FEAP-UG-92/03
June 1992

MP GL-92-14

FACILITIES ENGINEERING APPLICATIONS PROGRAM

USER'S GUIDE

USER'S GUIDE: FUEL-RESISTANT PAVEMENT SEALERS

by

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U.S. Army Engineering and Housing Support Center
Fort Belvoir, VA 22060-5516

Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 1992	Final report

4. TITLE AND SUBTITLE
User's Guide: Fuel-Resistant Pavement Sealers

5. FUNDING NUMBERS

6. AUTHOR(S)
James E. Shoenberger

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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Geotechnical Laboratory
3909 Halls Ferry Road
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8. PERFORMING ORGANIZATION REPORT NUMBER
Miscellaneous Paper
GL-92-14

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers
Engineering and Housing Support Center
Bldg. 2593
Fort Belvoir, VA 22060-5516

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FEAP-UG-92/03

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The user guide provides the technical information required to implement application of fuel-resistant pavement sealers to asphalt concrete. Included are details on areas of application, benefits/advantages, limitations/disadvantages, and costs associated with this technology. Information on two demonstration sites at Fort Rucker and Fort Belvoir is provided. Also provided is information concerning funding, procurement, maintenance, and performance monitoring. A summary of the demonstrations, fact sheets on the five sealers used during these demonstrations, and a reference are provided in the appendices.

14. SUBJECT TERMS
Asphalt concrete sealer
Fuel-resistance
Pavement sealer

15. NUMBER OF PAGES
36

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

CONTENTS

USER'S GUIDE: FUEL-RESISTANT PAVEMENT SEALERS

PART I: EXECUTIVE SUMMARY

Description

Significant damage can occur to asphalt pavements that are exposed to fuel spillage. Parking and maintenance areas are the locations normally most exposed to fuel spillage. The use of fuel-resistant pavement sealers protects these asphalt concrete pavements from exposure to these spillages. Coal tar emulsion sealers are used almost exclusively with some other sealers being tried, on an experimental basis, in small quantities.

Application

Fuel-resistant pavement sealers will protect asphalt pavements from the effects of fuel spillage and extend the life of parking and maintenance areas.

Benefits

Fuel-resistant pavement sealers protect existing asphalt pavements from distress caused by fuel spillage. These asphalt pavements would quickly fail and require expensive repairs if not protected by the sealers. These sealers allow for expanded use of any asphalt pavement as an acceptable maintenance area after coverage of a sealer.

Limitations

The useful life of a fuel-resistant pavement sealer varies normally from 3 to 5 years before requiring resealing. As with most bituminous materials, construction should occur during the summer when the temperature is warmer than any other time of the year.

Costs

The cost of applying a fuel-resistant pavement sealer will vary with the size of the area sealed, the method of sealing utilized (hand versus mechanical), the type of sealer used, and availability of an experienced contractor. The costs of the materials for the two demonstration projects varied from $0.45 to $10.88 per sq yd. The cost for a coal tar emulsion seal for an average size parking lot would normally vary between $1.00 to $1.75 per sq yd. (1992 prices).

Recommendations for Use

Fuel-resistant pavement sealers are recommended for use on any asphalt pavement to be exposed to fuel spillage. All refueling areas, maintenance areas, and any area where vehicles will be parked on asphalt pavements should be sealed.

Points of Contact

Points of contact regarding this technology are:

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Fort Rucker, AL 36362-5135
Telephone: 205-255-3393

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PART II: PREACQUISITION

Description of Fuel-Resistant Sealers

The vase majority of Army pavements are constructed of asphalt concrete. Spilled fuel, oils, and hydraulic fluids soften the asphalt binder of these pavements causing the pavement to disintegrate and erode. Asphalt parking lots, airfield parking aprons, fueling sites, and maintenance areas are all subject to fluid damage. These fuel spills can be relatively large amounts spilled in accidents; however, the majority of spillage occurs in small amounts during normal operations over a long period of time.

Coating the pavement with a fuel-resistant sealer can prevent or minimize asphalt pavement damage due to spilled fluids. For years, coal tar emulsions have been the standard sealer used. However, these sealers have a relatively short life due to their susceptibility to cracking and raveling. Several manufacturers have developed additives for these coal tar sealers that are designed to increase their effectiveness. Recently, other fuel-resistant sealers have appeared on the commercial market, including various epoxy or rubber compounds. All of these sealers can be applied by hand as a slurry mixture or mechanically by spraying or squeegeeing in one or more coats. Sand is usually added to provide a skid-resistant surface.

