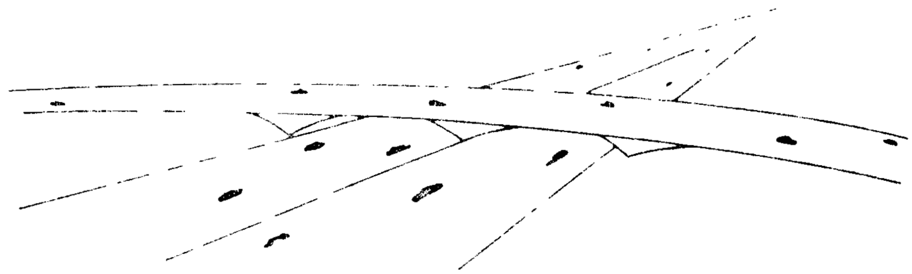

DEPARTMENTAL RESEARCH

Report Number 629-2

THE EFFECT OF A POLYMER ADDITIVE IN HMAC

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

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15. Supplementary Notes		

16. Abstract

A contract was awarded in the summer of 1983 to Young, Inc. Contractor for the construction of SH 6 in Robertson County from Hearne southeast to 1.0 miles northwest of Benchley. This work consisted of widening an existing 2 lane road to a four lane undivided facility.

A representative of Texas Emulsions volunteered to furnish a polymerized AC asphalt for test purposes, at no additional cost to the State or Contractor. The Contractor was cooperative and agreed to the change. A field change was approved allowing the polymerized asphalt to be used.

Four tests sections on the riding surface were constructed utilizing a polymer. This report reflects the results of these 4 test sections.

17. Key Words	18. Distribution Statement
HMAC Additives Polymer Additives	This report is available from State Department of Highways and Public Transportation, Transportation Planning Division, P.O. Box 5051 Austin, Texas 78763-5051

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Form DOT F 1700.7 (8-69)

THE EFFECT of a POLYMER ADDITIVE IN HMAC

by

Nick Turnham
Laboratory Supervisor
District Seventeen

Table of Contents

A contract was awarded in the summer of 1983 to Young, Inc. Contractor for the construction of SH 6 in Robertson County from Hearne southeast to 1.0 miles northwest of Benchley. This work consisted of widening an existing 2 lane road to a four lane undivided facility.

The existing two lane road was widened on each side with 6" lime stabilized subgrade, 14" of Flexible Base and approximately 3" of Asphalt Stabilized Base (Plant Mix). The base and surface failures were repaired using cement stabilized base with a Type "B" Hot Mix surface. After widening and repairs were completed, Type "B" Hot mix was used to level-up the existing pavement. Two courses of Hot Mix Type "B" (165#/SY each course) were laid over the entire width.

Type "D" Hot Mix (120#/SY) was used for the riding surface. This mix consisted of approximately 56% D-F Blend, 14% Screenings both from Texas Crushed Stone, 12% Washed Sand treated with 1½% lime by weight and 18% local field sand. The asphalt content was 5.3 percent.

A representative of Texas Emulsions volunteered to furnish a polymerized AC asphalt for test purposes, at no additional cost to the State or Contractor. The contractor was cooperative and agreed to the change. A Field Change was approved allowing the polymerized asphalt to be used.

Four tests sections on the riding surface were constructed utilizing a Polymer. These sections were between Stations 431+00 and 541+50, southbound, inside lane. The Polymer used was Styrelf 13.

All of the test sections contained the same mineral aggregates proportioned as shown above. The percent of asphalt, percent of Styrelf and lime treatment of washed sand were varied. The test mixes and their locations were as follows:

TEST SECTION	LANE	LOCATION STA TO STA	% ASPHALT	% STYRELF IN ASPHALT	TREATMENT OF WASHED SAND
Control	Southbound Outside	401+90 541+50	5.3	None	1 1/2% Lime
"A"	Southbound Inside	431+00 509+00	5.3	1.0	1 1/2% Lime
"B"	Southbound Inside	509+00 527+00	5.3	3.0	1 1/2% Lime
"C"	Southbound Inside	527+00 571+15	5.0	3.0	1 1/2% Lime
"D"	Southbound Inside	575+38 584+40	5.0	3.0	None

The design for the control section was the same as that used on the remainder of the project. This section was selected for purposes of comparison as it was constructed under the same conditions of weather, construction methods, etc. as the test sections.

The asphalt used with the Styrelf was an Asphalt Cement from Exxon, Baytown (See Exhibit A). The Styrelf was added to the asphalt at the refinery by the producer. The Styrelf was added at the rate of 3.0% by weight of the Asphalt. The 1.0% Styrelf (See Exhibit B) was mixed at the hot mix plant by adding one part asphalt containing 3% Styrelf with two parts AC-20 (See Exhibit C) from Exxon, Baytown Refinery.

Three specimens from each mix were molded and tested for Hveem Stability. Results (average of three) are shown on Figure 1.

Specimens were molded utilizing Test Method TEX 531-C "Prediction of Moisture-Induced Damage to Bituminous Paving Mixtures Using Molded Specimens." The individual results and indirect tensile strength for dry and conditioned specimens are shown in Exhibits D through H. The indirect tensile strength (TSR) for dry and conditioned specimens are shown in Figure 2. The average TSR for each mix is shown in Figure 3.

All mixes including the control mix were sampled and Test Method TEX 530-C "Effect of Water on Bituminous Paving Mixtures" was performed on each. No apparent stripping was observed on any mix.

Samples on all Styrelf mixes were submitted to File D-9 for extraction, gradation and extracted asphalt properties. These results are shown in Exhibits I and J. Extraction and gradation of the control mix was performed by the District Laboratory. These results are shown in Exhibit K.

