COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY 40601

CHARLES PRYOR, JR.
COMMISSIONER OF HIGHWAYS

December 4, 1972

ADDRESS REPLY TO:
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
533 SOUTH LIMESTONE STREET
LEXINGTON, KENTUCKY 40508
TELEPHONE 606-254-4475

H.3.15

MEMORANDUM TO: J. R. Harbison
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report 346; "Tar Concrete Pavement Construction and Performance;" KYP-68-15, HPR-1(8), Part III.

The report enclosed finalizes the history of an experimental, tar concrete pavement. The pavement carried very heavy truck loads; severe wheel-track rutting developed; and the entire section was overlaid with asphaltic concrete. The tar concrete was laid in late 1969; the overlay was placed in early 1972.

The items of special interest in this report are the comparative rut-depth measurements. The asphaltic concrete sections have also rutted significantly.

Rutting is being observed on our highest-type flexible pavements; significant wear has been observed on PCC pavements (I 75 in the Covington area and I 64 in the Louisville area). Rutting affects steering control and causes hydroplaning. We have begun a new study (KYHPR-72-72) of the rutting phenomenon in flexible pavements. In our recent studies on flexible pavement design criteria, rutting was not found to be "preventable" -- but was proportionalized so that it would diminish with increasing design traffic.

No further work is scheduled in connection with the Ky 15 project; however, rutting measurements will likely be made in connection with KYHPR-72-72.

Respectfully submitted,

Jas. H. Havens

Jas. H. Havens
Director of Research

JHH:dw
Attachment
cc's: Research Committee

Research Report
346

TAR CONCRETE PAVEMENT CONSTRUCTION AND PERFORMANCE

Final Report on Experimental Project
KY 15, APD 102 (64) and APD 102 (65)
Perry - Knott Counties

KYP-15, HPR-1(8); Part III

by

Jerry G. Rose
Former Research Engineer

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

December 1972

INTRODUCTION

In 1969, a 6.6-mile section of relocated KY 15 in Perry and Knott Counties was paved utilizing coal-tar (RT-12) concrete base and surface. This project was authorized under the Appalachian Regional Development Act of 1965 and was designated as experimental as a means of implementing a section of the Act.

Two nearby sections of KY 15, containing asphalt (PAC-5) concrete base and surface, were designated as control sections and used for comparison purposes. With the exception of the bituminous material, the experimental and control sections were purposefully made equal in all other respects. A design soil CBR of 9 was used throughout, and the EWL's were estimated at 40-80 million. Total thickness for each section was 17.5 inches (11 inches DGA base and 6.5 inches bituminous concrete). The coal-tar binder was substituted for the asphalt cement on the basis of equal volume. A project map is shown in Figure 1.

A previous report* contains the special provision for the coal-tar concrete, surveillance of the construction, laboratory evaluation of the paving materials, and analysis of the comparative performance of the experimental and control sections through June 1971. The purposes of this report are to compare the performances of the sections since June 1971 and to document resurfacing of the coal-tar concrete section.

PERFORMANCE SURVEYS

Performance surveys, subsequent to the interim report, were made during June 1971, April 1972, and May 1972. These surveys consisted of wheel-track rutting measurements and visual observations.

June 1971

On June 29th, a series of wheel-track rutting measurements was taken on the three sections. An average of two locations per mile was tested; measurements were taken in each wheel track. The locations were precisely those used for a previous series of measurements during April 1971. A ten-foot long, metal straightedge was used to span the rut; and the maximum depth was measured with a ruler.

Table 1 contains average wheel-track rutting data for each section; Table 2 contains data for each location.

During the 2 1/2 month interval following the April measurements, the average rut depth in the outside lanes on the tar sections increased by 0.04 inch. Surface cracking did not appear to be increasing; however, the areas of severe rutting did have a significant effect on the driveability of an automobile, and the tar concrete was quite soft during hot, sunny weather. The rut depths on the asphalt control sections (C-1 and C-2) remained essentially the same when compared to the previous measurements.

