EVALUATION OF BONDING/POSITIONING OF ELASTOMER JOINT SEALERS AND BRIDGE BEARING PADS

by

Ken Benson

Final Report

Highway Research Project TRC - 73

Conducted For

The Arkansas State Highway and Transportation Department

December 1985

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The opinions, findings, and conclusions are those of the author and not necessarily those of the Arkansas State Highway and Transportation Department.

December 1985

TRC-73 - "Evaluation of Bonding/Positioning of Elastomer Joint Sealers and Bridge Bearing Pads"

FINAL REPORT

Background

Elastomer pre-formed joint sealers and bearing pads have been used extensively by the Department for several years. There have been several cases where the sealers have moved out of position, although an adhesive was applied during placement. Some elastomer bearing pads have also experienced this same problem.

This project was begun as an effort to determine the most cost effective method of maintaining the positioning of pre-formed sealers and bearing pads through the use of better adhesives or mechanical devices or by improving construction techniques.

Literature Search

A thorough search of available literature was made. There are very few published documents which provide any data on this subject. In general, those few reports which were found indicated that if the preformed sealer was the proper size for the joint as-built, no mechanical devices were needed and the required adhesive strength was fairly low. Letter reports from several states indicated that they had experienced no problems with the adhesives used, and that the few problems with preformed joint sealers could be attributed to the sealer being too small for the joint in which it was used. Louisiana does not use an adhesive on bearing pads and Minnesota uses adhesives only in maintenance work; both states reported no problems with maintaining positioning of the sealers or pads.

Tests and Inspections

Several adhesives were tested in the laboratory in August, September and October of 1981. The all purpose cement, XL-8, from R. H. Products, Inc., had an extremely low bond strength to both concrete and the elastomeric pads. This material appeared to be an ordinary rubber cement.

Of the four epoxy adhesives tested, two showed fair adhesion to the elastomer (Sika shx 370 from Sika Chemical and A-103 from Industrial Coatings). The other two (FX-762 and FX-763 from Fox Industries) showed good adhesion to the elastomer. All four showed excellent adhesion to both concrete and unpainted steel.

The other six adhesives tested (Delastiseal, Neolube, Prima-Lub, Betaseal 32-025 Bon-Lashe, and Scotch-Grip Rubber Adhesive 1300 and 2141) showed generally fair adhesion to the elastomer.

Tests were made in November, 1982, using various adhesives on "cyclized" polymer sealers. "Cyclizing" involves treating the neoprene seals with a paste prepared from silica powder and sulfuric acid. This was supposed to increase the bonding strength; however, the tests did not show any significant difference in bond strength between cyclized and untreated seals.

Several installations where failures had occurred were inspected. In most cases, the pre-formed sealer was narrower than the joint opening.

Conclusions and Actions Taken

Based on the responses received from other states and the tests and inspections made during this study, it appears that the primary problem has been joints opening wider than the width of the pre-formed sealer. The sealers are not designed to stretch. They are intended to be under compression at all times. When, for whatever reason, the joint opens wider than the sealer, a failure is inevitable. The solution is simply to be sure that the sealer installed is wider than the maximum width to which the joint is expected to open.

No attempt was made to determine the cause of undersized sealers, although several possible explanations were noted. These include the possibility that the wrong size was furnished by the supplier, the joint was built wider than the plans called for, or the plans called for the wrong size.

During the progress of this project, the Bridge Design Division made some modifications in their procedures. Present policy calls for the anchor bolts to be installed through the bearing pads. This procedure keeps the bearing pads in place, without relying on any adhesive. The steel members which make the sides of the joints are required to be blocked at the fabricator's shop to the proper width. This insures that the joint is built at the proper width. They also eliminated the 5" and 6" joint widths, which had been the most likely to develop problems.

These modifications in policy and procedure have reduced the problem this project was intended to solve; therefore, work on this project has stopped and the project will be closed.

The Department is presently working on FHWA Evaluation Project No. 5, which is designed to evaluate the performance of various types of bridge deck joints in use. If the results of this project - or any other reports - indicate that the problem has not been solved, further study will be made.

October, 1985

BOMAG Demonstration Project

Post Construction Report

Introduction

On July 11, 1985, in a meeting at District 8 headquarters, arrangements were made for a demonstration of a BOMAG machine in a shoulder stabilization. Mr. George Thweatt of Riffe Petroleum Company was the industry representative who was in charge of the demonstration.

The site selected for the demonstration was a section of outside shoulder of the westbound lanes of I-40 near mile marker 119. The Arkansas Highway and Transportation Department core-drilled and obtained samples of the existing shoulder for mix design purposes, and agreed to provide traffic control and purchase the asphalt emulsion to be used. In addition, AHTD would be responsible for sealing the treated shoulder after it was completed.

Mr. Thweat was to prepare the mix design, furnish all needed equipment, materials, and labor necessary to process approximately 2000 L.F. of the 10' wide shoulder, except for the asphalt emulsion and traffic control.

The basic process involves scarifying the existing material to a specified depth, adding a designed amount of asphalt emulsion, mixing, spreading, shaping, and rolling the material in place. A wearing surface is applied after an appropriate curing period. The curing period can vary from 2 to 14 days, depending on the moisture content of the processed material and the temperature and humidity conditions.

Existing Site Conditions

The shoulder was originally constructed in the 1960's as a compacted base course (SB-2) with a double bituminous surface treatment (DBST) for a wearing course. Several years ago, this section had been resealed with one additional BST course. Later, poritions of the shoulder selected for BOMAG treatment had been patched with an asphalt cold mix and one short section had been repaired with an approximate 1 inch layer of ACHM.

