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Provincial Highways

Evaluation of Crack Sealing Compounds for Asphaltic Pavements

EVALUATION OF CRACK SEALING COMPOUNDS

FOR ASPHALTIC PAVEMENTS

EMO PROJECT NO. 33

Final Report

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ABSTRACT

Prior to 1983, materials used to seal cracks in asphalt pavements had to be supplied from an MTC List of Designated Sources for "Joint Sealing Compounds Hot-Poured Rubberized Asphalt". To be placed on this list, the material had to conform to ASTM D-1190 requirements, plus pass a more stringent MTC bond test. Opinions were expressed in the industry that products were available which would perform well in asphalt that would not meet the criteria to get on the Designated Sources List.

In 1980 the Ontario Ministry of Transportation and Communications embarked on a programme of field trials to identify materials suitable for sealing cracks in asphalt pavement.

This paper presents the findings resulting from two trial sites constructed since 1980, as follows:

1980 - Thirteen products, ten hot-poured and three cold poured, were installed according to the method recommended by the manufacturer under his supervision. Each trial contained approximately 1000 m of crack sealing.

1981 - Eleven hot-poured and two cold poured products were installed using a common specified method. In addition, a separate trial employing hot compressed air only to prepare a crack for sealing was constructed in cold and wet conditions.

The trials proved that existing MTC testing criteria would exclude three of the four best-performing materials in that they would fail the bond test. Current testing methods do not indicate the ability of a material to perform in asphalt pavements. It was established that sealants which are installed such that they overlap on the pavement surface on each side of a routed crack have a much better winter survival rate than those poured flush. Clean and dry conditions were also established to be a requisite for bonding of hot poured sealants.

This work has led to three additional materials being approved for use in asphalt pavements and the creation of a Designated Source List for "Joint Sealing Compounds for Use in Asphaltic Concrete Pavements".

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INTRODUCTION

In 1980 the Ontario Ministry of Transportation and Communications embarked on a program to identify the most suitable materials for sealing cracks in asphalt pavements. Up to this time the products used were supplied from a list of designated sources of hot applied rubberized asphalt which conformed to ASTM D-1190 requirements, plus a more stringent MTC bond test (MTC Form 1212). Opinions were expressed in the industry that products were available which would perform well in asphalt pavements but would not meet the criteria for the Designated Source List. The appropriateness of the bond test which is performed between concrete blocks was questioned since these materials were to be used in asphalt pavements.

Manufacturers of products for sealing asphalt pavement cracks were invited to participate in a field evaluation through an advertisement in The Daily Commercial News as well as by personal contact by members of the Bituminous Section's staff. Six manufacturers responded offering a total of fourteen products along with proposed methods of installation. The Ministry accepted all proposed products for trial installation. Table 1 lists the materials used in the 1980 trials along with the generic type and method of installation.

THE 1980 TRIAL AREA

A nine kilometre portion of Hwy. 69 between Port Severn in the south and MacTier in the north was selected for the crack sealing trials. This location has a severe environment for crack sealing with January mean daily temperatures of -10°C and three expected occurences of -30°C per winter. This section of highway has two 3.65 m driving lanes with 2.74 m paved shoulders constructed in 1976. The pavement had non continuous multiple longitudinal cracking about centreline and transverse cracking at approximately 6 m intervals extending from centreline to the edge of pavement.

The trials were constructed only in the northbound lanes so as to permit two way traffic on the southbound lane and shoulder during construction of the trials. The trial area was subdivided into twenty 450 m sections, each containing approximately 1,000 m of cracks. Each section was marked with a bar of yellow paint and the sections were numbered from one in the south to twenty in the north.

The manufacturers of the crack sealing products were responsible for the installation of their products with the Ministry providing traffic protection. The manufacturers identified the installer of their products and a timetable was then prepared. The middle three weeks of July were selected for the trials, anticipating the most favourable weather in this period. Due to heavy summer weekend traffic on this highway a four-day week, Monday to Thursday, was selected to minimize inconvenience to Friday afternoon traffic. To install 14 products in twelve working days and make allowance for inclement weather, the installation of two products at one time was required.

As each section was completed, the installer would then move to the next vacant section. Since 20 sections were laid out and only 14 products were to be installed, the last 14 sections 7 to 20 were selected for use. This was to take advantage of the straighter alignment in that portion of the highway. One cold pour sealant (RS-1 & sand) was cancelled from the trials, causing the trials to end in section 19 rather than section 20.

Table 1 lists the materials used in the 1980 trials along with the generic type and method of installation.

TABLE 1

SUMMARY OF MATERIALS & INSTALLATION METHODS (1980)

TRIAL	MANUFACTURER	PRODUCT	PRODUCT DESCRIPTION	INSTALLATION METHOD
7	Uniroyal	6160	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
8	Be-Ram	Supergook 21-151	Hot Applied Rubberized Asphalt	Routed/Air Blown /Overfilled & Levelled
9	Uniroyal	6165	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
10*	Flintkote	X-8032	Cold Poured Rubber Asphalt Emulsion	Routed/Air Blown /Filled Flush
11	Chevron	Rubberized Crack Filler	Cold Poured Rubber Asphalt Emulsion	Routed/Air Blown /Overfilled & Levelled
12	Meadows	164R	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
13	Flintkote	X-8006	Cold Poured Solvent Borne Rubber Asphalt	Routed/Air Blown /Filled Flush
14	Meadows	164	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
15	Flintkote	X-8013	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
16	Meadows	Sof-Seal	Hot Applied Rubberized Asphalt	Routed/Air Blown /Filled Flush
17	Crafco/ Sahuaro	Overflex - MS Modified	Hot Applied Rubberized Asphalt	Routed/Air Blown /Overfilled & Levelled
18	Crafco	Overflex MS	Hot Applied Rubberized Asphalt	Routed/Air Blown /Overfilled & Levelled
19	Flintkote	X-8013	Cold Applied Two-Part Rubber Asphalt Emulsion	Routed/Air Blown /Filled Flush

