

MICHIGAN  
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EXPERIMENTAL CONTRACT RESEALING OF JOINTS AND  
CRACKS ON US-16  
Nunica to Fruitport  
Project Mc 70-28, C3

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Cooperative Research Program between the Maintenance Division  
and Testing and Research Division

Research Project 53 G-68

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EXPERIMENTAL CONTRACT RESEALING OF JOINTS AND CRACKS ON US-16

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In order to determine the practicability of using hot-pour rubber-type joint sealing materials to reseal joints in old concrete pavements some experimental work was done along this line in 1945 on US-16 west of Lansing under Research Project 36 G-4(6). The following year this type of work was continued on a much larger scale on US-12 west of Battle Creek, starting at the Calhoun-Kalamazoo County line and continuing west to Galesburg. All joints in this section were cleaned and resealed. This work, done under regular maintenance conditions, included the use of three brands of joint sealing material for comparison and a record was kept on equipment, methods, and costs. The results of the investigation were reported in Research Report No. 94, March 14, 1947. The joints resealed in the project are still performing satisfactorily after seven years without need of the normal yearly resealing.

During July of 1953, Mr. W. W. McLaughlin, Testing and Research Engineer, and Mr. B. R. Downey, Maintenance Engineer, requested the Research Laboratory with the early resealing work as a background, to establish a program for the experimental contract resealing of joints and cracks in an old concrete pavement with hot-pour rubber-type joint sealers. It was understood that the work was to be done by a contractor who was specially qualified to do that type of work. The object of the program was to establish whether the workmanship and cost of such work would warrant its adoption as a future Department maintenance policy on concrete pavements which are otherwise in such good physical condition that resurfacing would not be anticipated for at least a period of 10 years.

On July 22, 1953 a condition survey of a 5-mile section of US-16 between Nunica and Fruitport, Michigan was made by Mr. C. C. Rhodes and the author, both of the Research Laboratory. The pavement was built on a sand subgrade and was of 9:7:9 cross section containing 60 pounds of steel, with 100-ft. expansion joints and no intermediate joints. No load transfer devices were used, and the expansion joints were all slightly faulted. The joints were about 1 inch wide and most of them had accumulated a considerable quantity of infiltrated sand and gravel. The cracks were of two types, open 1/4 inch or more, and closed tight. The closed cracks, although tight enough to prevent infiltration of dirt, were spalled and needed sealing.

After this survey was completed, a program was established for the cleaning and resealing of joints and open cracks in the 5-mile section and a force account contract was awarded to David C. Byers, Jr. of Grand Rapids, Michigan on August 11 for the execution of the work. The work was started on August 11 and completed on September 10, covering a period of approximately one month. During this time, several methods of removing old filler, sealer, and foreign material from the joints were tried. Also several experiments were carried out on the proper treatment of open cracks before sealing. Shortly after the project was begun, it was decided that the closed cracks in the pavement should also be sealed, so various methods of preparing such cracks for sealing were tried out.

As a result of the various experiments run on joints and cracks the following methods were established and used to complete the project:

**Transverse Joints -**

1. Remove bulk of old sealer to a 1-inch minimum depth with a garden tractor and plow attachment
2. Clean pavement surface to a minimum of 1 inch on each side of joint with a Tennant joint cleaning machine equipped with a scarifying head

3. Clean sides of joint with a Tennant joint cleaning machine equipped with a routing head
4. When necessary, use hand tools for removing any material missed by mechanical cleaning
5. Sandblast joint faces and pavement surfaces each side of joint
6. Blow out with compressed air and seal

Longitudinal Joint -

1. Remove old felt to a 1-inch minimum depth with a garden tractor and plow attachment
2. Clean sides of joint with a Tennant machine equipped with a routing head
3. Sandblast to further clean sides of joint and to remove paint stripe to a minimum of 1 inch each side of joint
4. Blow out with compressed air and seal

Open Cracks -

1. Sandblast faces of crack and pavement surface 1 inch each side of joint
2. Blow out with compressed air and seal

Closed Cracks -

1. Sandblast to form a V shape groove along crack and to clean pavement surface 1/2" each side of groove
2. Blow out with compressed air and seal

A total of 35,600 lineal feet of joints plus cracks were sealed at a unit cost of \$0.361 per foot and an average of 0.593 pounds of hot-pour rubber-type joint sealer was required per lineal foot of joints plus cracks.

The contractor carried out the work with efficiency and thoroughness and showed constant progress in developing methods of speeding up operations. Future contract resealing work should result in still more progress in faster and more thorough ways of preparing joints and cracks for resealing and thus tend to lower costs.

## Materials and Equipment

Six brands of hot-pour rubber-type joint sealing material were used in this project for sealing joints and cracks. Locations of the various materials used in the project are given in Table I and the schematic drawing of Figure I.

The joint sealing materials were melted in a "Sealz" melter, Figure 2, which is of the double boiler type using oil as the heat transfer medium. It 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 by the author 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.