Construction Methods:

The test sections were laid on October 3 and 4, 1985. The control section was laid on October 10, 1985. All of the mix was laid at approximately 300°-310°F. The air temperature was approximately 75°F. A three wheel steel roller was used immediately behind the lay down machine. The rolls were filled with water ballast for a total weight of 10 tons. Three passes were used with the three wheel roller.

A 10 ton, 9 wheel pneumatic tire roller was used behind the three wheel roller. The mix could not be rolled because it "picked up" on the rubber tires until it had cooled to approximately 170°F. Getting the tires hot or adding more water did not reduce the amount of "pick-up". This condition existed on all the mixes including the control section. However, there seemed to be less "pick-up" on the control mix. The use of this roller was discontinued.

A single drum self-propelled vibratory roller was used for compaction behind the three wheel roller. This roller was used in the static mode. The mix using Styrelf had a tendency to "pick-up" on the two rubber tires at a temperature above 175°F. The control mix would "pick-up" above a temperature of approximately 185°F.

A tandem wheel vibratory roller in the static mode was tried in place of the single wheel roller. This roller did not "pick-up" at temperature above 175°F, but left roller marks and cut the mat so badly that its use was discontinued.

After trial and error the rolling pattern selected for the test sections and control section were three passes with the three wheel roller, followed by three passes with the single wheel steel roller. Care had to be used with the single wheel roller to control mix "pick-up". All rolling was completed with the mix as hot as possible. However, some rolling was done below 175°F.

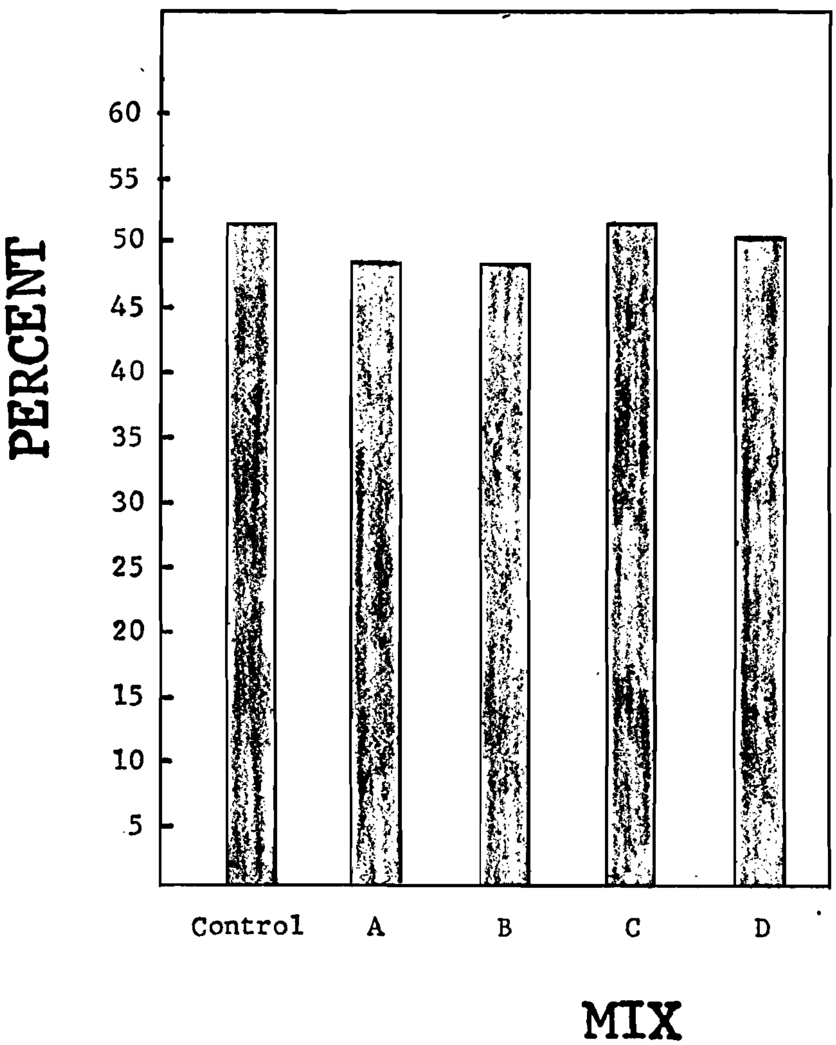
The addition of Styrelf apparently had little effect on roadway density. Cores were taken approximately one week after laying and percent air voids on the Styrelf mix averaged 10.5. The air voids on the regular mix averaged 9.3 percent. Additional cores were taken January 7, 1986 after the pavement had been under traffic approximately 90 days. The average percent air voids on the Styrelf mixes were 6.5. The control section air voids were 9.5 percent. The Styrelf cores were on the inside lane. The control mix cores were in the outside lane. All cores were in the wheel path. Additional cores will be taken to determine possible changes due to time and traffic.

Observations

The Styrelf mixes were more tender than the control mix. Any rubber tire roller "picked up" the mix more readly than mix without Styrelf. There were no significant differences in the workability of the mixes. Vacuum extractors with methelene chloride solvent are used in District Seventeen. These extractors could not be used on any of the Styrelf mixtures. However, they worked very well on the control mix. File D-9 reported that no problems were encountered using the centrifuge extractor with trichloroethylene solvent.

