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# PAVEMENT CRACK AND JOINT SEALANTS

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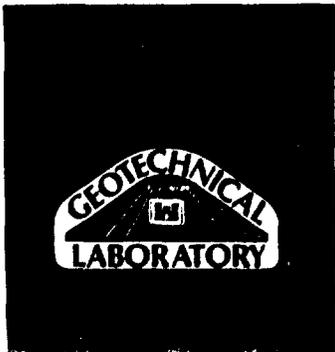
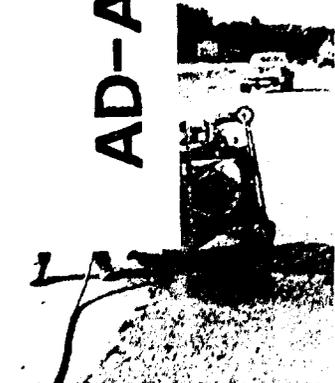
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PREFACE

This project was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the O&MA Program, Facilities Application Technology Tests (FTAT) Demonstration Program FY 85 through FY 88, and was conducted by the Geotechnical Laboratory (GL) of the US Army Engineer Waterways Experiment Station (WES).

The project was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, Geotechnical Laboratory (GL), WES, and under the direct supervision of Mr. H. H. Ulery, Jr., Chief, Pavements Systems Division (PSD), GL; Mr. J. W. Hall, Jr., Chief, Engineering Investigations, Testing, and Validation Group, PSD; and Mr. L. N. Godwin, Chief, Materials Research Center, PSD. The WES FTAT manager is Mr. R. C. Ahlrich. The WES Principal Investigator was Mr. L. N. Lynch, GL. This report was prepared by Mr. Lynch.

Photographic support was provided by Messrs. V. Magee and R. Smith, Information Products Division (IPD), Information Technology Laboratory (ITL). This report was edited by Mrs. Joyce H. Walker, IPD.

COL Dwayne G. Lee, EN, is Commander and Director of WES. Dr. Robert W. Whalin is Technical Director.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)  
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI  
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
Fahrenheit degrees	5/9	Celsius degrees or kelvins*
feet	0.3048	metres
gallons (US liquid)	3.785412	cubic decimetres
inches	2.54	centimetres
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
square yards	0.8361274	square metres

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\* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula:  $C = (5/9)(F - 32)$ . To obtain Kelvin (K) readings, use:  $K = (5/9)(F - 32) + 273.15$ .

## PAVEMENT CRACK AND JOINT SEALANTS

### PART I: INTRODUCTION

#### Background

1. The sealing or resealing of joints and cracks in both portland cement concrete (PCC) and bituminous pavements is a reoccurring maintenance problem for most military installations. The frequency of required resealing projects is dependent upon the sealing procedures used to install the original sealant, the condition of the pavement, type of sealant used, the amount and type of traffic on the pavement, and the climate to which the sealant is exposed.

2. Joint sealants are used to minimize water seepage through pavement joints or cracks into water susceptible subbase or subgrade soils and to prevent joints or cracks from collecting incompressibles. Water seepage into the subbase or subgrade soils can cause a weakening of the pavement structure which can be seen by a pumping action of the pavement. Incompressibles collected in the joint negate the thermal stress relief of the pavement structure which can cause the pavement to spall. Neglecting to maintain pavement joints and cracks can result in premature pavement failures, in turn leading to higher maintenance costs and higher pavement life-cycle costs.

#### Purpose of Report

3. The purpose of this report is to demonstrate the proper procedures for installing various types of hot- and cold-applied sealant materials-- specifically, those sealants which conform to Federal Specifications SS-S-1401C, SS-S-1614A, and SS-S-200E along with a silicone material.

## PART II: SEALING MATERIALS

### Types of Sealants

4. There are three types of pavement joint sealant materials which are covered by Federal Specification. The three sealant materials are (a) hot-applied, nonfuel resistant sealants which are tested to Federal Specification SS-S-1401C, (b) hot-applied, fuel resistant sealants which are tested to Federal Specifications SS-S-1614A and (c) cold-applied, two-component fuel and blast resistant sealants which are tested to Federal Specification SS-S-200E. The silicone sealant that will be discussed in this report is a low modulus silicone sealant.

5. Each type of sealant has a specific use. Sealants conforming to SS-S-1401C are used on roadways, streets, and parking lots. Materials conforming to SS-S-1614A are used in motor pools, maintenance areas, aircraft parking aprons, or any other pavement that is subjected to fuel spillage. In areas subjected to excessive heat, such as blast from aircraft engines, sealants that conform to SS-S-200E should be used. Sealing materials not covered by a Federal Specification, such as silicones, should be considered on a project to project basis. The silicone sealant used in the FTAT projects was installed in two areas--a motor pool area and a heavily traveled roadway.

### Testing of Sealants

6. Testing of joint sealant materials is required to assure that the sealing materials conform to the appropriate Federal Specification so that the use of inferior materials is eliminated.

7. The Corps of Engineers procedure for all construction is for the Contractor to perform quality control and for the Government to perform quality assurance. Quality assurance may involve reviewing the Contractor's test results, observing the Contractor's test procedures, or conducting check tests. For joint sealant materials, it is necessary to test the actual batch or batches of joint sealant materials to be used on a project. The manufacturer's certificate of specification conformance should not be accepted unless

the quantity of joint sealant to be used is less than 50 gal\* or 500 lb. In instances where the manufacturer's certificate of conformance is accepted samples of the joint sealant materials should be retained for future testing, if necessary.

