Transportation

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University of Kentucky

Year 1962

Class I, Type B, Plant-Mix Initial Treatment, PAC-9

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MEMORANDUM

TO: A. O. Neiser
   Assistant State Highway Engineer

SUBJECT: Progress Report
   Class I, Type B, Plant-Mix Initial Treatment, PAC-9
   Butler County

Initial-treatment surfaces have been criticized repeatedly for their inability to withstand break-up under traffic during the first winter and spring of service. It has been found that pavements designed to permit large deflections have required less maintenance even though some of the deflection resulted in rutting and displacement. The obvious solution would be to provide adequate pavement thickness and to limit deflections; but restrictions on funds available, program extent, and other items have prevented this procedure. A variety of types of initial bituminous treatments have been used in Kentucky in recent years; some are listed below:

1. C-1 Roadmix
2. Penetration Macadam
3. Class I, Modified Base
4. Class I, Type B Surface
5. Portland-Cement Treated Base, with A-2 Seal
6. Granular-Stabilized Base, with Calcium Chloride, A-2 Seal
7. Bituminous-Stabilized Base, with A-2 Seal
8. Dense-Graded Aggregate Base Course, with Class I, Type B Surface
9. Dense-Graded Aggregate Base, with C-1 Roadmix
10. Granular-Stabilized Base, with Calcium Chloride, C-1 Roadmix
11. Granular-Stabilized Base, with Calcium Chloride, Class I, Type B Surface
12. Soil-Cement Base, with C-1 Roadmix or Class I, Type B Surface

There have been satisfactory initial treatments constructed using each of the types mentioned. In these cases, however, sufficient thicknesses were provided to limit deflections below the critical amount for the material used. Of those mentioned, the penetration macadam, Class I, modified base, and soil-cement base would permit less deflection prior to serious break-up. The C-1 roadmix and the bituminous-stabilized base would probably permit more deflection without breaking up.

One factor of considerable significance in the initial treatment program is application rates for the relatively thin courses available. Mixed-in-place treatments are subject to non-uniform application rates and also to varying thickness of material upon final spreading. Some of these items are overcome through central mixing and uniform machine spreading.

In an effort to provide a plant-mix asphaltic concrete surface to withstand greater deflection, an experimental pavement was placed on the Morgantown-Woodbury road last year. This project is described in the attached memorandum by R. L. Florence. The contractor, R. E. Gaddie, Bowling Green, placed his plant and paving crews at the Department's accommodation in order that all of the variables desired might be incorporated into this project. Additional asphalt quantities, mineral filler, etc., beyond specifications requirements, were supplied at no extra cost to the Department.

Performance to date (January 24, 1962) on this minimum-surfacing-type initial treatment has been good. Application rates
were fairly uniform; the surface is dense and does not appear to be permitting surface water to reach the base. There may be some bleeding during warmer weather, but this could be remedied by blotting with sand if it occurs.

We plan to make an inspection during the late spring.

Respectfully submitted,

W. B. Drake
Director of Research

WBD:dl
Enc.
cc: Research Committee Members
    Bureau of Public Roads (3)
Commonwealth of Kentucky
Department of Highways

PROGRESS REPORT
CLASS I, TYPE B, PLANT-MIX
INITIAL TREATMENT, PAC-9

by
R. L. Florence
Research Engineer Associate

Highway Materials Research Laboratory
Lexington, Kentucky
February, 1962
Initial surface treatments of so-called traffic-bound macadam rural secondary roads presents a challenging but frustrating problem in the over-all highway program. In many cases, these roads do not merit the expenditures that would be needed to construct the type of pavement desired, yet there is a need for a dust-free, all-weather type of surface for these roads. It may be argued, for instance, that initial surfacing should be deferred until such time that the construction of a proper base and surface would be justified. On the other hand, one might argue that even a light surfacing would be preferred despite the fact that expensive maintenance might be incurred subsequently. Notwithstanding these or other persuasive arguments, initial treatment work comprises an engrossing proportion of the highway program.

Although sufficient TBM stone may have been placed on the road at the time of construction and supplemented from time to time thereafter, there is rarely sufficient depth of stabilized base to ensure reliable performance of an initial, light bituminous surfacing. Of course, where an adequate base is encountered or is otherwise constructed in preparation for the initial treatment, the surface performs quite well. In such cases, multiple bituminous seals or light bituminous surfacing may suffice.
One method of base preparation consists of scarifying, reshaping and recompaction -- the idea being to blend loose floater stone into the base and to distribute the granular material more uniformly. When feasible, 3 in. or so of dense-graded aggregate base may be placed over the existing or re-worked TBM base.