* Washed out by rain and repaired with X-8013

CONSTRUCTION OF THE 1980 TRIALS

Routing the Grooves

All the manufacturers of the sealing compounds required the cracks to be routed. Tennant and Crafco routers were used for most of the work with vertical routers of various manufacture being employed for the more meandering cracks. Even though this was a demonstration project, and one would expect to see above average workmanship, there were numerous examples of cracks being missed in the routing operation. This problem was most severe where the Tennant router was employed, for it is best suited to straight line cracks. The Crafco router could follow meandering cracks far better than the Tennant. The Crafco routers could be used alone but whenever the Tennant router was used alone many meandering cracks were missed. All the routers produced grooves with semi-vertical sides and rounded bottoms. Most routing was to a width and depth of about 19 mm but some were deliberately less with Section 10 being only routed to 10 mm square.

Unfortunately, the weather was not too favourable during the trials and rain caused several delays and some less than desirable installations. After a rain and subsequent drying of the pavement surface, the cracks would still be moist for up to a day. When the damp cracks were routed, the moisture caused the finer fraction of the cuttings to form a slurry in the groove which resisted removal by either brushing or blowing.

Cleaning the Grooves

The routed grooves were all cleaned with a jet of air, mostly from back pack blowers with air velocity of up to 320 km/hr. A rented compressor was at first used in Section 7 at the manufacturer's request but was given up in favour of a back pack blower after a very short time. A compressor is bulky and must be constantly moved therefore is not nearly as convenient as a back pack blower. The back pack blowers were found to be in very poor to good condition. Only back pack blowers in top working condition were able to do a satisfactory job of cleaning out the grooves. Problems encountered with these units included:

- engine hard to start,
- engine would not run at full speed,
- engine stalling,
- hoses and nozzles in poor repair.

A Crafco wire brush/blower was used for short periods in Sections 16, 17 and 18, and this equipment did a superior job of cleaning the groove. The Crafco wire brush/blower was much more convenient than a compressor but still much slower in operation than a back pack blower.

In routed grooves that were damp neither back pack blowers nor the Crafco wire brush/blower would remove the fine slurry deposit.

It was necessary to air blow the grooves immediately preceding the filling operation or adjacent traffic blew dirt back into the grooves. Whenever the blowing of the grooves got more than about 30 metres ahead of the pouring of the sealant, the grooves were observed to be dirty.

Filling the Grooves

The sealant was placed in the routed grooves with either a hand pouring cone, or by hose and application wand from a low pressure pump on the melter. The hand pouring cones are equipped with replaceable nozzles (standard 3/4 inch iron pipe thread) and with some of the more viscous sealants, these had to be removed to allow sufficient flow of material.

All but four of the materials were poured flush with the pavement surface. The other four sealants, three hot applied and one cold applied, were installed by overfilling the routed groove and then striking the material off. In trial Sections 17 and 18 a "v"-shaped steel strike-off which limited the width of the spread was used. A rubber squeegee was used in Sections 8 and 11.

Hot poured sealants placed in damp grooves did not develop much of a bond within the groove. In Section 8, the northerly 171 metres of the section was placed in a damp condition but since the surface was dry and the material overfilled and levelled, a good bond was achieved on the surface. Section 9 installed at the same time was poured flush in a damp groove and a poor bond was observed. Six days later an examination of Section 9 revealed some improvement in bond of the sealant.

The hot poured sealants, when dusted with sealbond or portland cement, could be exposed to traffic within 15 minutes. All the cold applied sealants were skinned over but still liquid under the skin after an hour and subject to damage and tracking if exposed to traffic.

In Section 10, the cold applied material was washed out of the grooves during an overnight rain. This section was subsequently repaired with the hot poured material used in Section 15 and removed from the evaluation.

In two of the hot applied trials the manufacturers' recommended temperature range for application was not followed; Section 14 was above and Section 16 below the recommended range.

OBSERVATIONS

- The Tennant router had the highest production rate of all the routers used on the trials but was not effective in routing meandering cracks.
- The Crafco router, although less productive than the Tennant router, could, with care, rout meandering cracks.
- The vertical routers are the least productive but most effective in treating meandering cracks.
- Many cracks were missed during routing in spite of the trials being a demonstration project.
- If the cracks showed dampness when routed, a muddy slurry was deposited within the groove which could not be removed by back pack blowers.
- Back pack blowers had to be in first class condition in order to do a satisfactory job.
- Cleaning of the grooves too far in advance of the filling operation allowed traffic to blow debris back into the groove.
- Hot poured sealants placed in a damp groove would not bond properly.
- Cold poured sealants do not set up quickly enough to be used in typical highway crack sealing operations where the seals are exposed to traffic in less than one-half hour.
- Emulsion type cold poured sealants are prone to wash out if rain occurs within a few hours of installation.
- Cold poured sealants are subject to tracking for up to a day after installation.

1980 TRIALS REVIEWED

Following three field appraisals (Nov.1980, Jan.1981 and June 1981) and discussions with the MTC staff responsible for maintenance of this section of highway, it was determined that the most successful 1980 trial installation was Section 8, which employed the method of overfilling the routed grooves and striking the sealant off flush. The second, and almost equally successful trial, employed the method of filling the routed groove flush with sealant. In this trial section (No.7) the material tracked out of the groove a little and had the final appearance of having been overfilled and struck off.

