ALTERNATIVE REFLECTION CRACK TREATMENTS

PULVERIZATION AND RUBBERIZED SLURRY SRI

INITIAL REPORT 75-1

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VERMONT DEPARTMENT OF HIGHWAYS

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ABSTRACT

Nearly five miles of Interstate pavement near the northern Vermont border was rehabilitated during the summer of 1974, using two entirely different methods. A section of approximately two miles was pulverized and compacted and the remainder treated with a strain relieving interlayer of rubberized slurry prior to placement of a two-inch overlay over the entire project. These treatments were required to prevent the reflection of cracks through the new pavement.

The two systems were chosen partly as an experimental program and partly due to the varying degree of distress of the pavement. Both were quite similar in cost, with the short-range benefits nearly equal. However, the pulverization process took a great deal longer than the rubberized slurry application.

The performance of the two treatments will be evaluated during the next two winter seasons.

INTRODUCTION

Concern over the condition of the northbound lane of Interstate 91 in the Town of Derby, Vermont had been cause for discussion for several years. This section begins at the Derby Interchange (Exit 28) and extends northerly for a distance of some 4.9 miles to the Canadian border. It was composed of two contracts: Derby I 91-3(3), which began at the Canadian border and extended southerly a distance of some 2.8 miles and was completed in November of 1962; and Derby I 91-3(5), which adjoined I 91-3(3) and extended southerly a distance of some 2.1 miles to the Derby Interchange and was completed during August of 1963.

One of the earliest records of the poor state of this roadway was a physical survey taken in July of 1969. The records indicate that the I 91-3(3) project had an average transverse crack interval in the travel lane of 20 feet, little longitudinal cracking and a recovered penetration of 36 for the top course. This was in contrast with the I 91-3(5) project which had a great deal of distress, both longitudinal and transverse, a transverse crack interval of 40 feet in the travel lane and a recovered penetration of 34 in the top course.

Surveys were taken in March of 1971 and again in November of 1973, at which time representatives of the Federal Highway Administration were in attendance. The conclusion of the 1973 field survey is as follows:

> "A review of the field observations reveals a considerable amount of transverse cracking. Tenting or heaving of the cracks, accompanied by settlement between cracks, creates a waviness in the road and undesirable riding qualities.
>
> Wheelpath cracking and rutting appears to be slight; however, random shrinkage cracking is interconnecting to form map and/or block cracking. The areas range from 1 to 10 square feet in area. Pitting is moderate to severe, with loss of matrix slight to

moderate. Continued cracking increases the possibility of surface moisture penetration, causing further breakup of the pavement.

Our analysis indicates that the existing pavement is deficient in structural strength for today's traffic and related loads and is inadequate for the projected requirements. This deficiency should be remedied by overlaying the existing surface with a substantial depth of bituminous concrete".

This final recommendation instituted a complete analysis of the problem area during the winter of 1973-1974.

PROCEDURE

Sites from which to obtain subsurface samples were selected during December of 1973. After several trips on this section of highway, it was separated into three catagories of condition. Test pits were dug at random locations on all three areas, materials sampled, and conditions noted. The test pits were five feet long by two feet wide and extended to the subgrade soils when feasible. Generally, the test pits were parallel to the centerline and located on the joint between the right-hand edge of pavement and shoulder. Several additional holes were dug in the shoulder at selected locations to observe drainage conditions.

To observe the extent of surface deterioration, a two man crew walked the entire project in February of 1974. Crack locations were recorded and distances were tied in with mile marker posts. All major cracks were drawn on a sheet to a scale of 1" = 50' longitudinal and 1" = 20' transversely. Areas of severe alligatoring were also noted.

Thirteen alternative corrective treatments were considered, either singularly or in combination, taking into account cost of construction, future maintenance and overall long-term serviceability. These certainly did not exhaust all possible solutions or combination of solutions but were selected for feasibility considerations.

Since one of the alternative treatments was to pulverize a portion of the project, samples of the pavement were crushed and mixed with emulsion, water and sand. As visual observation appeared favorable, it was decided that this method would be feasible for a field trial.

Experimentation for the rubberized slurry seal portion of the project had been carried out previously and reported in Report 74-3 "Relieving Reflection Cracking in Bituminous Overlays Utilizing a Strain Relieving Inter-Layer of Rubberized Slurry".

DATA

The typical section, as found from the test pits, was generally 3" of bituminous pavement, 4-1/2" to 6" of penetration base course, 18" to 19" of sand bound crushed rock subbase course and 4" to 8" of sand cushion.

The property of the materials removed from the test pits indicated that the bituminous pavement had a recovered asphalt content of 6.4% with an average absolute viscosity of 15000 poises and a penetration of 20. The asphalt had aged since 1969 when the measured viscosity was 6400 poises and the penetration was 36. The original penetration grade of asphalt was 85-100.

