Asphalt Rubber Cement Concrete
Webster County

Final Report
Iowa Department of Transportation
Office of Materials
Project HR-555

April 2003

Highway Division

Iowa Department
Of Transportation

Asphalt Rubber Cement Concrete
Webster County

Final Report
for
Iowa Department of Transportation
Project HR-555

by
Edward J. Engle, P.E.
Office of Materials
Highway Division
Iowa Department of Transportation
Ames, Iowa 50010

April 2003

Disclaimer

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute any standard, specification or regulation.

TECHNICAL REPORT TITLE PAGE

1. REPORT NO.

HR-555

2. REPORT DATE

April 2003

3. TITLE AND SUBTITLE

Asphalt Rubber Cement Concrete
Webster County

4. TYPE OF REPORT & PERIOD COVERED

Final Report, 4-92 to 2-93

5. AUTHOR(S)

Edward Engle, P.E.
Secondary Road Research Coordinator

6. PERFORMING ORGANIZATION ADDRESS

Iowa Department of Transportation
Office of Materials
800 Lincoln Way
Ames, IA 50010

7. ACKNOWLEDGMENT OF COOPERATING ORGANIZATIONS/INDIVIDUALS

8. ABSTRACT

Discarded tires have become a major disposal problem in the U.S. Different techniques of recycling these discarded tires have been tried. The state of Iowa has evaluated the use of discarded tires ground into crumb rubber and blending it with asphalt to make asphalt rubber cement (ARC). This was the sixth project using this process. The project is located on US 169 from the east junction of IA 175 west and north to US 20.

Only the binder course was placed during this research with the surface course to be let at a later date. There were four test sections, two sections with conventional mixtures and two with ARC mixtures.

There were no significant differences in placement or performance between the two mix types. The cost of the ARC mixture was significantly higher.

9. KEY WORDS

Ground crumb rubber,
Recycled tires,
Asphalt rubber cement,
Crumb rubber modifier,
Asphalt concrete

10. NO. OF PAGES

20

TABLE OF CONTENTS

INTRODUCTION

Recycling discarded tires into asphalt rubber cement (ARC) has been evaluated in several research projects by the Iowa DOT and others. The process used in this project involved blending the crumb rubber with AC-5 before mixing it with the aggregates (this is the so-called "wet process").

Only the binder (lower) course was completed as part of this research. There were areas of reconstruction and finally an overlay of the entire project at a later date. The project contained two test sections with ARC and two control sections with conventional asphalt cement concrete (ACC). The control sections were placed on August 13, 1992 and the test sections later on August 24, 1992.

OBJECTIVE

The objective of this project was to compare the cost and performance of ARC to conventional ACC.

CONTRACTORS

Mathy Construction Company of Onalaska, Wisconsin was the contractor on this project. Rouse Rubber Products of Vicksburg, Mississippi furnished the reactor and the crumb rubber for the project.

PROJECT LOCATION

The project was located on US 169 from the east junction with IA 175 west and north to the junction with US 20. Test sections are shown in Table 1 below. A map is provided in Appendix A.

Test Section	Stations (Mileposts)	Type
1	221+00 (137.76) to 247+00 (138.25)	Conventional
2	303+50 (139.32) to 383+50 (140.84)	ARC binder
3	430+00 (141.72) to 510+00 (143.23)	ARC binder
4	565+00 (144.27) to 590+00 (144.75)	Conventional

PRECONSTRUCTION SURVEY

The original road was a 24-foot wide by 7-inch thick Portland cement concrete (PCC) pavement built in 1930. It had been overlaid with three inches of ACC in 1960. The 1991 traffic volume was 2550 VPD with 12 percent trucks.

A preliminary crack and patch survey was conducted and the Road Rater was used to test the structural rating of the test sections prior to construction. Portions of the test sections had been milled. The road had a large number of reflective cracks and was showing signs of distress.

MATERIALS

The ground tire rubber provided by Rouse Rubber Products was listed as GF-50 rubber. Course aggregate was furnished by Martin-Marietta, Fort Dodge Mine, Webster County, Iowa. The crushed limestone, manufactured sand was produced by Martin-Marietta, Hodges, Humboldt County, Iowa. Finally, the natural sand was produced by Northwest Limestone, Yates, Webster County. AC-5 and AC-10 were supplied by Bituminous Materials of Algona, Iowa.

MIX DESIGNS

Low lab voids were a problem with both the conventional mixtures and the ARC mixtures. The mix design for the conventional sections was changed twice and a new mix design adopted for the last two days of production. The asphalt content was reduced from 5.1 to 4.9 percent. Even with the new mix design, including an aggregate interchange and reduced asphalt content, the lab voids remained below three percent.

The ARC mix had low lab voids (1.5 percent on the first day). The asphalt/rubber content was reduced from 6.5 to 6.1 percent. This did increase the lab voids to 3.6 percent.

The ARC mix contained 15 percent crumb rubber. This amounted to one percent of the ACC mixture. All of the mix designs are shown in Appendix B.

PLANT OPERATION

This was the first time a drum plant was used for producing an ARC mixture in Iowa (usually a batch plant was used). It worked satisfactorily with approximately 250 tons per hour being produced. Normally this particular drum plant (Bituma Drum Plant) would be expected to produce 350 tons per hour with conventional mixtures.

