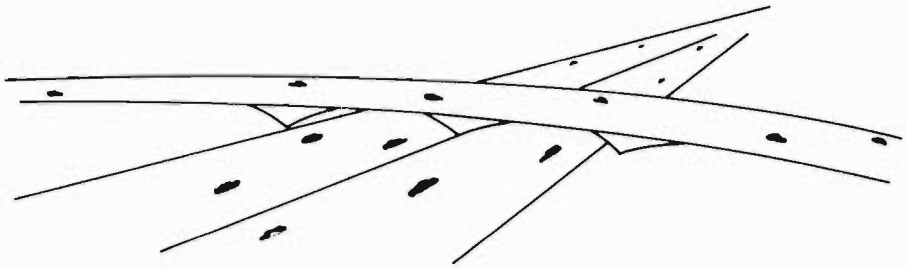


DEPARTMENTAL RESEARCH

Report Number SS 24.1

THE EFFECTS OF LIME AS AN ANTI-STRIPPING AGENT

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

THE EFFECTS OF LIME AS AN ANTI-STRIPPING AGENT

by

Nick Turnham

Laboratory Supervisor

District Seventeen

Bryan, Texas

A cooperative effort between the Texas Hot Mix Asphalt Pavement Association, National Lime Association, Young Brothers, Inc., Texas Transportation Institute, Center for Transportation Research, and the State Department of Highways and Public Transportation

February 1983

The opinions expressed herein are those of the author and are not necessarily those of the Texas State Department of Highways and Public Transportation.

The report does not constitute a standard, specification or regulation.

THE EFFECTS OF LIME AS AN ANTI-STRIPPING AGENT

This project was a cooperative effort between the Texas Hot Mix Asphalt Pavement Association, National Lime Association, Young Brothers, Inc., Texas Transportation Institute, Center for Transportation Research, and the State Department of Highways and Public Transportation, District Seventeen.

It was felt that a full-scale field test of the effects of lime as an anti-strip agent was needed. The field test was planned for good control and to include several variables. The variables being point of addition of lime, slurry or dry treatment of individual aggregates and total mixture, and time effect of lime from application to mixture. Appendix A contains a listing of the various test sections with their limits.

The project selected for the tests was MH 240 (Villa Maria Road) in Bryan. This is a main north-south arterial with an ADT of 7,450. The completed street had curb and gutter with sixty feet surface. The section provided for 6 inches of subgrade stabilized with 4% lime, 6 inches of asphalt stabilized base (2 courses) and 1 inch of hot mix asphalt concrete pavement riding surface. The original ASB provided for a maximum size of 1½ inches. This design was field changed for our research project to provide for a maximum size of ½ inch.

The design used in the entire research project was as follows:

	Percent by Weight
Retained on 1/2" Sieve	0
1/2" - 3/8"	0.3
3/8" - No. 4	38.7
No. 4 - No. 10	24.8
+No. 10	63.8
No. 10 - No. 40	8.7
No. 40 - No. 80	15.0
No. 80 - No. 200	10.7
-No. 200	1.8

The aggregates used were 62% washed river gravel (Gifford-Hill, College Station plant), 15% washed sand from the same source, and 23% local field sand. With an asphalt content of 5.0%, the design values were: Percent Density, 95.5; Hveem Stability, 41; and Cohesiometer, 164. Appendix B contains additional design information.

All of the mix used in research on this street was placed on the top 3 inches of ASB and laid on the east side of centerline. It is to be covered with 1 inch of hot mix asphalt concrete pavement.

Both batch and dryer drum plants were used with 5.0% Exxon Asphalt AC-20, and lime was added at the rate of 1.5% by weight of the aggregate treated. When slurry was used, it was made by mixing 70% water and 30% lime (by weight).

District Seventeen provided the site for the mix to be placed, performed certain laboratory and plant mix tests, correlated addition of lime with the contractor, and provided plant inspection.

Laboratory Mix

The variables used in the laboratory mix were:

Untreated or Control Mix

Dry Lime Added to Total Mix

Dry Lime Added to Asphalt

Lime Slurry Added to Total Mix (5 Min. Treatment)

Lime Slurry added to Individual Aggregates in Complete Mix (2 Day treatment)

Lime Slurry Added to Total Mix (2 Day Treatment)

Lime Slurry Added to Total Mix (30 Day Treatment)

The Texas Freeze-Thaw Pedestal Test was performed on untreated and treated individual aggregates and also on the complete mix (Appendix C-2). This is not a standard test but we believe it indicates how a pavement will perform under adverse climatic conditions. A briquet is molded approximately $^{3}/_{4}$ inch high and $1^{3}/_{4}$ inch in diameter. This specimen is placed on top of a pedestal in a glass container and covered with water. It is then placed in a deep freeze at 10°F for 15 hours and then in an oven at 120°F for 9 hours. This constitutes one cycle. Figures 1 and 2 depict the results of the Freeze-Thaw Pedestal Test.

Also, the Texas Boiling Test was performed on untreated and treated individual aggregates and complete mix (Appendix C-3). Figures 3 and 4 depict the results of this test.

Film Stripping, TEX-218-F, was performed on untreated and treated mix (Appendix C-4). Figure 5 shows these results.

Pressure Wetting and Unconfined Compression, TEX-126-E, was performed on untreated and treated mix (Appendix C-5). No real significant changes were noted by the addition of lime except the strength increased 2 to 8 pounds with lime. Density (PCF) and percent water absorbed were virtually unchanged by the addition of lime.

Plant Mix:

Variables used in the plant mixes were:

Untreated or Control Mix - Batch and Drum Plants

Dry Lime Added in Pug Mill

Dry Lime Added on Cold Feed Belt - Drum Plant

Dry Lime Added with Fines in Drum Plant

Lime Slurry Added to Individual Aggregates and also to all Aggregates in Mix - Drum Plant

Lime Slurry Added to Individual Aggregates in Mix and also to all Aggregates (2 Days) (Batch and Drum Plants)

Lime Slurry Added to all Aggregates in Total Mix (30 Days) (Drum Plant)

The Texas Boiling Test was performed on the total mix, untreated and treated (Appendix D-2). Results of the tests on mix produced by the batch plant are shown in Figure 6, and results of the tests on mix produced by the dryer drum plant are shown in Figure 7.

Film Stripping Tests, TEX-218-F, were performed on the same mix as the Boiling Tests (Appendix D-3). Results of the tests on the mix produced by the batch plant are depicted in Figure 8 and test results for the mix produced by the dryer drum plant are shown in Figure 9.

Pressure Wetting and Unconfined Compression Tests were also performed on the same mix (Appendix D-4).

The densities (PCF) when mixing in the laboratory or plant were nearly the same. The only exception was that when dry lime was added to the aggregate in the pug mill, the density dropped approximately 5 pounds. The strength (PSI) increased greatly between the lab mix and the plant mix. This was apparent in all cases when the same variable was used. The only exception was when dry lime was added to the aggregate in the pug mill. This indicated that a better job of mixing was achieved in the plant than in the laboratory, and that the reheating and remolding of the plant mix in the lab improved strength and reduced stripping. Also, the precent water absorbed was less in the plant mix than in the laboratory mix. Again, the only exception was dry lime added in the pug mill.

In all the tests which were run, the least effect of lime was seen when dry lime was added to the aggregates in the pug mill.

District Seventeen is only doing part of the testing. Texas Transportation Institute and Center for Transportation Research are continuing series of tests that will be included in the final report.

Tentative conclusions based on the District's testing are:

1. All aggregates used had stripping characteristics.

2. There was no conclusive evidence that lime has significant effects on stability, density and other physical characteristics.

3. Lime decreased stripping tendency.

4. Maximum improvement in stripping was achieved with 1½% lime added to the total aggregates - less quantity gave some reduction. With aggregates used, 1½% lime appears to be the optimum amount of lime.

