EVALUATION OF RECYCLED RUBBER IN ASPHALT CONCRETE

Construction Report
Highway Research Advisory Board
Project HR-330
Federal Highway Administration
Project DTFH71-91-TE03-IA-30

December 1991

Highway Division
Iowa Department of Transportation

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Evaluation of Recycled Rubber in Asphalt Concrete

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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 a standard, specification or regulation.

ABSTRACT

Discarded tires present major disposal and environmental problems. The recycling of those tires in asphalt cement concrete is what this research deals with. The Iowa DOT and the University of Northern Iowa (UNI) are evaluating the use of discarded tires in asphalt rubber cement and rubber chip mixes.

The project is located on US 61 between Blue Grass and Muscatine in Muscatine County. It contains four rubberized asphalt sections and control sections. One section consists of reacted rubber asphalt cement used in both the binder and surface courses, and one section, both lanes, contains a rubber chip mix.

The reacted rubber asphalt and the rubber chip mixes were laid in July 1991. The project construction went well with a few problems of shoving and cracking of the mat.

This report contains information about procedures and tests that were run and those that will be run. It also has a cost comparison since this is a major concern with the use of asphalt rubber. Evaluation of this project will continue for five years.

Three more research projects containing rubberized asphalt were constructed in 1991 and another is to be constructed in 1992.

INTRODUCTION

Discarded tires have become a major disposal problem. In the U.S. there are approximately 250 million automobile tires and about 25 million truck tires discarded every year. There are approximately three million tires discarded annually in Iowa. Since these tires do present many environmental problems, a way to recycle them has become vitally important.

In the late 1960's a method was introduced to use rubber in asphalt mixtures. It was originally used as a seal coat and a binder in hot mixes. Now field testing and evaluation has begun in Iowa using recycled rubber asphalt cement. Five projects have been selected for the testing and evaluation. There will be two different types of asphalt rubber used in this research project. There will be a reacted rubber asphalt cement referred to as asphalt rubber cement (A.R.C.). This was used in both a binder course and a surface course on a test section. It was used in a surface course with a conventional mix used as a binder in two test sections. A rubber chip mix was used and tested in one test section on this project.

OBJECTIVES

The objective of this research project is to evaluate the use of finely ground recycled tire rubber as asphalt rubber cement and recycled rubber granules in asphalt concrete pavements.

CONTRACTORS

The contractor on this project was Manatt's Inc. of Brooklyn, Iowa. Their plant was adjacent to the project. Their plant provided the conventional asphalt mix. They also laid the conventional asphalt and the rubber chip mixes.

The A.R.C. was subcontracted to Determann Construction. It was furnished by an asphalt plant at the Wendling Quarry at Moscow. The rubber chip mix was also produced at the Wendling Quarry.

PROJECT LOCATION

This asphalt rubber project was located on US 61 between Muscatine and Blue Grass in Muscatine County. The test sections are listed in Table I.

Table I

Test Section	Sta. to Sta.	Lane	Type of Mix
1	129+00 to 150+00	EB	Conventional Control Section
2	150+00 to 154+00	EB&WB	Rubber Chip Surface
3	154+00 to 180+00	EB	A.R.C. Surface Only
4	180+00 to 212+50	EB	Conventional Control Section
5	212+50 to 239+00	EB	A.R.C. Binder & Surface
6	239+00 to 262+65	EB	Conventional Control Section
7	262+65 to 290+00	EB	A.R.C. Surface Only
8	290+00 to 317+00	EB	Conventional Control Section

PRECONSTRUCTION SURVEY

The existing pavement was a 10 inch by 24 feet jointed portland cement concrete pavement constructed in 1957. The

joints were spaced 20 feet apart. The 1988 traffic volume was 7490 vehicles per day with 17% trucks.

A crack and patch survey was conducted on the research section before construction began. The Road Rater was used to test a portion of the project in April of 1991. A few weeks after the completion of the project it was used on the entire section. These results are shown in Appendix D.

Patching was required on some areas of the project prior to the overlay.

The existing pavement showed minimal signs of distress or wear.

MATERIALS

The ground tire rubber and the rubber chips were provided by Rouse Rubber Products from Vicksburg, Mississippi. Both were delivered in 50# paper bags. Rouse had originally intended to use a GF-80 rubber or a GF-40 rubber for the ground rubber. Preliminary testing on these products concluded they could not meet specification gradation limits. Rouse then submitted a GF-35 rubber which met gradation limits and was used in the project. The gradation limits on all the materials used in this project are located in the Special Provisions in Appendix A in the back of this report. The gradations of the GF-35 rubber used in this project are given in Appendix D.

The AC-5 used in the reacted rubber mixes and the AC-10 for the rubber chip and conventional mixes were supplied by Amoco Oil of Davenport.

Aggregate sources are given in Appendix C; test reports and the gradation in Appendix D.

A.R.C. VISCOSITIES

Viscosity testing for specification purposes was originated in the fall of 1990. The percents of ground rubber tested for viscosities were 5.0%, 10.0%, 15.0%, 17.0% and 20.0%. Readings were taken at 3 minutes, 10 minutes, 30 minutes and 1 hour intervals. The temperature used in the testing was 350°F $\pm$ 10°F. The viscosity testing was done using a Brookfield viscometer reporting centipoise (CP) readings. A test was also made using AC-5 with no rubber. That reading held constant at 100 CP. The readings are listed and charted in Appendix B.

The specification for the A.R.C. was 1500-4000 CP. Laboratory testing prior to mix design determined that 15% of GF-35 rubber would yield viscosities within these specifications.

During construction, viscosity testing was done at the plant by Rouse Rubber. These results are shown in Appendix D.

MIX DESIGN

Samples of all materials were obtained for preliminary testing. The job mix for all mixes used in this project are given in Appendix C.

It was recommended a field change be made in the A.R.C. binder mix at Sta. 225+75. The mix appeared dry with some cracking and shoving occurring. At that time, the AC-5 was increased .2% from 6.6% to 6.8%. Shortly after that, the gradation at the plant was completed showing it was in noncompliance. The mix design was again changed at Sta. 234+50, lowering the AC-5 .2% back to the original 6.6%. An interchange was also made at this time on the materials, increasing the 1/2" chips by 5% and lowering the manufactured sand 5%. This changed the aggregate proportions as shown in Table II.

Table II

Material	Original	Revised
3/4" - Limestone	45%	45%
1/2" With Chips	20%	25%
Manufactured Sand	10%	5%
Sand	25%	25%

The mix design for the A.R.C. surface mix was not altered.

There was a change made in the rubber chip mix due to high voids. This change is given in Table III.

Table III

Material	Original	Revised
Granite	25%	25%
1/2" - Limestone	45%	40%
3/4" - Limestone	15%	13%
Sand	15%	22%

The lab and field densities and the difference between them along with the voids are shown in Appendix D.

PLANT OPERATION

The A.R.C. and the rubber chip mixes were both produced by a Cedar Rapids batch plant at Wendling Quarry in Moscow. The conventional mix was produced by a Cedar Rapids drum plant near the project.

The Rouse reactor was overseen by a technical director employed by Rouse. The finely ground GF-35 rubber was manually fed into a hopper on the reactor. From there it was gravity fed into the reaction chambers where it was agitated for 15 to 20 minutes. There are two chambers equipped with baffles between them so the reacted rubber asphalt flows between both tanks. It is then piped from the reactor into the regular asphalt system. There is a monitoring device that is based on the rpm's of the motor and the percent of rubber desired. The temperature of the reacted rubber AC before it was discharged into the regular system ran 300°F to 350°F. The valve and piping connecting the Rouse system to the conventional system was relatively small. This caused production to slow down, dropping it from the normal 250 ton per hour to around 150 ton

per hour. Another cause for the difference could be attributed to the fact the reacted rubber runs slower once the system cools down.

The rubber chips were added to the mix by means of a hopper. The 50 lb. bags of rubber chips were placed on a platform next to the hopper. They were manually dumped into the hopper and combined with the mix. The entire mix was mixed for an additional 15 seconds before dumping it into the truck.

PAVING OPERATION

The A.R.C. binder and surface courses were laid with a Blow-Knox PF-500 Paver. They both laid similar to a conventional mix.

The A.R.C. binder appeared very dry. The contractors had trouble with shoving and cracking as it was being rolled. The mix design was altered which yielded some improvement. Determann also tried using a smaller roller but that was of no help. The next morning after traffic had been on the mat, it appeared much better. Some of the cracks had closed up and the mat had become more stable.

The appearance of the A.R.C. surface was much different than the binder. It looked more uniform with more voids. The A.R.C. seemed to lay well but it needed extra time before the rolling operation could begin. This was due to the fact the A.R.C. was laid at a higher temperature than the conventional

mix. The gates of the paver were adjusted to allow for the shoving on the edges of the mat.

The rubber chip mix was laid using a Cedar Rapids CR531 Paver. This mix looked much coarser and richer than a conventional mix. The contractor had problems with shoving of the mix as well as problems with it sticking to the drum of the roller. This may have been caused by the high AC content (7.6%) or another factor could have been the higher temperature of the chip mix at laydown which was 330°F.

The mix was changed before the westbound section of the rubber chip mix was laid. This was shown in Table III.