The section which had only the three BST courses was in fair condition. There was some rutting and a few cracks evident and the outer edge was raveling. The area next to the PC slab (within 12-16 inches) was deeply rutted and generally in poor condition.

The areas which had been repaired with cold mix and hot mix were both in poor condition. The entire shoulder had severe random cracking and some mild rutting. The outer edge had only minor raveling. The area within 12-16 inches of the PC slab was rutted to nearly the same depth as the sealed section.

It was decided to process the top 4 inches of approximately 900 L.F. of the sealed section and 900 L.F. of the hot/cold mix patched area. Figure 1 shows the limits of the demonstration project.

Tests run by Riffe Petroleum on the samples obtained for mix design showed 2.5% moisture and a unit weight of 103.7 lb/ft^3. An extraction analysis yielded a 3.0% AC content. Their test reports and mix design data sheets are included in the Appendix.

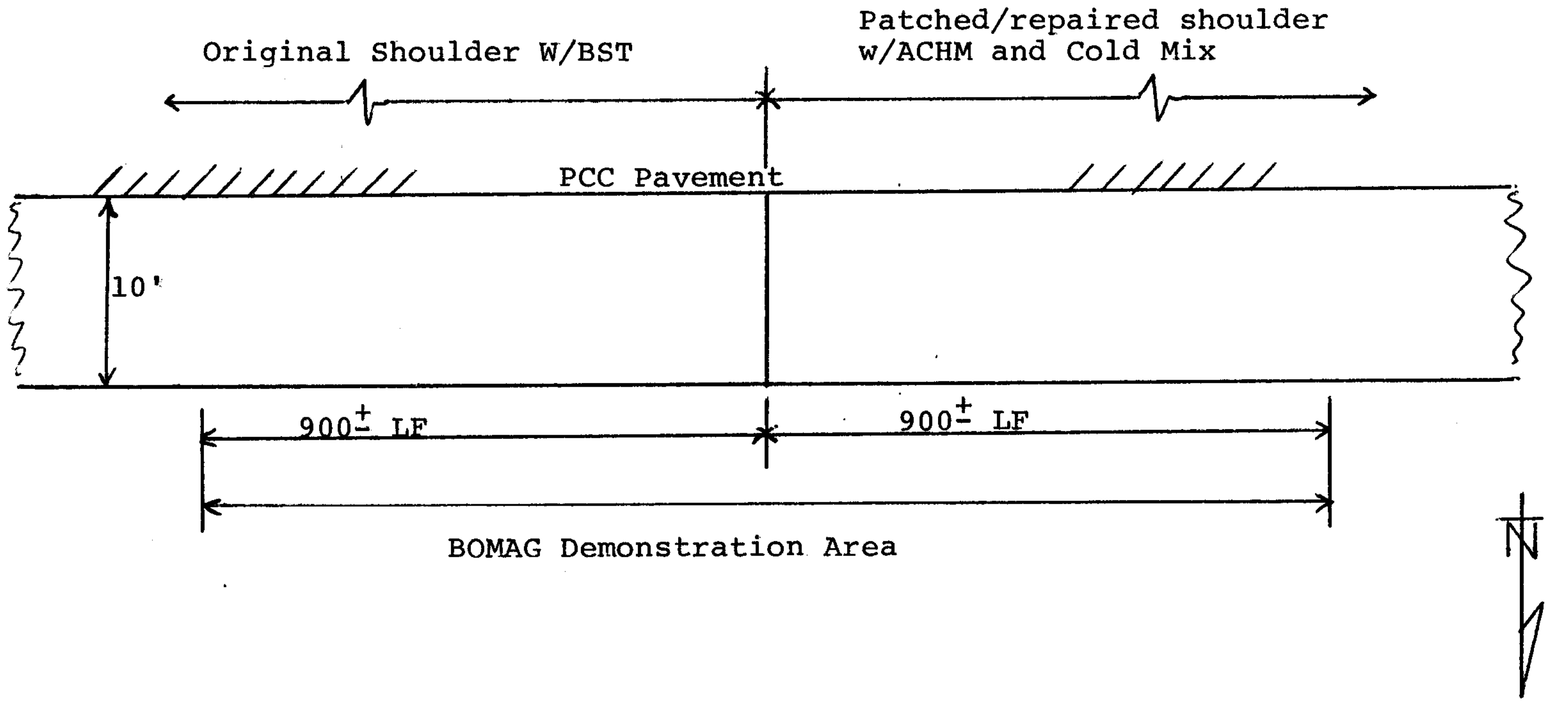


Figure 1. BOMAG Demonstration Site near LM 119, I-40

Mix Design and Construction

Riffe Petroleum's mix design called for the addition of 4.9% SS-1 which had a 62.8% residue. This would be equivalent to an additional 3% AC residue or a total of 6% asphalt in the final mixture. This was based on a consolidated sample which included material from both the sealed section and the hot mix section. For the 4" depth, this called for 2.4 gallons of emulsion added per square yard.

The demonstration was conducted on August 29, 1985. The BOMAG machine processed a non-adjustable width of 6'-7"; therefore, two overlapping passes were required to process the 10-foot width. The first pass was made adjacent to the PC slab, adding 2.4 gallons per square yard of SS-1 at the same time. The loosened material was pulled away from the slab with a motor patrol before the second pass was made, adding SS-1 for the remaining 3'-5" width. Water was added to bring the total moisture content to approximately 10%, then a third pass was made to thoroughly mix the material. The material was windrowed by the motor patrol and a final mixing pass was made.

After mixing the material was spread and shaped to final crown profile and the compaction process began. The first rolling was done by a vibratory sheepsfoot roller, which covered the entire area twice. This was followed by a rubber-tired roller which provided a single coverage of the area. The final rolling was a double coverage with a static steel-wheel roller.

