HEATER SCARIFICATION AND ASPHALT-RUBBER-SAMI
NEPT KS-7701 F
77-57-F 055-2(6) Marion County
Final Report
August 1978 to October 1986
by

ABSTRACT

The prime objective of this experimental project was to evaluate a Surface Absorbing Membrane Interlayer (SAMI) supplied and applied by Sahuaro Petroleum and Asphalt Co.

The SAMI was constructed by applying an asphalt-rubber mix over a heater-scarified bituminous pavement. Aggregate was applied on top of the asphalt-rubber, rolled, and the whole system was overlayed with 2.5 inches of hot mix.

A test section, containing the constructed SAMI, was compared with a control section without a SAMI. The SAMI test section did not perform as well as the control section from about the third year on. After eight years of service, the SAMI section had more cracks than the section without the SAMI. The SAMI section cost $20,560 more a mile. Thus, the SAMI was not effective in reducing cracks and it had a negative cost benefit.
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ACKNOWLEDGMENTS

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Mr. Ray Wilcox, former Area Engineer, and personnel in the Marion, Kansas Construction Office were in charge of construction and accomplished most of the post-construction crack surveys. Mr. Jim Thissen and Mr. Robert Heinen of the Research Unit did the data tabulation and other information gathering for this report.

Initial typing of this report was done by Mrs. Mary Remboldt. Thanks are due to the Word Processing Unit of the Support Services Section for their processing of the report.

NOTICE

The authors, the State of Kansas, and the United States Government do not endorse products or manufacturers. Product or manufacturers names appear herein solely because they are considered essential to the object of this report.

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or policies of the State of Kansas or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PREFACE

Mr. Rodney G. Maag and Mr. William H. Parcells, Jr., previous Bituminous Research Engineers, were responsible for the preliminary investigations, work plan, and the first few years of the post-construction phases. Mr. Glenn A. Fager, present Bituminous Research Engineer, made the cost evaluation and wrote this final report.

INTRODUCTION

Bituminous pavements can fail in one of basically five modes, cracking, raveling, rutting, shoving, and/or bleeding. There may be other modes of bituminous pavement failures but for simplicity we have classified them in those modes. Rutting, shoving and bleeding are sometimes seen together and usually do not result in a pothole, but are considered a failure of the whole bituminous mix system. Rutting could be further classified as compaction or plastic flow rutting. Raveling can be caused by segregation, stripping, surface oxidation, or bacterial action in the mix. Cracks can be caused by traffic, the environment, or a reflection from the underlying surfaces.

It is the intention of this research report to specifically address the attempt to reduce or eliminate reflective cracks. There are several methods of treatment available to possibly reduce the amount of reflective cracks. One of these treatments is called the SAMI (Stress Absorbing Membrane Interlayer). Sometimes it is referred to as a SRMI (Stress Relieving Membrane Interlayer).
The SAMI (or SRMI) installation is a surface treatment made with rubber-asphalt on the old surface and with the applied aggregate, may be up to 0.5 inch thick. It has been reported to be effective over flexible pavements with fatigue cracking but has been ineffective on the linear or opening mode of cracking as found in a rigid pavement (Portland Cement Concrete). The rubber asphalt is typically a 75 to 80 percent conventional paving grade asphalt mix, blended (around 400°F) with 20-25 percent rubber. The rubber usually is from ground-up used vulcanized vehicular tires. The rate of surface application is 0.6-0.8 gallons/yd². Aggregate that is placed on top of the asphalt-rubber is spread at 16-25 lbs/yd². The aggregate chips are described as coarse sand to pea size gravel. Small amounts of solvent or extender oil (1 to 5 percent) may be added to facilitate bonding depending on the grade of asphalt and the type of rubber used. The idea is to apply just enough aggregate to cover and give a working surface that is one layer thick. This is to ensure that the resulting SAMI will exhibit primarily the desired properties of the asphalt-rubber material with least interference from the aggregate particles. A SAMI so constructed would have a thickness of 0.35-0.50 inch.

It is with this previous described SAMI system in mind, that a research project was undertaken on US-77 in Marion County. This project was part of an overall effort to reduce reflective cracking. The project was to evaluate the use of the SAMI and its cost effectiveness. Figure 1 shows the location of the construction site.

PRECONSTRUCTION INVESTIGATION

The selected project site (US-77 Marion County) was surfaced in 1949 with 6 inches of an AB-3 (Waterbound Limestone) plus 2.5 inches of a HM-2A (Binder Course). A 3 inch HM-6 (Mixed Aggregate, Surface Course) overlay was constructed in 1958. In 1969 a 0.75 inch HM-R (Hot Mix Machine Laid Seal) was added to the surface. By 1978, numerous maintenance patches had been applied throughout the length of the project. Total thickness of the bituminous layers, including the seals, was approximately 6 inches.

An investigation by KDOT's Soils Section had been requested by management in July 1976. The investigation consisted of a condition survey, deflection study, and physical measurements of the subgrade and pavement. Two test sites in each mile were selected on a random basis, and the type of cracks, spacing, and severity of failure were recorded. Structural failures, maintenance patches, and the general appearance were also recorded.

The condition survey showed that the pavement was badly cracked (Figure 2). The primary causes were inadequate structural thickness and shrinkage cracking. It could be seen that the cracks had reflected through previous overlays and maintenance patches. In a few locations, a "rich" thin maintenance overlay had flushed in the wheel paths and had effectively sealed the cracks (Figure 3). Many of the transverse cracks were open 0.5 to 1 inch in width, and water had entered in the immediate area causing saturation of the subgrade and stripping of the asphalt. As the traffic passed over the weakened crack/joint, a depression resulted. Some sites showed complete fatigue failure in the form of alligator cracking.

A deflection study was conducted by obtaining Benkelman Beam deflections from the pavement. These deflections were obtained by measuring pavement vertical movements before and after the pavement was unloaded. An 18,000 lb.
Figure 1. Location of Project No. (R) 77-57 F 0552(6).

Figure 2. Roadway before construction.
Figure 3. Roadway before construction.

Figure 4. Heater-scarification.
load/force applied to a single axle with dual wheels was used as the load/force in generating the deflections. The exact "point of contact" in measuring the deflections was between the dual wheels. A series of five tests were run at 50 foot intervals at each test site. Two beams were used, one in each wheel path to record the respective deflections.

The results from the deflection study indicated that the average representative rebound deflection was 0.047 inches with a range of 0.035-0.139 inches. Given this deflection and the projected traffic for a ten year design life, the overlay thickness required would be a 2.5 and 4.0 inch overlay. Two areas would require a 4 inch overlay to adequately carry the anticipated traffic for the next ten years.

The physical measurements taken were temperatures of the pavement and subgrade, and thickness of the surface and base. Moisture and soil samples of the subgrade were also taken.

The recommendations from the Soils Section showed that the overlay thickness required for the project would be satisfied by a 2.5 inch hot mix overlay, and a 4.0 inch hot mix overlay in a river valley area. Even though the 2.5 inches provided the needed structural strength, it was anticipated that reflective cracking would appear as early as one year. Also, complete and total reflective cracking was anticipated within 3 years after the overlay had been constructed. It was also felt that a thicker overlay (3 inch) would not appreciably extend the time before reflective cracking would appear. An additional 0.5 inch would be virtually useless in preventing reflective crack failure.

Two more recommendations were made by the Soils Section. In order to reduce the amount of reflective cracking and thereby increase the service life of the overlay, a SAMI would be constructed. Tests in some other states indicated that a SAMI would eliminate or substantially reduce reflective cracking. Several asphalt-rubber SAMI's had been constructed in Arizona from 1971 through 1973. The results were favorably reported, therefore any additional cost of construction was predicted to be worth the money spent to obtain a virtually crack-free pavement. Construction of a SAMI would not add any structural thickness of the Section. It would be merely a stress relieving membrane. The SAMI as described earlier, would be an asphalt-rubber interlayer membrane and the savings realized in not placing the additional 0.5 inch overlay thickness could be applied to the SAMI. It was felt that any additional cost would be worth the money. Not only was the pavement predicted to be structurally sound for a 10 year period, but maintenance on the cracks should be reduced substantially.

The procedures to be used to construct the asphalt-rubber SAMI are listed in Table 1. The specifications for the SAMI are presented in Appendix A (Special Provision 73P-265).

