



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

July 17, 1962

HENRY WARD
COMMISSIONER OF HIGHWAYS

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

B.2.2.10

MEMORANDUM

TO: A. O. Neiser
Assistant State Highway Engineer

FROM: W. B. Drake *W.B.D.*
Director of Research

SUBJECT: Processed Kentucky Rock Asphalt
Submitted for Consideration by
Mr. Holman R. Wilson

Following the April 27th meeting in Commissioner Ward's office,
attended by:

1. Commissioner Henry Ward,
2. Mr. Holman R. Wilson, The Kentucky Company,
3. Mr. C. H. McKinney, an associate of Mr. Wilson's,
4. Mr. H. V. Wheelock, Turnbull Engineers,
5. Mr. Sam J. Johnson, Jr., Consultant,
6. Mr. Damon Surgener, Kentucky Asphalt Sales,
7. Mr. P. F. Phelan, Koppers Company,
8. Mr. A. O. Neiser, Assistant State Highway Engineer,
9. Mr. J. H. Havens, Assistant Director of Research,
10. Dean D. V. Terrell, Consultant, and
11. Myself,

the Research Division has devoted considerable time and effort to the
evaluation of the processed rock asphalt. I feel that we have been quite
fortunate to have available the services of Dean D. V. Terrell, who has a

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long time knowledge of rock asphalts and of Mr. J. H. Havens, who has worked with rock asphalts for the past 12 years and has been directly responsible for major research projects conducted on these materials in both Kentucky and Indiana.

This memorandum has been prepared following numerous discussions with Messrs. Terrell, Havens and R. L. Florence, Research Engineer Associate, Head of the Bituminous Section of this Division. I believe that it represents the best conclusion that we can develop under the time and material limitations.

Mr. Florence reported the laboratory test results on a 50-lb. sample of processed rock asphalt on June 20, 1962. A copy of his memo is attached. This material was brought to the laboratory by Messrs. C. H. McKinney and L. W. Huntington and was reported by Mr. McKinney as having been processed from material taken from the Highway Department's stockpile of bituminous rock asphalt near Sweeden in Edmonson County. This material had been crushed and stockpiled for a period of over five years.

Mr. Wilson has submitted various samples of rock asphalt to the laboratory of Koppers Company, Inc. for analyses. By letter of July 10, to Mr. Wilson from Mr. P. F. Phelan, two reports dated June 18 and June 22, were made on a companion 50-lb. sample of processed rock asphalt received in the Kopper's laboratory on June 6, 1962. A copy of this letter and the reports noted are attached.

An effort was made to compare the processed rock asphalt with the natural rock asphalt and so far as we can determine the material is still rock asphalt with some of the light oil removed. The remaining asphalt appears to have a penetration of 51 which is somewhat harder than the asphalt normally used in surface courses. The process also separated the

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grains of sand each apparently coated with asphalt sufficiently hard to resist sticking together at room temperatures.

Based upon the tests that we performed on the materials as submitted, and from our previous experience with non-skid, sand-asphalt, wearing surfaces, and our knowledge of rock asphalt gained by several years of experience and considerable extended research, we can see no promise from an economic standpoint or from what we believe would be a service record in the use of this so-called processed rock asphalt.

We know very little about the proposed processing and can not judge the expected product from the widely varying existing rock asphalt deposits. We do not believe that the material as submitted can be used in high-type, hot-mix-plant bituminous surfaces. No rational proposal for incorporating the processed material into a high-type pavement has been submitted.

We are of the opinion that the processed rock asphalt as submitted by Mr. Wilson is not worthy of further experimentation or road testing and do not recommend its consideration as a material for high-type bituminous pavements.

WBD:dl

- Enc. 1. Memo. from R. L. Florence, June 20
 2. Letter from P. F. Phelan to H. R. Wilson, W/attachments, dated July 10.

W. B. Drake

June 20, 1962

June 20, 1962

MEMORANDUM

B.2.2.10

TO: W. B. Drake

Director of Research

FROM: R. L. Florence *RLF*
Research Engineer Associate

SUBJECT: Laboratory Testing of Wet-Processed Kyrock

REFERENCE: Memo from W. B. Drake, J. H. Havens,
and D. V. Terrell, to Henry Ward
Dated May 31, 1962.

The following laboratory test results were obtained on the 50-lb. sample of wet-processed Kyrock delivered to the laboratory on May 23, by Mr. Huntington.