The penetration base course appeared loose and the asphalt binder no longer effective. This material had an average of 97% passing the 2" sieve, 48% passing the 3/4" sieve, 14% passing the #4 sieve and 2% passing the #200 sieve. There was considerable water flow through this base course as shown by the photographs in Appendix A.

The sand bound crushed stone base course was tight and the stone content was approximately 77%. There was an average of 3% fines based on the total sample; however, the fines content based on the sand portion was 12%. The percent of wear on the stone was 8.6% according to AASHTO T-3 (Deval). The percentage thin and elongated pieces averaged 32%.

The sand cushion was tight with an average fines content of 12%.

The soil subgrade varied from a silty to sandy gravel, with a CBR of 12 at 90% compaction (AASHTO T-99).

As the recordation of the surface deterioration taken in February of 1974 is too long to be presented here, it will be found in Appendix B.

The alternative corrective treatments considered with economic analysis are shown in Table I. As there are several identical probable chances of success, it is difficult to pick the most desirable even when comparing the cost factors. Disparity in "remove and replace" costs of pavements compared

TABLE I ALTERNATIVE CORRECTIVE TREATMENTS

Method of Corrective Construction and Estimated Cost Per Mile	Alternate No. 1	2	3	4	5	6	7	8	9	10	11	12	13
Fill Cracks, $9,500	X							X		X	X		
Slurry Seal, $10,000	X									X			
Rubberized Slurry Seal, $19,000		X									X		
6" X 38' Open Mix Overlay, $30,000			X									X	
New 5" Base Course Overlay, $48,000				X									
Remove Pavement & Replace, $37,500					X								
Remove Pavement & Base Course & Replace, $105,000						X			X				
Pulverize Pavement & Base Course, stabilize with asphalt, $56,000							X						X
Edge drains - one side only, $35,000					X	X	X	X		X	X	X	
New 2" Bit. Conc. Overlay, $44,000	X	X	X	X			X	X		X	X	X	
New 3" Bit. Conc. Overlay, $56,000													X
Estimated Cost Per Mile, $ (1973 data)	63,500	63,000	74,000	92,000	72,500	140,000	135,000	88,500	105,000	98,500	107,500	109,000	112,000
Probable % success of Treatment * for Section 1 I 91 north from US 5 to Beebe Plain Rd. (2.0 miles)	30	30	50	50	60	70	70	60	50	60	60	60	60
for Section 2 I 91 north from Beebe Plain Rd. to US 5 (1.2 miles)	60	60	70	60	70	80	80	70	70	70	80	80	70
for Section 3 I 91 north from US 5 to Canadian Border (1.7 miles)	50	50	60	50	60	70	80	60	60	60	70	70	60

NOTE: Each alternate includes one or more construction items as manifested by an (X).

* Probable % success assumes the perfect highway at 100% in 10 years whereas the present highway would rate between 30% and 50%. Figures are combined judgements of Materials Division staff based upon experience and research.

to overlay costs is due to the fact that shoulders must be paved in an overlay situation.

Initially, when the subsurface investigation was performed in late December of 1973, samples of the pavement pieces were brought back to the laboratory. There they were crushed down to 1" minus in the laboratory crusher. From telephone conversations with emulsion suppliers, it was decided to add some sand, water and emulsion to the pulverized pavement. The water acts as a carrier for the emulsion which coats the sand, thus forming a matrix to hold the pulverized pavement in place. Trials were made with approximately 25% sand, 3% water and 4% emulsion by weight added to the crushed pavement. These results appeared acceptable as far as consistency and stability were concerned, although no specific tests were run on them.

After a portion of the project had been pulverized in September, several bags were brought to the laboratory. The pulverization process had picked up some of the base course and the following average gradation indicated a uniform product:

Sieve Size	% Passing
1 1/2"	100
1"	97
3/4"	93
1/2"	82
3/8"	69
#4	48
#8	38
#16	30
#30	25
#50	19
#200	7

Variances in grading were from 2% to 6% for the #4 sieve or greater, and within 2% for the #8 sieve and smaller. Because of this, it was decided the addition of sand was not necessary. It was determined that the theoretical unit weight of the material was 250 pounds per square yard for a 3" depth. Four Marshall briquettes were made with a constant 3% water and varying the emulsion content from 0.7% to 4%. Subsequent visual observation and compressive testing indicated that 0.5 gallons per square yard emulsion and 1 gallon per square yard water would be acceptable in view of cost considerations.

For purposes of information, the CBR of the actual pulverized pavement, as run in the laboratory, was 19 at 100% density.

On October 3, 1974, field nuclear density and moisture tests were run on a short (± 500 feet) section of pulverized pavement that had been rolled at the north end of the reclaimed section. This had been rolled at least a week previously so a control curve was not established at this time.

