Iowa State Highway Commission

materials department

special report

ASBESTOS FIBERS IN TYPE B ASPHALTIC CONCRETE SURFACE COURSE

Chickasaw County

project F-63-8(1)

FOR BETTER HIGHWAYS

IOWA STATE HIGHWAY COMMISSION

MATERIALS DEPARTMENT

SPECIAL REPORT

ON

ASBESTOS FIBRES IN TYPE B ASPHALTIC CONCRETE SURFACE COURSE

CHICKASAW COUNTY

Project F-63-8(1)

Mix Produced and Placed

October 12, 13, 1967

Reported February 5, 1968

By

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Bituminous Concrete Engineer

SYNOPSIS

The Standard Specifications for this project included requirements for placing two 500 foot test sections of Type B asphaltic concrete with 1-1/2 per cent asbestos fibres (mix size 3/8 inch, lift thickness 3/4 inch) as part of the regular construction of the surface course. These requirements were designed to provide asbestos modified mixtures for laboratory analysis and road performance evaluation. This report provides the preliminary results and analysis of test data obtained from tests on the mixtures placed on the roadway. Previous research by G. S. Zuelke (1) and J. H. Kestzman et al (2) indicated that asphaltic concrete mixtures modified with asbestos fibres improved stability, decreased permeability, and allowed the use of higher bitumen contents. This study indicated that the addition of asbestos fibres would permit the use of higher bitumen contents, theoretically improving durability, without adverse results. An indication was also obtained to the effect that asbestos mixtures were more difficult to compact in the field.

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PURPOSE

The principle purpose of this study is to evaluate the effect of asbestos fibres in fine dense graded asphaltic surface courses.

SCOPE

This study is limited to one project and to one basic asphaltic concrete mixture. The following excerpt from the project specifications defines the general limits of the basic experiment.

"For a minimum of two 500 ft. sections which will be designated by the engineer, asbestos fibres shall be substituted for 1-1/2% of the total dried mineral aggregate. The asbestos fibres shall be of a type recommended by the manufacturer for use in asphaltic concrete and be approved by the engineer. The fibres shall be added to the hot aggregate by methods and procedures approved by the engineer.

The contractor shall submit information relative to the additional costs for adding asbestos fibres to the asphaltic concrete mix."

Inasmuch as the scope is limited to one project and one mixture, the evaluation is limited to the specific conditions and parameters associated with the project.

MATERIALS

The basic material constituents (refer to data sheet No. 1) for the test sections were from the normal production of materials for the balance of the project. The job mix required a 50 per cent crushed stone and 50 per cent sand mixture for the surface course (3/8" Max. size). The recommended asphalt content for the standard surface course mixture was 7.50 per cent of 85-100 penetration grade asphalt cement. The supplementary job mix incorporating 1-1/2 per cent asbestos fibres furnished by the Johns-Manville Products Corporation indicated a minimum asphalt demand of 8.00 per cent asphalt cement. Production characteristics of the mixtures at the project site predicated the decision by the Bituminous Concrete Engineer, District Materials Engineer and the Resident Construction Engineer to place sections as follows:

<u>October 12, 1967 Run</u>

AC%	Fibre	Station (from)	Station (to)	Side
8	1-1/2%	316±	311±	East
8	None	311±	306±	East
9	1-1/2%	287±	281+60±	East
7.50	None	Balance of day's run		

<u>October 13, 1967</u>

AC%	Fibre	Station (from)	Station (to)	Side
8	None	322±	317±	West
8	1-1/2%	316±	311±	West
9	1-1/2%	287±	282±	West
7.50	None	Balance of day's run		

Samples were taken of the constituents as follows:

<u>October 12, 1967</u>

1 - gallon of asphalt cement
1 - bag combined aggregate (from cold feed)
2 - boxes of mixture of each type of mix (plant samples)
2 - boxes of mixture of each type of mix (road samples)

<u>October 13, 1967</u>

2 - gallons of asphalt cement
1 - bag combined aggregate (from cold feed)
2 - boxes of mixture of each type of mix (road samples)

TESTS PROCEDURES (3), (4)

The various mixture samples and core samples were analyzed in the Central Laboratory in a normal manner. In addition to the usual tests, the following special tests were performed on specially selected samples: High Pressure Meter measurements for air voids and solid density, Marshall stability and flow measurements, and Density and Hveem stability measurements on 75 blow Marshall specimens.

