Technical Report Documentation Page

1. REPORT No.

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE

Copperopolis Test Section- Binder Modifiers as Construction Seals First Progress Report

5. REPORT DATE

December 1974

6. PERFORMING ORGANIZATION

19301-762503-633105

7. AUTHOR(S)

Predoehl, Nelson H and Kemp, Glenn R.

8. PERFORMING ORGANIZATION REPORT No.

CA-DOT-TL-3105-1-74-35

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

D-3-41

12. SPONSORING AGENCY NAME AND ADDRESS

California Department of Transportation
Division of Construction and Research
Sacramento, California 95807

13. TYPE OF REPORT & PERIOD COVERED

Interim

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. This study is part of a project entitled "Binder Modifier Agents as Construction and Maintenance Seals".

16. ABSTRACT

Seven different binder modifier agents were placed as construction seals on Road 10-Sta, Cal-4-8.0/10.3 near Copperopolis, California. This report details the placement, field testing, and laboratory testing of the different products. Skid tests were performed prior to, four days after, 10 weeks after, and 21 weeks after treatment application. Laboratory tests were conducted on the original products and evaluating cores were removed two weeks after treatment. Evaluation of the cores consisted of testing the asphalt recovered from four 1/4 inch thick slices starting from the surface.

The findings revealed that several of the products produced potentially hazardous wet weather skid conditions immediately after treatment and that these conditions remained for up to 10 weeks for some of the products. Testing of the 1/4 inch thick core slices revealed that none of the products penetrated deeper than the top 1/4 inch.

17. KEYWORDS

Binders, surface treatments, penetration, field test, skid resistance testing, laboratory test, core analysis

18. No. OF PAGES:

24

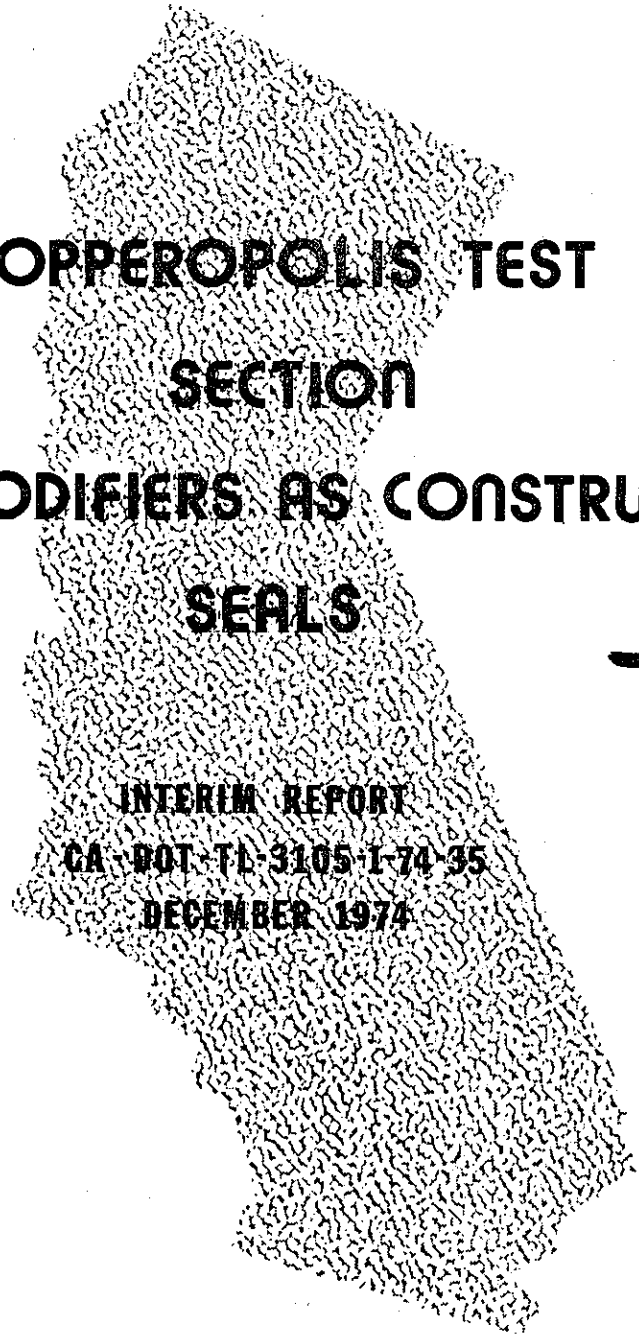
19. DRI WEBSITE LINK

http://www.dot.ca.gov/hq/research/researchreports/1974-1975/74-35a.pdf

20. FILE NAME

74-35A.pdf

TRANSPORTATION LABORATORY
RESEARCH REPORT



COPPEROPOLIS TEST SECTION

BINDER MODIFIERS AS CONSTRUCTION SEALS

74-35A

INTERIM REPORT
CA-DOT-TL-3105-1-74-35
DECEMBER 1974

Prepared in Cooperation with the U.S. Department of Transportation,
Federal Highway Administration

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1 REPORT NO	2 GOVERNMENT ACCESSION NO	3 RECIPIENT'S CATALOG NO

4 TITLE AND SUBTITLE
Copperopolis Test Section -
Binder Modifiers as Construction Seals
First Progress Report

5 REPORT DATE
December 1974

6 PERFORMING ORGANIZATION CODE
19301-762503-633105

7 AUTHOR(S)
Predoehl, Nelson H and Kemp, Glenn R.

8 PERFORMING ORGANIZATION REPORT NO
CA-DOT-TL-3105-1-74-35

9 PERFORMING ORGANIZATION NAME AND ADDRESS
Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819

10 WORK UNIT NO

11 CONTRACT OR GRANT NO
D-3-41

12 SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
Division of Construction and Research
Sacramento, California 95807

13 TYPE OF REPORT & PERIOD COVERED
Interim

14 SPONSORING AGENCY CODE

15 SUPPLEMENTARY NOTES
Study was conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration. This study is part of a project entitled "Binder Modifier Agents as Construction and Maintenance Seals".

16 ABSTRACT

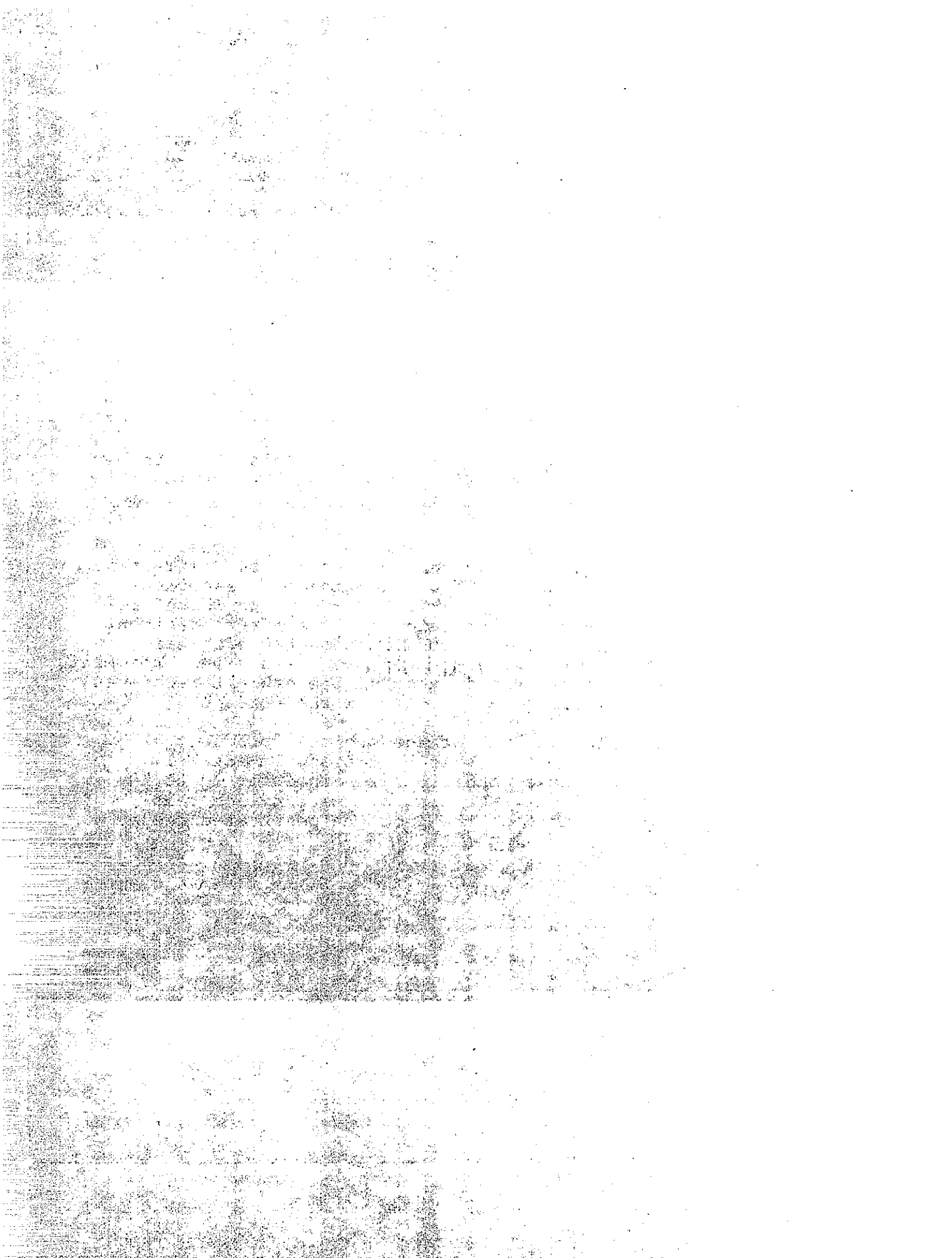
Seven different binder modifier agents were placed as construction seals on Road 10-Sta,Cal-4-8.0/10.3 near Copperopolis, California. This report details the placement, field testing, and laboratory testing of the different products. Skid tests were performed prior to, four days after, 10 weeks after, and 21 weeks after treatment application. Laboratory tests were conducted on the original products and evaluating cores were removed two weeks after treatment. Evaluation of the cores consisted of testing the asphalt recovered from four 1/4 inch thick slices starting from the surface.

