EXPERIMENTAL USE OF POLYPROPYLENE FIBER MODIFIED BITUMINOUS PAVEMENT ON VERMONT ROUTE 14

INITIAL REPORT 84-7

SEPTEMBER 1984

REPORTING ON WORK PLAN 83-R-30

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

P. J. GARAHAN, P.E., SECRETARY OF TRANSPORTATION
S. J. GAGE, P.E., DIRECTOR OF ENGINEERING & CONSTRUCTION
R. F. NICHOLSON, P.E., MATERIALS & RESEARCH ENGINEER

PREPARED BY:

E. C. Houston
Research & Development Technician

Reviewed By:

R. F. Nicholson

R. F. Nicholson, P.E.
Materials & Research Engineer

Date: 10-16-'84

"The information contained in this report was compiled for the use of the Vermont Agency of Transportation. Conclusions and recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Agency policy. This report does not constitute a standard, specification, or regulation. The Vermont Agency of Transportation assumes no liability for its contents or the use thereof."

TABLE OF CONTENTS

ABSTRACT

Approximately 105 tons of bituminous concrete mix modified with Hercules Fiber Pave, a polypropylene fiber, was produced and placed as a one inch wearing course on August 5, 1983. The experimental mix is located on Vermont Route 14 at milemarker 0602 and extends to milemarker 0634 in the town of Royalton.

The fibers were added manually to the bituminous concrete mix directly into the pugmill at the plant. The experimental mix was produced by Cooley Asphalt Paving Corporation in Berlin, Vermont.

Mays Ride Meter readings taken on the project after construction averaged 30.9"/mile on the standard mix and 34.1"/mile on the modified mix. Friction tests taken on the project area after construction averaged 53 for the standard mix and 55 for the modified mix.

Crack count survey results from April 9, 1984, show a reflective crack rate of 12% in the mix modified with fibers at a rate of ten pounds per ton as compared to 34% in the standard mix. Results in the mix modified with fibers at a rate of six pounds per ton totaled 5% compared to the standard mix which totaled 30%. However, 100% reflection of the only two full width transverse cracks indicate failure of both mixes to eliminate the most common type of reflective crack.

INTRODUCTION

The Vermont Agency of Transportation was offered 800 pounds of Fiber Pave at no charge for a field evaluation. With the co-operation of the local bituminous concrete producer, Cooley Asphalt Paving Corporation, an experimental bituminous concrete mix was batched and placed in August of 1983.

This report describes the initial observations during production and placement of the modified mix and performance during the first eight months of service for the project Royalton/Randolph RS 0147(9).

PRODUCT INFORMATION PROVIDED BY THE SUPPLIER

Fiber Pave 3010 is a short-length, fine-denier, water-insoluble polypropylene fiber that is made for use as an additive for hot-mix asphalt aggregate paving materials. Laboratory fatigue data and cold-temperature studies indicate that mixes containing Fiber Pave offer extended highway service life, and that thinner overlay designs are possible. Fiber Pave 3010 is also an effective replacement for asbestos in curb-type mixes.

One ounce of Fiber Pave 3010 contains approximately 1½ million (1 centimeter long) fine denier fibers. These fibers function to improve adhesive and cohesive strength of the asphalt, thereby improving the durability of the asphalt concrete when it is under stress and strain.

Translating these improved physical properties into performance means (1) improved elongation capability of the asphalt concrete, (2) better resistance against reflective cracks caused by freeze-thaw cycles or heavy vehicle loading, and (3) a more durable and longer lasting service life, particularly in cold-climate regions.

Fiber Pave 3010 polypropylene fiber is processable in pugmill mixers and is compatible with almost all local aggregates and mix designs. Fiber addition during the dry cycle is recommended. Temperatures must not exceed 280°F.

Fiber concentration is dependent on the mix design and on the extent of damage of the surface to be paved. Normal fiber concentration is 6 pounds per ton of mix (0.3% by weight). Concentrations higher than 6 pounds per ton are recommended for thin (1 inch) overlays or for the more severely damaged areas to be paved. Suggested content for paving or curb mix is as follows:

When normal mix is used (0.3% fiber by weight) an increase of asphalt cement of 0.2 - 0.3% is recommended.

Standard paving equipment such as Barber-Greene, Cedarapids, or Blaw Knox has been used sucessfully without modifications. For base course, a rubber tire or steel roller can be used. For the wearing surface, use only a steel roller; vibrating type rollers are especially effective.

COST INFORMATION

The material cost F.O.B. Georgia is $1.25 per pound. When F.P. is added at the regular rate of 0.3% by weight (6 lbs/ton) the modified mix including contractor costs could be expected to cost approximately $7.50 - $10.00/ton extra.

