Technical Report Documentation Page

1. REPORT No.
CA/TL-86/04

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Rapid Pavement Repair Using Polyurethane

5. REPORT DATE
February 1986

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
Enrico Maggenti

8. PERFORMING ORGANIZATION REPORT No.
641139

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of Transportation Laboratory
California Department of Transportation
Sacramento, California 95819

10. WORK UNIT No.

11. CONTRACT OR GRANT No.
F66TL61

13. TYPE OF REPORT & PERIOD COVERED
Final

12. SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
Sacramento, California 95807

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
This study was conducted as a state-financed research project under the research project titled "Minor Research Projects."

16. ABSTRACT
This report describes investigating the use of two-part polyurethane resins as a rapid set patching materials for highway pavements. It was found that the uncontrolled expansion of polyurethane resin concretes upon mixing could be mitigated through proper aggregate grading. Field tests were used to evaluate polyurethane resin concrete as a rapid set patching material for both asphalt concrete and Portland cement concrete pavements. Application equipment was successfully developed.

17. KEYWORDS
Patching, rapid set patching material, polyurethane resin, urethane

18. No. OF PAGES:
38

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1981-1988/86-04.pdf

20. FILE NAME
86-04.pdf

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF FACILITIES CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

RAPID PAVEMENT REPAIR USING POLYURETHANE

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TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
CA/TL-86/04		

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Patching, rapid set patching material, polyurethane resin, urethane.	

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified		

DS-TL-1242 (Rev.6/76)

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The State of California does not endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.

CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quality	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40 .02540	millimetres (mm) metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2) square feet (ft^2) acres	6.432×10^{-4} .09290 .4047	square metres (m^2) square metres (m^2) hectares (ha)
Volume	gallons (gal) cubic feet (ft^3) cubic years (yd^3)	3.785 .02832 .7646	litre (1) cubic metres (m^3) cubic metres (m^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s	28.317	litres per second 1/s)
	gallons per minute (gal/min)	.06309	litres per second (1/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour (mph) feet per second (fps)	.4470 .3048	metres per second (m/s) metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity (G) (ft/s^2)	9.807	metres per second squared (m/s^2)
Density	(lb/ft^3)	16.02	kilograms per cubic metre (kg/m^3)
Force	pounds (lbs) (1000 lbs) kips	4.448 4448	newtons (N) newtons (N)
Thermal Energy	British termal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds (ft-lb) foot-kips (ft-k)	1.356 1356	joules (J) joules (J)
Bending Moment or Torque	inch-pounds (in-lbs) foot-pounds (ft-lbs)	.1130 1.356	newton-metres (Nm) newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch ($ksi\sqrt{in}$)	1.0988	mega pascals$\sqrt{metre}$ ($MPa\sqrt{m}$)
	pounds per square inch square root inch ($psi\sqrt{in}$)	1.0988	kilo pascals$\sqrt{metre}$ ($KPa\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{+F - 32}{1.8} = +C$	degrees celsius (°C)

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INTRODUCTION

The very rapid strength gain and flexibility of polyurethane resins suggests that these resins may be useful as rapid set patching materials. The apparently inherent expansion of polyurethane concretes evaluated previously at TransLab prompted an investigation into the causes and mitigation of this expansion. It was determined that the expansion was somehow related to the surface area of the aggregate. Expansion was reduced by adjusting the aggregate grading to reduce its surface area. Further tests revealed that certain polyurethanes could be used when water is present. Modulus of Elasticity, Modulus of Rupture, bond stresses, and abrasion resistance values were obtained.

All polyurethane used in this investigation was manufactured by ARNCO, located in South Gate, California. Three separate formulations were used. There was no consideration of color. The combined color of the initial formulation used was red; the combined color of the formulation labled "Jet Set" was amber, and, the combined color of the formulation used in the field tests was green.

After three preliminary investigations of the properties of polyurethane concrete, described in detail in Parts 1, 2, and 3 of this report, polyurethane concrete was tested in the field as an emergency repair material for PCC (7-Ven-118-28/29) and AC (2-Sis-97-42/50) pavements. These pavements were selected by TransLab due to their high rate of deterioration. The polyurethane used in the field was Percol-S, a two-component resin manufactured by Arnco. Two

16-gallon drums were purchased - one drum of each component. Component A was red while component B was blue. The combined resin mixture was green. The test sections selected were on Highway 97 near the Oregon border and on Highway 118 in the Simi Valley in Ventura County.

CONCLUSIONS

The results from the field tests indicate that both AC and PCC pavements can be repaired with polyurethane. To date, the pavement repairs with polyurethane resin have been successful. No patch failures have occurred. The low viscosity of the resin allows it to penetrate cracks at the surface of the spall, thus reconstituting the bonding surface of the pavement as well as establishing a mechanical interlock between the patch and the pavement. Due to the low viscosity, the polyurethane may be an alternative to the High Molecular Weight Methacrylate resin currently being used for the sealing bridge decks. Since lane closures can be reduced to an absolute minimum due to the rapid set characteristics of this material and potholes can be repaired under adverse weather conditions, safety is enhanced for both maintenance workers and motorists.

PART 1: POLYURETHANE POLYMER CONCRETE EXPANSION INVESTIGATION

Initially, 2" polyurethane concrete cubes were fabricated (Lab Mix #521, Concrete Section Files, TransLab) using a two-part polyurethane and a well-graded mix of Teichert-Perkins sand and Bear River pea gravel. The concrete began to expand, forming a hemispherical top on each of the cubes. A series of tests was then performed to determine the cause of this expansion.

The two-part polyurethane was mixed together with various kinds of aggregate. Each sample consisted of 10g to 25g aggregate and 20g to 30g resin. Controls were made without aggregate. The samples were cast in approximately 1-1/2" diameter x 1" high cylinders. The aggregates initially used were: steel shot, Teichert- Perkins PCC sand, Ottawa sand, Monterey sand, Bear River pea gravel, crushed lime-stone sand and pea gravel (from Cool, California), Type II portland cement, Fondu cement, Alcoa calcium - alumina cement, fly ash, fumed silica, technical grade CaO, and montmorillonite clay. All except the montmorillonite clay and control expanded, forming hemispherical tops (see Plate C). The molds prevented lateral expansion . The control mix produced gas bubbles as did all the mixes. However, the bubbles dissipated at the surface even during gelling and, thus, the control did not ultimately expand. The montmorillonite mix began foaming within 10 minutes of mixing. Setting time was magnitudes faster than for the other mixes. It expanded above the top of the plastic mold, then settled back down roughly to the level of the mold. A cellular structure resulted which was visible at the surface. The steel shot mixes reacted similarly to the sand and rock mixes, although this mix appeared to release the bubbles to the atmosphere more readily. Thus, the net expansion was less.

A test was run to determine if this expansion was due to a chemical reaction with the aggregate or the mere presence of any solid used as an aggregate. One of the control samples previously cast and polymerized was crushed and used as an aggregate. The result was identical to that for the sand and rock mixes. The expansion, therefore, appeared to be related to the surface of the material used as "aggregate".

Since the type of aggregate did not significantly affect the resin's expansion, various chemical defoaming agents were tried with sand. Large quantities of baking soda had no observable effect on the foaming. Silane caused the expansion to increase. However, "NDW" and "NXZ" defoaming agents, generally used in paints, did seem to reduce the expansion (see Plate C, Figure 2).