Percent organic matter (ignition) ----- 5.5
Percent bitumen (CS₂) (centrifuge) ----- 5.4
Percent bitumen (benzene) (centrifuge) - 5.25

GRADATION OF EXTRACTED AGGREGATE

Sieve Size	Percent Passing
No. 16	100
No. 30	98.9
No. 50	73.2
No. 80	18.5
No. 100	11.9
No. 200	5.5

Tests on Recovered Bitumen (benzene extraction)
Softening Point (ring and ball) ----- 156°F.
Penetration at 77°F., 100 g., 5 sec. -- 51.0

The Marshall method of test was performed on the material as received and with added quantities of PAC-5 and RT-12. The results of this testing are shown graphically in Figures 1, 2, and 3 (attached). These data are also shown in Table 1 (attached). In order to use the sample sparingly, Marshall specimens were prepared by re-using the same material throughout each test series. This, of course, may have caused some hardening of the binders due to re-heating the specimens several times.

It is of interest to compare this material with a 20-lb.

June 20, 1962

sample of processed rock asphalt submitted by Mr. C. H. McKinney in September, 1959 (Ref: Res. Lab. File B.2.2.10, Memo dated 9-23-61). The sample submitted then had a bitumen content of 6.0% by weight. The gradation of the extracted aggregate was nearly identical to that of the present sample. The sand grains were well coated with bitumen but the material was not sticky. Due to the size of the sample, the bitumen was not recovered for determination of penetration. High void contents in Marshall specimens prepared from the material with added asphalt cement indicated the bitumen performed more-or-less as an aggregate rather than as a typical binder material. However, the bitumen was largely soluble in CS₂; but evidently it was not dissolved by or did not blend with the added asphalt cements. In other words the amount of asphalt cement needed to achieve the maximum strength was about equal to that needed by the same sand without the existing bitumen.

Whereas the earlier efforts toward processing the material (above) left the bitumen on the sand in a totally ineffective condition, the present sample appears to be much improved in this respect. At least the bitumen in the sample presently under study softens sufficiently, by heating, to permit compaction and, thereupon, to provide some cemented strength. The existing bitumen is not present in a sufficient quantity (from the standpoint of good design practices) and would therefore have to be supplemented with a significant quantity of other bitumen. Additions of soft bitumens would naturally result in a decrease of strength; whereas, additions of bitumen in the 50-pen. class would enhance the strength greatly.

In order to be able to blend the additional bitumen into this material and in order to otherwise prepare it for spreading on the road, the material would have to be heated to approximately 300°F. This fact alone presents a real deterrent and perhaps precludes any actual use of the material -- this may prove to be so because of economic considerations as well as the practical limitations on heating and mixing equipment. As you know, there would be no real interest in this material if the cost of such processing and the product therefrom exceeded the cost of ordinary sand-asphalt materials.

RLF:mkb

Attachments: Figs. 1, 2, and 3
Table 1

TEST DATA		HIGHWAY MATERIALS RESEARCH LABORATORY LEWISTON, KENTUCKY	
Opt. % Bit. _____	Unit Wt. _____	MARSHALL STABILITY TEST	
Stability No. _____	Flow _____	Mix No. _____	Date 6/20/62
% Voids Comp. Agg. _____		Project _____	_____
% Voids Comp. Mix. _____		Aggregate _____	_____
% Voids Filled With Bit. _____		Bitumen _____	_____
Chart B-3	February, 1955		