Conclusion:

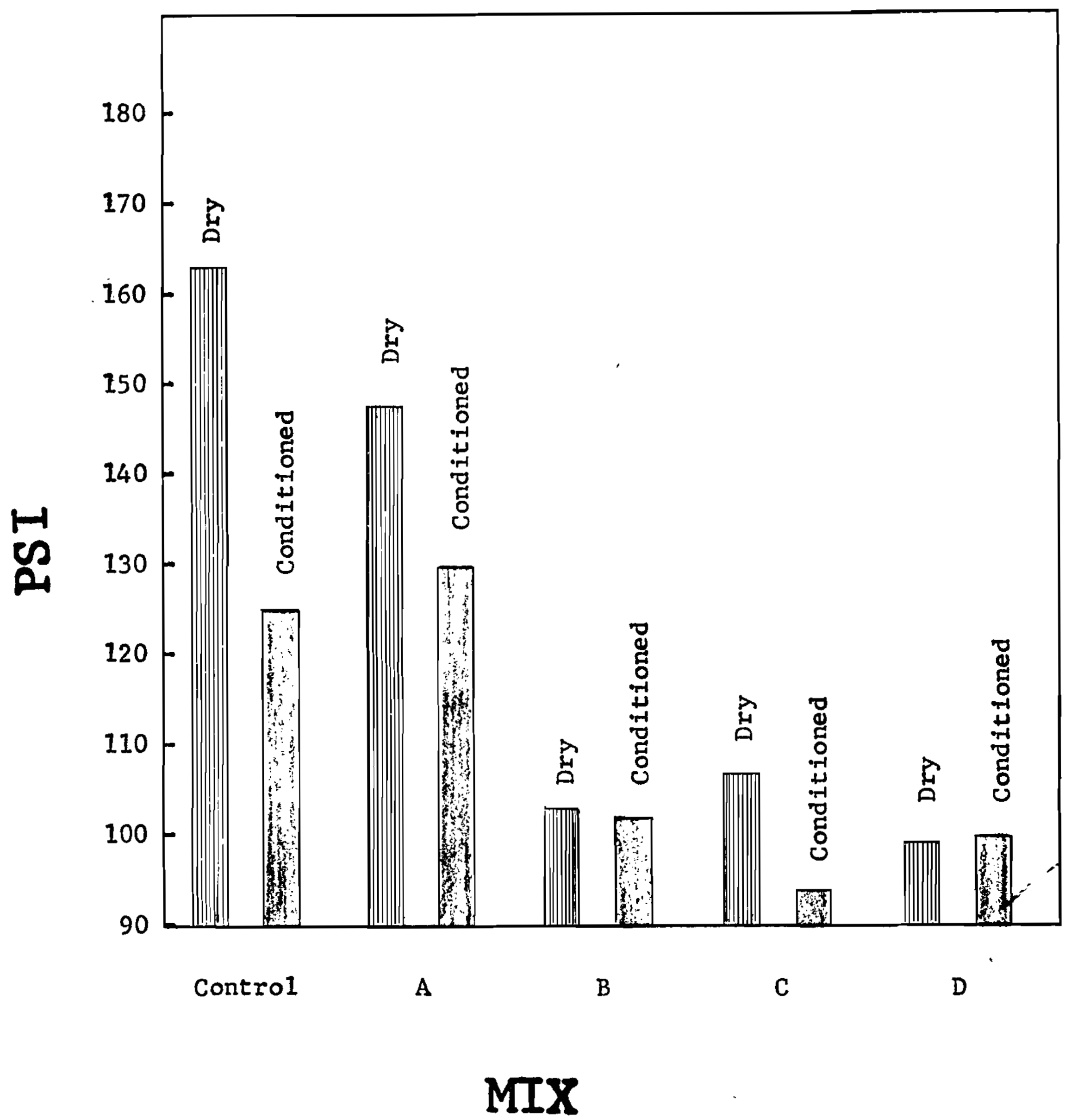
From results of these studies the addition of Styrelf increases the TSR of hot mix specimens. Styrelf shows promise as an anti-stripping agent. Additional studies should be made using stripping aggregates to better evaluate the effect of Styrelf as an anti-stripping agent and to determine the percent of Styrelf needed for different aggregates.



HVEEM STABILITY

(Average of Four Specimens)