Application

Fuel-resistant pavement sealers should be used on any asphalt concrete pavement surface exposed to possible fuel spillage. Parking, maintenance, and refueling areas are locations normally requiring sealers. These sealers will protect the asphalt surface and extend the life of the pavement.

Limitations/Disadvantages

The vast majority of fuel-resistant sealers currently available contain coal tar as their main ingredient. Coal tar ages quickly and is very susceptible to temperature cracking, usually within 1 year of placement. Latex rubber and other proprietary materials are often added to improve the

properties of the coal tar; however, the sealed areas will normally require resealing within 3 to 5 years depending upon local climatic conditions.

FEAP Demonstration/Implementation Sites

In 1984 demonstration projects were conducted at Fort Rucker, Alabama and Fort Belvoir, Virginia. Five different types of fuel-resistant pavement sealers were placed at each location. At Fort Rucker, the asphalt pavement around ten helipads was sealed. The concrete pads each measured 13 by 15 ft with the sealer extending a minimum of 15 ft in each direction beyond the pad. Ten pads were selected with each sealer placed at two of the pads. The sealers were placed in two lifts at each location with each lift containing sand for a skid-resistant surface. Table 1 lists the name and application rate of each pavement sealer material. At Fort Belvoir several parking locations on an asphalt apron were sealed. The parking areas each measured about 50 by 60 ft. Six parking areas were sealed with one product placed in a single lift on two of the parking areas. These single lifts each had sand added to them for skid resistance. The remaining four locations each had one of the remaining sealers placed on them. The sealers were placed in two lifts with sand added to only the last (top) lift. Table 2 lists the name and application rate of each pavement sealer material. The sealers at both Fort Rucker and Fort Belvoir were mixed and placed by hand. The mixing took place in a plastic garbage can with a hand-held electric mixer. The sealers were then dumped onto the pavement and applied with hand-held squeegees.

Life-Cycle Costs and Benefits

Fuel spillage will damage asphalt pavements and will result in a severely reduced service life, increased maintenance costs, and decreased overall appearance. Fuel-resistant sealers can prevent or severely reduce the damage caused by these spills. The increased cost of these sealers is easily offset by the decreased maintenance costs that would have occurred if a sealer had not been applied. When selecting a type of sealer to be used, the life-cycle costs must be considered and not just the initial costs. A material which performs better for a longer period of time may be more cost-effective even with a higher initial cost.

Table 1
Fort Rucker Demonstration

Material	Layer	Sand Content* lb per sq yd	Application Rate** gal per sq yd
AEX-1480	1	0.9	0.17
	2	0.7	0.15
No. 21 Epoxy	1	0.9	0.16
	2	0.6	0.14
Super Seal	1	1.2	0.18
	2	1.0-2.2†	0.14
R-526B and R-607	1	0.9	0.13
	2	0.7	0.11
M-6249	1	1.1	0.18
	2	1.0	0.14

* Sand content, except for Super Seal and to a lesser extent M-6249, is limited by the sealer's ability to hold sand in suspension.

** Application rates for the first layer are generally higher due to sealer absorption and pavement defects (filling in cracks, etc.).

† The larger amount of sand was added to part of one pad. It mixed and applied well, and even more could have been added.

Table 2
Fort Belvoir Demonstration

Material	Layer	Sand Content* lb per sq yd	Application Rate** gal per sq yd
AEX-1480	1	None	0.15
	2	0.8	0.13
No. 21 Epoxy	1†	1.0	0.12
Super Seal	1	None	0.18
	2	1.5	0.13
R-526B and R-607	1	None	0.15
	2	0.9	0.12
M-6249	1	None	0.18
	2	1.0	0.16

* Sand was not applied in the first layer except for No. 21 Epoxy, Sand content, except for Super Seal and to a lesser extent M-6249, is limited by the Sealer's ability to hold sand in suspension.

** Application rates for the first layer are generally higher due to sealer absorption and pavement defects filling in cracks.

† No. 21 Epoxy was placed in one layer only.

Costs

Five sealers were used in each demonstration at Fort Rucker and Fort Belvoir. The sealer materials used and the material cost per square yard as they were applied are given in Table 3 below:

Table 3
Material Costs (1984 Prices)

Material	Fort Rucker (Cost per sq yd)	Fort Belvoir (Cost per sq yd)
AEX-1480	$10.88	$9.52
No. 21 Epoxy	$5.97	$2.39
Super Seal	$0.46	$0.45
Rub-R-Road (R-526B)	$3.95	$4.44
Royal M-6249	$4.78	$5.08

The costs given above do not include the costs of application which would be approximately equal for each of the sealers. The cost for application of the sealers at the two demonstrations was approximately $1.70 per square yard. The cost of materials and of applying them will tend to decrease as the size of the area sealed increases. For the more expensive sealer materials to be cost-effective, the useful life of the sealer must be several times longer than the less expensive sealers.