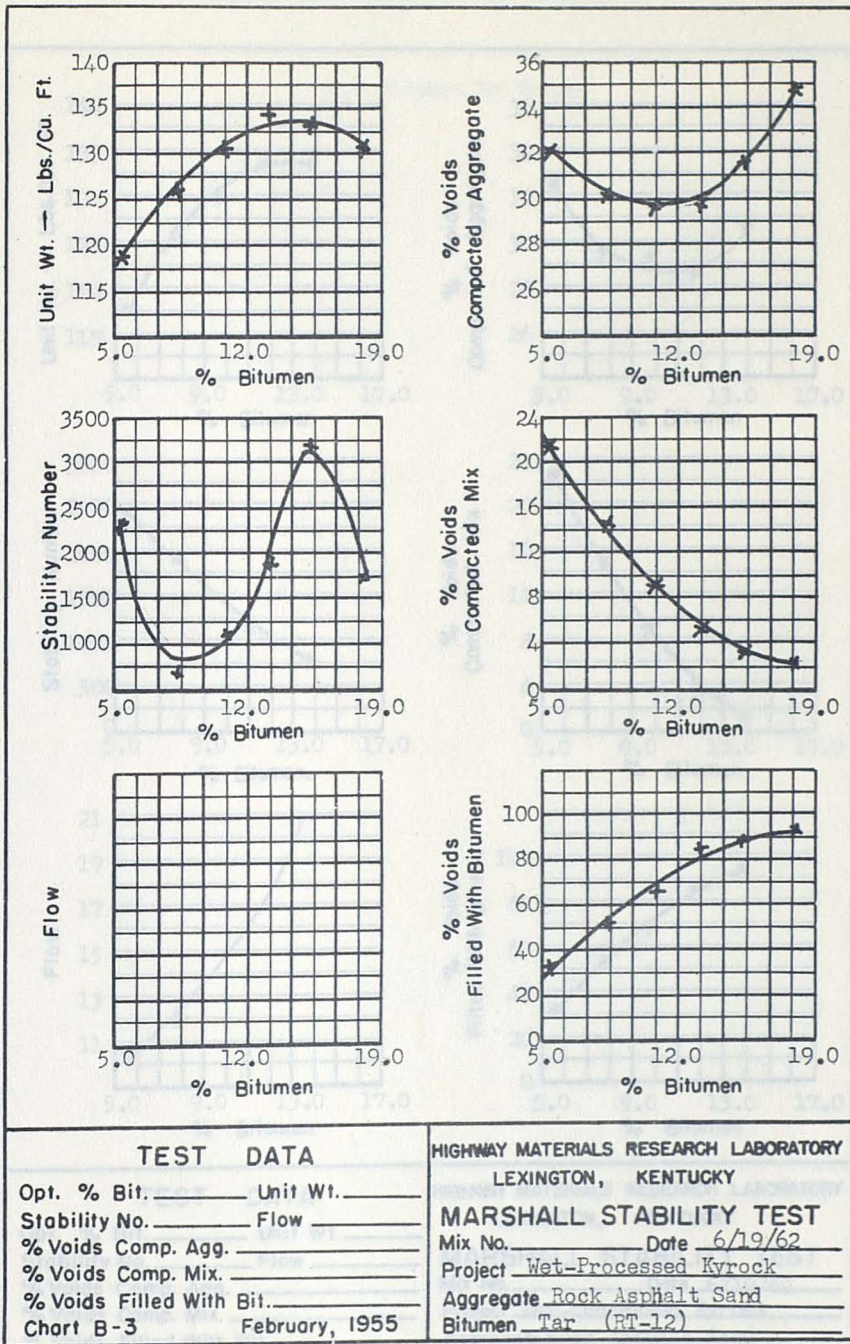


Fig. 1

COMPARATIVE MARSHALL TEST RESULTS

