

# REFLECTION CRACKING IN BITUMINOUS OVERLAYS

Mark Safford

Phil McCabe

COLORADO DIVISION OF HIGHWAYS  
4201 EAST ARKANSAS AVENUE  
DENVER, COLORADO 80222



December 1971

INTERIM REPORT

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Prepared for  
FEDERAL HIGHWAY ADMINISTRATION  
Research and Development.

Washington, D.C.  
20590

72-1

REFLECTION CRACKING  
IN  
BITUMINOUS OVERLAYS

INTERIM REPORT  
December 1971

Prepared By  
DIVISION OF HIGHWAYS  
STATE OF COLORADO

PLANNING AND RESEARCH DIVISION

In Cooperation With  
U. S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION

The opinions, findings, and conclusions expressed in this  
publication are those of the authors and not necessarily  
those of the Federal Highway Administration

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## REFLECTION CRACKING IN BITUMINOUS OVERLAYS

### ABSTRACT

Nine different treatments to the pavement were included in the design of an Interstate project in Colorado in anticipation of finding a method of reducing or eliminating reflection cracking through bituminous overlays. Each treatment is represented by two 1,000 foot long sections, and there are two standard sections which will be used as a basis for comparisons.

The major item of work included in this project is a leveling course and a two inch overlay of an existing three inch bituminous pavement which will bring this section of Interstate 70 to full design thickness. The linear cracking in the eight year old pavement averaged 41 feet per 1,000 square feet, and the alligator cracking averaged 36 square feet per 1,000 square feet of test section.

Construction of the test sections began in September and was completed in October 1971. Pre-and-post construction evaluations as well as description of the construction methods are included in this report. About two months after completion, some cracks had reflected through the overlay in the squeegee seal sections. Also, some of the normal roadway developed reflection cracking.

More evaluations will be made before any conclusions can be drawn.

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## REFLECTION CRACKING IN BITUMINOUS OVERLAYS

### INTRODUCTION

Experimental sections to reduce reflection cracking in bituminous overlays were included in the design of Project I 70-1(31) in West Central Colorado. This is part of a National Experimental and Evaluation Program as suggested in an Informational Memorandum from Mr. G. M. Williams.

Construction of the test sections began in September and was completed in October 1971. The types of treatment were:

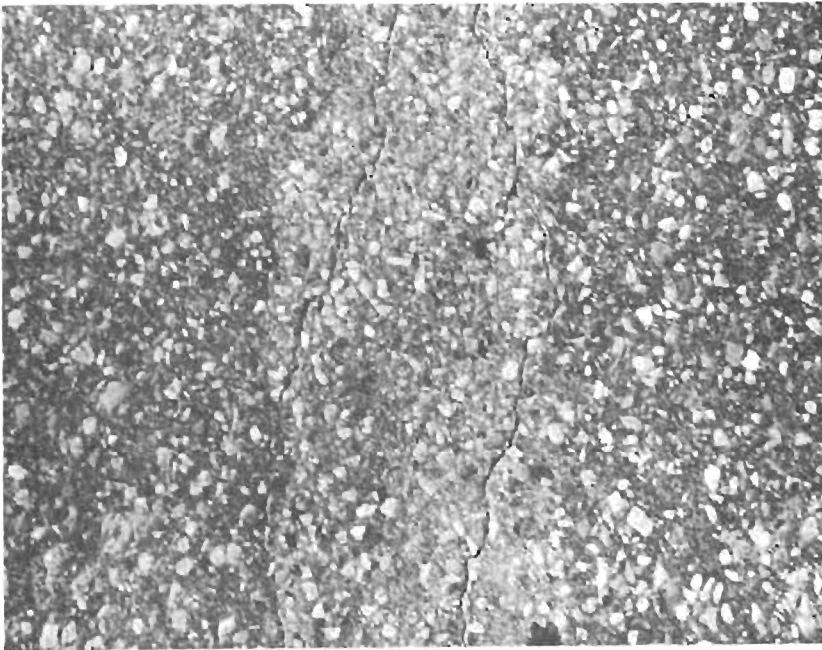
1. Application of an asphalt rejuvenating agent to the surface of the existing bituminous surface prior to overlay.
2. Polypropylene fabric bound to the existing surface with a cationic asphalt emulsion.
3. Asphalt emulsion slurry placed on the existing surface.
4. A squeegee seal of asphalt and limestone dust on the existing surface.
5. Heater-blade scarifier on the existing surface followed by an application of a rejuvenating agent.
6. A plant mixed seal placed on the existing surface.
7. Asphalt emulsion poured into the cracks in the existing surface.
8. Rubberized asphalt cement in the bituminous overlay.
9. Emulsified asphalt pavement binder containing rubber solids applied on new overlay.

Each type is represented by two-1000 foot long sections, and there are two standard sections that were tacked with an asphalt emulsion prior to being overlaid. The sections were located randomly in roadway fill sections because the cuts are through swelling shale formations.

The project is located between Clifton and Cameo and will bring this section of Interstate 70 up to full standard design. The first stage

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construction was completed and opened to traffic in 1963. The A-4 and A-6 subgrade had been covered with 6 to 17 inches of untreated subbase, 4 inches of base course and 3 inches of hot bituminous pavement. In the eight years since then, the pavement had become badly cracked and was considered a good location for an experiment to reduce reflection cracking. Photograph No. A1 (below) and Photograph No. 3 on page 4 show the typical cracked condition of the pavement before the new overlay was added.



Photograph No. A1

#### PRECONSTRUCTION EVALUATIONS

Cracks in the existing pavement were plotted on maps with a scale of 1 inch = 10 feet. These maps were reviewed immediately before the overlay was begun, and any new cracks were added. The average amount of linear cracking was 41 feet per 1,000 square feet, and alligator cracking was 36 square feet per 1,000 square feet of test section.

CHLOE Profilometer measured the Present Serviceability Index as an average of 2.9 uncorrected for texture, rut depth, cracking or patching. The average deflection and radius of curvature corrected for temperature of the pavement were 0.020 inch and 334 feet respectively.

Eight cores were removed from the existing pavement and submitted to

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Staff Materials for analysis. The average penetration at 77° was 27, the average ductility at 77° was 26, the average asphalt content was 5.6%, the average moisture content was 0.38%, and the average specific gravity was 2.37.

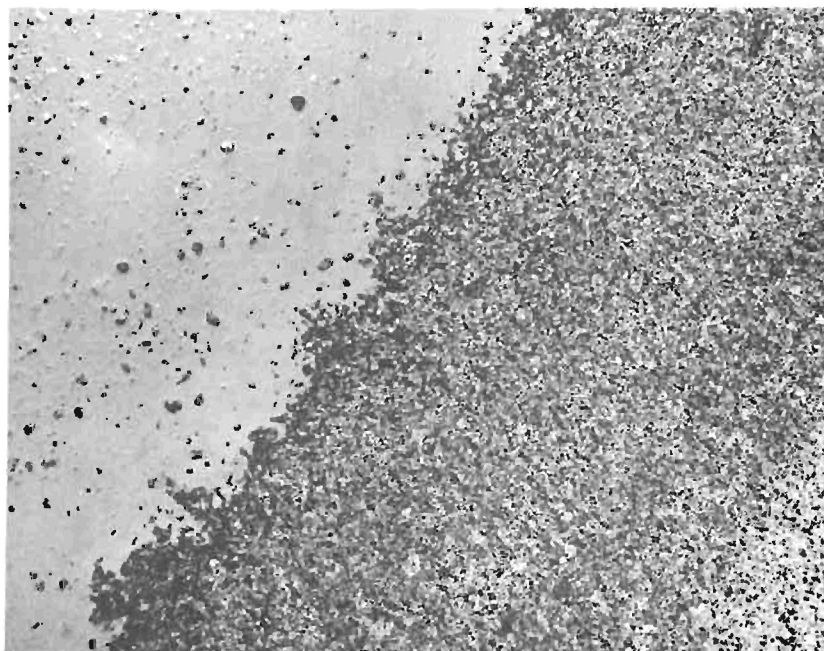
The data for the individual sections is tabulated in the Appendix.

#### CONSTRUCTION OF THE TEST SECTIONS

##### Sections 9 and 16 - Asphalt Rejuvenating Agent

The asphalt rejuvenating agent was applied directly to the old mat at a rate of 0.1 gallon per square yard. Since Section 16 had to have at least one lane open for traffic, the passing lane was treated. Four days after "shooting" Section 9 and the passing lane of Section 16, a soapy film still remained on the surface. Skid tests were taken, and the roadway proved to be very slippery. In order to open the passing lane to traffic and treat the driving lane of Section 16, it was necessary to cover the rejuvenating agent with a thin layer of hot plant mix asphalt mixture of minus one-half inch material. It was decided to cover Section 9 in this manner also.

