



COMMONWEALTH OF KENTUCKY

DEPARTMENT OF HIGHWAYS

FRANKFORT, KENTUCKY 40601

December 1, 1972

CHARLES PRYOR, JR.
COMMISSIONER OF HIGHWAYS

ADDRESS REPLY TO:
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
533 SOUTH LIMESTONE STREET
LEXINGTON, KENTUCKY 40508
TELEPHONE 606-254-4475

H.2.24

MEMORANDUM TO: J. R. Harbison
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report 345; "Spraygrip Anti-Skid Treatments, Kentucky Turnpike;"
KYP-56; HPR-1(8), Part III.

The report submitted herewith documents the experimental application of a proprietary, glue-and-grit deslicking treatment at three places on the Kentucky Turnpike. The term "glue-and-grit" is as vernacular as "sandpaper." Many bridges have been treated with epoxy resin-sand seals; a wide variety of resins and sands have been used; service-life has varied greatly; some have failed to adhere; all have eventually worn off in the wheel tracks. We have considered wear as somewhat inevitable; we have also considered the treatments to be renewable. The hardest grits employed here have been quartz sands. Others have employed carborundum, calcined bauxite, etc. The more expensive grits make endurance more compulsory and places greater dependence upon the glue.

Practically speaking, all abrasive surfaces of this type provide high resistance to skidding and continue to do so until the grit becomes dulled or torn off. Skid tests have not been made on the treated sites. Tests will be made after there has been ample opportunity for wear to occur. The endurance of adhesion and loss of grit will be observed and reported from time to time.

Respectfully submitted,

A handwritten signature in cursive script, reading "Jas. H. Havens".

Jas. H. Havens
Director of Research

JHH:dw

Attachment

cc's: Research Committee

Research Report
345

**SPRAYGRIP ANTI-SKID TREATMENTS,
KENTUCKY TURNPIKE**

KYP-56, HPR-1(8), Part III

by

Jerry G. Rose
Former Research Engineer

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views or policies of the Kentucky Department of Highways. This report does not constitute a standard, specification, or regulation.

December 1972

INTRODUCTION

Negotiated contract No. CH 14076 was entered into on November 24, 1971, by and between the Commonwealth of Kentucky, Department of Highways, and Prismo Universal Corporation, Rockville, Maryland, for the purpose of applying experimental, anti-skid, pavement treatment (Spraygrip) to the approaches at the Elizabethtown and Shepherdsville toll plazas and to the bridges over Valley Creek Road and Clear Creek on the Kentucky Turnpike.

The contract was awarded on December 1, 1971. A decision was made for the Department to supervise the project as a routine construction contract. The work order was issued on April 7, 1972. Inspection of the Valley Creek Road bridges revealed that the surfaces were not in proper condition for the anti-skid treatment since reinforcing steel was exposed in several places. The Department and the contractor agreed that the Valley Creek Road bridges be deleted from the contract. A copy of the Notice of Award of Contract is contained in APPENDIX A.

The primary attribute of this form of surface treatment is its skid resistant qualities. It has reportedly proved extremely successful at high-accident locations, such as intersections, where there has been a high frequency of wet-road skidding accidents (1). In London, England, where 41 sites were treated, rear-end collisions were reduced by 73 percent during a two-year period (2). First applied in the United Kingdom in 1967, several applications have been made in the United States, including the toll plaza northbound on the Delaware Memorial Bridge and sites in North Carolina, Ohio, and Washington. James (1) reports extensive use of the "Shellgrip" system in the United Kingdom. Apparently, the materials and application process are comparable to the "Spraygrip" system reported herein.

British portable skid-test readings of more than 70 after one year were obtained on Spraygrip in the United Kingdom; initial readings with the tester at a North Carolina site were 97 (2). MacKenzie (2) reports that "the main advantage of the process is that high readings are obtained throughout the life of the installation."

MATERIALS

The binder and polish-resistant aggregate were furnished by Prismo Universal Corporation. The binder was a chemically-curing, asphalt-extended, two-component epoxy compound. The components were heated, measured in proper proportions and homogenized just prior to being sprayed onto the pavement. The cover aggregate was RASC grade, calcined bauxite mined in Guiana. Calcined at 1600°C,

the aggregate had a Mohs hardness of eight or higher and was composed of 86 percent aluminum oxide (Al_2O_3). It was sized between a No. 7 and No. 16 sieve. A forward-moving spreader was used.

Technical specifications for the materials, application equipment and construction procedures are contained in APPENDIX B.