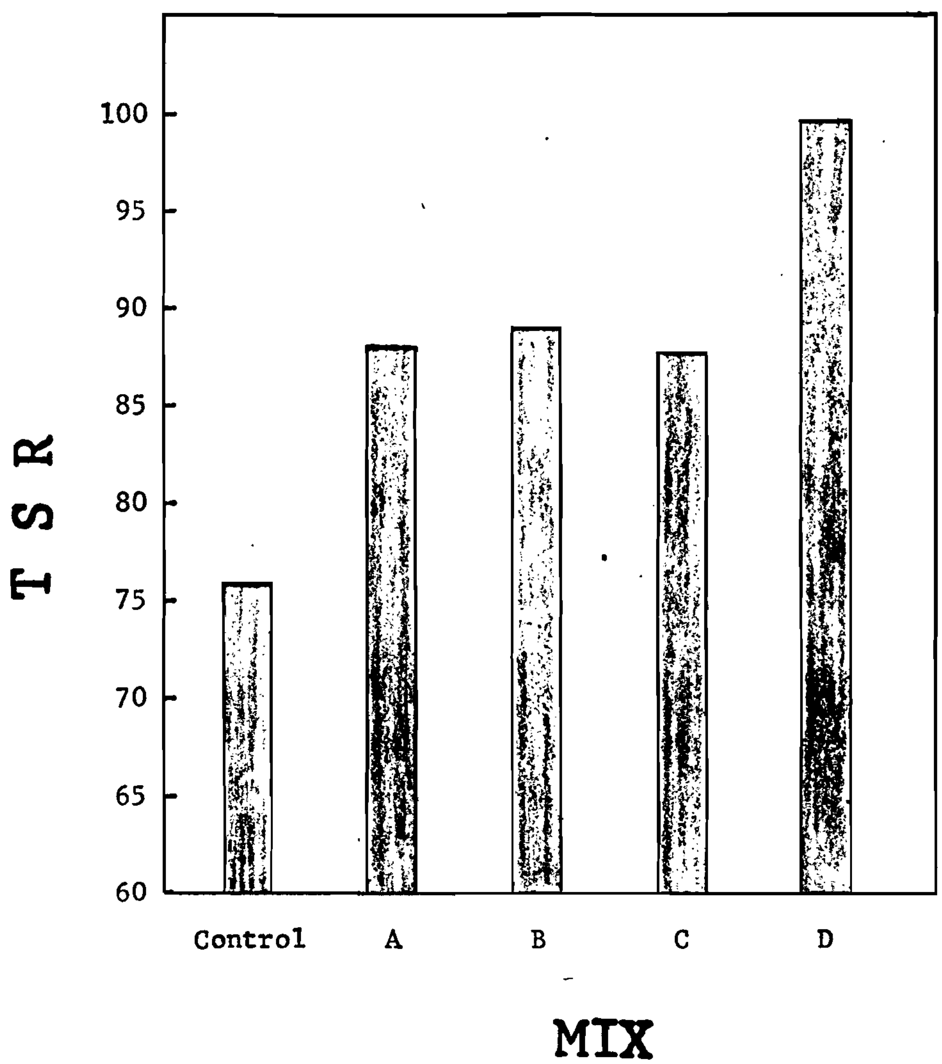
Figure I



INDIRECT TENSILE STRENGTH

(Average of Four Specimens)

Figure II



TENSILE STRENGTH RATIO

(Average of Four Specimens)

Figure III

EXHIBIT A

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

.TST.03 LIQUID ASPHALT TEST REPORT D-9 CHARGES 95.00

...ACT NO. 05830019 REQ NO. CONTROL 0049-08-038 8063
...PER FRANK SHENKIR PROJECT F 401(8)
...ACTOR YOUNG, INC. CONTRACTORS DIST 17 CO ROBERTSON HWY SH 6

****

LABORATORY NO. C85377105 DATE RECD 10/09/85 DATE REPTD 10/16/85
DATE SAMPLED 10/03/85
MATERIAL STYRLELF 13 CODE 0000000700
PRODUCER TEXAS EMULSIONS, INC BAYTOWN, TX CODE 99253
IDENTIFICATION MARKS STYRLELF 13(3.0%) SPEC. ITEM 340 D
SAMPLED FROM TRUCK QUANTITY 1.000 UNIT GAL

****

...SITY, STOKES 140F 1717 275F 05.5 KINEMATIC VISCOSITY 140F,CST
...L. VISCOSITY, SECONDS AT 77F 122F 140F 180F
...TRATION AT 77F 111 SPECIFIC GRAVITY AT 60F 1.021 77F 1.015
...PT F COC 600 TOC SIEVE TEST % CEMENT MIXING %
...SIBILITY- 50CC N/10 CACL2 % ASPH RESIDUE BY DISTILLATION
35CC N/50 CACL2 % % BY WEIGHT
35ML 0.8% S.D.S. % BY VOLUME
DISTILLATION- IBPF % BY VOLUME OF TOTAL DISTILLATE AT-
320F 347F 374F
437F 500F 600F
... PORTION OF DISTILLATE %
TEST ON RESIDUE FROM (T.F.O.T./DISTILLATION)
...SITY IN STOKES, AT 140F 3461 DUCTILITY 77F CM 141
...ETRATION 77F 080
...T CHG CODE 301

* DIVISION OF MATERIALS AND TESTS *

* FOR INFORMATION ONLY *

AC Shenkir

EXHIBIT B

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

CORRECTED REPORT R

..TST.03 LIQUID ASPHALT TEST REPORT D-9 CHARGES 95.00

..TRACT NO. 05830019 REQ NO. CONTROL 0049-08-038 8063
..INEER FRANK SHENKIR PROJECT F 401(8)
..TRACTOR YOUNG, INC. CONTRACTORS DIST 17 CO ROBERTSON HWY SH 6

****

LABORATORY NO. C85377104 DATE RECD 10/09/85 DATE REPTD 10/16/85
DATE SAMPLED 10/03/85
MATERIAL STYRELF MATERIAL CODE 00000007DD
PRODUCER TEXAS EMULSIONS, INC BAYTOWN, TX CODE 99253
IDENTIFICATION MARKS STYRLFLF 13(1.0%) SPEC. ITEM 340 D
SAMPLED FROM QUANTITY 1.000 UNIT GAL

****

..SCOSITY, STOKES 140F 1671 275F 04.8 KINEMATIC VISCOSITY 140F,CST
..L. VISCOSITY, SECONDS AT 77F 122F 140F 180F
..ETRATION AT 77F 088 SPECIFIC GRAVITY AT 60F 1.001 77F 0.995
..ASH PT F COC 600 TOC SIEVE TEST % CEMENT MIXING %
..ULSIBILITY- 50CC N/10 CACL2 % ASPH RESIDUE BY DISTILLATION
35CC N/50 CACL2 % % BY WEIGHT
35ML 0.8% S.D.S. % BY VOLUME
..TILLATION- IBPF % BY VOLUME OF TOTAL DISTILLATE AT-
320F 347F 374F
437F 500F 600F
..L PORTION OF DISTILLATE %
TEST ON RESIDUE FROM (T.F.O.T./DISTILLATION)
..SCOSITY IN STOKES, AT 140F 3242 DUCTILITY 77F CM 141
..ETRATION 77F 063
..T CHG CODE 301

..RKS: CORRECTING MATERIAL.

