

# A FIELD STUDY of JOINT and CRACK RESEALING METHODS and MATERIALS



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METHODS AND MATERIALS

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# A FIELD STUDY OF JOINT AND CRACK RESEALING METHODS AND MATERIALS

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## SYNOPSIS

During August and September of 1953, the joints and cracks in a 19-year old, 5-mile stretch of concrete pavement on US 16 between Nunica and Fruitport, Michigan, were resealed under contract on a force account basis. Six different brands of hot-pour joint sealer were used. In addition to the resealing work, experimental concrete repairs were made in several places where corners were broken from slabs at the junction of the joint and pavement edge.

Various methods of cleaning and resealing the joints and cracks were investigated until a practical, efficient procedure was developed. This procedure included sandblasting of joints and cracks prior to sealing and the use of thermostatically controlled pouring equipment for applying the sealer.

After two and one-half years of service, the various maintenance repairs have held up very well with the exception of material failures in two of the six brands of joint sealer used. The results of this work indicate that the widespread failure of joint seals in Michigan has been due partly to deficiencies in the sealing material and partly to inadequate cleaning and sealing operations. An extensive experimental project involving both field and laboratory tests has been initiated in order to study these factors quantitatively and to develop better materials and methods.

## A FIELD STUDY OF JOINT AND CRACK RESEALING METHODS AND MATERIALS

With the advent of hot-poured rubber-asphalt joint sealing compounds, the problem of sealing joints in concrete pavements appeared to have been solved. Postwar pavements in Michigan, however, have shown widespread failure of the seal in joints containing such materials. Examination of these failures indicated that in most cases they were of the adhesive type and were probably due to inadequate cleaning and sealing methods although the possibility existed that at least part of the trouble could be attributed to some deficiency in the sealing compounds themselves. As a result, steps were taken to inaugurate a general program directed toward improvement in materials and methods for sealing joints in concrete pavements, both in new construction and in maintenance operations.

As one phase of this program, a project was set up in July, 1953, for experimental contract resealing of joints and cracks in an old pavement with hot-pour, rubber-asphalt joint sealers. The project had three main objectives: 1) to evaluate current rubber-asphalt joint sealing materials; 2) to develop the most effective sealing procedures possible; and 3) to determine whether the workmanship and cost of such an operation would warrant adoption of contract resealing as a future maintenance policy on concrete pavements in such good physical condition that resurfacing would not be anticipated for at least 10 years. The work was to be done by a contractor specially qualified in this field and the contract drawn up on a cost-plus basis so that effective procedures could be developed as the work progressed.

This paper gives the location and a general description of the pavement, tells what materials and equipment were used, and what methods of cleaning and resealing were tried. It also contains a summary of the procedures finally adopted and a brief discussion of four condition surveys made since the work was completed, together with a cost analysis of the entire operation.

In conjunction with the joint and crack resealing, a few experimental concrete repairs were made in places where slab corners were broken at the junction of the joint and pavement edge. Because of its close relationship to the joint sealing operation, a brief description and cost analysis of this phase of the work is also included.

TABLE 1

## LABORATORY DATA ON JOINT SEALING MATERIALS

Brand	Pour Temp., Deg. F.	Penetration, 77 F., 150 g., 5 Sec., cm.	Flow, cm.	Bond
A	401	0.53	0.40	Passes
B	401	0.64	0.20	Passes
C	401	0.70	0.20	Passes
D	401	0.70	0.10	Passes
E	401	0.65	0.20	Passes
F	425	0.84	0.30	Passes

## LOCATION AND DESCRIPTION OF THE PAVEMENT

A 5-mile section of US 16 between Nunica and Fruitport was selected for the project and a condition survey made on July 22, 1953. This pavement was built in 1933-34 on a sand subgrade and is of 9-7-9 cross-section containing 60 lb. of reinforcing steel mat per 100 sq. ft., with 100-ft. expansion joints and no intermediate joints. No load transfer devices were used and the joints were all slightly faulted. The joints were about 1 in. wide and most of them had accumulated a considerable quantity of infiltrated sand and gravel which had forced the filler downward through the compacting action of traffic.

The longitudinal joint contained a premolded filler as a divider strip in the plane of weakness at the top. In many places this filler was partly gone and in some cases a section of concrete between a transverse joint and a nearby transverse crack had become laterally displaced, causing the adjacent longitudinal joint to open excessively.

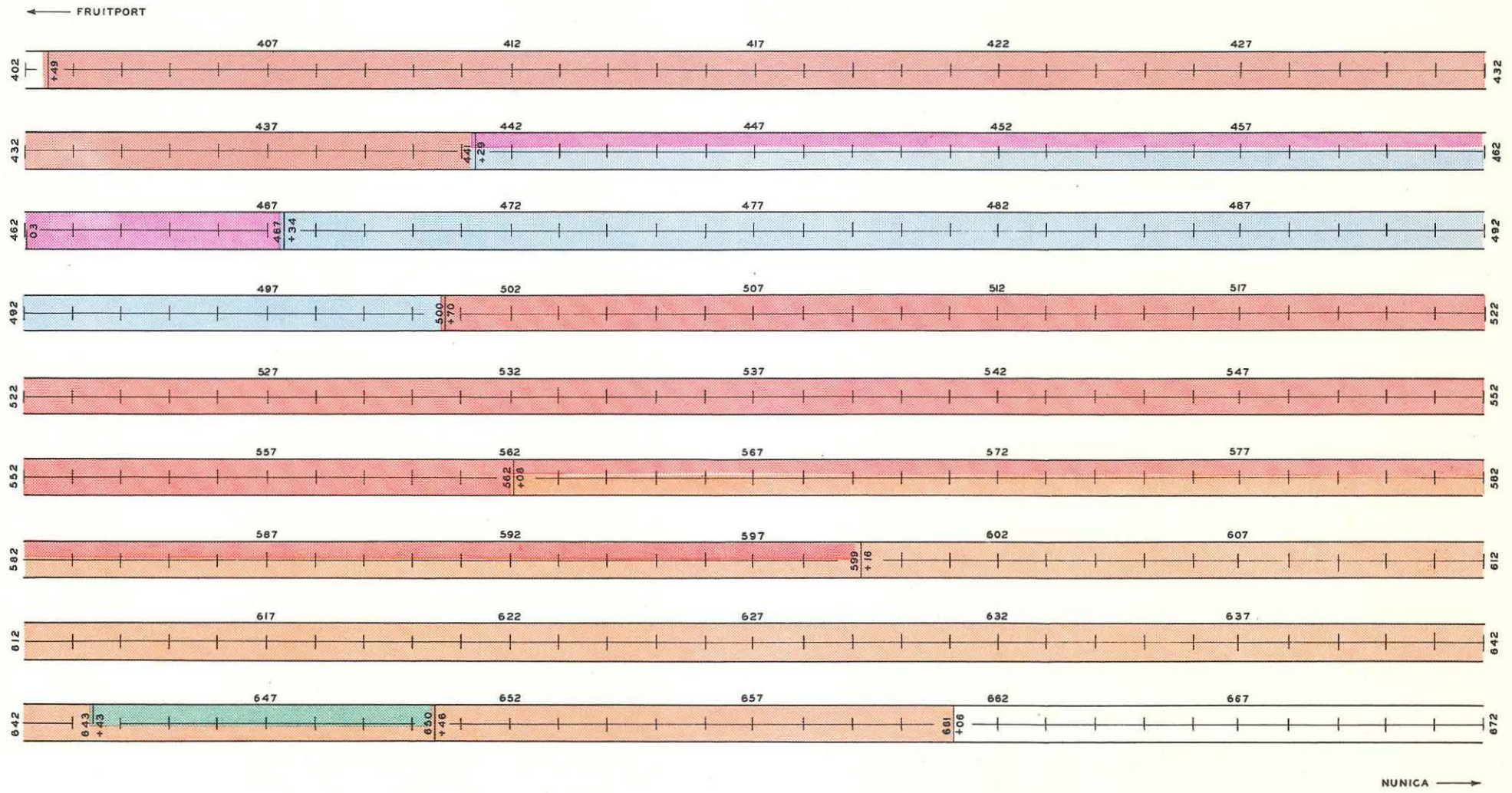
Cracks in the pavement were almost entirely transverse and were of two distinct types--open 1/4 in. or more, and closed tight. Although the closed cracks were tight enough to prevent infiltration of dirt and gravel, many of them were becoming badly spalled at the edges and needed sealing.

