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INSTALLATION REPORT

RUBBER MODIFIED ASPHALT MIX

by

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Senior Research Scientist

(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

This report describes the design of an asphalt mix containing up to 3.0% closed cell waste rubber and a field installation of the mix. The Marshall design procedure was used to determine the asphalt content for the mix containing 3.0% rubber as well as that of a control mix which did not contain rubber. In the field installation, 211 tons of mix containing 1.5% or 3.0% rubber were laid on Route 460 in Bedford County. The only problem encountered was that the breakdown roller tended to pick up the mix until the temperature decreased to 225°F. Results of Marshall tests made on samples taken from the field mix are presented in the report.

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INTRODUCTION

Interest in the use of waste, ground rubber in asphalt mixes has been renewed recently because of two factors:

1. The large amounts of used tires and other waste rubber that are becoming increasingly difficult and expensive to discard, and

2. The 5% increase in the FHWA participation ratio allowed under the 1983 Surface Transportation Assistance Act where states use recycled materials (which include waste rubber) or additives.

This spring, Virginia had an opportunity to experiment with the use of waste rubber in cooperation with the Rubbertex Company of Bedford, Virginia. Rubbertex makes a closed cell rubber for use in antivibration pads, gaskets, sheet insulation, etc. The Company has been paying to have the waste material hauled to a land fill and believed that the use of this material in a paving mixture could be mutually beneficial.

It was anticipated that the mix would be more flexible than a conventional mix and, as reported elsewhere,* might retard the accumulation of ice and snow and have an extended life as compared to non-rubberized mixes.

Following laboratory tests, it was decided to field test 200 tons of asphalt mix that included 3% rubber. This report describes both the lab and field investigations.

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*Esch, David C., "Construction and Benefits of Rubber Modified Asphalt Pavements," Transportation Research Record 860, Transportation Research Board 1982.

LABORATORY TESTING

The Marshall method was used to design an I-2 mix incorporating 3% rubber. A control mix was developed around the job mix formula used by the Adams Construction Company, since they would be producing the mix to be field tested. The job mix formula gradation and asphalt content are shown in Table 1.

Table 1

Gradation and Asphalt Content of Control Mix

Sieve Size	Percent Passing
1"	100
3/4"	98
1/2"	82
3/8"	70
#4	50
#8	40
#30	18
#50	11
#100	5
#200	3
Asphalt content	5

The gradation of the rubber, shown in Table 2, indicates that most of it was contained between the #4 and 30 sieves. Because it is a closed cell rubber, its specific gravity, ranging from about 0.2 to 0.6, is lower than that of conventional rubber such as the type used in tires.

Table 2

Rubber Gradation

Sieve Size	Percent Passing
3/8"	100
#4	98
#8	46
#30	5
#50	1
#100	0

To accommodate inclusion of the rubber, the aggregate was gap-graded to produce the gradation shown in Table 3.

Table 3

Modified Aggregate Gradation

Sieve Size	Percent Passing
1"	100
3/4"	98
1/2"	78
3/8"	63
#4	45
#8	33
#30	14
#50	8
#100	5
#200	3

The difference between the control and gap gradations can easily be compared in Figure 1. Although the modified gradation was slightly gapped and the laboratory mix design appeared satisfactory, field results indicate that even a more severe gap-grading from the -#4 to the +#30 sieves would have been advantageous. This will be discussed later.

The Marshall results for both the control and modified mixes are shown in Figure 2, with the results at the design asphalt content being shown at the bottom.

To obtain Marshall data for the control mix, the asphalt content from the job mix formula was used. For the rubber modified mix, an asphalt content was chosen that would produce a low void mix on the road. The previously referenced report states that "when core samples are taken from the finished pavement and tested, the average void content should be less than 5 percent." Thus from the Marshall design, a VTM of 3% would require an asphalt content of about 6.8%. However, to try to ensure high field densities an even higher asphalt content of 7.0% was chosen, and this produced a VTM of 2.5%.

