Final Report
for
Iowa Department of Transportation
Project HR-529

Foamed Asphalt Shoulders
City of Muscatine

by
Chris Anderson
515-239-1392
Office of Materials
Highway Division
Iowa Department of Transportation
Ames, Iowa 50010

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TECHNICAL REPORT TITLE PAGE

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Chris Anderson Technician 4 Materials Department	Iowa Department of Transportation 800 Lincoln Way Ames, Iowa 50010

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8. ABSTRACT

Foamed asphalt shoulders were placed on an Industrial Connector road at the south edge of Muscatine. The foamed asphalt was produced by injecting 1 to 2 percent water into hot asphalt cement in a patented foaming chamber. A foam develops which is 10 to 15 times the original volume of the asphalt cement. A 3/8" limestone aggregate was used in the foamed asphalt mixture. This foamed asphalt was placed on the shoulders and in the radii on the Industrial Connector road in May 1987. The radii were later replaced due to reconstruction, but the shoulders remain and performed fairly well with some recent stripping and potholing. The performance appeared to be lower than expected from conventional hot mix on projects with similar traffic.

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Foamed asphalt Asphalt concrete	14

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DISCLAIMER

INTRODUCTION

The city of Muscatine proposed the use of foamed asphalt as an experimental project because of the lower initial cost compared to portland cement concrete paved shoulders and to have a color differentiation between the mainline pavement and the shoulders. They had experienced problems at a different location with motorists using the shoulder as a driving lane and felt the color difference might deter this.

This project, M-4946(1)--81-70, involved using 9" foamed asphalt shoulders from US 61 to the railroad tracks just west of Stewart Road in the westbound lane (Figure 1). Some of this material was also used in the shouldering of the eastbound lane so all the material could be used. The foamed asphalt was also placed at both radii at the west side of Stewart Street but was later replaced due to reconstruction in that area.

The foamed asphalt material has very little structural properties, but the slurry seal is very effective in holding the top together. It is a very black surface which provides a definite contrast to the paving. The shoulders appear to be doing fairly well but they have recently had some stripping and potholes have developed.

PROJECT LOCATION AND DESIGN

The project location was at the southern edge of Muscatine as shown in Figure 1. The typical section and variable design distances are given in Figure 2.

OBJECTIVE

The objective of this research project was to evaluate the performance of the foamed asphalt shoulders.

MATERIALS

The aggregate for the foamed asphalt mix was minus 3/8" limestone screenings from the Wendling Quarry at Moscow, Iowa. The AC-5 asphalt cement came from Koch Asphalt Company, Dubuque, Iowa.

The foamed asphalt process involves injecting 1 to 2 percent water into hot asphalt cement in a patented foaming chamber. A foam develops which is 10 to 15 times the original volume of the asphalt cement. The foamed asphalt mix was made with limestone screening and 3.5% intended AC-5 grade asphalt cement. The material was mixed in September 1986 and stockpiled until May 1987.

The shoulders in the experimental section are 9" of foamed asphalt over 4" of emulsion bound 3/4" open-graded limestone. The surface is a boiler slag slurry seal coat.