PROJECT DESCRIPTION

An area of 5,830.02 square yards was surfaced at a unit price of \$10.00 per square yard. Detailed locations of the three treated areas follow:

Bullitt County Toll Plaza at Sheperdsville, MP 15-574-TPA; Northbound Approach Lanes -- 287 feet in length; Southbound Approach Lanes -- 288 feet in length. Total 2,310.74 square yards.

Hardin County Toll Plaza at Elizabethtown, MP 47-69-TPA; Northbound Approach Lanes -- 348 feet in length; Southbound Approach Lanes -- 320 feet in length. Total 2,998.44 square yards.

Hardin County Bridges over Clear Creek, MP 47-69-TP6, North- and Southbound -- 62.5 feet long by 37.5 feet wide. Total 520.84 square yards.

CONSTRUCTION

Work began July 24, 1972, at the Shepherdsville toll plaza. Preparatory treatment of the pavement consisted of roughening the surface with a Tennant machine equipped with hardened steel grinders, followed by thorough brooming with a power broom. Certain handwork was required to remove layered paint and excess joint material. These operations are depicted in Figures 1, 2, and 3.

The binder was applied with a specially designed distributor at a rate of 3 to 4 pounds of binder per square yard. A four-foot wide strip was sprayed. Within a time span of 5 to 10 minutes after spraying the binder, the aggregate was spread using a specially manufactured forward-moving spreader (gritter). Approximately 15 pounds of aggregate per square yard was used. Photographs of the operations are shown in Figures 4 and 5.

The surface was generally cured for 4 to 5 hours before traffic was permitted to use the surface. About 24 hours were required to effect a complete set of the material; however, traffic did not appear to damage the treatment after the 4 to 5 hours cure period. Loose aggregate was swept off the surface.

Due to high traffic volumes and accompanying traffic control problems at the toll plazas, applications of the binder and aggregate were not permitted until after 6:30 p.m. Preparatory operations were permitted during normal working hours. Surfacing of the bridge was accomplished during daytime, since blocking of a single lane for a long period of time did not constitute a traffic problem.

The Elizabethtown toll plaza and the Clear Creek bridges were surfaced during the first week of August. The project was completed on August 4. Thicker applications were placed on the bridges.

PERFORMANCE SURVEY

A performance survey of the three sites was conducted on August 14. Some attrition of the aggregate is still occurring; however, this is expected to soon cease. The treated areas appear to be maintaining a sufficient quantity of aggregate.

A number of cracked and jointed areas, particularly those somewhat faulted, in the old concrete surface did not coat well with the epoxy binder. Aggregate was not retained at these locations, as depicted in Figure 6. Generally, these non-coated areas extend only an inch or two back from the joint.

One soft area where the binder had not hardened was noticed. This was located in the outside travel lane of the northbound bridge over Clear Creek. A portion of the cover aggregate has worn away exposing the darker binder material as shown in Figure 7. Corrective measures are contemplated.

With the exception of the above noted minor problems, the treatments appear very satisfactory. The binder is quite hard and is retaining an adequate covering

of aggregate. The grayish aggregate provides a noted contrast to the abutting existing concrete pavement. The treatment provides a very low noise level, which is generally not the case with surface treatments; however, the nominal size of the cover aggregate was between the No. 7 and No. 16 sieve (80 to 95 percent) with only a maximum of three percent permitted to be retained on the No. 6 sieve. Views of the completed treatment at the Elizabethtown toll plaza and Clear Creek bridges are shown in Figures 8 and 9, respectively.

REFERENCES

1. James, J. G., *Trial of Epoxy-Resin/Calcined-Bauxite Surface Dressing on Al, Sandy, Bedfordshire, 1968, RRL Report LR 381, Road Research Laboratory, Crowthorne, Berkshire, 1971 (Great Britain).*
2. MacKenzie, A. J., *Spray Grip Anti-Skid Surfacing Materials, Record 376, Highway Research Board, 1971, pp. 61-62.*
3. James, J. G., *Calcined Bauxite and Other Artificial, Polish-Resistant Roadstones, RRL Report LR 84, Road Research Laboratory, Crowthorne, Berkshire, 1967 (Great Britain).*