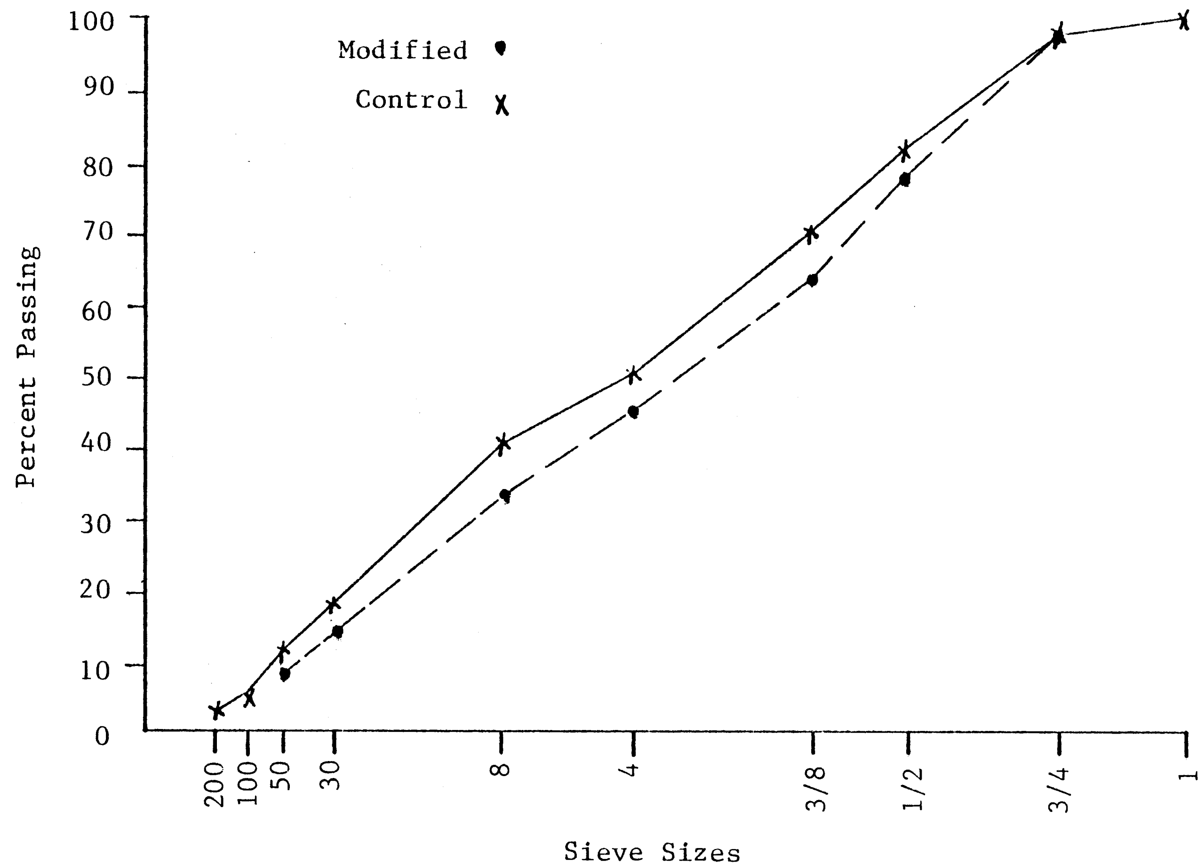
