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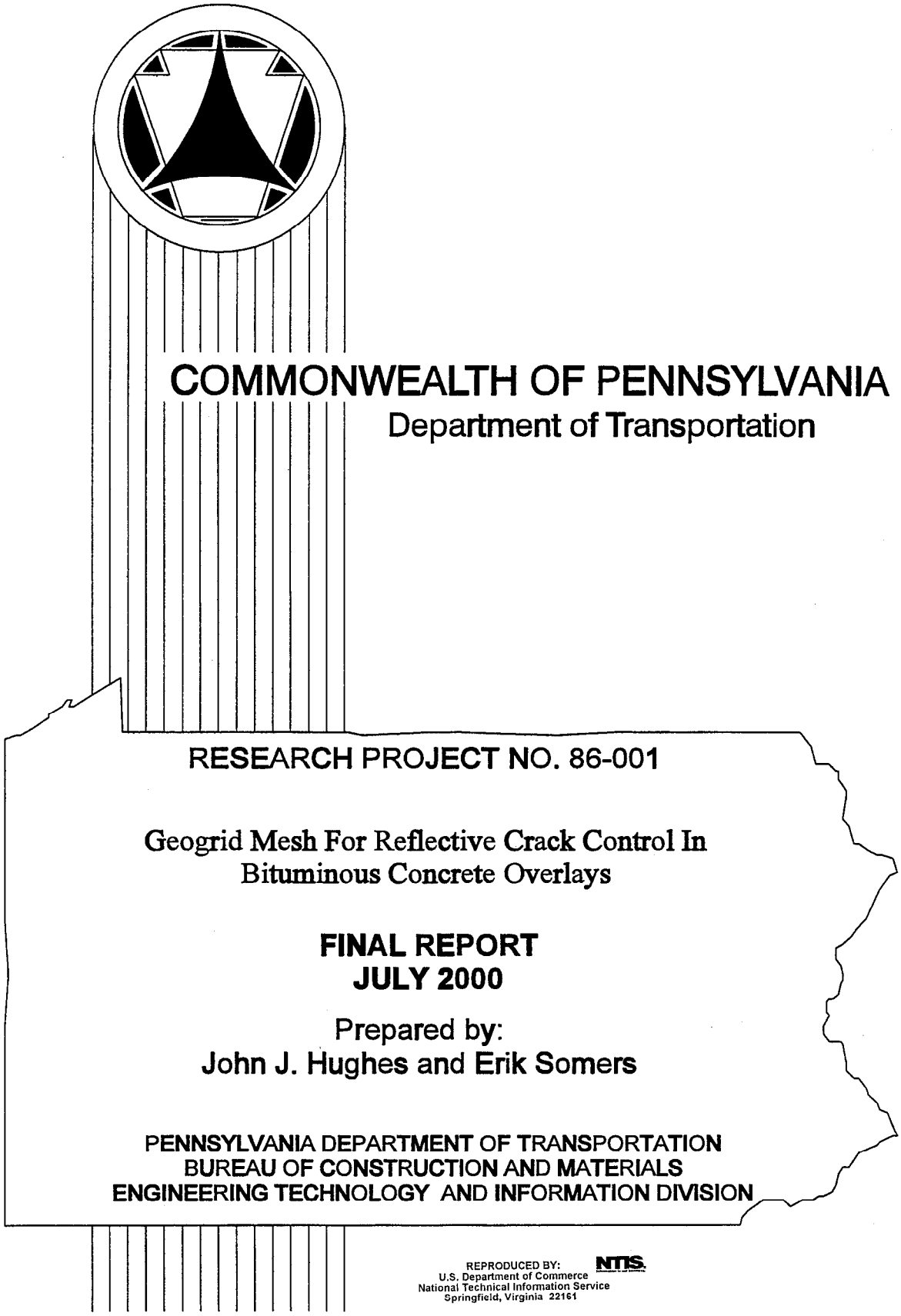

COMMONWEALTH OF PENNSYLVANIA

Department of Transportation

RESEARCH PROJECT NO. 86-001

Geogrid Mesh For Reflective Crack Control In Bituminous Concrete Overlays

FINAL REPORT
JULY 2000

Prepared by:
John J. Hughes and Erik Somers

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF CONSTRUCTION AND MATERIALS
ENGINEERING TECHNOLOGY AND INFORMATION DIVISION

REPORT DOCUMENTATION PAGE PAGE	1. REPORT NO. PA 200-013+86-001	2.	3. Recipient's Accession No.
4. Title and Subtitle Geogrid Mesh for Reflective Crack Control In Bituminous Overlays Final Report			5. Report Date July 2000 6.
7. Author(s) John J. Hughes, Research Project Engineer Erik Somers, Engineering Intern			8. Performing Organization Rept. No. 86-001
9. Performing Organization Name and Address Pennsylvania Dept. of Transportation Materials and Testing Division 1118 State Street, Harrisburg, PA 17120			10. Project/Task/Work Unit No.
12. Sponsoring Organization Name and Address Pennsylvania Department of Transportation Bureau of Construction and Materials Materials and Testing Division Engineering Technology Section 1118 State Street, Harrisburg, PA 17120			11. Contract(C) or Grant (G) No. (C) 86-001 (G)
15. Supplementary Notes Research Project 86-001 Project Manager: Paul M. Ingram, P.E.			13. Type of Report & Period Covered: Final Report June 95 to May 98 14.

16. Abstract (Limit 200 words)

This final report summarizes the installation procedures and final performance evaluation of three paving fabric type products used to prevent reflective cracking in bituminous overlays over ridged pavements. These products were evaluated in three test sections with two control sections at two separate locations in Engineering District 6-0 Montgomery County. A paving fabric called "Petromat" and a combined paving fabric and geogrid called "Bit-U-Tex" were placed on SR 0073 near Gilbertsville. The fiberglass paving grid called "Glasgrid" was placed on SR 0663 in Pennsburg. The Petromat and Bit-U-Tex were mechanically placed with a specialized tractor over the full width of the road. The Glasgrid was placed by hand and only over six transverse joints and one longitudinal joint.

17. Document Analysis a. Descriptors
Pavement, Reflective Cracks, Asphalt

b. Identifiers/Open-Ended Terms
Paving Fabric, Petromat, Bit-U-Tex, Glasgrid
c. COSATI Field/Group

18. Availability From: The Penn DOT, Reference Center Room 903 Transportation and Safety Building	19. Security Class (This Report) Unclassified	21. No. of Pages 80
	20. Security Class This Page) Unclassified	22. Price

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Engineering Technology Section
Evaluations and Research Unit

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EXECUTIVE SUMMARY

This study evaluated three materials used to prevent reflective cracking in bituminous overlays with ridged bases. The following materials were evaluated in this study: Petromat, a paving fabric manufactured by Amoco, Bit-U-Tex, a paving fabric with a polyester geogrid heat bonded to a non-woven needle-punched geotextile and Glasgrid 8501, a bitumen coated fiberglass grid. The Petromat and Bit-U-Tex were placed on SR 0073 near Gilbertsville. The Glasgrid 8501 was placed on SR 0663 near Pennsburg. These paving projects consisted of a 1½ inch depth ID-2 bituminous wearing course overlay. The existing pavements on both projects was a concrete roadway with an existing bituminous overlay. The primary objective of this study was to determine if the placement of an AC-20 tack coat and a fabric inter-layer reinforcement over a rigid substructure prior to a flexible overlay eliminates or reduces the formation of reflective cracks. The purpose of a paving fabric is to act as a waterproofing and stress relieving membrane within the paving structure. The relative effectiveness and the cost/benefit ratios of the different inter layers being studied were also to be determined after three years if the performance was satisfactory.

Findings:

Placement of these materials during construction is simple, however consideration must be given to air temperature prior to placement. This became apparent at the Gilbertsville test site on SR 0073. The AC-20 used to tack the materials down needed to cool so that the paving fabric adhered to the road surface and was not picked up by the paving equipment.

The Bit-U-Tex and Petromat paving fabrics evaluated on SR 0073 at this site also did not prevent or retard reflective cracking. Both the control and test sections performed the same and began to show reflective cracks in the third year of this study. This is illustrated in Photographs 52 to 80.

The research project conducted on SR 0663 in Pennsburg to evaluate the Glasgrid 8501 was discontinued after the second year due to poor performance. Initially the Glasgrid 8501 was performing better than the control section during the first year. However, by the end of the second year it became evident that the cracks in the test section were deteriorating the road surface more severely than the control section. The Glasgrid caused the reflective crack to spread out over a larger area. This is evident in Photographs 99 to 109 and a visual record is listed in Table 1 on page 69.

Recommendations:

Based on the findings from this study Petromat, Bit-U-Tex, and Glasgrid 8501 are not recommended for approval or further study. This recommendation is based on the results of this study and previous research efforts conducted by the Department of Transportation over the past 25 years.

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METRIC CONVERSION FACTORS

TO CONVERT FROM	TO	MULTIPLY BY
Length		
foot (ft)	meter (m)	0.3048
inch (in)	millimeter (mm)	25.4
yard (yd)	meter (m)	0.9144
mile (statute)	kilometer (km)	1.609
Area		
square foot (ft^2)	square meter (m^2)	0.0929
square inch (in^2)	square centimeter (cm^2)	6.451
square yard (yd^2)	square meter (m^2)	0.8361
Volume		
cubic foot (ft^3)	cubic meter (m^3)	0.02832
cubic yard (yd^3)	cubic meter (m^3)	
gallon (U.S. liquid)**	cubic meter (m^3)	0.003785
gallon (Can. liquid)**	cubic meter (m^3)	0.004546
ounce (U.S. liquid)	cubic centimeter (cm^3)	29.57
Mass		
ounce-mass (avdp)	gram (g)	28.35
pound-mass (avdp)	kilogram (kg)	0.4536
ton (metric)	kilogram (kg)	1000
ton (short, 2000 lbm)	kilogram (kg)	907.2
Density		
pound-mass/cubic foot	kilogram/cubic meter (kg/m^3)	16.02
pound- mass/cubic yard	kilogram/cubic meter (kg/m^3)	0.5933
pound-mass/gallon(U.S.)**	kilogram/cubic meter (kg/m^3)	119.8
pound-mass/gallon(Can.)**	kilogram/cubic meter (kg/m^3)	99.78
Temperature		
deg Celsius (°C)	kelvin (°K)	$t^{oK}=(t^{oC}+273.15)$
deg Fahrenheit (°F)	kelvin (°K)	$t^{oK}=(t^{oF}+459.67)/1.8$
deg Fahrenheit (°F)	deg Celsius (°C)	$t^{oC}=(t^{oF}-32)/1.8$

*The reference source for information on SI units and more exact conversion factors is the "Metric Practice Guide" ASTM E 380.

**One U.S. gallon equals 0.8327 Canadian gallon.

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Final Report

INTRODUCTION

For over 20 years, synthetic fabrics have been used under bituminous paving overlays to prevent or at least retard reflective cracking and surface water intrusion of the base. A majority of the fabrics being marketed for this purpose is manufactured from polyester (polyethylene terephtalate) or polypropylene. However, in the past, other materials and combinations of materials have been attempted, including nylon and glass fibers. Various processes, including woven, spun-bonded, needle-punched, or combinations thereof, are being used to manufacture the fabrics. At least one manufacturer has produced a fiber-reinforced membrane made with asphalt cement. Although it is not a true fabric, it is designed for eliminating reflective cracking in bituminous overlays.

The use of the inter-layer has been tested by various agencies in many locations in this country. However, many of the tests have not been reported. Results that have been reported vary from favorable to unfavorable[1]. Pennsylvania's experience has been limited to several projects where the work was performed between 1973 and 1988. Petromat ®, a non-woven polypropylene fabric produced by Phillips Petroleum Co., was one of the products tested. The final report[2] stated that although cracking was retarded, use of the fabric was not recommended since the benefits were insufficient to justify the cost. It was also concluded, "the fabric was more effective in retarding transverse cracking in bituminous concrete associated with thermal changes (horizontal movement) than with cracking associated with structural inadequacies (vertical movement)". Other studies evaluated heavy duty membranes for the reduction of reflective cracking in bituminous concrete overlays[3]. This report evaluated six heavy-duty membranes. Of the six, this evaluation resulted in Paveprep®, Roadglas®, Petrotac®, and Polygard® being Penn DOT approved for state projects. The latest study completed a comparison of methods to retard reflective cracking in bituminous concrete using fabrics and fibers[4]. This study evaluated four paving fabrics, one stress-absorbing interlayer (SAMI), and a fiber reinforced asphalt cement mix. The study concluded that these materials only retarded cracking and were not cost effective for the life cycle of the pavement.

This study will be performed in a similar manner, however, the paving fabrics being evaluated, Glasgrid, and Bit-U-Tex, have different physical properties.

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[1] NCHRP- Synthesis of Highway Practice, Report No. 92, September 1982

[2] Office of Research & Special Studies, Research Report No. 73-20, August 1981

[3] Office of Research & Special Studies, Research Project No. 79-6, September 1981
Research Project No. 79-6, Interim Report, December 1983

[4] Bureau of Bridge & Roadway Technology, Research Project No. 83-8, September 1985
Research Project No. 83-8, Follow-Up Report, September 1987
Research Project No. 83-8, Final Report, July 1988

MATERIAL DESCRIPTION

The following materials were evaluated:

Bit-U-Tex

This material is made by heat bonding a PVC coated polyester geogrid to a needle-punched nonwoven geotextile. This hybrid material produces a high tensile strength paving fabric. This product must be tacked to the existing pavement with heavy coat of AC-20 at a rate of 0.25 gallons per square yard to promote adhesion. Bit-U-Tex may demonstrate an improved bond with the bituminous material due to the texture of the nonwoven needle-punched geotextile.

Glasgrid

This material is a bitumen coated, high tensile strength fiberglass grid used for pavement reinforcement. This material is placed similar to a pavement fabric, however, due to the larger apparent openings in Glasgrid the material knits or interlocks better with bituminous paving materials. The purpose of this material is to retard reflective cracking for the seven to eight year life cycle of the bituminous overlay.

Petromat 4596,

This material is a nonwoven polyester needle-punched geotextile, paving fabric. The fabric absorbs the AC-20 tack coat during placement and knits with the bituminous overlay. This creates a waterproof membrane between the existing pavement and the new bituminous overlay.

See Appendix A, for the material properties of these products.

PROJECT DESCRIPTION

Engineering District 6-0 had two road resurfacing projects in Montgomery County selected as test sections for this research project. The first resurfacing project was on SR 0073 near Gilbertsville and was scheduled for paving on June 5, 1995 as a daylight operation. The second resurfacing project was on SR 0663 near Pennsburg and was scheduled for paving September 5, 1995 and was a night paving operation. These paving projects both placed a 1½-inch depth ID-2 bituminous wearing overlay. The existing pavement on both projects was a concrete roadway with an existing bituminous overlay. Each construction project was constructed through a Maintenance Contract. Work was performed by the same contractor: Allen A. Myers, Inc.

- SR 0073 is a two lane concrete highway with a lane width of 12 feet and a transverse joint spacing of 63 feet 6 inches. The (ADT) average daily traffic count is 17,364 with 5% trucks. The two products, Bit-U-Tex,® and Petromat® have been selected for evaluation at this test site.

- SR 0663 is a two lane concrete highway with a lane width of 11 feet with a shoulder width of 6 feet and a transverse joint spacing of 76 feet 6 inches. The (ADT) average daily traffic count is 6,489 with 15% trucks. The product Glasgrid has been selected for evaluation at this test site. Each test site has a control section for comparison.

PLAN OF STUDY

The objective of this study is to determine whether the placement of a fabric inter-layer reinforcement over a rigid substructure prior to placing a flexible overlay reduces or eliminates the formation of reflective cracks. The purpose of a paving fabric is to act as a waterproofing and stress relieving membrane within the pavement structure. The relative effectiveness and the cost/benefit ratios of the different inter-layers being studied will be determined in the final report. The research project sites located on SR 0073 and SR 0663 in Montgomery County will be inspected annually during the fall and spring seasons for three years. These roads are two of the more high volume rural traffic routes in the state. The severe climatic conditions at the sites regarding high temperature extremes and freeze-thaw cycling will be relatively high and may effect performance of the materials.

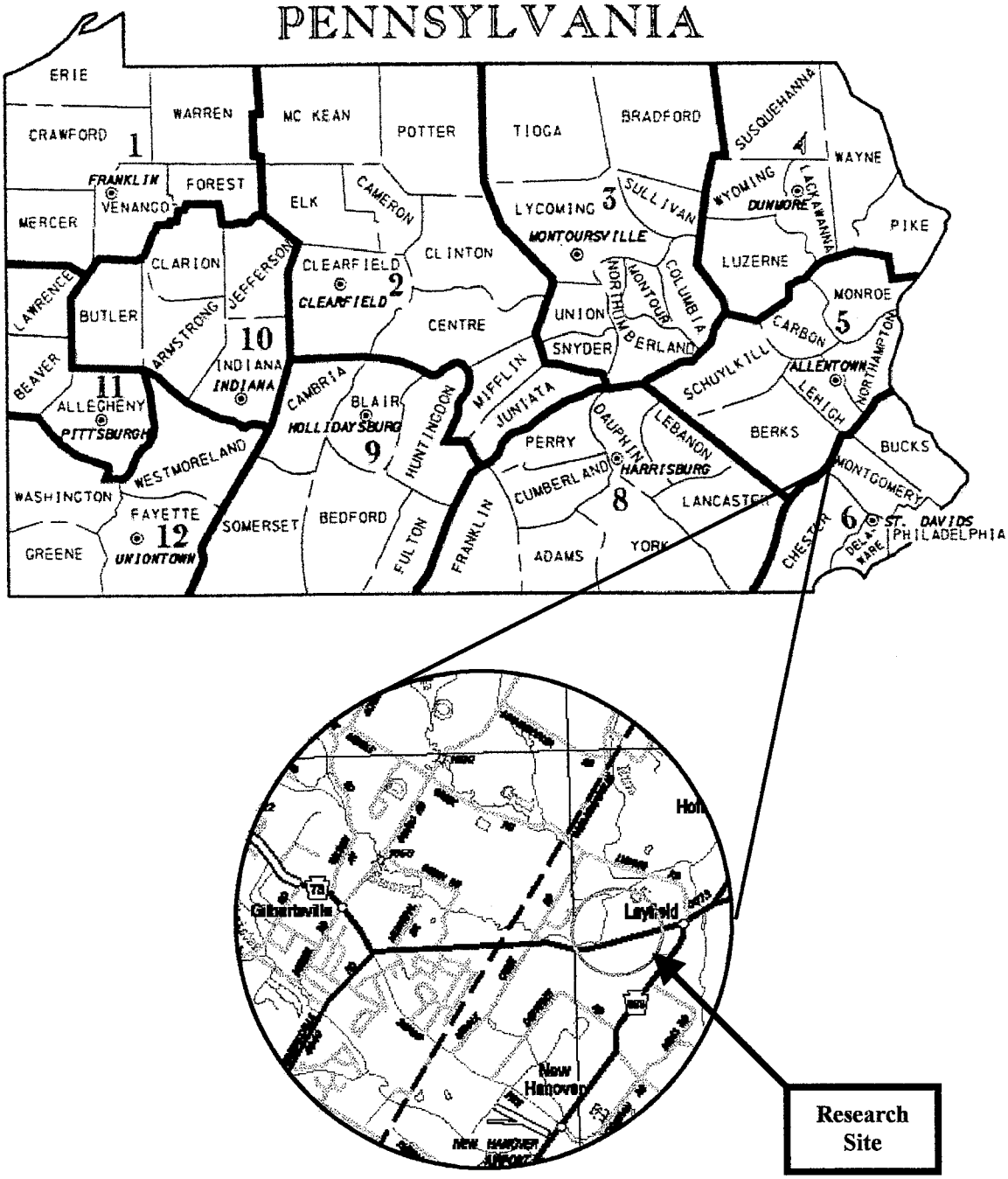
Pre-Construction Procedure

A detailed crack evaluation, including type, length, and location, was made. Any other significant surface conditions, including drainage problems, were to be noted at this time.

Post-Construction Evaluation

After construction is complete (overlay is in place), a crack evaluation similar to the pre-construction evaluation will be made annually. These evaluations or inspections will be made in the spring, immediately after the freezing season. Again, any significant cracking conditions will be noted for a period of 3 years.

Location Map - Site A



SITE A
SR 0073, Gilbertsville, Montgomery County
Engineering District 6-0

CONSTRUCTION - SITE A

The experimental materials, Bit-U-Tex, and Petromat were placed on June 5, 1995 on SR 0073, New Hanover Township, Montgomery County. All of the cracks were located and measured (see figure 1 on page 7 & 8). The pavement cracks on this project were not cleaned and sealed prior to paving. The prime contractor, Allen A. Myers Inc., swept the road surface of all debris using a power broom. Land Saver Inc., a subcontractor and affiliate of Atlantic Construction Fabrics, mechanically placed the AC-20 and the paving fabrics. This was accomplished by first tacking the road with AC-20 at a desired rate 0.20 to 0.25 gallons per square yard from a mobile oil distributor. The calculated actual rate of AC-20 applied to the road exceeded the manufacturer's recommendations, with 0.35 gallons per square yard. After the AC-20 was applied to the road, Bit-U-Tex was placed with a small specialized, four-wheel drive tractor (see photographs 36 and 43). This tractor was equipped with an attachment that allowed the machine to place a roll of fabric on the road surface up to twelve feet in width. This tractor simplified the placement of the paving fabrics.

The Bit-U-Tex and Petromat test sections were installed in two phases. The west bound lane materials were placed, then paved over with a 1½ inch thick layer of bituminous ID-2 wearing and compacted to the specified density. There were no problems evident during this phase of construction. The second phase of construction in the eastbound lane, however, experienced some problems. The core tube in the roll of Bit-U-Tex disintegrated during placement of the west bound lane. This resulted in the remainder of the roll being placed manually and unevenly in some areas (see photographs 42 and 47).

The Petromat test section was installed adjacent to the Bit-U-Tex without incident but was being picked up by the tires on triaxle dump trucks as the trucks were unloading ID-2 into the hopper on the paver (see photograph 41). The paver even picked up the Petromat at each of the overlapped seams during placement of the ID-2 bituminous wearing course. The fabric was being pulled off the AC-20 tack coat by the rubber-tired equipment. The high air temperature did not allow the AC-20 to harden sufficiently prior to placing the bituminous wearing. The first phase of construction on the test sections was done during the cool of the morning. This allowed the AC-20 to cool and become tacky enough to hold down the fabric. The afternoon phase of operations did not have the optimum field temperature to allow the material to be placed without experiencing some problems.