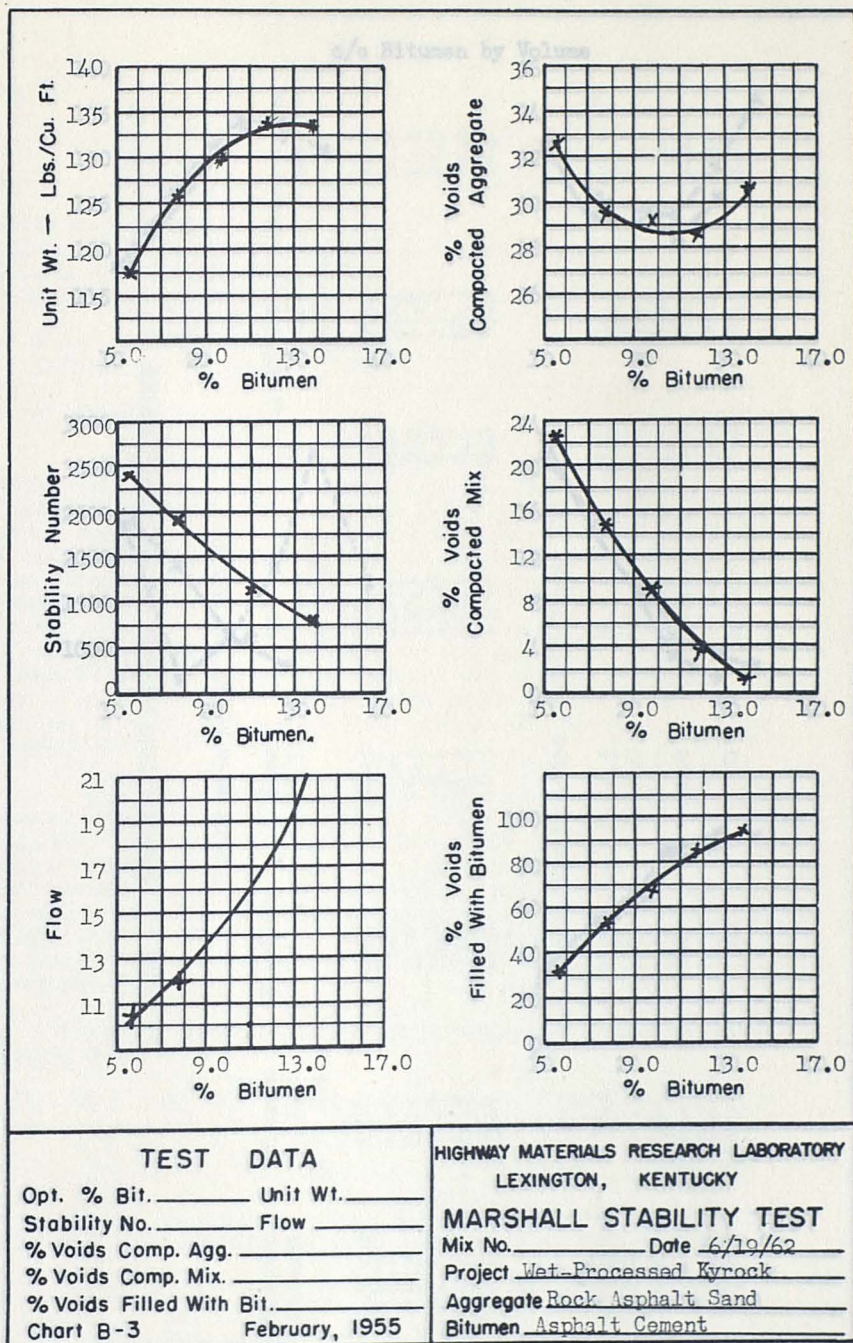
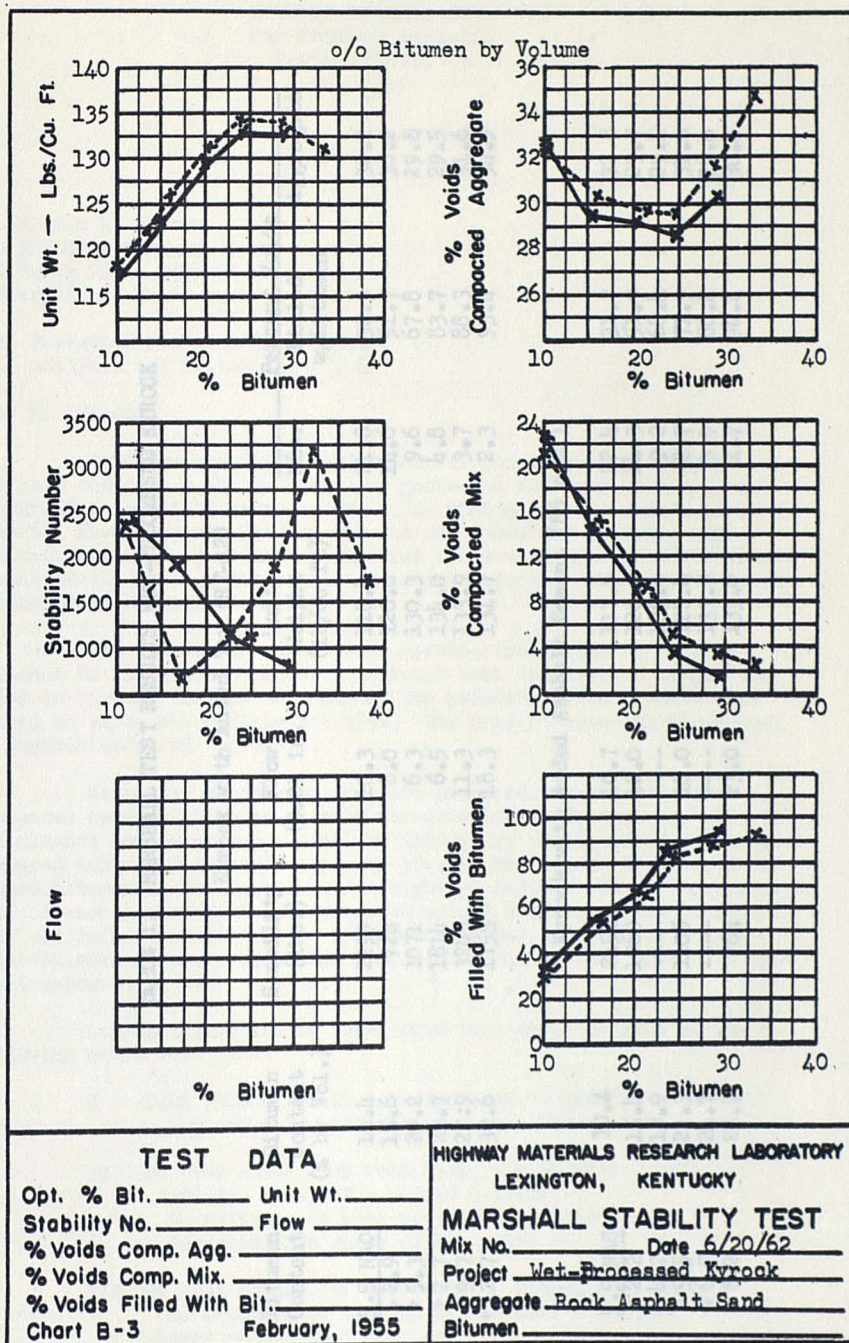