All samples gassed, but without aggregate, the resin samples did not expand. Bubbles, believed to be CO_2, formed throughout and rose to the surface. The bubbles appeared to adhere to the aggregate surface. This was observed under a stereo microscope.

The control samples were mixed the same as the samples with aggregate to ensure that the foaming or expanding was not due to entraining air, and hence moisture, during mixing. The temperature was approximately 70°F and relative humidity 50%. Set times were about one hour.

PART 2: PRELIMINARY INVESTIGATION OF POLYURETHANE CONCRETE AS A RAPID POTHOLE REPAIR MATERIAL

Using the two-part polyurethane used in the expansion study discussed in Part 1, an attempt was made to determine if expansion of polyurethane concrete could be mitigated by limiting the surface area of the aggregate. Two trials were run using this resin. Six inch diameter cylinder cans were used as molds.

Teichert-Perkins aggregate (3/8"x3/4") was placed in the can to a height of 1 1/2". Water was poured into and drained out of the can to wet the rock. Five grams of water remained on the rock. The rock was moistened to simulate adverse field conditions.

The two-part polyurethane, proportioned 1:1 by volume, was mixed with a wooden stick and then poured into the can until just below the top surface of the rock. Bubbles existed after polymerization but they did not extend above the top of the rock.* This suggested that expansion may be controlled by controlling the surface area of the rock.

After this work, a series of trials was run to study the effect of different aggregate gradings and large amounts of

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*This same test was run concurrently was 1 1/2" x 1" wet Teichert-Perkins rock to a height of 3". Even though bubbles protruded 1/4"-1/2" above the rock after polymerization, further testing utilizing uniformly graded aggregates justified the relationship between surface area and expansion. This does not exclude other factors that can affect expansion such as some undetected contaminate.

water on the polyurethane concrete. A two-component Arnco polyurethane labeled "Jet Set" was used. This was a two-part resin which had a set time of five minutes at 70°F. When used with a well-graded aggregate, the mix expanded 25% (Ref: Lab Mix #475).

A 3-1/4" high paper cup with a top and bottom diameter of 3" and 2 1/4" respectively was filled with wet 3/8"x#4 Teichert-Perkins aggregate. The resin was then poured on top until flush with the top of the container. The resin displaced water up and over the sides of the cup. It penetrated to the bottom, and, the concrete did not noticeably expand. The specimen was sawed in half to view a cross section. The resin was bonded to the rock, leaving no voids larger than 28 mils, except for a pocket 3/4"x1/2"x1/4" near the top and to one side of the specimen where the resin did not bond to the rock. This was apparently caused by an accumulation of displaced water at this location. This test was repeated with #8x#4 Teichert-Perkins sand. A water pocket consisting of about 10% of the total volume resulted so it was concluded that the 3/8"x#4 was the more effective of the two aggregate sizes used.

A test was then run to observe the effect of polyurethane on aggregate submerged in water. Three 1/2-inch thick layers of aggregate were placed in a 2-1/4" high, 2" diameter paper cup. The bottom layer consisted of Teichert-Perkins PCC sand; the second layer was 3/4"x3/8" Teichert-Perkins rock; the top layer was 3/8" Bear River pea gravel. The total height was 1-1/2". Water was poured into the cup until level with the top of the rock. Resin was mixed and then poured in until level with the top of the cup, i.e., 3/4" above the top of the aggregate, thus displacing the water. Though the resin did not bond the PCC sand, it did bond the top two layers of rock. This test revealed the resin's penetrating and bonding capabilities under an extremely adverse condition. However, since the sand was not bonded, these results indicated that sand and fines should be removed from the bottom of potholes.

The adhesion of a polyurethane concrete patch to asphalt concrete (AC) was investigated. A 4" thick x 4" diameter AC core was placed in the bottom of a 4" diameter x 6" deep mold. 3/8"x#4 Teichert-Perkins aggregate was placed on top of the AC core to a height of 2" and then flooded with resin. The specimen was left at room temperature and subjected to a direct shear test three hours later. The shear plane was at the bond line. The specimen failed above the bond line in the AC. The shear value was 150 psi. This stress was considered the maximum shear value of the AC.

The same test was repeated with a specimen that had been in a freezer for 24 hours. The surface temperature of the AC was 22°F at the time of the test. In addition, five grams of frost covered 30% of the top surface of the core. The shear test resulted in only 28 psi but the failure was again above the bond line in the AC. It was concluded that the polyurethane would adequately bond to AC, even at temperatures below freezing.

A pothole repair method was tried on AC pavement on January 17, 1985 near the TransLab. The pothole was elliptical in shape with a major axis of 14", a minor axis of 12", and a depth of 2". One and one-half quarts of resin and 20 pounds of saturated-surface-dry (SSD) pea gravel were used. The air temperature was 35°F, the weather was foggy, and the AC was damp. The surface of the AC was also 35°F.

The hole was filled with the pea gravel and then flooded with the two-part resin that had been mixed in a bucket. There was no preliminary preparation of the hole. The center of the patch set in five minutes but the outer edges did not set until 10 minutes. This was assumed to be caused by the cold AC. At 10 minutes, a pickup truck was parked on the patch. It was then driven back and forth over the patch. The edge of the patch, where the resin was still soft, depressed but showed no visible damage. It was noted that the polyurethane penetrated into the cracks around the hole, thus giving the patch "fingers" which helped secure the patch in place.

On June 5, 1985, almost six months after the patch was placed, it was still bonded to the AC. The patch showed no signs of distress.

PART 3: RESULTS ON POLYURETHANE CONCRETE USING CALIFORNIA TENTATIVE TESTS FOR PATCHING MATERIALS

The Percole-S polyurethane purchased from ARNCO and used for the field test was tested for Modulus of Rupture, Modulus of Elasticity, bond stress to SSD PCC and dry PCC, and abrasion resistance. Twenty-four hour and 30 day results were run, (Lab Mix #569). Two specimens were tested for each test except abrasion, where one 24-hour and one 30-day test were run, and Modulus of Elasticity where one 30-day test was run. Air-dried Bear River pea gravel was vibrated, with a vibrating table, into molds and resin was then mixed and poured into these molds. Air temperature was 45°F. The set time was eight minutes. The molds were stripped after 1-1/2 hours and placed in the lab at 70°F. About 1-1/2 lbs of resin was used. The results were as follows:

Calif. Tentative Test:	24 hour	30 day
3-point Modulus of Rupture test on 3"x3"x9" block (2 samples)	1665 psi	1565 psi
Bond Stress to SSD PCC; 2 point Modulus of Rupture (2 samples)	515 psi	310 psi*
Bond Stress to Dry PCC, 2 point Modulus of Rupture (2 samples)	1240** psi	775 psi**
Abrasion loss (1 sample)	3*** grams	3*** grams
Modulus of Elasticity		$.51 \times 10^6$ psi

*Broke on bond line.

**Broke 100% into PCC.

***The abrasion loss appeared to be primarily due to abrasion on rock. A comparative value for seven-sack, high-quality PCC is 17 gm/28 day.