AUTOMATION-PAO LABORATORY
BRYAN, TEXAS
OCT 17 1985
RECEIVED

cc Shenkir

****
* DIVISION OF MATERIALS AND TESTS *
* M E E T S *
* S P E C I F I C A T I O N S *
****

EXHIBIT C

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

?S.TST.?3 LIQUID ASPHALT TEST REPORT D-9 CHARGES 95.00

??TRACT NO. 05830019 REG NO. CONTROL 0049-08-038 8063
??I?EER FRANKLIN SHENKIR PROJECT F 401(8)
??NTRACTOR YOUNG, INC. CONTRACTORS DIST 17 CO ROBERTSON HWY SH 6

LABORATORY NO. C85377173 DATE RECD 10/11/85 DATE REPTD 10/16/85
DATE SAMPLED 10/09/85

MATERIAL AC-20 ASPHALT CODE 0000000120
PRODUCER CODE 00000
IDENTIFICATION MARKS SPEC. ITEM
SAMPLED FROM STORAGE PIT QUANTITY 1.000 UNIT GAL

?I?COSITY, STOKES 140F 2298 275F 05.0 KINEMATIC VISCOSITY 140F,CST
??R?L. VISCOSITY, SECONDS AT 77F 122F 140F 180F
?ENETRATION AT 77F 058 SPECIFIC GRAVITY AT 60F 1.037 77F 1.031
?LASH PT F COC 600 TOC SIEVE TEST % CEMENT MIXING %
??ULSIBILITY- 50CC N/10 CACL2 % ASPH RESIDUE BY DISTILLATION
35CC N/50 CACL2 % % BY WEIGHT
35ML 0.8% S.D.S. % BY VOLUME
?ISTILLATION- IBPF % BY VOLUME OF TOTAL DISTILLATE AT-
320F 347F 374F
437F 500F 600F
?IL PORTION OF DISTILLATE %
TEST ON RESIDUE FROM (T.F.O.T./DISTILLATION)
?ISCOSITY IN STOKES, AT 140F 4192 DUCTILITY 77F CM 141
?ENETRATION 77F 041
TEST CHG CODE 301

? DIVISI? OF MATERIALS AND TESTS ?
?EETS
??ECIFICATIONS

cc Shenkir

EXHIBIT "D"
LOTTMAN STRIPPING TEST DATA

Mix Identification

Control Mix

Project	F 401(8)
Highway	SH 6
Resident Eng.	Shenkir
Spec Item No.	340-D
% Asphalt	5.3
Laboratory No.	

Density Calculations Terms and Equations

A = Weight of specimen in air (g)

C = Weight of specimen in water (no paraffin used) (g)

D = A-C = Actual volume of specimen (cc)

G_t = Theoretical specific gravity of specimen (from Mix Design)

$G_{ad} = \frac{A}{D}$ = Actual specific gravity of specimen (dry)

$D_{sd} = \frac{100\ G_{ad}}{G_t}$ = Density of specimen (dry) (%)

S = Weight of specimen in water after vacuum saturation (no paraffin used) (g)

V = A-S = Volume of specimen after vacuum saturation (cc)

$G_{sa} = \frac{A}{V}$ = Specific gravity of saturated specimen

$D_{ss} = \frac{100\ G_{sa}}{G_t}$ = Density of specimen saturated (%)

G_t = 2.420

Voids filled with water (%) = $\frac{100\ (D_{ss} - D_{sd})}{100 - D_{sd}}$

Specimen No.	3	9	10	11	1	5	7	8
A	925.7	925.2	925.9	925.8	925.2	925.9	925.8	925.2
C	514.8	515.8	515.3	515.5	514.1	514.1	514.2	515.8
D	410.9	409.4	410.6	410.3	411.1	411.8	411.6	409.4
G_{ad}	2.253	2.266	2.255	2.256	2.251	2.248	2.249	2.260
D_{sd}	93.1	93.4	93.2	93.2	93.0	92.9	92.9	93.4
Dry or Condition	D	D	D	D	C	C	C	C
S					534.8	535.5	535.1	535.3
V					390.4	390.4	390.7	389.9
G_{sa}					2.370	2.372	2.370	2.373
D_{ss}					97.9	98.0	97.9	98.1
Voids filled with water (%)					70.0	71.8	70.4	71.2

Mix Identification

Control Mix

LOTTMAN STRIPPING TEST DATA

Indirect Tensile Strength Terms and Equations

h = Height of specimen, in inches

P_f = Gauge load if soil press is used (psi)

F_{tv} = Total applied vertical load at failure (pounds) = P_f X 16.35 if soil press is used or direct reading if load cell is read in pounds

S_t = Indirect tensile strength (psi) = $\frac{0.156\ (F_{tv})}{h}$

TSR = Tensile strength ratio = $\frac{S_t\ (\text{Conditioned})}{S_t\ (\text{Dry})}$

	Dry				Conditioned			
Specimen No.	3	9	10	11	1	5	7	8
h	2.050	2.052	2.050	2.060	2.053	2.053	2.047	2.052
P_f	132	137	138	116	83	97	105	115
F_{tv}	2158.2	2240.0	2256.3	1896.6	1357.1	1586.0	1716.8	1880.3
S_t	164.2	170.3	171.7	143.6	103.1	120.5	130.8	142.9
S_t Average	162.5				124.3			

TSR = 76

EXHIBIT "E"
LOTTMAN STRIPPING TEST DATA

Mix Identification

Test Section "A"

<u>Density Calculations Terms and Equations</u>

A = Weight of specimen in air (g)

C = Weight of specimen in water (no paraffin used) (g)

D = A-C = Actual volume of specimen (cc)

G_t = Theoretical specific gravity of specimen (from Mix Design)

$G_{ad} = \frac{A}{D}$ = Actual specific gravity of specimen (dry)

$D_{sd} = \frac{100\ G_{ad}}{G_t}$ = Density of specimen (dry) (%)

S = Weight of specimen in water after vacuum saturation (no paraffin used) (g)

V = A-S = Volume of specimen after vacuum saturation (cc)

$G_{sa} = \frac{A}{V}$ = Specific gravity of saturated specimen

$D_{ss} = \frac{100\ G_{sa}}{G_t}$ = Density of specimen saturated (%)

Voids filled with water (%) = $\frac{100\ (D_{ss} - D_{sd})}{100 - D_{sd}}$

Project	F 401(8)
Highway	SH 6
Resident Eng.	Shenkir
Spec Item No.	340-D
% Asphalt	5.3
Laboratory No.	