*petroleum resin - oil base emulsified with water*



Photograph No. 1  
Rejuvenating Agent Immediately After Application

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Photograph No. 2  
Rejuvenating Agent After Four Days



Photograph No. 3  
Rejuvenating Agent After Four Days

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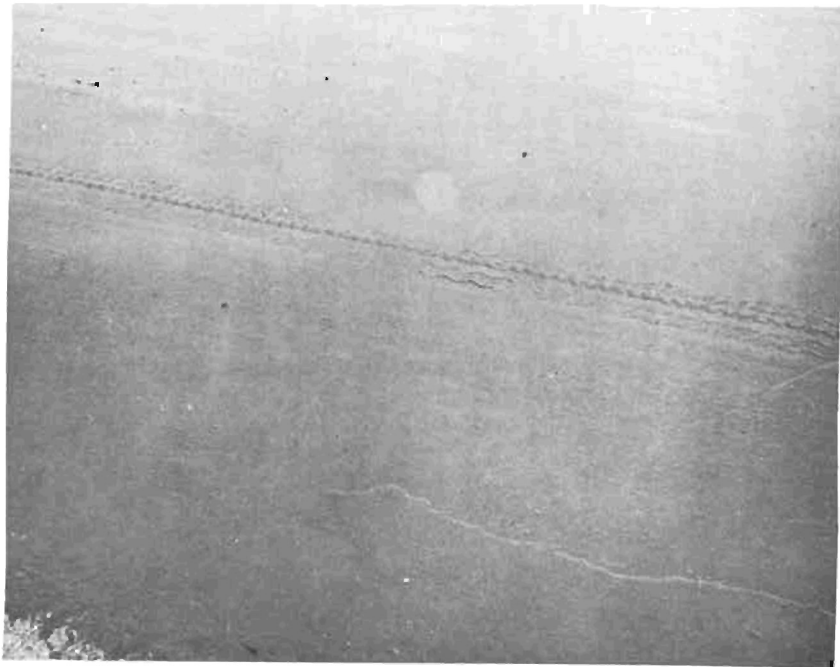
Section 16 also received 0.05 gallon per square yard of rejuvenating agent on top of the overlay and was flushed with water shortly after.

#### Sections 10 and 12 - Polypropylene Fabric

Because of the nearly total absence of cracking in the passing lane of Sections 10 and 12 and the cost of the fabric, it was decided to place it only on the driving lane.

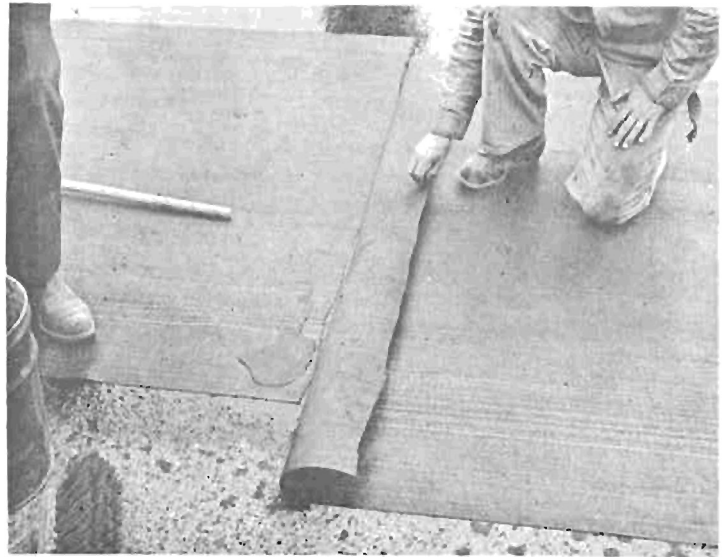
The cracks in Section 10 and Section 12 were hand poured with CRS-2h prior to laying of the polypropylene fabric. Approximately five days after the cracks had been filled the fabric laying was begun on Section 12.

Cationic Asphalt Emulsion (CRS-2h) was first applied at the rate of 0.3 gallon per square yard. See Photograph No. 4. The fabric was then laid down in 6 foot strips. A machine that actually lays the fabric was not available; consequently, the fabric had to be laid by hand. The 6 foot rolls were placed on a rod and carried over the section. It was straightened and smoothed out as it was laid. Photograph Nos. 5, 6, and 7 show this part of the operation. Photograph No. 8 shows the fabric in place prior to overlay. The fabric was rolled with a rubber tired roller before it was overlaid with hot bituminous pavement.



Photograph No. 4

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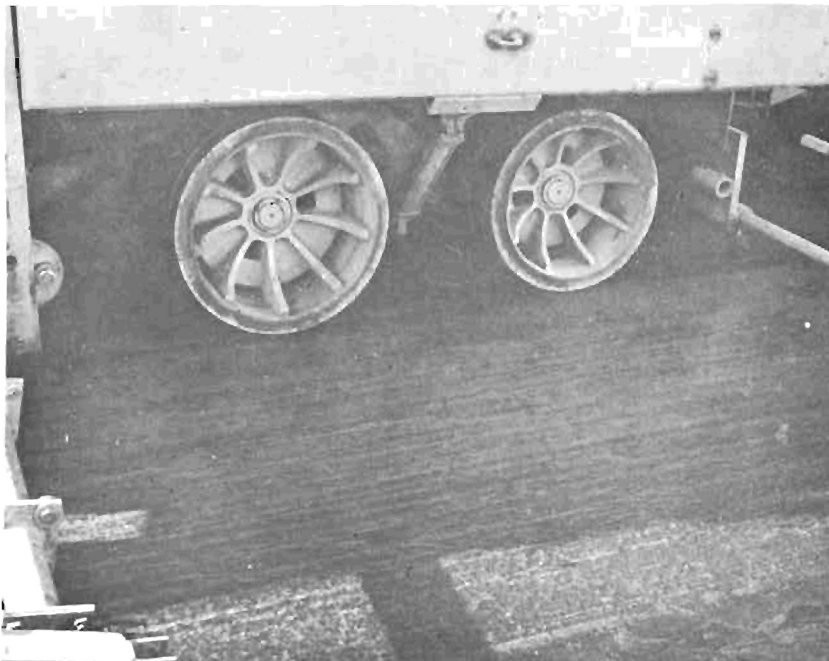
**Photograph Nos. 5, 6, and 7  
Placing the Polypropylene Fabric**

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Photograph No. 8  
Polypropylene Fabric  
In Place

It was decided to overlay the fabric in two lifts to get it protected right away. Sections 10 and 12 were overlaid with approximately  $1\frac{1}{4}$  inch lifts. Very little trouble was experienced in the laydown except when the paver had to stop for any length of time. The large rear wheels of the paver had a tendency to pick up the fabric. (Photograph No. 9).



Photograph No. 9

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Only once did this actually happen, and the fabric was ripped behind the paver (Section 12 at Station 860+33, 13 feet left of right shoulder.) See Photograph No. 10.



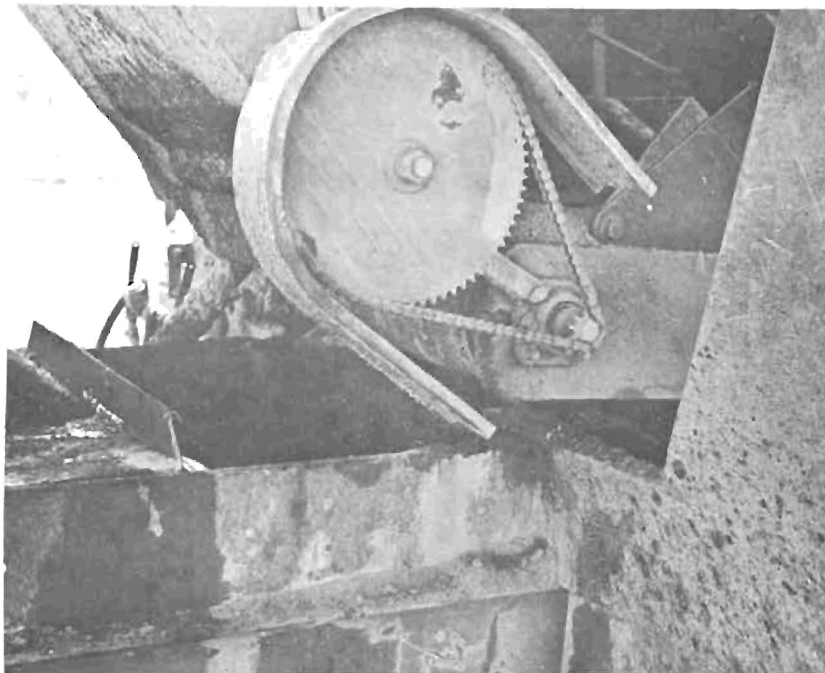
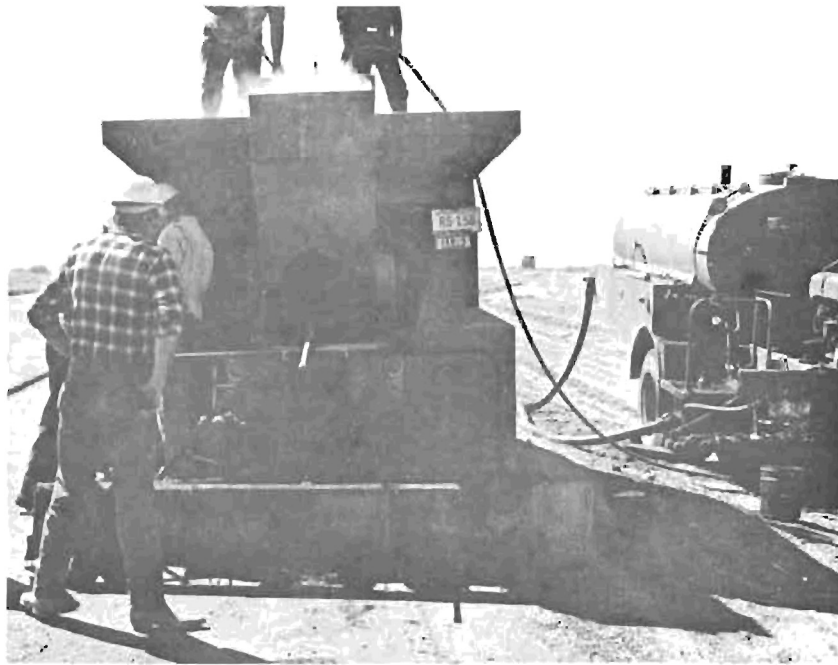
Photograph No. 10

Most of the paving was done in the morning in cooler temperatures. If it had been done in hot weather, more trouble may have been experienced with the paver slipping and picking up the fabric.

