

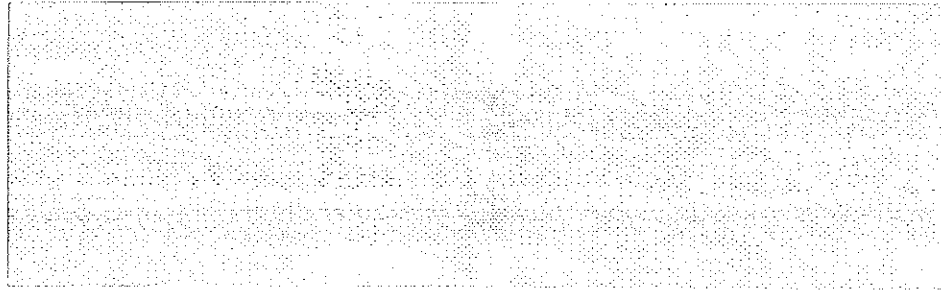
RESTORATION AND PREVENTIVE MAINTENANCE
OF CONCRETE PAVEMENTS



MATERIALS and TECHNOLOGY DIVISION



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RESTORATION AND PREVENTIVE MAINTENANCE
OF CONCRETE PAVEMENTS

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A category 2 project conducted in cooperation
with the U. S. Department of Transportation,
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Research Laboratory Section
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Research Project 79 G-245
Research Report R-1267

Michigan Transportation Commission
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SUMMARY

In 1976 the Department began a study aimed at developing a preventive maintenance program for reinforced concrete pavements having neoprene sealed transverse joints. The developed procedures were to be such that traffic could be maintained through the repair area and compatible with daylight lane closures. Following laboratory testing to determine the most promising fast-set patching materials and development of repair procedures, a nine-mile section of I 69 in Calhoun County was selected as a field testing site. The procedures applied on I 69 involved the use of five fast-set patching materials for joint groove spall repairs; removing damaged or malfunctioning contraction joint seals and resealing with new neoprene seals; and removing tight and frayed neoprene expansion joint seals, resawing the joint groove, and resealing the joint with either a liquid sealant or a new neoprene seal.

Based on the I 69 field work experience and the performance of the spall repairs and resealed joints, specifications for experimental contract maintenance work were prepared. A first contract covering a section of I 75 in Arenac County was let in 1983 and a second contract was let in early 1984 which included an eight-mile section of M 47 in Saginaw County. Since these pavements were relatively old (I 75, 17 years and M 47, 19 years old) the work, rather than being preventive maintenance became more of a restorative type maintenance. In addition to joint groove spall repairs and resealing transverse joints, full-depth repairs were made at severely deteriorated joints and transverse cracks. Further, less severely deteriorated cracks underwent spall repair, routing and sealing with a liquid sealant, which was also used to seal the resawed longitudinal joints.

The repair work on the two projects involved 232 sq yd of full-depth repairs, 19,090 lin ft of spall repairs, 2,510 cu ft of fast-set patching material, 46,150 lin ft of contraction joint resealing, 9,120 lin ft of expansion joint resealing, 220,970 lin ft of longitudinal joint resealing, and 19,610 lin ft of transverse crack sealing.

Observation of the contractor's construction operations indicated no major problems in conducting the various types of maintenance or restoration work. The most delicate operation was the restoration of the joints, which required careful workmanship in removing the deteriorated concrete and preparing the exposed surface for bonding to the patching material. It is very important that personnel performing the spall repairs are familiar with the mixing, placing, and finishing requirements specified for the patching material to ensure lasting performance of the repairs. Early cracking and bond failure in repairs during the first few months service appear to be related to errors in proportioning and placing the material rather than to traffic loads because, characteristically, the number of these failures decreased with time. Follow-up repairs of early patch failures by Department maintenance forces is recommended on future projects.

It is concluded that restoring concrete pavements using the techniques

employed by the two contractors is feasible provided the pavement contains high quality aggregates and major base problems are not present. Recommendations for future restoration projects suggest that the possibility of overnight lane closures be considered as a means of reducing costs and to allow use of patching materials less sensitive to construction problems than the current fast-set materials. It is also recommended that the Department consider adopting the developed restoration technique as a standard preventive maintenance program for our new concrete pavements as well as recycled and overlaid ones to preserve their aesthetically pleasing appearance, smoothness, and structural integrity.

INTRODUCTION

Concrete pavements constructed from 1967 through 1979 have 71-ft slab lengths and those built from 1979 to the present have 41-ft slab lengths. The dowelled transverse joints on these pavements were constructed without baseplates, have sawed joint grooves, and were sealed with neoprene seals. Condition surveys and cores taken through the joints show that pavements with this type of joint design are performing much better than pre-1967 pavements which had 99-ft slabs, baseplates, formed joint grooves, and hot-poured rubber-asphalt seals. However, on neoprene sealed pavements some problems do develop that require maintenance in order to maintain the effectiveness of the seals and thus retard the deterioration of the joints.

Basically, there are five problems that need attention to minimize entrance of liquids and incompressibles at joints or transverse cracks. These problems and needed maintenance are as follows:

- 1) Spalls developing along the joint grooves must be repaired to restore the effectiveness of the preformed neoprene compression seals.
- 2) Broken, loose, or lost seals must be replaced to prevent entrance of contaminants into the joints.
- 3) Tight expansion seals must be removed and the joint resealed to ensure that spalling of the joint grooves does not occur.
- 4) Open transverse cracks must be repaired and sealed to prevent excessive increase in compressive forces due to incompressible materials filling the open cracks.
- 5) Longitudinal joints must be sealed to prevent surface moisture from reaching the tie bars which accelerates their corrosion and causes premature fractures.

Since neoprene seals depend on the compressive force between the seal and the joint face to be effective, it was evident that spall repair using bituminous material could not be used to restore and maintain the

required seal pressure on the joint groove walls. Therefore, in April 1976, the Department approved an experimental project for the development of procedures for maintaining neoprene sealed pavements.

The first phase of the project consisted of categorizing the different types of distresses involved and developing a speedy and accurate survey procedure. Seven distress types were identified and named as follows: open spall, shattered spall, joint spall, tight expansion joint seal, tight expansion joint seal with spalls, loose or lost seals, and open transverse cracks. Each failure type was assigned a number for easy recording. Since all seven distress types were repaired, severity levels for each distress are not necessary. Once a condition survey of a pavement is completed the extent of the needed maintenance work can easily be determined. A copy of the survey procedure including distress identifications is included in Appendix A. This survey procedure will be modified for future projects.

The second phase involved the development of repair procedures and evaluating materials under traffic that would be suitable for this type of maintenance. The repairs were to be opened to traffic the same day they were placed. The development work was carried out by Research and Maintenance Division personnel over a three-year period on I 69 in Calhoun County, and described in Research Report R-1065.

Five repair mortars which have shown—through laboratory tests—to have the physical properties required for suitable field application were tried. They were: epoxy, "Set 45," Fondu (high alumina), Darex 240, and regular cement mortar with chloride added as a strength accelerator. On the basis of handling, mixing, placing, finishing, curing time, and early performance data, the "Set 45" mortar was selected as the best mortar type for small spall repairs.

As a result of the good performance of the I 69 experimental maintenance work, the Department's Engineering Operations Committee at its October 5, 1977 meeting, asked that the Research Laboratory Section, in cooperation with the Design Division prepare a contract for this type of concrete pavement maintenance work. The project was to be carried out under Research Project 79 G-245 and the Category 2 Experimental program. Work Plan No. 68, describing the proposed work, was approved by the Federal Highway's Division Administrator February 20, 1979.

Objectives

- 1) To evaluate the developed construction procedures on a contract project.
- 2) To determine the performance of the specified mortar, liquid seals, and preformed neoprene compression seals.

Planning

Originally it was planned to have a project ready for contract letting

in late 1979. However, funding problems developed, initially because Federal participation in this type of repair work was denied. Finally, when the 4R program was approved, Federal funds became available, and a contract was let in July 1983 and another one in January 1984.

Pavements on which these maintenance procedures (resealing, crack sealing, and partial-depth repair) should be applied must be in reasonably good structural condition. The use of partial-depth repair on pavements where the deterioration is caused by D-cracking should be avoided. The search for likely candidates began in 1979 and consisted of a cursory examination of the pavement surface followed by coring through the joints to ensure that the cross-section of slab was in satisfactory condition.

The first project selected consisted of a 12-mile portion of I 75 in Arenac County from M 61 north to Maple Ridge Rd (Construction Project IR 06111-15112A). The second project (Construction Project FRR 73073-20218A) is located on M 47 in Saginaw County and runs from south of the old US-10 relocation southerly for 8.3 miles to north of M 58 (Fig. 1). Both projects have a 9-in. thick reinforced slab with 71-ft joint

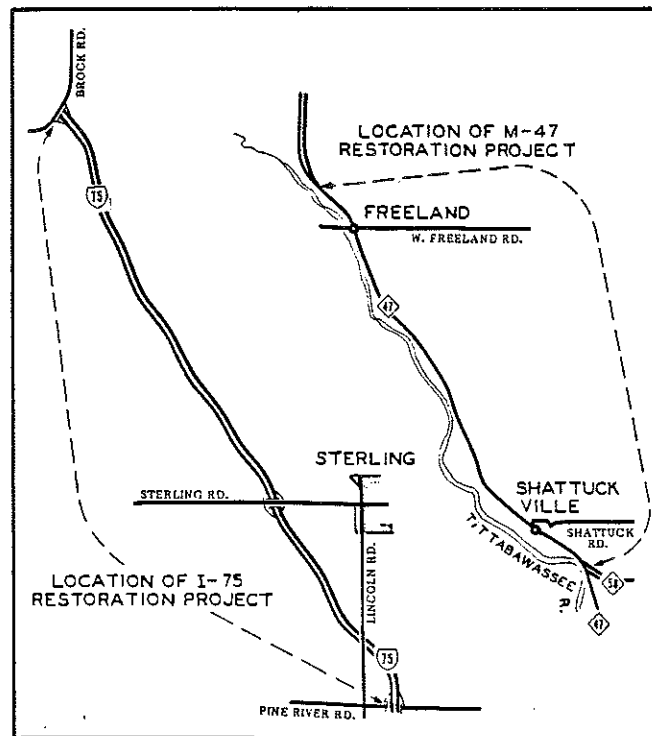


Figure 1. Location of the I 75 and M 47 restoration projects in Arenac and Saginaw Counties, respectively.

spacings. The joints are dowelled, have sawed joint grooves, and are sealed with a neoprene seal. I 75 was constructed in 1968 and consists of dual two-lane roadways, one each way. M 47, constructed in 1966, is a five-lane facility with the middle lane for left turns only. The two-way ADT on I 75 is 13,400 with a 690 commercial volume and on M 47 the ADT is 13,900 with a commercial volume of 730.

Once these pavements were selected they were surveyed using the procedure described in Appendix A. However, because of the delay in letting the contracts a resurvey was conducted to add any new distresses or increases in previously recorded ones. Originally only the main line pavement on I 75 was planned to be included in the contract, but just prior to finalizing the contract proposal it was decided to include the ramp pavements at interchanges. Another change was made concerning the resealing of contraction joints. Originally it was planned to reseal only the contraction joints with malfunctioning or lost seals; however, the Department and the FHWA agreed that all contraction joint seals should be replaced. To determine the effectiveness of the original neoprene seals, concerning their ability to maintain compressive force and recovery requirements, samples were taken and tested in the laboratory.

Design

The design for both projects was based on the previous experimental work done on I 69 in the late seventies by Department personnel. The work would be done a lane at a time with traffic maintained through the construction area and lane closures limited to daylight hours. A brief description of each repair item follows:

Full-depth repair - The outer limits of the distressed area are sawed full-depth with a diamond-bladed saw. The failed concrete is lifted out with a front-end loader by attaching cables to lift pins inserted in sound concrete within the repair limits. Final cleanup is done with hand tools. Ten 1-3/8-in. holes 8-1/2 in. deep are drilled into each end face of a lane repair and 1-5/16-in. diameter dowels inserted into the holes. The longitudinal edges are formed and reinforcement placed on chairs. The repair concrete consists of a 9-sack mix with calcium chloride added for set-acceleration. A groove is formed at each transverse repair joint and sealed with a hot-poured sealant. Curing consists of a membrane compound sprayed on the surface with curing blankets used when the air temperature is below 65 F. The repairs are closed to traffic until a flexural strength of 300 psi is obtained.

Partial-depth repairs - The limits of the repairs are sawed 1-3/4 in. deep with a diamond-bladed saw. The unsound concrete within the sawed limits is removed with chipping hammers. The repair area is then cleaned with oil-free compressed air. If a dowel bar is exposed it is lubricated and the plane-of-weakness joint re-established by using a compressible foam. The joint groove is formed to the same width as the remaining

portion of the groove. The patching material is "Set 45" extended with 25A aggregate. Prior to placing the patching mixture the cleaned surface is wetted with water.

Resealing contraction joints - The existing neoprene seals are removed and any spalls along the groove are repaired using "Set 45" material. The joint groove is cleaned by mechanical wire brushing followed by cleaning with compressed air. To remove and reseal the vertical edges of the slab a small area of the bituminous shoulder is removed which after resealing is repaired with a bituminous hot mix. Prior to installing the new seal a lubricant-adhesive is applied to the groove walls. The new seal extends across both lanes which requires the seals to be coiled at the centerline joint, the traffic shifted to the sealed lane and the sealing operation completed on the adjacent lane.

