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Construction Report on Experimental Use of Natural, Bituminous, Quartz Sandstone (Kentucky Rock Asphalt) as a Traffic-Bound Aggregate

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MEMO TO: A. O. Neiser
Assistant State Highway Engineer

The attached "Construction Report on Experimental use of Natural Bituminous Quartz Sandstone (Kentucky Rock Asphalt) as a Traffic-Bound Aggregate" by Mr. George R. Laughlin, Research Engineer Associate, represents our first report on this project. As you know, the Research Division, since its establishment, has been vitally interested in the economical use of Kentucky Rock Asphalt for highways. We have been involved in numerous experimental road projects and research endeavors.

The present project was proposed to the Department by representatives of W. G. Reynolds & Associates (Owners or Lessors of the former holdings of the Kyrock Company). This organization retained a consulting engineering firm whose engineers have a long-standing knowledge of Kentucky Rock Asphalt, including its production, previous shortcomings and probable uses.

After preliminary meetings with the above noted people and discussion of the possibilities of such an experimental project with Mr. T. R. Marcum, Deputy Commissioner of Rural Highways. A project in Edmonson County (Sunfish-Independence School Road, MP 31-298A) was selected.

Mr. J. Paul Hunter, District 3 Engineer, and the district maintenance personnel were most helpful and cooperative in the construction of the experimental project. Some delays were experienced in the production of the crushed Rock Asphalt, as might be expected in a research project of this type, but the field personnel arranged their programs to provide for a minimum of interference with their normal routine maintenance.
I have inspected the project on two occasions, and although somewhat surprised at the behavior of the crushed Rock Asphalt, am very pleased with its appearance to date. I believe that the winter and spring seasons performance should be most helpful in our evaluation of the use of this material. We plan to make regular inspections of the road through both of these seasons. The district maintenance personnel are supplying us with the maintenance requirements for this section along with a regular traffic-bound limestone road selected for control purposes (Note: Fig. 3, page 11 of attached research report).

We plan to prepare a performance report following the spring inspection.

Respectfully submitted,

W. B. Drake
Director of Research
CONSTRUCTION REPORT
ON
EXPERIMENTAL USE OF NATURAL, BITUMINOUS, QUARTZ SANDSTONE (KENTUCKY ROCK ASPHALT) AS A TRAFFIC-BOUND AGGREGATE

by
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Lexington, Kentucky
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INTRODUCTION

Major deposits of natural, bituminous, quartz sandstone (Kentucky Rock Asphalt) occur in six counties of western Kentucky and a few minor deposits occur in eastern Kentucky. Crushed rock asphalt has been used extensively in Kentucky and elsewhere for over 50 years for surfacing roads.* The most productive area was in Edmonson County where the Caseyville and Bee Springs formations were quarried and mined. These deposits have been described as oil-pools which are now defunct and from which only the asphaltic residue remains. The bitumen content of the rock varies locally in a quarry or mine; and, because of this, enormous quantities of lean rock asphalt (containing up to seven percent bitumen) were wasted as tailings in obtaining material having a higher bitumen content.

Following liquidation of the assets and holdings of the Kentucky Rock Asphalt Company, 1957-58, which was then the only Kentucky producer, representatives of the W. G. Reynolds & Associates (owners or lessors of the former holdings of the Kyrock Company) agreed to a trial use of lean rock asphalt (waste material referred to above) as a traffic-bound aggregate on a reconstructed subgrade or as replacement aggregate on an existing traffic-bound road.

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In the summer of 1962, the Department negotiated a contract with the Reynolds' interests to apply crushed rock asphalt as a maintenance replacement aggregate on the reconstructed Sunfish-Independence Road (MP 31-298-A) in Edmonson County. The objective was to determine the value of the crushed, lean rock asphalt as a dust-free, traffic-bound aggregate.

MP 31-458-A, being close to the test section and being maintained with crushed limestone, was chosen for comparison with the test project. Evaluation of the test section and the comparative section was to be based upon appearance, aggregate retention, and maintenance costs. Costs of labor, equipment, and materials were to be taken from the Department's monthly maintenance reports.