8. Assurance of Federal Specification conformance does not automatically assure a high quality sealing job. Field inspection, the proper equipment, and quality workmanship are still required.

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\* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

### PART III: SEALING AND RESEALING PROCEDURES

#### Equipment Required

9. The equipment required to properly prepare and seal or reseal a joint or crack consists of the following:
- a. Tractor-mounted routing tools or plows (Photo 1) allow for easy removal of the old sealant from PCC for resealing projects. The plow should be approximately 1/8 in. smaller than the joint width to prevent spalling of the PCC.
  - b. A vertical spindle router (Photo 2) serves two purposes--to remove old damaged sealant material and to enlarge random cracks to the proper width and depth, normally 1/2 by 1/2 in.
  - c. Self-propelled concrete saws are used to reface joint walls (Photo 3) or to cut out deteriorated joints for reconstruction. The concrete saw is also used to cut joints to the correct depth and width in sealing projects. The correct depth and width will be given in the contract design drawings.
  - d. Sandblasting equipment (Photo 4) is used to remove from the joint walls foreign residue such as laitance, dirt, oil, curing compounds, etc. that will hinder the sealants adhesion properties and performance.
  - e. Hot-pour sealant equipment (Photo 5) consists of a double-boiler, agitator-type kettle, and a nozzle shaped to fit inside the joint. The equipment should be capable of circulating the sealant material back into the kettle when not in use.
  - f. Cold-applied two-component sealing equipment (Photo 6) should be equipped with an agitated reservoir for each component. The equipment should be capable of consistently delivering the semifluid components to the portable mixer head at a given preset ratio.
  - g. Silicone sealing equipment (Photo 7) consists of an extrusion pump to transfer the sealant material to the joint and an air compressor to aid in the removal of the sealant from its storage container. Most silicone manufacturers recommend the use of teflon-lined hoses to prevent moisture intrusion into the system.
10. All equipment should be inspected prior to beginning work to ensure that it meets the specifications and is in proper working condition. Equipment specifications are usually spelled out in the contract specifications. Department of the Army, Office, Chief of Engineers CECS-02583 (1988) can also be helpful when inspecting equipment.

## Joint Preparation

11. Joint preparation is the beginning phase of any joint and crack sealing or resealing project. The procedures for joint preparation are the same, regardless of the type sealing material used. If care is not used during this phase of the project, the overall quality of the project will suffer.

12. Joints or cracks in the pavement that have never been sealed must first be sawed or routed to the desired depth and width. The joint should be deep enough to accommodate a backing material and should be between  $3/8$  and  $3/4$  in. wide. Random cracks that are  $3/4$  in. or wider should not be widened. Instead, they should be sandblasted and cleaned. Random cracks that are between  $1/2$  and  $3/4$  in. may be routed to approximately  $7/8$  in. or simply sandblasted and cleaned. Cracks that are between  $1/4$  and  $1/2$  in. should be routed to approximately  $5/8$  in. If the random cracks are smaller than  $1/8$  in., engineering judgment must be used on what method of correction should be taken. If the crack is in a bituminous pavement, a fog seal could be used. If the crack is in PCC, it might be feasible to not seal the crack until regular maintenance warrants corrective measures.

13. To remove debris left by the saw, the joint will need to be sandblasted or waterblasted. It is easier to flush the joint with water immediately after sawing to remove all laitance. Sandblasting is generally used after the water used during the sawing operation has dried. A multiple pass technique with the nozzle close to the joint wall (Photo 8) yields the best cleaning results when sandblasting. Approximately 1 in. on both sides of the joint will also require sandblasting to ensure no bond breaking debris will contaminate the joint. The sandblasting must be done on the same day that the joint will be sealed. This is to ensure clean surfaces for the sealant to be placed against.

14. Resealing requires the old sealing material to be removed. One of the easiest methods for removing old sealants from joints is with a tractor-mounted plow. The plow should fit inside the joint without chipping the joint wall. Plows that are "V-shaped" (Photo 9) should not be allowed on the job-site. Plows that are V-shaped cause chipping and spalling of the concrete which is detrimental to the pavement and could also result in premature sealant failure.

15. Vertical rotary routers can be used with ease to remove old sealant from random cracks. To prevent spalling and cracking of the pavement, impact routers should not be used.

16. The residual joint sealant left in the joints or cracks after plowing or routing must be removed or it will act as a bond breaker between the pavement and the sealant. Adhesion failures caused by bond breakers allow moisture and debris to accumulate in the joint. Multiple-pass sandblasting techniques, as previously described, are normally the best methods for removing the residual sealant and debris. In some areas, sandblasting may not be allowed because of environmental reasons. If sandblasting is not allowed, waterblasting or wirebrushing may be used. When waterblasting is used, the joint must be allowed to dry before the sealant is installed. When wirebrushes are used, care must be taken to ensure that the residual joint sealant material is removed instead of "smeared" on the joint walls.

17. When the sandblasting operation is completed, all sand and debris must be removed from the joint (Photo 10). This is accomplished by cleaning with compressed air. The air cleaning operation should precede the sealing operation by 200 to 300 ft. Keeping the sealing operation close to the cleaning operation ensures all debris has been removed prior to sealing and none has been allowed to blow back into the joint.