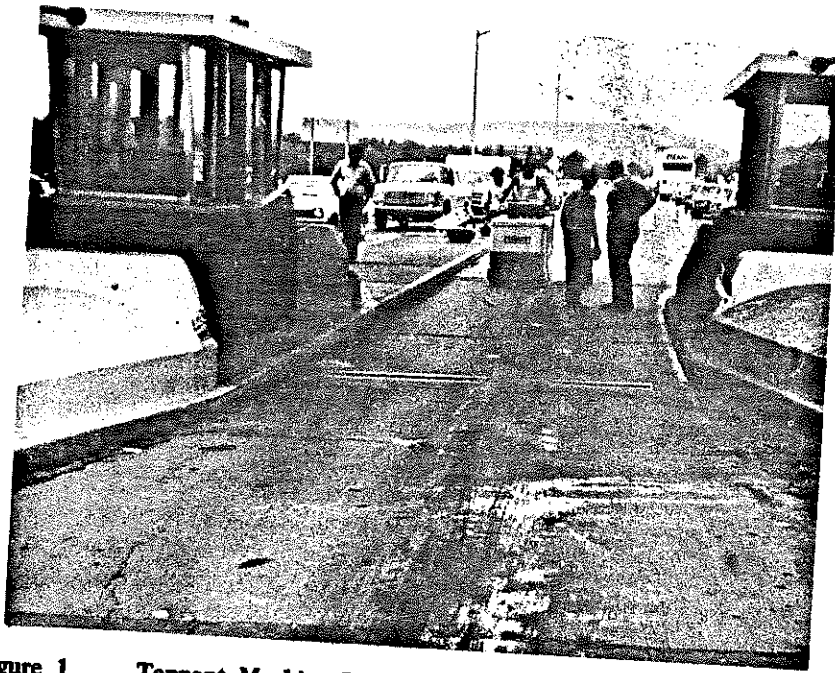


Figure 1. Tennant Machine Used for Roughening the Concrete Surface.



Figure 2. Handwork Used in Conjunction with the Cleaning Operation.

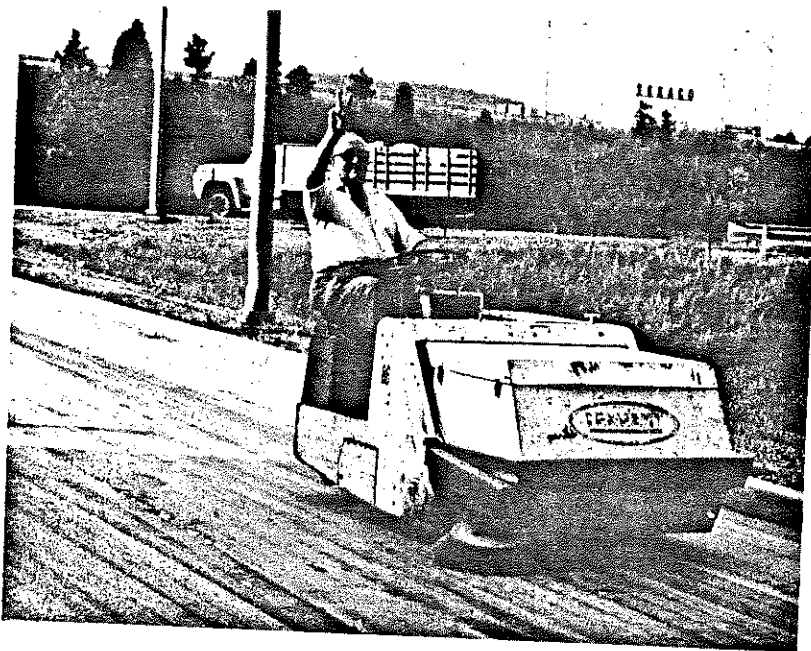


Figure 3. Sweeping the Surface Preparatory to Applying Binder.

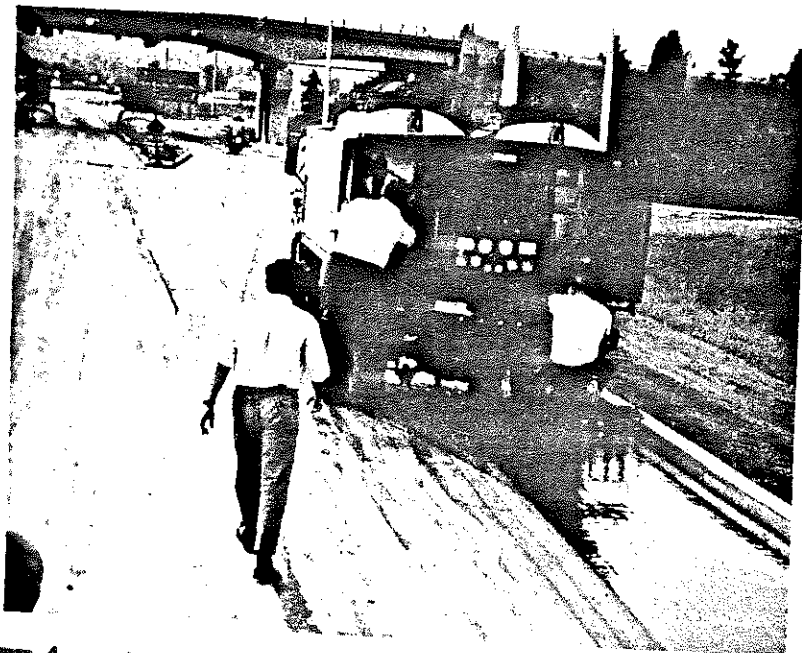


Figure 4. Applying Binder Material with a Specially Designed Distributor.

