REPORT 2013 - 09

VERMONT AGENCY OF TRANSPORTATION

Materials & Research Section
Research Report

EVALUATION OF ASPHALT TREATED PERMEABLE BASE

Report 2013 – 09

December 2013

Evaluation of Asphalt Treated Permeable Base
Georgia, Vermont

Report 2013 – 09
December 2013

Follow-up from Report 2005 – 01
as Amended on November 26, 2013
Reporting on Workplan 1997-R-08

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIAL & RESEARCH SECTION

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16. Abstract

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The performance was based on deterioration criteria including cracking, roughness and field observations. After 13 years of use, both sections exhibit low roughness values for ride. The control treatment had lower roughness values after a 6-year period but throughout time, the experimental roughness values became lower than the control section. There also seems to be a lower cracking average for the control section compared to the experimental test sections. There is not sufficient data to conclude it was substantially better.

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ABSTRACT

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The performance was based on deterioration criteria including cracking, roughness and field observations. After 13 years of use, both sections exhibit low roughness values for ride. The control treatment had lower roughness values after a 6-year period but throughout time, the experimental roughness values became lower than the control section. There also seems to be a lower cracking average for the control section compared to the experimental test sections. There is not sufficient data to conclude it was substantially better.

INTRODUCTION

In the early 1990's the Vermont Agency of Transportation determined a section of Interstate 89 was in need of rehabilitation. To remediate this section, a project using full depth rehabilitation of the bituminous pavement between MM 106.90 and 111.00 in both the northbound and southbound barrels of the highway was initiated and constructed in the 1998 construction season. The original pavement structure was 8" of bituminous concrete pavement over 24" of crushed rock subbase course with an excess of fines. After a 1" maintenance treatment of bituminous concrete in 1982, the pavement had developed thermal related fatigue, which is evident by regularly spaced transverse cracking. The condition of the pavement worsened due to retention of moisture within the aggregate layer, below the pavement. As a result, frost heaves became very noticeable to the driver. The combination of poor ride quality and accelerated rate of deterioration were instrumental in determining a need for rehabilitation.

During the design stage of this particular rehabilitation project, designated as Georgia-Fairfax IM 089-3(26), the Vermont Agency of Transportation (VTrans) determined that this would be an opportune time to examine the performance of asphalt treated permeable base (ATPB) as a solution to the freeze-thaw pavement distress, such as was experienced in this section of highway. Encouraged by reports of New York State DOT's success with this treatment, VTrans elected to use New York's material specifications and incorporate a ½-mile test section of the material into a particularly troublesome area of the project, from MM 109.00 to 109.50 in the northbound lane.

During construction, problems with the material size made it difficult to construct the control section per plan. According to the change order, the necessity for the revision was that the existing subbase material was too large to be reclaimed with base course pavement. The revision included changing the roadway typical and quantities from one of reclaiming to one of total pavement removal. This resulted in cancelling the predetermined control test sites. The experimental sites were constructed as per plan.

While continuing the efforts of this project the Research Unit discovered an inaccurate description of the construction activities in the 2005 as published in the initial report for this project. Construction activities as originally published in report (#2005 – 01) did not accurately depict the construction. An amended report clarified that two different pavement sections were built. The experimental section with ATPB was contrasted with six inches of new Dense Graded Crushed Stone over undisturbed subbase.

PROJECT LOCATION AND SUMMARY

The pavement rehabilitation project was constructed during the summer of 1998. It initially consisted of a full depth removal and reclamation of the existing bituminous pavement to the sub-base. Typically, this is done to improve the drainage patterns, frost and moisture related distresses. The project extended from MM 106.90 to MM 111.00 in both the northbound and southbound lanes, with the experimental ATPB section constructed between MM 109.00 to MM 109.50 in the northbound lane.

MATERIAL DESCRIPTION

The ATPB layer placed on this project was designed in accordance with New York State DOT specification. The planned pavement structure consisted of the courses of materials shown in Figure 1. To correct drainage issues, an 8-inch diameter perforated PVC under drain was placed under the edge of each shoulder. Theoretically, the stable voids of the permeable base course should have created a porous layer where moisture can freely flow to the edge drains.