Fig. 2

COMPARATIVE MARSHALL TEST RESULTS



———— Asphalt Cement (86 Penetration)
 - - - - Tar (RT-12)

Fig. 3

206

TABLE 1. MARSHALL TEST RESULTS WET-PROCESSED KYROCK

Kyrock with Added Tar (RT-12)							
Bitumen Content	Bitumen Content (% by Vol.)	Stability (lbs.)	Flow (0.01 in.)	Unit Weight (lb/cu ft)	Percent Voids		
					Mix.	Filled w/Bitumen	Aggregate
5.5 NAC	10.4	2299	10.3	118.4	21.8	32.3	32.2
+2.9	15.6	724	8.0	126.0	14.6	51.7	30.2
+5.3	20.2	1071	6.3	130.3	9.6	67.8	29.8
+7.7	24.7	1814	6.5	134.0	4.8	83.7	29.5
+9.7	27.9	3245	11.3	133.9	3.7	88.3	31.6
+12.7	32.6	1755	18.3	131.7	2.3	93.4	34.9
Kyrock with Added Asphalt Cement (86 pen.)							
5.5 NAC	10.4	2450	10.7	117.5	22.4	31.7	32.8
+2.2	15.4	1960	12.0	126.0	14.3	51.9	29.7
+4.2	19.9	----	----	129.6	9.2	68.4	29.1
+5.5	22.3	1105	10.0	128.4	8.7	71.9	31.0
+6.2	24.7	----	----	133.8	3.9	86.4	28.6
+8.2	28.7	764	23.0	133.0	1.7	94.4	30.4

Mr. Holman R. Wilson

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July 10, 1962

KOPPERS COMPANY, INC.
Tar Products Division
Pittsburgh 19, Pa.

15 Plum Street
Verona, Penna.

July 10, 1962

Mr. Holman R. Wilson
The Kentucky Company
320 South Fifth Street
Louisville 2, Kentucky

RE: Processed Kentucky Rock Asphalt
Analysis and Evaluation - 1962

Dear Mr. Wilson:

Attached are three copies each of two laboratory reports covering tests on a 50 lb. sample of processed Kentucky rock asphalt forwarded to our laboratory by Mr. C. H. McKinney. The sample arrived June 6. These reports include results of laboratory analysis and evaluation tests - and small scale road tests - to determine the proper amount of tar to be added to the processed material to produce a satisfactory road surfacing mixture.

Mr. Wise's analytical test results are listed on Sheet I attached to his June 18 report. He found that this latest sample was lower in bitumen content than any of the processed rock asphalt furnished to us by Mr. McKinney in 1961. The present material was found to contain about 5% 'bitumen'.

Using tar binders, mixes were prepared to evaluate the processed material for use in cold mix-cold lay surfacing, and also in hot mix-hot lay surfacing. Based on laboratory tests, seven mixes were prepared and applied (at 20 lbs./sq. yd.) to one square foot areas on a worn bituminous pavement (a state highway) adjacent to our laboratory. Half of each square foot test area was primed with tar grade RT-6 and half was left unprimed. These mixes were compacted to about a 3/16 inch finished depth. Since that time it has rained only once - an all-day downpour.