None of the twelve materials installed in the 1980 trials maintained a 100% seal throughout the first winter. Most of the failures were in bond to the side of the routed groove with some cohesive failures. Six trials were considered complete failures (11, 13, 15, 17, 18 and 19), all three cold poured and three of the nine hot poured sections. The other four hot poured trials, all employing the fill flush method, although not considered complete failures, are deemed to have performed less than satisfactorily. Two hot poured trials (17 and 18) which employed the system of overfilling the routed groove and striking off the sealant, failed, due to the material becoming very hard and brittle in the cold weather. The materials in these two sections cracked down each side of the routed groove and offered little resistance to water infiltration until the following June when the warm weather softened the material and it resealed considerably. This resealing of previously failed seals in warm weather was observed in several of the trial sections. It is apparent that summer only evaluation of crack sealing can easily deceive the observer into thinking that a particular seal had been effective and still in good condition when, in fact, it may well have failed badly when it was most needed.

Due to the variation in installation technique and the variable conditions of the installations, it was not possible to determine to what degree the individual materials influenced the rate of failure.

1981 PROGRAMME

In order to evaluate all of the materials on an equal basis, it was decided to repeat the trials in 1981, specifying a common method and condition of installation for each product as follows:

- Each supplier to have a representative on the site to supervise the installation of his product.
- Routing and sealing work to be performed only when the cracks (not only the pavement surface) are dry.
- Only routing that would be filled the same day to be performed. Width and depth of rout to be 19 mm. Routers capable of following the exact crack line to be employed.
- Immediately ahead of sealing, the routed grooves to be thoroughly cleaned by compressed air.
- The routed grooves to be overfilled with sealant and struck off such that a minimum overlap of 40mm on each side of the groove is achieved.
- The completed seal to be dusted with an appropriate material to eliminate surface tackiness.

The manufacturers who participated in 1980 and who did not employ the overfill and strike off method were encouraged to reparticipate in 1981 and other prospective manufacturers were advised of the trials through an advertisement in the Daily Commercial News.

Nine suppliers offered fourteen products for evaluation and thirteen of those were approved for installation. A cold pour material that failed badly in the 1980 trials was declined. Of the thirteen products accepted, two were cold poured materials which had not been installed in the previous year's trials and were only accepted with the suppliers assurance that they would set up sufficiently to permit traffic in 15 minutes. Section 8 which employed the overband method and had performed well in the 1980 trials was included in the new trials.

Each supplier advised the Ministry which contractor would install his product and a timetable for the installations was drafted for July 6-23.

LOCATION OF TRIAL AREA

The trial area continued northward from the end of the 1980 trials.

Table 2 lists the materials used in the 1981 trials with the generic type and method of strike off.

TABLE 2

SUMMARY OF MATERIALS AND STRIKE OFF METHOD (1981)

TRIAL	MANUFACTURER	PRODUCT	PRODUCT DESCRIPTION	STRIKE OFF
8	Bemac	Supergook	Hot Poured Rubberized Asphalt	Flat
20	Bakelite Inc.	Flintseal 590-13	Hot Poured Rubberized Asphalt	Flat
21	Hydrotech	Sealz 6165	Hot Poured Rubberized Asphalt	Flat
22	Crafco Inc.	Roadsaver 201	Hot Poured Rubberized Asphalt	Flat
23	Hydrotech	Sealz 6160	Hot Poured Rubberized Asphalt	Shaped
24	Paraseal	Super-Seal 2065	Hot Poured Rubberized Asphalt	Flat
25	Paraseal	Ultra-Seal 2070	Hot Poured Rubberized Asphalt	Flat
26	Meadows	164R	Hot Poured Rubberized Asphalt	Flat
27	Shell Can.	Cariphalte ELT	Hot Poured Rubberized Asphalt	Shaped
28	Meadows	Sof-Seal	Hot Poured Rubberized Asphalt	Flat
29	Meadows	Hi-Spec	Hot Poured Rubberized Asphalt	Flat
30	Chevron	C.I.M.	Two Part Asphalt Extended Urethane	Flat
31	Southwestern Petroleum	Patching Compound	Cold Applied Asphaltic Mastic	Flat
32	IBIS	Prismoseal A-1	Hot Poured Rubberized Asphalt	Flat
33*	Bemac	Supergook	Hot Poured Rubberized Asphalt	Flat

* Overband sealing trial using HCA only to treat crack.

CONSTRUCTION OF THE 1981 TRIALS

The weather during the trials was exceptionally good with no time loss due to rain. Daily temperatures ranged between 18 and 32°C with mostly clear skies. The environmental conditions for the trials, 20 through to 31, should be considered equal. Trial No. 32 was conducted more than a month later in cool but dry conditions.

In addition to the 13 material trials, a demonstration was performed in Section No. 33 using hot compressed air (HCA) to dry unrouted cracks prior to overband sealing. This work was performed intentionally in adverse weather conditions. A similar HCA lance with less air volume and heat, was used to blow out the routed cracks in Trial No. 32.

Routing the Cracks

As in the 1980 trials, the routers used by the contractors were either:

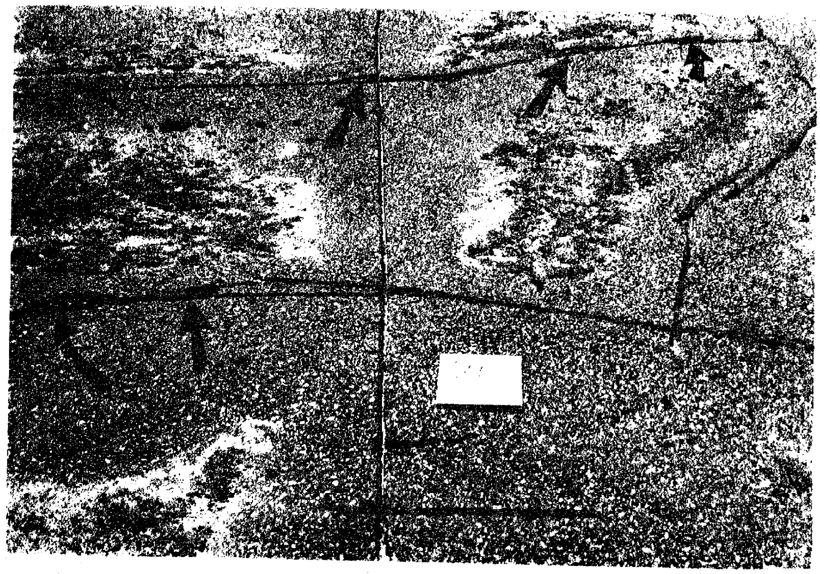
(a) A Tennant router followed by a vertical router or

(b) a Crafco router working alone.