## MATERIALS AND EQUIPMENT

Six brands of hot-pour rubber-asphalt joint sealer were used in this project and were tested in the laboratory with the results given in Table 1. Locations of these six materials in the project are given in Table 2 and the schematic drawing of Figure 1.

The joint sealing materials were melted in a melter of the double boiler type using oil as the heat transfer medium. This melter had thermostatically controlled gas heat, constant agitation, and a thermometer to indicate the temperature of the oil bath. Temperatures of the sealing material were taken at frequent intervals with a hand thermometer. A temperature differential of 50 F. was maintained between the temperature of the oil bath and that of the sealing material.

The sealing materials were poured from a mechanical pour pot, also of the double boiler type (Figure 2) using oil as the heat transfer medium, with thermostatically controlled gas heat and a thermometer to indicate the oil temperature. The pour pot was mounted on rubber tired wheels and was



LEGEND:

- |                                                                                                                                     |                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #f4a460; border: 1px solid black;"></span> BRAND A | <span style="display: inline-block; width: 15px; height: 10px; background-color: #a6c9ec; border: 1px solid black;"></span> BRAND D |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black;"></span> BRAND B | <span style="display: inline-block; width: 15px; height: 10px; background-color: #d8bfd8; border: 1px solid black;"></span> BRAND E |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #f08080; border: 1px solid black;"></span> BRAND C | <span style="display: inline-block; width: 15px; height: 10px; background-color: #f080f0; border: 1px solid black;"></span> BRAND F |

COLOR CODE INCLUDES MATERIALS  
IN LONGITUDINAL JOINT.

FIGURE I. LOCATION OF SEALING MATERIALS  
IN THE PROJECT

TABLE 2

## LOCATION OF SEALING MATERIALS USED IN THE PROJECT

Brand	Station Location			Pouring Temp. Deg. F.
	Cracks and Transverse Joints		Longitudinal Joint	
	North Lane	South Lane		
A	661+06 to 650+46 643+43 to 599+16	661+06 to 562+08	661+06 to 560+46 643+43 to 562+08	425
B	650+46 to 643+43		640+46 to 643+43	425
C	599+16 to 500+70	562+08 to 500+70	599+16 to 500+70	395
D	500+70 to 467+34	500+70 to 467+34 462+03 to 441+29	500+70 to 467+34	425
E	467+34 to 441+29	467+34 to 462+03	467+34 to 441+29	425
F	441+29 to 402+49	441+29 to 402+49	441+29 to 402+49	425





FIGURE 2. SEALING LONGITUDINAL JOINT WITH MECHANICAL POURPOT.



FIGURE 3. CONTRACTOR'S JOINT - CLEANING MACHINE IN OPERATION.

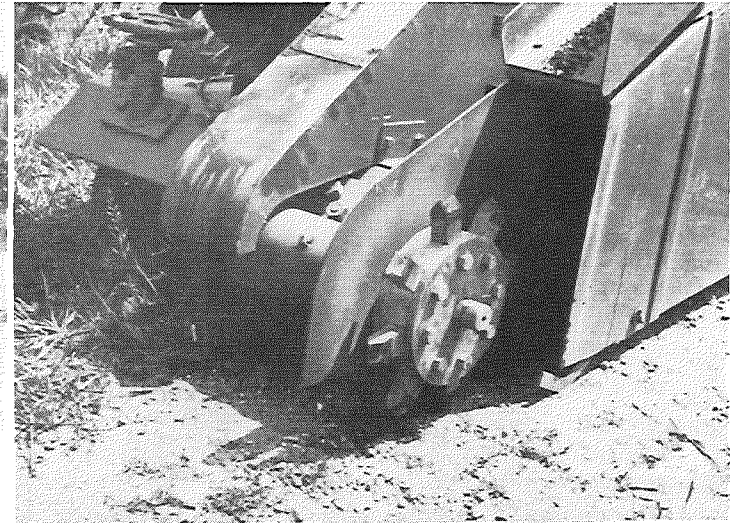


FIGURE 4. CUTTING HEAD OF CONTRACTOR'S JOINT - CLEANING MACHINE.

FIGURE 6. GARDEN TRACTOR WITH PLOW ATTACHMENT REMOVING OLD JOINT SEALER.

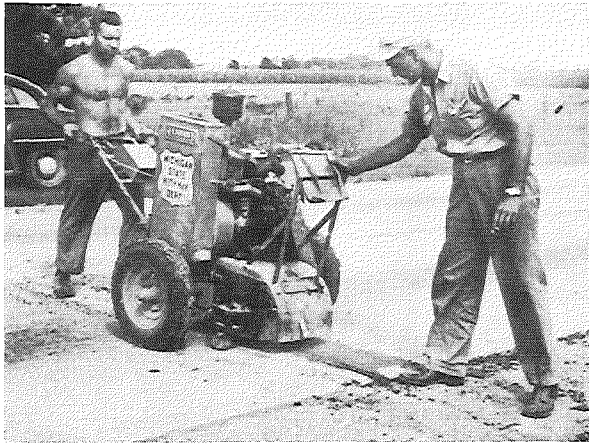
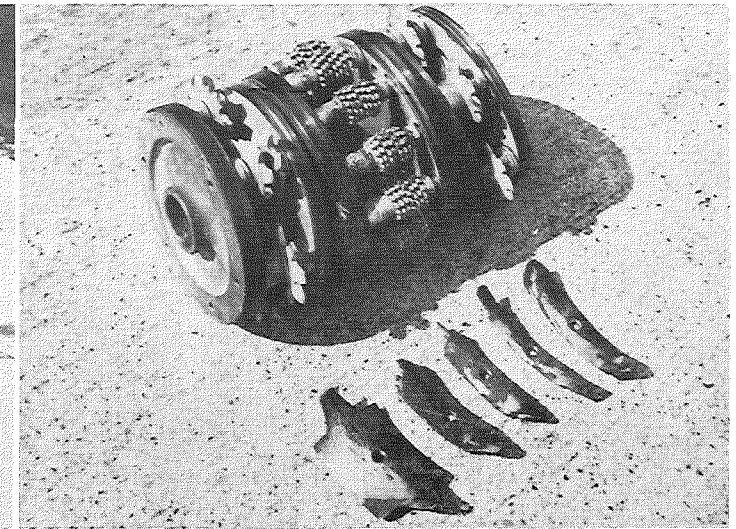


FIGURE 5. MSHD JOINT CLEANING MACHINE IN OPERATION.