Resealing expansion joints - The existing seals are removed and the joint groove resawed to dimensions of 3 in. deep by 1-1/2 in. wide. To remove and reseal the vertical slab edge the shoulder is treated in the same manner as the contraction joints. The vertical grooves are not resawed. Prior to resealing, spalls are repaired using "Set 45" and the groove sandblasted followed by cleaning with oil-free compressed air. A 2-in. diameter polyurethane foam rod is inserted into the groove to form a 1-1/4 in. deep reservoir. The groove is then sealed with a hot-poured sealant.

Resealing longitudinal joints - The longitudinal joints are resawed to a width of 1/4 to 3/8 in. and to a depth of 1 to 1-1/4 in. Saw slurry is removed by flushing with water and prior to sealing the groove is cleaned with compressed air. Spalls are repaired using "Set 45." A hot-poured sealant is used to seal the groove.

Sealing transverse cracks - Cracks selected for sealing are routed to a width of 1 in. and to a depth of 1-1/4 in. Cracks open more than 1 in. do not need routing. Spalls along the cracks are repaired using "Set 45." The crack is formed through the spall repair area using flexible form material which follows the curvature of the crack. The routed groove is sandblasted followed by cleaning with oil-free compressed air. For cracks wider than 1/4 in. a polyurethane backer rod is inserted into the crack below the routed groove to form a reservoir for a hot-poured sealant.

Detailed updated Special Provisions covering the various restoration techniques are included in Appendix B.

Construction

The I 75 experimental project [Michigan Project IR 06111, Job No. 15112A, Federal No. IR 75-3 (72) 191, Federal Item HP 0228] and the M 47 project [Michigan Project FRR 73073, Job No. 20218A, Federal No. FR 47-2 (301), Federal Item FJ 681] were awarded to the low bidders

August 3, 1983 and April 4, 1984, respectively. Since most of the work covered in the proposals was new to the contractors, the Department sponsored a pre-bid meeting at which the Special Provisions and suggested construction procedures were discussed and clarified. As a further step in ensuring the best possible implementation of the developed procedures, pre-construction meetings were held with Department construction personnel assigned to supervise the construction operations. In addition, Research personnel who developed the procedures and prepared the Special Provisions were on the job site periodically to monitor the work and provide technical assistance.

Construction work on the I 75 project began in August 1983 and after being suspended during the winter, was completed in September 1984. Because of cost overruns resulting from an increase in the spall repair quantity, the contraction joint groove spall repairs and seal replacement were completed only on five and one-half miles of the northbound roadway and on four miles of the southbound roadway. All other types of restoration work were completed on the entire 12-mile project length. On the M 47 project construction operations began in May 1984 and were completed in August 1984. All types of restoration work were completed on this project.

Both contractors used essentially the same repair techniques and the work was completed without encountering major difficulties. A brief description of each type of restoration work follows and the techniques are shown pictorially in Appendix C.

Full-depth repairs - The end limits of the repairs were sawed full-depth with a diamond-bladed saw and the larger sections of the distressed concrete lifted out without disturbing the base material. After final cleanout by hand the dowel holes were machine drilled, the dowels inserted in the holes, and the reinforcement placed on chairs. Ready mix concrete, with flake CaCl_2 added in the required dosage, was cast, consolidated with hand-held immersion type vibrators, screeded with a vibratory screed, and cured with a curing compound applied to the repair concrete surface. The repairs were opened to traffic the same day they were cast.

Partial-depth repairs - Both contractors used saws equipped with multiple diamond blades to saw parallel to the joint groove. The end limits of the spalled areas were sawed with a single-bladed saw. The use of multiple saw cuts facilitated the removal of the concrete within the repair limits. The repair area was cleaned of loose debris and prewetted before placing the fast-set mortar. In areas where the spall repair extended below the joint groove a compressible filler was used to re-establish the plane-of-weakness crack. On the I 75 project a problem developed with the fast-set mortar in that it expanded an excessive amount. It was determined that the problem was confined to a certain lot of the product which was then replaced by the manufacturer.

Resealing expansion joints - Two methods were used to remove the existing neoprene expansion joint seals. Where the pavement exerted excessive pressure on the seal a single-blade saw cut was made through the center of the seal to relieve the pressure. The seal was then pulled out by hand and a saw cut was made using dual blades spaced to widen the existing groove to 1-1/2 in. When the existing seals were not under excessive pressure, the seals were left in place while resawing the groove with the dual-bladed saw. The resawed grooves were sandblasted and cleaned with compressed air immediately prior to installing the polyurethane rod in the bottom of the groove and sealing with a hot-poured sealant.

Resealing contraction joints - Since the pressure on existing contraction joint seals is limited by the prescribed joint groove width it was possible to pull the existing seals out by hand on both projects. Once the seals were removed the groove walls were cleaned by mechanical wire brushing followed by compressed air cleaning. The new neoprene seals were installed using a "skateboard" type installer except in the vertical edge grooves hand installation was used. A lubricant-adhesive was applied to the groove walls before the seal was installed. Since the seals were required to extend across all lanes in one piece they were coiled at the longitudinal center joint and the installation completed when traffic was shifted onto the resealed lane.

Resealing longitudinal joints - Resawing the grooves was done using a diamond bladed saw. On the I 75 project the contractor used a saw with the blade turning counter clockwise. With the blade rotating in that manner the old sealant was removed effectively without gumming up the blade or the new groove. On the M 47 project the old cold-pour sealant was missing in nearly the entire joint length and resawing the groove with the blade turning in the normal clockwise direction was done without problems. Prior to sealing, the new grooves were power washed and after air drying they were cleaned with compressed air. The I 75 longitudinal joint was sealed using an upgraded hot-poured rubber-asphalt sealant and on the M 47 project a low modulus hot-poured rubber-asphalt sealant was used.

Crack sealing - A random crack saw was used for routing the transverse cracks. The routed groove was sandblasted and cleaned with compressed air prior to installing a hot-poured rubber-asphalt sealant. Spalls along the cracks were repaired before sealing. In the spall repair areas the seal groove was formed using a polyethylene foam strip. Since all the cracks were less than 1/4 in. open when sealed the use of a polyethylene rod in the crack at the bottom of the groove was not required.

Cost Information

The actual construction quantities and unit bid prices are given in Table 1. From these values the cost of restoring a lane-mile on M 47 was \$10,600 including traffic control. Since the I 75 project was not completed because of cost overruns the lane-mile cost is not available.

TABLE 1
QUANTITIES AND UNIT PRICES

Item	Unit	Quantity		Unit Price	
		I 75	M 47	I 75	M 47
Full-depth repairs	sq yd	192	40	77.60	76.10
Spall repair	lin ft	8,171	10,918	8.00	16.00
Patching material	cu ft	1,476	1,032	53.00	42.00
Resealing contraction joints	lin ft	17,639	28,507	3.08	3.10
Resealing expansion joints	lin ft	1,367	7,752	2.50	4.25
Resealing longitudinal joints	lin ft	135,139	85,834	0.80	0.60
Sealing transverse cracks	lin ft	3,111	16,500	2.50	1.75

Evaluation

The performance of the restored pavements will be monitored for a five-year period. The first inspection was in the winter of 1985. The second one was conducted in the summer of 1985 with subsequent inspections every winter. The items being evaluated are: full-depth repairs, partial-depth repairs, hot-poured rubber-asphalt sealant used in expansion and longitudinal joints and in transverse cracks, and preformed neoprene seals installed in contraction joints. The number of items in each category subject to evaluation on each project are:

	<u>I 75</u>	<u>M 47</u>
Expansion joints	13	31
Contraction joints	70	80
*Longitudinal joint sections	7	10
Transverse Cracks	29	40
Full-depth repairs	11	1
Partial-depth repairs	275	241

*Each section 71' long (one slab length)

A brief description of the evaluation procedures and the results of the initial winter inspection follows. Since the evaluation is conducted under traffic from the shoulder, only the traffic, or right-hand, lane is being evaluated.

Hot-poured sealant - The performance of the resealed expansion and longitudinal joints and the sealed cracks is evaluated using the rating system given in Table 2, which was developed by the Pennsylvania Department of Transportation. In addition, the width of the expansion joint and crack grooves is measured and the length and width of any new spalls developing along the grooves are estimated.

TABLE 2
PERFORMANCE RATING SYSTEM
RATING LEVELS

	Rating	Degree	Description
Sealing	5	None	Seal is intact and in the condition as constructed.
	4	Slight	Seal has experienced adhesion, cohesion, and/or spalling defects in less than 5 percent of the joint area.
	3	Moderate	Seal has experienced adhesion, cohesion, and/or spalling defects in less than 25 percent, but more than 5 percent of the joint area.
	2	Severe	Seal has experienced adhesion, cohesion, and/or spalling defects in less than 50 percent, but more than 25 percent of the joint area.
	1	Deteriorated	Seal has experienced adhesion, cohesion, and/or spalling defects in more than 50 percent of the joint area.
Weathering	5	None	Seal is intact and in the condition as constructed.
	4	Slight	Seal surface aged or oxidized.
	3	Moderate	Seal surface has weather checking.
	2	Severe	Seal surface has alligator cracking.
	1	Deteriorated	Seal surface has eroded.
Debris Intrusion	5	None	Seal is intact and in the condition as constructed.
	4	Slight	Seal is intact and in the condition as constructed with debris accumulated, but no intrusion.
	3	Moderate	Seal has accumulated debris with scattered intrusion.
	2	Severe	Seal has accumulated debris with much intrusion.
	1	Deteriorated	Seal is broken and eroded by excessive intrusion of debris.

Preformed neoprene sealant - Although the rating system was developed to determine the performance of liquid sealant it is also used to evaluate the neoprene seals installed in contraction grooves. The width of the grooves and the size of new spalls along the grooves are measured at the time of rating the seal performance. The performance ratings from the first winter survey are given below:

Project	Item	Number of Seals with given rating														
		Sealing					Weathering					Debris Intrusion				
		5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
I 75	Expansion Joint	1	7	2	3	0	13	0	0	0	0	4	0	8	1	0
	Longitudinal Joint	7	0	0	0	0	7	0	0	0	0	7	0	0	0	0
	Transverse Crack	1	12	12	3	1	29	0	0	0	0	6	13	9	1	0
	Contraction Joint	56	10	4	0	0	70	0	0	0	0	61	0	8	1	0
M 47	Expansion Joint	17	6	5	2	1	31	0	0	0	0	23	0	8	0	0
	Longitudinal Joint	8	0	0	0	0	8	0	0	0	0	8	0	0	0	0
	Transverse Crack	23	12	5	0	0	40	0	0	0	0	28	0	12	0	0
	Contraction Joint	79	1	0	0	0	80	0	0	0	0	62	18	0	0	0

Since only the initial winter groove width has been measured the elongation to which the liquid seals have been subjected is not as yet known, but will be determined when further measurements are taken. A few

new groove spalls of minor significance have developed since construction.

Full-depth repairs - The hot-poured seals used in the repair joints are evaluated using the previously referenced rating system. Measurements are taken on joint movements, joint faulting, and spalling along the joint grooves in both the old and new concrete. The general appearance of the repair with respect to cracking and fracturing is noted.

Based on the initial winter evaluation all repairs are performing satisfactorily. As additional measurements become available a more quantitative evaluation of the repairs performance can be made.

Partial-depth repairs - A total of 9,523 partial-depth repairs were made on the two projects. The distribution with respect to length of the total number of repairs made and the number sampled for performance are as follows:

Project	Distribution of Repair Lengths, ft						
	0-1	1-2	2-3	3-4	4-5	5-6	6 and over
I 75 (Total No.)	2943	1494	433	154	40	39	33
I 75 (Sample No.)	166	71	24	11	2	0	1
M 47 (Total No.)	2291	1358	464	160	68	24	22
M 47 (Sample No.)	118	65	31	15	6	4	2

The repair samples selected for evaluation are those present at the joints and cracks subjected to seal evaluation.

The repairs are rated for cracking, shattering, and debonding. The 1985 winter survey showed that on I 75, 25 repairs exhibited surface cracks, eight had shattered but were still in place, and one repair had lost its bond entirely. On M 47, surface cracks were found in 11 repairs, and one repair had completely debonded and the repair material was missing from the area.

Condition of original neoprene seals

The I 75 and M 47 projects were among some of the first ones where the transverse joints were sealed with a preformed neoprene seal. Since then several changes have been made to improve both the seal itself and the installation process. Noticeably, expansion joints are no longer sealed with preformed seals, primarily because an economical seal that would function properly as the joint closes permanently with time could not be obtained. As the joints closed the seals became solid and extended out of the groove. The extruded portion of the seals was then torn by traffic and extensive spalling developed along the grooves. Current expansion joint seals are hot-poured rubber-asphalt placed on top of a backer rod in a 1-1/2 in. wide by 1-1/4 in. deep groove.

In the area of contraction joint seals some of the major improvements have been: the joint grooves are sawed to the specified width plus the width of the plane-of-weakness crack at the time of sawing; the lubricant-adhesive now contains more solids which have improved the seal between the surface contact area of the seal and the groove wall and provides more adhesive power. When the standard slab length was changed from 71 to 41 ft, the seal design and dimensions remained unchanged which results in the compressive force of the seal against the groove being higher because of less groove opening during cold weather. Also, internal web sticking was common during the early use of neoprene seals, but this problem is rarely encountered now.

