Final Report
For
Iowa Highway Research Board
Research Project HR-232

Reducing the Problem Of Transverse Cracking

March 1985

Highway Division
Iowa Department
of Transportation

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REDUCING THE PROBLEM OF TRANSVERSE CRACKING

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INTRODUCTION

The Iowa Department of Transportation (DOT) is continually improving the pavement management program and striving to reduce maintenance needs. Through a 1979 pavement management study, the Iowa DOT became a participant in a five state Federal Highway Administration (FHWA) study of "Transverse Cracking of Asphalt Pavements"(1). There were numerous conclusions and recommendations but no agreement as to the major factors contributing to transverse cracking or methods of preventing or reducing the occurrence of transverse cracking. The project did focus attention on the problem and generated ideas for research. This project is one of two state funded research projects that were a direct result of the FHWA project.

Iowa DOT personnel had been monitoring temperature susceptibility of asphalt cements by the Norman McLeod Modified Penetration Index. Even though there are many variables from one asphalt mix to another, the trend seemed to indicate that the frequency of transverse cracking was highly dependent on the temperature susceptibility. Research project HR-217 "Reducing the Adverse Effects of Transverse Cracking" was initiated to verify the concept. A final report(2) has been published after a four-year evaluation. The crack frequency with the high temperature susceptible asphalt cement was substantially greater than for the low temperature susceptible asphalt cement. An increased asphalt cement content in the asphalt treated base also reduced the crack frequency.

PROBELM STATEMENT

The severly restricted highway funding has emphasized the need to extend the life of our highways. Transverse cracking and subsequent crack deterioration results in increased maintenance requirements and reduced

life. Not only is it a severe problem in regard to maintaining the original asphalt concrete pavement, but thicker overlays are needed in an effort to prevent reflection cracking. The transverse cracks generally continue to be a problem even after resurfacing. Water movement through the cracks causes stripping of the asphalt cement which results in a large void. The material over the void collapses producing an unacceptable dip.

OBJECTIVE

The objective of the research was to identify a method of reducing the frequency of transverse cracking.

PROJECT LOCATION AND DESIGN

The research was incorporated into Jones-Jackson County primary project F-64-1(13)--20-53 on Iowa 64 from Wyoming to Monmouth. This highway carries an ADT of 890 with 6% trucks. The typical section for this project was 1.5" of Type B asphalt cement concrete (ACC) Surface Course over 1.5" of Type B ACC Binder Course over 9" of Class 1 Asphalt Treated Base (ATB). The design included granular surfaced earth shoulders.

RESEARCH SECTIONS

Two designs with one layer of engineering fabric were placed in 500 foot long repetitive sections (a total of four fabric sections). The thickness of the ATB was reduced from 9 inches to 8 inches where the fabric was used. The typical sections for the research sections are:

Research Section 1:

1-1/2" Type "B" Surface

1-1/2" Type "B" Binder

8" Class "1" ATB

Dilute emulsion tack coat (0.05 to 0.10 gal. bit./sq.yd.).

Layer of engineering fabric.

Dilute emulsion tack coat (0.15 gal. of bit./sq.yd.).

Research Section 2:

1-1/2" Type "B" Surface

1-1/2" Type "B" Binder

2nd lift of Class "1" ATB (3" & 4")

Layer of engineering fabric

AC-10 Asphalt cement tack coat (0.25 gal./sq.yd.).

First lift of Class "1" ATB (5" & 4")

CONTRACTOR AND CONTRACTURAL ARRANGEMENTS

The successful bidder for the project was Norris Construction of Ottumwa, Iowa. The research work was added by extra work order and the fabric was purchased by the Iowa DOT. Phillips Fibers Corporation provided the equipment to place the fabric at no cost.

MATERIALS

All materials used on the project were tested and met Iowa DOT specifications applicable at time of construction. The sources of the material for the ATB, Type B binder and Type B surface were:

AC-10 grade asphalt cement - Koch Asphalt at Dubuque

Crushed Limestone - Bagus Quarry near Wyoming in Jones County

Sand - Knapp Pit near Oxford Mills in Jones County

The viscosities for the Koch AC-10 grade asphalt cement for this project ranged from 930 to 1090 poises or an average of about 1010 poises. The penetration is about 100 which yields a McLeod Modified Penetration Index of - 0.66, which for asphalt cements used in Iowa, is a relatively low temperature susceptible AC.

The mix for the Class 1 ATB was initially composed of 65% crushed limestone, 35% sand and an AC content of 4.50%. These aggregate proportions were used for the first lift of ATB on the research between Stations 942 and 967. For the second lift in this area and all the ATB for the repetitive sections between Stations 1128 and 22 the proportions were changed to 55% crushed limestone and 45% sand. This change was necessary to limit the filler-bitumen ratio by reducing the % passing the #200 screen (filler). A typical gradation for each mix is shown in Table 1.

The mix design for the Type B binder used 65% crushed limestone and 35% sand. The proportion for the Type B binder was changed to 55% crushed limestone and 45% sand to reduce the filler bitumen ratio. The 55-45 Type B binder was used for both research sections.

The proportion for the 1/2" Type B surface was 60% crushed limestone and 40% sand. Typical gradations are shown in Table 1.

