

EVALUATION OF SPRINKLE TREATMENT  
FOR IMPROVING SKID RESISTANCE  
OF ASPHALT SURFACES

Final Report



**TESTING AND RESEARCH DIVISION  
RESEARCH LABORATORY SECTION**

EVALUATION OF SPRINKLE TREATMENT  
FOR IMPROVING SKID RESISTANCE  
OF ASPHALT SURFACES

Final Report

J. H. DeFoe

Demonstration Project No. 50 Done in  
Cooperation with the Federal Highway Administration

Research Laboratory Section  
Testing and Research Division  
Research Project 78 C-19  
Research Report No. R-1223

Michigan Transportation Commission  
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## INTRODUCTION

Limestone is the predominant source of aggregate in several areas of Michigan. Bituminous paving mixtures containing limestone aggregates are susceptible to polishing by traffic which may result in lower friction values. Aggregate that is more durable and polish resistant must be transported into these limestone-predominant areas if bituminous surfaces with adequate friction levels are to be achieved.

A potential method for reducing the cost of transporting high quality aggregate into these areas is to apply the more durable aggregate to only the surface of a pavement rather than to use it throughout the wearing course mixture. 'Sprinkle treatment,' a method of applying such high quality aggregate, has been developed by several state transportation agencies, supported by the Federal Highway Administration.

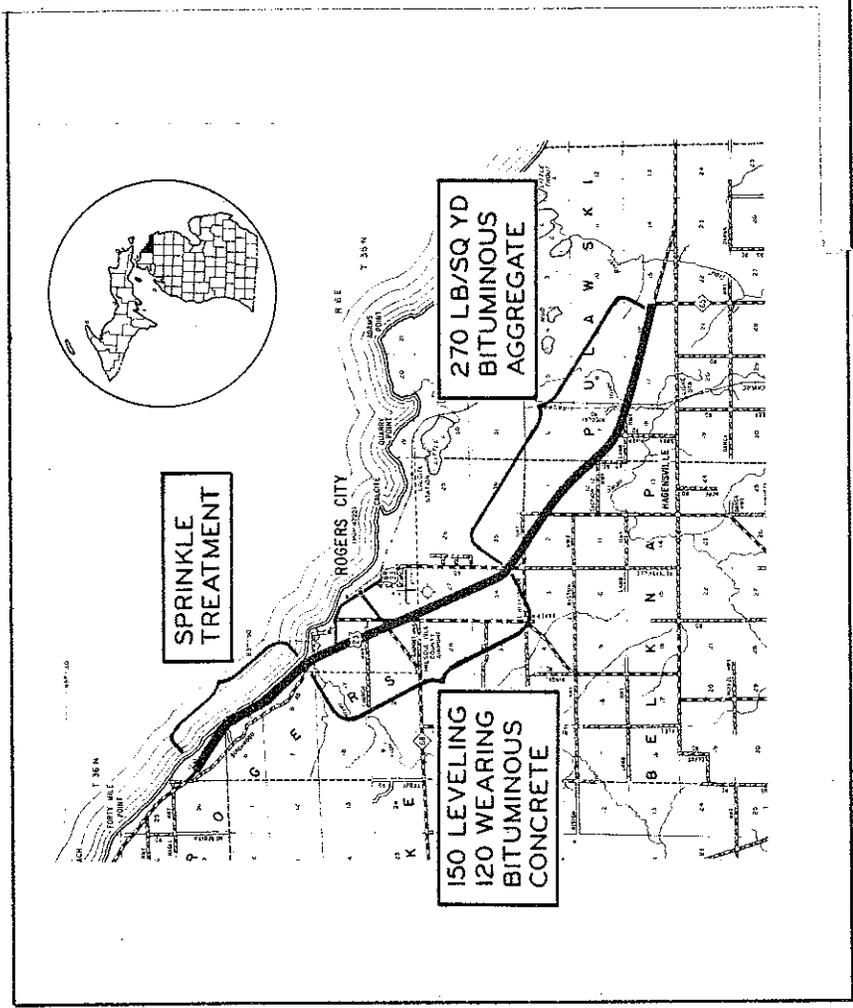
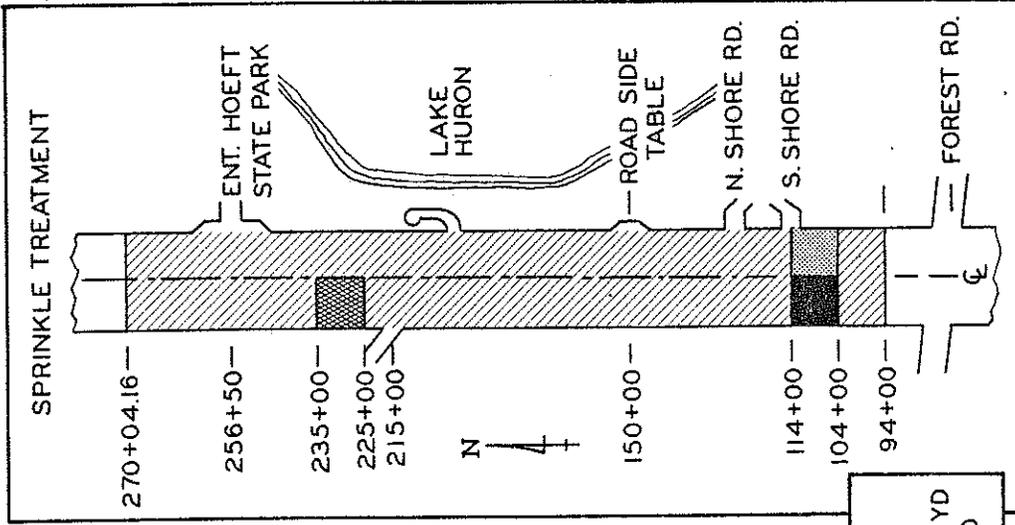
Sprinkle treatment consists of the application of 5 to 10 lb/sq yd of precoated, high quality aggregate particles, 1/2-in. nominal size, onto the surface of a wearing course with embedment achieved by the rolling operation. Application of sprinkle aggregate is made immediately behind the paver, and prior to compaction, by a specially designed chip spreader which is commercially produced and was made available for this project by the FHWA. Specifications for the sprinkle aggregate, as well as pre-coating and application requirements, are described in the "Special Provision for Bituminous Wearing Course Mixture with Precoated Aggregate," appended to this report.