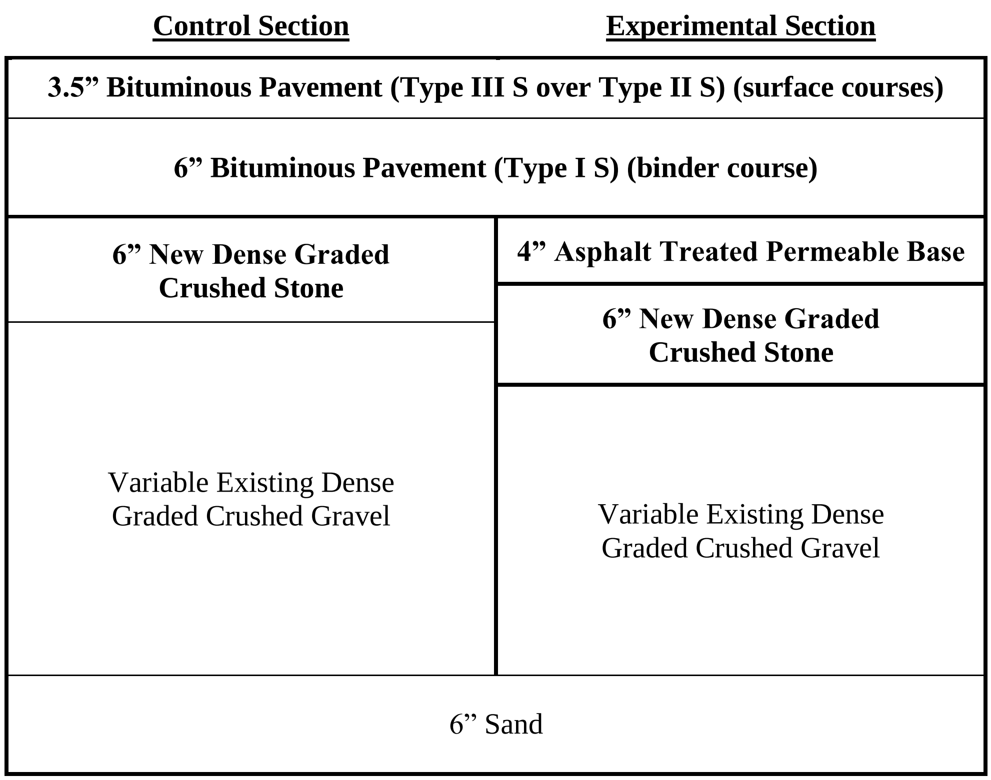


Figure 1 - Asphalt Treated Permeable Base Layering

The rest of the northbound lane was designed using a reclaimed base method. This required remixing and compacting eight inches of the existing bituminous concrete and base course in both the travel and passing lanes. Two 3-inch lifts of Type I Superpave bituminous concrete binder course were placed directly on the ATPB layer. The wearing course was constructed by placing a 2-inch lift of Type II Superpave bituminous concrete followed by a 1 ½ -inch lift of Type III Superpave bituminous concrete lift. This design as well as the shoulder design is shown in the typical sections in the project plans. The asphalt binder used was PG 64-28.

PERFORMANCE AND OBSERVATIONS

Laboratory Testing

Bituminous Concrete samples were used as acceptance samples and transported back to the VTrans' Materials Laboratory for analysis. These included the ATPB sections as well as the standard bituminous concrete. All samples met contract specifications in gradation and asphalt content. PG 64-28 asphalt cement was also sampled and analyzed at the laboratory. These materials also met contract specifications.