Past production of ARC using a Rouse reactor resulted in 150 tons per hour. The lower production was due to difficulties in maintaining temperature in the reaction unit, resulting in longer reaction times. Between 1991 and 1992, Rouse Rubber added an auxiliary heater to the reactor which increased production.

PAVING OPERATION

There were no construction problems with the conventional mix and segregation was minimal.

The ARC mix seemed to handle well, but the mix appeared rather dry. The appearance seemed to improve after the first 1500 feet. There was a minor problem with tearing of the mat when the finish roller was working. Mathy backed the finish roller off some behind the paving operation which helped reduce the problem. This same problem had occurred in previous ARC projects such as the one for HR-330 in Muscatine county. With both the Muscatine project and this one, the tearing was not apparent by the next day. The temperature of the mat behind the paver was between 275 °F and 300 °F with the conventional mixture and approximately 290 °F with the ARC.

Mathy used a Blaw-Knox PF-180H paver and a Dynapac vibratory roller with a steel finish roller on this project.

CONSTRUCTION TESTING

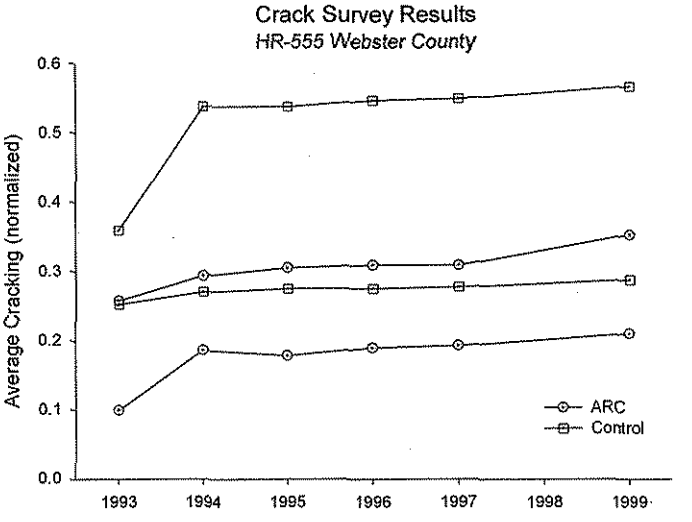
A sample of the GF-50 rubber was tested for gradation. The rubber and AC-5 were tested for viscosity. Finally, samples of the mix were subjected to creep and resilient modulus testing. These laboratory results are provided in Appendix C.

PERFORMANCE MONITORING

This road was evaluated approximately annually from just before the construction until 2001. The results of this testing are shown below.

CRACKING

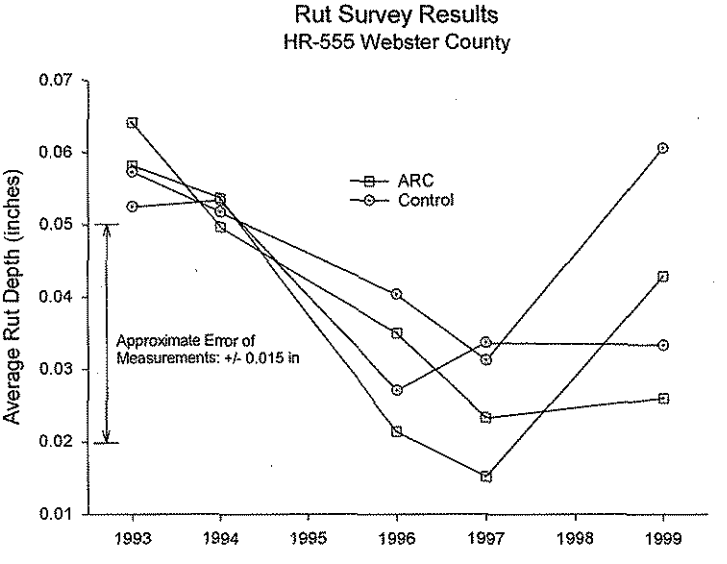
Crack surveys were performed six times over the course of this project. Figure 1 shows the results of these surveys.



The data in this graph have been normalized. That is to say that because almost all of the cracks in the overlay are reflective, the cracks in the underlying pavement have a strong effect on the number of cracks in the overlay. These data were normalized by dividing the cracks-per-hundred feet by the original (pre-construction) cracks-per-hundred feet. As can be seen from the figure, there are no significant differences apparent between the ARC sections and the control sections.

