Improvement of Longitudinal Joints in Asphalt Pavement

Final Report
Iowa Highway Research Board
Project HR-215

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in
Asphalt Pavement

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Improvement of Longitudinal Joints in Asphalt Pavement

Introduction

One significant benefit of asphalt concrete pavement construction is that it may be opened to traffic within one hour after being placed. Therefore, road closure and detour are not normally necessary, but only temporary lane closure and control of traffic.

This one lane construction, even though desirable in regard to maintaining traffic flow, does pose an additional problem. The longitudinal joint at centerline often becomes a maintenance problem.

The objective of this research project is to identify construction procedures that will provide an improved centerline joint.

Location

The research was incorporated by extra work order into project FR-44-4(26)--2G-39. This was a widening and asphaltic concrete resurfacing project on Iowa 44 in Guthrie and Dallas Counties, Figure 1. The research sections total approximately 8.7 miles between stations 156+14 in Guthrie County and 451+00 in Dallas County.

Construction

The experimental sections were constructed between July 23 and August 12, 1980.

The paver was a Blaw-Knox PF-500, the breakdown roller was a Ray-Go Vibratory, the pneumatic tired roller was a Michigan

Model RW 181 with a tire pressure of 120 psi, and the finish roller was a Huber Model T-1014H.

There were eight construction procedures used with two sections (A and B) for each procedure.

Section 1A, stations 156+14 to 183+14 and section 1B, stations 206+40 to 232+40 were placed with a one inch overlap at the centerline joint as presently described in the construction manual.

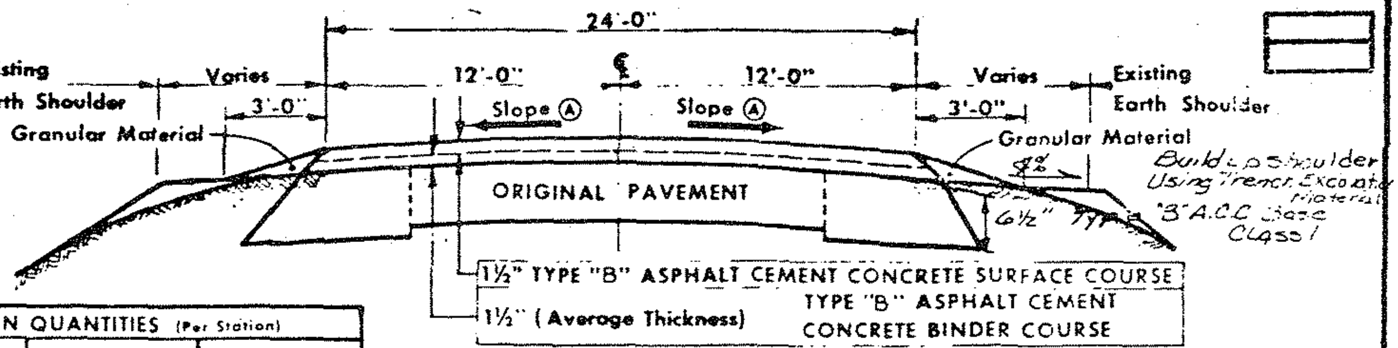
Section 2A, stations 183+14 to 7+95 and section 2B, stations 232+40 to 258+40 required a double tack coat on the vertical face of the previously placed pass. The first shot of tack was at the end of the day the first pass was placed and the second shot was the morning that the joint was closed.

Section 3A, stations 7+95 to 32+95 and section 3B, stations 258+40 to 284+40 were placed without a horizontal offset between layers; the centerline joint for the two layers being vertical.

Section 4A, stations 76+40 to 102+40 and section 4B, stations 317+00 to 344+00 were placed with the 1:1 edge slope shoe removed from the paver. This was done only on the surface course.

Section 5A, stations 102+40 to 128+40 and section 5B, stations 344+00 to 372+00 were placed and compacted using a revised rolling procedure. The revised procedure used on the second lane placed was to roll within four inches of the longitudinal joint on the breakdown pass and to overlap on the second pass rather than overlapping on the first pass as is currently specified.