#### Sections 6 and 7 - Asphalt Emulsion Slurry

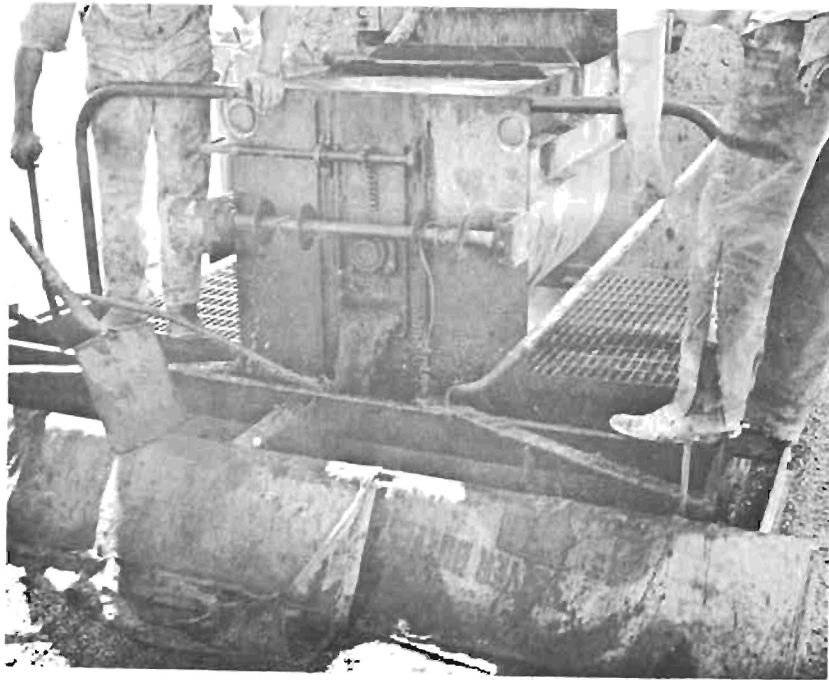
A truck conforming to the Special Provisions for use on the slurry seal sections was used. It was a self-contained unit that mixed the required proportions of aggregate, cement, asphalt and water and spread a pancake consistency-like batter under a screed onto the old mat. The width of the laydown was  $7\frac{1}{2}$  feet. Photograph Nos. 11, 12, and 13, on the following pages, shows different views of the machine.





Photograph Nos. 11 and 12  
Slurry Truck

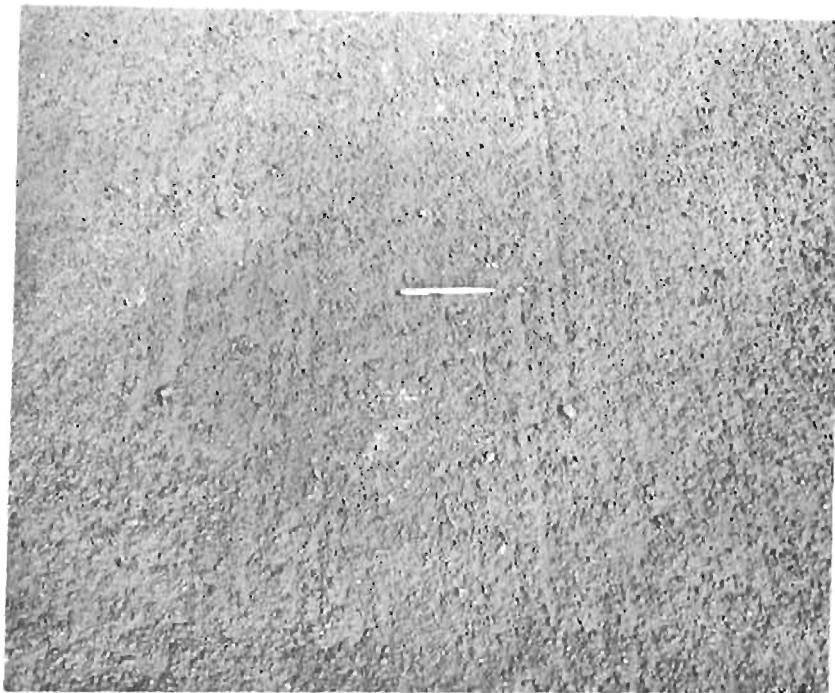
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Photograph No. 13  
Slurry Truck

CSS-1h was used on Section 7 for 800 feet only. Due to an error in the planned quantities, there was not enough CSS-1h ordered to complete the full 2,000 feet. As a result SS-1 was then used on the remaining 1,200 feet. These two sections abut each other.

The aggregate used for the slurry seal did not conform to the required gradation of the Special Provisions. There was quite a bit of oversized aggregate due to the fact the contractor was using a slotted 3/8 inch screen at the plant. The desirable "pancake batter" type of mix was not affected by this oversized material; if anything this gave a better bond for the new mat to the old. In retrospect, the lack of the fines in the material did not appear to keep the slurry from filling the cracks as is evident in Photograph Nos. 14 and 15 on the following pages.



Photograph Nos. 14 and 15  
Slurry Seal

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### Sections 1 and 2 - Squeegee Seal

MC-70 was applied at a rate of 0.12 gallon per square yard. A rubber grader blade squeegeed the MC-70 back and forth three times, and then it was blotted with hydrated lime. The procedure did not fill all of the cracks.

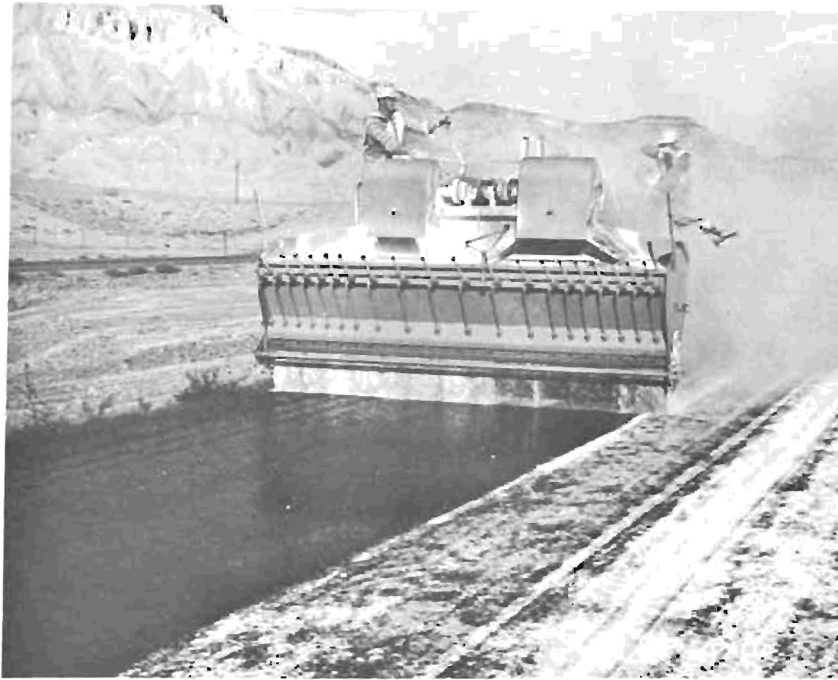
Maintenance crews have used squeegee seals on badly cracked asphalt pavements with good results. The procedure they use consists of applying MC-70 at the same rate then adding several pounds per square yard of silty-sand soil. This soil and asphalt mixture is then squeegeed back and forth until the batter fills the cracks.

Because the procedure used on the test sections did not fill all the cracks, another application of MC-70 was provided at a ratio of 0.07 gallon per square yard. A mixture of concrete sand and hydrated lime was spread over the fresh asphalt, and the rubber blade attempted to squeegee this mixture back and forth. Apparently the hydrated lime contributed to excessive drying of the asphalt, since it could not be squeegeed more than one pass with the blade. The results of this operation can be seen in Photograph No. 16 below and Nos. 17 and 18 on the following page.