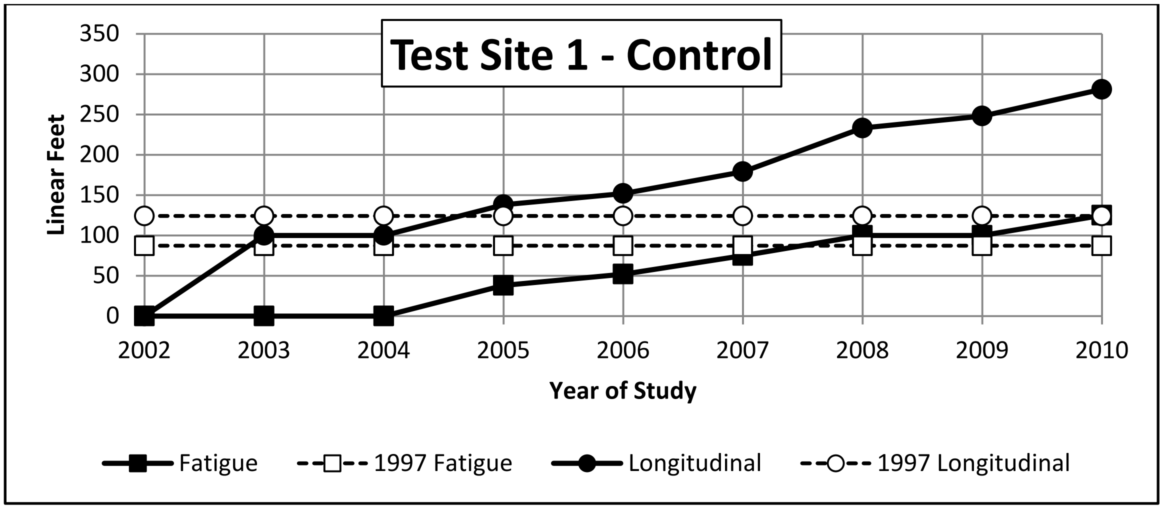
Field Observations

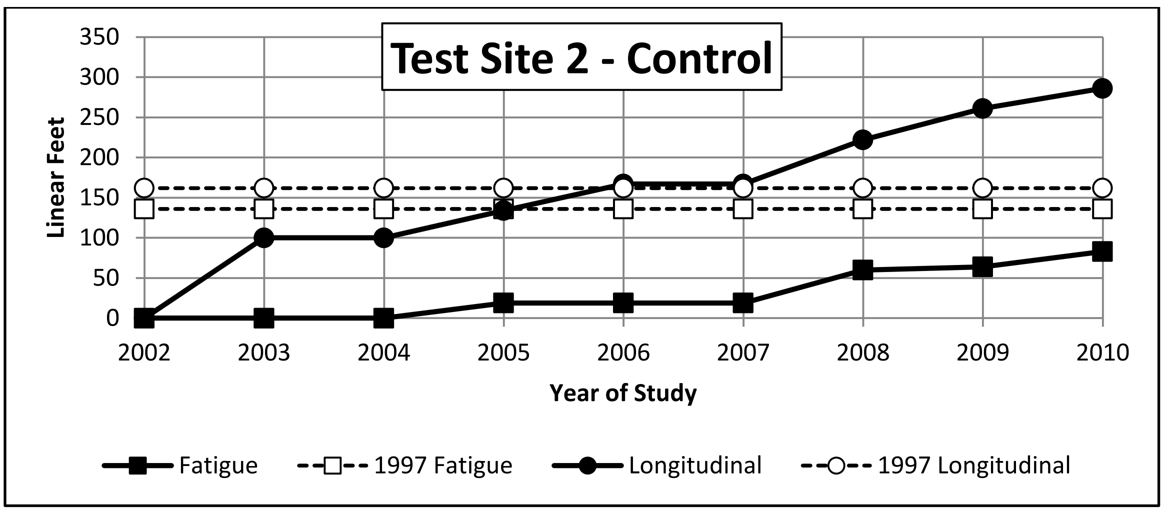
Cracking

The performance of the ATPB treatment are evaluated by observing the pavement condition over time, and identifying developing crack patterns using procedures detailed in the *Distress Identification Manual for the Long-Term Pavement Performance Project* (SHRP-P-338). Prior to construction, six test sites were established. Three test sites were in the experimental section where the ATPB was to be placed and the other three in the control section. Crack measurements were taken in linear feet and are summarized in Table A1, in the Appendix. Figures 2 and 3 shows the growth of fatigue and longitudinal cracks in the control and experimental test sites. The lengths of transverse and miscellaneous cracks were generally minimal. The overall total amount of cracking was far less than that of other projects; however, the most severe cracks were transverse, occurring in roughly three-meter intervals.

The completed project was evaluated four years after construction in 2002. As shown in Table A1, there was very little initial cracking in the test site; however, there were less cracks in the control section. The control section averaged 33 linear feet of cracking where the ATPB section averaged 116 linear feet. All of these cracks had also been sealed as part of the statewide crack seal project. Most of these appear to be center and edgeline paving joints shown in Figures 4 and 5 below.

As noted in the introduction, regularly spaced transverse cracking distresses and frost heaving were contributing factors in the decision to rehabilitate this roadway section. As of the inspection of October 2004, there was no evidence of transverse cracking, except in test site 5 where a minimal total of 8 feet was noted. During the remainder of the study period, longitudinal cracking increased steadily, while transverse cracks remained at a minimum. At the close of the evaluation, test sites 3 and 6 still had no traces of transverse cracking. The other four test sites had very little transverse cracking with test site five having the most with 8 linear feet.