Table 1. Typical Properties of the SAMI.

1. Asphalt-rubber.
   a. Use 25 percent rubber and 75 percent asphalt.
   b. Rubber is obtained from "ground-up" vulcanized tires.
c. React the rubber and asphalt at approximately 400°F for such a time that the material will reach application consistency.

d. Lower the viscosity with 1 to 5 percent kerosene or as required.

2. Aggregate.

   a. Used crushed limestone.

   b. Spreading rate is approximately 25 lbs/yard².

The last recommendation was that all cracks be filled. During previous investigations it was noticed that attempts to seal cracks 0.5 inch or wider with asphalt had not been entirely successful. A major portion of the problem resulted from asphalt running out the end of the crack. It was therefore recommended that a less fluid bituminous mixture (such as an asphalt and sand mix) be used to fill cracks 0.5 inch or wider. This mixture would be less fluid than pure asphalt, causing it to stay put, and requiring less asphalt to fill the cracks. The asphalt-rubber mixture previously described could be used as an alternate for the crack filler.

The original work plan submitted to the Federal Highway Administration included five other projects (see Appendix B). The work plan called for test and control sections to be set up, constructed, and monitored for approximately 10 years. At least twice during the first year, then once each year, a crack survey would be taken of the test and control sections. A comparison was to be made between the test and control sections. Long term effectiveness of the treatments in preventing reflective cracking was the prime objective of this experimental work. For this project the original work plan called for crack repair, an asphalt-rubber SAMI, and a 2.5 inch BM-2 overlay with an additional 1.5 inch BM-2 thru the river valley as needed. Later (approximately May 1978) management made the decision to eliminate the crack repair and substitute a 0.75 inch heater-scarification with Reclamite (See Appendix C, Special Provision 73P-1235 Heater-Remix). The condition of the roadway required a more substantial rehabilitation than could be attained by the crack repair alone. The supplement to the work plan is presented in Appendix D. This supplement and the original work plan made up the complete work plan for this project.

The Control and Test section to be constructed were as follows:

<table>
<thead>
<tr>
<th>Control Section (Sta. 385+00 to 395+00)</th>
<th>Test Section (Sta. 395+00 to 405+00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000' long Heater Scarification</td>
<td>1000' long Heater Scarification</td>
</tr>
<tr>
<td>No SAMI</td>
<td>Asphalt-Rubber SAMI</td>
</tr>
<tr>
<td>2.5 inch BM-2 Overlay</td>
<td>2.5 inch BM-2 Overlay</td>
</tr>
</tbody>
</table>

CONSTRUCTION

The original crack survey was completed by the Research Unit on August 1, 1978. This survey was completed before any new construction, therefore the condition of the "old" roadway test sections were documented. A summary of the pavement cracking (before construction) is shown in Table 2. Evaluation of the crack surveys would be based as a percent of the before construction crack survey.
Table 2. Pavement Cracking before Construction.

<table>
<thead>
<tr>
<th>Location</th>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sta. 385+00 to 395+00 (Control - No SAMI)</td>
<td>2451</td>
<td>3273</td>
</tr>
<tr>
<td>Sta. 395+00 to 405+00 (SAMI)</td>
<td>2376</td>
<td>3156</td>
</tr>
</tbody>
</table>

On August 9, 1978, the contractor started heater-scarification (See Figure 4 and 5). The rejuvenator (Reclamite) was applied with a distributor at 0.075 gallons/yd² (see Figure 6). (Note the contractors method of heater scarification was crude by today's standards.) Samples were obtained from the pavement before and after scarification at different time periods. The asphalt was extracted by the Abson method in order to determine the properties at the selected times. The results of the laboratory tests are shown in Figure 7. Heater-scarification had little or no effect on penetration, ductility, and 140°F. viscosity, but did increase the 275°F. viscosity and softening point number. The samples taken 5 minutes and 1 hour after Reclamite was applied showed a significant improvement in the penetration, ductility, viscosity, and softening point. After 5 weeks, the asphalt properties showed a significant amount of hardening. This may indicate that the effects of the Reclamite may be short lived at an application rate of approximately 0.075 gallons per square yard.

A letter from the Resident Engineer indicated several problems associated with spraying the Reclamite on top of the scarified surface. Five paragraphs from his letter are quoted and illustrates his concern. His comments were:

"Field observations indicated that we were not obtaining 100 percent penetration into the heater-remixed material when applying the concentrated rejuvenating agent at the rate of 0.10 gal. sq. yd. The use of the word "penetration" in this particular instance may and or may not be the correct terminology. We are attempting to convey the thought that we fully expected the heater-remixed material to act more like a sponge and or blotter after the rejuvenating agent was applied.

Numerous areas appeared to have a surface glaze after the application of Reclamite. This glazed appearance however, did not propagate into a "slick spot" to the magnitude anticipated by K.D.O.T. Field Personnel.

(a) Applying Blotter Sand to the aforementioned areas proved to be surprisingly ineffective.

In areas where K.D.O.T. Maintenance Forces had installed "premix" either as a patch or overlay and or where extensive crack filling material was used, the heater-remix operation actually re-activated the asphalt in the "existing material to such a high degree that a greasy and or flushing" condition existed. The use of Reclamite in these areas was, in the Engineers opinion, an exercise in futility and unjudicious.
Figure 5. Heater-scarifier teeth.

Figure 6. Application of Reclamite.
Figure 7. Effects of Scarification and Reclamite in Rejuvenating Bituminous Pavement on US-77 in Marion County. (Samoles taken from the top 0.75 inches of the old pavement).
TRAFFIC WAS CARRIED THROUGH CONSTRUCTION on both projects and prompts the following remarks:

a. The "TIME" and or interim, which vehicular traffic actually traversed the Reclamite surface varied anywhere from forty-eight (48) hours (Refer 73P-227R) to as much as four (4) weeks.

b. We did not observe any "bleeding through" the 1" overlay on the US 50 project nor the rubber-asphalt seal on the US 77 project in so far as Reclamite is concerned.

c. "Raveling" of the heater-remix with application of Reclamite was negligible and or non-existent.

d. To the nearest of our knowledge there was one passenger car which the Contractor was required to pay for "Cleaning" as the result of excess Reclamite on the surface which was picked up by the vehicle tires.

e. Most rejuvenating agent applications on the heater-remixed and rolled material were made in one thousand (1,000) foot increments.

As the result of our past construction seasons experience with a concentrated rejuvenating agent we recommend the following:

The rate of application should read 0.10 gal. sq. yd. and or as directed by the Field Engineer i.e. we feel that the actual rate of application should be definitely the Field Engineers decision.

The asphalt-rubber SAMI was applied by Sahuarro Petroleum to both lanes in August, 1978. The SAMI application was a good uniform operation. A 75 to 25 asphalt to rubber-mix by weight was applied at 0.7 gallons per square yard (see Figure 8). Average ambient conditions in the afternoons during application were as follows:

Pavement Surface Temperature: 103°F.
Air Temperature: 96°F.
Relative Humidity: 39%
Windspeed: 18mph.

Aggregate was then added (see Figure 9) and then rolled by large pneumatic rollers (Figure 10).

The 2.5 inch bituminous overlay was a good uniform operation. Standard equipment was used with no major problems. Operations started in September and finished in October, 1978. Hot-mix had an average hopper temperature of 264°F. and an average temperature of 238°F. immediately after laydown. Rolling was accomplished immediately after laydown. Average ambient conditions in the afternoon during overlay were as follows:

Pavement Surface Temperature: 91°F.
Air Temperature: 85°F.
Relative Humidity: 70%
Windspeed: 4.3mph.
Figure 8. Application of asphalt-rubber.

Figure 9. Application of aggregate onto the asphalt-rubber.
Figure 10. Pneumatic rollers on the Asphalt-Rubber.

<table>
<thead>
<tr>
<th>Station 385+00</th>
<th>Station 395+00</th>
<th>Station 405+00</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Sta. 385+00 to 395+00</strong></td>
<td><strong>Test Sta. 395+00 to 405+00</strong></td>
<td></td>
</tr>
<tr>
<td>2.5&quot; BM-2</td>
<td>2.5&quot; BM-2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAMI 0.75&quot; Heater 0.75&quot; Scarification plus reclaimite</td>
</tr>
<tr>
<td>6&quot; Original Bituminous Mat</td>
<td>0.75&quot; HM-R 1969 3.0&quot; HM-6 1958 2.5&quot; HM-2A 1949</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6&quot; AB-3 Rock Base</td>
<td></td>
</tr>
</tbody>
</table>

Figure 11. Control and Test Section.
Figure 11 is a cross section of the test and control sections. The original base and pavement mat is shown along with the newly constructed SAMI and 2.5 inch BM-2 overlay.