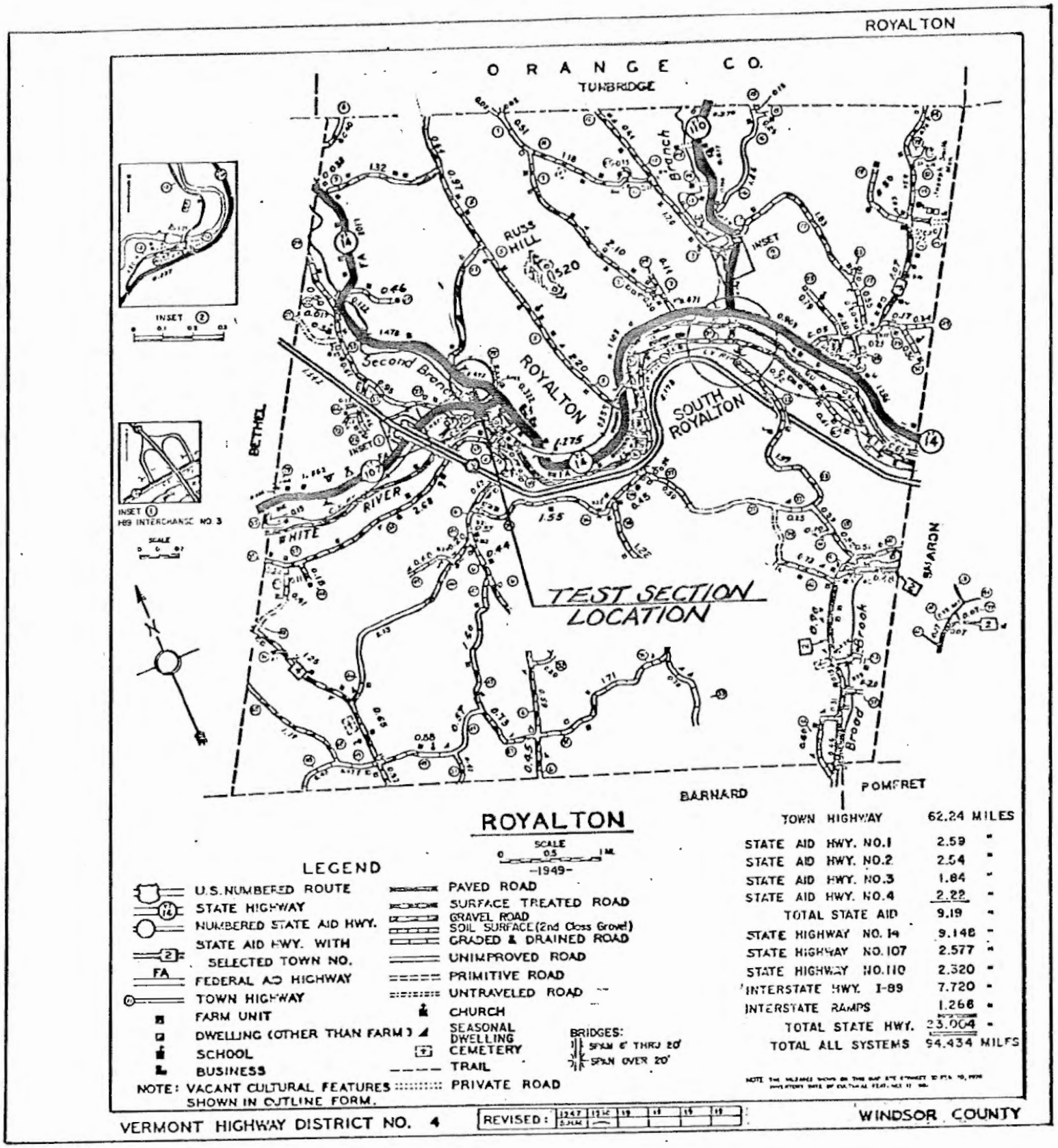
PROJECT DESCRIPTION & ROADWAY CONDITION

The project is located in the towns of Royalton, Bethel and Randolph on Vermont Route 14 beginning in the town of Royalton at MM 5.865 and extending northerly 11.879 miles, ending in Randolph at MM 7.734. See location map on page 5.

The route logs indicate that the existing roadway in the area of the test section was constructed in 1927 using gravel. Several blade mix treatments were applied during the period of 1946 to 1962. A chip seal treatment was applied in 1976.

Detailed crack counts were made at two locations (test sections 1 & 2) approximately one week prior to paving the roadway. Crack counts revealed an average of 377 ft of cracks per 100 lf of 22' wide roadway. Approximately 67% of the cracks were longitudinal, 31% were transverse and the remaining 2% were miscellaneous. The pavements original condition can be seen on the crack count field survey sheets, Appendix A1 - A3.

The average daily traffic for this section of Vt. Route 14 in 1982 was 760.



— PROJECT LOCATION —

MIX PRODUCTION & TESTING

The 800 lbs of Hercules F.P. arrived in individual pre-weighted bags (6 & 10 lbs.) at the Cooley Asphalt Paving Corporation in Berlin, Vermont on August 1, 1983.

The modified mix was produced under the direct supervision of a technical representative of Hercules Incorporated (Hercules T.R.). Production began at approximately 9:00 AM on August 5, 1983. The wet cycle was increased from 35 seconds to 45 seconds to insure adequate blending of the fibers and asphalt cement. After inspection of the first truck load, the Hercules T.R. stated that mixing was adequate and the normal wet mix cycle of 35 seconds would be sufficient.

The design for the modified mix at the rate of six pounds of fibers per ton calls for the addition of asphalt at 4 pounds per ton drop (0.2% - 0.3%). However, due to a miscalculation, no additional asphalt was added. The Hercules T.R. inspected the mix and felt that it looked satisfactory and the difference of 4 pounds per ton would not have a significant effect. Additional asphalt was added at 0.5% by weight on the 10 pounds of fiber per ton design. During production, the temperature of the mix ranged from 280°F - 300°F with the latter in excess of the maximum as stated in the product literature. When questioned on this issue, the Hercules T.R. stated that the temperature could be as high as 310°F as the maximum.)

The bags of F.P. were emptied individually into the pugmill through the side door during the dry mix cycle. The Hercules T.R. instructed that the bags must be emptied quickly to avoid any increase in the dry mix cycle and the danger of asphalt splatter during the wet mix cycle. Preparation for this task involved opening the bags prior to the beginning of mix production

and placing them on the first level of the hot mix plant. There were no significant problems accomplishing this task in the 5 second dry mix time utilizing two men.