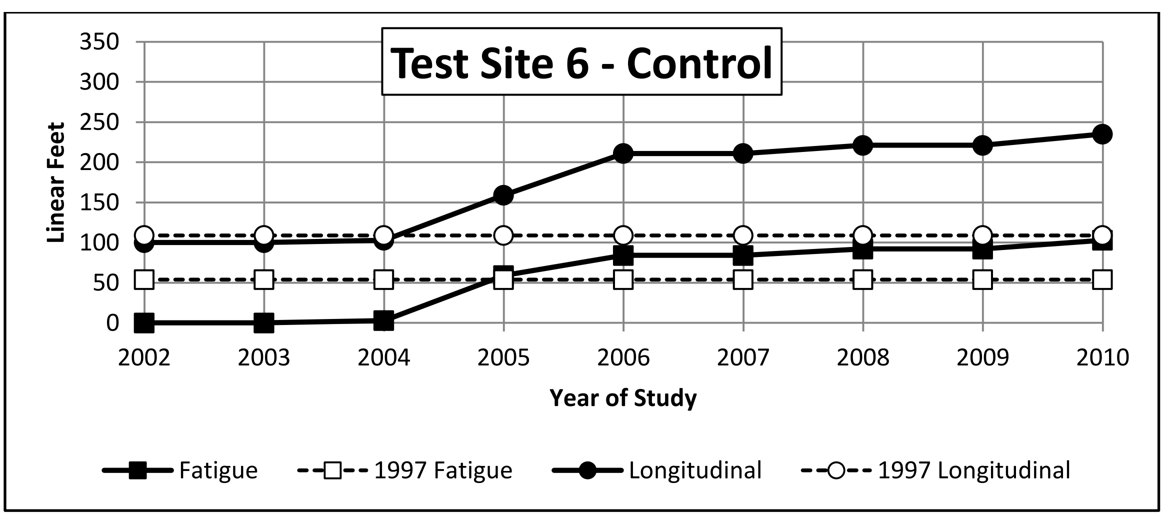
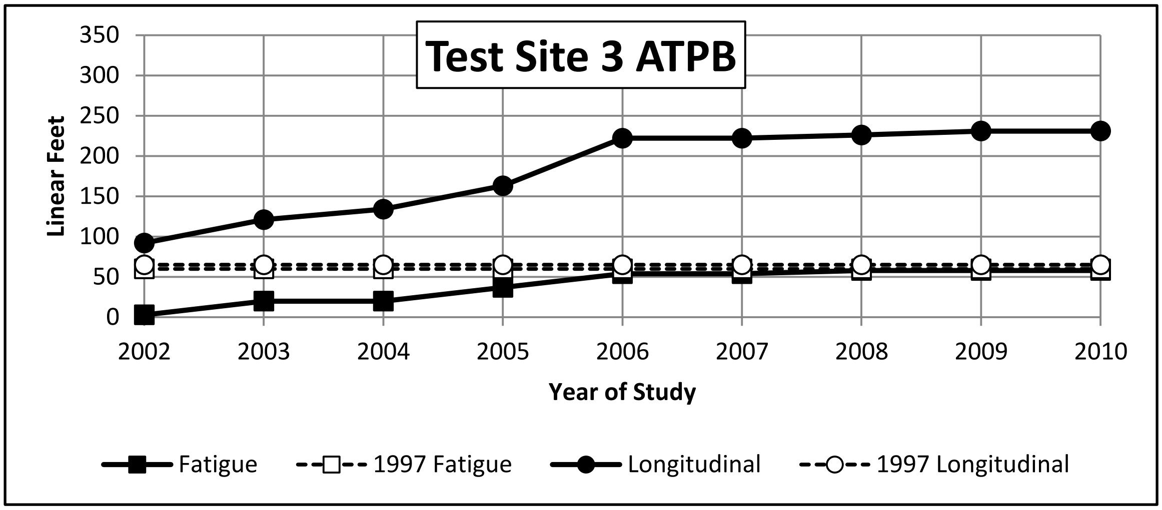
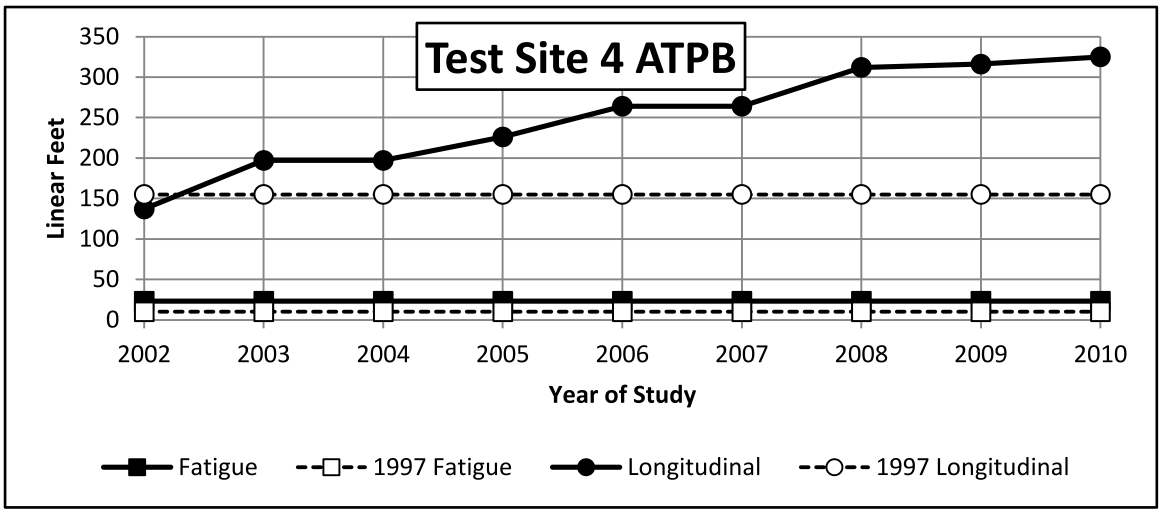