The findings revealed that several of the products produced potentially hazardous wet weather skid conditions immediately after treatment and that these conditions remained for up to 10 weeks for some of the products. Testing of the 1/4 inch thick core slices revealed that none of the products penetrated deeper than the top 1/4 inch.

17 KEY WORDS	18 DISTRIBUTION STATEMENT
Binders, surface treatments, penetration, field test, skid resistance testing, laboratory test, core analysis	Unlimited

19 SECURITY CLASSIF (OF THIS REPORT)	20 SECURITY CLASSIF (OF THIS PAGE)	21 NO OF PAGES	22 PRICE
Unclassified	Unclassified	24	

DMRT 1242 (ORIG 9 72)



STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION AND RESEARCH
TRANSPORTATION LABORATORY

December 1974

FHWA D-3-41
TL No. 633105

Mr. R. J. Datel
Chief Engineer

Dear Sir:

I have reviewed and submit for your information this interim research project report titled:

COPPEROPOLIS TEST SECTION

BINDER MODIFIERS AS CONSTRUCTION SEALS

FIRST PROGRESS REPORT

Study made by.....Pavement Section

Under the Supervision of.....John B. Skog, P. E.

Principal Investigator.....Robert N. Doty, P. E.

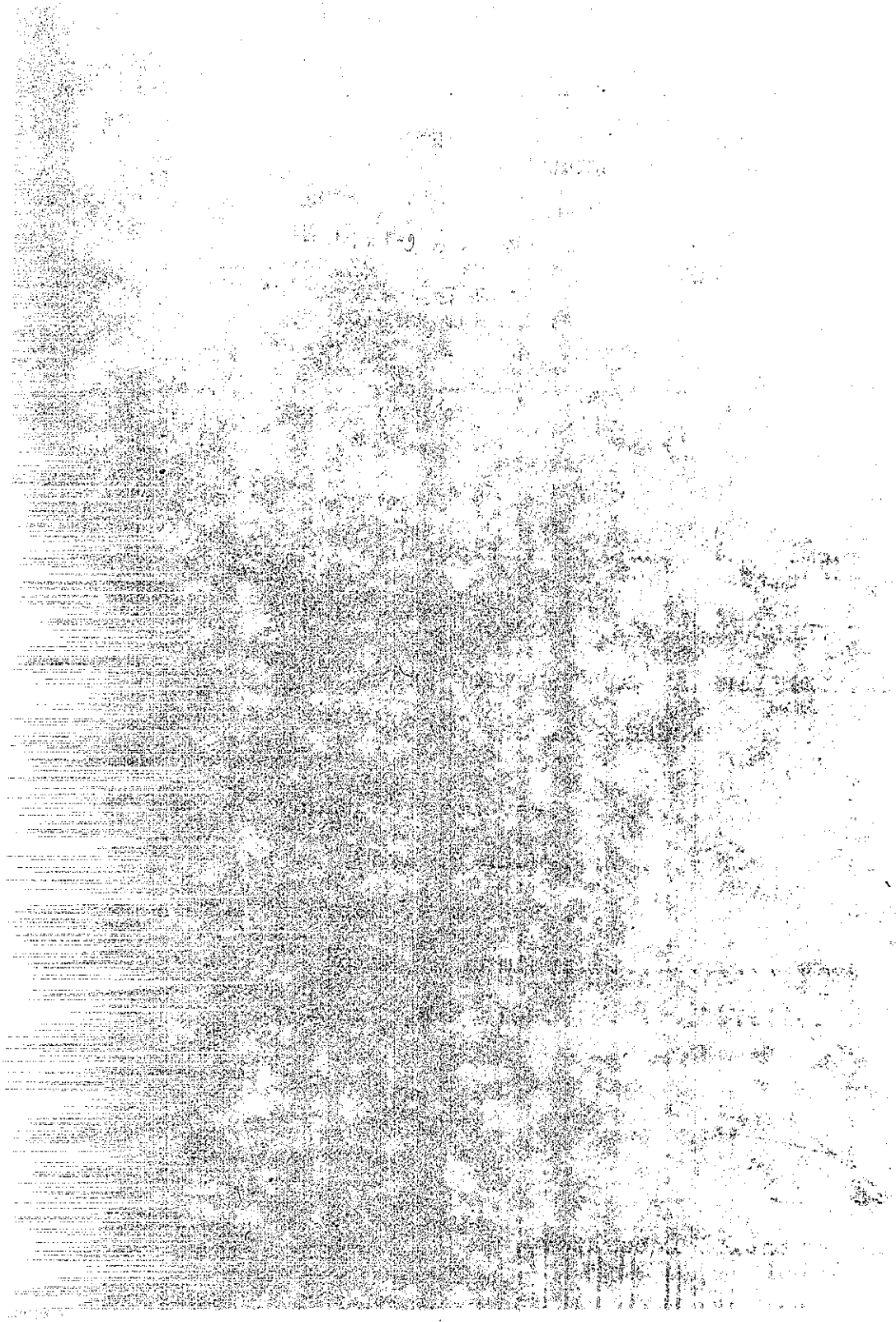
Co-Principal Investigator.....Glenn R. Kemp

Report Prepared by.....Nelson H. Predoehl

Very truly yours,

JOHN L. BEATON
Chief Engineer, Transportation Laboratory

Attachment



ACKNOWLEDGMENT

This work was done in cooperation with the U. S. Department of Transportation, Federal Highway Administration, and their cooperation is hereby acknowledged.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Acknowledgement is made of the work of James Henderson who performed most of the laboratory testing, and also to the coring and skid testing units.

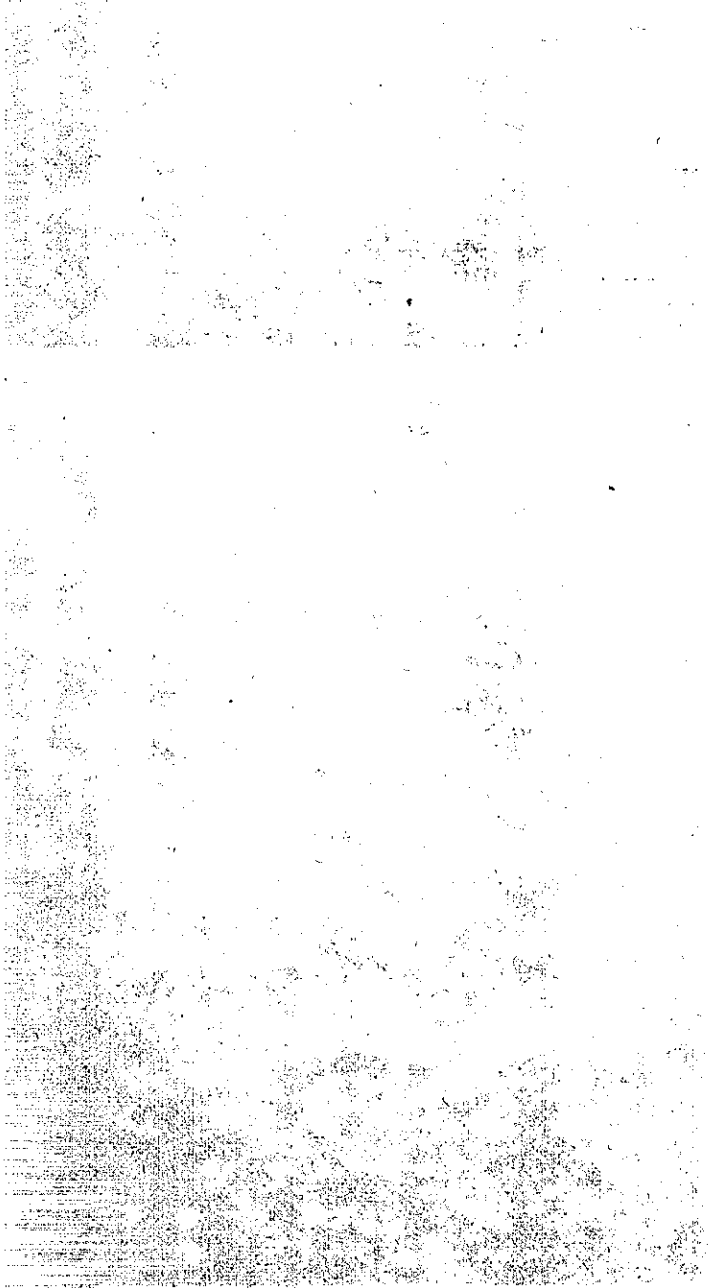


TABLE OF CONTENTS

INTRODUCTION

Various sealing materials have been available for years for use on asphalt concrete pavements. They may be characterized as binder modifiers since their functions have generally been to bind or modify the surface to stop raveling, pitting, cracking, etc. Probably the most common binder modifier has been an asphalt emulsion fog seal used on new construction. The binder modifiers may be characterized into three groups:

1. Hardening agents: These products consist of a very hard base asphalt cutback with a highly volatile solvent to coat the surface of the pavement thereby causing the surface film to be very hard and impenetrable. Some examples are products such as "Gilsabind", "Satin Black", "Astec Pavement Sealer", and others.

