FINAL REPORT

AN EXPERIMENT WITH PACZYME

by
M. C. Anday
Highway Research Engineer

Virginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia
Department of the Highways and the University of Virginia

P. O. Box 3817, University Station
Charlottesville, Virginia 22903
November 1970
VHRC 70-R19

SUMMARY

This study investigated a liquid, enzymatic, proprietary product, Paczyme, to determine if it could be used effectively and economically as a soil stabilizer in highway construction. Specific objectives were sought to prove or disprove the claims of the company that produces Paczyme, the Larutan Corporation.

The specific objectives included the determination of the effect of Paczyme on (a) moisture distribution; (b) compaction characteristics; (c) bearing capacity; and (d) durability.

As a result of laboratory and field investigations with one type of soil, it was concluded that Paczyme either did not affect the above mentioned characteristics or its effects were insignificantly small.

FINAL REPORT

AN EXPERIMENT WITH PACZYME

by
M. C. Anday
Highway Research Engineer

INTRODUCTION

In accordance with the outline given in the working plan* for this study a liquid, enzymatic, proprietary product, Paczyme, was investigated to determine if it could be used effectively and economically as a soil stabilizer in highway construction. The effects of Paczyme used as a soil stabilizer were investigated both in the laboratory and in the field. Specific objectives were sought to prove or disprove the claims of the company that produces Paczyme, the Larutan Corporation.

PURPOSE AND SCOPE

The purpose of the study was to evaluate Paczyme as a soil stabilizer. Specifically, the following factors were investigated:

Objective 1 — Determination of the effect of Paczyme on the distribution of moisture in a soil media.

Objective 2 — Determination of the effect of Paczyme on the compaction characteristics of soils.

Objective 3 — Determination of the effect of Paczyme on the bearing capacity of soils.

Objective 4 — Determination of the permanency of Paczyme treatments.

One type of soil, a clayey, silty, gravelly sand was used for the study.

---

*"Working Plan - An Experiment with Paczyme" by M. C. Anday, Virginia Highway Research Council March 1970.

PROCEDURE AND RESULTS

A site 500' long and one lane wide on project 029-062-104, C506, B612, in Nelson County, Virginia, south of Lovingston and about 0.5 mile north of the intersection of Routes 29 and 158, was selected for the study. This site offered a soil that appeared homogenous on visual inspection. Soil samples were obtained from 50' stations and sent to the Larutan Corporation to be used for the determination of the amount of Paczyme needed for stabilization with this type of soil. Samples from the same stations were also brought to the Council's laboratory and mixed to give a 250 lb. composite sample. All laboratory tests were performed using this composite sample.

The Larutan Corporation, as a result of their testing, recommended the use of one gallon of Paczyme per 23 to 28 cubic yards of soil. Since a composite sample was used in the laboratory, an average rate of one gallon of Paczyme per 25.5 cubic yards of soil was used for all experiments.

Laboratory Investigations

The properties of the composite sample and the soils from each section of the test site are given in Table I. As can be seen from the table the properties of the composite sample are very similar to those of the soils from each station. The test values were obtained to determine if the use of a composite sample in the laboratory testing would create unwanted variabilities. The results justified the use of a composite sample.

Compaction Tests

As part of Objective 2 it was decided to run a limited number of compaction tests with and without Paczyme in the compaction water. Results of the compaction tests, using AASHO Method T-99, are shown in Table II.