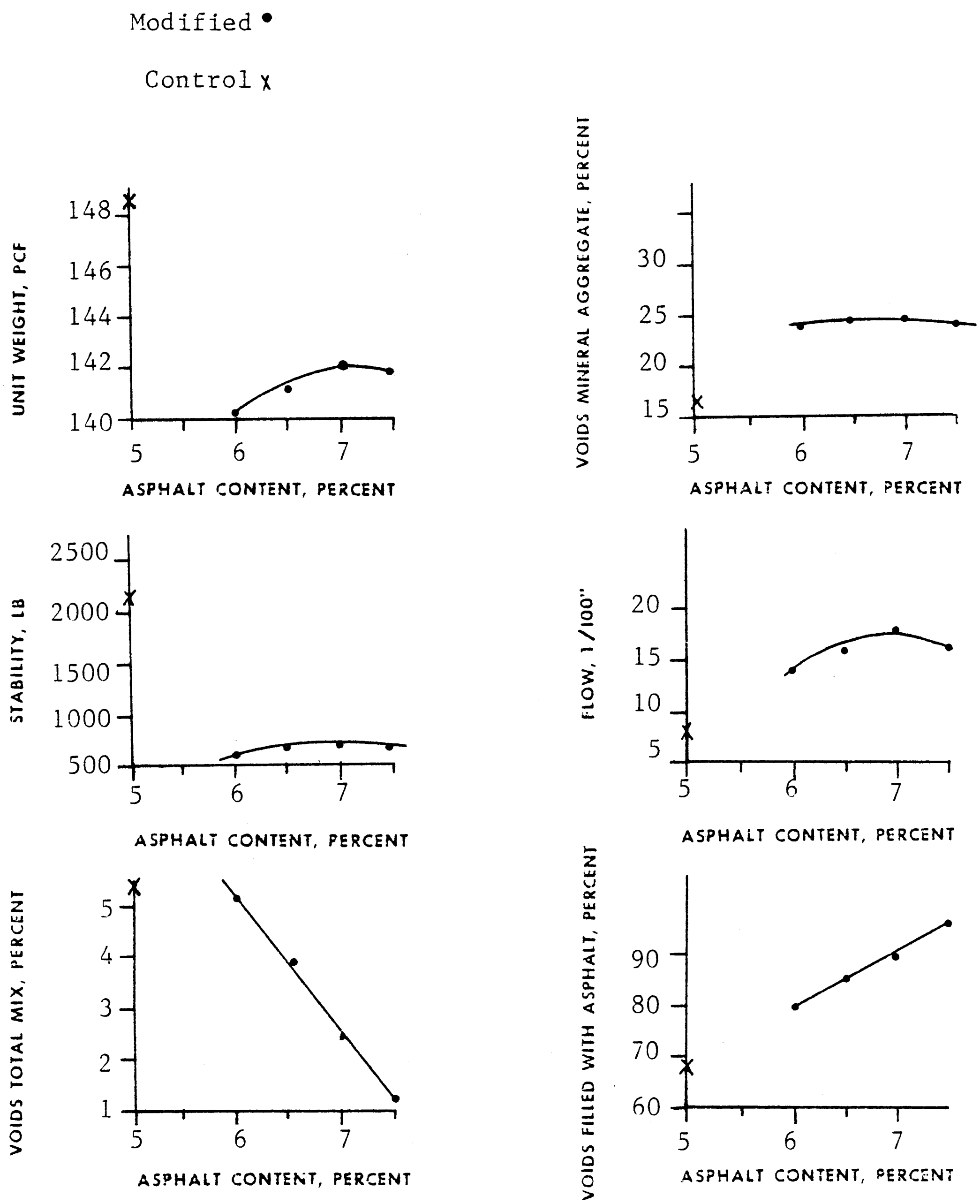