In March 1979, the Michigan Department of Transportation and the Federal Highway Administration entered an agreement to evaluate the sprinkle treatment method for achieving adequate friction levels on new bituminous surface courses.

This report describes Michigan's three-year evaluation of sprinkle treatment applied to a new bituminous wearing surface in accordance with FHWA Demonstration Project No. 50.

## EVALUATION PROGRAM

A four-mile portion of a bituminous resurfacing project on US 23 in Presque Isle County was selected for application and evaluation of the sprinkle treatment method (Fig. 1). In addition to the four-mile experimental section, two adjacent sections resurfaced with conventional bituminous aggregate (MDOT Standard Specification section 4.11) and bituminous



- 3 LB/SQ YD
- 5 LB/SQ YD
- 7 1/2 LB/SQ YD
- 10 LB/SQ YD

Figure 1. Experimental sprinkler treatment sections on US 23 in Presque Isle County.

concrete (MDOT Standard Specification mixtures section 4.12) were selected to provide a basis for comparison with the sprinkle treatment. Paving of the experimental section was completed in July 1979. A progress report describing the construction, materials, and initial friction values was published in January 1980.\*

Evaluation consisted of the measurement of friction levels at six test locations, twice each year, throughout the three-year evaluation period. The test locations consisted of the four sprinkle treatment application sections, plus the bituminous concrete and bituminous aggregate control sections as shown in Figure 1. Friction tests were performed at 30, 40, and 55 mph using the Department's Pavement Friction Tester (ASTM E-17). Tests were conducted at different speeds in order to determine the effects of vehicle speed on friction levels as expressed by speed gradient values. Speed gradients used in this evaluation were calculated as the difference between friction numbers, FN, measured at 30 mph and those measured at 55 mph divided by the 25 mph speed differential.