2. Softening agents, also known as rejuvenating agents, are composed of resins and oils derived from the treatment of lubricating oils. They are supposed to combine with the weathered asphalt in a pavement to provide "new life". The best known example is "Reclamite".

3. Altering agents: These are materials normally containing rubber which are purported to combine with the asphalt in the pavement to rubberize it. An example is "Petroset AT".

In an effort to determine the value or failings of the various binder modifier agents, it was considered necessary to study the binder modifier agents under identical climatic and traffic conditions on test roads in several different climatic areas as both construction and maintenance seals. This report details the placing and first year performance of a construction seal test section containing seven different products on Road 10-Sta, Cal-4-8.0/10.3 (Contract 10-075914) near Copperopolis, California. The climatic conditions at this location are hot summers and wet, mild winters. It is located near the foothills within the central valley of California due east of Stockton. The average daily traffic for the section was estimated to be approximately 400 vehicles during 1972 with about 3% trucks. Evaluation of the effect of the various products will continue for several years.

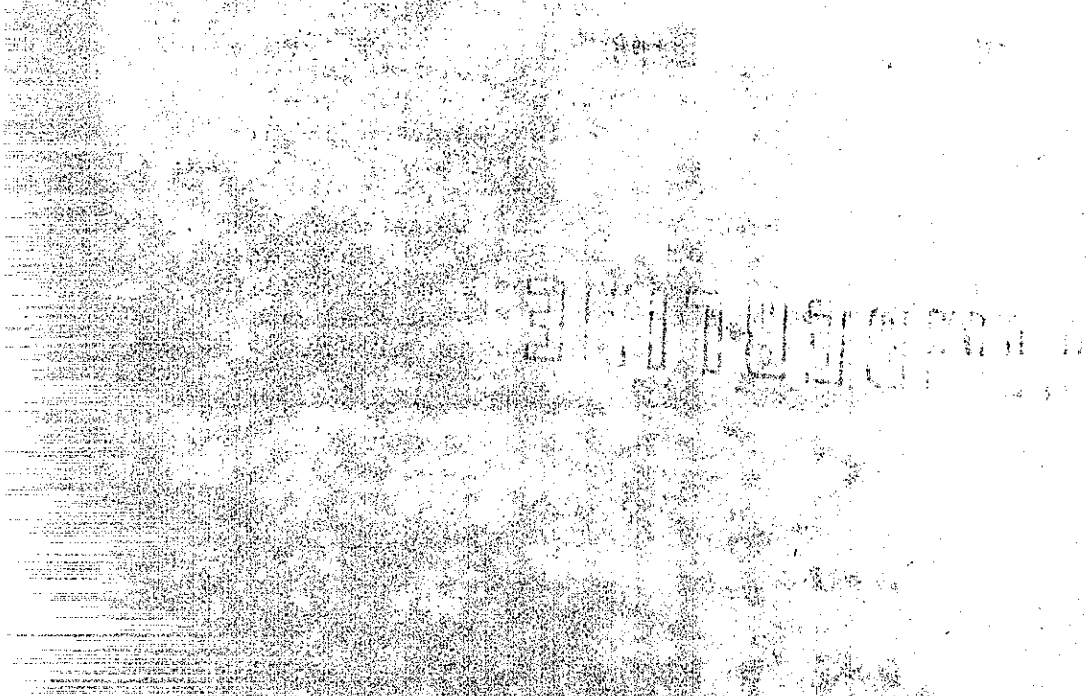
FINDINGS

Findings which appear to be significant are as follows:

1. All of the binder modifier products placed caused an immediate reduction in coefficient of friction values as measured with a towed trailer according to test method ASTM E-274.

2. Application of several of the products, notably the hardening agent types and the SS-1 fog seal, caused a potentially hazardous wet weather skid condition for approximately three to ten weeks after placement.

3. Penetration of all the binder modifier agent products was restricted to the top 1/4 inch of the pavement as determined from recovered core slices.



IMPLEMENTATION

As a result of the findings in this report, a memorandum urging caution when considering the use of binder modifier agents was sent to all the Districts as well as the Construction, Maintenance, and Traffic Branches of the California Department of Transportation. The cautions were in regard to the potential skid hazard possible under certain conditions.

PLACEMENT

The binder modifier products were placed as construction seals on Road 10-Sta, Cal-4-8.0/10.3 under contract 10-075914 on May 11 and 12, 1972. The pavement treated was a Type B, 3/4 inch maximum asphalt concrete mix (5.7% of 85-100 asphalt) which had been paved (0.35' thick) approximately six months previously. It had been open only to construction traffic. The products were applied in 300 foot sections at a rate of 0.10 gallons/square yard. Figure 1 shows the location of each of the products. A 300 foot control section was left between each treated area. The amount of application of each product was pre-set at 0.10 gallons/square yard. Permeability tests with samples of each of the products had been run at random locations prior to application to insure that the products would penetrate into the pavement within 15 minutes. Air temperatures during the applications varied from 74°F to 92°F on a sunny and dry day with almost no wind. The section was almost flat except for a slight slope from west to east. The products were applied with an asphalt distributor truck which applied an 8 foot spread on the shoulders and a 12 foot spread on the travel lanes. All products except for the "Satin Black" hardening agent were applied with the same distributor. Thorough flushing and cleaning of the distributor was accomplished between the use of each product.

FIELD TESTING

Of primary importance was the determination of the possible hazards presented by the products when applied. By the nature of the products and their method of application, whereby the agents are applied directly to the surface, a skid hazard is very possible.

While hazardous skid conditions are dependent on a wet surface to provide the lubrication for skidding, there are several other factors which should also be considered when using any of the various binder modifier products on a traveled way. Some of these are:

1. Character of the surface texture to be treated. A very rough texture may not be affected adversely by any of these products, though some of these products tend to produce a type of painted surface initially and until this surface finish can be worn off, a potentially hazardous condition may be present when the pavement is wet.

2. Penetration of the treatment. An excess of a product will cause a hazardous skid condition for several hours after application if the excess is not removed by blotting with sand, etc. Normally, this condition only occurs with the water base products since their evaporation rate is much slower. An excess of the hardening agents could result in the filling of the interstices, thereby causing a potentially hazardous skid condition when wet.

3. Amount of traffic. Low traffic volumes leave more leeway for evasive action under hazardous skid conditions. However, low traffic volumes will also delay the wearing away of any coatings (See No. 1 above).

4. Rainfall Potential. The length of time between application of a treatment and the occurrence of rain would be important if use of the treatment created a slick surface; thus desert sites may have much more potential for these products.

5. Equilibrium of the asphalt mix. The softening agents and possibly the other agents can cause an excess of binder in the mix if they combine with the asphalt present and/or if they cause a softening of the asphalt in the mix. In either case, a very rich mix may result that could present a potentially hazardous skid condition when wet.

The field testing consisted of skid testing and water permeabilities. Cores were also taken from the sections. Data concerning them are discussed under "Laboratory Testing".

Skid testing was performed in accordance with ASTM Designation: E-274 prior to the placement of the binder modifier agents and at intervals thereafter necessary to maintain a critical observation. Table A shows the results of four different sets of skid tests of the treated sections. Figures 2 and 3 show how the skid resistance values of the different treatments have increased consistently since their application. The figures also indicate that the application of some of the products, viz, the hardening agents and the asphalt emulsion fog seal, caused a potentially hazardous wet weather condition to exist for up to 10 weeks after application. From this data, it would appear that these hardening agent products and asphalt emulsion fog seals should be used with utmost caution on traveled ways during the wet weather season.

Water permeabilities were performed two weeks after the application of the binder modifier agents. Table B shows the results of this testing. The results indicate little difference between the permeabilities of the different products and the control areas. Overall, the results indicate that the pavement was tight and that the binder modifier products would not appreciably benefit the pavement in reducing water permeability. The results of air permeabilities run on the 4 inch cores taken at the same time as the water permeabilities (see Table B) also indicate that the binder modifiers did not appreciably benefit the pavement in reducing air passages in the pavement.

LABORATORY TESTING

The laboratory testing consisted of performing tests on original samples of the binder modifier agents taken from the distributor truck at the time of application and on cores removed two weeks after application.

The tests performed on the original products were the tests prescribed for the identification of the different products. The hardening agents were tested for compliance with the State of California RC-10H specification (see Figure 4) while the softening agents were tested for compliance with the rejuvenating agent specification (see Figure 5). No California specification is available for the testing of the altering agents although there are some manufacturers' specifications. Since the altering agents were water soluble, they were tested with tests designed for rejuvenating agents. Table C shows the results of all the tests and the specification requirements.