After the final rolling, a fog seal coat of dilute SS-1 was applied to hold the surface while the processed material cured. AHTD maintenance forces applied a single BST approximately two weeks later.

Samples of the processed material were taken from both the seal section and the hot/cold mix patched section. An extraction analysis showed 3.6% AC in the seal section and 5.4% AC in the patched section. The cause of the discrepancy between the actual AC content and the designed 6% AC content has not been determined. Proctor densities were run on samples from both sections, yielding a maximum dry density of 127.1 lb/cf with optimum moisture of 6.4% for the seal section and 125.1 lb/cf at 4.0% for the hot/cold mix section. Test reports are included in the Appendix. No density tests were made of the completed shoulder prior to the final seal coat application.

Post-Construction Testing

Nuclear density tests were made on October 17, 1985. The valves obtained included the seal coat, and therefore do not reflect the actual density of the underlying base. The new seal coat was extended beyond the limits of the BOMAG treated area on both ends, and densities were measured in these extended areas. The values obtained showed a slight increase (approximately 3%) in density in the seal section and a slight decrease (approximately 3%) in density in the hot/cold mix section. The test record is included in the Appendix.

On September 24, 1985, the shoulder was tested with the Falling Weight Deflectometer (FWD). The results of these tests showed a marginal increase in strength on the seal section and a slight decrease in the hot/cold mix section. These results correlate directly with the results of the density tests.

Conclusions

The BOMAG machine does an excellent job of scarifying and mixing a material to a specific depth. The material was broken up into well-graded size particles, with a minimum of oversize chunks.

Nuclear density and FWD tests after construction reflect only a marginal improvement in the area where the existing shoulder was composed of base course and BST courses and a slight decrease in density and strength in those areas where the existing shoulder had been patched/repaired with cold mix or ACHM. The changes noted are not significant. The size of differences fall within the limits of precision of the tests performed.

The compaction effort may have been insufficient. No tests were made to determine the degree of compaction obtained; however, the completed shoulder seemed to be soft, based only on a visual inspection of the material as the roller made its final pass. Additional rolling probably would have yielded a significant improvement in both density and strength.

It is too soon to determine whether any improvement has been made with respect to cracking and rutting.

Cost

The cost of the processing was as follows:

BOMAG Machine	$0.55	per square yard	
Asphalt Emulsion (SS-1)	1.92	" " "	(2.4 gal/sy)
Rollers & Motor patrol	0.40	" " "	
Total	$2.87	per square yard	

These costs do not include traffic control nor the cost of sealing the shoulder.

Monitoring

This project will be monitored for one year. Visual inspections will be made, Falling Weight Deflectometer and other tests will be conducted as needed. A final report will be prepared at the end of this period.

APPENDIX

Riffe Petroleum

Riffe Petroleum Company
5131 East 68th Street
P.O. Box 470860
Tulsa, Oklahoma 74147-0860
Telephone 918-492-0952
Telex 79-6087 RIFFE TUL

MEMORANDUM

TO: George Thweatt

FROM: Bill Porter

DATE: August 5, 1985

RE: SS-1 MIX DESIGN OF SHOULDER MATERIAL (SOIL, AGGREGATE AND ASPHALT MIXTURE) FROM MILE MARKER 119 ON I-40 HIGHWAY, ARKANSAS HIGHWAY AND TRANSPORTATION DEPARTMENT. WR 85-195

We ran an extraction on the original material and a gradation on the recovered material. The extraction yielded 3% asphalt residue.

If SS-1 is used on this project we would recommend 4% moisture and 4.9% emulsion which would be equivalent to an additional 3% asphalt residue in the mix. This would mean that the total residue would be 6.0% asphalt in the final mix.

If CMS-2 is used on this project we would recommend 5 - 6% moisture and 4.3% emulsion which would be equivalent to an additional 3% asphalt residue in the mix which is the same as for the SS-1 mix.

The SS-1 coated 90 - 100% as compared with 75 - 80% for the CMS-2. The CMS-2 produced 1570 pound Marshall stability as compared with 1276 pounds stability for the SS-1. There was no difference in the moisture absorbed on the soak test.

All test data please find enclosed.

BP:je
attachment
c: John Huffman
Bob Johnson
C. V. Morgan

A Subsidiary of Charter Oil Company

Riffe Petroleum

AGGREGATE TEST REPORT

WR 85-195

Type Agg. Soil-agg, and asphalt mixture

Source Mile Marker 119 I-40 (Shoulder Work) AHTD

Application Bomag Stabilization

Date Rec'd. 7/19/85

Date Sampled

Date Tested 7/22/85-7/29/85

Moisture as Rec'd. (C-566)(T-255) 2.5 %

Sand Equivalency (D-2419) 18

Agg. Specific Gravity (C-128)(T-84)

Agg. Specific Gravity (C-127)(T-85)

Unit Wt. (C-29)(T-19) 103.7 #/ft. 3

Moisture/Density (T-99) % Opt. Moisture

Liquid Limit (T-89) %

Plasticity Index (T-90) %

Absorption (T-84, T-85) %

Contractor

State Arkansas County

ASPHALTIC CONCRETE EXTRACTION (D-2172 Method A)

Total Ash, g = G[V'/(V")]

G = Ash in solvent tested, g

V' = Total volume of solvent

V" = Solvent minus that used for ash ml

% Asphalt of dry sample = $[(\overset{1144.6}{W^1} - W^2) - (\overset{1110.8}{W^3} + \overset{33.8}{W^4})/(W^1 - W^2)] \times 100$ 3.0% A.C.