#### Backer Rods and Bond Breaking Tapes

18. Backer rod materials are compressible, nonabsorptive materials that are placed in joints to maintain the proper depth-to-width ratio (shape factor) of the sealant reservoir and to prevent three-sided adhesion of the joint sealant material. Bond breaker tapes are materials that are placed in joints where the shape factor is satisfactory without the use of backer rod materials. The tapes also prevent three-sided adhesion.

19. The proper shape factor is 1.0 to 1.5. A shape factor in this range should keep the internal stresses in the sealant material small enough to prevent cohesion failure, a splitting of the sealant material, or adhesion failure--a breaking of the bond between the sealant and the concrete.

20. Three-sided adhesion of a joint sealant material is the material's adherence to both walls of the joint and to the bottom of the joint. Three

sided adhesion causes stresses to become so great in the material that it has cohesion failure, as shown in Photo 11.

21. Along with being compressible and nonabsorbitive, backer rod materials and bond breaker tapes should be nonshrinking, nonstaining, and nonreactive with the joint sealant. The materials should have a melting point at least 5° F higher than the pouring temperature of the sealant. The diameter of the backer rod material should be 25 percent larger than the nominal width of the joint. The bond breaker tape should be 1/8 in. wider than the nominal width of the joint. The larger sizes ensure that the materials will not move during the application of the sealant.

22. The backer rod or bond breaker tape should be placed in the joint immediately behind the air cleaning operation and immediately prior to the sealing operation (Photo 12). The placement of the material in this manner helps prevent debris from collecting in the joint before the sealant is installed. The materials should be inserted in such a manner that they are not twisted, torn, or stretched.

23. The equipment shown in Photo 12 inserts the backer rod material to the predetermined depth without tearing the material. Most equipment that is used to insert the backer rod material is made by the individual contractors, but usually consist of a wheel to push the backer rod into the joint and rollers to adjust the depth of the wheel in the joint.

#### Sealant Application

24. Hot-applied sealants, both those conforming to SS-S-1401C and SS-S-1614A, are heated in a double-boiler, agitator-type kettle with an oil medium for heat transfer. The double-boiler allows uniform heating of the sealant material. Direct heating of the sealant creates hot spots in the material which lead to inferior sealing results. The sealant material is transferred from the kettle to the joint by an extruding device fitted with a nozzle that can be inserted into the joint. It is important that the nozzle fits into the joint so that the joint can be filled from the bottom to the top. Excessive bubbling is caused when the sealant is gravity-fed into the joints; therefore, gravity installation of sealants should never be allowed. The bubbling creates an unsightly finish and also may cause premature sealant failure. No material should be subjected to the application temperature for

over 3 hr. Any material that has been heated above the manufacturer's recommended safe heating temperature, heated at the application temperature over 3 hr, or remains in the applicator equipment at the end of a day's production should be wasted to prevent defective material from being placed during the next working day. If any bubbling or other irregularities are noticed, work should be stopped until the problem is corrected.

25. Cold-applied, two-component sealants are more difficult to apply due to the nature of two-component materials. Each component is placed in mechanically agitated reservoirs. The components are delivered from the reservoirs to a portable mixer located at the nozzle. The two components are delivered to the mixer in a 1:1 ratio (by volume) for uniform mixing. The delivery lines from the reservoirs should be operated independently of one another so that the machine can be calibrated. The machine is calibrated by collecting a known volume of one component and measuring the time required to collect the material. The second component is collected in the same manner and the results compared. Differences between the measurements are corrected by adjusting the delivery pressure of the components. It is important that a 1:1 ratio be maintained. Failure to do so will result in a sealant that is brittle or one that does not properly cure. To ensure proper curing of the two-component sealant, a trial section of approximately 400 ft can be required. After curing, the sealant can be examined for any defects.

26. The nozzle of the two-component machine must fit inside the joint (Photo 13) to allow the joint to be sealed from the bottom to the top in the same manner as the hot-applied sealants. The speed of the operator must be slow and consistent to prevent air entrapment in the joint. Air entrapment will reduce the effectiveness of the sealant by creating voids in the sealant and reducing the effectiveness of the sealant bond to the joint wall.

27. Silicone sealants are transferred from their storage container to the joint by an extrusion pump. The joints should be filled from the bottom to the top as with the other sealants, using the same precautions to prevent air entrapment.

28. The hot-applied and cold-applied two-component sealant materials, in general, are self-leveling and therefore tooling is not required after placement. Silicone sealants generally are not self-leveling and therefore must be tooled to smooth the sealant surface and to ensure bonding between the sealant and the concrete. Tooling of a sealant is pulling a small object,

such as a piece of backer rod material, along the surface of the sealant (Photo 14). The tooling forces the sealant against the sides of the joint increasing the bonding properties.

29. All sealant materials should be placed in the joints so that the top of the sealant is approximately 1/4 in. below the surface of the pavement. The placement of the joint sealant in such a manner allows the pavement to expand without forcing the sealant out of the joint. The depth below the pavement surface that a sealant should be placed is dependent upon the atmospheric temperature, where the sealant is being placed, and the type of sealant being used. In general, 1/8 to 1/4 in. below the pavement surface is acceptable.

30. Work should be discontinued during inclement weather (i.e. rain) and should not be allowed to resume until the joints have been recleaned and are dry. Air blowing of the joints is usually sufficient for recleaning; however, the joints should be inspected to determine if further cleaning or sandblasting is required since rainfall runoff can be muddy and carry organic materials.