Two 4 inch diameter cores were removed at each coring site. One core was tested whole for properties such as air permeability and specific gravity (results on Table B) while the other core was sliced for more detailed examination. The slices were 1/4 inch thick starting at the top surface, thus four slices comprising the upper 1-3/4 inches of pavement were tested. The asphalt was recovered from each slice (1/8 inch lost in slicing) by a micro-recovery process using benzene as the solvent (Test Method No. Calif. 365-A - Appendix A), after which microviscosity and microductility tests were performed on the residue. Table D shows the results of these tests. Figure 6 shows a graphic portrayal of the four slices from the top slice down. The figure shows that none of the products seemed to penetrate any deeper than the first layer. The viscosities for the three deeper slices are all quite uniform, indicating no effects from any of the treatments. From this data, it would appear that any benefits obtained from any of these products when used as a construction seal are only to the uppermost quarter inch of the pavement except that the sealing of this surface portion could affect the remainder of the pavement.

TABLE A

COPPEROPOLIS TEST SECTION
Skid Test Results

40 MPH Skid Number (ASTM E-274-65T) (Ribbed Tire)

Location Station	Product Conc, 0.10 gal/yd.^{2} (May 11, 12, 1972)	Eastbound				Westbound			
		Orig. 5-9-72	After 4 Days 5-15-72	After 10 Weeks 7-19-72	After 21 Weeks 10-4-72	Orig. 5-9-72	After 4 Days 5-15-72	After 10 Weeks 7-19-72	After 20 Weeks 10-4-72
345 to 348	Gilsabind	61	28	46	54	64	31	43	52
348 to 351	Control	57	62	57	60	64	63	57	60
351 to 354	Astec P.S.	55	21	33	42	62	26	35	43
354 to 357	Control	59	60	57	60	66	67	56	60
357 to 360	Satin Black	64	23	41	49	63	23	34	43
360 to 363	Control	61	62	57	61	63	65	55	62
363 to 366	Petroset	61	53	55	60	63	43	50	59
366 to 369	Control	61	62	58	60	62	66	54	60
369 to 372	Reclamite	64	45	52	58	61	41	47	55
372 to 375	Control	59	61	57	63	62	61	55	60
375 to 378	Reclamite XM	63	39	50	59	60	41	44	54
378 to 381	Control	62	61	59	63	57	55	53	59
381 to 384	SS-1 + 50% H_2O	61	37	49	54	56	26	40	49

TABLE B

Copperopolis Test Section

Water Permeabilities and 4" Core Test Results
(Permeabilities and Cores Taken 2 Weeks After Treatment)

SECTION	STA EB BWT	WATER PERM. ml./min.	STA EB BWT	WAX Sp. Gr.	% Voids	AIR PERM. ml/min/in^2/1" vac
Gilsabind	346+25	5	346+00	2.29		3.5
	346+50	6	347+00	2.29		3.5
	346+75	7				
	Average	6	Average	2.29	5.8	3.5
CONTROL	349+50	9	350+00	2.29	5.8	2.4
Astec Pavement Sealer	352+25	7	352+00	2.28		4.4
	352+50	7	353+00	2.28		4.0
	352+75	7				
	Average	7	Average	2.28	6.2	4.2
CONTROL	355+50	10				
Satin Black	358+25	7	358+00	2.27		10.4
	358+50	10	359+00	2.24		35.8
	358+75	12				
	Average	10	Average	2.26	7.0	23.1
CONTROL	361+50	10,14,15 = 13	361+00	2.28	6.2	5.3
Petroset AT	364+25	15	364+00	2.24		18.3
	364+50	18	365+00	2.23		14.3
	364+75	14				
	Average	16	Average	2.24	7.8	16.3
CONTROL	367+50	25				
Reclamite	370+25	10	370+00	2.24		14.3
	370+50	12	371+00	2.24		19.9
	370+75	10				
	Average	11	Average	2.24	7.8	17.1
CONTROL	373+50	20	374+00	2.30	5.4	2.6
Reclamite XM	376+25	22	376+00	2.28		6.4
	376+50	12	377+00	2.29		6.8
	376+75	15				
	Average	16	Average	2.29	5.8	6.6
CONTROL	379+50	23				
SS-1+50%H_2O	382+25	15	382+00	2.30		2.6
	382+50	8	383+00	2.27		5.3
	382+75	9				
	Average	11	Average	2.29	5.8	4.0
CONTROLS	Average	17	Average	2.29	5.8	3.4
Gilsabind	Average	6	Average	2.29	5.8	3.5
Astec P.S.	Average	7	Average	2.28	6.2	4.2
Satin Black	Average	10	Average	2.26	7.0	23.1
Petroset AT	Average	16	Average	2.24	7.8	16.3
Reclamite	Average	11	Average	2.24	7.8	17.1
Reclamite XM	Average	16	Average	2.29	5.8	6.6
SS-1+50%H_2O	Average	11	Average	2.29	5.8	4.0

Copperopolis Test Section
Road 10-Sta, Cal-4-8.0/10.3

BINDER MODIFIER AGENTS - ORIGINAL PROPERTIES

(*No Calif. Specification Requirements)

(H) HARDENING AGENTS RC-10H Spec. TEST	Test Method AASHTO	Gilsabind (H)	Astec P.S. (H)	Satin Black (H)	Reclamite (S)	Reclamite XM (S&A)	Petroset AT (A)	SS-1	Calif. Spec. Requirement
Kinematic Viscosity at 140° F, cs	T201	15	30	45					10-20
Distillation @ 374,%	T78	71	80	57					50 min.
(percent of @ 437,%		87	87	85					85 min.
total distil- @ 500,%		93	93	94					90 min.
late to 680°F) @ 600,%		97	99	97					95 min.
Residue from Dist. by difference,%		31	30	33					30 min.
Tests on Penetration at 77°F,	T49	1	1	3					2-10 min.
Residue Solubility in CCl_4,%	T44	99.8	99.9	99.96					99.5+
Softening Point, °F	T53	195	210	233					190 min.
HCl precipitate,%	Calif. 357	36	27	21.6					20 min.
(S) Softening Agents & (A) Altering Agents (Rejuvenating Agent Spec.)									
Viscosity at 77°F (Saybolt Furol), sec.	T59					*	*		
%Residue-Rejuvenating Agent,%	Calif. 351				19	17	18		15-40
					60.4	59.2	51.2		60 min.
Sieve Test	T59				.0	.0	.02		0.10 max.
Particle Charge Test	T59				+	+	+		+
Test on Kinematic Vis. at 140°F, cs.	T201				114	305	24.6s		100/200
Residue % Asphaltenes,%	Calif. 352				0.6	0.4	28.5		0.75 max
EMULSIFIED ASPHALT (Typical Fog Sealing Agent)									
% Asphalt Residue %	T59							56.4	57 min.
Viscosity (Saybolt Furol) at 77°F, sec	T59							19	20-100
Cement Mixing Test, %	T59							3	2 max.
Sieve Test,%	T59							.0	0.10 max