All routing was performed to a width and depth of 19 mm. The overall quality of routing this year was improved over that observed in the 1980 trials. It was evident that even with the additional care being taken that the Tennant router was incapable of routing the meandering cracks. When a crack changed direction quickly, the Tennant router would not respond fast enough and would miss the crack, requiring the vertical router to be employed to cut the missed portion. This would result in two cuts side by side which would either create a wide groove or leave an island of pavement between the actual crack and the groove cut by the Tennant router. (See arrows in Figure No. 1). The cutting debris left by the Tennant would often obscure the missed cracks and the operator of the vertical router would then miss cutting some.

FIGURE 1

ROUTING DEFICIENCIES



The Crafco router, with its cutting head on the same axis as the wheels supporting the machine, could respond quickly to a change in crack direction.

Although the Tennant router is much more productive on straight line cutting, the Crafco router is more productive cutting meandering cracks.

Cleaning the Grooves

The routed grooves were blown out with back pack blowers in all but one test section. The blowers used this year were in a good state of repair and were effective. As in the 1980 trials the problem with adjacent traffic blowing dirt back into the cleaned grooves occurred when the cleaning operation was more than about 30 metres ahead of the sealing operation.

In trial No.32, a Prismo hot compressed air (HCA) lance #35 was used to blow out and heat the routed grooves prior to placing the sealant. The HCA lance system is comprised of a compressor, liquid propane tank(s), mixing unit, hoses, lance and an ignition device. In operation, the combustion chamber glows red hot. This lance (with a 13 mm orifice) did an excellent job of cleaning out and heating the routed grooves but was much slower than cleaning with a back pack blower.

Filling the Grooves

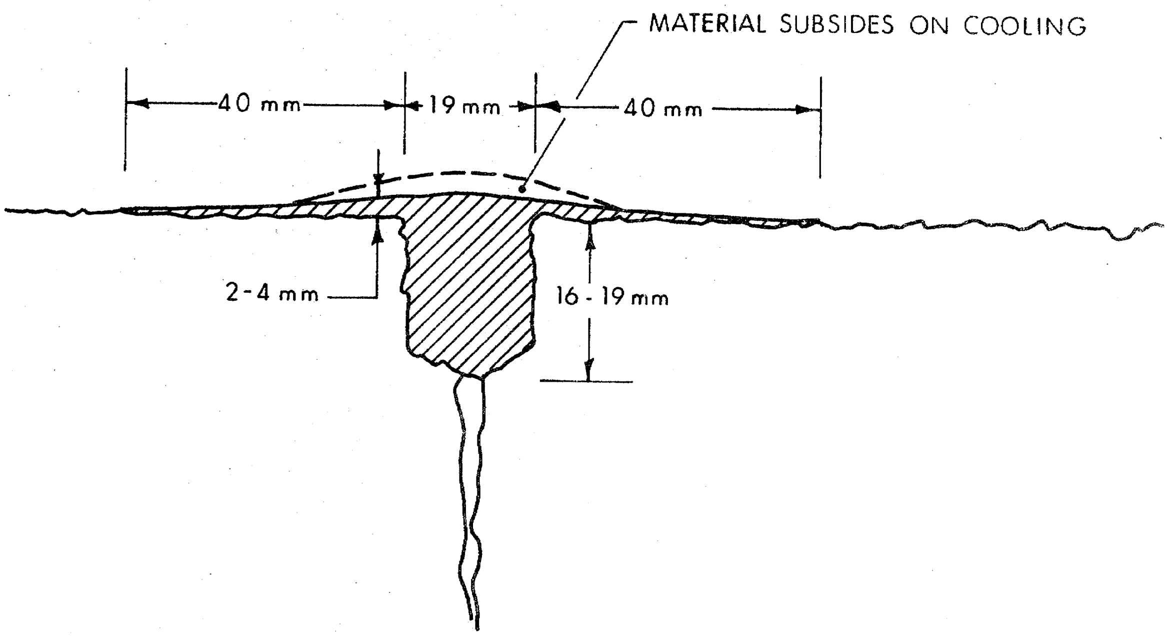
All the melters used in the trials were of the oil jacketed double boiler type except for the Prismo unit used in Section 32 which was direct fired. The Prismo melter and the Crafco melter used in Sections 22, 24, 25 and 27 had thermometric controls which automatically controlled the product temperature. These automatic controls are a definite advantage in preventing overheating of the sealant which occurred in 50% of the trials using melters without automatic controls. With this high incidence of overheating in well controlled demonstration trials, one must wonder what happens during routine contract work.

The materials were all placed so as to overfill the groove and then struck off so that the material overlapped the pavement surface on each side of the groove to a minimum of 40mm. Most of the contractors performing this work had no experience with the overfill and strike-off method and were not previously equipped with strike-off devices. They came to the trials with mostly improvised devices some of which performed well and others not so well. Most of the improvisations employed a standard floor squeegee bent to form a "U".