31. All joint sealing equipment should be cleaned at the end of each day's work. Cleaning the equipment prevents sealant material from curing in the lines, causing downtime and contaminated sealant the following day.

#### PART IV: SEALING AND RESEALING INSPECTION

32. Inspection of all steps in a sealing or resealing project is required to ensure that the procedures are being performed in a high quality manner at all times. This means an inspector must be present on the jobsite any time work is being performed.

##### Equipment

33. Before work begins, the inspector should evaluate all equipment and materials for damage. The materials should be checked to see if they are the materials that have been specified and tested. If different size backer rods or bond breaker tapes are required, they should be at the jobsite at this time.

34. Equipment inspection should be conducted with the equipment in use. This can be accomplished by requiring the contractor to install a test section of 400 lin ft. This also allows the sealant to be examined in the field. Any procedural problems can be corrected at this time.

35. The guidelines listed below will aid the inspector in evaluating the equipment and its operation thoroughly and intensively.

- a. The joint plow should be supplied with sufficient cutting tools (plows) of various widths to accommodate any width joint that may be encountered. The plows must be rectangular to prevent pavement spalling and chipping. The use of V-shaped plows is not acceptable. The mounting assembly should have some mobility in both the vertical and lateral directions. This will help prevent pavement spalling. If spalling or chipping of the concrete cannot be controlled, another operator should be used or the equipment disapproved.
- b. The vertical spindle router should be supplied with a sufficient number of bits of various diameters for the cracks present in the pavement. The router must be maneuverable to allow easy following of the crack without spalling the pavement. This equipment is also operator-dependent; therefore, if spalling persists, the operator should be changed or the equipment should not be approved.
- c. The concrete saw should be self-propelled, capable of having more than one blade on the same arbor, and have a water supply to cool the blades while in use. The blades must be on the same arbor and be spaced so that a joint of the specified depth and width is produced. The depth and width of the joint should be uniform at all points along the joint. A saw that is unable to produce a straight uniform cut should not be approved.

- d. All pressure gages on the sandblasting equipment should be checked when work begins to ensure proper line pressures are being maintained. The traps on the lines should also be examined to prevent oil and water from contaminating the compressed air. The same air compressor is usually used for both the sandblasting and air cleaning; therefore, once the compressor has been approved for sandblasting, it is also approved for air cleaning. If a different air compressor is used for air cleaning the same considerations apply.
- e. There are basically two types of hot-applied joint sealant applicator equipment--those designed to apply sealants that are shipped in solid form and must be heated up to application temperature and those designed to apply liquid polymer sealants that heat only a small portion of the material at a time. The two types of equipment are not interchangeable. The solid joint sealant applicator has a heated reservoir with an agitator that aids in keeping the material uniformly heated. The circulation pump in the heat transfer oil jacket must be operating correctly to prevent hot spots. The temperature gages should be calibrated and should be easy to read when in place on the equipment. There should be a minimum of two on the application equipment--one to measure the temperature of the heat transfer oil and one to measure the temperature of the sealant. It is also beneficial to have a temperature gage in the dispensing line or nozzle to ensure there is not a temperature loss to below the pouring temperature of the sealant during application. The sealant recirculation system must also be inspected before work begins. The liquid polymer applicator equipment stores the material in an unheated reservoir. The sealant is pumped from the reservoir through a series of tubes located in a heated oil bath. The oil bath heats the joint sealant to the specified temperature before installation. The temperature gages must also be checked and visible for easy reading. The liquid polymer equipment is not designed to recirculate the sealant. Both types of equipment require a competent operator to control the sealing nozzle and apply the sealant correctly. The time required to bring the equipment to sealant application temperature should also be noted. The pouring temperature and safe heating temperature of the joint sealant material are supplied by the manufacturer.
- f. Two-component, cold-applied sealant applicators have two separate reservoirs to inspect. Each reservoir will have pressure gages and pumps that should be examined. The critical component of the equipment is the mixing head at the dispensing nozzle. To determine if the correct amount of each component of joint sealant material is being delivered to the mixing head, a timed sample of each must be collected in separate cans and weighed. The ratio of the components should be compared with the manufacturer's recommendations.
- g. Silicone sealant applicators have an extruder pump that transfers the material to the joint. All pressure gages and water traps should be examined to ensure that they are working

properly. The water traps should be located on the air lines between the air compressor and the application equipment.

#### Joint Preparation

36. The acceptance of the equipment and procedures used for the test section does not eliminate the need for inspection during the actual work. Each phase must be monitored to ensure a high quality job.

37. The overall condition of the pavement before the project begins should be noted by the inspector so that spalling or chipping of the pavement caused by the removal of old joint sealant or the saw cutting of the joints can be detected. During the old sealant removal and saw cutting, the joints should be checked for depth, width, and straightness. An easy check for joint width and depth is to obtain a template that has the same measurements as the joint with the tolerances included. Any place in the joint where the template cannot be inserted perpendicularly should be resawed to meet the specified values.

38. Sandblasting and air cleaning of the joint is one of the most critical steps in a sealing or resealing job. If the joint is not clean, premature joint sealant failure will occur. The joint can be checked by wiping a finger along the wall of the joint. If any dust is detected, the joint must be sandblasted and air cleaned again. A dental mirror and clipboard are also beneficial when inspecting joints. The clipboard is used to shadow the mirror from the sun as the side of the joint is examined for residual sealant and other debris. Moisture in the joint can also be determined when examining for cleanness. If a joint appears moist anywhere along its length, the joint should not be sealed until it has been airblown dry.