CONSTRUCTION TESTING

Samples were taken at the time of construction by UNI for the ductility tests, aging tests, tensile creep tests, and fatigue tests. The Iowa DOT obtained samples for creep and resilient modulus testing. Results of these tests will be available later.

Gradations were run on all materials at the time of construction. These appear in Appendix D.

Box samples and cores were taken by construction and materials personnel to determine densities and voids. These results are also shown in Appendix D.

Post construction Road Rater and friction testing have been completed. Rut depth measurements have been completed also. These results are given in Appendix D.

COST COMPARISON

A drawback to using A.R.C. or a rubber chip mix is the higher cost. The cost of the A.R.C. and the rubber chip mixes are more than double the price of the conventional mix. On this project, the conventional asphalt cement was bid at $155/ton while the asphalt cement (reacted rubber) was bid at $686/ton. The contract prices of the different asphalt mixes are summarized in Table IV.

Table IV

Conventional Binder		Conventional Surface	
	$17.39		$22.19
AC-10 (6.0%)	9.30	AC-10 (5.1%)	7.91
	$26.69/Ton		$30.10/Ton

A.R.C. Binder		A.R.C. Surface	
	$25.25		$25.25
6.56% A.R.C.	45.00	5.72% A.R.C.	39.24
	$70.25/Ton		$64.49/Ton

Rubber Chips	
	$59.32
AC-10 (7.6%)	11.78
	$71.10/Ton

EVALUATION

The evaluation will consist of ductility tests, aging tests, tensile creep tests and fatigue tests.

There will also be annual friction testing, Road Rater testing and crack and rut surveys.

In addition to the standard project testing of the mix, creep and resilient modulus testing will also be performed.

This project will be evaluated for five years.

This project in Muscatine County will be tested and evaluated for the next five years along with four other projects using asphalt rubber in Iowa. Three have been completed (US 151 in Dubuque, US 218 in Black Hawk and IA 140 in Plymouth). An IA 21 Black Hawk project will be constructed in 1992.

After five years, hopefully a conclusion can be made to determine if using asphalt rubber binders and recycled rubber granules will:

1. Improve performance.
2. Extend the life of the roadway.
3. Be of enough value in an environmental standpoint to compensate for its higher cost.

CONCLUSIONS

From this project the following conclusions can be made:

1. A.R.C. mix and the rubber chip mix can be constructed with little or no difference from that of a conventional mix.

2. A.R.C. pavement and rubber chip pavement appear to be in as good a condition as the conventional. Visually, there is a slight color difference in the conventional and the A.R.C. but the rubber chip mix is much darker than the other two mixes.

County MUSCATINE Project No. F-61-4(49)--20-70
Res. Engr. JOSEPH W. DEMETER Address MOUNT PLEASANT RCE 525100
Letting Date OCTOBER 2, 1990 Liquidated Damages $850 PER DAY
Special Prov. FHWA-1273 08/01/89, FHWA-1273 08/01/89, SP- 952A 10/02/90,
SP- 954A 10/02/90, SS- 964 07/31/84, SS-1006 12/17/85,
SS-1057 02/23/88, SS-1059 02/23/88, SS-1062 08/01/88,
SS-1083 06/27/89, SS-1089 12/05/89, SS-1090 12/05/89,
SS-1091 12/05/89, SS-1094 12/05/89, SS-5001 03/27/90,
SS-5003 05/01/90, SS-5006 08/28/90
Date Started _____ Field Comp. _____ Cert. Comp. _____

Form 650019 4-86 H-6284

CONTRACT NO. 32313

County MUSCATINE Project No. F-61-4(49)--20-70
Type of Work ASPH CEMENT CONC RESURFACING Miles 14.5180
Cost Center 611000 Object Code 891 Milepost 92.13 TO 106.76
ON U.S. 61 FROM JUST EAST OF THE E.C.L. OF THE CITY OF MUSCATINE, EASTERLY TO JUST EAST OF THE W.C.L. OF THE CITY OF BLUE GRASS IN SCOTT COUNTY.

This agreement made and entered by and between the IOWA DEPARTMENT OF TRANSPORTATION AUSTIN TURNER, DOUGLAS SHULL, C. ROGER FAIR, ROBERT H. MEIER, SHELDA HERTZKE BEENER, SUZAN STEWART & CATHERINE DUNN Contracting Authority, and
MANATTS INC. & SUBSIDIARY OF BROOKLYN, IOWA
00028200 Contractor.

It is agreed that the notice and instructions to bidders, the proposal filed herein, the general specifications of the Iowa Department of Transportation for 1984, together with supplemental specifications and special provisions, together with the general and detailed plans, if any, for said project F-61-4(49)--20-70, together with Contractor's performance bond, are made a part hereof and together with this instrument constitute the contract. This contract contains all of the terms and conditions agreed upon by the parties hereto. A true copy of said plans and specifications is now on file in the office of the Contracting Authority under date of SEPTEMBER 27, 1990.

Contractor, for and in consideration of $ **3,950,811.08, payable as set forth in the specifications constituting a part of this contract, agrees to construct various items of work and/or provide various materials or supplies in accordance with the plans and specifications therefor, and in the locations designated in the Notice to Bidders.

Contractor certifies by his signature on this contract, under pain of penalties for false certification, that he has complied with Iowa Code Section 324.17(8) (1985) as amended, if applicable.

In consideration of the foregoing, Contracting Authority hereby agrees to pay the Contractor promptly and according to the requirements of the specifications the amounts set forth, subject to the conditions as set forth in the specifications.

It is further understood and agreed that the above work shall be commenced or completed in accordance with the following schedule:

START. DATE	COMPL. DATE	WORK. DAYS
	11/01/91	90

Time is the essence of this contract.

To accomplish the purpose herein expressed, Contracting Authority and Contractor have signed this and four other identical instruments as of the _____ day of _____.

IOWA DEPARTMENT OF TRANSPORTATION

By _____
Contracting Authority

MANATTS INC. & SUBSIDIARY OF BROOKLYN, IOWA

By _____ _____
Contractor

Proposal I.D. No. 901603 CONTRACT NO. 32313 Bid Order No. 49

Contractor's No. 12-82-21-01 County MUSCATINE Page No. 1

Project No. F-61-4(49)--20-70 Type of Work ASPH CEMENT CONC RESURFACING

Line No.	Item	Item Quantity and Units	Unit Price Dollars X,XXX,XXX	Unit Price Cents XXXX	Amount Dollars XX,XXX,XXX	Amount Cents XX	
0010	PAVEMENT SCARIFICATION	5521 SQ. YDS.	4.2000		23,188.20		
0020	ASPHALT CEMENT CONCRETE, TYPE A SURFACE COURSE, MIXT. SIZE 3/4 IN.	24349 TONS	22.1900		540,304.31		
0030	ASPHALT CEMENT CONCRETE, TYPE A BINDER COURSE, MIXT. SIZE 3/4 IN.	30709 TONS	17.3900		534,029.51		
0040	ASPHALT CEMENT CONCRETE, TYPE A SURFACE COURSE, 3/4 IN. (RUBBER CHIPS ADDED)	153 TONS	59.3200		9,075.96		
0050	A.C.C., TYPE A SURFACE COURSE, 3/4 IN. (REACTED RUBBER BINDER - A.C.C. MIX)	1288 TONS	25.2500		32,522.00		
0060	A.C.C., TYPE A BINDER COURSE, 3/4 IN. (REACTED RUBBER BINDER - A.C.C. MIX)	547 TONS	25.2500		13,811.75		
0070	ASPHALT CEMENT (REACTED RUBBER)	138 TONS	686.0000		94,668.00		@7.5%
0080	ASPHALT CEMENT	3777 TONS	155.0000		585,435.00		@5.5%
0090	BASE, TYPE B CLASS 1 ASPHALT CEMENT CONCRETE	2071 TONS	23.5900		48,854.89		
0100	BACKFILL, SPECIAL	1323 TONS	11.8300		15,651.09		
0110	ASPHALT CEMENT CONCRETE, TYPE A WEDGE, LEVEL OR STRENGTH. COURSE	11188 TONS	20.7300		231,927.24		
0120	PRIMER OR TACK-COAT BITUMEN	30858 GALLONS	0.9500		29,315.10		
0130	BASE, CLEANING & PREPARATION OF	14.53 MILES	1200.0000		17,436.00		
0140	SHOULDERS, GRANULAR, TYPE A	45029 TONS	11.6500		524,587.85		
0150	FABRIC REINFORCEMENT	1807 SQ. YDS.	3.0000		5,421.00		
0160	ASPHALT CEMENT CONCRETE (COMPOSITE SECTIONS)	65.1 TONS	100.0000		6,510.00		
0170	PATCHES, FULL-DEPTH, BY COUNT	195 ONLY	375.0000		73,125.00		
0180	PATCHES, FULL-DEPTH, BY AREA	7413.4 SQ. YDS.	77.8500		577,133.19		
0190	DOWEL ASSEMBLIES	170 ONLY	70.0000		11,900.00		
0200	PATCHES, SURFACE	200 TONS	40.0000		8,000.00		