Table 1
Typical Gradation and Asphalt Content
for Asphalt Concrete Mixes

	Class 1 ATB		Type B Binder	Type B Surface
Asphalt Content, %	4.50	4.50	5.50	5.60
% Crushed Limestone	65	55	55	60
% Sand	35	45	45	40
% Passing				
3/4"	100	100	100	
1/2"	91	94	93	100
3/8"	82	84	83	93
#4	59	64	63	64
#8	47	53	52	48
#16	38	45	42	39
#30	27	33	30	28
#50	14	15	14	14
#100	8.5	7.0	6.4	8.7
#200	6.4	5.2	4.6	7.2

The engineering fabric used in this research was H01 black nonwoven Petromat (R).

Asphalt emulsion tack coat (SS-1) was used except where AC-10 was used to tack the fabric between ATB lifts.

CONSTRUCTION

Construction of the ATB began on July 1, 1981. The asphalt cement concrete was mixed in a Barber Greene Drum Mix plant. The ATB, binder, and surface were laid one lane at a time and the asphalt surface was completed September 24, 1981.

A 200' transition was used to raise the grade 1" in the areas where fabric was used. This decreased the thickness of the ATB from 9" to 8". The fabric placed on grade beneath the ATB was held in place by a dilute emulsion (SS-1) tack coat applied prior to fabric placement.

The fabric was placed with a special tractor-mounted applicator provided by the fabric manufacturer. It was very effective in placing the fabric in a straight line with very few wrinkles. The applicator was equipped with a number of brooms to brush out the wrinkles. Fabric placement went very well and there were no significant problems.

Where the fabric was placed between lifts of the ATB, the first lift was 5" thick with a 3" lift above the fabric. The research required an AC-10 tack coat on the first lift of ATB. This caused extra work, as the distributor had to be cleaned between using for emulsion and AC-10. On the second research section, the fabric was placed between a 4" thick first lift and a 4" thick second lift of ATB.

During construction, very soft grade was noted in the area of the research between Stations 942 and 967.

Due to construction to the east of this project, the pavement was not opened to through traffic until November 18, 1982.

EVALUATION

The objective of the research was to prevent transverse cracking, so the most important performance evaluation was the frequency of cracks. Crack surveys were conducted periodically (Table 2). There is no apparent depression at any of these cracks.

To determine if the fabric contributes structurally, Road Rater deflection testing was conducted periodically (Table 3).

Table 2. Transverse Cracking Survey

Section Description	Number of Cracks				
	10-16-81	6-2-83	1-25-84	1-22-85	3-4-85
Standard Construction	0	0	2	5	5
Fabric Between ATB Lifts	0	0	1	2	2
Standard Construction	0	0	1	4	5
Fabric Beneath ACC	0	0	2	2	4
Standard Construction	0	0	1	3	3

	Cracks per 1000 Lineal Feet			
	6-2-83	1-25-84	1-22-85	3-4-85
Standard Construction	0	1.3	4.0	4.3
Fabric Between Lifts	0	1.0	2.0	2.0
Fabric Beneath ACC	0	2.0	2.0	4.0

Table 3. Summary of Road Rater Deflections

Section Description	Deflections, Mils			
	10-16-81	5-3-83	6-5-84	Average
Standard Construction	1.06	0.91	1.57	1.18
Fabric Between ATB Lifts	1.29	1.17	2.07	1.51
Standard Construction	1.28	1.10	1.97	1.45
Fabric Beneath ACC	1.28	1.21	2.07	1.52
Standard Construction	1.19	1.05	1.87	1.37

Average Deflections, Mils

Standard Construction	1.33
Fabric Between ATB Lifts	1.51
Fabric Beneath ACC	1.52

DISCUSSION OF RESULTS

From our experience with HR-217 (2), most transverse cracking occurs during extended periods of cold weather. If a relatively low temperature susceptible asphalt cement is used, the cracking occurs relatively slowly. Currently there is a total of 19 cracks in the two research sections. Based on our experience, this number should continue to increase with age. Crack surveys will be conducted on these two research sections, even though a final report will have been released.

There was a total of 13 cracks from Station 942 to 967 with only 6 cracks from Station 1128 to 22. This may be due to the soft grade in the area of Station 942 to 967 at time of construction.

The fabric did not prevent transverse cracking although the 2.0 and 4.0 cracks per 1000 feet of fabric sections were somewhat better than the 4.3 without fabric. Cracking in all test sections is continuing to occur but may be retarded slightly on fabric sections.

The fabric sections with 8" of ATB exhibits greater deflections than the 9" thick ATB sections without fabric. It would appear that the fabric contributes very little to the structural capability.

CONCLUSIONS

This research on prevention of transverse cracking with fabric supports the following conclusions:

1. Engineering fabric does not prevent transverse cracking of asphalt cement concrete.

2. Engineering fabric may retard the occurrence of transverse cracking.

3. Engineering fabric does not contribute significantly to the structural capability of an asphalt concrete pavement.

ACKNOWLEDGEMENTS

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REFERENCES

1. Summary Report "Transverse Cracking of Asphalt Pavements", Federal Highway Administration, FHWA-TS-82-205, July 1982.

2. Marks, V. J., "Reducing the Adverse Effects of Transverse Cracking", Final Report, Iowa Department of Transportation, May 1984.