Asphalt in Pavement Maintenance

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INTRODUCTION

Inasmuch as road and street maintenance is big business, and becoming more so, public officials have an obligation and responsibility to adopt the best maintenance programs and procedures.

There are some things that are putting maintenance more in the limelight. First, one-third of the total road and street effort is going into maintenance. Because of this, maintenance is growing out of second class citizenship.

Recently the Asphalt Institute published a new manual *Asphalt in Pavement Maintenance.* This paper reviews parts of the manual but the primary purpose of the paper is to explore the why and how of the various types of maintenance programs by showing that:

a) Effective maintenance involves continuous planning, programming, and reappraisal.
b) There are proven techniques and methods for maintenance.
c) There are new developments in equipment and new materials affecting maintenance programs.
d) Maintenance should and is fast becoming a major operation.

MAINTENANCE PROCEDURE

There are five maintenance operations in the care of asphalt surfaces:

1. Patching, which consists of the repair of small area breaks;
2. Surface repair for distortion, wear, settlement and extensive surface damage;
3. Crack sealing;
4. Seal coating, for which there are several methods;
5 Rehabilitation, consisting of the repair and complete rebuilding of a wearing course.

Only two of these operations are considered here, namely, patching and crack sealing.

PATCHING OF ASPHALT SURFACES

There is probably no more widespread problem in the highway and street field than that of patching. No type of pavement is immune.

If holes do not occur from natural causes, man-made service cuts and trenches will produce them. These defects vary from shallow abrasions to deep, dangerous chasms, and from small spots to extensive areas. It is no trouble to locate the holes. If the road official doesn't find them himself the public soon will and will let him know promptly and emphatically where they are.

Patching requires skill and close supervision. It is very important that it be properly and promptly done. The repairing of small breaks promptly will have much to do with keeping down expenditures because once an area is broken so as to permit entry of water to the subgrade a larger failure will result.

Essential Elements for a Good Patch

1. Determine reason for pavement distress and remedy cause.
2. Prepare the hole properly.
3. Use accurately proportioned mixtures of proper composition.
4. Choose careful placement of the patching mixture.
5. Make sure of good compaction.

   All patches should be thoroughly compacted before they are opened to traffic. If a patch is not compacted, traffic will kick out and whip off some of the patching mixture and produce a rough spot. It will be porous and non-durable and eventually "wash" out.

   Patches should be compacted either with a loaded truck, a conventional roller, a portable roller, or by hand tamping so that the patch can be built to the proper thickness and density.

Types of Patching

There are three general types of patch work used in repair of asphalt surfaces:

1. Paint patching
2. Penetration type patching
3. Pre-mix patching

(1) *Paint Patching:* This is a miniature surface treatment or spot sealing over a small area. This type is used to seal areas that have begun to ravel or disintegrate. It is also used in the late fall and early spring in areas badly checked and cracked to supply a fluid asphalt that will flow into cracks and prevent water infiltration from the road surface—it all knits.

(2) *Penetration Type Patch:* This entire operation is similar to the construction of a new bituminous penetration macadam pavement.

A course of substantial thickness of mineral aggregate is first uniformly spread and compacted, after which sufficient asphaltic binder is applied to the surface to penetrate the entire depth of compacted aggregate. The surface is then finished with a seal coat. This method produces a new low cost type of patch that is frequently used because it is a quick, easy procedure that may be accomplished with a minimum of equipment. However, the result is often unsatisfactory—if not properly done the patch may vary from rich to lean, bleed, push or ravel.

(3) *Pre-mix Patching:* Probably more patching is done with pre-mixed bituminous material than with any other material. Two general types are used—the cold mix and the hot mix.

There is a definite trend to use more of the hot mixes and less of the cold mixes for patching. The hot mixes have several advantages. Generally this mix is better controlled than cold mixes made on the job, and as a result is more uniform. Fat patches caused by excess bitumen cease to be a problem. The mix sets quicker and can be smoothed out better under the roller. Traffic will disturb the hot mix less than other types. The work can be done more quickly and thus with less obstruction to traffic and less danger to the men doing the work. It can be used in cold or damp weather and still give results.

Often the patching mix, either cold or hot, can be obtained from a commercial mixing plant. This plant may be at a permanent location or may be a contractor's plant that has been moved into the area. Generally, an excellent patching mix can be obtained in this manner. The plant operator can usually produce about any mix desired by the customers. It may be necessary to take the special patching mix at times when he is not producing his regular material. Hot mix can be hauled by truck direct to the patching job and will remain workable for several hours. Cold mixes can be used on the job, if necessary, or may be piled for storage and used from there.