POST-CONSTRUCTION MONITORING

After the construction was completed, crack surveys were normally conducted twice a year. The last survey was completed in October 1986. At this time it was obvious that the SAMI test section had about twice as many cracks as the control section and thus was not performing as well as the control section. Based on the amount of cracking before the overlay, both longitudinal and transverse cracking were more severe in the SAMI test section than the control section from about the third year on. Figures 12 and 13 show the crack deterioration rate in each section. Thus far, the reflected cracks have not required sealing in either section and there is minimal wheelpath rutting. On September 26, 1986 the wheel ruts average 0.14 and 0.12 inches for the SAMI and control test sections respectively. However, the ride quality for both sections remained acceptable after 8 years of exposure to traffic.

COST ANALYSIS

The research project is being terminated even though the percentage of reflective cracking has not reached 100%. It was felt by the Research Unit that the SAMI would not perform as well as the control section. In order to determine a cost/mile/year, one would have to determine the life of each test section. Then the construction cost and periodic maintenance cost would have to be determined and deflated back to the time of construction. Knowing the life and the present worth of each test section, then the cost/mile could be prorated over its individual life. Due to the fact that the entire life will not be known, only the cost/mile of the test and control sections will be determined. The cost rates for each construction action was computed from the construction records and are listed in Table 3.

Table 3. Unit Cost Rates for Each Construction Action.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost/Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Scarification</td>
<td>$6,220</td>
</tr>
<tr>
<td>SAMI</td>
<td>20,560</td>
</tr>
<tr>
<td>BM-2 Overlay</td>
<td>51,590</td>
</tr>
<tr>
<td>Misc. (earthwork, traffic control, office, mobilization, concrete, etc.)</td>
<td>83,150</td>
</tr>
</tbody>
</table>

The actual cost/mile of the SAMI, heater scarification, and overlay will vary slightly due to a limited amount of shoulder and interchange construction. Except for a few minor variations, the heater scarification and SAMI were constructed in 24 and 30 foot widths respectively. The BM-2 overlay was 2.5 inches thick and 28 feet in width, except at the intersections and a small section in a river valley where it did vary in width and depth.

The miscellaneous cost rate is abnormally high due to extensive earthwork, concrete pipe culverts, and other associated construction work. However, it must be included as it did add to the total cost of the project.
Figure 12: Percent Transverse Cracks vs Time

Figure 13: Percent Longitudinal Cracks vs Time
Table 4. Unit Cost for each Section (Excluding Miscellaneous).

<table>
<thead>
<tr>
<th>Section</th>
<th>Cost/Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Section (No SAMI)</td>
<td>$57,810</td>
</tr>
<tr>
<td>Test Section (SAMI)</td>
<td>78,370</td>
</tr>
</tbody>
</table>

The construction costs of the control and test section is shown in Table 4. As can be seen the cost of constructing a SAMI resulted in an additional $20,560/mile.

CONCLUSIONS

On this particular project the addition of a SAMI (Surface Absorbing Membrane Interlayer) did not increase pavement life and was not cost effective.

From the crack surveys, as indicated in Figures 12 and 13, the addition of a SAMI did not increase the life of the pavement. The control section performed better than the SAMI test section. Even though the control and test sections had not reached the same state of deterioration that was present before the reconstruction, it is obvious from the figures that the SAMI will not increase pavement life on this project. The SAMI would also cost an additional $20,560/mile.
NOTE: Whenever this Special Provision conflicts with the Plans, Supplemental Specifications or Standard Specifications, this Special Provision shall govern.

HOT RUBBER-ASPHALT SEAL TREATMENT

1.0 DESCRIPTION: This Special Provision covers the requirements for materials, application rates, equipment and construction methods for use on the Hot Rubber-Asphalt Seal Treatment.

Big Items:
Rubber-Asphalt
Kerosene
Cover Material - Special
Blotter Sand
Emulsified Asphalt (SS-1H)
Water for Emulsified Asphalt Manipulation

2.0 MATERIALS:

A. REQUIREMENTS:

(1) Bituminous Materials

1.1 Asphalt Cement ............... Section 1002.01 (Std. Specs.)
As shown on the Plans
1.2 Emulsified Asphalt (SS-1H) ........ Section 1002.01 (Std. Specs.)

(2) Kerosene - The kerosene shall have a boiling point of not less than 350°F or 177°C.

(3) Water ....................... Section 1014.02 (Std. Specs.)

(4) Ground Vulcanized Tire Rubber - The ground tire rubber shall be fully vulcanized and shall meet the following requirements:

4.1 Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>$%$ Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>0</td>
</tr>
<tr>
<td>No. 10</td>
<td>0 - 2</td>
</tr>
<tr>
<td>No. 40</td>
<td>50 - 100</td>
</tr>
</tbody>
</table>

4.2 The ground tire rubber, irrespective of diameter shall be less than 7 mm in length.

4.3 The specific gravity of this material shall be 1.15 ± 0.03.

4.4 This material shall contain no more than a trace of fabric and shall be free from wire or other contaminating materials, except that up to 1% of calcium carbonate may be included to prevent the particles from sticking together.

(5) Aggregate for Blotter Sand - shall comply with the requirements of FA-A in Section 1001.02 (c).

(6) Aggregate for Cover Material - The aggregate for cover material shall comply with the requirements of Section 1001.08 of the Standard Specifications with the following additions and exceptions:

6.1 Quality Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soundness, Minimum</td>
<td>0.30</td>
</tr>
<tr>
<td>Wear, Maximum</td>
<td>40%</td>
</tr>
<tr>
<td>Absorption, Maximum</td>
<td>4.0%</td>
</tr>
</tbody>
</table>
6.2 Chat or sandstone aggregates will not be allowed.

6.3 Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>0</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0 - 30</td>
</tr>
<tr>
<td>No. 4</td>
<td>90 - 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 200</td>
<td>98 - 100</td>
</tr>
</tbody>
</table>

6.4 It shall be clean and free of any clay coating.

6.5 Percent Crushed - A minimum of 75 percent of the material, by weight, retained on the No. 8 sieve shall have at least one fractured face.

B. Basis of Acceptance,

1. Bituminous Material ------------ Section 1002.01 (Std. Spec.)

2. Ground Vulcanized Tire Rubber - will be accepted on the receipt and approval of a Type D Certification as described in Section 1016 of the Standard Specifications.

3. Aggregate ------------ Section 1001 (Std. Specs.)

4. Kerosene - will be accepted on the receipt and approval of a certification from the Supplier indicating the material complies with the specifications.

5. Water ------------ Section 1014.02 (Std. Specs.)

3.0 Equipment Requirements:

A. Self Propelled Pneumatic Tired Rollers. Self propelled pneumatic tired rollers shall be used. They shall meet the requirements stipulated in Section 601 of the Standard Specifications except they shall carry a minimum of 5000 lbs. (2270 kilograms) on each wheel with each tire being inflated to a minimum pressure of 100 lbs. (45.4 kilograms) per square inch (6.95 sq. cm.).

B. Self-propelled aggregate spreader. A self-propelled aggregate spreader meeting the requirements stipulated in Section 601 of the Standard Specifications shall be used. Rear-end wheels (non-steering) shall be dualized wheels.

C. A self-powered pressure distributor equipped with a separate power unit, distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating and mixing the bituminous material. The distribution bar on the distributor shall be fully circulating with nipples and valves so constructed that they are in such intimate contact with the circulating asphalt that the nipples will not become partially plugged with concealed asphalt upon standing, thereby causing preliminary streaked or irregular distribution of the asphalt. Any distributor that produces a streaked or irregular distribution of the material shall be promptly removed from the project.

Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, mixing equipment and a thermometer for reading temperature of tank contents. The spray bars on the distributor shall be controlled by a person riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible to him for controlling spread widths.

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture. The mixing equipment shall be capable of producing and maintaining a homogeneous mix of rubber and asphalt so that separation does not occur.