DISCUSSION

Aggregate Characteristics

Coarse Aggregate

Dotzler Quarry: NE-1/4 23-99-12, Howard County
Operated by Welp & McCarten (formerly owned by Grupp)

Beds Used: 7-8 of Myers' 11-3-67 Revision of Michaels' 1-28-65 Geologic Section

The rock is fine-grained earthy dolomite. The crushed fragments tend to be cubical with blunted rather than sharp edges, with a rough to hackly surface. There are many fine pores throughout the rock. It is composed of fine-grained, 3-10 micron sized dolomite crystals that give each fracture face a sandy or granular surface. The rock is leached and oxidized and tends to crumble under a hammer blow.

Normal Test Characteristics: (3)

"A" freeze and thaw test:	Avg. 6 or less
L.A. Abrasion test:	Less than 40
Calcium Carbonate:	95%+

Sand

Lourdes Pit: Section 31-98-12, Howard County

The pit run material is generally a mixture of rock types in the coarser sizes, with more carbonate rock in the larger size fractions. The fine fraction, the minus 4 material is predominately quartz grains in the smaller sizes with some fragments of granite and carbonate rocks in the sizes between the 16 and No. 4 sieves.

The particles in all sizes tend to be spherical and subrounded to well rounded. The degree of sphericity and roundness is less in the larger sizes and is generally greatest in the material retained on the 100 and passing the 16 sieve.

Mix Characteristics (refer to data sheets 2 - 4)

The test data indicates that the 50 blow Marshall specimens generally exhibited high relative density, low air voids and moderate to poor stability values. The Marshall stability results compare favorably with results published by other agencies and laboratories (1, 2).

Increasing the level of laboratory compaction to 75 blow Marshall did not appear to significantly affect the density and void levels of the specimens, although an increase was observed in the Hveem side pressure (indicating a decrease in stability) in varying amounts for all the special mixtures tested.

The extraction results indicate that the production process did not vary appreciably, although the differential between the intended asphalt content and the extracted asphalt content is significant. The duration of the production runs was quite short, therefore it was not practical to make volumetric asphalt content determinations in the usual manner.

The air void percentages as measured by the high pressure meter on the 50 blow Marshall specimens are quite low as judged by normal standards. Normally, void levels in this range are avoided due to the fact that experience has taught asphalt paving technologists that rutting and flushing will result at these levels. These void levels in fine dense graded mixtures may not be hazardous if the mixtures are placed in thin lifts and treated with additives such as asbestos.

The variation in compacted and solid density results would indicate that the production process did not vary appreciably and that minor changes in the proportions (asphalt and asbestos) in this case did not affect the behavior of the mixtures appreciably in the laboratory.

Apparently the differential between the production temperature for the two runs did not affect the test results observed in this study. The first day's run (10-12-67) was made under normal operating conditions (3); the mix was produced at 280°F to 300°F. The temperature of the mixture produced on the second day's run (10-13-67) was maintained at approximately 325°F.

The Hveem side pressure test observations for the 8 per cent mixtures averaged 52 psi without asbestos and 50 psi with asbestos; these stability values are considered acceptable for virtually all types of traffic conditions encountered in Iowa at the present time.

It will be noted that the 9 per cent A.C. mixture exhibited an average side pressure value of 92 psi; this stability level would be considered unacceptable for mixtures subjected to heavy traffic.

Even though the void levels were quite low in the laboratory compacted specimens, the stability results indicated that this aggregate combination (with asbestos added) would be safe with an asphalt content of approximately 8.5 per cent.

Pavement Core Sample Characteristics (refer to data sheets 5 and6)

The primary parameters requiring consideration are: In-place density, air voids and asphalt content. It will be noted that considerable variation was observed in the density and void testing, and that the extracted A.C. content of the cores agreed quite well with the intended A.C. content. The latter observation does not agree with the differential observed between the intended A.C. content, and the A.C. content as determined by extraction of the loose mix samples. This latter observation cannot be resolved within the scope of this study. The differential is not considered significant with regard to the overall goal of the study and, therefore, it will be disregarded at this time. In either case the actual A.C. content can be accepted as being near enough to the intended to validate the balance of the test observations.

In reviewing the density and void data obtained from the tests on the core samples, a wide variation is noted. The data indicates that a slightly higher level of compaction was achieved on the second day's run for the special mixtures. These results may in part be attributed to the higher temperature of the mix (325°±F) at the time of placement, although other non-identifiable factors may be involved.