In this evaluation, sprinkle treatment was compared with two conventional overlay mixtures, bituminous aggregate and bituminous concrete. The sprinkle treatment was applied to the surface of the same bituminous concrete mixture that was used on the adjacent section as shown in Figure 1. The most direct comparison for evaluating sprinkle treatment is with this bituminous concrete section.

## RESULTS

Friction numbers measured throughout the three-year evaluation period are summarized in Table 1 and Figure 2. Friction numbers measured at 30, 40, and 55 mph for the four sprinkle treatment application rates and for the bituminous concrete and bituminous aggregate sections are shown in Figure 2. Initial measurements made immediately after construction, July 1979, show no significant difference between sprinkle treatment, regardless of application rate, and either the bituminous concrete or bituminous aggregate sections. Data for later years, especially 1982, show higher friction levels for sprinkle treatment than for bituminous concrete. Bituminous aggregate values were higher than those for bituminous concrete but not as high as for the sprinkle treatment sections.

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\* DeFoe, J. H., "Evaluation of Sprinkle Treatment for Improving Skid Resistance of Asphalt Surfaces, Progress Report," MDOT Research Report No. R-1134, January 1980.

TABLE 1  
 FRICTION NUMBERS MEASURED ON  
 SPRINKLE TREATMENT TEST SECTIONS

Test Section	Test Speed, mph	Friction Number, FN						
		1979		1980		1981		1982
		July	October	August	November	June	October	July
<b>Sprinkle Treatment</b>								
3 lb/sq yd	30	51	52	55	53	49	51	53
Station 225+00 to	40	45	46	52	53	45	46	49
Station 235+00 SB	55	44	43	47	49	42	43	48
5 lb/sq yd	30	45	50	53	58	46	49	53
Station 104+00 to	40	41	42	50	55	44	42	49
Station 114+00 NB	55	35	38	44	49	41	37	45
7-1/2 lb/sq yd	30	50	52	56	58	51	51	54
Station 114+00 to	40	44	45	53	54	45	48	50
Station 225+00 SB	55	38	44	49	48	43	42	49
10 lb/sq yd	30	49	52	58	54	51	51	57
Station 104+00 to	40	43	47	53	52	47	48	53
Station 114+00 SB	55	39	43	49	47	44	44	49
<b>Bituminous Concrete</b>								
US 23A North to	30	51	44	46	50	39	39	43
Forest Rd	40	44	38	44	46	36	35	38
	55	35	32	37	40	30	29	34
<b>Bituminous Aggregate</b>								
M 65 North to	30	52	46	53	51	44	46	50
US 23A	40	44	39	48	47	39	40	46
	55	36	32	42	39	33	34	39

TABLE 2  
 FRICTION LEVELS AFTER  
 THE THREE YEAR EVALUATION PERIOD

Test Speed, mph	Friction Number, FN			Percent Improvement Over	
	Sprinkle Treatment	Bituminous Concrete	Bituminous Aggregate	Bituminous Concrete	Bituminous Aggregate
30	54	43	50	25.6	8.0
40	50	38	46	31.6	8.7
55	48	34	39	41.1	23.1
Speed Gradient (FN <sub>30</sub> - FN <sub>55</sub> ) ÷ 25	0.24	0.36	0.44	33.3	45.4