Prior to the spreading of the rubber asphalt composition all distributor trucks proposed for use shall have been tested within six months from the date of spreading to determine the rate of the transverse spread. The Contractor shall furnish the engineer with evidence that the transverse spread of the distributor trucks, when the trucks were approved for use, was as uniform as practicable and under no conditions was there a variance on any of the test pads greater than plus or minus 15 percent. If there is evidence to the contrary, the Engineer may require that each distributor truck be tested to determine the rate of the transverse spread. Transverse spread shall be determined on the vulcanized rubber asphalt product meeting these specifications only.
4.0 CONSTRUCTION REQUIREMENTS:

A. MIXING,

(1) The materials shall be combined as rapidly as possible for such a time and at such a temperature that the consistency of the mix approaches that of a semi-fluid material. The temperature of the asphalt shall be between 350°F (177°C) and 450°F (232°C). The Engineer shall determine when the material has reached application consistency.

(2) The proportions of the two materials, by weight, shall be 75 percent, plus or minus 2 percent, asphalt; and 25 percent, plus or minus 2 percent, rubber. (The percentage of rubber shall equal 33 1/3% 2 percent of the asphalt weight). After the full reaction described in mixing (1) above has occurred, the mix shall be diluted with kerosene. The amount of kerosene used shall not exceed 6.6% by weight, of the hot rubber-asphalt composition. The kerosene is required to adjust the viscosity for spraying and better "wetting" of the cover aggregate. The kerosene shall have a boiling point of not less than 350°F (177°C), and the temperature of the hot composition shall not exceed this temperature at the time of adding the diluent.

(3) After reaching the proper consistency, application shall proceed immediately.

The effect of kerosene on viscosity is lost with the passage of time. If the viscosity has become so affected that non-uniform transverse spread and chill-frothing develops the remainder of the load shall be rejected.

B. SPREADING

(1) Prior to the hot rubber-asphalt treatment, the surface to be sealed shall be cleaned, by power brooming or other approved method, patched as required, and treated with a bituminous tack coat consisting of 0.05 to 0.1 gallon per square yard of diluted SS-11 emulsified asphalt (.02 to .05 cal/yd.² residue).

(2) The application rate of the hot rubber-asphalt mixture shall be 0.75 to 0.15 gallons per square yard or as otherwise designated on the plans or by the Engineer, (based on 7 1/2 pounds (3.4 kilograms) per hot gallon). Do not use conversion factors to 60°F (16°C); use weight only. After reaching the proper consistency, application of the material shall proceed immediately. The material shall be placed only when a uniform application is being achieved. The end result must be a uniform impermeable membrane of rubber-asphalt.

(3) The application of cover material shall proceed immediately behind the distributor. The cover material shall be applied with a self-propelled aggregate spreader at a rate of approximately 35 to 39 pounds per square yard for 3/8 inch nominal size aggregate as directed by the Engineer. In any event the rate shall be high enough to prevent pickup by the equipment involved in the spreading and rolling of the aggregate.

The operations of distributing the rubber asphalt shall be so controlled that under no circumstances shall operations proceed in such a manner that the rubber asphalt will be allowed to chill, set-up or dry prior to the application of cover material.

The moisture content in the aggregate applied directly to the surface of the rubber-asphalt shall not exceed one (1) percent of free moisture (when) compared to the surface dry condition determined as follows:

Weigh approximately 1000 gram sample of aggregate from the stock pile. Place weighed sample in large absorbent cloth and roll to remove all visible films of water. Weigh surface dried sample. Calculate free moist by the following formula:

\[ M = \frac{W_1 - W_2}{W_2} \times 100 \]

WHERE \( M \) = percent free moist
\( W_1 \) = weight in grams of original stock pile sample
\( W_2 \) = weight in grams surface dried sample

Procedures of starting, stopping or turning any piece of equipment which results in displacement of the cover material or damage to the rubber-asphalt shall be prohibited.
The spreading equipment shall be of such width and arrangement that as the aggregate is placed complete coverage will be obtained. Any rearrangement of cover material necessary prior to rolling shall be performed by hand methods. All spillage shall be removed from the surface.

Rolling of the cover material shall be performed with self-propelled pneumatic rollers meeting the requirements stipulated under Equipment A. The first pass of the rollers shall proceed immediately after application of the cover material in order to ensure maximum embedment of the aggregate. Rolling shall continue until four (4) complete coverages are obtained. A minimum of three (3) rollers shall be furnished. The initial rolling of one (1) complete pass will be completed as close behind the spreader box as possible. An application of approximately five (5) lbs. per square yard of blotter sand (FAS) shall be applied after the second coverage of rolling has been completed and prior to the final rolling. Final rolling shall be completed after the application of sand. The rollers shall be operated at a speed at which the aggregate will not be displaced and damage result to the rubber asphalt. Damaged areas where the membrane has been broken or punctured will be repaired by spraying on additional material.

(4) All joint edges shall be swept clean of overlapping cover material prior to the adjacent application of rubber-asphalt material. All longitudinal joints shall be lapped a minimum of 2 inches (5.1 cm). All reasonable precautions shall be taken to protect the surfaces of adjacent structures from being spattered or marred. All transverse joints shall be made by placing building paper over the ends of the previous applications, and the joining application shall start on the building paper. The paper shall be removed and disposed of to the satisfaction of the Engineer.

(5) Traffic shall not be permitted on the completed surface until such time as determined by the Engineer. The minimum cure time shall be three hours after the completion of the final rolling. The speed of all hauling equipment and pilot cars which must use the fresh seal coat shall be limited to 15 miles per hour during the cure period.

(6) All loose cover material shall be removed by a rotary sweeper power broom as soon as sweeping causes no discernible displacement of the embedded cover aggregate.

(7) Rubber asphalt operations shall be performed only when the weather is satisfactory; the pavement is dry; the ambient air temperature is above 60 degrees F (15 degrees C) and rising, and the wind conditions such that a satisfactory membrane can be achieved.

5.0 METHODOF MEASUREMENT: Rubber-Asphalt, Bituminous Materials and Kerosene will be measured by the ton as provided in Division 100 of the Standard Specifications.

Cover Material and Blotter Sand will be measured either by the cubic yard or by the ton as indicated in the proposal. When measured by the cubic yard, the material will be measured in the vehicle at the time and place of unloading. When measured by the ton, the material will be weighed in the vehicle at the time and place of unloading or at such other points as may be designated by the Engineer. No deductions will be made for moisture in the cover material or blotter sand.

Manipulation will be measured per one hundred foot (100-foot) station which includes all widened and irregular areas. The item includes all necessary items of work and incidentals not listed as bid items. No additional measurement will be made of widened sections or for irregular areas.

Water ordered by the Engineer will be measured per thousand (1,000) gallons by means of calibrated tanks or water meters.

6.0 BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, will be paid for at the contract unit price bid per cubic yard or per ton for "Cover Material and Blotter Sand", per ton for Rubber-Asphalt, Kerosene and the various types and grades of Bituminous Materials and per one hundred foot (100 foot) stations for "Manipulation", per thousand (1,000) gallons for "Water", which prices will be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.
APPENDIX A

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
TO THE
STANDARD SPECIFICATIONS
EDITION OF 1973

NOTE: WHENEVER THIS SPECIAL PROVISION CONFLICTS WITH THE PLANS, SUPPLEMENTAL SPECIFICATIONS OR STANDARD SPECIFICATIONS, THIS SPECIAL PROVISION SHALL GOVERN.

HOT RUBBER-ASPHALT SEAL TREATMENT

1.0 DEFINITION: THIS SPECIAL PROVISION GOVERNS THE REQUIREMENTS FOR MATERIALS, APPLICATION RATES, EQUIPMENT AND CONSTRUCTION METHODS FOR USE ON THE HOT RUBBER-ASPHALT SEAL TREATMENT.