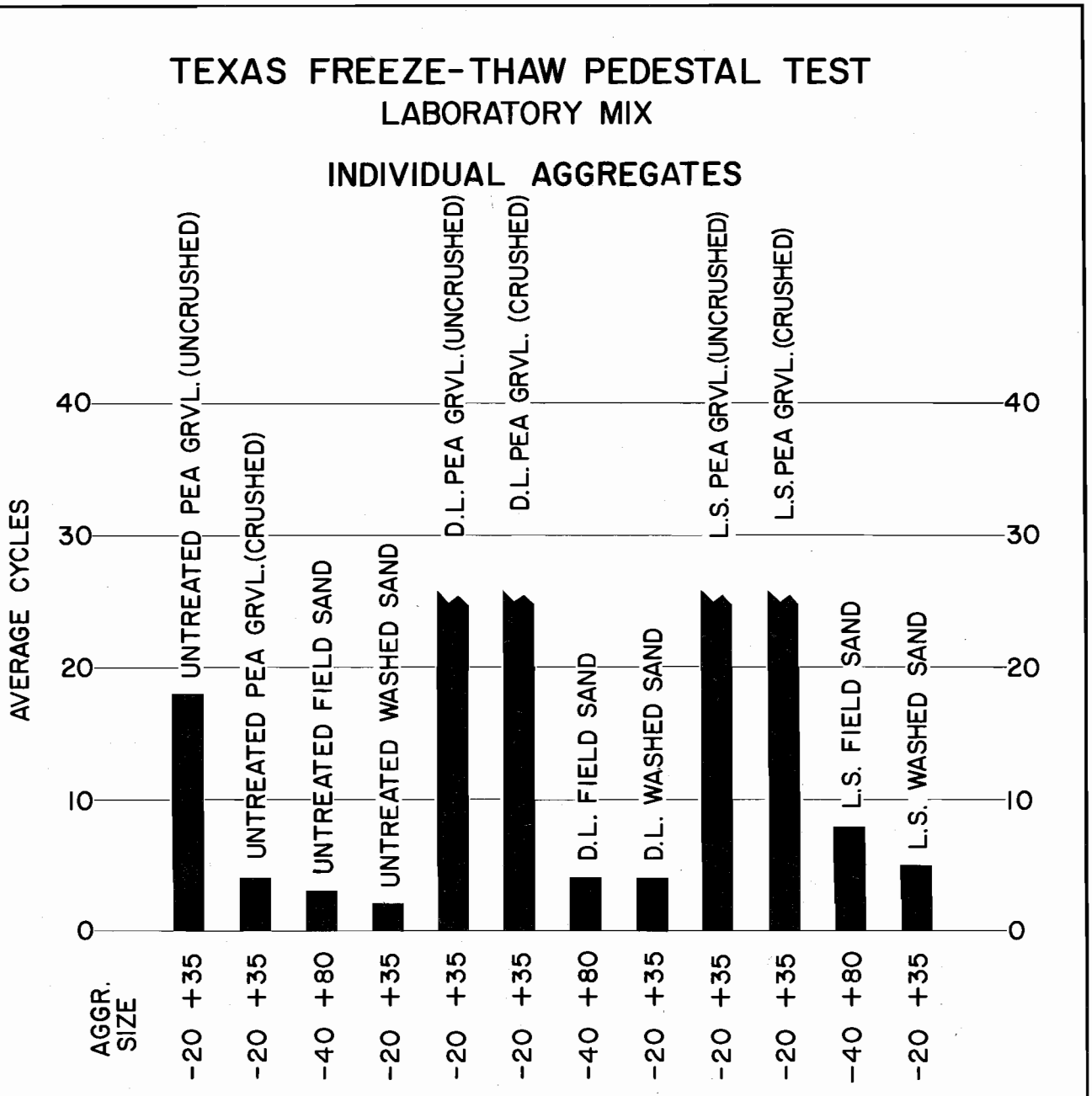
5. Adding dry lime to the pug mill was the least effective method used.

6. The most effective method of adding lime was slurry spray.

7. The benefit of lime slurry does not increase with the time it is in contact with aggregate. Results from adding slurry on cold feed belt, curing in stockpile for 2 days and curing in stockpile for 30 days are essentially the same. One advantage of stockpiling is that excess moisture drains out and does not have to be removed in the dryer.

8. The Texas Boiling Test is an effective method for determining stripping characteristics of aggregates.

At this stage of the research it appears that lime slurry treatment of stripping aggregates is the most effective. District Seventeen has initiated a policy requiring lime treatment of all aggregates that strip more than 30% when subjected to the Texas Boiling Test. This treatment will be in the form of lime slurry with 1½% lime by weight of the aggregate being treated. Special Provisions to Specification Items 292 and 340 are contained in Appendix E.



NOTE: CYCLES USED WERE 15 HOURS FREEZE AND 9 HOURS THAW.

FIGURE 1

TEXAS FREEZE-THAW PEDESTAL TEST
LABORATORY MIX

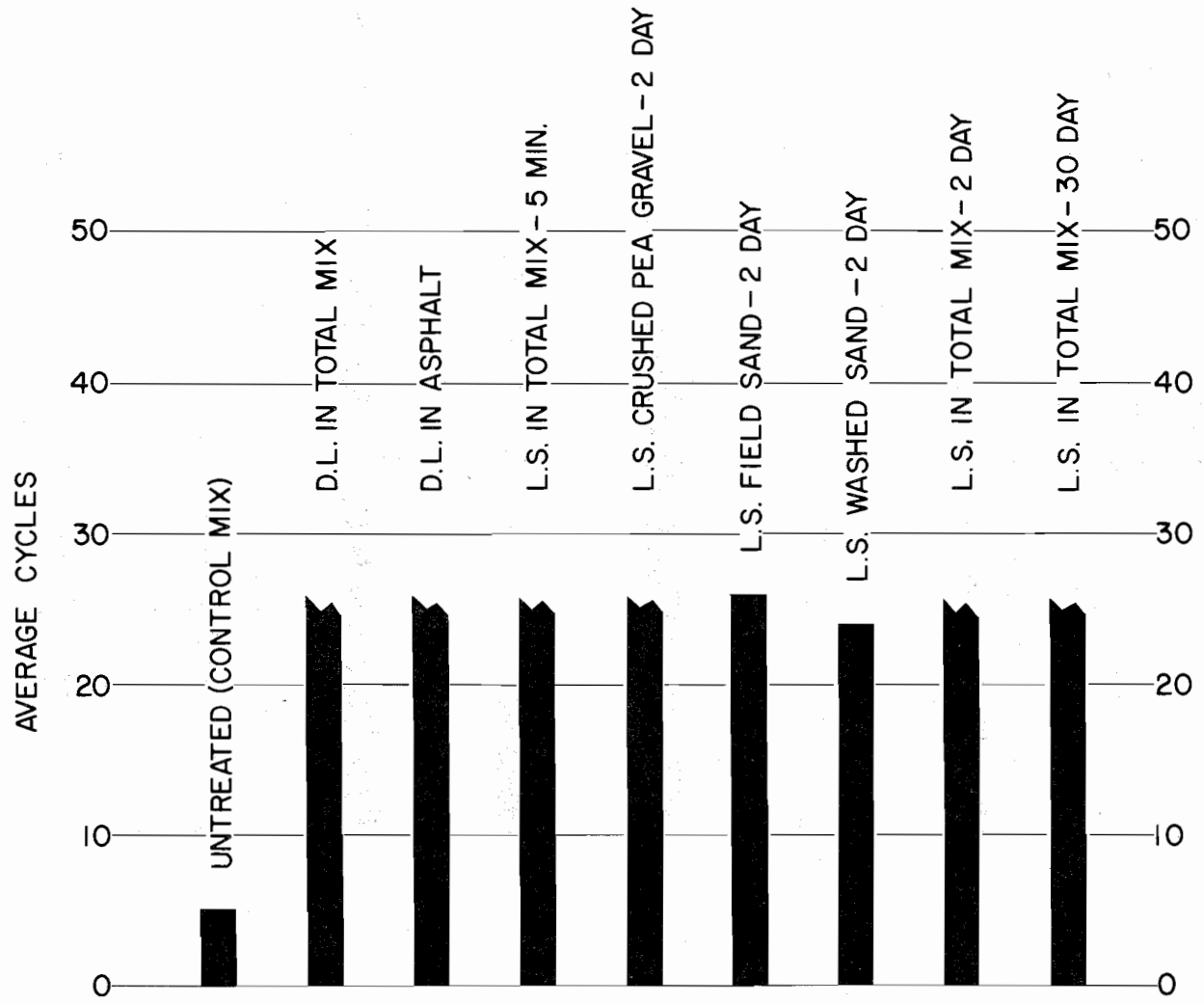
COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0% EXXON AC-20



NOTE: AGGREGATE SIZES USED IN SPECIMENS WERE:
PEA GRAVEL -20 +35
WASHED SAND -20 +35
FIELD SAND -40 +80

CYCLES USED WERE 15 HOURS FREEZE AND 9 HOURS THAW.