Figure 2 Linear Feet of Cracks in Control Test Sites





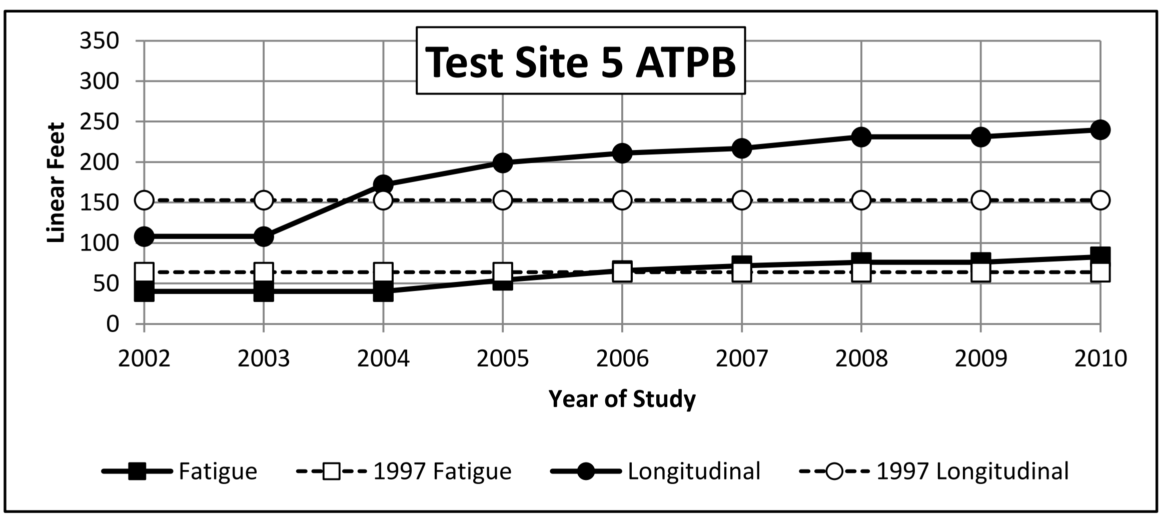


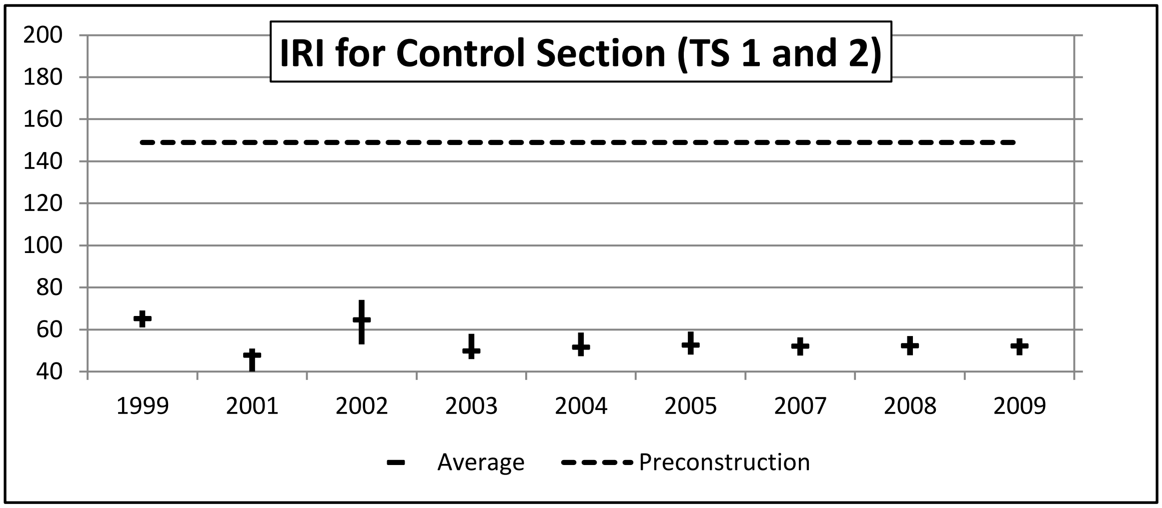
Figure 3 Linear Feet of Cracks in Experimental Test Sites

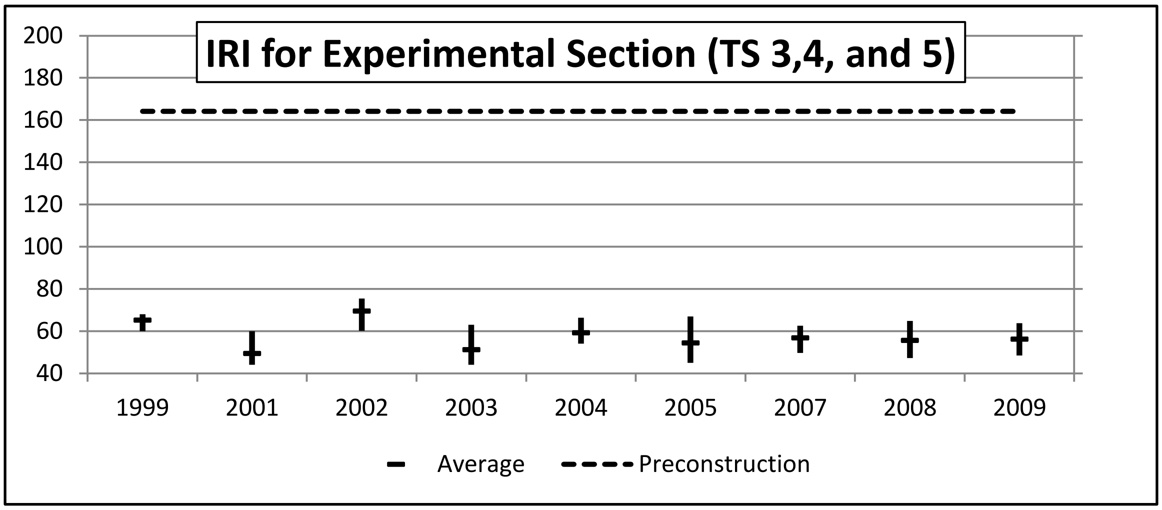
Figure 4 Typical Control Site (MM 108.70)