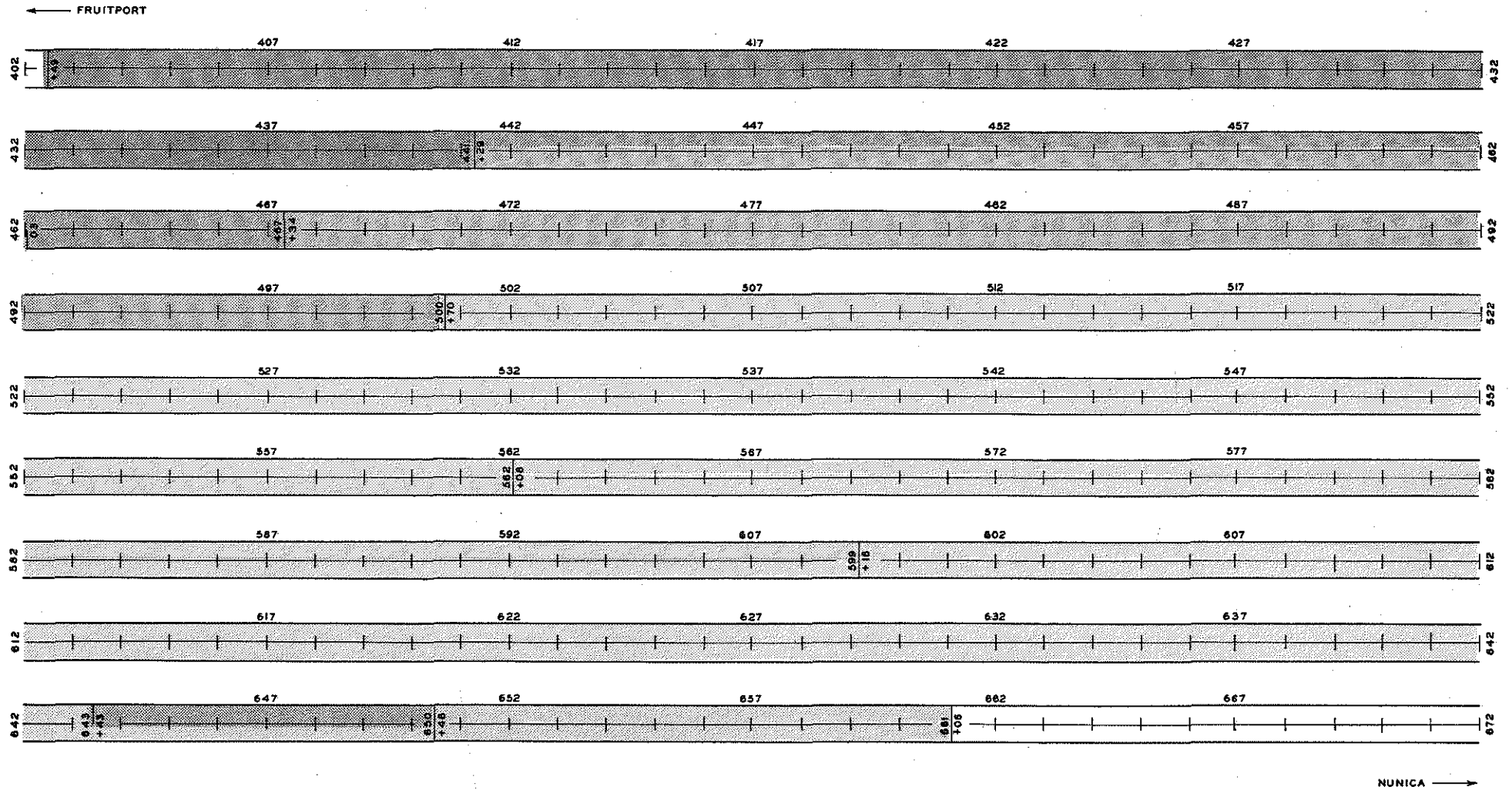
The sealing materials were poured from a mechanical pour pot, Figure 3, also of the double boiler type, using oil as the heat transfer medium and having thermostatically controlled gas heat and a thermometer to indicate the oil temperature. The pour pot was mounted on rubber tired wheels and was provided with a mechanical agitator. Temperatures of the materials in the pour pot were also taken at frequent intervals by the writer. A temperature differential of 50°F was found 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 should be installed on all joint seal heating equipment as required in current department specifications, to insure that the compound is heated and poured in the specified temperature range.






TABLE I  
LOCATION OF SEALING MATERIALS USED IN THE PROJECT

Brand	Station Location			Pour Temperature
	*North Lane	*South Lane	Longitudinal Joint	
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°F
B	650+46 to 643+43		650+46 to 643+43	425°F
C	599+16 to 500+70	562+08 to 500+70	599+16 to 500+70	395°F
D	500+70 to 467+34	500+70 to 467+34 462+03 to 441+29	500+70 to 467+34	425°F
E	467+34 to 441+29	467+34 to 462+03	467+34 to 441+29	425°F
F	441+29 to 402+49	441+29 to 402+49	441+29 to 402+49	425°F

\*Cracks and Transverse Joints



LEGEND:

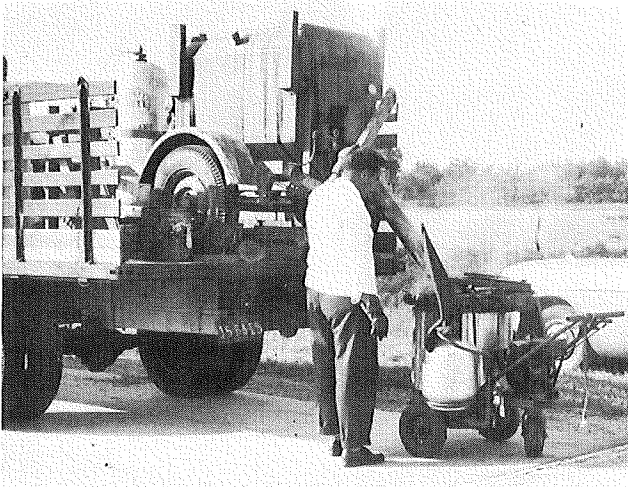
- |   |   |
|---|---|
|  BRAND A |  BRAND D |
|  BRAND B |  BRAND E |
|  BRAND C |  BRAND F |

LONGITUDINAL OR TRANSVERSE JOINTS ARE TO BE INTERPRETED AS SEALED WITH BRAND INDICATED BY INCLUSIVE COLOR.