FIGURE 2

TEXAS BOILING TEST
LABORATORY MIX

INDIVIDUAL AGGREGATES

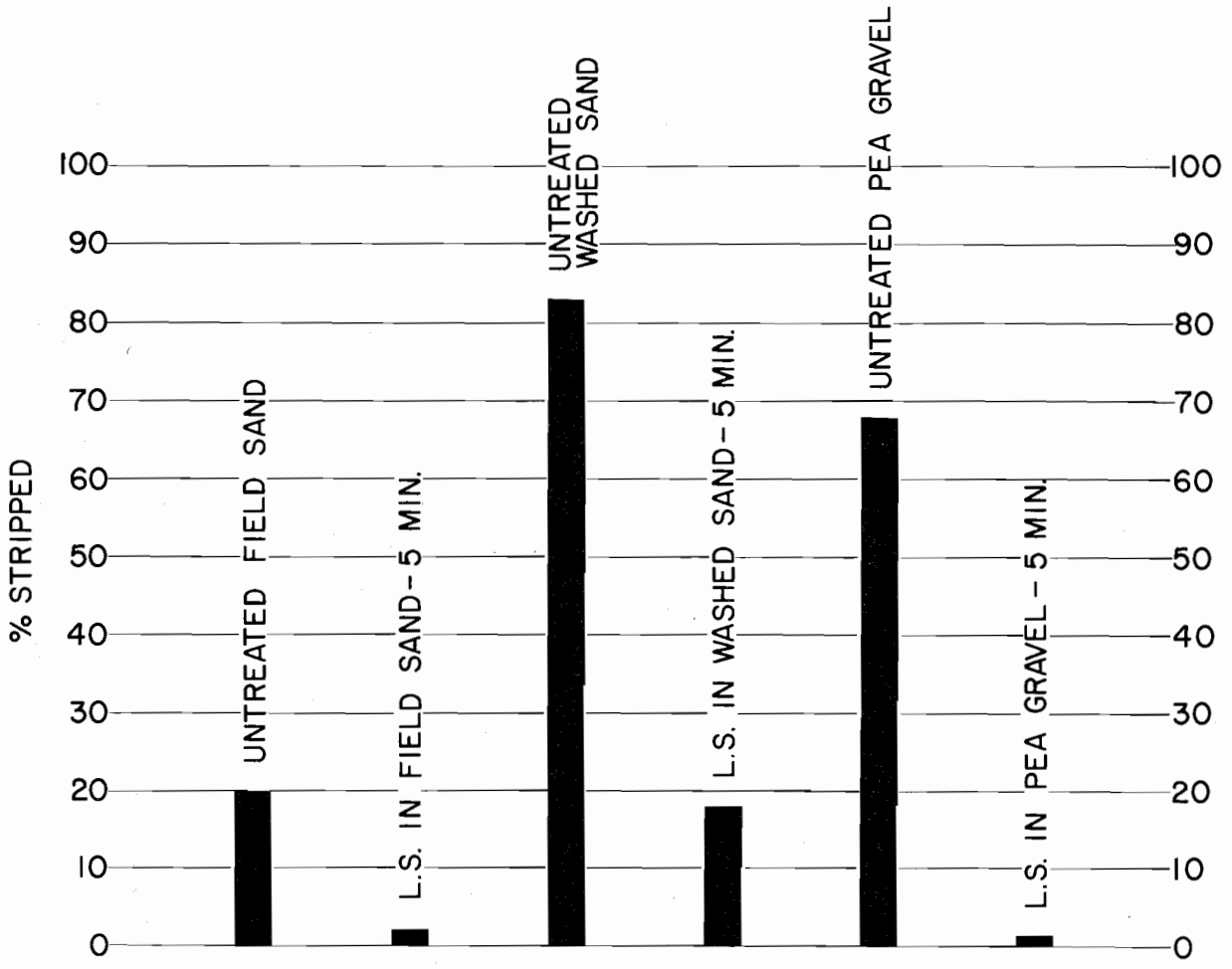


FIGURE 3

TEXAS BOILING TEST
LABORATORY MIX

COMPLETE MIXTURE

AGGREGATE

62 % PEA GRAVEL
15 % WASHED SAND
23 % FIELD SAND

ASPHALT

5.0 % EXXON AC-20

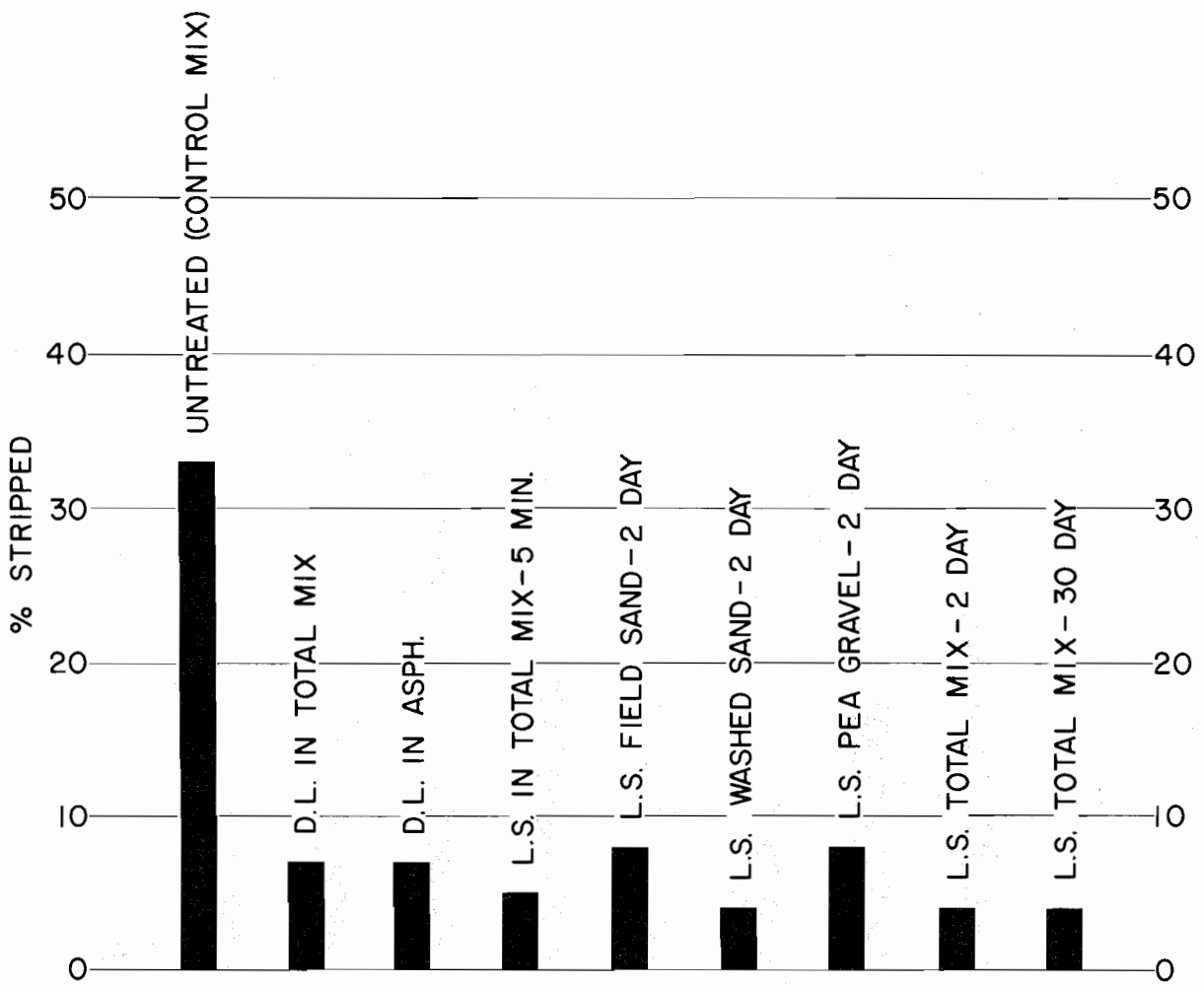


FIGURE 4

FILM STRIPPING TEX-218-F
LABORATORY MIX

COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0 % EXXON AC-20

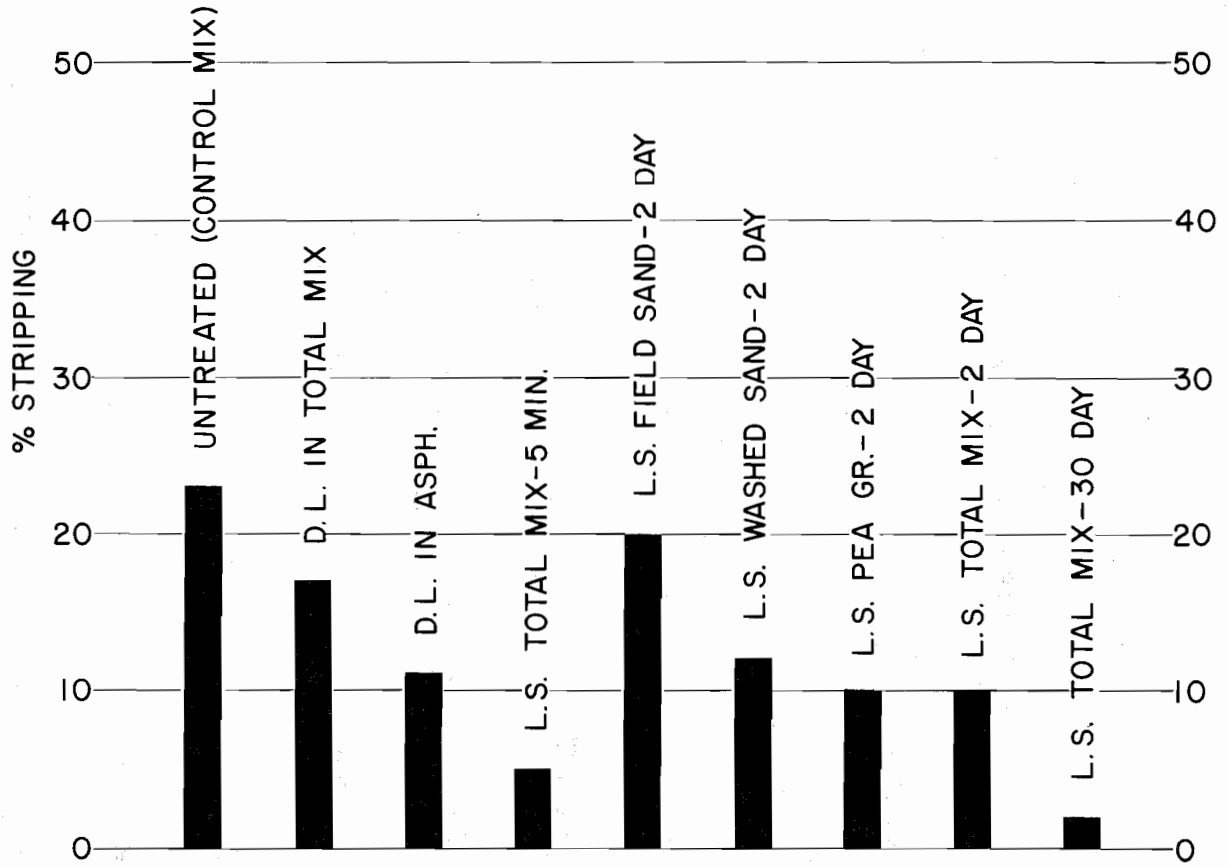


FIGURE 5

TEXAS BOILING TEST
PLANT MIX
(WEIGH-BATCH PLANT)

COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0% EXXON AC-20

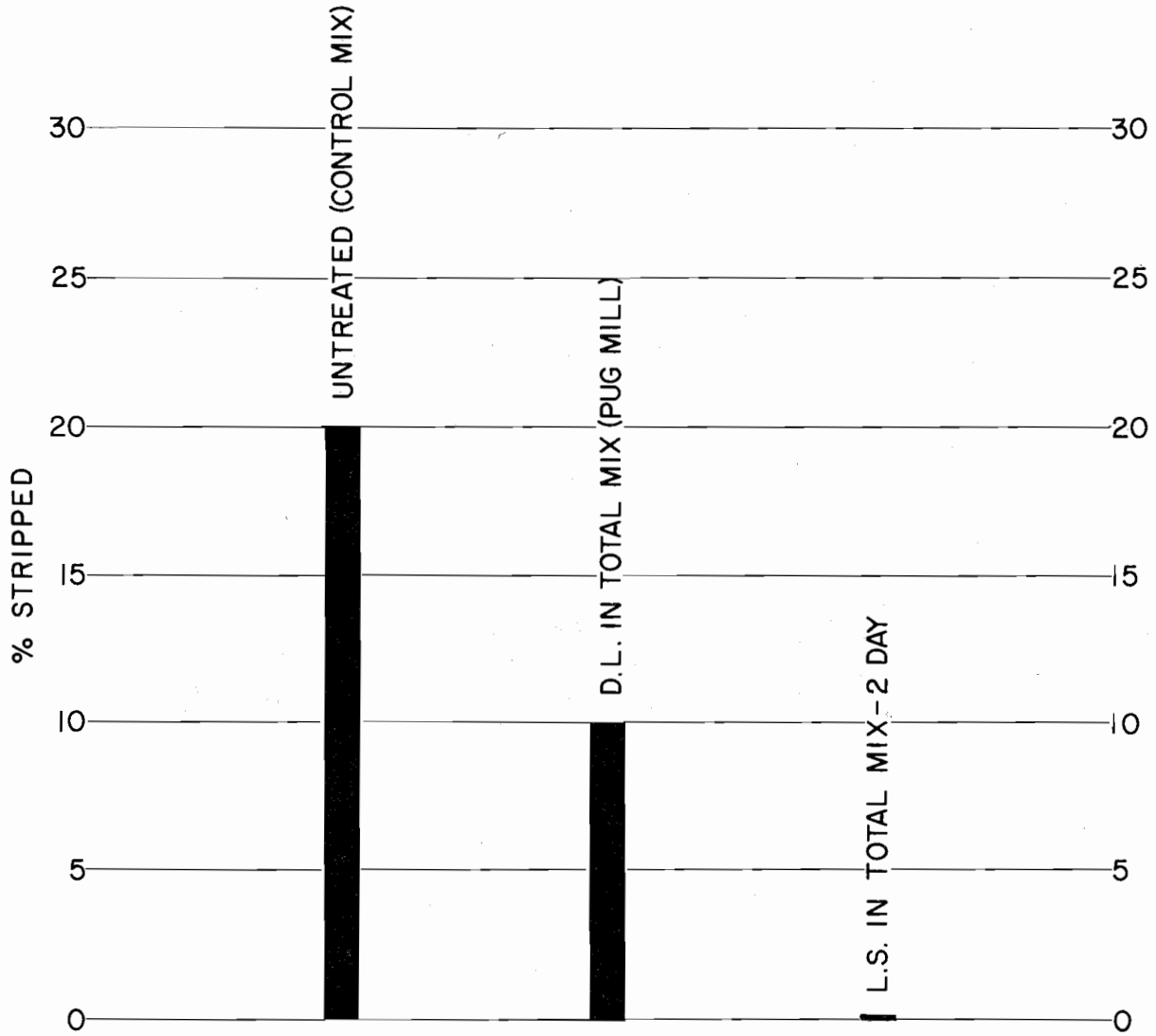


FIGURE 6

TEXAS BOILING TEST
PLANT MIX
(DRYER DRUM PLANT)

COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0% EXXON AC-20

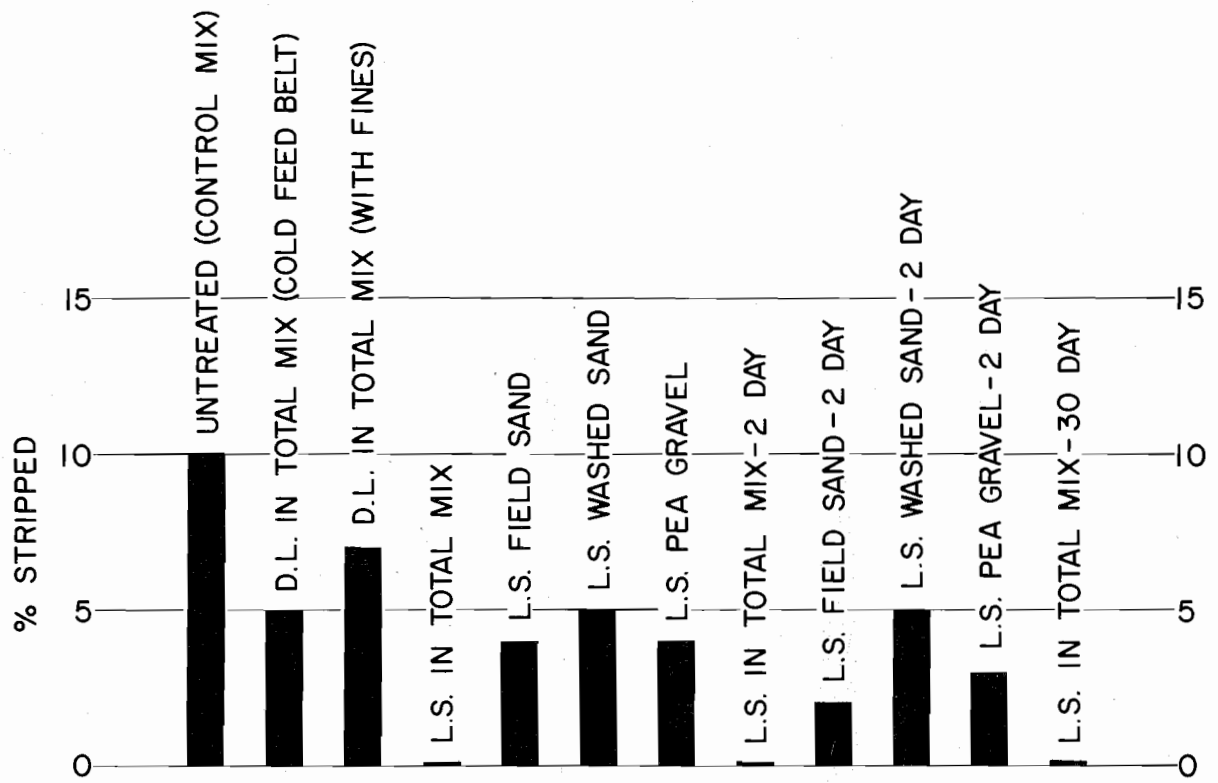


FIGURE 7

FILM STRIPPING TEX-218-F

PLANT MIX
(WEIGH-BATCH PLANT)

COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0% EXXON AC-20

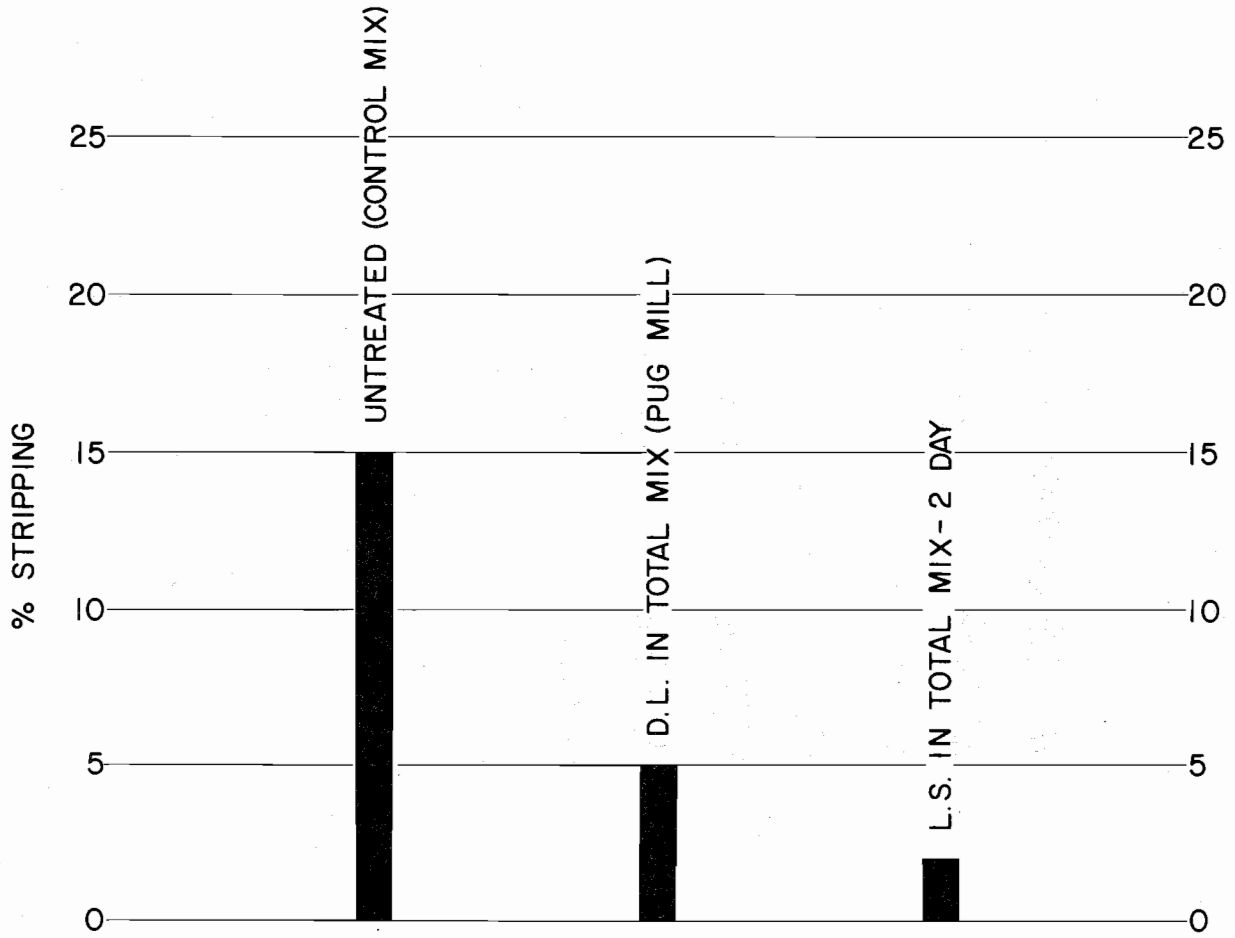


FIGURE 8

FILM STRIPPING TEX-218-F

PLANT MIX
(DRYER DRUM PLANT)

COMPLETE MIXTURE

AGGREGATE

62% PEA GRAVEL
15% WASHED SAND
23% FIELD SAND

ASPHALT

5.0% EXXON AC-20

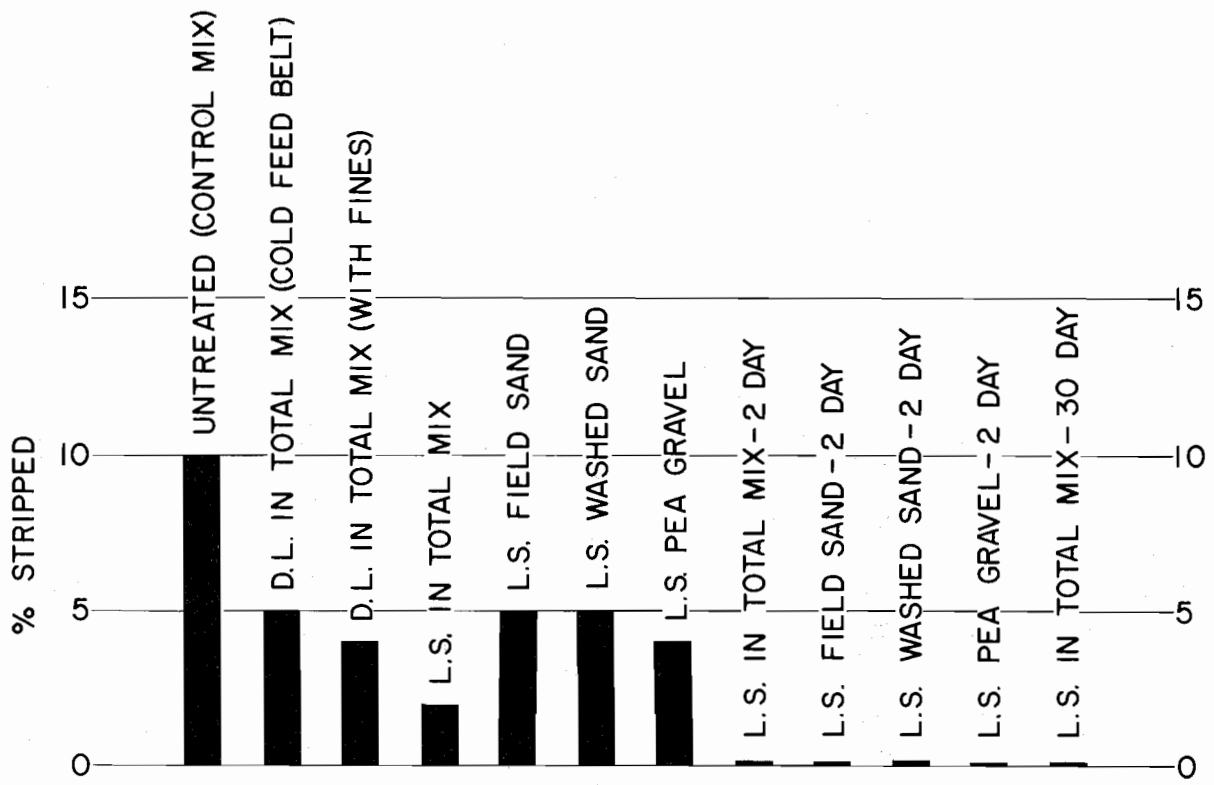


FIGURE 9

APPENDIX A

APPENDIX A

LOCATION OF TEST SECTIONS
MH 240 PROJECT NO. DP J017(3)etc.

All mix placed left of centerline (Eastside). Mix produced by Dryer Drum Plant unless noted.

Code	Limits	Lane	Description	Date Placed
M	124+80 to 128+80	Outside	Untreated (Control Mix) Batch Plant	8-19-82
M	124+40 to 128+00	Inside	Untreated (Control Mix) Batch Plant	8-19-82
L	121+80 to 124+80	Outside	Dry Lime - Total Mix (Batch Plant)	8-19-82
L	121+85 to 124+40	Inside	Dry Lime - Total Mix (Batch Plant)	8-19-82
H	107+90 to 113+80	Outside	Two Day Lime Slurry - Total Mix (Batch Plant)	8-30-82
C	81+85 to 87+55	Outside	Untreated (Control Mix)	9-08-82
D	87+55 to 93+60	Outside	Dry Lime - Total Mix	8-30-82
B	74+40 to 81+85	Outside	Dry Lime - Total Mix (added with Fines)	9-08-82
K	116+20 to 121+85	Inside	Lime Slurry - Total Mix	8-28-82
O	128+80 to 135+55	Outside	Lime Slurry - Field Sand	8-28-82
N	128+00 to 133+70	Inside	Lime Slurry - Washed Sand	8-28-82
J	114+85 to 120+90	Outside	Lime Slurry - Pea Gravel	8-28-82
E	93+60 to 98+15	Outside	Two Day Lime Slurry - Total Mix	8-30-82
I	109+80 to 116+20	Inside	Two Day Lime Slurry - Field Sand	8-30-82
G	102+55 to 104+60	Outside	Two Day Lime Slurry - Washed Sand	8-30-82
G	105+60 to 107+90	Outside	Two Day Lime Slurry - Washed Sand	8-30-82
F	98+15 to 102+55	Outside	Two Day Lime Slurry - Pea Gravel	8-30-82
A	64+75 to 70+50	Inside	Thirty Day Lime Slurry - Total Mix	9-27-82

APPENDIX B

17-82-HMAC-21

The District Seventeen Laboratory has completed a Design for, A Test Section, using 1.5% Lime as an Anti-Stripping Agent, to be used on MH 240 in Brazos County. Material used in this Design were 62% Processed Gravel, 15% Washed Sand from Gifford Hill and 23% Field Sand from Heath Pit.

This Design was made under Laboratory Identification Number 17-82-HMAC-21. Exxon AC-20 Asphalt was in the Mix. Density, Hveem Stability and Cohesiometer Values are shown in Tabular and Graphical Form within this Report.