TABLE I

PROPERTIES OF THE SOILS

Properties	Composite	Stations									
		57+00	57+50	58+00	58+50	59+00	59+50	60+00	60+50	61+00	61+50
% Passing 1 1/2" sieve	100	100	100	100	100	100	100	100	100	100	100
% Passing 1" sieve	100	100	100	100	100	100	100	100	100	100	100
% Passing 3/4" sieve	100	100	100	100	100	100	100	100	100	100	100
% Passing 3/8" sieve	98.5	98.1	97.1	98.6	100	100	100	97.5	98.2	100	94.3
% Passing No. 4 sieve	92.5	90.2	93.5	93.6	94.5	91.9	93.7	89.0	90.7	94.3	84.6
% Passing No. 10 sieve	77.7	72.3	83.2	75.3	74.0	70.2	75.9	69.3	72.7	75.1	64.3
% Passing No. 20 sieve	75.0	68.5	80.1	73.1	72.2	67.5	73.8	67.2	70.3	72.9	62.3
% Passing No. 40 sieve	71.2	64.8	75.2	69.5	69.2	63.7	70.2	64.2	66.6	70.2	59.7
% Passing No. 80 sieve	63.2	57.1	66.3	61.4	62.0	56.2	62.2	57.3	58.6	63.1	53.8
% Passing No. 100 sieve	60.1	54.1	62.6	58.2	59.3	53.6	59.1	54.6	55.4	60.3	51.4
% Passing No. 200 sieve	52.4	44.6	50.4	48.1	51.2	45.9	49.5	47.1	45.8	52.2	44.0
Liquid Limit, %	39	45	44	44	46	42	41	41	38	40	42
Plasticity Index, %	3	7	3	10	10	8	3	5	6	4	7
% Sand and gravel	57	56	49	53	53	54	50	55	61	58	60
% Silt	22	25	33	21	20	22	26	23	21	25	18
% Clay	21	19	18	26	27	24	24	22	18	17	22
HRB Classification	A-5(2)	A-5(2)	A-5(3)	A-5(3)	A-5(4)	A-5(2)	A-5(3)	A-5(3)	A-4(2)	A-4(3)	A-5(2)
Specific Gravity	2.76	2.74	2.77	2.78	2.78	2.78	2.78	2.76	2.78	2.75	2.76

TABLE II

RESULTS OF COMPACTION TESTS

Sample No.	With Paczyme		Without Paczyme	
	Maximum Density, pcf	Optimum Moisture Content, %	Maximum Density, pcf	Optimum Moisture Content, %
1	100.2	22.2	100.0	21.5
2	99.5	22.5	100.5	22.0
Average	99.9	22.4	100.3	21.8

California Bearing Ratio Tests

As part of Objective 3, CBR tests were performed on specimens with and without Paczyme in the water used to bring them to optimum moisture. In molding the CBR specimens the procedure outlined in the Virginia Test Method 8 (VTM-8), "Conducting California Bearing Ratio Test", was used. As part of Objective 4, however, the prescribed soaking and drying periods were modified.

The results of the CBR tests are shown in Table III.

TABLE III

RESULTS OF CBR TESTS

Sample No.	Soaking Period	Drying Period	CBR Data			
			With Paczyme		Without Paczyme	
			% CBR	% Swell	% CBR	% Swell
1	4 days	None	7.7	1.1	10.7	1.4
2	4 days	None	9.3	1.2	7.5	1.8
3	4 days	None	12.3	1.1	9.8	1.1
4	4 days	None	9.2	1.2	8.7	1.1
Average			9.6	1.15	9.2	1.35
5	4 days	7.5 hours	10.2	0.5	13.8	0.9
6	4 days	7.5 hours	9.3	0.6	10.2	1.3
Average			9.8	0.55	12.0	1.10
7	14 days	None	8.1	1.1	9.2	1.3
8	14 days	None	7.4	1.0	10.1	1.3
Average			7.8	1.05	9.7	1.30

Field Investigations

The layout of the field project is shown in Figure 1. As can be seen from this figure, test and control sections of 250 feet each were provided. Tests were conducted only in the middle 200 feet of each section to eliminate variabilities that can result from contamination.

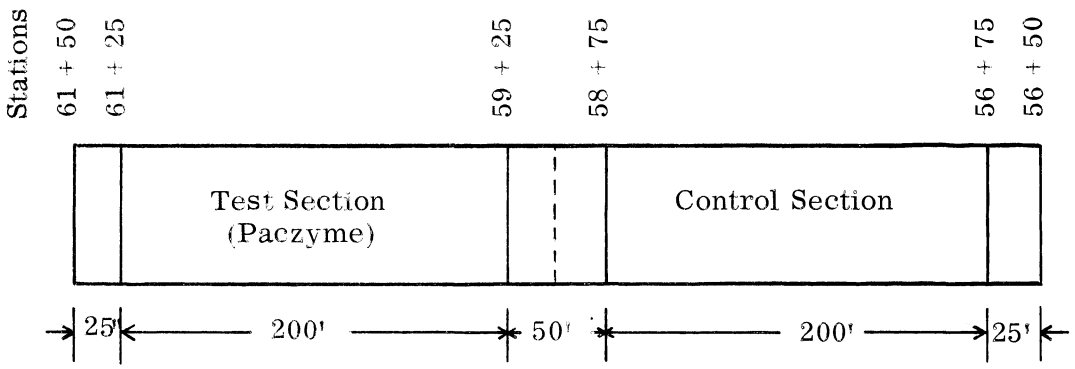

Figure 1. Layout of the experimental sections.

