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TEST TRACK EVALUATION OF PATCHING MATERIALS

FINAL REPORT

No. 22.1

By

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Prepared for
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Department of Highways

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16. Abstract

Evaluation of pavement patching materials was accomplished by simulating potholes in the surface, repairing the holes and subjecting them to traffic loadings. Loadings were applied utilizing the Pavement Test Facility which applies truck tire and various passenger car tire types simultaneously. Measurements of strength, skidding potential and pavement performance resulted in a comparative evaluation. Tread wear and protrusion of studs in the tires was determined.

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Pavement Patching Material, Polishing, Skidding Potential, Studded Tires, Garnet Impregnated Tires	

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SUMMARY

Through use of the Pavement Test Facility, an evaluation of pavement patching materials was made. Most of the materials are fairly new in the State of Washington and a comparative evaluation was preferred to several expensive trial runs.

Nine materials were evaluated on their merits of placement, strength, skidding potential and performance under stress. Ancillary information on tread wear and studded tire action was obtained. Six different tire types were used in the testing.

Testing was concluded after more than three-quarter million wheel passes. Material evaluation should be useful in maintenance procurement and use decisions.

Chapter 1

MATERIALS

1.1 DESCRIPTION

Various types and brands of patching materials used in highway pavements were included in this test series. The specific materials were as requested in the letter from the Washington State Highway Commission, Department of Highways, dated 26 March 1975. The letter was signed by Mr. LeClerc, Materials Engineer and was addressed to the Research Investigator.

The numbers noted in this report as assigned to each product are for identification only and have no rating significance. Two types of one material were used plus one product added to the original listing resulting in a total of 10 "patches."

Table 1-1 indicates the product and project identification numbers.

Table 1-1

Product Identification

Number	Product	Patch Designation(1)
1-1	"Specrete"	1-1
1-2	"Specrete"	1-2
2	"Tigercrete"	1-3
3	"Duracal"	2-1
4	"Bostik"	4-2
5	"Embeco"	3-1
6	"Speedcrete"	3-2
7	"Darex"	4-1
8	"Dow"	2-2
9	"Roadpatch"	2-0

Note:

(1) Indicates location in Test Track. First digit shows section, second digit is number within section. Section numbers are as used in previous research projects with clockwise sequences.

1.1.1 "Specrete"

Identification number 1-1 and 1-2.

"Specrete" was furnished by:

Specrete Products
W. N. Merriman
2524 SE 12th Avenue
P.O. Box 42252
Portland, Oregon 97202
Phone: 503-233-5266

The product consists of a mixture of Cement Fondu, aluminum powder, lithium carbonate, "Ribtech" wire fibers, "Alag" aggregate combined with a Styrene Butadiene liquid, masonry sand and water. Specific mix

used is described in the Appendix to this report.

1.1.2 "Tigercrete"

Identification number 2.

"Tigercrete" was furnished by:

Garon Products, Inc.
Cooper Crowley
Raritan Center
Woodbridge Avenue
Edison, New Jersey 08817
Phone: (201) 225-2555
(800) 631-5380

Water is added to the mix by approximately 30% by volume. Placement directions are detailed in the Appendix.

1.1.3 "Duracal"

Identification number 3.

"Duracal" is a product of the U.S. Gypsum Company and was furnished by:

Lone Star Industries
Richard Skerritt
901 Fairview North
Seattle, Washington
Phone: (206) 622-2900

Authorized by:

U.S. Gypsum Company
Robert Bartlett
101 South Wacker Drive
Chicago, Illinois 60606
Phone: (312) 321-4100
(800) 621-7326

Placement directions are detailed in the Appendix.

1.1.4 "Bostik"

Identification number 4.

Bostik 275 is a product of the Upco Company, which is a member of the Bostik Chemical Group of the USM corporation. The material was furnished by:

David Corbett Company
David Corbett
P.O. Box 3113
Federal Way, Washington 98002
Phone: (206) 941-2266

A specification sheet for the use of this product is included in the Appendix.

1.1.5 "Embeco"

Identification number 5.

"Embeco" 411A is a product of Master Builders and was furnished by:

Master Builders
Burt Hutchinson
13 South Nevada
Seattle, Washington
Phone: (206) 623-8411

A specification sheet for the use of this product is included in the Appendix.

1.1.6 "Speedcrete"

Identification number 6.

"Speedcrete" is a product of TAMS Industries Company and was furnished by:

TAMS Industries Company
Charles Hornaby
1222 Ardmore Avenue
Itaska, Illinois 60143
Phone: (312) 773-9441

Local Representative:
Norman Christiansen
Seattle, Washington
Phone: (206) 827-4282
(206) 788-1318

Instructions for use are included in the Appendix.

1.1.7 "Darex"

Identification number 7.

"Darex 240" is a product of W. R. Grace Corporation and was furnished by:

Ed J. Krieger
Tuwiller, Oregon
Phone: (503) 638-6801

Instructions for use are included in the Appendix.

1.1.8 "Dow"

Identification number 8.

"Dow SM-100" is a product of Dow Chemical Corporation and was furnished by:

Dow Chemical, U.S.A.
Neil C. Foor
Barstow Building
2020 Dow Center
Midland, Michigan 48640
Phone: (517) 636-1900

Instructions for use are included in the Appendix.

1.1.9 "Roadpatch"

Identification number 9.

"Roadpatch" is a product of Standard Dry Wall Products, Inc. of New Eagle, Pennsylvania and was furnished by:

Larry Johnson
Yakima, Washington
Phone: (509) 966-5906

Instructions for use are included in the Appendix.

1.1.10 Mix Summary

The following Table 1-2 summarizes the mixes as used in the project.

Table 1-2

Mix Summary

Material I.D. No.	Water Added at Site	Local Sand Aggregate Added	Local Small Coarse Aggregate Added	Slump Inches	Bonding Coat Used	Curing Medium	Ambient Air Temp (°F)	Remarks
1-1	Yes	No	No	1.25	Yes	Compound	45	
1-2	Yes	Yes	Yes	7.5	Yes	Compound	50	Excessive Water
2	Yes	No	No	4.5	Yes	Moist	60	
3	Yes	Yes	Yes	3.75	Yes	Moist	60	
4	No	No	No	0.0	No	None	60	
5	Yes	No	Yes	4.0	No	Compound	50	
6	Yes	No	Yes	0.0	No	Moist	50	
7	No	No	No	0.0	No	Moist	65	
8	Yes	Yes	Yes	3.0	No	Moist	62	
9	Yes (+Acryl 60)	No	Yes	0.5	No	Moist	56	

1.1.11 Curing Time

Due to the relatively cold temperatures at time of placement, curing of the patching material was different from that which might be expected. For comparative purposes, Schmid Impact hammer readings were taken to measure curing time. Though lacking in extreme accuracy, the readings do indicate general curing rates.

Hammer readings are shown in Figures 1-1 and 1-2.

Manufacturer's curve of reading vs. compressive strength is shown in Figure 1-3.

1.1.12 Material Strengths

Sampling of the material as placed was accomplished by preparation of 2" diameter by 4" in length cylindrical specimens. Compressive and splitting tensile strength tests were performed at 7 and 28 day ages. Table 1-3 shows the results of these tests.

Table 1-3

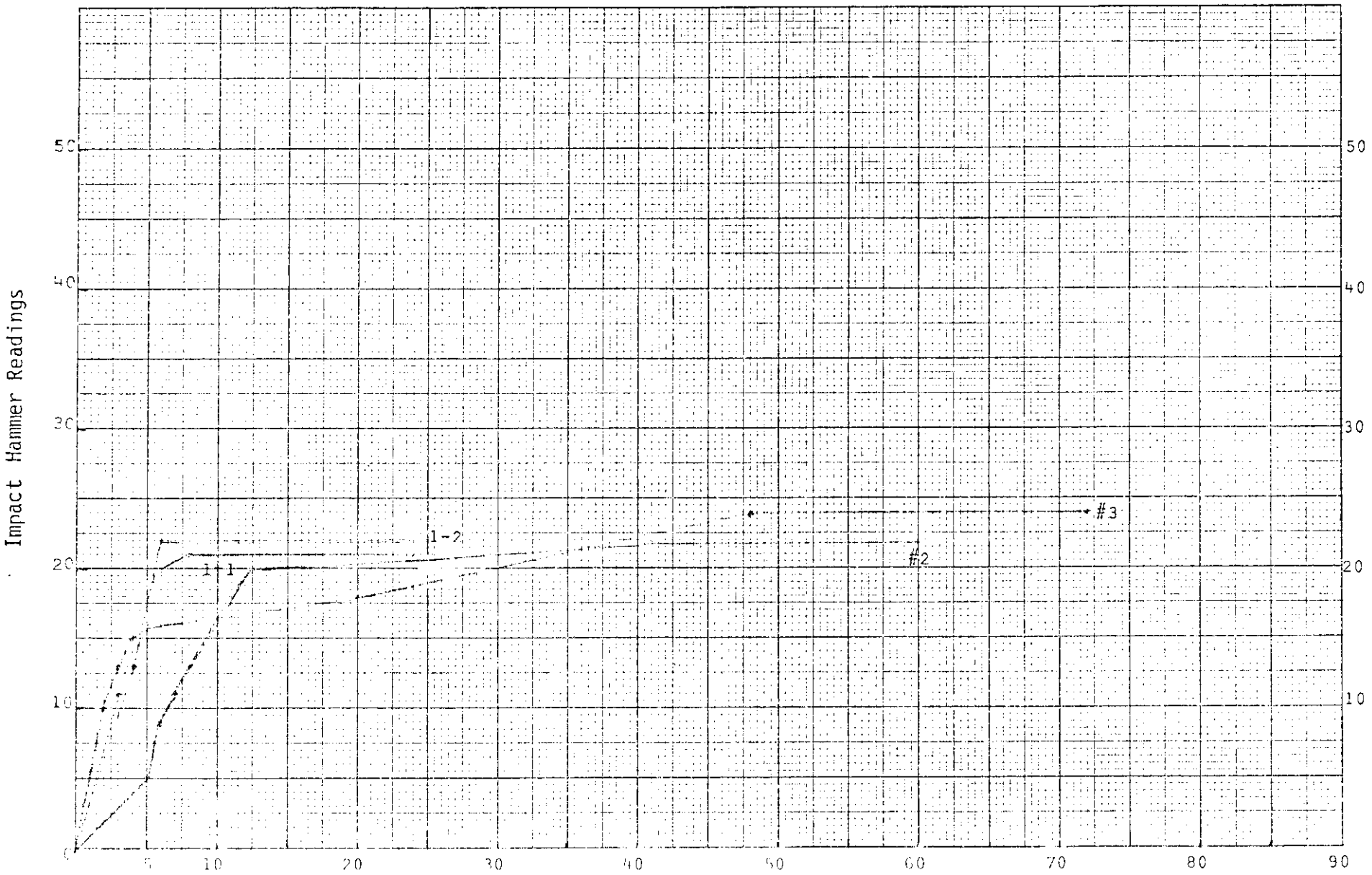
Results of Strength Tests
2" D x 4" L Cylindrical Specimens

Mat'l No.	7-Day		28-Day	
	Compressive Strength psi	Splitting Tensile Strength psi	Compressive Strength psi	Splitting Tensile Strength psi
1	6370	1420	6345	1400
2	3930	420	5410	470
3	3810	540	4530	640
4	5180	540	6920	770
5	2710	310	2840	320
6	3420	410	5570	495
7	5400	460	5570	500
8	3880	525	4080	750
9	3760	440	4070	650

Note: Results should be viewed as comparative only. Scale factor must be considered in evaluation of above results. Comparison with 6" D x 12" L cylinders or 2" cubes may lack validity.