Line No.	Item	Item Quantity and Units	Unit Price Dollars X,XXX,XXX	Unit Price Cents XXXX	Amount Dollars XX,XXX,XXX	Amount Cents XX
	(CONTINUED)					
0210	EMBANKMENT-IN-PLACE	1308 CUBIC YDS	10.0000		13,080.00	
0220	EXCAVATION, CLASS 13, FOR WIDENING	1310 CUBIC YDS	9.3600		12,261.60	
0230	TRENCHING & RESHAPING	5.5 STAS.	100.0000		550.00	
0240	SAW CUT	351 LINEAR FT	1.5000		526.50	
0250	REMOVAL OF PAVEMENT	191 SQ. YDS.	3.5000		668.50	
0260	CULVERT, CONCRETE ENTRANCE PIPE, 18 IN. DIA.	18 LINEAR FT	30.0000		540.00	
0270	CULVERT, CORRUGATED METAL ENTRANCE PIPE, 15 IN. DIA.	12 LINEAR FT	25.0000		300.00	
0280	CULVERT, CONCRETE ROADWAY PIPE, 24 IN. DIA.	90 LINEAR FT	70.0000		6,300.00	
0290	ELBOWS, CORRUGATED METAL PIPE, 24 IN. DIA.	1 ONLY	300.0000		300.00	
0300	APRONS, CONCRETE, 18 IN. DIA.	1 ONLY	300.0000		300.00	
0310	APRONS, CONCRETE, 30 IN. DIA.	1 ONLY	400.0000		400.00	
0320	APRONS, METAL, 15 IN. DIA.	1 ONLY	125.0000		125.00	
0330	APRONS, CONCRETE, 24 IN. DIA.	1 ONLY	350.0000		350.00	
0340	CULVERT, CONCRETE ROADWAY PIPE, 30 IN. DIA.	24 LINEAR FT	125.0000		3,000.00	
0350	CULVERT, REMOVE & RELAY CONCRETE ROADWAY PIPE, 30 IN. DIA.	186 LINEAR FT	35.0000		6,510.00	
0360	CULVERT, CONCRETE ROADWAY PIPE, 42 IN. DIA.	6 LINEAR FT	500.0000		3,000.00	
0370	CULVERT, REMOVE & RELAY CONCRETE ROADWAY PIPE, 42 IN. DIA.	72 LINEAR FT	75.0000		5,400.00	
0380	CULVERT, REMOVE & RELAY CONCRETE ROADWAY PIPE, 48 IN. DIA.	90 LINEAR FT	100.0000		9,000.00	
0390	CULVERT, REMOVE & RELAY CONCRETE ROADWAY PIPE, 24 IN. DIA.	186 LINEAR FT	75.0000		13,950.00	

Proposal I.D. No. 901603 CONTRACT NO. 32313 Bid Order No. 49

Contractor's No. 121812101 County MUSCATINE Page No. 3

Project No. F-61-4(49)--20-70 Type of Work ASPH CEMENT CONC RESURFACING

Line No.	Item	Item Quantity and Units	Unit Price Dollars XXXX.XXX	Unit Price Cents XXXX	Amount Dollars XX,XXX,XXX	Amount Cents XX
	(CONTINUED)					
0400	REMOVAL OF GUARDRAIL	425 LINEAR FT	3.0000		1,275.00	
0410	GUARDRAIL, FORMED STEEL BEAM	2350 LINEAR FT	8.0000		18,800.00	
0420	GUARDRAIL, POSTS, BEAM	358 ONLY	42.0000		15,036.00	
0430	GUARDRAIL, END ANCHORAGES, BEAM, RE-52	12 ONLY	350.0000		4,200.00	
0440	OBJECT MARKER, TYPE 3	12 ONLY	80.0000		960.00	
0450	PAVEMENT MARKINGS	2885 STAS.	16.9500		48,900.75	
0460	SAMPLES	1 LUMP SUM	16725.0000		16,725.00	
0470	TRAFFIC CONTROL	1 LUMP SUM	45000.0000		45,000.00	
0480	STABILIZING CROP - SEEDING AND FERTILIZING	3.2 ACRES	404.0000		1,292.80	
0490	SEEDING & FERTILIZING	3.2 ACRES	528.0000		1,689.60	
0500	MULCHING	3.2 ACRES	490.0000		1,568.00	
0510	SHOULDER CONSTRUCTION, EARTH	105.5 STAS.	200.0000		21,100.00	
0520	EXCAVATION, CLASS 20, FOR ROADWAY PIPE CULVERT	1380 CUBIC YDS	15.0000		20,700.00	
0530	SILT FENCE FOR DITCH CHECKS	120 LINEAR FT	3.5000		420.00	
0540	SUBDRAIN, LONGITUDINAL, (SHOULDER) 4 IN. DIA.	1596 LINEAR FT	6.9400		11,076.24	
0550	SUBDRAIN OUTLET, CORRUGATED METAL PIPE, 6 IN. DIA.	10 ONLY	150.0000		1,500.00	
0560	FIELD LABORATORY	1 ONLY	1000.0000		1,000.00	
0570	MOBILIZATION	1 LUMP SUM	272010.0000		272,010.00	
0580	CULVERT, REMOVE & RELAY CONCRETE ROADWAY PIPE, 36 IN. DIA.	108 LINEAR FT	50.0000		5,400.00	
0590	CULVERT, CONCRETE ROADWAY PIPE, 36 IN. DIA.	18 LINEAR FT	150.0000		2,700.00	

TOTAL $3,950,811.08

LAST PAGE

REVISED

SPECIAL PROVISIONS
for
REACTED RUBBER BINDER -
ASPHALT CEMENT CONCRETE

F-61-4(49)—20-70, Muscatine-Scott Counties

October 2, 1990

THE STANDARD SPECIFICATIONS, SERIES OF 1984, ARE AMENDED BY TH FOLLOWING MODIFICATIONS. THIS IS AN ADDENDUM TO THE SPECIA PROVISIONS, WHICH SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDAR SPECIFICATIONS AND SP-952(New).

952A.01 DESCRIPTION.

The reacted rubber binder-asphalt cement concrete mix composition will include th incorporation of reacted asphalt cement (reacted rubber) in the mixture, using th aggregates selected by the Contractor. The volumes of ingredients in the mixture sha be in accordance with the recommendation of the supplier of the asphalt cement (reacte rubber).

The Contractor shall have a representative of the supplier be available on the proje site during the erection of the asphalt plant, during the initial production of th materials. The Contractor shall have a representative of the supplier on call fo technical assistance during production operations.

952A.02 GENERAL REQUIREMENTS.

Reacted rubber binder-asphalt cement concrete mix shall conform to the requirements o the standard specifications for the standard mixes as called for in the plans, the Special Provisions, and the Standard Specifications which are modified as follows.

A. Mineral Aggregate for Reacted Rubber Binder - Asphalt Cement Concrete Mix.

Mineral aggregates shall meet Type "A" quality as per the plans and specificatio except the gradation shall meet the following:

Sieve size	Percent passing
1"	100
3/4"	98-100
1/2"	76-92
3/8"	60-83
#4	40-62
#8	26-45
#30	11-24
#200	3-7

B. Asphalt Cement (Reacted Rubber)

The asphalt cement (reacted rubber) shall be a uniform mixture of compatible paving grade asphalt cement, ground reclaimed vulcanized rubber, and if required by the mixture design, a liquid anti-strip agent. The asphalt cement (reacted rubber) shall meet the following physical parameters when reacted at 350 ±10 degrees Fahrenheit for 60 minutes.

Test	Requirements
Viscosity Haake, 350°F	1500 - 4000 CP
Cone Penetration 77°F ASTM D1191	Per job mix
Softening Point 135-200°F ASTM D36	Per job mix
Resilience 77°F ASTM D3407	15% min.

952A.03 GROUND RECLAIMED VULCANIZED RUBBER.

The rubber used shall be produced from the recycling of automobile and truck tires. Final grinding of the rubber shall be accomplished with ambient temperature processes only. The use of ground rubber from multiple sources is acceptable provided the over-all blend of rubber meets the gradation requirements. The gradation of the rubber when tested in accordance with ASTM C136 using approximately 50 grams shall be in accordance with the following table.

Sieve Size	Percent passing
#10	100
#30	90-100
#50	10-90

Gradation of the rubber may be adjusted due to compatibility and reaction characteristics with the asphalt cement as required in the job mix formula.

Specific gravity of the rubber shall be 1.15 ± 0.05 and it shall be free from fabric, wire, or other contaminating materials. However, up to four percent calcium carbonate may be included to prevent the particles of rubber from sticking together.

The rubber shall be dry so as to be free flowing and not produce foaming when blended with hot asphalt cement. Not more than 1% of the particles shall exceed six times their minimum dimension.

952A.04 PACKAGING.

The ground rubber shall be supplied in moisture resistant disposable bags which weigh 50 ± 2 lbs. The bags shall be palletized into units each containing 50 bags to provide net pallet weights of 2500 ± 100 lbs. Glue shall be placed between layers of bags to increase the unit stability during shipment. Palletized units shall be double wrapped with ultra-violet resistant stretch wrap.

952A.05 CERTIFICATION.

The manufacturer shall ship with the rubber, certificates of compliance which certify that all requirements of these specifications are complied with for each production lot number of shipment.

952A.06 ASPHALT CEMENT (REACTED RUBBER) BLEND DESIGN

The asphalt cement (reacted rubber) shall be grade AC-5. The mixture design shall be performed by the asphalt-rubber supplier. The proportion of ground rubber shall be between 10 and 25 percent by weight of the asphalt cement.