The desired cross section of seal in a routed groove is as shown in Figure 2. Most of the strike off devices used just levelled the sealant but the "U" and "V" shaped squeegees with a crescent cut out of the rubber at the back gave the desired cross section to the sealant. The sealant needs to be struck off so as to leave a bead of material over the routed groove with the edges of the material feathered out. The bead of material will flatten out considerably after subsiding into the crack and through thermal shrinkage. If the sealant stands too proud of the surface, it is subject to snow plough damage. Due to either inappropriate strike off devices or lack of operator skill, lumps of sealant were left proud of the pavement surface at the ends of cracks or where a crack changed direction. This material created a noticeable bump which will likely be cut off in the winter by snow plowing operations, with the risk that additional material may be pulled out of the sealed crack.

FIGURE 2

DESIRED CROSS-SECTION OF ROUTED AND SEALED CRACK



Strike-off devices which are pushed rather than pulled allow the operator to see where he is going and thus contribute to a safer operation. Another advantage of the push type strike off is that the operator applying the sealant can see the needs of the strike off and adjust the amount of material dispensed accordingly.

One hot poured material (Section 27) was found to be subject to traffic damage 15 minutes after installation. The cold poured materials (Sections 30 and 31) were both subject to tracking after 15 minutes. In Section 30, a two component material, one batch had not set up the next day and tracked down the highway 50 metres or more. After being opened to traffic, the cold poured sealant on the pavement surface in Section 31 tracked badly, but remained fairly well in the transverse grooves. The material in the longitudinal grooves was almost all removed by traffic in this section.

Demonstration of Overband Sealing

Kardey Ltd. (UK) in co-operation with Bemac Ltd. (Toronto) performed a demonstration of their equipment at the MTC Downsview complex November 19th, 1981. The equipment demonstrated consisted of a hot compressed air (HCA) lance, barrow applicator, hand pouring pot and band forming tools. This demonstration was to show the equipment capabilities and to promote the U.K. system of overband sealing of asphalt pavement cracks.

The hot compressed air lance is supplied by a 100 lb. L.P. propane bottle and a 160 C.F.M. compressor. The propane and compressed air are metered and mixed in a special mixing unit and the product supplied to the lance via a single hose. The gas is ignited by a sparking device in the combustion chamber and the unit allowed to heat up for about 3 minutes until cherry red. The HCA lance is a hand tool about 1.5 m long which is coursed along the pavement crack at a slow walk to blow out debris and to heat and dry the crack. The HCA lance is also very effective in removing zone paint without any apparent harm to the pavement.

The barrow applicator is a three wheeled device which can hold about 25 kg of molten sealant at application temperature and deposit it into the heated crack and strike it off. The barrow has burners supplied by a 20 lb. propane bottle which maintains the product temperature during application. This hand pushed barrow can seal significantly more crack than a pouring cone.

The hand pouring pot and band forming tools were used to fill areas of crack that had subsided after the barrow application - a touchup operation.

Staff observing the demonstration were impressed by the equipment and arrangements were made to construct a field trial in Section No. 33 of the Hwy. 69 trial area on 81 10 23 using Bemac's Supergook as the sealant. The weather was very poor for this type of work with an ambient temperature of 0°C and intermittent rain and snow showers. The HCA Lance was capable of drying and blowing out the cracks faster than the barrow applicator could seal them. Work with the barrow applicator was a little slow due to the sealant not being hot enough to get a good flow. It was noted that the barrow applicator could actually raise the product temperature. The barrow was very efficient on straight cracks but was awkward to use on the meandering cracks. By the time the touchup work with hand pouring pot and band forming tool was performed, the areas had been wetted by rain and snow.

1981 TRIALS REVIEWED

December 1981

The December review revealed that an unexpected 30% of the 15 trials were already experiencing some splitting of the sealant. The splitting was mostly at the edges of the routed groove where the sealant on the pavement surface was struck off very thin.

February 1982

The February appraisal revealed that two trials were performing well; (0-10% Splitting)

1 - Section 27, Shell Cariphalte ELT

2 - Section 33, Overband Sealing Trial without routing employing HCA and Bemac Supergook

Two other trials were acceptable; (10-20% Splitting)

1 - Section 21, Hydrotech Sealz 6165

2 - Section 29, Meadows Hi-Spec.

Four materials were rated marginal in performance; (20-50% Splitting)

1 - Section 20, Bakelite 590-13

2 - Section 23, Hydrotech Sealz 6160

3 - Section 24, Paraseal 2065

4 - Section 26, Meadows 164R

The best four performing materials are formulated to meet ASTM D-3405 requirements and the next four to the lower requirements of D-1190.

The remaining seven trial sections were unacceptable. It should be noted that Section 8 which performed satisfactorily the first winter is now in its second winter and is included in the unacceptable category.

November 1982

The November evaluation confirmed the observation reported in Interim Report 27A that seals that have failed in winter may well heal themselves during a warm period. In twelve of the fifteen trials, the sealant remaining in the grooves was in an acceptable class with less than 20% of their length exhibiting any splitting. It must be emphasized that this appraisal is based on the sealant remaining in each trial, i.e. on the approximately 75% of remaining sealant in Sec. 28. Only two of the distressed sections, No. 31 and 32, did not improve their performance rating value since the February appraisal. At this point, four trials were considered outright failures -Sections 25, 28, 31 and 32 and will not be included in subsequent appraisals.

February 1983

Now in their second winter* the sealants were observed to be splitting at or above the same rate as the previous winter, in spite of the fact that this winter was relatively mild.

Only two trials now remained in the acceptable range (10-20% splitting).

1 Section 27, Shell Carphalte ELT

2 Section 29, Meadows, Hi-Spec

Four materials rated in the marginal category (20-50% splitting)

1 Sections 8 & 33, Bemac, Supergook

2 Section 21, Hydrotech 6165

3 Section 23, Hydrotech 6160

4 Section 26, Meadows 164R

It is interesting to note that the Supergook and 6165 have dropped a category since the previous winter and the 6160 and 164R have maintained the status quo. The Bakelite, 590-13 and the Paraseal, 2065 that fell in the marginal catgory the previous winter have now dropped into the unacceptable class along with the other six products.

