USE OF CARBON BLACK IN BITUMINOUS CONCRETE IN VIRGINIA

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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SUMMARY

In an attempt to verify the claim that the addition of carbon black to bituminous concrete increases its stability and performance, a test section placed on a deformed bridge deck surface near Altavista and one on Route 360 near Richmond are being evaluated.

Marshall tests on samples of the mixtures taken at the time of placement indicated an increase of stability in the experimental mix on only one of the test sections. After 14 months, the mix on the bridge deck is performing satisfactorily with no discernible distortion. It will probably be several years before the performance of the test sections can be used to assess the desirability of using carbon black.

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INTRODUCTION

Certain highway situations necessitate the use of an unusually stable mix to prevent detrimental deformation of the pavement such as rutting and shoving. Often the stability of the mix can be increased by changing the gradation or grade of asphalt cement, and there are additives that are supposed to increase the stability. Sometimes, however, the first two options are not practical, and the use of an additive appears to be an acceptable alternative.

This report describes the installation and performance of two test sections of bituminous concrete containing carbon black as an additive. This additive, Microfil 8, is a combination of very fine carbon black (0.1 μm to 0.2 μm particle size) and fluxing oil, and is manufactured by the Cabot Corporation. It functions as a microfiller that reinforces the 5 μm to 10 μm asphalt films.* The claimed benefit is improved temperature susceptibility, which results in stiffer mixes at high temperatures and more flexible mixes at low temperatures.

The two experimental installations are discussed separately.

BRIDGE DECK SURFACE AT ALTAVISTA

Installation

The bituminous concrete surface on the deck of the Route 29 bridge over the Roanoke River near Altavista had undergone deformation resulting in complaints from the traveling public.

*"MICROFIL Reinforcing Agents for Asphalt", Special Blacks Technical Service Report S-35, Cabot Corporation.

The location is on a grade and is subjected to stop and start traffic. The surface displayed pushing and shoving, and maximum rut depths of 0.5 in. were measured in the wheel paths. The surface on the north end of the bridge was in worse condition than that on the south end. Although it would have been desirable to remove the deformed surface, it was feared that an epoxy seal coat beneath it would be disturbed; therefore, the new surface was placed directly on the old one.

The experimental mixes were placed August 27, 1979, starting at 8:00 a. m. (ambient temperature - 75°F) and finishing at 12:00 noon (ambient temperature - 85°F). A scratch course of 85 lb /yd ^{2} was applied prior to the final 100 lb /yd ^{2} of surface mix in an attempt to obtain a smooth surface. One truck load of control mix without carbon black was placed on the south end of the bridge (see Figure 1) for comparison.

The source of materials and batch weights are listed in Table 1. The carbon black was added to the pugmill in 25-lb plastic bags and mixed dry with the stone for 7 seconds, and then the asphalt cement was added and wet mixed for 30 seconds. It was thought that some of the carbon black might have been removed by the dust collector system during the dry mixing. The designed mix gradation and extraction results are listed in Table 2.

Samples of the mix were taken from the truck, carried to the lab, reheated, and compacted into Marshall specimens using a 50-blow compactive effort. The results of the Marshall tests appear in Table 3, where it can be seen that there was no significant difference in the Marshall stability between the mixes. The control mix was below the minimum specified value of 3% for voids total mix (VTM). Cores were not taken so that the epoxy seal coat would not be disturbed.

The carbon black manufacturer's representatives indicated that the mix containing carbon black should have been darker than the control mix; however, this was not so.

Performance

The experimental mix appears to be performing satisfactorily, with no discernible distortion. The average depth of ruts in the wheel paths at approximately 14 months was minor (0.10 in.). There was no significant difference in the rut depths of the carbon black and control sections, which might reflect the high stabilities of both mixes (Table 3).