Initially, direct readings were tried but when the hole was made in the material with a steel punch, to receive the probe, it was hard enough that the surrounding surface cracked, giving incorrect readings. This method was abandoned for the backscatter air gap, which does not require disturbance of the material to be tested.

The results were as follows:

Test No.	Wet Density, pcf	Dry Density, pcf	% Moisture
1	136.0	122.0	11.5
2	137.5	123.4	11.4
3	142.3	128.2	11.0
4	135.0	121.3	11.3
5	135.3	119.6	13.1
Avg.	137.2	122.9	11.7

From previous gradations on the material, it was established that the pulverized pavement fell into the category of an A-1-a sandy gravel. From moisture density studies done by the Soils Subdivision and published in February of 1974, an A-1-a sandy gravel has an average maximum dry density of 127.5 pcf, with a range from 106.6 to 139.9 pcf and an average optimum moisture content of 10.4%, with a range of 7.5 to 17.1%. From this, it is apparent that the pulverized pavement is a well graded, compactable material.

On October 10, 1974, a control strip was run for compaction purposes on the pulverized pavement. Counts were taken on a controlled corridor 120 feet long and five feet from the left hand shoulder. This was to eliminate compaction due to truck traffic hauling to paving operations northerly of the test strip. The guage was activated 15 minutes in advance to allow for warm up and then set to perform counts with the source in the backscatter position. Five direct, 15 second counts were taken on the strip, averaged, and then plotted on the graph versus roller passes, Figure 1. As in all nuclear guages, the lower the count the higher the density. While actual density is never calculated, this is a method whereby the highest density per amount of mechanical effort can be obtained.

The strip was tested after the water and emulsion had been mixed, graded and rolled once the evening before. No water, with the exception of the original pass the afternoon before, was added to this strip. However, a misty rain was falling during the construction of this control strip. Grading of the material was done concurrently with the rolling to aid in the compaction and the shaping of the roadway, as well as to aerate the mixture of pulverized pavement and emulsion, to hasten the cure. This process is also noted in Figure 1. Operations ceased after the counts on the strip began to read lower than counts on the original shoulder pavement.

The results of Figure 1 indicate that there was a rapid increase in compaction up to 4 roller passes, then an appreciable variance in compaction from 4 to 10 roller passes as the grading process was going on. The final gain from 10 to 16 roller passes was slow, but appreciable.

DISCUSSION

The northbound lane existed in three categories of condition as determined from field inspection by laboratory engineers and verification with the District Engineer and maintenance patrolman assigned to this section of highway. The worst area was from the US Route 5 entrance to I 91 at Derby, northerly to the Beebe Plain Road overpass (2.0 miles). This section was severely cracked and rough riding. The best area was the section from the Beebe Plain Road overpass, northerly to the US Route 5 underpass (1.2 miles). Although it had many cracks, it provided a moderate ride all year. The area north of the US Route 5 underpass to the Canadian border (1.7 miles) had a condition in-between the first two areas, in that it had many cracks, but gave a rough ride in the winter and spring, and a moderate ride during the summer and fall.

Review of the field data indicated that the asphalt in the pavement had aged to a very brittle state making it practically non-effective for flexible service over a wide range of temperatures. The penetration base course was no longer effective as constructed. The asphalt was dead and the material was in a loose, unbonded condition. Considerable water also perculated through this course. The sand bound crushed stone base course and the sand cushion should continue to provide acceptable service and should be relatively non-frost prone, even though the stone is of an undesirable quality (schist) and has a wear just outside the maximum tolerances permitted in our present specifications. The subgrade soils were compact and provided adequate support as evidenced by the CBR values.

The rapid aging of the asphalt in the surface and penetration base courses had caused brittleness in the pavement with the result being severe transverse cracking associated with low temperature contractions. The cracks permitted all surface water (rainfall or melt water) to enter the penetration base course.

The water flowed laterally under the pavement causing ice jacking in the winter and material displacement. The water was trapped under the pavement, as it apparently could not escape under the shoulder to the ditches or into the subbase course. The photographs accompanying this report, in Appendix A, demonstrate this condition. The saturated base course combined with traffic loads appear to be the cause of the random cracking and general pavement breakup observed in isolated sections.

Design, Construction, and Materials personnel met several times before coming to the decision to pulverize, emulsify, and relay the severely distressed portion of the project, treat the remainder with rubberized slurry, install edge drains at selected locations and overlay the entire project with 2" of dense graded bituminous concrete.

Perhaps two of the over-riding factors in this decision were the visual surface distress observed and the rideability of the project. This may appear to be a "seat of the pants" approach, but without question, the roadway was telling both the engineer and the general public something. Certainly, common sense and engineering data can and should be intermingled to reach a meaningful decision.

The northbound lane was closed to traffic on September 9, 1974. All northbound traffic was re-routed on US Route 5, which runs approximately parallel to the interstate. Traffic in this area is such that no great inconvenience was caused by this action. Signing and traffic control was accomplished by the Department.