PART 4: FIELD TESTS

The AC pavement used for the field test was 2-Sis-97-42/50. This portion of Highway 97, between Grass Lake and the Oregon border, is a two-lane AC road subjected to freeze-thaw conditions. It has 50% heavy truck traffic and had a 1982 AADT of 2100. The truck AADT is 1080 with 78% being five (or more) axle trucks. The road has an abnormal amount of damage. Potholes, ruts, alligator cracks, and depressions are all present. Because of long periods of low temperatures, often below 20°F, patching of the AC with conventional cold patch material has not been successful. However, polyurethane can be handled easily at such temperatures, and its set times can be controlled by the amount of catalyst formulated into component "B" so lane closure time can be minimized. Thus, on January 24, 1985, TransLab personnel and Grass Lake Maintenance Station personnel placed the patching material under field conditions for evaluation. The outside temperature was 35° to 40°F. Potholes of varying dimensions, a rut, and a portion of a 5'x30'x4" deep depression were patched to evaluate the polyurethane. The potholes were at PM 43.9 and 42.2; the rut at PM 46.9; and the depression at PM 49.8. All this work was in the southbound lane (see Plates B_1-B_3).

There was no preliminary preparation of the damaged pavement. The rut and holes were filled with 5/16" rock and then flooded with activated polyurethane resin. A 10'x3' section of the depression was also filled with the 5/16" rock and then flooded with resin (see Plate B_3). The two-part polyurethane was formulated at a 1:1 ratio, by volume. Calibrated five gallon mixing buckets were used to mix the resin. The repaired road sections supported heavy truck traffic within 20 minutes.

On February 28, 1985, TransLab personnel observed and recorded, with photographs, the repaired sections. The patches showed no loss of integrity (see Plates B1-B3). By February 28, the polyurethane had withstood six snow storms and two rain storms. The road had undergone a freeze-thaw cycle daily since the polyurethane concrete was placed one month earlier.

On four occasions, February 4, 11, 19 and 25, the daily temperature differential exceeded 40°F. On February 4, the temperature was as low as -5°F. The average daily temperature differential was 32°F. (The temperatures were recorded by the Grass Lake maintenance crew.) The patches appeared more durable than the surrounding pavement since AC continued to spall during this period. The patch in the rut remained intact although the rut continued to grow immediately north of the patch.

The patches were still intact in late May, 1985. The Grass Lake Maintenance Station personnel are continuing to monitor the performance of these patches, and they have reported no distress. They are enthusiastic about the possibility of using the polyurethane as a fast setting patching material, particularly when adverse weather conditions exist.

This test indicated that AC pavement can be effectively patched during winter. The polyurethane proved to be durable under adverse conditions. Thus, a deteriorating AC pavement can be maintained during winter more successfully than by the use of contemporary methods.

The PCC pavement (7-Ven-118-PM 26,32) near Simi Valley in Ventura County, is in a severe state of deterioration caused by reactive aggregate. Potholes more than 2-1/2 feet in diameter and up to 2 inches deep are occurring in the outside lane. Due to the high ADT (75,000 east or west, 1984) and the rapid rate of deterioration of the road, a quick, efficient and durable way of repairing the pavement is necessary.

For this field test, a system was devised so that the two components could be continuously mixed as needed. The drums of resin were pressurized between 5 and 10 psi to force the resin to flow through attached hoses. The two hoses, one from each drum, converged into a single hose. Globe valves were installed on each hose before they converged. The valve system was constructed so that both valves could be turned on or off simultaneously. The valve handles were also spring loaded so that the valves were either completely open or shut. The hoses immediately after the valves were transparent so that the resin flow could be observed. This was to ensure that both components were flowing through the valves (see Plate A3).

On April 4, 1985, TransLab personnel and Moorpark Maintenance Station personnel placed the material. The outside air temperature was approximately 75°F. Five craters, numbered 1 through 5 from east to west, 75'-150' apart, between PM 28.7 and 29.0 on the westbound #3 lane, were patched. Also, a 15'x10' section of pavement in the #3 lane about 25' west of hole #5 was flood treated with polyurethane resin in an attempt to penetrate and seal the alligator cracks and prevent future damage. This section was chosen because of the extensive cracking and the loose material on the top surface. The interlock of the pieces seemed to be the only thing holding the surface together (see Plate A2). As heavy trucks went by, some 1"-diameter pieces could be seen moving independently of the slab, a sign the interlock was beginning to break down.

The potholes were inspected by the maintenance crew and loose concrete and debris were removed by hand. Holes #2 and #5 had been previously patched with AC, and although the AC was removed, a thin layer of asphalt still coated the surface of the holes. The potholes were first filled with uniformly graded 3/8" aggregate and then resin was added until level with the top of the pavement. Holes #2 and #5 showed visual signs that the asphalt coating was dissolved by the resin and percolating to the surface. However, this did not seem to cause any deleterious effects. The patches supported traffic within five minutes of the flooding with resin (see Plate A1).

There was no surface preparation on the flood treated 10'x15' area. The resin was pumped through the hoses attached to the drums sitting in the back of a van moving forward at 3-5 mph. A crew followed the vehicle squeegeeing the resin for a uniform application and broadcasting sand on it to increase the coefficient of friction (see Plate A2). Though the resin appeared to penetrate the cracks and bond the surface back together, cores will be taken to determine if the flood treatment was effective.

The Moorpark Maintenance Station is monitoring the patches and flooded area. As of June 1985, the patches were still intact. No potholes have occurred in the 15'x10' flooded area, although this area is too small for a conclusive appraisal without core samples. The maintenance crew prefers the polyurethane over patching material presently used because the fast set time and ease of placement keep lane closure time to a minimum. The polyurethane patch system may be an efficient stopgap measure to maintain a safe and efficient traffic flow on this section of freeway until the pavement is rehabilitated.