Section 6A, stations 128+40 to 154+40 and section 6B, stations 372+00 to 398+00 called for trimming 1 1/2 inches from the centerline edge of the first lane placed just before the edge was tacked for the



DESIGN QUANTITIES (Per Station)		
ITEM	RATE	VOLUME
Surface Course	140 lbs./cu. ft.	21.11 Tons
Binder Course	140 lbs./cu. ft.	21.33 Tons
Tack Coat	0.05 gal./sq. yd.	27.08 Gal. ①
Granular Material	——→	8.00 Tons ②

① Estimated for 2 applications.

② Estimated for 2 shoulders.

TYPICAL CROSS SECTION

ASPHALT CEMENT CONCRETE RESURFACING

ROAD IDENT.	STATION TO STATION	
Ia. 44	0+75.00	58+96.00
Ia. 44	76+00.00	173+62.55
Ia. 44	175+32.15	202+39.00
Ia. 44	Equation: Sta. 202+39.00=Sta. 0+00.00	
Ia. 44	0+00.00	40+00.00
Ia. 44	54+51.00	339+22.00
Ia. 44	340+98.00	613+00.00

Ⓐ Finished slope shall match existing pavement except that the maximum allowable slope is 3.0% and minimum allowable slope is 1.5%. Section may be modified as directed by the engineer through areas of special spacing

Refer to tabulated listing of superelevated curves and Standard Road Plans for additional requirements through superelevated curves

Figure 1: Project FR-44-4(26)--2G-39 Guthrie County

second pass. The method of trimming was not specified but it was assumed it would be by sawing or using a rolling Colter. Neither method was used. An attempt was made to do the trimming with a motor patrol blade but a straight edge could not be obtained. The edge of the bucket on a skid-type loader was sharpened and used to trim the edge. Immediately following the trimming, the mat was rolled to assure bond with the underlying layer. The edge was tack coated the same day and again prior to closing the longitudinal joint.

Section 7A, stations 154+40 to 180+40 and section 7B, stations 398+00 to 424+00 again had the centerline edge trimmed as in sections 6A and 6B but with the revised rolling pattern used in sections 5A and 5B, that is lapping over the longitudinal joint on the second roller pass instead of the first.

Section 8A, stations 180+40 to 206+40 and 8B, stations 424+00 to 451+00 had the longitudinal joint sealed by the pneumatic tired roller on the final pass.

The project was paved from east to west and the joint was normally closed from the south side.

Evaluation

Cores were drilled from each section August 15, 1980, about three inches left and right of the longitudinal joint and from the quarter-point of each lane. The densities of each core and the average for each location per longitudinal joint procedure are included in Table 1.

TABLE I

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IMPROVEMENT OF LONGITUDINAL JOINTS IN ASPHALT PAVEMENT

Section No.	Sta.	Density 8-15-80 ¼ pt. Rt.	CL Rt.	CL Lt.	¼ pt. Lt.	Procedure
1A	170	2.24	2.25	2.23	2.30	Present
1B	220	2.35	2.24	2.35	2.35	construction
1	AV	2.30	2.25	2.29	2.33	procedure - 1" overlap
2A	195	2.29	2.24	2.12	2.28	Tack coat
2B	245	2.34	2.21	2.20	2.29	vertical face
2	AV	2.32	2.23	2.16	2.29	between passes
3A	20	2.30	2.14	2.21	2.31	Delete
3B	270	2.27	2.25	2.17	2.32	transverse
3	AV	2.29	2.20	2.19	2.32	offsets
4A	90	2.36	2.27	2.31	2.29	Delete 1:1
4B	330	2.33	2.33	2.30	2.32	slope shoe
4	AV	2.35	2.30	2.31	2.31	on edge
5A	115	2.34	2.23	2.18	2.37	Roll within 4" of CL
5B	360	2.33	2.25	2.19	2.31	on breakdown, overlap
5	AV	2.34	2.24	2.19	2.34	CL on 2nd pass
6A	140	2.36	2.26	2.27	2.33	Trim 1st pass ±1½"
6B	385	2.32	2.24	2.26	2.33	before 2nd pass tack.
6	AV	2.34	2.25	2.27	2.33	Standard roll pattern. Surface course only.
7A	165	2.38	2.29	2.28	2.31	
7B	410	2.32	2.23	2.26	2.33	Same trim as 6, rolling
7	AV	2.35	2.26	2.27	2.32	procedure as 5.
8A	195	2.32	2.25	2.25	2.29	Use pneumatic roller
8B	440	2.35	2.26	2.29	2.35	on joint on final pass.
8	AV	2.34	2.26	2.27	2.32	