Advantages/Benefits

Fuel-resistant pavement sealers reduce the maintenance and operating costs of asphalt pavements exposed to fuel spillage. Fuel-resistant pavement sealers will allow for the utilization of existing asphalt pavements for areas to be subjected to fuel spillage as requirements dictate or in expedient situations.

PART III: ACQUISITION/PROCUREMENT

Potential Funding Sources

Typically, installations fund the implementation of pavements and railroads technologies out of their annual budgets. However, the annual budget is always underfunded and normally the pavements and railroads projects just do not compete well with other high visibility/high interest type projects. As a result, it is in your best interest to seek all of the funds possible from other sources when the project merits the action. Listed below are some sources commonly pursued to fund projects.

a. Productivity program. See AR 5-4, Department of the Army Productivity Improvement Program for guidance to determine if the project qualifies for this type of funding.

b. Facilities Engineering Applications Program (FEAP). In the past, a number of pavement and railroad maintenance projects located at various installations were funded with FEAP demonstration funds. At that time, emphasis was placed on demonstrating new technologies to the Directorate of Engineering and Housing (DEH) community. Now that these technologies have been demonstrated, the installations will be responsible for funding their projects through other sources. However, emphasis concerning the direction of FEAP may change in the future; therefore, don't rule out FEAP as a source of funding.

c. Special programs. Examples of these are as follows:

(1) FORSCOM mobilization plan which may include rehabilitation or enlargement of parking areas and the reinforcement of bridges.

(2) Safety program which may include the repair of unsafe/ deteriorated railroads at crossings and in ammunition storage areas.

(3) Security upgrade which may include the repair or enlargement of fencing.

d. Reimbursable customer. Examples of this source are roads to special function areas such as family housing or schools and airfield pavements required to support logistical operations.

e. Special requests from MACOMS.

f. Year end funds. This type funding should be coordinated with the MACOMS to ensure that the funds will not be lost after a contract is advertised.

g. Operations and Maintenance Army (OMA). These are the normal funds used for funding pavement and railroad projects.

Technology Components and Sources

Components of this technology which must be procured for the application of fuel-resistant pavement sealers are the sealer material and an aggregate to provide a skid resistant surface texture. The proportioning of materials must be developed depending on the materials used and the pavement to be sealed. The pavement to be sealed must be properly prepared, including sweeping and repairing of deficient areas. The fuel-resistant sealers can then be mixed and placed on the pavement surface. On small jobs this work can be handled in-house, but on larger jobs or where in-house labor is not available the work can be contracted out. A construction contractor is needed (may be in-house) to perform pavement preparation and obtain necessary fuel-resistant sealer and aggregate. Also, a contractor is necessary to mix and place the fuel-resistant sealer on the pavement.

All of the items used in the installations of a fuel-resistant pavement sealer are conventional materials and procedures that are normally used by the construction industry. The procedures and equipment used are similar to those for asphalt slurry seals.

Procurement Documents

The specifications used by most installations are particular to that installation and are drawn from various agencies and manufacturer guide specifications. A Corps of Engineers guide specification CEGS-02584 "Fuel Resistant Sealers" is available and can be obtained from your supporting USACE District Office. No specifications were developed for either demonstration project, as they were completed in-house. The following is a list of vendors and prices:

a. AEX-1480
Adhesive Engineering Company
1411 Industrial Road
San Carlos, CA 94070
415-592-7900

Cost: $34.00/gal (1984)

b. No. 21 Epoxy
American Protective Coatings Corporation
American Building
11350 Brook Park Road
Cleveland, OH 44130
216-676-9500

Cost: $19.90/gal (1984)

c. Super Seal
Koppers Company, Inc.
440 College Park Drive
Monroeville, PA 15219
412-227-2295 or 614-522-3131

Cost: $1.45/gal (1984)

d. Rub-R-Road (R-526B)
Rub-R-Road, Inc.
1206 North Main Street
Akron, OH 44720
216-499-2900

Cost: $16.44/gal (1984)

e. Royal M-6249
Uniroyal, Inc.
312 N. Hill Street
Mishewaka, IN 46544
219-255-2181

Cost: $14.93/gal (1984)

Procurement Scheduling

Normal construction contract schedules should be established that allow adequate design and plan preparation time; design, review, and approval; contract preparation; advertising and award; and construction time. A typical pavement sealing project is normally planned and prepared for 1 year before it

is constructed; however, relatively small projects that require limited plans and specifications can be prepared and ready to go within a few months.

