MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

PERFORMANCE OF HOT-POURED RUBBER-ASPHALT JOINT SEALING COMPOUNDS

L. A. Fickes

Highway Research Project 53 G-71

Research Laboratory
Testing and Research Division
Report No. 220
May 19, 1955

PERFORMANCE OF HOT-POURED RUBBER-ASPHALT JOINT SEALING COMPOUNDS

During the past year a State-wide survey was made by the Research Laboratory to determine the condition of the rubber-asphalt joint sealer in Michigan's postwar pavements. This survey was made as a preliminary step in a general program directed toward possible improvement in materials and methods for sealing joints in concrete pavements, both in new construction and maintenance operations. The survey revealed that various types of joint seal failure had occurred on all projects surveyed. The types of joint seal failure that were found are illustrated in Figures 1 through 6. Experience indicates that such failures could have resulted from cleaning and sealing operations or possibly by some deficiency in the joint sealing compound.

A typical adhesion failure is shown in Figure 1. This is one of the most common types of failure. The sealer in this type of failure is usually in fairly good condition, but can be pulled intact from the joint with various degrees of ease. In these adhesion failures, close examination of the joint faces gives no evidence that true adhesion of the sealer to the joint faces had ever occurred. This might indicate insufficient cleaning of joints, improper pouring temperatures at the time the joints were sealed, or lack of adhesive properties in the sealing material. Dirt and moisture were found deposited below the sealer and between the sealer and joint faces in such cases.

In some of the projects, the sealer had adhered fairly well to one joint face but was completely separated from the other. This is a modification of the complete loss in adhesion type of failure. Figure 2 shows a joint with such partial loss in adhesion.

Another type of failure is shown in Figures 3 and 4. In these cases, there is not only partial or total loss in adhesion, but the sealer itself is

cracked or wrinkled and admixed with sand and dirt. This type of failure is not as common as the other types and may be due to an inherent property of some of the sealing materials themselves.

Figure 5 shows a condition met occasionally in which lack of resilience causes a fold to occur in the sealer when the joint closes. This fold is usually filled with foreign material which eventually becomes thoroughly mixed with the sealer.

An unusual type of failure which occurred on a new pavement which had not been open to traffic is shown in Figure 6. The material became tough, wrinkled and crevassed.

A summary of notes on the various surveyed projects are presented in Table I at the end of this report. Observers were L. A. Fickes, William Martin and Lewis Kiwala.

Sealing Operations on Two Current Projects

On June 24, 1954 the joint sealing operations of Carl Goodwin and Sons, Contractors were observed by the writer on Construction Project F 70-41,04. This is located on US-31 between Holland and Grand Haven. Figures 7 and 8 show the melter in use on this project. It is labeled "Heat-Master" and was indirectly heated by circulating hot oil through several 2-inch straight pipes. These pipes in turn run through the joint seal material. It was not very efficient as it took from 8:00 A.M. until 2:00 P.M. to raise the temperature of the joint seal to 350 F as measured by a pocket thermometer. The operator was pouring the material at that temperature since the only temperature indicator on the melter read 475 F, apparently the temperature of the oil.

Prior to sealing the joints, they were partially blown out with compressed air, as seen in Figure 7, and then poured with a hand pouring pot,

Figure 8. The faces of many of the joints were coated with membrane curing compound, Figure 9, prior to sealing and nothing was done to remove it. Examination of a joint poured 5 days previously indicated that it was not blown out at all previous to sealing. In this joint the sealer was not adhered at all; sand and dirt were found between the sealer and joint face and a 1-inch layer of sand and dirt below the sealer, Figure 10. In addition, white membrane curing compound from the joint faces was adhered to sealer pulled from the joint, Figure 11.

Joint sealing operations of the Sargent Construction Company on Construction Project FI 6-21,C6 and 7 and FI 9-4,C3 and 6 were observed. This is located on US-23 between Pinconning and Standish. The sealer was being melted in an oil-jacketed heater, Figure 12, with indicating thermometers for both the oil and the sealing material. It was being poured from 400 to 425 F as checked with a pocket thermometer. Cleaning operations included raking with a hand tool, Figure 13, and blowing with compressed air, Figure 14. In Figure 15 the hand-pouring operation can be seen as well as the strip each side of the joint which is free of membrane curing compound. The joints were covered with strips of heavy paper during the spraying operation.

