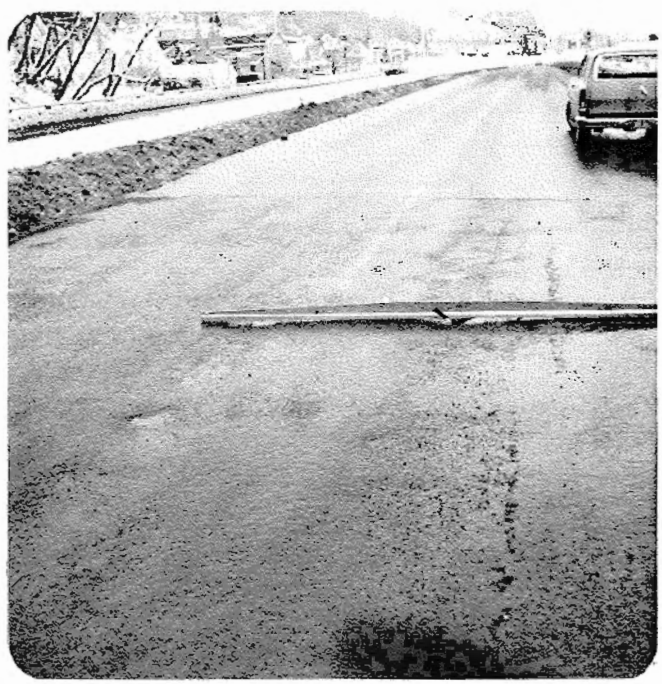
August 1974



Placing the Gussasphalt directly in front of the leveling screed.

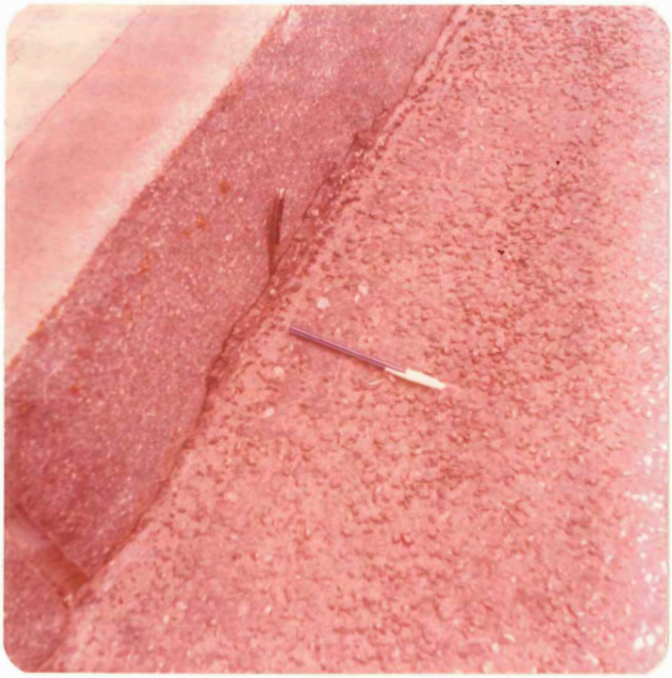
Eastbound lane complete. Note where stone chips penetrated into the Gussasphalt.

Difficulties with the leveling screed dragging the mix.



Depressions in the finished surface at locations where the mix was dragged.

Gussasphalt Bridge Deck
Protective System
April, 1976



Loss of seal at curb line

Cracks in Gussasphalt

Core hole showing full depth crack

Routing and burning cracks prior to sealing

VERMONT ROUTE 62/BLACKWELL STREET

Data on Traffic Volume, Climatic Conditions and Deicing Chemical Applications

Traffic Volume

Average Daily Traffic	1974 - 2875 (Nov.-Dec.) 1975 - 3697 1976 - 4400 (Jan.-Aug.)
Percent Trucks	6%

Climatic Conditions

Date	Average Temperature	Average Minimum Temp.	Freeze-Thaw Cycles	Snowfall
Oct. 1974	44°	34°	15	Trace
Nov. 1974	36°	29°	13	11.9"
Dec. 1974	28°	22°	23	21.9"
Jan. 1975	23°	15°	11	15.5"
Feb. 1975	22°	14°	10	20.0"
Mar. 1975	28°	20°	17	17.0"
Apr. 1975	37°	30°	19	25.4"
		Totals	108	111.7"
Oct. 1975	50°	43°	1	Trace
Nov. 1975	42°	36°	10	12.0"
Dec. 1975	19°	11°	8	29.7"
Jan. 1976	12°	2°	5	45.3"
Feb. 1976	24°	14°	18	18.4"
Mar. 1976	30°	21°	14	28.6"
Apr. 1976	47°	38°	10	2.0"
		Totals	66	136.0"

Annual Application of Deicing Chemicals

1974 - 1975	35.5 tons per mile
1975 - 1976	49.3 tons per mile

SUMMARY OF CHLORIDE LEVELS, RESISTIVITY AND MOISTURE STRIP READINGS

CHLORIDE LEVELS

Cores taken from westbound span at points 36 feet west of easterly approach slab joint on 9-14-76.

Core #	Location	0 - 1" PPM	0 - 1" lbs.	1" - 2" PPM	1" - 2" lbs.
1	1 ft. off curb 4.6' from nearest crack	284	1.1	300	1.2
2	4.1' off curb 1.5' from nearest crack	755	3.0	275	1.1
3	10.2' off curb 7' and 13 feet down grade from nearest cracks	510	2.0	210	0.8

Initial chloride levels recorded at 49 - 66 ppm WB lane
62 - 68 ppm EB lane

ELECTRICAL RESISTANCE

1975 -
Eastbound - Infinity at 31 locations
Westbound - Infinity at 33 locations

1976 -
Eastbound - Infinity at 28 locations
Westbound - Infinity at 22 locations

40 million, 25 million and 8 million ohms at filled crack areas.

RESISTANCE READINGS ON COPPER FOIL STRIPS IN OHMS

STRIP NUMBER

Date	1	2	3	4
8-21-74	95,000	29,000	30,000	
9-25-74	9,500	35,000	95,000	60,000
11-14-74	7,000	10,000	130,000	55,000
6-5-75	800	250	700	400
6-26-75				280,000
2-25-76	500	500	650	
9-15-76	80	75	20,000,000	100