FIGURE 7. MSHD CUTTER HEADS AND TRACTOR PLOW BLADES USED FOR CLEANING JOINTS.



provided with a mechanical agitator. Temperatures of the materials in the pour pot were also taken at frequent intervals with a hand thermometer. A temperature differential of 50 F. was maintained between the oil and the sealing material in the pour pot.

It should be noted here that, while indication of the oil bath temperature is useful for proper control of the heating and melting process, an indicating thermometer to measure the temperature of the melted joint sealing material should be installed on all heating equipment to insure that the compound is heated and poured in the specified temperature range. In this connection it should also be emphasized that the thermostatically controlled pour pot prevents pouring at too low a temperature, which could result in poor adhesion of the sealer to the joint faces.

Two types of mechanical joint cleaning equipment were used for cleaning joints—one, a machine furnished by the contractor, Figures 3 and 4, and the other, a commercial joint cleaning machine owned by the Michigan State Highway Department, Figure 5.

A small garden tractor with a plow attachment was used to remove the bulk of old materials from joints, Figure 6. Plow blades of various shapes are shown in Figure 7.

The sandblast and air blowing operations on joints and cracks were accomplished with a portable air compressor capable of maintaining a pressure of 90 psi., and a sandblast machine mounted in a pickup truck.

A mechanical wire brush was used in some of the earlier joint cleaning operations but was abandoned later when better plowing techniques were developed.

#### METHODS OF CLEANING AND RESEALING

The first experiments in cleaning old materials from joints involved the use of both the Highway Department's (MSHD) and the contractor's joint cleaning machines. In cleaning transverse joints, old sealer and filler were first removed with the contractor's new machine and then the pavement surface at each side of the joint was freed from the old sealer and other materials, using the MSHD machine equipped with a surface scarifying head. Adjustments of various depths and cutters of various widths were tried with the contractor's machine, and a satisfactory cut was finally obtained with cutters 1 in. wide set to clean the sides of the joint to a 1-in. depth. The head of this machine equipped with 1-in. cutters is shown in Figure 4.

Because the transverse joints were faulted, scarifying operations with the MSHD machine required a pass on each side of each joint. In Figure 7, the center head is the type used for scarifying operations. The MSHD machine with a single row of 4-in. cutters (Figure 7, upper right), was tried for routing old material from the transverse joints but failed to perform as well as the contractor's machine.

At first the contractor's machine was used to clean the old filler from the longitudinal joint, using cutters 3/8 or 1/2 in. wide, depending on the width of the joint. Trouble was encountered on the second day of operations with the carboloy tips which broke frequently on these narrower cutters. After ruining several sets of cutters, this machine was abandoned in favor of the MSHD machine using a head with a single row of 4-in. cutters. The MSHD machine produced a longitudinal joint as clean as that prepared by the contractor's machine. Where the longitudinal joint was excessively wide, a lateral swinging movement by the operator served to clean the joint faces satisfactorily.

The MSHD machine was again tried for removing old material from the transverse joints, but this time single and double cutters were alternated around the head (Figure 7, upper left). Since this operation left a cleaner joint than routing with the contractor's machine, the MSHD machine was adopted for this purpose.

Even after routing out both types of joints with the MSHD machine, small pieces of sealer and sections of filler still remained in greater quantities than were considered desirable or could be easily removed in the final operation of sandblasting and blowing with compressed air. To remedy this, a mechanical wire brush was used in the longitudinal joint, which took out sections of filler left by the MSHD machine in a fairly satisfactory manner. Pieces of old sealer left by the cleaning machine on the transverse joint corner were thinned enough by the brush to be removed later by sandblasting.

From the start of the project, experiments in plowing out old materials from the joints were run daily with a small garden tractor and plow attachments. The problem was one of developing a plow blade properly shaped to remove maximum material to a sufficient depth. After six days of experimental work, the plow was put into permanent operation on transverse joints, and by the twelfth day it was in use for the longitudinal joint. Plow blades of several typical shapes are shown in the lower portion of Figure 7. Since none of the several shapes developed was considered completely satisfactory, this operation is open to further experimentation.

In all of this earlier work the plowing operation was followed by use of the MSHD machine and then by the wire brush. It was soon noted, however, that the introduction of the plowing operation made the use of the brush

unnecessary so this brush was eliminated from the procedure, speeding up the work. Both longitudinal and transverse joints before and after sealing are shown in Figures 8 through 11.

One open crack was cut out with the contractor's machine using 1/2 in. cutters at a depth of 1/2 in. Another open crack was routed out with the MSHD machine using a single row of 4-in. cutters. The crack prepared with the contractor's machine was satisfactory in appearance but did not look much different than one treated with sandblast only. The crack routed with the MSHD machine was opened much wider than necessary at the top. As a result of these two experiments it was decided to prepare all open cracks with sandblast only, followed by a final blowing out with air.

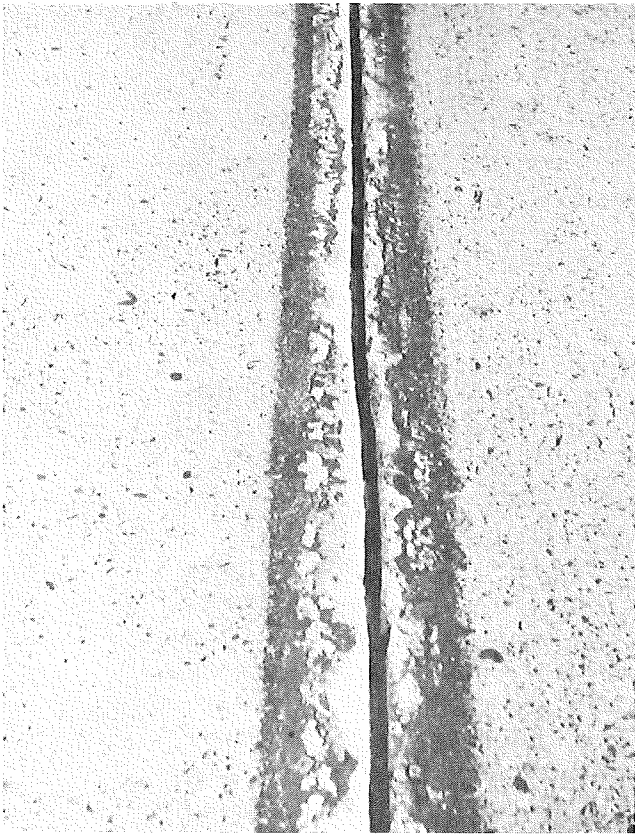
As soon as a decision had been made to seal closed cracks, two such cracks were sandblasted until a shallow groove was formed along the crack. The groove was 3/16 to 1/4 in. deep and 1/2 to 3/4 in. wide at the top. The pavement surface was cleaned with sandblast about 1/2 in. each side of the groove, blown out with air, and the crack sealed. Sealing material was applied in one pour to a level sufficient to allow an overlap on the pavement surface of about 1/8 in. This allowed the top surface of the sealer to be slightly higher than the pavement surface. After traffic had crossed these two cracks for 24 hr. it appeared that the sealing material tended to become even more firmly wedged down into the groove and seemed to form a very tight seal. As a result, all closed cracks from station 581+65 to the west end of the project were treated in this manner. A crack of this type is shown ready for sealing in Figure 12 and after sealing, in Figure 13.