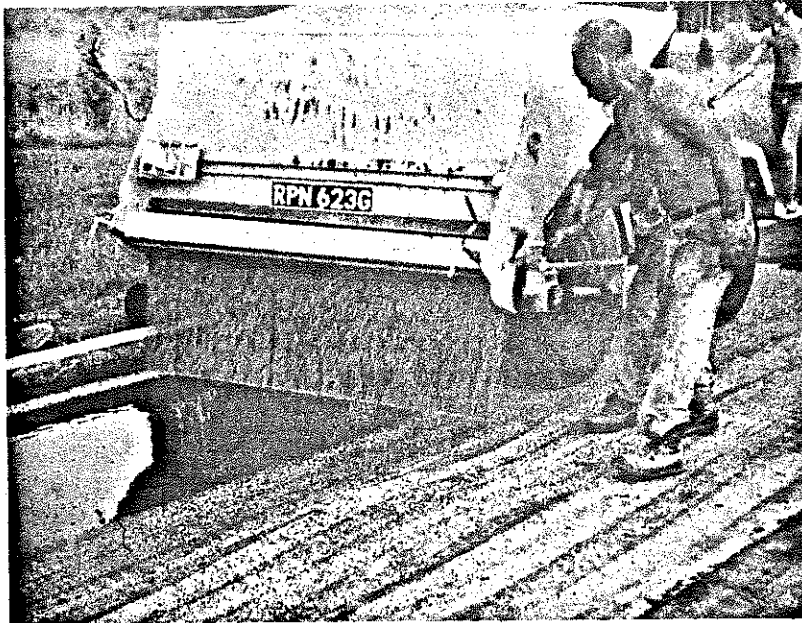


Figure 5. Spreading Aggregate with a Specially Manufactured Forward-Moving Spreader.

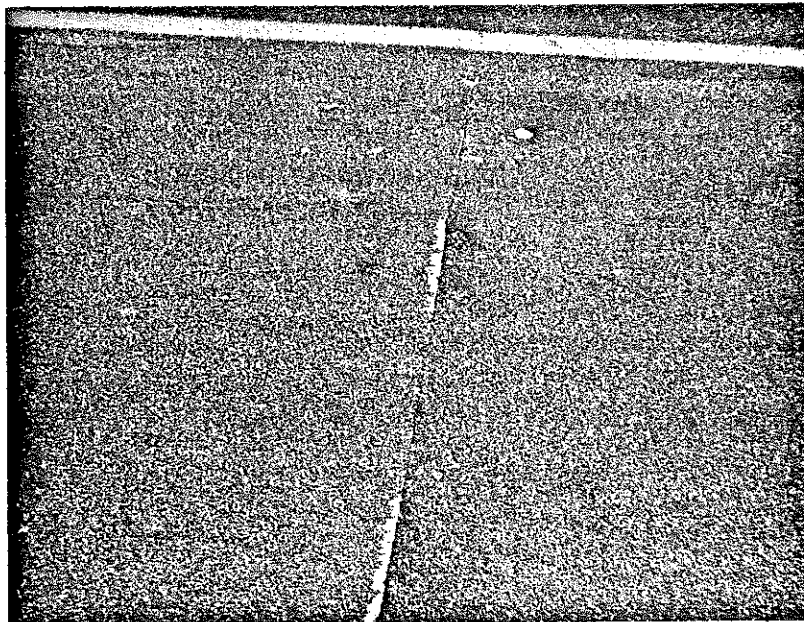


Figure 6. Non-Coated Area Adjacent to Faulted Expansion Joint at the Elizabethtown Toll Plaza.



Figure 7. Soft Area in Northbound, Outside Travel Lane on the Clear Creek Bridge (Only Soft Area Noticed).



Figure 8. Northbound View of Completed Elizabethtown Toll Plaza, Deceleration Lanes Only.