Edge drains were installed on 50 foot spacings at locations shown in Table II. These were not continuously placed throughout the project but were intermittent as dictated by field conditions. The drains were basically trenches approximately 3 feet wide by 2 feet deep, that sloped from within the old shoulder and were "daylighted" near the toe of slope. Coarse concrete aggregate was used as backfill, with the material compacted and the surface patched prior to the overlay. During the construction of the trenches it was evident that the shoulder slopes did not contain a free draining material. Possibly these slopes were contaminated with poorly draining material during the original construction. Costs of these drains in place varied from $28.00 to $51.00 each, depending on their length.

TABLE II EDGE DRAIN LOCATIONS - 50 FOOT SPACINGS

Mile Marker	Left	Right
172.80 - 173.20		X
173.50 - 173.113		X
173.123 - 173.85		X
173.552 - 173.618	X	
173.628 - 173.864	X	
174.05 - 174.10		X
174.055 - 174.112	X	
176.30 - 176.45		X
176.46 - 176.50		X
176.305 - 176.428	X	

The general reclaiming operation consisted of cutting the shoulder-pavement edge with a grader mounted disk and scarifying the old pavement with a ripper behind a grader. Pavement chunks varied up to five feet long. The material was then windrowed and the pulverizer pulled through it as many times as was necessary to break the material into 2" minus pieces. This was generally accomplished with a series of three complete passes of the pulverizer over one particular area with windrowing done between passes. The area was continuously watered during the pulverization and grading process. The material was rough graded back between the shoulders after the pulverization was completed.

The pavement was continuously pulverized from MM 172.725 to MM 174.731 and not intermittently as shown in Figure 2. It was felt that a better job could be achieved in this manner. The time to scarify, pulverize and rough grade this nearly two mile section was 23 working days for 24 feet of width, or approximately a week to do one mile of 12' pavement width. The equipment was varied from time to time on the job but usually consisted of two graders, one bulldozer, one front end loader, one pulverizer and one water wagon. Breakdowns were numerous but there was usually some equipment working all the time.

The emulsion and water applications varied somewhat. Basically, water was applied at the rate of 1 gal./s.y. just prior to the application of the emulsion. From MM 172.725 to MM 173.5185 and from MM 173.9685 to MM 174.6375, emulsion was applied at the rate of 0.5 gal./s.y. From MM 173.5185 to MM 173.9685, emulsion was applied at the rate of 0.75 gal/s.y. As an experimental area, nearly 500 feet had no emulsion from MM 174.6375 to MM 174.731.

After the emulsion was applied, the material was thoroughly mixed with a Seamans mixer and graded into a large windrow. This served two purposes. First, as the material was worked back and forth to obtain proper shape for the roadway, it was left in thin layers, enhancing the compaction. Secondly, the grading served to aerate the mixture to hasten the cure. Rolling was accomplished with two, two-axle 8 to 12 ton tandem rollers with 16 passes applied as previously described. As the pulverization process bulked the material somewhat, the crown of the road was increased slightly in order to accomodate the material back between the undisturbed shoulders.

The application of emulsion, mixing, grading and rolling was accomplished in four days.

From MM 174.731, north to the Canadian border, cracks of 1/2" or larger were routed, blown clean with a high heat blower and filled with rubberized crack filler meeting Federal Specifications SS-S-1401. This was done by the District maintenance crew.

From MM 174.731 to MM 174.779, a tack coat of RS-1 was applied along with crack filling prior to the overlay. Construction equipment being repaired was parked in this area and neither pulverization nor the rubberized slurry treatment could be done. This area will be of interest even though it is only approximately 250 feet long.

Rubberized slurry was applied from MM 174.779 to MM 177.35 with the exclusion of the bridge over US Route 5. The materials used were SS-1h emulsion, graded limestone from Shelburne, Vermont, and rubber shreds from Massachusetts. The rubber and aggregate were mixed by equal volumes on the job site with a loader. The 2.57 miles of rubber slurry, 26 feet wide, was applied by one slurry truck in four days.

In order to get the required 3/8" average depth, it was necessary to pull two complete passes over the entire roadway. Inclement weather necessitated removing a 900 foot strip, 13 feet wide, with a grader and redoing. This was caused by a heavy rain washing the emulsion from the mix. It is emphasized that weather is a very critical factor with emulsion mixes. During late September when the project was done, it sometimes took up to 48 hours for the emulsion to break. Until the slurry is cured, rain can cause varying degrees of damage. It should also be recognized that traffic not be allowed to travel on the rubber slurry. It is therefore necessary to provide alternate routes until the slurry is covered with pavement.

Due to traffic considerations and ramps at the United States-Canadian border, the rubber slurry was stopped at MM 177.35. From there to the border, a distance of approximately 900 feet, the roadway received only crack filler.