SITE A Montgomery County

Location of Material SR 0073

Station to Station		Experimental Feature
0+00	261+00	Bit-U-Tex®
261+00	450+00	Petromat®
450+00	600+00	Control Section

	Trade Name	Process of Manufacturer	Manufacturer
1.	Bit-U-Tex®	Geogrid/Geotextile Composite Geogrid, SBR coated polyester grid (SBR) Styrol Butadiene Rubber Geotextile, Nonwoven polyester	SYNTEEN USA, Inc.
2.	Petromat 4596®	A nonwoven needle-punched geotextile	Amoco Fabrics & Fibers Co.

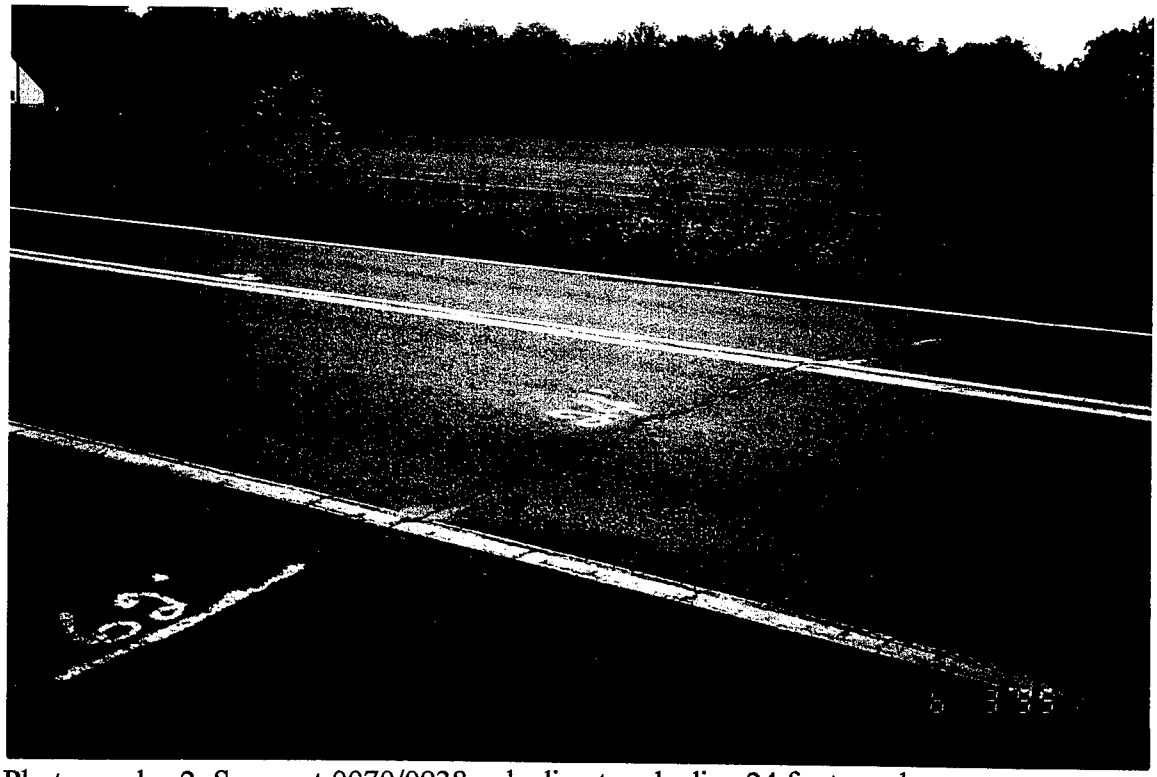
Each product will be studied in a test section and compared to a control section with no interlayer.

INITIAL PERFORMANCE DATA

The Bit-U-Tex, Petromat, and control sections on SR 0073 were inspected on March 27, 1996. The pavement was dry and no hairline reflective cracking was evident. The test and control sections were marked so cracks could be identified when they appear. This test section was inspected again on June 7, 1996; some very faint hairline cracks were barely visible in both the test and control sections. These cracks were just beginning to migrate to the surface and will be noted and photographed after they become more visible in future inspections.

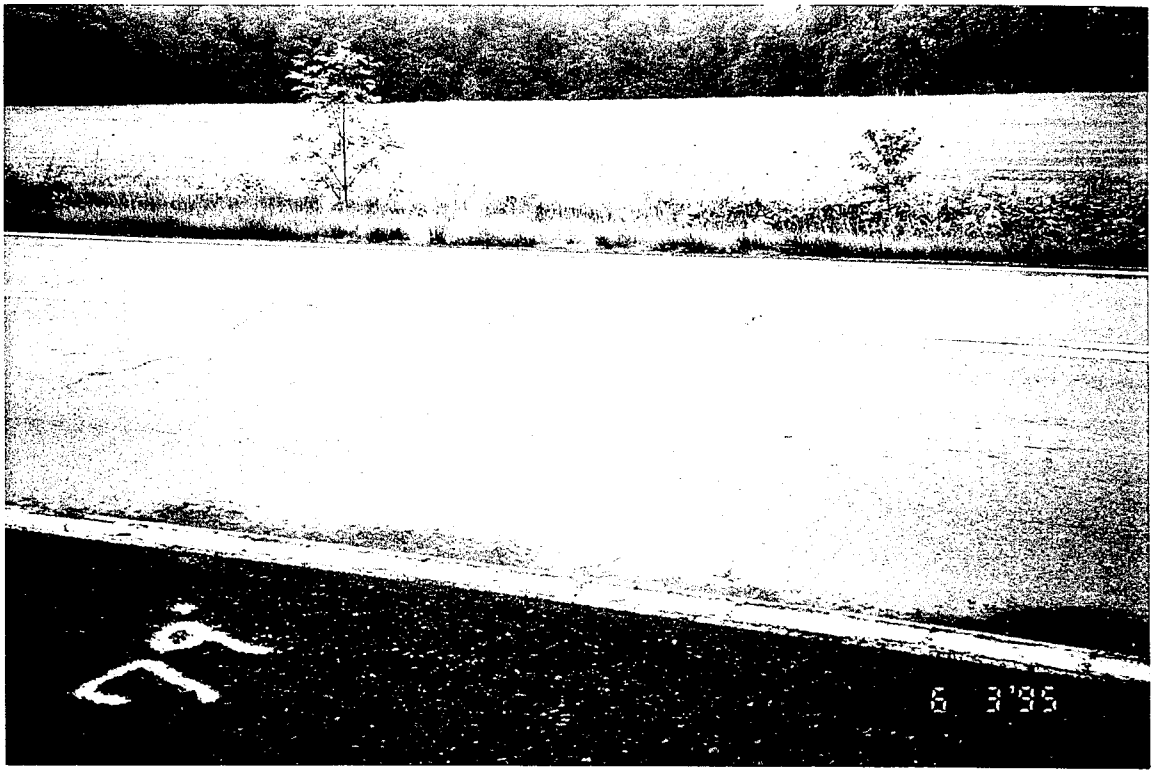
Bit-U-Tex Test Area Prior to Paving

Photograph - 1, Segment 0070/0990, 9 foot crack edgeline toward centerline



Photograph - 2, Segment 0070/0938, edgeline to edgeline 24 foot crack

Bit-U-Tex Test Area Prior to Paving



Photograph - 3, Segment 0070/0921, 2 foot crack 12 feet from the edgeline

Photograph - 4, Section, 0070/0912, 12 feet long, from the edgeline to the double yellow line.

Bit-U-Tex Test Area Prior to Paving

Photograph - 5, Segment 0070/0905, 10 foot crack from the double yellow line to 2 feet from the edgeline.

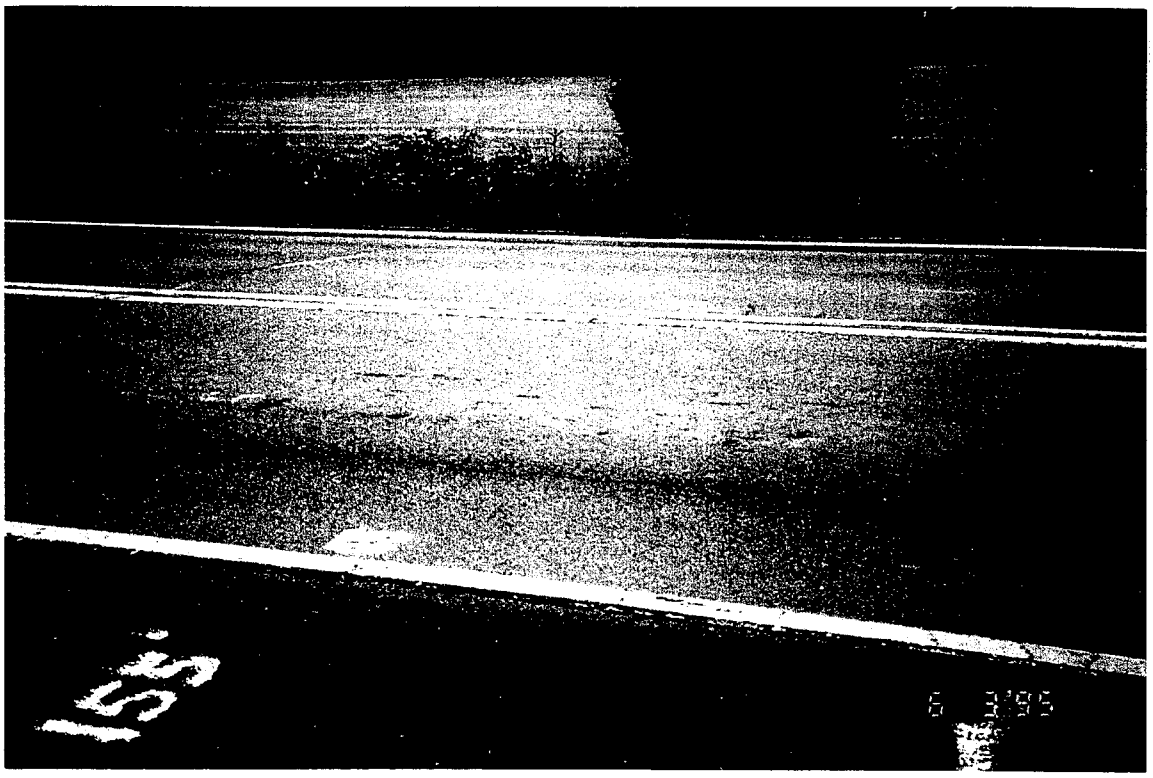
Photograph - 6, Segment 0070/0891, 15 foot crack, starting 3 feet from the eastbound edgeline.

Bit-U-Tex Test Area Prior to Paving

Photograph - 7, Segment 0070/0876, 20-foot crack, that starts 2 feet from the east bound edgeline.

Photograph - 8, Segment 0070/0862, 10 foot crack, 12 feet from the east bound edgeline.

Bit-U-Tex Test Area Prior to Paving



Photograph - 9, Segment 0070/0845, 1 foot crack, 12 feet from the east bound edgeline.

Photograph - 10, Segment 0070/0834, 22-foot crack, starting at the east bound edgeline.

Bit-U-Tex Test Area Prior to Paving

Photograph - 11, Segment 0070/0820, 8-foot crack, starting 4 feet from the east bound edgeline.

Photograph - 12, Segment 0070/0802, 18-foot crack, 3 feet from the east bound edgeline.

Bit-U-Tex Test Area Prior to Paving

Photograph - 13, Segment 0070/0785, 18-foot crack, 3 feet from the east bound edgeline.

Photograph - 14, Segment 0070/0760, 10-foot crack, 4 feet from the east bound edgeline

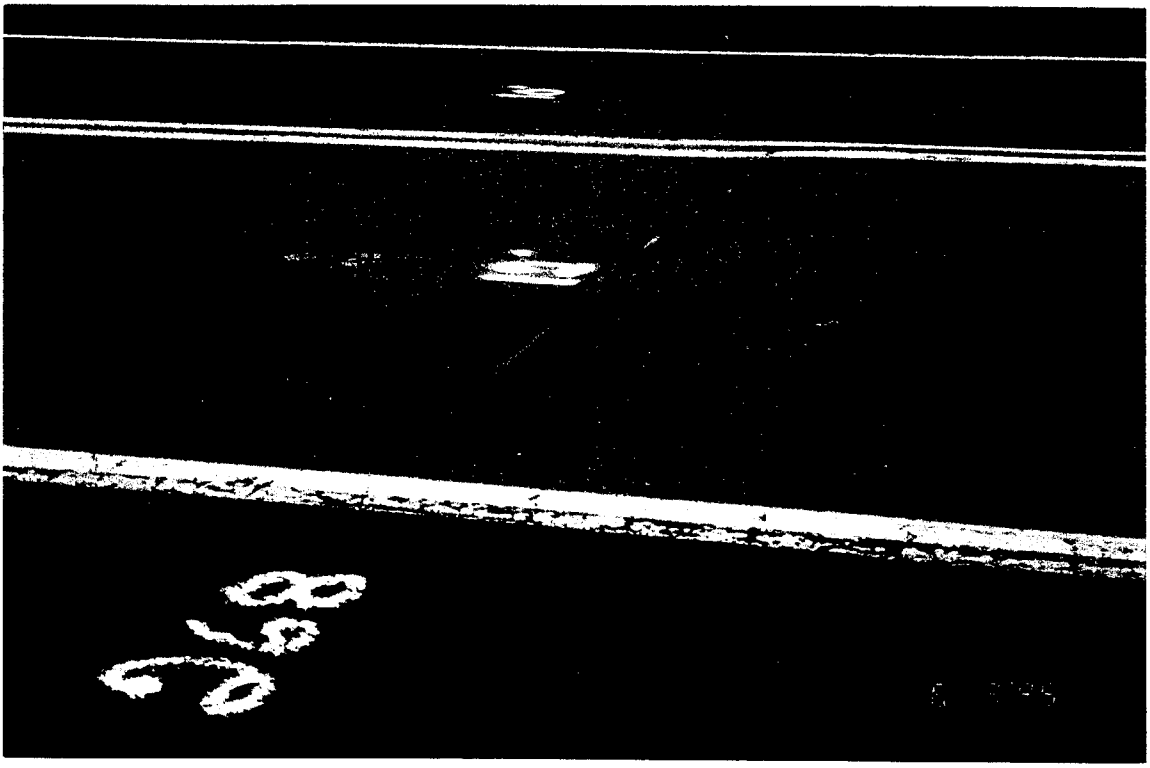
Bit-U-Tex Test Area Prior to Paving

Photograph - 15, Segment 0070/0750, 12-foot crack, 12 feet from the east bound edgeline

Photograph - 16, Segment 0070/0745, 9-foot crack, 3 feet from the east bound edgeline.

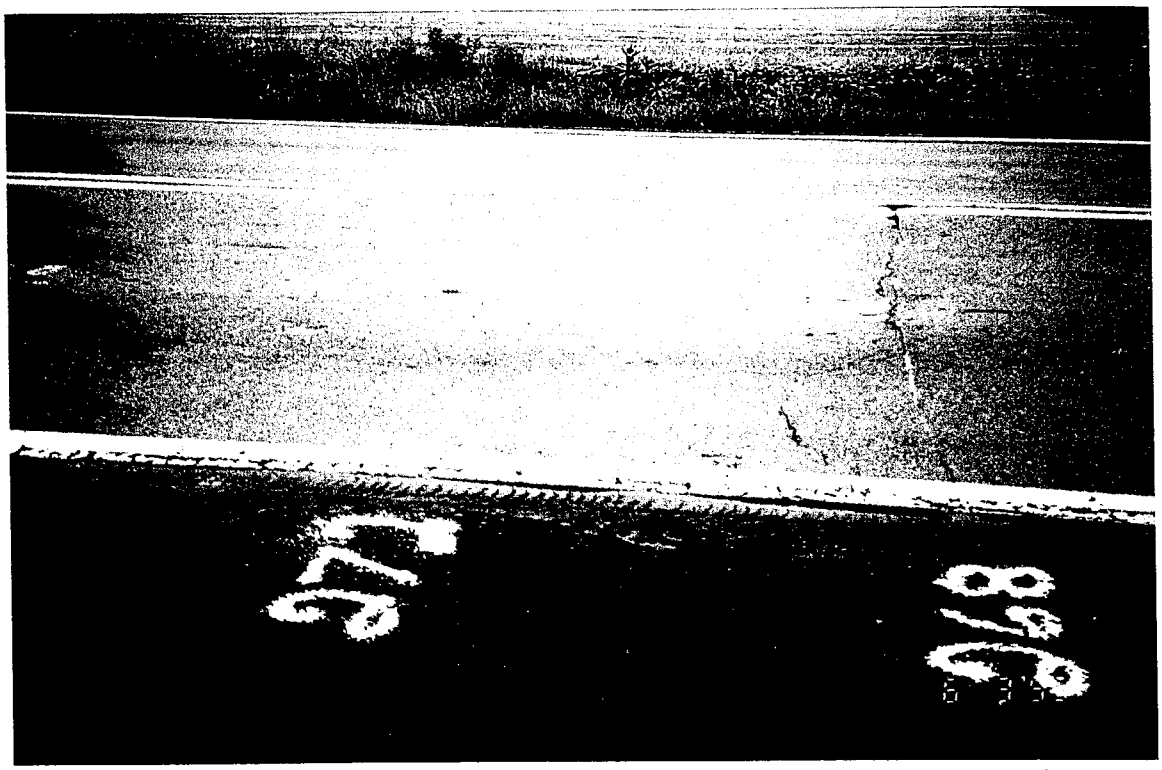
Petromat Test Area Prior to Paving

Photograph - 17, Segment 0070/0739, 16-foot crack, 5 feet from the east bound edgeline.



Photograph - 18, Segment 0070/0732, 12-foot crack, starting at the east bound edgeline.

Petromat Test Area Prior to Paving

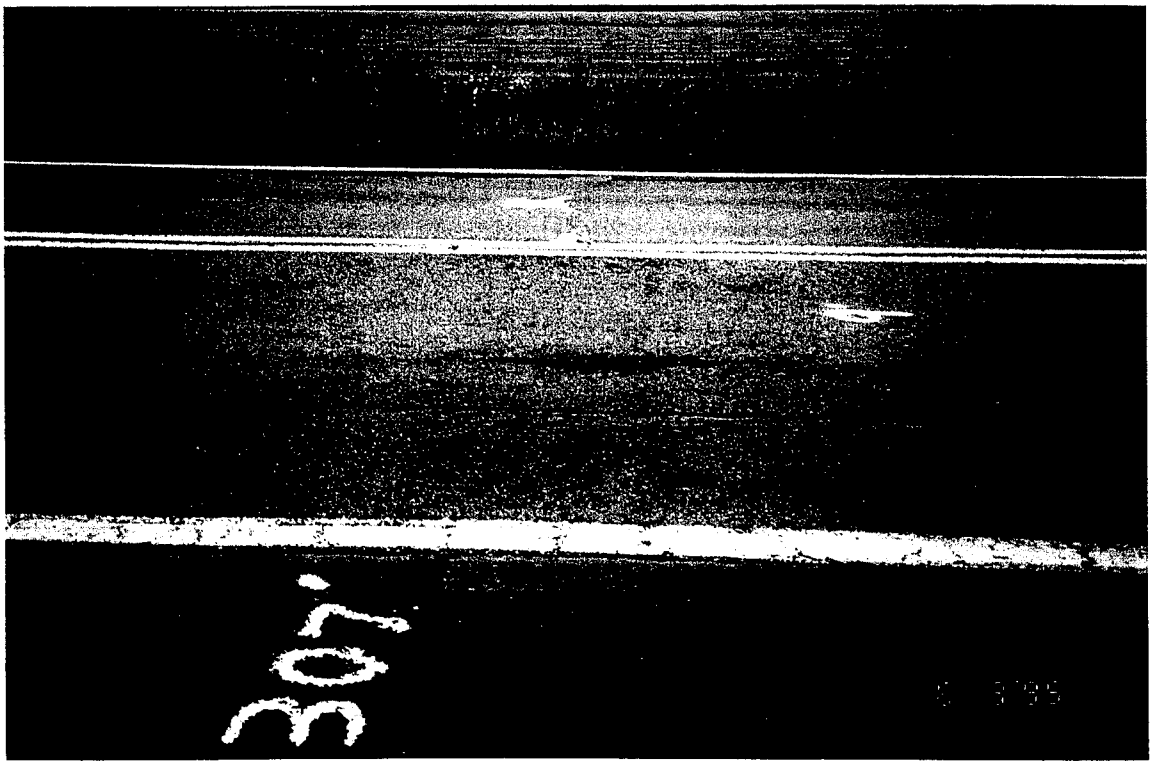


Photograph - 19, Segment 0070/0728, 10-foot crack, 12 feet from the east bound edgeline.

Photograph - 20, Segment 0070/0714, 12-foot crack, starting at the east bound edgeline. Segment 0070/0712, 10-foot crack, 12 feet from the east bound edgeline.

Petromat Test Area Prior to Paving

Photograph - 21, Segment 0070/0700, 9-foot crack, 8 feet from the east bound edgeline.



Photograph - 22, Segment 0070/0693, 12-foot crack, from the double yellow line toward the edgeline.

Petromat Test Area Prior to Paving

Photograph - 23, Segment 0070/0667, 21-foot crack, 3 feet from the east bound edgeline.

Photograph - 24, Segment 0070/0652, 22-foot crack, starting at the east bound edgeline.
Segment 0070/0652, 2-foot crack, starting at the eastbound edgeline.

Petromat Test Area Prior to Paving

Photograph - 25, Segment 0070/0590, 24-foot crack, edgeline to edgeline.

Photograph - 26, Segment 0070/0575, 12-foot crack, 12 feet from the east bound edgeline.