Big Items:
- Rubber-Asphalt
  - Diluent
  - Cover Material - Special
  - Blotter Sand
  - Emulsified Asphalt (US-14)
  - Water for Emulsified Asphalt

2.0 MATERIALS:

A. REQUIREMENTS:

1.0 Bituminous Materials

1.1 Asphalt Cement. .........................Section 1092.01 (Std. Specs.)

1.2 Emulsified Asphalt (US-14) ..........Section 1092.01 (Std. Specs.)

2.0 Diluent - The Diluent Shall Be A Solvent Having A Boiling Point Of Not Less Than 250°F (127°C).

3.0 Water .......................Section 1014.02 (Std. Specs.)

4.0 Ground Vulcanized Tire Rubber - The Ground Tire Rubber Shall Be Fully Vulcanized And Shall Meet The Following Requirements:

4.1 Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>0</td>
</tr>
<tr>
<td>No. 10</td>
<td>0 - 2</td>
</tr>
<tr>
<td>No. 20</td>
<td>90 - 100</td>
</tr>
</tbody>
</table>

4.2 The Ground Tire Rubber, Irrespective Of Diameter, Shall Be Less Than 7 MM In Length.

4.3 The Specific Gravity Of This Material Shall Be 1.15±.03.

4.4 This Material Shall Contain No More Than A Trickle Of Fabric And Shall Be Free From Wipe Or Stain Contaminating Materials, Except That Up To 4% Of Calcium Carbonate May Be Included To Prevent The Particles From Sticking Together.

4.5 Aggregates For Blotter Sand - Shall Comply with the Requirements of FA-A in Section 1001.02 (c).

4.6 Aggregates For Cover Material - The Aggregates For Cover Material Shall Comply With The Requirements of Section 1074.05 Of The Standard Specifications With The Following Additions and Exceptions:

4.7 Quality Requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soundness, Minimum</td>
<td>0.90</td>
</tr>
<tr>
<td>Neg. Maximum, Maximum</td>
<td>0.75</td>
</tr>
<tr>
<td>Absorption, Maximum</td>
<td>4.05</td>
</tr>
</tbody>
</table>
6.2 Cut of granite aggregate WILL NOT BE ALLOWED.

6.3 Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>6</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0 - 20</td>
</tr>
<tr>
<td>1/4 in.</td>
<td>90 - 100</td>
</tr>
<tr>
<td>3/16 in.</td>
<td>95 - 100</td>
</tr>
<tr>
<td>1/8 in.</td>
<td>98 - 100</td>
</tr>
</tbody>
</table>

6.4 It shall be clean, washed, and free of any clay coating.

6.5 Percent Crushed - A minimum of 75 percent of the material, by weight, retained on the 1/8-inch sieve shall have at least one fractured face.

6.6 Basis of Acceptance

1. Bituminous Material.............Section 1002.01 (Std. Spec.)

2. Ground Vulcanized Tire Rubber - Will be accepted on the receipt and approval of a Type A Certification as described in Section 1011 of the Standard Specifications.

3. Aggregate.....................Section 1101 (Std. Spec.)

4. Diluent - Will be accepted on the receipt and approval of a certification from the supplier indicating the material complies with the specifications.

5. Water.............................Section 1014.02 (Std. Spec.)

3.0 EQUIPMENT REQUIREMENTS:

A. Self-Propelled Pneumatic Tire Rollers. Self-propelled tire rollers shall be used. They shall meet the requirements stipulated in Section 001 of the Standard Specifications except they shall carry a minimum of 5000 lbs. (2270 kilograms) on each tire with each tire being inflated to a minimum pressure of 100 lbs. (45.4 kilograms) per square inch (6.45 sq. cm.).

B. Self-propelled Aggregate Spreader. A self-propelled aggregate spreader meeting the requirements stipulated in Section 001 of the Standard Specifications shall be used. Rear-end wheels (non-steering) shall be double wheels.

C. A self-propelled pressure distributor equipped with a separate power unit, distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating and mixing the bituminous material. The distribution bar on the distributor shall be fully adjustable with nipples and valves so constructed that they are in such intimate contact with the circulating asphalt that the nipples will not become partially plugged with concealed asphalt upon standing, thereby causing preliminary streaked or irregular distribution of the asphalt. Any distributor that produces a streaked or irregular distribution of the material shall be promptly removed from the project.

Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, mixing equipment and a thermometer for reading temperature of tank contents. The spray bars on the distributor shall be controlled by a person riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible to him for controlling spread widths.

The method and equipment for combining the curbs and asphalt shall be so designed and accessible that the engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture. The mixing equipment shall be capable of producing and maintaining a homogeneous mix of rubber and asphalt so that separation does not occur.

Prior to the spreading of the rubber asphalt composition all distributor trucks proposed for use shall have been tested within six months from the date of spreading to determine the rate of the transverse spread. The contractor shall furnish the engineer with evidence that the transverse spread of the distributor trucks, when the trucks were approved for use, was as uniform as practicable and uniform conditions was there a variance on any of the test pads greater than plus or minus 15 percent. If there is evidence to the contrary, the engineer may require that each distributor truck be tested to determine the rate of the transverse spread. Transverse spread shall be determined on the vulcanized rubber asphalt product meeting these specifications only.
4.9 CONSTRUCTION REQUIREMENTS:

A. MIXING.

1. The materials shall be combined as rapidly as possible for such time and at such a temperature that the consistency of the mix approaches that of a semi-fluid material. The temperature of the asphalt shall be between 350°F (177°C) and 395°F (207°C). The engineer shall determine when the material has reached application consistency.

2. The proportions of the two materials, by weight, shall be 75 percent, plus or minus 2 percent, asphalt, and 25 percent, plus or minus 2 percent, rubber. (The percentage of rubber shall equal 33 1/3 percent of the asphalt weight). After the full reaction described in mixing (1) above has occurred, the mix shall be diluted. The amount of diluent used shall not exceed 6.8% by weight, of the hot rubber-asphalt composition. The diluent is required to adjust the viscosity for spraying and better "wetting" of the cover aggregate. The diluent shall have a boiling point of not less than 350°F (177°C), and the temperature of the hot composition shall not exceed this temperature at the time of adding the diluent.

3. After reaching the proper consistency, application shall proceed immediately.

The effect of diluent viscosity is lost with the passage of time. If the viscosity has become so affected that non-uniform transverse spread and drill-rowing develops the remainder of the load shall be rejected.

B. SPREADING.

1. Prior to the hot rubber-asphalt treatment, the surface to be sealed shall be cleared, by power grooming or other approved method, patched as required, and may be treated with a bituminous tack coat consisting of .05 to 0.1 gallon per square yard of diluted SS-11 emulsified asphalt (.02 to .05 gal./yd.² residue) as directed by the engineer.

2. The application rate of the hot rubber-asphalt mixture shall be 0.750±0.05 gallons per square yard or as otherwise designated on the plans or by the engineer. (Based on 0.4 pounds (3.4 kilograms) per hot gallon). Do not use conversion factors to 60°F (16°C); use weight only. After reaching the proper consistency, application of the material shall proceed immediately. The material shall be placed only when a uniform application is being achieved. The end result must be a uniform impermeable membrane of rubber-asphalt.

3. The application of cover material shall proceed immediately behind the distributor. The cover material shall be applied with a self-propelled aggregate spreader at a rate of approximately 35 to 39 pounds per square yard for 3/8 inch nominal size aggregate as directed by the engineer. In any event the rate shall be high enough to prevent pickup by the equipment involved in the spreading and rolling of the aggregate.

The operation of distributing the rubber asphalt shall be so controlled that under no circumstances shall operations proceed in such a manner that the rubber asphalt will be allowed to chill, set-up or dry prior to the application of cover material.

The moisture content in the aggregate applied directly to the surface of the rubber-asphalt shall not exceed one (1) percent of free moisture (when) compared to the surface dry condition determined as follows:

Weigh approximately 1000 gram sample of aggregate from the stock pile. Place weighed sample in large absorbent cloth and roll to remove all visible films of water. Weigh surface dried sample. Calculate free moisture by the following formula:

\[ M = \frac{W_1 - W_2}{100} \times 100 \]

where M = % FREE MOISTURE

\[ W_1 = \text{WEIGHT IN GRAMS OF ORIGINAL STOCKPILE SAMPLE} \]

\[ W_2 = \text{WEIGHT IN GRAMS OF SURFACE DRIED SAMPLE} \]

Procedures of starting, stopping or turning any piece of equipment which results in displacement of the cover material or damage to the rubber-asphalt shall be prohibited.
The spreading equipment shall be of such width and arrangement that as the aggregate is placed complete coverage will be obtained. Any reappangement of cover material necessary prior to rolling shall be performed by hand methods. All spillage shall be removed from the surface.