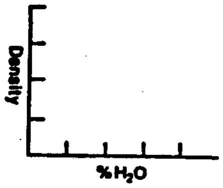
W¹ = Wt. of sample 1144.6

W² = Wt. of water in sample 0

W³ = Wt. of extracted aggregate 1108.8 + .7 gms in filter

W⁴ = Wt. of ash in extract 1.3 gms.

%H₂O	Unit Wt.
A)	
B)	
C)	
D)	



Sieve Analysis (C-136)(T-27) Dry/ washed

Sieve	Cum. Wt.	% Retained	% Passing	Specifications
No. 3/4	205.8	18.5	81.5	
No. 1/2	370.2	33.3	66.7	
No. 3/8	449.6	40.5	59.5	
No. 4	605.7	54.5	45.5	
No. 10	720.8	64.9	35.1	
No. 40	824.1	74.2	25.8	
No. 80	918.4	82.7	17.3	
No. 200	992.9	89.4	10.6	
Pan	1110.8			

AGGREGATE BLENDS:

No. 1			No. 2			No. 3			No. 4			Total % in Blend
% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	

Mix Design

✓ Marshal stability (T-245) ___ Hveem stability (T-246) ___ Cured at 140 F for 15 Hrs. MIN. TOTAL

	Type A.E.	% H₂O-A.E.	Coating	Thickness	Factor	x Load	= Pounds Stability	Flow	Voids	Stability Value	Temp.	% Residue	Bulk Sp. Gr.	% Absorbed
A	SS-1	4 - 2.4		2 3/8"	1.09	1330.7	1450.5	13			140°F	4.5		
B	✓	4 - 2.4		2 7/16"	1.04	1135.0	1180.4	7			✓	4.5		
C	✓	4 - 2.4		2 7/16"	SOAK						✓	4.5	2.230	3.9
D	✓	4 - 3.2		2 7/16"	1.04	1104.0	1148.2	14			✓	5.0		
E	✓	4 - 3.2		2 1/2"	1.00	948.9	948.9	8			✓	5.0		
F	✓	4 - 3.2		2 1/2"	SOAK						✓	5.0	2.111	4.4
G	✓	4 - 4.0		2 1/2"	1.00	1083.4	1083.4	11			✓	5.5		
H	✓	4 - 4.0		2 1/2"	1.00	814.0	814.0	7			✓	5.5		
I	✓	4 - 4.0		2 1/2"	SOAK						✓	5.5	2.113	3.8
J	✓	4 - 4.9	90-100	2 5/16"	1.14	1000.7	1140.8	7			✓	6.0		
K	✓	4 - 4.9		2 5/16"	1.14	1238.1	1411.4	10			✓	6.0		
L	✓	4 - 4.9	↓	2 5/16"	SOAK						✓	6.0	2.196	1.6

Recommendation

Type Emulsion — SS-1 RES. 62.8%

% Moisture — 4.0

% Emulsion — 4.9

% Residue — 6.0 Total

Comments:

Riffe Petroleum

AGGREGATE TEST REPORT

WR 85-195

Type Agg. Soil-Agg., and asphalt Mixture

Source Mile Marker 119 I-40 (Shoulder Work) AHTD

Application Bornag Stabilization

Date Rec'd. 7/19/85

Date Sampled

Date Tested 7/22/85 - 7/29/85

Moisture as Rec'd. (C-566)(T-255) ______%

Sand Equivalency (D-2419) ______

Agg. Specific Gravity (C-128)(T-84) ______

Agg. Specific Gravity (C-127)(T-85) ______

Unit Wt. (C-29)(T-19) ______#/ft. 3

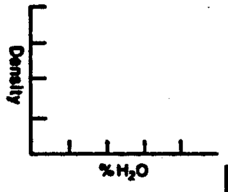
Mositure/Density (T-99) ______% Opt. Moisture

Liquid Limit (T-89) ______%

Plasticity Index (T-90) ______%

Absorption (T-84, T-85) ______%

$\%H_2O$	Unit Wt.
A)	
B)	
C)	
D)	



Contractor

State Arkansas County

ASPHALTIC CONCRETE EXTRACTION (D-2172 Method A)

Total Ash, g = G[V'/(V²)]

G = Ash in solvent tested, ______g

V' = Total volume of solvent

V² = Solvent minus that used for ash ______ml

% Asphalt of dry sample = [(W' − W²) − (W³ + W⁴)/(W' − W²)]x100 3.0% AC.

W' = Wt. of sample

W² = Wt. of water in sample

W³ = Wt. of extracted aggregate

W⁴ = Wt. of ash in extract

Sieve Analysis (C-136)(T-27) Dry/ washed					AGGREGATE BLENDS: No. 1			No. 2			No. 3			No. 4			Total % in Blend
Sieve	Cum. Wt.	% Retained	% Passing	Specifications	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
Pan																	

✓ Marshal stability (T-245) ___Hveem stability (T-246) ___Cured at 140 F for 15 Hrs. Min TOTAL

Mix Design															
	Type A.E.	% H_2O-A.E.	Coating	Thickness	Factor x	Load =	Pounds Stability	Flow	Voids	Stability Value	Temp.	% Residue	Bulk Sp. Gr.	% Absorbed
A	SS-1	4 − 5.6		2 3/8"	1.09	897.0	977.7	10			140°F	6.5		
B	✓	4 − 5.6		2 3/8"	1.09	1083.4	1181.0	13			✓	6.5		
C	✓	4 − 5.6		2 5/16"	SOAK						✓	6.5	2.163	1.2
D														
E														
F														
G														
H														
I														
J														
K														
L														

Recommendation

Type Emulsion — SS-1 RES. 62.8%

% Moisture — 4.0

% Emulsion — 4.9

% Residue — 6.0 Total

Comments:

Tested By: Jim Kratik

WR 85-195

RIFFE PETROLEUM, TULSA, OK
EMULSION ANALYSIS

Date: 7/30/85

Purpose: CMS-2 for use with RAP on I-40 shoulder in Arkansas using Little Rock formulation.