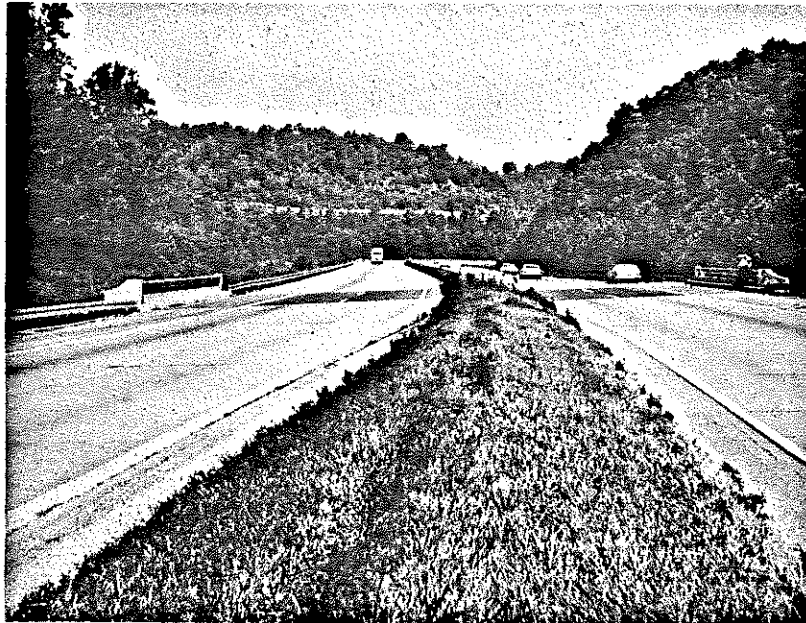


Figure 9. Northbound View of Completed Clear Creek Bridges.

APPENDIX A
NOTICE OF AWARD OF CONTRACT
AND
HD 63-5

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF FINANCE
NOTICE OF AWARD OF CONTRACT

DEPARTMENT OF HIGHWAYS

CONTRACT No. CH ¹⁴⁰⁷⁶~~138022~~

Division of Toll Facilities

Account No. 43-5-11-154-400

District No. _____ County Name _____ County Number _____

Name of Allotment or Revolving Account _____

Section _____ Sub-section _____

Date December 1, 1971

Prismo Universal Corporation 1365-0155
4 Research Place
Rockville, Maryland

Contract Completion Date Jan. 31, 1972

You are hereby awarded the contract described below in accordance with the bid submitted

by you on _____

DESCRIPTION	AMOUNT
-------------	--------

As per Agreement Attached:

\$58,720.00

Estimated:

TOTAL AMOUNT \$58,720.00

DEPARTMENT OF HIGHWAYS

BY _____
DIRECTOR OR AUTHORIZED AGENT, DIVISION
OF ADMINISTRATIVE SERVICES

APPROVED AS TO AVAILABILITY OF FUNDS

COMMISSIONER OF FINANCE

Agreement between
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
and
PRISMO UNIVERSAL CORPORATION
4 Research Place
Rockville, Maryland 20850
for
Experimental Application of Spray Grip
Anti-Skid Pavement Treatment to the Kentucky Turnpike

THIS AGREEMENT made and entered into this 24th
day of November, 1971, by and between the COMMONWEALTH
OF KENTUCKY, DEPARTMENT OF HIGHWAYS, hereinafter referred to
as THE DEPARTMENT, and PRISMO UNIVERSAL CORPORATION,
hereinafter referred to as PRISMO.

WITNESSETH:

WHEREAS, THE DEPARTMENT desires to better protect
bridge decks, and apply an anti-skid treatment in a more permanent
and more efficient fashion than is provided by conventional surfacing
material; and

WHEREAS, it is the desire of THE DEPARTMENT to decrease
the number of motor vehicle accidents which occur at toll plazas for the
common good of the motoring public, and

WHEREAS, PRISMO now offers further promising innovations
in anti-skid pavement treatments and their application; and

WHEREAS, it is the intention of THE DEPARTMENT to test the
PRISMO anti-skid pavement treatment and its proposed advantages for
research purposes; it is

THEREFORE, agreed by and between the parties hereto,
as follows:

I. PRISMO

- A. For the consideration stipulated herein, shall apply Spray Grip anti-skid pavement treatment to the toll plaza at Shepherdsville, North and South bound approaches; the toll plaza at Elizabethtown, North and South bound approaches; and to the bridges over Valley Creek Road and over Clear Creek Road on the Kentucky Turnpike approximately 5875 square yards.
- B. Shall guarantee the application of Spray Grip anti-skid treatment against failure attributable to wear or poor adhesion to the pavement and shall replace, without cost to THE DEPARTMENT, all portions of the treatment which fail to provide satisfactory service for a period of three years but shall not be liable under this guarantee to replace portions of the treatment removed by others.
- C. Shall furnish all materials, workmen, equipment and traffic controls and shall hold THE DEPARTMENT free from any claims arising from the work.
- D. Shall complete application of Spray Grip anti-skid treatment within 30 working days; a working day being defined as one during which the temperature reaches at least 40° Fahrenheit which has less than one-hundredth of an inch of precipitation. PRISMO may elect to apply treatment during days when the temperature reaches 35° Fahrenheit but does so at their own liability.
- E. Shall submit to THE DEPARTMENT an auditable invoice showing quantities of materials used and the numbers of square yards treated.