The core densities show that densities at centerline are less than those at the quarter points. This difference in density could be eliminated by using a full width paver which would require closing the road.

Visual inspections were made the first three years after construction. At four, five, and six years, measurement of centerline cracking was done with the roadmeter car using the distance counters. One counter was used for cracked areas and the other counter for areas not cracked. The total of the two counters was the denominator when determining the percentage of centerline cracking for each section. The totals for corresponding sections were added to determine percentages for each procedure.

The only procedure to rank the same when comparing cracking and density is No. 4 (delete the 1:1 slope shoe on the edge). This procedure had the highest average density and also had the least cracking through 1985. The other sections did not correlate well when comparing density to cracking.

All but procedures 1, 2, and 3 had cracked 100% of their length by November 1986, and they were cracked 96.1%, 92.7%, and 92.5% respectively. Each of those procedures had one section that was 100% cracked. The percentage of cracking by section and year is listed in Table II along with the densities near the centerline that were determined after construction in 1980. After 1984, all procedures exhibited a very steep slope in the rate of cracking (Figure 2).

TABLE II
TABULATION OF CRACKING AND CENTERLINE DENSITY

	% Cracked			CL Density	
Section	1984	1985	1986	Rt	Lt
1A	56.9	87.1	92.0	2.25	2.23
B	3.0	24.7	100.0	2.24	2.35
A+B	27.3	55.5	96.1	2.25	2.29
2A	25.7	61.8	85.8	2.24	2.12
B	24.0	48.1	100.0	2.21	2.20
A+B	24.9	55.2	92.7	2.23	2.16
3A	17.1	35.5	84.4	2.14	2.21
B	13.5	68.6	100.0	2.25	2.17
A+B	15.2	52.8	92.5	2.20	2.19
4A	4.4	24.9	100.0	2.27	2.31
B	19.0	73.0	100.0	2.33	2.30
A+B	9.0	40.2	100.0	2.30	2.31
5A	7.6	58.7	100.0	2.23	2.18
B	58.3	89.7	100.0	2.25	2.19
A+B	33.8	74.7	100.0	2.24	2.19
6A	13.4	47.9	100.0	2.26	2.27
B	41.7	85.5	100.0	2.24	2.26
A+B	23.8	66.3	100.0	2.25	2.27
7A	1.0	22.1	100.0	2.29	2.28
B	64.3	92.9	100.0	2.23	2.26
A+B	32.7	57.6	100.0	2.26	2.27
8A	18.5	68.0	100.0	2.25	2.25
B	12.4	52.2	100.0	2.26	2.29
A+B	15.4	59.9	100.0	2.26	2.27

Conclusions

None of the procedures used on this project succeeded in preventing a longitudinal crack along centerline.

The method providing the best performance for four years after construction was removal of the 1:1 slope shoe from the paver when placing the surface course. This method had 9.0% cracked after four years and 100% cracked after six years of service.

