Joint-Sealing Maintenance Operations

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JOINT sealing has constituted a major maintenance problem over a period of years in Ohio. Various types of bituminous materials and hot-poured sealer, rubber type, have been used extensively with fair to good results.

Efforts were made to find an easily applied, long-lasting material for this purpose, and experiments were conducted in the fall of 1951 with cold-applied ready-mixed sealing material, rubber type. This test, and an additional experimental project in February 1952, indicated definite possibilities for both maintenance and construction application.

The cold seal material is applied by means of a pressure pump, hose, and nozzle applicator, and covered with paper stripping to prevent traffic pick up. Application at near freezing temperatures permits filling operations when slabs are contracted and joints are open enough to hold material.

● THE design and construction of transverse and longitudinal joints in concrete streets and pavements have gone through several cycles in the past 63 years. The first concrete pavement was laid in the United States (Bellefontaine, Ohio, 1890 and 1891) in blocks ranging from approximately 5 feet square to approximately 10 feet square. Within a few years the pendulum had swung so that it was common practice to place concrete full width with transverse joints only at the end of the day's work and at structures. Since the pavements tended to crack at regular intervals and since it was easier to maintain a joint than a crack, it became the policy to use longitudinal joints between traffic lanes and to divide the slabs longitudinally with transverse joints.

The spacing between transverse joints varied widely between states and even within a given state, depending on whether the slab was plain or reinforced, and many times, if plain slabs were used, on the aggregates in the concrete. Until a relatively recent date it was thought that some provision was necessary to allow for expansion of concrete-pavement slabs. During the era we, in common with most other states, generally provided a 1-inch expansion joint every 120 feet with intervening contraction joints.

Within the last 10 years, the pendulum again swung and the use of expansion joints was restricted. The designs used on the majority of pavements which we are now resealing are divided into four rather broad classifications, all of which have distributed reinforcement and load transfer devices at all transverse joints. These classifications are: (1) Expansion joints, 120-foot centers; contraction joints, dummy groove, ¼ to ⅓ depth of slab, 40-foot centers. (2) Expansion joints, at structures and intersecting rigid pavements; contraction joints, steel plate ½ inch below surface, 40-foot centers. (3) Expansion joints, at structures and intersecting rigid pavements; contraction joints, steel plate ½ inch below surface, 100-foot centers. (4) Expansion joints, at structures and intersecting rigid pavements; contraction joints, steel plate 1 inch below surface, 60-foot centers.

Classification 4 is our current design and was only used on a portion of the pavement built in 1953. Although Classification 1 represents the older pavements, the resealing of the 100-foot contraction joints in Classification 3 represent the hardest resealing problem of the three.

When the pavements were constructed, the contraction joint openings were approximately ¼ inch wide. Under conditions existing in Ohio, these joints might open ½ inch, due to temperature changes in the 100-foot slabs. Thus we were asking a joint sealer to effectively seal an opening whose volume might be 300 percent larger in the winter than it was in the summer at the time of the original sealing operation. It can readily be seen that this is a severe requirement.

In the past our maintenance forces have generally used bituminous materials as joint sealers. Over the years we have used a wide range of bituminous materials including heavier grades of cutbacks, emulsions, and tars, and the hot-poured rubber-type material.

The performance of many of the sealers left much to be desired. On the ones requiring heating before using, it was impossible to obtain anywhere near maximum efficiency. In the morning it was necessary for the entire crew to wait until the material was heated to the proper temperature, and in the afternoon it was necessary for the crew to quit sealing joints early enough so that the equipment could be cleaned before quitting time.

During the latter part of 1951, we began experimenting with a cold-applied, ready-mixed rubber sealer using pressure-pump application. This material is a homogeneous blend of asphalt, rubber, and suitable solvents. The material, first developed for sealing sawed joints, is extruded through a nozzle which can be inserted to the bottom of the joint.

REMOVING OLD SEALER

The first requirement for efficient joint resealing is to have a good method of removing the old sealer and debris from the joints. On our first resealing project using cold rubber, we used a joint-grooving-and-cleaning machine to remove the old sealer, which was the hot-poured rubber type. The heat generated by the grooving-and-cleaning machine reactivated the old sealing material and the consequent sticking of material in the joint, on the machine, and on the pavement resulted in an unsatisfactory condition.