TABLE I
ORIGINAL SIEVE ANALYSIS

SIEVE SIZE	PROCESSED GRAVEL	WASHED SAND	FIELD SAND	LAB GRADING	ITEM 340 SPECS:
½	0			0	0
½-3/8	0.4	0		0.3	0-5
3/8-4	61.6	3.6		38.7	20-50
4-10	35.5	18.7		24.8	10-30
+10				(63.8)	50-70
10-40	2.0	49.3	0.4	8.7	0-30
40-80	0.2	26.2	48.0	15.0	4-25
80-200	0.1	1.7	44.8	10.7	3-25
-200	0.2	0.5	6.8	1.8	0-6

TABLE II
PROPORTIONING OF MATERIALS

PROCESSED GRAVEL	WASHED SAND	FIELD SAND
62%	15%	23%

TABLE III
TEST RESULTS BY ASPHALT CONTENT

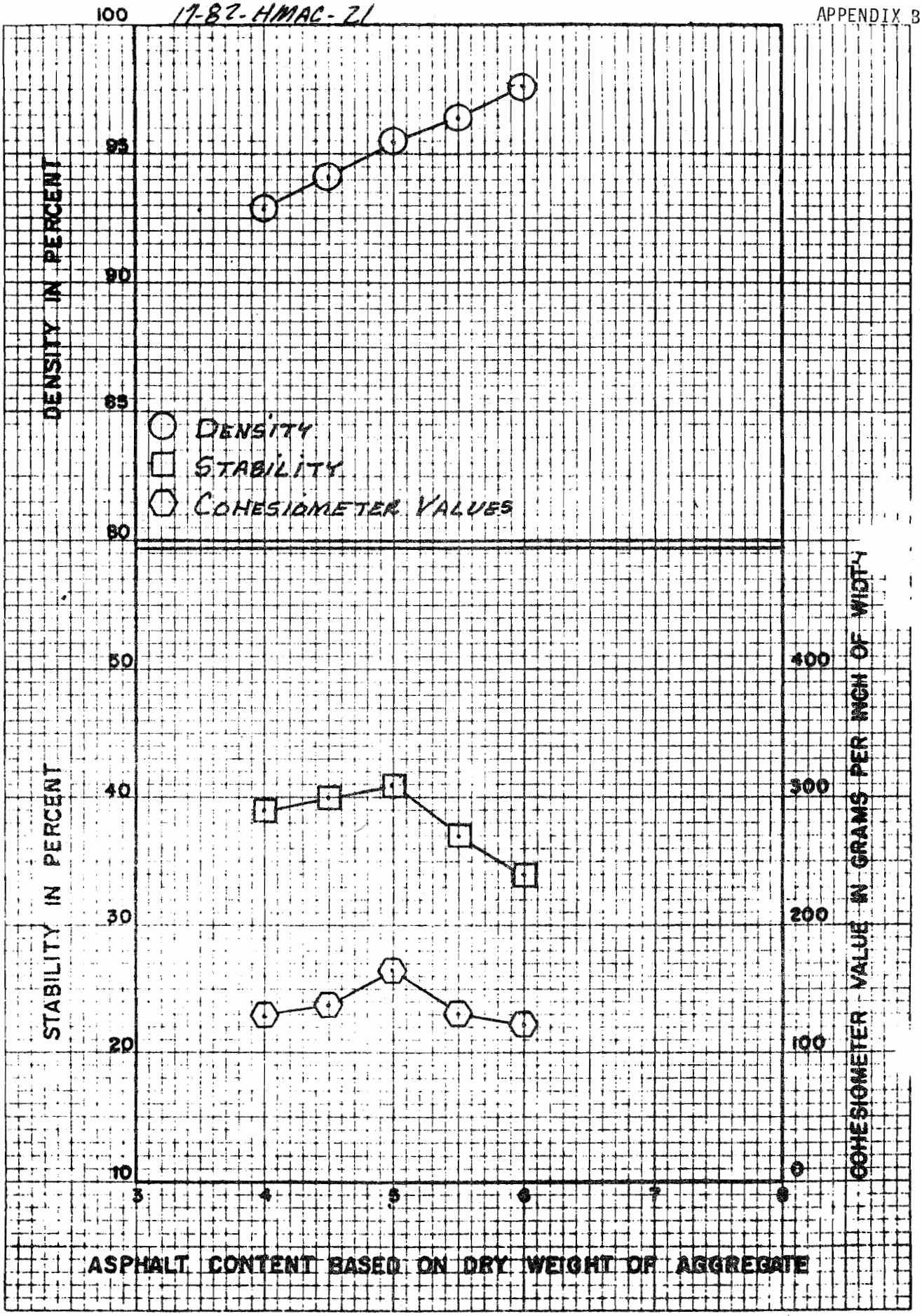
ASPHALT CONTENT	% DENSITY	HVEEM STABILITY	COHESIOMETER VALUES
4.0	92.8	39	129
4.5	94.1	40	138
5.0	95.5	41	164
5.5	96.4	37	130
6.0	97.6	34	122

TABLE IV
SPECIFIC GRAVITY

SIEVE SIZE	PROCESSED GRAVEL	WASHED SAND	FIELD SAND
+10	2.639	2.615	
10-80		2.637	2.637
-80			2.709

Poor practice → 3/8"-No.4 = 61.6%, No.4-No.10 = 35.5% Gravel sieve Analysis.

The Combined Specific Gravity of the Aggregate is 2.646.
The Specific Gravity of Exxon AC-20 Asphalt is 1.028.


17-82-HMAC-ZL
DENSITY IN PERCENT
100
95
90
85
80
DENSITY
STABILITY
COHESIOMETER VALUES
STABILITY IN PERCENT
50
40
30
20
10
COHESIOMETER VALUE IN GRAMS PER INCH OF WIDTH
400
300
200
100
0
3
4
5
6
7
8
ASPHALT CONTENT BASED ON DRY WEIGHT OF AGGREGATE

Form 418A
File T.98

APPENDIX B

SOILS AND BASE MATERIALS TEST REPORT

Laboratory No. 17-82-114
Date Rec'd _____ Reported _____
Engineer _____
Address _____
Contractor Young Bros.
Sampler Bobby J. Wade
Sampler's Title Engineering Tech V.
Sampled From Design
Producer _____
Quantity Represented by Sample _____
Has been Used on _____

Control Number	Section Number	Job Number
Brazos		MH 240
County	**Federal Project No.**	**Highway No.**
17		6-82
District No.	**I.P.E. No.** **Req. No.**	**Date Sampled**

Specification Item No. _____
Material from Property of _____

Proposed for Use as Test Section on MH 240

Lab. No.	LL	PI	% SB	DESIRED Moist. (%)	DESIRED Den. (pcf)	MEASURED Moist. (%)	MEASURED Dry Den (pcf)	DECANTATION	DELETERIOUS	SAND EQUIV
17-82-114	21	3						0.6	0.0	85
	FIELD	SAND						(COMBINED AGG)		

PERCENT RETAINED ON

Lab No.	Square Mesh Sieve — Opening in Inches								Sieve Numbers							Grain Diam. in Millimeters			Specific Gravity
	3	2½	2	1¾	1¼	⅞	⅝	⅜	4	10	20	40	60	100	200	.05	.005	.001	

SAMPLE IDENTIFICATION

Lab. No.	Identification Marks	Location—Properties—Station Numbers	Type of Materials
17-82-114		17-82-HMAC-21	Processed Gravel, Washed Sand, and Field Sand

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

MCS.TST.14 ASPHALTIC CONCRETE STABILITY REPORT CORRECTED REPORT R
D=9 CHARGES 105.00

CONTRACT NO. RFQ NO. IPE. CONTROL - - IPE 300
ENGINEER CAROL ZEIGLER PROJECT
CONTRACTOR DIST 17 CO HWY

****

LABORATORY NO. H82401777 DATE RECD 06/15/82 DATE REPTD 06/16/82
DATE SAMPLED 06/11/82
MATERIAL TYPE D CODE 0000000000
PRODUCER CODE 000
IDENTIFICATION MARKS SPEC. ITEM 0340
SAMPLED FROM DESIGN QUANTITY UNIT

****

SAMPLE NUMBER	SPEC. NO.	IDENT. MARKS	COHESIOMETER VALUE (AVG.)		ASPHALT (% BY WT.)	SPEC. HT. (IN.)	SPEC.DENS. FIELD (AVG. %)	HVEEM STABILITY (%)	(AVG.%)
46	1	17-82-HMAC	112			2.00		39	
	2	-21	149	129	4.0	2.00		39	39
	3		125			2.01		39	
47	1	17-82-HMAC	124			2.01		38	
	2	-21	138	138	4.5	2.01		39	39
	3		153			2.00		41	
48	1	17-82-HMAC	166			2.00		41	
	2	-21	148	164	5.0	2.00		40	40
	3		178			2.00		40	
49	1	17-82-HMAC	145			2.00		37	
	2	-21	117	130	5.5	2.01		36	36
	3		128			2.02		36	
50	1	17-82-HMAC	131			1.99		33	
	2	-21	124	122	6.0	1.98		33	33
	3		110			1.99		33	

REMARKS: CORRECTING SPEC. HT. ON SAMPLE #49 SPEC. #3 PREVIOUSLY REPORTED ON 6-15-82

****
* HVEEM STABILITY *
* AND/OR COHESIOMETER *
* VALUES *
* MEET SPECIFICATION *
****

AUTOMATION-PAD LABORATORY
BRYAN, TEXAS
JUN 17 1982
RECEIVED

APPENDIX C

SUMMARY OF TESTS PERFORMED BY DISTRICT SEVENTEEN (Laboratory Mix)

Texas Freeze-Thaw Pedestal Test

Untreated
1. Field Sand
2. Washed Sand
3. Coarse Aggregate (Natural)
4. Coarse Aggregate (Crushed)
5. Complete Mixture - Field Sand, Washed Sand and Coarse Aggregate (Crushed)