Although the contraction joint seals and the installation procedure used on these two projects are not entirely representative of those in current use, the performance of their sealing ability was investigated during the resealing work. The joints were inspected for infiltration of solids and the seals were tested for permanent set, web sticking, and compressive force at certain simulated groove width.

A total of 59 seal samples, representing three brands of seals, were removed for examination and the groove width measured at the time of removal. The compressive set was measured one hour and 24 hours after removal. Web sticking was checked at removal time, and the compressive force at a seal width of 0.50 in. and 0.85 in. was measured in the laboratory at a later date. The results of the examinations and tests follows:

Item	Average Value for each brand		
	A	B	C
Joint Groove Width (in.)	0.53	0.60	0.55
Compressive Set at 1 hour (%)	40	26	38
Compressive Set at 24 hours (%)	37	24	36
Web Sticking (% of samples)	93	0	0
Compressive Force (lbs/lin in.) at 0.50 in.	35.9	45.7	4.0
Compressive Force (lbs/lin in.) at 0.85 in.	0.8	2.5	0.3

From the results, it is seen that the seals have a permanent set and the compressive force at a width of 0.85 in. (maximum expected groove opening) is very small for all three seal brands. This small compressive force indicates that the seal may be ineffective in preventing liquids from entering the joint during extreme cold weather. Examination of the plane-of-weakness crack at the time of sample removal showed that only a minimal amount of solid contamination was present. As can be seen, the compressive force at a 0.50 in. width is sufficiently high to effectively seal the joints in warm weather.

Conclusions

Observation of the repair procedures used and the subsequent initial evaluation indicate that restoration of concrete pavements by contract is feasible. The procedures are somewhat labor-intensive and the various

steps involved in the repair or sealing operation must be carefully done in accordance with prescribed methods. It is especially important that grooves to be sealed with a liquid sealant be sandblasted and air cleaned properly for good adhesion of the sealant to the groove walls. The use of fast-set mortars in repairing groove spalls requires that the workers be familiar with its properties, know its initial set time, and follow the preparation procedure for the existing concrete area being repaired.

After one winter's service the neoprene seals in the contraction joints are performing satisfactorily and so is the hot-poured seal in the resawed longitudinal groove. The hot-poured seals in the expansion joints and in the transverse cracks are performing quite well but a small amount of adhesion failure has developed on a few joints.

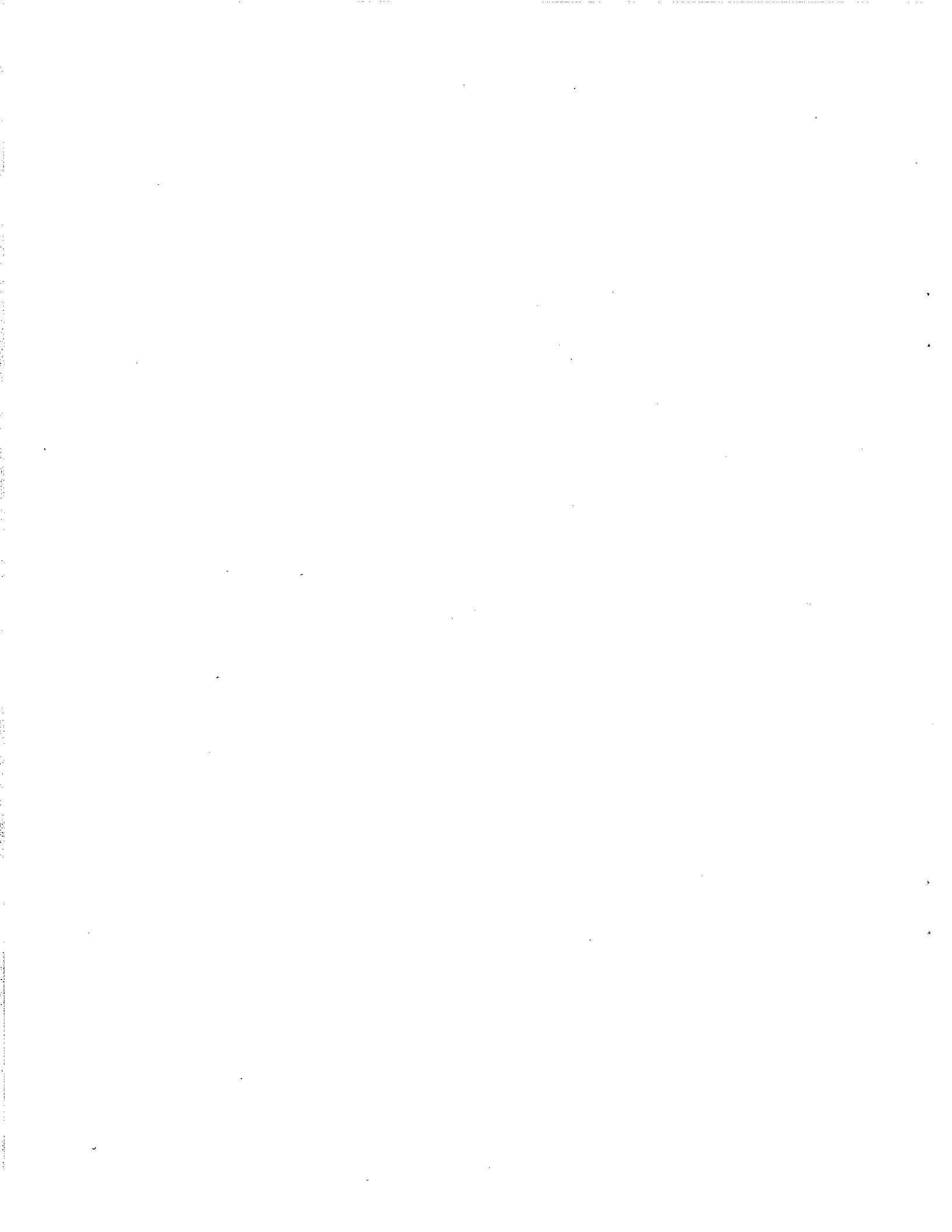
The full-depth repairs are in satisfactory condition. Cracking in several partial-depth repairs has occurred and a few repairs contain multiple cracks. A recent cursory survey showed that in several cases the repair material had broken up and was kicked out by traffic. It is anticipated that these are initial performance problems confined to repairs inherently weak either because of errors in proportioning, mixing or placing the fast-set mortar or in preparing the existing concrete repair surface.

Examinations and tests of neoprene samples removed after about 18 years of service during resealing work indicate that although the seals take a permanent set and lose some of their ability to maintain the compressive force against the groove walls, the amount of solids infiltrating the joints is minimal. Thus, on future restoration projects pretesting of the existing seals may reveal that complete resealing may not be necessary.

Recommendations

Based on the conclusions of this report it is recommended that the procedures used to restore the two pavements be used on other projects suitable for such work. However, since a small number of early patch failures may occur, it is recommended that the Department's maintenance forces be instructed to conduct follow-up repairs. It is very important that future pavements be surveyed and cored at the joints to determine aggregate quality and their structural condition prior to selection for restoration work. Also, consideration should be given to permit overnight closures which would allow the use of less expensive patching materials and should decrease construction costs as well. Another cost saving possibility exists in leaving satisfactorily performing contraction joint seals in place based on seal performance tests on samples removed from M 47 and I 75.

With respect to preventive maintenance, it is recommended that the procedures used to restore the M 47 and I 75 pavements be adopted as standards for maintaining newly constructed concrete pavements, recycled and overlaid ones. To be fully effective in preserving the pavement as long as possible, preventive maintenance techniques must be applied as soon as distresses are detected.

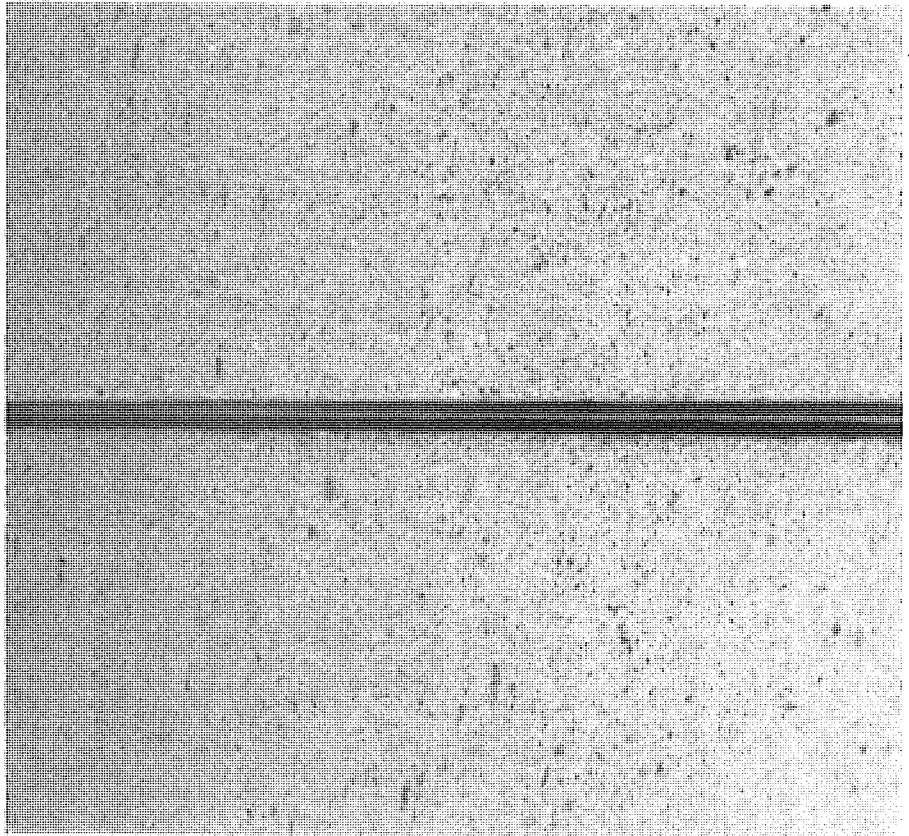


APPENDIX A

Name: Satisfactory Joint

Description: A satisfactory joint contains a neoprene seal that exerts sufficient pressure on the groove walls to prevent foreign materials from entering the joint. The seal itself is generally without tears and only minor spalls have occurred along the groove edges.

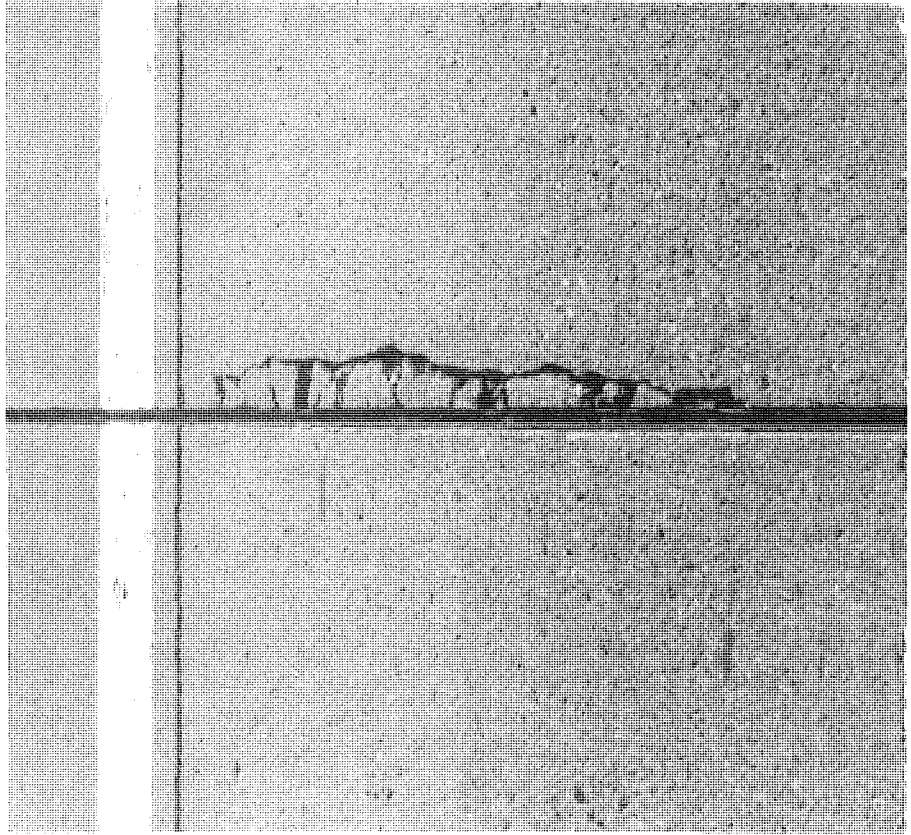
Rating Number: 0



Name: Shattered Spall

Description: Shattered spall is the breaking or cracking of the concrete along the joint groove. Generally, most of the broken concrete pieces are still in place and the seal is still under compression. The spall can also be a solid piece.

