OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

April 16, 1970

To: L. T. Oehler, Engineer of Research
Research Laboratory Section

From: R. C. Mainfort

Subject: Evaluation of Paczyme as a Soil Stabilizing Agent. Research Project 69 NM-244. Research Report No. R-734.

Paczyme is the trade name of a liquid substance marketed as a soil stabilizer and compaction aide by the Larutan Corporation of Anaheim, California. It is claimed by the producer to be a liquid biocatalytic compound containing enzymes developed specifically for road building purposes. Through extensive advertising in road construction trade journals, the material has attracted considerable interest from various contractors and engineers, and numerous requests have reached the Department for information as to its value as a soil additive. As a result, R. L. Greenman, Engineer of Testing and Research, requested the Research Laboratory Section to evaluate the effectiveness of Paczyme as a soil stabilizing agent.

Function and Application of Paczyme

Among the claims made for Paczyme are that its use will:

1. Help achieve high compaction density by reducing frictional resistance of soil particles.

2. Reduce volume of water normally required to achieve optimum moisture.

3. Develop molecular attraction between organic and inorganic soil components so that cementation occurs when the treated soil undergoes compaction.

4. Increase resistance to re-entry of moisture after curing.

5. Partially digest organic materials that cause cohesion of individual soil particles.

To obtain these results the producers recommend that Paczyme normally be used in a concentration of one gallon of Paczyme to 1,000 gallons of water and be applied and mixed with the soil in the same manner as water would be. A curing period of approximately 24 to 72 hours is required for the solution to react properly with the treated soils. When soils are quite wet or of high clay content, the ratio of Paczyme to water may be increased up to four gallons per 1,000. Laboratory testing is recommended to determine specific Paczyme concentrations for each project. The Larutan Corporation claims to offer such

service but the type of testing required is not stated nor is there any indication of their competency to make such tests.

Chemical Analysis of Paczyme

A chemical analysis of Paczyme, performed by John Ellis of the Spectroscopy and Photometry Unit of the Research Laboratory, is summarized as follows:

> "Paczyme is a brown, slightly acid material (pH, approximately 6) in a water solution containing 19.5 percent solids. Infra-red spectra of the solid fraction indicate that Paczyme is primarily an anionic sulfonated surface active agent. Such materials are commonly used as detergents, wetting agents, penetrants, dispersing agents and emulsifiers. Evidence of enzymes was not determined."

A separate analysis, made by Dow Chemical Company of Midland, Michigan, showed Paczyme to consist of over 80 percent water plus minor amounts of an unknown enzyme, a fatty acid, and a sodium salt.

When diluted in 1,000 gallons of water the original 20 percent or so solids form a very small part of the final solution.

Laboratory Evaluation

Three soil types were used in the laboratory to determine the effectiveness of Paczyme; a processed aggregate (22-A), a sand and a clay. Characteristics of these soils are shown in Table 1.

TABLE 1

Test Sample	Gradation, percent passing					Plasticity		Maximum Unit Dry Weight, pcf.	Optimum Moisture, percent	AASHO Class
	#200	#30	#4	3/8	3/4	P.I.	L.L.			
Sand	3	88	100			N.P.	----	104.1	12.7	A-1
Gravel-22A	6	28	59	76	96	N.P.	----	139.7	7.0	
Clay	54	80	100			14.4	34.1	123.1	12.4	A-6 (6)

Each soil was separated into three representative portions to which Paczyme solutions in concentrations of 0, 2, and 4 gallons per 1,000 gallons of water were added. The possible effects of Paczyme on the soils were evaluated using standard AASHO testing procedures where such were applicable. Special tests were made to determine particular characteristics of the treatment. Testing results are summarized in Table 2, where all values shown are the average of three replicate tests.

Results shown in line 1 indicate that the Atterberg limits, as expressed by the liquid limit and plasticity index for the clay soil, are not appreciably changed by the addition of Paczyme.

In order to determine the value of Paczyme with respect to its effect on the compaction characteristics of soils, treated and untreated samples were compacted by the Michigan Cone (gravel and sand) and the T-99 (clay) methods and the results compared. Line 2 shows that compaction characteristics of the three soils are not changed by the presence of Paczyme. Also of interest for compaction control, is the ability of a soil to retain moisture during the placing and compaction processes. Line 3 shows that there was no decrease in evaporation loss for the soils where Paczyme was added.

Line 4 shows the compressive strength of 2- by 4-in. clay samples with and without Paczyme treatment. No improvement in bonding or strength properties were shown by the treatment; in fact, the unconfined compressive strengths of the treated samples were less than that of the untreated. In this test, samples were moist cured for 72 hours and tested at near optimum moisture content.