Petromat Test Area Prior to Paving

Photograph - 27, Segment 0070/0550 to 0070/1000,

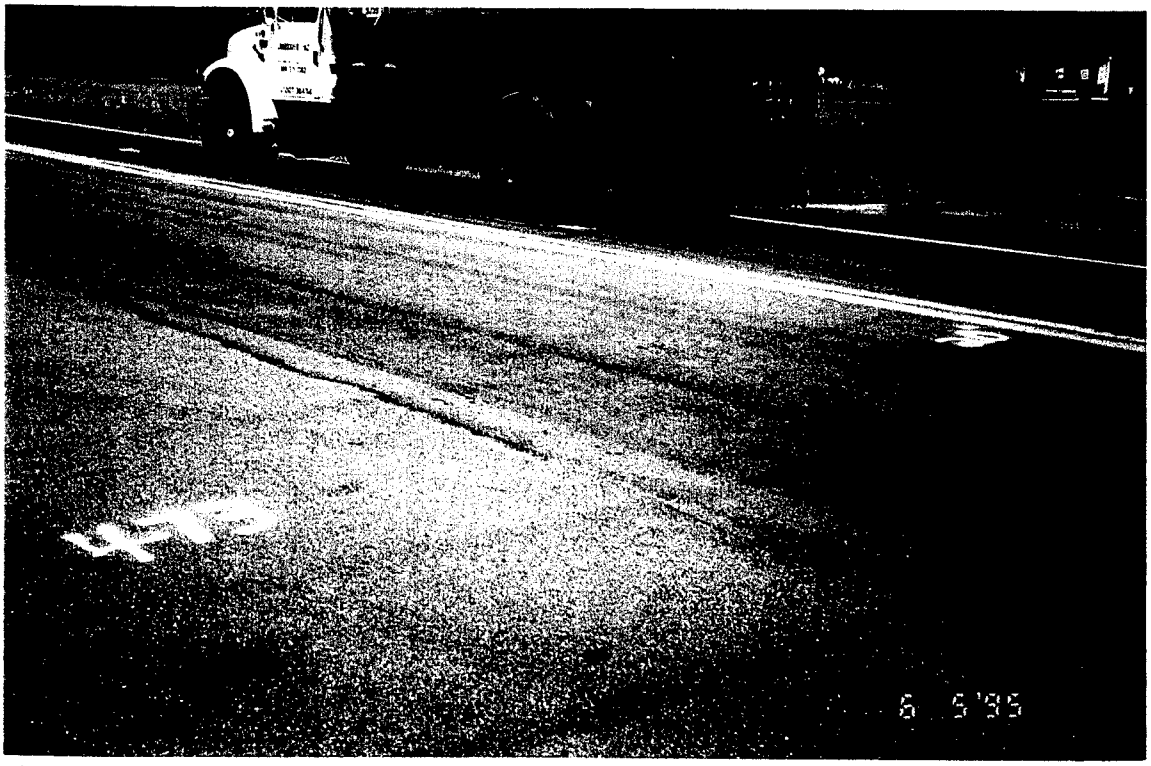
450-foot longitudinal crack, 3 feet from the west bound lane.

450-foot longitudinal crack, down the middle of the double yellow line.

450-foot longitudinal crack, 3 feet from the east bound lane.

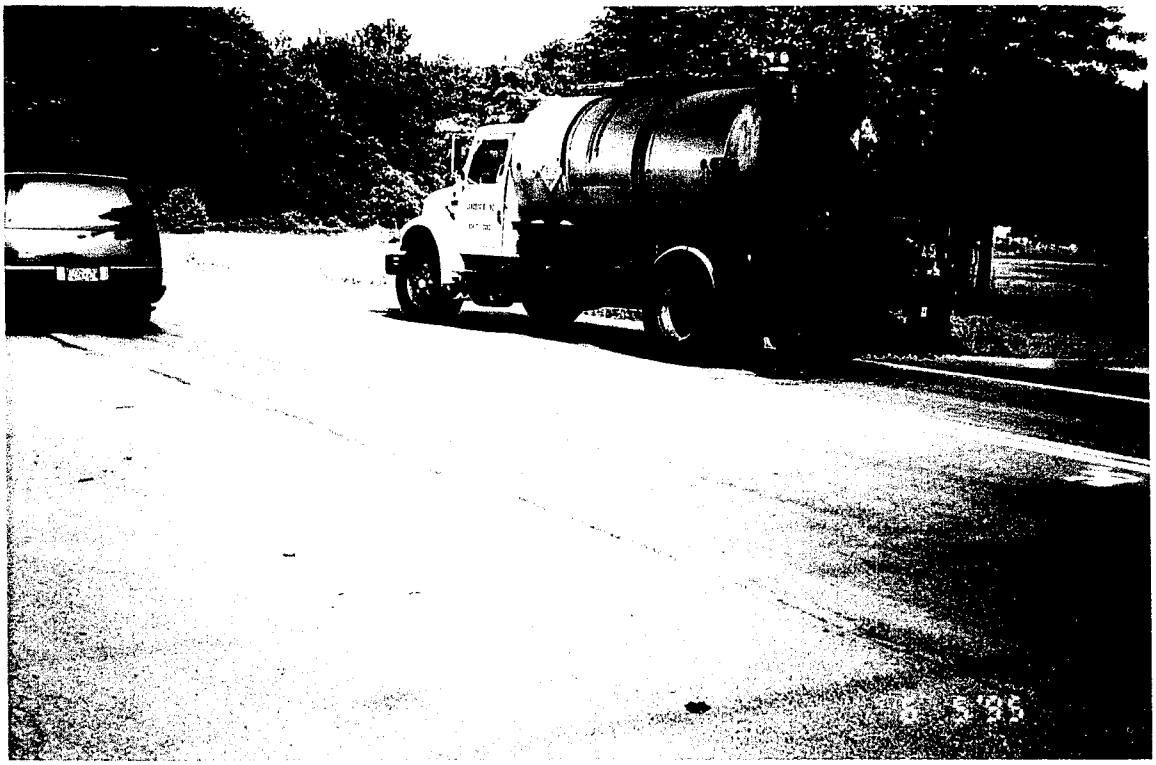
Control Section Prior to Paving

Photograph - 28, Segment 0070/0545, 18-foot crack, 4 feet from the east bound edgeline.



Photograph - 29, Segment 0070/0527, 20-foot crack, 4 feet from the east bound edgeline.

Control Section Prior to Paving



Photograph - 30, Segment 0070/0543, 10-foot crack, 12 feet from the east bound edgeline.

Photograph - 31, Segment 0070/0522, 8-foot crack 3 feet from the east bound edgeline.

Control Section Prior to Paving

Photograph - 32, Segment 0070/0522, 8-foot crack, 3 feet from the east bound edgeline.

Photograph - 33, Segment 0070/0484, 20 foot crack, 4 feet from the east bound edgeline.

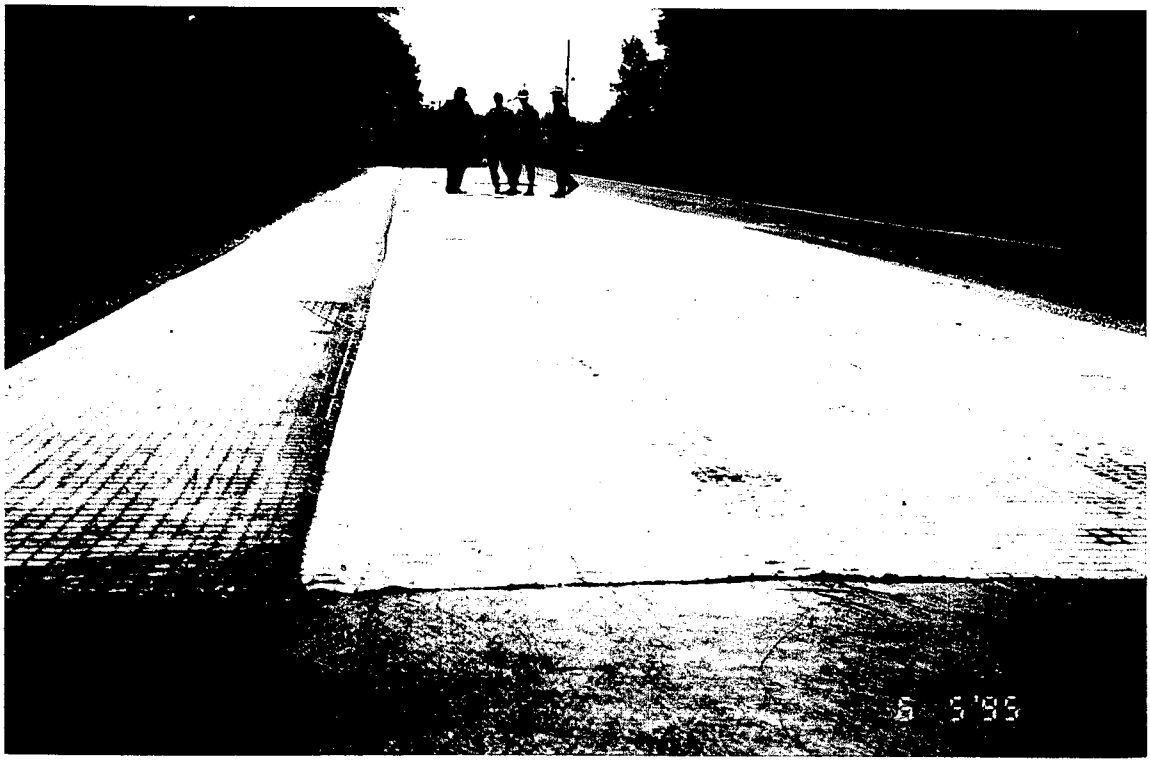
Control Section Prior to Paving

Photograph - 34, Segment 0070/0467, 18-foot crack, 4 feet from the east bound edgeline.

Photograph - 35, Segment 0070/0454, 25-foot crack, edgeline to edgeline.

Construction 5 June 95

Photograph - 36, Placement of Petromat at 0070/0714 east bound.



Photograph - 37, Placement of Bit-U-Tex at 0070/0739 west bound.

Construction 5 June 95

Photograph - 38, 1½" ID-2 bituminous wearing overlay placed over Bit-U-Tex.

Photograph - 39, 1½" ID-2 bituminous wearing overlay placed over Bit-U-Tex.

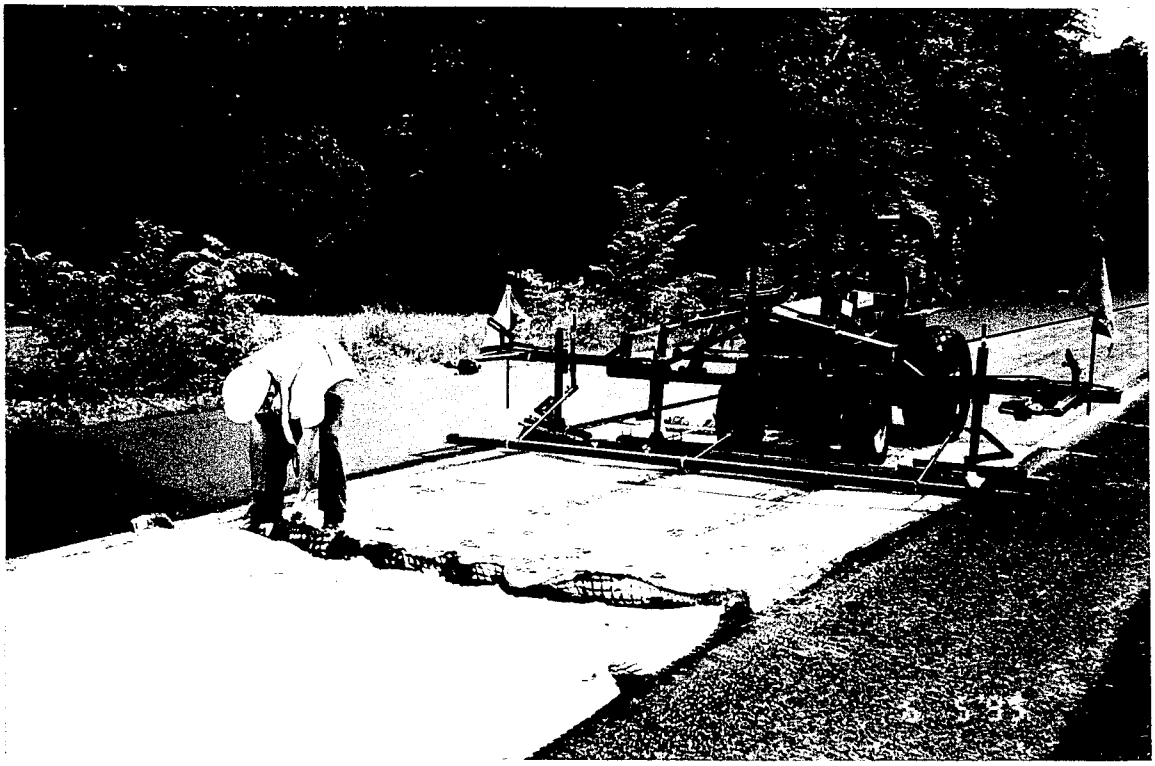
Construction 5 June 95

Photograph - 40, Note the amount of Bit-U-Tex overlap onto the Petromat.

Photograph - 41, Petromat sticking to the dump truck tires.

Construction 5 June 95

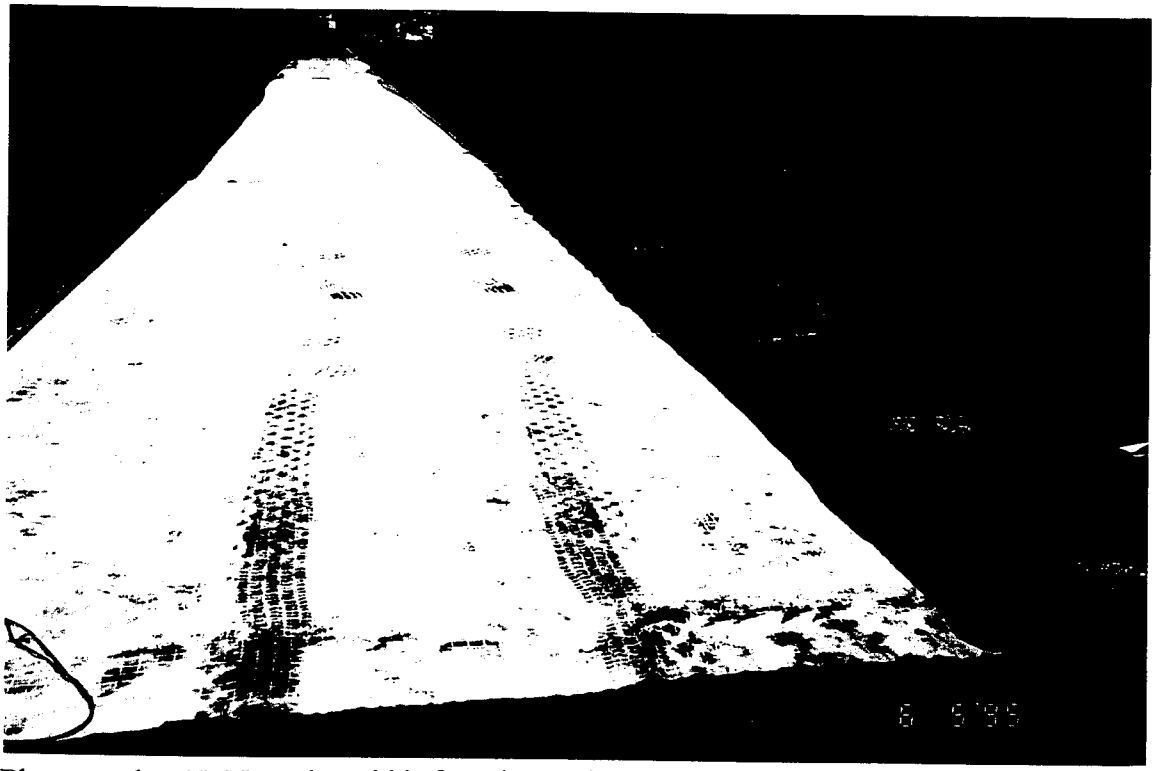
Photograph - 42, Contractor had to place second pass by hand with grid facing down.



Photograph - 43,Note the grid is falling down and there are wrinkles in the fabric.

Construction 5 June 95

Photograph - 44, Note that there is no overlap from east bound to westbound and AC-20 is showing



Photograph - 45, Note the grid is face down, does not overlap, and area's are patched with Petromat.

Photograph - 46, Note there is no overlap with Petromat and Bit-U-Tex.

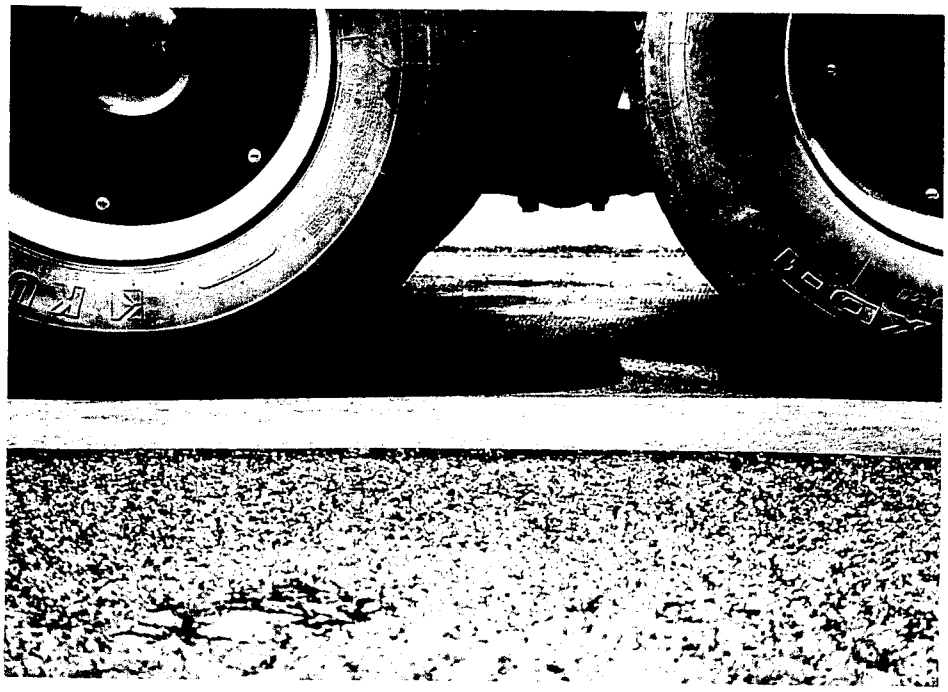
Photograph - 47, 2nd pass Bit-U-Tex, grid is facing down, uneven, and has wrinkles.

Construction 5 June 95

Photograph - 48, Note the patching with Petromat in the Bit-U-Tex test area.

Photograph - 49, Removing a double fold from the Bit-U-Tex ensure adhesion of the material to the pavement.

Photograph - 50, Paving over the Bit-U-Tex



Photograph - 51, Shows the Petromat being picked up by the tire of a triaxle dump truck while unloading bituminous hot mix into the hopper of the paver.