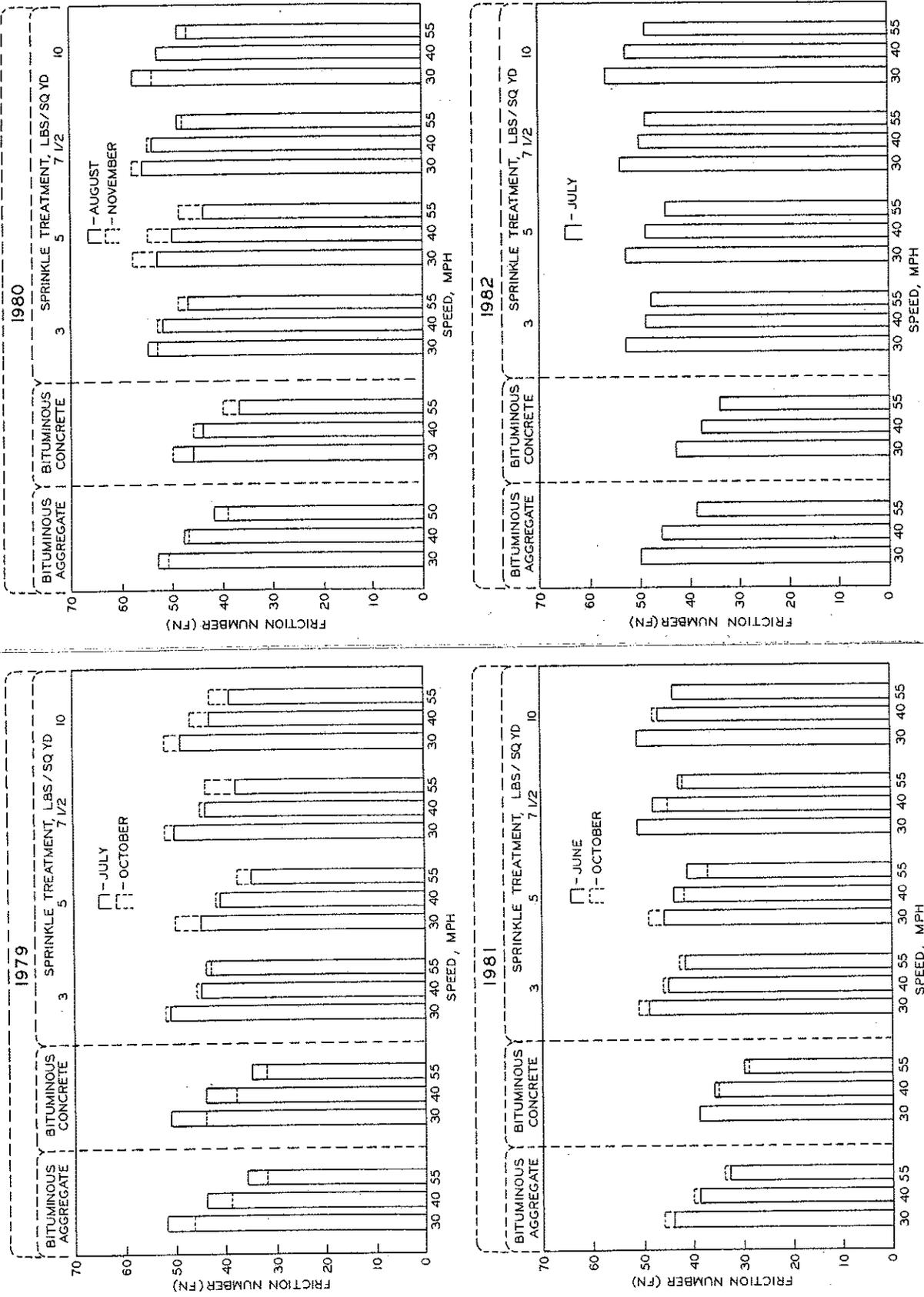


Figure 2. Influence of sprinkle treatment application rate on 40 mph friction numbers during the three-year evaluation.