G_t = 2.411

Specimen No.	3	6	7	8	4	5	9	10
A	925.6	925.4	925.5	925.5	925.6	925.8	925.7	925.6
C	510.0	511.6	511.9	512.4	513.4	511.9	512.4	512.7
D	415.6	413.8	413.6	413.1	412.2	413.9	413.3	412.9
G_{ad}	2.227	2.236	2.238	2.240	2.246	2.237	2.240	2.242
D_{sd}	92.4	92.7	92.8	92.9	93.2	92.8	92.9	93.0
Dry or Condition	D	D	D	D	C	C	C	C
S					534.3	534.8	534.6	534.0
V					391.3	391.0	391.1	391.6
G_{sa}					2.365	2.368	2.367	2.364
D_{ss}					98.1	98.2	98.2	98.1
Voids filled with water (%)					72.1	75.0	74.6	72.9

Mix Identification

Test Section "A"

LOTTMAN STRIPPING TEST DATA

Indirect Tensile Strength Terms and Equations

h = Height of specimen, in inches

P_f = Gauge load if soil press is used (psi)

F_{tv} = Total applied vertical load at failure (pounds) = P_f X 16.35 if soil press is used or direct reading if load cell is read in pounds

S_t = Indirect tensile strength (psi) = $\frac{0.156\ (F_{tv})}{h}$

TSR = Tensile strength ratio = $\frac{S_t\ (\text{Conditioned})}{S_t\ (\text{Dry})}$

	Dry				Conditioned			
Specimen No.	3	6	7	8	4	5	9	10
h	2.073	2.068	2.067	2.065	2.060	2.063	2.055	2.059
P_f	105	124	121	129	100	99	106	114
F_{tv}	1716.8	2027.4	1978.4	2109.2	1635.0	1618.7	1733.1	1863.9
S_t	129.2	152.9	149.3	159.3	123.8	122.4	131.6	141.2
S_t Average	147.7				129.8			

TSR = 88

EXHIBIT "F"
LOTTMAN STRIPPING TEST DATA

Mix Identification

Test Section "B"

Project F 401(8)

Highway SH 6

Resident Eng. Shenkir

Spec Item No. 340-D

% Asphalt 5.3

Laboratory No.

Density Calculations Terms and Equations

A = Weight of specimen in air (g)

C = Weight of specimen in water (no paraffin used) (g)

D = A-C = Actual volume of specimen (cc)

G_t = Theoretical specific gravity of specimen (from Mix Design)

$G_{ad} = \frac{A}{D}$ = Actual specific gravity of specimen (dry)

$D_{sd} = \frac{100\ G_{ad}}{G_t}$ = Density of specimen (dry) (%)

S = Weight of specimen in water after vacuum saturation (no paraffin used) (g)

V = A-S = Volume of specimen after vacuum saturation (cc)

$G_{sa} = \frac{A}{V}$ = Specific gravity of saturated specimen

$D_{ss} = \frac{100\ G_{sa}}{G_t}$ = Density of specimen saturated (%)

G_t = 2.407

Voids filled with water (%) = $\frac{100\ (D_{ss} - D_{sd})}{100 - D_{sd}}$

Specimen No.	1	3	6	10	5	7	8	9
A	926.1	925.7	925.5	925.7	926.0	926.0	925.8	926.0
C	512.5	512.2	511.9	512.2	512.6	512.8	511.7	512.5
D	413.6	413.5	413.6	413.5	413.4	413.2	414.1	413.5
G_{ad}	2.239	2.239	2.238	2.239	2.240	2.241	2.236	2.239
D_{sd}	93.0	93.0	93.0	93.0	93.1	93.1	92.9	93.0
Dry or Condition	D	D	D	D	C	C	C	C
S					533.3	533.7	533.6	533.9
V					392.7	392.3	392.2	392.1
G_{sa}					2.358	2.360	2.361	2.362
D_{ss}					98.0	98.1	98.1	98.1
Voids filled with water (%)					71.0	72.5	73.2	72.9

Mix Identification

Test Section "B"

LOTTMAN STRIPPING TEST DATA

Indirect Tensile Strength Terms and Equations

h = Height of specimen, in inches

P_f = Gauge load if soil press is used (psi)

F_{tv} = Total applied vertical load at failure (pounds) = P_f X 16.35 if soil press is used or direct reading if load cell is read in pounds

S_t = Indirect tensile strength (psi) = $\frac{0.156\ (F_{tv})}{h}$

TSR = Tensile strength ratio = $\frac{S_t\ (\text{Conditioned})}{S_t\ (\text{Dry})}$

	Dry				Conditioned			
Specimen No.	1	3	6	10	5	7	8	9
h	2.076	2.069	2.069	2.071	2.062	2.063	2.065	2.075
P_f	75	84	88	86	72	83	86	87
F_{tv}	1226.3	1373.4	1438.8	1406.1	1177.2	1357.1	1406.1	1422.5
S_t	92.1	103.6	108.5	105.9	89.1	102.6	106.2	106.9
S_t Average	102.5				101.2			

TSR = 99

EXHIBIT "G"
LOTTMAN STRIPPING TEST DATA

Mix Identification

Test Section "C"

Project	F 401(8)
Highway	SH 6
Resident Eng.	Shenkir
Spec Item No.	340-D
% Asphalt	5.0
Laboratory No.	