39. Immediately following the cleaning operation, the backer rod or separating material should be inserted into the joint. Care must be taken not to twist or stretch the material. The backer rod or separating material must fit firmly in the joint and must be able to maintain the required sealant reservoir. If the backer rod or separating material does not comply with the above requirements, it should be replaced with a different size material. The type of backer rod or separating material, once it has been approved, should not be changed during the project without the approval of the Contracting Officer.

## Sealant Application

40. The sealing operation should also be monitored closely. When applying hot-applied sealants, the temperature should be checked at regular intervals. Hot-applied sealants that are heated at the application temperature for longer than 3 hr, or have been heated above the safe heating temperature as recommended by the manufacturer, should be wasted. Two-component sealing equipment should be checked daily to ensure the correct amount of each component is being used.

41. All joints should be filled from the bottom to the top and the sealing nozzle should be moved along slowly to prevent air entrapment. If bubbling does occur, the sealing operation should be discontinued until the cause has been corrected. The sealant material should be applied to a depth no less than 1/8 in. below the surface of the pavement and to a depth of 1/4 ± 1/8 in. on roadways and areas that will experience tracked-vehicle traffic. Joints should never be overfilled. The overfilling of joints can cause the sealant to be tracked onto the pavement and damage the sealant. Hot putty knives or other suitable devices should be used to remove any spillage or overfilling.

42. When the joint sealant has become tack-free, several joints should be examined for bonding. The amount of time required for the sealant to become tack-free is dependent on weather conditions and the properties of each sealant. An estimate of the time required can be found in the manufacturer's literature. If properly bonded, fingertips can be pulled lightly across the sealant without the sealant separating from the joint walls. If the sealant is easily separated from the joint wall, then the joint wall should be examined for dust and debris. The sealant should also be checked to see if it is curing properly. This can be accomplished by puncturing the sealant with a pin; if sealant adheres to the pin, the sealant has not completely cured. The amount of time required for curing can also be found in the manufacturer's literature. All sealant that pulls loose from the joint wall, has excessive bubbling, or has not cured correctly should be removed and replaced before final acceptance of the job.

43. The atmospheric temperature near the pavement surface should be at least 50° F and rising before sealing operations begin. Work should be

suspended if the temperature starts falling below 50° F.

#### Joint Reconstruction

44. Joints that have deteriorated excessively (similar to those in Photo 15) should be reconstructed before they are resealed. The sealing of such joints without reconstruction will only slightly retard the deterioration process. Joints that have been resealed several times and are wider than 1 in. should also be reconstructed. Joints that are 1 in. or wider place too much stress on the sealant material, causing cohesion failures, as noted in Photo 16.

45. To repair the defective concrete, a concrete saw, like the one used to reface joint walls, is used to cut around the defective area (Photo 17). The defective concrete is then removed using a jack-hammer (Photo 18) or similar suitable means. To ensure all of the defective concrete has been removed, a minimum depth of 3 in. should be removed. The width of concrete removal should be 3 to 5 in. wider than the defective area.

46. Once the defective concrete has been removed to expose sound concrete, the area is sandblasted and air cleaned (Photo 19) to remove all loose debris. The procedures used to sandblast and clean are basically the same as those used in joint preparation. After the final cleaning, a primer material is applied so that the concrete or epoxy patch material will bond to the old concrete. A filler material, as shown in Photo 20, is used to maintain the integrity of the joint (i.e., provide the correct width for the joint). The finishing work is accomplished using standard finishing techniques and then the curing compound is applied.

47. The filler material used in the joint is sawed out using a concrete saw after the concrete or epoxy patch has cured. The joint is then ready to be cleaned and sealed as previously described.

48. The material used to repair the spalled concrete or the deteriorated joint could be an epoxy-resin grout, mortar, or concrete. The advantages, disadvantages, and the construction procedures for each material can be found in Headquarters, Departments of the Army and the Air Force TM-5-822-9-AFM 88, Chapter 10, 1978.

## REFERENCES

Department of the Army, Office, Chief of Engineers. 1988(Mar). "Field Molded in Sealants for Sealing and Resealing Joints in Concrete Pavements," CEGS-02583, Washington, DC.

Federal Specification SS-S-1401C. 1984a(15 Aug). "Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements," Washington, DC.

\_\_\_\_\_. 1984b(15 Aug). "Sealants, Joint, Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements," Federal Specification SS-S-1614A, Washington, DC.

\_\_\_\_\_. 1984c(15 Aug). "Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement," Federal Specification SS-S-200E, Washington, DC.

Headquarters, Department of the Air Force. 1983(Jan). "Standard Practices for Sealing Joints and Cracks in Pavements," AF Manual 88-6, Chapter 7, Washington, DC.

Headquarters, Departments of the Army and the Air Force. 1975(Sep). "Standard Practice for Concrete Pavements," TM 5-822-7/AFM 88-6, Chapter 8, Washington, DC.

\_\_\_\_\_. 1978(Jan). "Repair of Rigid Pavements Using Epoxy-Resin Grouts, Mortars, and Concretes," TM 5-822-9-AFM 88, Chapter 10, Washington, DC.