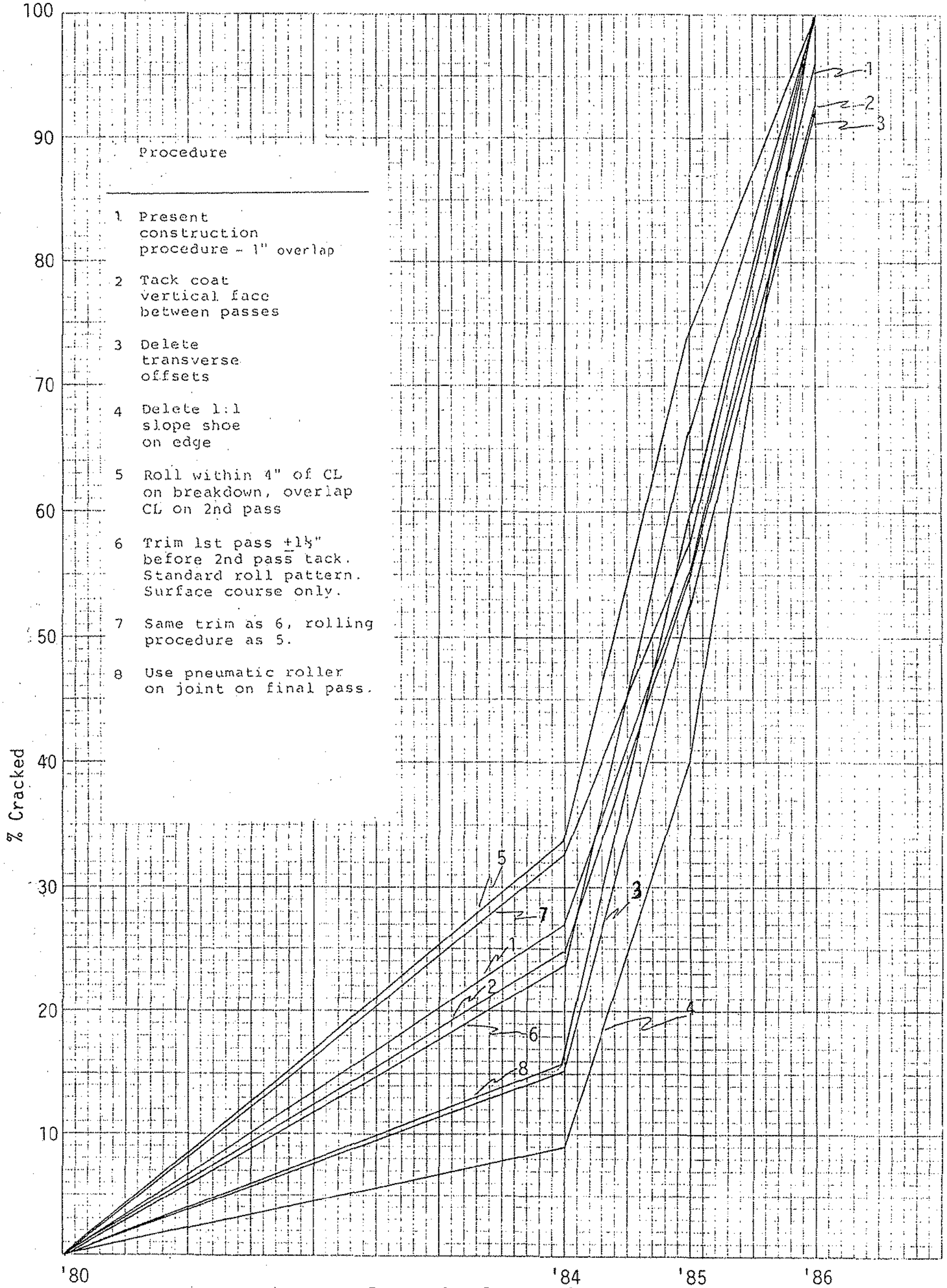

Figure 2: Rate of Cracking

The areas placed with a one inch overlap as presently described in the construction manual had 27.3% of the joint cracked after four years and 96.1% cracked after six years of service.

Between four and six years of service the rate of cracking for all methods used on this project was about the same. Overall, there was no one method that out performed the others in this project.

Acknowledgement

The cooperation of the contractor, Henningsen Construction Company, is appreciated, as is the help of personnel from the Creston Construction Office, especially Larry Delaney, Project Supervisor for his help in supplying construction information included in this report.

