EVALUATION OF "LAKELITE" AGGREGATE AS A LIGHTWEIGHT FILL MATERIAL

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

EVALUATION OF "LAKELITE" AGGREGATE AS A LIGHTWEIGHT FILL MATERIAL

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Testing Laboratory Section
Testing and Research Division
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An investigation to evaluate "Lakelite" aggregate with respect to possible use as a fill or backfill material has been conducted by the Field Investigation Subunit of the Soils Unit, Testing Laboratory Section. This need arises since the Department sometimes encounters conditions where the natural soil cannot support roadways near ground level or fills of normal weight material and an alternative must be found. In certain cases the use of a lightweight fill material may be the best alternative either as an embankment material or to replace weak natural soil. While some industrial by-products have been used for this purpose in their own localities, there is a need for a suitable material having uniform and dependable desirable qualities which can be made more widely available and which will be available when needed.

"Lakelite" is the trade name of a porous sintered clay product marketed by United States Steel and produced by Construction Aggregates, Inc. located near Grand Haven, Michigan. It is a mixture of approximately 70 percent native crushed clay, 10 percent coke breeze and 20 percent return fines that is pelletized and sintered at 1800 to 2200 F (1900 F desired). The plant-run material is stockpiled before crushing and afterward is screened into fractions designated:

Coarse - 3/4-inch to No. 4
Medium - 3/8-inch to No. 4
Fine - passing No. 4.

See Figure 1 for typical gradations of these fractions.

A prior evaluation of this material has been made, primarily for use in lightweight structural concrete and concrete products* (ASTM C330 and C331). In addition, some test information is available on a Lakelite sample very closely approximating the "medium" gradation and submitted to the Laboratory in September, 1970, as a bituminous sealcoat aggregate. Results for this sample, 70A-4780, follow:

Los Angeles C Abrasion	34.3 percent wear
Dry-loose density	49.0 pcf
Michigan cone density @ 125 total blows, dry	68.0 pcf
AASHO T-85 Absorption	19.09 percent
AASHO T-85 Bulk Specific Gravity (Dry Basis)	1.51

*An Evaluation of Lakelite Aggregate for Use in Concrete and Concrete Products, by Edwin L. Saxer, Professor of Civil Engineering, University of Toledo.