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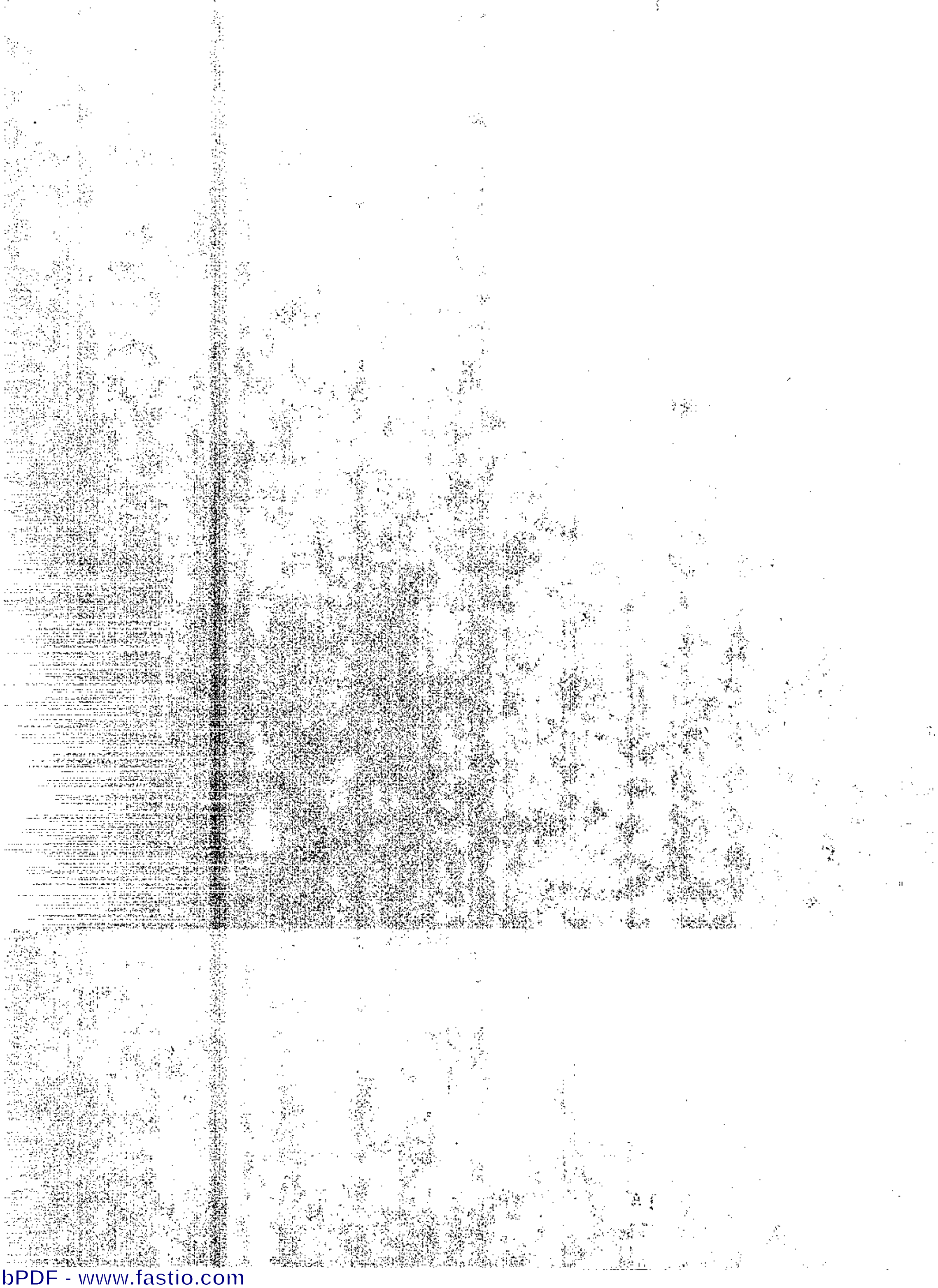
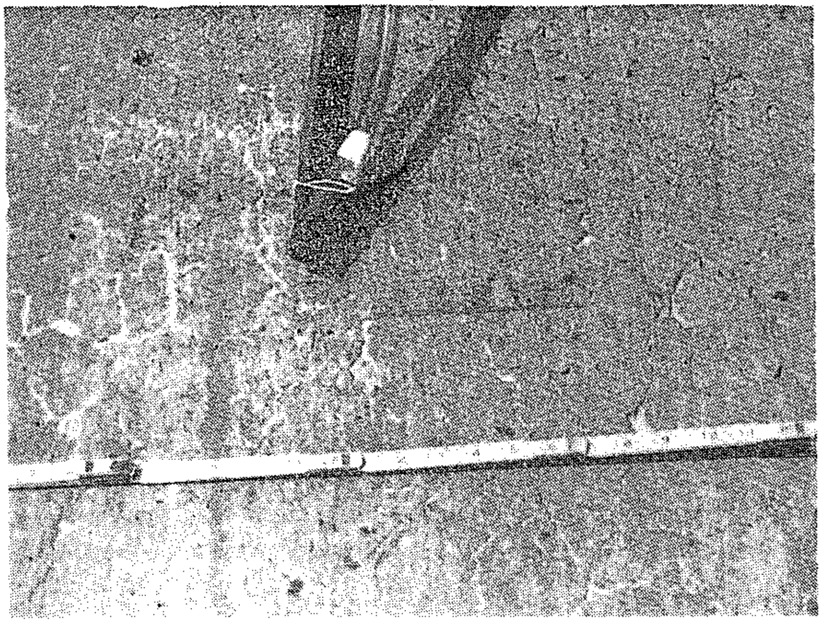
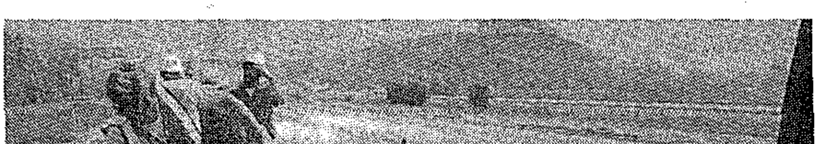