Rolling of the cover material shall be performed with self-propelled pneumatic rollers meeting the requirements stipulated under Equipment above. The first pass of the rollers shall proceed immediately after application of the cover material in order to ensure maximum embedment of the aggregate. Rolling shall continue until four (4) complete coverages are obtained. A minimum of three (3) coverages shall be furnished. The initial rolling of one (1) complete pass will be completed as close behind the spreader box as possible. If directed by the Engineer, an application of approximately five (5) lbs. per square yard of blotter sand (FAA) shall be applied after the second coverage of rolling has been completed and prior to the final rolling. The rollers shall be operated at a speed at which the aggregate will not be displaced and damage result to the rubber asphalt. Damaged areas where the membrane has been broken or punctured will be repaired by spraying on additional material.

(4) All joint edges shall be swept clean of overlapping cover material prior to the adjacent application of rubber-asphalt material. All longitudinal joints shall be lapped a minimum of 2 inches (5.1 cm). All reasonable precautions shall be taken to protect the surfaces of adjacent structures from being spattered or marked. All transverse joints shall be made by placing building paper over the ends of the previous applications, and the joining application shall start on the building paper. The paper shall be removed and disposed of to the satisfaction of the Engineer.

(5) Traffic shall not be permitted on the completed surface until such time as determined by the Engineer. The minimum cure time shall be three hours after the completion of the final rolling. The speed of all hauling equipment and pilot cars which must use the fresh seal coat shall be limited to 15 miles per hour during the cure period.

(6) All loose cover material shall be removed by a rotary sweeper power broom as soon as sweeping causes no discernible displacement of the embedded cover aggregate.

(7) Rubber asphalt operations shall be performed only when the weather is satisfactory; the pavement is dry; the ambient air temperature is above 60 degrees F (16 degrees C) and rising, and the wind conditions such that a satisfactory membrane can be achieved.

(5.0 Method of Measurement: Rubber-Asphalt, Bituminous Materials and Diluent will be measured by the ton as provided in Division 100 of the Standard Specifications. Cover Material and Blotter Sand will be measured either by the cubic yard or by the ton as indicated in the proposal. When measured by the cubic yard, the material will be measured in the vehicle at the time and place of unloading. When measured by the ton, the material will be weighed in the vehicle at the time and place of unloading or at such other points as may be designated by the Engineer. No deductions will be made for moisture in the cover material of blotter sand.

Manipulation will be measured per one hundred foot (100-foot) station which includes all widened and irregular areas. The item includes all necessary items of work and incidental not listed as bid items. An additional measurement will be made of widened sections or for irregular areas.

Water ordered by the Engineer will be measured per thousand (1,000) gallons by means of calibrated tanks or water meters.

(6.0 Basis of Payment: The amount of completed and accepted work, measured as provided above, will be paid for at the contract unit price bid per cubic yard or per ton for "Cover Material and Blotter Sand", per ton for Rubber-Asphalt, Diluent and the various types and grades of Bituminous Materials and per one hundred foot (100 foot) stations for "Manipulation", per thousand (1,000) gallons for "Water", which prices will be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

2-20-79

A-8
WORK PLAN FOR CATEGORY 2 EXPERIMENTAL PROJECTS

Evaluation of Stress Absorbing Membrane Interlayer (SAMI) and Heater Scarification for Prevention of Reflective Cracking in Flexible Pavements

1. Items to be Evaluated.

This work plan covers experimental features to be evaluated on the six projects listed in Table 1. Prime objectives will be evaluation of stress absorbing membranes and heater scarification in prevention or reduction of reflective cracking in hot mix overlays constructed over badly cracked flexible pavements. The type of treatment and the type of crack repair for each project are listed in Table 1. A detailed description of the types of crack repairs are listed in Attachment 1.

2. Construction Procedures.

Initially, the cracks will be repaired. Polypropylene fiber stress absorbing membrane will be applied on approximately 5.5 miles of K-4 in Jefferson County and on approximately 6.7 miles on US 75 in Coffey County. On US 50 in Ford County, polypropylene fiber strips will be applied over the cracks. Rubber-asphalt (Overflex) stress absorbing membrane will be applied on approximately 7.8 miles of US 77 in Marion County and on approximately 9.8 miles of K-68 and K-268 in Osage County. Heater scarification with rejuvenating agent will be used on approximately 1.7 miles in Brown County.

All roadways will be overlaid with hot mix. BM-1 gradation will be used on K-68, K-268, and US 50 and BM-2 gradation will be used on the remainder of the projects. The overlay thicknesses are listed in Table 1. The overlay thicknesses were determined from the results of Benkelman Beam deflection tests.

Profiles of the test and control sections are shown in Figure 1 for the stress absorbing membrane interlayers and in Figure 2 for the heater scarification.


Test and control sections will be selected for the six project as shown in Table 2. Before construction, low level (600 ± feet) aerial photographs will be taken of the whole projects. A visual survey will also be made of the test and control sections.

Construction will be monitored in the test and control sections. On US 73 in Brown County, asphalt properties will be determined by Nelson Recovery methods before heater scarification, after heater scarification, and after rejuvenating.

At least twice during the first year, then once each year, a crack survey will be taken of all test and control sections. A comparison will be made between test sections and control sections. Depending on the progression of cracking in the overlays, additional aerial photographs may be taken.
4. **Anticipated Time Frame for Evaluation of the Treatments.**

Long term effectiveness of the treatments in preventing reflective cracking is the prime objective of this experimental work. It is anticipated that monitoring will need to be continued for 10 years. Annual crack survey reports will be issued.
<table>
<thead>
<tr>
<th>Project Statistics</th>
<th>Planned Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>District I</strong></td>
<td></td>
</tr>
<tr>
<td>(R) 4-44-RP068-3(18)</td>
<td></td>
</tr>
<tr>
<td>Jefferson</td>
<td></td>
</tr>
<tr>
<td>6.9 mi</td>
<td></td>
</tr>
<tr>
<td><strong>Project Number</strong></td>
<td><strong>Present</strong></td>
</tr>
<tr>
<td><strong>County, Length</strong></td>
<td><strong>1950</strong></td>
</tr>
<tr>
<td>S 1/3 proj. 1/2 lane &amp; full lane width transverse cracks 3'-9' apart. Middle 1/3 proj. wide trans. cracks 60'-100' apart. N 1/3 proj. good cond. w/some hairline cracks 40'-60' apart. Rebound deflection: Ave .070, range .026-.108.</td>
<td>(5.5mil.) + 3&quot; BM-2 overlay</td>
</tr>
<tr>
<td>**(R) 73-7-RP 069-1(22)</td>
<td><strong>1400</strong></td>
</tr>
<tr>
<td>Brown</td>
<td></td>
</tr>
<tr>
<td>5.4 mi</td>
<td></td>
</tr>
<tr>
<td>S 1.7 mi. severely cracked w/some rutting. Remainder proj. wide trans. cracks (3/4&quot;-1-1/2&quot;) 50'-100' apart. Rebound deflection: Ave .083; range .033-.156.</td>
<td>3/4&quot; heater scarification (1.7 mi.) + 4&quot; BM-2 overlay, Type I, II &amp; III crack repair. Type I &amp; II sealed with rubber-asphalt.</td>
</tr>
<tr>
<td>**(R) 5-268-70-RP058-1(17)</td>
<td><strong>1533</strong></td>
</tr>
<tr>
<td>Osage</td>
<td></td>
</tr>
<tr>
<td>10.3 mi</td>
<td></td>
</tr>
<tr>
<td>Frequent transverse cracking through recent maint. overlay. Some shoving &amp; rutting in wheel-path between M.P. 7.5 &amp; 8.0. Rebound deflection: Ave .0359; range .017-.072.</td>
<td>Cold mill exist. surface to level (1/2&quot; +), rubber-asphalt (9.8mil.)+ 1&quot; BM-1 overlay with additional 1&quot; BM-1 between Sta. 495+69 to Sta.517+80. Type II crack repair sealed with rubber-asphalt.</td>
</tr>
<tr>
<td>**(R) 5-68-70-RP058-1(18)</td>
<td><strong>1533</strong></td>
</tr>
<tr>
<td>Osage</td>
<td></td>
</tr>
<tr>
<td>10.3 mi</td>
<td></td>
</tr>
<tr>
<td><strong>District II</strong></td>
<td></td>
</tr>
<tr>
<td>(R) 77-57-RP055-2(6)</td>
<td><strong>1100</strong></td>
</tr>
<tr>
<td>Marion</td>
<td></td>
</tr>
<tr>
<td>8.0 mi</td>
<td></td>
</tr>
<tr>
<td>Pavement, badly alligator cracked, open trans. cracks (1/2&quot;-1&quot;) some fatigue failures &amp; depressions. Rebound deflection: Ave .0466, range .035-.139.</td>
<td>Rubber-asphalt (7.8mil.)+ 2-1/2&quot; BM-2 overlay with additional 1-1/2&quot; BM-2 thru river valley. Type II &amp; III crack repair.</td>
</tr>
<tr>
<td>**(R) 67-66-RP059-2(60)</td>
<td><strong>2935</strong></td>
</tr>
<tr>
<td>Coffey</td>
<td></td>
</tr>
<tr>
<td>5.9 mi</td>
<td></td>
</tr>
<tr>
<td>Pavement, severely cracked, some complete failures. Rebound deflection: Ave .0492; range .034-.073</td>
<td>Polypropylene fiber membrane (6.7 mi.)+3&quot; BM-2 overlay, Type III crack repair.</td>
</tr>
<tr>
<td><strong>District VI</strong></td>
<td></td>
</tr>
<tr>
<td>(R) 50-29-RP050-2(40)</td>
<td><strong>2175</strong></td>
</tr>
<tr>
<td>Ford</td>
<td></td>
</tr>
<tr>
<td>9.4 mi</td>
<td></td>
</tr>
<tr>
<td>Surface condition good except for rutting &amp; shoving at cracks which are spaced on ave. of 100' apart. Rebound deflection: Ave .0497; range .020-.096.</td>
<td>Strips of polypropylene fiber mem- $175,211</td>
</tr>
</tbody>
</table>
### Table 2 - Items for Evaluation.