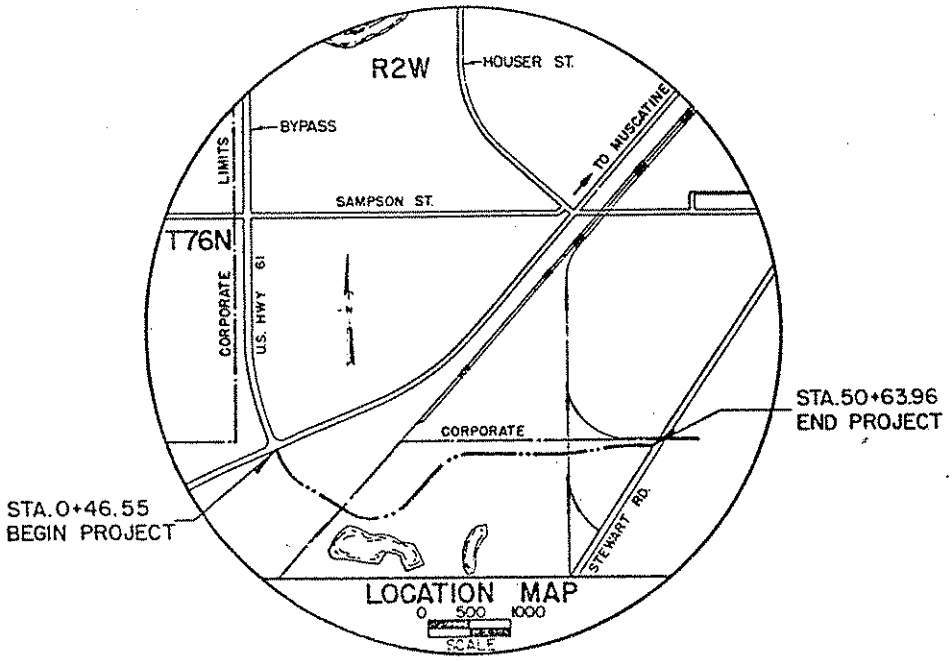
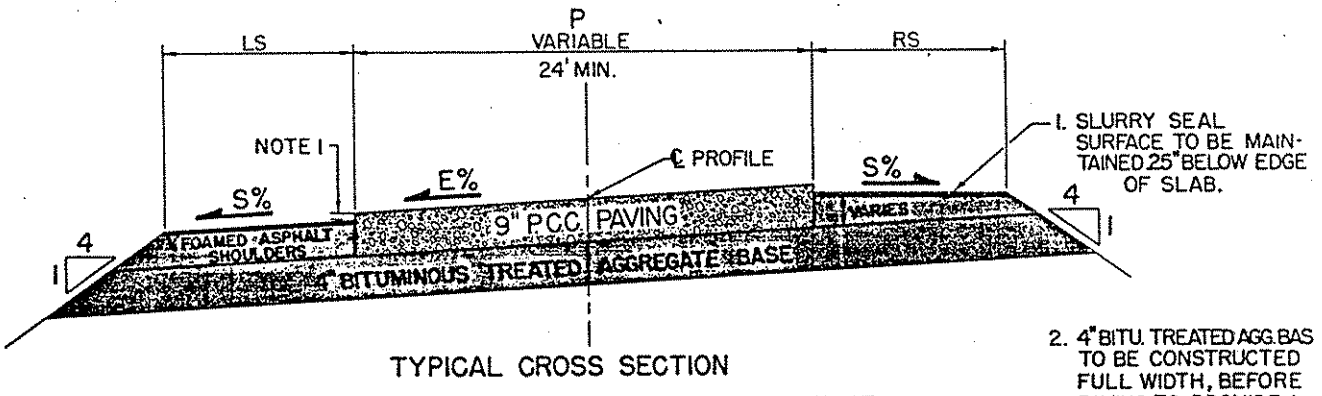


Figure 1 Project Location



TYPICAL CROSS SECTION

BASE, PAVING, & SHOULDER TREATMENT

2. 4" BITU. TREATED AGG. BAS TO BE CONSTRUCTED FULL WIDTH, BEFORE PAVING, TO PROVIDE A WORK PLATFORM.

3. E% = CROWN SLOPE OR SUPERELEVATION
4. S% = SLOPE OF HIGH SHOULDER
5. $[E-(-S)] < 7$: BUT S% SHOULD BE ≥ 1
6. TANGENT SECTIONS E% = 2.08, S% = 4.0

LOCATION			LS	P	RS
ROAD IDENTITY	STATION TO STATION				
INDUSTRIAL CONN.	0+47	5+00	10	VARIES	10
"	5+00	49+13	10	24	10
"	49+13	50+64	10	VARIES	10
ACCESS ROAD	11+10	RT SIDE	4	24	4
"	46+18	LT SIDE	4	VARIES	4

PAVING SLOPE	TO	SHOULDER SLOPE
8		1
7		1
6		1
5		2
4		3
3		4
2.08		4
1		4

Figure 2 Typical Section

CONSTRUCTION

The prime contractor on this project was Flynn Company, Inc. of Dubuque, Iowa who sublet placing of the shoulders to Iverson Construction, Inc. of Platteville, Wisconsin.

The equipment used for placement of the shoulders was a Blaw-Knox RW-195 shouldering machine, BOMAG 40-67 dual drum roller and a John Deere JD 570-A motor patrol.

The shoulders were 9" deep and 10′ wide. The foamed asphalt mixture was placed in three lifts. Each lift was compacted before placing the next lift.

The stockpile, which had been produced the winter before the construction of the shoulders in May, was misted with water about four hours before hauling began. No other moisture was added and the stockpile had sufficient moisture for placement. The weather was clear and warm with the temperature reaching about 80°F. The humidity was low as the weather had been dry.

The foamed asphalt mix was loaded with an endloader, hauled to the job site, spread, and compacted. The only problem was when large chunks would be dragged by the shouldering machine causing a furrow in the loose material. The chunks were broken by the roller and the furrows were filled in and compacted with the next lift. If the furrow was in the top lift, it had to be filled prior to compaction.