Photograph No. 16

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Photograph Nos. 17 and 18  
Squeegee Seal

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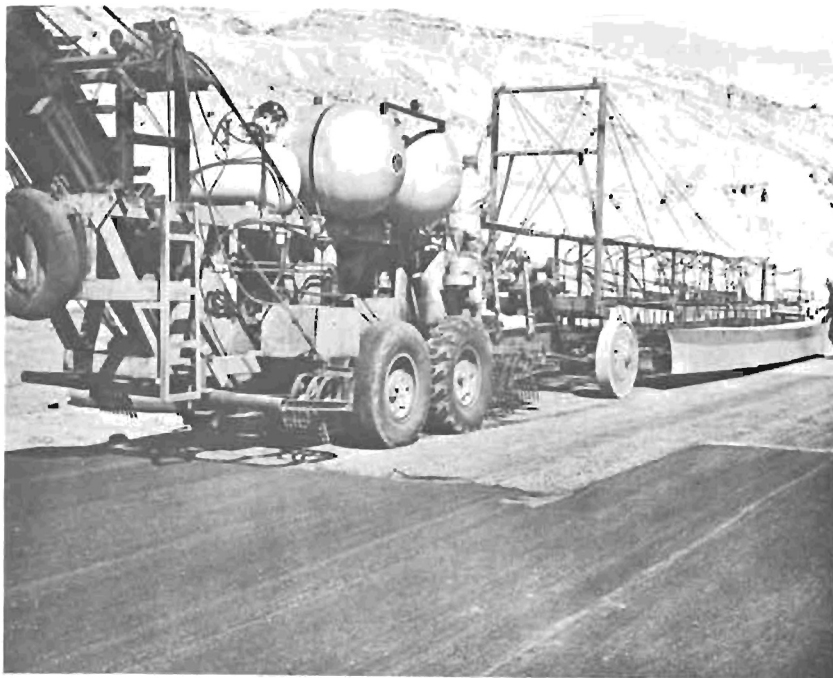
The Special Provisions also called for these sections to be opened to traffic for at least seven days before being overlaid. This could not be accomplished due to the skid hazard created by this method. These two sections were overlaid immediately.

Approximately one month after the completion of the overlay, transverse cracks had begun to show through. This is true of the standard sections in this area also.

#### Sections 4 and 8 - Heater Blade Scarifier

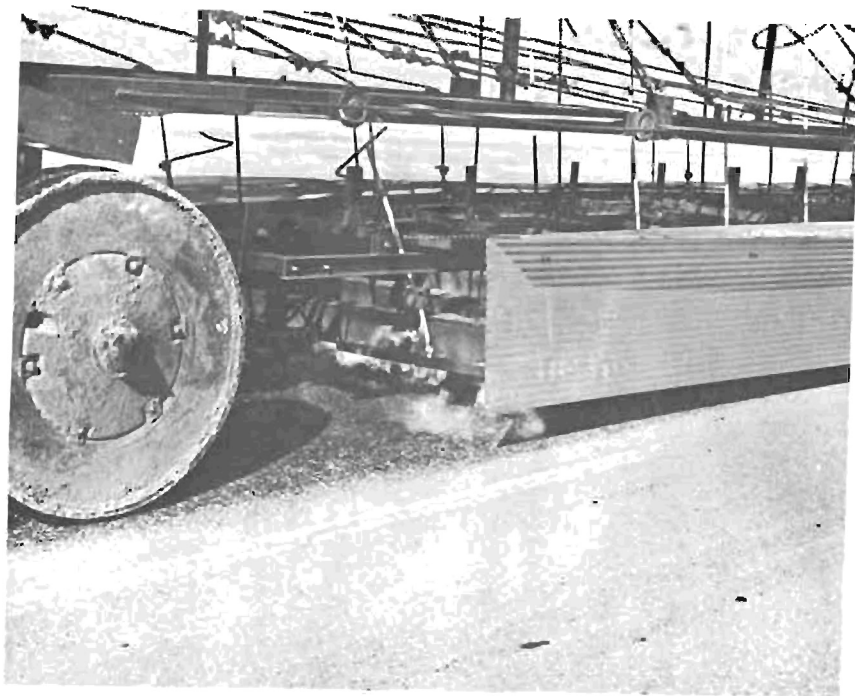
A fire breathing monster called a Heater Scarifier was used on Sections 4 and 8. Considerable trouble was encountered getting the machine to the job, and once there the assembly took two days.

The machine has a series of 20 burners mounted on the front. These burners are fueled by LP gas, and they heat the old mat to approximately 250° to soften it. Photograph No. 19 below shows the machine, and Photograph No. 20, on the following page, shows the burning. Photograph No. 21, also on the following page, shows that directly behind the burners are two rows of teeth that scarify the old mat to a depth of between 5/8 inch and 3/4 inch.



Photograph No. 19

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Photograph Nos. 20 and 21  
Heater Blade Scarifier

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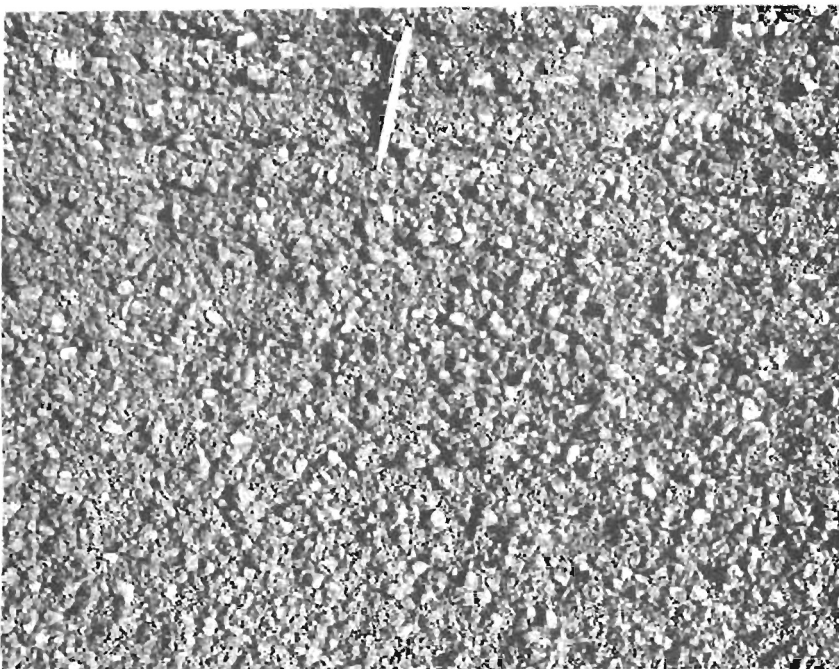


While the old mat was still hot, a rejuvenating agent was applied from a distributor at the rate of 0.15 gallon per square yard. (Photograph No. 22.)



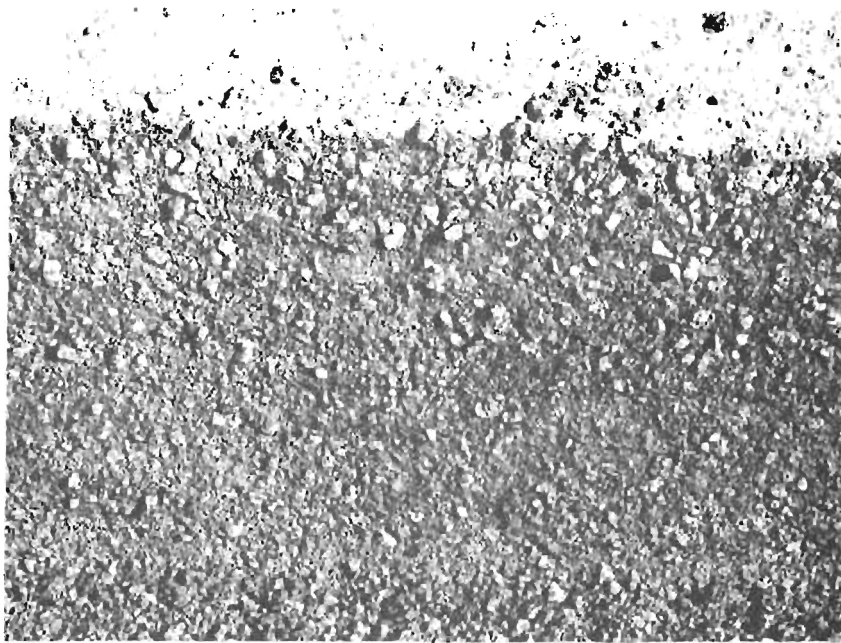
Photograph No. 22

Photograph No. 23 shows a close-up of the mat before the rejuvenating agent was applied and Photograph No. 24, on the following page shows rejuvenating agent which has been applied to part of the section.