<table>
<thead>
<tr>
<th>Route</th>
<th>County</th>
<th>Control Section</th>
<th>Test Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-4</td>
<td>Jefferson</td>
<td>1000' long, 3&quot;BM-2 overlay</td>
<td>1000' long, 3&quot; BM-2 overlay Polypropylene fiber membrane, Types I, II &amp; III repair.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No SAMI Types I, II &amp; III repair.</td>
<td></td>
</tr>
<tr>
<td>US 73</td>
<td>Brown</td>
<td>1000' long, 4&quot;BM-2 overlay No heater scarification Type I repair</td>
<td>1000' long, 4&quot;BM-2 overlay No heater scarification Type I repair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000' long, 4&quot;BM-2 overlay No heater scarification No crack repair</td>
<td>1000' long, 4&quot;BM-2 overlay No heater scarification Type I, II, &amp; III repair.</td>
</tr>
<tr>
<td>K-268</td>
<td>Osage</td>
<td>1000' long, 1&quot;BM-1 overlay No SAMI Type II repair, Cold Planer Blacktop.</td>
<td>1000' long, 1&quot;BM-1 overlay Rubber-asphalt interlayer Type II repair, Cold Planer.</td>
</tr>
<tr>
<td>K-68</td>
<td>September</td>
<td>1000' long, 2-1/2&quot; BM-2 overlay, No SAMI Type II &amp; III repair.</td>
<td>1000' long, 2-1/2&quot;BM-2 overlay Rubber-asphalt interlayer Type II &amp; III repair.</td>
</tr>
<tr>
<td>US 77</td>
<td>Marion</td>
<td>1000' long, 3&quot;BM-2 overlay No SAMI</td>
<td>1000' long, 3&quot;BM-2 overlay Polypropylene fiber membrane Type III repair.</td>
</tr>
<tr>
<td>US 75</td>
<td>Coffey</td>
<td>1000' long</td>
<td>1000' long or a minimum of 20 Type I cracks (whichever is greater) 3/4&quot;BM-1+1-1/2&quot;BM-2 overlay Polypropylene fiber strips Type III repair.</td>
</tr>
<tr>
<td>US 50</td>
<td>Ford</td>
<td>1000' long</td>
<td>1000' long or a minimum of 20 Type I cracks (whichever is greater) 3/4&quot;BM-1+1-1/2&quot;BM-2 overlay Polypropylene fiber strips Type III repair.</td>
</tr>
</tbody>
</table>

3/4"BM-1+1-1/2"BM-2 overlay. No SAMI Type III repair
Figure 1—Profile of Stress Absorbing Membrane Interlayer (SAMI) and Control Section

Test Section

<table>
<thead>
<tr>
<th>Hot Mix Overlay</th>
<th>Asph. Conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMI</td>
<td>(1&quot; BM-1 or 2&quot; to 4&quot; BM-2)</td>
</tr>
<tr>
<td>Existing Surfacing</td>
<td></td>
</tr>
</tbody>
</table>

1000' 1000'

Figure 2—Profile of Heater Scarification and Control Section

Test Section

<table>
<thead>
<tr>
<th>Hot Mix Overlay</th>
<th>4&quot; Asph. Conc. (BM-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; Heater Scarification</td>
<td></td>
</tr>
<tr>
<td>Existing Surfacing</td>
<td></td>
</tr>
</tbody>
</table>

1000' 1000'
Type I: K-4 Jefferson County, US 73 Brown County, US 50 Ford County.

This is a major repair of a wide transverse crack which generally shows secondary cracking, shoving, and depression. Repair consists of removing the failed material and replacement as shown in the typical section of the construction plans. The removal will be with cold milling equipment or other suitable means. Replacement material will be with BM-2 hot mix to provide stability. Additional repair steps will include sealing crack with rubber-asphalt (US 73) or placing polypropylene fiber membrane over the repair (US 50).

Type II: K-4 Jefferson County, US 73 Brown County, K-68 and K-268 Orange County, US 77 Marion County.

This repair consists of filling those cracks over 1/4" with asphalt-rubber or those over 3/8" with slurry crack pour after blowing the crack clean with compressed air. This repair will usually be limited to cracks under 1" in width. These cracks generally will show a sharp break, i.e. no depression or shoving adjacent to the crack.

Type III: K-4 Jefferson County, US 73 Brown County, US 77 Marion County, US 75 Coffey County, and US 50 Ford County.

This type is a conventional repair of hairline (<1/4" to 3/8") by filling with CRS-1M emulsified asphalt. Normally this repair will be performed by District Maintenance forces. On US 50, polypropylene fiber membrane will be placed over the Type III cracks after they are filled.
1.0 DESCRIPTION: This work shall consist of heating, scarifying, rejuvenating and recompacting existing bituminous pavements in substantial compliance with the specifications and the lines, grades, thicknesses and typical cross sections shown on the Plans or established by the Engineer.

2.0 MATERIAL REQUIREMENTS: Asphalt Rejuvenating Agent. The asphalt rejuvenating agent shall be composed of a petroleum resin-oil base uniformly emulsified with water and shall conform to the requirements as specified in 7SP-213.

Blotter Sand. Blotter sand shall be any clean, fine sand approved by the Engineer.

3.0 EQUIPMENT REQUIREMENTS:

(A) HEATER-SCARIFIER. Scarifying equipment shall consist of self-contained units which are specifically designed to heat and scarify the upper portion of existing pavement. The machine or machines shall be self-propelled, capable of covering a minimum of 1200 square yards per hour while evenly heating the bituminous surface to the extent that it can be scarified to a depth of not less than 3/4 inch. The scarifier shall also have the capability of scarifying not less than 3/4 inch in existing 2-inch depressions. The heating unit shall be adjustable in width from 3' to 12' and equipped with either ports permitting fuel and forced air injection for proper combustion, or controlled radiant heating elements for evenly heating the bituminous surface without excessive smoking. The scarifier mechanism shall be arranged to provide complete coverage without leaving ridges. The heating mechanism and operation shall extend to or beyond the width to be scarified on each side.

(B) DISTRIBUTOR. If a distributor is used for application of rejuvenating agent the distributor shall conform to the requirements of Section 601 of the Standard Specifications. The rejuvenating agent may be added by the heater scarification unit after heating and scarifying the existing roadway. The distribution unit shall be capable of uniformly adding the rejuvenating agent to the scarified material at the rate stipulated.