VISUAL OBSERVATIONS AND TEST RESULTS

Visual field reviews have been made annually. It appears in the past year the foamed asphalt shoulders have begun to deteriorate somewhat with stripping and potholing. There was some longitudinal cracking in the 12" adjacent to the pcc pavement. The deterioration could be due to the fact that the material was stored over the winter before placement and compaction. It may have performed better if it had been placed warm immediately after mixing. The lower asphalt content could be a factor. Extraction test results of the materials showed bitumen percentage to 2.59. These results are shown in Appendix B.

The Road Rater has been run annually with results given in Appendix C. The structural test results show an increase in the structural ratings each year since the time of construction. This is due primarily to the fact that the foamed asphalt has a wet, mushy texture when placed. Promoters claim it cures and oxidizes slower than normal asphalt mixtures and takes longer to achieve its structural peak. For the reasons stated above, and the low bitumen content, as well as the mix usually having higher air voids, the foamed asphalt sometimes has a tendency to break up quicker than would a normal mixture.

CONCLUSION

The foamed asphalt shoulders performed well for the first four years but began to deteriorate after that point and are now

stripping somewhat and potholes are developing. They do not appear to have given as good of performance as expected from conventional hot mixed shoulder on other projects with similar traffic.

Appendix A
Special Provisions

SPECIAL PROVISIONS FOR
FOAM ASPHALT CONCRETE SHOULDERS
CITY OF MUSCATINE INDUSTRIAL CONNECTOR
PROJECT #M-4946(1)--81-70

The Standard Specifications of the Iowa Department of Transportation, series of 1984, shall apply to this project except as amended by the following additions. These are Special Provisions and they shall prevail over those published in the Standard Specifications.

.01 Scope: The bidder is to provide all necessary equipment, experienced labor, and materials to process and apply a foam asphalt shoulder as shown in the plans and detailed specifications, or as directed by the Engineer.

.02 General: The work on this project consists of construction of foamed asphalt shoulders, using limestone screenings and AC-5 asphalt cement.

Foamed asphalt concrete shoulders are a mixture of moistened, unheated aggregates, and asphalt cement, combined while the asphalt cement is in a foamed state.

The Continental Oil Company has proprietary rights to the foamed asphalt process and a royalty fee may be required to use this process. The royalty fee, if any, shall be paid by the contractor and shall be incidental to the construction of the shoulders. Inquiries concerning this process may be directed to Conoco, Mr. Roy Hodson, 5717 East Ferguson Drive, Los Angeles, California, 90022, or telephone (213)723-2121.

.03 Materials: The foamed asphalt shoulder mixture shall meet the following requirements.

A. Aggregates shall be limestone screenings from a source meeting the requirements of Section 4126. The aggregates shall be within the following gradation limits.

Sieve Size	% Crushed Limestone Passing
1/2	100
3/8	90-100
#4	75-90
#8	50-66
#30	28-40
#200	20-30

B. Asphalt cement shall meet the requirements of Section 4137 for Grade AC-5. The asphalt cement shall not contain an antifoaming agent. Use of a foaming agent will be required if necessary.

C. Mixture The aggregate shall be limestone screenings mixed with 3.5% AC-5 by dry weight of aggregate. The AC-5 shall have a temperature of 330°F ± 15°F. The amount of potable water added shall be 2% by weight of asphalt. The volume of the foamed asphalt to the volume of AC shall be a minimum of 10:1. The minimum structural number shall be .28. The minimum temperature during processing shall be 50°F. Any of the above may be adjusted by the Engineer in the field as required.

.04 Equipment: The Contractor shall provide all equipment necessary for the construction of the foamed asphalt shoulders as specified. Equipment shall comply with Section 2001.01 and the following.

A. Proportioning Equipment shall meet the requirements of Section 2205.04. However, a split-bin aggregate proportioning system for two aggregate mixes is unacceptable.

B. Mixing Plant. The mixing of foamed asphalt shoulders shall be accomplished in a stationary plant with a pug mill mixer specifically designed to produce foamed asphalt materials. The plant shall have a positive driven feed to proportion the aggregate from the bin or bins in a synchronized volume proportioning method with automatic controls. It shall have suitable pumps, proportioning, metering, and weighing devices that are interlocked by automatic controls to assure proper foamed asphalt to aggregate ratio. The plant shall contain any other necessary equipment to produce the shoulder mixture on a quality controlled basis. The foam chamber shall be mounted above the header spray bar and proper nozzles included to produce the necessary foaming action to assure maximum penetration of foam to aggregate. The spray header shall be equipped with an external sampling valve with same nozzle size as in the header to conveniently take samples of foam in a 5-gallon container to accurately measure the foam half-life and stability. A plant designed for a similar mixing process or modifications to these requirements may be approved, as provided in 494.01.

C. Spreading Equipment. Article 2001.19 shall apply.

D. Compaction Equipment shall meet requirements of 2001.05B, C or F. A smooth faced, steel or pneumatic-tired roller shall be used for finish rolling.