The Contractor shall supply to the Engineer a mix formulation at least 10 days before pavement construction is scheduled to begin. The mix formula shall consist of the following information.

A. Aggregate
   - Source
   - Gradation
   - Blend Percentages
   - Mixture Gradation

B. Asphalt Cement (Reacted Rubber)
   - Source and grade of asphalt cement.
   - Source and grade of ground rubber.
   - Ground rubber percentage for the asphalt cement (reacted rubber).
   - Temperature when added to the aggregate.

C. Asphalt Cement (Reacted Rubber) Content

D. Mix Temperature

E. Placement Temperature

F. Density Requirement - The mixture design will be based on 75 blow marshall.

952A.07 ASPHALT CEMENT (REACTED RUBBER) MIXING AND PRODUCTION EQUIPMENT

All equipment utilized in production and proportioning of the asphalt cement (reacted rubber) shall be described as follows:

A. An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the ground rubber. If required, this unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement to 375° F.

B. An asphalt cement (reacted rubber) mechanical blender with a two stage continuous mixing process capable of producing a homogeneous mixture of asphalt cement and ground rubber, at the mix design specified ratios, as recommended by the supplier of the ground rubber. This unit shall be equipped with a ground rubber feed system capable of supplying the asphalt cement feed system as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

C. An asphalt cement (reacted rubber) storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the binder to the aggregate and an internal mixing unit within the ground vessel capable of maintaining a proper mixture of asphalt cement and ground rubber.

D. An asphalt cement (reacted rubber) supply system equipped with a pump and metering device capable of adding the asphalt cement (reacted rubber) by volume to the aggregate at the percentage required by the job-mix formula.

An interlock of the asphalt-rubber binder and aggregate feed systems will not be required. The Contractor shall be required to accurately proportion the reacted asphalt cememt to the mixture.

952A.08 ASPHALT CEMENT (REACTED RUBBER) MIXING AND REACTING PROCEDURE.

A. Asphalt Cement Temperature

The temperature of the asphalt cement shall be between 290^{o} and 400 degrees F. at the addition of the ground rubber, or as directed by the supplier.

B. Blending and Reacting

The asphalt and ground rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes or as directed by the supplier from the time the ground rubber is added to the asphalt cement. Temperature of the asphalt cement (reacted rubber) mixture shall be maintained between 290^{o} and 375 degrees F. during the reaction period, or at a temperature specified by the supplier.

C. Transfer

After the material has been reacted, the asphalt cement (reacted rubber) shall be metered into the mixing chamber of the reacted rubber binder-asphalt cement concrete production plant at the percentage required by the job-mix formula.

D. Delays

When a delay occurs in binder use after its full reaction, the asphalt cement (reacted rubber) shall be reheated slowly just prior to use to a temperature between 290^{o} and 375 degrees F., and shall also be thoroughly mixed before pumping and metering into the hot mix plant for mixing with the aggregate. The viscosity of the asphalt cement (reacted rubber) shall be checked by the asphalt-rubber supplier. If the viscosity is out of the range specified in Section 952.02B of this special provision the asphalt cement (reacted rubber) shall be adjusted by the addition of additional asphalt cement or ground rubber to produce a material with the appropriate viscosity.

952A.09 COMPACTION REQUIREMENT. The Reacted Rubber Binder-Asphalt cement concrete shall be compacted to 95% of laboratory density.

952A.10 COMPACTION EQUIPMENT.

A minimum of two rollers meeting Article 2001.05B shall be furnished. Pneumatic tired rollers will not be allowed.

952A.11 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

The Reacted Rubber Binder - Asphalt Cement Concrete Mix will be measured as per the standard specification, and be paid for in tons. Asphalt cement (reacted rubber) for use in the Reacted Rubber Binder - Asphalt Cement Concrete Mix will be measured as per the standard specifications and be paid for in tons.

SP-954A
Revision of SP-954

REVISED

SPECIAL PROVISIONS
for
ASPHALT CEMENT CONCRETE SURFACE COURSE
(RUBBER CHIPS ADDED)

F-61-4(49)—20-70, Muscatine-Scott Counties

October 2, 1990

THE STANDARD SPECIFICATIONS, SERIES OF 1984, ARE AMENDED BY THE FOLLOWING MODIFICATIONS. THIS IS AN ADDENDUM TO THE SPECIAL PROVISIONS, WHICH SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS AND SP-954(New).

954A.01 DESCRIPTION.

The Asphalt Cement Concrete Surface Course (Rubber Chips Added) mixtures will include the incorporation of approximately 5% #4 sieve size tire-rubber chips into the asphalt cement concrete mixture.

954A.02 REQUIREMENTS.

The Asphalt Cement Concrete Surface Course (Rubber Chips Added) shall conform to the standard mix design criteria, which are modified as follows.

A. Mineral Aggregate.

Mineral aggregates shall meet the Type "A" surface course quality as specified in the plans and Iowa DOT Standard Specifications, except the gradation shall meet the following.

Sieve size	Percent passing
1"	100
3/4"	98-100
1/2"	76-92
3/8"	60-83
#4	40-62
#8	26-45
#30	11-24
#200	3-7

B. Asphalt Cement.

Asphalt cement shall meet requirements of Section 4137 of the Standard Specifications, grade AC-10. The amount of asphalt cement required shall be within a range of 5.5% to 8.0%, based on total weight of mixture and as determined by the job mix formula.

C. Rubber Chips.

Rubber chips shall be produced from the recycling of automobile and truck tires at ambient temperature. The rubber chips shall be cubical or thread-shaped, and individual rubber particles, irrespective of diameter, shall not contain more than 2% of the total to be more than 3/8" in length. The maximum allowable moisture content of the rubber chips is 2.0 percent.

The rubber chips shall conform to the following gradation requirements.

Sieve Size	Percent Passing by Weight
3/8"	100
#4	95-100
#8	8-50
#16	0-7

The rubber chip supplier shall furnish a written certification of compliance with these requirements.

954A.03 MIXING AND PRODUCTION EQUIPMENT.

The rubber chips shall be proportioned into the plant by a method which will uniformly feed the mixer within ± 10% percent of the required amount.

A. Batch Plants.

Whole bags of rubber chips may be fed into the mixer providing the total batch weight has been adjusted so no partial bags need to be used.

The rubber chips shall not be added into the dryer with the cold feed. They rubber chips shall be added into the aggregate after it leaves the dryer or into the mixer itself.

B. Drum-Mix Plants.

There shall be a means of accurately calibrating the continuous feed system.

Satisfactory means shall be provided to have a positive interlocking control between the flow of granulated rubber, asphalt cement, and aggregates.

Drum-mixing plants shall be equipped with a heat shield or other means to prevent the open flame from coming in contact with the granulated rubber.

954A.04 MIXING.

The Contractor shall prepare a work plan describing the planned procedures for mixing and placing the Asphalt Cement Concrete Surface Course (Rubber Chips Added).

The rubber chips shall be mixed with the aggregate and asphalt cement for at least seconds before discharge from the mixer.

The temperature of the finish mixture shall meet the requirements in Article 2 303.05 or as otherwise directed by the rubber chip supplier.

954A.05 CONSTRUCTION.

The asphalt cement concrete surface course (rubber chips added) shall be placed as specified in the standard specifications for other Type "A" asphalt cement concrete course surface mixtures, except pneumatic tire rollers will not be allowed due to possible pickup of the mixture on the tires.

954A.06 COMPACTION

Asphalt rollers and compaction procedures for the special surface course shall conform with the Standard Specification requirements and supplemented with the following.

A. Breakdown compaction should begin immediately behind the paving machine. However, some delay may be required to prevent roller pickup.

B. Breakdown compaction shall be accomplished using a minimum 10 ton vibratory or static steel roller.

   A minimum 8 ton steel roller in a non-vibratory mode shall be used for finish rolling.

C. A minimum of 10 coverages shall be made in a vibratory made. Fewer coverages can be made if it can be shown that maximum density can still be achieved. Rolling must be completed before the temperature of the mat drops below 180 ^{O} F., unless otherwise directed by the Engineer.

954A.07 METHODS OF MEASUREMENT.

The Asphalt Cement Concrete Surface Course (Rubber Chips Added) properly placed will be measured in tons as provided in Article 2303.27A.

Asphalt cement will be measured as provided in Article 2303.27B.

954A.07 BASIS OF PAYMENT.

For the number of tons of Asphalt Cement Concrete Surface Course (Rubber Chips Added) placed, the Contractor will be paid the contract price per ton. This payment shall be full compensation for furnishing and placing the asphalt mixture, including the rubber chips.

For amount of asphalt cement used in the work, the Contractor will be paid the contract price per ton.

Appendix B
Viscosity Testing

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

LAB NO....:AZ 1-0008

MATERIAL.....:AC-5 TIRE RUBBER RESEARCH
INTENDED USE....:RESEARCH
PROJECT NO.....:DEPT. INFO.
SAMPLED BY.....: SENDER NO.:
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 05/30/91

PERCENT GROUND TIRE RUBBER USED WAS 5.0%, 10.0%, 15.0% AND 20.0%.
TIME FROM START TO FINISH WAS 1 HR WITH READINGS AT 3 MIN., 10 MIN.,
30 MIN. AND 1 HR. TEMP. USED WAS 350 F. +/- 10 F. A BROOKFIELD VISCOMETER
WAS USED TO REPORT CENTIPOISE READINGS. ONE BROOKFIELD VISCOSITY WAS TAKEN
OF THE AC-5 WITH NO RUBBER WITH A READING OF 100 CENTIPOISES.
FOLLOWING ARE THE PERCENT RUBBER AND READINGS AT THE VARIOUS TIMES.