Prior to construction the moisture content of each section was checked at each station and was found to be fairly uniform and slightly below optimum. No adjustments, therefore, were made to the moisture content of the material.

The field experiment was conducted on September 15, 1970.

Construction Procedure

Both sections were scarified using the teeth of a grader, and the amount of water necessary to bring the soil approximately to its optimum moisture content was calculated. To this amount of water, Paczyme was added. The rate of application of Paczyme was approximately one gallon per 25.5 cubic yards of soil. The Paczyme-water solution was distributed over the entire test section using a water truck equipped with spray bars. During the sprinkling procedure it was found necessary to make a pass with the mixer (Seamen) to prevent the solution from running off the material.

After the addition of the Paczyme-water solution one pass was made with the mixer, and the soil was then rolled with a sheepsfoot roller. It was intended to continue rolling with the sheepsfoot roller until it "walked out"; however, it was observed that this was not going to happen because of the nature of the soil, so rolling was discontinued after 14 passes.

The test section was then lightly bladed and as part of Objective 2 "a roller pattern" using the nuclear devices was run on the pavement.

Roller Pattern

A "roller pattern" is determined by rolling a section of a layer of pavement with a known number of passes and determining the dry density of the layer. The results are then plotted with dry density as the ordinate and the number of passes as the abscissa. If the above process is continued, several points can be obtained and a curve such as the one shown in Figure 2 is obtained.

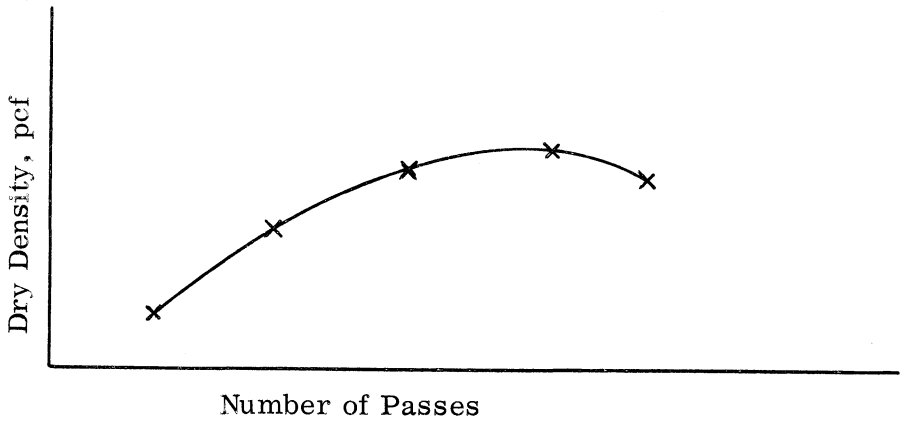

Figure 2. Typical roller pattern.

Leveling of the curve is an indication of the attainment of the maximum density possible at a given moisture content and with a given compaction effort. In some cases a drop in density might result after the curve levels off. This is attributed to over rolling.

The compaction equipment used in this project was a rubber tired roller weighing approximately 10 tons.

The control section was constructed using the same procedure except that only water was added instead of the water-Paczyme solution.

The data for the roller patterns of the control and test sections are shown in Table IV.

The roller patterns for the test and control sections, based on the average data shown in Table IV, are shown in Figure 3.

TABLE IV

ROLLER PATTERN DATA

No. of Passes	Test No.	Compaction Data			
		Test Section		Control Section	
		Dry Density, pcf	Moisture, %	Dry Density, pcf	Moisture, %
2	1	100.2	16.8	95.0	16.3
2	2	97.2	16.9	95.9	17.3
2	3	93.8	19.4	96.2	18.4
2	Ave.	97.0	17.7	95.7	17.3
5	1	—	—	98.2	17.0
5	2	—	—	96.1	17.1
5	3	—	—	98.1	17.1
5	Ave.	—	—	97.5	17.1
9	1	100.6	18.0	103.2	15.3
9	2	104.0	17.8	104.0	16.1
9	3	102.7	19.3	104.0	16.5
9	Ave.	102.4	18.4	103.7	16.0
19	1	104.9	17.4	97.0	16.1
19	2	103.8	18.0	95.9	17.4
19	3	101.2	18.4	105.2	17.3
19	Ave.	103.3	17.9	99.4	16.9