LOCATION OF SEALING MATERIALS  
USED IN RESEALING PROJECT

US-16 NUNICA WEST TO FRUITPORT  
CONSTRUCTION PROJECT MC-70-28-C3  
RESEARCH PROJECT 53-G-68

FIGURE 1



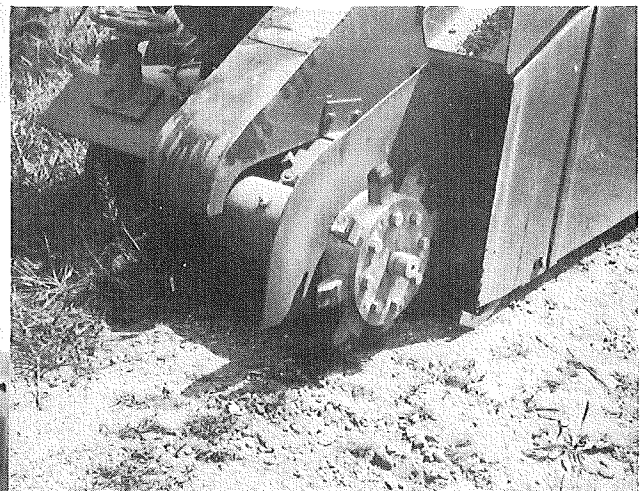
▲ FIGURE 2. FILLING POURING POT FROM SEALZ MELTER ON TRUCK.



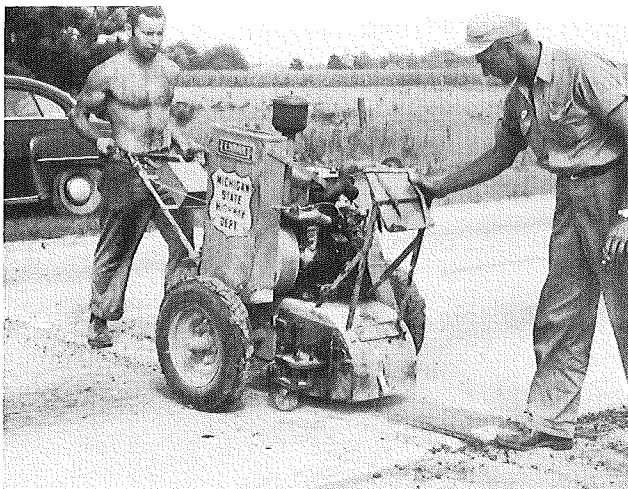
▲ FIGURE 3. USE OF MECHANICAL POUR POT IN SEALING LONGITUDINAL CENTER JOINT.



▲ FIGURE 4. HECKER JOINT CLEANING MACHINE IN OPERATION.



▲ FIGURE 5. CUTTING HEAD OF HECKER JOINT-CLEANING MACHINE.



▲ FIGURE 6. TENNANT JOINT CLEANING MACHINE IN OPERATION.



Two types of mechanical joint cleaning equipment were used for cleaning joints, namely, the Hecker joint machine, Figures 4 and 5, and the Tennant joint cleaning machine, Figure 6.

For removing the bulk of old materials from joints a small garden tractor with a plow attachment, Figure 7, was used. Plow blades of various shapes are shown in Figure 8.

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. Both pieces of equipment are shown in Figure 9.

A mechanical wire brush used in some of the earlier joint cleaning operations is shown in Figure 10.

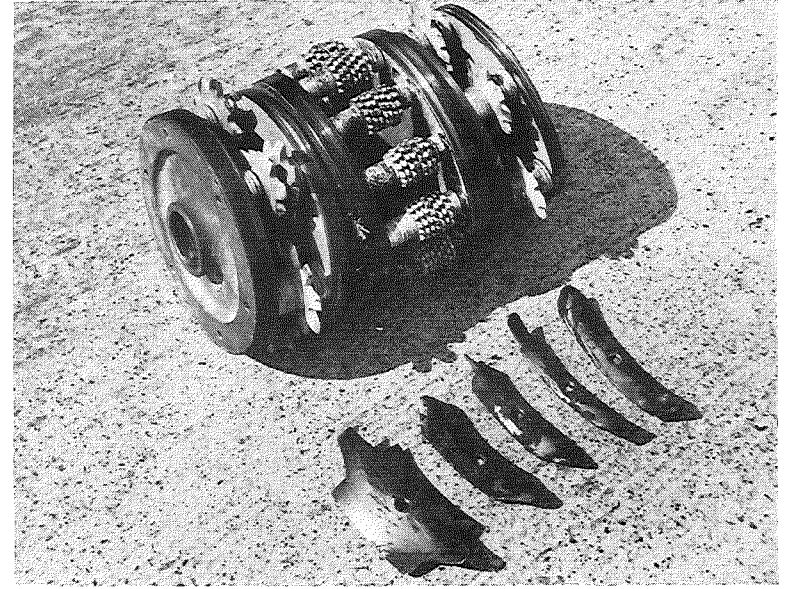
#### General Condition of Pavement

The pavement on which the sealing operations were performed was constructed in 1933 and 1934 and was in good condition for a pavement of that age. It was built on a sand subgrade and was of 9:7:9 cross section containing 60 lb. of reinforcing steel mat per 100 square feet, with expansion joints at 100 foot intervals and with no intermediate joints. The expansion joints contained no load transfer devices and were all slightly faulted causing extruded or displaced joint sealer to be spread over the pavement surface on the lower side of the joints. A typical transverse joint is shown in Figure 11.