II. THE DEPARTMENT

- A. Shall pay PRISMO \$10.00 per square yard of acceptable anti-skid treatment for approximately 5875 square yards not to exceed 10% more in over run.
- B. Shall remove the existing bridge deck treatment and patch any damage to the bridge decks to insure that a consistent flat surface over which Spray Grip anti-skid pavement treatment maybe applied on the bridges over Valley Creek road and Clear Creek Road on the Kentucky Turnpike.
- C. Shall furnish all inspection and engineering supervision to assure compliance with the terms contained herein and to audit PRISMO'S invoice.

III.

- PRISMO further agrees, during the performance of the work to:
 - A. Comply with the regulations of the United States Department of Commerce relative to nondiscrimination (Title 15, Code of Federal Regulations), which are by reference made a part hereof.

- B. Shall not consider its employees to be employees of THE DEPARTMENT and shall consider any and all claims arising under Workman's Compensation of Kentucky to be solely PRISMO'S obligation and responsibility.

Frank Harshbarger
Executive Director
Office of Toll Facilities

J. R. Hansen
State Highway Engineer

APPROVED AS TO FORM AND LEGALITY:

Carl Miller
General Counsel
Department of Highways

PRISMO UNIVERSAL CORPORATION

BY: Gerald F. Lewis

Gerald F. Lewis
Vice-President-Sales

DEPARTMENT OF HIGHWAYS

D. E. Gray
Commissioner

I certify that this voucher has been examined that the proposed expenditure is authorized by appropriation and allotment and does not exceed the unencumbered balance of the allotment to which it is properly chargeable. And that the total estimated cost has been entered as a charge against the fund above mentioned.

This DEC 2 Day of 1971

Robert Christensen
COMMISSIONER OF FINANCE

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

HD 63-5
11-69

FORMAL ACCEPTANCE REPORT OF COMPLETED CONSTRUCTION

DATE OF REPORT October 23, 1972

DISTRICT 4 COUNTY Bullitt-Hardin PROJECT NO. 23-15-574-TPA; LENGTH N/A
23-47-69-TPA;
23-47-69-TP6
ROAD NAME Kentucky Turnpike
TYPE OF CONST. Anti-Skid Treatment ROADWAY & SURFACE WIDTH N/A
PRIME CONTRACTOR Prismo Universal Corp.
ADDRESS 4 Research Place, Rockville, Md. 20850
DATE OF COMPLETION 8-4-72
DATE OF COMPLETION OF ADDITIONAL WORK AS OUTLINED October 9, 1972

FINAL INSPECTION REPORTS SUBMITTED BY REPRESENTATIVES OF THIS DEPARTMENT

DATE OF INSP. REPORT	TYPE OF FINAL INSPECTION REPORT	ADDITIONAL WORK OUTLINED	
		Yes	No
<u>10-3-72</u>	REPRESENTS ALL ITEMS IN CONTRACT	_____	_____
_____	" MAJOR STRUCTURES & INCLUSIVE ITEMS	_____	_____
_____	" ALL ITEMS EXCLUSIVE OF ABOVE LINE 2	_____	_____
_____	" ALL ITEMS EXCEPT AS LISTED BELOW **	_____	_____
_____	" SPECIAL REPORT IN ADDITION TO ABOVE	_____	_____

BUREAU OF PUBLIC ROADS ADDITIONAL WORK REQUESTED AT TIME OF FINAL INSPECTION

DATE _____ VERBAL _____ * ADDITIONAL WORK REQUESTED _____ *
DATE _____ WRITTEN _____ * " " " " _____ *

* INSERT YES OR NO ON ABOVE LINES AS REQUIRED

**

(XX DISTRICT ENGINEER REPORTED October 16, 1972 THAT ALL ADDITIONAL WORK REFERRED TO ABOVE HAS BEEN COMPLETED IN A MANNER SATISFACTORY TO THE RESIDENT ENGINEER AND HIS OFFICE.