As proposed, the contractor furnished and placed all materials on the road under the supervision of District 3 maintenance personnel. Part of the aggregate was placed on the project during the period beginning July 30, and extending into the first part of August. Because of difficulties at the crushing plant, completion of the project was delayed until September 8.

The material placed on the portion of the project completed during warm, dry weather consolidated readily -- the asphalt binding the aggregate into a dense, tight base. The portion put down in cool, wet weather has not bonded; however, there has been no loss or noticeable attrition of the aggregate. In summary, the materials appear to be exceptionally stable on the road; segregation of the large-size aggregate seems to be the principal concern; and the problem of dusting,
which has been so typical of traffic-bound roads, seems to have been wholly alleviated.

This report records the objectives of the project, the terms of the agreement with the Reynolds interest, the production of the material and its placement on the road, and the present condition of the road.
PROPOSAL AND SPECIAL PROVISIONS
OF CONTRACT

The following are transcribed copies of the working agreement:

PROPOSED EXPERIMENTAL USE OF
CRUSHED ROCK ASPHALT (BITUMINOUS SANDSTONE)
FOR TRAFFIC-BOUND MACADAM

The Kentucky rock asphalt industry which centered predominantly in Edmonson County left rather large quantities of quarried sandstone rock containing varying amounts of natural bitumen lying in the quarried areas. Some such rock was rejected because it was too large for crushing while other rock was adjudged to be of low bitumen content.

In keeping with the Department's continuing interest in the utilization of locally available road materials which are adjudged to be worthy of investigation, it is proposed that the above mentioned material be selected, according to two or more levels of bitumen content, and crushed to a suitable traffic-bound macadam grading for limited experimental use in the maintenance of existing traffic-bound roads in the nearby area.

The experimental use presently proposed involves the production of approximately 3500 tons of aggregate conforming to "Special Provision for Crushed Rock Asphalt (Bituminous Sandstone) Traffic-Bound Macadam" (copy attached hereto). It is proposed that this material be used for reconstruction of the Sunfish-Independence Road, KY 238, MP 31-298-A, which is an existing traffic-bound road approximately 3.55 miles in length. The project is in Edmonson County and is within approximately nine miles of an aggregate source. The stone is to be spread from dump trucks, at approximately 200 lbs. per sq. yd. (approximately 2 inches in depth). No subsequent compaction other than that which may be incidental to the hauling and spreading of the aggregate, will be required.

The terms and conditions under which the trial use of the aggregate is to be made are:
1. That approximately 1750 tons each of Type I and Type II crushed rock asphalt traffic-bound macadam be placed on the experimental project noted.

2. That the contractor crush, deliver, and spread the aggregate in accordance with the attached Special Provision...

3. That the cost per ton will not exceed the current in-place price of standard traffic-bound aggregate in the same area (estimated to be $2.65 per ton).
SPECIAL PROVISION

FOR

CRUSHED ROCK ASPHALT (BITUMINOUS SANDSTONE)
TRAFFIC-BOUND MACADAM
(Experimental)

This Special Provision shall be applicable only when indicated on plans or in the proposal and, when so indicated, shall supersede any conflicting provisions of the Department's Standard Specifications...

I. DESCRIPTION

Traffic-bound macadam aggregate as described herein shall consist of crushed rock asphalt (bituminous sandstone) sized in accordance with these provisions. It is intended to be spread uniformly on a prepared subgrade or existing traffic-bound road-bed. Spreading shall be to the width and depth set forth in proposals and (or) as otherwise directed by the Engineer. No compaction, in addition to that which may be incidental to the hauling and spreading of the crushed rock, shall be required.

II. MATERIALS

Traffic-bound aggregate shall consist of angular fragments of bituminous sandstone of uniform quality, hardness, and strength and shall be free of soft particles, shale, and dirt.

A. Classification-Type. Aggregate shall be designated according to the following classification:

Type I - Bituminous sandstone adjudged (by visual inspection) to contain 1.5 to 5 percent bitumen by ignition or extraction.

Type II - Bituminous sandstone adjudged (by visual inspection) to contain not less than 4 percent bitumen by ignition or extraction.