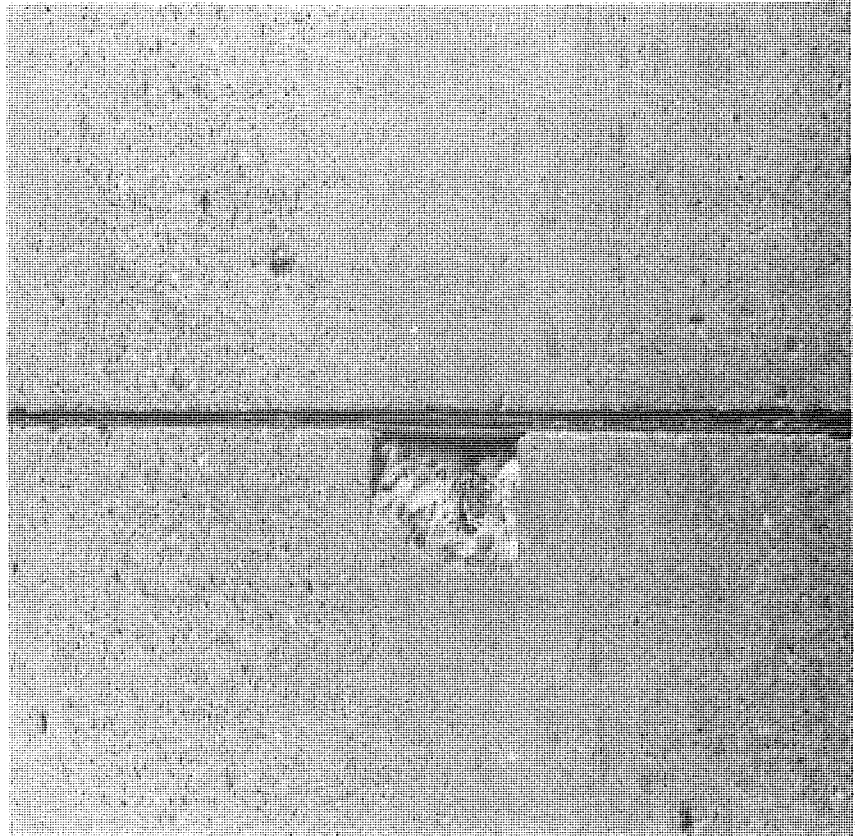
Rating Number: 1



Name: Open Spall

Description: An open spall is the breaking or cracking of the concrete along the joint groove and the broken concrete is missing. Seal compression is lost in the spall area.

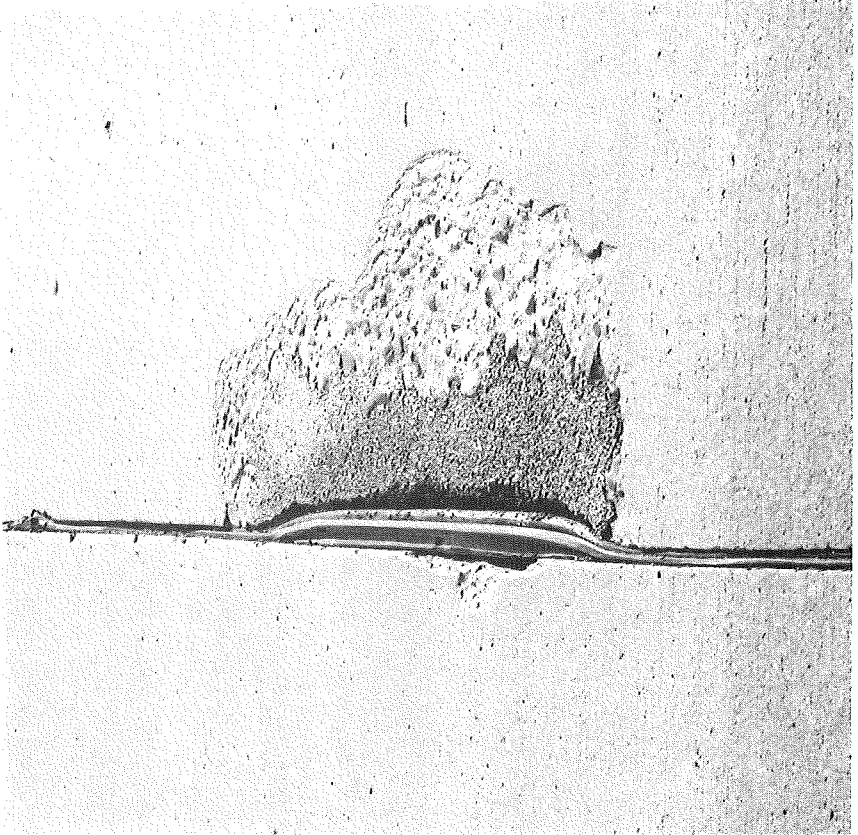
Rating Number: 2



Name: Joint Spall

Description: A joint spall is the breaking or shearing of the concrete along the joint groove. The spall extends from the bottom of the groove and several inches away from the joint. The broken concrete is missing and bituminous repair may be required. Compression in the seal is lost and the seal may be torn in the spall area.

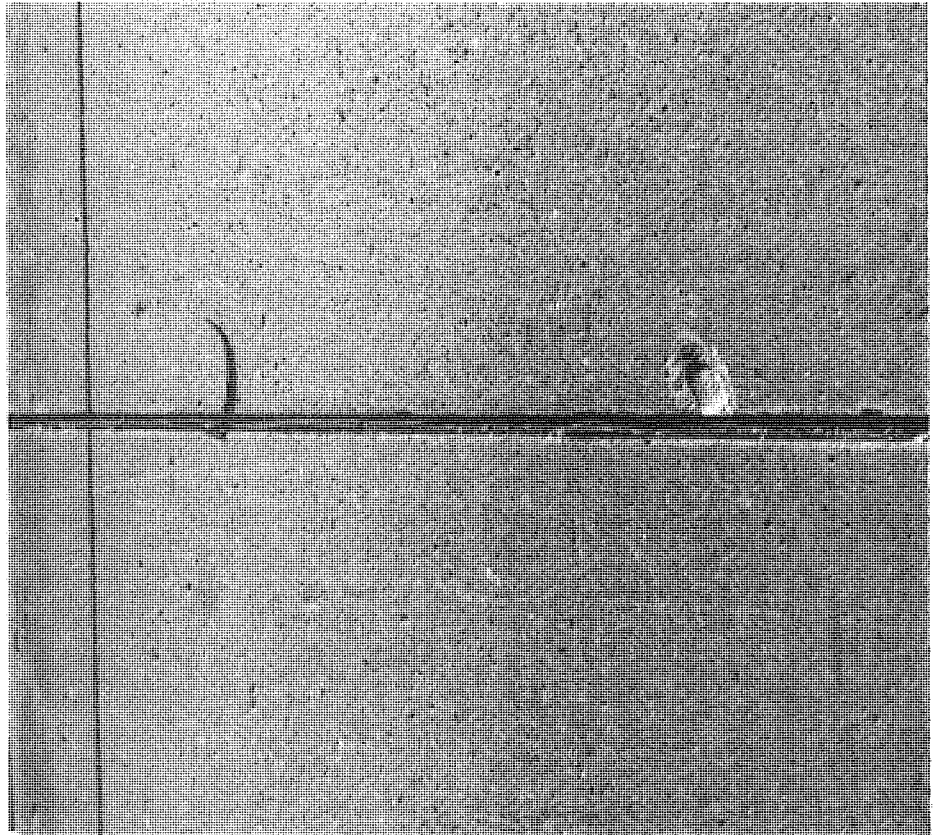
Rating Number: 3



Name: Tight Seal

Description: A tight seal is an expansion joint seal that is compressed beyond its design limit. The groove opening may range in width from 1/4 to 1/2 inch, the seal normally is torn, but no spalling has occurred. The seal is still sealing the joint satisfactorily.

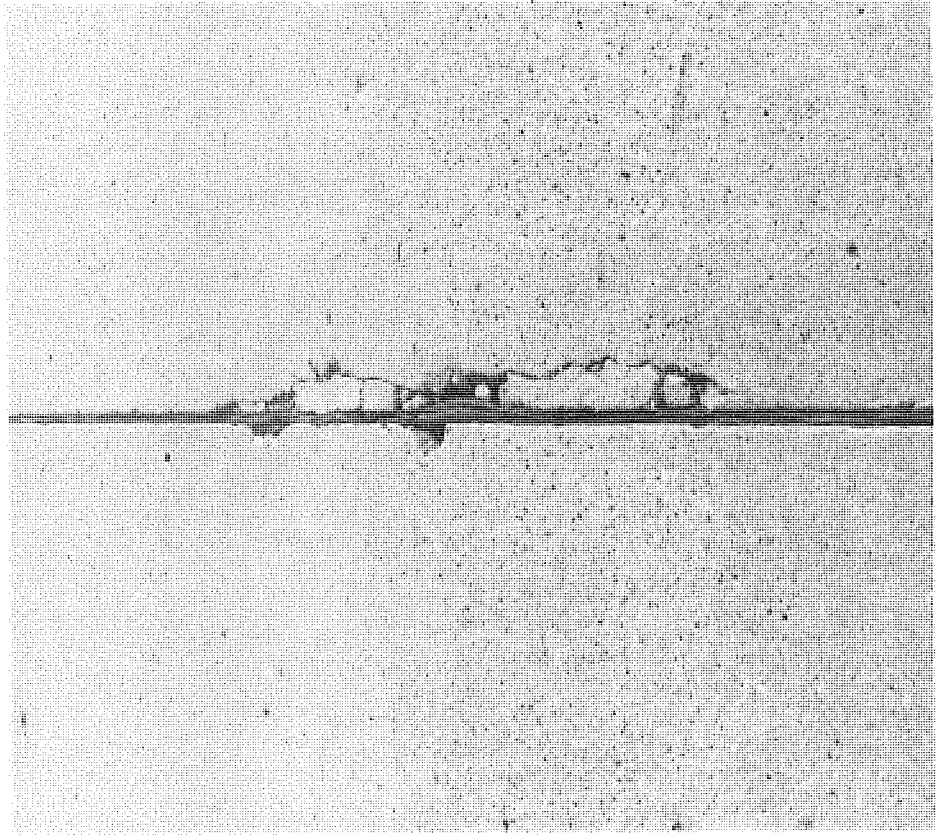
Rating Number: 4



Name: Tight Seal with Spalled Groove

Description: A tight seal with spalled groove is an expansion seal compressed beyond its design limit and spalls along the groove have occurred. The seal normally is torn and the spalls may be either shattered, open, or of the joint spall type.

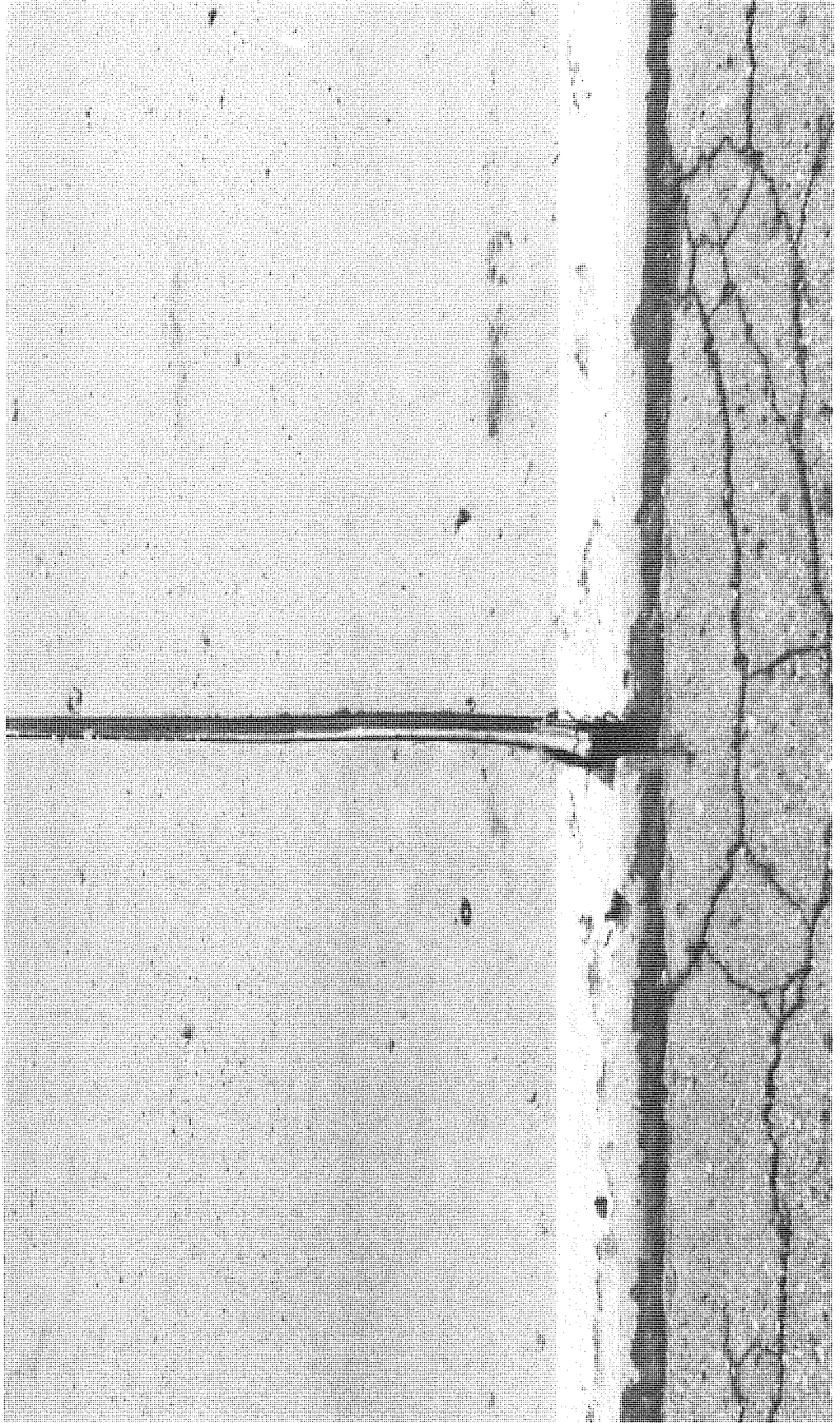
Rating Number: 5



Name: Loose Seal

Description: A loose seal is one where the pressure on the groove walls is lost. Spalls of either of the three types may be present.