The desire to achieve structural thickness of initial treatment work led to the use of modified Class I bituminous concrete base* as the initial stage of surfacing. The modified Class I base was envisioned as a highly stable, lean, multi-purpose mix which would be capable of serving temporarily as a surface and which would be capable of being laid and compacted in 3- to 4-in. lifts. This mix proved to be brittle and unable to withstand severe deflections in instances where the base was inadequate and the surfacing was too thin, but it did perform well in instances where existing TBM base was sufficiently thick.

The problem has many ramifications and provides sufficient incentive for experiment and study. Whereas logic favors the construction of at least six inches of combined thickness, the job frequently has to be constructed with less; hence, the effects of traffic and freezing weather tends to be far more damaging. The deflections under load are much greater, and the otherwise stable but thin bituminous surfaces break up. Considering this point of view, a less stable, mastic, membrane-type of surface might be preferred. To illustrate this viewpoint, Fig. 1 depicts an unstable asphalt-treated bank-gravel base having a double-seal surface. Tire marks or ruts and shoving of the base are readily discernible, yet the surface remained unbroken for some time. Eventually the surface did break up, but it withstood extreme deformations for a surprisingly long time. Somewhere between this extreme and the opposite extreme represented by highly stable, rigid, bituminous concrete, there must be a deformable, mastic mix which would be less vulnerable to cracking but which would not be rutted by a single pass of a wheel. In contrast, Fig. 3 illustrates a typical failure of a bituminous concrete surface subjected to excessive deformation.

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Fig. 1. Double Seal Coat over an Unstable Asphalt-Treated Bank-Gravel Base, near LaCenter, Kentucky. Each vehicle tended to iron out existing tire marks and to mark the surface anew.
Higher-than-normal bitumen contents together with high filler contents are known to impart resistance to break-up under severe deformation to bituminous concrete mixes. Additional deformability may be obtained through the use of soft asphalts, although the desirability of this might be debatable. The resulting mixes are necessarily in the region of zero voids; consequently, there would be some risk of bleeding and slipperiness. During 1953, high asphalt contents in bituminous concrete made with 100% limestone aggregate were used in resurfacing several miles of pavement. Some of those pavements flushed and resulted in slipperiness that required remedial action.

In order to study the aforementioned possibilities, a Class I, Type B, initial treatment, with soft asphalt cement and high asphalt and filler contents, was constructed last October on a 2.67-mile section of the Morgantown-Woodbury Road in Butler County. The location of the project is shown in Fig. 2. The section surfaced extended over three rural secondary projects. A condition survey (Fig. 11) was made September 7, before surfacing. Other pertinent information concerning the projects follows:

RS 16-1516 extends 0.353 miles from the junction with US 231 to the south city limit of Morgantown. The existing surface was bituminous concrete in an advanced state of deterioration (Fig. 3). Ledge rock was exposed on a steep grade near the city limit (Fig. 4).

RS 16-516 extends 0.807 miles south from the city limits of Morgantown. The road, which crosses a bottom on a 5- to 10-ft. fill, was in comparatively good condition. The traffic-bound surface (limestone aggregate) was tight and of uniform thickness (approximately 4 in.).

RS 16-326 extends 1.510 miles south across a second bottom and the project ends near the entrance to the Cook Cemetery. The traffic-bound surface, made with river gravel aggregate, was loose and of variable thickness — due to erosion and rutting (Figs. 5 and 6).

Note: The existing road-bed material appeared to be uniform throughout the length of the project and had a minimum laboratory CBR of 30.
Fig. 2: Map Showing Location of Project and Termini of Experimental Sections. Note: Flags at the left of the road, showing asphalt contents, apply to the south-bound lanes only.
Fig. 3. RS 16-1516, Existing Bituminous Surface, in Morgantown.

Fig. 4. RS 16-1516, Exposed Ledge Rock, near Morgantown.
Fig. 5. RS 16-326, TBM, River Gravel, Shows Some Erosion in Up-Hill Lane.

Fig. 6. RS 16-326, near Sta. 22+00, Facing Northward.
The proposal called for a 1-1/2-in. (165 lbs/sq.yd.) surfacing and 0.40 gal/sq.yd. RT-2 prime. It was tentatively planned to surface the first 0.9 mile from the Cook Cemetery with a mix having an asphalt content of 6.5%, the second 0.9 mile at 7%, and the section in and near Morgantown at 6%. It was also planned to run the dust or filler content of the mix as high as possible at each asphalt content.