Figure 1-1

Curing Rate from Impact Hammer Readings



Note: Placement ambient air temperature 50° F

Figure 1-2

Curing Rate from Impact Hammer Readings

Note: Placement ambient air temperature ~ 60° F

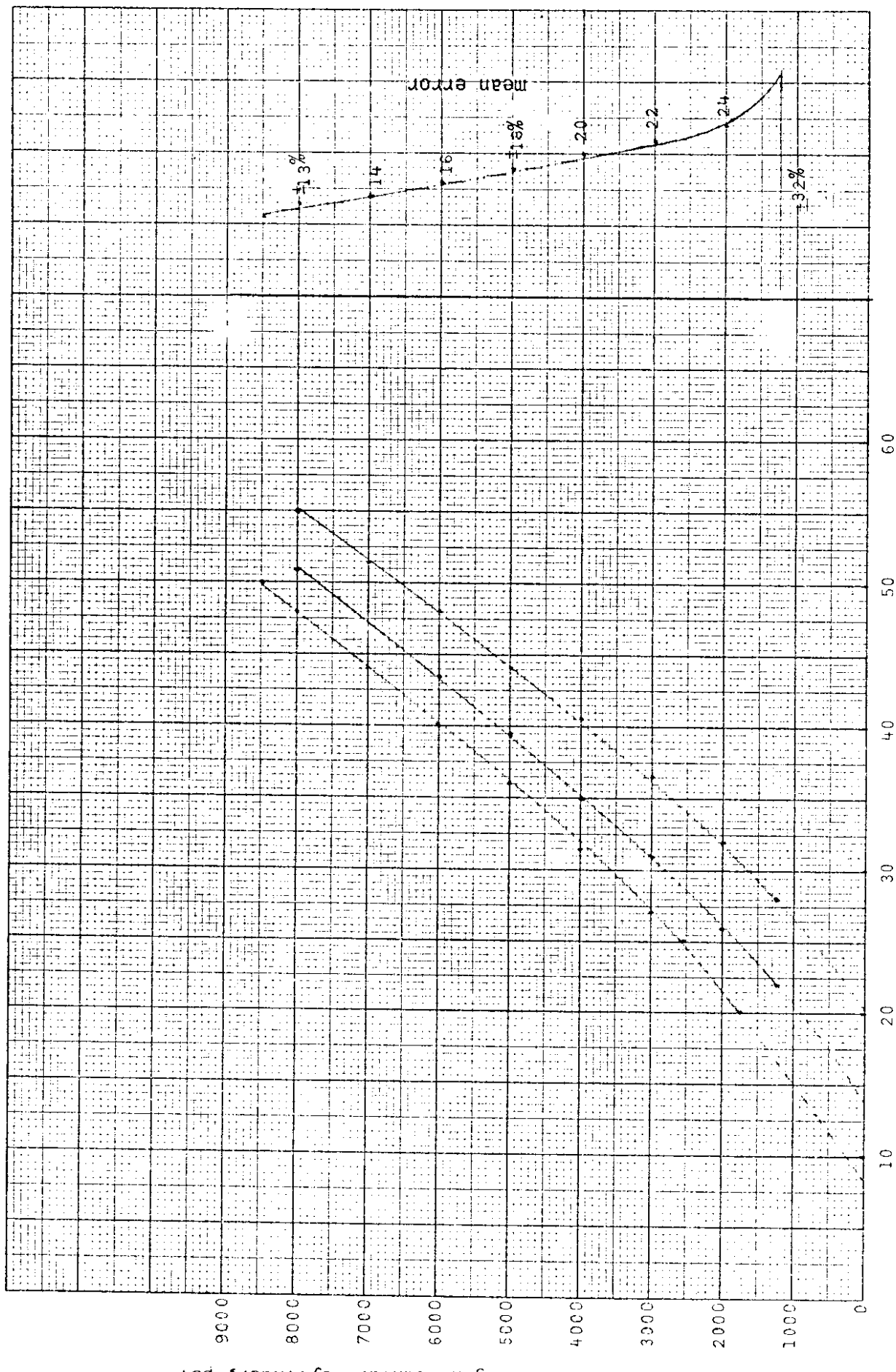


Figure 1-3

Manufacturer's Curves
Impact Hammer Readings

Chapter 2

TEST EQUIPMENT AND TIRES

2.1 TEST EQUIPMENT

The G. A. Riedesel Pavement Test Facility was used in the evaluation of patching materials. The configuration of wheels was similar to that used in the previous studded tire-pavement research.

Eight wheel paths were utilized. Each of the two wheel paths inboard of the main duals was subjected to one wheel from each truss (arm). Thus, each revolution of the machine provided three wheel passes in wheel paths 1 and 2.

The four outboard wheel paths were subjected to a single wheel pass. Two individual wheels are supported on each of arms 1 and 2. The dual wheel paths are designated wheel paths 3 and 4. The outboard wheel paths are designated 5 through 8.

Each passenger car tire was loaded with 1000 pounds through use of an air cell.

2.2 TIRES

Six different types of passenger car tires were used in this project. These were:

1. "Garnetread" mud and snow tread with garnet chips embedded in the tread.
2. Studded tires with mud and snow tread. Studs installed were P.S. (Pavement Saver).
3. "Regular" mud and snow tread tire.
4. Highway design tire.

5. Belted bias tire.

6. Steel belted radial tire.

The first four types were supplied by the Kisor Tire Company of Olympia, Washington.

The belted tires were supplied by a major American tire manufacturer.

2.3 TIRE LOCATION

Table 2-1 indicates type and location of tire during test.

Table 2-1

Tire Location

Wheel Path	Arm	Tire Type
WP-1	1	Garnet
WP-1	2	Garnet
WP-1	3	Garnet
WP-2	1	Studded
WP-2	2	Studded
WP-2	3	Studded
WP-3	1,2,3	Driver, Truck
WP-4	1,2,3	Idler, Truck
WP-5	1	Belted Bias
WP-6	1	Highway Tread
WP-7	2	Steel Belted
WP-8	2	Mud and Snow

Chapter 3

TESTS AND OBSERVATIONS

3.1 TEST OBJECTIVES

To evaluate pavement patching materials through use of the pavement test facility, the following objectives were stipulated:

1. Simulate pavement deterioration usually classified as potholes.
2. Repair the simulated potholes by using various materials.
3. Observe placement activities for maintenance implementation.
4. Measure and record tire wear and stud protrusion.
5. Measure and record pavement patching material effects from traffic loadings.

3.2 TEST PROCEDURES

1. Simulated potholes were obtained by jackhammering or cutting holes in the existing concrete overlay. Each "hole" was 24" "wide" in the longitudinal direction of the test track; 10' "long" in the transverse direction of the track, thus crossing all wheel paths; and approximately 1½" in depth equivalent to the overlay depth.

2. The holes prepared as described above were then filled with the respective materials. Each material was applied according to the manufacturer's direction. One possible exception was the ambient temperature which was lower than some of the suggested application temperatures.

3. Tire wear was measured by periodic tread depth determinations. Similar measurements were also made on the protrusion of the stud from the tire as wear progressed.

4. Observations of the performance of the patching materials were made continuously. Through the use of a California Skid Tester, skid numbers were obtained periodically.

Multitudinous photos were taken of the various materials in different test stages. These photos indicate the polishing effect of the garnet and studded tires as well as the crack development.

5. Wear of patches due to studded tires was measured through use of a depth gauge. Measurements were taken in Wheel Path-2 only. Results are shown in Table 3-5.

6. Pavement temperatures were monitored during test period. Summary of these measurements is given in Table 3-6. Hourly data represented by this summary is available by request.

3.3 TEST RESULTS

3.3.1 Skid Tests

Results of skid tests as determined from use of the California Skid Tester are shown in Table 3-1.

Table 3-1

Skid Test Results

Material	1-1	1-2	2	3	4	5	6	7	8	9
April 23, 1975 Revolutions: 112,331 Tire Passes: 336,993										
Reference*	30	27	25	29	27	28	19	18	27	29
Garnet WP-1	26	20	23	23	19	25	13	20	26	15
Stud WP-2	16	27	17	16	18	24	22	14	18	19
June 6, 1975 Revolutions: 200,011 Tire Passes: 600,033										
Reference	27	26	26	27	26	26	20	20	30	27
Garnet WP-1	23	25	21	22	18	22	15	15	24	5
Stud WP-2	14	12	15	23	22	28	20	17	19	24
June 18, 1975 Revolutions: 272,671 Tire Passes: 818,013										
Reference	32	29	26	29	28	27	22	28	30	29
Garnet WP-1	24	25	21	23	20	22	9	20	28	24
Stud WP-2	9	19	12	23	22	26	22	16	15	11

Attached photos also show the effects of traffic as evidenced by the polishing of the patching material.

*"Reference" is reading taken on adjacent patching material surface which was not subjected to traffic wear.

3.3.2 Tire Wear

Tire wear, as measured by tread depth at various numbers of revolutions, is shown in Table 3-2. Each reported number is the average of 50 measurements, 10 stations circumferentially and 5 transverse grooves.

3.3.3 Tire Stud Protrusions

Protrusion of the tire stud is shown in Table 3-3. Each reported number is the average of 84 measurements, 42 on the outside row of studs and 42 on the inside row.

Table 3-2

Tire Wear
(tread depth in inches)

	WP-1 Garnet #1	WP-1 Garnet #2	WP-1 Garnet #3	WP-2 Stud #1	WP-2 Stud #2	WP-2 Stud #3	WP-5 Belt Bias	WP-6 High-way	WP-7 Steel Belt	WP-8 Mud & Snow
Revolutions: 0										
Miles	0			0			0	0	0	0
Tread Depth	0.382	0.379	0.384	0.386	0.392	0.390	0.371	0.308	0.303	0.393
Revolutions: 33,800										
Miles	1,484			1,521			1,744	1,781	1,815	1,852
Tread Depth	0.373	0.372	0.375	0.382	0.384	0.379	0.342	0.315	0.294	0.359
Revolutions: 64,649										
Miles	2,838			2,909			3,336	3,407	3,471	3,543
Tread Depth	0.372	0.363	0.372	0.374	0.376	0.378	0.304	0.292	0.299	0.352
Revolutions: 86,822										
Miles	3,811			3,907			4,480	4,576	4,662	4,758
Tread Depth	0.359	0.355	0.363	0.368	0.374	0.368	0.266	0.284	0.282	0.340
Revolutions:112,331										
Miles	4,931			5,055			5,796	5,920	6,032	6,156
Tread Depth	0.359	0.345	0.343	0.369	0.375	0.371	0.254	0.279	0.281	0.331
Revolutions:137,853										
Miles	6,052			6,203			7,113	7,265	7,403	7,554
Tread Depth	0.363	0.345	0.360	0.354	0.373	0.374	0.239	0.277	0.254	0.322
Revolutions:165,452										
Miles	7,263			7,445			8,537	8,719	8.885	9,067
Tread Depth	0.356	0.356	0.362	0.370	0.368	0.372	0.248	0.265	0.273	0.325
Revolutions:200,001										
Miles	8,780			9,000			10,320	10,540	10,740	10,960
Tread Depth	0.348	0.352	0.354	0.364	0.364	0.372	0.244	0.263	0.267	0.300
Revolutions:225,810										
Miles	9,913			10,161			11,652	11,900	12,126	12,374
Tread Depth	0.363	0.360	0.370	0.364	0.369	0.368	0.240	0.250	0.257	0.286
Revolutions:272,671										
Miles	11,970			12,070			14,070	14,370	14,642	14,942
Tread Depth	0.350	0.354	0.367	0.358	0.368	0.352	0.225	0.240	0.250	0.297
TOTAL WEAR	0.032	0.025	0.017	0.028	0.024	0.038	0.146	0.068	0.053	0.094