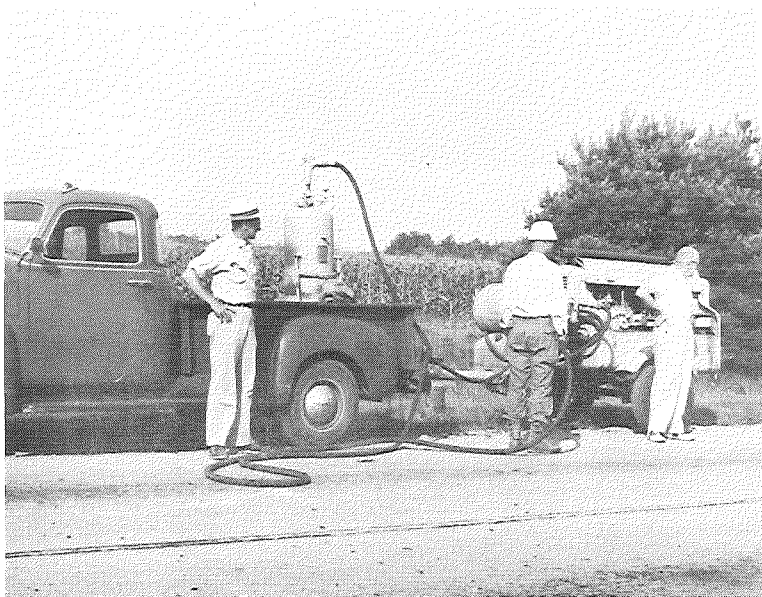
Most of the joint filler in the expansion joints had been forced downward, apparently by infiltration of gravel followed by compaction from traffic. It was found that the joint filler near the edges of the pavement had been forced slightly into the subgrade. A piece of filler that had been found in such a position is shown in Figure 12. The transverse joints



▲ FIGURE 7. GARDEN TRACTOR WITH PLOW ATTACHMENT REMOVING OLD JOINT SEALER.



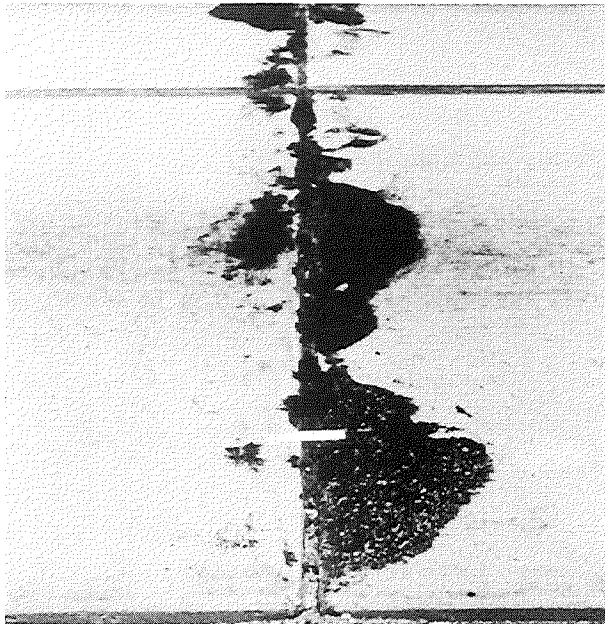
▲ FIGURE 8. TENNANT CUTTER HEADS AND TRACTOR PLOW BLADES USED FOR CLEANING JOINTS.



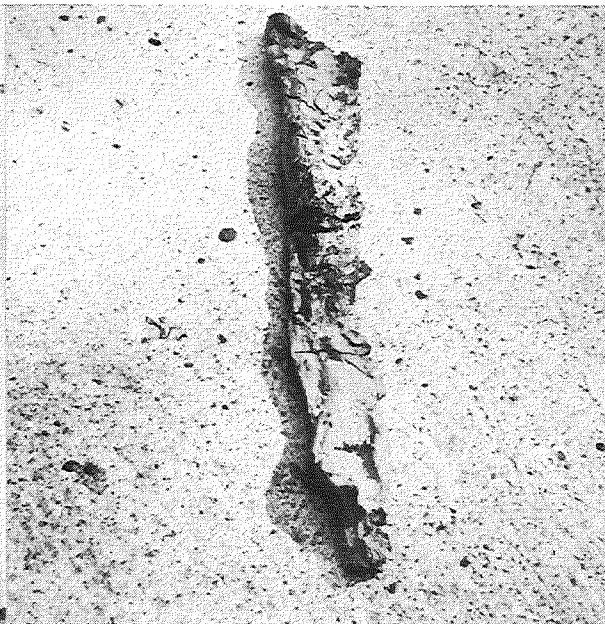
▲ FIGURE 9. PORTABLE AIR COMPRESSOR AND SANDBLAST MACHINE.