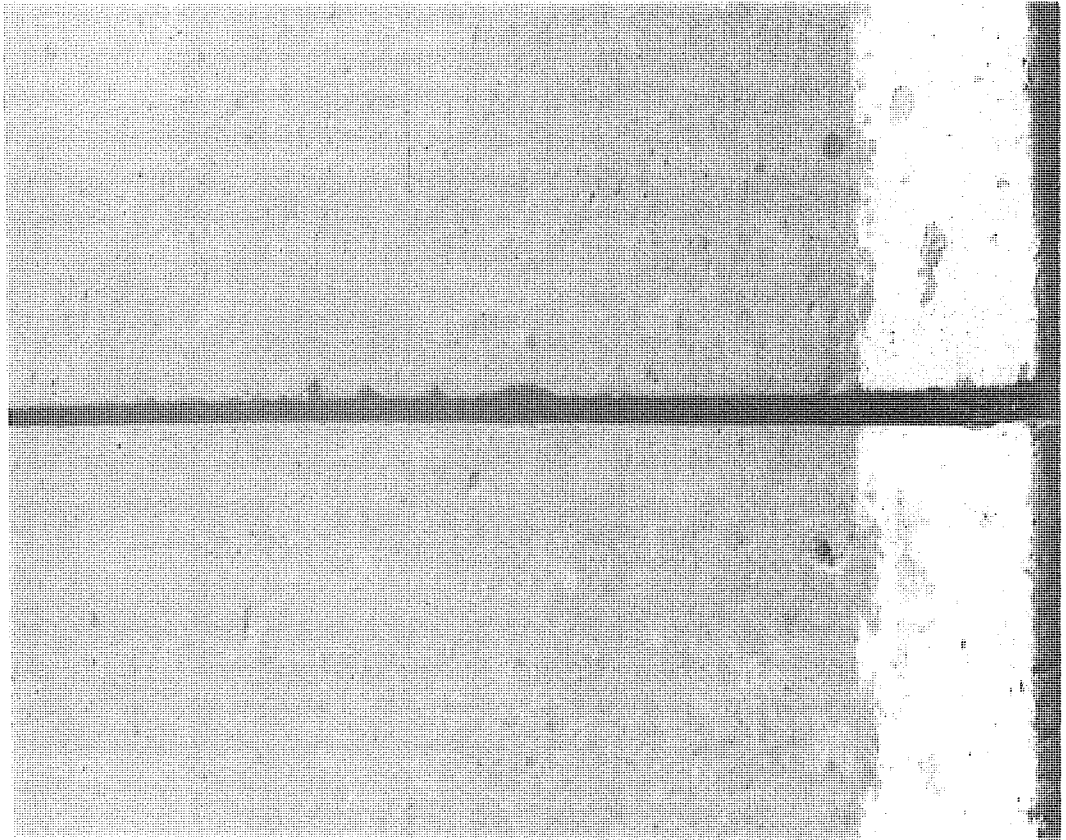
Rating Number: 6



Name: Lost Seal

Description: A lost seal is where part of, or the entire length of seal is missing. Spalls may be present.

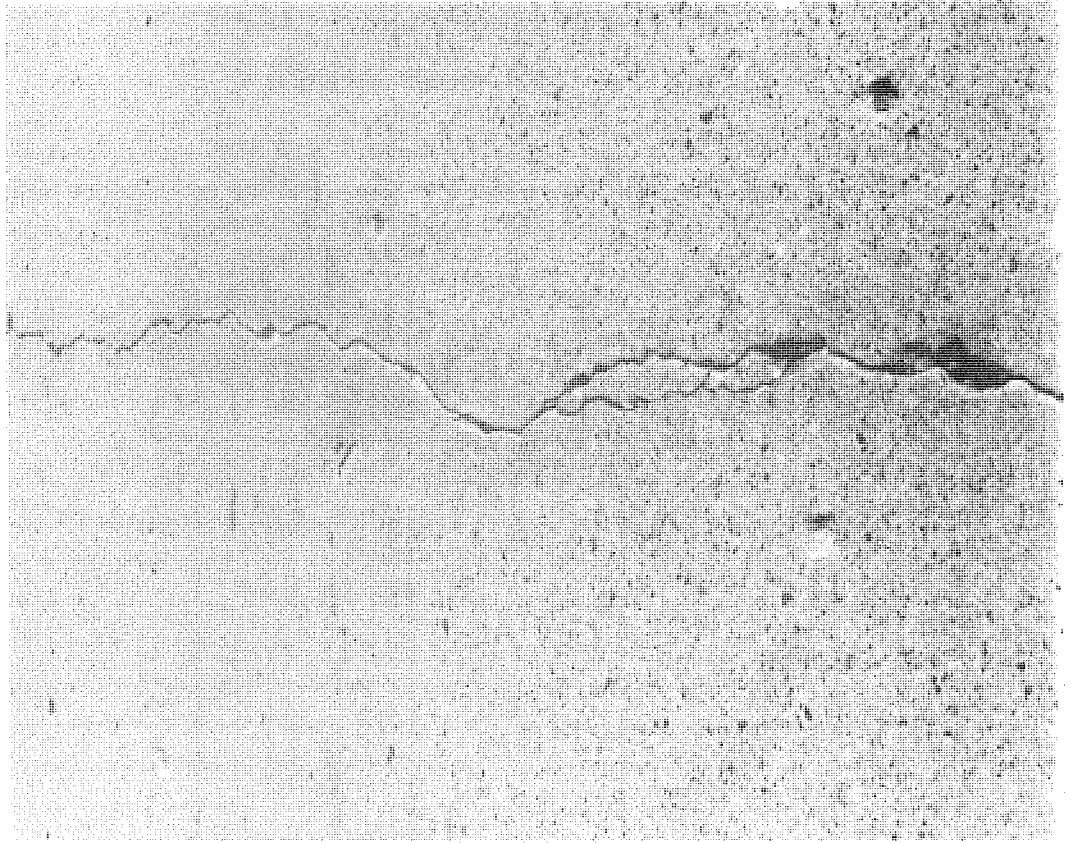
Rating Number: 7



Name: Open Transverse Crack

Description: An open transverse crack is 1/8 inch or more in width at the surface.

Rating Number: 8





JOINT CONDITION SURVEY DATA

Construction Project SAMPLE

Route I-69 SOUTHBOUND

Joint No. and Type	Year and Rating				Year & Accumulated Length or size of Distress, in.				Station Tie-ins and Remarks
	76				76				
1	0								0+00
2	0								
E 3	0								
4	0								2+88
5	0								
6	1				1x3				
7	0								
7a	8								
E 8	4								
9	1				1x8				
10	2				1x2				
11	0								
12	0								
E 13	0								
14	3				12x2				
15	0								
16	1				2x4				
17	0								
E 18	0								
19	0								
20	0								
21	2				2x4				
22	1				1x6				
E 23	5				1x18				
24	1				1x2				
25	1				2x4				
26	0								
27	7								
E 28	4								
29	6								
30	0								21+60
31	0								
32	2				2x2				
E 33	0								
34	1				1x4				

APPENDIX B

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS
FOR
JOINT SPALL REPAIR

SCOPE

This work includes furnishing all labor, equipment, and materials necessary to remove all unsound concrete, reform the joint groove, and patch the spall area using "Set 45."

All work and material shall be in accordance with the 1984 Standard Specifications with the exceptions and additions specified herein.

The size and location of the repair areas will be as shown in the proposal or as determined by the Engineer. The total length of spall and volume of material for bidding purposes has been increased from that shown on the log to allow for increase in spalls since the initial survey and to include the increase in area due to the repair procedure.

REMOVAL OF UNSOUND CONCRETE

Unless otherwise approved by the Engineer, the repair limits shall be constructed by sawing. The saw shall be equipped with a 12-inch (or smaller) diameter blade. The depth of the saw cut shall be 1-3/4 inch \pm 1/4 inch. The saw cut to control the width of the repair area shall be 2 inches beyond the widest portion of the spall (6 inch minimum width) and approximately parallel to the joint groove. The saw cuts to control the length of the repair shall be 2 inches beyond the length of the spall (minimum of 6 inches apart) and approximately perpendicular to the joint groove. Additional saw cuts may be made within the repair area to facilitate the removal of the unsound concrete.

The unsound concrete shall be removed by hand chipping with a light weight chipping hammer (15 pound class). The slope of the bottom of the repair area shall not exceed 1 vertical to 4 horizontal.

All areas of the existing concrete which must bond to the patching material shall be freshly sawed or chipped to remove all unsound concrete and contamination.

The repair area shall be cleaned with oil-free compressed air or high pressure water, and any other tools required to remove all slurry and debris.

All waste material and debris shall be disposed of by the Contractor as directed by the Engineer.

JOINT GROOVE FORMING

The neoprene seal shall be removed from the joint groove prior to reconstructing the joint groove. The existing neoprene seal shall be removed as specified in the Special Provisions for Replacement of Neoprene Joint Seals contained in this proposal. The joint groove can then be reconstructed using a stiff form wedged into position or other suitable methods approved by the Engineer. The surface of the form in contact with the patching material shall be coated with a bond breaker to prevent adhesion between the form and the patching material.

Regardless of the forming method used, the finished joint groove shall be straight and of the same width as the joint groove adjacent to the repair area.

PREPARATION OF REPAIR AREA

After the joint groove has been formed, any dowel bars visible in the repair area shall be heavily coated with grease to prevent adhesion between the patching material and the dowel bars. Care shall be exercised in applying the grease to insure that the bonding surface of the concrete is not contaminated. In the event the repair area extends below the bottom of the joint groove or is adjacent to the longitudinal joint, the plane of weakness crack shall be recreated by fitting a layer of compressible foam adjacent to the existing concrete prior to placing the patching material. The foam shall be a polyethylene or polyurethane material $1/4" \pm 1/16"$ thick which is compressible, but has sufficient compressive strength to resist the pressure of the patching material without deforming. The surface of the patch area and adjacent pavement shall be wetted with clean water after the area has been cleaned of all debris.

PATCHING MATERIAL

The patching material shall consist of a mixture of "Set 45" (as manufactured by Set Products of Macedonia, Ohio) and dry crushed natural aggregate (25A) conforming to Standard Specification 8.02.03. The patching material shall be proportioned by bulk volume as follows: 6 parts "Set 45," 3 parts aggregate, and 1.1 parts clean water. One fifty pound bag of "Set 45" plus the aggregate will yield approximately 0.55 cu ft.

The components of the patching material shall be sufficiently mixed to insure that the material is of uniform consistency.

The limited working time of the material requires that it be mixed in small batches, then placed and finished immediately after mixing.

The patching material shall not be used when the air temperature is less than 40 F or greater than 95 F. When the air temperature is less than

50 F, the components of the patching material shall be heated to 75-85 F prior to mixing. When the air temperature is greater than 85 F, the dry components of the patching material shall be kept cool and ice water shall be used in the mix.

PLACING THE PATCHING MATERIAL

Immediately prior to placing the patching material, the repair area shall be inspected to insure that all surfaces are thoroughly wet, but contain no free standing water. Any dry areas shall be rewetted and any excess water shall be removed.

If any segregation is evident in the patching material, the material shall be remixed by hand immediately prior to placing in the repair area. The material shall be firmly worked into the bottom and sides of the repair area to insure good bond and consolidation. The repair area shall be completely filled before any portion of the material has taken an initial set. Immediately after placing and consolidating the material, it shall be troweled off to produce a surface flush to 1/8" below the existing pavement.

FORM REMOVAL

The forms may be removed any time after the patching material has gained sufficient strength to allow removal without damage to the repair.

RESEALING JOINT GROOVE

The joint groove shall be resealed as specified in the Special Provisions for Replacement of Neoprene Contraction Seals contained in this proposal.

SHOULDER REPLACEMENT

In the event the shoulder is damaged by the Contractor's operation, it shall be restored to the existing line and grade before opening to traffic using bituminous Mixture No. 1100, 20A, Standard Specification 7.10.06. Prior to placing the bituminous mixture, the edge of the repair shall be trimmed to a neat periphery. The bituminous material shall be compacted by mechanical or hand methods suitable for the size hole being filled. The bituminous mixture shall be compacted while hot. If cold patch material is used as temporary repair, it shall be removed prior to placing the hot mix. Bituminous and other materials removed from the shoulder shall be disposed of by the Contractor as directed by the Engineer.