#### FINAL PROCEDURES

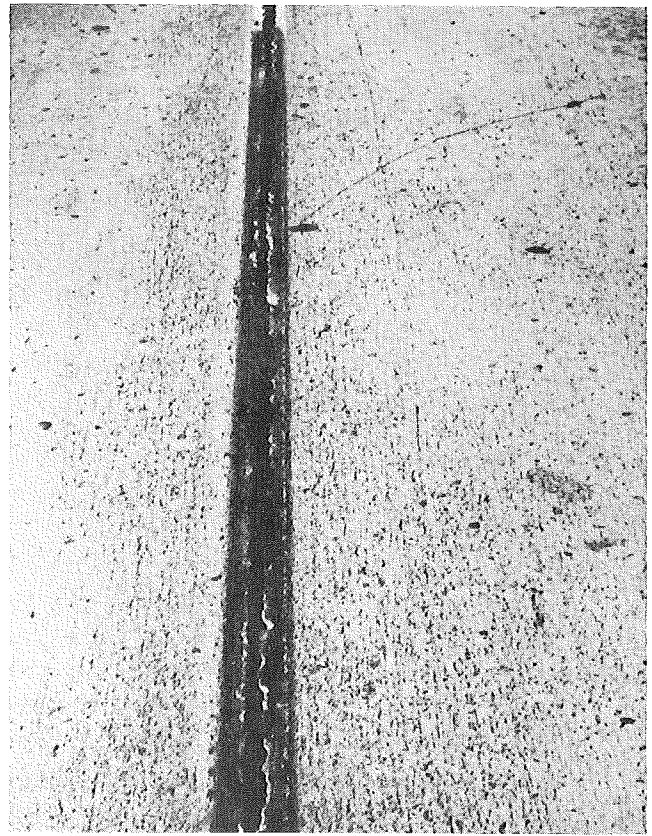
The most satisfactory procedure arrived at for joints and cracks is outlined below:

##### Longitudinal joint:

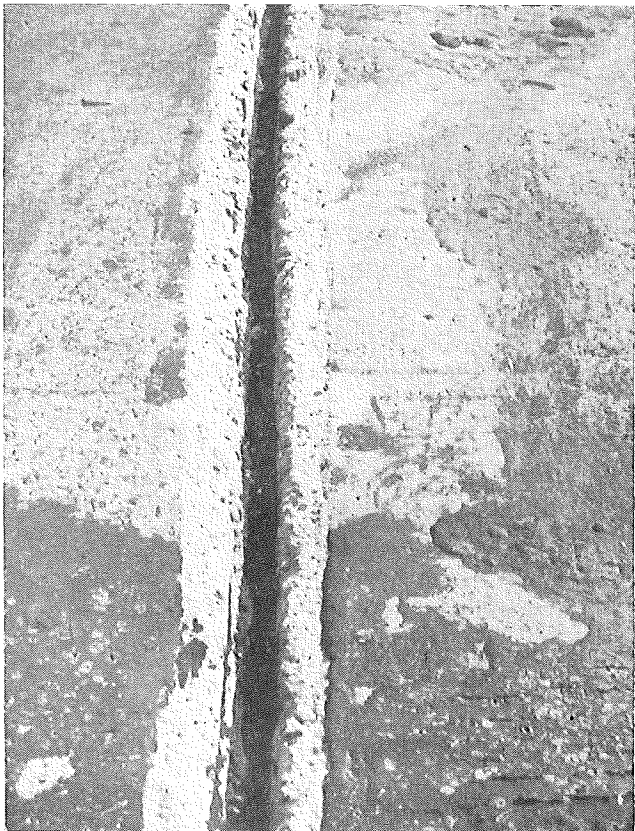
1. Plow out old filler to a depth of 3/4 to 1 in., preferably making one pass each way.
2. Make one pass with MSHD machine, using a single row of 4-in. cutters in the head to clean the vertical faces of the joint and to further remove the filler.
3. Sandblast vertical faces of the pavement surface to a distance of about 1 in. each side of the joint to remove traffic paint. If necessary, use hand tools to remove any filler left in the top inch of the joint.



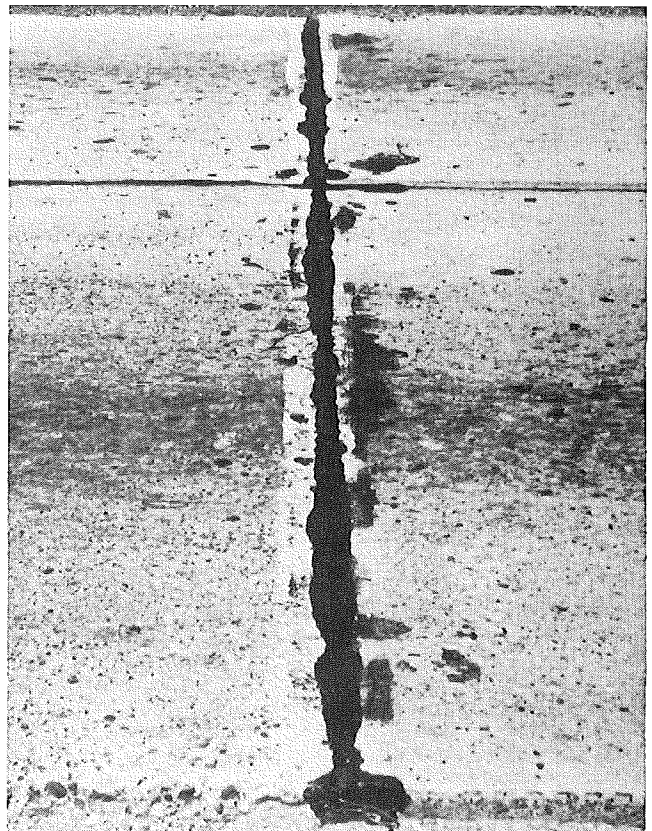
▲ FIGURE 8. LONGITUDINAL JOINT CLEANED AND READY FOR SEALING.