In view of this unsatisfactory experience and after experiments with a small garden-type tractor, a satisfactory rooter was developed to plow the old material from the joints. The rooter is essentially a modified, hand-operated small garden tractor. It is powered by a 4.2 hp. gasoline engine and is equipped with a clutch and two-speed drive, a high speed for travel between joints and a low speed for use when the machine is used to plow the old material from the joint. The latest rooter made by the department has a reverse in addition to three forward speeds. The rooter is shown in Figures 1 and 2.

A quickly detachable drawbar was designed with a satisfactory tool for removing the old material. In designing this tool it was necessary to consider the various types of joints on which it would be used. The width of the groove varies widely due to construction practices and due to the amount, if any, that the concrete is contracted when the joints are cleaned. It was also considered desirable to scrape the pavement surface on both sides of the joint to remove excess sealer. This scraper also sheared off the rooted sealer where it was still bonded to the concrete. This was done by making the rooter tooth rigid and the scraper tooth to operate up and down within limits.

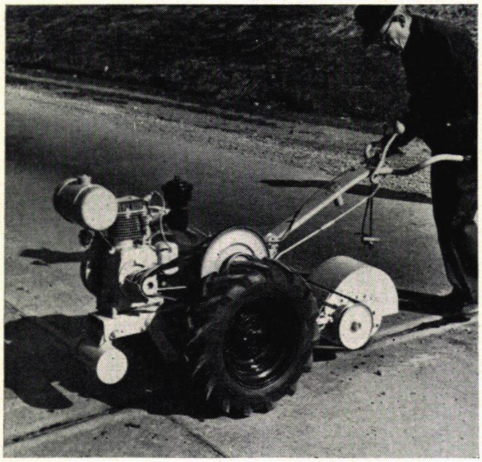

Figure 1. General view of rooter showing counterbalance, rooter tool, surface scraper and rotary brush.

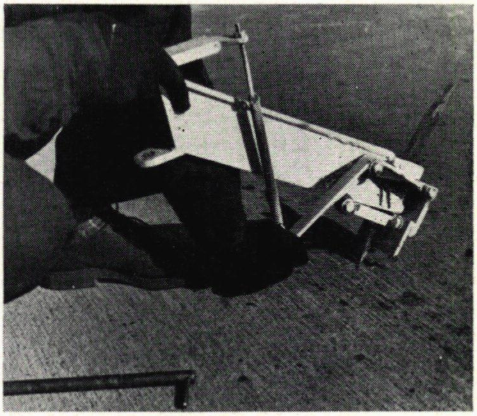

Figure 2. Close-up of rooter tool and spring-mounted surface scraper.

The rooter tool is supplied in various widths from ¼ to ¾ inches by 1/16-inch increments. The tool used should be the one that passes through the joint without excessive side friction. These tools can be changed to the width tool required in 30 seconds, the same holder being designed to hold any width tool in the above range.

The rooter is also equipped with a rotary brush constructed with an aluminum assembled hub filled with steel wire street broom bristles. This brush is approximately 15 inches in diameter and 6 inches wide with a loaded pressure sufficient to make it sweep out the joint and clean the pavement surface on each side. This brush is designed so that it can be easily filled with new wire when necessary.

A counterweight is mounted on the front of the machine to give sufficient weight for traction. The counterweight serves as a support when the machine is standing idle, keeping the engine in a plane which prevents it from stopping.

With this rooter, the old sealing material can be quickly removed from the joint and from the surface adjacent to the joint. At the same time, the rotary brush has swept the joint and it is ready for air-jet blasting and resealing.

RESEALING

The cold-applied ready-mixed sealing compound is pumped directly from 55-gallon shipping drums through an air-operated pressure pump, hose, and nozzle to the bottom of the joint groove.

With respect to the pressure pumps, initial experiments were made in cold weather operations with pumps of various ratios. Table 1 summarizes the tests.

As a result of these tests and further field experience, the department now has in use seven pressure pumps with a ratio of 24 to 1. The latest pump purchased by the department has a ratio of 28 to 1. This pump is equipped with an elevator and a flexible drum cleaner. The elevator, in addition to raising and lowering the pump, forces the sealer around the pump so that it always has a plentiful supply of material. This is especially useful during cold weather.