RUTTING

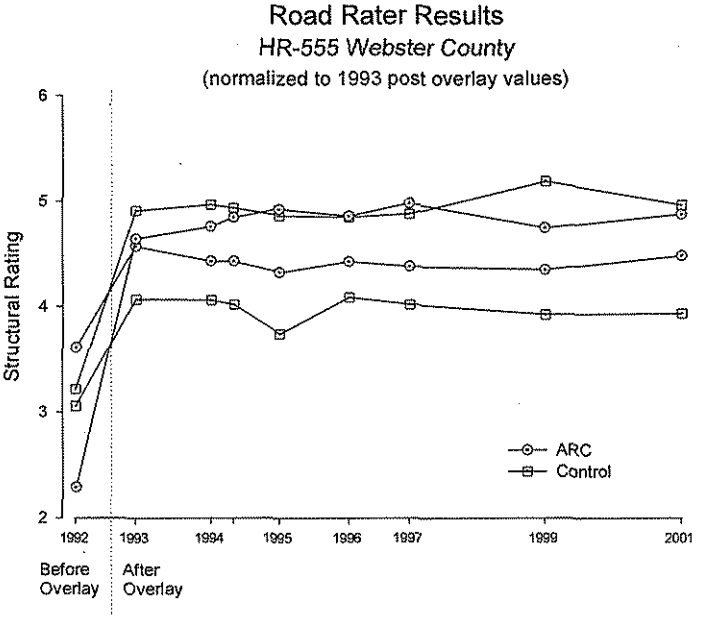
Rutting measurements were made using a standard four-foot straight edge in each wheel track. Figure 2 shows the results of rut measurements between 1992 and 2001. The level of rutting was not significant within the accuracy of the measurements.



STRUCTURE

The structural support of the road – a measure of its strength was measured using the Iowa DOT's Road Rater. This device non-destructively determines the thickness, and strength of pavement by measuring its stiffness. It accomplishes this by vibrating a large mass resonantly against the surface and measuring the deflection of the pavement in response. The values obtained are structural numbers (bigger is better) which can be correlated with equivalent thicknesses of various types of pavement.

Figure 3 shows the results of Road Rater testing for this project. Once again the data have been normalized. This is because the structural number is strongly affected by the strength and moisture content of the subgrade. Under certain conditions, such as a wet spring, the structural numbers are lower across the board. Because this research was mostly concerned with comparison between ARC and control sections, it was assumed that the subgrade values were similar for all of the projects. So the structural numbers were normalized to a fixed average. This makes the data inappropriate for absolute measures but useable for comparison purposes.



The data for the control sections straddle the data for the ARC sections. As a result, there is no indication of a significant difference between the two.

COST COMPARISON

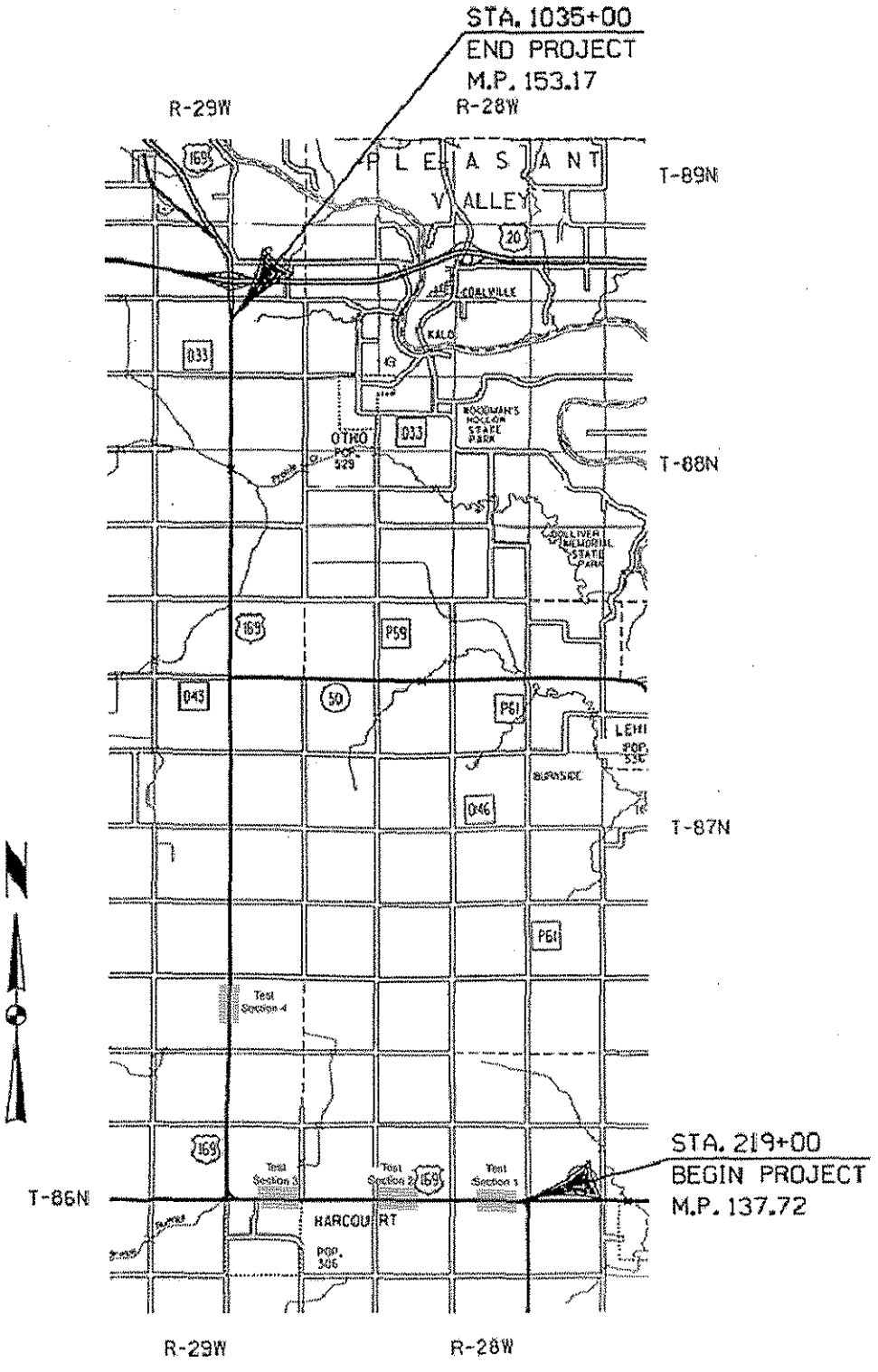
A major difference between conventional mixtures and the ARC mixtures was the cost. On this project, the asphalt cement was bid at $84.00 per ton while the bid for ARC was $190.00 per ton. The cost of the conventional ACC and ARC mix are shown in Table 2 below.