April and May 1972

A decision was made during July 1971 to resurface the coal-tar section. The contract was let in March 1972.

An attempt was made in mid-April, just prior to the beginning of resurfacing, to remeasure rut depths on the coal-tar section. Many of the locations of previous measurements had been patched and leveled by maintenance forces during the fall and winter. Only those locations, previously measured, which could be found and which contained no patch material, were measured. These limited data are contained in Table 3.

During May, rut depths on the two control sections were taken. These data are shown in Table 4. Average

TABLE 1

AVERAGE WHEEL-TRACK RUTTING DATA
JUNE 1971

	RUTTING DEPTHS (inches)	
SECTION	OUTSIDE OR PASSING LANES*	INSIDE LANES*
C-1	0.22	0.11
TAR	0.61	0.16
C-2	0.15	0.09

*Average for both wheel tracks in both directions.

NOTE: Inside lanes occur only on four-lane or passing sections.

*Newberry, D. C. and Rose, J. G., *Hot-Mix Coal-Tar Concrete Pavement (Construction and Interim Performance),* Research Report 309, Kentucky Department of Highways, June 1971.

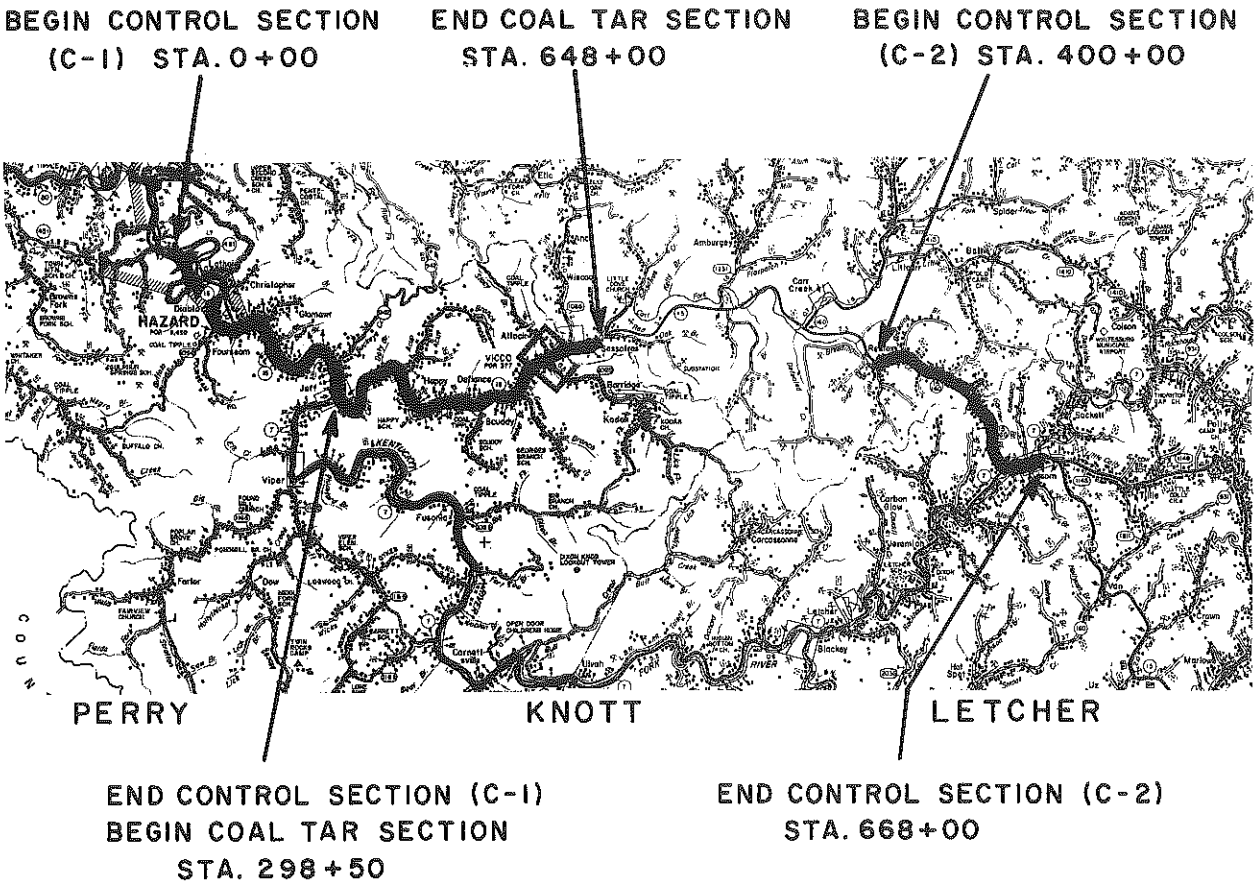


Figure 1. **Project Map, KY 15, Perry-Knott-Letcher Counties.**

wheel-track rutting data for each section are given in Table 5. Average rut depths in the outside lanes increased by about 0.05 inch during the 11-month time interval.

Summary of Wheel-Track Rutting Measurements

Table 6 contains a summary of average wheel-track rutting depths for each series of measurements on each section. As pointed out in the earlier report, average rut depth on the tar section was about three times deeper than that of the control sections in the outside or passing lane. Rut depths in the inside lanes were much less; there the tar section had about 50 percent greater rut depths than the control sections.

CORRECTIVE MEASURES