PCC PAVEMENT
07-VEN-118-28.7/29 APRIL 4, 1985

REPAIRING TYPICALLY DAMAGED PAVEMENT

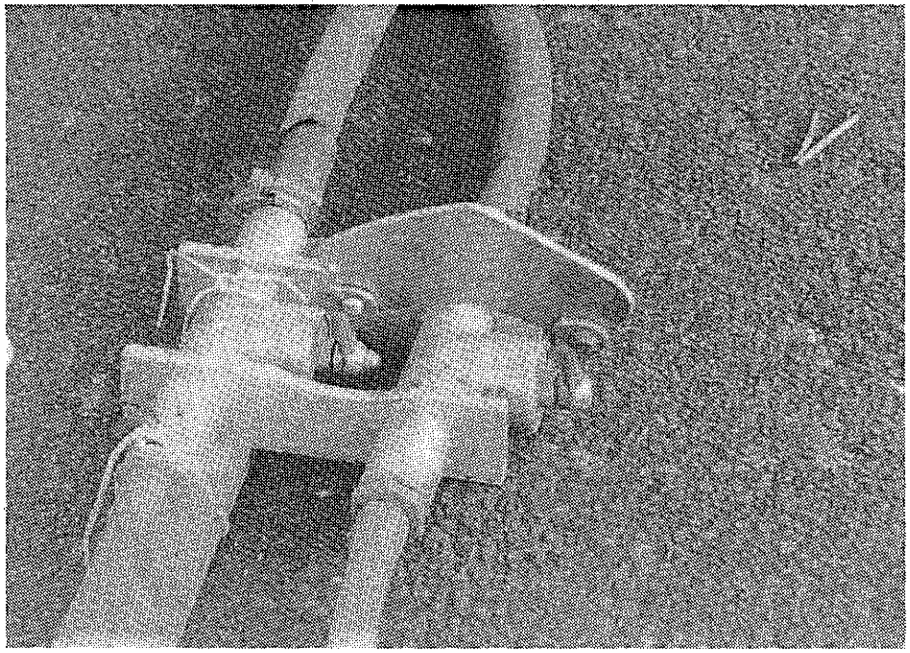


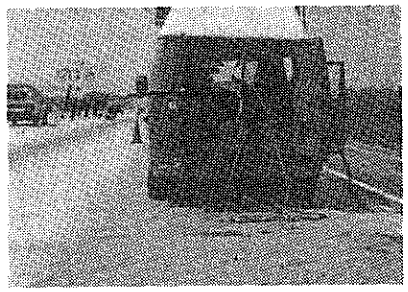


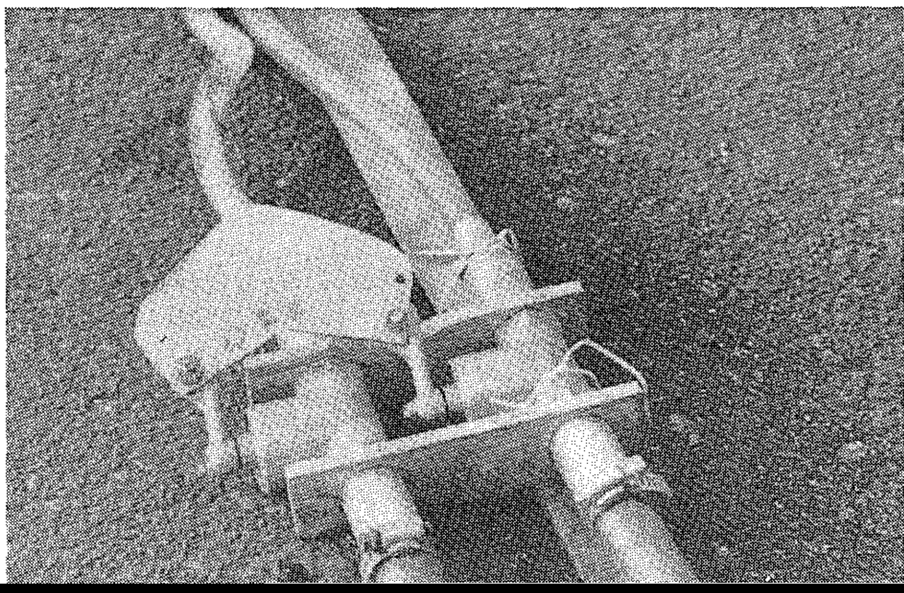
FLOOD TREATMENT OF PCC PAVEMENT WITH URETHANE