Photo 1. Tractor-mounted plow



Photo 2. Vertical spindle router



Photo 3. Concrete saw



Photo 4. Sandblasting equipment



Photo 5. Hot-pour sealant application equipment

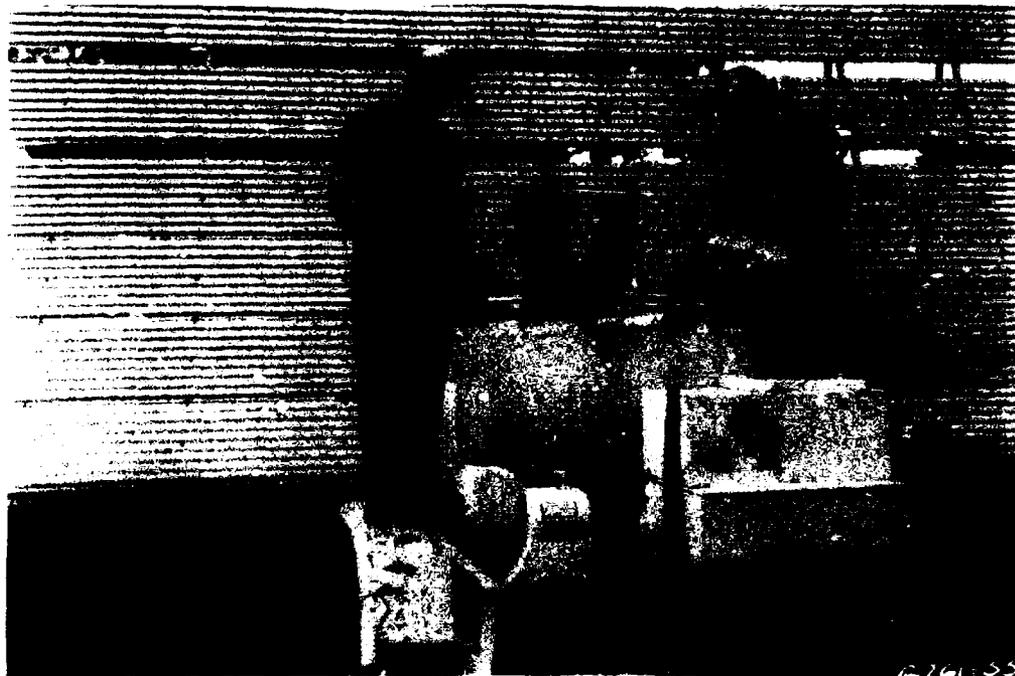


Photo 6. Cold-applied two-component sealant application equipment



Photo 7. Silicone sealant application equipment

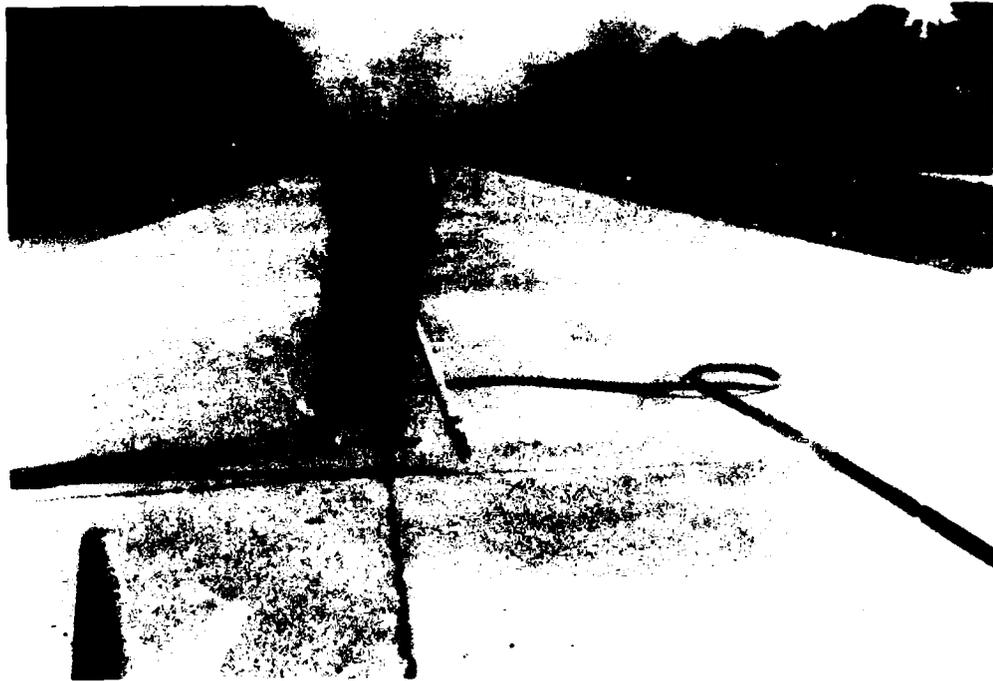