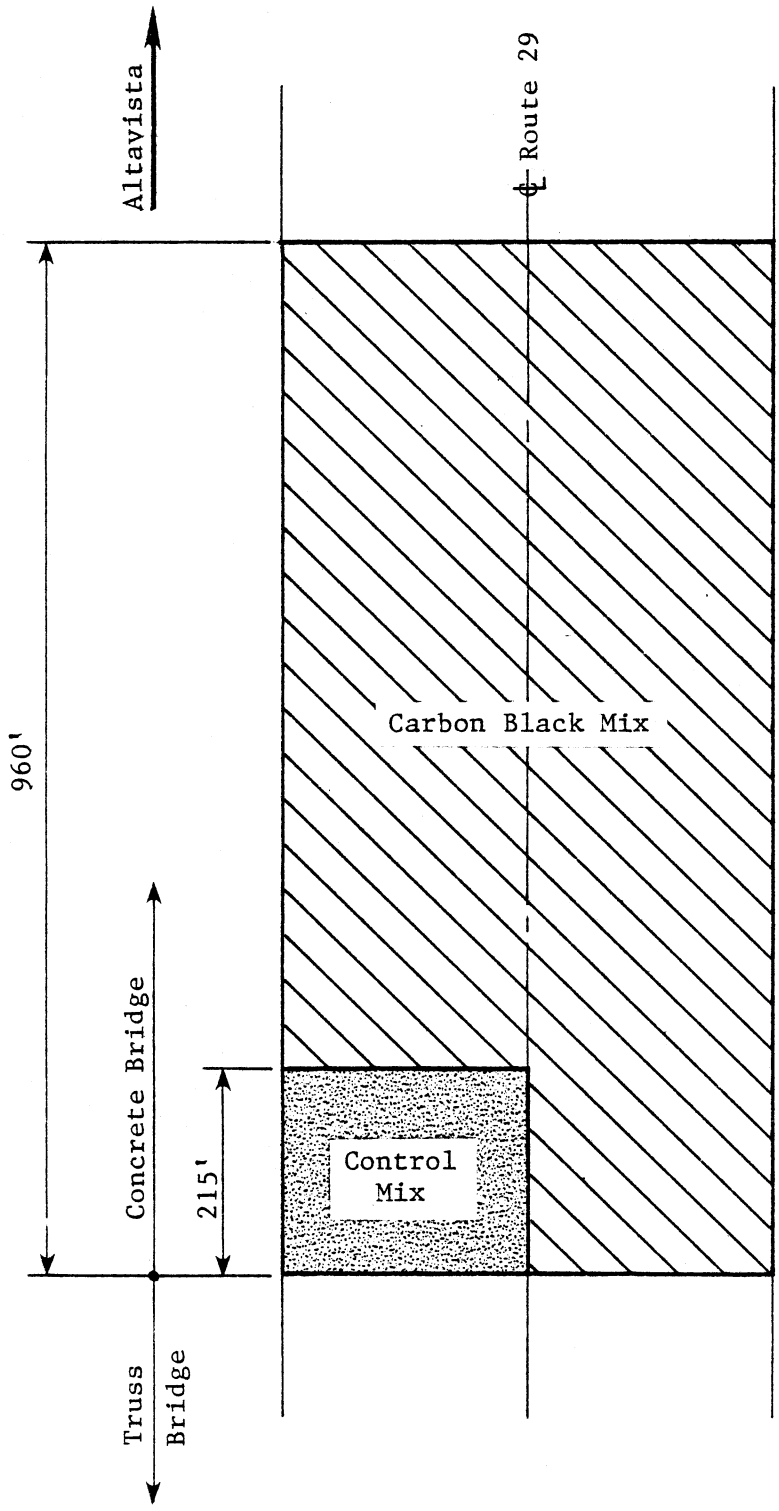

Figure 1. Test section on Roanoke River bridge.

Table 1. Source of Materials and Batch Weights
Route 29 Bridge Deck, Altavista

	Sources
50% #8 crushed stone	- Blue Ridge Stone, Lynchburg, Va.
30% #10 crushed stone	- Blue Ridge Stone, Lynchburg, Va.
20% local sand	- Staunton River
AC-20 Chevron asphalt	- Richmond, Va.
Carbon black (Microfil 8)	- Cabot Corp., Billerica, Mass.