Figure 5 ATPB Site (MM 109.25)

International Roughness Index

International Roughness Index (IRI) is utilized to characterize the longitudinal profile within wheel paths and constitutes a standardized measurement of smoothness. According to AASHTO R 43M, “an IRI statistic is calculated from a single longitudinal profile measured with a road profiler in both the inside and outside wheel-paths of the pavement.” IRI readings were collected prior to and annually following construction by Pavement Management with the use of a road profiler. All measurements were reported in increments of 1/10th of a mile. The following tables contain the average IRI value for each lane along the entire segment of either the control or experimental section and their associated IRI Pavement Condition Scale. The IRI values ranges are shown in Figure 6 and in Table A2, in the Appendix. As figure 6 shows, the IRI values for both the control and experimental sections are far below the preconstruction values.





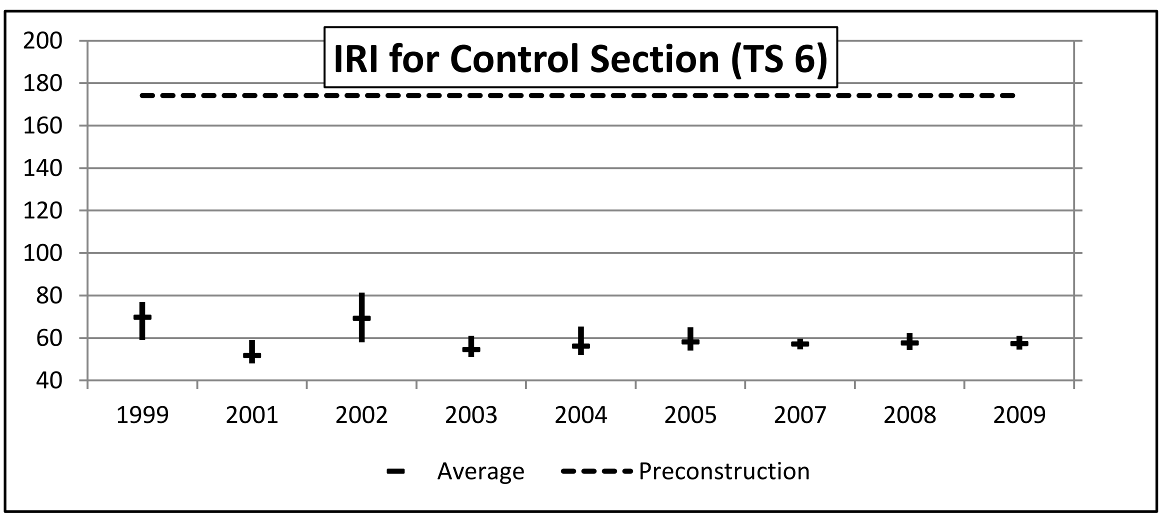


Figure 6 IRI Readings in Control and Experimental Test Sites

COST ANALYSIS

The following costs apply to a single 12-foot lane mile.

Table 3: Cost Data ATPB Section

Asphalt Treated Permeable Base Section			
Item Number	**Item Description**	**Unit**	**Average Unit Price**
203.15	Common Excavation	CY	$3.25
210.1	Cold Planing	SY	$1.10
212.2	Scarify Pavement (MOD)	SY	$0.90
303.25	Plant Mixed Base Course (MOD) - ATPB	TON	$30.00
406.3	Super Pave Bituminous Concrete Pavement	TON	$33.00
409.25	Open Graded Friction Course	TON	$38.00

The cross section was revised in the field, which is reflected in the as bid. The 2013 costs were calculated using 2013 pricing for the as built cross sections. The 212.2 item has been modified over the years and the pricing reflects applicable inflation accumulated with time.

Table 4: Bidding and Pricing Data ATPB Section

As Bid 1998		As Built 1998		2013		
390	$1,267.50	390	$1,267.50	$6.10	390	$2,379.00
7040	$7,744.00	7040	$7,744.00	$1.80	7040	$12,672.00
7040	$6,336.00	7040	$6,336.00	$1.60	7040	$11,264.00
2480	$74,400.00	2480	$74,400.00	$56.00	2480	$138,880.00
3762	$124,146.00	3762	$124,146.00	$62.00	3762	$233,244.00
300	$11,400.00	0	$0.00		0	$0.00
	$225,293.50		**$213,893.50**			**$398,439.00**

The Non Asphalt Treated Permeable Base section costs are displayed below in Table 5.