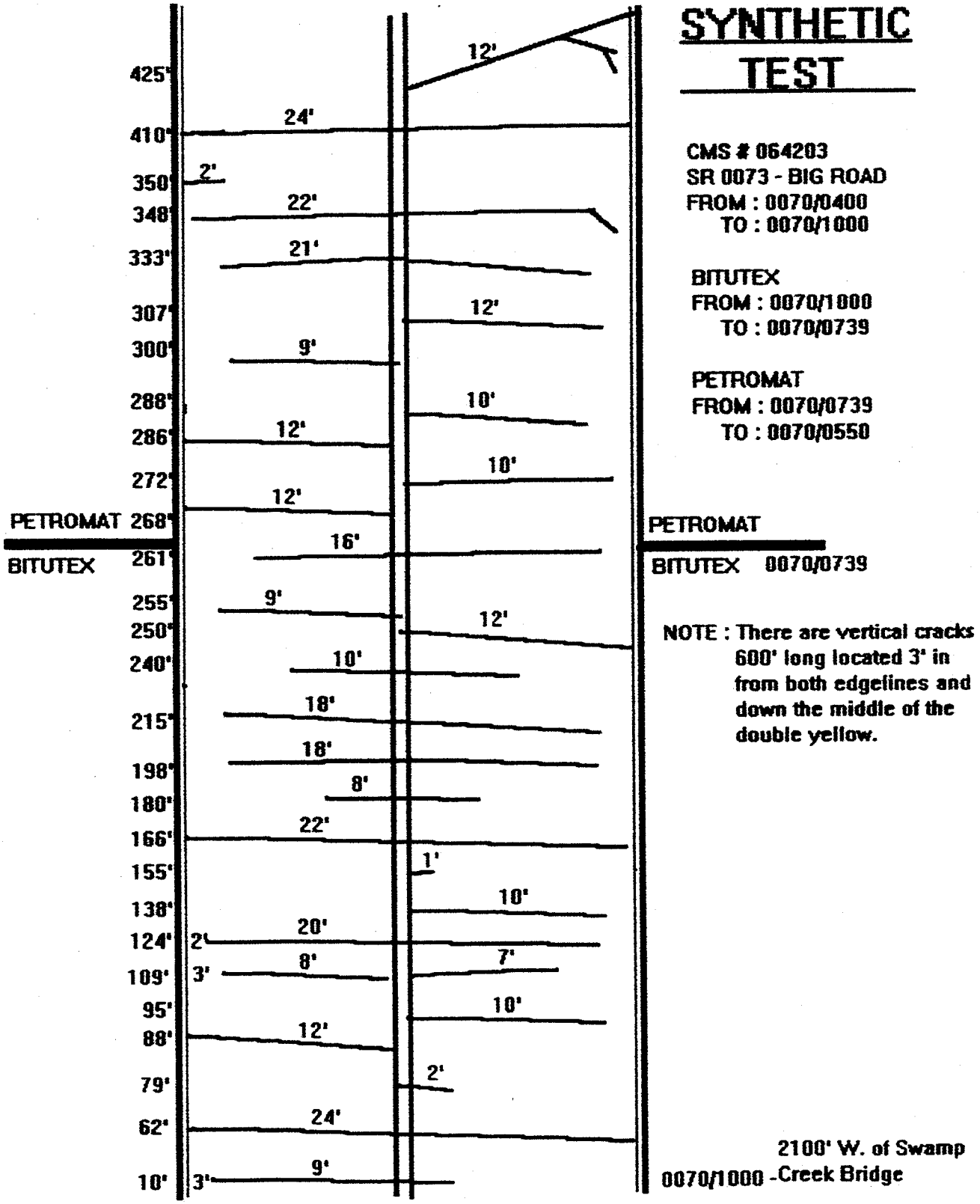


Figure 1. Site A – Crack Mapping

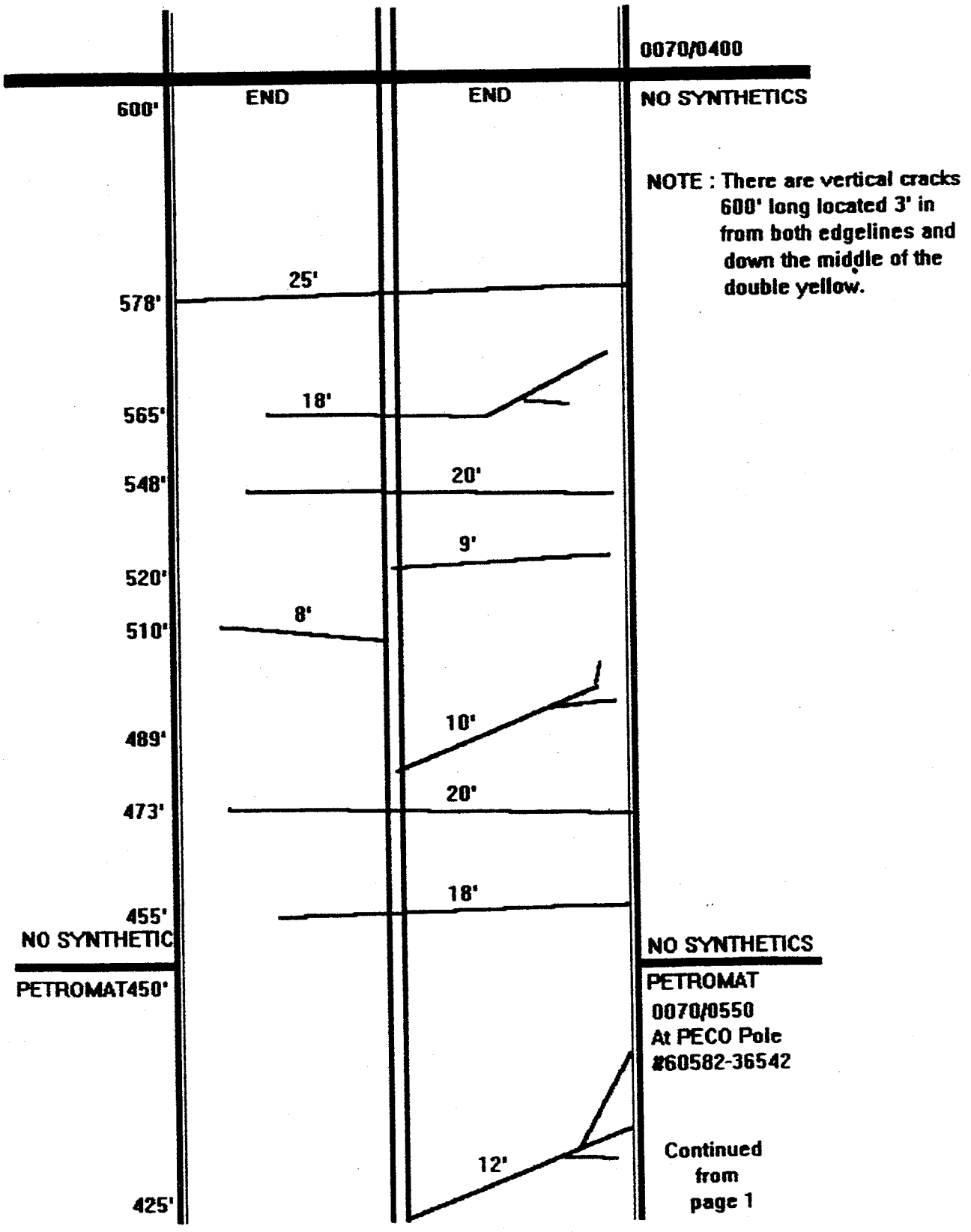
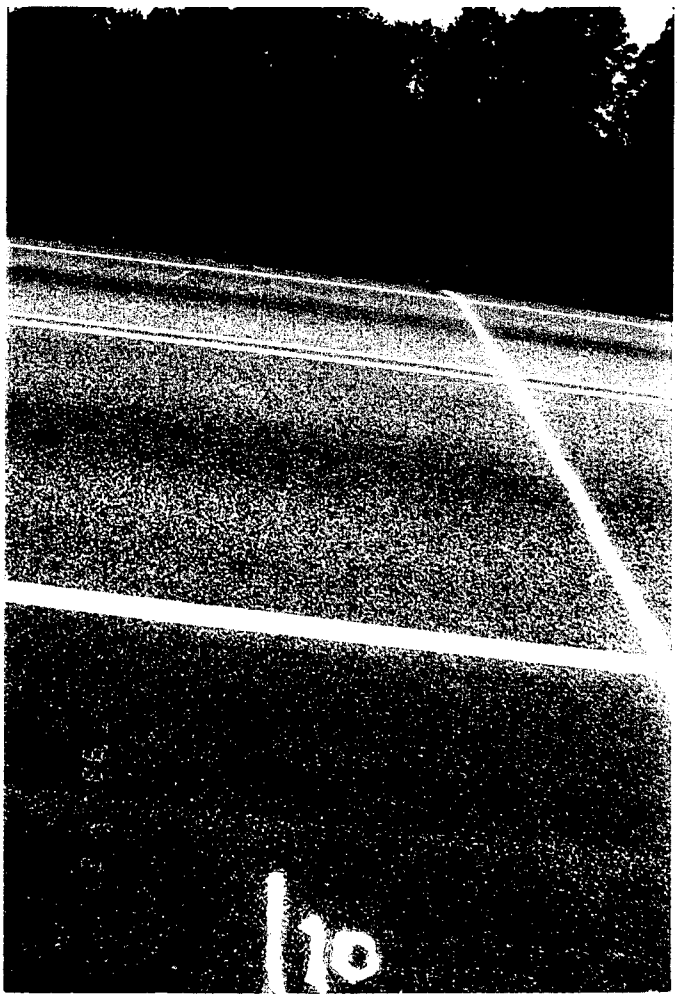


Figure 1. Site A – Crack Mapping (Continued)

Final Photographs 27 May 98
SR 0073 Gilbertsville
6-0 Montgomery County

Photograph – 52, Test Section



Photograph – 53, Location 10', Bitutex Test Section

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Photograph – 54, Location 62', Bitutex Section

Photograph – 55, Location 79',
Bitutex Section

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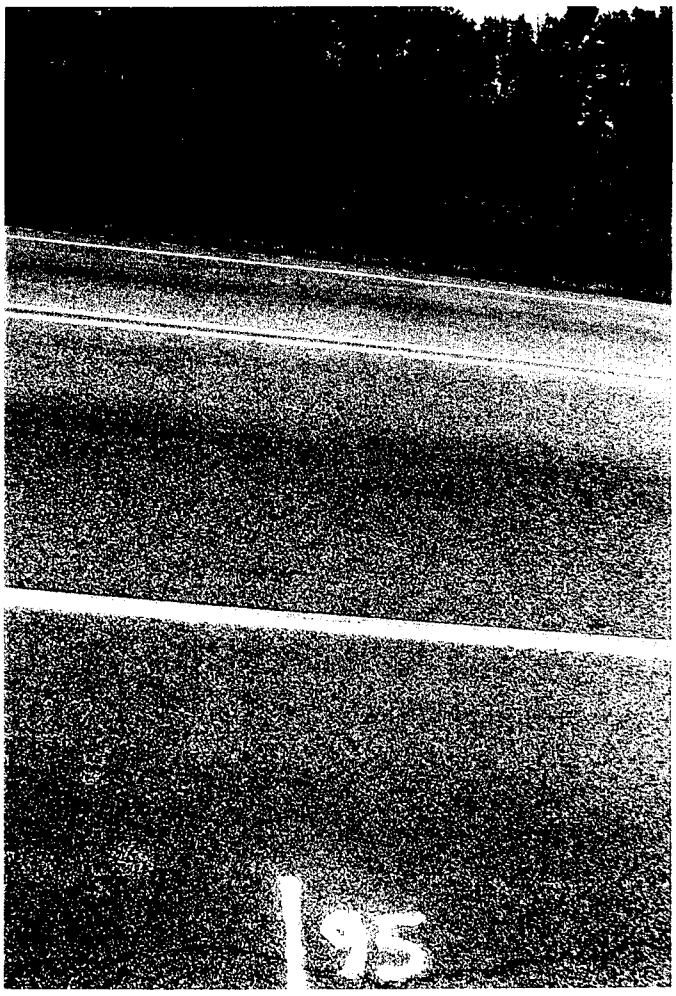
Photograph – 56, Location 88', Bitutex Test Section



Photograph – 57, Location 95', Bitutex Test Section

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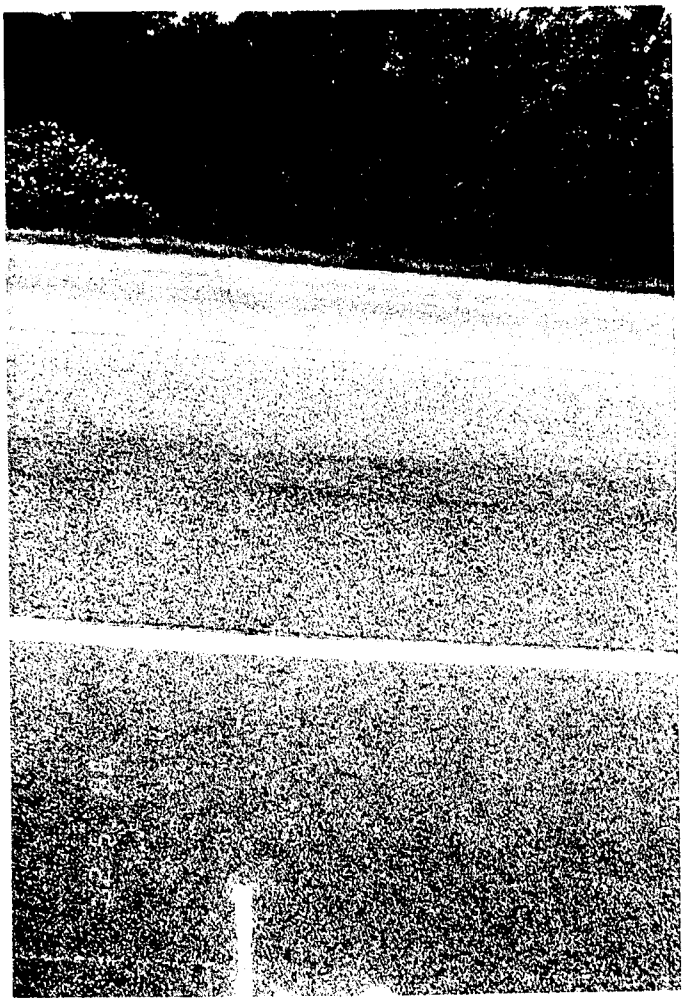
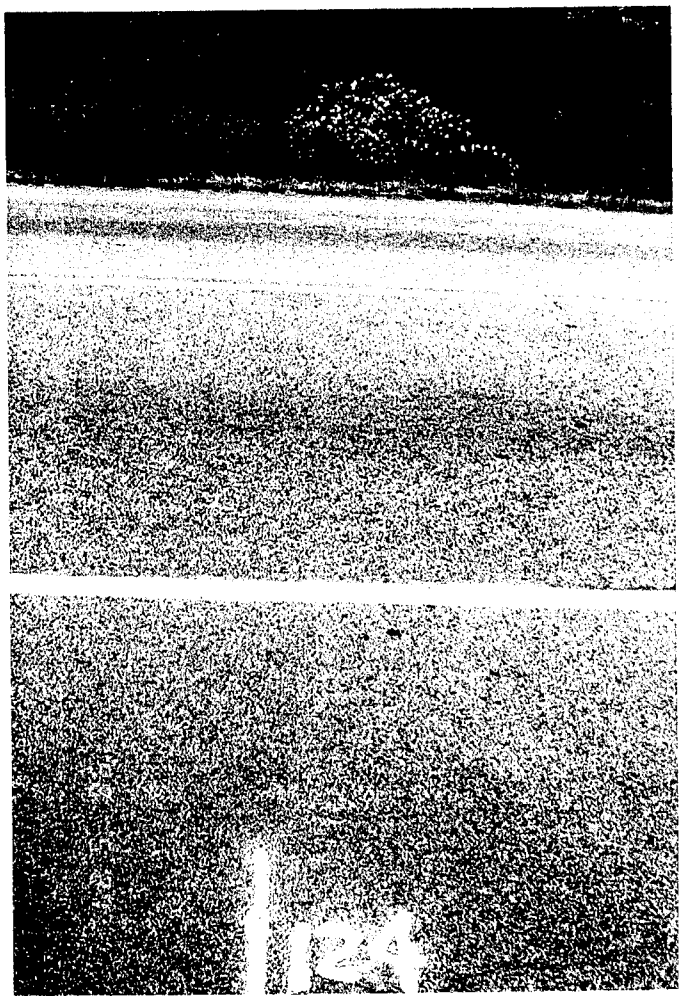
SR 0073 Gilbertsville
6-0 Montgomery County



Photograph – 58, Location 109', Bitutex Test Section



Photograph –59, Location 124', Bitutex Test Section

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Photograph – 60, Location 138', Bitutex Test Section

Photograph – 61, Location 155', Bitutex Test Section

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Photograph – 62, Location 166', Bitutex Test Section

Photograph – 63, Location 180', Bitutex Test Section

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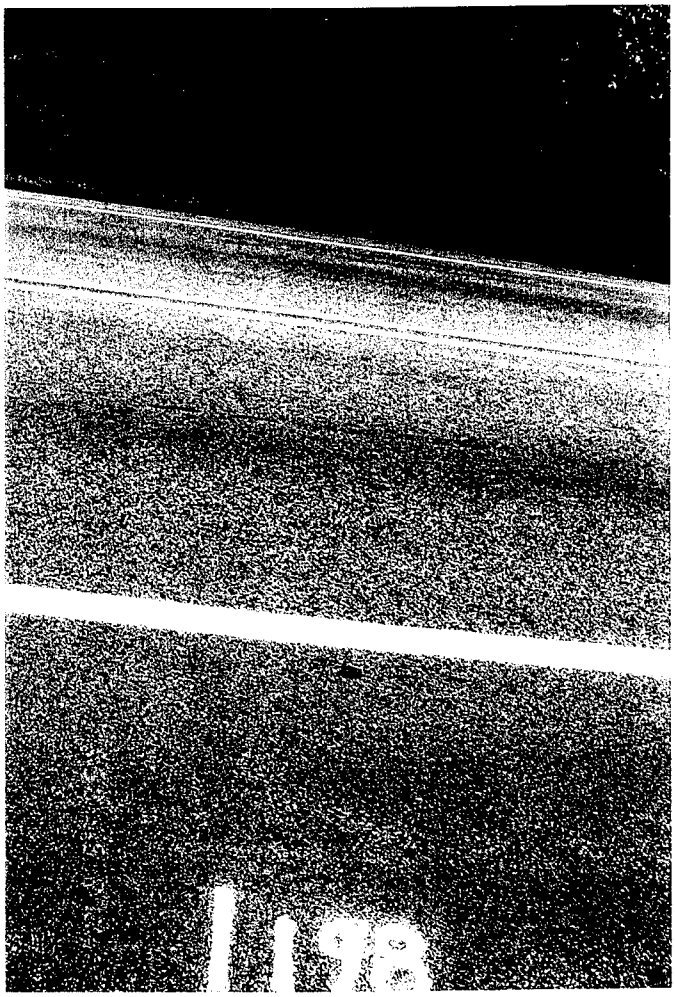
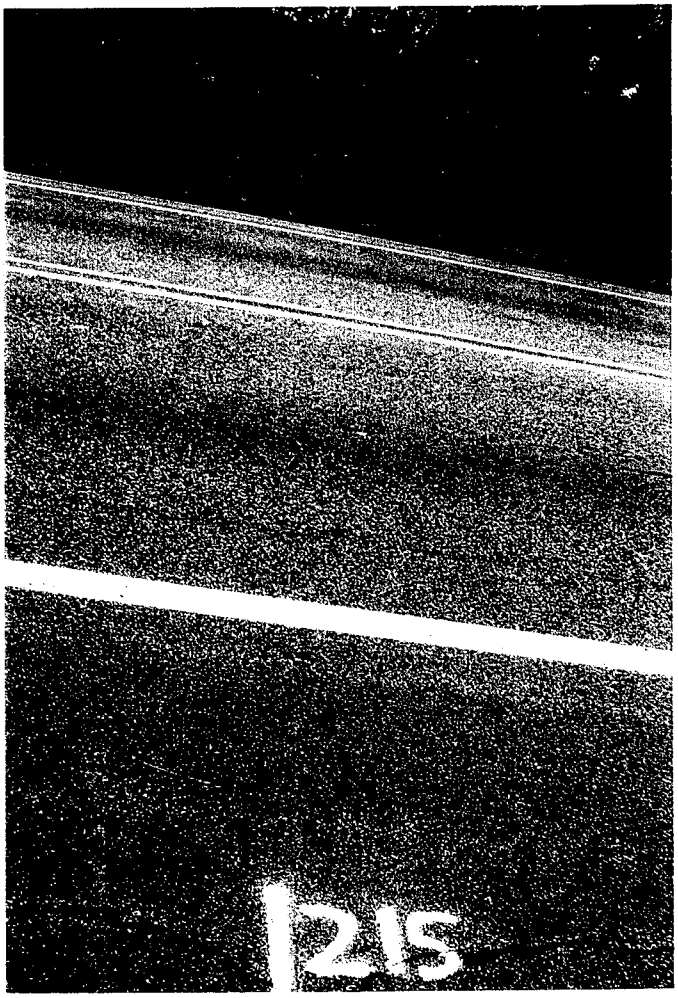


Photograph – 64, Location 198', Bitutex Test Section



Photograph – 65, Location 215', Bitutex Test Section

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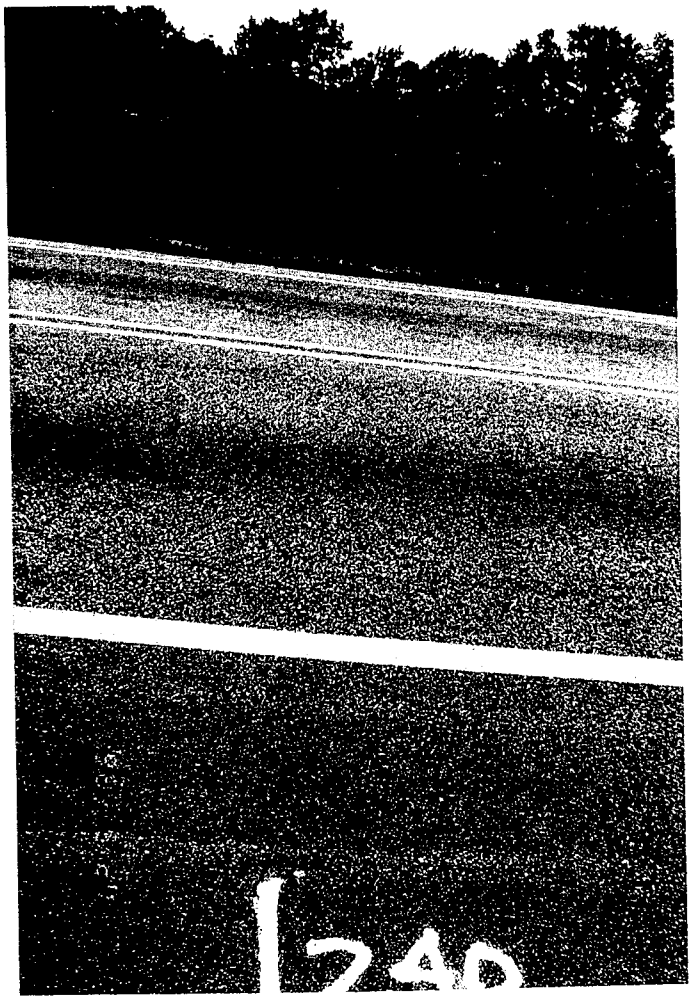
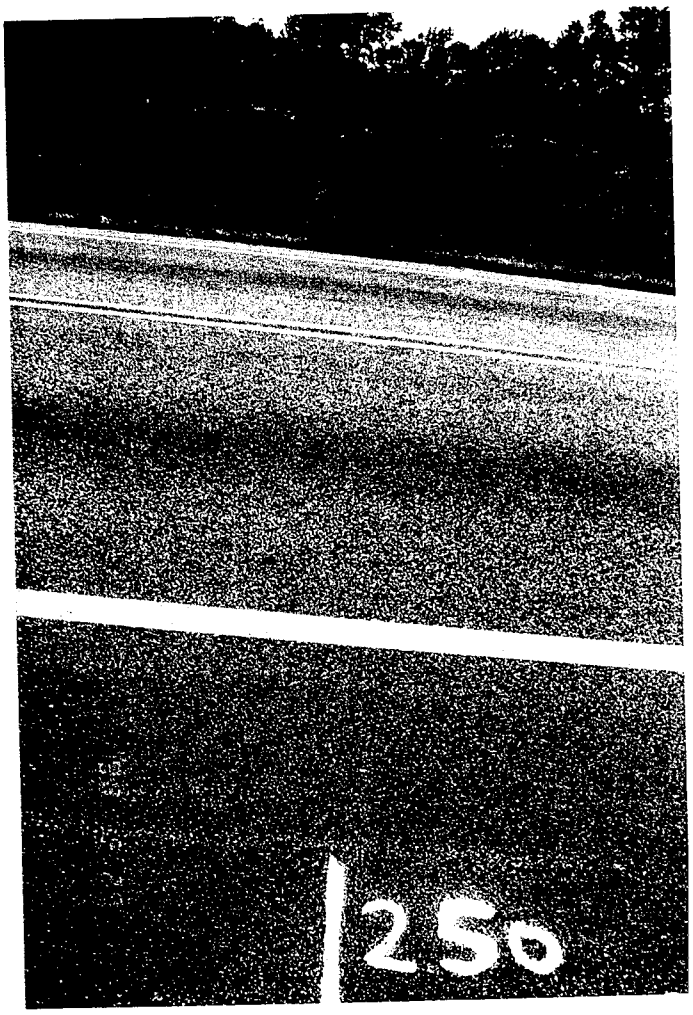
SR 0073 Gilbertsville
6-0 Montgomery County