The density data also indicates that general compliance with the 95 per cent density specification (3) was not universally achieved. It should be pointed out that at the time of the letting virtually no information was available in this area, therefore, the standard specifications (3) were not modified for the test sections. Studies by other researchers (1, 2) on these types of mixtures tend to indicate that high levels of field compaction are not easily obtained. These studies also indicate that lower levels of field density are not detrimental when asbestos is used. The follow-up programs on in-service mixtures apparently are not showing additional compaction or consolidation under traffic. Additional field work on this characteristic is needed to verify this preliminary observation.

The void levels are higher in the mixture in place than expected. These results may be directly attributed to the low level of field compaction. Due to the small size of the void spaces and the high A.C. content, it is doubtful that these void levels will be detrimental. Generally traffic action and foreign matter tend to choke and seal the surfaces of most surface courses in time such that the permeability of the surface course is reduced to a safe level. These mixtures were considered harsh by the observers on this project; this characteristic, without additional influence, is considered to affect the construction compaction process in an adverse manner although it does improve stability test values and prevent additional traffic consolidation.

Two other factors affecting the density and void levels on this project are: the low air and surface temperatures at the time of placement and the core sampling difficulties which are common to thin surface course construction. The temperature of the air and binder course was in the 40°F to 50°F range; this condition generally complicates placement and compaction operations on most projects. The problem of obtaining core samples from thin courses (3/4" and 1") of asphaltic concrete is particularly acute on experimental projects since additional information must necessarily be extracted from test data. In view of these conditions and limitations, considerable care must be exercised in interpreting the results; extrapolation must also be severely restricted.

In summary, the various factors affecting the level of field compaction were considered significant even though it was not possible to identify or measure the influence of the individual factors. This in part resulted from the limitations of the project and the application of a standard compaction process. The latter process consisted of the standard methods and equipment required by the specifications (3) supplemented by one additional pneumatic tired roller.

CONCLUSIONS

1. The addition of 1-1/2 per cent of asbestos fibres to the surface course mixture on this project permitted an asphalt content increase of approximately 1 per cent.
2. The addition of asbestos fibres to these mixtures did not improve the stability as measured by the Hveem stabilometer. (Lateral pressure observed in PSI at 400 PSI vertical load).
3. It would appear that mixtures incorporating asbestos fibre are slightly more difficult to compact in the field than conventional mixtures.
4. The addition of asbestos fibres did not significantly affect the air void level in the field compacted mixtures.
5. The addition of asbestos fibres did not significantly affect the percentage of aggregate voids "V.M.A." filled with asphalt in the field compacted mixtures.
6. Field compaction on this project did not approach the level of compaction reached in the laboratory, (50 blow Marshall). This conclusion applies to all of the mixtures tested.

RECOMMENDATIONS

1. Additional, although larger, test sections should be placed on future projects.

2. The analysis of future test sections should include a study phase wherein the permeability characteristics of the compacted mixtures are determined.

REFERENCES

1. Zuehlke, G. S., "Marshall and Flexural Properties of Bituminous Pavement Mixtures Containing Short Asbestos Fibres", HRB Record No. 24, 1963.

2. Kietzman, J. H., Blackhurst, M. S. and Foxwell, J. A., "Performance of Asbestos-Asphalt Pavement Surface Courses with High Asphalt Contents", HRB Record No. 24, 1963.

3. Iowa State Highway Commission Standard Specifications, 1964, and Special Provisions Applicable to the project.

4. The Asphalt Institute Manual Series 2(MS-2) 1963, "Mix Design Methods for Asphalt Concrete".

5. Csanyi, L. H., et al, "Effect of Fillers on Asphaltic Concrete Mixes", Iowa Highway Research Board Project HR-79, ISU, 1963.

MATERIALS DEPARTMENT
DATA SHEET
No. 1

Chickasaw County
F-63-8(1)

Analysis of Cold Feed Samples (3)

Aggregate Intended for Test Sections

Combined Aggregate - 50 percent Cr. Limestone & 50 percent Sand

	Sample Date 10-12-67	Sample Date 10-13-67	Job	Spec.
Passing Sieve	Percent Passing	Percent Passing	Mix	Limits
1/2"	100	100		100
3/8"	100	100	100	100
4	80	82	82	70-100
8	60	63	63	50-74
16	43	45	-	-
30	29	30	32	24-43
50	16	16	-	-
100	12	11	-	-
200	9.6	9.0	8.7	5-12
S.S. Dry Sp. Gr.	2.721	2.720		
Bulk Sp.Gr.	2.691	2.695		
Apparent Sp.Gr.	2.774	2.766		
S.S. Dry Absorption	1.10%	0.95%	0.60%	
HRB Sp. Gr. Comb. Aggr.	2.732	2.730	2.728	

Samples were taken from cold feed during production of test section mixtures.