Examination of the joints just prior to sealing showed them to be free of all extraneous matter except for a very fine dust on the joint faces. This dust, observable only by wiping the finger tips across the joint faces, apparently results from cement laitance. Examination of a joint sealed the previous day indicated that adhesion was fair but not perfect. This lack of perfect adhesion, as seen in Figure 16, appeared to result from the fine laitance dust just described.

Nunica to Fruitport Experimental Resealing Project

The joints and cracks in a section of pavement on US-16 located between Nunica and Fruitport were resealed with rubber-asphalt joint sealing material during September, 1953. Six different sealing brands of joint sealing material were included for comparative study (Research Laboratory Report No. 197). The joints in the project had been completely cleaned by sandblasting and blowing with compressed air so that surface mortar was completely removed and a clean concrete surface exposed. The pouring temperatures of the materials were rigidly controlled at the recommended level for each material and all the the porper procedures and precautions rigidly observed. In this case, however, the concrete in the pavement was 20 years old and probably in a much better physical condition for sealing.

A field survey made during March, 1955 revealed that after 1-1/2 years of service the joints containing three particular brands of sealer were still completely sealed and the sealing materials in good condition. The other three brands of sealer used in the project showed various degrees of adhesion and cohesion failures (Research Laboratory Report No. 225).

The results of this project so far indicate that the brand or source of material definitely is an important factor in the problem along with proper joint preparation and sealing methods.

Summary

The results of the State-wide survey of joint conditions clearly demonstrate that present Department specifications for sealing joints in new pavements are not producing the results desired. Present specifications should be revised with the view of obtaining a better quality joint sealing material and also to insure that the joints are properly prepared to receive the joint sealing material.

Recommendations

As a result of the various observations made in this investigation, it is recommended that:

1. Dirt be kept from joints by caulking methods until time for sealing.
2. All pavement joints be sandblasted and blown out with compressed air just prior to sealing.
3. All brands of hot-pour rubber-asphalt type joint sealer undergo field service testing before being approved for use by the Department.
4. All contractors be required to use modern equipment including oil-jacketed, thermostatically controlled melters and pouring pots with built-in agitators.
5. Department inspectors be thoroughly educated in the proper sealing of joints.
6. Paving contractors be encouraged to subcontract joint sealing operations to specialists in that type of work.

FIGURE 1. TYPICAL JOINT SEAL FAILURE WITH COMPLETE LACK OF ADHESION TO BOTH JOINT FACES. PAVEMENT 7 YRS. OLD. CONSTR. PROJ. F 17-7, C 6. STA. 1171 + 00.

FIGURE 2. PARTIAL ADHESION FAILURE OF JOINT SEAL. NOTE LACK OF ADHESION TO LEFT FACE OF JOINT. PAVEMENT SEALED ONE WEEK. CONSTR. PROJ. 39-45, C 2 AND 3.