TYPE:	CMS-2					
Formulation on Total:	0.3% AA-54-100					
(Based on 69% A.C.)	% Hcl					
In Soap tank →	10% Diesel					
pH	2.05 2R					
Base Asphalt	Ergon 120/150					
Solution Temp. °F(°C)	102					
Asphalt Temp. °F(°C)	270					
Discharge Temp. °F(°C)	171					
Flowmeter Setting	24½					

EMULSION TEST RESULTS (D-244)

Sieve, wt. %						
Residue, wt. %	70.0					
Viscosity @ 77/122 °F,SFS						
E-70)						
Particle Charge						
Settlement______days, T						
Settlement______days, B						
Cement Mix, wt. %						
Demulsibility______ml. wt. %						
Classification Test						
API Gravity @ 60°F(15.6°C)						
Mixes: Aggregate, %H_2O, %A.E.						

TESTS ON RESIDUE

Oil in Dist. by Volume (D-244), %						
Penetration (D-5), mm/10						
Float @140 °F(60 °C), (D-139), sec.						
R&B Softening Pt. (D-36), °F						
idue by Dist. (D-244), wt.%						

Notes and Observations:

Copies to:

Tested by:

Riffe Petroleum

AGGREGATE TEST REPORT

WR 85-195

Date Rec'd. 7/19/85

Type Agg. Soil-Agg., and Asphalt Mixture (Extra Matl.)

Date Sampled

Source Mile Marker 119; I-40 (Shoulder Work) AHTD

Date Tested 7/31/85 to 8/2/85

Application Bomag Stabilization

Moisture as Rec'd. (C-566)(T-255) ______ %

Sand Equivalency (D-2419) ______

Agg. Specific Gravity (C-128)(T-84) ______

Agg. Specific Gravity (C-127)(T-85) ______

Unit Wt. (C-29)(T-19) ______ #/ft. 3

Mositure/Density (T-99) ______ % Opt. Moisture

Liquid Limit (T-89) ______ %

Plasticity Index (T-90) ______ %

Absorption (T-84, T-85) ______ %

Contractor

State Ark. County

ASPHALTIC CONCRETE EXTRACTION (D-2172 Method A)

Total Ash, g = G[V'/(V")]

G = Ash in solvent tested, ______ g.

V' = Total volume of solvent

V" = Solvent minus that used for ash ______ ml.

% Asphalt of dry sample = [(W' – W") – (W³ + W⁴)/(W' – W")]x100 3.0% ac

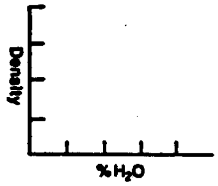
W' = Wt. of sample

W" = Wt. of water in sample

W³ = Wt. of extracted aggregate

W⁴ = Wt. of ash in extract

$\%H_2O$	Unit Wt.
A)	
B)	
C)	
D)	



Sieve Analysis (C-136)(T-27) Dry/ washed					AGGREGATE BLENDS: No. 1			No. 2			No. 3			No. 4			Total % in Blend
Sieve	Cum. Wt.	% Retained	% Passing	Specifications	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	% Pass x	% of Blend	% in Blend	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
No.																	
Pan																	

Mix Design

✓ Marshal stability (T-245) ___ Hveem stability (T-246) ___ Cured at 140 °F for 15 Hrs. min

		Type A.E.	% H_2O-A.E.	Coating	Thickness	Factor x	Load =	Pounds Stability	Flow	Voids	Stability Value	Temp.	% Residue	Bulk Sp. Gr.	% Absorbed
1)	A	CMS-2	5.5-3.6		2 5/16	1.14	1505.1	1715.8	7			140°F	5.5		
2)	B	↓	5.5-3.6		2 3/8	1.09	1104.0	1203.9	9			140°F	5.5		
3)	C		5.5-3.6		2 5/16								5.5	2.198	2.3
4)	D		5.5-4.3	75-80	2 1/4	1.19	1330.7	1583.5	6			140°F	6.0		
5)	E		5.5-4.3		2 5/16	1.14	1371.7	1563.7	8			140°F	6.0		
6)	F		5.5-4.3		2 1/4								6.0	2.226	1.7
7)	G		5.5-5.0		2 5/16	1.14	1207.2	1376.2	8			140°F	6.5		
8)	H		5.5-5.0		2 1/4	1.19	1227.8	1461.1	7			140°F	6.5		
9)	I		5.5-5.0		2 5/16								6.5	2.215	1.6
	J														
	K														
	L														

Recommendation Res. 70.0%

Type Emulsion — CMS-2

% Moisture — 5-6

% Emulsion — 4.3

% Residue — 6.0 total

Comments:

Tested By: Richard Eames

FORM MT-387—70955—11-8—A59418—7/25/74—20,000

ARKANSAS STATE HIGHWAY DEPARTMENT

DIVISION OF MATERIALS AND TESTS

LITTLE ROCK, ARKANSAS

Riffe Petroleum

9-4-85

FOR INFORMATION ONLY

STATE JOB NO. (SPECIAL)
REQ. NO. P.O.
F.A.P. NO.
PROJECT NAME

REPORT OF TESTS OF SS-1 EMULSIFIED ASPHALT

Lab. No. A-85-223 Tank No. JUG No. 2 Batch No.
Date Sampled 8-29-85 Date Received 8-29-85 Date Tested 8-30-85
Material Source & Address RIFFE PETROLEUM, LITTLE ROCK, AR
Quantity Represented
Sampled From TANK 6 Submitted by KEN BENSON
Type Construction 30 MAB