The Type IV bituminous concrete mix used an 85/100 penetration grade asphalt cement supplied by Gulf of Canada, Montreal, Quebec, Canada. The coarse aggregate consisted of crushed granite. Fine aggregate included natural sand and stone screenings from crushed granite.

Modified and standard mixes were tested for asphalt content, gradation, air void content, stability and flow. For details on the test results, refer to Appendix B1 - B7.

PAVING OPERATION

Paving began about 7:00 AM on August 5, 1983 under clear skies with an ambient temperature of 70°F. Approximately 490 tons of standard mix was produced prior to switching over to the modified mix. A plan view of the installation can be seen on page 8.

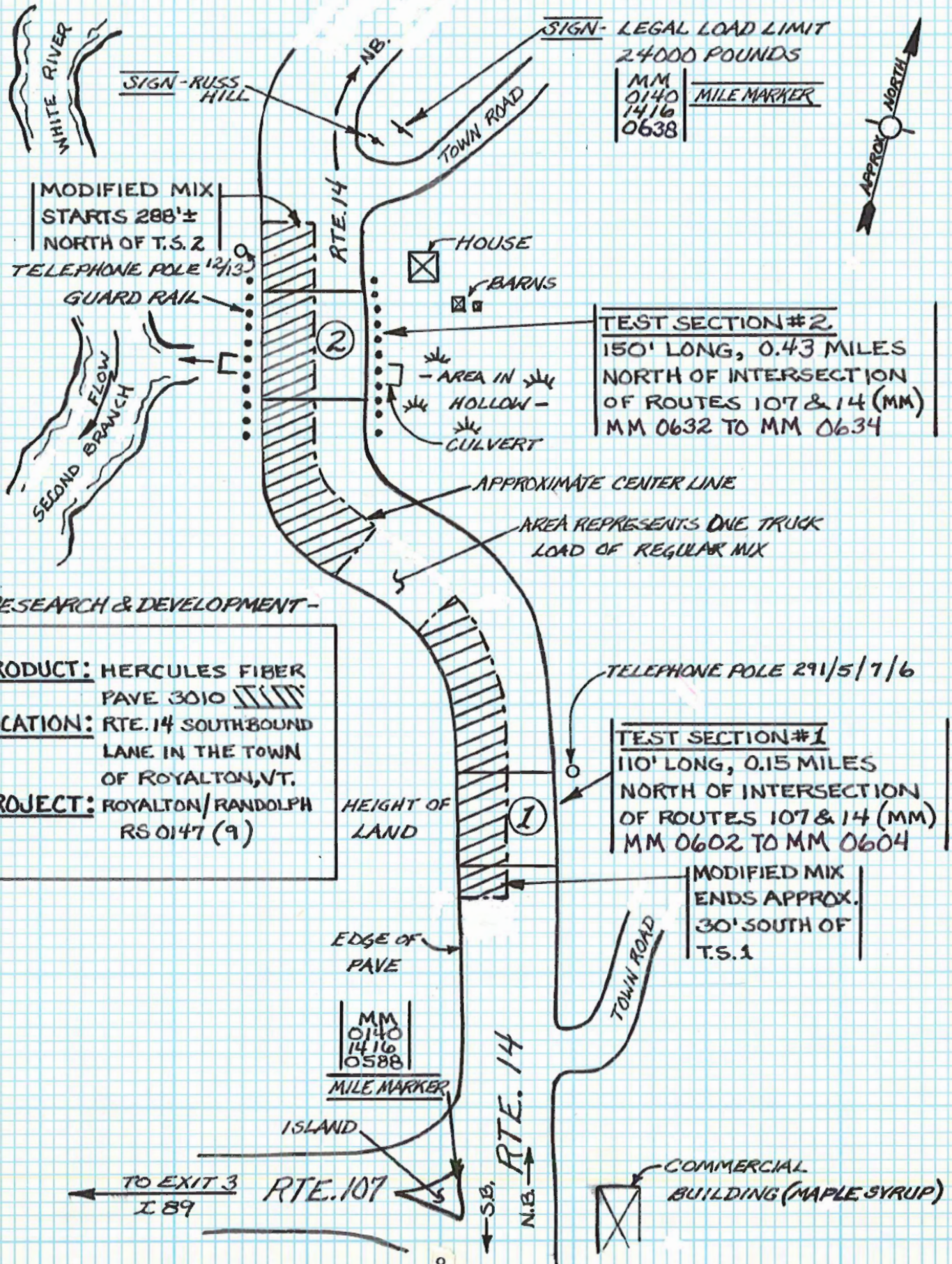
A previously placed 1/2"± leveling course covered the area approximately 2' each side of centerline and extended out to the shoulders. This paving sequence proceeded from north to south in the southbound lane. Standard mix was used until the paver neared the test sections, at which time the fibers were added to the mix at the plant. The modified mix covered the southbound lane in both test sections. Test section number one begins at milemarker 0602 and extends to 0604±. Test section number two begins at milemarker number 0632 and extends to 0634±. Both test sections are in the town of Royalton.

The first three truck loads containing fibers added at a rate of six pounds per ton were placed in test section number two. The last three loads containing

VERMONT A.O.T.
MATERIALS & RESEARCH
DIVISION

PLAN VIEW
— LOCATION SKETCH —
NOT TO SCALE
HERCULES FIBER PAVE

BY: E.C. HOUSTON
DATE: 2/84



fibers added at a rate of ten pounds per ton were placed in test section number one. One load of standard mix was needed between the two modified mixes to make sure the ten pound per ton mix covered the test section.