Paving was done with an automated wide paver which laid 32 feet on the first pass, approximately one inch deep. To protect the rubber slurry from damage due to trucking, a dusting of agricultural lime was placed at strategic turn-around locations. A small amount of straight line trucking does not appear to be detrimental to rubber slurry.

RESULTS

The most important results will, of course, be the long term ones measured by cracking and roughness. This project will be monitored for two winter seasons in an attempt to estimate the success of the different applications.

The immediate improvement in the ride is shown in Figure 3. This illustrates the cumulative inches of roughness from mile marker to mile marker, as measured by the Mays Meter, for the major portion of the project. It can plainly be seen that the ride was very rough in the spring, as compared to the fall, and prior to any work, was above acceptable limits. Further, the relativity of sections remained in the spring and fall readings, as indicated by the peaks and valleys. After the project had been completed, the Mays Meter showed the roughness well within limits, with perhaps the pulverized section looking a little better than the slurried area. For the ride then, the results have been satisfactory.

The relative costs per mile of the alternative corrective treatments are indicated in Table III. Comparing the estimated costs from Table I with the actual costs shown in Table III, it is evident that we did not correctly forecast the tremendous price increase in asphalt associated products. Just prior to construction, it was decided to pulverize only the top three inches of pavement and not the full five inches of base with it, thus reducing the overall cost to $1.65 per square yard for pulverization and rolling. The crack filling is also much cheaper to do with in-house forces than by contract.

TABLE III COST PER MILE FOR ALTERNATIVE CORRECTIVE TREATMENTS

Test Section	Crack Filler	Pulverize	Emulsify and mix	Rubber Slurry	Two-inch Overlay	Total cost per mile
Pulverize	No	$23,230	$3,750	No	$60,860	$87,840
Rubber Slurry	$3,420	No	No	$24,470	$60,860	$87,750

As it appears that the total cost differential in either system is not that great, it would seem that the important considerations are the time involved in construction and the long term benefits.

Presently, there are few areas that could displace traffic for the time required to pulverize the pavement. This method would be ideal for shorter stretches of severely distressed pavements and may find limited applications in this respect. The pulverized material may possibly be acceptable without adding and mixing emulsion. It appears well graded and compactable, giving the impression that a prime coat may be satisfactory enough to provide a paving platform. The short section that did not receive any emulsion will hopefully address itself to this question.

As of mid-December, no cracking had occurred in the overlay. While we would expect to observe some reflection cracking over the rubber slurried area by mid-January, we do not know what to expect over the pulverized area.

CONCLUSIONS

1) The ride of a distressed highway can be substantially improved with a two-inch overlay.
2) Based on previous experience, overlaying distressed pavements with two inches of bituminous concrete is a futile effort, as reflection cracks will occur during the first winter. Therefore, some concentrated effort must be applied to eliminate or reduce them.
3) Pulverization is a viable alternative in the rehabilitation of distressed pavements, although it is considerably slower than certain other methods.
4) Weather conditions are critical with alternatives utilizing emulsified asphalts.
5) Pulverization and rubber slurry appear to be economically competitive.
6) Benefits other than short-term cannot be determined prior to two winter seasons.