During fall and winter 1971-72, a maintenance crew applied approximately 1500 tons of asphaltic concrete leveling material on the coal-tar section. If that material had been spread evenly over the roadway, an average depth of 1/4 inch would have been obtained. It should be pointed out, however, that most of the patching material was confined to the wheel tracks. A somewhat greater thickness existed in the wheel tracks.

The contract for resurfacing the coal-tar section was awarded to the Adams Construction Corporation and work began on April 19, 1972. Resurfacing was necessary because of the excessive and continued rutting in the wheel tracks and the extreme roughness of the surface. The greater sensitivity of the tar to summer temperatures -- together with very heavy wheel loads -- were believed responsible for greater rutting occurring in the tar surface than in the asphalt surfaces.

Overlay thickness requirements were determined using the 1967 AASHO design procedure for upgrading existing interstate pavements to a 20-year design. Load-carrying capability of the tar concrete was estimated on the basis of relative rut-depth measurements on the tar and adjoining asphalt sections. The relative strength of the tar concrete was then weighted somewhat higher inasmuch as the asphaltic concrete overlay would provide a temperature-insulation layer and thereby reduce the temperature in the tar concrete -- resulting in greater stiffness of the tar concrete.

Calculations indicated that leveling of the existing surface, together with a 4.5-inch insulating overlay of asphalt concrete, should restore the pavement to the original 20-year design and thus to normal service capabilities. It was decided, however, to use only a 2.5-inch insulating overlay (plus 0.5-inch allowance for leveling) -- thereby deferring the remaining 2 inches until a more definite need became evident.

The contractor used 4611 tons of asphaltic concrete for leveling and wedging. This was an average of 760 tons per mile and was equivalent to 3/4-inch average depth over the entire surface. Actual depth of material in the wheel-track ruts was much greater than between the wheel tracks.