Density Calculations Terms and Equations

A = Weight of specimen in air (g)

C = Weight of specimen in water (no paraffin used) (g)

D = A-C = Actual volume of specimen (cc)

G_t = Theoretical specific gravity of specimen (from Mix Design)

$G_{ad} = \frac{A}{D}$ = Actual specific gravity of specimen (dry)

$D_{sd} = \frac{100\ G_{ad}}{G_t}$ = Density of specimen (dry) (%)

S = Weight of specimen in water after vacuum saturation (no paraffin used) (g)

V = A-S = Volume of specimen after vacuum saturation (cc)

$G_{sa} = \frac{A}{V}$ = Specific gravity of saturated specimen

$D_{ss} = \frac{100\ G_{sa}}{G_t}$ = Density of specimen saturated (%)

G_t = 2.416

Voids filled with water (%) $= \frac{100\ (D_{ss} - D_{sd})}{100 - D_{sd}}$

Specimen No.	6	7	10	11	1	3	8	12
A	925.4	925.6	925.5	925.8	925.8	925.5	925.7	925.5
C	514.0	514.4	514.2	514.1	512.5	513.2	513.3	512.2
D	411.4	411.2	411.3	411.7	413.3	412.3	412.4	413.3
G_{ad}	2.249	2.251	2.250	2.249	2.240	2.245	2.245	2.239
D_{sd}	93.1	93.2	93.1	93.1	92.7	92.9	92.9	92.7
Dry or Condition	D	D	D	D	C	C	C	C
S					533.3	534.8	535.1	535.3
V					392.5	390.7	390.6	390.2
G_{sa}					2.359	2.369	2.370	2.372
D_{ss}					97.6	98.1	98.1	98.2
Voids filled with water (%)					67.1	73.2	73.2	75.3

Mix Identification

Test Section "C"

LOTTMAN STRIPPING TEST DATA

Indirect Tensile Strength Terms and Equations

h = Height of specimen, in inches

P_f = Gauge load if soil press is used (psi)

F_{tv} = Total applied vertical load at failure (pounds) = P_f X 16.35 if soil press is used or direct reading if load cell is read in pounds

S_t = Indirect tensile strength (psi) = $\frac{0.156\ (F_{tv})}{h}$

TSR = Tensile strength ratio = $\frac{S_t\ (\text{Conditioned})}{S_t\ (\text{Dry})}$

	Dry				Conditioned			
Specimen No.	6	7	10	11	1	3	8	12
h	2.063	2.055	2.070	2.070	2.072	2.067	2.075	2.095
P_f	85	85	84	92	71	84	80	71
F_{tv}	1389.8	1389.8	1373.4	1504.2	1160.9	1373.4	1308.0	1160.9
S_t	105.1	105.5	103.5	113.4	87.4	103.7	98.3	86.4
S_t Average	106.9				94.0			

TSR = 88

EXHIBIT "H"
LOTTMAN STRIPPING TEST DATA

Mix Identification
Test Section "D"

Project	F 401(8)
Highway	SH 6
Resident Eng.	Shenkir
Spec Item No.	340-D
% Asphalt	5.0
Laboratory No.	

Density Calculations Terms and Equations

A = Weight of specimen in air (g)

C = Weight of specimen in water (no paraffin used) (g)

D = A-C = Actual volume of specimen (cc)

G_t = Theoretical specific gravity of specimen (from Mix Design)

$G_{ad} = \frac{A}{D}$ = Actual specific gravity of specimen (dry)

$D_{sd} = \frac{100\ G_{ad}}{G_t}$ = Density of specimen (dry) (%)

S = Weight of specimen in water after vacuum saturation (no paraffin used) (g)

V = A-S = Volume of specimen after vacuum saturation (cc)

$G_{sa} = \frac{A}{V}$ = Specific gravity of saturated specimen

$D_{ss} = \frac{100\ G_{sa}}{G_t}$ = Density of specimen saturated (%)

G_t = 2.406

Voids filled with water (%) = $\frac{100\ (D_{ss} - D_{sd})}{100 - D_{sd}}$

Specimen No.	1	2	4	7	3	6	8	11
A	925.2	925.5	925.8	925.6	926.0	925.5	925.5	925.5
C	513.6	513.5	513.4	512.5	516.0	515.4	515.8	515.4
D	411.6	412.0	412.4	413.1	410.1	410.1	409.7	410.1
G_{ad}	2.248	2.246	2.245	2.241	2.259	2.257	2.259	2.257
D_{sd}	93.4	93.4	93.3	93.1	93.9	93.8	93.9	93.8
Dry or Condition	D	D	D	D	C	C	C	C
S					533.6	533.0	533.5	532.9
V					392.4	392.5	392.0	392.6
G_{sa}					2.360	2.358	2.361	2.357
D_{ss}					98.1	98.0	98.1	98.0
Voids filled with water (%)					68.9	67.7	68.9	67.7

Mix Identification

Test Section "D"

LOTTMAN STRIPPING TEST DATA

Indirect Tensile Strength Terms and Equations

h = Height of specimen, in inches

P_f = Gauge load if soil press is used (psi)

F_{tv} = Total applied vertical load at failure (pounds) = P_f X 16.35 if soil press is used or direct reading if load cell is read in pounds

S_t = Indirect tensile strength (psi) = $\frac{0.156\ (F_{tv})}{h}$

TSR = Tensile strength ratio = $\frac{S_t\ (\text{Conditioned})}{S_t\ (\text{Dry})}$

	Dry				Conditioned			
Specimen No.	1	2	4	7	3	6	8	11
h	2.040	2.402	2.041	2.052	2.041	2.046	2.032	2.037
P_f	73	77	80	88	75	79	80	85
F_{tv}	1193.6	1259.0	1308.0	1438.8	1226.3	1291.7	1308.0	1389.8
S_t	91.3	96.2	100.0	109.4	93.7	98.5	100.4	106.4
S_t Average	99.2				99.8			

TSR = 100

EXHIBIT I
STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION

Charge $260.00

GENERAL TEST REPORT

Contract/Reqn.No. 05830019 Control 49-8-38 No. PD 8063
Engineer Frank Shenkir Project F 401(8) Hwy. SH 6
Contractor Young, Inc. District 17 County Robertson

****

Laboratory No.F85500289 thru F85500290
Date Sampled 10-03-85 Date Received 10-09-85 Date Reported 10-18-85
Material HMAC Code
Producer Young Bros., Inc.-Bryan Code
Identification Marks See Below Spec.Item 340-002, Ty D
Sampled From Truck Quantity Units
****