FIGURE 1

BACKSCATTER COUNTS VS ROLLER PASSES

15 Second Backscatter Count

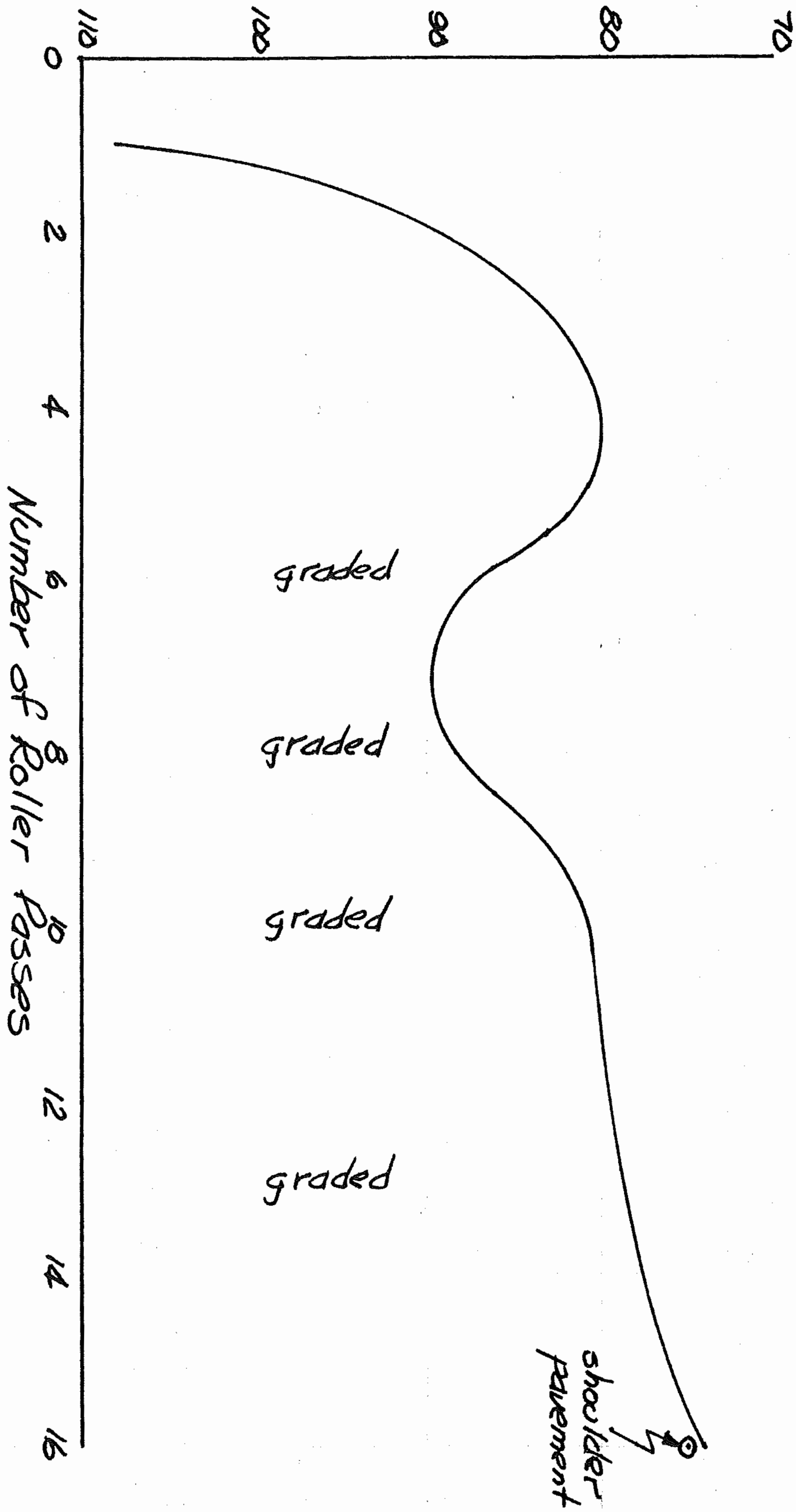


FIGURE 2