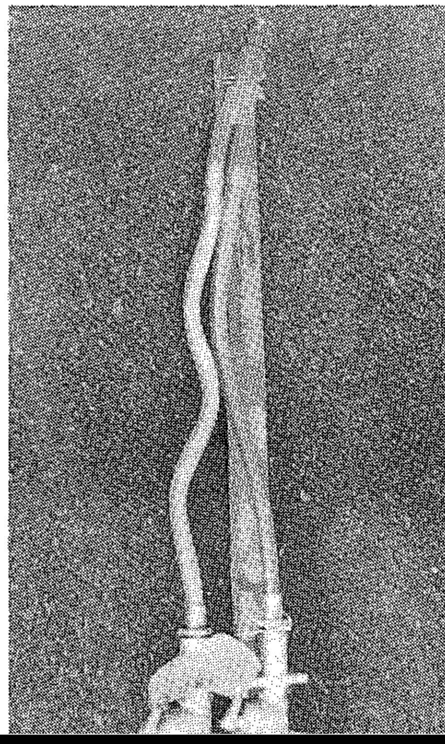
VEN-118-29 APRIL 4, 1985

DISTRIBUTOR & CLOSE-UP OF VALVE SYSTEM USED ON PCC PAVEMENT

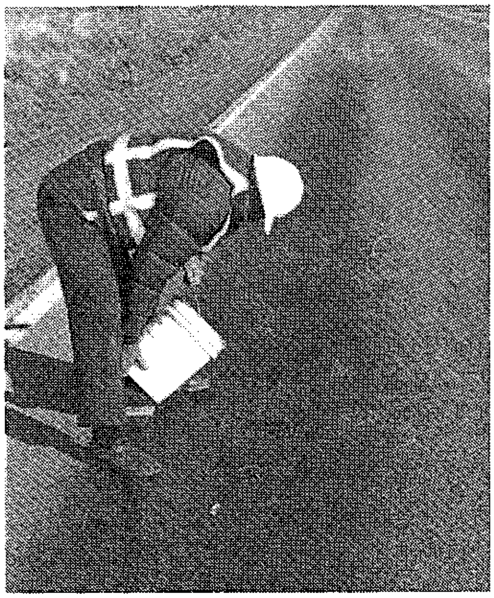




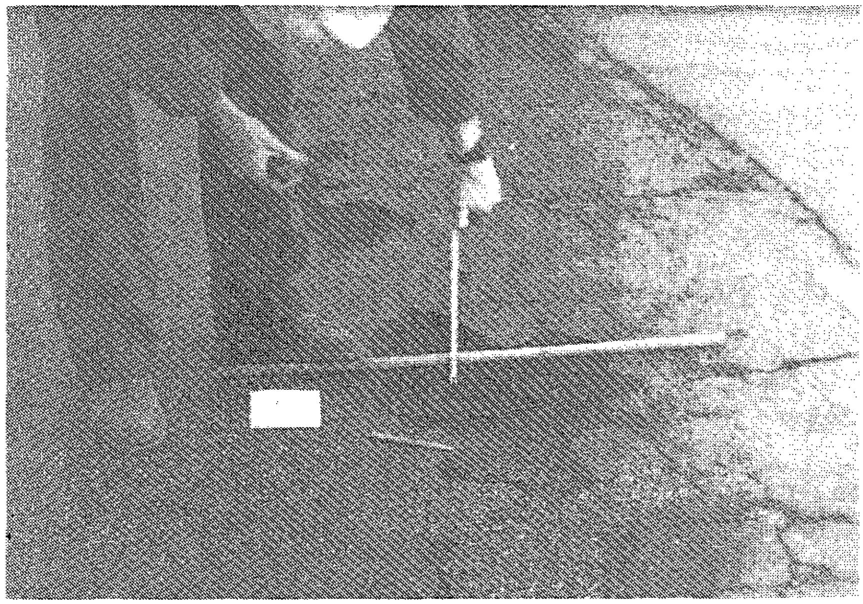




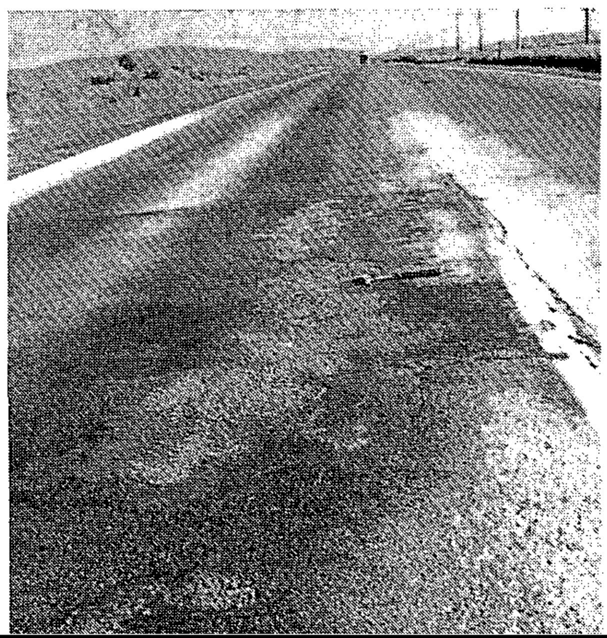
A.C. PAVEMENT POTHOLES
02-SIS-97-41/43



FLOODING WITH ACTIVATED POLYURETHANE HOLES FILLED WITH 5/16" CHIPS

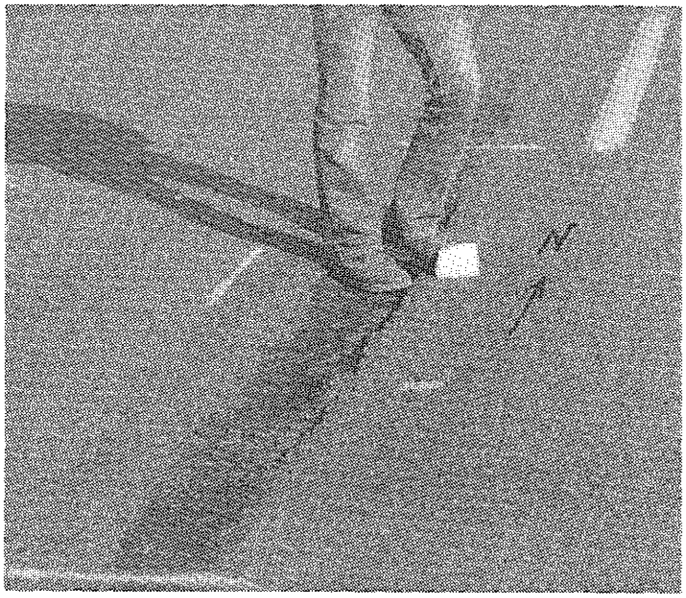


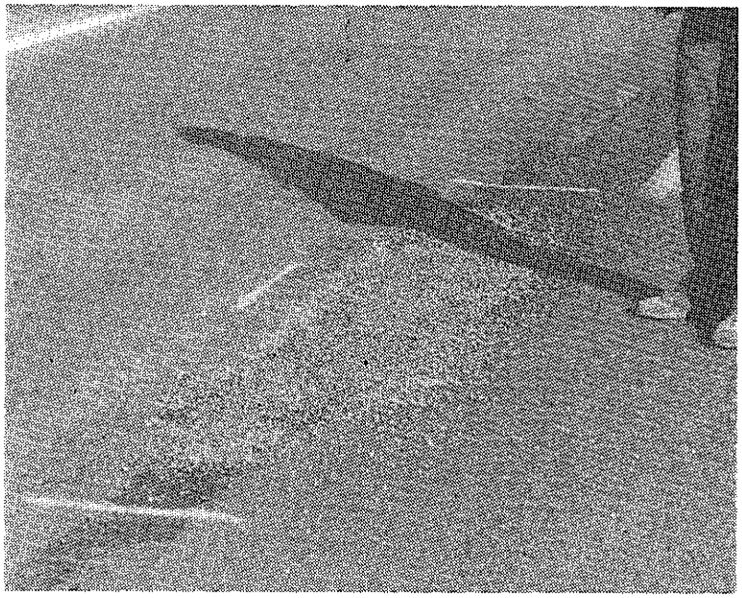
P.M. 42.9 JANUARY 24, 1985



A.C. PAVEMENT 8"x10' RUT

02-SIS-97-46.9





JANUARY 24, 1985

DEPRESSION ON A.C.
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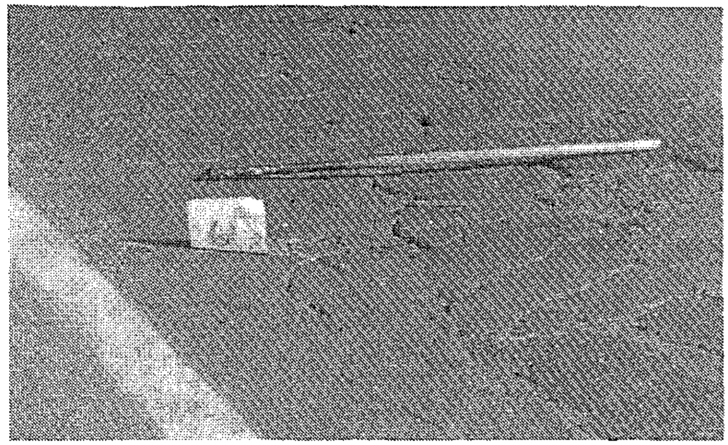
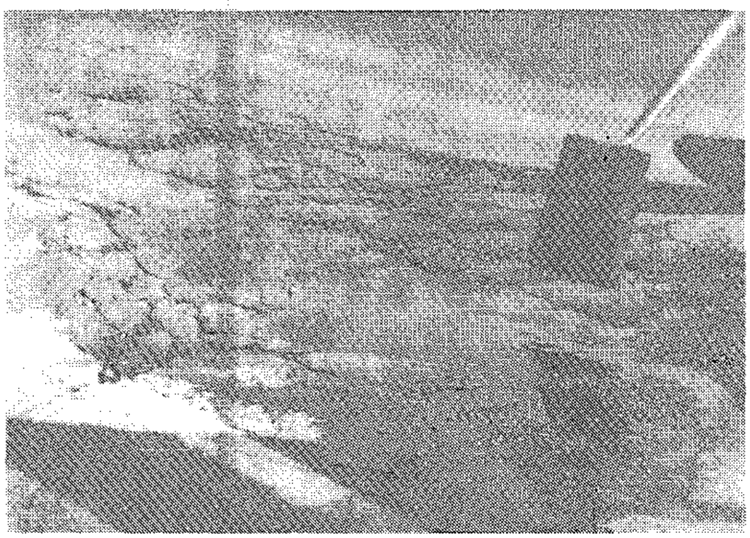
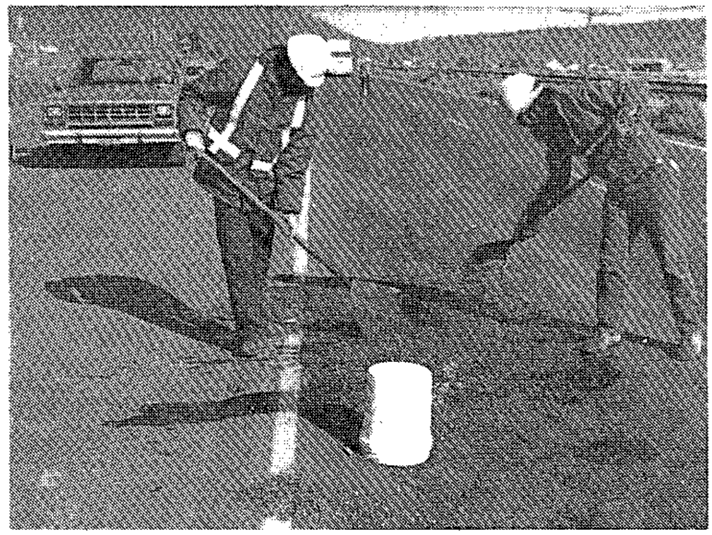
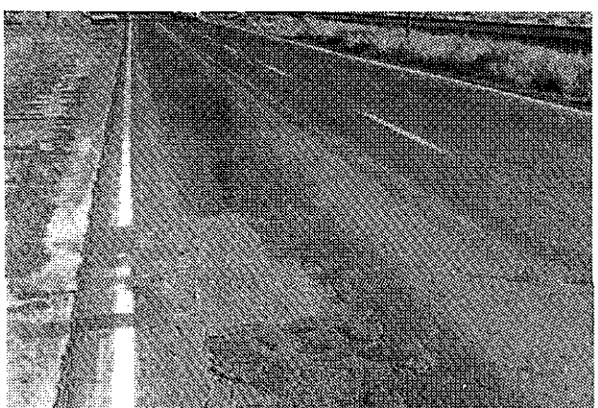