The mixture was produced by the R. E. Gaddie plant located in the Gary Bros. quarry at Bowling Green. The materials used were No. 9 limestone, No. 11 limestone, Class I limestone sand, and a 238-penetration (PAC-9) asphalt cement. The following acceptance test data on the asphalt cement were supplied by the Materials Division:

Manufacturer - Texaco Inc., Lawrenceville, Ill.
Water Content - 0.0%
Specific Gravity - 1.0016
Solubility in CC14 - 99.9%
Flash Point (COC) - 600°F.
Ductility at 60°F
(5 cms/min.) - 150+ cm.
Penetration at
77°F (100 g., 5 sec.) - 238

Thin Film Oven Test
Loss in Weight - 0.0%
Pene. of Residue - 55.9% of original
Ductility of Residue - 150 cm +

On the first day of production (Monday, October 16th), the asphalt content was initially set at 6%, and the aggregate blend consisted of No. 11 limestone, No. 9 limestone, and Class I limestone sand. Dust from the collector was fed back at 4%. It was soon noticed that the collector could not maintain the 4% dust. The No. 11 limestone was removed from the blend, and the limestone sand was increased in order to increase the amount of dust collected. The asphalt content was then increased to 6.5%. Fat spots appeared in several of the first loads when they were placed on the road. The dust collector still could not maintain the dust at 4%, so this was reduced to 2%. The draft on the dryer was reduced to a minimum in order to collect more fines.
On Thursday, October 19th, the asphalt content was reduced to 6%, and a very short one-lane section of 90 tons was laid. The asphalt content was then increased to 7%, and the proportion of fines was increased slightly. The dust from the collector was still maintained at 2%. Bleeding (flushing) occurred in several areas on the road after rolling. No material was laid the following day due to rain. On Monday, the 23rd, the material was laid at 7%. The project was finished out at 6% asphalt content on the 24th and 25th. A diagram locating the sections at each asphalt content is shown in Fig. 12.

The aggregate gradation varied little during the entire project. Primary control of the gradation was at the hot bins of the plant. Gradations of mixtures, sampled daily, are shown in Table 1. The gradation approximated the center of the Class I, Type B, gradation limits except for the minus-50 material which ran high (Fig. 13). Minus-200 material (filler) was maintained at approximately 5%. It was not possible to increase this amount without adding extra mineral filler to the aggregate. Inasmuch as the aggregate voids were over 80% filled at 6.5 and 7% asphalt content, this was not done.

Samples of the mixture were taken daily for laboratory Marshall testing (Table 2). The stability values remained unusually high at all asphalt contents. At 6.5 and 7% asphalt, flow values were very high; and the void contents were very low when considered from the standpoint of normal mixture design.

Prior to surfacing, the road surface was primed with RT-2 and reshaped. The traffic-bound surface with river gravel remained loose and unstable after priming. The ledge-rock outcropping was smoothed somewhat by filling-over and reshaping. No difficulty was experienced in laying the mixtures having a high asphalt content. The three-wheel roller, on the break down rolling, had to stay far back of the paver, and the tandem or finish rolling could be delayed until long after the surface was laid.

An inspection of the surface was made on January 24, 1962. At that time, no cracking or additional bleeding was noted. It is anticipated with the onset of warm weather and additional traffic that some bleeding will occur in the rich sections. Figures 7, 8, 9 and 10 are photographs taken soon after the January 24 inspection. Additional inspections will be made from time to time in order to record the performance of the surfacing mixtures.
Fig. 7. Same View as Shown in Fig. 3, After Surfacing.

Fig. 8. Same View as Shown in Fig. 4, After Surfacing.
Fig. 9. Same View as Shown in Fig. 5, After Surfacing.