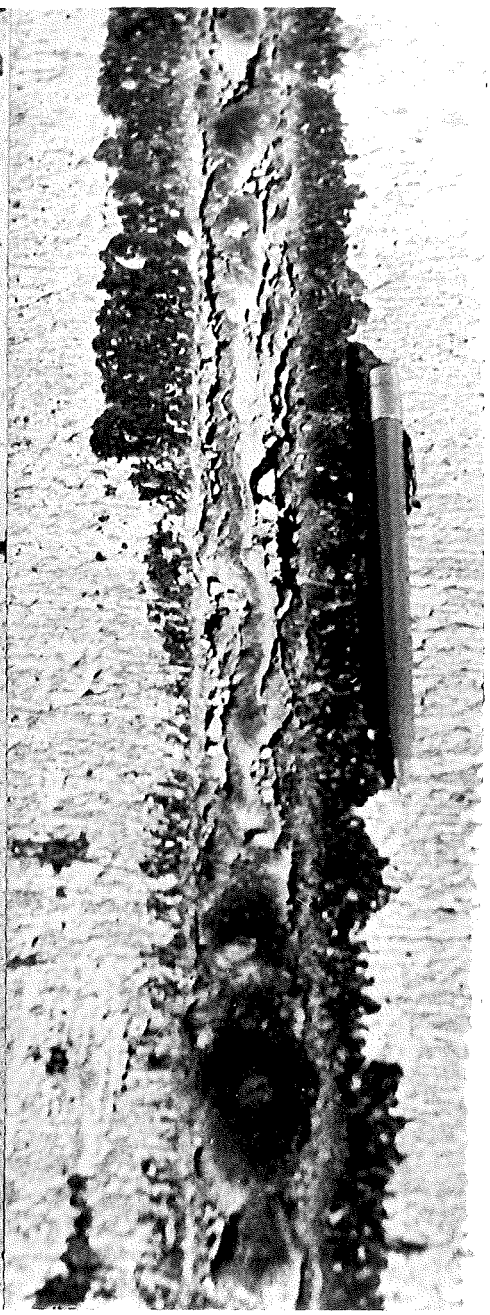

FIGURE 3. JOINT SEAL FAILURE WHERE CRACKS AND DIRT ARE FOUND IN SEALER MATERIAL. ADHESION USUALLY POOR. MIDDLEBELT ROAD, DETROIT. CONSTR. PROJ. 82-176, C 2.

FIGURE 4. FAILURE IN BOTH ADHESION AND COHESION OF JOINT SEAL, US-12.

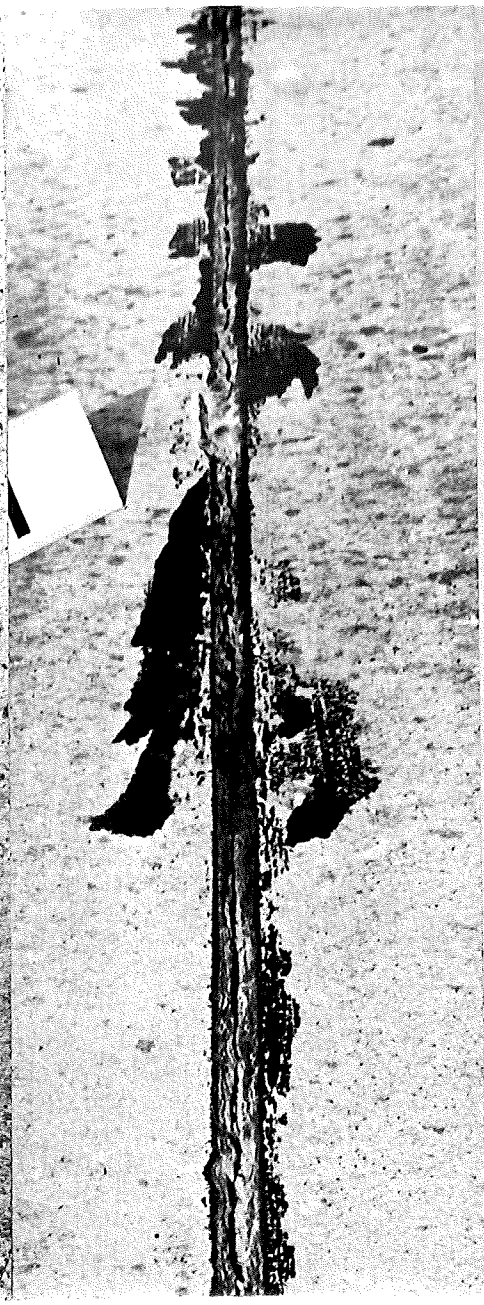

FIGURE 5. LONGITUDINAL FOLD IN JOINT SEAL CONTAINING INFILTRATED FOREIGN MATERIAL. SEALER STILL INTACT BELOW FOLD. CONSTR. PROJ. F19-41, C6. STA. 435+25.

FIGURE 6. NEW CONSTRUCTION NOT YET OPENED TO TRAFFIC IN WHICH SEALER HAS BECOME TOUGH AND FISSURED. CONSTR. PROJ. 39-40, C 4. STA. 981 + 60.

FIGURE 7. JOINT SEAL MELTER, RIGHT, AND AIR BLOWING OPERATION, LEFT, OF CARL GOODWIN AND SONS, CONTRACTORS.

FIGURE 8. JOINT SEAL POURING OPERATION OF CARL GOODWIN AND SONS.