Table 3-3

Stud Protrusion
(inches)

		WP-2 Stud #1	WP-2 Stud #2	WP-2 Stud #3
Revolutions: Miles Stud Protrusion	11,358 511	0.025	0.024	0.021
Revolutions: Miles Stud Protrusion	64,649 2,909	0.030	0.024	0.027
Revolutions: Miles Stud Protrusion	86,822 3,907	0.035	0.026	0.028
Revolutions: Miles Stud Protrusion	112,331 5,055	0.034	0.028	0.028
Revolutions: Miles Stud Protrusion	137,853 6,203	0.034	0.027	0.031
Revolutions: Miles Stud Protrusion	165,452 7,445	0.034	0.029	0.027
Revolutions: Miles Stud Protrusion	200,011 9,000	0.034	0.029	0.030
Revolutions: Miles Stud Protrusion	225,810 10,161	0.038	0.030	0.034
Revolutions: Miles Stud Protrusion	272,671 12,070	0.035	0.038	0.034
INCREASE IN PROTRUSION		0.010	0.014	0.013

3.3.4 Crack Development

As the loading cycles increased, cracks developed in some of the patches. The cracks extended to the depth of the patch. Table 3-4 summarizes the extent of cracking of each material. Attached photos also represent the cracks.

Table 3-4

Crack Development

Material No.	1-1	1-2	2	3	4	5	6	7	8	9
Initial Cracking	No	No	No	No	No	No	No	No	Yes(1)	No
Final(2) Cracking										
WP-1	None	None	None	None	None	None	Mod	None	Slgt	Mod
WP-2	None	None	None	None	None	None	Mod	None	Slgt	Mod
WP-3	None	None	None	Slgt	Mod	Mod	Mod	None	Sev	Sev
WP-4	None	None	None	Ext	Mod	Mod	Ext	None	Sev	Sev
WP-5	None	None	None	Mod	None	Slgt	Mod	(3)	Mod	Mod
WP-6	None	None	None	None	None	None	Mod	--	Mod	Mod
WP-7	None	None	None	None	None	None	Mod	--	Mod	Mod
WP-8	None	None	None	Slgt	None	None	Slgt	--	Mod	Mod

Notes:

1. Initial cracking accurred within 40 minutes of placement. Repairs made prior to start of wear tests by brushing in original type slurry.
2. Final is condition after 272,671 revolutions.
3. Patching material did not extend through WP 5-8.
4. Above ratings are subjective and comparative only.

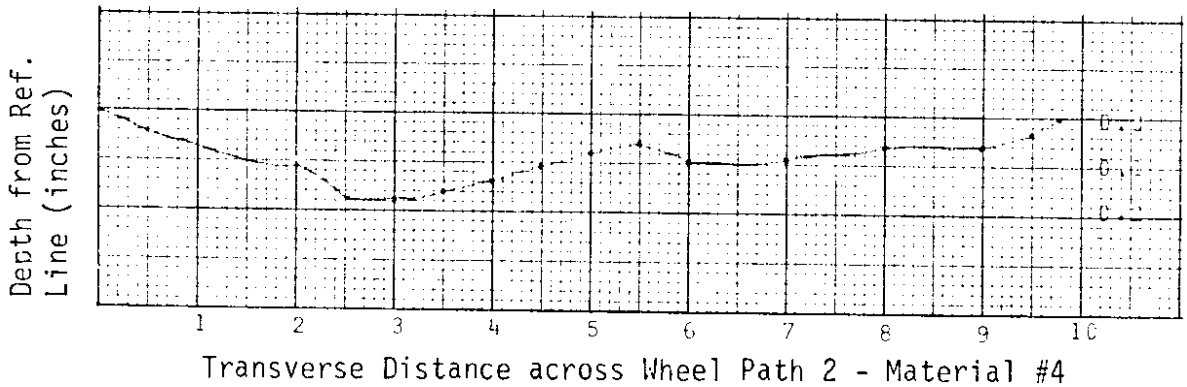
Table 3-5

Studded Tire Wear of Pavement Patches

Material Number	Groove Depth, inches[1] Maximum
1-1	.032
1-2	.102
2	.044
3	.001
4	.187
5	.012
6	.074
7	.070
8	.115
9	.102

(1) Readings taken after 818,013 wheel passes of studded snow tire.

(2) Rut configuration generally similar for deeper ruts. Profile of Material #4 at end of test is shown below.



Transverse Distance across Wheel Path 2 - Material #4

Table 3-6

Temperatures During Test

Dates	Air Temperature Maximum	Air Temperature Minimum	Ground Temperature Maximum	Ground Temperature Minimum
4-22-75 to 4-28-75	56	33	51.5	27
4-28-75 to 5-07-75	65	26	63	25
5-07-75 to 5-12-75	75	34	71	31
5-12-75 to 5-19-75	85	36	82	35
5-19-75 to 5-26-75	75	33	67	30
5-26-75 to 6-03-75	93	39	83	39
6-03-75 to 6-09-75	85	42	72	31.5

(1) Temperatures given in ^{o}F.

(2) Air temperature from shielded box 4' above ground. Ground temperatures from thermocouple 2.5' below surface in Section 09.

Chapter 4

PRACTICAL IMPLICATIONS

4.1 RATING OF MATERIALS

In order to follow the evaluation objective of this report, comparative ratings should be attempted. Obviously, such a rating would be subjective and not conclusive. Other environmental conditions or fiscal considerations might change the rating significantly. Thus, rating will be limited to general statements only.

4.1.1 Strength and Curing Time

Probably due to the relatively low temperatures at time of placement, curing times were longer than might be expected from reading the brochures on the various materials. Materials 1, 2, 3, 4, 7 and 9 gained most of their initial strength within 10 hours of placement. Materials 5, 6 and 8 strength gains were within 30 hours of placement.

Ultimate strengths, as indicated by test specimens, indicated all materials except number 5 to be relatively equal in strength.

4.1.2 Skidding Potential

From the results using the California Skid Tester, all of the materials indicated a low initial skid number. As the tests continued, polishing occurred from the action of the garnet and studded tires. Number 3 material abraded significantly from the action of the truck tires. Materials numbered 6 and 7 had comparatively lower initial readings but did not decrease as much with traffic.

4.1.3 Patch Performance

Using crack development under stress as a criteria, materials 1, 2, and 7 appeared to withstand loading successfully.

Using studded tire wear potential, material 4 appears to have the least resistance to wear from studded tires. Materials 1, 3, and 5 appear to have the most resistance.

4.2 USE IMPLICATIONS

All of the materials can probably be used for pavement patching. As noted above, performance may vary widely, thus negating specific blanket endorsement or rejection.

Possible expansion of a patch to an overlay of considerable length could result in a dangerous skid condition. Such action should be augmented by some means of increasing the skid number of the surface. Studded tires as well as garnet will continue to aggravate the aggregate.

Most of the materials will probably crack with use, thus restricting their total acceptance.

APPENDIX AP

Photographs

Tires Prior to Wheel Applications. AP-1A

Tire Condition after Partial Number of Revolutions AP-1B

Jackhammering Precut Patch Sections. AP-2

Sawing Undercut of Patch Section AP-2

Patch Section Prior to Placement AP-2

Weighing and Mixing Patch Materials. AP-2

Water Spraying Patch Area. AP-3

Placing Patching Material. AP-3

Slump Test AP-3

Making 2"d x 4" Test Cylinders AP-3

Finishing the Patch. AP-4

Broom Finishing. AP-4

Water Curing AP-4

Burlap Curing. AP-4

Impact Hammer Curing Time Determination. AP-5

Overall View of Patch Placement. AP-5

Cracks Developed in Material #8. . . . . .AP-5

Material 1-1 . . . . . .AP-6

Material 1-2 . . . . . .AP-7

Material 2 . . . . . .AP-8

Material 3 . . . . . .AP-9

(continued)

APPENDIX AP (continued)