Conventional Mix		ARC Mix	
Aggregate	$14.53	Aggregate	$14.53
4.9 % AC-10	$ 4.12	6.1% ARC	$11.59
Total	$18.65 per ton mix	Total	$26.12 per ton mix

CONCLUSIONS

1. The ARC mixture can be constructed with little or no difference from that of a conventional mixture.
2. The performance of the two mixes was very similar in terms of cracking, rutting and strength.
3. The cost of ARC mix was significantly higher than that of conventional mixes (this could change with improved technology and possible patent issues).
4. Under the conditions of this research project there is insufficient benefit of using ARC to outweigh the higher cost.

APPENDIX A
Project Location Map


STA. 1035+00
END PROJECT
M.P. 153.17
R-29W
R-28W
PLEASANT VALLEY
T-89N
T-88N
T-87N
T-86N
OTHO
POP. 329
COALVILLE
KALO
HARCOURT
POP. 306
LEHI
POP. 336
BURNSIDE
Test Section 4
Test Section 3
Test Section 2
Test Section 1
STA. 219+00
BEGIN PROJECT
M.P. 137.72
R-29W
R-28W

APPENDIX B
Mix Designs

ABD2-0183 MIX DESIGN
BD

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT MIX DESIGN
LAB LOCATION - AMES

LAB NO....:ABD2-0183

MATERIAL........:TYPE A ARC
INTENDED USE....:BINDER
PROJECT NO......:NHS-169-6(43)--19-94
COUNTY..........:WEBSTER CONTRACTOR:MATHY
SPEC NO.........:5040.00 SIZE......:3/4
SAMPLED BY......: SENDER NO.:
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 08/21/92
PROJ. LOCATION: FROM E. JCT. IOWA 175 TO U.S. 20

- -

AGG. SOURCES: CR. LST. & CHIPS - MARTIN MARIETTA, FORT DODGE MINE, WEBSTER CO.; MAN. SAND - MARTIN MARIETTA, HODGES, HUMBOLDT CO.; SAND - NORTHWEST LST., YATES, WEBSTER CO./ 15% RUBBER ADDED TO AC.

JOB MIX FORMULA-COMB. GRADATION

1 1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100.0	92.0	79.0	56.0	45.0	33.0	22.0	11.0	5.3	4.0
TOLERANCE /100 :											
		98	7	7	7	5		4			2

MATERIAL MIX	A94002	A94002	A46006	A94502	
% AGGR. PROP.	52.50	12.50	10.00	25.00	0.00

% ASPHALT IN MIX	5.25	6.25	7.25	0.00
NUMBER OF MARSHALL BLOWS	50	50	50	0
MARSHALL STABILITY - LBS.	1933	1777	1600	0
FLOW - 0.01 IN.	9	12	13	0
SP GR BY DISPLACEMENT (LAB DENS)	2.332	2.338	2.354	0.000
BULK SP. GR. COMB. DRY AGG.	2.697	2.697	2.697	0.000
SP. GR. ASPH. @ 77 F.	1.022	1.022	1.022	0.000
CALC. SOLID SP. GR.	2.497	2.459	2.423	0.000
% VOIDS - CALC.	6.60	4.94	2.85	0.00
RICE SP.GR.	2.469	2.438	2.405	0.000
% VOIDS - RICE	5.55	4.10	2.12	0.00
% WATER ABSORPTION - AGGREGATE	0.47	0.47	0.47	0.00
% VOIDS IN MINERAL AGGREGATE	18.07	18.73	19.05	0.00
% V.M.A. FILLED WITH ASPHALT	63.47	73.65	85.04	0.00
CALC. ASPH. FILM THICK. MICRONS	10.41	12.48	14.56	0.00
FILLER/BITUMEN RATIO	0.00	0.62	0.00	0.00

A CONTENT OF 6.5% BINDER IS RECOMMENDED TO START THE JOB.
TARGET VOIDS 3.5%
COPIES TO:

CENTRAL LAB	R. MONROE	J. ADAM
D. HEINS	MATHY	W. OPPEDAL
DIST. 1	JEFFERSON RES.	