Table 3 summarizes the sealant splitting ratings for the four evaluations with:

1 = 0 - 10% splitting

2 = 10 - 20% splitting

3 = 20 - 50% splitting

4 = 50 - 80% splitting

5 = 80 - 100% splitting

* Section No. 8 is now in the third winter.

TABLE 3

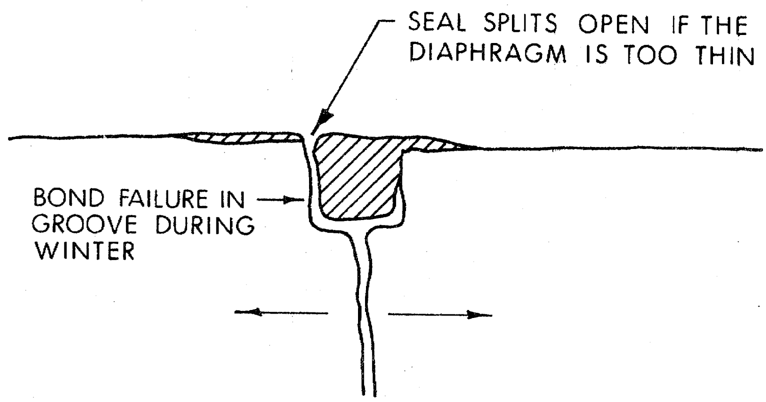
Sealant Splitting						
Trial No.	Product	Dec. 81	Feb. 82	Nov. 82	Feb. 83	Comments
8	Bemac Supergook	No	4	1	3	
20	Bakelite 590-13	Yes	3	1	4	
21	Hydrotech 6165	Yes	2	1	3	
22	Roadsaver 201	Yes	4	1	4	
23	Hydrotech 6160	No	3	2	3	
24	Paraseal 2065	Yes	3	2	5	
25	Paraseal 2070	Yes	5	3		Failure. General loss of bond.
26	Meadows 164 R	No	3	1	3	
27	Shell Cariphalte	No	1	1	2	
28	Meadows Sof-Seal	Yes	4	1		Failure. High loss of sealant.
29	Meadows Hi-Spec	No	2	1	2	
30	Chevron C.I.M.	Yes	4	2	5	
31	Swepco Crack Filler	Yes	5	5		Failure. Sealant loss and extensive splitting.
32	Prismoseal A-1	Yes	5	5		Failure. Sealant loss and extensive splitting.
33*	Bemac Supergook	No	1	1	3	

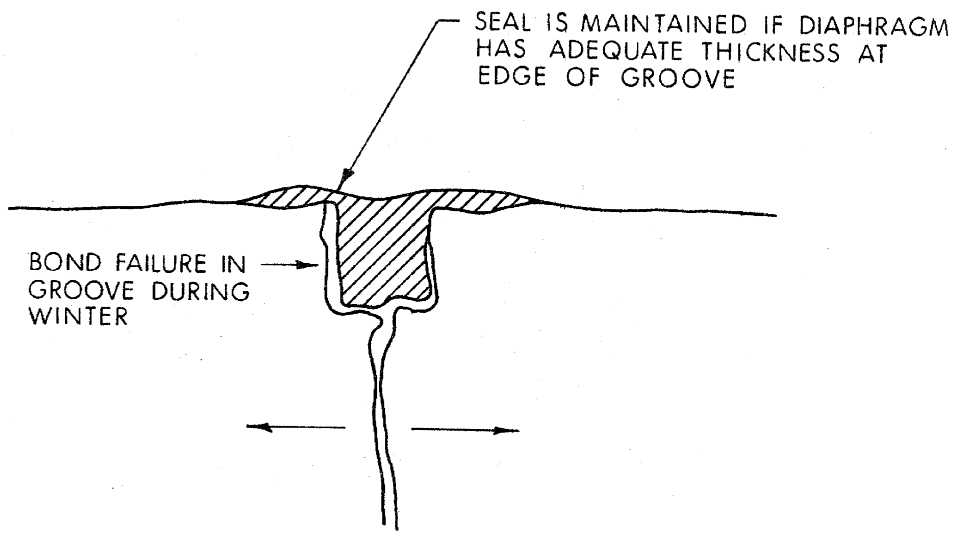
* Overband sealed using HCA.

COMMENTARY

During the four appraisals it became evident that splitting of the seals at the edge of the rout was minimized if the membrane at that point had a 2-3 mm cross-sectional thickness. Where the sealant was struck off thin, (less than 1 mm) poor performance was common. In several sections it was noted that an effective seal was maintained even though the material was no longer bonded in the routed groove as confirmed by pinching the seal between thumb and forefinger and lifting it up and down. This occurred when the diaphragm across the rout had enough cross-sectional area to maintain its integrity. Figure 3 indicates how the cross-section of the seal can affect winter performance.