Photographs

Material 4 . . . . . .AP-10

Material 5 . . . . . .AP-11

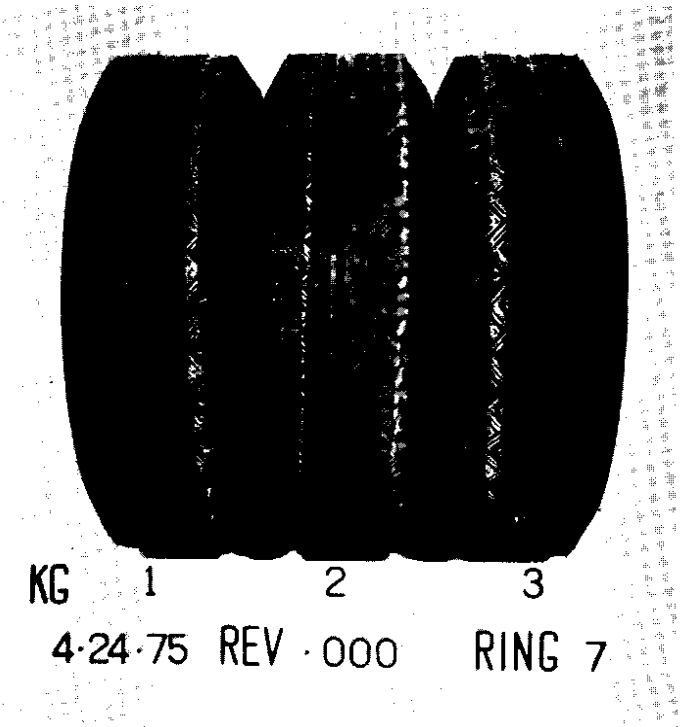
Material 6 . . . . . .AP-12

Material 7 . . . . . .AP-13

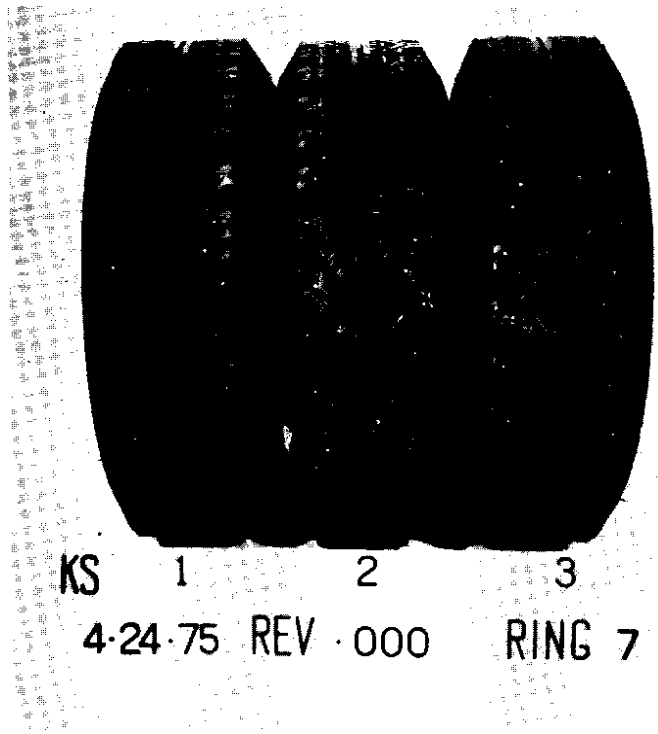
Material 8 . . . . . .AP-14

Material 9 . . . . . .AP-15

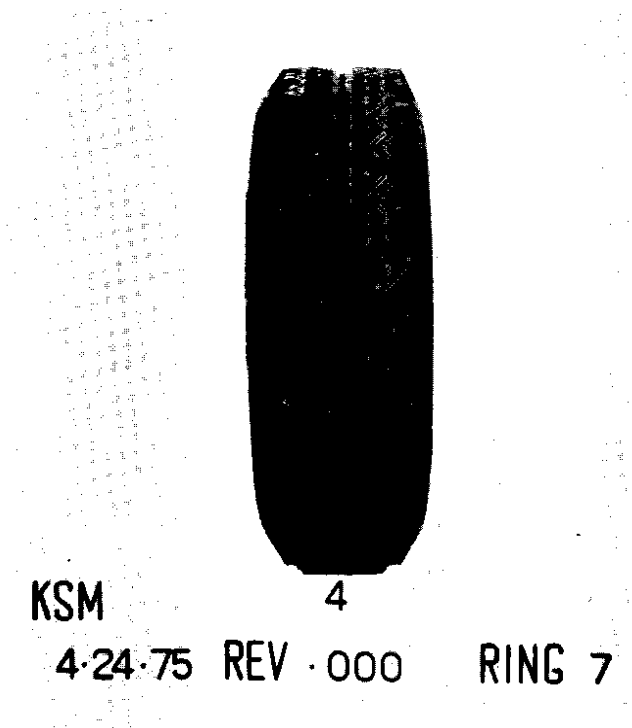
PRIOR TO WHEEL APPLICATIONS



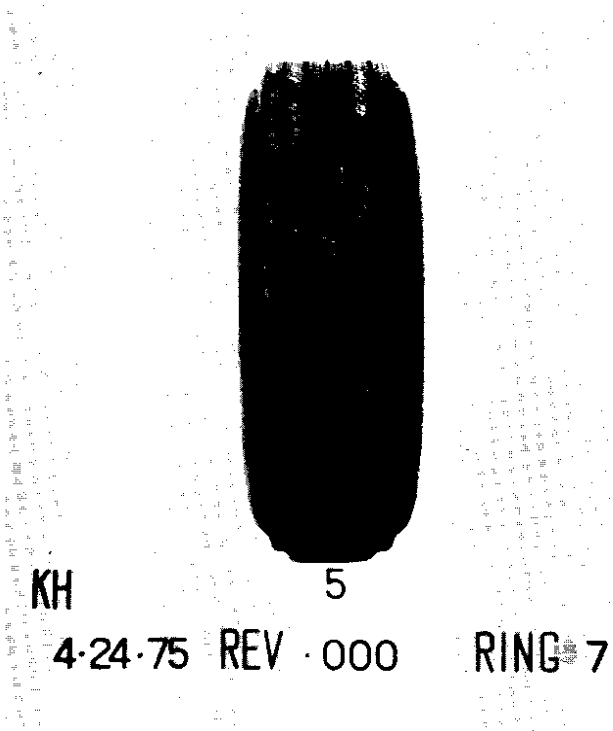
KISOR GARNET TIRE



KISOR STUDDED TIRE



KISOR SNOW AND MUD TIRE



KISOR HIGHWAY TIRE

TIRE CONDITION

PARTIAL NUMBER OF REVOLUTIONS
KISOR STUDDED TIRE

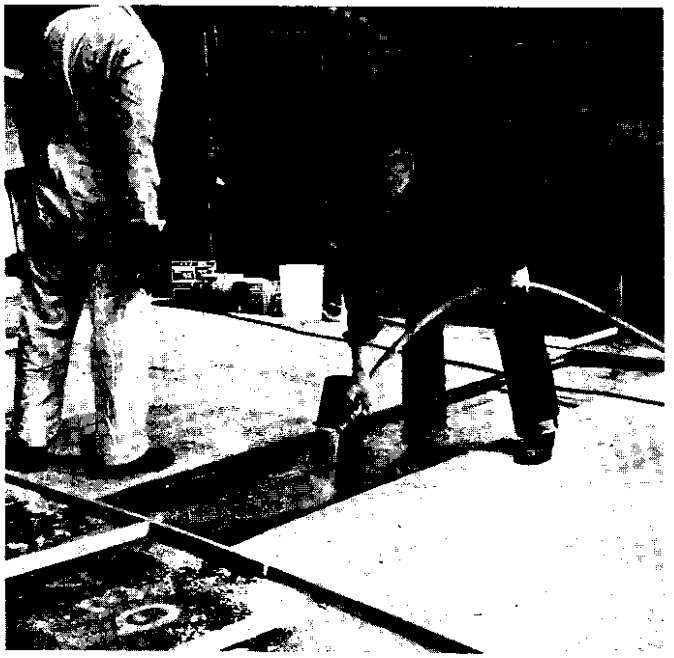
PARTIAL NUMBER OF REVOLUTIONS
KISOR GARNET TIRE