Photo 8. Sandblasting nozzle blasting inside the joint

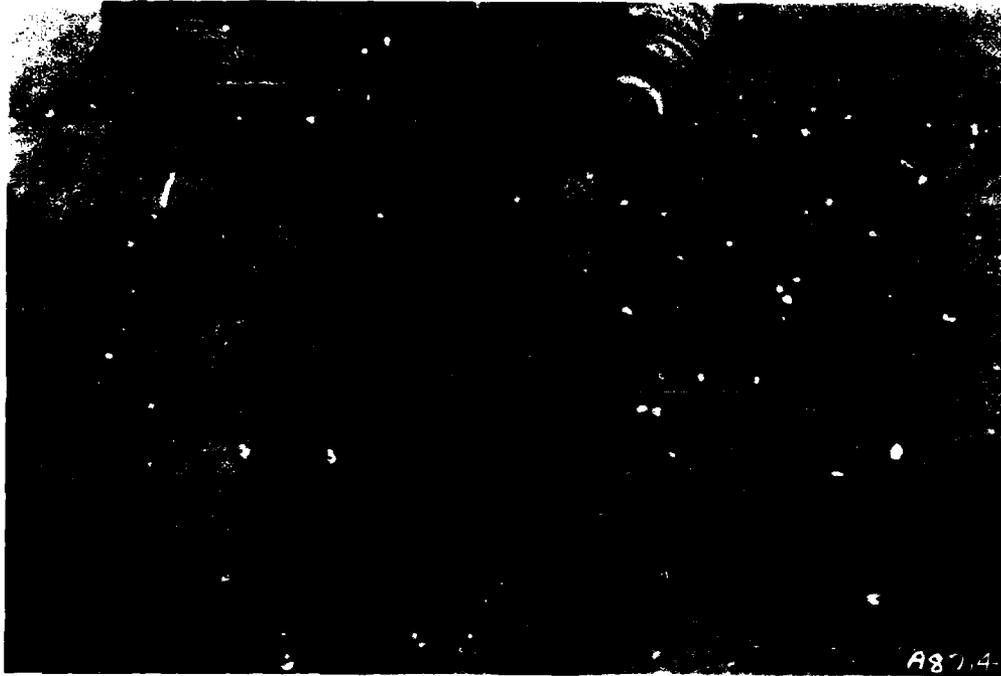


Photo 9. V-shaped plow

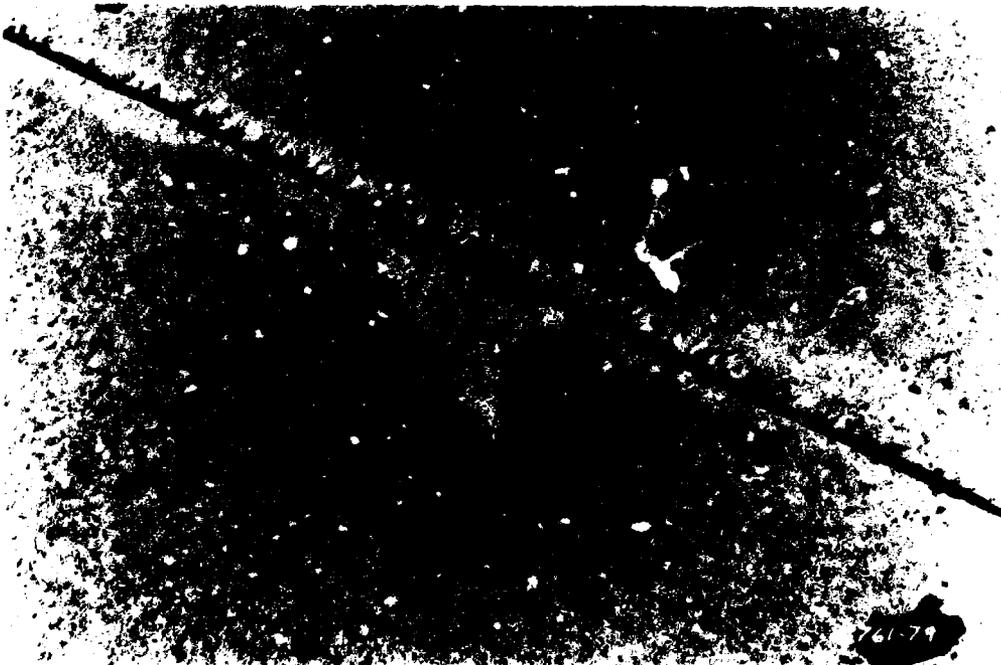


Photo 10. Joint wall after sandblasting

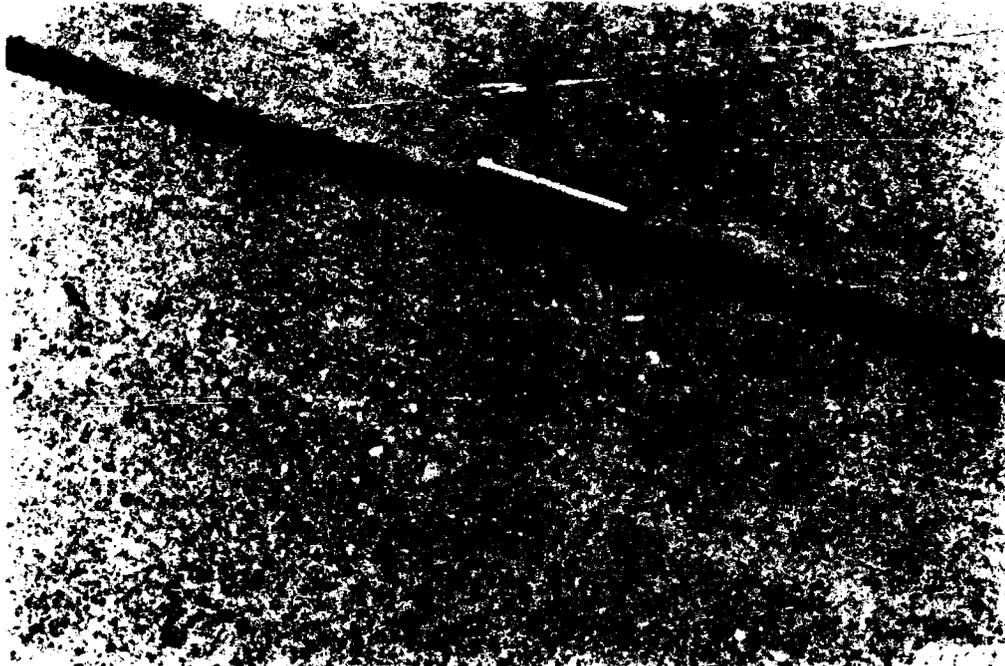


Photo 11. Cohesion failure in sealant material

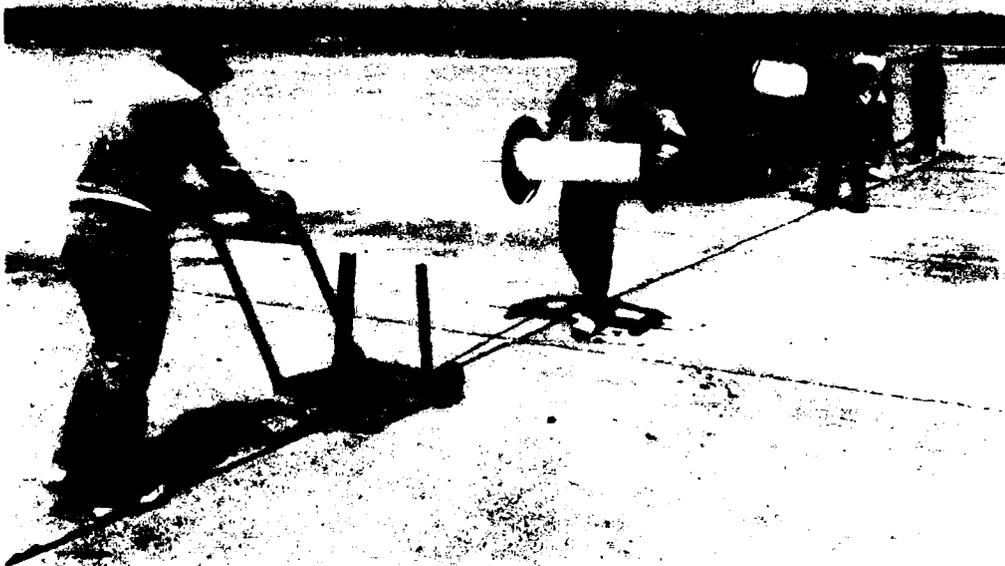


Photo 12. Air cleaning the joints and installing backer rod material