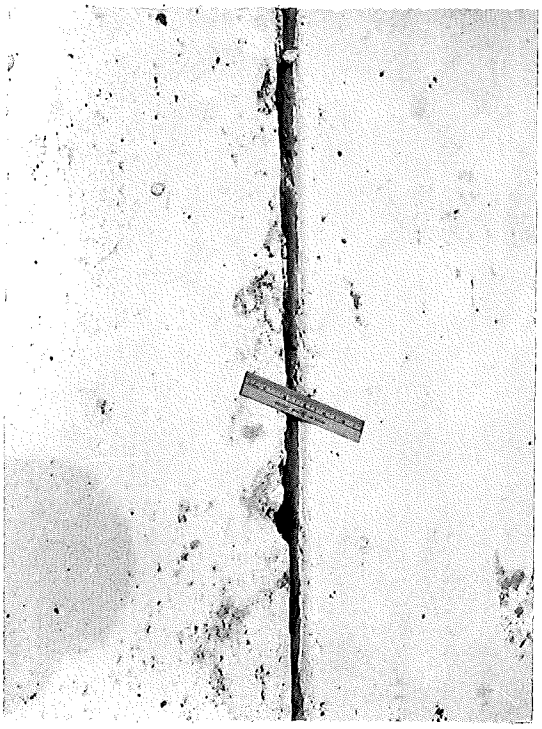

FIGURE 9. MEMBRANE CURING COMPOUND ON JOINT FACE PRIOR TO SEALING BY CARL GOODWIN AND SONS.

FIGURE 10. JOINT SEALED BY CARL GOODWIN AND SONS. NOTE LACK OF ADHESION AND LAYER OF DIRT IN BOTTOM OF JOINT.

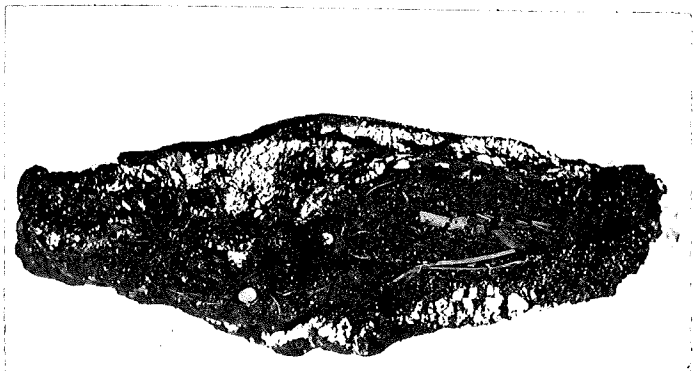

FIGURE 11. JOINT SEAL REMOVED FROM JOINT SHOWN IN FIGURE 9. NOTE WHITE MEMBRANE CURING COMPOUND ADHERED TO SEALER.

FIGURE 13. RAKING OUT OF JOINT PRIOR TO SEALING. SARGENT CONSTRUCTION COMPANY.

FIGURE 12.
JOINT SEAL MELTER AND AIR COMPRESSOR OF SARGENT CONSTRUCTION COMPANY.

FIGURE 14. BLOWING OUT JOINT WITH COMPRESSED AIR PRIOR TO SEALING BY SARGENT CONSTRUCTION COMPANY.

FIGURE 15.
SEALING OPERATION BY SARGENT CONSTRUCTION COMPANY. NOTE AREA EACH SIDE OF JOINT FREE OF MEMBRANE CURING COMPOUND.

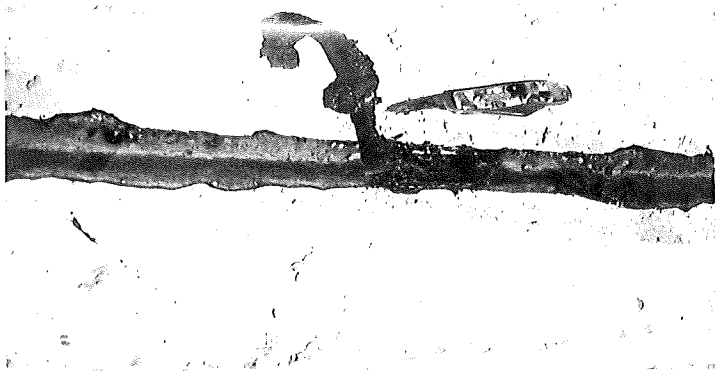

FIGURE 16. JOINT SEALED BY SARGENT CONSTRUCTION COMPANY. ADHESION GOOD BUT NOT PERFECT.