Photograph – 66, Location 240', Bitutex Test Section



Photograph – 67, Location 250', Bitutex Test Section

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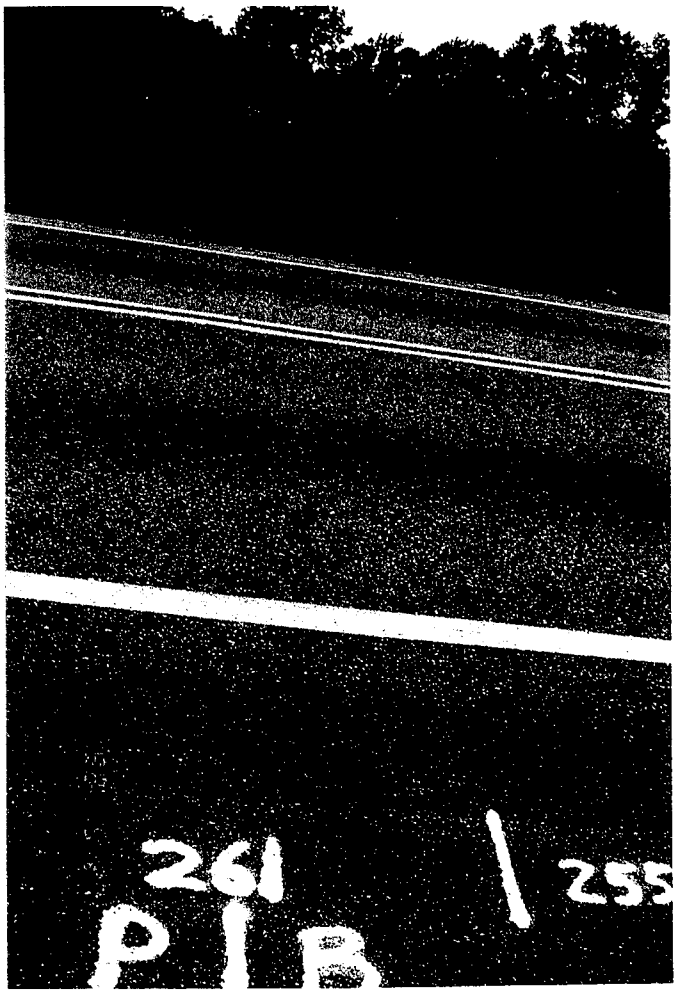
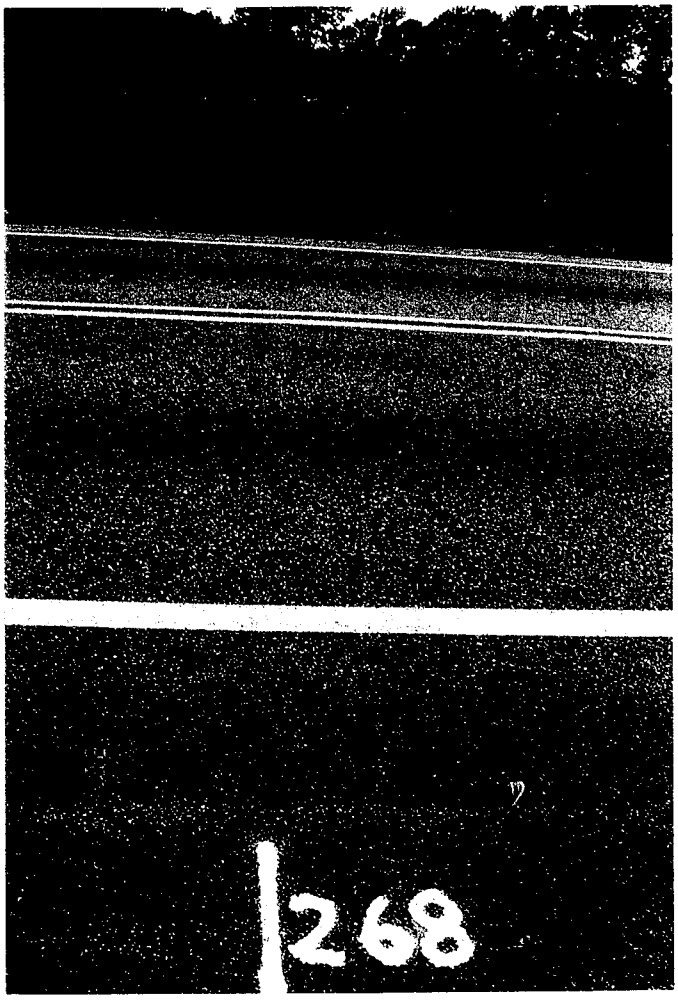


Photograph – 68, Location 255' & 261', Bitutex Test Section



Photograph – 69, Location 268', Petromat Test Section

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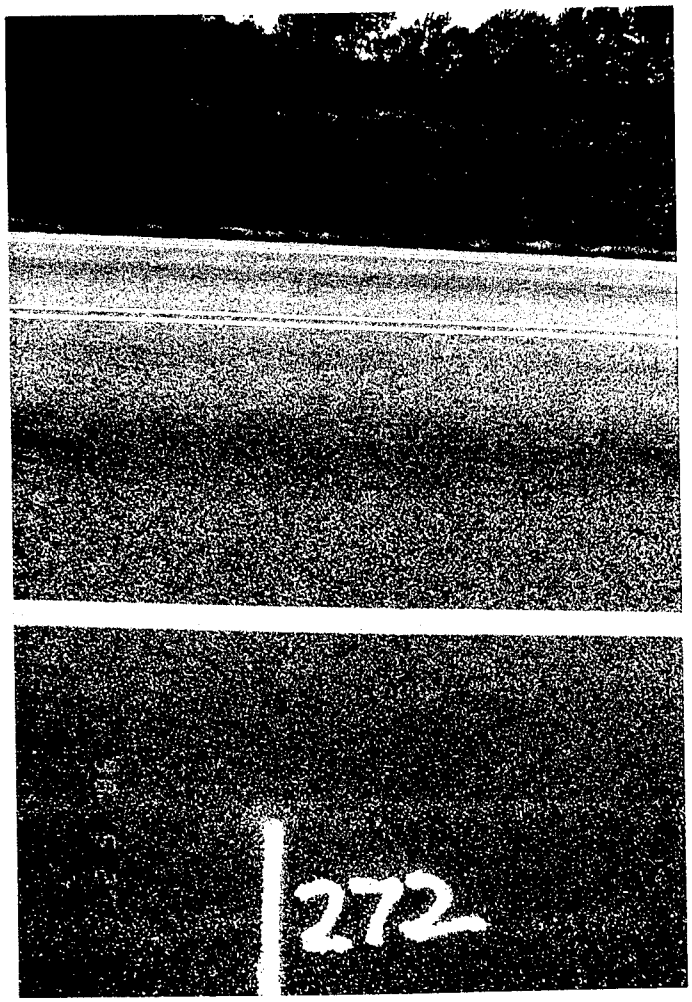
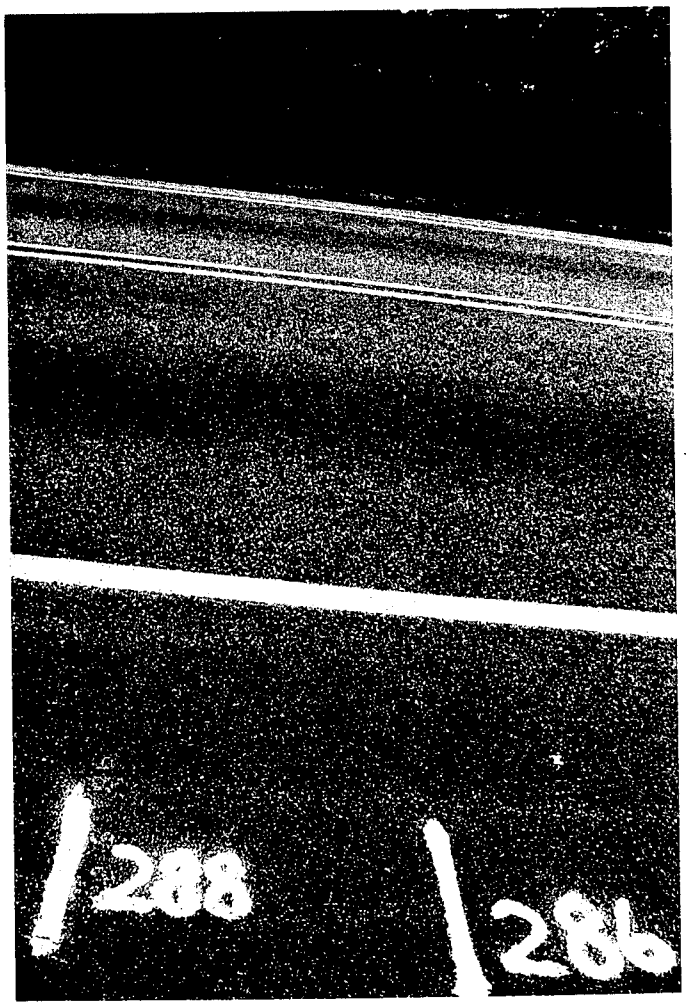


Photograph – 70, Location 272', Petromat Test Section



Photograph – 71, Location 286' & 288', Petromat Test Section

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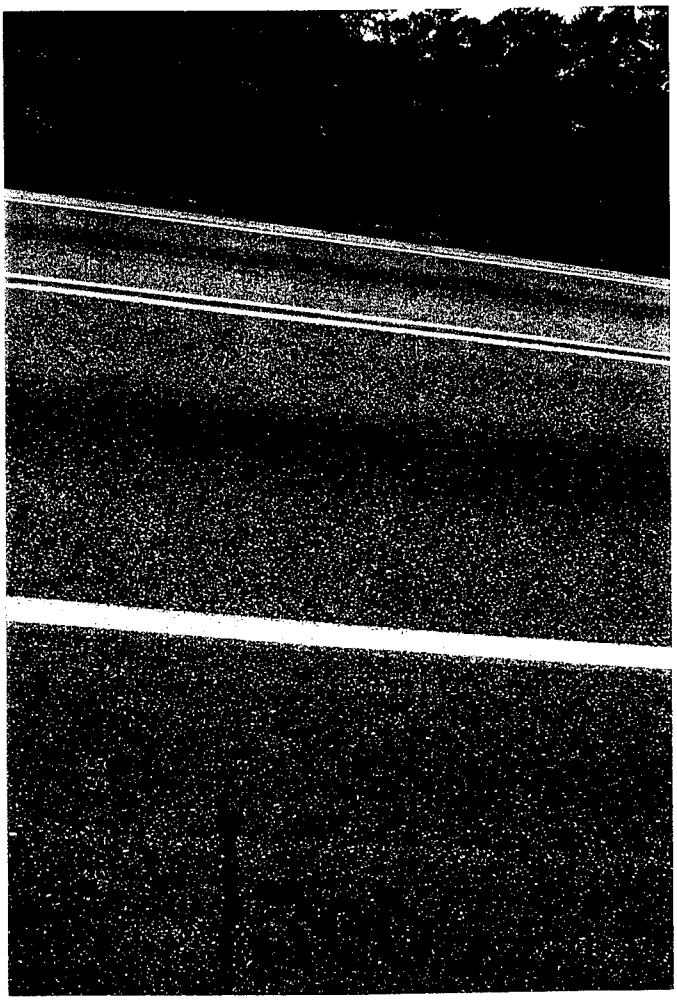
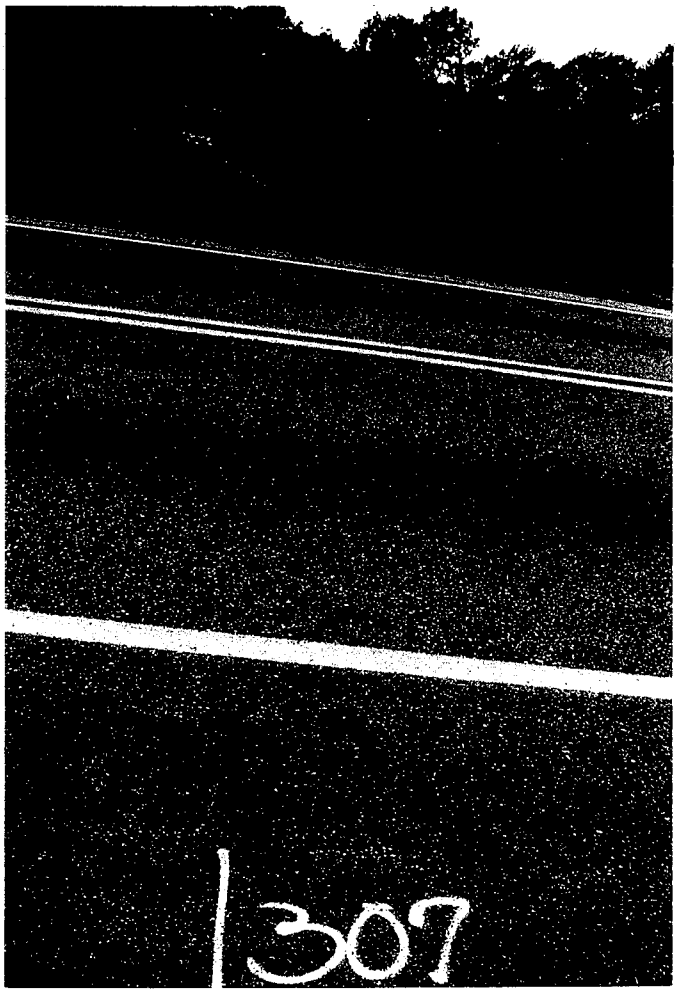


Photograph – 72, Location 300', Petromat Test Section



Photograph – 73, Location 307', Petromat Test Section

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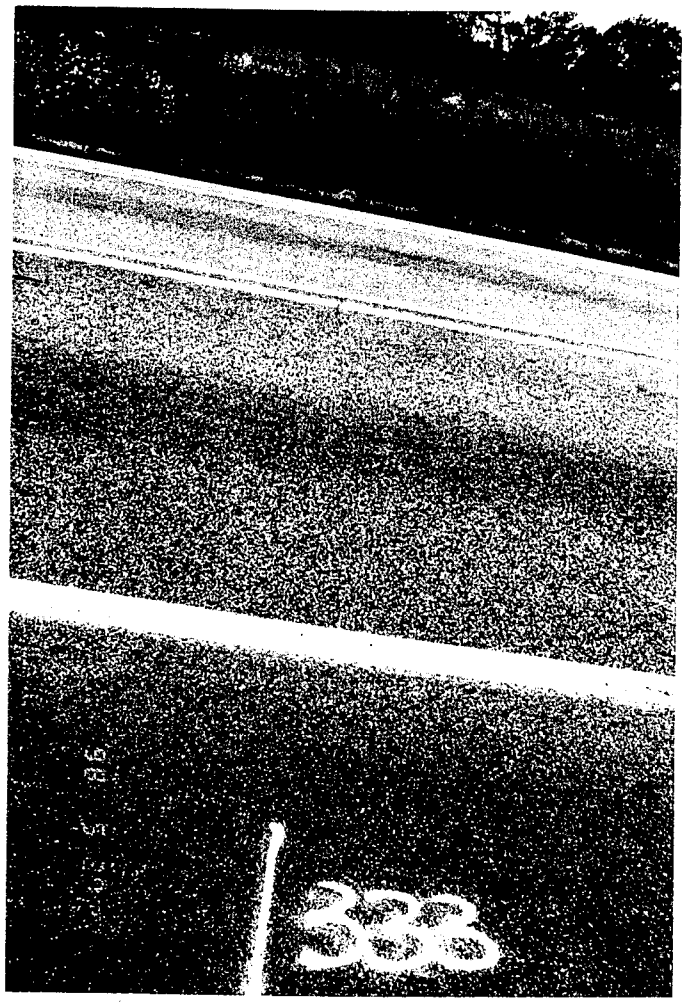
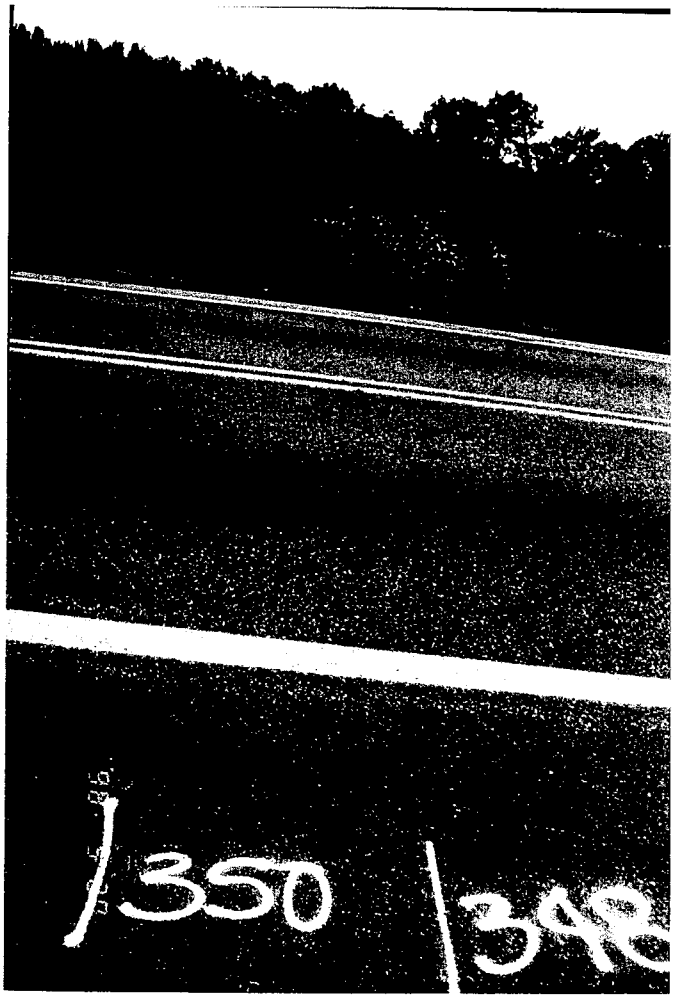


Photograph – 74, Location 333', Petromat Test Section



Photograph – 75, Location 348', $ 350', Petromat Test Section

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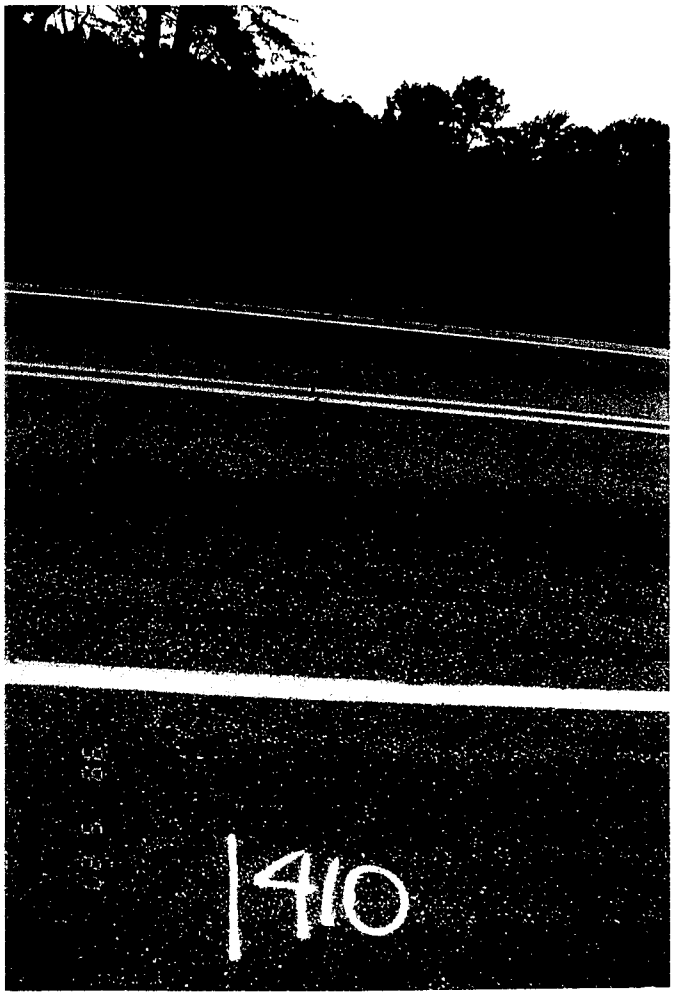
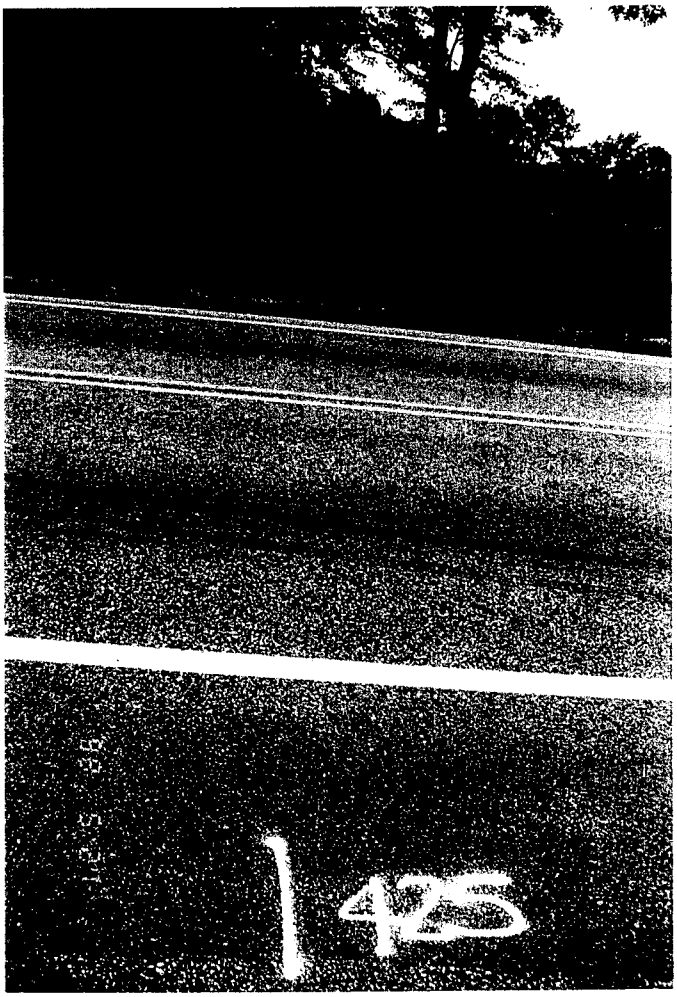
6-0 Montgomery County