Photo 13. Filling joints from bottom to top



Photo 14. Tooling silicone joint sealant



Photo 15. Deteriorated joint in need of repair



Photo 16. Cohesion failure in sealant material



Photo 17. Cutting around defective concrete



Photo 18. Concrete removal

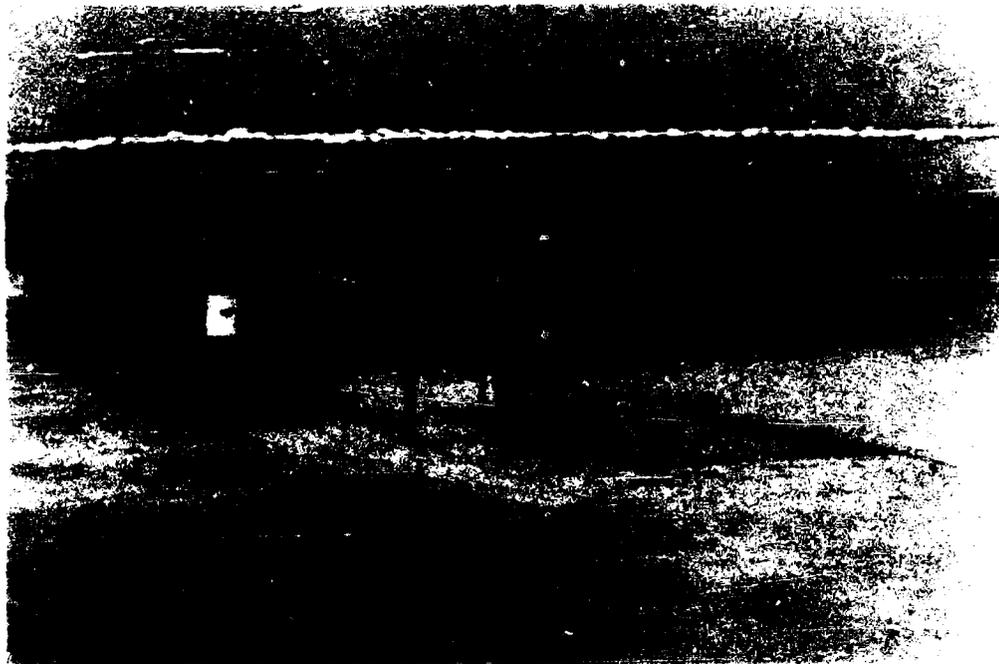


Photo 19. Sandblasting area to be repaired



Photo 20. Placing filler material for joint integrity