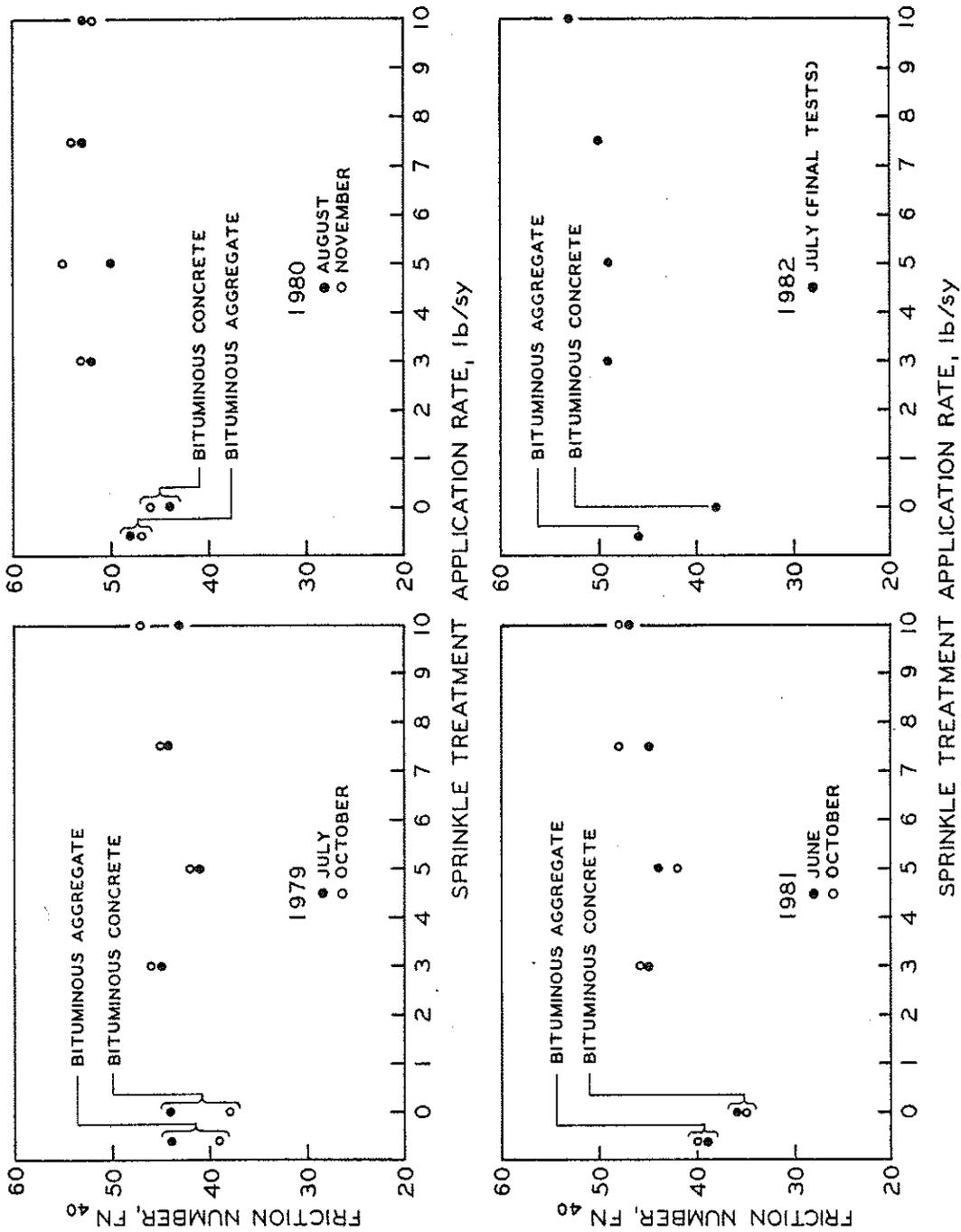


Figure 3. Influence of sprinkle treatment application rate on 40 mph friction numbers during the three-year evaluation.

The rate of sprinkle treatment application does not seem to have a significant effect on friction numbers as shown in Figure 3, where 40 mph values are presented. All levels of sprinkle treatment result in improved friction levels as compared with the bituminous concrete and bituminous aggregate surfaces.

Typical variations in friction levels measured throughout the three-year evaluation are shown in Figure 4 using 40 mph friction numbers. Despite the anomalous decrease in all values between 1980 and 1981, sprinkle treatment values are consistently greater than those of the bituminous concrete and the bituminous aggregate sections. Furthermore, the difference between the sprinkle treatment and bituminous concrete is increasing with time.