Excluding a new passing lane constructed between Stations 403+15.5 and 415+15.5 and new construction between Stations 505+00 and 525+00 (due to railroad track relocation), the following were used on the mainline resurfacing:

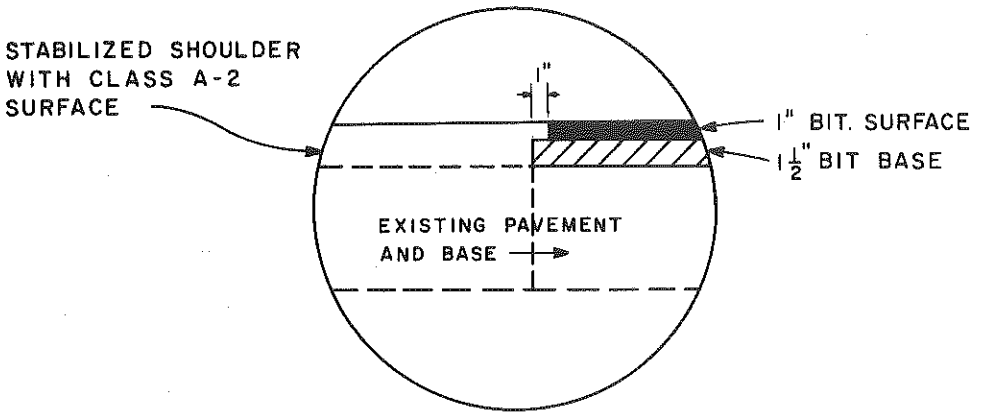
1 1/2-inches thickness of Class I Binder, containing DGA limestone aggregate and 4.7 percent AC-10 asphalt cement. Design results at optimum were: 153.2 pcf unit weight, 2400 lbs Marshall stability, 0.18 in flow, 1.2 percent voids in mix, and 2.488 maximum specific gravity.

1-inch thickness of Class I, Type A Surface, containing 40 percent No. 8 limestone, 42 percent natural sand, 15 percent limestone sand, 3 percent mineral filler and 5.4 percent AC-10 asphalt cement. Design results at optimum were: 148.7 pcf unit weight, 1900 lbs Marshall stability, 0.12 in flow, 2.3 percent voids in mix, and 2.443 maximum specific gravity.

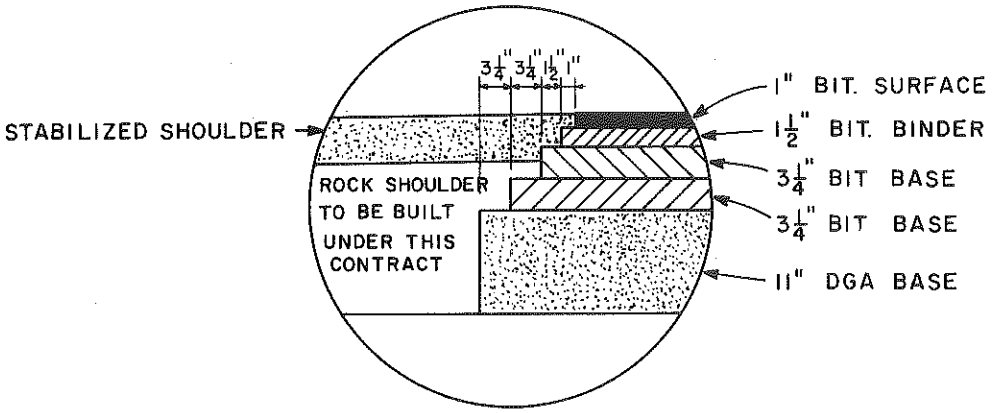
Elevation views of the resurfacing and new construction sections are shown in Figure 2. The newly constructed sections required a DGA base and two bituminous concrete bases. The lower bituminous base contained 5.2 percent AC-10 asphalt cement and the upper contained 4.7 percent.

Class A-2 surface was used on shoulders. Three lifts, each containing crushed limestone aggregate and RT-9 road tar, were placed after all mainline resurfacing was finished.