JACKHAMMERING PRECUT PATCH SECTIONS

SAWING UNDERCUT OF PATCH SECTION

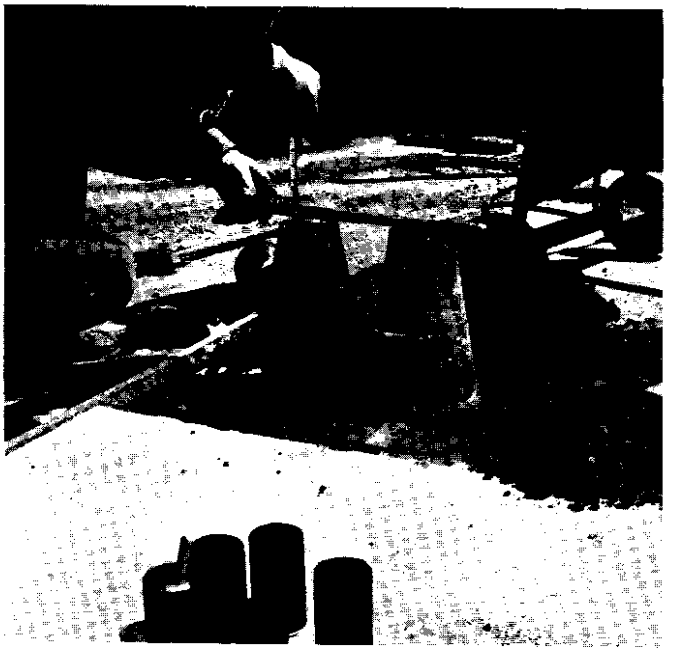
PATCH SECTION PRIOR TO PLACEMENT

WEIGHING AND MIXING PATCH MATERIALS



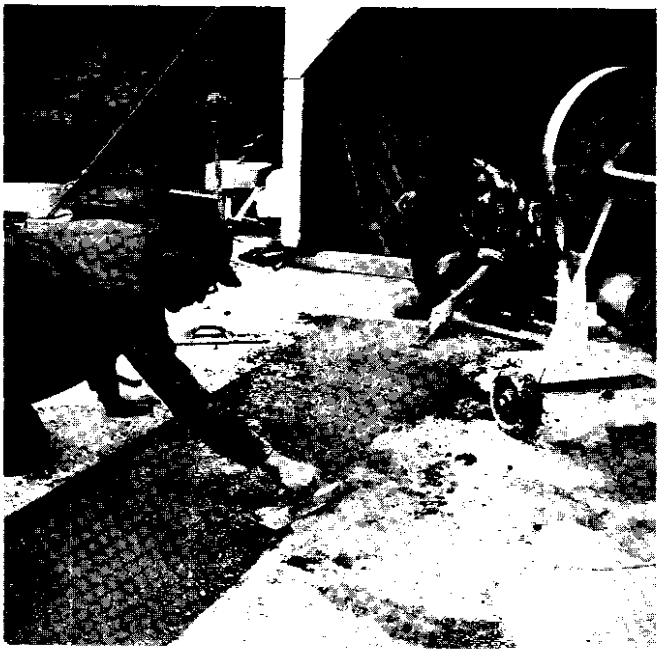
WATER SPRAYING PATCH AREA

PLACING PATCHING MATERIAL



SLUMP TEST

MAKING 2"d X 4" TEST CYLINDERS



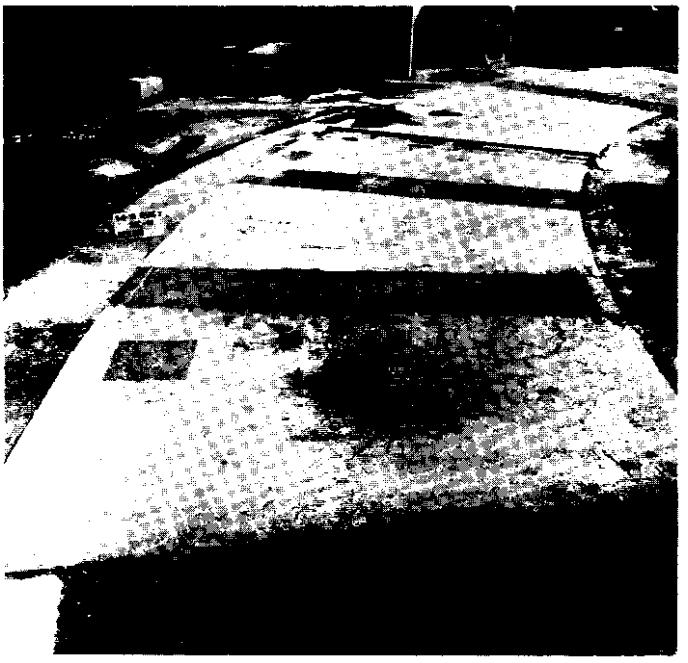
FINISHING THE PATCH

BROOM FINISHING

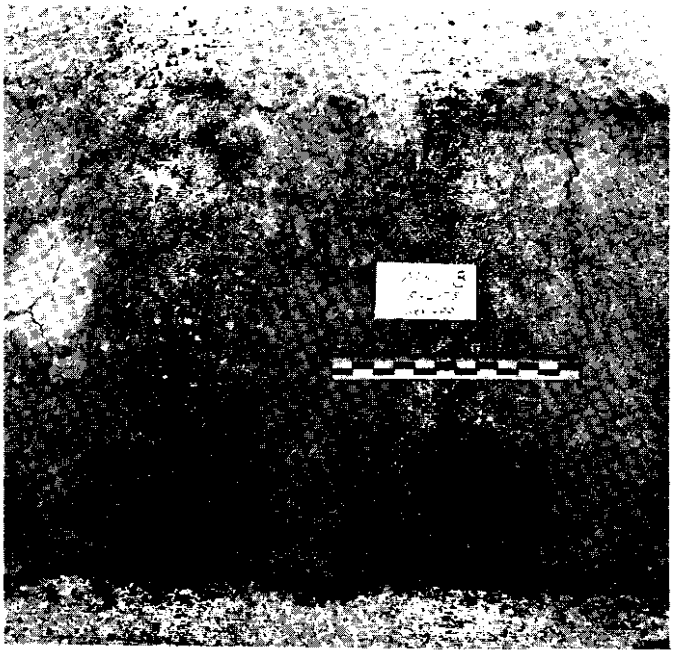
WATER CURING

BURLAP CURING

IMPACT HAMMER CURING TIME DETERMINATION

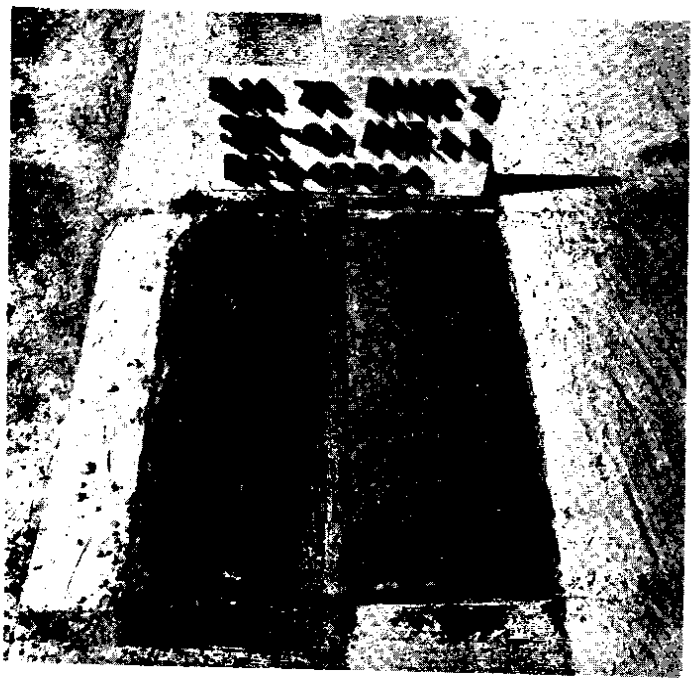


OVERALL VIEW OF PATCH PLACEMENT



CRACKS DEVELOPED IN MATERIAL #8
40 MINUTES AFTER PLACEMENT
(TEMP. <50°F)

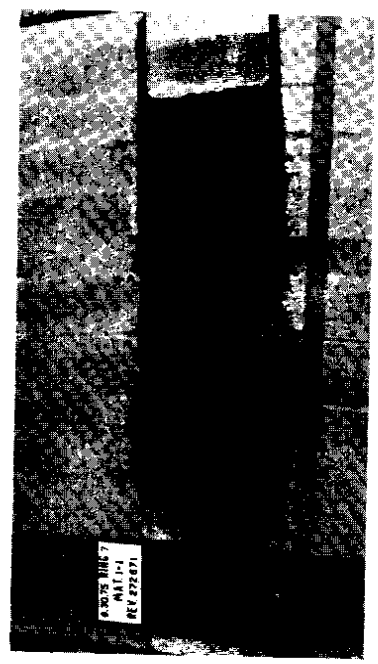
MATERIAL 1-1



WP-1 & 2

WP-1 & 2

WP-1 & 2
(CURVATURE REVERSED)