In addition to friction levels, another important consideration is the change in friction with changing vehicle speed as expressed by the speed gradient. Speed gradient used in this evaluation is the difference between friction numbers at 30 and 55 mph divided by the speed differential, 25 mph. Lower speed gradient values would indicate better friction characteristics than would higher values; low speed gradients mean little loss of friction at increased vehicle speeds. Speed gradients are much less for all sprinkle treatment applications than for the bituminous concrete or bituminous aggregate surfaces as shown in Figure 5.

The three-year evaluation of sprinkle treatment is summarized by the data in Table 2 where 1982 friction numbers and speed gradients are compared for the three different surface types. The sprinkle treatment values shown in the table are the average of test results obtained for the four sprinkle treatment application rates. When compared with bituminous concrete, sprinkle treatment friction numbers were higher (by as much as 41.1 percent at 55 mph), depending on vehicle speed, as well as exhibiting a 33.3 percent improvement (reduction) in speed gradient. Compared with bituminous aggregate, however, friction numbers improved by only 23.1 percent at 55 mph while the speed gradient improved by 45.4 percent.

Measurements after several more years of service may show greater benefit of sprinkle treatment.

## CONCLUSIONS

Results of this study show that sprinkle treatment provides significantly improved friction levels as compared with the bituminous concrete and bituminous aggregate surfaces which were also measured in this evaluation. Specifically the results show that:

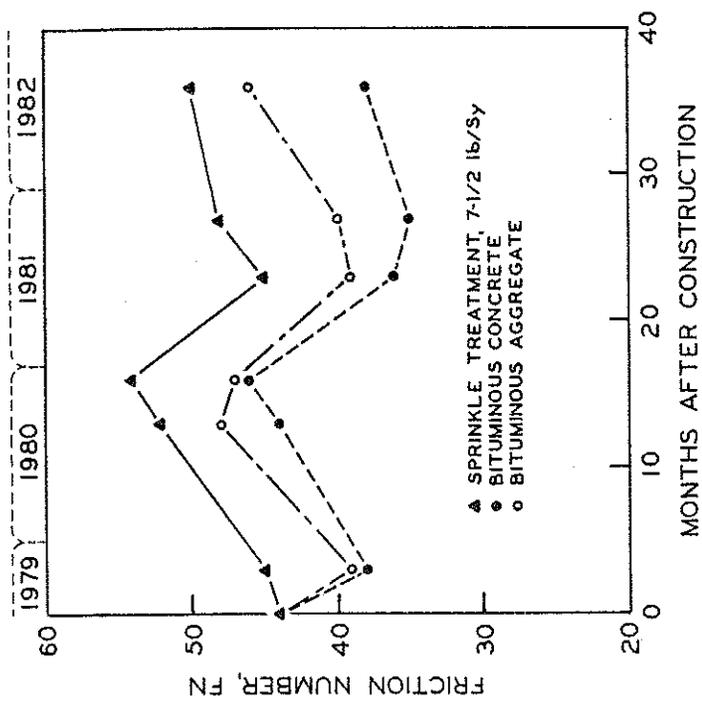


Figure 4. Relationship between friction number at 40 mph and age for the three comparative surface types.