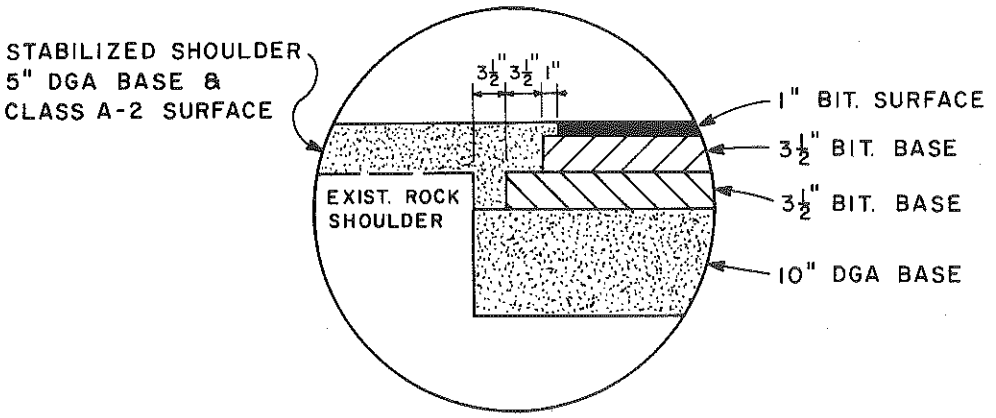
The project was completed on July 14, 1972. A cursory inspection on July 18 indicated a smooth riding surface.



SECTION USED FOR RESURFACING OVER
EXISTING COAL-TAR CONCRETE SECTION



SECTION USED FOR PAVING NEW
PASSING-LANE SECTION



SECTION USED FOR PAVING NEW
CONSTRUCTION SECTION

Figure 2. **Typical Sections.**

TABLE 2

RUTTING MEASUREMENTS, JUNE 1971

			RUTTING MEASUREMENTS (1/16's of an inch)							
			NORTHBOUND LANES				SOUTHBOUND LANES			
			OUTSIDE LANE		INSIDE LANE		INSIDE LANE		OUTSIDE LANE	
SECTION	COUNTY	LOCATION	OUTER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	OUTER TRACK
C-1	PERRY	0.3[a]	2	3			2	3	4	5
		0.9	3	3	2	0	2	2	2	3
		1.1	2	4	3	0	1	1	3	2
		1.5	2	3	2	0	0	0	2	2
		2.0	5	9	1	6	3	0	4	2
		2.3	1	4	4	0	0	3	6	2
		3.5	3	4	0	4	2	0	7	2
		3.9	4	5	3	0	4	3	5	3
		4.5	2	3	2	4	0	4	4	4
		4.8	4	5	0	4	0	0	4	2
		5.1	2	7	3	0	3	0	5	1
		Averages	2.73	4.55	2.00	1.80	1.55	1.45	4.18	2.55
TAR	PERRY-KNOTT	0.3[b]	5	6					5	5
		0.8	9	10					7	11
		0.9	6	4					6	10
		1.6	6	8	3	2	4	4	7	10
		1.9	11	6	1	4	2	3	14	15
		2.1	4	6					16	9
		3.1	4	4					8	10
		3.2	6	6					4	6
		4.0	10	21					14	12
		4.9	25	16					14	9
		5.2	8	7					7	8
		5.5	12	14					13	8
		6.2	3	4	0	1			8	6
		6.5	37	33					10	7
		Averages	10.43	10.36	1.33	2.33	3.00	3.50	9.50	9.00
C-2	KNOTT-LETCHER	0.4[c]	2	7	0	3	3	0	6	1
		1.1	1	0	1	3	4	0	3	1
		1.5	3	4			0	0	2	3
		1.7	0	3			0	2	1	0
		2.1	2	4			0	1	0	0
		2.4	2	4	2	1	3	0	3	2
		3.0	2	2	3	0			1	3
		3.4	3	4	0	0			0	4
		4.2	0	6	2	3	4	1	1	2
		4.6	2	6					3	2
		Averages	1.70	4.00	1.33	1.67	2.00	0.57	2.00	1.80

