

For those who do not care to use cinders or sand, a very thin layer of sodium chloride may be spread on the ice by means of a mechanical spreader

In the absence of field experiments to show that sodium chloride, when properly used, will not injure cement concrete pavements more than calcium chloride, the use of sodium chloride will prove economical and efficient on the thousands of miles of asphalt, tar-bound macadam, water-bound macadam, brick and gravel roads to make them safe for traffic

It is hoped that consideration will be given to the continuation of this research by some field work in which the effects of sodium chloride on concrete, when properly applied, be observed under actual traffic and highway conditions

REPORT OF SUBCOMMITTEE ON MAINTENANCE OF CONCRETE PAVEMENT CRACKS AND EXPANSION JOINTS

W H Root, *Subcommittee Chairman*

Maintenance Engineer, Iowa Highway Commission

SYNOPSIS

This report is a record of the conditions of application and results secured with various fillers on three experimental road sections in Iowa. In 1931 five asphalts, three tars, one asphalt cut back and one asphalt emulsion were tried on one road. In 1932 materials similar to the more successful asphalts and tars used in 1931 and a heavier cut back asphalt were used on two other roads.

The cut back and the emulsion used in 1931 gave some trouble in application and neither appeared to solidify rapidly enough to be considered satisfactory for use under traffic. The heavier emulsion gave satisfaction although it was difficult to apply.

The asphalts with penetration around 100 at 25°C and fairly soft tars with a float test around 112 gave good results.

The results of similar experiments in California and Connecticut are to be reported later.

In 1931 this subcommittee of the Maintenance Committee of the Highway Research Board presented a statement of the results which are desired to be attained by the maintenance of expansion joints and cracks in concrete pavements. This statement was as follows:

- 1 By the proper maintenance of cracks and joints in concrete pavements we hope to prolong the life of such pavements by
 - a Reducing the spalling and breaking down of the concrete adjacent to the crack or joint, and
 - b Deferring the blowing up of the pavement, due to compression failures and reducing the number of such failures

- 2 In order to maintain the cracks and joints adequately we should have a material which will:
- a Penetrate the entire depth of the crack,
 - b Remain in the crack for several seasons,
 - c Be stiff enough that it will not flow from the crown to the sides of the pavement and yet not so stiff that it will form objectionable ridges when forced out of the crack by expansion,
 - d Pour cold, and
 - e Largely prevent surface water and foreign material from entering the crack

TABLE I
IDENTIFICATION OF CRACK FILLERS
Research Project R-70, On Iowa Primary Road No 15

Key	Brand of Material	Name of Producer
Section A Asphalt Crack Fillers		
C	Genasco Crack Filler	Barber Asphalt Co
D	Genasco Block & Joint Filler	Barber Asphalt Co
Z	—	Carter-Waters Co
G	—	The Texas Co
H	—	Shell Petroleum Corp
Section B Tar Crack Fillers		
A	Tarmac Hot Patch	Koppers Products Co
B	Tarmac Special Crack Filler	Koppers Products Co
F	Barrett Special Pitch	The Barrett Co
Section C Asphalt Cut-Back		
I	●	Shell Petroleum Corp
Section D Asphalt Emulsion		
E	Colas Quick Breaking Emulsion	The Flintkote Corp

At the meeting of the Maintenance Committee it was decided that three independent experimental projects should be carried on, one by Mr Dennis in California, one by Mr Hamlin in Connecticut and one by Mr Root, chairman of the subcommittee, in Iowa. The Connecticut and California experiments are not complete and this report deals entirely with the Iowa project.

In 1931 the Iowa Department chose Primary Road No 15 from Ames to the Hamilton county line for experimental study. These 12 miles of road were constructed in 1931 with premolded fibre type expansion joints at intervals of 80 feet and at the time of the experiment no maintenance of cracks or joints had been done.

For the purpose of this investigation one drum samples of five asphalt crack fillers, three tar crack fillers, one asphalt cut-back and one emulsion crack filler were available The identification of these materials

TABLE II
CHARACTERISTICS OF ASPHALT CRACK FILLERS, SERIES OF 1931

Key	Lab No	Specific Gravity at 25°C	Softening Point (R. & B) °C	Penetration		Loss on Heating 5 Hrs @ 163°C %	Flash Point Deg F	Total Bitumen Soluble in CS ₂ %	Ductility at 25°C Cm	Inorganic Ash %
				0°C 200 Gm 60 Sec	25°C 100 Gm 5 Sec					
C	B-462	1 118	46	29	91	0 4	460	87 2	100+	9 9
D	B-463	1 204	52	12	43	0 2	450	74 0	80	20 9
Z	B-464	1 005	44	34	130	0 4	565	99 7	100+	0 0
G	B-466	1 012	49	38	89	0 2	525	99 1	37	0 6
H	B-467	1 041	51	24	68	0 2	510	99 6	104	0 2