TABLE D

Copperopolis Test Section

Cored May 26, 1972 - 2 Weeks After Treatment Application

Core Location BWT,EB Ln.	Treatment at 0.10g/s.y.	Recovered Asphalt Test Results (on 1/4" thick core slices - depths from surface) 0 to 1/4" Depth Micro-Vis. at 0.05*	Micro-Vis. at 0.001*	M-D (mm)	S-S	3/8" to 5/8" Depth Micro-Vis. at 0.05*	Micro-Vis. at 0.001*	M-D (mm)	S-S	3/4" to 1" Depth Micro-Vis. at 0.05*	Micro-Vis. at 0.001*	M-D (mm)	S-S	1 1/8" to 1 3/8" Depth Micro-Vis. at 0.05*	Micro-Vis. at 0.001*	M-D (mm)	S-S
Sta.																	
346+00	Gilsabind	29.5	81.0	3	.26	5.6	10.5	24	.17	4.9	7.1	39	.10	4.6	7.9	23	.14
347+00	Gilsabind	24.5	70.0	4	.27	5.2	8.7	9	.13	4.8	9.1	33	.16	4.6	6.0	13	.07
Average		27.0	75.5	4	.27	5.4	9.6	17	.15	4.9	8.1	36	.13	4.6	7.0	18	.11
352+00	Astec P.S.	24.5	72.0	4	.27	5.9	9.6	41	.12	5.3	8.4	43	.12	4.9	9.9	20	.18
353+00	Astec P.S.	20.5	44.0	5	.19	5.6	9.7	45	.15	5.3	9.0	21	.14	4.9	8.8	18	.15
Average		22.5	58.0	5	.23	5.8	9.7	43	.14	5.3	8.7	32	.13	4.9	9.4	19	.17
358+00	Satin Black	27.0	75.0	3	.26	5.8	9.4	40	.12	5.9	8.6	28	.10	4.7	6.9	22	.10
359+00	Satin Black	46.0	155.0	0	.31	6.3	11.5	37	.16	6.0	10.8	43	.15	4.8	7.3	47	.11
Average		36.5	115.0	2	.29	6.1	10.5	39	.14	6.0	9.7	36	.13	4.8	7.1	35	.11
364+00	Petroset AT	11.8	25.0	7	.20	6.6	12.0	30	.16	6.3	11.2	22	.15	5.7	11.2	20	.17
365+00	Petroset AT	7.1	13.5	16	.17	5.1	8.7	48	.14	5.0	8.6	46	.14	4.1	5.9	30	.10
Average		9.5	19.3	12	.19	5.9	10.4	39	.15	5.7	9.9	34	.15	4.9	8.6	25	.14
370+00	Reclamite	3.9	6.9	27	.15	6.1	10.8	26	.15	4.9	8.0	31	.12	4.9	7.1	63	.10
371+00	Reclamite	3.1	5.9	13	.17	5.3	9.9	10	.16	3.4	4.7	46	.08	4.5	8.2	30	.15
Average		3.5	6.4	20	.16	5.7	10.4	18	.16	4.2	6.4	39	.10	4.7	7.7	47	.13
376+00	Reclamite XM	3.3	6.9	29	.19	5.2	8.5	33	.13	4.6	7.9	53	.14	4.5	7.0	34	.12
377+00	Reclamite XM	4.8	11.2	24	.22	4.8	8.5	34	.15	4.2	7.7	36	.16	4.0	6.6	13	.14
Average		4.1	9.1	27	.21	5.0	8.5	34	.14	4.4	7.8	45	.15	4.3	6.8	24	.13
382+00	SS-1+50%H_2O	17.8	45.0	4	.24	5.1	8.0	19	.12	3.7	6.7	49	.16	4.8	8.2	46	.14
383+00	SS-1+50%H_2O	12.3	24.5	6	.18	5.0	8.8	33	.14	4.5	7.3	30	.12	4.2	7.2	15	.14
Average		15.1	34.8	5	.21	5.1	8.4	26	.13	4.1	7.0	40	.14	4.5	7.7	31	.14
350+00	(No Treatment)	25.0	60.0	0	.23	4.8	8.5	12	.15	4.8	7.3	48	.11	4.8	8.0	33	.13
361+00	(No Treatment)	13.5	30.5	8	.21	5.6	9.7	25	.15	5.2	9.2	39	.15	3.6	6.3	36	.14
374+00	(No Treatment)	13.7	29.0	7	.19	5.3	8.4	13	.12	4.8	8.5	23	.15	4.1	5.9	28	.10
Average		17.4	39.8	5	.21	5.2	8.9	17	.14	4.9	8.3	37	.14	4.2	6.7	32	.12
SUMMARY OF AVERAGE RESULTS																	
Gilsabind		27.0	75.5	4	.27	5.4	9.6	17	.15	4.9	8.1	36	.13	4.6	7.0	18	.11
Astec P.S.		22.5	58.0	5	.23	5.8	9.7	43	.14	5.3	8.7	32	.13	4.9	9.4	19	.17
Satin Black		36.5	115.0	2	.29	6.1	10.5	39	.14	6.0	9.7	36	.13	4.8	7.1	35	.11
Petroset A.T.		9.5	19.3	12	.19	5.9	10.4	39	.15	5.7	9.9	34	.15	4.9	8.6	25	.14
Reclamite		3.5	6.4	20	.16	5.7	10.4	18	.16	4.2	6.4	39	.10	4.7	7.7	47	.13
Reclamite XM		4.1	9.1	27	.21	5.0	8.5	34	.14	4.4	7.8	45	.15	4.3	6.8	24	.13
SS-1+50% H_2O		15.1	34.8	5	.21	5.1	8.4	26	.13	4.1	7.0	40	.14	4.5	7.7	31	.14
(No Treatment)		17.4	39.8	5	.21	5.2	8.9	17	.14	4.9	8.3	37	.14	4.2	6.7	32	.12

*sec^{-1}

Micro-Vis. = Microviscosity at 77° F Results in Megapoise.

M-D = Micro-Ductility at 77° F

S-S = Shear Susceptibility (Slope)

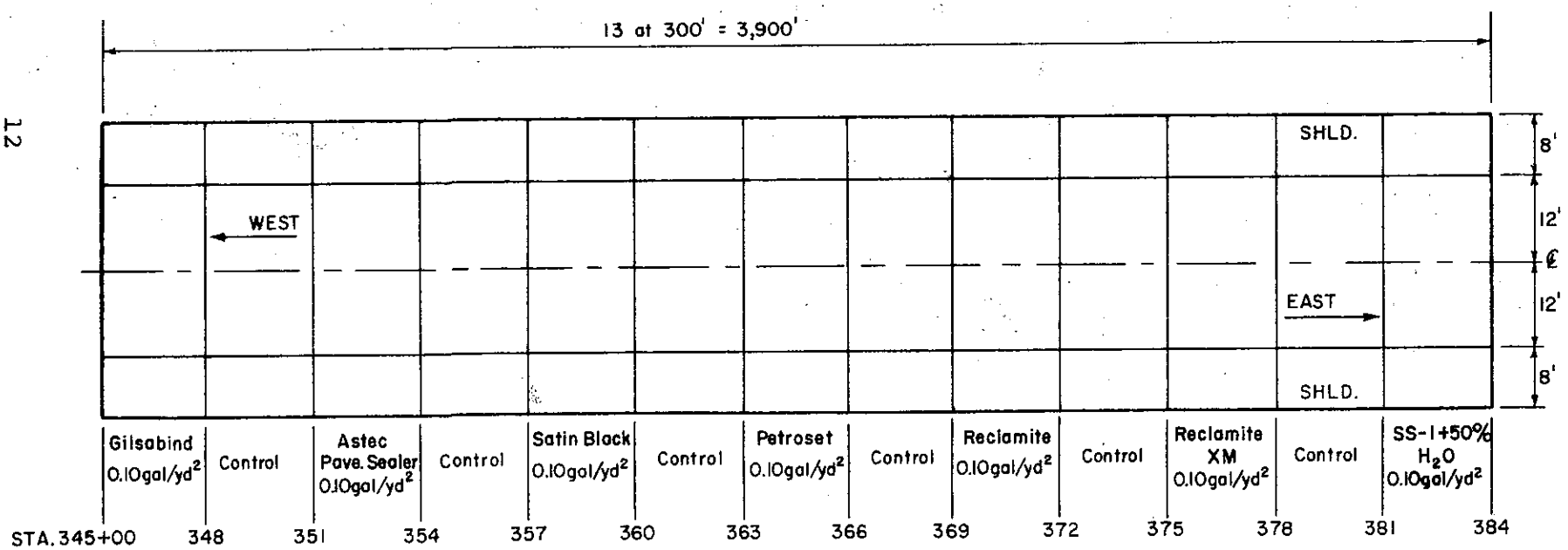


FIGURE 1

COPPEROPOLIS TEST SECTION RD 10-Sta, Cal-4-8.0/10.3

BINDER MODIFIER AGENTS PLACED ON BOTH SHOULDERS AND TRAVEL WAYS.