PART IV: POST ACQUISITION

Initial Implementation

Equipment

The type of equipment used depends on the amount and type of sealer to be placed and the area to be sealed. Small amounts can be adequately placed by hand with squeegees and portable mechanical mixers. A small portable generator can be used to provide electricity. Larger amounts require placement by suitable self-propelled mechanical-type distributors capable of accurately metering and mixing the slurry components and placing the mixture all in one operation.

Materials

The materials required include sand and sealer. The sand is required for filling small voids and cracks and also provides a suitable skid-resistant surface for traffic. The amount of sand used will vary with the type of sealer and other conditions as required. The sealers can normally be obtained in containers varying in size from 5 gallon buckets to 55 gallon drums. For larger jobs the sealer can be obtained in bulk by truck or rail car tanker. The storage requirements of these materials will vary with the type of material, but generally the materials should be kept in a dry location with the temperature maintained above freezing.

Personnel

Properly training personnel are required to assure proper mix proportions and application of fuel-resistant pavement sealers. These skills are easily developed, and one or two of these trained personnel could supervise untrained personnel to mix and apply the sealers. Mechanical application would require from two to four people for normal operations. Hand application of the sealers requires a larger number of laborers for mixing and placement.

Procedure

Given an asphalt pavement potentially subjected to or damaged by past fuel spillage, the procedure has two major steps:

a. Establish a cost-effective solution from one of three options as listed:

    (1) Place a fuel-resistant sealer on existing surface.

(2) Repair damaged pavement and place a sealer.

(3) Replace asphalt with PCC.

b. Construct the fuel-resistant pavement sealer. The judgment to seal or repair the existing pavement will depend upon the extent of the damage in the existing pavement. Pavements that are structurally sound can be sealed. Pavements containing areas where the asphalt surface has raveled or rutted due to fuel spillage or other structural damage should be repaired (removal and replacement). The third option, to replace the asphalt pavement with PCC, eliminates the need for the sealer. This option should be considered when it is cost-effective or justifiable by use.

The construction method recommended varies with the type of sealer and the size of the area to be sealed. The following are general construction recommendations for pavement sealing:

a. The pavement should be cleaned of all organic and loose material using hand or power brooms.

b. Damaged pavement should be repaired prior to sealing. Newly laid asphalt pavements should be allowed to cure for several weeks prior to sealing.

c. The use of a mechanical squeegee to apply the sealer when applicable will provide for a more uniform surface than hand squeegeeing. The application rate can be more accurately controlled by mechanical than by hand application. No matter how the sealer is applied, when a squeegee is used the minimum rate or thickness is controlled by the maximum sized aggregate particle in the sealer mixture. The squeegee must ride over these particles and the as-placed thickness cannot be less than the diameter of the largest aggregate particles. Spraying of the sealer provides the most control over application rates, as the rate is not affected by the size of the aggregate. Where large cracks are to be sealed, they should be filled and allowed to cure completely before the first coat of sealer is applied.

d. Clean, dry sand is added to the sealer to provide a suitable riding surface. The sand will also aid in filling any cracks and normally improves workability of the sealer.

e. A second coat of sealer is required (except for No. 20 Epoxy) when there are pinholes or voids left in the first coat. These pinholes or voids occur most often when a component of the sealer evaporates as it cures. A second coat also helps correct minor surface defects present in the pavement, such as small cracks and holes.

f. Traffic should not be allowed on the sealer for a minimum of 24 hr after placement, but in no case before the sealer has achieved an initial set.

Operation and Maintenance

Operation and maintenance of a fuel-resistant pavement sealer is no different than that of any asphalt concrete surface.

The life expectancy of a fuel-resistant sealer will depend on a combination of factors including type of sealer, local climatic conditions, and traffic. Manufacturers have developed additives and proprietary products designed to prolong the life of the sealers. As a general rule, the milder the climate (less exposure to extreme hot or cold) the longer a sealer or any pavement will last. High traffic levels or traffic with heavy loads or high pressure tires will tend to reduce the life of a sealer. The normal span of time between required maintenance or possible resealing is normally 3 to 5 years. The application of a sealer can be accomplished by hand for small areas. Mechanical application equipment is commercially available for larger amounts. The amount of training required is minimal; all that is normally required is to follow the product manufacturer's directions for mixing and application.

Service and Support Requirements

No special services or support is required to implement or maintain this technology.