MATERIALS DEPARTMENT
DATA SHEET
No. 2

, Chickawas County
F-63-8(1)

3/8" Standard Surface Mix (3)(4)(5)

Intended A.C. Content 8%

Rt. Side of Road Sta. 306 to Sta. 311 - Lt. Side of Road Sta. 317 to Sta. 322

Sample Date	Location	Extrac.AC%	50 Blow Marshall Compaction: % Air Voids H.P.M.	Disp. Sp. Gr.	Solid Sp.Gr.	Hveem[1] Side Press.
10-12-67	Rt. Side Rd.	8.00	2.3	2.32	2.38	45
10-12-67	Rt. Side Rd.	7.93	2.5	2.33	2.39	53
10-12-67	@ Plant	8.27	3.1	2.31	2.39	43
10-12-67	@ Plant	8.40	2.0	2.32	2.37	58
10-13-67	Lt. Side Rd.	8.20	2.6	2.32	2.39	59
10-13-67	Lt. Side Rd.	8.13	3.3	2.31	2.39	57
	$\bar{X}$ =	8.16	2.6	2.32	2.385	52
	S =	0.17	0.5	-	-	6.9

10-13-67 Lt. Side Rd. Marshall Stability 1847 lbs. Flow 13

[1]at 400 psi Vert. Load Ave. VMA = 22.5% Ave. VMA Filled with A.C. = 88.4%

75 Blow Marshall Compaction

Date	Location	Extrac.AC%	% Air Voids H.P.M.	Disp. Sp. Gr.	Solid Sp.Gr.	Hveem Side Press.
10-13-67	Lt. Side Rd.	-	1.9*	2.34	-	72

*Computed

$\bar{X}$ = Mean value

S = Sample Standard Deviation

MATERIALS DEPARTMENT
DATA SHEET
No. 3

Chickasaw County
F-63-8(1)

3/8" Surface Mix +1½% Asbestos (3)(4)(5)

Intended A.C. Content 8%

Rt. Side of Road Sta. 311 to Sta. 316 - Lt. Side of Road Sta. 311 to Sta. 316

Sample		50-Blow Marshall Compaction				
Date	Location	Extra.AC%	%Air Voids HPM	Sp.Gr.	Solid Sp.Gr.	Hveem[1] Side Press.
10-12-67	Rt. Side Rd.	8.27	2.4	2.33	2.38	47
10-12-67	Rt. Side Rd.	8.20	2.0	2.35	2.38	50
10-12-67	@ Plant	8.40	2.5	2.32	2.38	46
10-12-67	@ Plant	8.27	2.4	2.32	2.38	42
10-13-67	Lt. Side Rd.	8.27	1.9	2.33	2.37	61
10-13-67	Lt. Side Rd.	8.33	2.8	2.31	2.38	52
	$\overline{X}$ =	8.29	2.3	2.33	2.38	50
	S =	0.07	0.3	0.01	-	6.5
10-13-67	Lt. Side Rd.	Marshall Stability 2106		Flow 10		
[1]at 400 psi Vert. Load		Ave. VMA = 21.8		Ave. VMA Filled with A.C. 89.5%		
				75 Blow Marshall Compaction		
10-13-67	Lt. Side Rd.	-	2.5*	2.32	-	55

*Computed value

$\overline{X}$ = Mean value
S = Sample Standard Deviation

MATERIALS DEPARTMENT
DATA SHEET
No. 4

Chickasaw County
F-63-8(1)

3/8" Surface Mix +1½% Asbestos (3)(4)(5)

Intended A.C. Content 9%

Rt. Side of Road Sta. 281+60 to Sta. 287 - Lt. Side of Road Sta. 282 to Sta. 287

Sample			50-Blow Marshall Compaction				
Date	Location	Extra. A.C.%	% Air Void	H.P.M. Sp.Gr.	Solid Gr.	Hveem[1] Side Press.	R. Stab.
10-12-67	Rt. Side Rd.	9.00	2.0	2.32	2.35	98	22
10-12-67	@ Plant	9.60	1.4	2.29	2.33	102	
10-12-67	@ Plant	9.40	1.3	2.30	2.33	105	
10-12-67	Rt. Side Rd.	9.47	1.2	2.30	2.33	98	
10-13-67	Lt. Side Rd.	9.00	1.7	2.32	2.36	71	
10-13-67	Lt. Side Rd.	8.80	1.9	2.32	2.36	78	
	$\bar{X}$ =	9.21	1.7	2.31	2.34	92	
	S =	0.28	0.35	0.01	0.01	14	