▲ FIGURE 9. LONGITUDINAL JOINT AFTER SEALING.



▲ FIGURE 10. EXPANSION JOINT IMMEDIATELY BEFORE SEALING.



▲ FIGURE 11. EXPANSION JOINT AFTER SEALING.

4. Blow out with compressed air at a pressure of at least 90 psi. and seal in two pours.

#### Transverse Joints:

1. Plow out old joint materials to a depth of at least 1 in. preferably making at least one pass each way.

2. Make one pass on each side of the joint with the MSHD machine using a 2-in. row of 2-in. cutters in the head to remove all foreign materials from the pavement surface to a distance of at least 1 in. each side of the joint.

3. Make one pass with the MSHD machine, using alternate single and double 4-in. cutters in the head to clean vertical faces of the joint and to assure removal of all old joint material to a depth of at least 1 in.

4. Sandblast vertical faces of the joint and the pavement surface to a distance of 1 in. each side of joint. Use hand tools to remove any traces of old sealer that might be left.

5. Blow out with compressed air at a pressure of at least 90 psi. and seal in two pours. Outer ends of joints must be dammed to prevent sealing material from running out onto the shoulder.

#### Open Cracks:

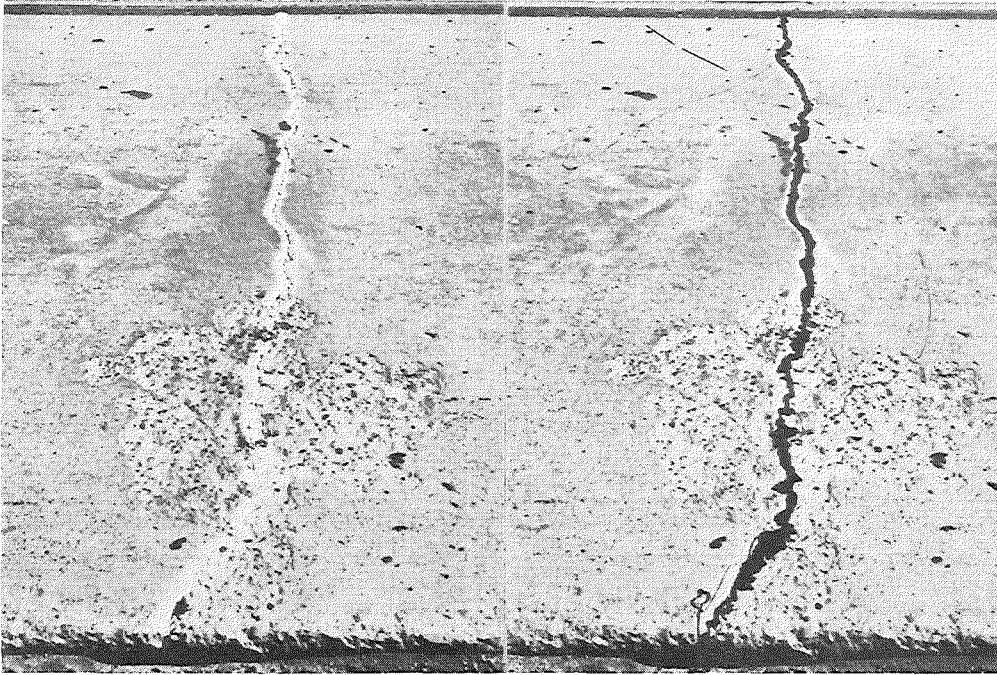
1. Sandblast vertical faces of the crack to a depth of at least 1 in. and the pavement surface to a distance of at least 1 in. each side of crack.

2. Blow out with compressed air and seal in at least two pours.

#### Closed Cracks:

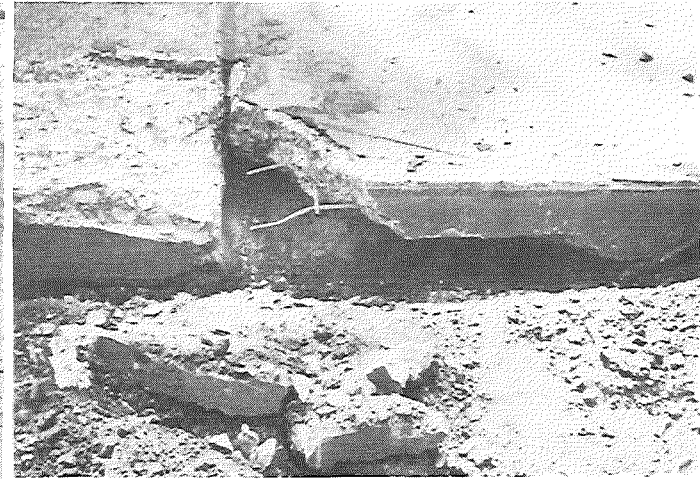
1. Sandblast until a shallow groove is formed along the crack. The groove should be 3/16 to 1/2 in. deep and 1/2 to 3/4 in. wide. The pavement surface should be sandblasted for about 1/2 in. each side of the groove.

2. Blow out with compressed air and seal in one pour. Fill until sealer overlaps pavement surface about 1/8 in.



▲ FIGURE 12. CLOSED CRACK AFTER SANDBLASTING SHALLOW GROOVE ALONG CRACK.

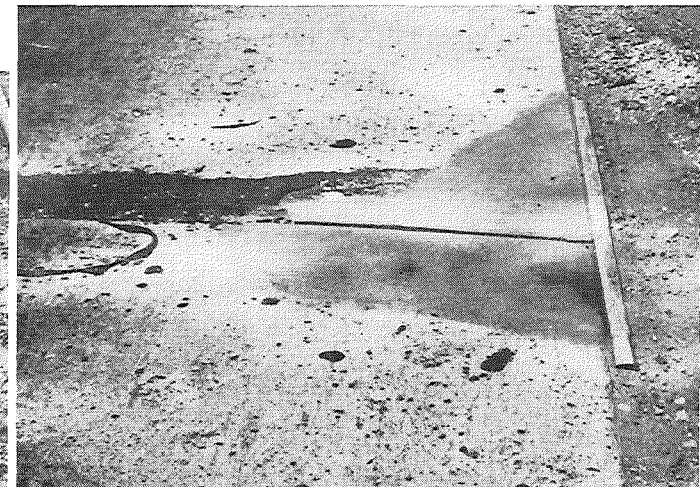
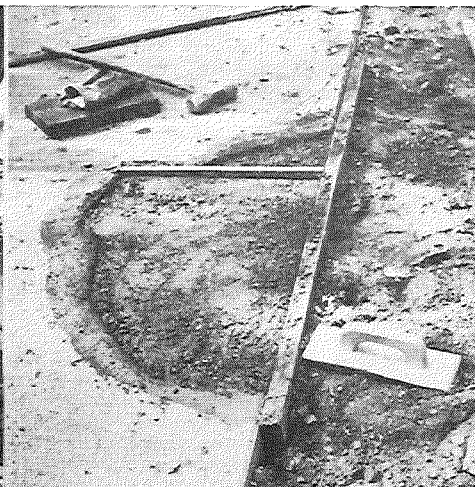
▲ FIGURE 13. SAME CRACK AS IN FIGURE 12 AFTER SEALING.