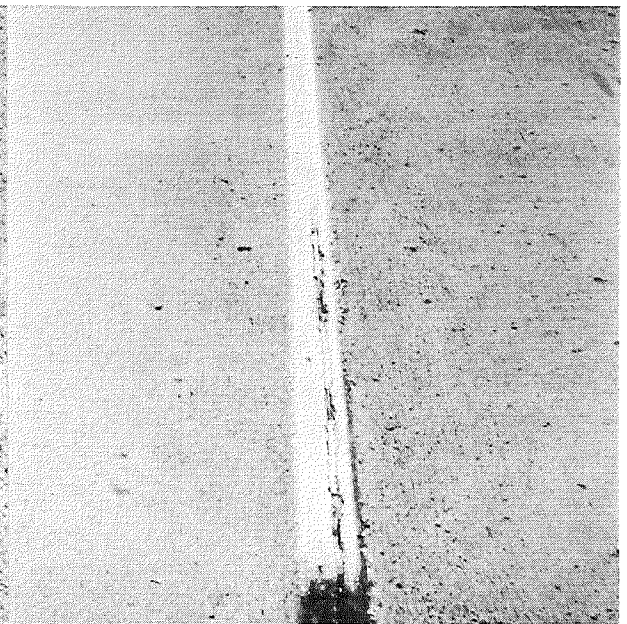
▲ FIGURE 10. MECHANICAL WIRE BRUSH USED IN EARLY JOINT CLEANING OPERATIONS.



▲ FIGURE 11. TYPICAL EXPANSION JOINT CONDITION.

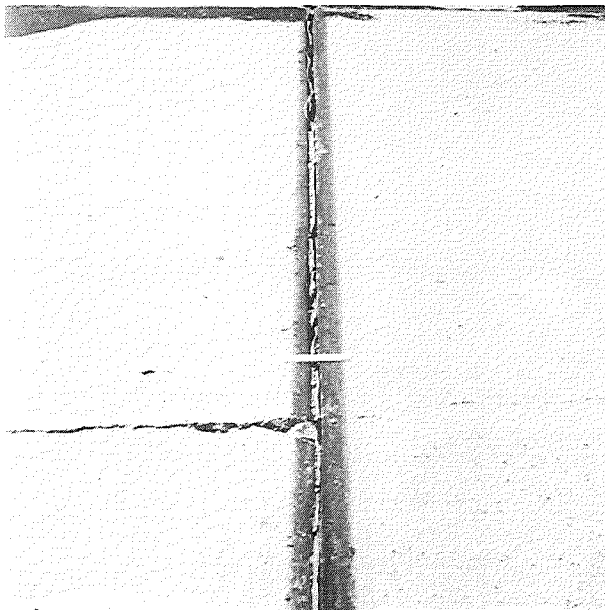


▲ FIGURE 12. SECTION OF OLD JOINT FILLER RECOVERED FROM SUBGRADE UNDER EXPANSION JOINT.

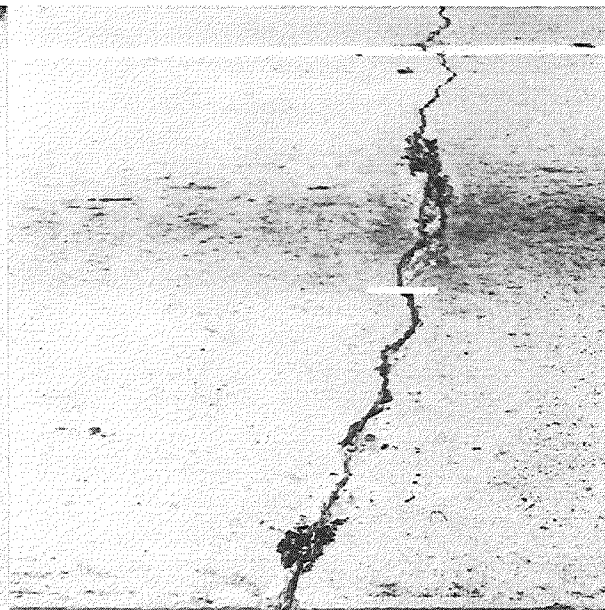


▲ FIGURE 13. SECTION OF TYPICAL LONGITUDINAL JOINT.

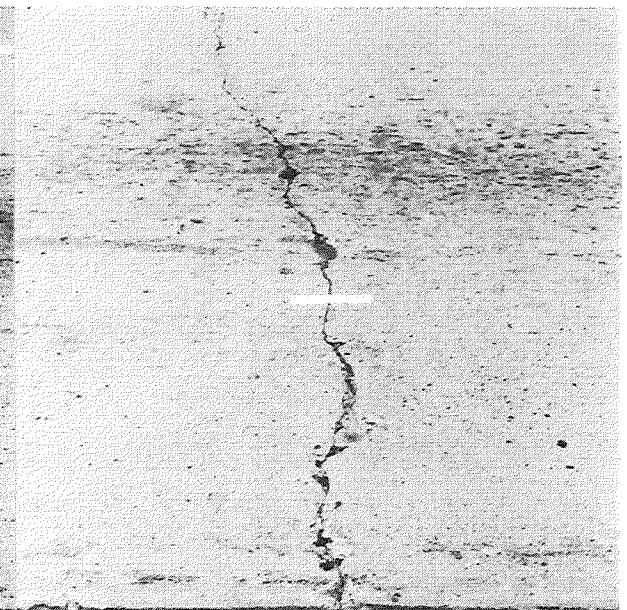
▼ FIGURE 14. EXCESS WIDENING OF LONGITUDINAL JOINT. SLAB DISPLACED SIDEWAYS.