Photograph No. 23





**Photograph No. 24**  
**Scarified Pavement with Rejuvenating Agent at Top**



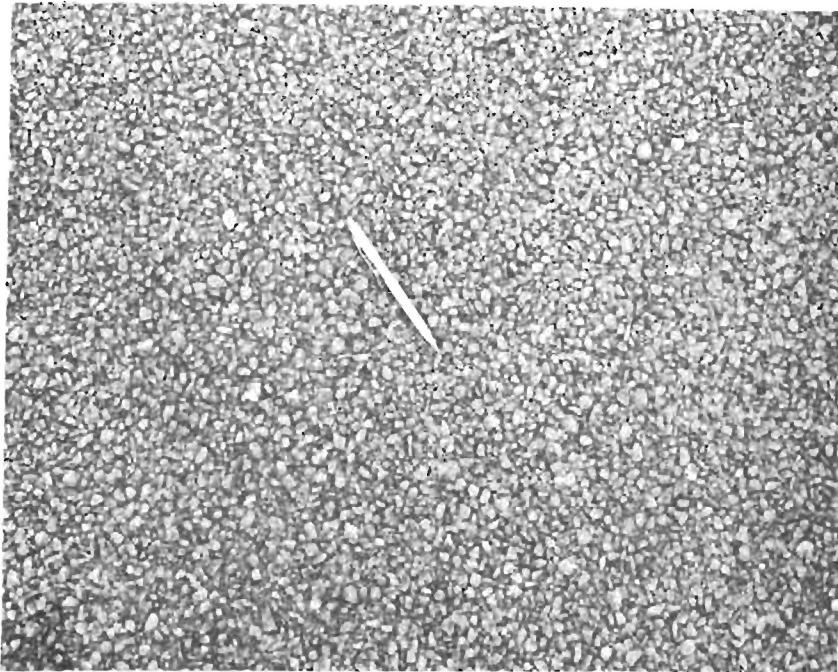
**Photograph No. 25**  
**Section 4 After Full Heater Scarifier Treatment**

This roughened surface acts as anchor for the new mat and at the same time is supposed to help fill the cracks. Both sections were overlaid with the 2 inch mat approximately two hours after completion with the scarifier.

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### Sections 13 and 14 - Plant Mixed Seal

These sections received a 5/8 inch thick plant mixed seal. The asphalt content for a regular plant mixed seal is 7%. For these test sections the content was cut to 4% in order to obtain a seal that would act like ball bearings. This was accomplished. Traffic was using part of the roadway before it could be overlaid with the 2 inch mat, and in this case some raveling occurred. Photograph No. 26 shows a close-up. (Note lack of asphalt.)



Photograph No. 26

### Sections 5 and 11 - Handpoured Crack Filling

The cracks in these sections were hand poured with CRS-2h prior to overlay. This was done in accordance with maintenance practices - simply pour enough asphalt into the cracks to seal them. One problem did occur in that the CRS-2h had a tendency to track quite badly. This was still happening after several days when it was noted that in the wider cracks the CRS-2h had disappeared. Section 11 already had a partial leveling course, but the cracks in Section 5 were filled with wet sand and covered again with the CRS-2h at 120°F.



**Photograph Nos. 27 and 28**  
**Cracks Without Sand**

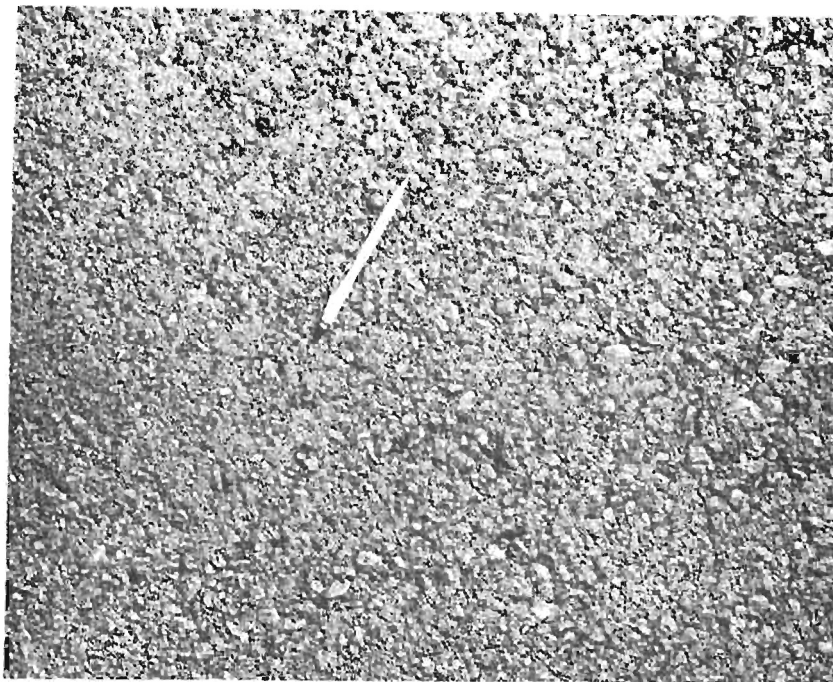
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Photograph No. 29  
Cracks With Sand on Section 5

Sections 17 and 18 - Rubberized Asphalt Cement

These sections were treated with the 2 inch overlay containing rubberized asphalt cement (Neoprene 1½% by weight) in the hot bituminous pavement. Photograph No. 30 is a close-up of the finished mat.



Photograph No. 30

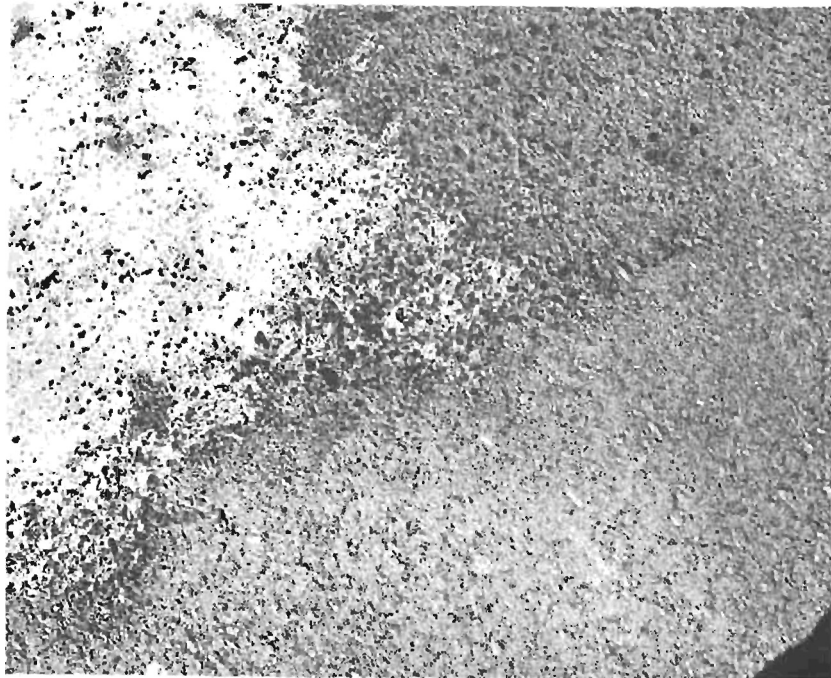
### Sections 3 and 15 - Emulsified Asphalt Pavement Binder

The overlay on these sections was treated on the surface with an emulsified asphalt pavement binder containing rubber solids. The purpose of the binder is to penetrate the 2 inch mat completely; bind the asphalt particles together, allowing some elasticity to the pavement, and prevent water from penetrating the mat.

The rubber binder was applied with a distributor at the rate of 0.2 gallon per square yard concentrate (2 parts binder to 1 part water). This was left to penetrate for approximately two hours and then blotted with sand at a rate of 2-3 pounds per square yard. Specifications called for two such applications, but field evaluation indicated that a second application would not be advisable.

Skid tests were taken on both sections after the sanding was completed and the results were skid numbers of 55.

Photograph No. 31 shows close-up of difference between no binder and binder on first and second shots.



Photograph No. 31

**Photograph No. 32 shows Section 3 after binder had just been applied.**



**Photograph No. 32**

**Photograph No. 33 shows Section 15 two hours after binder had been applied.**



**Photograph No. 33**

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Photograph No. 34 shows Section 15 being sanded.



Photograph No. 34

For some reason, yet to be determined, both Sections 3 and 15 in the week following the operation began to flush in the driving lane under traffic. Skid tests were taken approximately four weeks after application in both the driving lane and the passing lane. The passing lane was all right with an average skid number of 55. The driving lane showed very dangerous when wet with a skid number of 20. A 1/2 inch plant mixed seal containing about 6.8% asphalt cement was then placed on both sections in both lanes to insure a good safety factor. This should not affect the test in any way.

As an afterthought a small piece of spun-bonded nylon 9.2' X 2' was placed under the mat at the west end of Section 18. This was placed in the left wheelpath of the driving lane from Station 956+90.9 to Station 957+00. It was tacked down with cement nails.

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## POSTCONSTRUCTION EVALUATIONS AND CONCLUSIONS

In addition to skid resistance measurements, other tests were performed after the experimental sections were overlaid. Deflections, radii of curvature, Present Serviceability Indices, and textures were measured. The sections were examined for reflection cracks one to two months after completion, and some cracks have reflected through the overlay in Sections 1 and 2 (Squeegee Seal) and also between test sections. Results for the individual sections are tabulated in the Appendix. Core samples of the new asphalt pavements were sent to Staff Materials for tests, but the results are not available at this time.