Fig. 10. Same View as Shown in Fig. 6, After Surfacing.
Fig. 11. Strip Map Indicating the Condition of the Road Prior to Surfacing.
Fig. 12. Strip Map Indicating the Locations on the Project where Various Asphalt Contents Were Used.
Table 1. Summary of Gradations and Extractions

<table>
<thead>
<tr>
<th>Date Sampled</th>
<th>% Asphalt</th>
<th>1/2</th>
<th>3/8</th>
<th>4</th>
<th>8</th>
<th>16</th>
<th>50</th>
<th>100</th>
<th>200</th>
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<td>AM 10-16-61</td>
<td>6.1*</td>
<td>100.0</td>
<td>92.7</td>
<td>54.2</td>
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<td>6.5*</td>
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<td>65.4</td>
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<td>14.4</td>
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Tests Performed at Laboratory

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<th>8</th>
<th>16</th>
<th>50</th>
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<th>200</th>
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<td>100.0</td>
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<td>60.0</td>
<td>38.9</td>
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<td>6.5**</td>
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<td>94.3</td>
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* By Extraction
Table 2. Marshall Test Results  

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<th>Date Sampled</th>
<th>Specimen No.</th>
<th>Asphalt Content (%)</th>
<th>Stability (lbs.)</th>
<th>Flow (0.01&quot;)</th>
<th>Unit Wt. (lb/cu.ft.)</th>
<th>Percent Voids</th>
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<td></td>
<td></td>
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<td>Asphalt Percent Voids</td>
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</table>

10-16-61
- B1-1 | 6.5 | 1708 | 23 | 149.1 | 3.0 | 18.2 | 83.5 |
- B1-2 | 6.5 | 1556 | 20 | 149.8 | 2.5 | 17.9 | 85.5 |
- B1-3 | 6.5 | 1802 | 22 | 149.4 | 2.8 | 18.0 | 84.4 |
- B1-4 | 6.5 | 1755 | 26 | 149.6 | 2.6 | 17.9 | 85.5 |
- B1-5 | 6.5 | 1834 | 25 | 149.4 | 2.8 | 18.0 | 84.4 |
- Avg. | 6.5 | 1730 | 23.2 | 149.4 | 2.7 | 18.0 | 84.7 |

10-17-61
- B2-1 | 6.5 | 1818 | 22 | 148.4 | 3.4 | 18.6 | 81.7 |
- B2-2 | 6.5 | 1960 | 17 | 148.8 | 3.1 | 18.3 | 83.1 |
- B2-3 | 6.5 | 1792 | 20 | 152.3 | 0.9 | 16.4 | 94.4 |
- B2-4 | 6.5 | 1869 | 13 | 148.5 | 3.3 | 18.5 | 82.2 |
- B2-5 | 6.5 | 1756 | 15 | 152.0 | 1.1 | 16.6 | 93.4 |
- B2-6 | 6.5 | 1952 | 17 | 147.9 | 3.7 | 18.8 | 80.3 |
- Avg. | 6.5 | 1860 | 17.3 | 149.7 | 2.6 | 17.9 | 85.9 |

10-18-61
- B3-1 | 6.5 | 1708 | 17 | 151.6 | 1.3 | 16.8 | 92.3 |
- B3-2 | 6.5 | 1820 | 15 | 151.6 | 1.3 | 16.8 | 92.3 |
- B3-3 | 6.5 | 1882 | 19 | 147.8 | 3.8 | 18.9 | 79.9 |
- B3-4 | 6.5 | 1792 | 18 | 152.6 | 0.7 | 16.3 | 95.7 |
- B3-5 | 6.5 | 1958 | 17 | 150.1 | 2.3 | 17.6 | 86.9 |
- B3-6 | 6.5 | 2016 | 22 | 149.0 | 3.0 | 18.2 | 83.5 |
- Avg. | 6.5 | 1860 | 18.0 | 150.4 | 2.1 | 17.4 | 88.4 |

10-23-61
- B4-1 | 7.0 | 1956 | 13 | 150.3 | 1.4 | 18.0 | 92.2 |
- B4-2 | 7.0 | 1527 | 16 | 152.5 | 0.0 | 16.8 | 100.0 |
- B4-3 | 7.0 | 1948 | 15 | 149.1 | 2.2 | 18.7 | 88.2 |
- Avg. | 7.0 | 1810 | 14.7 | 150.6 | 1.2 | 17.8 | 93.5 |

10-24-61
- B5-1 | 6.0 | 2121 | 12 | 151.4 | 2.2 | 16.5 | 86.7 |
- B5-2 | 6.0 | 2174 | 15 | 151.2 | 2.3 | 16.6 | 86.1 |
- B5-3 | 6.0 | 2076 | 13 | 151.0 | 2.5 | 16.7 | 85.0 |
- Avg. | 6.0 | 2120 | 13.3 | 151.2 | 2.3 | 16.6 | 85.9 |
Fig. 13. Graph Showing the Average Gradation of the Aggregate Used in the Surfacing Mix (Dashed Line). Solid lines represent the specification limits of grading for Class I, Type B Surface.