AASHTO M-140

TEST RESULTS

SPECIFIC GRAVITY @ °F:
FURIOL VISCOSITY @ °F: sec.
KINEMATIC VISCOSITY @ °F: Cs
ABSOLUTE VISCOSITY poises
DISTILLATE (% of total distillate to 680°F):
to 374°F. % to 500°F. %
to 437°F. % to 600°F. %
RESIDUE FROM DISTILLATION TO 500 °F:
by volume %
by weight 61.5 %
THIN-FILM OVEN RESIDUE TESTS:
Loss on Heating %
Absolute Viscosity poises
Ductility cm
Penetration (% original) %
SOLUBLE IN TRICHLOROETHYLENE %
SOLUBLE IN CARBON DISULFIDE %
INSOLUBLE IN BE-NAPTHA %
SPOT TEST

ASPHALT CEMENT OR RESIDUE TESTS:
Ductility cm
Penetration @ 77°F.
Penetration @ 32°F.
Ash %
Float sec.
Flow cm
RESIDUE OF 100 PENETRATION %
FLASH POINT °F.
SOFTENING POINT °F.
SIEVE TEST %
COATING TEST: Dry %
Wet %
PARTICLE CHARGE
MISCIBILITY WITH WATER
CEMENT MIXING %
DEMULSIBILITY %
SETTLEMENT %
OIL DISTILLATE %

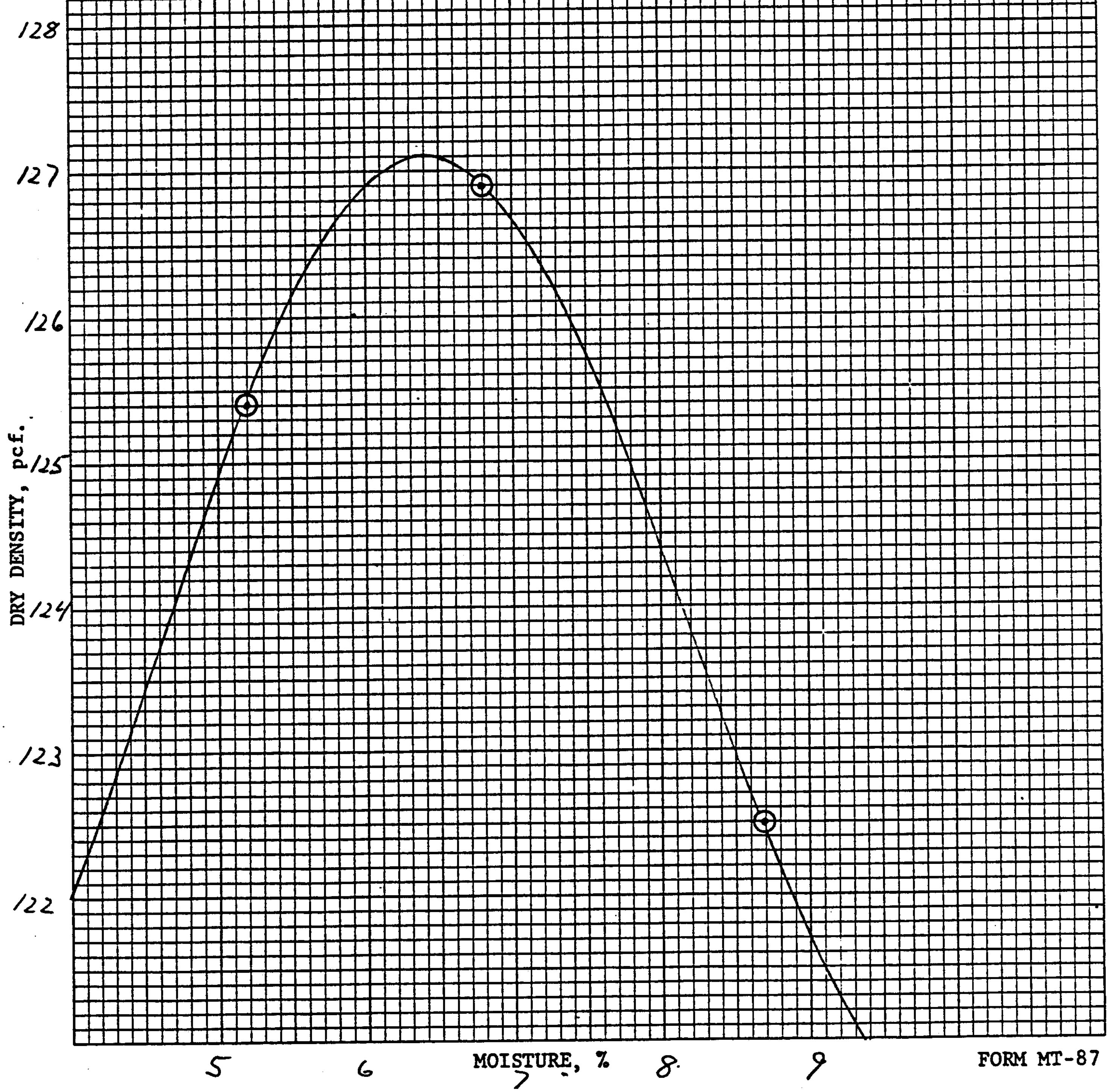
cc KEN BENSON, RESEARCH ✓

LABORATORY PROCTOR CURVE

Seal Section

JOB No. Research
LAB. No. AM-7
MATERIAL IV-Phase Shoulder
SOURCE Shoulder
DATE TESTED 9-6-85
TESTED BY Mechanical
MAX. DEN. 127.1 pcf
OPT. MOIST 6.4 %
MAX. DEN. (1pt.) ____ pcf
OPT. MOIST. (1pt.) ____ %