(C) ROLLER. The rollers shall meet the requirements in Section 601 of the Standard Specifications.

4.0 CONSTRUCTION REQUIREMENTS: Pavement Preparation. Prior to commencing heater scarifying operations, the pavement shall be cleaned of any loose material that could interfere with the work. Any soil or aggregate adhering to the pavement shall be loosened and removed. Power brooming shall be supplemented by hand brooming and scraping if necessary to render the surface free from deleterious material. Any required patching work designated on the Plans shall be completed prior to beginning the scarifying process.

Heating, Scarifying and Remiking. Unless otherwise provided on the Plans, or in the Special Provisions, the existing pavement shall be evenly heated and scarified to a depth of at least 3/4 inch in one operation. For purposes of inspection, a minimum of one inch of loose scarified material spread uniformly over the scarified surface shall be considered to meet the depth requirements. The heated and scarified material shall be left on the surface in an evenly spread state with a minimum of pulverized or broken material. A substantial percentage of the material shall be displaced and mixed by the scarification process. The minimum temperature of the scarified material measured within 3 minutes after treatment shall be 225°F (107°C). To prevent surging and damage to the existing base, maximum temperatures of the pavement shall not exceed 325°F (163°C).
In areas where existing pavement surface variation is more than one inch (25.4 mm), additional heating, scarifying and leveling passes shall be made prior to the final scarifying and leveling pass in order that proper leveling results may be obtained.

Immediately after heating and scarification the remixed material shall be compacted with a standard pneumatic and/or steel wheeled roller. Compaction shall be adequate to consolidate the remixed material to the satisfaction of the engineer. A minimum of 3 passes of a roller will be required with the final pass being completed with a flat steel roller. Traffic will not be allowed on the remixed surface until it has been compacted. The contractor will be responsible for maintaining the surface until it is overlaid.

Concentrated asphalt rejuvenating agent shall be applied at the rate shown on the plans or as specified by the engineer. The agent may be applied with the heater scarification unit during the remixing of the scarified material with the scarification unit; or application may be made with a distributor (meeting the requirements stipulated in Subsection 3 (B)) as soon as practical after rolling and prior to opening to traffic. The temperature of the rejuvenating agent shall be between 120°F and 150°F (49°C and 66°C) at the time of application.

Blotter sand shall be available for spreading on the pavement surface after application of the asphalt rejuvenating agent if the surface remains hazardous after a reasonable waiting period. Application shall be made sparingly and only in hazardous areas.

5.0 Method of Measurement: Heater-Remix shall be measured by the (100 ft.) station, regardless of pavement width and shall include surface preparation prior to heating, scarifying, remixing, application of asphalt rejuvenating agent, application of blotter sand if required, compaction of remixed material and maintenance of the completed surface overlaid. No additional measurement will be made for widened sections or irregular areas.

Asphalt rejuvenating agent will be measured by the ton to the nearest one-hundredth of a ton.

Blotter sand will be measured by the ton or cubic yard measured in the truck at point of usage.

6.0 Basis of Payment: The amount of completed and accepted work, measured as provided above, will be paid for at the contract unit price bid per station for heater-remix which price shall be full compensation for furnishing all materials, preparation of surface prior to heating, for heating, scarifying and remixing the surface, for compaction and for all labor, equipment, tools and incidentals necessary to complete the work.

Rejuvenating agent shall be paid for at the contract bid price per ton which price shall include all material, mixing and application of the agent and for all tools, equipment, labor and incidentals necessary to complete the work.

Blotter sand, if required, shall be paid for at the contract bid price per ton or cubic yard which price shall include all material, labor, tools, equipment and incidentals necessary to complete the work.
May 17, 1977

Mr. Robert W. Morrissey  
Division Administrator  
Federal Highway Administration  
444 S. W. Quincy  
Topeka, Kansas  66603

Re:  (R) 77-37-2055-2(6)  
Marion County  
Revised Work Plan

Dear Mr. Morrissey:

Transmitted herewith is our revised Work Plan for a Category 2 Experimental Project. The original Work Plan dated April 12, 1977 and approved on May 3, 1977 called for Type II and III crack repair, and the rubber-asphalt membrane to be placed directly on the existing surface. Due to the present condition of the roadway we desire to heater-scarify the top 0.75" of the existing surface, eliminate crack repair, and apply the rubber-asphalt membrane directly on the scarified surface. Attachment 1A has been revised to indicate this change.

Stationing for the 2000' to be monitored will be designated by the Engineer at the time of construction. Both the control and test section will be heater scarified. No crack repair will be accomplished. The rubber-asphalt membrane will be placed directly on the scarified surface, except on the 1000' control section. Attachment 2A has been revised to indicate these changes. The sections will be monitored as outlined in the letter of April 12, 1977.

It is estimated that this revision will increase the cost of the project by an additional $8,700 to a total increase of $153,000, instead of the $149,300 listed in the April 12, 1977 Work Plan. We believe the present surface condition of the roadway requires a more substantial rehabilitation than can be attained by crack repair alone prior to application of the rubber-asphalt membrane. We therefore, request your approval of these changes.

Yours very truly,

W. U. Ogan, P. E.  
STATE TRANSPORTATION ENGINEER
<table>
<thead>
<tr>
<th>Project Number</th>
<th>Present</th>
<th>Design Year Traffic</th>
<th>Present Condition</th>
<th>Rehabilitation Treatment</th>
<th>Increase in Rehabilitation Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>County, Length</td>
<td>AADT 1952</td>
<td>280</td>
<td>Pavement badly alligator cracked, 0.75&quot; heater scarification open trans. cracks (0.5&quot;-1&quot;) (7.0mi.) + rubber-asphalt Some fatigue failures &amp; depressions. Rebound deflection: with additional 1.5&quot; BM-2 thru Ave. 0.0466&quot;, range 0.035&quot;-0.139&quot;.</td>
<td>+$158,000 + (6.8mi.) + 2.5&quot; BM-2 overlay river valley.</td>
<td></td>
</tr>
<tr>
<td>Elizion, 7.7 miles</td>
<td>1100</td>
<td>1932</td>
<td>280</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PROJECT STATISTICS**

**PLANNED REHABILITATION**
<table>
<thead>
<tr>
<th>Route</th>
<th>County</th>
<th>Control Section</th>
<th>Test Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>95-77</td>
<td>Marion</td>
<td>1000' long, 2.5&quot; EM-2 overlay, No SAEF, heater scarification</td>
<td>1000' long, 2.5&quot; EM-2 overlay, rubber-asphalt interlayer, heater-scarification</td>
</tr>
</tbody>
</table>
Prevention of Reflective Cracking in Flexible Pavements
(Heater Scarification and Asphalt Rubber - SAMI)
77-57-F 055-2(6) Marion County, NEPT KS-7701F
1985 Annual Report

Previous Activity:

The initial crack survey was conducted in 1977 and construction was completed in 1978 using two techniques:

1. 0.75" Heater Scarification + 2.5" BH-2 (Control)
2. 0.75" Heater Scarification + Rubber Asphalt Stress Absorbing Membrane Interlayer (SAMI) + 2.5" BH-2.

Reports were published in May 1978, February 1979, November 1980, November 1981 and December 1982.

Current Activity:

During 1982 through 1985 we continued to monitor the performance of the project using periodic crack surveys and visual inspection. The results of the crack surveys are shown in Figures 1 and 2. Both sections continue to serve reasonably well without major repair thus far.

Summary:

The ride quality remains acceptable after seven years of exposure to traffic.

The reflected cracks in both sections have not required sealing yet and there is minimal wheelpath rutting.

Since the percent of reflected cracks is higher in the SAMI test section, it does not appear the added expense is justifiable.

Bureau of Materials & Research
Research Unit
Prepared by: William H. Parcells, Jr., P.E.
Bituminous Research Engineer
Date: January 27, 1986
Figure 1: Percent Transverse Cracks vs Time

- SAMI (0.75" Heater Scarification + SAMI + 2.5" BM-2)
- Control (0.75" Heater Scarification + 2.5" BM-2)

Figure 2: Percent Longitudinal Cracks vs Time

- SAMI (0.75" Heater Scarification + SAMI + 2.5" BM-2)
- Control (0.75" Heater Scarification + 2.5" BM-2)