Thickness of the overlay averaged 15/16" in the area of the test sections, not including the leveling course. Mix temperatures sampled from trucks on the project ranged from 260°F to 295°F. There was some difference in surface color after the mix was in place for several hours. The modified mix appeared to have a purple sheen but this difference was only evident when viewed from a distance of 50' or greater.

POST CONSTRUCTION OBSERVATIONS

Two core samples of the fibered mix taken on August 8, 1983, showed that compaction was within the job specifications when tested in lab. Percent air voids were 8.47 on the core sampled from the mix with 6 lbs per ton fiber concentration and 7.11 on the core sampled from the mix with 10 lbs per ton fiber concentration.

On July 25, 1983, and August 8, 1983, a Mays Rider Meter surface tolerance run was made over the project area. Readings in inches per mile for the test section were as follows:

Type Mix (Lane)	Initial Readings (7-5-83)	Post Construction (8-5-83)
Standard (NB)	136"	31"
Modified (SB)	124"	34"

There were no significant differences in roughness between the standard mix and modified mix.

On September 9, 1983, friction tests were taken on the project area by Federal Highway Administration and State personnel using a locked wheel friction trailer under the control of the Region 15, Demonstration Projects Division. The

measurements, taken in the left wheel path at a speed of 40 mph, averaged 53 for the project. Friction values on the fibered mix averaged 55.

Test sections 1 & 2 were surveyed for reflective cracks on February 14, 1984 and April 9, 1984. The following charts show a comparison of crack count data taken prior to paving and after the first eight months of service:

*CRACK SUMMARY CHARTS

- TEST SECTION # 1 -

Standard Mix

Type of Crack	Pre-Const. 6/7/83	Percent Reflection 2/14/84	4/9/84
Transverse	135'	39%	43%
Longitudinal	33'	0%	0%
Miscellaneous	2'	0%	0%
Totals	170'	31%	34%

Modified Mix (Fibers added at a rate of 10#/ton)

Type of Crack	Pre-Const. 6/7/83	Percent Reflection 2/14/84	4/9/84
Transverse	94'	28%	30%
Longitudinal	124'	0%	0%
Miscellaneous	11'	0%	0%
Totals	229'	11%	12%

- TEST SECTION # 2 -

Standard Mix

Type of Crack	Pre-Const. 6/7/83	Percent Reflection 2/14/84	4/9/84
Transverse	39'	74%	74%
Longitudinal	322'	18%	23%
Miscellaneous	6'	100%	100%
Totals	367'	26%	30%

Modified Mix (Fibers added at a rate of 6#/ton)

Type of Crack	Pre-Const. 6/7/83	Percent Reflection 2/14/84	4/9/84
Transverse	34'	32%	32%
Longitudinal	180'	0%	0%
Miscellaneous	0'	0%	0%
Totals	214'	5%	5%

*Details can be found on the Crack Count Summary Sheet in Appendix A-3.

Total cracks in the standard mix in June 1983 was 537'. As of February 1984 the total was 146' or 27% and 166' or 31% in April, 1984. Total cracks in the modified mix in June 1983 was 443'. As of February, the total was 37' or 8% and 39' or 9% in April, 1984.

After eight months of service, reflective cracks totaled 34% in the standard mix and 12% in the modified mix for test section number one. In test section number two, the totals are 30% for the standard mix and 5% for the modified mix. These percentage rates seem to indicate that the modified mix is out performing the standard. However, 100% reflection of the only two full width transverse cracks indicate failure of both mixes to eliminate the most common type of reflective crack.

On August 2, 1984, core samples were taken from the project for testing to determine if damage had occurred due to high temperatures reached during production. Extraction tests conducted on the cores showed that the fibers were present and in good condition.

SUMMARY

1) Five of the six loads of bituminous concrete modified with Fiber Pave 3010 exceeded the maximum temperature covered in the product literature by as much as 15°F, but core samples tested showed that fibers were present and in good condition.