OPEN TO TRAFFIC

Traffic shall not be allowed on the completed repair for at least 1-1/2 hours after the material has been placed, unless otherwise approved by the Engineer.

METHOD OF MEASUREMENT

Joint Spall Repair will be measured parallel to the transverse joint in linear feet.

Patching material will be measured in cubic feet of material used as determined by bag count. Deduction will be made for excess waste as determined by the Engineer.

BASIS OF PAYMENT

Joint Spall Repair will be paid at the contract unit price per linear foot. Payment for Joint Spall Repair includes all labor, equipment, and material (with the exception of the patching material) required to complete the joint spall repair.

Patching material will be paid for at the contract unit price per cubic foot.

Bituminous material used for shoulder repair or regrading or trimming of the bituminous surface will not be paid for separately.

Replacement of Neoprene Contraction Seals will be paid for as provided under the Special Provisions for Replacement of Neoprene Contraction Joint Seals contained in this proposal.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS
FOR
SAWING AND SEALING LONGITUDINAL PAVEMENT JOINTS

SCOPE

This work includes all labor, equipment, and material required to saw and seal existing longitudinal concrete pavement joints.

All work and materials shall be in accordance with the 1984 Standard Specifications with the exceptions and additions specified herein.

The longitudinal joints shall be resawed to the dimensions specified, cleaned, and sealed with a hot-poured joint sealant as directed by the Engineer.

SAWING

The existing longitudinal joints shall be sawed to a depth of 1" to 1-1/4" and a width of 1/4" to 3/8". Immediately following the sawing operation, the joint groove shall be flushed with water of sufficient pressure to remove the slurry and debris from the joint groove.

The longitudinal joints shall be sawed prior to resealing the intersecting transverse joints.

JOINT SPALL REPAIR

All spalls along the joint which are directed by the Engineer to be repaired, shall be repaired as specified under the Special Provisions for Joint Spall Repair contained in this proposal.

CLEANING AND SEALING

The joints shall receive a final cleaning, just prior to sealing, as specified in Sub-Section 4.50.21. The hot-poured sealant shall be Sealtight Sof-Seal as manufactured by W. R. Meadows, Inc., Crafcro Roadsaver Brand Type 231 as manufactured by Crafcro, Inc., or High Performance Joint and Crack Sealer, Product No. 9032 as manufactured by Allied Materials Corp.

The method of sealing the joint groove shall be as specified in Sub-Section 4.50.22-c. The joint groove shall be filled with the sealant to a depth of 1/8" below the surface of the pavement.

The longitudinal joint groove shall be sealed prior to resealing the intersecting transverse joint grooves.

METHOD OF MEASUREMENT

Sawing and Sealing Longitudinal Pavement Joints will be measured in linear feet.

BASIS OF PAYMENT

Sawing and Sealing Longitudinal Pavement Joints will be paid for at the contract unit price per linear foot.

Payment for this item will include all labor, equipment, and materials required to saw the joint groove, clean the joint groove, and seal the joint groove with a hot-poured sealant.

Joint Spall Repair and Patching Materials will be paid for as provided in the Special Provisions for Joint Spall Repair contained in this proposal.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS
FOR
SEALING TRANSVERSE OPEN CRACKS
WITH HOT-POURED SEALANT

SCOPE

This work includes all labor, equipment, and material required to rout, repair spalls, clean, and seal transverse cracks with hot-poured joint sealant.

All work and materials shall be in accordance with the 1984 Standard Specifications with the exceptions and additions specified herein.

The location of the cracks to be sealed will be as shown in the proposal, on the plans, or as directed by the Engineer.

CRACK ROUTING

All cracks which are less than 7/8 inch in width shall be routed to a minimum width of 7/8 inch and a minimum depth of 1-1/4 inches. The cracks shall be routed with a vertical spindle router or a random crack saw equipped with a diamond blade.

CRACK SPALL REPAIR

Spalls along the crack faces which are more than 2 inches in width shall be repaired in accordance with the Special Provisions for Joint Spall Repair. A flexible form material such as polyethylene foam covered with polyethylene film will be necessary to conform to curved portions of the routed crack.

CRACK CLEANING

Just prior to sealing, the top 1-1/4 inches of both faces of the crack shall be sandblasted to remove all contamination and texture the surface. After sandblasting, the crack shall be cleaned with oil-free compressed air to remove all loose debris and residue.

CRACK SEALING

A backer rod consisting of a solid round heat resistant polyurethane foam with a density of 2-4 lb/cu ft shall be inserted into the crack to form a reservoir at the surface of the pavement, as shown on the Special Details sketch if the crack is wider than 3/8 in. The backer rod is optional for the smaller cracks.

The reservoir above the backer rod shall be filled to a level 1/4 inch below the surface of the pavement with a hot-poured sealant as specified in Sub-Section 4.50.22-c of the 1984 Standard Specifications. The hot-poured sealant shall be Sealtight Sof-Seal as manufactured by W. R. Meadows, Inc., Crafcro Roadsaver Brand Type 231 as manufactured by Crafcro, Inc., or High Performance Joint and Crack Sealer, Product No. 9032 as manufactured by Allied Materials Corp.

METHOD OF MEASUREMENT

Sealing Transverse Open Cracks with Hot-Poured Sealant will be measured in linear feet.

Crack Spall Repair and Patching Material will be measured as provided in the Special Provisions for Joint Spall Repair contained in this proposal.

BASIS OF PAYMENT

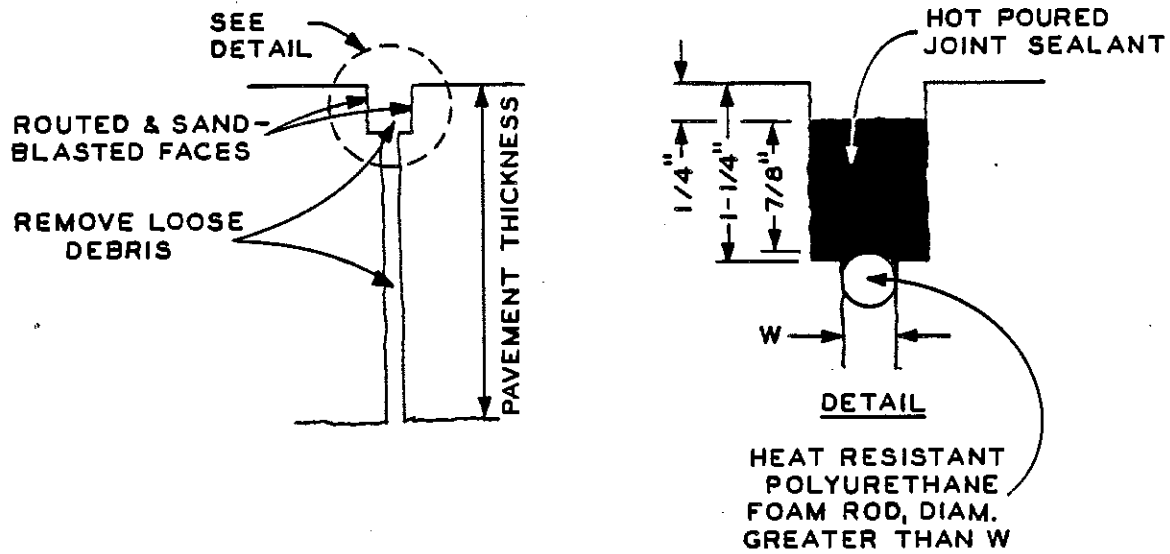
Sealing Transverse Open Cracks with Hot-Poured Sealant will be paid for at the contract unit price per linear foot.

Payment for this item will include all labor, equipment, and materials required to rout, sandblast, clean, and seal the cracks.

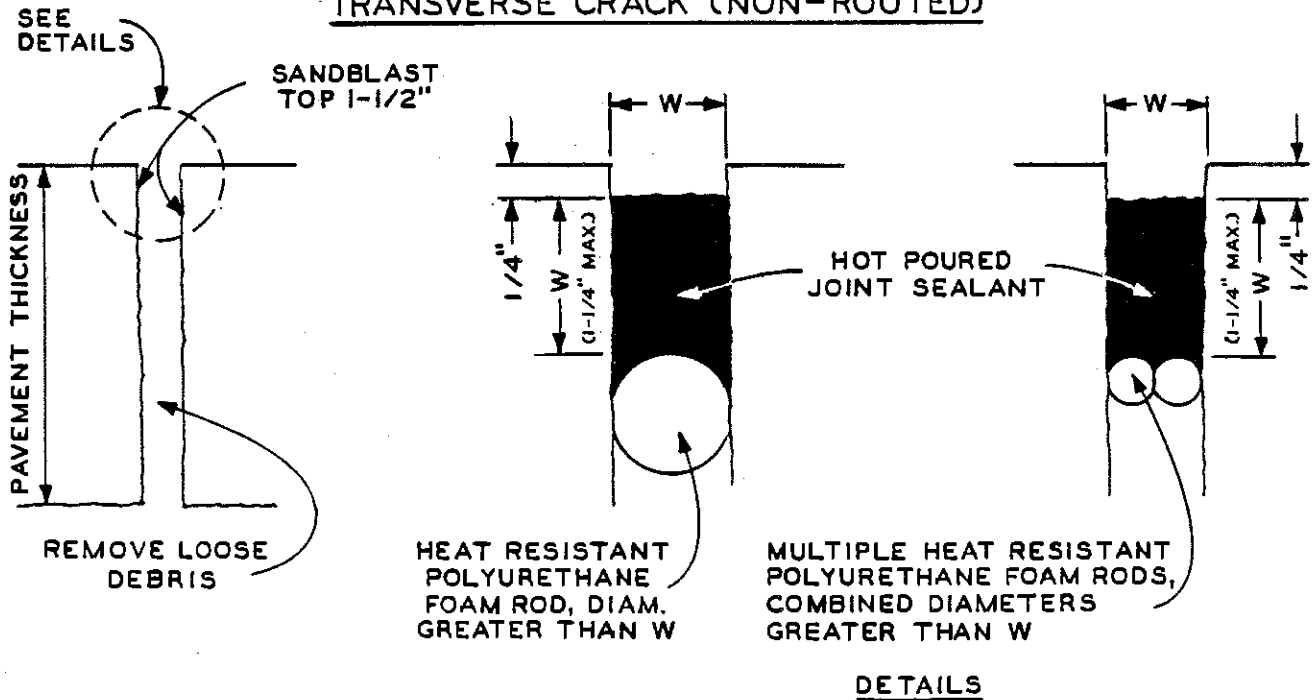
Crack Spall Repair and Patching Materials will be paid for as provided under the Special Provisions for Joint Spall Repair included in this proposal.

Special Details for Sealing Transverse Open Cracks
With Hot Poured Joint Sealant

TRANSVERSE CRACK (ROUTED)



TRANSVERSE CRACK (NON-ROUTED)



MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS
FOR
REPLACEMENT OF NEOPRENE CONTRACTION JOINT SEALS

SCOPE

This work includes all labor, equipment, and material required to replace all neoprene contraction joint seals within the project limits.

All work and materials shall be in accordance with the 1984 Standard Specifications with the exceptions and additions specified herein.

All existing contraction joints in the mainline pavement, ramps, and ramp tapers shall be resealed with a preformed neoprene joint seal, unless otherwise directed by the Engineer.

EXISTING JOINT SEAL REMOVAL

All existing neoprene joint seals shall be removed from the joint grooves. To facilitate removal, the existing seal may be cut at the edge and centerline of the pavement.

All waste material shall be disposed of by the Contractor as directed by the Engineer.

JOINT SPALL REPAIR

Prior to resealing, all spalls along the joint shall be repaired as specified in the Special Provisions for Joint Spall Repair contained in this proposal.

JOINT GROOVE PREPARATION

Prior to resealing, a 1-1/2' by 1-1/2' full depth section of the shoulder at the end of the joint groove shall be removed. Any neoprene seal still remaining in the vertical joint groove shall be removed. The horizontal joint groove shall be cleaned by mechanical wire brushing and with any other tools required to remove all debris from the joint groove. The vertical edge groove shall be cleaned with hand tools as required to remove all debris. The joint groove (including the vertical groove) shall receive a final cleaning with compressed air to remove all loose debris in the joint groove and in the crack below the groove.

JOINT SEALING

Immediately after the final cleaning, the joint groove shall be sealed with a 1-1/4" preformed neoprene contraction seal conforming to Standard

Specification 8.16.04-c. The seal shall be installed as one continuous piece extending from the bottom of the pavement at one edge up to the surface, and across the entire pavement (including connected ramps) to the bottom of the pavement at the opposite edge. When the transverse joint is adjacent to curb and gutter, the seal shall not extend down the pavement edge, but shall terminate at the pavement edge.

This process will necessitate coiling the seal at the centerline, switching traffic into the lane sealed, and then completing the sealing operation.

The seal may be installed with a hand roller or with an installation machine provided that the method used does not stretch the seal by more than 5 percent or compress the length of the seal more than 2 percent. A lubricant-adhesive conforming to Standard Specification 8.16.04-d shall be used to install the seal regardless of the method used.