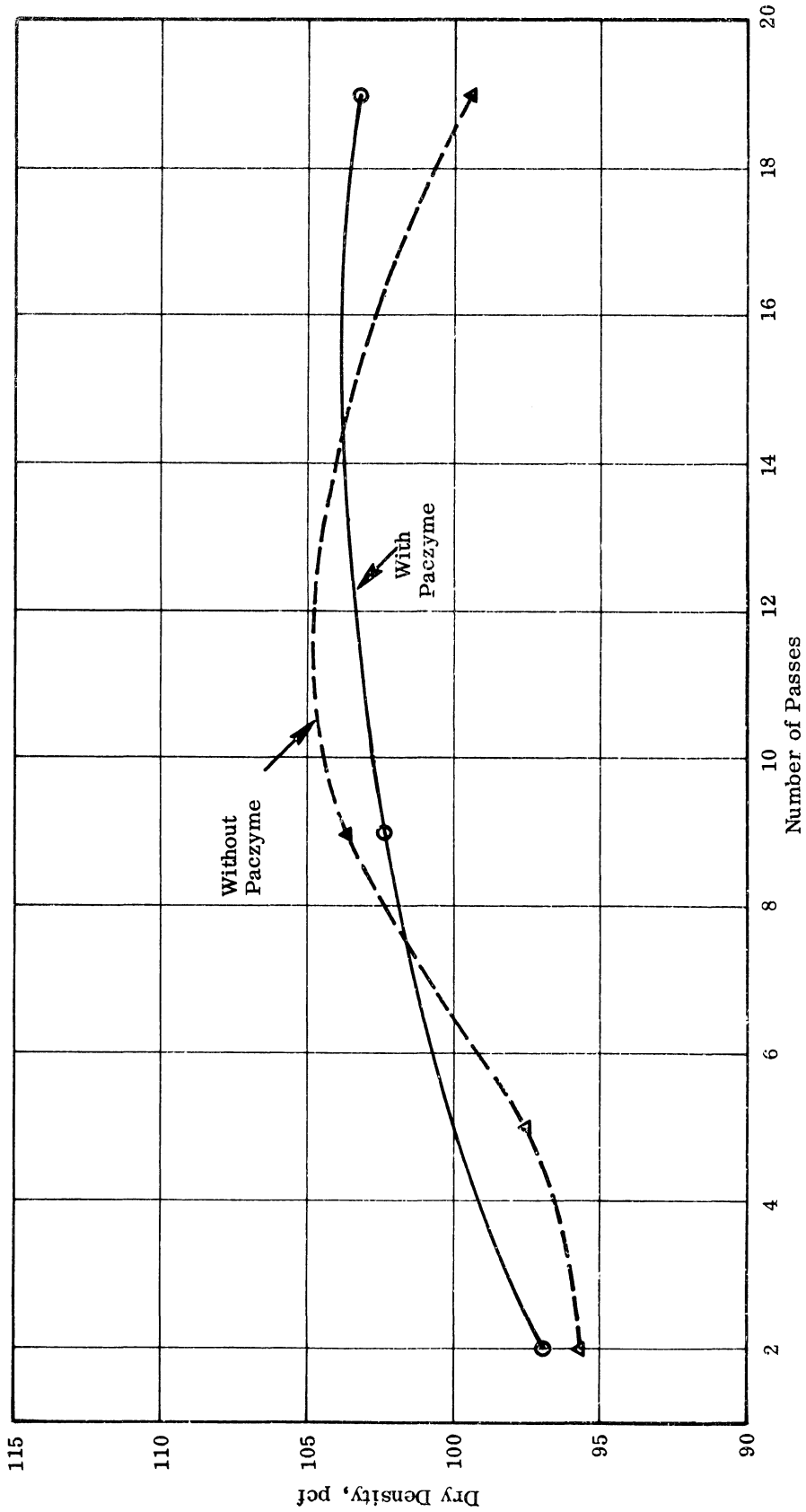

Figure 3. Roller patterns for the test and control sections.