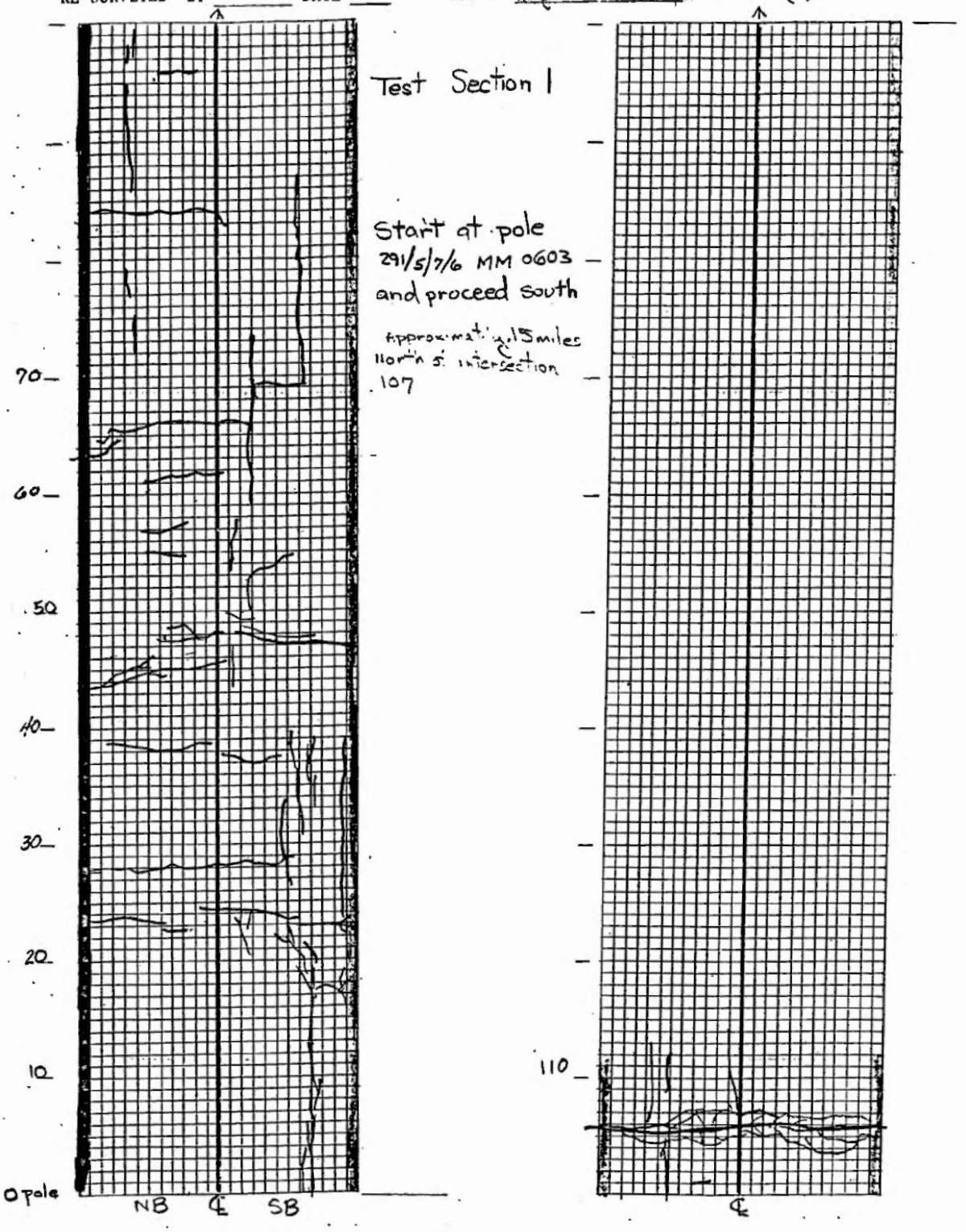
2) With the exception of adding the fibers to the pugmill, which required two additional men, the mix procedure is basically the same. The bituminous mix producer felt that the mixing process would not significantly alter the normal plant procedures.

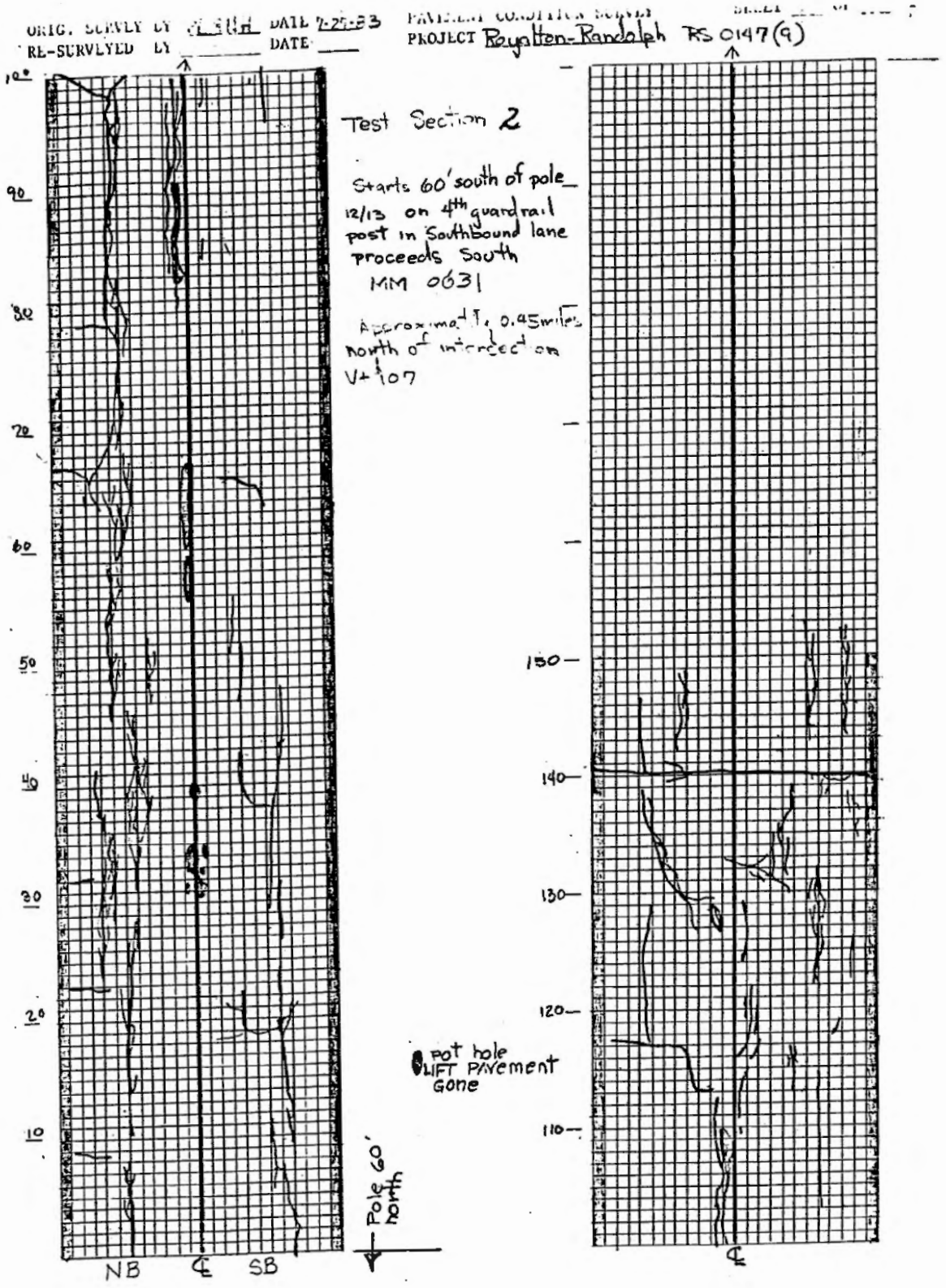
3) Reflected cracks totaled 31% for the standard mix and 9% for the modified mix. However, with regard to the transverse cracks, there is a reflection of at least 30% in all of the test sections. This indicates failure of both mixes to eliminate the most common type of reflective cracks.