Photograph – 76, Location 410', Petromat Test Section



Photograph – 77, Location 425', Petromat Test Section

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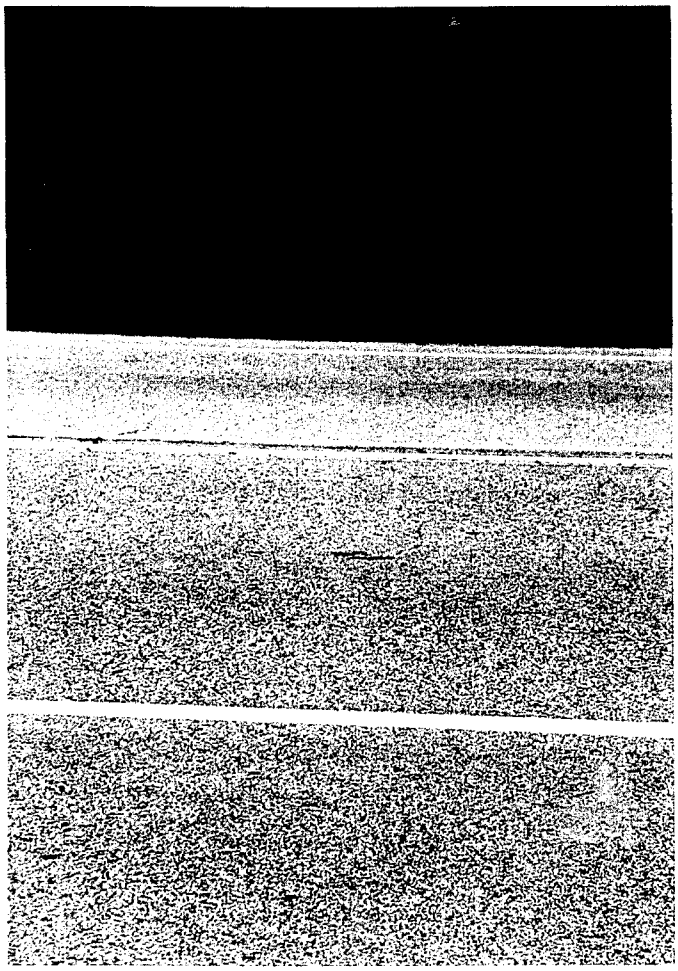
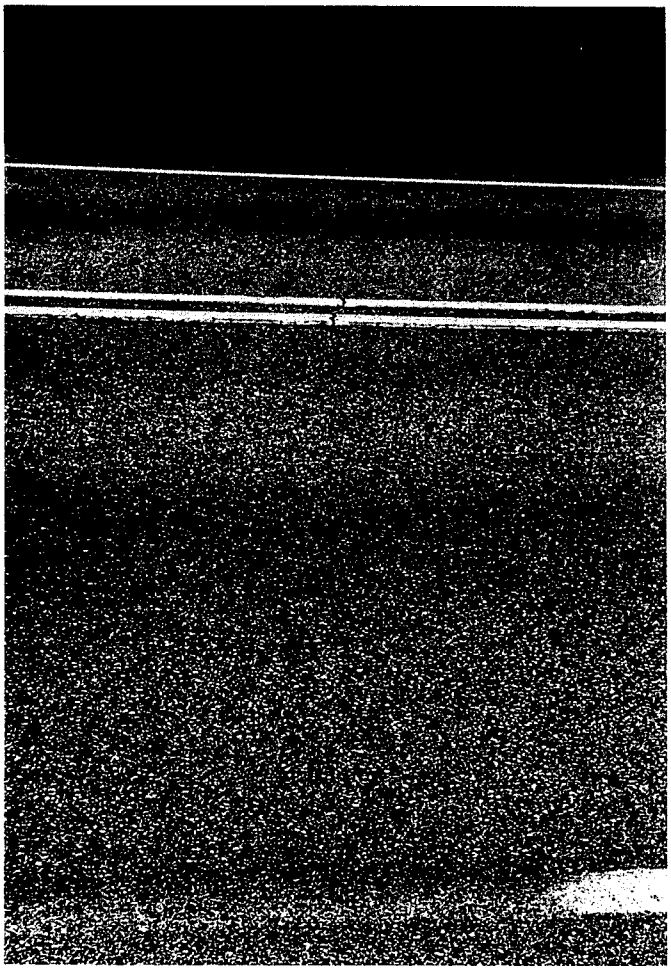


Photograph – 78, Location 548', Control Section Section



Photograph – 79, Location 578', Control

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SR 0073 Gilbertsville
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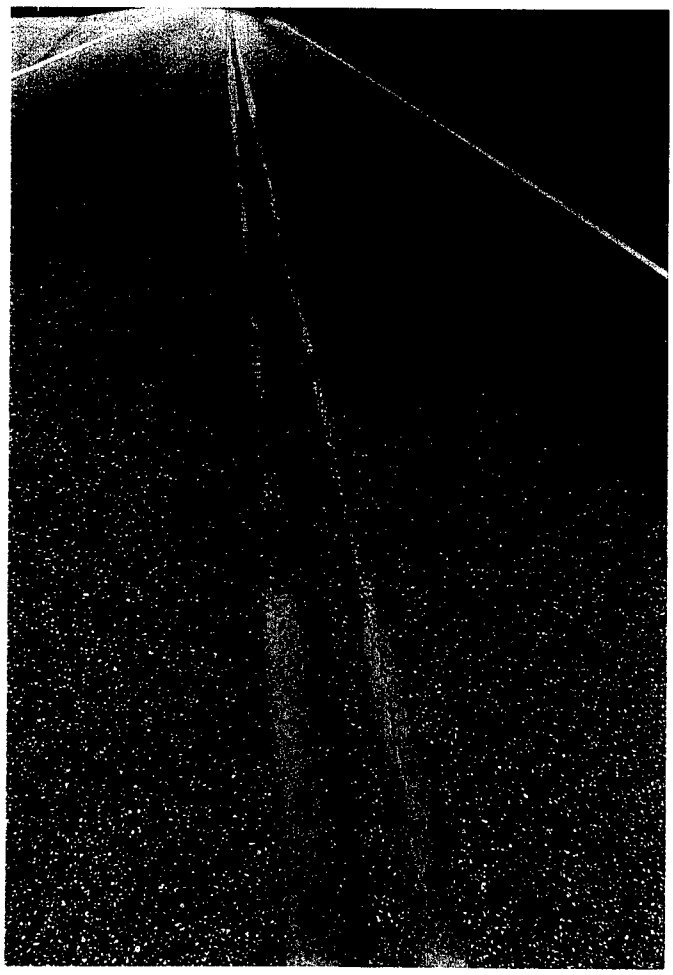


Photograph – 80, Longitudinal Crack in the Test Section

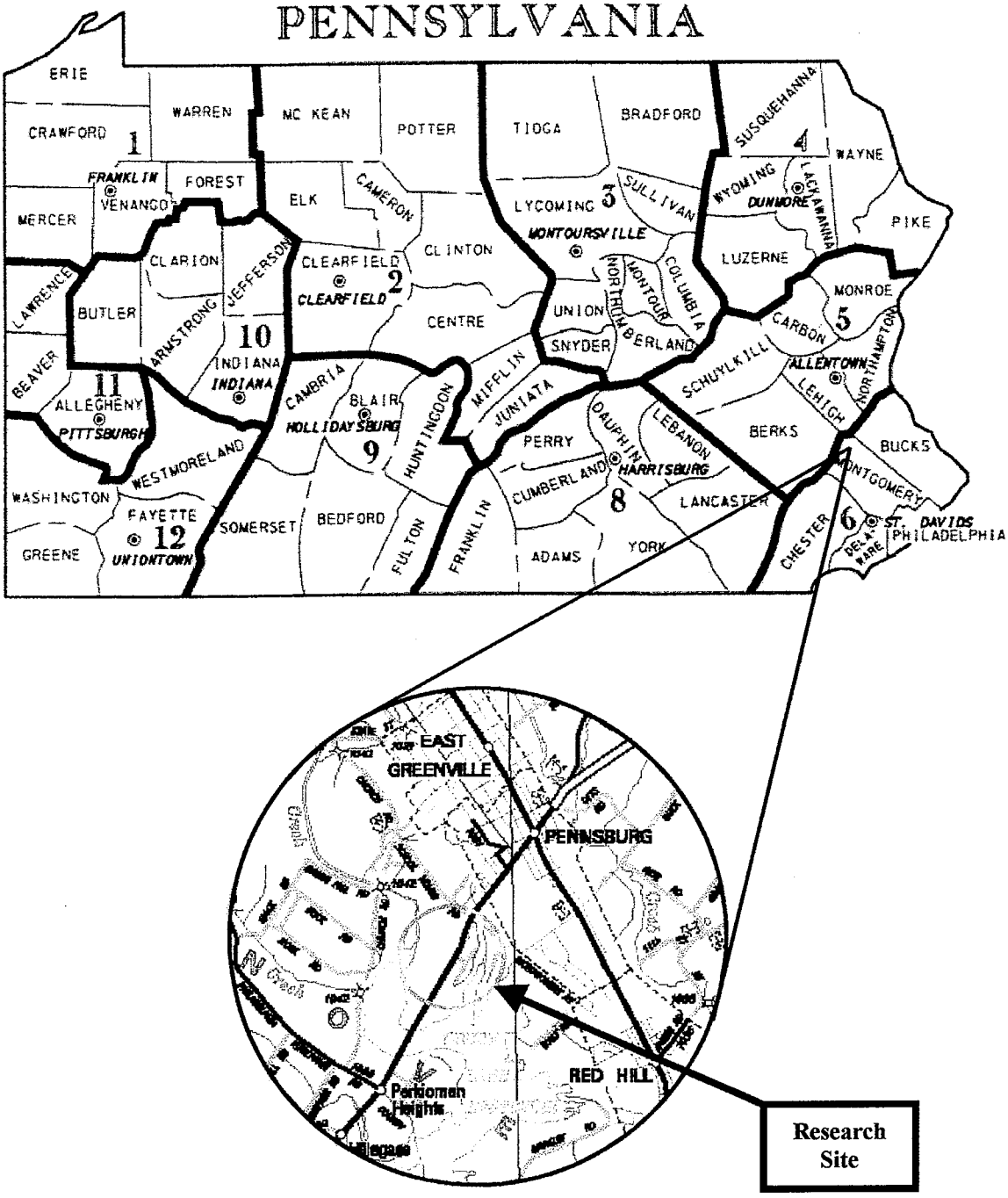
Conclusion

The Synteen, Bit-U-Tex, and Amoco Petromat paving fabrics were evaluated for 3-years. These materials were placed on SR 0073, Montgomery County, Pennsylvania, under a 1½" depth overlay of bituminous ID-2 wearing on June 5, 1995. The research site was inspected on June 7, 1996; some very faint hairline cracks were visible. These cracks were very thin and not easily seen. During inspection of the site September 11, 1997 no hairline cracks were evident. This seemed to indicate that the hairline cracks had been knitted back together by traffic and the summer heat on the bituminous roadway. This lack of evidence also indicated the possibly that the pavement section may have stabilized due to repeated bituminous overlays over the rigid pavement base. These overlays over time allowed the pavement section to thicken and may have resulted in a stabilized road section. A Core was taken and the total depth of the bituminous overlays was determined to be 5¼ inches. This speculation of a stabilized roadway however, became invalid at the end of the third year when reflective cracks appeared both in the control and test sections. Final photographs (52-80) of the research site were taken on May 27, 1998. These photographs illustrate reflective cracks at various locations as indicated on the original crack survey. These cracks appeared open enough to photograph in both the control and test sections. The paving fabrics failed to even retard reflective cracks from forming in either Bit-U-Tex or the Petromat test sections.

This research project reflects similar results from previous research studies mentioned in the introduction and listed as foot notes on the bottom of page one.

Therefore as a result of this field evaluation the Synteen, Bit-U-Tex and Amoco, Petromat paving fabric products did not prevent reflective cracks from forming on the road surface. The Synteen, Bit-U-Tex, and Amoco Petromat paving fabric products are not recommended for approval.

Location Map - Site B



SITE B

SR 0663, Pennsburg, Montgomery County
Engineering District 6-0

CONSTRUCTION - SITE B

Glasgrid 8501 was placed on SR 0663 near the Borough of Pennsburg, Upper Hanover Township Montgomery County, September 5, 1995, during a night paving operation (see photographs 93-98). Test and control sections were selected (see photographs 81-92). The test section consisted of six transverse joints and one longitudinal joint. The control section had six transverse joints. These joints were all located, numbered, and photographed before the paving operation began. During the paving operation, the transverse joints could only be covered by the Glasgrid one lane at a time because the road remained open to traffic.

The Glasgrid 8501 was unrolled, placed, and cut by hand in the lane closed to traffic. This material did not need to be tacked with AC-20 or emulsion oil because the fiberglass grid was coated with bitumen. The bitumen coating on the Glasgrid was sticky and once it was tracked in with an automobile the material stayed in place. A small amount of bituminous ID-2 wearing was "fanned" over the Glasgrid as a precaution to ensure that the material would not be picked up by the dump trucks or paver. The Glasgrid was then covered with 1½ inches of ID-2 bituminous wearing course. Construction equipment did not pick up the Glasgrid during paving. All of the roadway joints within the limits of work on this project site were cleaned and sealed prior to paving in accordance with Publication 408 Specifications (see Appendix B).

The paving operation began at 6:00 PM and continued until dawn. The test and control sections were paved at 7:45 PM (Eastbound) and 1:30 AM (Westbound).

SITE B Montgomery County

Product: GLASGRID 8501; roll width 5.0 feet, roll length 135 feet
Project: SR 0663, Pennsburg, Montgomery County, Engineering District 6-0
Date: September 5, 1995 Tuesday, Night Paving Operation
Weather: Clear and Warm
Road Data: Lane Width - 11.0 feet, Shoulder Width - 6.0 feet, Transverse Joint Spacing 17.0 feet average
Location: Utility Pole # 657, 14.0 feet north to Station 289+00
Average Daily Traffic (ADT): 6,489
Trucks: 15 %

Test Section

	Transverse Joint #	Station Location
	G-1	289+21
	G-2	289+98
	G-3	290+74
	G-4	291+50
	G-5	292+27
Longitudinal Joint	⇒	
	G6	293+05

Control Section

C1	293+82
C2	294+52
C3	295+36
C4	296+08
C5	296+85
C6	297+63

Material Data: Glasgrid, roll width 5.0 feet, roll length 135 feet
Material Model Number: 8501