Table 5: Cost Data Non-ATPB Section

Non Asphalt Treated Permeable Base Section			
Item Number	**Item Description**	**Unit**	**Average Unit Price**
203.15	Common Excavation	CY	$3.25
210.1	Cold Planing	SY	$1.10
210.1	Cold Planing (MOD)	SY	$2.25
310.20 and 310.24	Reclaimed Stabilized Base and Aggregate	SY	$2.09
301.35	SDGCS and SDGCS (MOD)	CY	$30.50
406.3	Superpave Bituminous Concrete Pavement	TON	$33.00
409.25	Open Graded Friction Course	TON	$38.00

Table 6: Bidding and Pricing Data Non-ATPB Section

As Bid		As Built		2013		
0	$0.00	1173	$3,812.25	$6.10	1173	$7,155.30
7040	$7,744.00	7040	$7,744.00	$1.80	7040	$12,672.00
0	$0.00	7040	$15,840.00	$1.80	7040	$12,672.00
7040	$14,721.34	0	$0.00		0	$0.00
0	$0.00	1173	$35,776.50	$32.45	1173	$38,063.85
3762	$124,146.00	3762	$124,146.00	$62.00	3762	$233,244.00
300	$11,400.00	0	$0.00			$0.00
	$158,011.34		**$187,318.75**			**$303,807.15**

SUMMARY AND RECOMMENDATIONS

The asphalt treated permeable was a successful treatment for the Georgia-Fairfax test sections. The results of the data collection efforts were mixed overall. The variability of the test results in the control section precludes a definitive comparison. Transverse cracking results were similar between control sections and test sections when using all control section data. Fatigue cracking in the ATPB was significantly reduced from the control sections. IRI data was similar for both control and test sections through the first ten years after construction. Rutting evaluations were not included in this study, but should be derived from the Pavement Management System to supplement this analysis. The analysis of pricing and cost shows that there was a calculated cost increase in the as built section of approximately 15 % (based on an equivalent construction length). The difference in actual costs (15%) compared with difference in "bid costs" (42%) was substantially less. The influence of a new technology bid against a conventional technology accounts for a portion of the difference in costs, but notably the ATPB was constructed for costs lower than average bid pricing by 5%. ATPB proved more effective in reducing fatigue, equally effective in reducing transverse cracking and comparable in ride quality in the ensuing decade after construction.

IMPLEMENTATION STRATEGY

Based on the data from this experimental feature, Asphalt Treated Permeable Base (ATPB) should be considered as a treatment for deteriorated pavements. The treatment performed well in eliminating frost heaves and transverse cracking with partial depth reconstruction. The initial pavement condition for this project was characterized with low to moderate cracking and severe ride condition. Based on post construction monitoring ATPB is a treatment beneficial into reduction in longitudinal and fatigue cracking. Further analysis of data pertaining to this project and examination of addition ATPB placements is necessary before wide scale deployment of ATPB. ATPB is worthy of further use and examination in Vermont.

APPENDIX

Table A1 Cracking Data from 1997-2010

	Cracking Type	1997	2002	2003	2004	2005	2006	2007	2008	2009	2010
TS 1 Control	Fatigue	87	0	0	0	38	52	75	100	100	125
	Longitudinal	124	0	100	100	138	152	179	233	248	281
	Transverse	97	0	0	0	0	0	0	1	1	1
	Miscellaneous	13	0	0	0	0	0	0	0	0	0
	Total	**234**	**0**	**100**	**100**	**138**	**152**	**179**	**234**	**249**	**282**
TS 2 Control	Fatigue	136	0	0	0	19	19	19	60	64	83
	Longitudinal	162	0	100	100	134	167	167	222	261	286
	Transverse	72	0	0	0	0	0	0	1	1	7
	Miscellaneous	0	0	0	0	0	0	0	0	0	0
	Total	**234**	**0**	**100**	**100**	**134**	**167**	**167**	**223**	**262**	**293**
TS 6 Control	Fatigue	54	0	0	3	59	84	84	92	92	103
	Longitudinal	109	100	100	103	159	211	211	221	221	235
	Transverse	115	0	0	0	0	0	0	0	0	0
	Miscellaneous	3	0	0	0	3	5	5	5	5	5
	Total	**227**	**100**	**100**	**103**	**162**	**216**	**216**	**226**	**226**	**240**
AVERAGE		**232**	**33**	**100**	**101**	**145**	**178**	**187**	**228**	**246**	**272**
TS 3 ATPB	Fatigue	60	3	20	20	37	54	54	58	58	58
	Longitudinal	65	92	121	134	163	222	222	226	231	231
	Transverse	118	0	0	0	0	0	0	0	0	0
	Miscellaneous	0	0	0	0	0	0	0	0	0	0
	Total	**183**	**92**	**121**	**134**	**163**	**222**	**222**	**226**	**231**	**231**
TS 4 ATPB	Fatigue	10	23	23	23	23	23	23	23	23	23
	Longitudinal	155	137	197	197	226	264	264	312	316	325
	Transverse	161	0	0	0	0	0	2	2	2	2
	Miscellaneous	0	2	2	5	5	5	5	7	7	7
	Total	**316**	**139**	**199**	**202**	**231**	**269**	**271**	**321**	**325**	**334**
TS 5 ATPB	Fatigue	64	40	40	40	54	66	72	76	76	83
	Longitudinal	153	108	108	172	199	211	217	231	231	240
	Transverse	95	8	8	8	8	8	8	8	8	8
	Miscellaneous	23	0	0	3	3	18	18	18	18	18
	Total	**271**	**116**	**116**	**183**	**210**	**237**	**243**	**257**	**257**	**266**
AVERAGE		**257**	**116**	**145**	**173**	**201**	**243**	**245**	**268**	**271**	**277**