JANUARY 24, 1985

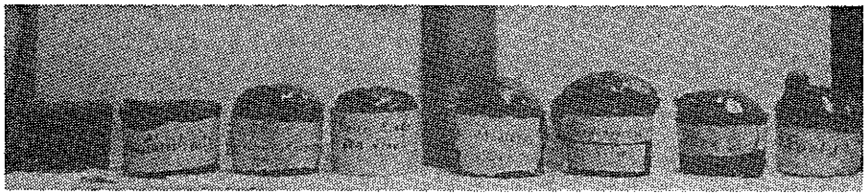




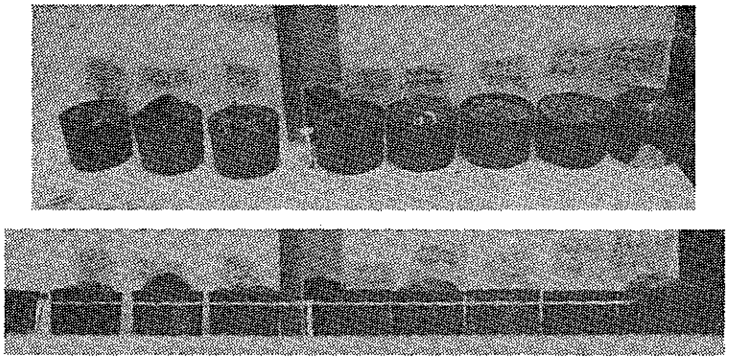
REPAIRING THE DEPRESSION
JANUARY 24, 1985



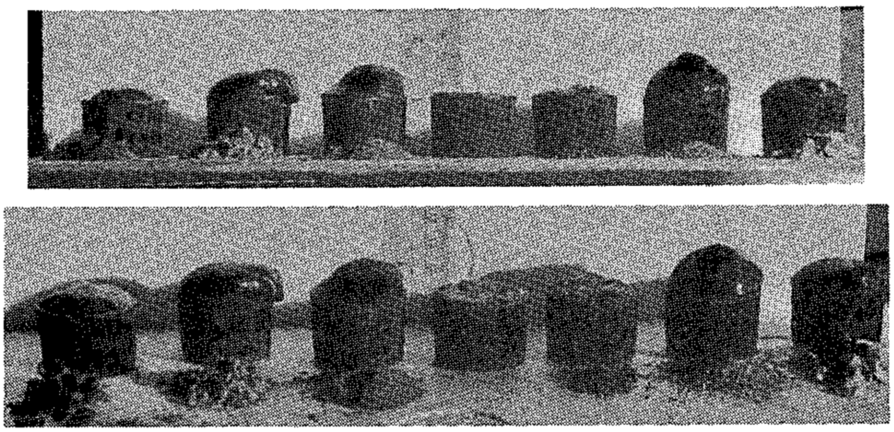
TEST SPECIMENS FROM EXPANSION DETERMINATION



1.) SAMPLES ORIGINAL HEIGHT AT TOP OF MOLD



2.) SAMPLES ORIGINAL HEIGHT AT STRING LINE



3.) SAMPLES SHOWING AGGREGATES. ORIGINAL HEIGHTS OF THOSE LABELED "URETHANE AGGRE.", "STEEL SHOT", AND "LIMESTONE" WERE AT STRING LINE AS SHOWN IN FIGURE 2. ALL OTHERS WERE AT TOP OF MOLD.

PLATE C

Fed. Std. No. 313B

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

TYPE OF DATA SHEET
☒ NEW ☐ REVISED

(If REVISED, Section No.

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME	FSCM/FSCNM	CONTRACT NUMBER OR ORDER NUMBER
ARNCO		

MANUFACTURER'S ADDRESS (Number, Street, City, State, and ZIP Code)	PART NUMBER, PRODUCT AND/OR TRADE NAME
5141 Firestone Place South Gate, CA 90280	PERCOL-S "B" Side

NATIONAL STOCK NUMBER, ACTIVITY CONTROL NUMBER, OR LOCAL STOCK NUMBER	HAZARDOUS MATERIAL	SPECIFICATION
	☒ YES ☐ NO	6810

TYPE, GRADE AND/OR CLASS	NRC LICENSE NUMBER	EPA REGISTRATION NUMBER
—	N/A	N/A

CHEMICAL NAME AND SYNONYMS	CHEMICAL FAMILY	FORMULA
Polyether polyol blend	Polyurethane	Proprietary

TYPED OR PRINTED NAME OF COMPANY POINT OF CONTACT	SIGNATURE	EMERGENCY TELEPHONE NUMBER	DATE
Tullio G. Vigano	Chemtrec	1-800-762-7620 1-800-424-9300	Jan. 1984

SECTION II - COMPOSITION

NIOSH NUMBER	CHEMICAL NAME (Ingredients)	%	TLV
	Proprietary		

SECTION III - PHYSICAL PROPERTIES

BOILING POINT (°F & °C)	284°F. 140°C	CRITICAL TEMP (°F & °C)	—	SOLUBILITY IN WATER	[illegible]
SPECIFIC GRAVITY (H_2O = 1)	1.37	VISCOSITY cps °C, °F	25 25,77	AUTOIGNITION TEMP (°F & °C)	—
EVAPORATION RATE (= 1)	—	VAPOR PRESSURE (MM HG)	—	CRITICAL PRESSURE	—
DECOMPOSITION TEMP (°F & °C)	—	PERCENT VOLATILE BY VOLUME (%)	—	CORROSION RATE (Temp =) (Material Ref =)	—
VAPOR DENSITY (Air = 1)	—	pH		APPEARANCE AND ODOR	Bluish liquid with sharp irritating odor.
FREEZING (Melting) POINT (°F & °C)	—	MAGNETISM (Milligauss)	—		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method Used)	FLAMMABLE LIMITS LEL	UEL
210°C., 410°F., open cup		

EXTINGUISHING MEDIA
waterfog, foam, CO_2, drychemical

SPECIAL FIRE FIGHTING PROCEDURES AND EQUIPMENT
Use waterspray to cool fire-exposed surfaces and to protect personnel. Respiratory protection required for fire fighting personnel.

UNUSUAL FIRE AND EXPLOSION HAZARDS
Low Hazard

SECTION V - HEALTH HAZARD DATA

EFFECTS OF ACUTE AND CHRONIC OVEREXPOSURE

None established

EMERGENCY AND FIRST AID PROCEDURES

Eyes - Flush with water.
Skin Contact - Wash with soap and water.
Inhalation - Remove to fresh air.
If Swallowed - Induce vomiting if conscious. Call physician immediately.

SECTION VI - REACTIVITY DATA

STABILITY	CONDITIONS TO AVOID (Stability)
☐ UNSTABLE ☑ STABLE	

INCOMPATABILITY (Materials to avoid)

Water, alcohols, and strong bases to protect quality. Reacts with magnesium, sodium, aluminum and strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, sulfur dioxide, nitrogen oxides, chlorine and hydrochloric acid.

HAZARDOUS POLYMERIZATION	CONDITIONS TO AVOID (Polymerization)
☐ MAY OCCUR ☐ WILL NOT OCCUR	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Clean up spilled material with absorbent materials (rags or sawdust) and/or solvents (methylene chloride or MEK or DMF). Advise local authorities if substance has entered a watercourse or sewer. Avoid skin contact or inhalation of vapors.