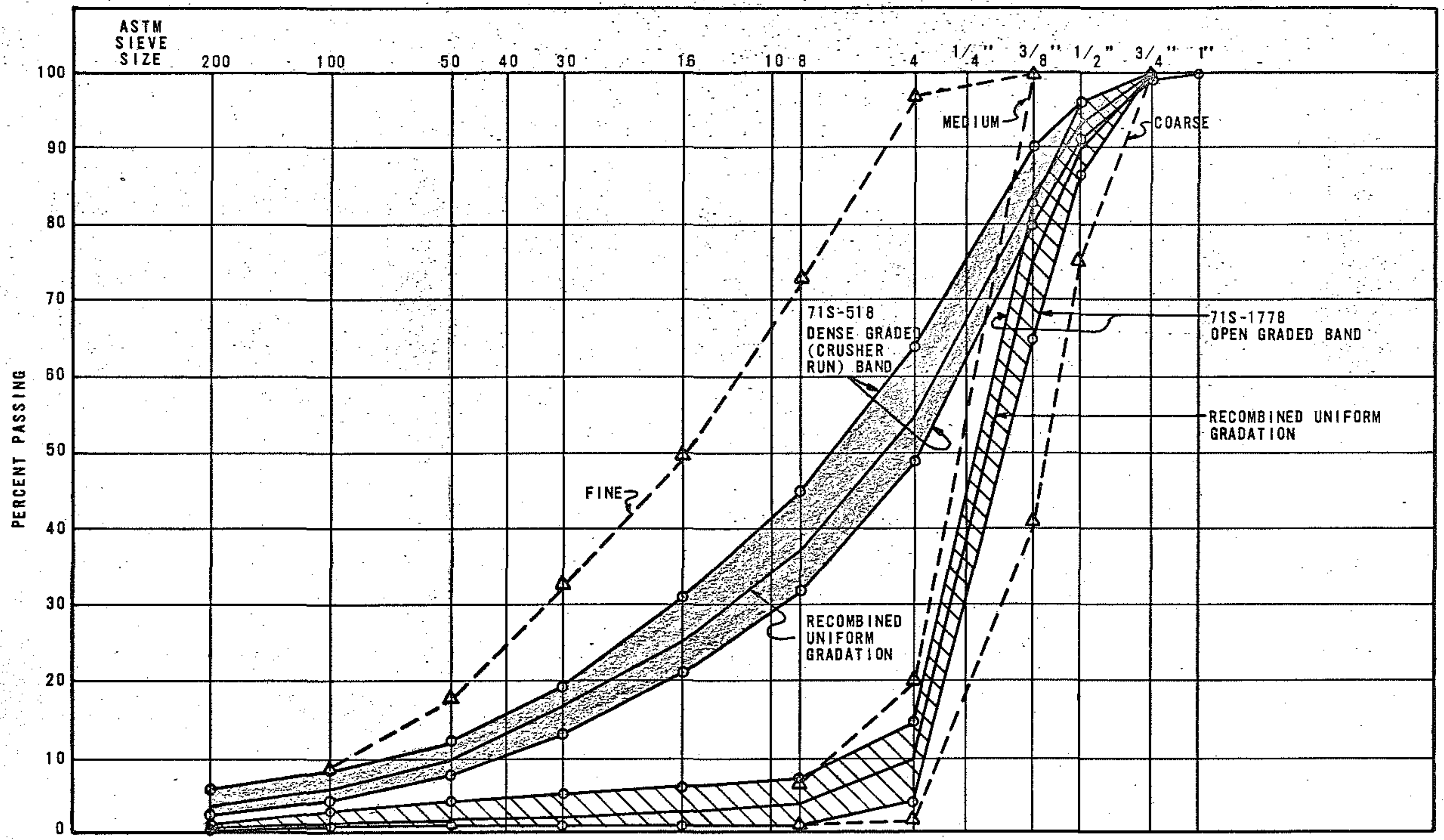


Figure 1
SUMMARY OF LAKELITE GRADATIONS

Magnesium Sulfate Soundness (3/8" to No. 4)		9.0 percent
Gradation, percent passing basis:		
	1/2"	100
	3/8"	99
	No. 4	20
	No. 8	7.1
	Loss by Washing	2.1

In this investigation, emphasis has been placed on determining those physical characteristics which would affect its performance in embankment applications or for supporting highway structures. These include compaction characteristics and sample degradation under a variety of compaction methods, water effect on material (swell or particle breakdown), stability and compressibility properties. Two gradations which are suitable and can be produced with relative ease have been evaluated. These include a dense graded crusher run material (71S-518) and an open graded material approximating a one-to-one combination of the producer's medium and coarse gradations (71S-1778). Figure 1 shows the gradation bands within which gradation tests on portions of these materials to be tested fall. Also shown are single recombined uniform gradations for each material at which most tests in the later phases of the testing were run. While materials larger than 3/4-inch could be used in fill applications, tests were limited to 3/4-inch topsize material due to the size of available testing equipment.

Compaction Characteristics.-

A variety of compaction methods were used to determine compaction characteristics and to learn more of the degradation characteristics of the aggregate. The Michigan Cone Density, normally used for granular materials, was run but limited to 25 blows per layer and 125 total blows as is common practice on materials expected to show significant degradation. Minimum and maximum vibrated densities were obtained in accordance with the Standard Method of Test for Relative Density of Cohesionless Soils, ASTM D2049-69. In addition, Proctor (AASHO T-99, Method C) densities, not normally run by the MDSH on granular material, were run on the crusher run (dense graded) material primarily to investigate the affect of a more severe impact type of compaction. Results of compaction tests are tabulated in the attached Reports of Tests and are summarized graphically in Figures 2a and 2c.