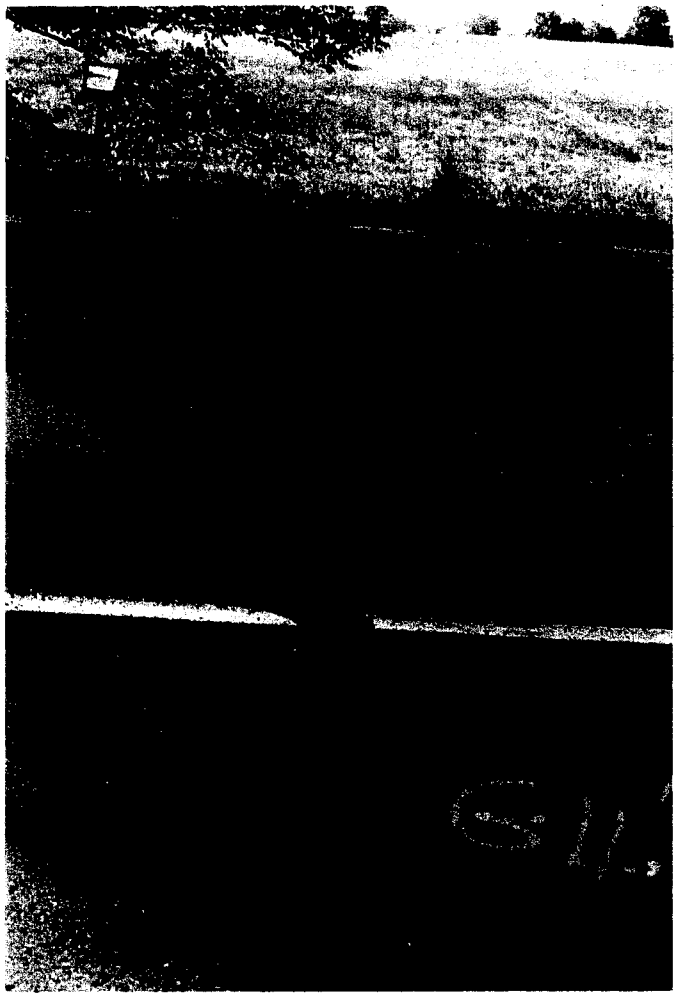
Glasgrid Test Section

Photograph - 81, Test Joint G-1

Photograph - 82, Test Joint G-2

Glasgrid Test Section

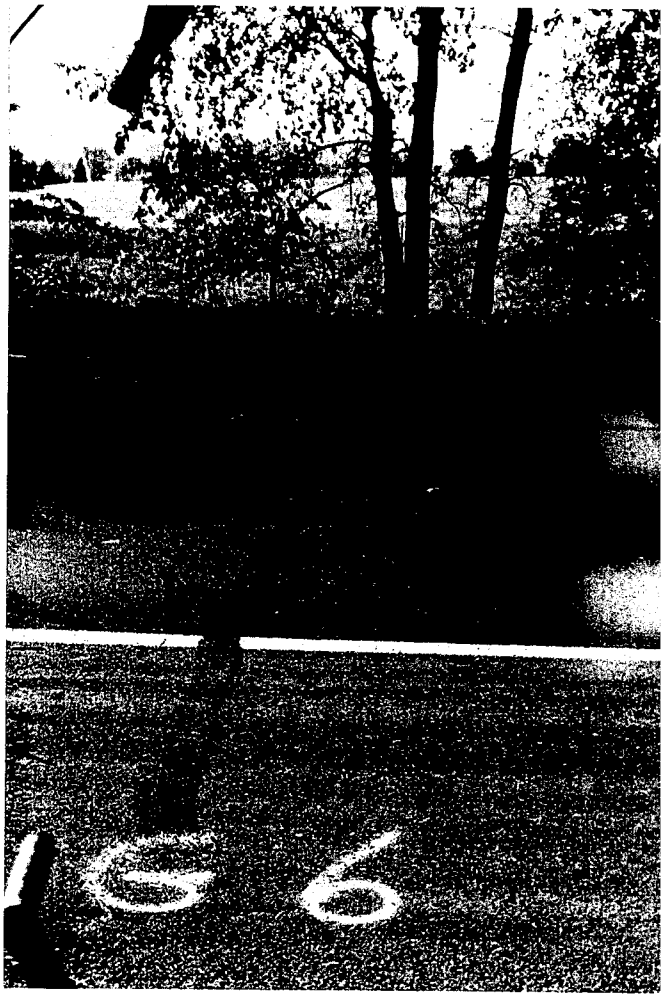
Photograph - 83, Test Joint G-3



Photograph - 84, Test Joint G-4

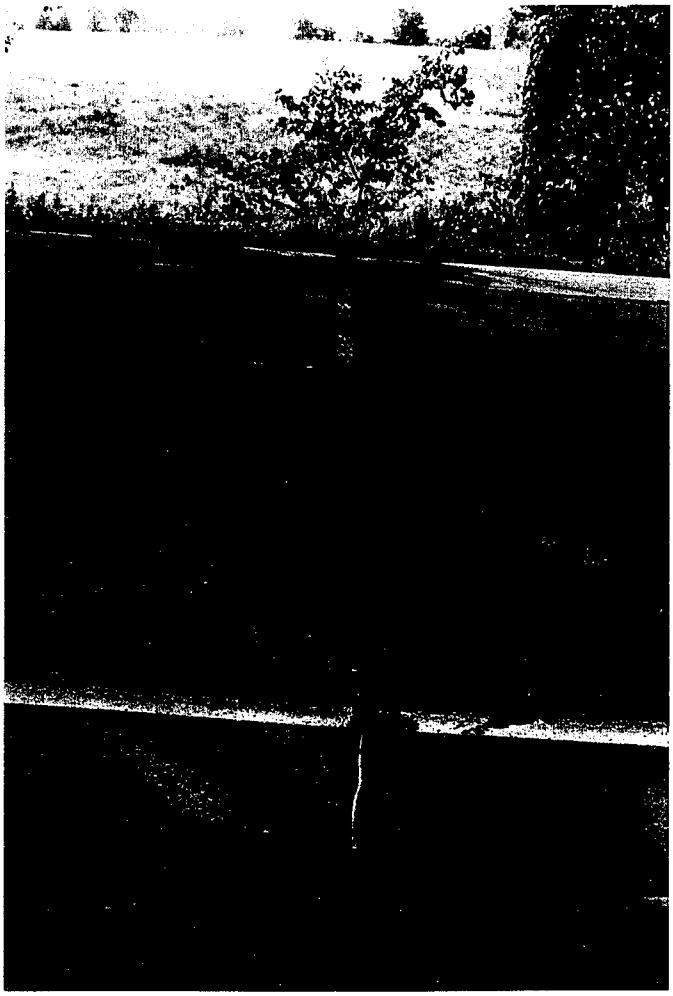
Glasgrid Test Section

Photograph - 85, Test Joint G-5



Photograph - 86, Test Joint G-6

Glasgrid Control Section

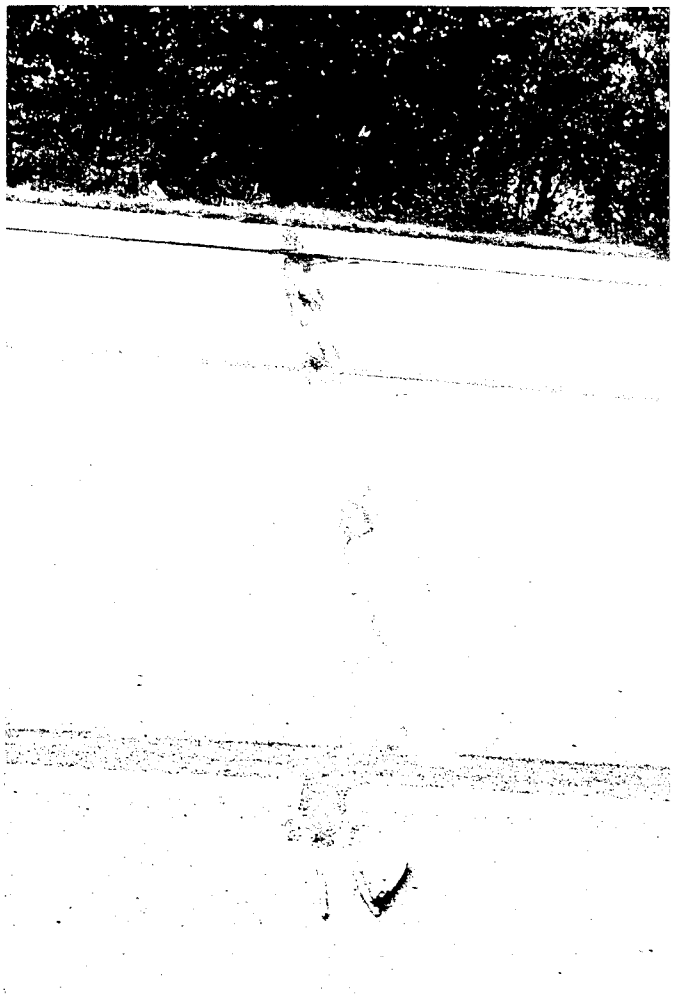


Photograph - 87, Control Joint C-1

Photograph - 88, Control Joint C-2

Glasgrid Control Section

Photograph - 89, Control Joint C-3



Photograph - 90, Control Joint C-4

Glasgrid Control Section

Photograph - 91, Control Joint C-5

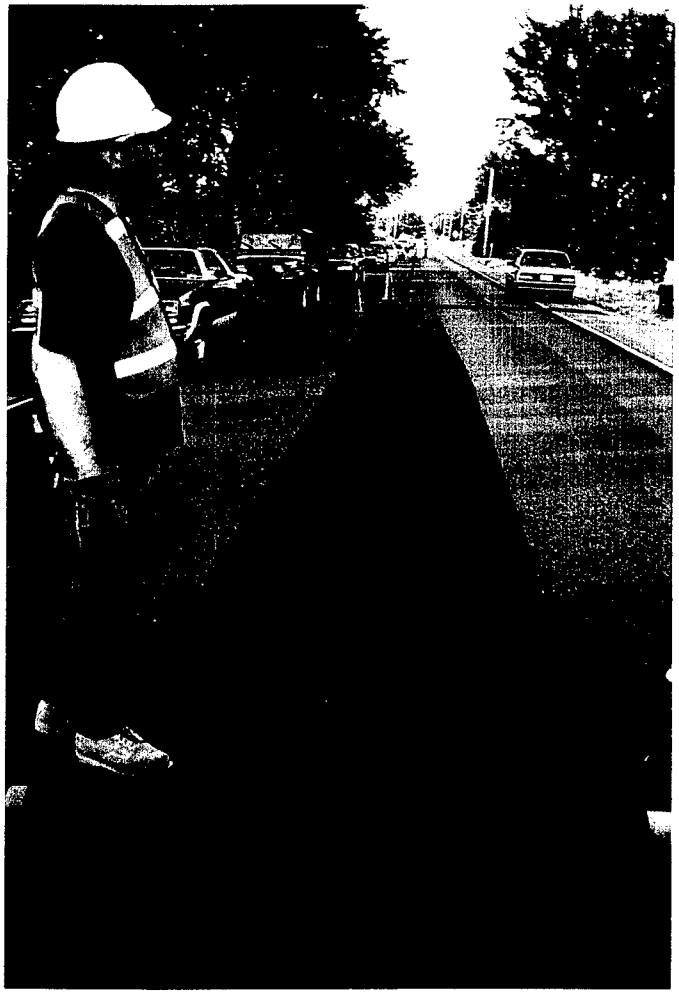
Photograph - 92, Control Joint C-6

Glasgrid Construction Photographs

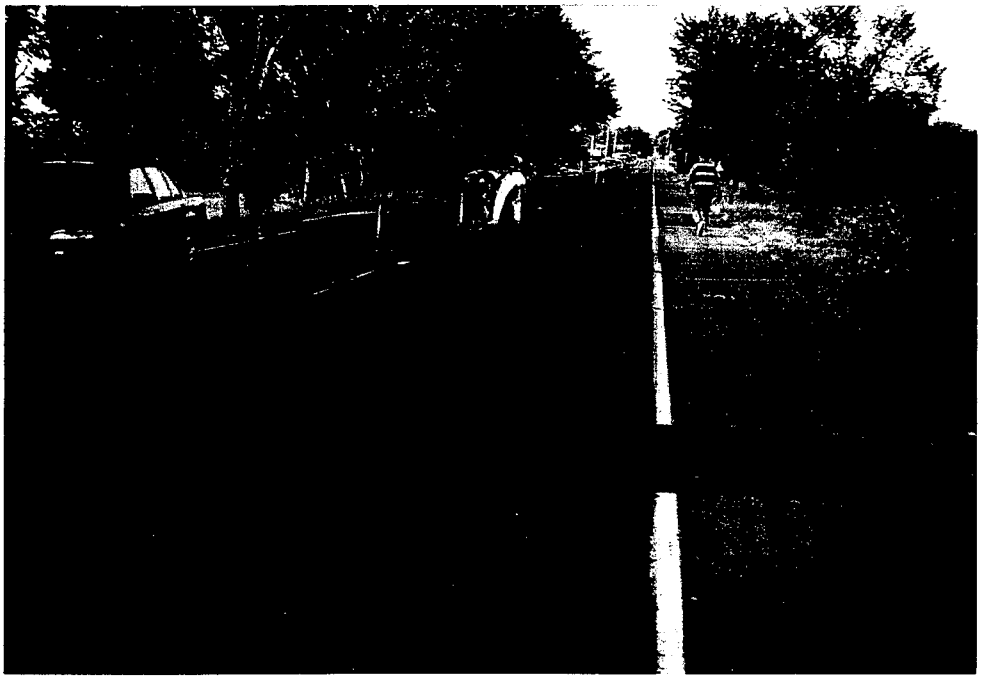
Photograph - 93, Glasgrid is unrolled to the correct length.

Photograph - 94, the Glasgrid is then placed, and cut to length over a longitudinal pavement joint.

Glasgrid Construction Photographs



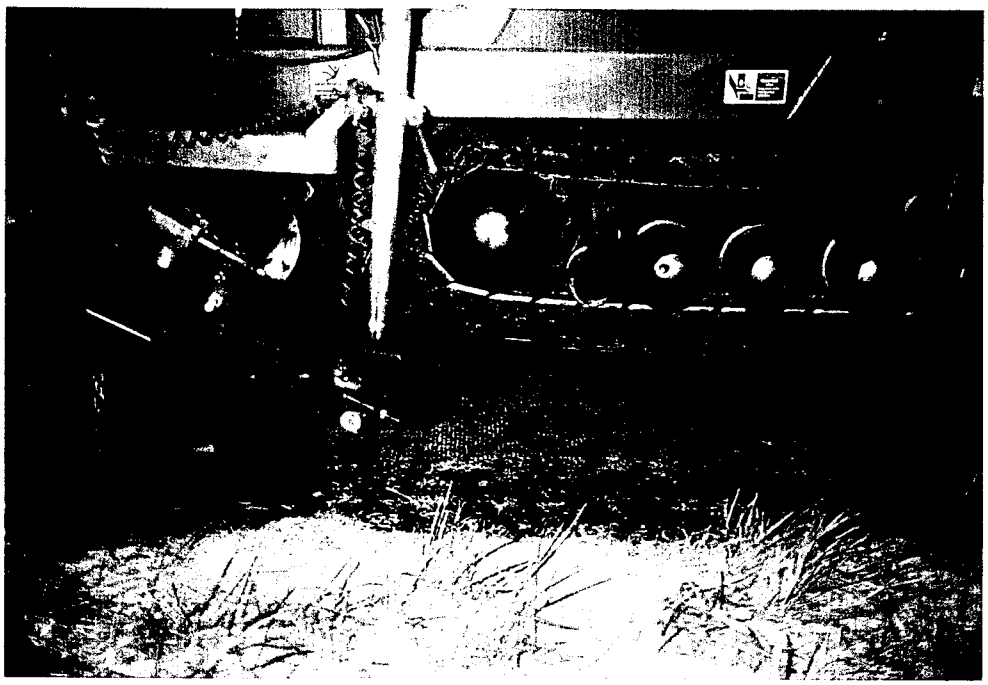
Photograph - 95, After the Glasgrid was placed an automobile was used to track the material in. This ensured adhesion of the material to the existing pavement.



Photograph - 96, The material was placed on 6 transverse and one longitudinal joint.

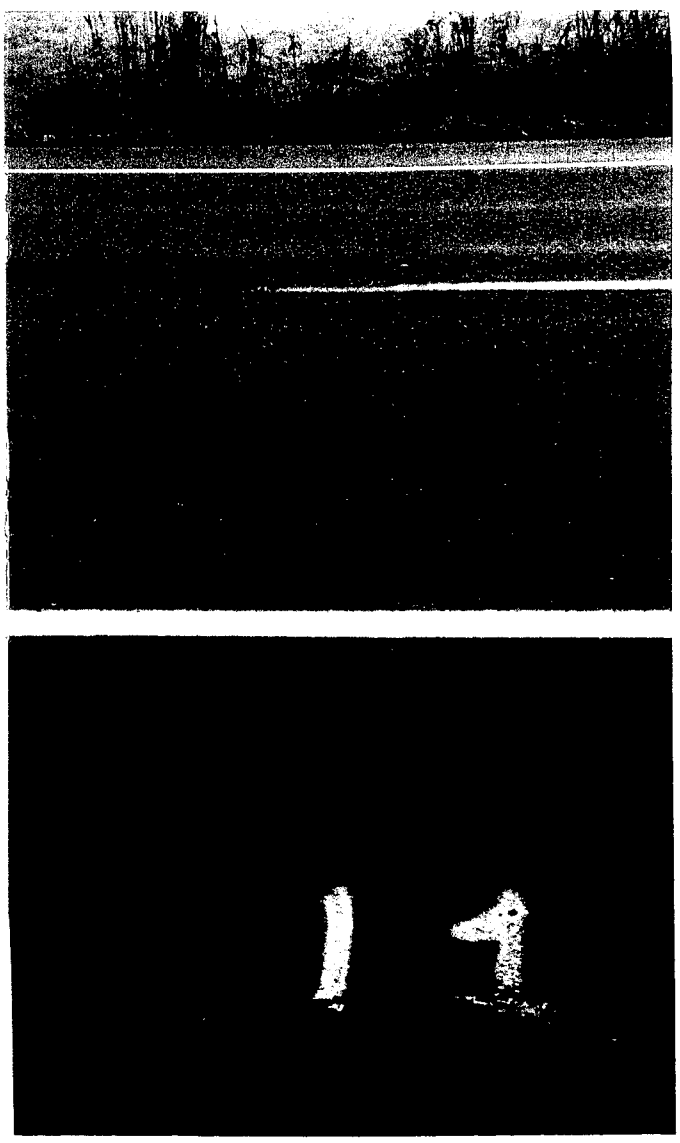
Glasgrid Construction Photographs

Photograph - 97, Bituminous ID-2 Wearing was fanned over the Glasgrid to reduce the possibility of the Dump Trucks and paver of picking up the material.

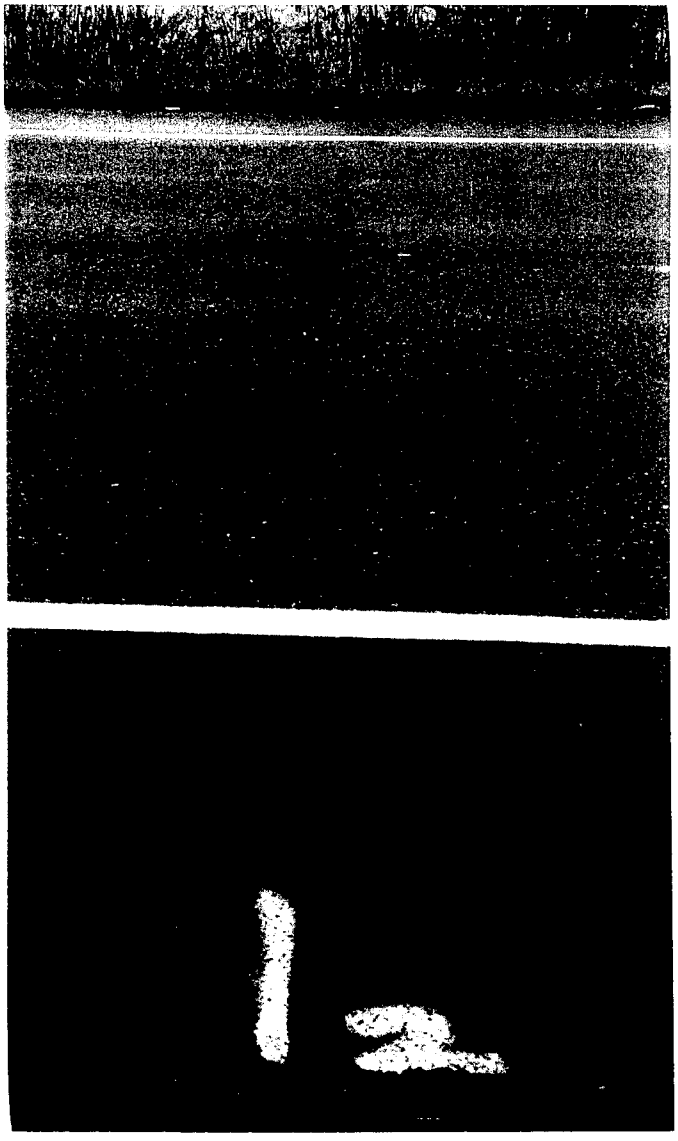


Photograph - 98, Note the paver on top of the Glasgrid and the material is not picking up on the machines treads