Figure 2

EFFECT OF BINDER MODIFIERS ON SKID NUMBER
COPPEROPOLIS TEST SECTION
EAST BOUND LANE
ADT = 400 WITH 3% TRUCKS

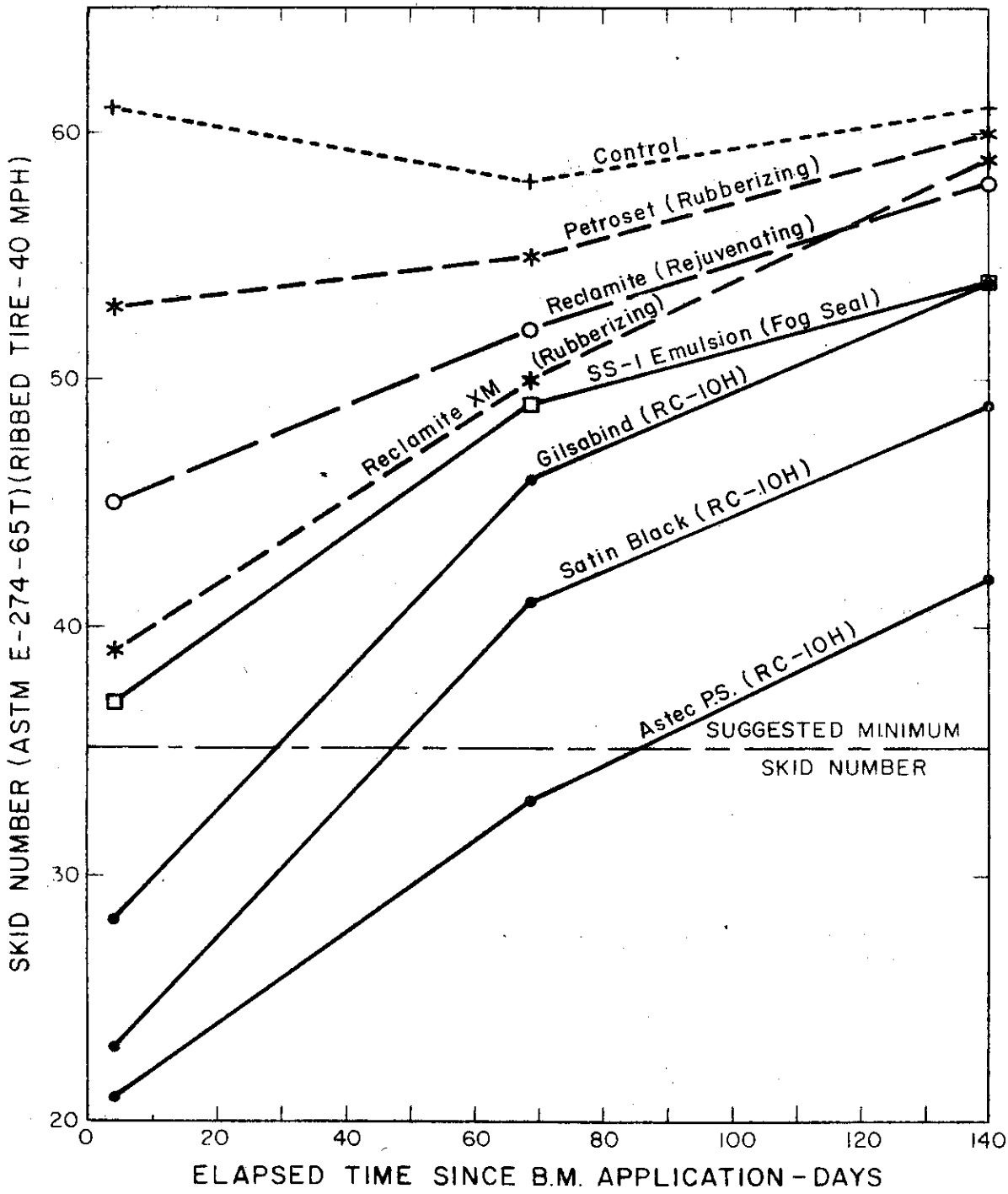


Figure 3

EFFECT OF BINDER MODIFIERS ON SKID NUMBER
COPPEROPOLIS TEST SECTION
WEST BOUND LANE
ADT = 400 WITH 3% TRUCKS

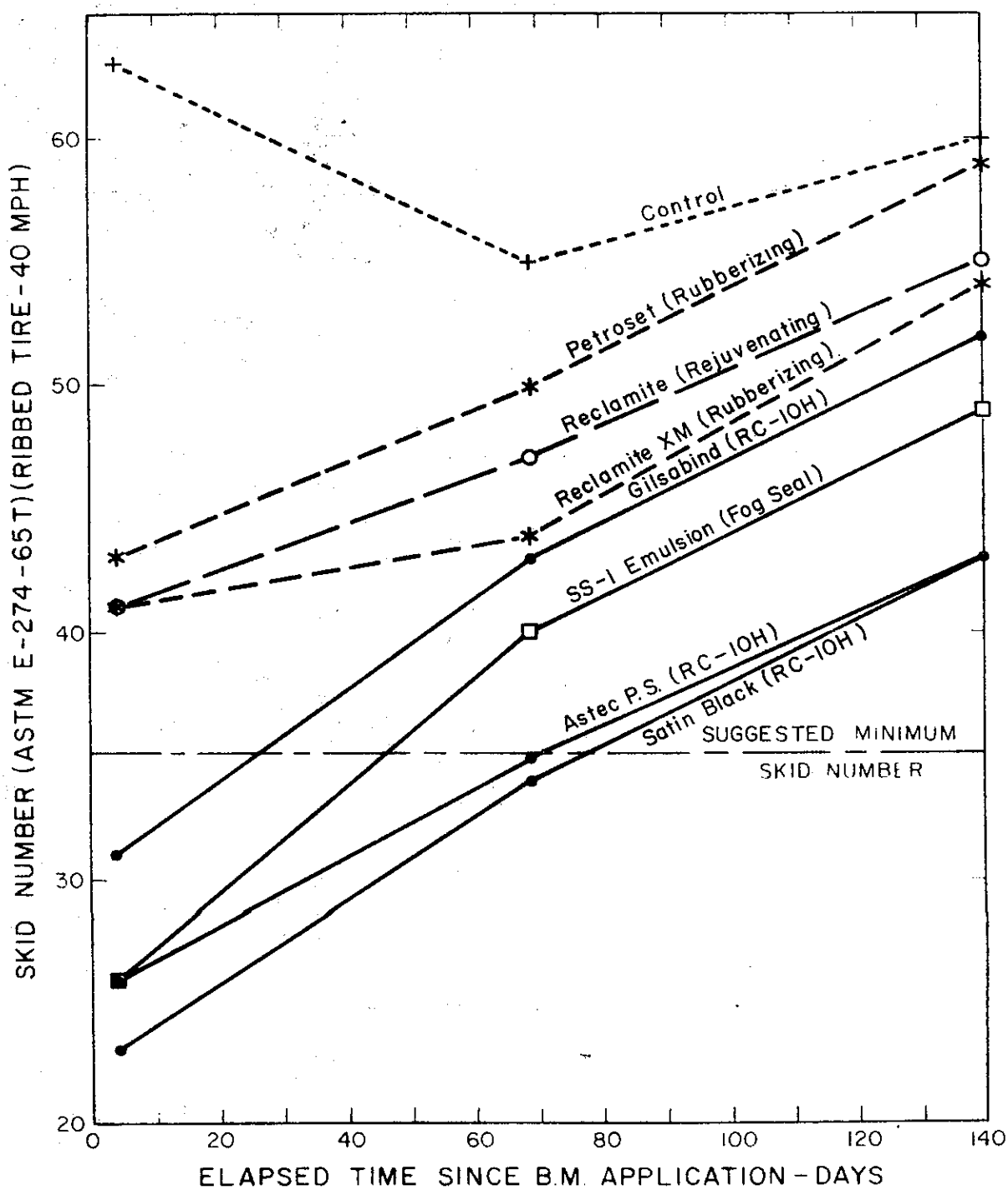


FIGURE 4

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
TRANSPORTATION LABORATORY

RAPID CURING LIQUID ASPHALT

Tentative Specification
RC-10H

Specification Designation	Test Method	Type RC-10H
Kinematic Viscosity at 140°F	AASHTO T201	10-20
Water % Maximum	AASHTO T55	0.2
Distillation	AASHTO T78	
Distillate (percent of total distillate to 680°F)		
To 374°F Minimum		50
To 437°F Minimum		85
To 500°F Minimum		90
To 600°F Minimum		95
Residue from distillation to 680°F. Volume percent of sample by difference, minimum.		30
Tests on Residue from Distillation		
Penetration at 77°F	AASHTO T47	2-10
Softening Point R&B °F Minimum	AASHTO T53	190
HCL Precipitation % Minimum	Calif. 357	20
Solubility in CCl_4 % Minimum	AASHTO T44	99.5

FIGURE 5

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
TRANSPORTATION LABORATORY

ASPHALT REJUVENATING AGENT SPECIFICATION

The asphalt rejuvenating agent shall be composed of a petroleum resin oil base uniformly emulsified with water and shall conform to the following requirements:

Test	Test Method	Requirements
Viscosity, 77°F.	AASHTO T59	15-40 SFS
Residue	No. Calif. 351	60% minimum
Tests on Residue		
Viscosity, 140°F	ASTM D 445	100-200 cSt
Asphaltenes	No. Calif. 352	0.75% maximum
Miscibility Test*	AASHTO T59	No coagulation
Sieve Test**	AASHTO T59	0.10% maximum
Particle Charge Test	No. Calif. 343A	Positive

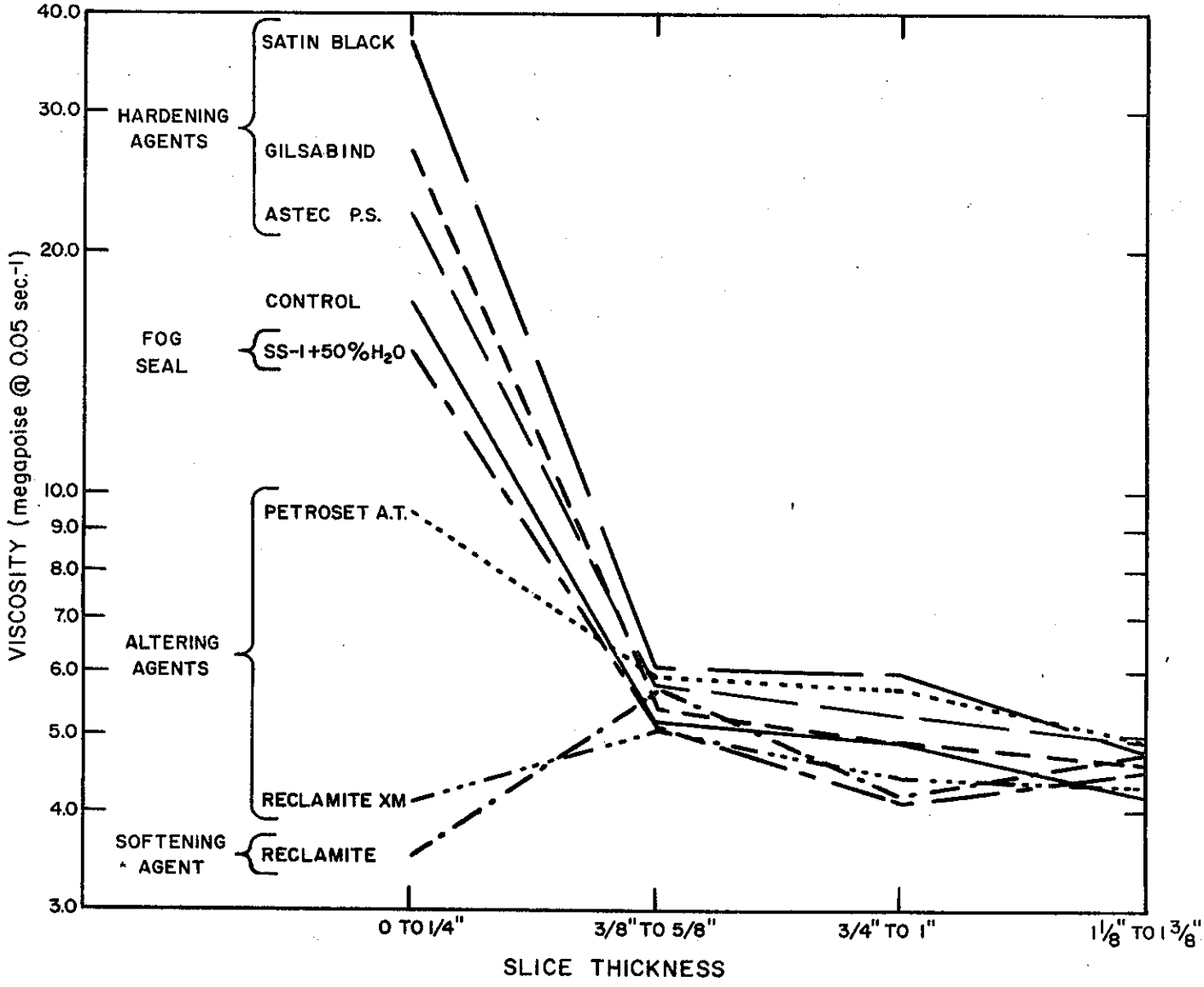
*Test procedure: AASHTO T59 to be modified by using 0.02 normal calcium chloride solution in place of distilled water.