FINAL

MATERIAL 1-2

WP-1 & 2

WP-1 & 2

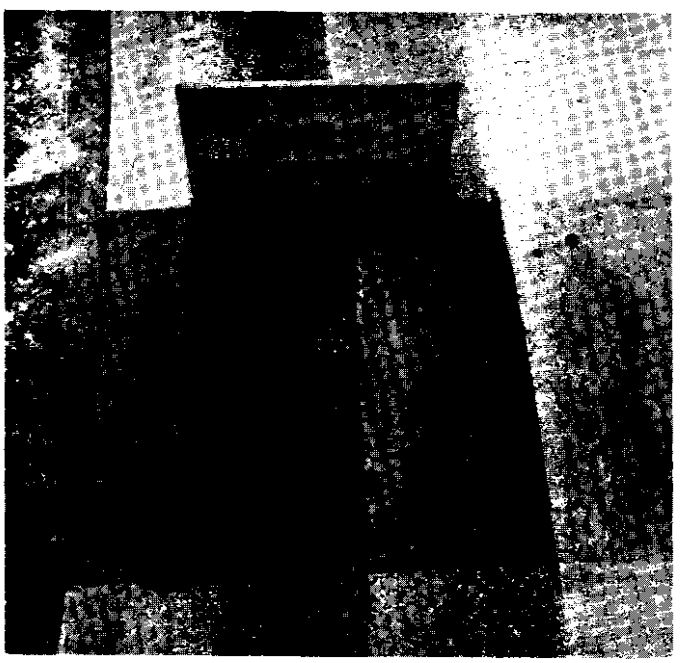
WP-1 & 2

FINAL

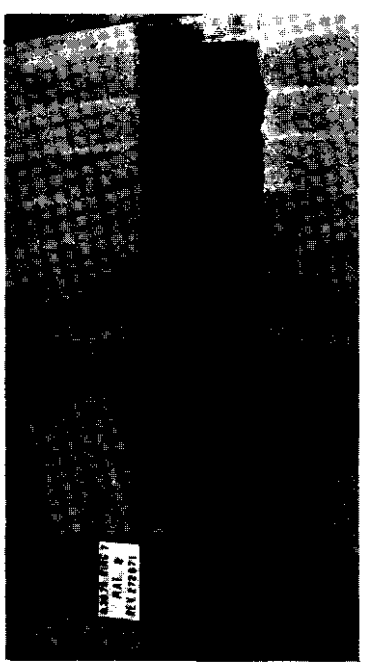
MATERIAL 2

WP-1 & 2

WP-1 & 2

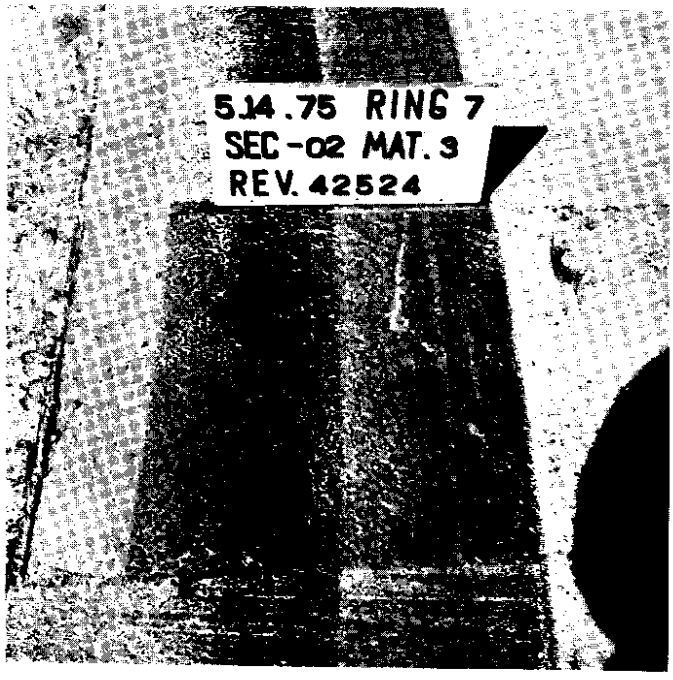


WP-I & 2



FINAL

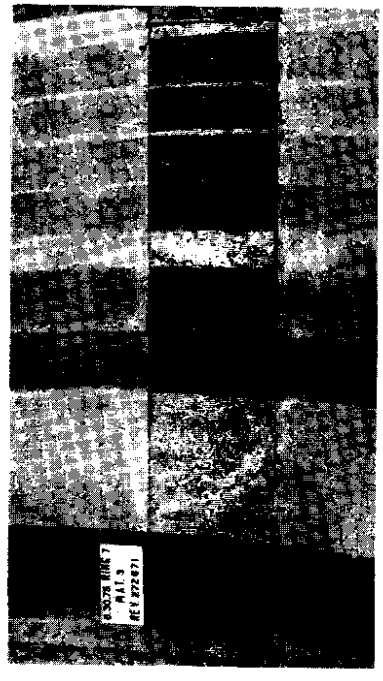
MATERIAL 3



WP-1 & 2

WP-1 & 2

WP-1 & 2



FINAL

MATERIAL 5

WP-1 & 2

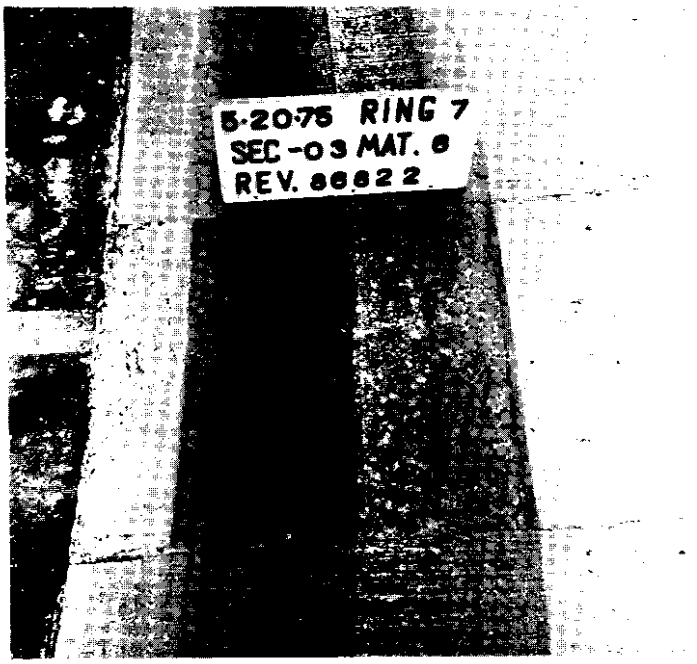
WP-1 & 2

WP-1 & 2

FINAL

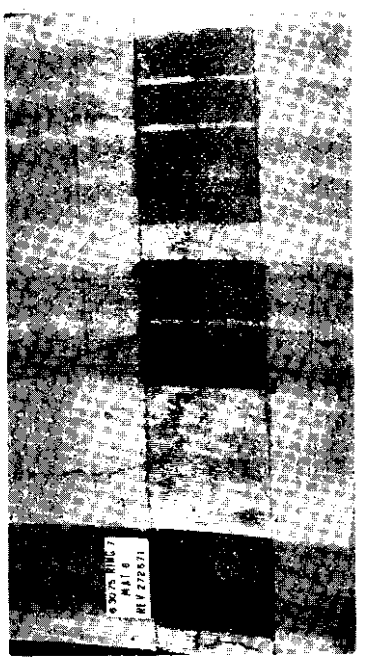
MATERIAL 6

WP-1 & 2



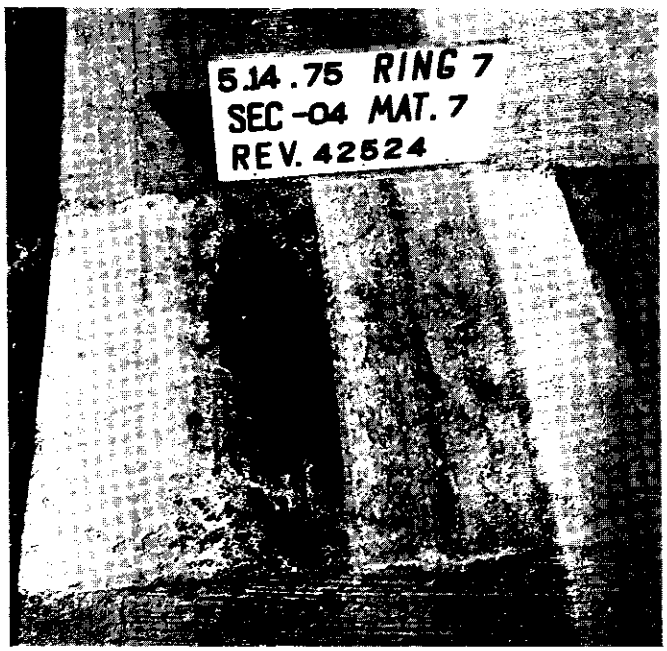
WP-1 & 2

WP-1 & 2

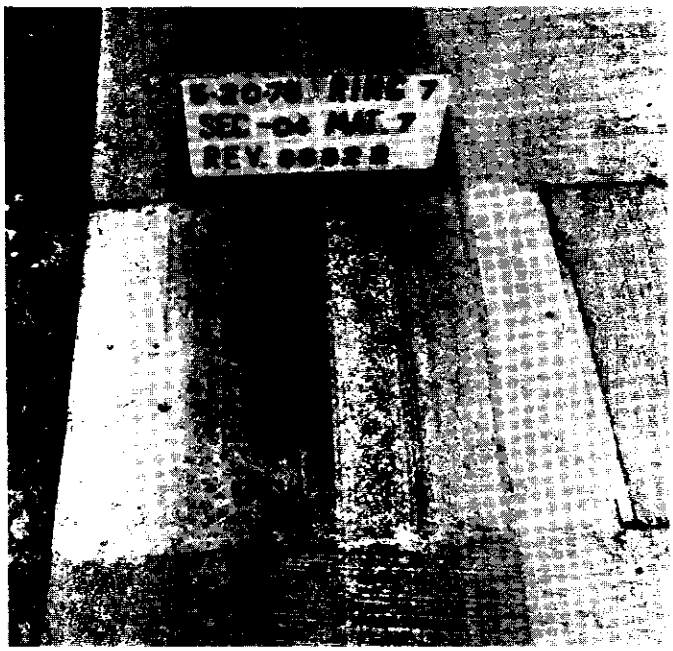


FINAL

MATERIAL 7

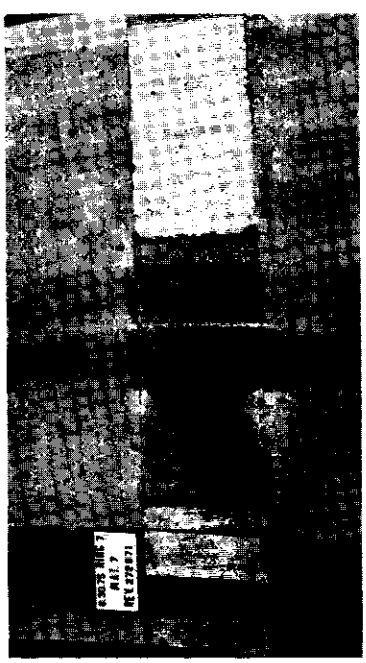


WP-1 & 2



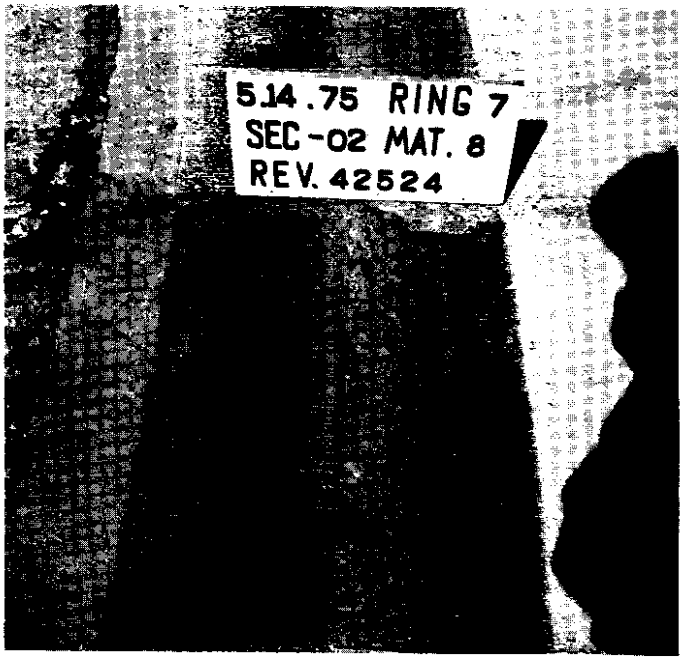
WP-1 & 2

WP-1 & 2
(CURVATURE REVERSED)