FOLLOW UP

The long term performance of the modified pavement will continue to be monitored with emphasis on the following areas: reduction in reflective cracks and retention of ride values.

ORIG. SURVEY BY [illegible] DATE 7-27-83 PAVEMENT CONDITION SURVEY
RE-SURVEYED BY _____ DATE _____ PROJECT Royalton-Randolph FC 0147(9)




ORIG. SURVEY BY DATE 7-25-83
RE-SURVEYED BY DATE
PROJECT Royalton-Randolph RS 0147(9)
Test Section 2
Starts 60' south of pole 12/13 on 4th guardrail post in Southbound lane proceeds South
MM 0631
Approximately 0.45miles north of intersection on Vt 107
pot hole LIFT PAVEMENT Gone
Pole 60' North
NB
SB
10
90
80
70
60
50
40
30
20
10
150
140
130
120
110

Vermont Agency of Transportation
Materials & Research Division

Page ___ of ___

CRACK COUNT SUMMARY SHEET

Location & Route ROYALTON & RANDOLPH RTE. 14 Job Number RS 0147(9)
Experimental Feature HERCULES FIBER PAVE Width of Roadway 22'

Code for Crack Type

Type A = Transverse from shoulder to centerline
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 7/27/83	2/14/84	/ /	/ /	/ /	/ /	/ /	/ /
Section # 1								
MM Type A	55'	44'						
0603 Type B	80'	9'						
110' Type C	33'	—						
Type D	2'	—						
Total	170'	53						
Avg./100' of roadway	155'	48'						
STANDARD MIX								
Section # 1								
MM Type A	33'	11'						
0603 Type B	61'	15'						
110' Type C	124'	—						
Type D	11'	—						
Total	229'	26'						
Avg./100' of roadway	208'	24'						
MODIFIED MIX								
Section # 2								
MM Type A	11'	11'						
0631 Type B	28'	17'						
150' Type C	322'	59'						
Type D	6'	6'						
Total	367'	93'						
Avg./100' of roadway	245'	62'						
STANDARD MIX								
Section # 2								
Type A	11'	11'						
MM Type B	23'	—						
0631 Type C	180'	—						
150' Type D	0'	—						
Total	214'	11'						
Avg./100' of roadway	142'	7'						
MODIFIED MIX								

Bituminous Concrete System FILE MAINTENANCE Control No. H616	Vermont Agency Transportation Materials & Research Division ASPHALT MIXTURE PROPERTIES - Field Test Data - (Items P401 or 406)	Sheet 1 of 1
Form No. 4 of 6 Form Date 8/5/83		Project Code No. 0
		Mix Design No. 26540

Project Name Royalton - Randolph Project No. RS 0147(9)

Source of Mix Cooley Ring No. Year 83

Item No. 40625 Type of Mix Sp. Gr. AC 1023

(Note- Begin a new page if any of the prior fields change)

Line	Formula	Description	1	2	3	4	5
A		Lab No. D8	,,,+F				
B		Field Spec. No RR	,,1,F	,,2,F			
C		Test Date (mo.:day)	0,8,0,5	0,8,0,5			
D3		% Passing 1"					
D4		" 3/4"					
D5		" 1/2"					
D6		" 3/8"	1,0,0,0	1,0,0,0			
D7		" #4	,6,7,8	,6,5,4			
D8		" #8	,4,7,9	,4,4,7			
D9		" #16	,3,7,8	,3,4,3			
D10		" #30	,2,6,8	,2,4,1			
D11		" #50	,1,3,9	,1,3,4			
D12		" #200	,,1,9	,,2,4			
E		Bitumen % (AC) Slip	,6,8,1	,7,3,2			
F		Effective % (AC)	,6,1,6	,7,0,1			
G	100(T-S)/T	% Voids - Mix	,,5,9	,,2,9			
H	100U/(U+G)	% Voids - Filled	,7,4,0	,8,4,8			
I	U + G	% VMA	,1,9,4	,1,9,3			
J	S x 62.4	Unit Wgt., lb/ft^3	1,4,0,0	1,4,2,3			
K		Stab.-Conv., lb.	1,2,5,2	1,9,8,0			
L		Marshall Flow	,0,1,0	,,1,1			
M		Sample Thick., in.	2,5,0,0	2,7,5,0			
N		Wgt. in Air, gm.	1,1,2,6	1,2,4,3			
P		Wgt. in Water, gm.	,6,2,5	,6,9,8			
R		Wgt. surf. dry, gm.	1,1,2,7	1,2,4,3			
S	N/(R-P)	Sp. Gr. - Bulk	2,2,4,3	2,2,8,1			
T		Sp. Gr. - Max.	2,3,8,4	2,3,4,9			
U	SxF/SpGrAc	AC by Volume %	1,3,5,1	1,6,3,6			
V		Stab.-Measured, lb.					
W		Accept, Reject or N					