FIGURE 3





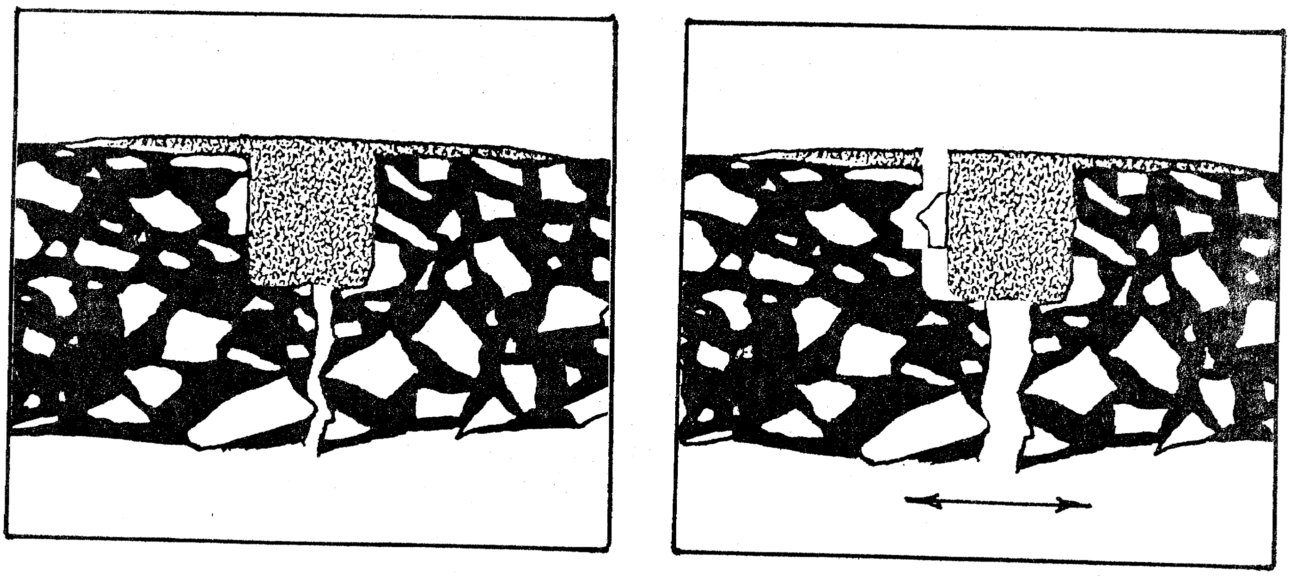
Damage to the sealant by snow plows was very limited. The plows usually just sheared off sealant that stood more than 3 mm proud of the pavement surface. Damage was most frequent on longitudinal seals and at high points on transverse seals such as between the wheel track ruts. In the case of the two materials with a much lower stiffness modulus (Cariphalte ELT & Sof-Seal) the plows tended to pull the sealant from the pavement rather than shear it off.

There had been concern that where the matrix of the pavement was etched out with HCA and not covered with sealant, premature deterioration would result. In several locations where this occurred in section No. 33 no deterioration is in evidence to date.

The work in 1981 and 1982 established that seals fail primarily in bond and that if moisture was present at the time of routing and sealing, bond failure was almost assured. To clarify, separation or splitting of a seal at the edge of the routed groove has been identified as a bond failure. This is a somewhat oversimplified description because the actual failure may be a combination of bond/cohesive failure plus a partial failure of the pavement. Sealants with a good bond and high stiffness modules will pull aggregate that have been disturbed in the cutting operation out of the side of the routed groove. This was observed in many of the test sections. Figure 4 demonstrates how a "bond" failure may be a combination of failures.

FIGURE 4

GENESIS OF A "BOND" FAILURE



Sampling and Testing

Samples of the materials delivered to the test sections were obtained and tested in the Downsview Laboratory for:

Cone Penetration	@ 25^{0}C @ 50^{0}C	C.G.S.B. 37-GP-50M C.G.S.B. 37-GP-50M
Flow	@ 60^{0}C	C.G.S.B. 37-GP-50M
Resilience original	@ 25^{0}C, oven aged	A.S.T.M. D-3405
Bond, 5 cycles	@ -17.8^{0}C	A.S.T.M. D-1190 Mod.
Cold Bend	@ -25^{0}C	C.G.S.B. 37-GP-50M Mod.
Toughness Peak Force Relative Density		C.G.S.B. 37-GP-50M.

The most interesting finding from all this testing was that of the four "best performing" materials in the Hwy. 69 trials, only the Meadows Hi-Spec met the MTC bond test. The industry contention that the bond test precluded suitable materials from use by the Ministry would appear to be valid. No correlation could be found between test values and field performance. Table 4 contains the test values for the best four performing materials in the Hwy. 69 trials.

The test values in Table 4 are also typical of many of the materials which did not perform well in the trials.

TABLE 4

SUMMARY OF TEST VALUES

Product	Cone Pen.		Flow	Cold Bend	Tough.	Peak Force	Ratio	Rel. Den.	Resil Orig. Aged	Bond
	@ 25^{0}C	@ 50^{0}C								
Supergook	64	102	0	Pass	19.8	271.0	0.073	1.35	84 80	Fail
Caraphalte	77	177	0	Pass	11.2	166.7	0.067	1.34	73 73	Fail
6165	105	139	0	Pass	7.3	160.2	0.046	1.13	73 72	Fail
Hi-Spec	92	160	0	Pass	14.9	203.5	0.073	1.17	56 59	Pass

OBSERVATIONS AND CONCLUSIONS

Equipment

1/ Tennant routers are highly productive on straight line cutting but are limited in their ability to follow meandering cracks.

2/ Crafco routers are lower in productivity than Tennant routers on straight line cutting but have the ability to follow most meandering cracks.

3/ Vertical spindle (Windsor) routers can follow any crack pattern but have very low productivity.

4/ Routers cut by impact and leave loosened aggregate in the cut faces of the rout.

5/ Melters with automatic temperature controls are an advantage in minimizing overheating of the sealant.

6/ Back pack blowers have limited ability to clean out routed grooves.

7/ The HCA lance is very effective in cleaning and drying routed or otherwise prepared cracks.

8/ The HCA lance permits work to proceed successfully in damp conditions.

Materials

1/ The cold poured sealants that were tried are not satisfactory for sealing asphalt pavement cracks in highways.