It is expected that if the cracks are going to reflect through the new overlay by a significant amount, they will do so by next spring. The next evaluation will probably be in March 1972, and it will be followed by at least two more evaluations before worthwhile conclusions will be made.

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APPENDIX A  
List of Test Sections

<u>Section No.</u>	<u>Stationing</u>	<u>Description</u>
S1	645+00 to 655+00	Standard - no treatment
1	662+00 to 672+00	Squeegee seal
2	677+00 to 687+00	Squeegee seal
3	689+00 to 699+00	Rubber seal on overlay
4	707+00 to 717+00	Heater-blade scarifier
S2	717+00 to 727+00	Standard - no treatment
5	730+00 to 740+00	Hand poured crack filling
6	753+00 to 765+00	Slurry seal SS-1
7	765+00 to 773+00	Slurry seal CSS-1h
8	777+50 to 787+50	Heater-blade scarifier
9	797+00 to 807+00	Rejuvenating agent on old pavement
10	817+85 to 826+16	Polypropylene fabric
11	828+00 to 838+00	Hand poured crack filling
12	853+00 to 862+54	Polypropylene fabric
13	883+70 to 893+36	Plant mix seal on old pavement
14	895+64 to 905+14	Plant mix seal on old pavement
15	869+00 to 879+00	Rubber seal on overlay
16	919+00 to 929+00	Rejuvenating agent on old pavement
17	934+00 to 943+60	Neoprene in HBP overlay
18	957+33 to 967+61.4 Bk.	Neoprene in HBP overlay

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## APPENDIX B

### COSTS OF TREATMENTS

For this Project the costs for the different treatments on a square yard basis were as follows. The average was \$0.77 per square yard. A more realistic figure is the second one which is based on 1970 average bid prices in Colorado. The slurry seal price of \$0.23/sq. yd. is the average price in Kansas.

#### Hand Poured Crack Filling

- \$0.02 (from bid price on this experimental project)
- 0.005 (based on maintenance costs for a similar road)

#### Asphalt Rejuvenating Agent

- \$0.09
- 0.075

#### Rubberized Asphalt Cement

- \$0.42
- 0.42

#### Squeegee Seal

- \$0.45
- 0.27

#### Plant Mixed Seal

- \$0.52
- 0.57

#### Heater Blade Scarifier

- \$0.74
- 0.18

#### Emulsion Seal Containing Rubber Solids

- \$1.00
- 0.40

#### Polypropylene Fabric

- \$1.40
- 0.75

#### Asphalt Emulsion Slurry Seal

- \$2.32
- 0.23

APPENDIX C  
Laboratory Tests

Section No.	OLD PAVEMENT			OVERLAY AT TIME OF PLACEMENT		
	Pen. @ 77°	Duct.	% AC	Pen. @ 77°	Duct.	% AC
S1						
1	30	23	5.3			6.3
2	35	48	5.5			6.3
3	27	33	5.7			
4				65	190+	6.1
S2						
5				60	190+	6.1
6	24	13	5.7	71	190+	6.5
7				65	190+	6.2
8				74	190+	6.1
9	30	25	5.8			
10						
11						
12	27	18	5.6	83	190+	6.4
13						
14						
15						
16						
17				104*	190	6.3
18				101*	190	6.1


Average test results of asphalt cement prior to mixing:  
penetration at 70° = 125, ductility at 77° = 190+

A sample of the rubber seal was submitted to Staff Materials  
but no tests were conducted.

\* Contains 1 $\frac{1}{2}$ % neoprene, original penetration and ductility  
before mixing were 125 and 190+, respectively.

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# FIELD MEASUREMENTS

OLD PAVEMENT						NEW PAVEMENT					
Sec. No.	Defl. (In.)	Radius Curv. (Ft.)	PSI	Crack/1000 Lin. (Ft.)	Sq.Ft. Alligator (Sq ft)	Defl. (In.)	Radius Curv. (Ft.)	PSI*	Skid No.	Crack/1000 Lin. (Ft.)	Sq.Ft. Alligator (Sq.ft.)
S1	.024	419	2.7	50	24	.023	1470	2.7/3.6	65	0	0
1	.025	275	2.7	48	40	.027	630	2.7/3.7	55	4	
2	.026	323	2.6	46	117	.029	412	3.0/4.0	59	5	
3	.026	466	2.5	75	23	.026	945	2.8/3.7	21	0	
4	.025	284	2.9	47	30	.031	945	2.8/3.8	55		
S2	.022	270	2.5	49	25	.015	1840	2.9/3.9	57		
5	.015	313	2.9	40	53	.025	494	2.8/4.0	57		
6	.017	347	2.6	31	46	.017	1610	2.7/3.7	51		
7	.022	259	3.1	41	54	.017	1290	2.8/3.8	50		
8	.015	390	2.9	28	75	.024	803	3.1/4.2	55		
9	.015	275	2.8	52	36	.018	804	2.9/3.9	56		
10	.020	276	3.2	26	19	.020	1610	2.9/4.0	55		
11	.014	366	3.1	43	9	.017	1070	2.5/3.6	54		
12	.017	368	3.4	49	18	.015	2010	2.8/3.7	52		
13	.022	288	2.9	29	27	.027	842	2.9/3.8	47		
14	.017	289	3.1	30	13	.019	935	3.1/3.9	54		
15	.017	397	3.0	39	38	.015	699	3.2/4.0	20		
16	.016	418	3.0	33	9	.017	990	2.8/3.7	44		
17	.017	294	3.1	22	30	.013	2400	3.0/3.8	54		
18	.020	357	3.2	32	31	.024	526	2.6/3.5	58	0	0
Average.	.020	334	2.9	41	36	.021	1120	2.8/3.8	55	1/2	0

\*The first value is raw data while the second is corrected for texture.

# STANDARD SPECIFICATION 702.04(b) REJUVENATING AGENT

- (b) Asphalt rejuvenating agent shall be composed of a petroleum resin-oil base uniformly emulsified with water and shall conform to the following physical and chemical requirements:

Specification Designation	Test Method	Requirements
<sup>1</sup> Viscosity, S.F., at 77°F., Sec.	ASTM D244	. . . 15-40
<sup>1</sup> Residue, % Min. . . . .	ASTM D244	. . . 60-65
<sup>2</sup> Miscibility Test . . . . .	ASTM D244	No Coagulation
<sup>3</sup> Sieve Test, % Max. . . . .	ASTM D244	. . . 0.10
Particle Charge Test . . . . .	ASTM D244	. . . Positive
Tests on Residue from ASTM D244-60 (Mod):		
Viscosity, c.s., 140°F. . . . .	ASTM D445	. . . 100-200
Asphaltenes, % Max . . . . .	ASTM D2006	. . . 0.75
<sup>4</sup> Maltenes Dist. $\frac{PC+A_1}{S+A_2}$ Ratio -	. . . ASTM D2006	. . . 0.3-0.5

<sup>1</sup> ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300°F. until foaming ceases, then cool immediately and calculate results.

<sup>2</sup> Test procedure identical with ASTM D244 except that .02 Normal Calcium Chloride solution shall be used in place of distilled water.

<sup>3</sup> Test procedure identical with ASTM D244 except that distilled water shall be used in place of 2% sodium oleate solution.

<sup>4</sup> In the Maltenes Distribution Ratio Test by ASTM Method D 2006:

PC = Polar Compounds

A<sub>2</sub> = Second Acidaffins

A<sub>1</sub> = First Acidaffins

S = Saturates

July 23, 1971

REVISION OF SECTION 403  
(JOB-MIX FORMULA)  
COLORADO PROJECT NO. I 70-1(31)38

Section 403 of the Standard Specifications is hereby revised for this project as follows:

The source for aggregate for Hot Bituminous Pavement is not designated for this project. The conditions for acquiring materials from undesignated sources are in Section 106.

Subsection 403.02 shall include the following:

The job-mix formula for the "Hot Bituminous Pavement (Grading E)" for this project shall be as follows:

Passing 3/4" Sieve	-	100%
Passing #4 Sieve	-	54%
Passing #8 Sieve	-	40%
Passing #200 Sieve	-	7%

Asphalt Cement (Viscosity Grade AC-5)

. . . . . 6.0% by Weight of Mix

Temperature of mixture when emptied from mixer . . 260° F.

1.5% Neoprene by weight of Asphalt shall be added to the Asphalt Cement for Test Sections 17 & 18 only.

A tack coat may be required between courses of pavement to improve bond.

Subsection 403.04 shall include the following:

Material used for tack coat will be measured and paid for as provided in Section 411.

The cost of asphalt cement, hauling and stripping will not be paid for separately but shall be included in the work.

Subsection 403.05 shall include the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Hot Bituminous Pavement (Grading E) (Haul & Asphalt)	Ton

June 11, 1971

REVISION OF SECTION 407  
HEATING & SCARIFYING TREATMENT  
COLORADO PROJECT NO. I 70-1(31)38

Section 407 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work shall consist of preparing and treating an existing bituminous surface by heating, scarifying, applying a rejuvenating agent and overlaying the surface with a layer of hot bituminous pavement. Work shall be done in accordance with these specifications and in reasonably close conformance with the lines and grades shown on the plans or established.