▼ FIGURE 15. TYPICAL OPEN TRANSVERSE CRACK.



▼ FIGURE 16. TYPICAL SPALLED CLOSED CRACK.



averaged about 1 inch in width and varied only very slightly either side of that dimension.

The longitudinal joint was a plane of weakness joint containing a premolded filler material at the top. In many places this filler was partly gone leaving the joint susceptible to infiltrations of foreign materials. A section of typical longitudinal joint is shown in Figure 13.

Figure 14 shows a longitudinal joint condition frequently encountered in which a section of concrete between an expansion joint and a nearby transverse crack has become laterally displaced causing the adjacent longitudinal joint to open excessively.

Cracks in the pavement were almost entirely transverse cracks and were of two distinct types, open 1/4 inch or more, and closed tight. A typical open crack is shown in Figure 15. Although the closed cracks were tight enough to prevent infiltrations of dirt and gravel, many of them were becoming badly spalled at the edges and were in need of sealing. Such a crack is shown in Figure 16.

#### Methods of Cleaning and Resealing

The first experiments in cleaning old materials from joints involved the use of both the Hecker and Tennant joint cleaning machines. In cleaning transverse joints, old sealer and filler was first removed with the Hecker machine and then the pavement surface at each side of the joint freed from old sealer and other materials by use of the Tennant machine equipped with a surface scarifying head. Various depth adjustments and various width cutters were tried with the Hecker machine and a satisfactory cut was finally obtained with cutters 1 inch wide set to clean the sides of the joint to a one-inch depth. The head of the Hecker machine equipped with 1-inch cutters is shown in Figure 5.

The scarifying operations with the Tennant machine necessitated a pass on each side of each transverse joint because of the faulting of these joints.

In Figure 8, the center head is the type used for the scarifying operations. The Tennant machine with a single row of 4 inch cutters, as shown in Figure 8 upper right, was tried in place of the Hecker for routing old material from the transverse joints but it didn't do quite as complete a job as did the Hecker.

For the longitudinal joint the Hecker machine was at first used to clean out the old felt. Cutters both  $3/8$  and  $1/2$  inch in width were used, depending on the width of the joint. Trouble was encountered the second day of operations with breaking the carbony tips from these narrower cutters. After ruining several sets of cutters, the Hecker machine was abandoned in favor of the Tennant using the head with a single row of 4 inch cutters. It was found that the Tennant machine produced as clean a longitudinal joint as did the Hecker. Where the longitudinal joint was excessively wide a lateral vibration of the Tennant machine by the operator served to clean the joint faces satisfactorily.

About this time, the Tennant was again tested for removing old material from the transverse joints but this time single and double cutters were alternated around the head, Figure 8 upper left. This operation left a cleaner joint than did routing with the Hecker machine so the latter was abandoned also for this purpose.

After routing out both types of joints with the Tennant machine, small pieces or sections of old sealer or felt were still more numerous than was considered desirable and could not be removed with the final operation, of sandblasting and blowing with compressed air. To take care of this a mechanical wire brush, Figure 10, was used. In the longitudinal joint, the sections of felt left by the Tennant machine were routed out in a fairly satisfactory manner by the mechanical brush. Pieces of old sealer left by

the Tennant on the transverse joint corners were thinned enough by the brush to be later removed by sandblasting.

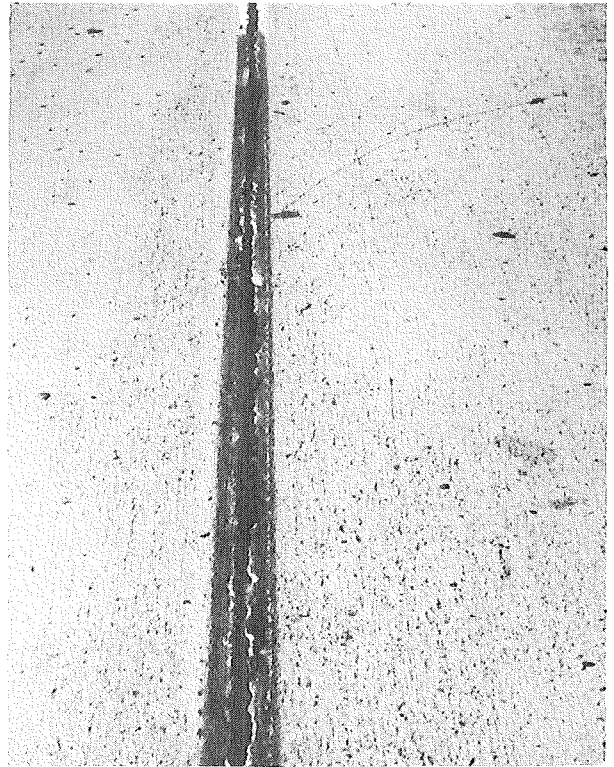
From the start of the project experiments were run daily with the small garden tractor and plow attachments for plowing out old materials from the joints. The problem seemed to be in getting the proper shaped plow blade to remove a maximum of material to a sufficient depth. On the sixth day of operation the plow was put into permanent operation on transverse joints and by the twelfth day it was used for the longitudinal joints. Several plow blades of typical shapes are shown at the bottom of Figure 8. No particular shape of the several developed was considered completely satisfactory so this operation is open to further experimentation.