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

ooooo

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT MIX DESIGN
LAB LOCATION - AMES

LAB NO....:AB02-0182

MATERIAL........:TYPE A
INTENDED USE....:BINDER
PROJECT NO......:NHS-169-6(43)--19-94
COUNTY..........:WEBSTER   CONTRACTOR:MATHY
SPEC NO.........:5040.00   SIZE......:3/4
SAMPLED BY......:   SENDER NO.:
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 08/20/92
PROJ. LOCATION: FROM E. JCT. IOWA 175 TO U.S. 20

- -

AGG. SOURCES: CR.LST. & CHIPS - MARTIN MARIETTA, FORT DODGE MINE, WEBSTER CO.; MAN. SAND - MARTIN MARIETTA, HODGES, HUMBOLDT CO.; SAND - NORTHWEST LST., YATES, WEBSTER CO.

JOB MIX FORMULA-COMB. GRADATION

1 1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100.0	92.0	79.0	56.0	45.0	33.0	22.0	11.0	5.3	4.0
TOLERANCE /100 :											
		98	7	7	7	5		4			2

MATERIAL MIX	A94002	A94002	A46006	A94502	
% AGGR. PROP.	52.50	12.50	10.00	25.00	0.00

ASPHALT SOURCE AND	ALGONA			
APPROXIMATE VISCOSITY POISES	0929			
% ASPHALT IN MIX	4.50	5.50	0.00	0.00
NUMBER OF MARSHALL BLOWS	50	50	0	0
MARSHALL STABILITY - LBS.	2482	2390	0	0
FLOW - 0.01 IN.	6	8	0	0
SP GR BY DISPLACEMENT (LAB DENS)	2.376	2.395	0.000	0.000
BULK SP. GR. COMB. DRY AGG.	2.697	2.697	0.000	0.000
SP. GR. ASPH. @ 77 F.	1.023	1.023	0.000	0.000
CALC. SOLID SP. GR.	2.526	2.488	0.000	0.000
% VOIDS - CALC.	5.94	3.73	0.00	0.00
RICE SP.GR.	2.497	2.462	0.000	0.000
% VOIDS - RICE	4.85	2.72	0.00	0.00
% WATER ABSORPTION - AGGREGATE	0.47	0.47	0.00	0.00
% VOIDS IN MINERAL AGGREGATE	15.87	16.08	0.00	0.00
% V.M.A. FILLED WITH ASPHALT	62.59	76.84	0.00	0.00
CALC. ASPH. FILM THICK. MICRONS	8.85	10.93	0.00	0.00
FILLER/BITUMEN RATIO	0.00	0.78	0.00	0.00

A CONTENT OF 5.1% AC 10 IS RECOMMENDED TO START THE JOB.
TARGET VOIDS 3.5%
COPIES TO:

CENTRAL LAB	R. MONROE	J. ADAM
D. HEINS	MATHY	DIST. 1
JEFFERSON RES.		

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

◦◦◦◦◦

APPENDIX C
Lab Test Results

TEST SECTION WORKSHEET

(1)

TEST SECTION WORKSHEET

DATE: 8/26/92 STATE: Iowa COUNTY: Webster

PROJECT NUMBER: _____ HIGHWAY: Co-169

MARKER: _____ % RUBBER: 15%

TYPE RUBBER: GFSDA UNIT RPM: 20

TOTAL RUBBER USED/DAY: 48,375 ASPHALT TEMP: 350°F

215 Sk. @ 225 ton = 48,375

BROOKSFIELD DATA

10 Rpm

TIME	TEMP	SPINDLE	B/F READING	FACTOR	CPS VISCOSITY	
8:30	350	3	2025	200	10.00	
11:30	350	3	6	200	1200	
1:30	350	3	5.5	200	1100	
5:00	350	3	7	200	1400	
	Made 875 Ton Asphalt Concrete					
		8/27/92				
		TORQ				
8:00	355	3	6	200	1200	
10:00	350	3	8	200	1600	
12:00	350	3	8.5	200	1700	
2:00	347	3	10.0	200	2000	
					1800	
5:00	345	3	9.5	200	1900	
	Rubber used = 21.5 Sacks @ 2250 48,375					

Made 2750 Tons Asphalt Concrete

Iowa Department of Transportation

DAILY PLANT REPORT

SITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Webster
Project NHS-169-6(43)--17-94
Contract No. 34398
Date 8-24-92
Report No. 11
Resident Engineer Ron DeBok

Contractor Mathy Construction — Plant Location 5 miles south Fort Dodge on Hwy 169
Plant Type Drum — Make Bituma — Pollution Equipment Bag House
Mix Type A — Class — Size 3/4" — Crushed Aggr. Sources Martin Marietta — Recycle Source
Asphalt Source & Grade Bituminous AC-05 — Sand Sources Hodges, Pate's — Plant Operated 7:45 A.M. to 6:30 P.M. — Mix No. ABD2-0162

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE Sol. ID	Time	Compl.	SIEVE NO. - % PASSING 1½	1	¾	½	4	8	16	30	50	100	200
JOB MIX FORMULA - LIMITS					98-100	85-97	72-86	49-63	39-50		18-26		2.0-6.0
KE-B11	AM	yes			100	93	84	60	46	35	25	14	7.5	5.2

SAMPLES SUBMITTED

Materials	Senders No.
¾" Type A	8-24-1
¾" Type A	8-24-2
¾" Type A	8-24-3
AC-05	AC-3901