TABLE I

SUMMARY OF DATA ON STATE-WIDE JOINT CONDITION SURVEY

District No. 1

Project No.	Year Built	Highway	Remarks
52-2, C7	1949	US-41	Could not locate; bit. concrete in this area.
52-2, C6	1949	US-41 M-28	Marquette; near Branch State Prison. General appearance is only moderate; very poor bond of joint seal to the concrete; shrinkage of joint seal in spots.
52-25, C9	1953	US-41 M-28	Marquette; 4 lane pavement. General appearance is only moderate; similar to previous project.
52-33, C6 & 7	1949	US-41 M-28	Negaunee - Ishpeming area. The pavement joints are filled, however due to the contraction of the slab, the bond is broken. This condition prevails in most of the joints.
52-39, C2	1947	US-41 M-28	Clarksburg west to Humbolt. Shrinkage and poor bond in spots. Resealed with SOA.
52-13, C3	1953	US-41	West of Humbolt to Champion. The joints are all sealed and present a good appearance. Note: Marquette Co. Road Commission, Ishpeming, Mich., informed me that US-41, M-28 was resealed with SOA in all bad sections, beginning at Negaunee and continuing west to Baraga county line.
7-20, C4 & 5	1948	US-41	Nestoria to Jct. US-141. Joints sealed, however the material can easily be lifted out with a screwdriver.
7-20, C6	1949	US-41	Jct. US-141 to Alberta. Very poor bond of joint seal.
7-21, C2	1949	US-41	Alberta west one mile. Joints have been resealed with SOA; very poor bond.

TABLE I (continued)

District No. 1 (continued)

Project No.	Year Built	Highway	Remarks
7-21, C4	1950	US-41	South of L'Anse; Joints well filled, very good bond. Note: Mr. Osterman, Supt. at L'Anse informed me that no repair work has been done in this section.
District No. 2			
49-29, C2	1948	US-2	East of Epoufette. Joints all filled and the general appearance good. The adherence of the joint seal to the concrete is only fair. The material can be stripped off by inserting a metal tool between the joint seal and the sides of the slab joint.
2-32, C1	1949	M-28	Munising. Joints all sealed and in good condition. Mr. Lockwood, Supt., informed me that this section has been resealed with SOA.
District No. 3			
15-12, C2	1948	US-31	Sealer hard and dry, not firmly adhered to joint faces. Some cracking and checking of surface of sealer.
District No. 4			
4-4, C7	1948	US-23	Apparently resealed with SOA.
71-19, C12	1946	US-23	Seal lifeless and hard on surface; adhesion fair.
71-20, C12	1946	US-23	Sealer hard and cracked; adhesion to joint faces poor.
District No. 5			
19-36, C1	1951	US-27	Sealer fairly soft and resilient but containing many cracks filled with dirt; adhesion fair.
19-41, C3	1949	US-27	Sealer soft, but contains cracks; adhesion fair; dirt infiltrated into cracks in sealer.

TABLE I (continued)

District No. 5 (continued)

Project No.	Year Built	Highway	Remarks
34-15, C3	1947	M-66	Project has apparently been resealed with SOA.
34-44, C1	1948	M-66	Sealer still pliable, but considerable cracking in surface; extensive loss in adhesion; dirt infiltrated into sealer and between sealer and joint face.
41-55, C4	1953	US-131	Sealer fresh internally, but cracked and checked on surface; adhesion only fair.
41-75, C3	1949	M-37	Project apparently sealed with SOA.
41-76, C1	1950	M-37	Sealer fresh and resilient, but adhesion to joint faces only fair; dirt mixed in sealer and between sealer and joint faces.
59-36, C2	1947	M-46	Project apparently sealed with SOA.
70-49, C3	1946	M-21	Sealer soft but no resilience; considerable cracking and checking on surface; very poor adhesion to joint faces.
70-49, C4	1947	M-21	Sealer soft internally, but checked and cracked on surface; adhesion to joint faces poor.
District No. 6			
56-27, C4	1947	M-20	Project apparently resealed with SOA.
56-29, C1	1947	M-18	Project apparently resealed with SOA.
9-12, C8	1951	US-23	Sealer fairly fresh and tacky but not adhered to joint faces.
District No. 7			
39-40, C4	1953	US-12	Sealer extremely tough and dry; partially adhered to concrete but a lot of separation in sealer itself.
13-51, C2 & 3	1948	M-89	Sealer fresh and sticky but not adhered to concrete at all. Dirt and moisture between sealer and concrete.