TABLE III
CHARACTERISTICS OF TAR CRACK FILLERS, SERIES OF 1931

Key	Lab No	Specific Gravity at 25°C	Float Test Seconds @ 50°C	Water %	Distillation Percentage by Weight Total to			Sp Gr of Distillate 0-300°C	Softening Pt of Residue (R & B) Deg C	Total Bitumen Soluble in CS ₂ %	Inorganic Ash %
					170°C	270°C	300°C				
A	T-110	1 208	68	0 0	0 0	9 5	24 7	1 030	44 5	92 4	0 0
B	T-111	1 232	1800+	0 0	0 0	0 6	2 2	—	67	78 5	1 05
F	T-112	1 255	1800+	0 0	0 0	0 0	—	—	76	67 2	1 62

TABLE IV
CHARACTERISTICS OF ASPHALT CUT-BACK CRACK FILLER, SERIES OF 1931

Key	Lab No	Water %	Distillation Percentage by Volume Total to			Flash Point Deg F	Specific Viscosity (Engler) 50 cc, 50°C	Penetration of Residue 100 gm, 5 Sec @ 25°C	Total Bitumen in Residue Soluble in CS ₂ %
			225°C	315°C	360°C				
I	B-468	Trace	0 0	22 5	30 0	190	63 7	Too Soft	99 0

TABLE V
CHARACTERISTICS OF ASPHALT EMULSION CRACK FILLER, SERIES OF 1931

Key	Lab No	Asphalt Content Percent	Penetration of Asphalt Residue 100 Gms, 5 Sec @ 25°C
E	B-465	57 0	120

is given in Table I The producer in each case furnished the material either from the producing plant or a company warehouse.

Shortly after the arrival of each drum of material at Ames, a sample was removed and filed in the Highway Commission Laboratory for

testing The tests were performed after the completion of the field work, and the results are presented in Tables II, III, IV and V

A condensed record of the data recorded during the application of the fillers appears in Table VI.

TABLE VI
RECORDS OF APPLICATION OF CRACK FILLERS
On Primary Road No 15, North of Ames, Iowa
Construction Project No F-72B

Date of Filling	Filler Key	Location		Weather	Temperature Record Deg F			Heating Time Hours	Applying Time Hours
		From Station	To Station		Air	Pave- ment	Filler		
Asphalt									
11/25/31	C	133	146	Fair	31 5	35 5	410	6 0	1 5
11/30/31		146	165	Cloudy	37 0	35 5	410	6 0	1 5
11/30/31		187	196	Cloudy	37 0	35 5	410		
11/30/31	D	165	187	Cloudy	37 0	32 5	400	4 5	2 5
11/25/31	Z	41	98	Fair	31 5	35 5	390	6 0	1 5
11/30/31	G	196	233	Cloudy	34 0	32 5	430	3 0	1 5
11/30/31	H	233	253	Cloudy	34 0	32 5	420	2 5	1 0
Tar									
11/25/31	A	1	41	Fair	23 0	30 5	295	5 0	1 5
11/25/31	B	98	133	Fair	31 5	35 5	400	2 0	1 5
12/ 1/31	F	254	279	Fair	27 0	30 0	370	1 5	1 0
Asphalt Cut-Back									
12/ 1/31	I	At Station 280		Fair	29 0	31 0	120	0 5	0 5
Asphalt Emulsion									
12/ 1/31	E	At Station 282		Fair	34 0	37 0	—	—	0 5

PREPARATION AND HANDLING OF MATERIAL

The materials, excepting the asphalt emulsion, were prepared for use by heating in a small, portable, gas-heated kettle having a capacity of about one and one-half drums. Each material was heated to the temperature at which it would readily flow from the pouring pots which were of the cone-shaped variety with bottom discharge. For the asphalts a temperature in the neighborhood of 400°F was found high enough in most cases to cause the desired liquidity. Temperatures for the tars were generally somewhat lower than that. The asphalt cut-back could be heated safely to but little more than 120°F, at which temperature it was in condition to pour satisfactorily. The asphalt

emulsion flowed satisfactorily without heating, although its temperature was only slightly above that of the air or pavement.

In Table IV, the temperature required to produce the optimum liquidity has been recorded for each material. Record was also made of the time required for heating each charge. The values varied principally on account of the differences in the sizes of the charges introduced into the kettle at the beginning of the melting. The values shown for heating time are slight indication of the resistance of the material to melting.