Figure 1. Control and modified design gradations.



	Control	Modified
Asphalt Content	5%	7%
Unit Weight (pcf)	148	142
Stability (lb.)	2,160	680
VTM	5.4	2.5
VMA	16.9	24.7
Flow	7.8	17.6
VFA	68.4	90.0

Figure 2. Marshall design for control and rubber modified mix.

The Marshall stability values do not compare well with those of a conventional mix. However, it was anticipated that with an appreciable amount of rubber in the mix the stability results would be lower.

Because of the optimism indicated in the Transportation Research Board paper, and the laboratory Marshall design results, it was decided to try 200 tons of mix on a road.

INSTALLATION OF FIELD SECTION

A portion of the maintenance schedule laid on Route 460 in Bedford County was chosen for the application of the experimental mix (Figure 3). The eastbound lanes carry 5,300 vpd, of which about 9% are trailer trucks and buses. Two hundred eleven tons of mix modified with rubber were laid on June 6, 1983, under sunny skies and temperatures in the 80's. The road was badly cracked and in need of an overlay. The application rate of the conventional I-2 mix was 165 lb./yd.^{2}

The rubber was introduced into the pugmill in 50 lb. polyethylene bags. It was planned to produce 5,000-lb. batches requiring 150 lb. of rubber for a 3% rubber modified mix. However, because it was feared that the rubber would create so much volume in the pugmill as to hinder mixing, it was decided to go with a 2 bag (100 lb.)/batch rubber mix. The total batch weight was 3,400 lb., of which 100 lb. was rubber, which calculates to 2.94% rubber. This is referred to as 3% rubber in this report. The last 64 tons of the 211 tons of rubber modified mix contained only one 50 lb. bag, or 1.47%, of rubber per batch, which is referred to as 1.5% rubber mix. A 10 sec. dry mixing time was used during which the rubber was introduced followed by a 30 sec. wet mixing cycle. This was adequate for thoroughly dispersing the rubber.

During paving, the rubber mix pulled slightly but not enough to be unsightly. However, the rolling had to be modified significantly. The breakdown roller was not able to operate at temperatures above 225°F because of the mix picking up on the steel wheels. The temperature of the mix was 275°F behind the paver and a 15- to 20-minute wait was necessary before rolling could commence. The flexibility of the mat was obvious; the mix compressed under the roller and then rebounded after it had passed. Densities on the 3% rubber section averaged 92.3% maximum theoretical density (MTD). This was not as high as the referenced report indicated was necessary for good durability, but due to the temperature-rolling relationship was all that could be obtained.