B. Size and Gradation. The aggregate shall conform to the following gradation, unless directed otherwise by the Engineer.
III. BASIS OF PAYMENT

The accepted materials shall be paid for at the contract unit price per ton of aggregate spread, and such payment shall be the full compensation for all incidentals thereto.
ADDITIONAL EXPERIMENTAL FEATURES

Bitumen contents of samples of rock asphalt taken by the Department from several stockpiles of waste material at the Old Indian Creek Quarry (source material for project) near Sweeden, Kentucky, indicated that the material could not be feasibly separated in the quarry into the two distinct types mentioned in the "Special Provision..." The asphalt contents of the samples averaged five percent (meeting the requirements for Type II Bituminous Sandstone), and it was decided to use the waste rock as it lay -- excluding only material of low asphalt content.

In addition to placing the crushed material on the road, the contractor volunteered to prime 1500 feet of surface on the east end of the test section with RT-2 (at the rate of 0.3 gal. per sq. yd.) before placing the bituminous sandstone. After completion of this section, the surface was to be compacted with a rubber-tired roller -- by the Department.

After several weeks, 500 feet of the new surface was to be sealed with RS-2 (at the rate of 0.05 gal. per sq. yd.) and overlaid with a spinner application of fine-graded rock asphalt (at the rate of 5.0 lbs. per sq. yd.). This additional work was to be done by the Department in conjunction with other rock-asphalt seal-coat maintenance operations in District 3.

The Department also furnished the services of a patrol grader for spreading and leveling the aggregate -- as is customary for maintenance replacement stone applications.
The Old Indian Creek Quarry near Sweeden, Kentucky, was chosen as the source of the crushed bituminous sandstone due to its nearness to the project. The waste material consists of rock asphalt ranging from sand size to rock fragments 6 feet in diameter. The asphalt content of random samples from the quarry ranged from 1.64 percent to 7.44 percent, and averaged 5.25 percent.
The production capacity of the plant was 75 tons per hour. The primary unit consisted of a 26-inch by 52-inch jaw crusher. The secondary crusher was a hammer-mill which had adjustable gratings. Any over-size product (larger than 1-1/2 inch) was scalped at the screening unit and recycled to the secondary crusher. Only the single, scalping screen was used.
LOCATION AND DESCRIPTION OF
TEST SECTION AND COMPARATIVE SECTION

Fig. 3: District 3, Edmonson County, Showing
Test Section and Comparative Section.

Test Section: (Ky. 238) MP 31-298-B
Width of Base ...... 16 feet
Type of Base ...... Traffic-bound (crushed rock asphalt)
Length of Section.. 3.27 miles

Comparative Section: (Ky. 1352) MP 31-458-A
Width of Base ...... 16 feet
Type of Base...... Traffic-bound (crushed limestone)
Length of Section.. 2.42 miles.
PRELIMINARY PREPARATION AND EVALUATION OF TEST SECTION

Prior to placement of the bituminous sandstone aggregate, the roadway and ditches were dressed and reshaped. The thickness of the existing limestone, traffic-bound base was evaluated by trenching across the roadway, from shoulder to shoulder, at 500-feet intervals. The thickness of the base varied from zero to three inches. The average thickness was 1-1/2 inches. The subgrade is composed of fine-grained sand exhibiting low plasticity. In cut sections of the road, lenses of plastic clay appear in the subgrade, and base failures may be expected at these locations particularly during wet weather.
CONSTRUCTION OF TEST SECTION

A No. 610 gradation of rock asphalt was placed on the test section (at the rate of 225 lbs. per sq. yd.). Of the 3500 tons specified in the contract, 3450 tons were placed on the project, and the remaining 50 tons were stockpiled on state facilities near Sweeden, Kentucky, and reserved for maintenance.

