MoDOT

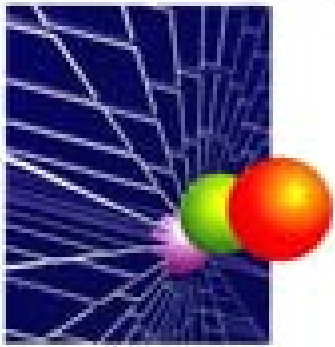
Research, Development and Technology Division

Materials Division

RDT 99-006
Final Report

Asphalt Rubber Overlay Performance Evaluation

Experimental Projects
Mo 92-09
Mo 92-11
Mo 91-01



April, 1999

TECHNICAL REPORT DOCUMENTATION PAGE

1 Report No. RDT 99-006	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Asphalt Rubber Overlay Performance Evaluation		5. Report Date January 1999
		6. Performing Organization Code UMC
7. Author(s) Vellore S. Gopalaratnam, James W. Baldwin, Jr. , Wei-Min Cao		8. Performing Organization Report No. RDT 99-006/Mo 92-09/Mo 92-11/Mo 91-01
9. Performing Organization Name and Address Missouri Department of Transportation Materials and Research Division P.O.Box270 Jefferson City, MO 65102		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Missouri Department of Transportation Research, Development and Technology Division P.O.Box270 Jefferson City, MO 65102		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code MoDOT
15. Supplementary Notes		

16. Abstract

On May 19, 1998, an evaluation was conducted on Route I-44, Phelps County and on Route I-44, Laclede County. On June 4, 1998 an evaluation was conducted on Route I-29, Platte County. The evaluations consisted of visual observations and rut measurements. The asphalt rubber overlay is an experimental feature.

17. Key Words Asphalt, Overlay, Polymer, Rubber Modified Concrete overlay	18. Distribution Statement No restrictions. This document is available to the public through National Technical Information Center, Springfield, Virginia 22161

19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 76	22. Price

Form DOT F 1700.7 (06/98)

MATERIALS FIELD OFFICE

DIVISION OF MATERIALS

SUBJECT: Route I-44, Phelps County
Job No. J9I0298
Experimental Project No. MO92-09
F.O. 92-6
Final Report

Route I-44, Laclede County
Job No. J8I0469
Experimental Project No. MO92-11
F.O. 92-11
Final Report

Route 71, Cass County
Project No. F.A.-71-4(54)
Experimental Project No. MO91-01
F.O. 91-1
Final Report

WRITTEN BY: Brett Trautman
Field Materials Engineer

Dale Williams
Intermediate Materials Research Assistant

APPROVED BY: David A. Campbell
Field Materials Director

DATED: April 14, 1999

SCOPE

On May 19, 1998, an evaluation was conducted on Route I-44, Phelps County and on Route I-44, Laclede County. On June 4, 1998 an evaluation was conducted on Route I-29, Platte County. No evaluation was conducted on Route 71, Cass County due to the fact that it was dropped from the program due to underlying failures. The evaluations consisted of visual observations and rut measurements. The asphalt rubber overlay is an experimental feature. This is the final report on the performance of these overlays. Each section of this report will be broken into four subsections that will address each project.

BACKGROUND

Route I-44, Phelps County

During the 1993 construction season, the Missouri Department of Transportation (MoDOT) placed four test sections containing various modifier on a portion of the westbound driving lanes of Route I-44, Phelps County (Job No. J9I0298). The modifiers included Type I Polymer (SBS), Type II Polymer (SBR), Type II Crumb Rubber (coarse) and Type IV Crumb Rubber (fine). A section of typical MoDOT Type IC asphaltic concrete was also constructed on the project that served as a control section.

All test and control section mixtures were placed 1 3/4 inches thick and 12 feet wide in the westbound driving lane.

The sources of the polymer asphalt modifiers included Elf Asphalt's Styrelf product conforming to AASHTO's PMAC-1C grading criteria (SBS), and UltraPave 70 (SBR), produced by Textile Rubber and Chemical company of Dalton, Georgia. Both polymer modified asphalt cements contained approximately three percent polymer solids, by weight of the binder.

The binder component for the Asphalt Rubber Concrete (ARC) mixtures was produced using the "wet process" to incorporate the rubber additive into the asphalt binder. International Surfacing, Inc., Chandler Arizona, produced both asphalt rubber modified products. The Type II modified mixture used 17 percent of a coarse crumb rubber from Baker Rubber, South Bend, Indiana, and the Type IV modified mixture used 14 percent of a fine crumb rubber from Rouse Rubber, Vicksburg, Mississippi. The Type II mixture cost $54.56/ton, and the Type IV mixture cost $52.65/ton.