During inspection of these road test areas on July 5, the following notes were made:

- I 5.8% RTCB-6 added - at room temp. - placed 6-11-62 - No evidence of wear - looks good.
- II 2% RT-2 added - at room temp. - + 3% RT-7 added - at 150°F - placed 6-11-62 - No evidence of wear on primed portion - unprimed area shows slight wear.
- III 2% RT-2 added - at room temp. - placed 6-11-62 - No evidence of wear on primed half - slight wear on unprimed portion.

July 10, 1962

- IV 2% asphalt cold mix liquifier added - at room temp. - placed 6-11-62 - Practically all worn away - primed half wearing away at slower rate.
- V 5% RT-12 added - rock asphalt and tar at 250°F - placed 6-12-62 - Slight wear on unprimed half, otherwise looks good.
- VI 5% RT-12 added - rock asph. at 350°F, tar at 250°F - placed 6-12-62 - Much evidence of wear all over, more wear on unprimed half. Quick wear probably due to overheating the tar.
- VII 8% RT-12 added - all materials at 250°F - placed 6-21-62 - Looks good - no evidence of wear.

From the above it appears that if this processed rock asphalt is to be used with tar for hot mix, about 8% tar grade RT-12 would have to be added to the processed material. This would make a total 'contained-bitumen' content of about 13%. In addition, it would be necessary to keep the temperature of any of the ingredients below 250°F. Probably 200°F would be more suitable. This assumes that a hot mix-hot lay surfacing mixture is to be produced, since it would probably be more likely to gain favor with hot mix contractors.

After three weeks under traffic, the cold mix in which about 6% RTCB-6 was added to the processed material, appears to be somewhat better than any of the other cold mixes. If this material is to be used, the temperatures of the ingredients should not exceed 125°F.

On the basis of these tests, Mr. Wise concludes that the use of tar as a binder for the processed rock asphalt improves its resistance to traffic abrasion. Further, the use of a tar 'prime' or 'tack' coat improves the adhesion of the finished surfacing to the underlying pavement. Mr. Wise also points out that "Definite conclusions about the proper amount of tar required to produce satisfactory tar - 'processed' rock asphalt hot mix cannot be established on the basis of one square foot road test sections. -----Considerably larger road tests are necessary." We concur.

At a recent meeting in New York City of the American Society for Testing and Materials, Mr. W. B. Drake and I had an opportunity to discuss our findings briefly and informally. It appeared his lab test results agreed quite well with those determined in ours. Note that we are forwarding him a copy of this letter and our laboratory reports.

If we can be of any further service, please let us know.

Attachments
CC: Mr. W. B. Drake

Very truly yours,
KOPPERS COMPANY, INC.
Tar Products Division
P. F. Phelan
P. F. Phelan
Technical Director
Road Materials

P. F. Phelan

Product Development

Product Development

June 18, 1962

Processed Kentucky Rock Asphalt

On June 6, a 50 pound sample of 'processed' rock asphalt was received at the Verona laboratory. The sample was submitted by Mr. C. H. McKinney of Frankfort, Ky. for evaluation for use with tar as a non-skid surface mixture.

As received - at room temperature - the material could be handled much like a sand. The material had some tendency to pack into lumps under its own weight, but these lumps could be readily broken up by hand into individual particles.

Various analytical tests were performed on the submitted sample and its two components - aggregate and bitumen. The results of these tests are listed on the attached Sheet I.

In addition to the analytical tests, the submitted 'processed' rock asphalt sample was used to prepare several mixes (containing tar binders) for testing under traffic. Each mix was applied (at 20 lbs./sq. yd.) to a square foot of worn bituminous pavement on a State Highway adjacent to the Verona laboratory. Half of each square foot test area was primed with RT-6, half was left unprimed. Initial compaction of each mix was obtained with a steel bar roller. Final compaction (to about 3/16") was obtained by directing a few slow-moving vehicles over each test mix immediately after placement. Then, normal traffic was allowed.

To evaluate the rock asphalt for use in hot-mixed, hot-laid bituminous paving, two mixes were prepared. Both contained 5.0% RT-12 that had been heated to 250°F. In one case, the rock asphalt was also heated to 250°F. In the other case, the rock asphalt was 'overheated' to 350°F. Each of these mixes was applied on the test road immediately after mixing, while they were still very hot.

To evaluate the rock asphalt for use in cold-mixed, cold-applied tar paving, three other mixes were prepared. In one of these 'cold mixes', 'processed' rock asphalt was mixed with 5.0% RTCB-6. Both components were at room temperature. Another mix was prepared by pre-coating the rock asphalt with 2% RT-2 (both at room temperature) and then adding 3% of RT-7 (at 150°F) to the mixture (thus bringing the total tar content of the mix to 5.0%). A third mix was prepared by mixing the rock asphalt with 2.0% RT-2 at room temperature. Each of these three mixes was applied on the test road within an hour after preparation.