▲ FIGURE 14. CORNER BREAK WITH LOOSE AND UNSOUND MATERIAL REMOVED.

▼ FIGURE 15. ADDING GROUTING MIXTURE.

▼ FIGURE 16. READY FOR FINISH COAT.



▲ FIGURE 17. A TYPICAL REPAIRED CORNER BREAK.

The old joint materials in almost all of the transverse joints had been displaced by gravel and dirt for all or most of the pavement depth for about two feet from each edge of the pavement. This necessitated extra sandblasting, blowing and hand raking in these sections to remove as much of the foreign material as practicable.

### EXPERIMENTAL CONCRETE REPAIRS

In a number of places, corners were broken from slabs at the junction of the transverse joint and the pavement edge. Since the pavement was in very good general condition, and resealing of joints and cracks had eliminated the necessity of resurfacing, it was felt that an investigation should be made into the practicability of repairing such corner breaks. This work was started immediately after completion of resealing operations and was done by the contractor on a force account basis.

It was found that usually only one corner break was apparent at the pavement edge. Removal of a section of the shoulder always indicated, however, that the other corner was also broken. It appeared that compressive stress at the joint caused the upper corner of one slab and the lower corner of the other to shear off at an angle of about 30 deg. to the horizontal. This condition is apparent in Figure 14 and is typical of all corner breaks examined in detail.

Figures 14 through 17 show the various steps used in making these repairs. The loose and unsound concrete was removed with an air hammer and the joint filler and groove form set in place. A wide board was used as a form for the pavement edge. A very thin water slurry of cement containing 10 percent by weight of a well known anti-shrink admixture was brushed into the faces of the old concrete for a bond coat. A grout made of 60 volumes of gravel of 1-in. maximum size, 40 volumes of No. 8 sand, and 33-1/3 volumes of cement containing 10 percent by weight of the same admixture was then packed into the cavity by hand and consolidated by tamping in with the end of a small board, Figure 15. This grout mixture was unusually dry, containing just enough water to retain its shape when squeezed into a ball in the hand, and was consolidated on the surface patches simply by tramping on it with the feet. Figure 16 shows a patch at this stage and ready for the finish coat. A 1/2-in. surface coat, in which the gravel was replaced by No. 8 sand, was used to finish off the patch. The patch was covered overnight with curing paper and then alternately wetted and dried for several hours in order to rust the iron in the admixture. Figure 17 shows a typical finished patch.



Breaks at the north end of 13 different expansion joints were repaired at an average cost of \$124.46 per patch. The area of the patchwork at each joint end averaged about 5 sq. ft. which means a cost of about \$24.90 per sq. ft. Within very wide limits, however, the cost per patch is somewhat independent of the size of the patch since about the same amount of time was required to repair each of the 13 corner breaks.

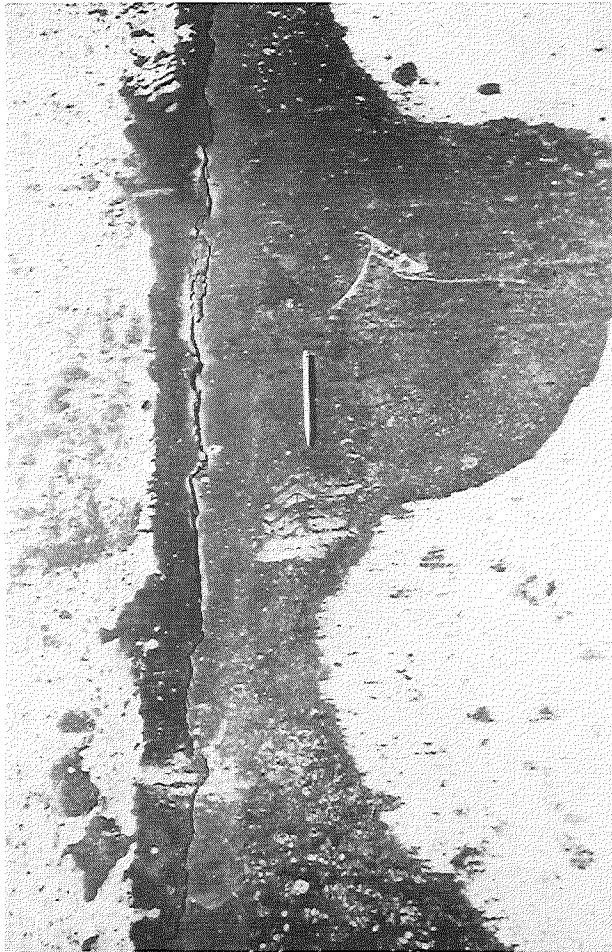
#### SUBSEQUENT CONDITION SURVEYS

Four detailed condition surveys of the experimental resealing of joints and cracks as well as the experimental patching of the broken concrete have been made to determine the effect of weathering and traffic on the repair work. These surveys were made on February 18, 1954, March 16, 1955, March 19, 1956 and October 1, 1956. The four surveys indicate the condition of the sealed cracks, the resealed joints and the concrete patches after 5 mo., 1-1/2 yr., 2-1/2 yr., and 3 yr. of service under varying weather conditions.

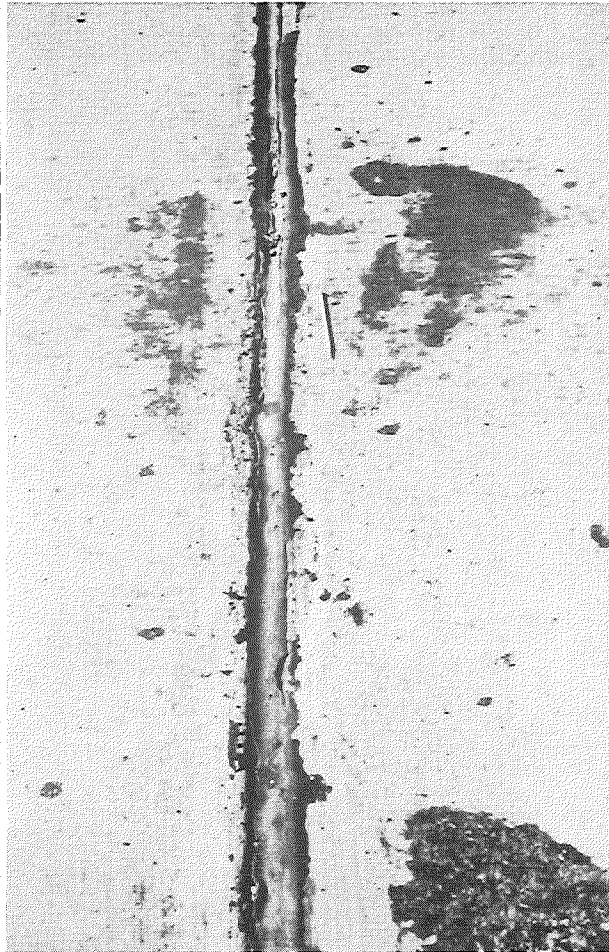
The 5-mo. survey showed that the various maintenance repairs had held up very well with the exception of most of the transverse joints and open cracks which had been sealed with Brand A joint sealer. This material was badly cracked and separated from the joint or crack faces and in some cases had worked entirely out of the open cracks.