Route I-44, Laclede County

During the 1993 construction season an experimental features project was constructed in the eastbound and westbound lanes of Route I-44, Laclede County (Job No. J8I0469). The project consisted of pavement repairs, cold milling, installing geocomposite pavement edge drains and an experimental Rubber Modified Asphalt Concrete overlay (RMAC).

RMAC is a generic name for the patented Plus Ride II System, which uses the "dry process" to incorporate the crumb rubber additive into the asphalt mix. The mix design consisted of 3 percent rubber, which was delivered in two fractions, one coarse and one fine supplied by Baker Rubber, South Bend, Indiana. In the eastbound lanes 2" of RMAC was placed over 3" of IB mix, which was placed on top of the existing Portland Cement Concrete Pavement (PCCP). In the westbound lanes 1 3/4" RMAC was placed on top of 1 1/4" of IC mix, which was placed on top of an existing overlay that was cold milled 3/4". The cost of the RMAC was $62.00/ton.

ARC or the "wet process" was used as the control section. The modified mixture used 17 percent ground rubber from Baker Rubber, South Bend, Indiana. In the eastbound lanes 1 3/4" of ARC was place over 1 1/4" of IC mix, which was placed on top of an existing asphalt overlay that was cold milled 3/4". In the westbound lanes 2" ARC was place over 3" of IB mix, which was placed on top of the existing PCCP. The cost for the ARC was $70.00/ton.

Route 71, Cass County

During the 1991 construction season an experimental features project was performed on Route 71, Cass County (Project No. F.A.-71-4(54)). The project consisted of pavement repairs, cold milling and resurfacing the traffic lanes.

The roadway was cold milled to a level surface and 1 1/4 " of ARC mixture was placed on the driving lanes and Type C mixture was used on the shoulders. The ARC mixture used 17 percent ground rubber which was supplied by Baker Rubber, South Bend, Indiana. The ARC cost $44.95/ton.

DISCUSSION

Route I-44, Phelps County

This is the final report of the ARC and polymer modified test sections. The test sections were inspected on May 19, 1998.

The Type II ARC surface course exhibited low severity reflective and transverse cracking, low severity longitudinal cracking down the center of each lane and low severity cracks at the shoulder and centerline of the road, as can be seen in Figure #1. Pumping was noted at lane mile 11.68 and potholes at Lane miles 11.05 and 12.05, as seen in Figure #2. Rut measurements were taken at the following locations in the driving lane:

LM	RWP	LWP
12.4	0.0	0.0
12.9	0.0	0.0
12.9**	1/16"	1/16"
13.2	0.0	0.0

** Rut measurement was taken in the 3rd lane for slower traffic.

ARAN data from the first annual report submitted on May 2, 1995, indicated the following value for rutting in the driving lane:

RWP	LWP
0.1"	0.1"

Sporadic potholes and low severity transverse reflective cracks were also in the first annual report.

The Type IV ARC surface course exhibited some distress in the driving and passing lane along the center of the lane, and raveling along the centerline, as seen in Figure #3. It also exhibited some pumping, as seen in Figure #4. Rut measurements were taken at the following locations in the driving lane:

LM	RWP	LWP
11.0	1/16"	1/16"
11.1	1/8"	1/16"
11.2	1/16"	1/16"

ARAN data from the first annual report submitted on May 2, 1995, indicated the following value for rutting in the driving lane:

RWP	LWP
0.1"	0.1"

Evidence of subsurface moisture was reported in the initial pavement evaluation of 1991 and was noted during construction of the test section.

The Type IC control section looked very similar to the Type II and Type IV ARC sections. Low severity longitudinal cracking at the center of the driving lane was evident, as can be seen in Figure #5. Rut measurements were taken at the following locations in the driving lane:

LM	RWP	LWP
10.3	0.0	0.0
10.6	1/16"	0.0

ARAN data from the first annual report submitted on May 2, 1995, indicated the following value for rutting in the driving lane:

RWP	LWP
0.1"	0.1"

The Type II SBR polymer modified test section exhibited some sub-grade failures, as seen in Figure #6, but no pumping was noted. Also the shoulder had been patched. Reflective cracking

did not seem to be as bad as the ones in the ARC test sections, as seen in Figure #7. No rut measurements were taken due to heavy traffic.