5.0% RUBBER
3 MIN. - 400 CP @ 355 F.
10 MIN. - 250 CP @ 355 F.
30 MIN. - 200 CP @ 350 F.
1 HR. - 200 CP @ 350 F.

10.0% RUBBER
3 MIN. - 1000 CP @ 350 F.
10 MIN. - 300 CP @ 350 F.
30 MIN. - 450 CP @ 350 F.
1 HR. - 700 CP @ 350 F.

15.0% RUBBER
3 MIN. - 1300 CP @ 350 F.
10 MIN. - 1900 CP @ 346 F.
30 MIN. - 2300 CP @ 350 F.
1 HR. - 2100 CP @ 350 F.

20.0% RUBBER
3 MIN. - 4850 CP @ 350 F.
10 MIN. - 5150 CP @ 350 F.
30 MIN. - OFF SCALE @ 350 F.
1 HR. - OFF SCALE @ 350 F.

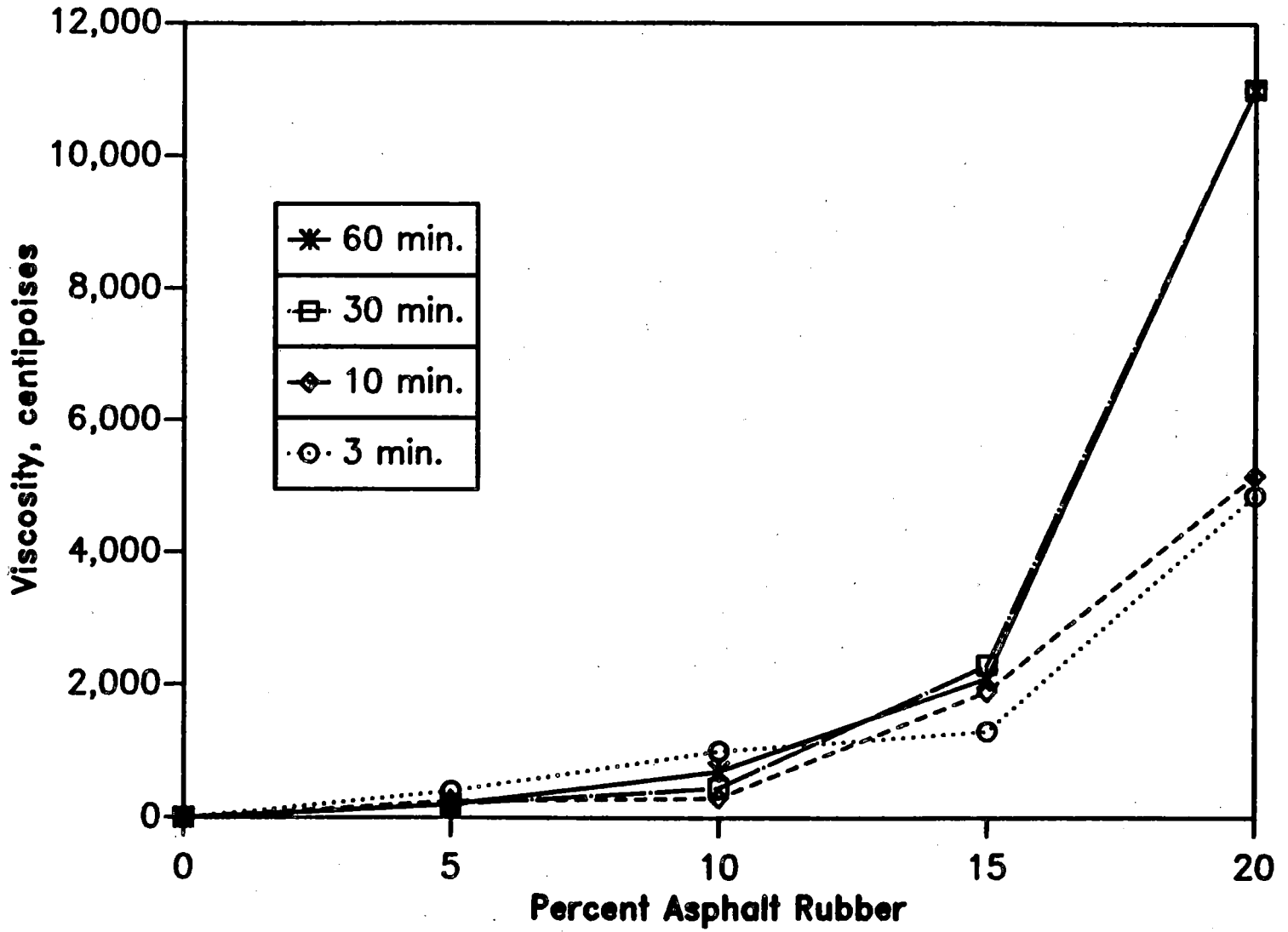
COPIES TO:
CENTRAL LAB V. MARKS B. BROWN
R. MONROE D. HINES D. HEINS

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

°°°°°

Asphalt Rubber Viscosity
Muscatine County



Plant Viscosities

July 8, 1991 A.R.C. Binder

Time	Viscosity
9:00 AM	1400 CP
10:30 AM	1800 CP
11:40 AM	2000 CP
1:00 PM	2200 CP
2:20 PM	2200 CP

July 9, 1991 A.R.C. Surface

Time	Viscosity
7:10 AM	2000 CP

July 10, 1991 A.R.C. Surface

Time	Viscosity
7:20 AM	1600 CP
8:00 AM	1800 CP
9:05 AM	2800 CP
12:00 PM	1800/1932 CP
2:00 PM	2400 CP
2:30 PM	2200 CP

July 11, 1991 A.R.C. Surface

Time	Viscosity
7:30 AM	1400/1600 CP

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

LAB NO....:AB 1-0308

MATERIAL.....:ASPHALT RUBBER BINDER
INTENDED USE....:ASPHALT BINDER
PRODUCER.....:WENDLING QRY
PROJECT NO.....:FN-61-4(49)--20-70
COUNTY.....:MUSCATINE CONTRACTOR:MANATTS
SOURCE.....:WENDLING QRY
UNIT OF MATERIAL:RUBBER POWDER GF-35 AC-5
SAMPLED BY.....:C. ANDERSON SENDER NO.:CP1-22
DATE SAMPLED: 07/08/91 DATE RECEIVED: 09/23/91 DATE REPORTED: 09/26/91

SP-1028

B. ASPHALT RUBBER CEMENT (15% BY TOTAL WGT. OF ASPHALT RUBBER MIX)

APPARENT VISCOSITY, 347 F., SPINDLE 3, 12 RPM CPS (ASTM D2669 BROOKFIELD)	MIN	1,000	
	MAX	4,000	1 HR. 1100
PENETRATION, 77 F., 100 G, 5 SEC.: 1/10 MM. (ASTM D5)	MIN	50	
	MAX	100	86
PENETRATION, 39.2 F., 200 G, 60 SEC.: 1/10 MM. (ASTM D5)	MIN	25	25
SOFTENING POINT: DEG. F., (ASTM D36)	MIN	120	125.6
RESILIENCE, 77 F.,: % (ASTM D3407)	MIN	10	21
DUCTILITY, 39.2 F., 1 CPM:CM. (ASTM D113)	MIN	10	78.5
TFOT RESIDUE, (ASTM D1754) PENETRATION RETENTION, 39.2 F.: %	MIN	75	96.0
DUCTILITY RETENTION, 39.2 F.: %	MIN	50	65.0

COPIES TO:
CENTRAL LAB V. MARKS R. MONROE
C. ANDERSON D. HINES

DISPOSITION: RESULTS COMPLY WITH SP-1028

°°°°°

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

Appendix C
Lab Testing of Mix & Mix Designs

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

LAB NO....:ABD1-0140

MATERIAL........:TYPE A RUBBER CHIPS
INTENDED USE....:SURFACE
PROJECT NO......:F-61-4(49)--20-70
COUNTY..........:MUSCATINE CONTRACTOR:MANATTS
SPEC NO.........:5015.00 SIZE......:3/4
SAMPLED BY......: SENDER NO.:
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 06/25/91
PROJ. LOCATION: E.C.L. MUSCATINE TO WCL BLUE GRASS

- -

AGG. SOURCES: GRANITE - ORTONVILLE STONE, BIG STONE, MN.;
3/4 & 1/2 CR. LS - WENDLING, MOSCOW, MUSCATINE CO.; SAND -
WENDLING, ATALISSA - MCKILLIP, MUSCATINE 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	86.0	64.0	45.0	33.0	26.0	19.0	12.0	9.0	6.1
TOLERANCE /100 :			98	7	7	7	5		4			2