Intended Added 5.5 % A.C. Tank Meas 5.60 % A.C.
Intended Total 6.5 % A.C. Total % A.C.
(with Rubber)

SAMPLES SUBMITTED

Materials	Senders No.
AC-5	ACC-02
AC-5	ACC-03
AC-5	ACV-01
AC-5	ACV-02 03

LAB. DEN. 2.371 — SOLID DEN. 2.408

DENSITY RECORD

Course Laid	Station	℄ Refer	Date Laid	*(T)	Density	% Density	% Voids
Binder	502+28	3' RT.	8-24-92	2¼	2.329	98.229	3.3
	490+27	7' RT.		2¼	2.322	97.933	3.6
	478+26	7' RT.		2½	2.366	99.789	1.7
	454+25	7' RT.		1¾	2.291	96.626	4.9
	444+64	9' RT.		2½	2.303	97.132	4.4
	511+78	7' LT.		1⅛	2.284	96.331	5.15
	491+98	5' LT.		2⅜	2.322	97.933	3.6

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	69	73	75	78	86	84
A.C.	303	320	325	325	330	330
Aggr.	303	305	310	315	305	310
Mix	300	300	305	312	300	305
Mat	290	295	300	325	295	300

RECYCLED MIX ONLY
Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC-5	2970	25.50
AC-5	2972	25.32
AC-5	2985	25.46
AC-5	2991	25.25
AC-5	2997	25.38
AC-5	2999	35.94

Avg. Field Density Lot #1 2.317
Avg. Field Density Lot #2

Advisory - Fines/Bitumen Ratio = 5.2/5.6 = 0.93
Ave % Field Voids = 3.8
Lab % Voids = 1.54
Q.I. (Density) = (Show Calculation)
(97.710 − 95.0) / 1.162 = 2.33 ✓

PRODUCTION AND PLACEMENT RECORD

*(2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
2	RT.	Binder	514+30 to 430+29	1421.69	
2	LT.	Binder	514+30 to 479+50	604.61	
				2026.30	30867.86

Acceptance Cold Feed (Certified Projects Only)	1"	¾"	½"	⅜"	#4	#8	#16	#30	#50	#100	#200
		100	96	84	59	45	34	23	12	7.5	4.6

COMMENTS: Started rubber mix today

Acceptance Fines/Bitumen Ratio = 4.6/5.6 = 0.82

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed Dick L. Olson 731
Inspector Kevin J. Ellis 318
Cert. No.

MATERIALS OFFICE – RECORDS CENTER COPY

Iowa Department of Transportation

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Webster
Project NHS-169-6(43)19-94
Contract No. 34398
Date 8-26-92
Report No. 19
Resident Engineer Ken DeBok

Contractor Mathy Construction Plant Location 5 miles south Fort Dodge on Hwy. 169
Plant Type Drum Make Bituma Pollution Equipment Bag House
Mix Type A Class Size 3/4" Crushed Aggr. Sources Martin Marietta Recycle Source
Asphalt Source & Grade Bituminous AC-05 Sand Sources Hodges, Yates Plant Operated 6:45 A.M. to 6:30 P.M. Mix No. ABB2-0162

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE Spl. ID	Time	Compl.	1½	1	¾	½	⅜	#4	#8	#16	#30	#50	#100	#200
JOB MIX FORMULA - LIMITS				98-100	85-99	72-96	49-63	40-50		14-26				2.0-6.0
KE-Ba	AM	YES		✓	100	92	91	57	45	35	26	14	7.1	5.0

SAMPLES SUBMITTED Materials	Sencers No.	SAMPLES SUBMITTED Materials	Sencers No.
¾" Type A	8-26-1	AC-5	ACC-06-09F
¾" Type A	8-26-2	AC-5	ACC-05-09
¾" Type A	8-26-3		
AC-5	ACC-05		

Intended Added 5.1 % A.C. Plant Meas. 5.37 % A.C.
Intended Total 6.1 % A.C. Total % A.C.

Lab. Den. 2.372 Solid Den. 2.445

DENSITY RECORD

Course Laid	Station	℄ Refer	Date Laid	(1)	Density	% Density	% Voids
Binder	508+46	5' RT.	8-26-92	2½	2.342	98.735	4.2
	469+77	1' RT.		1½	2.318	97.723	5.2
	441+24	9' RT.		2¼	2.364	99.663	3.3
	505+78	11' LT.		2 3/8	2.303	97.091	5.8
	490+92	3' LT.		2¼	2.299	96.585	6.4
	456+71	1' LT.		2⅜	2.374	100.084	2.9
	447+42	1' LT.	↓	2⅜	2.300	96.965	5.9

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	54	58	59	67	76	75
A.C.	328	337	329	323	324	333
Aggr.	315	310	320	320	315	310
Mix	310	305	315	315	310	305
Mat	300	305	320	315	310	305

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC-5	3006	25.39
AC-5	3008	25.62
AC-5	3012	25.68
AC-5	3019	25.39
AC-5	3022	25.69
AC-5	3027	25.90