Dry Lime Added
1. Field Sand
2. Washed Sand
3. Coarse Aggregate (Natural)
4. Coarse Aggregate (Crushed)
5. Complete Mixture - Field Sand, Washed Sand and Coarse Aggregate (Crushed)

Lime added to Asphalt prior to application to Aggregate.
1. Complete Mixture - Field Sand, Washed Sand and Coarse Aggregate (Crushed)

Lime Slurry on Aggregate five minutes
1. Complete Mixture - Field Sand, Washed Sand and Coarse Aggregate (Crushed)

Lime Slurry on Aggregate for 2 Days
1. Field Sand
2. Washed Sand
3. Coarse Aggregate (Natural)
4. Coarse Aggregate (Crushed)
5. Complete Mixture - Field Sand treated, Washed Sand untreated and Coarse Aggregate (Crushed) untreated
6. Complete Mixture - Field Sand untreated, Washed Sand treated and Coarse Aggregate (Crushed) untreated
7. Complete Mixture - Field Sand untreated, Washed Sand untreated and Coarse Aggregate (Crushed) treated
8. Complete Mixture - All Aggregates treated

Lime Slurry on Aggregates for 30 Days
1. Complete Mixture - All Aggregates treated

Texas Boiling Test, Film Stripping (TEX-218-F), and Pressure Wetting & Unconfined Compression (TEX-126-E)

Untreated
1. Complete Mixture - All Aggregates

Dry Lime added
1. Complete Mixture - All Aggregates treated

Dry Lime added to Asphalt prior to application to Aggregate
1. Complete Mixture

Lime Slurry on Aggregate for 5 Minutes
1. Complete Mixture

Lime Slurry on Aggregate for 2 Days
1. Complete Mixture - Field Sand treated, Washed Sand untreated and Coarse Aggregate untreated
2. Complete Mixture - Field Sand untreated, Washed Sand treated and Coarse Aggregate untreated
3. Complete Mixture - Field Sand untreated, Washed Sand untreated and Coarse Aggregate treated
4. Complete Mixture - All Aggregates treated

Lime Slurry on Aggregates for 30 Days
1. Complete Mixture - All Aggregates treated

The lime added in all cases was 1½% based on weight of the aggregate. Lime slurry was 70-30 mixture by weight. All aggregates treated with lime slurry were stored in air tight container for their respective curing time. After curing, aggregates were dried as fast as possible prior to addition of asphalt.

The design proposed for control was 17-82-HMAC-21 (attached). All laboratory mix was 5.0% asphalt.

TEXAS FREEZE-THAW PEDESTAL TEST
LABORATORY MIX
Individual Aggregates

Description	Aggr Size (Sieve)	Average Cycle
Untreated Pea Gravel (Uncrushed)	-20 +35	18
Untreated Pea Gravel (Crushed)	-20 +35	4
Untreated Field Sand	-40 +80	3
Untreated Washed Sand	-20 +35	2
1.5% Dry Lime added to Pea Gravel (Uncrushed)	-20 +35	
1.5% Dry Lime added to Pea Gravel (Crushed)	-20 +35	
1.5% Dry Lime added to Field Sand	-40 +80	4
1.5% Dry Lime added to Washed Sand	-20 +35	4
1.5% Lime Slurry added to Pea Gravel (Uncrushed)	-20 +35	
1.5% Lime Slurry added to Pea Gravel (Crushed)	-20 +35	
1.5% Lime Slurry added to Field Sand	-40 +80	8
1.5% Lime Slurry added to Washed Sand	-20 +35	5

Note: Cycles used were 15 hours freeze and 9 hours thaw.

TEXAS FREEZE-THAW PEDESTAL TEST
LABORATORY MIX
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Average Cycles
Untreated	5
1.5% Dry Lime added to Total Mix	
1.5% Dry Lime by wt. of Aggregate added to Asphalt	
1.5% Lime Slurry added to Total Mix (5 Min.)	
1.5% Lime Slurry added to Crushed Pea Gravel (2 Days)	
1.5% Lime Slurry added to Field Sand (2 Days)	26
1.5% Lime Slurry added to Washed Sand (2 Days)	24
1.5% Lime Slurry added to Total Mix (2 Days)	
1.5% Lime Slurry added to Total Mix (30 Days)	

Note: Aggregate sizes used in specimens were:
Pea Gravel -20 +35
Washed Sand -20 +35
Field Sand -40 +80

Cycles used were 15 hours freeze and 9 hours thaw.

TEXAS BOILING TEST
LABORATORY MIX

Individual Aggregates

Description	Percent Stripping
Untreated Field Sand	20
1.5% Lime Slurry added (5 Min.)	2
Untreated Washed Sand	83
1.5% Lime Slurry added (5 Min.)	18
Untreated Pea Gravel	68
1.5% Lime Slurry added (5 Min.)	1

TEXAS BOILING TEST
LABORATORY MIX

Complete Mixture

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	33
1.5% Dry Lime added	7
1.5% Dry Lime by wt. of Aggregate added to Asphalt	7
1.5% Lime Slurry added to Total Mix (5 Min.)	5
1.5% Lime Slurry added to Field Sand (2 Days)	8
1.5% Lime Slurry added to Washed Sand (2 Days)	4
1.5% Lime Slurry added to Pea Gravel (2 Days)	8
1.5% Lime Slurry added to Total Mix (2 Days)	4
1.5% Lime Slurry added to Total Mix (30 Days)	4

FILM STRIPPING TEX-218-F
LABORATORY MIX

Complete Mixture

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	23
1.5% Dry Lime Added to Total Mix	17
1.5% Dry Lime (by wt. of Aggregate) added to Asphalt	11
1.5% Lime Slurry added to Total Mix (5 Min.)	5
1.5% Lime Slurry added to Field Sand (2 Days)	20
1.5% Lime Slurry added to Washed Sand (2 Days)	12
1.5% Lime Slurry added to Pea Gravel (2 Days)	10
1.5% Lime Slurry added to Total Mix (2 Days)	10
1.5% Lime Slurry added to Total Mix (30 Days)	2

PRESSURE WETTING AND UNCONFINED COMPRESSION
TEX-126-E
LABORATORY MIX

Complete Mixture

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Density P.C.F.	Strength PSI (.15"/min)	% Water with pyc
Untreated (Control Mix)	151.14	11.6	0.23
Untreated (Control Mix)	151.49	11.6	0.24
1.5% Dry Lime added to Total Mix	151.19	17.3	0.15
1.5% Dry Lime added to Total Mix	151.13	17.3	0.11
1.5% Dry Lime by wt. of Total Aggr added to Asph	151.11	20.2	0.13
1.5% Dry Lime by wt. of Total Aggr added to Asph	150.98	17.9	0.15
1.5% Lime Slurry added to Total Mix (5 Min.)	151.32	15.0	0.10
1.5% Lime Slurry added to Total Mix (5 Min.)	151.08	13.3	0.20
1.5% Lime Slurry added to Field Sand (2 Days)	151.12	13.9	0.24
1.5% Lime Slurry added to Field Sand (2 Days)	151.39	13.9	0.30
1.5% Lime Slurry added to Washed Sand (2 Days)	151.31	15.6	0.20
1.5% Lime Slurry added to Washed Sand (2 Days)	151.40	15.6	0.24
1.5% Lime Slurry added to Pea Gravel (2 Days)	151.08	17.9	0.14
1.5% Lime Slurry added to Pea Gravel (2 Days)	151.14	19.1	0.17
1.5% Lime Slurry added to Total Mix (2 Days)	151.23	16.2	0.15
1.5% Lime Slurry added to Total Mix (2 Days)	151.24	16.8	0.12
1.5% Lime Slurry added to Total Mix (30 Days)	151.30	16.2	0.09
1.5% Lime Slurry added to Total Mix (30 Days)	151.25	16.8	0.10

APPENDIX D

SUMMARY OF TESTS PERFORMED
BY DISTRICT SEVENTEEN
(Plant Mix)

Texas Boiling Test, Film Stripping (TEX-218-F), and
Pressure Wetting & Unconfined Compression (TEX-126-E)

COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

1. Untreated (Control Mix)(Batch Plant)
2. Untreated (Control Mix)(Drum Plant)
3. Dry Lime added to Total Mix (Pug Mill)
4. Dry Lime added to Total Mix (Cold Feed Belt)(Drum Plant)
5. Dry Lime added with Fines (Drum Plant)
6. Lime Slurry added to Field Sand (Drum Plant)
7. Lime Slurry added to Washed Sand (Drum Plant)
8. Lime Slurry added to Pea Gravel (Drum Plant)
9. Lime Slurry added to Total Mix (Drum Plant)
10. Lime Slurry added to Field Sand (Drum Plant)(2 Days)
11. Lime Slurry added to Washed Sand (Drum Plant)(2 Days)
12. Lime Slurry added to Pea Gravel (Drum Plant)(2 Days)
13. Lime Slurry added to Total Mix (Drum Plant)(2 Days)
14. Lime Slurry added to Total Mix (Batch Plant)(2 Days)
15. Lime Slurry added to Total Mix (Drum Plant)(30 Days)