MATERIAL MIX	AMN028	A70002	A70002	A70504	
% AGGR. PROP.	25.00	15.00	45.00	15.00	0.00

ASPHALT SOURCE AND	POISES			
APPROXIMATE VISCOSITY POISES	0947			
% ASPHALT IN MIX	6.50	7.50	0.00	0.00
NUMBER OF MARSHALL BLOWS	75	75	0	0
MARSHALL STABILITY - LBS.	920	760	0	0
FLOW - 0.01 IN.	19	24	0	0
SP GR BY DISPLACEMENT (LAB DENS)	2.240	2.229	0.000	0.000
BULK SP. GR. COMB. DRY AGG.	2.751	2.751	0.000	0.000
SP. GR. ASPH. @ 77 F.	1.026	1.026	0.000	0.000
CALC. SOLID SP. GR.	2.509	2.471	0.000	0.000
% VOIDS - CALC.	0.00	9.78	0.00	0.00
RICE SP.GR.	2.357	2.331	0.000	0.000
% VOIDS - RICE	4.96	4.38	0.00	0.00
% WATER ABSORPTION - AGGREGATE	1.02	1.02	0.00	0.00
% VOIDS IN MINERAL AGGREGATE	23.87	25.05	0.00	0.00
% V.M.A. FILLED WITH ASPHALT	55.10	60.95	0.00	0.00
CALC. ASPH. FILM THICK. MICRONS	10.58	12.35	0.00	0.00
FILLER/BITUMEN RATIO	0.00	0.80	0.00	0.00
TEMP=	215			
WT=	7300			
SLOPE=	9.08			
ICPT	-24.25			

A CONTENT OF 7.6% ASPHALT IS RECOMMENDED TO START THE JOB.
I-CEPT = (-24.25)
COPIES TO:

CENTRAL LAB	R. MONROE	J. ADAM
D. HEINS	MANATTS	W. OPPEDAL
DIST. 5	MT. PLEASANT RES.	

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

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

LAB NO....:ABD1-0125

MATERIAL.....:TYPE A
INTENDED USE....:BINDER-RUBBERIZED
PROJECT NO.....:F-61-4(49)--20-70
COUNTY.....:MUSCATINE
SPEC NO.....:0952.00
SAMPLED BY.....: ,
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 06/18/91
PROJ. LOCATION: FROM E.C.L. MUSCATINE TO WCL BLUE GRASS

CONTRACTOR:MANATTS
SIZE.....:3/4
SENDER NO.:

AGG SOURCES: CR. LST, CHIPS & MAN. SAND- WENDLING, MOSCOW QRY, MUSCATINE CO; SAND- WENDLING, ATALISSA PIT, MUSCATINE 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	83.0	60.0	45.0	34.0	24.0	11.0	6.7	4.6
TOLERANCE /100 :		98	7	7	7	5		4			2

MATERIAL MIX	A70002	A70002	A70002	A70504	
% AGGR. PROP.	45.00	20.00	10.00	25.00	0.00

ASPHALT SOURCE AND	AMOCO			
APPROXIMATE VISCOSITY POISES	0472			
% ASPHALT IN MIX	4.00	5.00	6.00	0.00
NUMBER OF MARSHALL BLOWS	75	75	75	0
MARSHALL STABILITY - LBS.	1650	1537	1717	0
FLOW - 0.01 IN.	10	10	10	0
SP GR BY DISPLACEMENT (LAB DENS)	2.289	2.322	2.377	0.000
BULK SP. GR. COMB. DRY AGG.	2.769	2.769	2.769	0.000
SP. GR. ASPH. @ 77 F.	1.024	1.024	1.024	0.000
CALC. SOLID SP. GR.	2.631	2.589	2.548	0.000
% VOIDS - CALC.	0.00	0.00	6.71	0.00
RICE SP.GR.	2.544	2.502	2.451	0.000
% VOIDS - RICE	0.00	7.19	3.02	0.00
% WATER ABSORPTION - AGGREGATE	1.22	1.22	1.22	0.00
% VOIDS IN MINERAL AGGREGATE	20.64	20.34	19.31	0.00
% V.M.A. FILLED WITH ASPHALT	36.98	49.29	65.24	0.00
CALC. ASPH. FILM THICK. MICRONS	6.46	8.36	10.26	0.00
FILLER/BITUMEN RATIO	0.00	0.81	0.00	0.00
TEMP=	215			
WT=	7300			
SLOPE=	3.71			
INTER=	-4.27			

A CONTENT OF 5.7% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES TO:

CENTRAL LAB	W. OPPEDAL	MANATTS
D. HEINS	J. ADAM	R. MONROE
DIST. 5	MT. PLEASANT RES.	

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

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

LAB NO....:ABD1-0106

MATERIAL....:TYPE A (RUBBER)
INTENDED USE....:SURFACE
PROJECT NO.....:F-61-4(49)--20-70
COUNTY.....:MUSCATINE
SPEC NO.....:0952.00
SAMPLED BY.....:
DATE SAMPLED: DATE RECEIVED: DATE REPORTED: 06/06/91
PROJ. LOCATION: FROM ECL MUSCATINE TO WCL BLUE GRASS

CONTRACTOR:MANATTS
SIZE.....:3/4
SENDER NO.:

AGG SOURCES: GRANITE- ORTONVILLE STONE, ORTONVILLE, MN;
CR. LST & CHIPS- WENDLING, MOSCOW QRY, MUSCATINE CO;
SAND- WENDLING, ATALISSA, MUSCATINE CO.
% TOTAL BINDER: 4.68 5.83 6.98

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	88.0	69.0	48.0	36.0	28.0	20.0	9.8	6.4	4.3

TOLERANCE /100 :

98	7	7	7	5		4	2

MATERIAL MIX	AMN026	A70002	A70002	A70504	
% AGGR. PROP.	27.00	38.00	10.00	25.00	0.00

ASPHALT SOURCE AND	AMOCO			
APPROXIMATE VISCOSITY POISES	0472			
% ASPHALT IN MIX	4.00	5.00	6.00	0.00
NUMBER OF MARSHALL BLOWS	75	75	75	0
MARSHALL STABILITY - LBS.	1483	1830	1597	0
FLOW - 0.01 IN.	9	9	10	0
SP GR BY DISPLACEMENT (LAB DENS)	2.324	2.371	2.378	0.000
BULK SP. GR. COMB. DRY AGG.	2.736	2.736	2.736	0.000
SP. GR. ASPH. @ 77 F.	1.024	1.024	1.024	0.000
CALC. SOLID SP. GR.	2.595	2.554	2.514	0.000
% VOIDS - CALC.	0.00	7.16	5.42	0.00
RICE SP.GR.	2.520	2.467	2.413	0.000
% VOIDS - RICE	7.78	3.89	1.45	0.00
% WATER ABSORPTION - AGGREGATE	0.09	0.97	0.97	0.00
% VOIDS IN MINERAL AGGREGATE	18.46	17.67	18.30	0.00
% V.M.A. FILLED WITH ASPHALT	43.46	59.47	70.36	0.00
CALC. ASPH. FILM THICK. MICRONS	7.45	9.57	11.69	0.00
FILLER/BITUMEN RATIO	0.00	0.88	0.00	0.00
TEMP=	200			
WT=	7400			

Slope 3.50 Ign. (-377)

COPIES TO:
CENTRAL LAB
D. HEINS
R. MONROE
MANATTS
V. MARKS
DIST. 5
W. OPPEDAL
J. ADAM
MT. PLEASANT RES.

DISPOSITION: A CONTENT OF 4.9% ASPHALT (5.72% TOTAL BINDER) IS RECOMMENDED TO START THE JOB. TOLERANCE ON #200 ALSO CONTROLLED BY FINES/BITUMEN RATIO.

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

Appendix D
Field Testing

Temperature Chart

July 8, 1991 A.R.C. Binder

Time	7 AM	9 AM	11 AM	1 PM	3 PM
Air	74°	76°	80°	82°	85°
A.C.	358°	358°	355°	340°	345°
Agg.		345°	340°	340°	340°
Mix		295°	300°	300°	305°
Mat		285°	285°	280°	280°

July 10, 1991 A.R.C. Surface

Time	7 AM	9 AM	12 PM	1 PM	3 PM
Air	67°	70°	78°	86°	87°
A.C.	355°	355°	335°	340°	345°
Agg.	350°	340°	345°	340°	345°
Mix	305°	300°	305°	295°	305°
Mat	275°	280°	280°	280°	280°

July 11, 1991 A.R.C. Surface

Time	7 AM	9 AM	11 AM
Air	70°	73°	77°
A.C.	355°	350°	335°
Agg.	340°	300°	300°
Mix	310°	295°	300°
Mat	265°	260°	260°

July 22, 1991 and July 23, 1991 Rubber Chip Mix

	EB Lane	WB Lane	
Time	7 AM	7 AM	9 AM
Air	84°	70°	
A.C.	300°	300°	
Agg.	340°	320°	
Mix	325°	295°	300°
Mat	325°		300°

Density Checks and Average Field Voids

	Lab Density	Avg. Field Density	% of Lab Density	Avg. % Field Voids
Reacted Rubber Binder	2.348	2.312	98	5.7
Reacted Rubber Surface	2.422	2.352	97	5.3
	2.413	2.330	97	6.1
Rubber Chips	2.177	2.344	108	2.9
	2.147	2.323	108	3.6