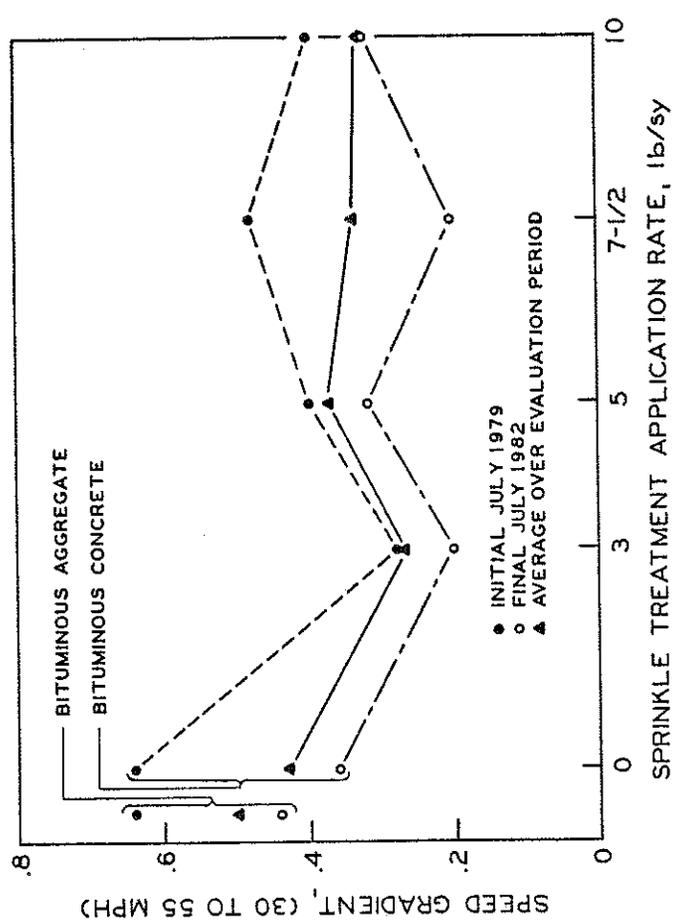


Figure 5. Relationship between rate of sprinkle treatment application and speed gradient.

1) Compared with bituminous aggregate, friction numbers can be increased by from 8.0 percent to as much as 23.1 percent with a corresponding improvement (decrease) in speed gradient of 45.4 percent.

2) Friction numbers were increased by values ranging from 25.6 percent to 41.1 percent when compared with bituminous concrete; speed gradient improved by 33.3 percent compared with bituminous concrete.

### RECOMMENDATIONS

A second sprinkle treatment resurfacing was constructed on M 35 in Menominee County in 1981 using the appended specifications (FRR 55031-17344A).

Coating and application problems were encountered due to an excessive amount of fine aggregate particles in the sprinkle mixture. Based on this experience the recommended gradation of sprinkle aggregate was modified to be as follows:

Sieve Size	Percent Passing
3/4 in.	100
3/8 in.	0-20
No. 4	0-5
Loss-by-Washing	0-2

It is recommended that sprinkle treatment be used wherever low friction level surfacing mixtures are expected due to polishing type aggregates.

A small depression outlines the exposed surface of the individual sprinkle aggregates creating a macrotexture appearance over the treated surface. In order to reduce the potential for retaining moisture on the pavement surface that may cause problems during winter ice control operations, it is recommended that application rates be restricted to the 3 to 5 lb/sq yd range to reduce the macrotexture. Further, to reduce costs, application of sprinkle treatment could be limited to sections of projects where the greatest potential for friction problems exist such as steep grades, sharp curves, or intersections.

Friction measurements, however, will be continued for several more years on these projects to determine the long term effectiveness of sprinkle treatment.

APPENDIX

SPECIAL PROVISION  
FOR  
SPRINKLING BITUMINOUS WEARING COURSE  
MIXTURE WITH PRECOATED AGGREGATE

US 23, FR 71072-15287A, Presque Isle County

a. Description.-The sprinkle treatment shall consist of properly graded, precoated aggregate applied to the surface of plant mixed bituminous concrete pavement immediately after laydown, for the purpose of providing a skid-resistant wearing surface. Sprinkle treatment will be applied to both traffic lanes, 22 feet in width, between Station 7337+50 and Station 7498+00.

b. Materials:

1. Asphalt.-The asphalt cement used to coat the sprinkle aggregate shall be the same as used in the bituminous concrete pavement. An approved anti-stripping agent may be required in the asphalt used to coat the sprinkle aggregate.

2. Sprinkle Aggregate.-Samples of the sprinkle aggregate shall be submitted to the Testing Laboratory at least three weeks prior to the start of coating operations.