MATERIALS

Rejuvenating agent shall conform to the requirements of subsection 702.04(b) and shall be accepted before loading into the distributor.

Hot bituminous pavement shall conform to the requirements of Section 403.

CONSTRUCTION REQUIREMENTS

Distributor equipment for rejuvenating agent shall conform to the applicable requirements of subsection 407.05.

Construction requirements for hot bituminous pavement shall conform to Section 403.

Equipment for heating and scarifying shall be self propelled and capable of scarifying to a depth of 1/2 inch to 3/4 inch. It shall be capable of covering a minimum of 1500 square yards per hour while heating the existing surface to the extent that it will be remixed by the scarifiers to a depth not less than 1/2 inch. At least 75 percent of the existing aggregate shall be tumbled or moved to a depth of 1/2 inch. The temperature of the scarified mixture measured within 3 minutes of scarifying shall not be less than 225° F.

The scarified surface shall be left in an evenly spread condition and aggregates shall not be pulverized, spalled or broken. Width of scarified surface shall be that necessary to accommodate hot bituminous pavement width. Immediately following the scarifying operation, asphalt rejuvenating agent shall be applied at the rate of approximately 0.15 gallon per square yard.

Application of rejuvenating agent shall conform to the requirements set forth in subsection 407.07.

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June 11, 1971

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REVISION OF SECTION 407  
HEATING & SCARIFYING TREATMENT  
COLORADO PROJECT NO. I 70-1(31)38

The hot bituminous pavement overlay shall be placed as soon as feasible after application of the rejuvenating agent to minimize heat loss and give a satisfactory bond between the two layers.

METHOD OF MEASUREMENT

Heating and scarifying treatment will be measured by the square yard and shall include all work completed and accepted prior to overlaying with hot bituminous pavement. The width for measurement will be the width of the pavement shown in the typical cross section of the plans, additional widening where called for, or otherwise directed. The length will be measured horizontally along the centerline of the roadway.

Asphalt rejuvenating agent will be measured and paid for in accordance with Section 411.

Hot bituminous pavement will be measured and paid for in accordance with Section 403.

BASIS OF PAYMENT

The accepted quantities of heating and scarifying treatment will be paid at the contract unit price per square yard for heating and scarifying treatment.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Heating and Scarifying Treatment	Square Yard

Payment for heating and scarifying treatment shall be full compensation for all work necessary to complete the item.



June 11, 1971

REVISION OF SECTION 409  
SQUEEGEE SEAL  
COLORADO PROJECT NO. I 70-1(31)

This work shall consist of furnishing and applying MC-70 liquid asphalt, working the asphalt into pavement cracks with a rubber squeegee blade, and blotting the treated surface with limestone dust or approved other material.

MATERIALS

The MC-70 liquid asphalt shall meet the applicable requirements of Section 702.

The blotter material shall meet the requirements of AASHO M 17 (Limestone Dust), or other approved blotter material. For other material to be considered for approval, it must be 95 percent finer than the No. 4 sieve and be at least 20 percent finer than the No. 200 sieve. Other approved material must be clean, friable and non-plastic when tested according to AASHO T 91.

CONSTRUCTION REQUIREMENTS

The liquid asphalt shall be applied on the designated surface by a pressure distributor at the rate of approximately 0.12 gal/sq. yd. or as designated. The liquid asphalt shall not be applied on a wet surface, when the temperature is below 60° F. or when weather conditions would otherwise prevent proper construction procedures. The full width to be treated shall be sprayed with liquid asphalt before beginning the squeegee operation. When the full width of the pavement for the length of section designated has been sprayed, the squeegee operation shall begin immediately. The squeegee shall consist of a rubber snowplow blade, minimum length 10 ft., mounted on the moldboard of a self-propelled, pneumatic tired, blade grader. The liquid asphalt shall be squeegeed from the low side of the roadway to the high side and back. One squeegee movement from one treated edge to the opposite treated edge shall constitute one pass. A minimum of 3 and a maximum of 5 passes will be required. On the last pass, any remaining asphalt shall be wasted onto the shoulder.

Before turning the squeegeed surface open to traffic, the surface shall be uniformly blotted with approximately one pound per square yard of limestone dust. Other material may be used when approved. The spread rate for other material shall be such that a minimum of 1/2 pound per square yard No. 200 material will be placed.

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June 11, 1971

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REVISION OF SECTION 409  
SQUEEGEE SEAL  
COLORADO PROJECT NO. I 70-1(31)

The treated surface shall be opened to full public traffic a minimum of seven days prior to placing the hot bituminous overlay.

METHOD OF MEASUREMENT

Squeegee seal will be measured by the number of square yards treated and accepted. Width shall be as directed by the Engineer. Length will be measured horizontally along centerline of roadway.

BASIS OF PAYMENT

The accepted quantities of squeegee seal will be paid for at the contract unit price per square yard, which price shall be full compensation for furnishing and placing all materials except the liquid asphalt. Liquid asphalt will be measured and paid for in accordance with Section 411. Blotter will not be paid for separately but will be included in the cost of the item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Squeegee Seal	Square Yard

July 13, 1971

SECTION 410 & 703.10  
PLANT MIXED SEAL COAT (TEST SECTIONS)  
COLORADO PROJECT NO. I 70-1(31)38

This work shall conform to Section 410 of the Standard Specifications with the following modifications:

The job-mix formula for the Plant Mixed Seal Coat (Type A) for test sections 13 & 14 for this project shall be as follows:

Passing 3/8" Sieve	-	100%
Passing #4 Sieve	-	40%
Passing #8 Sieve	-	14%
Passing #200 Sieve	-	4%

Asphalt Cement (AC-5 Penetration) 4.0% by Weight of Mix.  
Temperature of Mixture when emptied from mixer . . 260° F.

The source for aggregate for Plant Mixed Seal Pavement is not designated for this project. The conditions for acquiring materials from undesignated sources are in Section 106.

The first paragraph of subsection 703.10 is deleted and following is substituted:

Aggregate for plant mixed seal coat shall consist of clean, hard, durable particles of natural gravel. The aggregates shall have a percentage of wear of not more than 45 when tested in accordance with AASHTO T 96.

July 13, 1971

REVISION OF SECTION 410  
SLURRY SEAL COAT  
COLORADO PROJECT NO. I 70-1(31)38

Section 410 of the Standard Specifications is revised to include:

DESCRIPTION

Slurry seal coat shall consist of a mixture of CSS-1h emulsified asphalt, mineral aggregate, Portland Cement fillers and water, properly proportioned, mixed and spread on the prepared bituminous surface of an existing roadway in accordance with these specifications and in reasonably close conformity with the details shown on the plans or established.

MATERIALS

Aggregates.

Aggregates shall be natural or crushed aggregate screenings composed of clean, hard, durable particles. The material shall be non-plastic. The grading requirements are as follows.

Passing #4 Sieve	-	100%
Passing #8 Sieve	-	90 - 100%
Passing #50 Sieve	-	35 - 55%
Passing #200 Sieve	-	15 - 25%

The source for aggregates for Slurry Seal Coat is undesignated for this project. The conditions for acquiring materials from undesignated sources are in Section 106.

Portland Cement Filler.

Portland Cement filler shall conform to the requirements of subsection 701.01. Type I or Type II cement may be used.

Emulsified Asphalt.

Emulsified asphalt shall conform to the requirements of subsection 702.04.

Water.

Water shall be potable and shall be free from harmful soluble salts.

Equipment

- (A) Slurry mixing equipment: The slurry mixing machine shall be a continuous flow mixing unit, truck mounted capable of delivering

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June 11, 1971

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REVISION OF SECTION 410  
SLURRY SEAL COAT  
COLORADO PROJECT NO. I 70-1(31)38

accurately, predetermined properly proportioned amounts of aggregate, filler emulsified asphalt and water. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, cement and water to maintain an adequate supply to the proportioning controls. Sufficient machine storage to mix properly and apply a minimum of four tons of aggregate without the use of auxiliary trucks and tanks shall be provided. The machine shall be fully powered so as to produce and spread slurry of an acceptable and uniform consistency without the addition of excessive water.

The mixing machine shall be equipped with an approved fines feeder. The mixing machine shall be equipped with a water pressure system and nozzle type spray-bar to provide a water spray to the road surface immediately ahead of the slurry spreading equipment.

The aggregate feed to the mixer shall be equipped with a revolution counter or similar device. The emulsion pump shall be of the positive displacement type and shall be equipped with a revolution counter or similar device.

The water pump for dispensing water to the mixer shall be equipped with a meter which will read-out in gallons per minute and/or total gallons.

The controls for proportioning each material to be added to the mix shall be calibrated and properly marked. They shall be accessible for ready calibration and so placed that the Engineer may determine the amount of each material used at any time.

The mixing machine shall be equipped with a "fifth wheel" type odometer that will measure the total feet traveled.

(B) Slurry Spreading Equipment.

Attached to the slurry mixing machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread.

