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Supplementary Notes

Abstract

This report summarizes the design and field installation of an asphalt mix containing up to 3.0% closed cell rubber by weight of the mix. The performance is discussed as well as possible reasons for the early failure of the mix. Suggestions are made for avoiding failures if it is decided to use rubber modified mixes in the future.

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FINAL REPORT

RUBBER MODIFIED ASPHALT MIX

by

C. S. Hughes
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.)

Virginia Highway & Transportation Research Council
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SUMMARY

This report summarizes the design and field installation of an asphalt mix containing up to 3.0% closed cell rubber by weight of the mix. The performance is discussed as well as possible reasons for the early failure of the mix. Suggestions are made for avoiding failures if it is decided to use rubber modified mixes in the future.

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INTRODUCTION

There has been renewed interest in the use of waste, ground rubber in asphalt mixes recently because of

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

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

In the spring of 1983, The Department of Highways and Transportation had an opportunity to experiment with the use of waste rubber in cooperation with the Rubatex Company of Bedford, Virginia. Rubatex makes a closed cell rubber for use in anti-vibration pads, gaskets, sheet insulation, etc. The company has been paying to have the waste material hauled to a landfill and believed that the Department's 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, (1) might retard the accumulation of ice and snow and have an extended service life as compared to nonrubberized mixes.

Following laboratory tests, it was decided to field test 200 tons of asphalt mix that included as much as 3% rubber. An Installation Report was written in August 1983 describing the lab investigation and field test results.(2)

This report briefly summarizes the design and installation date, discusses the performance problems, and mentions improvements that should be made if rubber modified mixes are used in the future.

DESIGN

The Marshall method was used to design an I-2 mix incorporating 3% rubber by weight of mix. A control mix was developed around the job mix formula used by the Adams Construction Company since they would be producing the rubber modified mix. Both gradations are shown in the Appendix as well as the gradation of the rubber.

As shown in Table 3 of the Appendix, the gradation of the rubber was mostly -#4 and #30 sieve material. Because it was closed cell rubber, its specific gravity of 0.2 to 0.6 was lower than that of rubber used in tires. To accommodate inclusion of the rubber, the aggregate was gap graded. However, based on field results, the gap grading was not sufficient to accommodate the amount of rubber used initially. However, because of the volume of rubber included in the experimental mix, the percent aggregate passing the #4 sieve should have been reduced below the 45% used in this project. The additional gap grading should be continued through at least the #30 sieve. The design asphalt content was 7.0%.

For future designs, the rubber content should be restricted to about 6% by volume.

INSTALLATION

The modified rubber mix was placed in June 1983 on Route 460 in Bedford County in the eastbound traffic lane just west of the entrance to the Blue Ridge Stone Quarry. The application rate was 165 lb/yd^2. Because the mix tended to pick up on the roller at temperatures above $225^{\circ}F$, it had to be allowed to cool and this led to difficulties in getting the desired density. Densities did average 92.3% of the maximum theoretical density, (MTD) but this was less than is recommended for good durability.

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 content to about 1.5% by weight of mix and the asphalt content to 6.0%. This was done for the last 64 tons of mix. The densities of the mix improved to 93.4% of the MTD.

Samples taken from these mixes indicated higher than expected voids total mix (VTM) and voids in the mineral aggregate (VMA) and lower voids filled with asphalt (VFA). These results indicate that the aggregate gradation did not provide sufficient voids for the rubber and that the asphalt content should have been slightly higher.

PERFORMANCE

The section with 3% rubber by weight did not perform well. After about 2 months, areas in the outside wheel path broke up and had to be removed and patched. The deterioration continued until October, when the section had to be removed and repaved with conventional mix. The rubber mix failed by debonding from the underlying layer, and the first failure occurred after a heavy rain. Since the densities were not as high as recommended, it is likely that water got in the mix and penetrated through the overlay, and traffic the created water pressures that debonded the mix. The difference in flexibility between the rubber mix overlay and the old surface could have been a contributing factor.

The section with 1.5% rubber performed well until recently. In July 1985 after about 25 months in service, this section was starting to fail in a manner similar to that observed on the 3% section. Only three or four small areas had failed, but once failure begins the areas appear to continue to deteriorate longitudinally.

The benefits of ice breakup on the rubber mix were not apparent in the two winters in which it has been in service. The area superintendent could not see any difference between the rubber and conventional sections. However, there was only a 0.1-mile section of the rubber mix (1.5% rubber) down through the winters, and it is extremely difficult to judge the adhesion of ice and snow on such a short section.

A recent report from the Minnesota Department of Transportation on the evaluation of "Plus Ride", a patented process using recycled tires in a similar mix, indicates that one of two projects laid in 1984 has failed in the same manner as the Virginia mixes.(3) In the words of the research project engineer in charge of the Minnesota project, "the rubber mix can perform satisfactorily if everything is in control at the plant and the paving site. However, the mix is very unforgiving if anything gets out of control."

FUTURE CONSIDERATIONS

From a technical viewpoint rubber can be used in bituminous mixes, if there is a sufficient need to dispose of waste rubber. It is obvious that the amount of rubber used in a mix is extremely important and should be based on volume of rubber in the mix. Additionally, the proper mix design and very good control of the asphalt plant and construction operations are important.

Assurance should be made that a sufficient gap in the gradation curve from +#4 to -#30 sieves exists to accommodate the amount of rubber to be used. As a guide the volume of rubber should be restricted to about 6%.

Finally, the rubber supplier and contractor for rubber modified mixes should be made aware that a patent on the use of vulcanized rubber in asphalt mixes is held by the All Seasons Surfacing Corporation of Bellevue, Washington.

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REFERENCES

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

2. Hughes, C. S., "Installation Report, Rubber Modified Asphalt Mix," VHTRC 84-R1, Virginia Highway and Transportation Research Council, Charlottesville, Virginia, July 1983.

3. Allen, Harvey S., "Evaluation of Plus Ride™," Special Study 387, Construction Report, Minnesota Department of Transportation, January 1985.

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APPENDIX

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

Table 2

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

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Table 3

Rubber Gradation

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