Satisfactory consistency for pouring was maintained throughout the entire charge of each material at the temperatures recorded, except that for asphalts C and D, which became steadily thicker in spite of the stirring given at frequent intervals during the heating and using of the batch. Slight increases of temperature offered but little remedy for this situation, which is believed to be due to the gradual segregation of the mineral matter contained in these two fillers. Some form of mechanical agitation would be necessary to keep this material in suspension at the temperatures required for pouring these asphalts in cold weather.

BEHAVIOR OF FILLERS IMMEDIATELY AFTER PLACING

The hot material, when introduced into the cold crack, sometimes sputtered and boiled violently due to the presence of ice, ice particles, small pieces of frozen earth, or free water. This action was usually of little consequence. Sometimes a small amount of frothy asphalt would overflow onto the pavement surface. The subsidence of the material in the crack would then, in most cases, require the addition of more material to fill the crack. The cold pavement soon cooled the material in the crack and the small amount unavoidably spilled on the edges in pouring.

During the application of all of these fillers the road was kept open to traffic. The action of the freshly placed filler under traffic was noted for each material. Without exception, the asphalts and tars behaved satisfactorily, in that they were unaffected by the traffic. None of these materials were picked up by the tires of cars or trucks, even immediately after they were poured.

The asphalt cut-back, however, was picked up extensively by the tires of passing cars; also it whipped out in strings and spattered the cars. This material could be used only in case a rather heavy sanding was given the crack immediately after pouring. This was tried and found to be a successful method of application, but of necessity a much slower process than that for fillers which could be used without sanding.

The asphalt emulsion behaved similarly, except that it spattered more than the cut-back, and failed to respond satisfactorily to the

sand treatment Neither the cut-back nor the emulsion appeared to solidify rapidly enough to be considered satisfactory crack fillers for use under traffic

These materials were observed frequently through the winter of 1931-1932 and a thorough inspection was made early in the summer of 1932 Tar A gave satisfactory results Tars B and F were too hard

TABLE VII
IDENTIFICATION OF CRACK FILLERS
Research Project R-70
On Primary Road No 14, Marshall County

Item	Section A Asphalt	Section B Tar	Section C Asphalt Cut-Back
Key	J	K	L
Brand of Material	Iowa State High- way Specifica- tion	Tarmac	Iowa State High- way Specifica- tion
Name of Producer	Pioneer Asphalt Co	Koppers Prod Co	Standard Oil Co

TABLE VIII
CHARACTERISTICS OF ASPHALT CRACK FILLERS, SERIES OF 1932

Key	Lab No	Specific Gravity at 25°C	Softening Point (R & B) Deg C	Penetration		Loss on Heating 5 Hrs @ 163°C %	Flash Point Deg F	Total Bitumen Soluble in CS ₂ %	Ductility at 25°C Cm	Inorganic Ash %
				0°C 200 Gm 60 Sec	25°C 100 Gm 5 Sec					
J	B-703	1 013	48	33	98	0 2	510	99 8	100+	—

TABLE IX
CHARACTERISTICS OF TAR CRACK FILLERS, SERIES OF 1932

Key	Lab No	Specific Gravity at 25°C	Float Test Seconds @ 50°C	Water %	Distillation Percent by Weight Total to			Sp Gr of Distillate 0-300°C	Softening Pt of Residue R & B Deg C	Total Bitumen Soluble in CS ₂ %	Inorganic Ash %
					170°C	270°C	300°C				
K	T-189	1 216	112	Nil	0 0	5 7	12 5	1 037	53	87 0	—

and were unsatisfactory Asphalt Z was satisfactory. Asphalts C, D, G and H seemed to lack adhesive qualities and were unsatisfactory Asphalt cut-back I and asphalt emulsion E were entirely unsatisfactory

In 1932 it was decided that this experiment should be carried further using an asphalt of the general characteristics of the 1931 Z asphalt and tar of the general characteristics of the 1931 A tar It was, also, decided that a heavier cut-back asphalt would be used in this experi-

TABLE X
CHARACTERISTICS OF ASPHALT CUT-BACK CRACK FILLERS, SERIES OF 1932

Key	Lab No	Water %	Distillation Percent by Volume Total to			Flash Deg F	Specific Viscosity (Engler) 50 cc, 50°C	Penetration of Residue 100 Gm, 5 Sec @ 25°C	Total Bitumen in Residue Soluble in CS ₂ -%
			225°C	315°C	360°C				
L	B-704	Nil	11 0	20 0	77 5	80	90	82	99 8

TABLE XI
RECORDS OF APPLICATION OF CRACK FILLERS ON PRIMARY ROAD NO 14 NORTH OF MARSHALLTOWN, IOWA, AND ON PRIMARY ROAD NO 169, WEST AND NORTH OF OGDEN, IOWA