SIEVE SIZE	RETAINED, %
2"	
1½"	
1"	
3/4"	
3/8"	
No. 4	
No. 10	
No. 40	
No. 80	
No. 200	
L.L.	
P.I.	
Sp.G., + No. 4	



FORM MT-87

: Weigh & shake 1 full pan
over 3/4 Sieve. Calculate
Percent retained on 3/4 Sieve,

Job No. Research
Lab. No. AM - 7
Material In Place Shoulder
Source Shoulder
Date

COMPACTION WORK SHEET

8000 gram sample

Factor - 0.0193

		Trace H_2O		
Moisture pan number	#5	#9	#9A	
Water added - cc	350	500	650	
Weight of compacted sample - grams	6835	7022	6904	
Wet weight of sample lbs. per Cu.Ft.	131.9	135.5	133.2	
Wt. of pan & wet sample	7242	7464	7327	
Wt. of pan & dry sample	6902	7014	6772	
Water Weight	340	450	555	
Wt. of pan & dry sample	6902	7014	6772	
Pan weight	409	442	423	
Dry weight of sample	6493	6572	6349	
Percent moisture	5.2	6.8	8.7	
Dry weight of sample-lbs. per Cu.Ft.	125.4	126.9	122.5	
	4.4 / 126.4	6.3 / 127.5	8.1 / 123.3 Sample Blend	

Gradation

Sieve	% Retained
2	
1 1/2	
1 1/4	
1	
3/4	
3/8	
4	
10	
40	
200	
LL	
PI	

___ lbs +3/4 →

___ lbs full pan

8000 gms Total sample
x 11.2 Retained 3/4"
896 gms (- 3/4", + # 4)

8000 gms Total sample
896 gms (- 3/4" + # 4)
7104 gms (- 3/4")

Calculated by

Checked by

2-8-62
JMH

Form MT-57

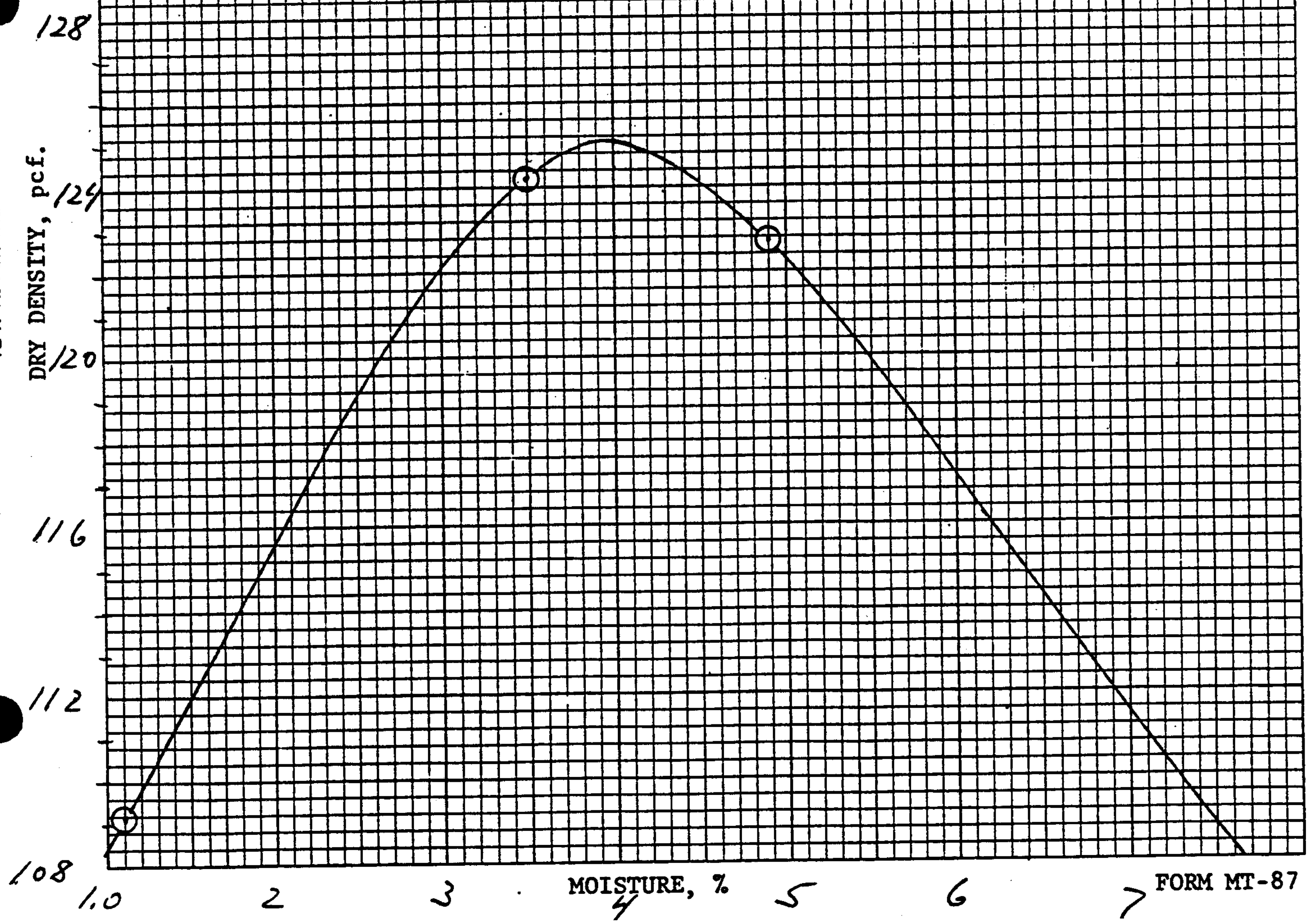
LABORATORY PROCTOR CURVE

Hot Mix Section

JOB No. Research
LAB. No. AM-6
MATERIAL In-Place Shoulder
SOURCE Shoulder
DATE TESTED 9-6-85
TESTED BY Mechanical
MAX. DEN. 125.1 pcf
OPT. MOIST 4.0 %
MAX. DEN. (1pt.) ____ pcf
OPT. MOIST. (1pt.) ____ %