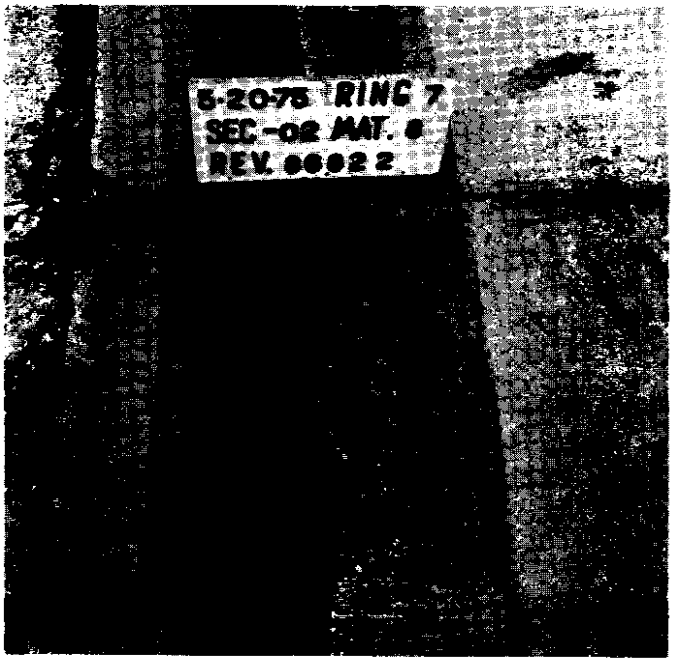


FINAL

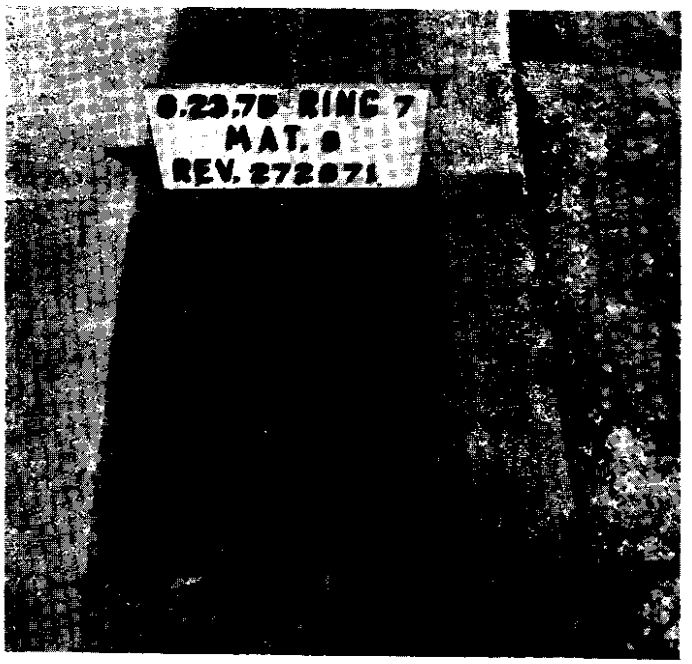
MATERIAL 8



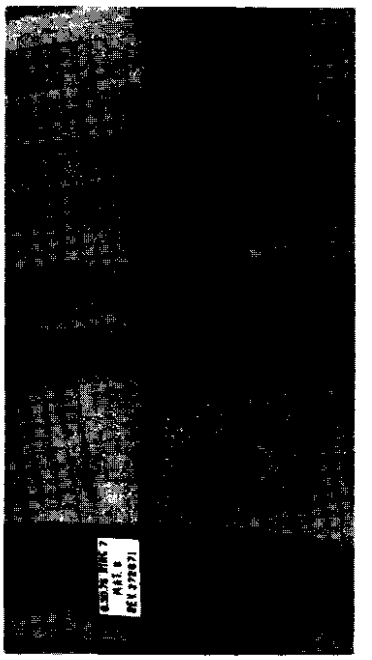
WP-1 & 2



WP-1 & 2

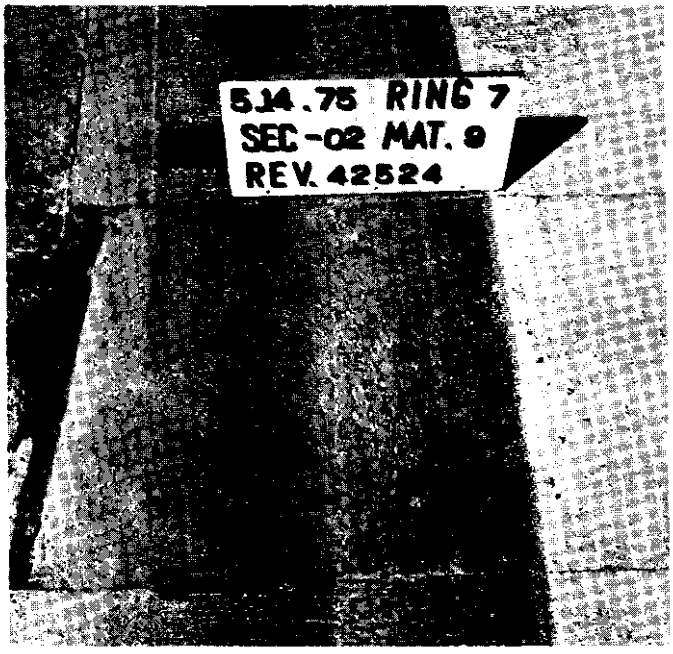


WP-1 & 2



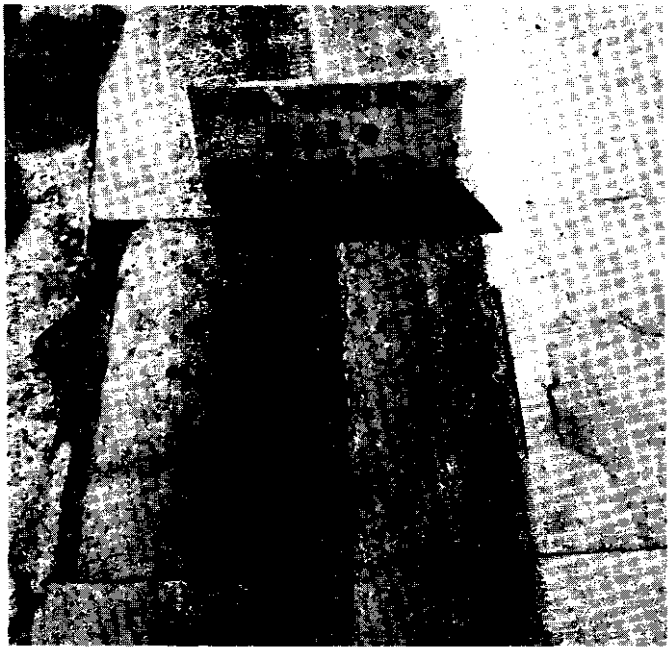
FINAL

MATERIAL 9

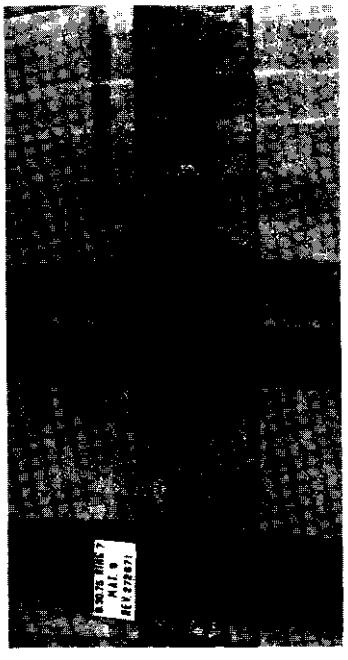


WP-1 & 2

WP-1 & 2



WP-1 & 2



FINAL

APPENDIX AM

Manufacturer's Mix Specifications

MATERIAL 1. . . . . .AM-1-1

MATERIAL 2. . . . . .AM-2-1

MATERIAL 3. . . . . .AM-3-1

MATERIAL 4. . . . . .AM-4-1

MATERIAL 5. . . . . .AM-5-1

MATERIAL 6. . . . . .AM-6-1

MATERIAL 7. . . . . .AM-7-1

MATERIAL 8. . . . . .AM-8-1

MATERIAL 9. . . . . .AM-9-1

SPECRETE

MIX PROPORTIONS

Bonding Slurry	Pounds
2 quarts Masco #2 WF defoamer	4.2
Cement "Fondu"	12.0
Masonry Sand	30.0
2 quarts H_2O	4.2
Yield - approx. 0.40 cf	50.4

Concrete Patching Material	
Cement "Fondu"	94.0
Concrete Sand, ssd	154.0
3/8" Pea Gravel, ssd	154.0
"Ribpatch" Wire	18.81
H_2O	37.6
Aluminum powder, 1 unit	
11.5 grams of Fisher aluminum powder in 0.5 lbs. fly ash	
Lithium Carbonate Accelerator, 1 unit	
9.0 grams of lithium carbonate in 0.5 lbs. fly ash	

Proprietary Mix	
Cement "Fondu"	94.0
"Alag" Fines	154.0
"Alag" coarse aggregate	154.0
"Ribtech" wire	18.81
Aluminum Power - 1 unit	
Accelerator - 1 unit	

PLACEMENT INSTRUCTIONS

Bonding Slurry

1. Place all Latex in bucket.
2. Add 1/2 mixing water.
3. Continue mixing with paddle mixer while adding sand.
4. Continue mixing while adding cement.
5. Add remaining water to brushing consistency.

Preparation of Old Concrete

Concrete to be patched should be clean and sound at edge of patch. Edges should be undercut approximately 3/4 inch.

Patch area should be saturated with water but without standing water.

Scrub bonding slurry into old concrete just prior to placing new concrete. Slurry should not be allowed to dry before placement of new concrete. If this occurs, reapply slurry material.

Concrete

1. Add aggregate as mixer revolves.
2. Add wire - mix thoroughly to eliminate wire balls or "clumps."
3. Add 3/4 of mixing water.
4. Add cement and continue mixing until thoroughly blended.
5. Add aluminum powder unit.
6. Add lithium carbonate.
7. Add remaining water.
8. Place concrete as rapidly as possible. Use compaction and vibration if available.

Finishing and Curing

1. Dust on mixture of 1 part Fondu cement to 4 parts "Alag" fines at a rate of 1 lb. per square foot of surface. Work into surface by using a float.
2. If desired, obtain diamond design texture by pressing expanded metal into surface.
3. Cure with wet burlap or brush on some of the bonding slurry. A membrane curing compound should also be used prior to opening to traffic.

Proprietary Mix

1. Prepare surface of old concrete in same manner as above.
2. Apply slurry as indicated previously.
3. Add 3/4 of the water to the mixer.
4. Add pre-mixed dry ingredients to mixer.
5. Add remaining water to desired consistency.
6. Finish and cure as indicated previously.

FIELD MIX AS USED IN WSU TEST

Mix 1-1

Proprietary mix used (pre-mixed ingredients)
4.5 gallons of water used
Slump 1.25 inches

Mix 1-2

Local concrete sand and gravel used. Moisture corrections made on aggregates. Total of 45 lbs. of water added. 132 lbs. of Fondu cement added to mix. Final slump 7.5 inches.

TIGERCRETE

GARON PRODUCTS INC.

DIRECTIONS
(as printed on sack)

SURFACE PREPARATION

Surfaces must be free from all oil, tar and foreign matter. Damaged Concrete surfaces should be cut back to sound concrete. Concrete floors subjected to traffic should be cut at right angles with surrounding surfaces. If steel rods are exposed all loose rust and concrete must be removed by sandblasting, hammer and chisel or wire brush.

Wash area to be patched, clean with water but do not leave excess standing water. Surfaces should be damp prior to application of TIGERCRETE.

APPLICATION

Mix TIGERCRETE to a batter consistency and apply a brush coat to cover all concrete and reinforcing rods prior to application of TIGERCRETE mortar. Mix approximately 30% water by volume to achieve a non-slump consistency. Mix only long enough to disperse the powder (approximately 1 minute). Avoid overmixing. Do not retemper with water once TIGERCRETE has started to set. Use conventional concrete curing methods.

Due to TIGERCRETE'S fast set only mix that amount of material that can be placed in five (5) minutes.

NOTE

For application to smooth surfaces it is recommended that TIGERBOND WP, concrete bonding additive be used with TIGERCRETE to achieve outstanding adhesion to concrete surfaces.

CAUTION

Prolonged contact of mixed mortar may irritate skin; use rubber gloves. After use, wash exposed skin promptly with water. In case of contact with eyes, flood eyes repeatedly with water.

These recommendations and suggestions for the use of our materials are based on tests believed to be reliable. However, since such use is beyond our control, we do not guarantee the results to be obtained in customer's processes. No representations either expressed or implied, are made with respect to the product, except as stated herein, and under no circumstances, either expressed or implied, will GARON PRODUCTS INC. be liable for damages in excess of the purchase price of this product.

WSU TEST MIX

WSU test used 30% water by volume. Instructions received subsequent to use recommends a w/c ratio of 0.19 by weight rather than the 0.25 actually used.

Recommended slump - 0.0 inches Actual slump - 4.5 inches

DURACAL

UNITED STATES GYPSUM
(as printed on sack)

DESCRIPTION

DURACAL cement is a fast-setting blend of portland and gypsum cements which develops high, early strength. It expands slightly during setting. Suitable for pavement patches, pothole repair and many other applications where these properties are required. Protect from moisture during storage and on the job.

PROPORTIONING

DURACAL cement can be used neat or aggregated. Since the various applications require different proportions and gradations of aggregate, refer to U.S.G. specifications for the proper proportions. Some typical proportions are below:

MIXING

Horizontal shaft mortar mixers such as plaster mixers are recommended. Conventional revolving drum concrete mixers may be used with coarse aggregate.
Mixing: Pour in water necessary for type of mix desired. With mixer operating, add one-half of aggregate. Add dry cement to aggregate and water. Add remaining aggregate. If necessary, add more water to obtain desired fluidity. Mix until lump-free, but not for more than five minutes. Use mix immediately.
Use clean water. Keep mixing and transporting equipment clean; wash after each mix. Dirty water and equipment will accelerate set of DURACAL Cement. Unless a special set is specified, this material will set in approximately 20 to 45 minutes. Acceleration from dirty conditions therefore, can cause problems.
Limitations: Do not permit DURACAL Cement mix to freeze before set has taken place. Use above grade only. Recommended only for temporary repairs.

	NEAT	1 PART SAND	1 PART SAND, 1 PART GRAVEL
DURACAL Cement	50 lb.	50 lb.	50 lb.
Water	1¼ gal.	1½ gal. (2)	1 3/4 (2)
Sand (1)	-	50 lb.	50 lb.
Coarse Aggregate (1)	-	-	50 lb.
Yield lbs. DURACAL per cu. ft. of mix	105.0	61.5	43.0

(1) Sand and coarse aggregate meeting ASTM C33 specifications. Maximum size of coarse aggregate not to exceed one third the minimum depth area to be patched.

(2) Water usage is approximate, and will be influenced by water content of aggregate.

WSU TEST MIX

Sand-Gravel (50-50) mix used. Actual water used was 1.5 gallons to obtain a slump of 3.75 inches.

BOSTIK 275

The Upco Company

Directions for Use
(as printed on sack)

1. Clean surface to which Bostik 275 is to be applied. All dirt, loose material, oil and grease must be removed to achieve proper adhesion.

2. Remove any surface water present.

3. Brush area to be repaired with a thin coating of Bostik 275 liquid.

4. Mix together rapidly in the proportion of 45 pounds (1 bag) of Bostik 275 powder and 1 gallon of Bostik 275 liquid. This may be mixed in a wheelbarrow or mortar box, but all mixed material must be placed within 5 minutes. Tamp well into hole. Screed to level and trowel immediately to desired finish. Patch will set within 10 minutes at 70^{0} F.

5. Never add water, fillers or solvents to mixture.

6. Clean all tools and mixers with water immediately after using.

CONTAINS MAGNESIUM OXIDE

Product is alkaline on contact with water. Avoid splashing into eyes or contact with skin. In case of such contact, flood eyes repeatedly with water and CALL PHYSICIAN. Wash thoroughly after handling and before smoking or eating. Do not take internally.

KEEP OUT OF THE REACH OF CHILDREN.

WARRANTY

This product was inspected before shipment and conforms to Upco's usual standards of quality for such goods at the time of shipment to Upco's purchaser. All other warranties, whether express or implied, including any warranties of merchantability and fitness for purpose, but without limitation thereto, are expressly excluded. Upco shall not be liable for consequential or special damages.

WSU TEST MIX

No bonding agent used.

Actual slump using recommended mix proportions was 0.0 inches.