The Type I SBS polymer modified test section visually looked similar to the IC control section and the Type IV ARC test section, as seen in Figure #8. That is the cracking was visually similar. Rut measurements were taken at the following locations in the driving lane:

LM	RWP	LWP
8.4	0.0	1/16"
8.4	1/16"	1/8"

ARAN data from the first annual report submitted on May 2, 1995, indicated the following value for rutting in the driving lane:

RWP	LWP
0.1"	0.1"

Route I-44, Laclede County

This is the final report of the ARC and RMAC sections. The test sections were inspected on May 19, 1998.

According to the First Annual Report, potholes were observed in the RMAC overlay in July of 1994. From July through October of 1994, the degree and frequency of pot holes worsened. MoDOT Maintenance forces patched the potholes, sometimes on a daily basis. By late October 1994 the potholing could be located in four distinct areas; all in the driving lane. The locations are as follows:

1. In the eastbound lane, one pot hoe at the beginning of the job in the left wheel path.

2. In the eastbound lane between mile markers 142 and 143, numerous potholes for a length of approximately 1200 lineal feet in the right wheel path.

3. In the eastbound lane at the east end of the RMAC section, numerous potholes for a length of approximately 450 lineal feet in the right wheel path.

4. In the westbound lane at the beginning of the RMAC section, numerous potholes for a length of approximately 65 lineal feet in the right wheel path.

In November of 1994, the potholed sections in Location 2, 3 and 4 were milled and replaced with IC mixture. The cause of the potholes was determined to be stripping of the aggregate.

The RMAC section in the westbound lane exhibited a few low severity reflective cracks and no longitudinal cracks were visible, as can be seen in Figure #9. Ground rubber pieces were visible on the surface, as can be seen in Figure #10.

The ARC section in the westbound lane exhibited low severity reflective transverse cracks at every joint and no longitudinal cracks were visible, as can be seen in Figure #11.

Figure #12, shows the transition from the RMAC into the ARC section in the westbound lane. Figure #13, a close-up photograph shows a transverse reflective crack in the ARC that stops once it reaches the RMAC.

Rut measurements were taken at the following locations in the driving lane of the westbound lane:

LM	RWP	LWP	Mix Type
32.7	0.0	1/8"	ARC
33.0	1/16"	1/8"	ARC
33.1	0.0	1/8"	RMAC

Rut measurements reported in the Second Annual Report were taken In August of 1993 and are as follows:

LM	RWP	LWP	Mix Type
31.7	1/16"	1/16"	ARC
32.5	1/16"	1/16"	ARC
33.05	0.0	0.0	ARC
33.05	1/8"	1/8"	RMAC
33.1	0.0	1/16"	RMAC

The RMAC section in the eastbound lane is similar to the RMAC section in the westbound lane. Few low severity reflective cracks and no longitudinal cracks were visible, as can be seen in Figure #14. Fatty spots appear in the mat, as can be seen in Figure #15. There were a couple of areas that exhibited Potholes which are believed to be caused by subgrade failure, as can be seen in Figure #16 and Figure #17. Also reflective cracks were visible at Log Mile (LM) 30.25. There were two reflective transverse cracks of moderate severity, as can be seen in Figure #18, and one rated low severity.

The ARC section in the eastbound lane is similar to the ARC section in the westbound lane. Low severity reflective transverse cracks visible and no longitudinal cracks were visible

Rut measurements were taken at the following locations in the driving lane of the eastbound lane:

LM	RWP	LWP	Mix Type
29.6	1/16"	1/16"	RMAC
30.25	1/16"	1/8"	RMAC
32.8	1/16"	1/8"	ARC

Rut measurements reported in the Second Annual Report were taken In August of 1993 and are as follows:

LM	RWP	LWP	Mix Type
29.3	0.0	1/16"	RMAC
29.7	1/16"	1/8"	RMAC
30.7	0.0	1/8"	RMAC
33.1	1/16"	3/16"	ARC

Route 71, Cass County

Dropped from program due to underlying failures, therefore no visual or physical evaluation was conducted.

CONCLUSION

Route I-44, Phelps County

The Type II SBR polymer modified test section visually appeared to have outperformed all test sections and the control section.

All other test sections, Type II ARC, Type IV ARC, Type I SBS and the Type IC control section appeared to have performed the same.