Performance Monitoring

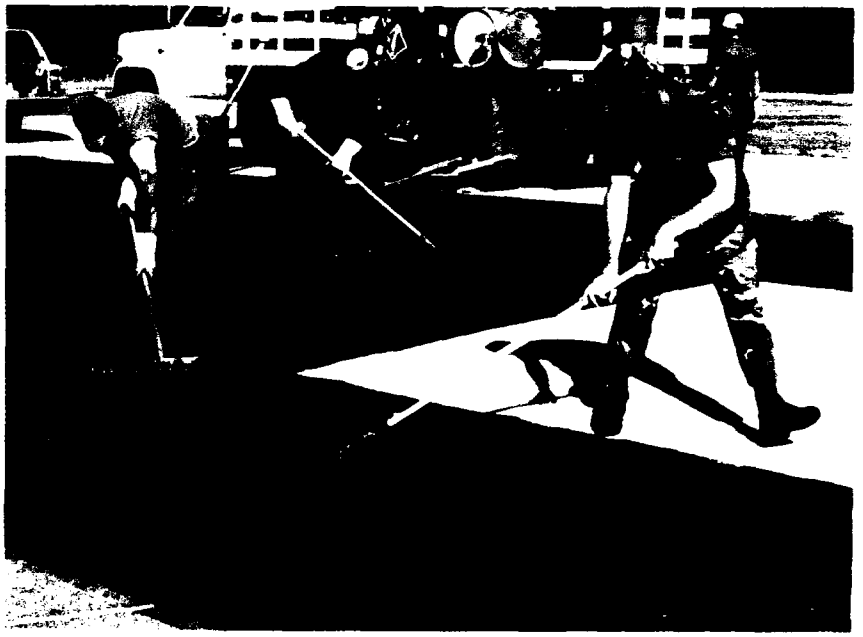
Installation personnel can monitor and measure the performance of the fuel-resistant sealer by making periodic inspections of the surface for signs of distress (cracking, rutting, etc.). Unusual traffic or climatic conditions could adversely affect performance and should be noted. The sealer should be considered to be performing satisfactorily, provided that it seals off the surface of the underlying asphalt pavement. Failure will occur when cracks or another distress forms that allows fuel spill to penetrate and affect the underlying surface.

APPENDIX A: AD FLIER

FACILITIES ENGINEERING APPLICATIONS PROGRAM

Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

Fuel-Resistant Sealers



Top left: **Fuel damaged pavement at Fort Belvoir, VA, had to be removed and patched before the fuel-resistant sealer could be applied.** ***Bottom left:*** **The mixed sealer is poured onto the pavement and spread with a squeegee.** ***Above:*** **Workers apply fuel-resistant sealer to the asphalt pavement that surrounds a concrete helipad at Fort Rucker, AL.**

Protect Asphalt Pavements Against Fuel Spills

PROBLEM: Spilled fuel, oil, and other fluids soften the asphalt binder, causing the pavement to disintegrate and erode.

TECHNOLOGY: Application of fuel-resistant seal coat protects asphalt pavements from fluid damage.

DEMO SITES: Fort Rucker, AL - FY84
Fort Belvoir, VA - FY84

BENEFITS: Fuel-resistant sealers can greatly extend the useful life of asphalt pavements in areas where fuel spills occur.

Description of Technology

Spilled fuels, oils, and hydraulic fluids soften the asphalt binder of concrete pavements, causing the pavement to disintegrate and erode. Asphalt parking lots, airfield parking aprons, fueling sites, and maintenance areas are all subject to fluid damage.

Coating the pavement with a fuel-resistant seal can prevent or minimize asphalt pavement damage due to spilled fluids. For years, coal emulsions have been the standard sealer used. However, these sealers have a relatively short life due to their susceptibility to cracking and raveling. In recent years, other fuel-resistant sealers have appeared on the commercial market, including various epoxy or rubber compounds. They can be applied mechanically, or by hand as a slurry mixture or in one or more coats. Also, sand can be added for a skid-resistant surface.

Details of Demonstration

Five different types of sealers were selected for field demonstrations: a coal tar emulsion with rubber, a coal tar epoxy, a resin epoxy, a rubberized sealant, and a rubberized adhesive.

In May 1984, the asphalt areas surrounding 10 portland cement concrete helipads at Fort Rucker, AL, were sealed using the five different sealants. All the sealers were mixed according to the manufacturers' recommendations. Concrete sand was added to the sealer mixtures to provide a skid-resistant surface. The sealer mixtures were poured onto the asphalt pavements and spread with squeegees. Two coatings of each sealer with sand were applied.

Six asphalt airplane parking areas at Fort Belvoir, VA, were sealed with the same products in June 1984. The procedure was changed slightly at the demonstration site. In two areas, a single coat of the coal tar epoxy with sand was applied. In the remaining areas, two coats of the other sealers were applied with sand added only in the last coating.