Moisture Samples

At the completion of the roller pattern, to fulfill the requirements of Objective 1, 30 moisture samples of about 300-400 grams each were taken from each section. These samples were kept in jars with sealed tops and were dried in the laboratory to constant weight. The moisture data are given in the Appendix. A summary of the moisture data and the statistical analysis is given in Table V.

TABLE V

SUMMARY OF THE MOISTURE DATA

Property	Test Section	Control Section
Average Moisture, %	19.87	18.55
Std. Dev. (σ), %	1.66	2.17

Conventional Compaction Test

It should be realized that in determining the roller patterns with the nuclear devices the backscatter technique was used. The compaction data are, therefore, relative and not absolute.

As part of Objective 2, to determine absolute compaction data, conventional sand-cone tests were performed on each section the day after construction. Also, at the suggestion of personnel of the Larutan Corporation, additional sand-cone tests were performed several days after construction. This suggestion was based on the assumption that Paczyme treated soils might increase in density with time.

The sand-cone density and moisture data are summarized in Table VI.

TABLE VI

SAND-CONE DENSITY AND MOISTURE DATA

Age	Test No.	Test Section		Control Section	
		Dry Density, pcf	Moisture, %	Dry Density, pcf	Moisture, %
1 day	1	94.0	17.1	96.2	15.1
1 day	2	97.4	20.3	97.2	18.6
1 day	3	98.0	18.0	92.5	18.0
1 day	4	97.4	18.6	97.7	16.1
1 day	5	96.1	19.1	91.4	20.5
1 day	Average	96.6	18.6	95.0	17.7
7 days	1	92.5	16.4	94.8	14.3
7 days	2	93.4	16.2	94.8	18.1
7 days	3	96.0	16.5	90.2	18.4
7 days	Average	94.0	16.4	93.3	16.9

Permanency of Paczyme Treatments

It was mentioned in the working plan that the permanency of Paczyme would be investigated by both annual observation and deflection tests on the experimental project and by modified CBR tests. The results of the modified CBR tests are shown in Table III.

Annual observations will not be made since the experimental section will be torn down for cement treatment, which the project calls for.

DISCUSSION OF RESULTS

Laboratory Investigations

From Table I it can be seen that the soil from the project was very uniform and, therefore, very suitable for experimentation. This uniformity gives more meaning to the test results obtained in the laboratory, where a composite sample was used.

Limited compaction test results, as shown in Table II, indicate that Paczyme does not influence the compaction characteristics of this soil, as determined by AASHO Method T-99.

Considering the large variabilities involved in CBR tests the results, as shown in Table III, indicate that Paczyme does not influence the CBR value of either standard 4-day soaked specimens or the specimens dried after 4 days of soaking. The percent swell values are somewhat lower for the Paczyme treated specimens. The reduction in percent swell, however, is very small. It should be realized that when one considers the reduction in percent swell, one is considering a value of at least 3-4 percent (such as the reduction caused by lime stabilization) and not a fraction of a percent.

Field Investigations

The roller pattern data shown in Table IV are somewhat variable. For three tests taken from a 200 foot section, however, they are not unreasonable.

The roller patterns shown in Figure 3 indicate that the soil behaves about the same with or without Paczyme. It should be noted again that in determining the roller patterns with the nuclear devices the backscatter technique was used. As mentioned, this technique was used to expedite testing and the test values should be looked upon as relative values. Also in the backscatter technique the important point is the increase or decrease in density due to different compactive efforts.

The absolute values of densities and moistures are, therefore, evaluated from the conventional sand-cone tests, as shown in Table VI. From these values it can be seen that with approximately equal moisture contents the densities with and without Paczyme are about the same. Small differences such as 1.6 pcf after construction and 0.7 pcf seven days after construction exist. These, however, are insignificant since the standard deviation (σ) for density is at least 2-3 pcf.

The moisture data as shown in Table V indicate that the average moisture of the test section (with Paczyme) was about 1.3% higher than that for the control section. This is considered comparable. The standard deviations (σ), which are an indication of the variation of the moisture within the sections, are 1.66 and 2.17 for the test and control sections respectively. At the 95% confidence level, which is a level preferred and most popularly used for highway related studies, these standard deviations are not significantly different (as concluded from the F-test). They are, however, borderline. That is, the computed F value for the 95% significance level was 1.706. To be significantly different, this F value would have had to be at least 1.8. Of course, at a lower confidence level, such as 90%, the results could be considered significantly different.