Table A2 IRI Data from 1997-2009

Test Section	MM	MM	Year									
			1997	1999	2001	2002	2003	2004	2005	2007	2008	2009
Control Section (Test Sites 1 and 2)	108.5	108.6	162.2	69	48	74.1	46	48.5	49	48.8	48.9	48.8
	108.6	108.7	148.9	61	40	69.1	46	47.3	48	47.6	47.8	47.7
	108.7	108.8	119.8	66	49	57	49	50.5	59	54.8	56.9	55.8
	108.8	108.9	148.3	61	51	52.9	50	53	53	53	53	53
	108.9	109	165.4	69	51	70	58	58.5	54	56.3	55.1	55.7
Average			**148.9**	**65.2**	**47.8**	**64.6**	**49.8**	**51.6**	**52.6**	**52.1**	**52.3**	**52.2**
Standard Deviation			**18.0**	**4.0**	**4.5**	**9.1**	**4.9**	**4.4**	**4.4**	**3.8**	**3.9**	**3.8**
Experimental Section (Test Sites 3,4, and 5)	109	109.1	202.1	65	46	72.9	49	58.3	67	62.6	64.8	63.7
	109.1	109.2	161.6	67	60	60.2	63	63	52	57.5	54.8	56.1
	109.2	109.3	162.8	66	49	72.9	50	54	55	54.5	54.8	54.6
	109.3	109.4	137.5	68	48	75.4	50	54.3	45	49.6	47.3	48.5
	109.4	109.5	156.5	60	44	65.9	44	66.3	53	59.6	56.3	58
Average			**164.1**	**65.2**	**49.4**	**69.5**	**51.2**	**59.2**	**54.4**	**56.8**	**55.6**	**56.2**
Standard Deviation			**23.5**	**3.1**	**6.2**	**6.3**	**7.0**	**5.4**	**8.0**	**5.0**	**6.2**	**5.5**
Control Section (Test Site 6)	109.5	109.6	207.8	69	49	66.2	53	55.3	54	54.6	54.3	54.5
	109.6	109.7	168.5	59	48	77.9	53	52	59	55.5	57.3	56.4
	109.7	109.8	151.4	69	59	63	61	54.3	65	59.6	62.3	61
	109.8	109.9	168.5	75	54	81.4	55	65.3	54	59.6	56.8	58.2
	109.9	110	174.2	77	49	58	51	54	59	56.5	57.8	57.1
Ave			**174.1**	**69.8**	**51.8**	**69.3**	**54.6**	**56.2**	**58.2**	**57.2**	**57.7**	**57.4**
Standard Deviation			**20.7**	**7.0**	**4.7**	**10.0**	**3.8**	**5.2**	**4.5**	**2.3**	**2.9**	**2.4**
Average Control			**161.5**	**67.5**	**49.8**	**67.0**	**52.2**	**53.9**	**55.4**	**54.6**	**55.0**	**54.8**
Average Experimental			**164.1**	**65.2**	**49.4**	**69.5**	**51.2**	**59.2**	**54.4**	**56.8**	**55.6**	**56.2**

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

WORK PLAN FOR
CATEGORY II EXPERIMENTAL PROJECT

EVALUATION OF ASPHALT TREATED PERMEABLE BASE
WORK PLAN 97"R"8

Objective of Experiment

This work plan will evaluate the performance of asphalt treated permeable base (ATPB) and its ability to improve drainage and extend the service life of the pavement.

Project and Test Site

An experimental test section containing ATPB will be incorporated into the Georgia-Fairfax IM 089-3(26) pavement rehabilitation project. The ATPB will be placed in the Town of Georgia between mile markers 109.00 and 109.50 in the northbound lanes of Interstate 89.

Materials to be Used

The existing pavement in the ATPB section will be cold planed to full depth plus 4 inches of subbase material. The following materials will then be placed: 4" ATPB, 6" base course (Type I Superpave), 3 ½" bituminous concrete pavement (1 ½" of Type III Superpave over 2" of Type II Superpave), and 3/4" open graded friction course.

Contract Cost of Materials

The contract price for asphalt treated permeable base on the Georgia-Fairfax IM 089-3(26) project is $6.67/SY.

Date of Installation Work to commence in the summer of 1997.

Evaluation Procedure

The performance evaluation will include the following steps:

1. Document initial design, construction and maintenance records on the sections of highway under rehabilitation.

2. Observe the production and paving process and document information on the method of production and job mix test results (gradations, AC content, stabilities, flow, air voids, voids in mineral aggregate).

3. Document laboratory and field tests taken during the construction of the project.

4. Select specific test sections and monitor the pavement performance, particularly fatigue cracking.

Surveillance and Reports

The experimental treatment will be observed during construction and surveyed once a year until conclusions become evident. Findings will be reported to FHWA through update reports.

Materials & Research Division
Agency of Transportation

Reviewed By:

____
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Materials & Research Engineer

Approved by Material and Research 08/14/1997 (RFC)