	Batch Weights, lb	
	Control Mix	Carbon Black Mix
Stone and sand	4,725	4,705
Asphalt	275	245
Microfil 8		50

Table 2. Gradation in Percent Passing
Route 29 Bridge Deck, Altavista

Sieve Size and Asphalt Content	Mix Design	Extractions	
		Control Mix	Carbon Black Mix
1/2	100	100	100
3/8	53-63	63	66
30	15-23	21	22
50		14	14
200	3.5-6.5	6.8	5.8
Asphalt content, %	5.5	5.7	5.3

Table 3. Results of Marshall Tests — Route 29 Bridge Deck

Mix	Stability, lb	Voids Total Mix, %	Voids Filled with Asphalt, %	Voids in Mineral Aggr., %	Flow, 0.01 in.
Carbon black	2,910	3.1	80.6	15.8	12
Control	2,820	1.8	88.5	15.3	11
Va. Specs.	1,450 Min.	3-6	65-85	14.8 Min.	8-18

ROUTE 360 - CHESTERFIELD COUNTY

Installation

Approximately 215 tons of surface mix containing carbon black was applied at the rate of 135 lb /yd ^{2} to the eastbound traffic lane of Route 360 in Chesterfield County (Figure 2) on September 3, 1980. The old surface was not deformed; however, there was moderate cracking and general deterioration that necessitated resurfacing. The mix containing carbon black was placed in the traffic lane and the control mix was placed in the passing lane. The weather was clear with a high temperature of approximately 90°F.

The sources of materials and batch weights are listed in Table 4. The designed mix gradation and extraction results for samples taken from trucks are listed in Table 5.

The carbon black was added to the pugmill in 25-lb plastic bags at the rate of 25 lb /ton. The bags had to be broken after partial introduction into the pugmill, because the passageway was too small to allow the entry of a full bag. Adding 4 bags to each batch required approximately 2 minutes of dry mixing time. The suction on the dust collector system had been eliminated in the pugmill; however, some carbon black was observed to be lost during mixing.

The results of Marshall tests on samples taken from the truck and compacted in the lab (50 blows) are presented in Table 6. The Marshall stability of the carbon black mix was approximately 125% that of the control mix. The VTM of the control mix was below the minimum specified value of 3%. Cores removed several days after construction yielded 5.0% VTM in the control section and 5.8% in the carbon black section.