The top of the installed seal shall be $1/4" \pm 1/8"$ below the surface of the pavement and shall be free of any excess lubricant-adhesive. Any void that may exist at the longitudinal joint adjacent to the transverse joint seal shall be sealed using a polyurethane sealant meeting Federal Specification TT-S-00230C, Type II.

The joint groove shall be resealed within two working days from the time of removing the original seal. At the Contractor's option, a temporary seal capable of preventing the infiltration of foreign material into the joint groove may be used, provided that the permanent seal is installed prior to the winter season.

SHOULDER REPLACEMENT

The shoulder shall be restored to the existing line and grade before opening to traffic using bituminous Mixture No. 1100, 20A, Standard Specification 7.10.06. Prior to placing the bituminous mixture, the edge of the repair shall be trimmed to a neat periphery. The bituminous material shall be compacted by mechanical or hand methods suitable for the size hole being filled. The bituminous mixture shall be compacted while hot. If cold patch material is used as temporary repair, it shall be removed prior to placing the hot mix. Bituminous and other materials removed from the shoulder shall be disposed of by the Contractor as directed by the Engineer.

METHOD OF MEASUREMENT

Replacement of Neoprene Contraction Joint Seals will be measured in linear feet, with no allowance made for the vertical edge groove.

Joint Spall Repair and Patching Material will be measured as provided in the Special Provisions for Joint Spall Repair contained in this proposal.

3/23/84

BASIS OF PAYMENT

Replacement of Neoprene Contraction Seals will be paid for at the contract unit price per linear foot. Payment of this item will include all labor, equipment, and materials required to remove the existing seal, prepare the joint, seal the joint, and repair the shoulder.

Joint Spall Repair and Patching Material will be paid for as provided under the Special Provisions for Joint Spall Repair contained in this proposal.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS
FOR
TIGHT NEOPRENE EXPANSION JOINT SEAL
REMOVAL AND JOINT RESEALING

SCOPE

This work includes furnishing all labor, equipment, and materials required to remove the existing neoprene seal, repair existing spalls, resaw the joint groove, and reseal the joint with hot-poured joint sealant.

All work and materials shall be in accordance with the 1984 Standard Specifications with the exceptions and additions specified herein.

The location of tight expansion joint seals to be removed will be as shown in the proposal or as determined by the Engineer.

SEAL REMOVAL

The tight neoprene seal shall be removed without damage to the joint groove. To remove the neoprene seal from the edge groove it may be necessary to remove approximately a 1-1/2' by 1-1/2' full depth section of the shoulder. A single saw cut throughout the length and depth of the joint seal may be required to relieve the pressure and facilitate removal.

All waste material shall be disposed of by the Contractor as directed by the Engineer.

RESAWING - JOINT GROOVE

The joint groove shall be sawed using multiple blades so that all concrete and existing filler are removed from the groove in one cutting operation. The new saw cut shall be centered over the old joint groove to produce a finished joint groove with two freshly sawed faces.

The joint groove shall be cut to a depth of 3" \pm 1/8" and to a width of 1-1/2" \pm 1/16"

Immediately after sawing, the joint groove and pavement area shall be cleaned with high pressure water to remove all slurry and debris.

JOINT SPALL REPAIR

All spalls greater than 2 inches in width shall be repaired as specified in the Special Provisions for Joint Spall Repair contained in this proposal.

JOINT GROOVE PREPARATION AND SEALING

Immediately prior to resealing, the joint groove including the vertical edge groove shall be cleaned to insure that all debris and contamination are removed from the joint groove and joint faces. The cleaning shall consist of sandblasting followed by a final cleaning with oil-free compressed air.

A 2" diameter backer rod, consisting of a solid round heat resistant polyurethane foam with a density of 2-4 lb/cu ft, shall be inserted into the joint groove to form a reservoir 1-1/4" deep at the surface of the pavement. The backer rod shall not extend into the vertical edge groove area. A temporary paper covered end form may be required at the pavement edge.

The reservoir above the backer rod and the vertical edge groove shall be filled to a level 1/4" below the surface of the pavement with a hot-poured sealant as specified in Sub-Section 4.50.22-c of the 1984 Standard Specifications. The hot-poured sealant shall be Sealtight Sof-Seal as manufactured by W. R. Meadows, Inc., Crafcro Roadsaver Brand Type 231 as manufactured by Crafcro, Inc., or High Performance Joint and Crack Sealer, Product No. 9032 as manufactured by Allied Materials Corp.

SHOULDER REPLACEMENT

The shoulder shall be restored to the existing line and grade before opening to traffic using bituminous Mixture No. 1100, 20A, Standard Specification 7.10.06. Prior to placing the bituminous mixture, the edge of the repair shall be trimmed to a neat periphery. The bituminous material shall be compacted by mechanical or hand methods suitable for the size hole being filled. The bituminous mixture shall be compacted while hot. If cold patch material is used as temporary repair, it shall be removed prior to placing the hot mix. Bituminous and other materials removed from the shoulder shall be disposed of by the Contractor as directed by the Engineer.

METHOD OF MEASUREMENT

Tight Neoprene Expansion Joint Seal Removal and Joint Resealing will be measured in linear feet with no allowance for the vertical edge groove.

Joint Spall Repair and Patching Material will be measured as provided in the Special Provisions for Joint Spall Repair contained in this proposal.

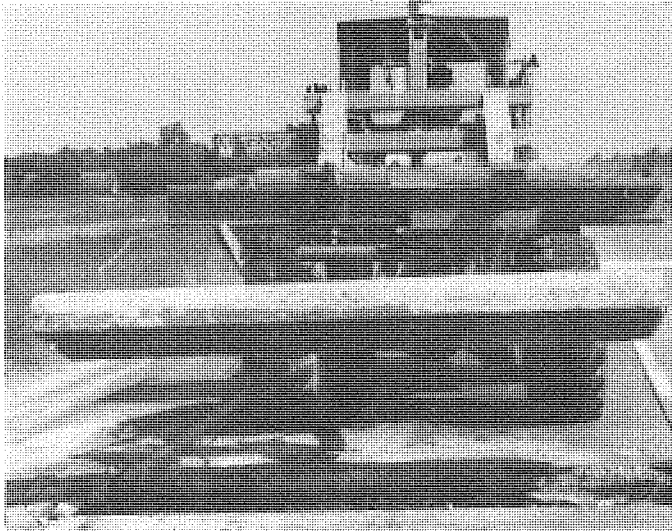
BASIS OF PAYMENT

Tight Neoprene Expansion Joint Seal Removal and Joint Resealing will be paid for at the contract unit price per linear foot. Payment for this item will include all labor, equipment, and material required to remove

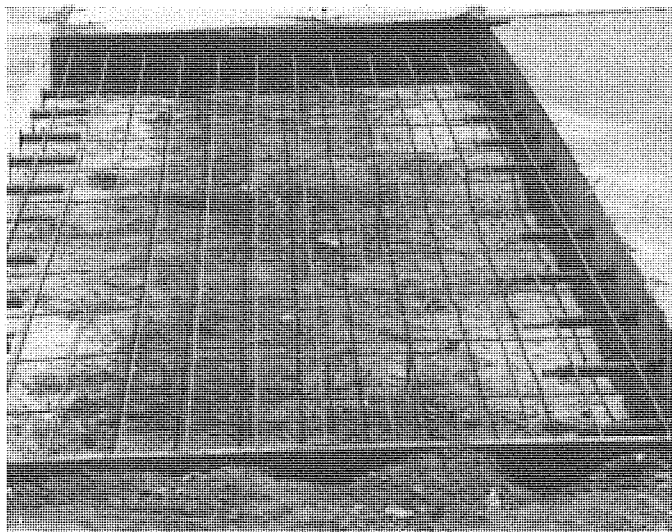
the existing seal, resaw the joint, prepare the joint for sealing, reseal the joint, and repair the shoulder.

Joint Spall Repair and Patching Material will be paid for as provided under the Special Provisions for Joint Spall Repair included in this proposal.

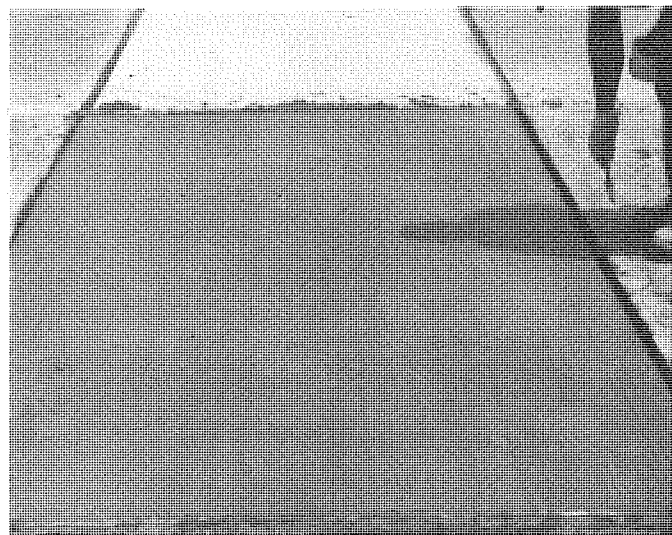
APPENDIX C



◀ Figure 1. Removal of full-depth distressed slab.



◀ Figure 2. Repair area with dowels and reinforcement in place.



◀ Figure 3. Finished concrete repair.

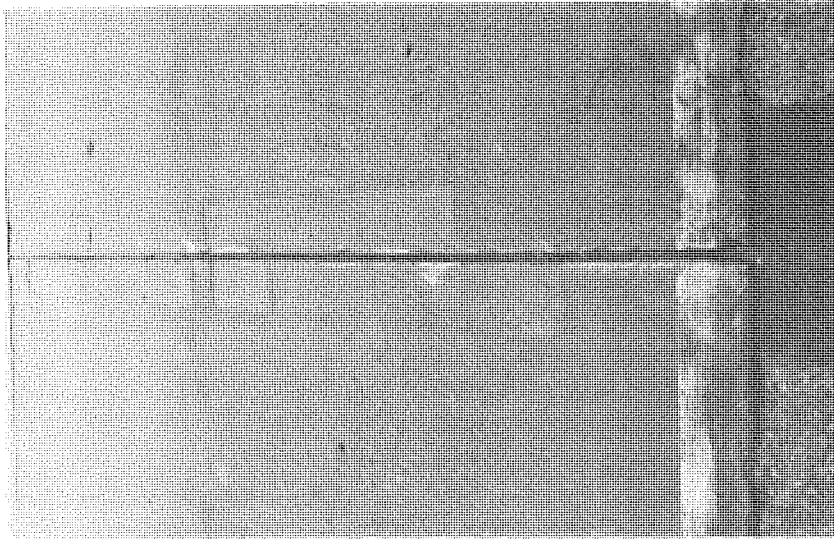


Figure 6. Finished repair along joint groove.

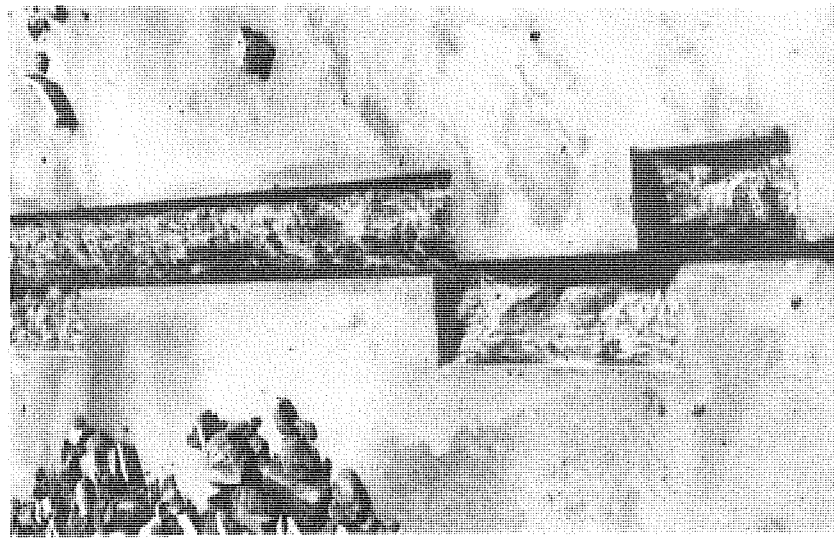


Figure 5. Concrete removed within the sawed repair perimeter.

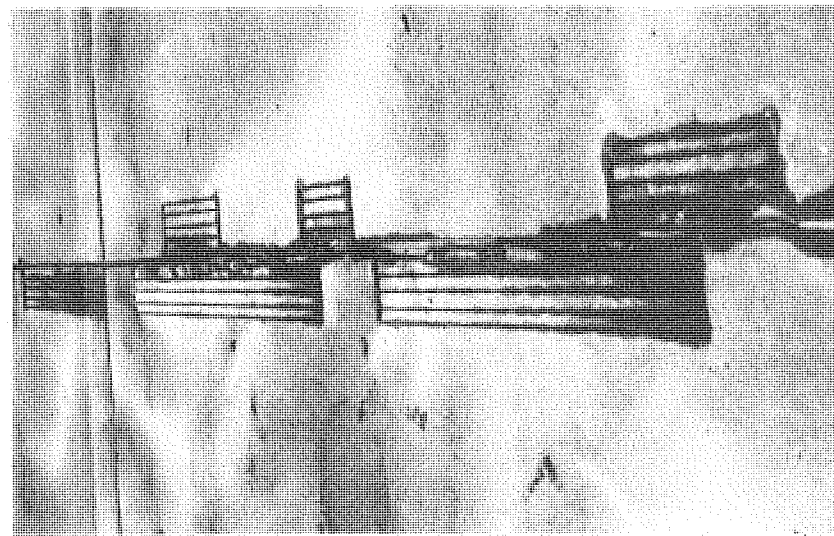


Figure 4. Sawed partial-depth spall repairs.