**Test procedure: AASHTO T59 to be modified by using distilled water in place of 2 percent sodium oleate solution.

COPPEROPOLIS TEST SECTION

ROAD 10-Sta,Cal-4-8.0/10.3

COMPARISON OF VISCOSITIES OF RECOVERED CORE SLICES (2 WEEKS)



APPENDIX A

TRANSPORTATION LABORATORY

State of California
Department of Transportation
Division of Highways

Test Method No. Calif. 365-A
October 7, 1974
(4 pages)

METHOD OF TEST FOR THE MICRO-RECOVERY OF ASPHALT FROM BITUMINOUS CORE SLICES AND SMALL SAMPLES OF LOOSE ASPHALT-AGGREGATE MIXTURES

SCOPE:

A rapid procedure using benzene to recover the asphalt from bituminous core slices and small samples of loose asphalt-aggregate mixtures is described in this test method.

Procedure:

A. Apparatus[1]

1. Glass Plates, of window glass 4 inches x 5 inches, free of scratches.

2. Flasks, Erlenmeyer design, 250 mls. capacity, of red low actinic glass.

3. Tube, pear shaped, 100 ml. capacity oil tubes.

4. Centrifuge, electric oil testing, International Model H, as designated in ASTM D-96 with 4 place head with Trunion rings and aluminum cups.

5. Evaporation Box, of metal with inlet tube entering on one end near bottom and outlet tube exiting near top on opposite end. It should be approximately 10 inches x 5 inches and 6 inches deep with a lid which is air tight when closed. It should contain a rack for holding the 4 inch x 5 inch glass plates in a vertical position baffling the flow of the nitrogen.

6. Flowmeter, capable of measuring a flow of 1500 ml. and 3000 ml. of nitrogen per minute.

7. Balance, at least 200 g. capacity accurate to 1 g.

---

[1] Most of the apparatus is shown in Figures I and II.

8. Nitrogen bottle with pressure gauges.

9. Hammer or other battering instrument.

B. Materials

1. Razor blade, single edge type.

2. Solvent, Benzene.

3. Cork stoppers for 250 ml. Erlenmeyer flask and 100 ml. pear shaped tubes.

4. Hardwood applicators for spreading solution on evaporation plates.

C. Preparation of Sample

1. Prepare the bituminous core slices or loose asphalt-aggregate mix sample in the following manner before placing in 250 ml. (red low actinic glass) Erlenmeyer flasks.

a. If the sample is a bituminous core, saw or break the core into slices as desired to properly evaluate the core. (For a four inch core, the minimum thickness of a sawed slice should be approximately 1/4 inch to insure enough material. The saw will waste approximately 1/8 inch between slices.) Use a hammer to break the slices into small pieces. Weigh approximately 60 grams[2] of each slice into a 250 ml. (red low actinic glass) Erlenmeyer flask and stopper the flask.

b. If the sample is a loose asphalt-aggregate mixture, weigh approximately 60 grams[2] of the sample into a 250 ml. (red low actinic glass) Erlenmeyer flask and stopper the flask.

---

[2]If the asphalt-aggregate mixtures have an asphalt content of approximately 5 to 6%, the 60 grams will provide a sufficient amount of recovered asphalt. Adjust the amount of sample used if the asphalt content varies substantially from the 5 to 6%.

2. Pour 30 ml. of benzene into the 250 ml. Erlenmeyer flask and let the contents soak for one hour. Agitate the flask approximately 6 times during the soaking period.

3. Decant the benzene-asphalt solution into a pear shaped 100 ml. tube and centrifuge for 20 minutes at about 400 g. The decanted solution will contain approximately 2.5 grams of asphalt. (There is some holdup of asphalt in the flask.)

4. Purge the evaporation box with 3000 ml. nitrogen per minute.

5. Pour a spot, about 2 inches in diameter, of the benzene-asphalt solution on a clean 4 inch x 5 inch glass evaporation plate. (See Figure III.) Spread the solution evenly on the plate with a hardwood applicator (See Figure IV); let set for 15 seconds, then place the plate immediately in the nitrogen evaporation box.

6. Continue with the nitrogen flow at 3000 ml./minute for 10 minutes after the evaporation box is loaded, then reduce the flow to 1500 ml./minute for an additional one hour and fifty minutes.

7. Remove the plates from the evaporation box as they are used and with a razor blade scrape all of the asphalt from all of the evaporation plates used for a sample (See Figure V). Divide the asphalt for testing (See Figure VI). (Three evaporation plates per sample will usually provide a sufficient amount of asphalt for micro-viscosity and micro-ductility testing.)

D. Testing and Reporting

1. Use the recovered asphalt to prepare test specimens within 30 minutes after removal from the evaporation plates.

2. Report the results of tests performed on the recovered asphalt as values representative of the asphalt in the parent asphalt-aggregate mix.

E. Precautions

1. Care should be taken that the solution be exposed to the air on the evaporation plates for exactly 15 seconds prior to placement in the evaporation box so that all plates will have the same film thickness and the effect of the drying in air will be the same.

2. All operations should be performed in subdued light as much as possible.

Hazards

Benzene used to dissolve the sample is a highly inflammable and explosive solvent. Also, the fumes and repeated body contact is dangerous since benzene is quite toxic; consequently, it should be used and kept under a well ventilated hood at all times.