Material	Asphalt J		Tar K		Asphalt Cut-Back L	
	1	4	3	6	2	5
Run Number						
Location						
From Station	341+42	341+42	255+45	80+40	315+15	492+32
To Station	315+15	429+32	218+50	123+00	255+45	439+00
Date of Filling	11/21/32	11/21/32	11/23/32	11/28/32	11/21/32	11/23/32
Weather	Fair Quiet	Fair Quiet	Cloudy Windy	Fair Windy	Fair Quiet	Cloudy Windy
Temperature of Air, Deg F	15-26	22-32	27-28	27-32	28-32	26
Temperature of Pavement, Deg F	15-30	31-33	30	25-26	33	30
Temperature of Filler, Deg F	350-400	250-365	210-260	225	120-150	140
Heating Time, Hours	3 0	2 50	0 5	0 75	5 5	0 5
Applying Time, Hours	1 5	2 75	1 5	2 00	3 0	1 0
Number of Cracks Filled	34	147	49	76	83	16
Thickness of Expansion Joint, Inches	1 0	0 75	1 0	0 75	1 0	0 75
Spacing of Joints, Feet	80	60	80	60	80	60
Quantity of Filler Used, Lbs	400	400	525	525	428	65
Length of Section, Miles	0 497	1 665	0 700	0 807	1 130	0 183
Quantity of Filler per Mile, Lbs	805	240	750	651	379	355

Notes

- Runs No 1 to 5, inclusive, were on Road No 14, and Run No 6 was on Road No 169
- Cracks at joints in Run No 1 appeared to be generally a little more open than the others having one inch joint material
- Cracks at joints in Run No 4 were somewhat smaller than those of the other runs for this thickness of joint material
- Runs Nos 1, 2 and 3 were on limestone concrete, and Nos 4, 5 and 6 on gravel concrete
- All pavement cured during construction with 24 hours of wet burlap, followed by asphalt emulsion coating, which was in turn coated with white-wash

ment A newly constructed pavement on Road No. 14 north of Marshalltown was chosen, also, a section of Road No 169 west and north of Ogden These pavements were constructed in 1932, some with one inch joints spaced at 80 foot intervals and some with $\frac{3}{4}$ inch joints spaced at 60 foot intervals This information is shown in Table XI In this experiment the joints which had opened were filled and also all cracks which had formed between the joints were filled Table VII shows the identification of the crack fillers used, Tables VIII, IX, and X the characteristics of the materials and Table XI general information The tar and asphalt were applied in the same manner as described in the 1931 experiment

The asphalt cut-back used in the series of 1932 does not appear to flow freely at any temperature to which it is safe to heat it in open kettles With care it may be handled at temperatures between 120 and 140°F. However, as it has a flash point of 80°F, great care must be used to prevent fire It flows sluggishly into the crack and frequently shows considerable settlement in cracks that were full when poured It sticks to wheels of passing traffic slightly when warm, but does not appear to adhere to them after cooling It sticks fairly well to concrete, and remains soft at 30°F when freshly placed

A year after the application of these materials a careful inspection of the roads was made and all three seemed to have given good satisfaction although it will be noted from the above that the asphalt cut-back was very difficult to apply

CONCLUSIONS

From these experiments it appears that asphalt of the general character used in the 1932 experiment with a penetration of about 100 at 25°C or fairly soft tar with a float test of about 112 makes satisfactory crack fillers. We are almost convinced, however, that the filling of openings adjacent to premolded expansion joints is a waste of material This filler, together with a considerable portion of the expansion joint material, is forced out of the crack by the expansion of the pavement during the first warm days in the spring and we have found it necessary to cut this excess material from the surface of the pavement with a motor grader As long as there is a fair thickness of expansion joint material in the joint we believe that foreign particles entering the crack along the side of the joint will not cause spalling but will be embedded in the expansion joint material

DISCUSSION
ON
MAINTENANCE OF CRACKS AND JOINTS

MR B FREIBERG, *Laclede Steel Co* Has any research been done in Iowa to find out whether material comes up into the crack and expansion joint from below or whether it comes primarily from the top? In other words, when we attempt to seal expansion or contraction joints, is it more necessary to seal them from below or from the top?

MR ROOT: We have never made any experiments along that line

CHAIRMAN LANG: I take it from Mr Root's paper what he has in mind is spalling—that the filling of the crack has not been of any particular aid in preventing spalling. A number of states are having trouble with what they call high joints, which appears to be due in some places to water getting into the joints causing swelling of the soil and in other places it is a distinct formation of ice crystals or layers