The material costs per square yard of the sealers for the demonstrations varied from $0.45 to $10.88, depending on the type of material and the application rate used. These costs should decrease proportionately with any increase in the amount of sealer purchased. Construction costs for applying the sealers are almost independent of the type of sealer used.

Benefits of Technology

Protecting Army asphalt pavements with fuel-resistant sealers can greatly increase their useful life, reduce maintenance, and provide a substantial cost savings over pavement replacement or patching.

Procurement Information

The videotape "Fuel Resistant Pavement Sealers" is available from the FEAP Information Center. The paper entitled "Facilities Technology Applications Test: Fuel-Resistant Pavement Sealers" is available from the U.S. Army Waterways Experiment Station (see **Points of Contact** below). The five sealers are commercially available. See Corps of Engineers Guide Specification (CEGS) 02576.

Points of Contact

Mr. James E. Shoenberger, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, COMM 601-634-3553. Mr. Ken Gregg, U.S. Army Engineering and Housing Support Center, Building 358, Fort Belvoir, VA 22060-5580, COMM 703-355-3582.

Issued by USAEHSC, Fort Belvoir, VA, IAW AR 25-30. Additional copies are available from the FEAP Information Center, 217-352-6511, ext 386.

APPENDIX B: FACT SHEETS

MATERIAL: AEX-1480

DESCRIPTION:

AEX-1480 is a water-based, resin epoxy produced by Adhesive Engineering Company, San Carlos, California. This epoxy is designed primarily as a sealer or primer for vertical concrete surfaces. It is fuel resistant and is suitable as a sealer for both asphalt and concrete pavements. The sealer is nearly colorless after curing.

AREAS OF APPLICATION:

AEX-1480 can be used as a fuel-resistant pavement surface sealer for asphalt concrete pavements. The material should be applied to parking, maintenance, and refueling areas subject to fuel spills.

PHYSIOGRAPHIC FACTORS:

The epoxy begins to react chemically immediately upon mixing. The time of reaction or curing is dependent on the temperature, varying inversely with the temperature. The temperature during placement and initial cure should remain above 50°F. Protective clothing should be worn, and prolonged breathing of the vapors should be avoided when handling or placing this sealer.

DISCUSSION AND RECOMMENDATION:

AEX-1480 has been proven in the laboratory and the field to be fuel resistant. The application rate of the sealer should be 0.1 to 0.2 gallon per square yard, applied in a minimum of two coats. Cracks can be filled with a sealer-sand mixture. The sealer's low viscosity makes mixing sand directly with the sealer very difficult. Broadcasting sand over the sealer after it is placed, but before it has cured, is an acceptable method of placement. The sealer forms a hard, nonductile surface. This hard surface causes cracks sealed with AEX-1480 to reflect back through within a short period of time. Estimated cost (1986) for this sealer was $34.00 per gallon.

SUMMARY:

AEX-1480 is a sealer that can be used in protecting asphalt pavement from the detrimental effects of fuel spillage; however, cracking is a major problem. The sealer forms a hard surface which is ineffective at sealing joints and cracks. This material should not be used as a sealer since the costs are high and performance marginal.

GENERAL REFERENCES:

Shoenberger, J. E., "Fuel-Resistant Porous Friction Surface," Report No. ESL-TR-83-33, Tyndall Air Force Base, FL.

Shoenberger, J. E., "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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MATERIAL: No. 21 Epoxy

DESCRIPTION:

No. 21 Epoxy is a fuel-resistant asphalt concrete pavement surface sealer produced by American Protective Coatings Corporation, Cleveland, Ohio. It is a two part coal tar epoxy system.

AREAS OF APPLICATION:

No. 21 Epoxy is promoted as a fuel-resistant pavement surface sealer for asphalt concrete pavements. It is recommended by the supplier to be used to seal parking, maintenance, and refueling areas subject to fuel spills.

PHYSIOGRAPHIC FACTORS:

No. 21 Epoxy starts to react chemically immediately upon mixing. The time of reaction or curing is primarily dependent on the temperature; therefore, after the components are mixed, the sealer must be applied within minutes before it begins to congeal. Protective clothing should be worn, and prolonged breathing of vapors should be avoided when handling or placing this sealer.