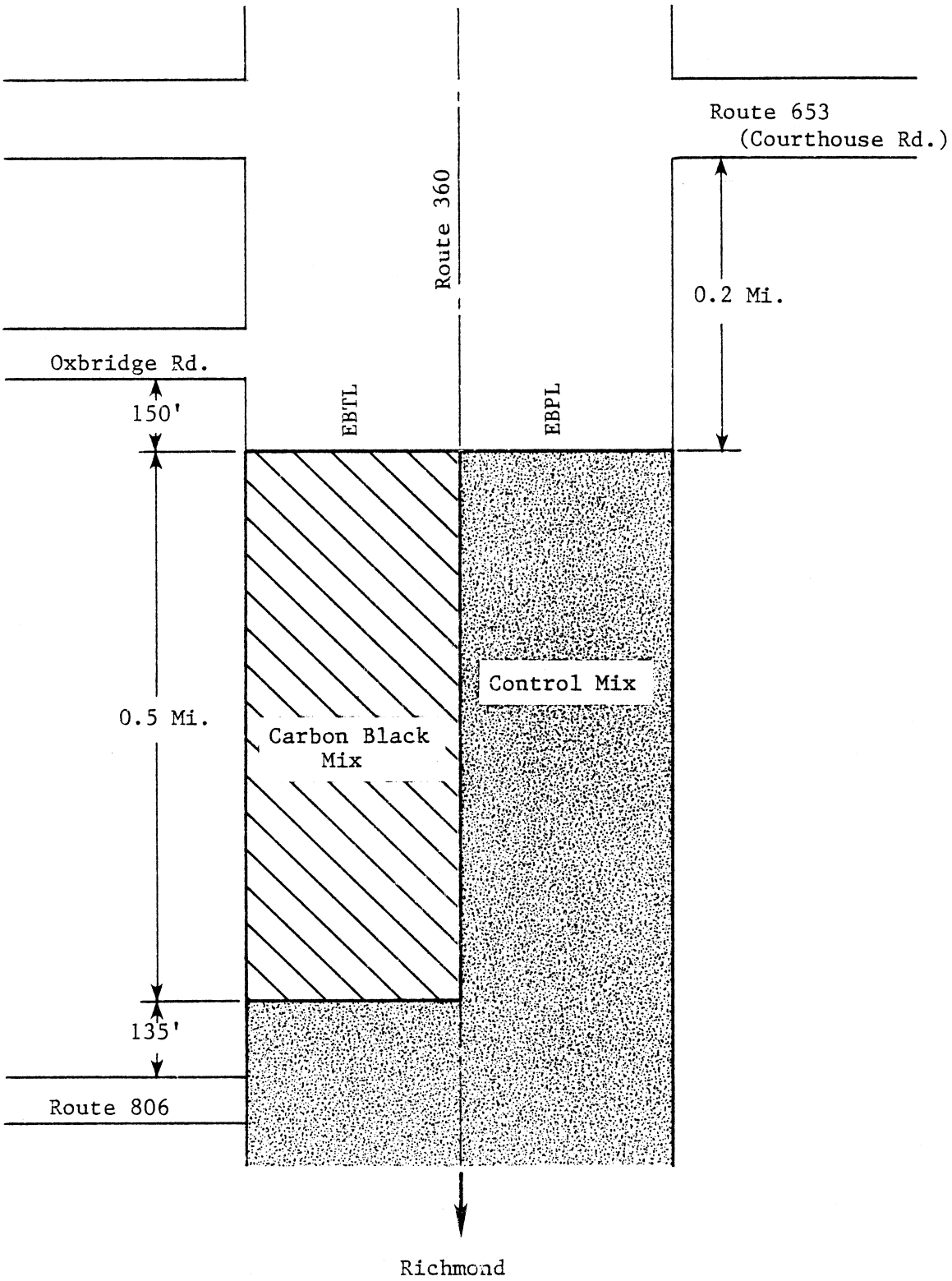

Figure 2. Test section on Route 360; Chesterfield Co.

Table 4. Source of Materials and Batch Weights
Route 360, Chesterfield Co.

	Sources
85% crushed stone	- Richmond Crushed Stone
15% concrete sand	- Lone Star Industries, Richmond, Va.
AC-20 Exxon asphalt	- Richmond, Va.
Carbon black (Microfil 8)	- Cabot Corp., Billerica, Mass.

	Batch Weights, lb	
	Control Mix	Carbon Black Mix
Stone and sand	7,552	7,512
Asphalt	448	388
Microfil 8	-	100

Table 5. Gradation in Percent Passing
Route 360, Chesterfield Co.

Sieve Size and Asphalt Content	Mix Design	Extractions	
		Control Mix	Carbon Black Mix
1/2	100	100	100
4	57-67	68	70
30	23-31	29	32
200	5-8	7.3	4.6
Asphalt content,%	5.6	5.8	5.1

Table 6. Results of Marshall Tests — Route 360

Mix	Stability, lb	Voids Total Mix, %	Voids Filled with Asphalt, %	Voids in Mineral Aggr., %	Flow, 0.01 in.
Carbon black	3,910	4.7	71.2	16.4	13
Control	3,060	1.6	89.4	15.3	13
Va. Specs.	1,450 Min.	3-6	65-85	14.8 Min.	8-18

The work of the paving crew was interrupted several times by another crew working on the shoulders. The delays produced several construction bumps in the traffic lane of the mix containing carbon black.

Performance

The control and experimental mixes are performing satisfactorily. There is some roughness in the carbon black section that probably resulted from construction delays as already discussed. Unlike the Altavista test section, the carbon black section is slightly darker than the control section.

FUTURE WORK

The test pavements will be examined periodically for deformation and general performance.