Aggregate for the sprinkle treatment shall be a crushed natural gravel obtained from an upper peninsula source producing material containing less than 10 percent carbonate particles and more than 25 percent sandstone particles. Additionally, the aggregate shall meet the requirements for 25A coarse aggregate in Section 8.02 of the 1976 Standard Specifications except that the aggregate shall have the following gradation:

Sieve Size	3/4-inch	3/8-inch	No. 4	No. 200
Percent Passing	100	20-55	0-5	1.5 max.

c. Preparing and Stockpiling Sprinkle Aggregate.-Precoating of the aggregate shall consist of drying the aggregate and mixing at a temperature between 240 F and 300 F. The range of asphalt content shall be between

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8-31-78  
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0.5 and 2.0 percent by weight, as determined by the Engineer. The intent is to produce a uniformly coated aggregate with approximately the maximum amount of asphalt that will allow the aggregate to be spread uniformly when cold.

The coated aggregate shall be stockpiled at the plant on an approved surface to prevent contamination of the coated aggregate. The coated aggregate shall not be stockpiled over 3 feet high while hot and shall be wetted with water after 15 minutes if its temperature is above 320 F. Manipulation in the stockpile may be required if crusting or unusual adherence of aggregate particles occurs. The Engineer may require the stockpile to be covered.

d. Equipment:

1. Rollers. -Pneumatic-tired rollers will not be permitted on any phase of the sprinkle treatment construction.
2. Spreader. -The spreader for applying the sprinkle aggregate has a 12-foot spreading width and will be provided by FHWA at no cost to the Contractor. FHWA will deliver the spreader to the job site, provide a man for training the Contractor's spreader operator for a period of time not to exceed one week, and will remove the spreader from the job site.

The Contractor is responsible for providing an operator and fuel for the spreader; and performing normal routine maintenance and minor repairs for the spreader.

The Contractor is responsible for notifying FHWA of his need for the spreader. The Contractor is advised that FHWA needs approximately 2 weeks notice to assure timely delivery of the spreader. The address for notifying FHWA of the need for the spreader is:

Federal Highway Administration  
Region 15  
1000 North Glebe Road  
Arlington, Virginia 22201  
Attn: Douglas Bernard  
(703) 557-0522

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- e. Temperature Limitations. -Wearing course and sprinkle treatment shall not be placed when the air temperature is below 50 F.
- f. Paving Limitations. -Construction of shoulder base and paving of shoulder surface shall not be started in the sprinkle treatment section until the section has been completed in both lanes.

A berm of aggregate shoulder material at least 6 inches wide shall be banked against the outside edge of the bituminous wearing course after each day's operation before the lane is open to traffic.

- g. Delivery of Precoated Sprinkle Aggregate. -The precoated aggregate shall be delivered to the spreader in a "Flo-Boy" type hauling unit operating beside the spreader on the shoulder. A front end loader, or other approved conveyance, shall be used to transfer the sprinkle aggregate from the "Flo-Boy" to the hopper of the spreader. The bucket on the loader shall be of a size to prevent spillage of the aggregate.
- h. Applying Precoated Sprinkle Aggregate. -Immediately after the passage of the paver and prior to any rolling, the precoated aggregate shall be applied uniformly to the surface of the wearing course with the mechanical spreader. The sprinkle aggregate shall be placed cold.

The aggregate shall be applied at the rate of 10 to 15 pounds per square yard, as directed by the Engineer.

- i. Rolling. -Rolling shall commence immediately after the coated aggregate is applied unless otherwise directed by the Engineer. Compaction of the sprinkle-treated surface course shall be as specified under Rolling, 4.12.08, of the 1976 Standard Specifications except that pneumatic rollers will not be permitted.
- j. Opening to Traffic. -Traffic will not be permitted on the surface until the pavement has cooled to such a temperature that the sprinkle aggregate will not pick up under the tires. Watering may be required by the Engineer to promote cooling of the pavement prior to opening to traffic.
- k. Measurement and Payment. -The completed work as measured for SPRINKLE TREATMENT will be paid for at the contract unit price for the following contract item (pay item).

<u>Pay Item</u>	<u>Pay Unit</u>
Sprinkle Treatment	sq yd

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Sprinkle treatment will be paid for by the square yard of surface treated and will include the asphalt and the aggregate, coating the aggregate, and applying to the wearing course surface; providing an operator and fuel for the spreader; and performing normal routine maintenance and minor repairs for the spreader. Water as required shall be incidental to the sprinkle treatment and will not be paid for separately.

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