Construction began on July 30, 1962. After a 1-mile portion had been completed, operations were suspended due to a lack of aggregate being produced at the crushing plant. Operations were resumed on September 4, and the test section completed on September 8. Trucks were prevented from hauling over completed portions -- by beginning the construction on the west end of the project. Difficulty was encountered in placing aggregate on the road surface. Whereas No. 610 limestone aggregate is easily spread to desired depth from tailgates, the rock asphalt did not flow freely but surged from the truck beds. It was discharged by raising the truck beds as high as possible and opening the tailgates to the full length of the chain. Subsequently, a patrol grader was used to spread the aggregate to the desired width and thickness. The grader tended to segregate the coarser aggregate to the outer portions of the road. This condition was more prevalent where the aggregate was placed in a dry condition.

Fifteen hundred feet of the road on the east end of the project was primed with RT-2 at the rate of 0.3 gal. per sq. yd. before placement of the rock asphalt. After the aggregate had been graded to the required width and thickness, the surface was compacted with a rubber-tired roller.
In October, a 500-ft. section, approximately one mile from the west end of the test section, but within the portion completed in warm, dry weather, was sealed. The seal coat consisted of priming the rock asphalt surface with RS-2 at the rate of 0.05 gal. per sq. yd. and then applying a spinner-coat of sand-sized rock asphalt at the rate of 5.0 lbs. per sq. yd.

Figures 4, 5, 6 and 7 illustrate the construction of the new bituminous sandstone surface.

Fig. 4: Bituminous Sandstone being Placed on the Test Section.
Fig. 5: Spreading Bituminous Sandstone Aggregate.

Fig. 6: Compacting Portion of Test Section Primed with RT-2.
Fig. 7: Completed Portion of Test Section Near West End.
INTERIM PERFORMANCE

The 1-mile portion at the west end of the project which was completed first and which was constructed during warm, dry weather consolidated very well under traffic. Figure 8 illustrates the excellent appearance of a section where the traffic has not been extremely channelized and where only the loose, coarse, particles along the outer edges remain unconsolidated. The section shown in the background of Fig. 9 is the eastern extremity of this 1-mile portion and shows some effects of channelized traffic. No grading has been needed thus far, and the only maintenance that has been required has been limited to the patching of a few chuckholes. No base failures have appeared, and the surface seems to be completely free of dust -- which has been so prevalent on other types of traffic-bound roads.

The remaining portion of the project, which was constructed during cool, damp weather has not consolidated so well under traffic. One section of this portion is shown in the foreground of Fig. 9 and a more typical section is shown in Fig. 10. The section shown in Fig. 10 was compacted with a pneumatic roller after the material had been spread with the grader. A thin crust has formed in the wheel tracks, in Fig. 10, but the material underneath has remained damp and has not cemented together nearly as well as in the first-mile-portion. Also, the material seems to have been washed and eroded by rain more in the latter portion than it has in the first portion. It seems, from this standpoint, that any compaction that might have been gained from the pneumatic
roller was nullified by the fact that the weather was unfavorable during and after construction of the section.

The 1500-ft. section near the eastern end which was primed with RT-2 and compacted has the same general appearance as the other unprimed section placed in cool, wet weather.

The 500-ft. section near the eastern end of the portion completed during warm, dry weather which was sealed seems to be in excellent condition, and the seal seems to be water-tight.

It will be of interest to follow the performance of the road as a whole as well as the various sections therein. Thus far, it appears that the first-mile-portion of the bituminous sandstone macadam is superior to so-called traffic-bound limestone. Although the second portion has not bound together as well as the first section, it appears to be equal if not superior to traffic-bound limestone in stability and in other ways. It is dustless and is at least partially consolidated. If this section survives the winter, it is expected that the following summer season will produce some beneficial effects in respect to drying and kneading together.

Of course, any attempt to re-shape and to re-compact the portions of the road which have consolidated could nullify the advantages gained thus far. However, past experiences have indicated that crushed-rock bases which are not highly cemented tend to ravel and to develop chuckholes; and, although this kind of defect might arise from time to time, patching and filling would be preferred to cutting and filling with a grader.
Fig. 8: Portion of Test Section Constructed Near West End in Early August.

Fig. 9: Portion in Background Constructed with Dry Material in Early August. Portion in foreground constructed during cool, wet weather in September.
Fig. 10: Portion Primed with RS-2 and Compacted with a Pneumatic Roller.