After 1-1/2 yr. of service the Brand A material had continued to deteriorate to the point where in all transverse joints it was badly cracked and separated from the joint faces. In addition, Brand B had also started to deteriorate. In about half of the transverse joints and all of the open cracks containing this sealer, failures occurred in both cohesion and adhesion, while in the remainder of the transverse joints the seal was still intact. A few of the transverse joints containing Brand C sealer showed adhesion failures in which adhesion to one joint face was lost but most of the joints containing Brand C were in very good condition.

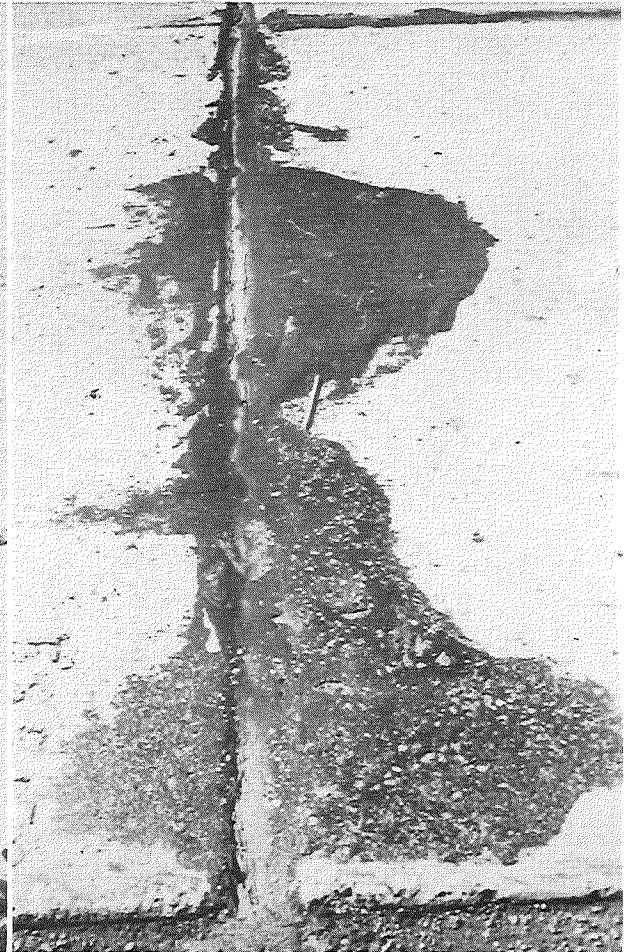
In the 2-1/2 yr. survey it was found that the only major changes since the previous survey had occurred with Brands A and B sealers in transverse joints. With the exception of a few adhesion failures, all of the Brand A failures had now become manifested as cohesion failures. The deterioration of Brand B sealer had continued to a point where all transverse joints containing this material had failed in adhesion. The remainder of the maintenance repairs appeared to be in exactly the same condition as they were at the time of the previous survey one year earlier. The Brand C sealer still showed adhesion failures in only a few transverse joints with most of them in good



▲ FIGURE 18. FAILURE MAINLY IN COHESION; TYPICAL OF BRAND A FAILURES AT 2 1/2 YEARS.



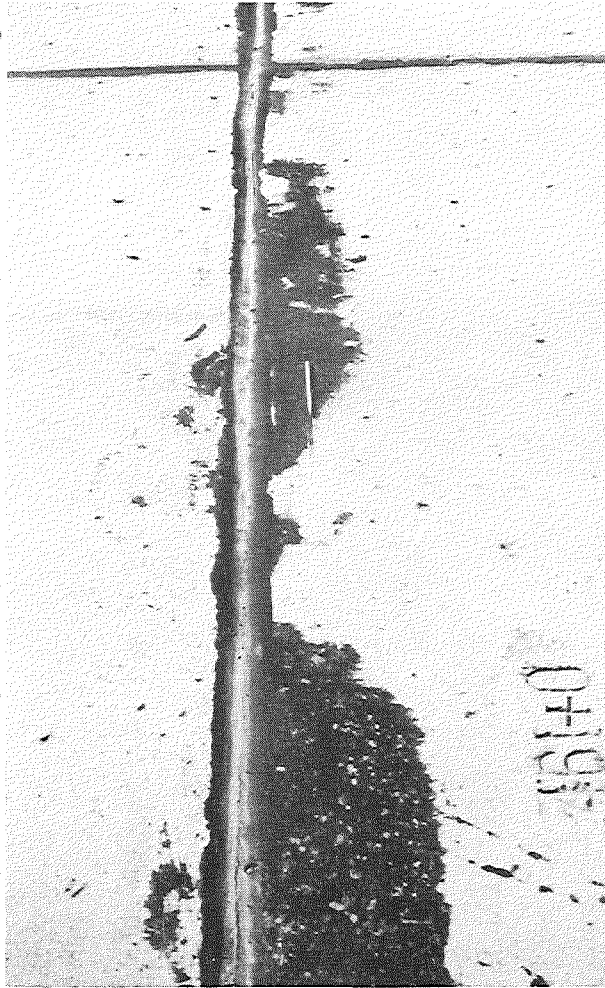
▲ FIGURE 19. ADHESION FAILURE; TYPICAL OF JOINTS RESEALED WITH BRAND B AT 2 1/2 YEARS.



▲ FIGURE 20. SEAL STILL INTACT. TYPICAL OF JOINTS CONTAINING BRAND C AT 2 1/2 YEARS.



▲ FIGURE 21. BRAND D; IN GOOD  
CONDITION AT 2 1/2 YEARS.



▲ FIGURE 22. BRAND E ; IN GOOD  
CONDITION AT 2 1/2 YEARS.



▲ FIGURE 23. BRAND F; IN GOOD  
CONDITION AT 2 1/2 YEARS.

condition. Transverse joints and open cracks containing Brands D, E and F were still well sealed with no apparent failures of any kind, while the longitudinal joint and the closed cracks were still maintaining an excellent seal regardless of the brand of sealer used. Typical condition of joints sealed with the six different brands of material are shown in the photographs of Figures 18 through 23, taken during the third survey in March, 1956.

There was little change in the condition of the project when the fourth survey was made in October 1956, except what appeared to be a progression of failure in the Brand C material, Figure 24. On closer examination, however, it was found that the visible cracking and wrinkling of the sealer extended only slightly below the surface, with the seal still intact.

The concrete patches still remained bonded to the old concrete after 2-1/2 yr. and appeared to be sound, although some surface scaling was apparent (Figure 25).

#### CONCLUDING REMARKS

This study has shown that the extra care exercised in cleaning and preparing the joints has been justified by the results obtained, and that the use of sandblasting for the final cleaning operation is the most effective method tried thus far for this purpose. Furthermore, experience with the thermostatically controlled pouring pot with mechanical agitator supports the conclusion of Robbers and Swanberg (1) that this type of equipment should be used exclusively for all accessible joints.