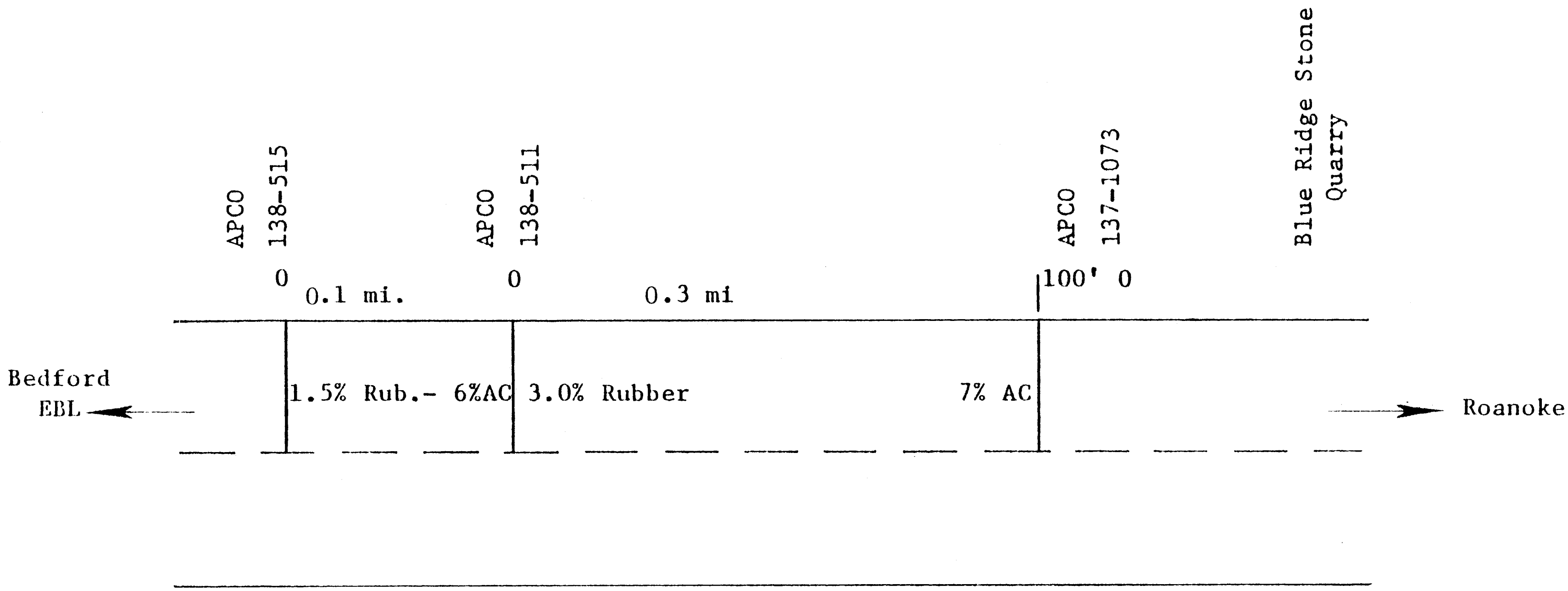


Figure 3. Location of rubber modified mix, Rte. 460 Bedford Co.

For about 45 minutes after rolling had been completed the mix was still quite flexible and tended to pick up on vehicle tires. Because there was concern that the mix might not set up properly in the warm temperatures, after 147 tons had been laid it was decided to reduce the rubber to one 50 lb. bag/batch and the asphalt content to 6.0% for the remainder of the experimental tonnage. As noted above, the last 64 tons of mix contained only 1.5% rubber, and this was more easily rolled and set up very well. The field densities averaged 93.4% MTD. Coincidently, just as the asphalt plant was switched back to producing the conventional mix, a shower cooled the pavement sufficiently so that traffic was turned onto the new mix with no pick up or rutting problems.

Samples of the 3% and 1.5% rubber modified mix were taken by the Research Council and the Salem District, and samples of the 3.0% mix by the Central Office Materials Division. The average results of test on these samples are shown in Tables 4 and 5. Table 4 shows the results from the Marshall tests and Table 5 shows the extracted gradations, which include the rubber and the asphalt content.

The samples were taken from different trucks and the results show a variability that was not totally unexpected. The Central Office results included relatively low VTM and VMA values, which would normally produce a high stability, as compared to the Research Council and Salem District results. The results for the 1.5% rubber mix were, as expected, more in line with conventional mix values. However, there was very little difference between the gradations of the 3.0% and 1.5% rubber mixes, as can be seen in Table 5. The fact that the gradations did not greatly differ while the Marshall results did is attributed to the low specific gravity of the rubber, which would not affect the results based on weight nearly as much as those influenced by volume.

Table 4

Marshall Results From Field Samples

	3.0% Rubber			1.5% Rubber	
Property	Research Council	Salem Dist.	Central Office	Research Council	Salem Dist.
Stability, lb.	720	635	995	1,445	1,145
Flow	16	29	17	14	21
VTM, percent	6.3	7.9	5.7	5.1	5.8
VFA, percent	77.8	65.4	73.4	77.0	71.6
VMA, percent	28.5	22.8	21.4	22.1	20.3
Recovered asphalt penetration	—	—	115	—	—

Table 5

Gradation, Including Rubber, and Asphalt Content From Field Samples

Sieve Size	3.0% Rubber			1.5% Rubber	
	Research Council	Salem Dist.	Central Office	Research Council	Salem Dist.
1"	100	100	100	100	100
3/4"	99.5	100	100	98.9	99.7
1/2	89.6	89.5	89.1	88.2	88.6
3/8	79.7	80.5	76.9	76.3	80.9
#4	52.1	53.9	50.6	47.9	53.8
#8	36.1	37.5	34.2	31.8	36.8
#30	15.7	15.9	13.9	13.8	15.7
#50	8.1	7.5	7.3	8.1	8.7
#100	4.0	3.9	4.4	4.8	5.4
#200	2.4	2.2	3.3	3.1	3.4
A.C., percent	7.33	7.12	7.32	6.02	6.52

The average gradations of the 3.0% rubber mix are shown in Figure 4. Judging from these values, as well as those in Figure 1 and the higher than desirable VTM on the road, it is very likely that the aggregate gradation used did not adequately accommodate the volume of rubber that was added, especially when the very low specific gravity of the rubber is considered. If additional work is done with rubberized mixes, a more severe gap-grading should be designed.