10-13-67 Lt. Side Rd. Marshall Stability 1606 Flow 19

[1]at 400 psi Vert. Load. Ave. VMA = 23.2% Ave. VMA Filled with A.C.=92.7%

75 Blow Marshall Compaction

10-13-67	Lt. Side Rd.	-	0.8*	2.32	-	108

*Computed

$\bar{X}$ = Mean value
S = Sample Standard Deviation

MATERIALS DEPARTMENT
DATA SHEET

No. 5

Chickasaw County
F-63-8(1)--20-19

Summary of Core Test Data (3)(4)(5)

3/8 inch Type B Surface Course

Standard and Asbestos Mixtures

Date Placed	Location	Sample N	A.C. Content % Intended	A.C. Content % Extracted	% Fiber	H.P.M. Density Displ.	% Air Voids	Solid Density	Marshall Density	% Marshall Density
10-11-67	Var.	4	7.5	7.45	No	2.175	9.3	2.395	Av.2.30	94.5
10-12-67	-	1	7.5	7.25	No	2.18	8.8	2.39	" 2.30	94.8
10-12-67	East side	1	8.0		No	2.22	8.7	2.43	2.32	95.7
10-12-67	East side	1	8.0	7.88	No	2.25	6.3	2.40	2.32	97.0
10-12-67	East side	1	8.0		No	2.11*	10.2*	2.35	2.32	90.4*
10-13-67	West side	1	8.0		No	2.20	-	-	2.315	95.0
10-13-67	West side	1	8.0	8.07	No	2.14	11.3	2.41	2.315	92.4
10-13-67	West side	1	8.0		No	2.20	7.5	2.37	2.315	95.0
"Average"		6				2.20	8.4	2.39		95.0
10-12-67	East side	1	8.0	8.03	1 1/2	2.17	8.7	2.38	2.33	93.1
10-12-67	East side	1	8.0		1 1/2	2.17	7.5	2.35	2.33	93.1
10-13-67	West side	1	8.0		1 1/2	2.20	-	-	2.33	94.4
10-13-67	West side	1	8.0	8.07	1 1/2	2.14	11.3	2.41	2.32	92.2
10-13-67	West side	1	8.0		1 1/2	2.20	7.5	2.37	2.32	94.8
"Average"		5				2.18	8.8	2.38		93.5
10-12-67	East side	1	9.0		1 1/2	2.10*	9.9*	2.33	2.30	91.3*
10-12-67	East side	1	9.0	8.76	1 1/2	2.25	5.4	2.38	2.30	97.8
10-12-67	East side	1	9.0		1 1/2	2.16	9.5	2.39	2.30	93.9
10-13-67	West side	1	9.0		1 1/2	2.21	6.4	2.36	2.32	95.3
10-13-67	West side	1	9.0	9.00	1 1/2	2.17	6.3	2.37	2.32	93.5
10-13-67	West side	1	9.0		1 1/2	2.21	8.7	2.38	2.32	95.3
"Average"		6				2.20	7.3	2.37		95.2

Values Marked * not included in averages.

MATERIALS DEPARTMENT
DATA SHEET
No. 6

Chickasaw County
F-63-8(1)

VOID & VMA DATA COMPARISONS (4)(5)

Standard and Asbestos Mixtures

"Core Samples"

Type of Samples	No. of Sample	Ave. Sample Density	Solid Density	Ave. Lab. Density	Ave. Total Voids	% VMA	% VMA Filled	Ave. % 50-B. Marshall
7.50% A.C. BPR Record Samples	15	2.20	2.39	2.30	8.0	25.5	68.5	95.6
8.00% A.C. Special Core Samples	6	2.20	2.39	2.315	8.4	25.9	67.6	95.0
8.00% A.C., 1½% Fibre Core Samples	5	2.18	2.38	2.324	8.8	26.6	66.9	93.5
9.00% A.C., 1½% Fibre Core Samples	6	2.20	2.37	2.31	7.3	26.7	72.6	95.2

VMA Computions based on HRB Specific Gravity of combined Aggregate 2.731.