Sieve Analysis of Combined Aggregate

A.R.C. Binder

Sieve Size	Spec. Limit	Dist. Materials Gradation	Plant Samples 1	2	3
1"	100	100	100	100	100
3/4"	98-100	99	100	99	99
1/2"	85-99	93	95	93	92
3/8"	76-90	84	87	85	81
4	53-67	64	69	63	59
8	40-50	48	53	47	43
16	---	37	43	36	33
30	20-28	23	26	23	21
50	---	12	12	12	11
100	---	6.4	6.1	7.0	6.4
200	2.6-6.6	5.0	4.7	5.4	4.9

Sieve Analysis of Combined Aggregate

A.R.C. Surface

Sieve Size	Spec. Limit	Dist. Materials Gradation	Plant Samples 1	2	3	4
1/2"	100	100	100	100	100	100
3/4"	98-100	100	100	100	100	100
1/2"	81-95	89	89	89	89	89
3/8"	62-76	71	71	72	71	71
4	41-55	48	48	50	51	48
8	31-41	36	36	38	38	36
16	---	29	29	31	31	29
30	16-24	20	20	21	21	20
50	---	11	11	12	11	11
100	---	6.1	6.1	6.2	6.6	6.1
200	2.3-6.3	4.7	4.7	4.8	5.0	4.7

Sieve Analysis of Rubber Chip Mixture

Sieve Size	Spec. Limit	Dist. Materials Gradation 1	Dist. Materials Gradation 2	Plant Samples 1	Plant Samples 2
1"	100	100	100	100	100
3/4"	98-100	100	100	100	100
1/2"	79-93	85	85	86	86
3/8"	57-71	66	65	61	68
4	38-52	44	48	43	48
8	28-38	33	37	32	37
16	---	26	29	25	30
30	15-23	20	21	19	21
50	---	12	12	11	13
100	---	8.2	8.5	8.4	8.4
200	4.1-8.1	6.1	6.4	6.3	6.5

Sieve Analysis of Fine Ground Reacted Rubber

Sieve Size	Ames Lab Gradation
10	100
30	98
50	54

Sieve Analysis of Recycled Rubber Chips

Sieve Size	Ames Lab Gradation
3/8"	100
4	100
8	37
16	5.7

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 07-03-91

OFFICE OF MATERIALS
ROAD RATER TESTS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... PC

BEGINNING MP.... 93.39
ENDING MP..... 96.05
COMPUTED MILES.. 2.66

LAB NO..... RA1-5268
YEAR BUILT.. 1957
DATE TESTED. 04-29-91

WEATHER CLEAR
OBS... FRETTE SIEFKEN
TIME... 10:45

FREQ. HZ... 30
DISP %..... 68
TEST TYPE..

ROAD RATER DEFLECTION (MILS)

		NORTHBOUND						SOUTHBOUND						
M-P		SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
93.400	Sec.	1.50	1.40	1.30	1.20	3.80	107.							
93.500	#1							1.40	1.30	1.20	1.00	4.02	125.	
93.600		1.40	1.40	1.30	1.10	4.02	50.	1.50	1.40	1.30	1.10	3.80	107.	
93.700														
93.800		1.20	1.10	1.00	0.90	4.56	155.	1.30	1.20	1.10	0.90	4.27	141.	
93.900														
94.000		1.40	1.30	1.30	1.20	4.02	125.	1.50	1.40	1.40	1.20	3.80	107.	
94.100														
94.200		1.30	1.20	1.10	1.00	4.27	141.	1.40	1.30	1.20	1.00	4.02	125.	
94.300														
94.400	Sec.2	1.20	1.10	1.00	0.90	4.56	155.	1.40	1.30	1.20	1.10	4.02	125.	
94.500														
94.600		1.30	1.30	1.20	1.10	4.27	50.	1.60	1.50	1.40	1.30	3.60	89.	
94.700	Sec.													
94.800	#3	1.50	1.40	1.30	1.20	3.80	107.	1.60	1.50	1.40	1.20	3.60	89.	
94.900														
95.000		1.40	1.30	1.10	0.90	4.02	125.	0.97	0.91	0.80	0.66	5.43	155.	
95.100														
95.200		1.20	1.10	1.00	0.90	4.56	155.	1.10	1.00	0.90	0.80	4.90	169.	
95.300	Sec.													
95.400	#4	1.90	1.80	1.70	1.50	3.13	50.	1.20	1.10	1.00	0.90	4.56	155.	
95.500														
95.600		1.30	1.20	1.10	0.90	4.27	141.	0.95	0.91	0.83	0.68	5.53	139.	
95.650														
95.700		1.30	1.20	1.10	1.00	4.27	141.	1.30	1.20	1.10	0.90	4.27	141.	
95.750														
95.800	Sec.	1.30	1.20	1.10	1.00	4.27	141.	1.30	1.20	1.10	0.90	4.27	141.	
95.850	#5													
95.900		1.40	1.30	1.20	1.10	4.02	125.	1.40	1.30	1.20	1.10	4.02	125.	
95.950														

S U M M A R Y O F D A T A

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END. TEMP
NORTH	0.18	1.90	1.20	1.37	1.52	1.29	1.19	1.06	0.09	0.063	4.12	3.81	118.	74.	74.
SOUTH	0.20	1.60	0.95	1.33	1.50	1.23	1.14	0.98	0.09	0.070	4.28	3.77	129.	74.	74.
COMB	0.19	1.90	0.95	1.35	1.51	1.26	1.16	1.02	0.09	0.067	4.20	3.78	123.		

H I S T O R Y

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

DATE TESTED	AVE.SR	AVE.SOIL K

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER

TESTS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 130.00
ENDING 150.00
COMPUTED MILES..

LAB NO..... RA1-5609
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %..... 68
TEST TYPE.. SI

Section #1

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	WESTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
130.000	1.00	0.90	0.80	0.70	5.69	182.							
132.000	1.10	1.00	0.90	0.80	5.29	169.							
134.000	1.30	1.20	1.00	0.90	4.66	141.							
136.000	1.10	1.00	0.90	0.80	5.29	169.							
138.000	1.10	1.00	0.90	0.80	5.29	169.							
140.000	1.10	1.00	0.90	0.80	5.29	169.							
142.000	1.20	1.10	1.00	0.90	4.95	155.							
144.000	1.20	1.10	1.00	0.90	4.95	155.							
146.000	1.30	1.20	1.10	1.00	4.66	141.							
148.000	1.10	1.00	0.90	0.80	5.29	169.							
150.000	0.83	0.80	0.75	0.62	6.57	144.							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.13	1.30	0.83	1.12	1.23	1.03	0.92	0.82	0.09	0.084	5.27	4.82	160.	97.	97.

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 150.00
ENDING 155.00
COMPUTED MILES..

LAB NO..... RA1-5610
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %..... 68
TEST TYPE.. SI

Section #2

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	WESTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
150.500							0.94	0.90	0.82	0.70	5.97	140.	
151.000	1.00	0.90	0.80	0.70	5.69	182.							
151.500							1.00	0.90	0.80	0.70	5.69	182.	
152.000	0.94	0.85	0.80	0.70	5.97	183.							
152.500							0.98	0.92	0.82	0.69	5.87	137.	
153.000	0.98	0.95	0.85	0.70	5.78	123.							
153.500							1.00	0.90	0.80	0.70	5.69	182.	
154.000	1.10	1.00	0.90	0.80	5.29	169.							
154.500							0.98	0.82	0.80	0.70	5.78	213.	

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.07	1.10	0.94	1.00	1.06	0.92	0.84	0.72	0.08	0.080	5.68	5.44	164.	97.	97.
WEST	0.03	1.00	0.94	0.98	1.00	0.89	0.81	0.70	0.09	0.090	5.80	5.70	171.	97.	97.
COMB	0.05	1.10	0.94	0.99	1.03	0.90	0.82	0.71	0.08	0.085	5.75	5.58	168.		

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER

STS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 155.00
ENDING 175.00
COMPUTED MILES..

LAB NO..... RA1-5611
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %..... 68
TEST TYPE.. SI

Section #3

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
156.000	1.10	1.00	0.90	0.80	5.29	169.							
158.000	1.20	1.10	1.00	0.90	4.95	155.							
160.000	0.97	0.92	0.84	0.72	5.83	146.							
162.000	1.20	1.10	1.00	0.90	4.95	155.							
164.000	1.10	1.00	0.90	0.80	5.29	169.							
166.000	1.00	0.90	0.80	0.70	5.69	182.							
168.000	1.20	1.10	1.00	0.90	4.95	155.							
170.000	0.90	0.88	0.82	0.70	6.17	122.							
172.000	1.00	0.90	0.80	0.70	5.69	182.							
174.000	0.90	0.84	0.77	0.66	6.17	165.							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.12	1.20	0.90	1.06	1.16	0.97	0.88	0.78	0.08	0.079	5.50	5.10	160.	87.	97.