TABLE 1

Pump Ratio	Average Pump Gauge Pressure psi	Average Temperature, deg. F.		No. Joints Sealed	Average Filling Time Per 24′ Width[a]
		Air	Joint Sealer		
8 to 1	97	28	34	3	5′15″
16 to 1	100	—	42	3	2′50″
18 to 1	90	30	42	2	2′10″
24 to 1	60	29	38	19	1′30″

[a] Does not include time required to clean out the joints. The blowing out with air was the most-time-consuming operation encountered.

The joints are filled from the bottom up by means of a nozzle so shaped that the end of the nozzle can be held in the bottom of the joint groove and moved along the groove as necessary to completely fill the joint. On later work, a spring loaded shield was mounted to the back of the nozzle to act as a trowel in smoothing out the filler, thus leaving the joint completely filled with a slight and uniform excess on the surface of the joint. This nozzle is shown in Figure 3.

On maintenance work where traffic will be over the joint almost immediately after it is resealed, a strip of 50-lb. to 70-lb. kraft paper 3 to 4 inches wide is rolled out over the newly sealed joint to prevent pickup until the material has had an opportunity to form an oxidized skin over its top surface.

During the early trials the paper was applied by merely unrolling it on the resealed joints. To avoid the difficulty of applying it in this manner, the next step was to mount handles on the roll of paper. In both instances the paper was pressed in place by having a workman lightly drag his foot over it. We have found that the best way to press the paper in place was to roll it with a pneumatic tire carrying little or no air pressure. This piece of equipment is shown in Figure 4.

Figure 3. Close-up of nozzle showing spring-mounted shield for troweling excess sealer.

Some of our divisions have been quite ingenious in making up outfits to take care of our resealing work. One such outfit is shown in Figure 5. This truck carries the compressor, rooter, air pump, supply of sealer and all other equipment necessary to perform the work.

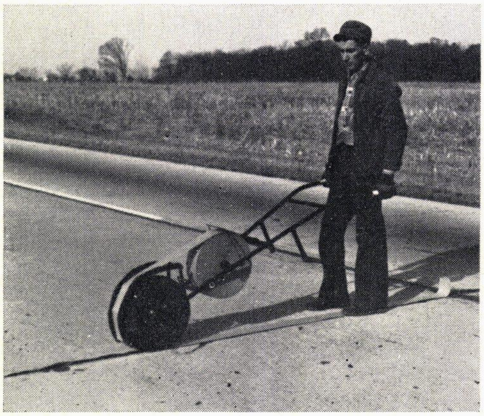

Figure 4. Machine for applying paper strip over resealed joint.

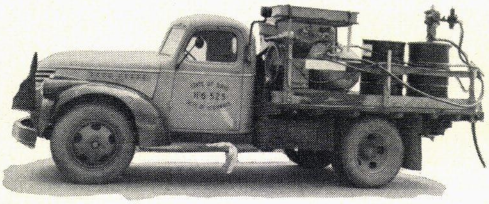

Figure 5. General view of truck completely equipped for this method of joint resealing. This truck will also carry the rooter.

COSTS

Resealing costs vary with the number of joints which need resealing, joint spacing, etc. The normal crew consists of six to seven men, and the operation requires two vehicles; one truck is needed for transportation of personnel and the other carries sealing material, a tractor, compressor, and pressure pump. The tractors were built by state forces at an approximate cost of $500. The seven pressure pumps with a ratio of 24 to 1 averaged $528, and the last pump with a 28-to-1 ratio, including elevator and drum cleaner, totalled $952.60. Material costs, F.O.B. delivery points, ranged from 10.3 cents to 12.0 cents per pound in 500-lb. drums. Complete applications costs, including labor, material, and equipment averaged 28.6 cents per pound, and varied from 23.2 to 39.9 cents per pound, with application rates of 0.18 lb. to 0.44 lb. per lin. ft. of resealed joint.

USE ON CONSTRUCTION PROJECTS

Based on the successful use of the cold-poured rubber material by our maintenance forces, the use of this material was permitted on several construction jobs during the last season. Several contractors elected to use this material.