Field Notes:

Inspector(s):

Office Time Stamp:

TA 418-D 5C 4/83

APPENDIX B-2

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

BITUMINOUS CONCRETE EXTRACTION WORK SHEET

PROJECT Royalton Randolph RS-0107(9) LAB NO.
SOURCE Colley Asphalt

DATE 8-3-83
MIX TYPE IV - Fibers
SAMPLE NO. 1F

BOWL & MIX 2463
BOWL 1230
MIX 1233

PAN & AGG. 1407
PAN 327
AGG. 1120 **

SLIP NO. 10353
TIME 9:12
MIX TEMP. 300-280° back

%AC = MIX - AGG / MIX 100 ____ % - ____ = ____ %

% Slip Ac = ____ %

% STONE (+8) 52
% SAND (-8) 48
% AIR VOIDS 5.7

RETAINED ON	WEIGHT	% RETAINED	% PASSING	JOB AIM	REPORTED
1 3/4					
1 1/2					
1					
3/4					
1/2				100	
3/8			100	95-100	100
4	359	32.2	67.8	62-74	68
8	222	19.9	47.9	41-49	48
16	113	10.1	37.8	31-39	38
30	123	11.0	26.8	20-28	27
50	144	12.9	13.9	9-17	14
200	134	12.0	1.9	1-3	1.9
Pass 200	21	1.9			
Totals	1116				
			% Slip AC	7.05	* 6.81

	BIN S	BIN NO. 2	BIN NO. 3	BIN NO. 4	BIN NO. 5	AC	TOTAL
BATCH WEIGHTS							
Wt. ADJUSTMENT							

CORRECTIVE ACTION

COMMENTS:
* Wrong calculation for asphalt batch weight
** Melted fibers on hot plate
This material is 0.9% high on % air voids for item 406.02 (4) Type IV

Paul E. [illegible]
Inspector

TA 417 Rev. 2M 4/83

TA 567A 1M 7/81
1M 5/83

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
BITUMINOUS CONCRETE SUBDIVISION

MAXIMUM SPECIFIC GRAVITY WORKSHEET
AASHTO T209-78
ASTM D2041-78

Project ROYALTON/RANDOLPH No. RS 0147(9) Date 8-5-83

Source Mix COOLEY ASPHALT CORP. Type IV Test No. 1F

Design No. 2654 Bulk Sp. Gr. 2.243

Flask No. 2

1. Wt. of Flask + Sample 2130
2. Wt. of Flask 1100
3. Wt. of Sample (1-2) (A) 1030
4. Wt. of Flask filled with H_2O (D) 3313
5. Wt. of Flask + Water + Sample (E) 3910

CALCULATION:

Max. Sp. Gr. = A/(A + D - E)

$$= \frac{1030}{1030 + 3313 - 3910} = 2.379$$

$$\% \text{ Voids Mix} = 100 \times \frac{\text{Max. Sp. Gr.} - \text{Bulk Sp. Gr.}}{\text{Max. Sp. Gr.}}$$

$$\frac{2.379 - 2.243}{2.379} = 5.72$$

Comments:	Inspector(s)	Office Time Stamp
FIBER MIX 1ST LOAD	Corti Houston	

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
BITUMINOUS CONCRETE SUB-DIVISION

EFFECTIVE ASPHALT CONTENT WORK SHEET

Project Royalton-Randolph RS0147(9) Date 8-5-83
Source _____ Mix Type IV
Sample No. 1F - 1st Load of fiber mix
Prepared by P. Corti

EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE

$$G = \frac{100 - C}{\frac{100}{M} - \frac{C}{A}}$$

G = Eff. Sp. Gr. of Agg.
C = % Asphalt
M = Max. Sp. Gr. of Mix
A = Sp. Gr. of AC

93.19

$$\frac{100 - 6.81}{\frac{100}{2.384} - \frac{6.81}{1.023}} = 2.641$$

~~2.384~~ ~~41.946~~ 41.946 − 6.657 = 35.289

BULK SPECIFIC GRAVITY OF AGGREGATE

$$\text{Bulk} = \frac{\text{(Cold Feed \% Used Each Size Agg.)}}{\text{(Cold Feed \% Used Each Size Agg.)}} = \_\_\_\_ = \_\_\_\_$$
$$\text{(Bulk Sp. Gr. Each Size Agg.)}$$

NA Sa GR 3/8

$$\text{Bulk} = \frac{28 + 28 + 44 + \_\_ + \_\_}{100} = 2.594$$

ASPHALT ABSORPTION

$$D = 100 \frac{G - B}{B\,G} A$$

D = Asphalt Absorption
G = Eff. Sp. Gr. of Agg.
B = Bulk Sp. Gr. of Agg.
A = Sp. Gr. of AC

$$D = 100 \frac{2.641 - 2.594}{2.641 * 2.594} (1.023) = 0.702$$

EFFECTIVE ASPHALT CONTENT

$$E = C - \left(\frac{D}{100} P\right)$$

E = Effective Asphalt Content
C = % Asphalt
D = Asphalt Absorption
P = % Total Agg.