REFERENCE

A California Method

ASTM D-96

End of Text on Calif. 365-A

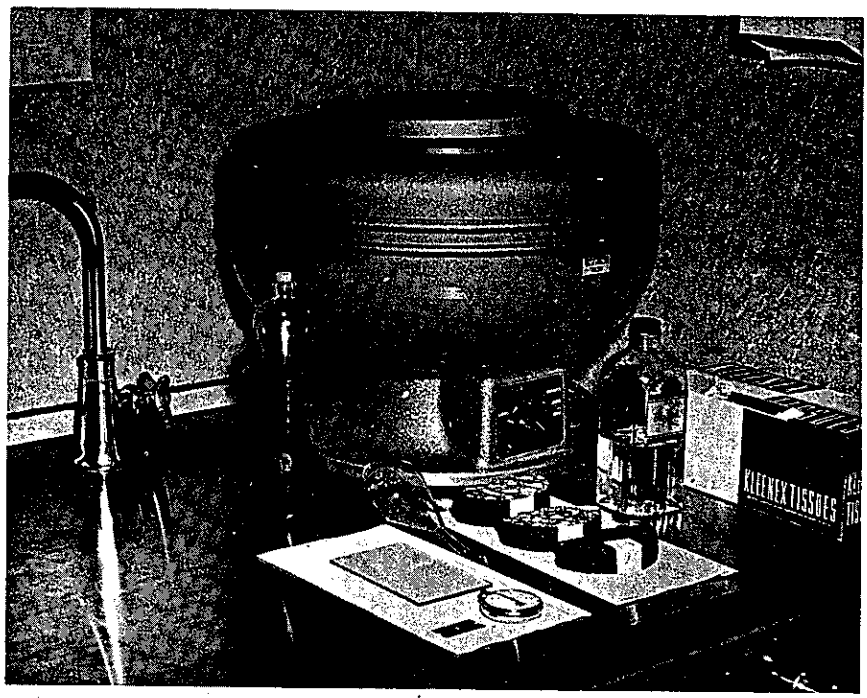


FIGURE I

APPARATUS FOR MICRORECOVERY OF ASPHALT MIXES

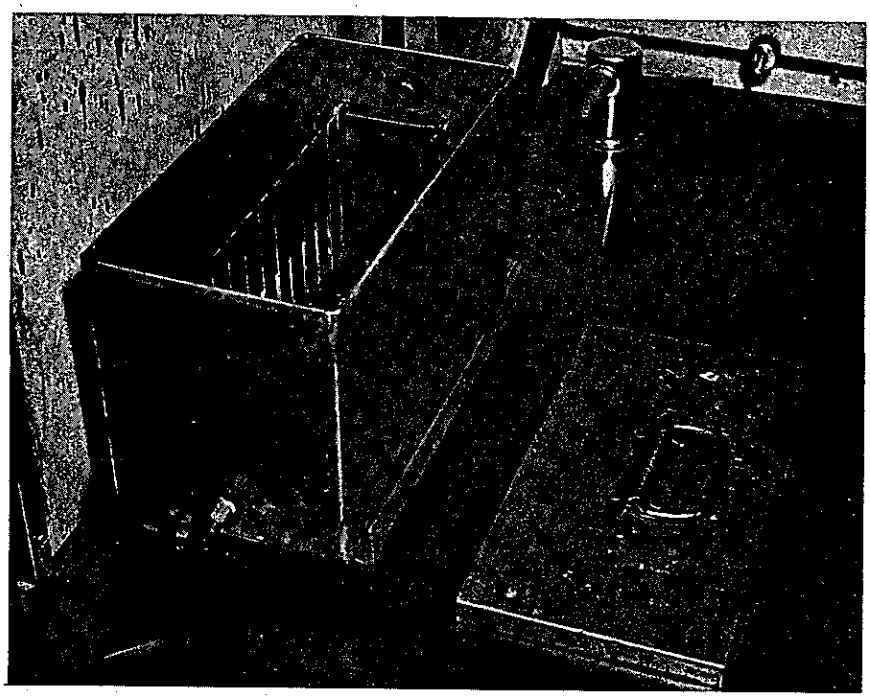


FIGURE II

EVAPORATION BOX WITH EVAPORATION PLATES

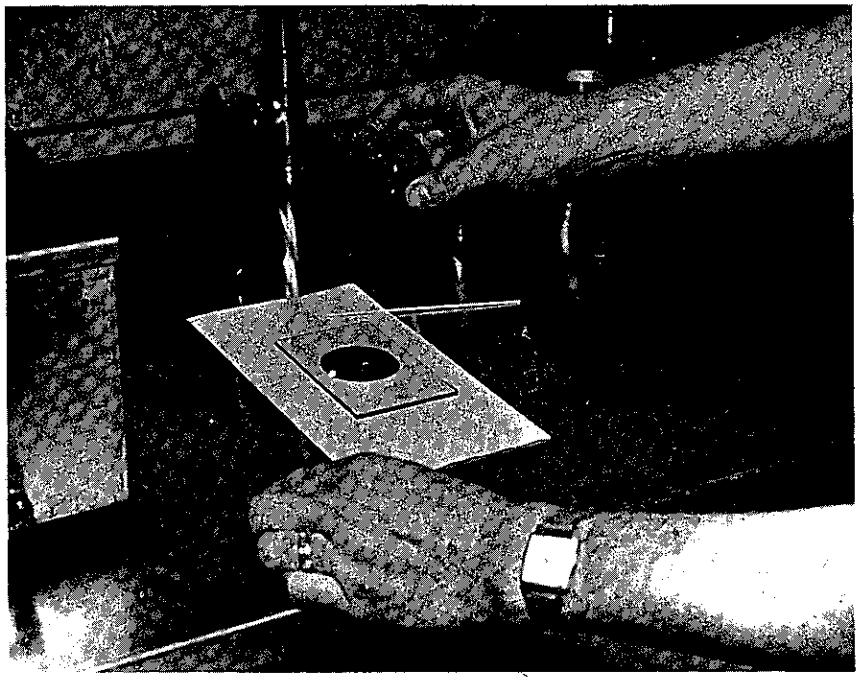


FIGURE III

TWO-INCH DROP OF ASPHALT-SOLVENT SOLUTION
ON EVAPORATION PLATE

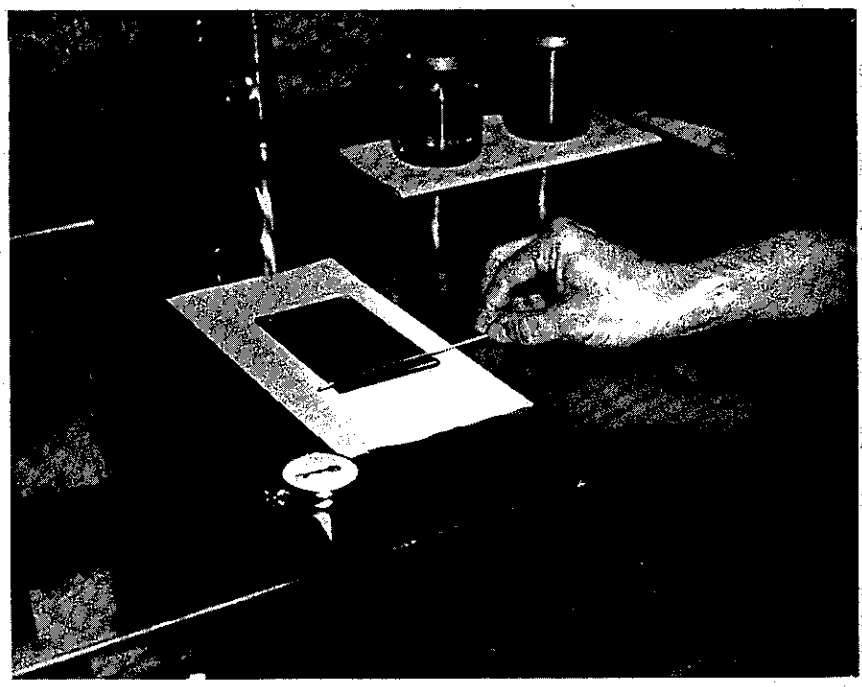


FIGURE IV

SPREADING SOLUTION ON EVAPORATION PLATE

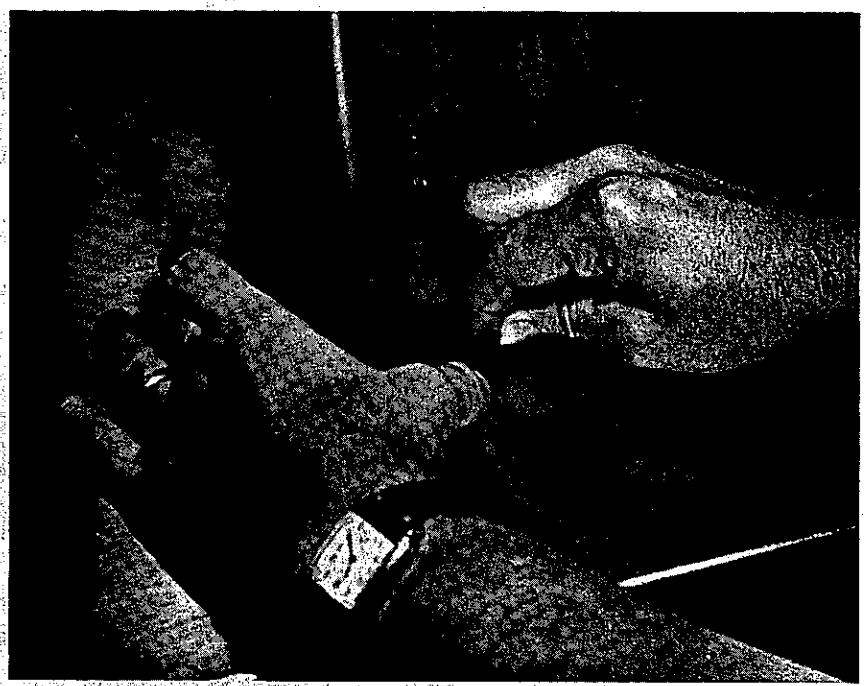
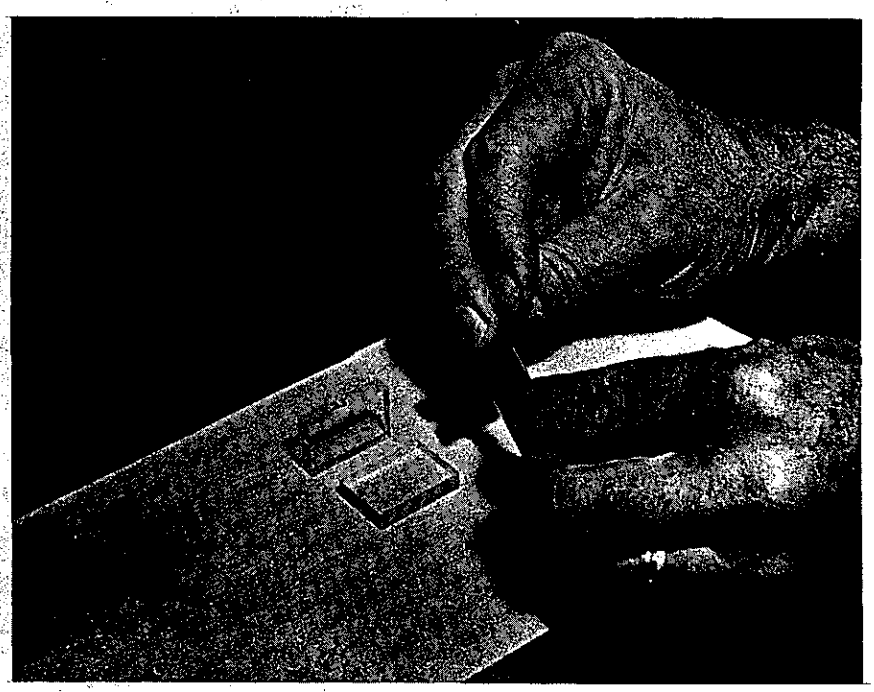


FIGURE V

SCRAPING RECOVERED ASPHALT FROM EVAPORATION PLATE



CT-Lab-Sacto
2/75 200

FIGURE VI

REMOVING RECOVERED ASPHALT FOR TESTING