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REVISION OF SECTION 410  
SLURRY SEAL COAT  
COLORADO PROJECT NO. I 70-1(31)38

The box shall be equipped with a steering device and shall be kept clean and free of any build up of asphalt and aggregate.

Proportions.

The Engineer shall approve all slurry seal materials and methods prior to mixing and application. The proportions of the mixture shall be as follows unless changes are approved by the Engineer.

Aggregate - 7 lbs.  $\pm$  1, per Sq. Yd. (Dry basis)  
Emulsified Asphalt-15%  $\pm$  1, residue by weight of dry aggregate  
Cement - 3% by weight of dry aggregate  
Water - as necessary to produce proper consistency.

Upon visual inspection the slurry mixture shall have a creamy, cake batter consistency and shall be free-flowing. Once the proper consistency is obtained changes in proportioning of the various components of the mixture shall be held to a minimum.

The aggregate shall be weighed on approved scales prior to use in order to check the mixing machine calibration and the yield of the mixture.

Construction Requirements

- (A) Surface Preparation. Immediately prior to applying the slurry seal, the surface shall be cleaned of all vegetation, loose materials, dirt and other objectionable materials and pre-wetted as directed by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the surface shall be damp and the cracks in the pavement shall be wet, but not have free water standing in them. To facilitate crack-wetting, sprinkling sometime in advance of the mixing machine may be required.
- (B) Application. The mixture shall be spread to fill all cracks and leave a uniform layer of mixture on the surface. A sufficient amount of slurry shall be carried in all parts of the spreader box at all times so that complete coverage is obtained. No lumping, balling, or unmixed aggregate shall be permitted. No streaks or slick spots shall be left in the finished slurry sealed surface.

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REVISION OF SECTION 410  
 SLURRY SEAL COAT  
 COLORADO PROJECT NO. I 70-1(31)38

- (C) Weather Limitations. Slurry seal shall be placed only when the atmospheric temperature is 60° F or above and when weather conditions otherwise permit proper construction procedures.
- (D) Traffic. The slurry seal shall be protected from traffic until such time that it has cured sufficiently to prevent pick up by the vehicle tires.
- (E) Overlay. A minimum of two days shall have elapsed after placement of the slurry seal before the hot bituminous pavement overlay shall be placed.

Method of Measurement

Slurry seal coat shall be measured by the square yard of accepted surface completed.

Emulsified asphalt shall be measured by the gallon.

Basis of Payment.

The accepted quantities of slurry seal coat will be paid for at the contract unit price per square yard which price and payment shall be full compensation for furnishing and placing all materials including aggregate, cement and water.

Emulsified asphalt will be measured and paid for in accordance with Section 411.

Payment will be made under:

Pay Item	Pay Unit
Slurry Seal Coat	Square Yard

June 11, 1971

REVISION OF SECTION 411  
EMULSIFIED ASPHALT  
COLORADO PROJECT NO. I 70-1(31)38

A tack coat may be required on top of old surface of bituminous pavement. The tack coat for this project shall be (SS-1H) Emulsified Asphalt diluted 1 to 1 with water and applied at the rate of 0.10 gal. per sq. yd.

Water will not be measured and paid for separately but will be included in the unit price bid for emulsified asphalt. Emulsified asphalt will be measured and paid for in accordance with Section 411.

The pay quantity for Item 411 Emulsified Asphalt shall be the number of gallons before dilution with water.



June 11, 1971

REVISION OF SECTION 411  
EMULSIFIED ASPHALT PAVEMENT BINDER  
COLORADO PROJECT NO. I 70-1(31)88

Section 411 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work shall consist of treating a newly laid bituminous surface course with an elastomeric emulsion product, Petroset - AT.

Work shall be done in accordance with these specifications and reasonably close conformance with lines and grades shown on the plans or established.

MATERIALS

Petroset - AT shall conform to the manufacturer's specifications.

CONSTRUCTION REQUIREMENTS

Petroset - AT shall be applied with a pressure distributor. Distributor equipment shall conform to requirements of subsection 407.05 or as directed by the Engineer.

APPLICATION REQUIREMENTS

Petroset - AT shall be applied on the newly completed asphalt pavement as soon as practical after compaction has been completed.

Rate of application and dilution of the Petroset - AT emulsion shall be in accordance with the manufacturer's recommendations. It is estimated that approximately 0.40 gallons per square yard of the concentrate will be required. This shall be applied in two separate applications of approximately 0.20 gallons per square yard.

For application, Petroset - AT should be diluted in a ratio of two parts of concentrated emulsion to one part water. This ratio is optimum and more water may be added, as directed by the Engineer. Highly alkaline water should be avoided and if used a trial mix shall be made on a small quantity and if emulsion does not separate the water is acceptable.

After penetration has been accomplished (Approx. 30 min.) the treated area shall be sanded with about 1 - 2 lb. per square yard, prior to opening to traffic.

General traffic shall be controlled such that no vehicle shall be permitted on the Petroset-AT treated pavement until sanding has been completed.

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REVISION OF SECTION 411  
EMULSIFIED ASPHALT PAVEMENT BINDER  
COLORADO PROJECT NO. I 70-1(31)88

METHOD OF MEASUREMENT

Petroset - AT, elastomeric emulsion, will be measured by the gallon of concentrate, before any water is added at the project.

BASIS OF PAYMENT

The accepted quantities of Petroset - AT, elastomeric emulsion, will be paid for at the contract unit price per gallon.

Pay items will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Petroset - AT Elastomeric Emulsion	Gallon

Payment for Petroset-AT, Elastomeric Emulsion shall be full compensation for all work necessary to complete the item.

June 11, 1971

REVISION OF SECTION 411  
CRACK REDUCTION FABRIC TREATMENT  
COLORADO PROJECT NO. I 70-1(31) 38

Section 411 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work shall consist of preparing and treating an existing asphalt surface with Non-Woven Fabric to reduce reflective cracking. Work shall be done in accordance with these specifications and reasonably close conformance with lines and grades shown on the plans.

MATERIALS

Fabric - Non-Woven Polypropylene, Trade name Petromat fabric.

Asphalt Emulsion CRS -2h (CRS-2h shall meet the requirements for CRS-2, except that the penetration of the residue shall be between 40 and 90.)

CONSTRUCTION REQUIREMENTS

The areas to be treated shall be as marked by the Engineer.

Cracks shall be filled - See Phillips Construction Spec. 4.1.

The pavement surface shall be broomed clean where necessary. A primer composed of Asphalt Emulsion CRS-2h, is to be applied to the surface at the rate of approximately 0.20 gal/sq. yd. based on residual asphalt.

The fabric strips shall be placed on the primed surface according to manufacturers recommendations.

Asphalt Emulsion, CRS-2h or SS-1h shall then be applied to the fabric surface at the rate of approximately 0.05 gal/sq. yd. as a tack coat prior to hot mix overlay.

Traffic shall be kept off the newly placed fabric until the bituminous surface course has been placed.

At least 36 to 48 hours setting time shall be allowed before covering the fabric with hot bituminous pavement.

The fabric shall not be subjected to temperatures higher than 300° F.

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REVISION OF SECTION 411  
CRACK REDUCTION FABRIC TREATMENT  
COLORADO PROJECT NO. I 70-1(31)38

METHOD OF MEASUREMENT

Non-Woven Polypropylene Fabric (Petromat) will be measured by the square yard and shall include all work completed and accepted prior to covering with hot bituminous pavement.

Emulsified Asphalt will be measured and paid for in accordance with Section 411.

BASIS OF PAYMENT

The accepted quantities of Petromat will be paid for at the contract unit price per square yard.

Payment will be under:

<u>Pay Item</u>	<u>Pay Unit</u>
Petromat	Square Yard

Payment for Petromat shall be full compensation for all work necessary to complete the item.

Emulsified Asphalt will be paid for under Section 411.

June 11, 1971

REVISION OF SECTION 702  
RUBBERIZED ASPHALT CEMENT  
COLORADO PROJECT NO. I 70-1(31)38

The following is added to Section 702 of the Standard Specifications for this project:

<u>PROPERTY</u>	<u>ASTM NO.</u>	<u>SPECIFICATION</u>	
		<u>Min.</u>	<u>Max.</u>
Pen @ 77° F. (100 gm, 5 sec)	D 5	120	150
Flash Point, ° F., C.O.C.	D 92	425	
Duct @ 77° F. (5 cm/min)cm	D 113	100	
Duct @ 39° F. (5 cm/min)cm	D 113	40	
Ash, %	D 271	1.0	
Thin Film Oven Test	D 1754		
Loss on Heating, %		1.0	
Tests on Residue:			
% of Original Pen	D 5	46	
Neoprene, Wt. %		1.5	
Toughness, Inch-pounds	*	45	
Tenacity, Inch-pounds	*	35	
Spot Test, Base Asphalt	AASHTO T 102	Neg.	
Specific Gravity @ 77° F.	D 70		
Specific Gravity @ 60° F.	D 70		
Pounds per Gallon @ 60° F.			

\* Benson Method of Toughness and Tenacity: Scott tester, inch-pounds@ 77° F., 20 inches per minute pull. Tension head 7/8 inch diam.