Final Photographs
Glasgrid Test Section
September 1997

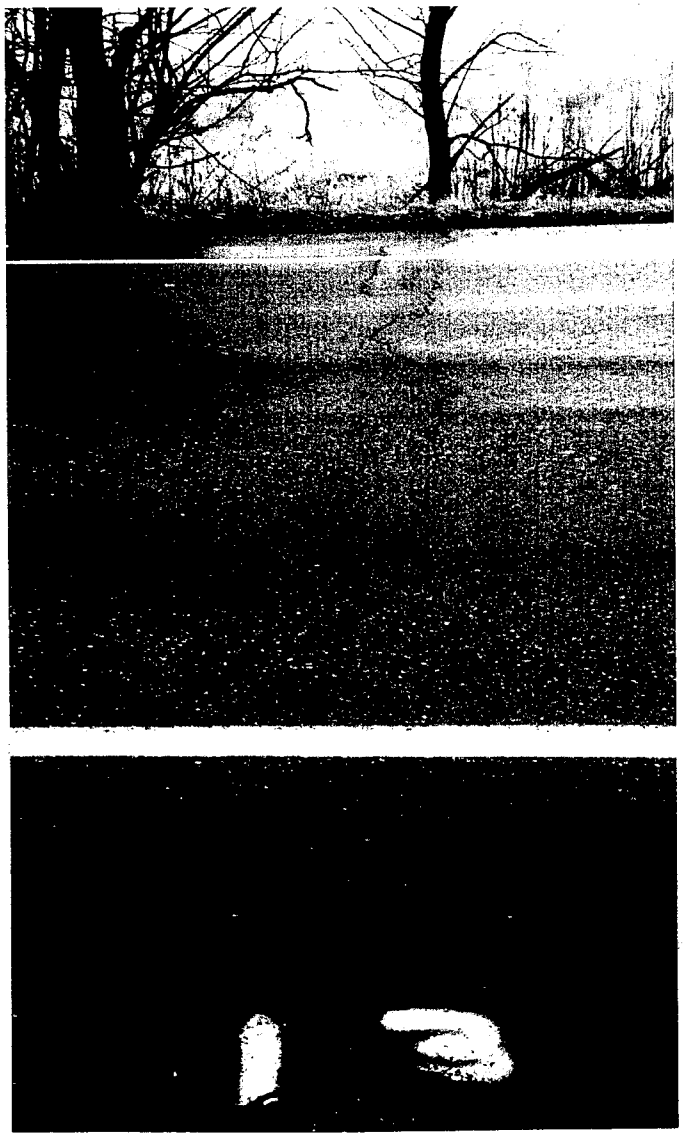


Photograph – 99, Test Section 1,
Reflective cracking after two years

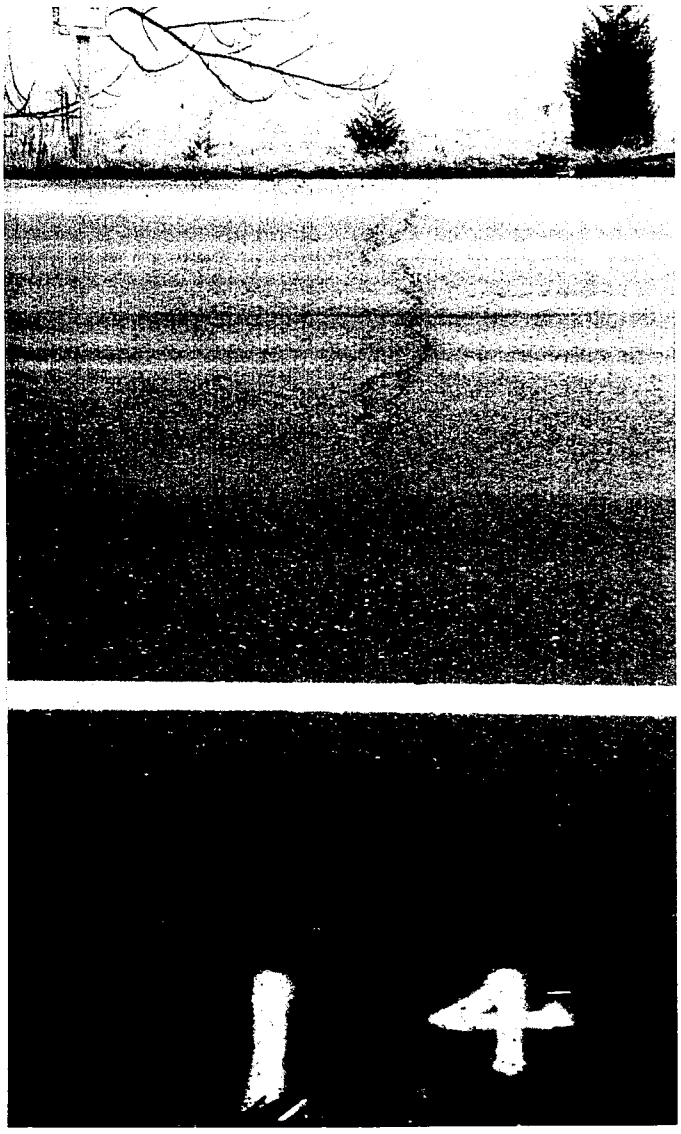


Photograph – 100, Test Section 2,
Reflective cracking after two years

Final Photographs
Glasgrid Test Section
September 1997

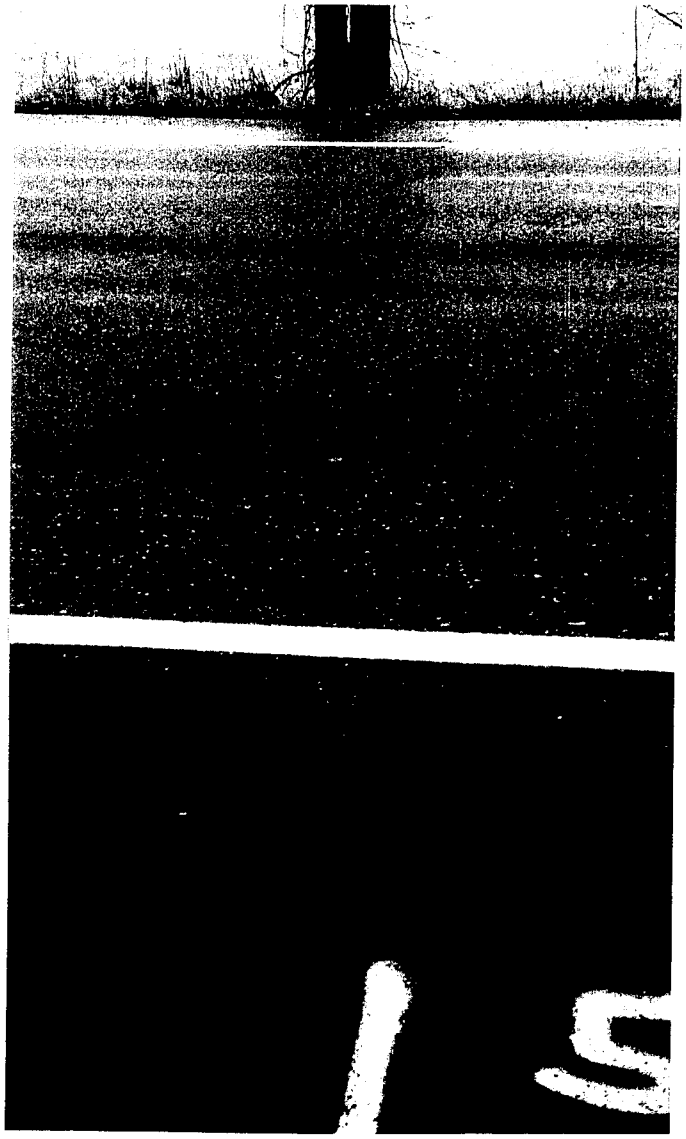


Photograph – 101, Test Section 3,
Reflective cracking after two years

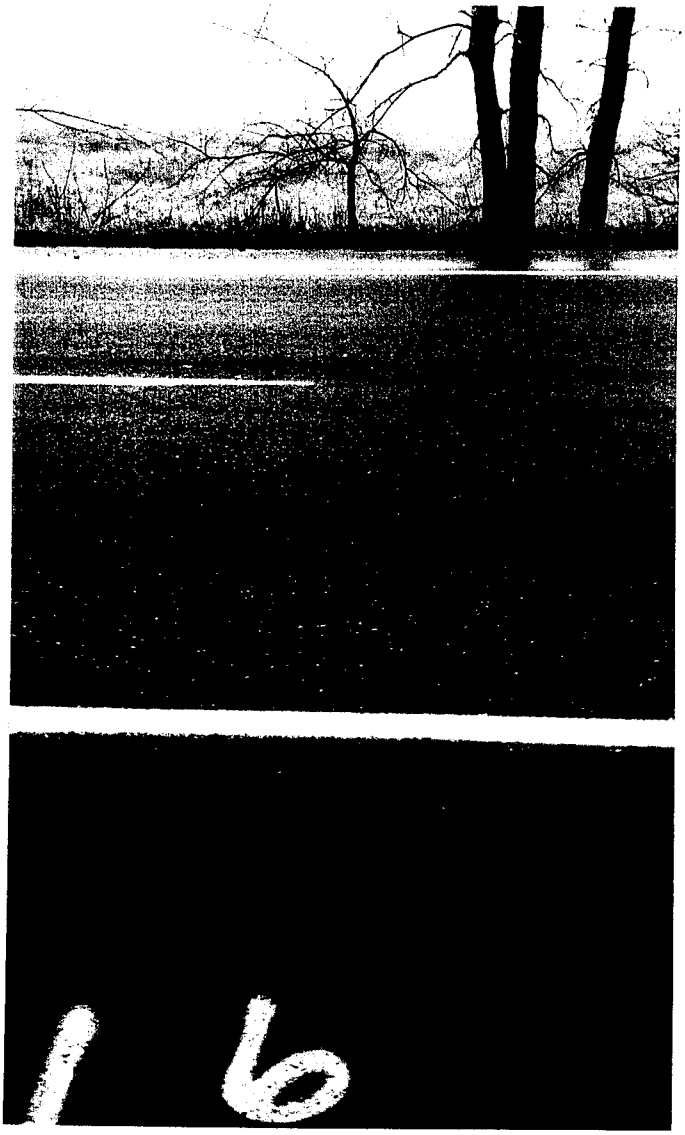


Photograph – 102, Test Section 4,
Reflective cracking after two years

Final Photographs
Glasgrid Test Section
September 1997

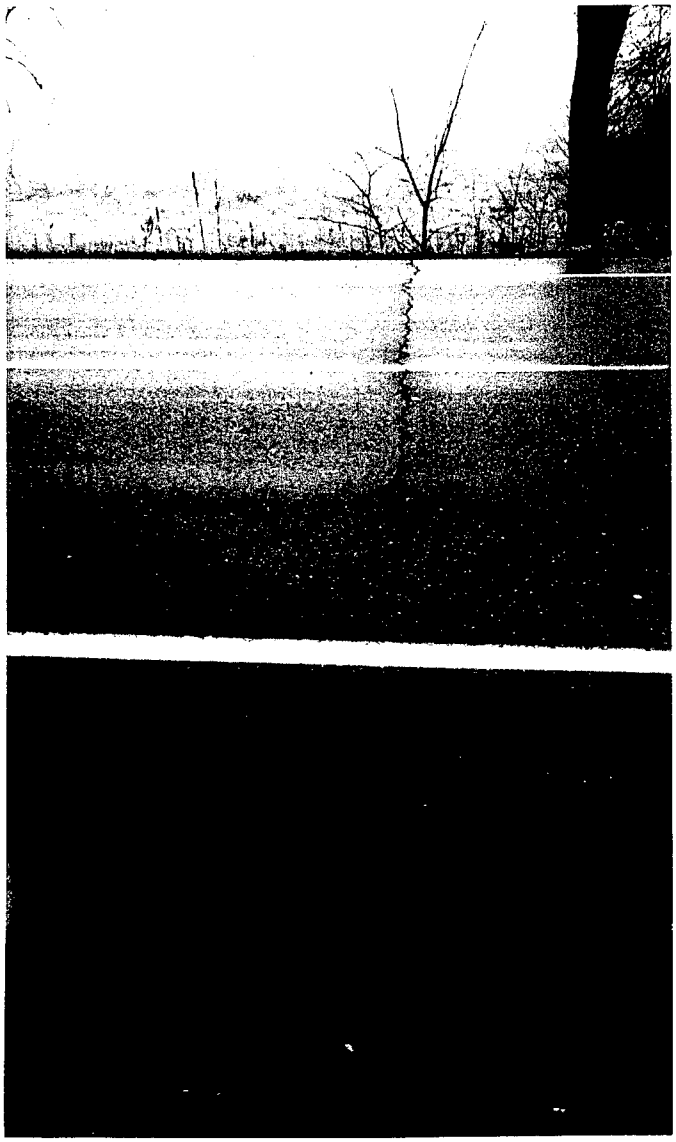


Photograph – 103, Test Section 5
Reflective cracking after two years

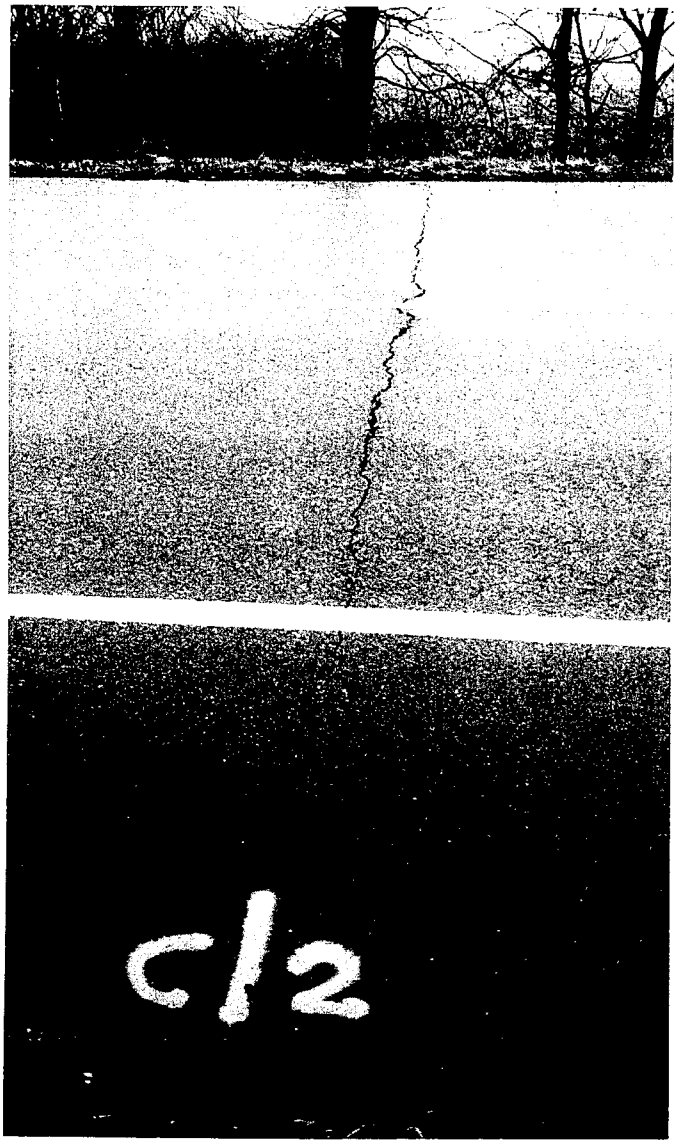


Photograph – 104, Test Section 6
Reflective cracking after two years

Final Photographs
Glasgrid Control Section
September 1997

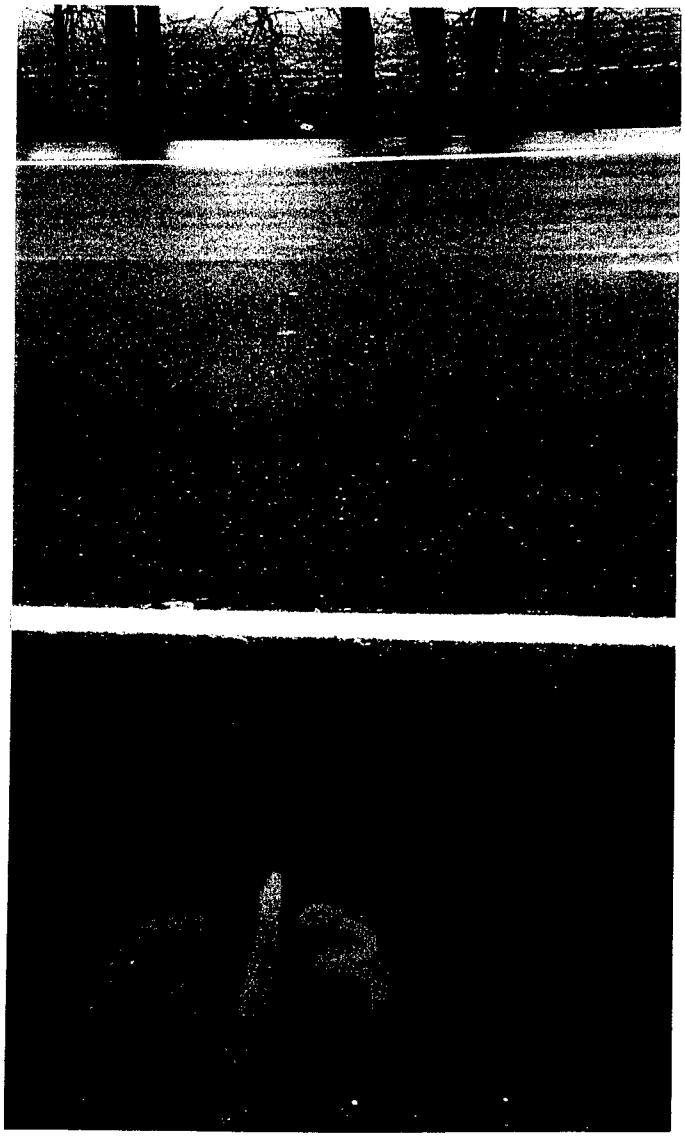


Photograph – 105, Control Section 1
Reflective cracking after two years

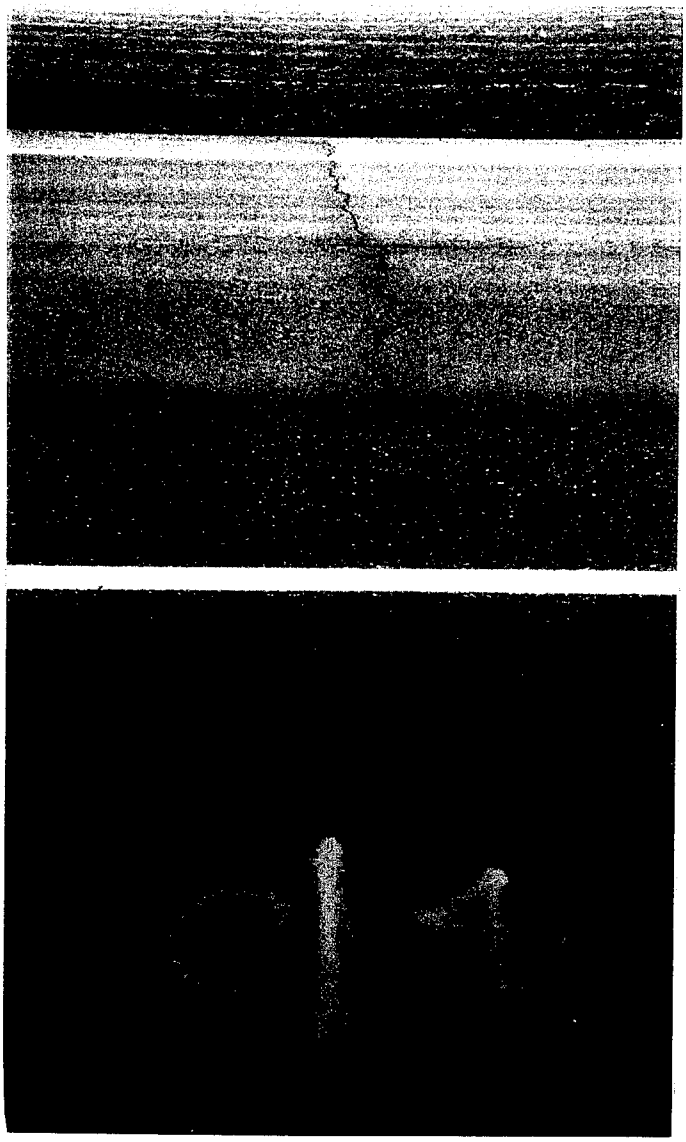


Photograph – 106, Control Section 2
Reflective cracking after two years

Final Photographs
Glasgrid Control Section
September 1997

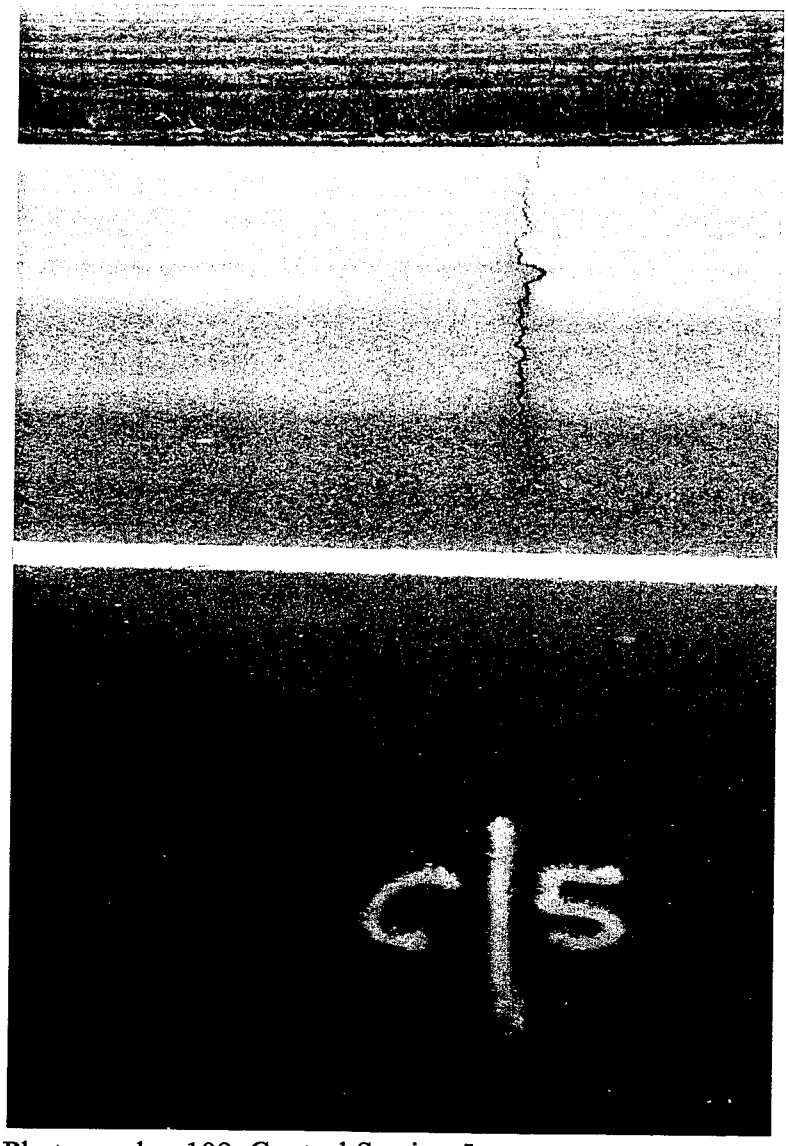


Photograph – 107, Control Section 3
Reflective cracking after two years



Photograph – 108, Control Section 4
Reflective cracking after two years

Final Photographs
Glasgrid Control Section
September 1997



Photograph – 109, Control Section 5
Reflective cracking after two years

Table 1. Performance Data of GLASGRID 8501

Test Section		**note:** pole #657, 14 feet north to station 289+00				
Transverse Joint #	Station Location	Field Inspection-1 Feb. 29, 1996	Field Inspection-2 March 27, 1996	Field Inspection-3 June 7, 1996	Field Inspection-4 Dec. 19, 1996	Field Inspection-1 Sept. 11, 1997
G-1	289+21	OK	OK	OK	OK	NB crack, SB crack
G-2	289+98	SB crack	SB crack	SB crack	SB crack	NB crack, SB open crack
G-3	290+74	SB crack	SB crack	SB open crack	SB open crack migrating into NB	NB crack, SB open crack
G-4	291+50	NB crack	NB crack	NB crack	NB has a parallel crack	NB has a open parallel crack, SB crack
G-5	292+27	NB crack	NB crack	NB crack	NB crack	NB open crack, SB crack
Longitudinal Joint		OK	OK	OK	OK	NB crack, SB crack
G-6	293+05	OK	OK	OK	NB crack 12" length	NB crack, SB crack
Control Section						
C1	293+82	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling
C2	294+52	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling
C3	295+36	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling
C4	296+08	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling
C5	296+85	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling
C6	297+63	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB	Open crack NB & SB is raveling

NB – North Bound SB – South Bound

CONCLUSION

The Glasgrid 8502 test section was evaluated from September 5, 1995 to September 1997 when the project was terminated due to poor performance, as noted in Table 1. The research project was suppose to last 3 years but further study and deferred maintenance would have been detrimental to the road and public safety. The open reflective cracks in the test section were widening and beginning to travel (see photographs 99-109). The test section was also beginning to exhibit open reflective cracks that would have started to ravel had the research project not been terminated at this time. Each of the joints in the test section had reflected through with the exception of the longitudinal joint. The longitudinal joint didn't reflect through on any other part either of the untreated test section or in the control section. This observation was also confirmed in previous research studies evaluating inter layers in bituminous overlays. These previous studies are referenced in the introduction (page 1).

The Glasgrid did not stop reflective cracking from occurring and it retarded reflective cracking for less than six months before hairline cracks were observed after the first winter. Therefore, Glasgrid 8502 is not recommended for approval or further research on Penn DOT projects. Glasgrid 8502 did not meet the vendors claim that the material will prevent reflective cracking.

ACKNOWLEDGEMENTS

This research project was made possible through a great deal of cooperation from the following individuals: Bill Tribbett from Synteen USA, Inc. for supplying the BIT-U-TEX material used on SR 0073. Land Saver Inc. for installing the Bit-U-Tex paving fabric, Vincent J. Cerlione from Site Engineering Inc. along with Khaled Mahmood, District 6-0 Summer Intern Program, for surveying and recording crack data on SR 0073 for the alternate research site that was used. Lorraine Davies, the District 6-0 Pavement Engineer, for locating the test and control sections used in this study and coordinating operations with the prime contractor. Also, Scott Keo and Randy Thomas, P.E., from Atlantic Construction Fabrics, for supplying and installing the Glasgrid on SR 0663 in Pennsburg.

APPENDIX A

Paving Fabric and Geogrid Material Properties

PAVING FABRIC AND GEOGRID MATERIAL PROPERTIES

AMOCO FABRICS & FIBERS CO.

PETTROMAT 4596 - Polypropylene Nonwoven Geotextile

ASTM D 3786 MULLEN BURST:	1137 kN (165 psi)
ASTM D 4632 GRAB TENSILE / ELONGATION:	0.35 kN (80 lbs / 50%)

SYNTEEN U.S.A., INC

BIT-U-TEX - Geogrid/Geotextile Composite

Geogrid, SBR coated polyester grid, (SBR) Styrol Butadiene Rubber

Geotextile, Nonwoven polyester

ASTM D 5261 Mass / Unit Area	376 g / m^2
ASTM D 3776 Mass / Unit Area	10 oz / yd^2
ASTM D 4751 Apparent Opening Size (U.S. Sieve Size)	#100
ASTM D 4833 Puncture Resistance	65.4 lbs
ASTM D 4632 MD Grab Tensile Strength	214.5 lbs
ASTM D 4632 XD Grab Tensile Strength	179.4 lbs
ASTM D 4491 Permitivity	2.22 sec^{-1}
ASTM D 3786 Mullen Burst	256.0 psi
ASTM D 4595 MD Wide Width Tensile Strength	288.7 lbs / ft
ASTM D 4595 XD Wide Width Tensile Strength	197.4 lbs / ft
ASTM D 4595 MD Wide Width Elongation	23.8 %
ASTM D 4595 XD Wide Width Elongation	26.0 %
ASTM D 4533 MD Trapezoidal Tear	488.7 lbs
ASTM D 4533 XD Trapezoidal Tear	484.4 lbs

BAY MILLS LIMITED, BAYEX DIVISION

GLASGRID 8501 - Bitumin Coated Fiberglas Geogrid

ASTM D 5261 Mass / Unit Area	370 g / m^2 (11 oz / yd^2)
Aperture Size	12.5 mm X 12.5 mm (0.5" X 0.5")
GR/GG/-87 MACHINE DIRECTION (MD)	100kN / m (6850 lbs / ft)
CROSS DIRECTION (XD)	100kN / m (6850 lbs / ft)

APPENDIX B

PUBLICATION 408 SPECIFICATIONS

SECTION 468 — FIBERIZED ASPHALT MEMBRANE

468.1 DESCRIPTION — This work is cleaning and sealing of longitudinal and transverse joints and cracks in existing pavement surfaces with a fiberized asphalt membrane prior to overlaying. Provide membrane having a width of 5 inches ±1 inch on concrete and bituminous pavement surfaces.

468.2 MATERIAL —

(a) Asphalt Cement Class AC-20. Section 702

(b) Synthetic Fibers. As listed in Bulletin 15. Include certification with each shipment as specified in Section 106.03(b)3.

(c) Bituminous Wearing Course FJ-1. Section 422

468.3 CONSTRUCTION —

(a) Mixing Procedures. Mix the AC-20 and fibers to the proportions recommended by the manufacturer, or provide a premixed composition. Blend the AC-20 and fibers in an oil-jacketed double wall kettle equipped with agitator and 2-inch hot asphalt pump. Provide separate thermometers for oil bath and melting chamber. Provide a pump for circulating the transfer oil bath. Do not allow the operating temperature in the kettle to exceed the melting point of the fibers.

(b) Surface Preparation. Apply membrane sealer only after the cracks, joints, and adjacent pavement surfaces are clean, dry, and free of any loose material and debris. Clean with a power broom as required. Air blast cracks and joints immediately prior to sealing. Use a compressed air stream of at least 100 psi measured at the source. Fill joints and cracks 1/8 to 1 inch wide with fiberized asphalt membrane. Fill joints and cracks in excess of 1 inch width with Bituminous Concrete Wearing Course, FJ-1, before applying the fiberized asphalt membrane.

(c) Membrane Placement. Use in-place hot extrusion to apply the AC-20 and fibers mixture. Apply the mixture to the width specified and 1/8 ± 1/16-inch thick. Center the membrane within 1 inch of the joint or crack.

(d) Compaction. Immediately level high spots with squeegee or wand. Compact with a water-wetted, steel-wheeled roller meeting the requirements of Section 108.05(c)3 .

468.4 MEASUREMENT AND PAYMENT —

(a) Fiberized Asphalt Membrane. Linear Foot for the type specified.

(b) Bituminous Wearing Course, FJ-1. Ton