[a]Miles from beginning of project at Hazard

[b]Miles from beginning of project at Jeff

[c]Miles from beginning of project at Red Fox

TABLE 3

RUTTING MEASUREMENTS, APRIL 1972

			RUTTING MEASUREMENTS (1/16's of an inch)							
			NORTHBOUND LANES				SOUTHBOUND LANES			
			OUTSIDE LANE		INSIDE LANE		INSIDE LANE		OUTSIDE LANE	
SECTION	COUNTY	LOCATION	OUTER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	OUTER TRACK
TAR	PERRY-KNOTT	0.3[a]	11	4						
		1.6	12	12	7	6	4	6	12	14
		3.1	7	7						
		Averages	10.00	7.67	7.00	6.00	4.00	6.00	12.00	14.00

[a]Miles from beginning of project at Jeff

TABLE 4

RUTTING MEASUREMENTS, MAY 1972

			RUTTING MEASUREMENTS (1/16's of an inch)							
			NORTHBOUND LANES				SOUTHBOUND LANES			
			OUTSIDE LANE		INSIDE LANE		INSIDE LANE		OUTSIDE LANE	
SECTION	COUNTY	LOCATION	OUTER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	INNER TRACK	OUTER TRACK	INNER TRACK	OUTER TRACK
C-1	PERRY	0.3[a]	3	4			0	2	5	9
		0.9	4	4	3	2	2	3	4	5
		1.1	3	4	1	2	1	1	5	4
		1.5	3	3	1	0	1	1	3	2
		2.0	6	8	1	4	2	0	4	2
		2.3	2	4	3	0	1	1	8	2
		3.5	3	4	0	4	2	1	8	2
		3.9	4	5	2	1	4	2	5	4
		4.5	3	3	2	5	1	2	4	4
		4.8	3	6	1	4	1	1	4	3
		5.1	3	5	3	0	3	1	7	3
		Averages	3.36	4.54	1.70	2.20	1.64	1.36	5.18	3.64
C-2	KNOTT-LETCHER	0.4[b]	4	4	1	3	3	1	5	2
		1.1	2	2	0	3	4	0	3	1
		1.5	3	5			0	0	2	4
		1.7	3	5			1	0	2	2
		2.1	3	4			1	1	1	2
		2.4	2	4	2	2	2	2	6	5
		3.0	2	3	4	0			3	5
		3.4	4	5	0	0			2	6
		4.2	1	6	3	2	3	0	1	3
		4.6	3	7					4	4
		Averages	2.70	4.50	1.67	1.67	2.00	0.57	2.90	3.40

[a]Miles from beginning of project at Hazard

[b]Miles from beginning of project at Red Fox

TABLE 5

AVERAGE WHEEL-TRACK RUTTING DATA
MAY 1972

SECTION NUMBER	RUTTING DEPTHS (inches) OUTSIDE OR PASSING LANES*	INSIDE LANES*
C-1	0.26	0.11
TAR**	0.68**	0.36**
C-2	0.21	0.09

*Average for both wheel tracks in both directions.
**Based on limited number of measurements as given in Table 3.
NOTE: Inside lanes only occur on four-lane or passing sections.

TABLE 6

AVERAGE WHEEL-TRACK RUTTING DATA
(APRIL 1971 - MAY 1972)

SECTION	RUTTING DEPTHS (inches) OUTSIDE OR PASSING LANES*				INSIDE LANES*			
NUMBER	April 1971	June 1971	April 1972	May 1972	April 1971	June 1971	April 1972	May 1972
C-1 Hazard to Jeff	0.22	0.22		0.26	0.09	0.11		0.11
TAR Jeff to Red Oak Branch	0.57	0.61	0.68**		0.15	0.16	0.36**	
C-2 Red Fox to Isom	0.14	0.15		0.21	0.10	0.09		0.09

* Averages for both wheel tracks in both directions.
** Based on limited number of measurements.
NOTE: Inside lanes only occur of four-lane or passing sections.