MASTER BUILDERS

EMBECO* 411-A MORTAR

For Repairing Bridge Decks, Highways and Other Concrete Surfaces

description: EMBECO 411-A MORTAR is a specially prepared, ready-to-use, non-shrink, high strength mortar. EMBECO 411-A MORTAR contains metallic aggregate which provides greater flexural strength and fatigue resistance to withstand repetitive loading. It also contains a special air-entraining admixture and is formulated to provide quick, durable repairs to heavily travelled concrete highways, bridge decks and similar concrete surfaces subject to traffic and high surface wear ... where concrete is exposed to cycles of freezing and thawing and de-icing salts. EMBECO 411-A MORTAR mixes like grout for easy pouring into wheelbarrow and area to be filled, then it screeds and finishes easier than concrete - without danger of either rapid set or long delay.

benefits: EMBECO* 411-A MORTAR provides:

- Greater flexural strength and fatigue resistance to withstand repetitive loading.
- High early strength to reduce traffic lane shutdown.
- A non-shrink dense, durable mortar to withstand heavy traffic, repetitive freezing and thawing and the application of de-icing salts.
- Good bond to existing concrete.
- An easily workable mortar that hardens without bleeding and with little or no linear shrinkage.
- No gas expansion or bloating.

where to use: EMBECO 411-A MORTAR is recommended for:

- Repairing highways and bridge decks
  - . . . by lanes during short traffic shutdowns.
  - . . . by whole road area in minimum time when traffic can be shut off.
- Patching holes and spalled and worn areas 1" to 8" deep in concrete slabs, columns and beams.
- Repairing floors and parking areas subjected to heavy traffic.
- Repairing sidewalks, curbs and gutters.

where not to use: Do not use EMBECO 411-A MORTAR where it will come in contact with aluminum, magnesium or post-tensioned or prestressed anchorages or tendons.

Typical (1) Data on EMBECO 411-A MORTAR

Mix Data

Mixing water per 55 lbs. - 5.5 lbs. Slump - 3 inches
Yield per 55 lbs. - 0.42 cu. ft. Air Content - 6%

Properties

Compressive Strength, p.s.i (2" cubes) (2)

6 hrs.	760	3-Day	7850
9 hrs.	1840	7-Day	8990
12 hrs.	2670	28-Day	10200
24 hrs.	5030		

	P.S.I.		
	3-Day	7-Day	28-Day
Flexural (3 x 4 x 16-in. beams)	740	800	850
Split Tensile (6 x 12-in. cyl.)	____	480	490
Shear (3 x 3 x 10-in. beams)	____	2400	2450
Elastic Modulus (2000 p.s.i. load)	____	4.75×10^6	5.06×10^6

Durability, 300 Cycles, ASTM C 666 Proc. A.

Immersed In	DF%	Wt. Loss,%
Water	98	0.06
5% $CaCl_2$	97	1.6
5% NaCl	87	6.5

Salt scaling, 50 cycles, ASTM C 672: Good.

(1) The data shown are based on carefully controlled laboratory tests. Reasonable variations from the results shown are to be expected. Either field or laboratory tests should be controlled on the basis of the indicated slump rather than on the water content.

(2) Actual strength may exceed these by 10-25%.

temperature precautions: Ambient temperature should be as close to 70F as possible. When the temperature is considerably above or below 70F, special information on high and low temperature application techniques are available from the local Master Builders fieldman.

curing: If possible, wet cure EMBECO 411-A MORTAR using wet oil-free rags or burlap for several hours; then apply a membrane-type curing and/or sealing compound such as Master Builders Masterseal or Master Builders MB-429 curing and sealing compounds.

field service: The owner and/or contractor are urged to request the services of a Master Builders fieldman for pre-installation conference and during the initial stages of the installation to supply information on the proper use of EMBECO 411-A MORTAR. There is no charge for this service.

packaging: EMBECO 411-A MORTAR is packaged in 55 and 100-lb. moisture-resistant bags.

WSU TEST MIX

1 sack Embeco 411 A	100 lbs.	
3/8 inch - concrete aggregate	50 lbs.	
Water - 1½ gallons	12.5 lbs.	
Slump obtained, inches		4.0

SPEEDCRETE

FOLLOW THESE EXACT INSTRUCTIONS
(as printed on sack)

Generally, SPEEDCRETE handles like any other concrete - except that you must work FASTER. It must be out of the mixer in one minute. It must be trowelled immediately. DO NOT FEATHEREDGE.

Strength builds up in the first 30 seconds of mixing. Prolonged mixing weakens the product. So does excess water.

In most climates, you will need about 6 quarts of water for each 50 lb. bag. IF MIXED IN ROTARY MIXER. Use small mixer with rubber blade. Mix no more than 100 pounds at a time. Simply pour required amount of water into mixer, then add SPEEDCRETE. Mix just long enough to achieve the consistency of putty with NO SLUMP. Best mixing time is usually about 30 seconds. Do not leave SPEEDCRETE in mixer more than 60 seconds. DO NOT RETEMPER.

IF MIXED BY HAND. Small amounts of SPEEDCRETE, such as 5 to 10 pounds, can be readily mixed in a bucket. For larger amounts, use a wheelbarrow or bin. Pour in the proper ratio of water then gradually add the required amount of SPEEDCRETE. Knead the mix with your hands until consistency is like putty, with NO SLUMP. If hoe is used for larger amounts, simulate kneading motion. Do not mix beyond 60 seconds. DO NOT RE-TEMPER.

HOW TO USE IN PATCHING. Dampen area to be patched with water. Mix SPEEDCRETE according to instructions. Place or force mix into the patch and trowel it quickly. Trowelling must be finished in 3 to 5 minutes. Therefore, never mix more than you can quickly use.

FOR USE IN FREEZING WEATHER. Do not add anti-freeze. Anti-freeze is not needed because SPEEDCRETE SETS FASTER THAN WATER FREEZES. Request additional information on use of SPEEDCRETE in freezing weather from the manufacturer.

Patches which will receive foot or vehicular traffic should be a minimum of 1/2" to 3/4" deep. For deeper holes and extensive patches you may wish to mix aggregate with SPEEDCRETE. The size of the gravel should be 3/8" pea gravel or chip stone and the amount should not exceed 40 lbs. of added aggregate to each 50 lb. bag of SPEEDCRETE.

SPEEDCRETE should be cured as should all concrete.

WSU TEST MIX

25 lbs. of 3/8" - concrete gravel added to mix (50 lb. sack of Speedcrete).

11.33 lbs. of water resulted in 0.0" slump.

DAREX® 240 CONCRETE

INSTRUCTIONS FOR USE
(Manufacturer's Instructions)

Preparation

Concrete to be repaired with Darex 240 Concrete should be sound and surface dry. Remove loose concrete with a jackhammer or other suitable means. Remove dust, grease, or other contaminants. It is not necessary to saw cut areas to be repaired, providing other preparation steps are followed.

Mixing

Because Darex 240 Concrete will set in 8 to 10 minutes at 70° F, mixing and placement must be done quickly in warm weather. Do not attempt to mix more than one unit at a time unless the weather is cool enough to extend the setting time. Larger batches can generate enough heat to cause faster setting.

Add contents of the Activator Solution container to one unit of Binder/Aggregate and mix thoroughly by hand or low speed mechanical mixer. Mix until uniform - usually 2 to 3 minutes. Do not overmix. **Do not adjust consistency with water - use only Activator Solution in Darex 240 Concrete.**

Darex 240 Concrete should be mixed and placed in well ventilated areas. Some ammonia odor will be noticed during mixing and placement.

Placement

Darex 240 Concrete should be placed and finished quickly. When placing the mix, be sure to work it into cavities to obtain maximum adhesion. For deep patches, Darex 240 Concrete can be placed in more than one lift. A second lift will adhere to the first even if the first lift has set. Don't place any material which has started to set. Do not retemper. Darex 240 Concrete should be finished in the conventional manner.

Cleanup

Equipment and tools should be cleaned promptly with water. Darex 240 Concrete will adhere to metal if cleaning is delayed.

Safety

Consult Activator Solution label for requirements for avoiding skin or eye irritation.

Use only in well ventilated areas.

WSU TEST MIX

1 50 pound sack to 1 gallon of Activator Solution.

Slump - 0.0 inches.

LABORATORY EVALUATION OF DOW CONCRETE MODIFIERS A AND B

Small Batch Mixing

Thoroughly wet inside of mixer and place in dump position briefly to allow free water to drain out. Place all of the concrete modifier, about one-half of mixing water and aggregate in mixer. Mix for about a minute or until liquid and aggregate are well blended. Stop mixer and add cement. Mix for not more than 4 minutes - - adding remainder of mixing water to provide desired consistency. If materials have lumped up or not properly dispersed discard mix and start over. Mixing beyond specified time entrains excessive air.

A revolving drum type mixer of 1 1/2 cu. ft. mix capacity provides adequate mixing for modified mortar or concrete. The following appears to be optimum mixes for this type of mixer.

MORTAR

Cement	14.5 lb.
Aggregate (fine)	47.0 lb. (D.W.)
Modifier	4.5 lb.
Water	2.75 lb. (Varies somewhat)

CONCRETE

Cement	14.5 lb.
Aggregate (fine)	36.3 lb. (D.W.)
Aggregate (coarse)	29.0 lb. (D.W.)
Modifier	4.5 lb.
Water	2.75 lb. (Varies somewhat)

Test Conditions:

If possible, all operations should be performed in an atmosphere maintained at 73°F ± 3° and a relative humidity of 50 percent. All materials and apparatus should be equilibrated to these conditions at time of use.

Curing Conditions

Specimens should be damp cured in the molds for 24 hours by covering with a damp cloth and a thin sheet of plastic film to retard evaporation. Curing thereafter at 73 4°F, 50% relative humidity is advisable if facilities are available. Otherwise dry air cure at room temperature.

WSU TEST MIX

Concrete mix on preceding page used. Local concrete sand and 3/8" minus aggregate were included. Water was added in the specified ratio. (Modifier B used)

Final Slump - 3.0 inches.

ROADPATCH
(as printed on sack)

ROADPATCH

A new cement base, fast-setting, non-shrinking patching mortar that develops strength quickly so that the concrete area that needs repair can be put back into service with just a minimal shutdown. ROADPATCH is packaged ready for use with just the addition of clean water. At normal temperatures, initial set takes place in 10-15 minutes and will set hard in 25-30 minutes. At lower temperatures, the setting time will be faster. It is recommended to keep traffic off the patch for at least two hours or longer, depending on setting conditions.

COVERAGE

1# fills 17 cu. in. or a 50# bag will cover about 25 sq. ft. 3/4" thick.

TEST DATA

Comprehensive strength, psi	4 hours	24 hours	7 days
	1250	2500	5150

APPLICATION

Surface to be patched must be structurally sound; clean area to be patched, thoroughly. Chip out all loose materials and disintegrated concrete, undercutting is desirable for a good mechanical lock. Remove all grease, oil, dirt, laitance, and provide a clean solid surface. (To remove grease and oil easily, use THOROCON. See Technical Bulletin 72B.)

Thoroughly mix the dry ingredients and add the proper amount of clean water to bring the material to the right low slump patching consistency. (Approximately 3-4 quarts clean water per 50# bag.) Do not overwet the mix. Mix only 1-2 minutes just enough to thoroughly wet the dry material. Note: 25 lbs. of clean, dry aggregate (3/4" or less) may be added to each 50# ROADPATCH for patches in excess of 1" thick.

Note: If extra bond strength is required, or desired, a mixture of one part ACRYL 60 to three parts water can be substituted for the regular mixing water. (See Technical Bulletin 67 C).

Force the material against the sides and bottom of the area to be patched. Fill the entire area. Do not feather edge ROADPATCH or apply in thin overlays or patches. Trowel and finish surface and allow to cure. Do not retemper; if ROADPATCH sets up, discard it. Not to be used in temperatures less than 35 degrees F, or over frozen or frost-filled surfaces.

WSU TEST MIX

25 pounds of 3/8" minus concrete gravel was used. Three quarts of water plus one quart of "Acryl 60" was included.

Actual slump - 0.5 inches.