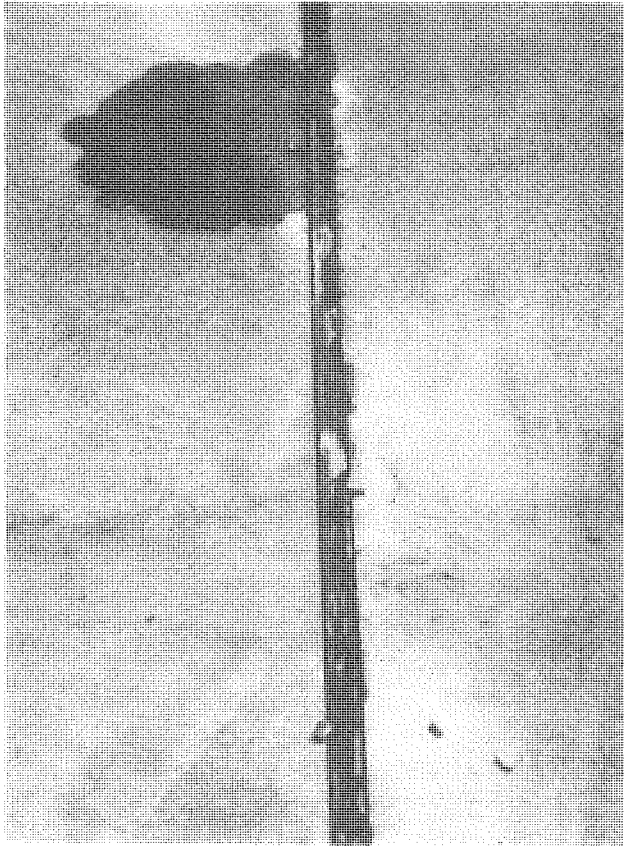


Figure 7. Resawed expansion joint groove.

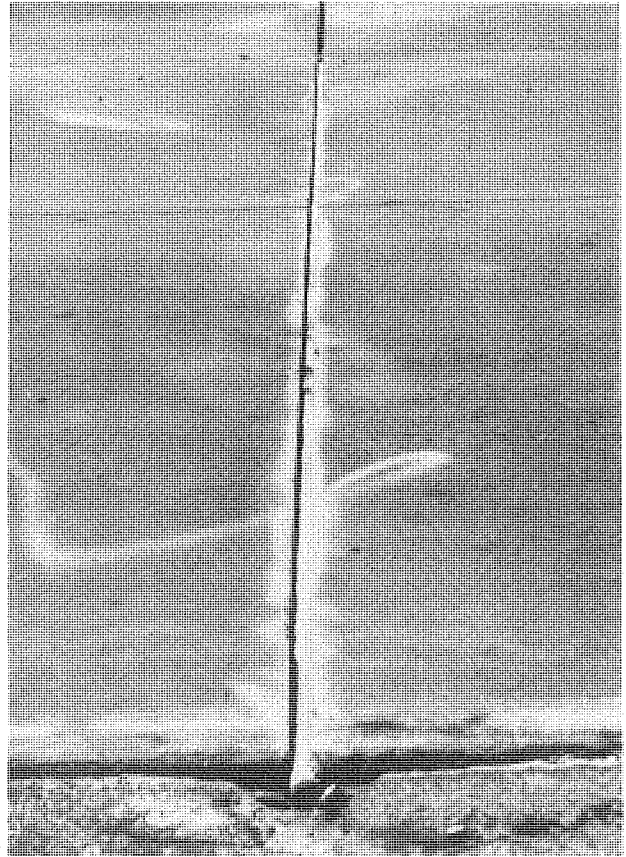


Figure 8. Sandblasted joint groove with foam rod in place.



Figure 9. Sealing expansion joint using a rubber-asphalt sealant.

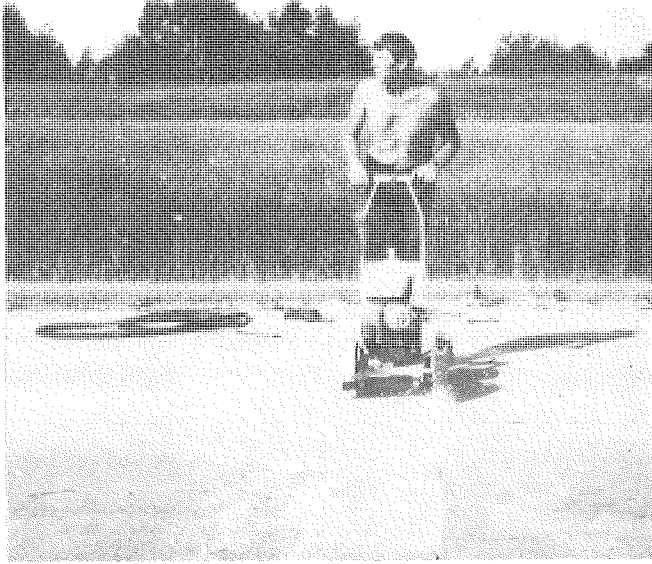


Figure 10. Cleaning contraction joint groove by wire brushing prior to resealing the joint.

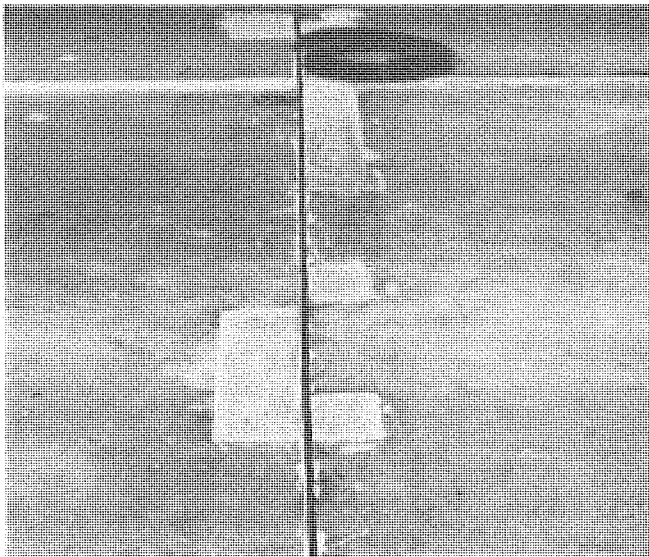


Figure 11. Contraction joint seal installed in one lane and coiled until traffic is shifted onto the sealed lane. Seal installation is then completed in the remaining lane.

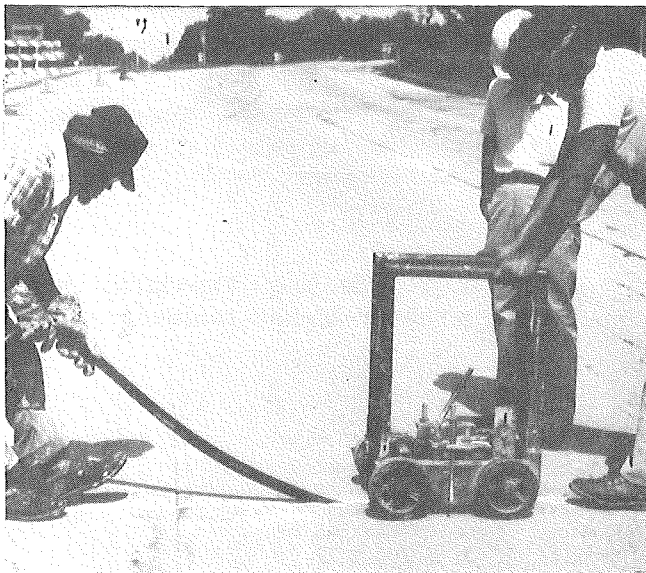


Figure 12. Installing neoprene contraction joint seal using a "skateboard."



Figure 13. Routing transverse crack using a random crack saw.

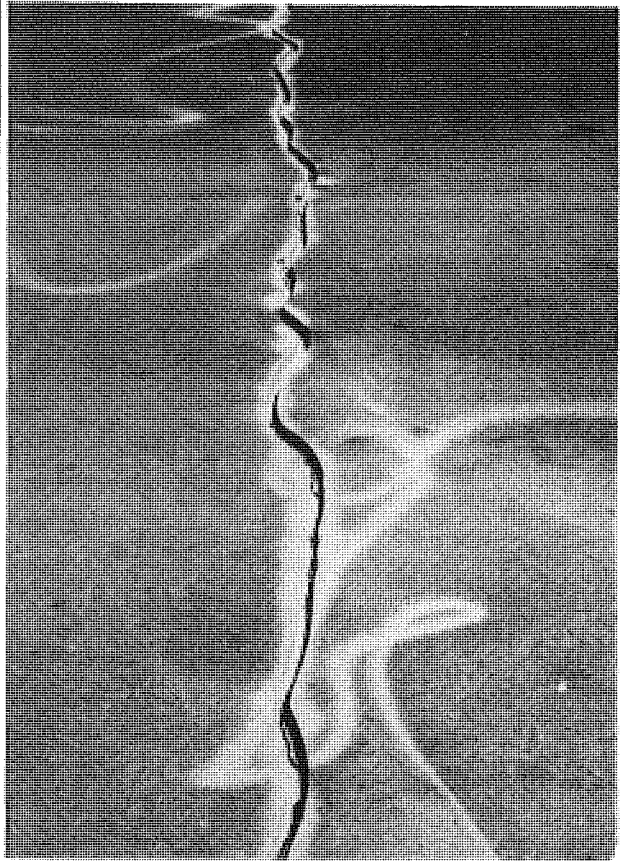


Figure 14. Sandblasted crack ready for sealing.

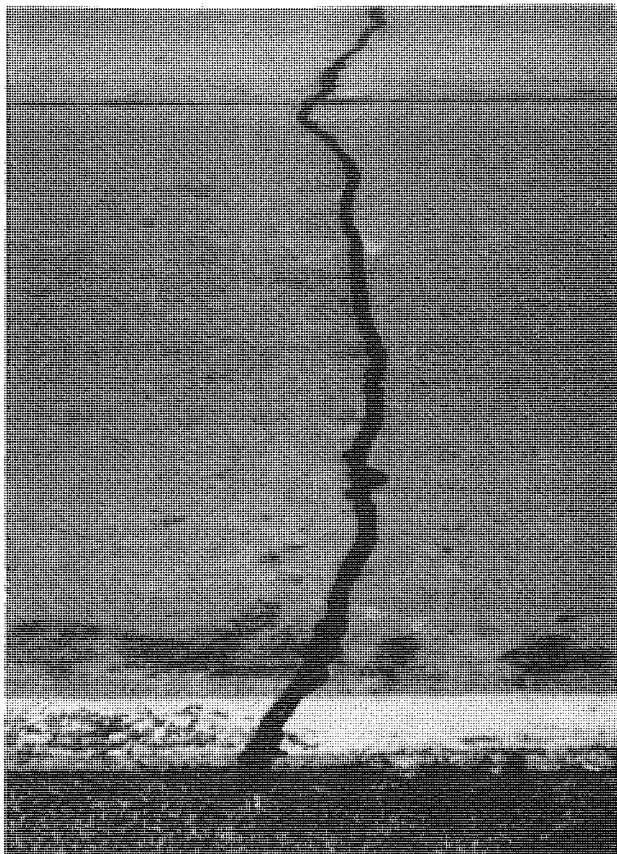


Figure 15. Crack sealed with hot-poured rubber-asphalt sealant.



Figure 16. Resawing longitudinal joint groove.



Figure 17. Installing hot-poured rubber-asphalt sealant in longitudinal joint groove.

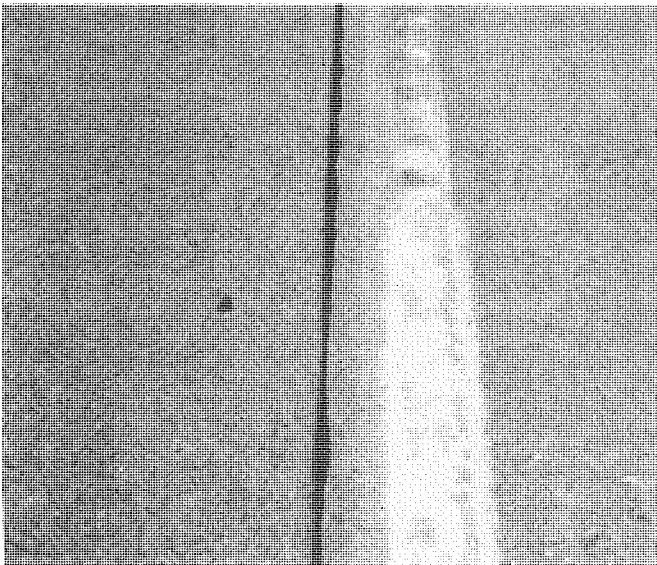


Figure 18. Resealed longitudinal joint.