Avg. Field Density Lot #1 2.327
Avg. Field Density Lot #2

Advisory - Fines/Bitumen Ratio = 5.0 / 5.37 = 0.93
Ave. % Field Voids = 4.8
Lab % Voids = 3.0
D.I. (Density) = (Show Calculation)

$$\frac{98.121 - 95.0}{1.386} = 2.25$$

PRODUCTION AND PLACEMENT RECORD

(2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
	RT.	Binder	514+60 to 429+00		
1	RT.	Binder	514+60 to 429+00	1368.17	
2	LT.	Binder	515+00 to 429+00	1362.74	
				2730.91	34399.74

Acceptance Cold Feed (Certified Projects Only)	1	¾	½	⅜	#4	#8	#16	#30	#50	#100	#200
		100	91	80	57	45	35	25	13	7.6	4.5

COMMENTS: 22 ton road waste

Rubber Mix

Acceptance Fines/Bitumen Ratio = 4.5 / 5.37 = 0.84

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

MT

Signed Ken J. Ellis (Inspector) 318 Cert. No.

MATERIALS OFFICE – RECORDS CENTER COPY

Iowa Department of Transportation

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Webster
Project NHS-169-6(43)--19-94
Contract No. 34398
Date 8-25-92
Report No. 12
Resident Engineer Ron DeBok

Contractor Mutter Construction — Plant Location 5 miles south Fort Dodge on Hwy. 169
Plant Type Drum — Make Barber Greene — Pollution Equipment Bag house
Mix Type A — Class — Size 3/4" — Crushed Aggr. Sources Martin Marietta — Recycle Source
Asphalt Source & Grade Bituminous AC-05 — Sand Sources Hodges, Yates
Plant Operated 7:00 A.M. to 10:30 P.M. Mix No. AB02-0162

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE				SIEVE NO. - % PASSING										
JOB MIX FORMULA - LIMITS				98-100	95-99	72-86	49-63	36-50		18-26				20-60
Set ID	Type	Comply	1½	1	¾	½	⅜	4	8	16	30	50	100	200
KC-AM	AM	yes		1	100	92	79	57	44	33	23	12	6.5	4.5

SAMPLES SUBMITTED		SAMPLES SUBMITTED	
Materials	Senders No.	Materials	Senders No.
3/4" Type A	8-25-1	AC-5	ACC-02
3/4" Type A	8-25-2	AC-5	ACC-03
3/4" Type A	8-25-3	AC-5	ACC-04
AC-5	ACC-04	AC-5	ACC-02, 03

Intended Added 5.1 % A.C. Tank Meas. 5.34 % A.C.
Intended Total 6.1 % A.C. Total % A.C.

LAB. DEN. 2.362 — SOLID DEN. 2.450

DENSITY RECORD

Course Laid	Station	℄ Refer	Date Laid	* (1)	Density	% Density	% Voids
Binder	474+63	3' LT.	8-25-92	3¼	2.331	98.684	4.9
	469+80	7' LT.		1 7/8	2.334	98.815	4.7
	463+05	5' LT.		2 7/8	2.286	96.782	6.7
	458+46	9' LT.		2	2.276	96.359	7.1
	449+55	11' LT.		2¼	2.306	97.639	5.9
	442+90	5' LT.		2½	2.333	98.772	4.8
	432+21	9' LT.		1 7/8	2.270	96.105	7.35

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	59	62				
A.C.	310	326				
Aggr.	310	316				
Mix	305	310				
Mat	310	310	300			

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC-5	3009	25.55

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

Avg. Field Density Lot #1 2.305
Avg. Field Density Lot #2

Advisory - Fines/Bitumen Ratio = 4.5 / 5.34 = 0.84
Ave. % Field Voids = 5.9
Lab % Voids = 3.6
O.I. (Density) = (Show Calculation)

$$\frac{97.593 - 95.0}{1.189} = 2.18$$

PRODUCTION AND PLACEMENT RECORD

* (2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
	LT.	Binder	478+56 to 431+25	800.99	3668.95

Acceptance Cold Feed (Certified Projects Only)	1	¾	½	⅜	4	8	16	30	50	100	200
		100	94	82	59	45	34	24	12	7.9	4.6

COMMENTS

Rained out at 10:30
A.C. changed to 5.1% from 5.5%

Rubber Mix

Acceptance Fines/Bitumen Ratio = 4.5 / 5.34 = 0.86

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

MT

Signed Ron DeBok Inspector — 318 Cert. No.

MATERIALS OFFICE — RECORDS CENTER COPY

Iowa Department of Transportation

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Webster
Project NHS-169-6(43):19-94
Contract No. 34398
Date 8-27-92
Report No. 14

Contractor Manatt Construction Plant Location 5 miles south Fort Dodge on Hwy 169
Plant Type Drum Make Bitumix Pollution Equipment Baghouse Resident Engineer Ron DeBok
Mix Type A Class ___ Size 3/4" Crushed Aggr. Sources Martin Marietta Recycle Source ___
Asphalt Source & Grade Bituminous AC-0.5 Sand Sources Hodges, Yates Plant Operation 6:45 A.M. to 6:00 P.M. Mix No. ABO2-0162

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE Sol. ID	Time	Comp.	1½	1	¾	½	⅜	4	8	16	30	50	100	200
JOB MIX FORMULA - LIMITS					98-100	85-99	72-86	49-63	40-52		18-26			3.0-6.0
VE-BIT	AM	yes			100	94	83	61	46	34	23	12	6.5	4.5

SAMPLES SUBMITTED

Materials	Senders No.
3/4" Type A	8-27-1
3/4" Type A	8-27-2
3/4" Type A	8-27-3
AC-5	Acc-10

Intended Added 5.1 % A.C. Tank Meter 5.27 % A.C.
Intended Total 6.1 % A.C. Total ___ % A.C.