Route I-44, Laclede County

The sections of the RMAC that failed and were replaced, appeared to be associated with stripping of aggregate. Other than a few areas, the RMAC section appears to have out performed the ARC section in terms of reflective cracking

Route 71, Cass County

This project was dropped from the program due to underlying failures. Therefore, it is impossible to draw any conclusions on the performance of the pavement.

OVERALL CONCLUSION

Overall, crumb rubber modified asphaltic concrete has not performed as well as MoDOT's traditional high type mixes. In one case they were about equal but for the most part they are inferior. It does, however, appear that the RMAC out performs the ARC. Also, when you compare the cost of a crumb rubber modified asphaltic concrete to that of a traditional MoDOT mix, it would almost have to outperform it by a margin of 2 to 1.

Figure #1
Typical Low Severity
Transverse Reflective
and Longitudinal Cracks

Figure #2
Potholes

Figure #3
Typical Photograph
of Type IV ARC

Figure #4
Pumping

Figure #5
Typical Photograph of IC Control Section Low Severity Longitudinal Crack in Center of Driving Lane

Figure #6
Sub-Grade Failure at Shoulder Line

Figure #7
Typical Photograph
of Type II SBR
Modified Asphalt

Figure #8
Typical Photograph
of the Type I SBS
Modified Asphalt

Figure #9
Typical Photograph
of RMAC in the
Westbound Lane

Figure #10
Visible Ground
Rubber

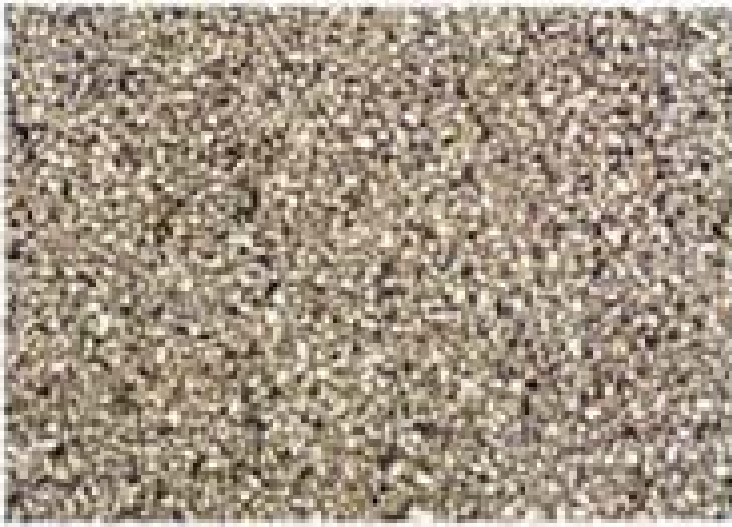


Figure #11
Typical Photograph
of ARC in Westbound
lane

Figure # 12
Transition of RMAC
into ARC in Westbound
Lane

Figure #13
Close-up Photograph of Reflective Crack in ARC That Stops at the RMAC

Figure #14
Typical Photograph of RMAC in the Westbound Lane

Figure #15
Fatty Spots in RMAC, Westbound Lane

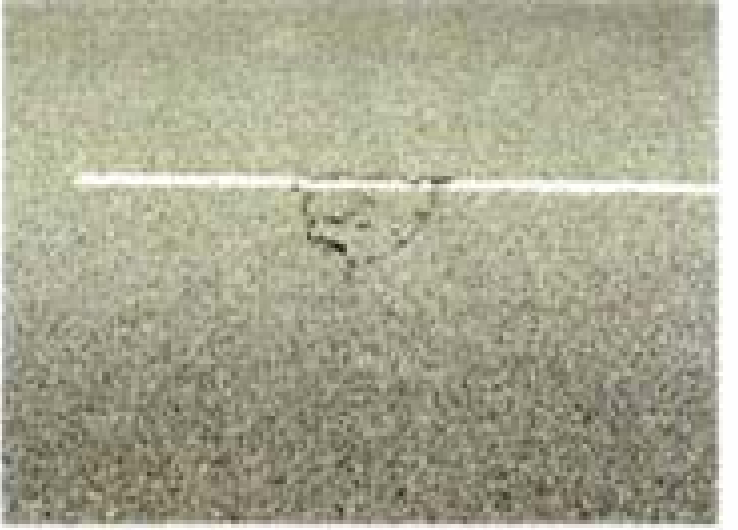


Figure #16
Pothole in RMAC
Westbound Lane

Figure #17
Pothole in RMAC
Westbound Lane

Figure #18
Moderate Severity
Reflective Transverse
Crack in RMAC
Westbound Lane