It is also apparent that there is considerable difference in the performance of different brands of rubber-asphalt joint sealers, all meeting the same specifications. In this project, three of the six materials are still performing well after three years of service, while two brands definitely failed to survive the first winter. The other, Brand C, is intermediate between the two extremes. Even though three of the materials are maintaining a satisfactory seal after three years, they do not look as good, or as though they would last as long, as some of the earlier rubber-asphalt sealers at the same age in projects sealed more than fifteen years ago.

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(1) Robbers, J. C., and Swanberg, J. H., Resealing Joints and Cracks in Concrete Pavements with Hot-Poured Rubber-Asphalt, Highway Research Board, Bulletin 63, Washington, D. C., 1952.



FIGURE 24. TYPICAL OF SURFACE CRACKING AND WRINKLING OF BRAND C AT 3 YEARS. SEAL STILL INTACT.

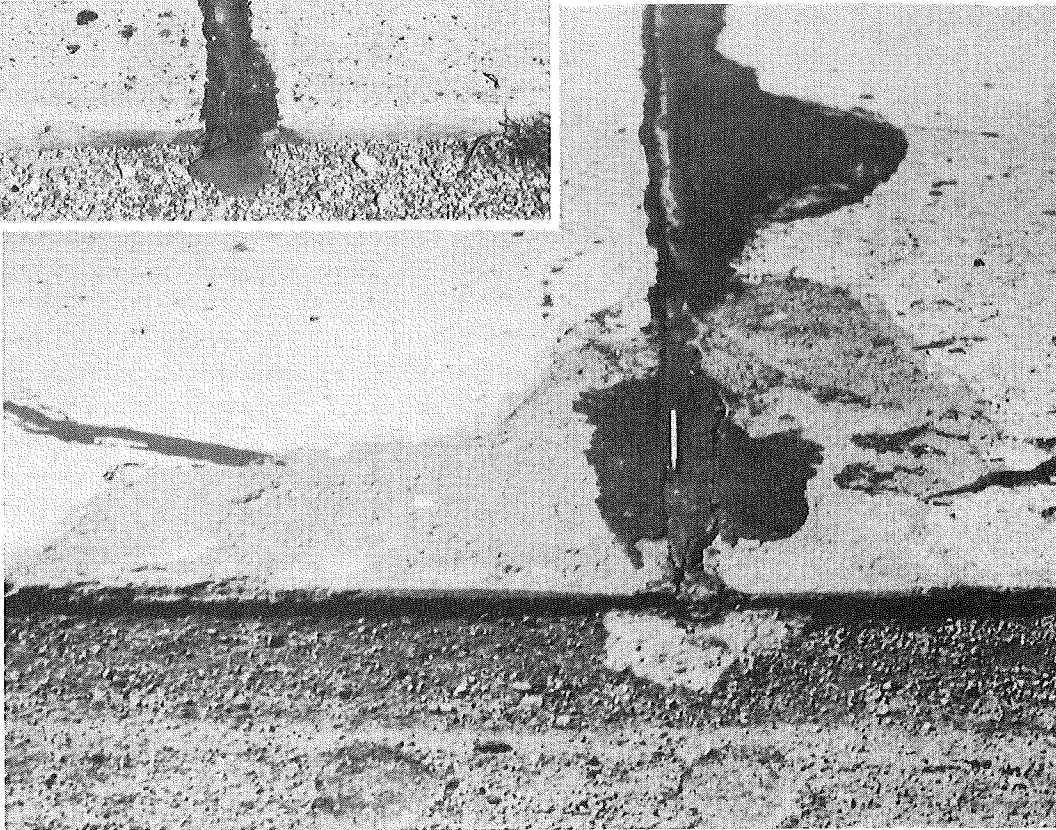


FIGURE 25. REPAIRED CORNER BREAK AFTER 2 1/2 YEARS.

Finally, it is becoming increasingly evident that more significant, discriminating, and reproducible tests for joint sealing materials are sorely needed. Such tests can be developed effectively only in conjunction with field tests to enable a comparison of laboratory results with performance in service. Several new tests have been proposed, but none has been specifically related to performance.

In order to evaluate present materials and to stimulate the development of better products, Michigan has undertaken an experimental joint sealing project with the cooperation of the Joint Sealer Manufacturers' Association, with all six member companies participating. During the past summer the joints of a 24-ft., two-lane concrete roadway about ten miles long were sealed with six different makes of each of two types of hot-pour rubber-asphalt sealer, and five brands of cold-applied material, as well as several products developed especially for the project by the various manufacturers. These special products included both hot-pour and two-component cold materials of the jet fuel resistant type. Standard tests and several new tests are being performed on these materials in an attempt to relate laboratory tests with field performance. A report will be made on this project as soon as significant results appear.

APPENDIX A

DATA ON JOINT SEALING MATERIALS

Brand	Price Per lb.	Quantity Used, lb.	Cost
A	\$. 1623	4000	\$ 649.20
B	. 12	1150	138.00
C	. 128	4000	512.00
D	. 14	2000	280.00
E	. 135	2000	270.00
F	. 125	2000	250.00
		Totals	
		15,150	\$ 2,099.20

APPENDIX B

COST ANALYSIS OF PROJECT

Total Materials, Sealer, Cutting Tools, Sand, etc.	\$3461.55	
15% for profit, overhead, supervision and general	<u>519.24</u>	\$3980.79
Total Labor	4969.62	
20% for profit, overhead, etc.	<u>993.93</u>	5963.55
Workmen's Compensation, .0429%	213.58	
Social Security Tax, 1.5%	74.55	
Michigan Unemployment Compensation 2.09%	<u>103.87</u>	
	<u>392.00</u>	
15% for overhead, profit, etc.	<u>58.80</u>	450.80
Employee's Travel Expense Allowance, \$.05 per mile	376.25	
15% for overhead, profit, etc.	<u>56.45</u>	432.70
Equipment Rental for Equipment Furnished by Contractor	1572.35	
15% for profit, overhead, etc.	<u>235.86</u>	1808.21
Operating Charges for Michigan State Highway Equipment		93.10
Joint Cleaning Machine and Sealing Compound Melter		
Total of Invoices		<u>\$12729.15</u>
1% for Bonds		<u>127.29</u>
Total Due Contractor		\$12856.44



APPENDIX B (con't.)

Lineal feet of joints and cracks sealed in project:

Longitudinal joint	25857
Transverse joints	5340
Open cracks	403
Closed cracks	<u>4000</u>
Total combined	35600

Weight of sealing material per lineal foot of crack plus joint:

$$\frac{15150}{35600} = 0.593 \text{ lb. per ft.}$$

Cost per lineal foot of crack plus joint for total operation:

$$\frac{12856.44}{35600} = \$0.361 \text{ per ft.}$$

Cost per pound to apply joint sealing material:

$$\frac{12856.44}{15150} = \$0.849 \text{ per lb.}$$