In all of this earlier work the plowing operation was followed by use of the Tennant 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 the brush was eliminated from the procedure, speeding up the work. Pictures of both longitudinal and transverse joints before and after sealing are shown in Figures 17 through 20.

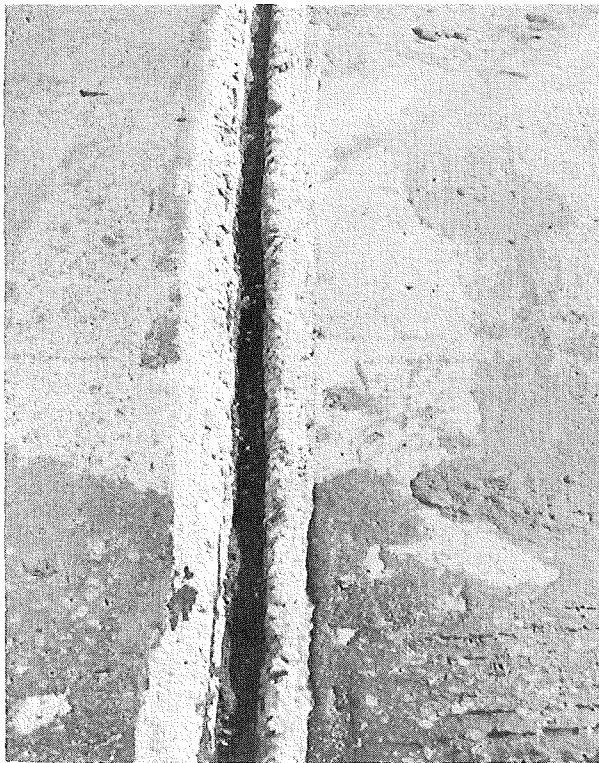
One open crack at station 658/75 was cut out with the Hecker machine using 1/2 inch cutters at a depth of 1/2 inch. Another open crack at 640/94, Figure 21, was routed out with the Tennant machine using a single row of 4-inch cutters. The crack prepared with the Hecker machine was satisfactory in appearance but did not appear much different from one treated with sandblast only. The crack routed with the Tennant 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 blowing out with air.



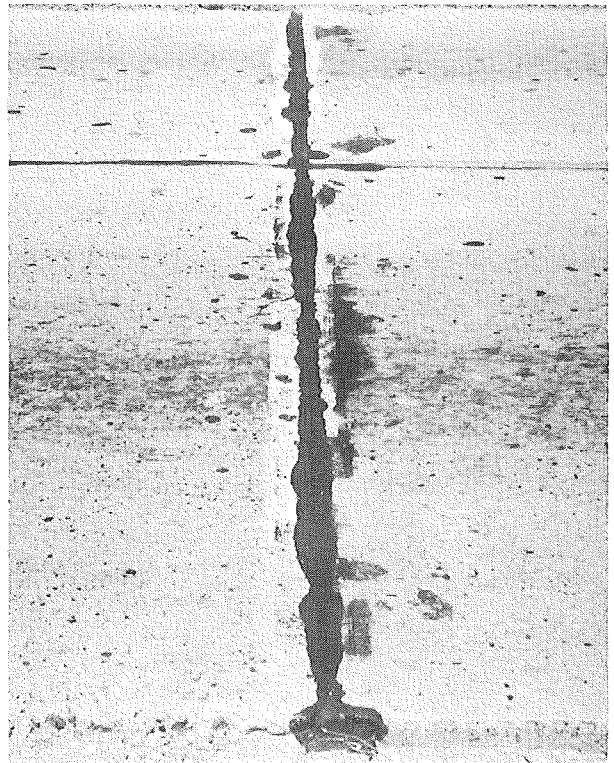
▲ FIGURE 17. CLOSEUP OF LONGITUDINAL JOINT, CLEANED AND READY FOR SEALING.



▲ FIGURE 18. LONGITUDINAL JOINT AFTER RESEALING.



▲ FIGURE 19. CONDITION OF EXPANSION JOINT JUST PRIOR TO POURING.



▲ FIGURE 20. EXPANSION JOINT AFTER RESEALING.

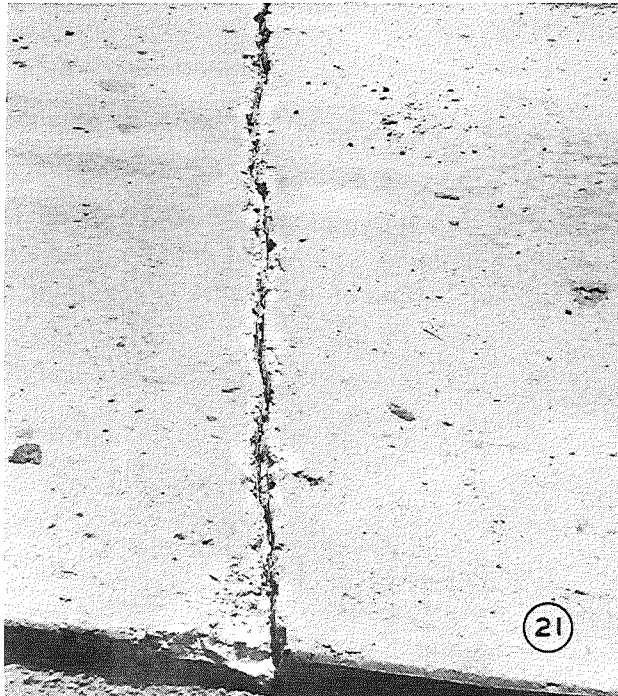


FIGURE 21. OPEN CRACK CUT OUT WITH TENNANT MACHINE, READY FOR SEALING.