Permeability of the samples was determined by the constant head method using 2-in. diameter by 4-in. high samples compacted to maximum density at optimum moisture content. The hydraulic head on each sample was maintained at 1.5 times the sample length and the amount of water flowing from the sample was measured at successive time intervals until a uniform and constant flow rate was reached. Results of this test indicate a slightly higher permeability for the Paczyme treated soils but this increase is not considered significant enough to cause a useful change in draining characteristics of the soils.

Line 6 shows the result of tests made to check the claim that Paczyme partially digests organic materials in soils. A peat material, containing 92 percent organic matter and a sand, to which had been added 20 percent lignin (an organic material), were saturated with a concentrated solution of Paczyme (no dilution with water) and the mixture allowed to "digest" for 48 hours. The weight loss in percent could be an indication of "digestion." The data show some weight loss when the concentrate Paczyme solution was applied indicating that the producer's claim, in this respect, is true under extreme conditions. When diluted to the maximum amount recommended (4 gals per 1,000 of water) however, the digestive effect was reduced to a value not considered to be significant.

Field Testing of Paczyme

During the summer of 1969 the City of Kalamazoo, Michigan placed two test sections of Paczyme. Both of these involved the reworking and compaction of 6-in. deep oil aggregate bases without surfacing used to carry residential street traffic. Both jobs were quite similar but Research Laboratory personnel were present during construction of only one of them. All of the work was under the supervision of Mr. Jim Hensen, City Superintendent of Streets.

The test section observed by Research Laboratory personnel formed a 320 foot long by 22 foot wide section of Lafayette St, extending from its intersection with Redwood St north toward W. Michigan Ave. The treated base consisted of approximately 6 in. of a 23A aggregate. Prior to the Paczyme application the base had been treated six times, over a two year period, with a medium cure road oil at a rate of 1.2 gallons per square yard. The oil had been applied to the surface, scarified, and mixed to the full 6 in. depth. The use of a previously treated base for a test section involving a different chemical is not recommended but this decision was made by the City of Kalamazoo.

For the Paczyme treatment, aggregate was removed to a depth of 6 in. by blading to the edges of the roadway. The exposed subgrade surface was sprayed with Paczyme solution (4 gallons of Paczyme to 1,000 gallons of water) and compacted. No density control was used on the job. The surfacing aggregate was replaced in two inch layers, treated with Paczyme and compacted. Local traffic was maintained throughout the operations. For the 320- by 22-ft wide test section a total of 6 gallons of Paczyme in 1,500 gallons of water was applied. No unusual problems were encountered, the Paczyme being applied the same as water and its effects seemed the same.

During construction and periodic observation of this job thereafter, there has been no indication that the Paczyme treatment acted in any other way than would plain water.

Conclusions

On the basis of laboratory tests and observation of field test sections it is concluded that Paczyme, when applied in the concentrations recommended by the producers, has no beneficial effects on soil or granular materials. Further, there is no evidence of any kind of study or evaluation of the material by the producers to indicate a scientific basis for using or promoting its use as a soil stabilizer or construction aide.

It is recommended that no further consideration be given to the use of Paczyme for highway construction pruposes.

TESTING AND RESEARCH DIVISION

Supervising Engineer
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TABLE 2
PACZYME TEST RESULTS
(Averages of three replicate tests)

Line	Test	Paczyme Treatment					
		Untreated		2 gal/1000		4 gal/1000	
1	Plasticity (clay only) Liquid Limit % Plasticity Index	34.1 14.4		34.8 15.7		33.8 13.4	
2	Compaction	MD,[1] pcf	OM,[2] %	MD, pcf	OM, %	MD, pcf	OM, %
	Gravel (cone)	139.7	7.0	140.3	8.0	140.1	8.0
	Sand (cone)	104.1	12.7	102.9	14.7	104.1	13.0
	Clay (T-99)	123.1	12.4	122.8	12.9	122.7	13.0
3	Evaporation Loss (% in 100 hours) Gravel Sand Clay	6.2 7.0 6.8		6.6 7.3 6.8		6.4 6.6 6.2	
4	Unconfined Compressive Strength psi (clay)	104		87		89	
5	Permeability (K cm/sec x 10^{-4}) Gravel Sand	2.2 10.5		5.3 13.7		77.6 15.2	
6	Organic Digestion	4 gal/1000		Concentrated			
	Peat	Slight		1.3%			
	Lignin in Sand	0.5%		7.9%			

[1] Maximum Density
[2] Optimum Moisture