DISCUSSION AND RECOMMENDATIONS:

No. 21 Epoxy has been proven in the laboratory and the field to be fuel resistant. When mixed according to manufacturer's recommendations, the sealer hardens within 8 hours at an ambient temperature of 70°F and is ready for full service the following day. This curing process is accelerated by high temperatures and retarded by low temperatures. The low viscosity of the sealer makes it difficult to keep sand suspended in the mixture. To minimize this problem, sand can be spread on the surface before the sealer cures. Field experience has shown that the amount of coverage is critical to performance. The manufacturer recommends an average coverage of 0.09 gallon per square yard. Variations in this coverage in field applications have caused distress. In one instance, a coating of approximately 0.2 gallon per square yard completely failed within 3 months. In another instance, the sealer cracked in isolated areas when the sealer application rate was not kept below the 0.09 gallon per square yard requirement. These failed areas contained cracks as well as pinholes. These types of failures became more severe in areas having greater sealer application rates than the manufacturer's recommended coverage. The sealer in field applications formed a hard, nonductile surface. Since this material becomes brittle after curing, it has a tendency to crack, thus, reducing its ability to protect the asphalt concrete from fuel spillage. Estimated cost (1986) for this sealer was $20.00 per gallon.

SUMMARY:

Due to cracking No. 21 Epoxy is a sealer that is not effective in protecting asphalt concrete pavement surfaces from the detrimental effects of fuel spillage. Application of this sealer is extremely critical since areas

having heavy applications tend to crack and fail. The sealer forms a hard surface which is ineffective at sealing joints and cracks. Because of poor performance this material should not be used as a fuel-resistant pavement surface sealer.

GENERAL REFERENCES:

Shoenberger, J. E., "Fuel-Resistant Porous Friction Surface," Report No. ESL-TR-83-33, Tyndall Air Force Base, FL.

Shoenberger, J. E., "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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MATERIAL: Super Seal

DESCRIPTION:

Super Seal is a rubberized coal tar emulsion produced by Koppers Company, Inc., Monroeville, Pennsylvania. This coal tar emulsion is manufactured as a fuel-resistant sealer for asphalt concrete pavement surfaces.

AREAS OF APPLICATION:

Super Seal can be used as a fuel-resistant pavement surface sealer for asphalt concrete pavements. The sealer should be applied to parking, maintenance, and refueling areas subject to fuel spills.

PHYSIOGRAPHIC FACTORS:

Super Seal can be placed with either a conventional asphalt distributor or a slurry seal truck with mechanical squeegee. During placement of the sealer the pavement to be sealed should contain no standing water. The ambient temperature should remain above 50°F. Protective clothing should be worn, and prolonged breathing of vapors should be avoided when handling or placing this sealer.

DISCUSSION AND RECOMMENDATION:

Super Seal has proven to be fuel resistant in laboratory and field testing; however, it does tend to wear quickly from the surface. The application rate will normally vary between 0.2 and 0.4 gallon per square yard. Two or three coatings are recommended depending upon pavement location and usage. Sand can be added to the sealer to provide an adequate wearing surface. In the field the sealer has experienced some cracking within 1 year after placement. These cracks were apparently caused by the sealer curing and shrinking. Cracks that were sealed during construction reopened within a few months. The fuel-resistant properties of this sealer are negated within a relatively short period of time. This would require a reapplication of the sealer approximately every 2 to 3 years. The approximate cost of this sealer in 1986 was $3.00 per gallon.

SUMMARY:

Super Seal is a sealer that is effective in protecting asphalt concrete pavements from the detrimental effects of fuel spillage; however, the pavement must be resealed on a periodic basis to provide continued protection. The requirement to reseal after 2 to 3 years makes the use of this sealer unattractive; however, the low cost of material more than offsets the cost for resealing and makes this sealer economical for use.

GENERAL REFERENCES:

Shoenberger, J. E., "Fuel-Resistant Porous Friction Surface," Report No. ESL-TR-83-33, Tyndall Air Force Base, FL.

Shoenberger, J. E., "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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MATERIAL: Rub-R-Road (R-526B)

DESCRIPTION:

Rub-R-Road sealing compound No. R-526B is a rubberized sealant manufactured by Rub-R-Road, Inc., Akron, Ohio. The sealer is normally black but can be purchased in other colors.

AREAS OF APPLICATION:

Rub-R-Road (R-526B) can be used as a fuel-resistant pavement surface sealer for asphalt concrete pavements. The sealer should be applied to parking, maintenance, and refueling areas subject to fuel spills.

PHYSIOGRAPHIC FACTORS:

The sealer may be thinned as required by adding the manufacturer's thinner No. R-607. The sealer has been used effectively as a fuel-resistant sealer when blended three parts R-526B to one part R-607. The sealer should be placed on a clean, dry pavement with a minimum ambient temperature of 50°F. Protective clothing should be worn, and prolonged breathing of vapors should be avoided when handling or placing this sealer.