Small portable bituminous mixers have been developed especially for the production of cold and hot mix, and do the mixing excellently and quickly. The advantage of these portable patch mixers is that the mix can be used for patching directly from the plant and hence is more workable.

Despite the desirability of hot mix patching, there still is an "enforced" need for cold mix patching. Use of material from prepared cold stockpiles is still of considerable scope. However, the inherent benefits of warmed mixes, especially during cold weather, has given impetus to various schemes for heating the pre-mix sufficiently to make it workable before applying it. Most mixes become "crawly" above 100°F.

Patching Summary

Patching requires skill and supervision. The purpose of placing a patch is to restore a distressed area of the pavement to its original condition. Inexperienced operators should never be assigned this task if overall maintenance costs are to be kept at a minimum. In reviewing the steps covered in the three types of patching, the following advice is offered:

1. Try to eliminate the recurrence of distress by investigating the factors affecting the condition.
2. Eliminate repetitious maintenance—do not allow the surface distress to get progressively worse.
3. Always bear in mind that it is the subgrade and base which must carry the load that is to be applied to the surface.
4. Do not use excessive quantities of asphalt. This is a common tendency to obtain a more workable mix.
5. Never overheat the patching material. Overheating the asphalt makes it brittle, increasing oxidation properties, and tends to destroy its binding qualities.
6. Be sure that patches are of the proper thickness and that the finished surface is level with the surface of the surrounding pavement.
7. Do not place asphaltic patches over a saturated subgrade or base.

CRACKS AND JOINT SEALING

Effective maintenance of highway and airfield pavements requires that the underlying base and subgrade be kept as dry as possible. To this end, the pavement surface should be maintained waterproof by keeping the cracks and joints sealed at all times. Open cracks and joints allow water to seep through the slab to the base and subgrade, softening them and reducing their load-supporting value. Cracks expose side surfaces which tend to oxidize and may ravel and spall.

The purpose of sealing the crack is to seal its sides and bottom to prevent further spalling and permeation of moisture and air into the pavement structure.

Merely designating crack sealing as a maintenance operation in no way simplifies the problem. There are many decisions to be made as to materials, equipment, etc., all of which impinge on the effectiveness of the crack sealing program. The problem may be approached, however, by dividing it into three interrelated parts, namely: (1) what cracks should be sealed, (2) when they should be sealed, and (3) what materials should be used. Although crack sealing equipment and

procedures will be mentioned, these topics are directly related to materials used and will not be treated separately.

What Cracks Should Be Sealed?

In answer to the first part of the problem, the obvious reaction is that all cracks which will admit surface water through the pavement should be sealed. But from the practical aspect, it must be remembered that to affect a seal, the sealing material must be able to flow into the crack. Since most sealing materials are more viscous than water, it is generally felt that approximately one-eighth inch is the limiting minimum dimension for effective crack sealing. When applied to cracks less than one-eighth inch wide, most compounds will simply bridge over the crack rather than penetrate into it.

For wider cracks, in the neighborhood of one-half inch, heavier crack sealing materials can be used. The upper limit of crack width is not definite. However, there is a point where the width becomes sufficient to necessitate the use of special crack sealing or patching technique rather than a normal crack sealing procedure.

When to Seal Cracks?

The general trend of the answer to this question is away from any calendar date. That is, crack sealing is not necessarily scheduled in the late fall season. And the tendency seems to be to let the crack dimension, discussed above, answer this question. Therefore, the time to seal cracks is whenever the cracks open up to one-eighth inch in width or more. Surface water infiltration is thus minimized, as is the accumulation of dust, silt, and other debris in the crack.

The decision as to the time of crack sealing should be tempered with judgement. Better sealing is assured if the material can flow freely into a dry crack. Since it is obvious that crack sealing cannot proceed normally in winter under these conditions, late fall and early spring is the time for special emphasis so that the pavement is in good shape for winter. However, the operations should be carried on during the rest of the year as the cracks appear in the pavement.

Small cracks develop from base and subgrade movement when the pavement is under load. Expansion and contraction of the pavement also contribute their share of cracks. As the pavement twists and squirms during changes in temperature, the small cracks gradually widen until they sometimes become an inch or more in width. Small cracks should be sealed immediately after occurrence, before water and dirt are allowed to penetrate the openings.

If a structurally sound pavement has only a few cracks, they should

be individually corrected by sealing them with asphaltic material. The use of a seal coat solely to seal the crack should not be resorted to unless there is a preponderance of cracks in the pavement.

Prompt maintenance keeps costs low and prevents progressive damage. Sealing of cracks and joints should not become a spring and fall operation but should be done as the need becomes apparent. At the approach of winter, special efforts should be made to get all cracks properly sealed. The work should be planned to allow completion in-spite of delays due to seasonal rains.