2/ Four hot poured rubberized asphalts formulated to meet A.S.T.M. D-3405 perform satisfactorily (with less than 20% splitting) during the first winter in locations with mean daily January temperatures -10^{0}C:

Shell Cariphalte ELT,
*Bemac Supergook,
Meadows Hi-Spec,
*Hydrotech Sealz 6165.

* More than 20% splitting in the second winter.

3/ Four hot poured rubberized asphalts formulated to meet A.S.T.M. D-1190, perform marginally (with less than 50% splitting) during the first winter in locations area with mean daily January temperatures of $-10^{0}C$:

*Bakelite 590-13,
Hydrotech Sealz 6160,
Meadows 164R,
*Paraseal 2065.

* More than 50% splitting in the second winter.

4/ Sealants with a low stiffness modulus, standing proud of the pavement surface, are prone to be removed by plows in the winter if not well bonded.

5/ Sealants with a high stiffness modulus standing proud of the surface are usually sheared off by plows in winter.

6/ The currently employed laboratory tests do not give an indication of a materials ability to perform satisfactorily in asphalt pavements during the winter.

7/ Laboratory tests which will more closely reflect sealing materials ability to perform in asphalt pavements must be identified.

Methods

1/ Moisture or dirt in the routed groove at the time of placing the hot sealant will lead to early failure of the sealant in winter.

2/ Sealant placed flush or slightly low in the routed grooves is prone to early failure through splitting at the edge of the rout during the winter.

3/ Sealant installed so as to overlap onto the pavement surface on each side of the rout has a higher success rate, particularly if the seal is formed with a convex shape over the rout.

SUMMARY

Mid-winter evaluation of crack sealing is essential in determining sealing effectiveness. Typically seals start failing through splitting in December and reach maximum distress around the end of January. With rising temperatures and traffic, most sealants will reseal over summer with some resealing as early as the end of March. This cycle will be repeated each year, with the seals appearing effective each summer.

Of the 22 products evaluated for sealing asphalt pavement cracks, only 8 performed well enough to be considered for use in Ontario's highways. All eight products are hot poured rubberized asphalts. Cold poured products were not found acceptable for use.

Based on mid-winter performance and minimal loss of sealant, four "premium" materials formulated to meet ASTM D-3405 were approved by the Ministry for use in asphalt pavements throughout Ontario and a further four materials are considered acceptable for use in the southern part of the province only.

A new Designated Source List DS:143.4 has been created for materials to be used in asphaltic concrete pavements. This list includes the best four performing materials as suitable for use throughout the province and further includes any product which meets MTC Form 1212 as suitable for use in the southern part of the province only (Districts 1-8)

The previously existing Designated Source List DS:143.2 has been retitled "For Use in Portland Cement Concrete". The materials on this list must meet MTC Form 1212.

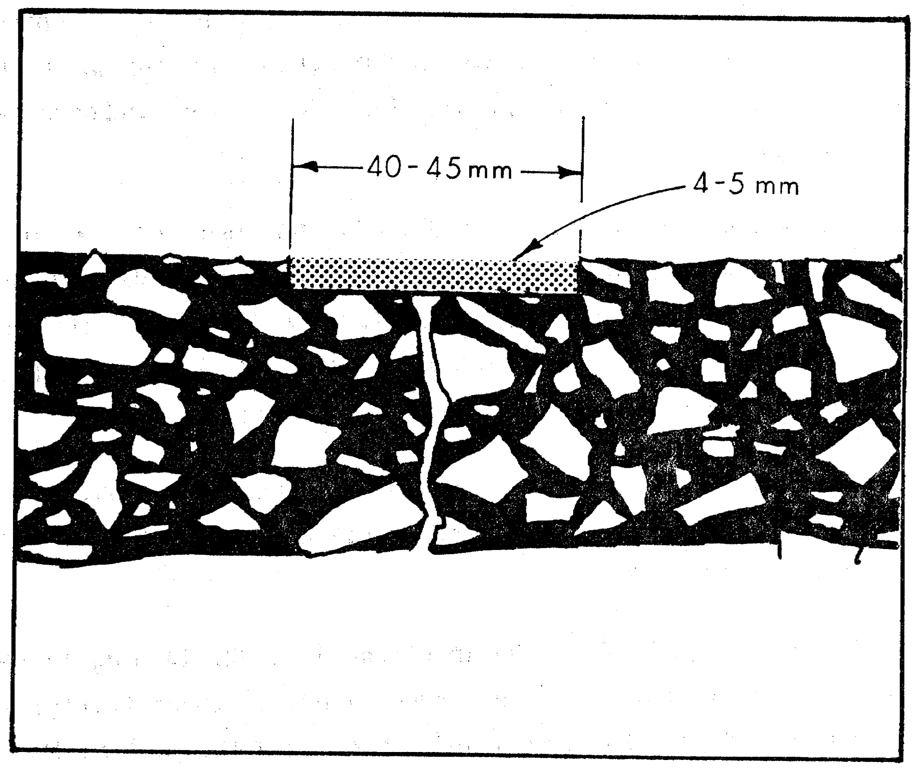
A further project (EMO #79) initiated in 1982, is progressing to evaluate asphalt crack sealing in damp conditions. In these trials; six methods of crack preparation have been constructed employing HCA as the final conditioner prior to placing the sealant. The six methods were constructed in triplicate using three of the best performing materials identified in the Hwy. 69 trials. A first interim report has been published on these trials (Materials Information No. 53).

Several trial installations have been constructed in 1983 using a method introduced to the Ministry by Klaruw of Holland (Fig.4). This method has the advantage of the overband seal without the hazard of snow plow damage. These installations will be reviewed over the winter of 83-84.

A new hot compressed air lance, developed by Klaruw, called the super jet lance which has the advantage of focusing the hot gasses will be evaluated in 1984.

FIGURE 4

KLARUW METHOD



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