TABLE I (continued)

District No. 7 (continued)

Project No.	Year Built	Highway	Remarks
39-45, C2 & 3	1949	M-89	East half of project - sealer dry and non-tacky; not adhered to concrete. West half of project - sealer fresh and tacky; partially adhered to concrete.
39-5, C1	1947	US-131	Sealer quite dry and not very tacky; not adhered at all to concrete.
23-6, C5	1949	M-43	Sealer not very fresh and tacky; not very firmly adhered to joint faces.
23-6, C4	1946	M-43	Sealer dry and non-tacky; not adhered to joint faces.
8-31, C1	1949	M-43	Apparently resealed with SOA.
13-51, C2	1948	M-96	Apparently resealed with SOA.
14-15, C13	1948	US-112	Apparently resealed with SOA.
14-33, C1	1947	M-60	Apparently resealed with SOA.
23-6, C5	1949	M-43	Sealer soft and resilient, but almost no adhesion to joint faces; considerable dirt infiltration.
23-38, C1	1952	US-27 US-78	Sealer still soft and resilient with some cracking; adhesion fair.
39-5, C5	1949	US-31	Apparently resealed with SOA.
78-5, C5	1952	US-131	Sealer resilient but full of cracks. Not adhered to joint faces.
78-5, C7	1952	US-131	Sealer resilient but full of cracks and alligator checking. No adhesion to joints.
78-27, C1	1953	US-131 By-Pass	Sealer resilient but is cracked and checked. Adhesion to joint faces only fair; no adhesion in some joints.

TABLE I (continued)

District No. 8

Project No.	Year Built	Highway	Remarks
30-4, C3	1947	US-127	Sealer still soft and resilient, but contains cracks; adhesions to joint faces poor, with dirt between sealer and joint faces. Might have been sealed with SOA.
33-15, C5	1952	M-43	Sealer hard and dry; adhesion poor to fair; considerable dirt in sealer.
33-54, C1	1948	US-127	Sealer hard and dry; complete lack of adhesion to joint faces.
33-54, C2	1953	US-127	Sealer still pliable, but has considerable cracks in surfaces. Adhesion fair; dirt infiltrated into cracks and between sealer and joint faces.
33-72, C1	1952	US-127	Sealer fairly fresh but cracked at surface; dirt between sealer and joint faces with considerable adhesion loss.
33-75, C1	1953	US-127	Sealer soft and resilient, but cracked at surface; adhesion fair.
38-48, C2	1949	US-12 By-Pass	Sealer resilient but cracked and checked at surface; adhesion poor with dirt between sealer and joint faces.
FI 38-48, C5	1951	US-12 By-Pass	Sealer pliable, but checked on surface; adhesion fair.
38-48, C9	1953	US-12 By-Pass	Sealer in fairly fresh condition, but some surface cracking; adhesion still fairly good in most joints but starting to separate from joint faces.
46-10, C9	1953	M-50	Sealer wedged tightly in joints but no adhesion to joint faces.
46-31, C7	1953	M-50	Sealer partly adhered and partly separated by dirt and moisture from joint face. Sealer fresh and sticky under surface.
47-18, C8	1953	US-23	Sealer not adhered. Sealer still appears fresh and sticky under surface.

TABLE I (continued)

District No. 8 (continued)

Project No.	Year Built	Highway	Remarks
47-26, C8	1952	M-59	Sealer fresh and tacky but not adhered to joint faces; dirt between sealer and joint face.
58-29, C1	1952	M-50	Joints well sealed; apparently resealed with SOA as they are overly full and sealer has consistency of SOA.
58-4, C3	1947	M-50	Sealer fresh and sticky but not adhered; dirt between sealer and joint face.
58-49, C2 & 3	1947	US-23	Sealer fresh and sticky but not adhered to joint face; dirt and moisture between concrete and sealer.
81-22, C4	1951	US-23	Sealer fresh and sticky but no adhesion; dirt and moisture between sealer and joint face.