SIEVE SIZE	RETAINED, %
2"	
1½"	
1"	
3/4"	
3/8"	
No. 4	
No. 10	
No. 40	
No. 80	
No. 200	
L.L.	
P.I.	
Sp.G., + No. 4	

No Requirement



FORM MT-87

Weigh & shake 1 full pan over 3/4" sieve. Calculate percent retained on 3/4 sieve

Job No. Research
Lab. No. AM - 6
Material In-place Shoulder
Source Shoulder
Date

COMPACTION WORK SHEET

8000 gram sample

Factor - 0.0193

Slight Trace

Moisture pan number	#10	#17	#19	#1A
Water added - cc	350	500	200	50
Weight of compacted sample - grams	6668	6701	6656	5713
Wet weight of sample lbs. per Cu.Ft.	128.7	129.3	128.5	110.3
Wt. of pan & wet sample	7063	7104	7080	6065
Wt. of pan & dry sample	6753	6701	6853	6003
Water Weight	310	403	227	62
Wt. of pan & dry sample	6753	6701	6853	6003
Pan weight	395	403	424	352
Dry weight of sample Plotted	6358	6298	6429	5651
Percent moisture Values	4.9	6.4	3.5	1.1
Dry weight of sample-lbs. per Cu.Ft.	122.7	121.5	124.2	109.1
	4.4 123.3	6.3 oil 121.7	2.5 125.3	.625 109.6

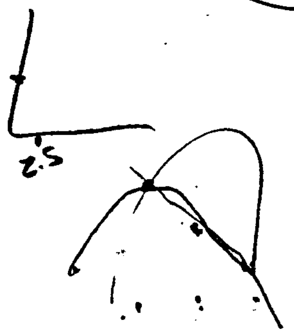
Sample Blend

Gradation	
Sieve	% Retained
2	
1 1/2	
1 1/4	
1	
3/4	
3/8	
4	
10	
40	
200	
LL	
PI	

lbs + 3/4
lbs full pan

8000 gms Total sample
X 0 Retained 3/4"
gms (- 3/4", + # 4)

8000 gms Total sample
8000 gms (- 3/4" + # 4)
gms (- 3/4")



Calculated by

Checked by

2-8-62

Form MT-57

Arkansas State Highway and Transportation Department
MATERIALS and RESEARCH DIVISION
Little Rock, Arkansas

Att. Research

Report of Tests of Bituminous Mixtures

Type of Mixture Hot Mix Seal

Job No. Special

Federal Aid Proj. No.

Bitumen in Mixture

Aggregates in Mixture

Job Name

Submitted By Ken Benson

Sampled From Shoulders

Date Sampled 8-29-85 Date Received 8-29-85 Date Tested 9-5-85

EXTRACTION ANALYSIS

	Hot mix	Seal					
Laboratory Number	AM 6	AM 7					Specification
Station Number	LM 118.7	LM 119.1					
Location	I40-Shlds.	I40-Shlds					
Total Ret. on 1 1/2" Sieve %							
Total Ret. on 1 1/4" Sieve %							
Total Ret. on 1 1/8" Sieve %							
Total Ret. on 1" Sieve %	0	0					
Total Ret. on 3/4" Sieve %	11.1	1.9					
Total Ret. on 1/2" Sieve %	18.7	13.5					
Total Ret. on 3/8" Sieve %	23.7	23.4					
Total Ret. on No. 4 Sieve %	41.1	43.3					
Total Ret. on No. 10 Sieve %	55.1	57.5					
Total Ret. on No. 20 Sieve %	—	—					
Total Ret. on No. 40 Sieve %	69.7	69.4					
Total Ret. on No. 80 Sieve %	82.4	79.7					
Total Ret. on No. 100 Sieve %	—	—					
Total Ret. on No. 200 Sieve %	90.3	89.8					
Bitumen %	5.9	3.6					
Density %							
Core Thickness							
Plan Qty., lbs. per sq. yd.							

SIEVE ANALYSIS BASED ON WEIGHT OF EXTRACTED AGGREGATE

REMARKS:

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
MATERIALS AND RESEARCH DIVISION

NUCLEAR MOISTURE-DENSITY GAUGE ANALYSIS

JOB NO. ______ JOB NAME BOMAG Demonstration

GAUGE NO. ______ DENSITY COUNT RATIO RANGE ______ MOISTURE STANDARD RANGE ______

MATERIAL ______ MAX. DENSITY (A) ______ Lb/Ft.^{3} OPT. MOISTURE ______%

DATE	STATION	LOCATION	LIFT ELEVATION	PROBE DEPTH	DC / DS	RATIO	MOIST. STD. MS	(B) DENSITY DD/WD	MOISTURE % M	[(B)÷(A)] X 100 % COMPACTION
10/17/85	East of processed section - on new seal			4"			124.4	113.1	10.0	
"	ON BOMAG Section - original Seal			4"			128.5	116.4	10.4	
"	"			4"			129.7	117.2	10.7	
"	ON BOMAG Section - patched w/cold mix/ACHM			4"			129.3	116.6	10.8	
"	"			4"			127.8	116.1	10.1	
"	West of processed section - on new seal over patched			4"			129.7	121.3	7.0	

4-25-79
sm

Form # M & R 98