CONCLUSIONS

In view of the results presented in this report, which are from one composite soil sampled from the project, the following conclusions are drawn. These are listed in the same order as the objectives outlined under "Purpose and Scope".

1. The effect of Paczyme on the distribution of moisture was not significant at the 95% confidence level. The significance is borderline, however, and with less certainty, that is at a lower confidence level, it can be said to be significant.

2. (a) The effect of Paczyme on the compaction characteristics of the soil is negligible based on limited laboratory compaction tests and sand-cone tests performed after excessive rolling of the field project.

   (b) The roller patterns of the sections with and without Paczyme are similar. (The final point of the roller pattern of the Paczyme treated section was 3.9 pcf higher than that of the pattern for the untreated section.)

3. The effect of Paczyme on bearing capacity as determined by the CBR test is not evident. The percent swell values for the Paczyme treated specimens are somewhat smaller, but the difference between these and the values of the untreated specimens is so small that the reduction in percent swell is considered to be insignificant.

4. The laboratory CBR data did not indicate any beneficial effect of the Paczyme treatment. The efforts expended in determining the permanency of the Paczyme treatments, therefore, were not justified and were discontinued.

ACKNOWLEDGEMENTS

This study was made possible through the help of many organizations within and outside the Virginia Department of Highways. The author, therefore, extends his gratitude to the following:

1. The English Construction Company
2. The Larutan Corporation
3. The Burrus Land and Lumber Company
4. The Materials Division, Virginia Department of Highways
5. The Materials Division, Lynchburg District, Virginia Dept. of Highways
6. The Amherst Residency, Virginia Department of Highways
7. Inspection Personnel of Project 0029-062-104, C506, B612 Nelson County
8. Personnel of the Soils Section, Virginia Highway Research Council

APPENDIX

868

MOISTURE DATA (Jar Samples)

Test Section				Control Section			
No.	Moisture, %	No.	Moisture, %	No.	Moisture, %	No.	Moisture, %
1	18.85	21	17.87	1	15.09	21	20.35
2	20.17	22	23.10	2	19.72	22	17.66
3	22.12	23	18.50	3	17.90	23	18.29
4	19.37	24	18.98	4	19.75	24	18.13
5	18.08	25	19.31	5	14.46	25	18.01
6	20.27	26	22.94	6	20.22	26	20.71
7	20.44	27	20.00	7	19.87	27	17.38
8	23.37	28	21.80	8	22.49	28	14.90
9	19.20	29	22.26	9	16.43	29	21.91
10	19.10	30	20.37	10	18.05	30	21.86
11	19.68			11	16.44		
12	18.07			12	19.14		
13	18.72			13	21.28		
14	20.58			14	18.78		
15	19.27			15	20.89		
16	20.92			16	14.82		
17	18.59			17	18.31		
18	17.12			18	17.27		
19	17.97			19	18.25		
20	19.05			20	18.14		

PAVEMENT DESIGN AND PERFORMANCE STUDIES

Progress Report No. 4 on Phase A:

Performance Study of Typical Virginia Pavements

by

K. H. McGhee
Highway Research Engineer

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Highway Research Council

(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways and the University of Virginia)

In Cooperation with the U. S. Department of Transportation
Federal Highway Administration

Charlottesville, Virginia

November 1970
VHRC 70-R20

SUMMARY

The performance of in-service typical Virginia flexible and rigid pavements in all areas of the state is under evaluation. The objectives are to provide a ready reference for designers and field engineers and to provide background information for design improvement. Periodic deflection and roughness tests are conducted along with field inspections. The records maintained on each pavement reflect condition, traffic, construction costs, and major repairs.

Among the major findings of the study to date are:

(1) Cement stabilized subgrades under recently constructed flexible pavements have virtually eliminated rutting and other major distortions,

(2) The cumulative number of trailer trucks and buses sustained by a pavement up to a fixed degree of cracking is directly related to a parameter used to define the shape of the Dynaflect deflection basin, and

(3) Terminal PSI as defined from the AASHO Road Test is too insensitive for use in the evaluation of flexible pavement performance in Virginia.