DISCUSSION AND RECOMMENDATIONS:

Rub-R-Road (R-526B) has proven to be a satisfactory fuel-resistant pavement sealer when applied with sand at the rate of 6 to 8 pounds per gallon of sealer. The sealer should be applied at a rate of approximately 0.2 gallon per square yard when thinned three parts sealer to one part thinner by volume. A minimum of two coats are recommended to assure a complete seal of the pavement. Pavement cracks can be filled with a sealer-sand mixture. The sealer's low viscosity makes mixing sand directly with the sealer very difficult; however, broadcasting sand over the in-place but uncured sealer is an acceptable method of placement. The sealer remains somewhat ductile after curing, allowing it to satisfactorily seal cracks up to a width of 1/2 inch. This ductility makes the sealer susceptible to rapid wear from high-pressure tire or high-volume, low-pressure tire traffic unless adequate sand as previously recommended is applied. Estimated cost (1986) for this sealer is $16.00 per gallon.

SUMMARY:

R-526B is a sealer that is effective in protecting asphalt concrete pavement from the detrimental effects of fuel spillage. The sealer is flexible enough to effectively seal small cracks.

GENERAL REFERENCES:

Shoenberger, J. E., "Fuel-Resistant Porous Friction Surface," Report No. ESL-TR-83-33, Tyndall Air Force Base, FL.

Shoenberger, J. E., "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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MATERIAL: Royal M-6249

DESCRIPTION:

Royal M-6249 is a nitrile rubber adhesive manufactured by Uniroyal, Mishawaka, Indiana. M-6249 has an amber color after curing, although other colors including black are available.

AREAS OF APPLICATION:

Royal M-6249 adhesive can be used as a fuel-resistant pavement surface sealer for asphalt concrete pavements. The material should be applied to parking, maintenance, and refueling areas subject to fuel spills.

PHYSIOGRAPHIC FACTORS:

Royal M-6249 can be thinned as required with either acetone or methyl ethyl ketone. It has been used as a sealer when thinned with one part acetone to two parts Royal M-6249. The ambient temperature during the time of placement and initial cure should not fall below 50°F. The pavement to be sealed should be dry during placement. Protective clothing should be worn, and prolonged breathing of vapors should be avoided when this sealer or thinner is handled or placed.

DISCUSSION AND RECOMMENDATIONS:

Royal M-6249 adhesive has been proven to be a fuel-resistant sealer. The application rate should be about 0.2 gallon per square yard, applied in a minimum of two coats. Cracks can be filled with a sealer-sand mixture. The sealer's viscosity makes mixing sand directly with the sealer the preferred method of application. However, broadcasting sand over the sealer after it has been placed, but before it has cured, is also an acceptable method of placement. One problem encountered with this sealer is the relative difficulty involved in spreading the sealer with squeegees. The sealer is very tacky upon contact and tends to pull and tear during placement. The sealer remains somewhat ductile after curing, allowing it to satisfactorily seal cracks up to a width of 1/2 inch. The crack sealing and wearing properties are at their best when the sealer is combined with 6 to 8 pounds of sand per gallon of sealer. Sand is required with this sealer to provide wear resistance when subjected to high-pressure tires because the sealer's flexibility makes it susceptible to wear. Estimated cost (1986) for this sealer was $15.00 per gallon.

SUMMARY:

Royal M-6249 is a sealer that is effective in protecting asphalt concrete pavement from the detrimental effects of fuel spillage. The sealer is flexible enough to effectively seal small cracks.

GENERAL REFERENCES:

Shoenberger, J. E., "Fuel-Resistant Porous Friction Surface," Report No. ESL-TR-83-33, Tyndall Air Force Base, FL.

Shoenberger, J. E., "Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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APPENDIX C: REFERENCES

Shoenberger, J. E. and Brown, E. R. 1986 (Aug), "Facilities Technology Application Tests; Fuel-Resistant Pavement Sealers," Miscellaneous Paper GL-86-19, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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Waterways Experiment Station Cataloging-in-Publication Data

Shoenberger, James E.
User's guide : fuel resistant pavement sealers / by James E. Shoenberger ; [prepared for U.S. Army Engineering and Housing Support Center].
38 p. : ill. ; 28 cm. -- (Miscellaneous paper ; GL-92-14)
Includes bibliographic references.
FEAP-UG-92/03
1. Pavements, Asphalt concrete -- Maintenance and repair -- Handbooks, manuals, etc. 2. Runways (Aeronautics) -- Maintenance and repair -- Handbooks, manuals, etc. 3. Sealing compounds. 4. Liquid fuels. I. Facilities Engineering Applications Program (U.S.) II. US Army Engineering and Housing Support Center. III. U.S. Army Engineer Waterways Experiment Station. IV. Title. V. Series: Miscellaneous paper (U.S. Army Engineer Waterways Experiment Station) ; GL-92-14.
TA7 W34m no.GL-92-14