TRANSVERSE CRACKS VS 0.1 MILE MARKERS

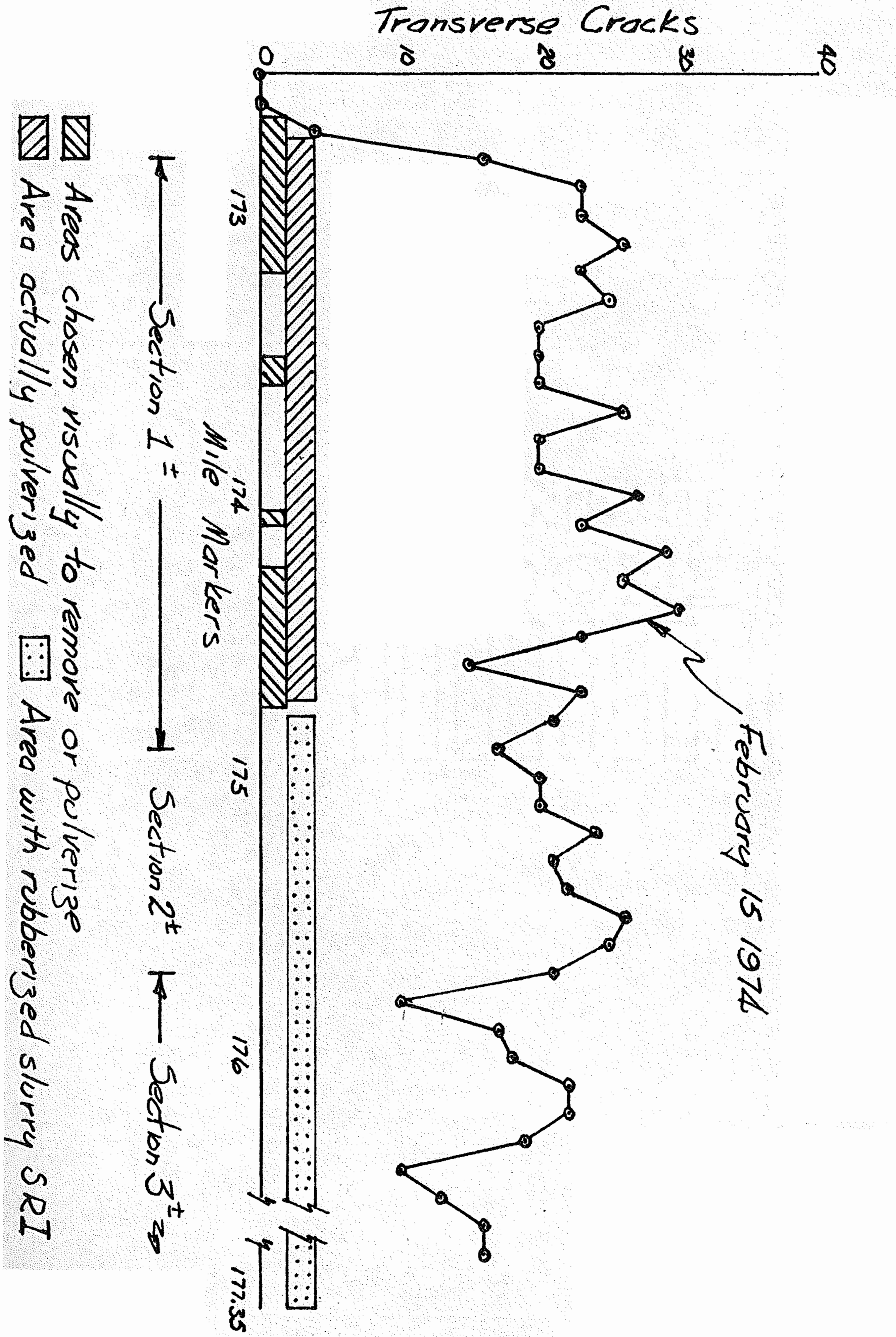
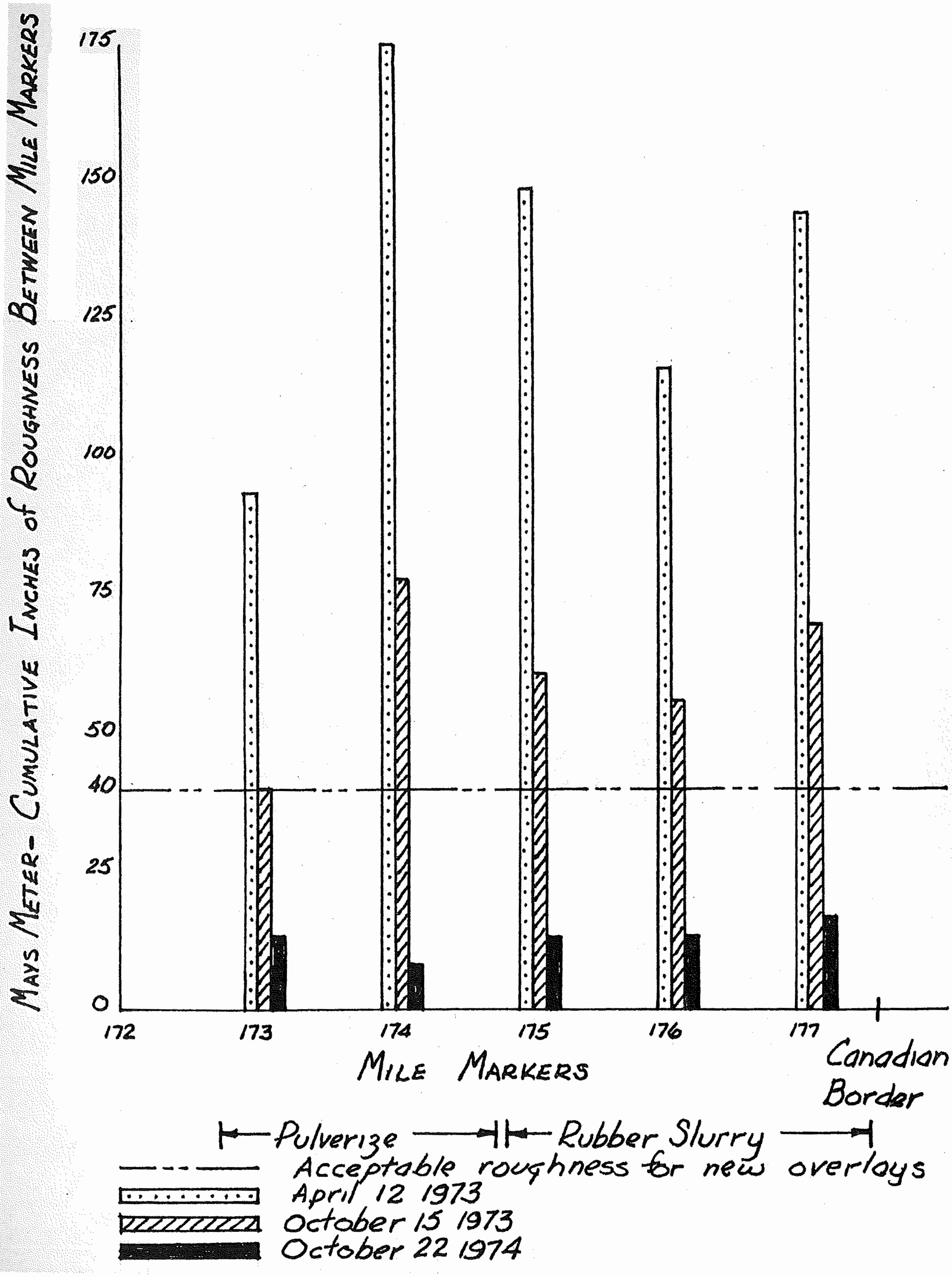