WASTE HANDLING AND DISPOSAL METHOD

Dispose of this material in accordance with federal, state and local regulations.

NEUTRALIZING AGENT

SECTION VIII - OCCUPATIONAL PROTECTIVE MEASURES

RESPIRATORY PROTECTION (Specify type) Wear protective clothing and respirator or self-contained breathing apparatus. Per 29CFR 1910.134

VENTILATION (specify type)

Dilution or general ventilation.

PROTECTIVE GLOVES (specify type)	EYE PROTECTION (specify type)	OTHER PERSONAL PROTECTIVE EQUIPMENT (specify type)
Rubber	Well fitted goggles or face shield	

SECTION IX - SPECIAL PRECAUTIONS

HANDLING AND STORAGE PRECAUTIONS

None other than normal for liquids stored at room temperature in closed containers. Protect from moisture and foreign material to prevent spoilage of material.

OTHER PRECAUTIONS

Storage temperature should not exceed 120°F.

SECTION X - TRANSPORTATION

APPLICABLE REGULATIONS

☐ 49 CFR ☐ IMCO ☐ TARIFF 6D ☐ IATA ☐ MILITARY AIR (AFR 71-4)

SHIPPING NAME	ID NUMBER	RQ/DAT QTY
PERCOL-S "B" Side		

HAZARD CLASS	LABELS

UNIT CONTAINER	DOT SPEC CONTAINER	DOT EXEMPT/DOD CCN	LIMITED QTY
55-gallon metal drum			

AEROSOL PROPELLANT(S)	NET EXPL WT

Form Approved
OMB No. 22-R1327

MATERIAL SAFETY DATA SHEET

TYPE OF DATA SHEET: [X] NEW [ ] REVISED

(If REVISED, Section No. ________)

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: ARNCO	FSCM/FSCNM:	CONTRACT NUMBER OR ORDER NUMBER:
MANUFACTURER'S ADDRESS (Number, Street, City, State, and ZIP Code): 5141 Firestone Place, South Gate, CA 90280	PART NUMBER, PRODUCT AND/OR TRADE NAME: PERCOL-S "A" Side	

NATIONAL STOCK NUMBER, ACTIVITY CONTROL NUMBER, OR LOCAL STOCK NUMBER:	HAZARDOUS MATERIAL: [X] YES [ ] NO	SPECIFICATION: 6810
TYPE, GRADE AND/OR CLASS: —	NRC LICENSE NUMBER: N/A	EPA REGISTRATION NUMBER: N/A
CHEMICAL NAME AND SYNONYMS: Isocyanate terminated resin	CHEMICAL FAMILY: Polyurethane	FORMULA: Proprietary

TYPED OR PRINTED NAME OF COMPANY POINT OF CONTACT: Tullio G. Vigano	SIGNATURE: [signature]	EMERGENCY TELEPHONE NUMBER: 1-800-762-7620; Chemtrec 1-800-424-9300	DATE: Jan. 1984

SECTION II - COMPOSITION

NIOSH NUMBER	CHEMICAL NAME (Ingredients)	%	TLV
	Proprietary		

SECTION III - PHYSICAL PROPERTIES

BOILING POINT (°F & °C)	>295°F. 145°C.	CRITICAL TEMP (°F & °C)	---	SOLUBILITY IN WATER	negligible
SPECIFIC GRAVITY (H_2O = 1)	1.11	VISCOSITY cps °C, °F	25; 25, 77	AUTOIGNITION TEMP (°F & °C)	--
EVAPORATION RATE (= 1)	--	VAPOR PRESSURE (MM HG)	--	CRITICAL PRESSURE	--
DECOMPOSITION TEMP (°F & °C)	--	PERCENT VOLATILE BY VOLUME (%)	--	CORROSION RATE (Temp =) (Material Ref =)	--
VAPOR DENSITY (Air = 1)	--	pH		APPEARANCE AND ODOR	Reddish liquid, sharp, irritating odor.
FREEZING (Melting) POINT (°F & °C)	--	MAGNETISM (Milligauss)	--		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method Used)	FLAMMABLE (Explosive) LIMITS LEL	UEL
82°C.,180°F open cup		

EXTINGUISHING MEDIA
Water fog, foam, CO_2, Dry chemical

SPECIAL FIRE FIGHTING PROCEDURES AND EQUIPMENT
Use waterspray to cool fire-exposed surfaces and to protect personnel. Respiratory protection required for fire fighting personnel

UNUSUAL FIRE AND EXPLOSION HAZARDS
Low hazard. Avoid water in closed containers (Carbon dioxide generated).

SECTION V - HEALTH HAZARD DATA

EFFECTS OF ACUTE AND CHRONIC OVEREXPOSURE

Irritation of respiratory tract. Skin irritation may result.

EMERGENCY AND FIRST AID PROCEDURES

Eyes - flush with clean water for at least 15 minutes. Call physician immediately.
Skin contact - Wash with soap and water.
Inhalation - Remove victim from contaminated area-administer fresh air supply.
If Swallowed - Induce vomiting if conscious. Call physician immediately.

SECTION VI - REACTIVITY DATA

STABILITY

☐ UNSTABLE
☒ STABLE

CONDITIONS TO AVOID (Stability)

INCOMPATABILITY (Materials to avoid)

Avoid moisture to protect product quality.
Reacts with magnesium, sodium, aluminum and strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, sulfur dioxide, nitrogen oxides, chlorine and hydrochloric acid.

HAZARDOUS POLYMERIZATION

☐ MAY OCCUR
☐ WILL NOT OCCUR

CONDITIONS TO AVOID (Polymerization)

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Clean up spilled material with absorbent materials (rags or sawdust) and/or solvents (methylene chloride or MEK or DMF). Advise local authorities if substance has entered a watercourse or sewer. Avoid skin contact or inhalation of vapors.

WASTE HANDLING AND DISPOSAL METHOD

Dispose of this material in accordance with federal, state and local regulations.

NEUTRALIZING AGENT

SECTION VIII - OCCUPATIONAL PROTECTIVE MEASURES

RESPIRATORY PROTECTION (Specify type) Wear full protective clothing and respirator or self-contained breathing apparatus. Per 29CFR 1910.134

VENTILATION (specify type)

Dilution or general ventilation

PROTECTIVE GLOVES (specify type)	EYE PROTECTION (specify type)	OTHER PERSONAL PROTECTIVE EQUIPMENT (specify type)
Rubber	well fitted goggles or face shield	

SECTION IX - SPECIAL PRECAUTIONS

HANDLING AND STORAGE PRECAUTIONS

None other than normal for liquids stored at room temperature in closed containers. Protect from moisture and foreign material to prevent spoilage of material.

OTHER PRECAUTIONS

Storage temperature should not exceed 120°F.

SECTION X - TRANSPORTATION

APPLICABLE REGULATIONS

☐ 49 CFR ☐ IMCO ☐ TARIFF 6D ☐ IATA ☐ MILITARY AIR (AFR 71-4)

SHIPPING NAME	ID NUMBER	REPORT QTY
PERCOL-S "A" Side		

HAZARD CLASS	LABELS

UNIT CONTAINER	DOT SPSC CONTAINER	DOT EXEMPT/DOD CCN	LIMITED QTY
55 - gallon metal drum			

AEROSOL PROPELLANT(S)	NET EXPL WT