The Desirable Qualities of a Crack Sealing Material

Listed, but not necessarily in order of importance, are some properties of a material best suited for a sealant:

(1) Ease of application: hot or cold, minimum preparation of crack
(2) Positive seal against water penetration
(3) Longevity of service relative to (2) above
(4) Ability to allow expansion and contraction without loss of adhesion or cohesion
(5) Ability to resist the intrusion of foreign material
(6) Ability to remain plastic under cold temperature conditions
(7) Resistance to flow or become tacky under warm temperature conditions
(8) Lack of detrimental reaction with asphalt
(9) Good "flow" characteristics when applied so that it penetrates into the crack as deep as possible
(10) Property of keeping the face of crack enlivened.

Such a variety of properties seems like a large order for any one material and, indeed, it is. A search of literature in which both field tests and laboratory tests were reported revealed that no one material possessed all of these desirable traits. Some materials perform well under some conditions, not so well under others. Materials which have been used as crack sealers and fillers include cutback asphalts, special asphalt cements, asphalt emulsions, rubber-asphalt, rubber-asphalt emulsions, filled rubber-asphalts, epoxy resins, neoprene rubber, and foam rubber, to mention a few.

All of these materials possess one or more of the desirable properties noted above. None possesses all of them as verified by both field tests and laboratory tests. Furthermore, a material which performed fairly well in one state has given poor service in another. The selection of a crack sealant thus becomes a compromise. The attempt is made

to select one material which has more of the desirable characteristics than the other available materials. A final selection is, of course, dependent somewhat on the overall cost of the crack sealing operation as well as the particular circumstance.

Crack Sealing Material—The Sealant

Generally, the less viscous asphaltic materials are recommended for crack filling. These include cutbacks, RC-800, MC-800, or SS-1 asphalt emulsions. It has been observed that frequently a much too heavy (high viscosity) asphalt material (like asphalt cement) has been used. This material did not get into the narrow crack and merely gave a superficial bridging result. For larger cracks (one-half inch plus) a heavier-bodied asphalt material or compound should be considered. Some suggested materials are:

(1) *Asphalt Slurry:* An asphalt emulsion slurry employs a mixture of fine aggregate (sand or crusher dust or both), emulsified asphalt (SS-1), and water. A mixer is used for the blending of the materials and the liquid slurry poured directly into the crack. The mortar-like consistency of the slurry makes an ideal crack filler.

(2) *Pre-Mixed Fine Graded Asphalt Mixtures:* Mixtures of fine, clean sand and asphalt material, prepared hot or cold, can be broomed into the wider cracks and then surface sealed with a liquid asphalt material. These mixtures must be workable.

(3) *Special Asphalt Compounds, Applied Both Cold and Hot:* Certain asphalt-rubber compounds possess excellent properties, and give good crack sealing performances.

A detailed write up of *Sealing of Wider Cracks With Hot Poured Rubber-Asphalt Sealant* is included as an appendix in the manual.

Preparation of the Cracks

Small cracks should be cleaned by directing a jet of compressed air into the openings and blowing the dust and fine dirt away. Another method is for the surface of each crack to be broomed vigorously with a stiff bristly broom.

In wider cracks it is desirable that they be cleaned by plowing out the dirt and other objectionable matter by a specially built routing tool to prepare a reservoir of proper shape for the sealing material.

Normal Sealing of the Cracks

In many cases, pouring of material into cracks is performed carelessly and is ineffective.

Sealing material should be used sparingly. Only enough material should be poured into the opening to fill the crevice flush with the surface. Overfilling may cause a build-up of the material. This not only produces an objectional bump but may track onto the pavement. To assure even distribution of the material, it will be found that a squeegee will serve well. It will also assist workmen in keeping the application to a minimum.

General Comment

Special conditions will determine the number of men and the amount and type of equipment needed on any one project or highway district. But a well organized crew soon pays for itself in faster pouring operations. The big cost of crack filling involves labor.

The principal causes of poor crack and joint sealing are:

(1) Use of too heavy grades of sealing material;

(2) Improper cleaning prior to pouring of sealing material;

(3) Pouring the sealing material during unsuitable weather conditions;

(4) Lack of care taken to distribute the material evenly in the crack, resulting in excessive material on surface.

CONCLUSION

It is hoped that interest in maintenance has been aroused to the end that:

(1) Highway personnel will make use of our *Asphalt Pavement Maintenance Manual* Series No. 16. It gives the details briefly covered here. A copy can be obtained by writing District Engineer Ward Bond, 4165 Millersville Road, Indianapolis, Indiana 46205.

(2) Highway departments will conduct maintenance schools for field men. We will be happy to assist.

(3) Highway departments will develop a preventative maintenance program.

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