THIS PROJECT IS NOW CONSIDERED COMPLETE IN ITS ENTIRETY, THEREFORE FORMAL ACCEPTANCE OF THIS WORK IS EFFECTIVE October 9, 1972

C. S. LAYSON
DIRECTOR OF CONSTRUCTION

BY: B. L. Wheat
B. L. WHEAT
ASSISTANT DIRECTOR

ORIG. & 2 COPIES TO DIST. ENGR. H.R. Ditto
COPY TO CONTRACTOR Prismo Universal Corp.
XXXXXXXXXXXXXXXXXXXX
BUREAU OF PUBLIC ROADS
XXXXXXXXXXXXXXXXXXXX

DIV. CONTRACT PROCUREMENT Hawkins/Jenkins
RESIDENT ENGINEER G.J. Smith

ASST. STATE HIGHWAY ENGR. CONST. G.F. Kemper
XXXXXXXXXXXXXXXXXXXX
DIV. OF MAINT. A.R. Romine
DIV. PLANNING L. Vaughn
Div. of Research _____

APPENDIX B
TECHNICAL SPECIFICATION

T E C H N I C A L S P E C I F I C A T I O NANTI-SKID PAVEMENT TREATMENT1. Scope

This specification covers a system of skid resistant treatment applied to the highway pavements using specialized material and equipment and a trained team of technicians. The treatment consists of an asphalt extended two component resin applied uniformly over the pavement and which is flooded with a polish resistant aggregate. The equipment consists of a specially developed machine that stores, agitates, circulates, heats, meters and sprays the special binder.

2. Materials2.1 Binder

The binder shall be a chemically curing asphalt extended two component epoxy compound, the two components to be heated and metered in proper proportions and homogenized immediately prior to application to the pavement. The material shall provide a good adhesion to clean asphalt, and concrete pavements and shall bind a properly applied skid resistant aggregate.

The two epoxy binder shall have the following general specification:

Component A	80% epoxy 20% aromatic extract
Component B	Amine curing agent Asphalt 24% Compatiblizers Accelerators

Components are to be heated to predetermined temperatures and proportions 50/50 by weight with no more than $\pm 2\%$ by weight variance of the specified proportions.

2.1.1 Cure Time of the Binder

The cure time shall be the period of time after application of binder during which the pavement must be closed to traffic. This critical period of time is temperature dependent according to the following tabulation:

<u>Surface Temperature</u>	<u>Cure Time Maximum</u>
35°F.	6 hrs.
40°F.	5-1/2 hrs.
50°F.	5 hrs.
60°F.	4 hrs.
75°F.	3-1/2 hrs.
95°F.	1-1/2 hrs.

1.2 Tensile Strength of the Binder

The tensile strength of the cured resin binder without aggregate shall have a minimum of between 1500 and 2500 pounds per square inch, determined according to A.S.T.M. Method of Test D638-64T (Test Speed B). The test specimen shall conform to A.S.T.M. Method D412-66 (Die C). The specimen shall be between 0.1" and 0.2" in thickness and shall be cured at a temperature between 50°F. and 90°F. for 5 to 8 days, and the test shall be sufficiently large that 6 specimens may be cut from it. The percent elongation at rupture shall be between 30% and 70%.

2.2 Aggregate

The aggregate shall be calcined bauxite (RASC Grade) calcined at a temperature no less than 1600°C. (2912°F.).

2.2.1 Aggregate Gradation

Sample conformity to this specification shall be determined using A.S.T.M. Method of Test C136-67. Sampling of the bulk material, which shall be supplied in 50 lb. bags, shall be accomplished according to A.S.T.M. Recommended Practice E105-58. The product gradation shall be within the following limits:

<u>U.S. Standard</u> <u>Passing</u>	<u>Sieve Size</u> <u>Retained</u>	<u>Percentage</u>	
		<u>Minimum</u>	<u>Maximum</u>
-	6	0	3
6	7	5	15
7	16	80	95
16	30	0	2
30	-		Trace

2.2.2 Chemical Analysis

The aggregate shall conform to the following chemical analysis:

Aluminum Oxide	Al ₂ O ₃	86%
Iron Oxide	Fe ₂ O ₃	2.5%
Silica	SiO ₂	7.5%
Titanium Dioxide	TiO ₂	4%

The above percentages may vary ± 10% of the value indicated.

2.2.3 Physical Characteristics

Hardness: The material shall possess a Mohs hardness value no less than 8.

Crushing Value: The aggregate shall have an aggregate crushing value of no more than 30, as determined by the method described in Appendix "A"

Aggregate Abrasion Value: The aggregate abrasion value shall be no more than 4, as determined by the method of test described in Appendix "B".

Polish Resistance: The polished stone value for the aggregate shall be no less than 70, as determined by the method of test described in Appendix "C".

3. Preparatory Treatment of the Pavement

The pavement surface shall be thoroughly swept clean of dust and loose foreign bodies, using a stiff broom or a street sweeping machine. Any oil visible on the surface shall be removed by washing and scrubbing with a weak solution of detergent followed by a clean water flush.