$$E = 6.81 - \left(\frac{0.702}{100} 93.19\right) =$$

Eff. AC Content % 6.16

TA.179B 5C 9/82

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

BITUMINOUS CONCRETE EXTRACTION WORK SHEET

PROJECT Royalton - Randolph LAB NO. RS 0147(9)
SOURCE Cooley

DATE 8-3-83
MIX TYPE III & Fibers
SAMPLE NO. 2F

BOWL & MIX 2474 PAN & AGG. 1485 SLIP NO. 10359
BOWL 1230 PAN 333 TIME 9:53
MIX 1244 AGG. 1152 MIX TEMP. 290 - 280° Puck

%AC = MIX - AGG / MIX 100 ____ % - ____ = 7.40 %

% Slip Ac = 7.32 %

% STONE (+8) 55
% SAND (-8) 45
% AIR VOIDS 2.9

RETAINED ON	WEIGHT	% RETAINED	% PASSING	JOB AIM	REPORTED
1 3/4					
1 1/2					
1					
3/4					
1/2				100	
3/8			100	95-100	100
4	398	34.6	65.4	62-74	65
8	238	20.7	44.7	41-49	45
16	120	10.4	34.3	31-39	34
30	116	10.2	24.1	20-28	24
50	123	10.7	13.4	9-17	13
200	126	11.0	2.4	1-3	2.4
Pass 200	28	2.4			
Totals	1149				
			% Slip AC	7.35	7.32

	BIN S	BIN NO. 2	BIN NO. 3	BIN NO. 4	BIN NO. 5	AC	TOTAL
BATCH WEIGHTS							
Wt. ADJUSTMENT							

CORRECTIVE ACTION COMMENTS:

Paul E. [illegible]
Inspector

TA 417 Rev. 2M 4/83

TA 567A 1M 7/81
1M 5/83

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
BITUMINOUS CONCRETE SUBDIVISION

MAXIMUM SPECIFIC GRAVITY WORKSHEET
AASHTO T209-78
ASTM D2041-78

Project Royalton - Randolph No. RS 0147(9) Date 8-5-83
Source Mix Cooley Asphalt Type IV Test No. 2F
Design No. 2654 Bulk Sp. Gr. _____
Flask No. 2

1. Wt. of Flask + Sample	2124
2. Wt. of Flask	1100
3. Wt. of Sample (1-2) (A)	1024
4. Wt. of Flask filled with H_2O (D)	3313
5. Wt. of Flask + Water + Sample (E)	3901

CALCULATION:

Max. Sp. Gr. = $A/(A + D - E)$

$$= \frac{1024}{1024 + 3313 - 3901} = 2.349$$

$$\% \text{ Voids Mix} = 100 \times \frac{\text{Max. Sp. Gr.} - \text{Bulk Sp. Gr.}}{\text{Max. Sp. Gr.}}$$

$$100 \; \frac{2.349 - 2.281}{2.349} = 2.9$$

Comments:	Inspector(s)	Office Time Stamp
	Corti Houston	

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
BITUMINOUS CONCRETE SUB-DIVISION

EFFECTIVE ASPHALT CONTENT WORK SHEET

Project Royalton - Randolph RS 0147(9) Date 8-5-93
Source Cooley Mix Type IV / FIBER
Sample No. 2F
Prepared by P. Corti

EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE

92.68

$$G = \frac{100 - C}{\frac{100}{M} - \frac{C}{A}} \qquad \frac{100 - 7.32}{\frac{100}{2.349} - \frac{7.32}{1.023}} = 2.617$$

G = Eff. Sp. Gr. of Agg.
C = % Asphalt
M = Max. Sp. Gr. of Mix
A = Sp. Gr. of AC

BULK SPECIFIC GRAVITY OF AGGREGATE

$$\text{Bulk} = \frac{\text{(Cold Feed \% Used Each Size Agg.)}}{\text{(Cold Feed \% Used Each Size Agg.)}} = \frac{\quad + \quad + \quad + \quad + \quad}{\quad + \quad + \quad + \quad + \quad} = \quad = \quad$$

$$\text{(Bulk Sp. Gr. Each Size Agg.)}$$

$$\text{Bulk} = \frac{\quad + \quad + \quad + \quad + \quad}{\quad + \quad + \quad + \quad + \quad} = \quad = 2.594$$

ASPHALT ABSORPTION

$$D = 100 \frac{G - B}{B\,G} A$$

D = Asphalt Absorption
G = Eff. Sp. Gr. of Agg.
B = Bulk Sp. Gr. of Agg.
A = Sp. Gr. of AC

$$D = 100 \frac{2.617 - 2.594}{2.594(2.617)} = 0.339$$

EFFECTIVE ASPHALT CONTENT

$$E = C - \left(\frac{D}{100} P\right)$$

E = Effective Asphalt Content
C = % Asphalt
D = Asphalt Absorption
P = % Total Agg.

$$E = 7.32 - \left(\frac{0.339}{100} 92.68\right) =$$

Eff. AC Content % 7.01

TA.179B 5C 9/82

TA405A Rev. 82

Sheet 1 of 1

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
BITUMINOUS CONCRETE SUBDIVISION

Date Prepared: 8-8-83

Core Analysis

Prepared By: P Carti

Project: Royalton-Randolph
RS 0147(9)

Type of Mix: IV with fibers

Lab Number	Core No.	Weight (grams)			Roadway Sp. Gr.	Plant Avg. Daily Bulk Sp. Gr.	Max. Sp. Gr.	Ratio %	% Voids in Place	In Place Unit Weight (p.c.f.)
		Air	Water	Surf dry						
A	B	C	D	E	F	G	H	I	J	K
					$\frac{C}{E-D}$			$\frac{F}{G}$	$\frac{H-F}{H}(100)$	62.4xF
Load 2 Fiber	2	644	356	645	2.182	2.243	2.384	97.3	8.47	136.16
Load 4 Fiber	4	539	293	540	2.182	2.281	2349	95.7	7.11	136.16
Load 2 Fiber	Depth 1 3/4".									
Load 4 Fiber	Depth 1/4"									