.05 Proportion and Mixing: The materials shall be proportioned in such a manner that a uniform mixture results and each aggregate is controlled within 5 percent of the intended quantity and the asphalt cement and water is controlled within 0.4 percentage points of the percent intended. Blending of the aggregates shall be accomplished before the asphalt is added.

Prior to foaming, the asphalt cement shall be heated to between 315 and 345°F, unless otherwise directed by the Engineer.

The asphalt cement shall be foamed immediately prior to mixing with the aggregates according to the procedure outlined by the Conoco Foamed Asphalt Process. The estimated quantity of water required for proper foaming is 2 percent of the liquid asphalt cement, by weight. Water shall be adjusted to provide a foam half-life of 26 seconds, or as determined by the Engineer.

The mixture is to be produced at 75 and 90 percent of optimum moisture, as designated on the plans for specific test sections. If the aggregate has less moisture than necessary for the mixture to meet the required percentage of optimum moisture, water shall be added to the aggregate prior to mixing the foam. The water may be added through a metered and controlled spray system prior to entering the mixing chamber.

.06 Construction: The construction of the foamed asphalt shoulders shall be as follows.

A. Base. The existing surface will be as Asphalt Treated Aggregate Base material. The contractor shall spread the foamed asphalt concrete shoulder mixture to the width and thickness shown on the plans. The intention of this specification is placement in 3" thick lifts. The mixture shall be promptly compacted. Compaction shall continue until maximum consolidation is achieved, and the Engineer may utilize nuclear testing equipment to determine this. In any case, compaction shall be at least 94 percent of Marshall density. Compaction of the first lift shall be to at least 92 percent of Marshall density. The Marshall density will be based on laboratory tests of field-mixed samples.

.07 Limitations: Foamed asphalt shoulders shall be placed with an aggregate and air temperature of not less than 50°F.

Should rain prevail and aggregate stockpiles retain moisture in excess of the required optimum moisture, time will be allowed to drain and dry the aggregate to meet the requirements of the specifications.

The foamed asphalt base shall be allowed to cure for seven days before the slurry surface treatment is applied, or longer if so directed by the Engineer.

.08 Method of Measurement: The Engineer will compute the quantity of foamed asphalt concrete base, satisfactorily placed, as provided in 2303.27. The Engineer will compute the quantity of asphalt cement used in the foamed asphalt base, as provided in 2303.27B.

.08 Basis of Payment: For the quantity of foamed asphalt shoulders furnished and placed, the contractor will be paid the contract price per ton. Such payment shall be full compensation for furnishing all aggregate and water, for mixing and placing, for subgrade work that is necessary, and for the cost, if any, for the right to use equipment and procedures protected by patents. Asphalt cement will be paid for in accordance with Article 2303.28B.

Appendix B
Extraction Results

IOWA DEPARTMENT OF TRANSPORTATION
Highway Division
Office of Materials

Asphalt
Don Hines
Dick Smith

FORM 257
20M 4-71

TEST REPORT — BITUMINOUS MATERIALS

Material Foamed Asphalt **Laboratory No.** ABC7-43

Intended Use Shoulders

Project No. HR-529 **County** Muscatine

Contractor Iverson Constr.

Producer

Plant Wendling Quarry at Moscow

Unit of Material Material was produced in September 1986

Sampled by Dick Smith **Sender's No.**

Date Sampled 5-8-87 **Date Rec'd** 9-2-87 **Date Reported** 9-24-87

SIEVE ANALYSIS — PER CENT PASSING

1½"	1"	3/4"	1/2"	3/8"	No. 4	No.8	No. 16	No. 30	No. 50	No. 100	No. 200
			100	99	92	75	54	42	33	28	23.6

% Aggregate—By Extraction 97.20
% Bitumen—By Extraction 2.59
Water 0.21
% Pcg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Pcg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit
Plastic Limit
Plasticity Index Percent Moisture (Based on Dry Weight) 6.01
" " (Based on wet weight) 5.67
Rice Sp. Gr. results not accurate (uncoated particles)
Marshall Density as Received 2.377

COMPACTION & STABILITY TESTS

Laboratory Density (Specific Gravity)
Marshall Stability (lbs.)
Marshall Flow (ins.)
Hveem Side Pressure (PSI)
Marshall density H20 removed (ovendried @ 100° F) then paraffin coated 2.266
Penetration @ 77°F 100 Gm. 5 sec. 166
ABS viscosity @ 140°F 300 MM Hg poises 226

DISPOSITION:

By Testing Engineer

Road Rater Test Results

Date	Structural Rating	Road Temp. (F)
10-8-87	2.96	35°
5-3-88	2.74	82°
5-1-89	3.42	52°
4-29-91	4.95	79°
3-17-92	5.46	60°