Some of these projects were sealed in July and August when the slabs were near their original length. Ohio, like many other states, had little rain during the last construction season. With little traffic and practically no rain the paper did not disintegrate. When the pavement was opened to traffic the paper, in many instances, was pulled from the joint removing much of the filler with it and the

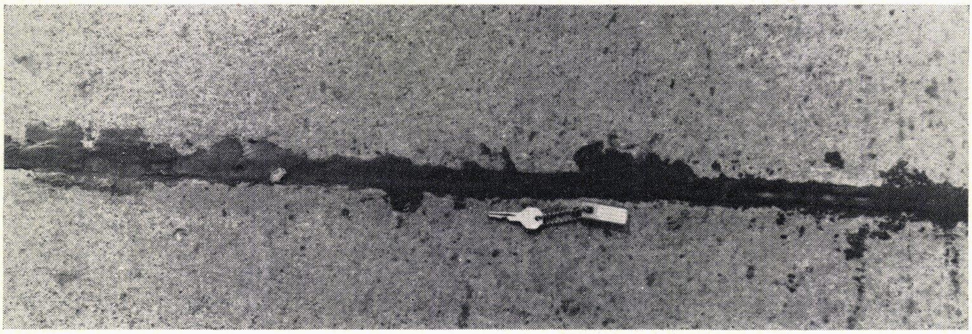

Figure 6. Close-up of resealed contraction joint after over 2 years of service.

sand which had accumulated under the edge of the paper dropped into the joint opening. These joints were cleaned out by the contractors and resealed by them during cooler weather.

When these joints were resealed, the weather was cooler and consequently it was possible to place a larger quantity of the sealer. Where traffic would not use the pavement for 24 hours after resealing, paper was not used, the joints being lightly dusted with cement.

Due to bond failures, it has been necessary for some contractors to reseal projects that were originally sealed with the hot-poured rubber type before the projects were accepted.

SEALING CRACKS

A small amount of the cold-poured type of rubber sealer has been used to seal cracks in portland-cement-concrete pavements and in bituminous resurfacings of this type of pavement. For this work special nozzles have been developed that leave a bead of the sealer on the surface. The best results have been obtained when the cracks are sufficiently open to allow some of the sealer to enter the crack.

CONCLUSION

We believe that the use of cold-applied, ready-mixed rubber sealer is the ideal material to use in maintenance work. The ease with which it can be placed during cold weather and its bond to concrete are especially desirable features. Figure 6 shows a close-up of one of the contraction joints resealed with this material more than two years ago.

Asphalt Emulsion for Undersealing Rigid Pavements

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● THIS is a short description of subsealing, void-filling, and joint-filling work done with emulsified asphalt in recent years on the state highway system in New York. The emulsion used conforms with the AASHO specification RS-1, a quick-setting grade with Furol viscosity 30–100 at 77 F. It is applied at air temperature but may be warmed to, say, 125 F., if desired. Substantial use has also been made of the RS-2 grade which has a higher viscosity (Furol 50–300 at 122 F.) requiring heating to around 170 F. to secure desired fluidity. Both of these grades are the same as used for penetration macadam and for surface treatment with stone cover and are both generally available. As manufactured for New York State use, they have a base asphalt of 180 penetration having a softening point of 100 F. Application is made at pressures of 25 to 50 lb. per sq. in.

The methods and materials were first used in New York for this purpose on a substantial scale in 1948. Little subsealing work of any nature had been done there up to that time, but the necessity was apparent. Trials were made with emulsion to discover if this low-temperature-application material would give results comparable with materials of high softening points. A season's use indicated that it was possible not only to fill the cavities beneath the pavement but also to do a satisfactory job of sealing joints and cracks from beneath the pavement in the same operation.

In the early stages of the work the emulsion was introduced by simply pouring it from hand-pouring pots. The pavements then being cared for were quite-badly broken and cracks were quite wide in many cases. The hand-poured emulsion quickly seeped down out of sight and two or three follow-up pours were necessary at times to completely fill the cracks. By the time the broken slabs, which in many places had been rocking quite badly, were completely filled they became firm and have