SAMPLES SUBMITTED

Materials	Senders No.
AC-5	Acc-11-13
AC-5	ACC-10-13

LAB. DEN. 2.331 SOLID DEN. 2.451

DENSITY RECORD

Course Laid	Station	℄ Refer	Date Laid	(1)	Density	% Density	% Voids
Binder	322+04	1' Rt.	8-27-92	2½	2.291	96.457	6.7
	300+66	5' Rt.		1¾	2.255	95.108	8.0
	337+80	11' Rt.		2½	2.273	95.967	7.3
	312+09	1' Rt.		2¼	2.293	96.298	6.4
	369+27	11' Lt.		2½	2.270	95.740	7.4
	337+79	1' Lt.		2	2.294	96.752	6.4
	322+55	1' Lt.		2⅛	2.302	97.090	6.1

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	54	58	70	74	76	76
A.C.	311	323	333	325	328	330
Aggr.	305	312	317	313	315	320
Mix	300	307	313	309	310	313
Mat	300	320	315	305	320	315

RECYCLED MIX ONLY

Total RAP Used Tons ___
Total Aggr. Used Tons ___
RAP Used % ___
Aggr. Used % ___

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC-5	3040	26.00
AC-5	3041	25.43
AC-5	3044	26.14
AC-5	3048	25.30
AC-5	3049	20.16

Avg. Field Density Lot #1 2.291
Avg. Field Density Lot #2

Advisory - Fines/Bitumen Ratio = 4.5/5.21 = 0.85
Ave. % Field Voids = 6.9
Lab % Voids = 3.3
Q.I. (Density) = (Show Calculation)

$$\frac{96.186 - 95.0}{0.669} = 1.77$$

PRODUCTION AND PLACEMENT RECORD

(1)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
	Rt.	Binder	393+50 to 303+50	1320.58	
	Lt.	Binder	353+50 to 303+50	1370.21	
				2700.79	37100.55

Acceptance Cold Feed (Certified Projects Only)	1	1½	¾	⅜	4	8	16	30	50	100	200
		100	93	82	60	45	34	23	12	7.1	4.5

COMMENTS: Finished job

Rubber Mix

Acceptance Fines/Bitumen Ratio = 4.5/5.27 = 0.45

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

MT

Signed Dick Peterson 231
Inspector
Kevin J. Ellis 318
Cert. No.

MATERIALS OFFICE – RECORDS CENTER COPY

TEST SECTION WORKSHEET

(2)

TEST SECTION WORKSHEET

DATE: 8/24/92 STATE: Iowa COUNTY: webster

PROJECT NUMBER: _____ HIGHWAY: IA 169

MARKER: _____ % RUBBER: 15%

TYPE RUBBER: GF-50A UNIT RPM: 80

TOTAL RUBBER USED/DAY: 19 Gallons ASPHALT TEMP: 340-360°F
@ 2250 #. Each = 42,750 #

BROOKSFIELD DATA

TIME	TEMP	SPINDLE	5RPM D&F READING	FACTOR	CPS VISCOSITY		
11:00	350	3	5	400	2000		
1:00	360	3	8	400	3200		
3:00	360	3	6	400	2400		
5:30	360	3	8	400	3200		
		8/25/92					10 RPM
7:30	345	3	4.5	400	1800	310	340 - 1200 CPS
9:00	345	3	5	400	2000	310	350 - 1200 CPS
11:00	345	3	6	400	2400	310	345 1400 CPS
	(6) used 6? gallon @						
	2250 #/gallon = 13,500						
	(3) made						

AAT2-0449
A

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - BITUMINOUS AGGREGATES
LAB LOCATION - AMES

LAB NO....:AAT2-0449

MATERIAL........:GF 50 CRUMB RUBBER
INTENDED USE....:A.R.C. BINDER
PRODUCER........:ROUSH
PROJECT NO......:NHS-169-6(43)--19-94
COUNTY..........:WEBSTER   CONTRACTOR:MATHY CONST.
UNIT OF MATERIAL:GF - 50 RUBBER GRANULES
SAMPLED BY......:C. ANDERSON   SENDER NO.:CA2-123
DATE SAMPLED: 08/24/92   DATE RECEIVED: 08/27/92   DATE REPORTED: 08/27/92

SIEVE NO. 10 - 100.0

LAB NUMBER	AAT2-0449
SIEVE ANALYSIS %	
#30	98.0
#50	33.0

COPIES TO:
CENTRAL LAB   GEOLOGY   V. MARKS

DISPOSITION:

ooooo

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

Marshall Stability, Creep and Resilient Modulus Testing

Test	Material	Conventional	ARC
Marshall Stability	¾ - inch binder, 50 blows	2,436	1,790
Creep	¾ - inch binder, 50 blows	88	77
Resilient Modulus	¾ - inch binder, 50 blows	710,000	580,000