To determine the advantages to be gained by using any of the aforementioned tars as a binder for the 'processed' rock asphalt, a mix was also prepared without tar. Instead, 2.0% of a standard, asphalt cold-mix liquefier was mixed with the rock asphalt to liquefy the bitumen already present in the material. This mix was placed on the test road using the same procedures that were used to place the tar mixes.

Shut 5-12
Processed Kentucky Rock Asphalt
Submitted by G. H. McKinney

Koppers Sample No. 12-875

- 2 -

Unit Weight - As Received

At present, all of the mixes have been exposed to typical summer weather and moderate traffic for about a week. Some wear is evident in the hot-mix (5.0% RT-12) made with rock asphalt that had been 'overheated' to 350°F - particularly on the unprimed half of the test patch. Some wear is also evident on the unprimed portion of the cold-mix containing only 2.0% of RT-2. The other mixes prepared with tar show no evidence of rapid wear; they are still in good condition. Both the primed and unprimed halves of the test mix prepared without tar (2.0% liquefier) are wearing away at a very rapid rate.

On the basis of the above observations, it appears that the use of tar as a binder for the 'processed' rock asphalt improves the material's resistance to traffic abrasion. It also appears that the use of tar prime beneath mixtures of the type herein described improves the mixture's adhesion to the underlying pavement. Beyond this, little more can be concluded from the road tests at this time.

Some laboratory work has been conducted to determine the optimum tar content necessary for hot-mix made with 'processed' rock asphalt. However, the data thus far collected is not indicative. Additional tests are planned. They should be completed in about a week.

% of total dry sample extracted -

by Retort - Xylol method

by Ignition at 1000°C.

4.77
4.72
3.36
A. J. Wise

Volatility Test (Shen, 326°F.)

JV % of bit. lost from mix -

Attachment % of bit. extracted by Retort

Tests on Benzol - extracted bitumen (ASTM D 762)

Penetration - 77°F., 100 gms, 5 secs.

Softening Point - R+B, °F.

Unit Weight of extracted Aggregate

lbs per cu. yd. (Gross)

4.23
21
161
2499
Koppers Company, Inc.
The Products Division
P.O. Box - Rd. 1111
6-62 A. J. Wise

PROCESSED KENTUCKY ROCK ASPHALT
Submitted by C. H. MCKINNEY

Koppers Sample No. 62-895

TO: UNIT WEIGHT - AS RECEIVED Location: Development Department
lbs./cu. yd. (loose) Date: June 22, 1952 2036

BALL-MILL STRIPPING TEST File: 0
% STRIPPED

EXTRACTION TEST
Grad. of extracted Agg. At the time, tests were underway to determine the tar content of various amounts of RT-12 (0% through 12%) were determined using a modified version of ASTM Method D 915. The mixtures were prepared by heating the two components (RT-12 and rock asphalt) to 235°F and thoroughly mixing them together with a spatula. After aging the mixture in an oven at 235°F and compacted as specified in ASTM Method D 915, Section 10, with the specimen was removed from the oven and extracted according to ASTM Method D 915, Section 10, with the test specimens. The amount of bit. (in lbs.) required to cause failure was recorded.

% Passing	
No. 20	100
" 40	95
" 80	21
" 200	6

% of Total dry Sample Extracted -	
by Rotarex-Xylol method	4.73
	4.76
by Ignition at 1000°C.	5.31
	5.36

Volatility Test (5 hrs., 325°F.)
% of bit. lost from mix -
(based on % of bit. extracted by Rotarex) 4.23

TESTS ON BENZOL-EXTRACTED BITUMEN (ASTM D 762)
PENETRATION - 77°F., 100gms., 5 secs. 21

SOFTENING POINT - R+B, °F. 161

UNIT WEIGHT OF EXTRACTED AGGREGATE
lbs./cu. yd. (loose) 2479

Koppers Company, Inc.
Tar Products Division,
Prod. Dev. - Rd. Mat'l's
6-62 A. J. Wise

Inter-Office Correspondence
KOPPERS COMPANY, INC.