* * * * * H I S T O R Y * * * * *

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

DATE TESTED	AVE.SR	AVE.SOIL K

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER .STS

COUNTY- MUSCATINE BEGINNING ... 180.00 LAB NO..... RA1-5612 WEATHER SUNNY FREQ. HZ... 30
U.S. ROUTE..... 61 ENDING ..... 200.00 YEAR BUILT.. 19 OBS.... SCHMIDT FRETTE DISP %..... 68
PAVEMENT TYPE... AC COMPUTED MILES.. DATE TESTED. 08-13-91 TIME... 11:37 TEST TYPE.. SI

Section #4

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
182.000	1.20	1.10	1.00	0.90	4.95	155.							
184.000	1.20	1.10	1.00	0.90	4.95	155.							
186.000	1.30	1.20	1.10	0.90	4.66	141.							
188.000	0.80	0.77	0.70	0.58	6.76	148.							
190.000	1.00	1.00	0.90	0.80	5.69	79.							
192.000	0.90	0.88	0.80	0.68	6.17	122.							
194.000	0.90	0.85	0.80	0.67	6.17	156.							
196.000	0.84	0.80	0.74	0.62	6.51	154.							
198.000	1.00	1.00	0.90	0.80	5.69	79.							
200.000	1.10	1.00	0.90	0.80	5.29	169.							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.17	1.30	0.80	1.02	1.17	0.97	0.88	0.76	0.05	0.053	5.69	5.09	136.	97.	97.

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER .STS

COUNTY- MUSCATINE BEGINNING .... 215.00 LAB NO..... RA1-5613 WEATHER SUNNY FREQ. HZ... 30
U.S. ROUTE..... 61 ENDING ..... 240.00 YEAR BUILT.. 19 OBS.... SCHMIDT FRETTE DISP %..... 68
PAVEMENT TYPE... AC COMPUTED MILES.. 25.00 DATE TESTED. 08-13-91 TIME... 11:37 TEST TYPE.. SI

Section # 5

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
215.000	1.00	0.90	0.80	0.70	5.69	182.							
217.000	1.30	1.20	1.10	1.00	4.66	141.							
219.000	0.86	0.80	0.72	0.60	6.39	170.							
221.000	1.00	0.90	0.80	0.70	5.69	182.							
223.000	0.97	0.92	0.85	0.72	5.83	146.							
225.000	1.00	0.90	0.80	0.70	5.69	182.							
227.000	0.88	0.82	0.74	0.68	6.28	167.							
229.000	0.91	0.85	0.79	0.67	6.12	164.							
231.000	1.00	0.90	0.80	0.70	5.69	182.							SECL
233.000	1.00	1.00	0.90	0.80	5.69	79.							SECL
240.000	0.99	0.94	0.88	0.77	5.74	143.							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.12	1.30	0.86	0.99	1.09	0.92	0.83	0.73	0.07	0.071	5.77	5.39	158.	97.	97.

* * * * * H I S T O R Y * * * * * REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

DATE TESTED	AVE.SR	AVE.SOIL K

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER
STS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 240.00
ENDING 260.00
COMPUTED MILES..

LAB NO..... RA1-5614
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %..... 68
TEST TYPE.. SI

Section #6

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
242.000	1.00	0.90	0.90	0.80	5.69	182.							
244.000	1.20	1.10	1.00	0.90	4.95	155.							
246.000	1.30	1.20	1.10	0.90	4.66	141.							
248.000	1.20	1.10	1.00	0.90	4.95	155.							
250.000	1.00	1.00	0.90	0.80	5.69	79.							
252.000	1.20	1.10	1.00	0.90	4.95	155.							
254.000	0.70	0.67	0.58	0.46	7.49	161.							
256.000	1.40	1.30	1.20	1.00	4.41	125.							
258.000	1.20	1.10	1.00	0.90	4.95	155.							

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DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.21	1.40	0.70	1.13	1.31	1.05	0.96	0.84	0.08	0.072	5.31	4.53	145.	97.	97.

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER

STS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 265.00
ENDING 285.00
COMPUTED MILES..

LAB NO..... RA1-5615
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %.... 68
TEST TYPE.. SI

Section #7

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
265.000	1.60	1.40	1.20	1.00	3.99	159.							
267.000	1.70	1.60	1.40	1.10	3.82	68.							
269.000	0.92	0.90	0.82	0.70	6.07	119.							
271.000	1.20	1.10	1.00	0.80	4.95	155.							
273.000	1.00	0.90	0.80	0.70	5.69	182.							
275.000	1.20	1.10	1.00	0.90	4.95	155.							
277.000	0.93	0.87	0.80	0.68	6.02	161.							
279.000	0.82	0.75	0.70	0.60	6.63	183.							
281.000	0.79	0.74	0.68	0.58	6.82	170.							
283.000	1.00	0.90	0.80	0.70	5.69	182.							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	MAX.	MIN.	AVE.	80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.31	1.70	0.79	1.12	1.38	1.03	0.92	0.78	0.09	0.081	5.46	4.61	153.	97.	97.

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

PROGRAM NUMBER- P2220050
COMPUTER RUN DATE- 08-19-91

OFFICE OF MATERIALS
ROAD RATER

STS

COUNTY- MUSCATINE
U.S. ROUTE..... 61
PAVEMENT TYPE... AC

BEGINNING 290.00
ENDING 310.00
COMPUTED MILES..

LAB NO..... RA1-5616
YEAR BUILT.. 19
DATE TESTED. 08-13-91

WEATHER SUNNY
OBS.... SCHMIDT FRETTE
TIME... 11:37

FREQ. HZ... 30
DISP %.... 68
TEST TYPE.. SI

Section #8

ROAD RATER DEFLECTION (MILS)

Station	EASTBOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	BOUND SENS 1	SENS 2	SENS 3	SENS 4	S.R.	SOIL K	REMARKS
290.000	0.80	0.77	0.68	0.58	6.76	148.							
292.000	1.00	0.90	0.80	0.70	5.69	182.							
294.000	0.68	0.58	0.52	0.46	7.67	217.							SECH
296.000	0.78	0.68	0.62	0.55	6.89	207.							SECH
298.000	0.78	0.58	0.52	0.44	6.89	225+							SECH
300.000	0.65	0.57	0.52	0.44	7.94	210.							SECH
302.000	0.67	0.58	0.52	0.45	7.75	213.							SECH
304.000	0.62	0.56	0.50	0.44	8.24	200.							
306.000	0.94	0.90	0.82	0.70	5.97	140.							
308.000	0.78	0.24	0.65	0.53	6.89	225+							

* S U M M A R Y O F D A T A *

DIRECTION	SENS1 STD.DEV.	SENS1 MAX.	SENS1 MIN.	SENS1 AVE.	SENS1 80%	SENS2 AVE.	SENS3 AVE.	SENS4 AVE.	SCI	SCI/SENS1	AVE. SR	80% SR	AVE. SOIL K	BEG. TEMP	END TEMP
EAST	0.12	1.00	0.62	0.77	0.87	0.64	0.61	0.53	0.13	0.174	7.07	6.37	197.	97.	97.

* * * * * H I S T O R Y * * * * *

DATE TESTED	AVE.SR	AVE.SOIL K

REMARKS: SECL- SUPERELEVATED CURVE, LOW SIDE. SECH- SUPERELEVATED CURVE, HIGH SIDE

Rut Depth Readings
US 61 - Muscatine County
October 15, 1991

SECTION	STATION	OWT	IWT
1	130+00	.01	.02
	135+00	.00	.00
	140+00	.01	.00
	145+00	.02	.00
2	150+00	.03	.03
Eastbound	151+00	.06	.04
	152+00	.05	.02
	153+00	.02	.07
	154+00	.02	.02
2	150+00	.03	.05
Westbound	151+00	.03	.08
	152+00	.05	.09
	153+00	.05	.10
	154+00	.03	.05
3	155+00	.01	.00
	160+00	.08	.09
	165+00	.06	.05
	170+00	.07	.00
	175+00	.01	.05
	180+00	.01	.03
4	185+00	.03	.00
	190+00	.04	.01
	195+00	.00	.00
	200+00	.01	.03
	205+00	.05	.03
	210+00	.05	.01
5	215+00	.06	.02
	220+00	.01	.03
	225+00	.08	.02
	230+00	.01	.03
	235+00	.05	.12
6	240+00	.05	.02
	245+00	.02	.01
	250+00	.04	.06
	255+00	.02	.04
	260+00	.03	.01

SECTION	STATION	OWT	IWT
7	265+00	.05	.02
	270+00	.07	.02
	275+00	.01	.04
	280+00	.02	.03
	285+00	.03	.05
	290+00	.01	.01
8	295+00	.02	.01
	300+00	.00	.00
	305+00	.02	.01
	310+00	.01	.03
	315+00	.01	.00

IOWA DEPARTMENT OF TRANSPORTATION

O OFFICE:

DATE: October 18, 1991

TTENTION:

REF. NO.: 435.204

ROM: Chris Anderson

FFICE: Materials - Research

UBJECT: Friction Testing on US 61 in Muscatine County from Milepost 93.96 to Milepost 97.49

Friction testing was conducted on US 61 on October 15, 1991. All testing was performed at 40 mph with standard tread (ASTM E-501-76) test tire. The results are as follows:

Section 1	Conventional Mix	Avg. 40
Section 2	Rubber Chip Surface	Avg. 26 EB
Section 2	Rubber Chip Surface	Avg. 35 WB
Section 3	A.R.C. Surface Only	Avg. 44
Section 4	Conventional Mix	Avg. 44
Section 5	A.R.C. Binder & Surface	Avg. 45
Section 6	Conventional Mix	Avg. 38
Section 7	A.R.C. Surface Only	Avg. 42
Section 8	Conventional Mix	Avg. 44

CA:kmd