FIGURE 3

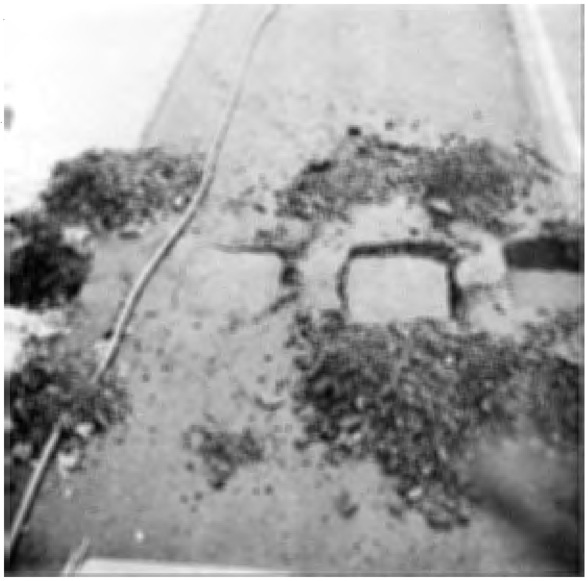
CUMULATIVE INCHES of ROUGHNESS vs MILE MARKERS



DERBY I 91

ROADWAY CONDITION PRIOR TO RECONSTRUCTION

MM 172/95. Condition of pavement in area to be pulverized. October, 1973.



MM 172/95. While opening test pits — free water seeking own level. Note snow on bank. December, 1973.

MM 172/95. 2' x 2' holes separated by 1' to edge of shoulder. Running out of third hole. December, 1973.

MM 172/95. Hole off point of shoulder dry except for some spillage. Note snow. December, 1973.

DERBY I 91

PULVERIZATION AND RUBBERIZED SLURRY SRI

Windrowing pavement between shoulders during pulverization process.

Motorized pulverizer drawn by front-end loader.

View of pulverized area after grading prior to addition of emulsion and rolling.

Laying first course of SRI. Note crack filler and shoulder overlap.

Report DATE 2/25/75
+ 4/16/75

REFLECTIVE CRACK SURVEY

DERBY I 91 - 3(33)

LINEAL FEET OF CRACKS

SECTION #1

PULVERIZE & EMULSIFY — MM 172.725

ORIGINAL 2/15/74		2/19/75	4/15/75		
Type A	9816	0	0		
Type B	816	0	0		
Type C	2392	0	0		
Type D	695 *	0	0		
TOTAL	13,719	0	0		

1.91 mi

MM 174.6375

SECTION #2

PULVERIZE ONLY

2/15/74		2/19/75	4/15/75		
Type A	480	0	0		
Type B	0	0	0		
Type C	175	0	0		
Type D	* 0	0	0		
TOTAL	655	0	0		

0.09 mi

MM 174.731

SECTION #3

CRACK FILLER & RS-1 TACK

2/15/74		2/19/75	4/15/75		
Type A	216	0	0		
Type B	72	0	0		
Type C	320	0	0		
Type D	* 0	0	12		
TOTAL	608	0	12		

0.05 mi

MM 174.779

SECTION #4

RUBBER SLURRY & CRACK FILLER

2/15/74		2/19/75	4/15/75		
Type A	9,984	0	0		
Type B	1812	0	84		
Type C	8222	41	0		
Type D	* 462	106	253		
TOTAL	20,480	147	~~0.72~~ ~~%~~ 1½%		

2.57 mi

MM 177.35

* ALLIGATOR TYPE CRACKING OR MANY SMALL PATTERN CRACKS NOT INDIVIDUALLY RECORDED.

Report DATE 2/25/75

REFLECTIVE CRACK SURVEY & 4/16/75

CON'D

MM 177.35

2/15/74 SECTION #5		CRACK FILLER ONLY 2/19/75	4/15/75		
Type A	192	0	0		
Type B	60	0	0		
Type C	735	0	0		
Type D	23	0	0		
TOTAL	1010	0	0		

0.17 mi

US CANADIAN BORDER

DEFINITION

TYPE "A"	Transverse from shoulder to shoulder
TYPE "B"	Transverse from ℄ to shoulder
TYPE "C"	Longitudinal
TYPE "D"	MISCELLANEOUS