TO: Each of the three aforementioned FROM: Determining stability
indicated that maximum stability of 'processed' rock asphalt
Mr. P. F. Phelan Location Development Department
Location Development Department Date June 22, 1962
Subject Processed Kentucky Rock Asphalt File

In a letter dated June 18 (on the above subject) we reported the laboratory analysis of a 50 lb. sample of 'processed' rock asphalt received from Mr. C. H. McKinney on June 6. At the time, tests were underway to determine the tar content necessary to achieve maximum stability in hot-mix made with the 'processed' rock asphalt.

The tests have now been completed. Three methods of determining stability were used. In one case, stabilities of tar-'processed' rock asphalt mixtures containing various amounts of RT-12 (0% through 12%) were determined using a 'modified' version of ASTM Method D 915. The mixtures were prepared by heating the two components (RT-12 and rock asphalt) to 235°F and thoroughly mixing them at that temperature with a spatula. After aging the mixture in an oven overnight at 140°F, they were cooled to 125°F and compacted as specified in ASTM Method D 915, Section 7. The compacted specimens were then placed in an oven maintained at 140°F. After one hour each specimen was removed from the oven and extruded according to ASTM Method D 915, Section 10, with the exception that the specimens had not been previously subjected to the water absorption test specified therein. The amount of load (in lbs.) required to cause failure of the specimens was recorded.

The second method of determining the stabilities of mixtures containing from 0% to 12% RT-12 was with a pocket soil penetrometer (Soiltest Model CL-700). In this test, compacted specimens that had been extruded by the preceding method (the 'modified' ASTM Method D 915) were brought to a constant temperature of 130°F. The penetrometer was then inserted into the center of each specimen. The amount of load (in tons/sq. ft.) necessary to force the penetrometer needle 1/4" into each specimen was recorded.

The third method of determining the stabilities of mixtures containing from 7% to 10% RT-12 was by a modification of Koppers standard stability test for the evaluation of road tars. Mixtures were prepared and aged in the manner first herein described. After aging overnight at 140°F, 15 gram portions of each mix were weighed into cylindrical, 1" i.d., molds. These were held in an oven at 130°F for one hour, compacted at 3300 psi for 30 seconds, and then returned to the 130°F oven for an hour. Specimens thus prepared were tested in a Koppers Shear Tester (Modified Hubbard Field Type). A Marshall Method compression testing machine was used to apply load to the Shear Tester. The amount of load required to cause failure - as indicated by the Marshall load-measuring dial - was recorded.

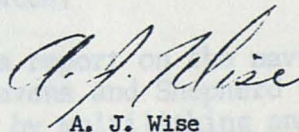
Each of the three aforementioned methods of determining stability indicated that maximum stability of 'processed' rock asphalt is obtained by adding 8% tar grade RT-12 (by weight of total mix) to the material.

A lab mix containing 8% RT-12 (and 92% 'processed' rock asphalt) was prepared to determine its ability to withstand traffic. Both components were heated to 250°F just prior to mixing. Immediately after mixing, while still hot, the mix was applied (at 20 lbs./sq. yd.) to a square foot of worn bituminous pavement on a State Highway adjacent to the Verona laboratory. Half of the square foot test area was primed with RT-6, half was left unprimed. Initial compaction of the mix was obtained with a steel bar roller. Final compaction (to about 3/16") was obtained by rolling the mix with an automobile immediately after placement. Traffic was then immediately allowed to use the test area in normal fashion.

At present, the mix has been in place under traffic for one day. It appears to be in good condition; no deterioration under traffic is evident.

The tests and observations herein reported, and those reported in our June 18 letter, indicate that the use of tar as a binder for the processed rock asphalt improves the material's resistance to traffic abrasion. They further indicate that while 8% tar is required to achieve maximum stability in lab-prepared hot-mix, hot-mix containing less than 8% tar may perform satisfactorily in service, perhaps by using a tar prime to bond the mixture to the underlying surface.

Definite conclusions about the proper amount of tar required to produce satisfactory tar-'processed' rock asphalt hot-mix cannot be established on the basis of one square foot road-test sections. Some problems (such as 'shoving' or 'rutting'), that could arise with too-rich or too-lean mixtures of the types under consideration, are not likely to occur in such small areas of mix. Considerably larger road-tests are necessary. Unfortunately, we are unable to conduct these larger road-tests; the sample of 'processed' rock asphalt submitted to us was quite small and most of it has already been used to conduct the tests reported herein and in our letter of June 18. We do, however, plan to keep the square foot road-tests under observation for further indications of relative performance.


A. J. Wise

jv

WBD:dl
Atts,

cc: A. O. Neises
J. A. Bittman
H. T. Bell