TEXAS BOILING TEST
PLANT MIX
(Weigh Batch Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	20
1.5% Dry Lime added to Total Mix (Pug Mill)	10
1.5% Lime Slurry added to Total Mix (2 Days)	0

TEXAS BOILING TEST
PLANT MIX
(Dryer Drum Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	10
1.5% Dry Lime added to Total Mix (Cold Feed Belt)	5
1.5% Dry Lime added to Total Mix (with Fines)	7
1.5% Lime Slurry added to Total Mix	0
1.5% Lime Slurry added to Field Sand	4
1.5% Lime Slurry added to Washed Sand	5
1.5% Lime Slurry added to Pea Gravel	4
1.5% Lime Slurry added to Total Mix (2 Days)	0
1.5% Lime Slurry added to Field Sand (2 Days)	2
1.5% Lime Slurry added to Washed Sand (2 Days)	5
1.5% Lime Slurry added to Pea Gravel (2 Days)	3
1.5% Lime Slurry added to Total Mix (30 Days)	0

FILM STRIPPING TEX-218-F
PLANT MIX
(Weigh Batch Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	15
1.5% Dry Lime added to Total Mix (Pug Mill)	5
1.5% Lime Slurry added to Total Mix (2 Days)	2

FILM STRIPPING TEX-218-F
PLANT MIX
(Dryer Drum Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Percent Stripping
Untreated (Control Mix)	10
1.5% Dry Lime added to Total Mix (Cold Feed Belt)	5
1.5% Dry Lime added to Total Mix (with Fines)	4
1.5% Lime Slurry added to Total Mix	2
1.5% Lime Slurry added to Field Sand	5
1.5% Lime Slurry added to Washed Sand	5
1.5% Lime Slurry added to Pea Gravel	4
1.5% Lime Slurry added to Total Mix (2 Days)	0
1.5% Lime Slurry added to Field Sand (2 Days)	0
1.5% Lime Slurry added to Washed Sand (2 Days)	0
1.5% Lime Slurry added to Pea Gravel (2 Days)	0
1.5% Lime Slurry added to Total Mix (30 Days)	0

PRESSURE WETTING AND UNCONFINED COMPRESSION
TEX-126-E
PLANT MIX
(Weigh Batch Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Density P.C.F.	Strength PSI	% Water with pyc
Untreated (Control Mix)	151.16	22.0	0.20
Untreated (Control Mix)	151.48	20.2	0.20
1.5% Dry Lime added to Total Mix (Pug Mill)	145.69	11.6	1.40
1.5% Dry Lime added to Total Mix (Pug Mill)	147.09	13.3	1.00
1.5% Lime Slurry added to Total Mix (2 Days)	150.93	17.3	0.00
1.5% Lime Slurry added to Total Mix (2 Days)	151.02	18.5	0.00

PRESSURE WETTING AND UNCONFINED COMPRESSION
TEX-126-E
PLANT MIX
(Dryer Drum Plant)
COMPLETE MIXTURE

Aggregate	Asphalt
62% Pea Gravel	5.0% Exxon AC-20
15% Washed Sand	
23% Field Sand	

Description	Density P.C.F.	Strength PSI	% Water with pyc
Untreated (Control Mix)	151.58	28.9	0.08
Untreated (Control Mix)	151.24	26.0	0.07
1.5% Dry Lime added to Total Mix (Cold Feed Belt)	151.99	23.1	0.06
1.5% Dry Lime added to Total Mix (Cold Feed Belt)	151.69	23.7	0.08
1.5% Dry Lime added to Total Mix (with Fines)	152.27	26.0	0.08
1.5% Dry Lime added to Total Mix (with Fines)	152.07	27.2	0.08
1.5% Lime Slurry added to Total Mix	150.07	24.3	0.00
1.5% Lime Slurry added to Total Mix	149.97	23.7	0.00
1.5% Lime Slurry added to Field Sand	151.39	25.4	0.12
1.5% Lime Slurry added to Field Sand	151.59	27.2	0.10
1.5% Lime Slurry added to Washed Sand	151.40	27.7	0.13
1.5% Lime Slurry added to Washed Sand	151.91	30.1	0.12
1.5% Lime Slurry added to Pea Gravel	151.31	28.3	0.09
1.5% Lime Slurry added to Pea Gravel	151.47	31.2	0.09
1.5% Lime Slurry added to Total Mix (2 Days)	151.53	19.1	0.03
1.5% Lime Slurry added to Total Mix (2 Days)	151.61	20.2	0.02
1.5% Lime Slurry added to Field Sand (2 Days)	151.48	23.1	0.12
1.5% Lime Slurry added to Field Sand (2 Days)	151.82	26.0	0.09
1.5% Lime Slurry added to Washed Sand (2 Days)	151.89	20.2	0.10
1.5% Lime Slurry added to Washed Sand (2 Days)	151.88	19.1	0.14
1.5% Lime Slurry added to Pea Gravel (2 Days)	151.27	19.7	0.05
1.5% Lime Slurry added to Pea Gravel (2 Days)	150.92	17.9	0.07
1.5% Lime Slurry added to Total Mix (30 Days)	151.14	23.1	0.12
1.5% Lime Slurry added to Total Mix (30 Days)	151.12	22.0	0.12

APPENDIX E

SPECIAL PROVISION

TO

ITEM 292

ASPHALT STABILIZED BASE

(PLANT MIX)

For this project the Item "Asphalt Stabilized Base" of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this item are waived or changed hereby.

Article 292.2 Materials, (2) Mineral Aggregate is hereby supplemented by the following:

Mineral aggregates from each source will be tested for susceptibility to asphalt stripping. If, in the opinion of the Engineer, aggregates are susceptible to stripping, lime will be added at the rate of 0.5% to 2.0% by weight for each aggregate or combination of aggregates, as directed by the Engineer. The lime shall meet the requirements of the Item, "Hydrated Lime and Lime Slurry", and may be Type A or Type B. The lime shall be added as a slurry. The Contractor shall provide necessary equipment for mixing, handling, metering, and dispensing the lime slurry. The lime slurry may be added to the aggregate immediately prior to its introduction into the drier; added to the aggregate in the cold feed; or added to the aggregate prior to stockpiling. The method of application of lime will be such that the lime is thoroughly mixed with the aggregate being treated. Lime-treated stockpiles shall be used within 15 days after the addition of lime. In the event that lime is lost from the treated stockpile because of rain or other conditions, the aggregate shall be re-treated at the Contractor's expense.

Article 292.8 Measurement is supplemented by the following:

Lime slurry, when required by the Engineer for anti-stripping purposes, will be measured by the ton of 2000 pounds, dry weight of Lime (Ty A or B) added to the aggregate or aggregates. The Engineer shall make sufficient checks of the metering equipment to insure that the specified amount of lime is being applied to the aggregate. The quantity of lime added to the paving mixture and measured for payment shall be calculated based upon the rates specified by the Engineer.

Article 292.9 Payment is supplemented by the following:

(4) Lime slurry, when required by the Engineer for antistripping purposes, will be paid for at the unit price bid for "Lime (Type A or B) (Antistrip)", which price shall be full compensation for furnishing lime, application of lime, and providing all necessary equipment for mixing, handling, metering and dispensing the lime slurry, and all labor and incidentals to complete the work.

SPECIAL PROVISION

TO ITEM 340

HOT MIX ASPHALTIC CONCRETE PAVEMENT

For this project the Item "Hot Mix Asphaltic Concrete Pavement" of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this item are waived or changed hereby.

Article 340.2 Materials, (1) Mineral Aggregate is hereby supplemented by the following:

Mineral aggregates from each source will be tested for susceptibility to asphalt stripping. If, in the opinion of the Engineer, aggregates are susceptible to stripping, lime will be added at the rate of 0.5% to 2.0% by weight for each aggregate or combination of aggregates, as directed by the Engineer. The lime shall meet the requirements of the Item, "Hydrated Lime and Lime Slurry," and may be Type A or Type B. The lime shall be added as a slurry. The Contractor shall provide necessary equipment for mixing, handling, metering, and dispensing the lime slurry. The lime slurry may be added to the aggregate immediately prior to its introduction into the drier; added to the aggregate in the cold feed; or added to the aggregate prior to stockpiling. The method of application of lime will be such that the lime is thoroughly mixed with the aggregate being treated. Lime-treated stockpiles shall be used within 15 days after the addition of lime. In the event that lime is lost from the treated stockpile because of rain or other conditions, the aggregate shall be re-treated at the Contractor's expense.

Article 340.7 Measurement is supplemented by the following:

Lime slurry, when required by the Engineer for anti-stripping purposes, will be measured by the ton of 2000 pounds, dry weight of Lime (Ty A or B) added to the aggregate or aggregates. The Engineer shall make sufficient checks of the metering equipment to insure that the specified amount of lime is being applied to the aggregate. The quantity of lime added to the paving mixture and measured for payment shall be calculated based upon the rates specified by the Engineer.

Article 340.8 Payment is supplemented by the following:

(4) Lime slurry, when required by the Engineer for antistripping purposes, will be paid for at the unit price bid for "Lime (Type A or B) (Antistrip)", which price shall be full compensation for furnishing lime, application of lime, and providing all necessary equipment for mixing, handling, metering and dispensing the lime slurry, and all labor and incidentals to complete the work.