FIGURE 22. CLOSED CRACK AFTER SANDBLASTING V-SHAPE GROOVE ALONG CRACK.

FIGURE 23. SAME CRACK AS FIGURE 22 AFTER SEALING.

FIGURE 24. INFILTRATION OF GRAVEL AT PAVEMENT EDGE IN TRANSVERSE JOINT.

FIGURE 25. SHOWS DEPTH OF CLEANING IN TRANSVERSE JOINT NEAR PAVEMENT EDGE.





As soon as a decision had been made to seal closed cracks, two such cracks were sandblasted until a V-shape groove was formed along the crack. The groove was 3/16 to 1/4 inches deep and 1/2 to 3/4 inches wide at the top. The pavement surface was cleaned with sandblast about one half inch 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 to the pavement surface of about 1/8 inch. 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 hours 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 ready for sealing is shown in Figure 22 and after sealing in Figure 23.

#### Final Procedures

The most satisfactory procedure arrived at in each case is outlined below.

##### Longitudinal joint:

1. Flow out old felt to a depth of 3/4 to 1 inch, preferably making one pass each way.
2. Make one pass with Tennant machine using single row of 4-inch cutters in head to clean vertical faces of joint and to further remove felt.
3. Sandblast vertical faces of joint and about 1 inch each side of joint to remove traffic paint. If necessary, use hand tools to remove any felt left in top inch of joint.
4. Blow out with at least 90 psi compressed air and seal in two pours.

##### Transverse joints:

1. Flow out old joint materials to a depth of at least 1 inch, preferably making at least one pass each way.

2. Make one pass on each side of joint with Tennant machine using about a 2 inch row of 2 inch cutters in head to remove all foreign materials from surface of pavement to at least 1 inch each side of joint.
3. Make one pass with Tennant machine using alternate single and double 4 inch cutters in head to clean vertical faces of joint and to assure removal of all old joint materials to a depth of at least 1 inch.
4. Sandblast vertical faces of joint and pavement surface to 1 inch each side of joint. Use hand tools to remove any traces of old sealer that might be left.
5. Blow out with at least 90 psi compressed air and seal in two pours. Outer ends of joints must be dammed to prevent sealing material from running out onto shoulder.

#### Open Cracks:

1. Sandblast vertical faces of crack to at least one inch depth and the pavement surface to at least one inch each side of crack.
2. Blow out with compressed air and seal in at least two pours.

#### Closed Cracks:

1. Sandblast until a V-shaped groove is formed along the crack. The groove should be  $3/16$  to  $1/2$  inches deep and  $1/2$  to  $3/4$  inches wide. The pavement surface should be sandblasted about  $1/2$  inch each side of the groove.
2. Blow out with compressed air and seal in one pour. Fill until sealer overlaps surface of pavement about  $1/8$  inch.

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, Figure 24. This necessitated extra sandblasting, blowing and hand raking in these sections to remove as much of the foreign material as was practicable. Figure 25 shows a joint cleaned and ready for sealing in which the depth of cleaning can be noted.

#### Concluding Remarks

The pavement after completion of the project presented a neat appearance. All joints and cracks were tightly sealed against infiltration of moisture and other foreign matter.

Many drivers of both commercial and passenger vehicles stopped at the project to comment on the improved riding quality that they had noticed after passing over completed sections of the pavement. They specifically stated that the transverse joints were much less noticeable since the sealing operation than they had been previously.

Throughout the project the work was performed with thoroughness, efficiency and neatness with a minimum of delay to traffic. The contractor and all the members of his personnel showed unusual ingenuity in solving new problems as they were met and in devising faster and more efficient methods of performing the various operations necessary to the work.

There is, however, room for still further experimentation in the development of even more efficient and thorough methods of preparing joints and cracks for sealing and there is no doubt that costs will tend to decrease as more of this type of work is done under contracts let through competitive bidding.

Appendix I

Data on Joint-Sealing Material

Code	Trade Name	Producer	Price Per lb.	Lbs. Quantity Used
A	Sealz	Naugatuck Chemicals	\$ .1623	4000
B	Kapco	Keystone Asphalt Prod. Co.	.12	1150
C	Paraplastic	Servicized Products Co.	.128	4000
D	Careylastic	The Philip Carey Mfg. Co.	.14	2000
E	Sealtight	W. R. Meadows, Inc.	.135	2000
F	Flintseal	The Flintcote Co.	.125	2000

Total quantity used 15150

Appendix II

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>	
	392.00	
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
Tenant joint cleaning machine and Sealz melter		
Total of Invoices		<u>12729.15</u>
1% for Bonds		127.29
Total Due Contractor		<u>12856.44</u>

Lineal feet of joints and cracks sealed in project:

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

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:

$$\frac{12856.44}{35600} = \$ 0.361 \text{ per foot}$$

Cost per pound to apply joint sealing material:

$$\frac{12856.44}{15150} = \$ 0.849 \text{ per pound}$$