EXTRACTION TEST RESULTS

Size	Specification Item 340-002, Type "D" (% by wt.)	F85500289 Mix C with 3.0% Polymer treated sand (% by wt.)	F85500290 Mix D with 3.0% Polymer untreated sand (% by wt.)
Pass 1/2"	100	100	0.2
Pass 3/8"	85-100	98.5	2.3
3/8"-No.4	21-53	28.8	31.2
No.4-No.10	11-32	28.8	26.3
Ret.No.10	54-74	59.0	60.0
No.10-No.40	6-32	14.6	13.5
No.40-No.80	4-27	13.3	11.2
No.80-No.200	3-27	6.3	8.6
Pass No.200	1-8	6.7	6.7
Residual Bitumen	4.0 - 8.0	* 5.2	4.9

* Resample under Lab No. F85500337

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F, stokes	2462	3150
Penetration @ 77°F	100	83
Ductility @ 77°F, cm.	141	141

3cc: District 17
1cc: Sec. F
1cc: Sec. C
1cc: Bobby Wade-District 17 Lab.

EXHIBIT J
STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION

Charge $260.00

GENERAL TEST REPORT

Contract/Reqn.No. 05830019 Control 49-8-38 No. PD 8063
Engineer Frank Shenkir Project F 401(8) Hwy. SH 6
Contractor Young, Inc. District 17 County Robertson

****

Laboratory No.F85500287 thru F85500288
Date Sampled 10-03-85 Date Received 10-09-85 Date Reported 10-18-85
Material HMAC Code
Producer Young Bros., Inc.-Bryan Code
Identification Marks See Below Spec.Item 340-002, Ty D
Sampled From Truck Quantity Units
****

EXTRACTION TEST RESULTS

Size	Specification Item 340-002, Type "D" (% by wt.)	F85500287 Mix A with 1.0% Polymer treated sand (% by wt.)	F85500288 Mix B with 3.0% Polymer treated sand (% by wt.)
Pass 1/2"	100	100	100
Pass 3/8"	85-100	98.5	98.4
3/8"-No.4	21-53	28.6	29.8
No.4-No.10	11-32	25.6	25.2
Ret.No.10	54-74	55.7	56.7
No.10-No.40	6-32	15.3	15.5
No.40-No.80	4-27	12.6	11.4
No.80-No.200	3-27	8.0	8.6
Pass No.200	1-8	8.4	7.9
Residual Bitumen	4.0 - 8.0	5.2	5.2

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F, stokes ---------------------------- 3470 ------------- 2258
Penetration @ 77°F ------------------------------------ 89 -------------- 101
Ductility @ 77°F, cm. -------------------------------- 141 -------------- 141

3cc: District 17
1cc: Sec. F
1cc: Sec. C
1cc: Bobby Wade-District 17 Lab.

State Department of Highways and Public Transportation
Form 404 Rev. 3

EXHIBIT K

DAILY CONSTRUCTION REPORT

ASPHALTIC CONCRETE PAVEMENT

DISTRICT LAB

County Robertson Highway SH 6 Project F 401(3) Control
Location of Plant Bryan Type of Plant Drum Mix Contractor Young Bros. Inc.
Date 10-16-85 Specification Item 340 Type D Plant Started 7:30 A.M. Plant Stopped 4:30 P.M.

Location No.							
1	LT Main Lane #2	3	Decel. Lane	5	Entr. Ramp	7	
2	Fr. Rd. Lane	4	Accel. Lane	6	Exit Ramp	8	

Sieve Size	Design No. 1	Combined Bin Analysis 1	2	3	4	5	6	7	8	Extractions 1	2	3	4	5
1 3/4"-7/8"														
7/8"-5/8"														
5/8"-3/8"														
1/2"-3/8"	3.0									3.9	1.9	3.2		
3/8"-4	32.0									31.8	30.2	32.3		
1/4"-10														
4-10	25.0									26.3	29.7	25.9		
-10	40.0									62.0	61.8	61.4		
10-40	14.0									13.5	13.2	13.7		
40-80	11.0									9.8	9.6	10.1		
80-200	10.0									7.9	8.2	8.3		
Pass 200	5.0									6.8	7.2	6.5		
Total	100.0									100.0	100.0	100.0		
Asphalt	5.3									5.4	4.9	5.2		

Bin Analy. No.	Extr. No.	Time	Location No.	Course	of Courses	Station No.	Mix Temp. °F. Plant	Road	Specimen Nos.	Road Dens.	Lab Dens.	% Stab.
	1	[illegible]			1	536	325	305	14ABC		97.7	51
	2	[illegible]			1	478	315	295				
	3	[illegible]			1	431	330	305				

Materials Used

	Asphalt (Tons)	Aggregate (Tons or C.Y.)
Previous Report	753.973	13546.437
This Report	76.065	1329.125
Total To Date	830.038	14875.562

Percent Complete-Asphaltic Concrete Pavement

Percent Complete—This Type	63.23	%
Percent Complete—All Types	63.12	%

Days Run

Location No.	Course of Courses	Station to Station		Width (Feet)	25 Inches Lbs/Sq. Yd. Sq. Yds.	Tons	Inches Lbs/Sq. Yd. Sq. Yds.	Tons	Inches Lbs/Sq. Yd. Sq. Yds.	Tons
		[illegible]	[illegible]	[illegible]		[illegible]				
		Total Today				[illegible]				
		Previous Report				[illegible]				
		Total To Date				[illegible]				
		Avg. Rate To Date				Lbs/Sq. Yd.		Lbs/Sq. Yd.		Lbs/Sq. Yd.

Weather Partly Cloudy
Min Temp 55 °F
Max Temp 80 °F
Remarks 9.0 - 2,333 = 1459 [illegible]
Material Treated with 1½% Lime

[signature] Inspector Type D Date 10-16-85 Report No. 14

[signature] 10-17-85 [initials]