The pavement shall be allowed to dry of free water, subsequent to the cleaning operation.

Permanent fixtures, manhole covers and other street furniture shall be masked where required.

4. Application Equipment

The resin shall be applied onto the pavement by a mechanical sprayer. This unit shall be capable of accurate and continuous combination of the two components of the resin system, mixing them thoroughly into a homogeneous state prior to uniformly spraying the mixture onto the pavement. Each component must be agitated continuously in the heated and lagged tanks, and shall be separately provided with flow meters to show amount of material sprayed and at the same time, indicating electrically the rate of flow during the spraying operation. In order that the mixture be reproducible regardless of ambient temperature variations, the two components shall be heated to predetermined temperatures controlled to assure that the sprayed mixture is proportioned to within two percent (2%) by weight of the nominal specified proportions. Volume flow meters for each component shall be calibrated to the precision required to assure this accuracy in proportioning.

The application equipment shall be capable of spraying the resin binder onto the pavement with a uniformity such that the thickness of binder collected on any strip two inches (2") wide, anywhere within the width of the spray bar, shall not vary by more than ten percent (10%). Furthermore, the mean amount of binder collected on any four adjacent strips shall not differ from the amount collected on any one of the strips by more than five percent (5%). The contractor shall provide a certificate of compliance of the requirements of this paragraph before work commences.

The binder after being applied to the pavement should be gritted using a forward-moving gritter. The aggregate must be accurately dispensed by falling upon a roller driven from the road wheel of the gritter through a mechanical clutch/gear box, thus enabling accurate dispensation of aggregate by the forward speed of the machine. The pneumatic tires must be smooth (and of a size adequate to prevent excessive wheel loading).

The gritter shall have the capability of adjusting the application width of the aggregate by means of a lever operating a gate, helical in form. The gritter must be sufficiently maneuverable to allow it to function in confined areas.

Qualification of Equipment and Certification of Experience

The equipment to be used by the contractor for applying the resinous coating and the aggregate shall be approved by the project engineer. The contractor shall furnish in writing a list of at least three previous contracts in which materials identical to the specifications listed above have been used successfully, and shall have laid at least 15,000 sq. yds. during the two preceding years from the date of the award.

5. Method of Application

The mixed resin system shall be sprayed onto the pavement at a rate not less than 2-1/2 pounds per square yard. After the resin system achieves the road surface temperature and prior to gelling, it shall be saturated with aggregate at a rate of approximately 12.5 pounds per square yard. The aggregate shall be dispensed in such a manner that it does not roll and cause the exposed surface of the particles to be wet with the binder. The masking material used to prevent undesirable coverage of permanent fixtures shall be removed before the binder achieves its cure. The road shall be maintained free of traffic until the binder is cured. Immediately prior to opening the pavement to normal traffic, the excess aggregate shall be removed.

Hand application of the mixed resin system to areas inaccessible to the application equipment shall be permitted, but materials shall be mixed by weight in quantities not exceeding 20 pounds and stirred by mechanical means and spread with a serrated rubber squeegee.

6. Control Testing During Application

A check shall be made at the completion of each application to determine the quantities of each binder component which have been used. The volume quantities shall be converted to weights to estimate the accuracy of proportioning and the average rate of spread over the measured area of the treated pavement.

The contractor shall sample the mixed resin system from the spray bar not less frequently than one sample for each 1,000 square yards completed or for each application area, whichever is the more frequent. These samples shall be poured into a shallow tray and allowed to cure undisturbed. From these samples, tensile strength tests specimens shall be prepared and tested according to Paragraph 2.1.2 above.

7. Limitations

7.1 Weather

Since the cure time of the resin increases with decreasing temperature, the contractor must satisfy himself that adequate time is available after the end of the spraying operation and the time when the road must be opened to traffic. It is imperative that the binder be undisturbed by traffic until it achieves a full cure, requiring that the road be closed for a period of time consistent with the cure times specified in Section 2.1.1 above.

While the treatment can be applied to a damp pavement, work shall not proceed when there is free water on the surface.

7.2 Site Condition

All sites for application of the anti-skid treatment shall be inspected by qualified technical personnel prior to acceptance of the award by the contractor. Not all pavement conditions are suitable for the treatment and sites being unsatisfactory shall be specified and eliminated from the award.

8. Warranty

The contractor shall replace or repair the treatment at any site which fails as a result of poor workmanship or failure to comply with the application procedures specified above. Such failures shall be called to the attention of the contractor within six (6) months of the application. Such repairs or replacements shall be carried out at the expense of the contractor.