EARLY PERFORMANCE

It was anticipated that because of the softness of the section with 3.0% rubber, pushing or rutting under traffic would occur, especially considering the hot weather that followed the construction. However, after 10 days no noticeable movement had taken place in the mix. There were indications of very fine cracks in the 3.0% rubber section but none in the 1.5% rubber section.

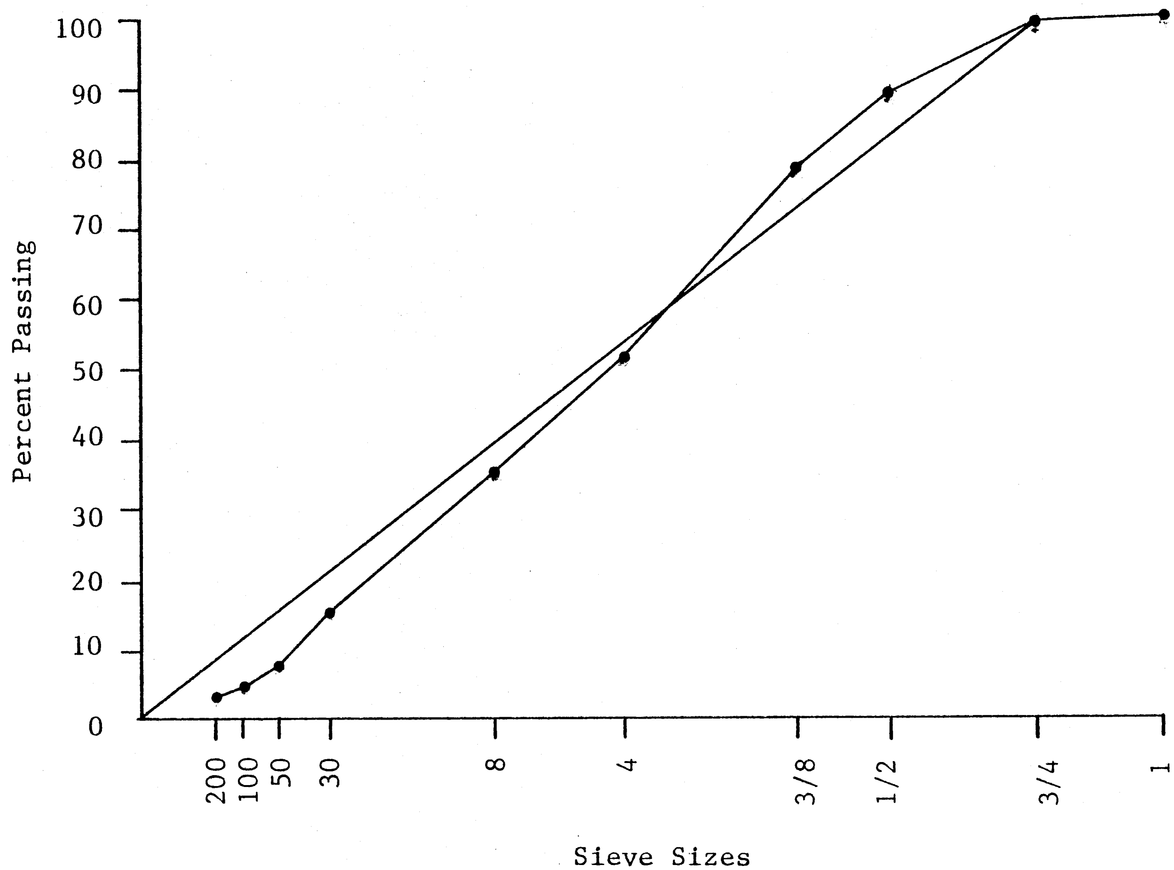


Figure 4. Modified mix with 3.0% rubber.

ACKNOWLEDGEMENTS

The cooperation of the Adams Construction Company in producing and laying the mix is greatly appreciated. Also appreciated is the testing performed by the Materials Division's Bituminous Lab and the Salem District Lab.

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