8.43 GUIDELINE STRINGS AND EDGE ALIGNMENT

True edge alignment controls the correct lap at the longitudinal joint. If there is no lap, the joint will lack density and raveling will occur. An excessive lap produces an objectionable wide scab of mixture on the surface next to the joint, that has to be removed with hand tools to obtain an acceptable appearance.

An intended lap of one inch with a variance of one-half inch each way has been observed to produce correct longitudinal joint construction with minimum effort. If these close variances are to be maintained, the adjacent lane has to be constructed with true edge alignment.

One of the inspector's duties in obtaining true edge alignment is to make frequent measurements to insure that the guideline string has been correctly set and maintained. The nails used to secure the guideline string shall be at intervals close enough to eliminate chords on curves and other irregularities caused by wind, etc.

Guideline strings placed on all two-lane pavements except old concrete should be located by measuring from redhead nails which have been placed on the centerline by instrument parties. The spreading of the lower layer will cover the redheads. For succeeding layers, the guideline string should therefore be located by measuring from the exposed nails that were used to hold the string for the lower layers.

When resurfacing old concrete pavements that are only two lanes in width, the contractors have been permitted to locate the guideline strings on the shoulders along the outer edges. This is done by measuring out from one of the pavement edges at intervals of approximately 500 feet, then tightening the string and using intermediate nails to secure the string. To insure that parallel alignment is used for the adjacent lane, the guideline string for that lane shall be located by measuring across the pavement from the nails used to secure the first line. To prepare a smooth location on the shoulder for the guideline string, the specifications require that the grass shall be closely mowed for a width of approximately 18 inches.

On curves for all surfaces, a sufficient number of nails shall be used to permit the finishing machine to follow the line exactly without producing objectionable chords on the curved edge alignment.

The finishing machine operator shall follow the guideline string exactly. If the machine goes off the line for any reason, it shall be adjusted back onto the line immediately. It is incorrect to smooth out the edge alignment by coming back onto the line gradually. This results in long stretches where incorrect lap at the longitudinal joint will occur. Also when batch trucks bump the finishing machines off the line on curves, the movement is usually down the slope of the curve. If the machine is brought back on the line gradually, an objectionable, long, straight chord will result in what is supposed to be the curved edge alignment.

When automatic screed controls are used, the short joint matching shoe shall not be permitted except when placing a single lift only, with a thickness of 1½ inches or less, or for placement in conjunction with heater scarification work. When the lower layers are constructed, the specified 30 foot ski device shall be used for joint matching on each layer.

The short joint matching shoes produce joints with smoother appearances than the 30 foot ski devices. However, they do not contribute toward construction of a smoother riding surface. The 30 foot ski device does.

Smooth longitudinal joints are very important for surface layers and the short joint matching shoes may be used when surface layers are spread.

Careful adherence to the inspection procedures described in Section 8.43 will insure true edge alignment which is essential for the correct construction of longitudinal joints.

8.45 PRIME AND TACK COATS USING EMULSIONS

A. <u>General</u>
Tack coats using emulsions are required prior to October 1. Dilution of emulsion is required if non-uniform tack applications are experienced. SS-1, SS-1H, CSS-1, and CSS-1H grades are specified.

B. <u>For Dilution</u>
Dilute at 1:1 ratio, i.e., 1 gallon emulsion to 1 gallon water.

C. <u>Application Rate</u>
Double the usual specification rates of application normally used for RC-70 or MC-70. Ex., 0.03 to 0.05 Gal./S.Y. increased to 0.06 to 0.10 Gal./S.Y. dilute emulsion.

D. <u>Sample for Compliance</u>
Sample the emulsion at the spray bar of the distributor with the bar valve in a circulating position.

E. <u>Measurement for Pay</u>
The net gallons of undiluted emulsion.

Note: Undiluted emulsion must contain a minimum of 57% asphalt residue. Diluted emulsion must therefore contain a minimum of 28.5% residue.

F. <u>Settlement of Diluted Emulsions</u>
Assurance sample reports received on a number of projects indicate that dilute emulsions are not meeting the minimum residue requirements. A review of this problem with producers in the state indicates that the dilution rate is being carefully controlled and that the residue of the original emulsion is higher than the minimum required.