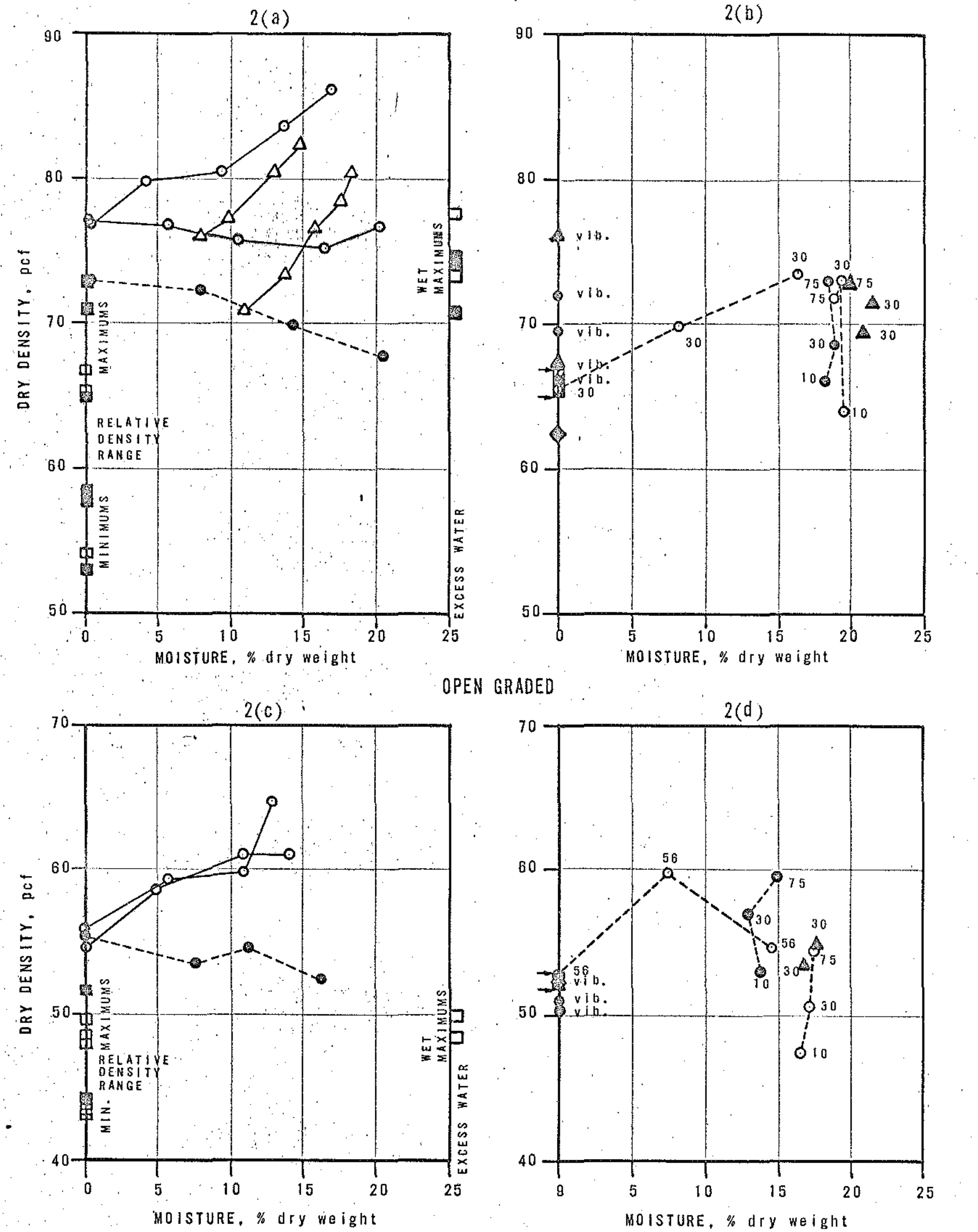
For the two Proctor test series on the dense graded (crusher run) material and the first two cone series on each type aggregate sample, portions were quartered from the overall sample. For

Figure 2
SUMMARY OF COMPACTION CHARACTERISTICS

COMPACTION TEST RESULTS — AS COMPACTED FOR TEST

DENSE GRADED (CRUSHER RUN)

OPEN GRADED



Compaction Key:
□ Relative Density (vibrated)
Δ T-99
○ Michigan Cone

As Compacted for Test Key:
Triaxial Range
Δ Compressibility } Blows per layer or vibrated maximums as noted
○ CBR
◇ Capillary Rise

General: Open symbol - quartered sample ——— Test series (portion reused)
Closed symbol - recombined uniform gradation - - - - Individual sample each test

these larger samples, material from each compacted mold was returned (less moisture samples) to the overall sample for subsequent compactions. Some deviations in gradation and compaction characteristics were inevitable. To minimize variation in compaction characteristics, a number of individual cones were pounded for each material, each using a fresh sample of material recombined to uniform gradation (see Figure 1). In the cone series there were marked tendencies to increase in density with succeeding cones and increasing water content, with one exception. When individual cones were compacted from fresh material at uniform gradations, decreasing trends with increasing water content were shown. For the Proctor compaction series, due to greater compactive effort, increases in density with each compaction and higher water content are much more rapid than in the cone series. A large part of the series build-ups is due to progressive breaking down of aggregate particles.

Degradations for each compaction method are shown in Table 1. Differences were obtained by comparing gradations before and after each test or series of tests and weighting them for number

Table 1

SUMMARY OF AVERAGE COMPACTION DEGRADATION

SIEVE SIZE	COMPACTION TEST METHOD				
	PROCTOR AASHO T-99 METHOD C MOD.	MICHIGAN CONE DENSITY		MAXIMUM RELATIVE DENSITY	
	DENSE GRADED 71S-518 2	DENSE GRADED 71S-518 2	OPEN GRADED 71S-1778 2	DENSE GRADED 71S-518 4	OPEN GRADED 71S-1778 4
1"	0	0	0	0	0
3/4"	.2	.1	0	0	0
1/2"	2.0	.6	1.0	.2	0
3/8"	4.1	1.0	3.3	.4	.4
No. 4	6.3	2.1	6.9	.1	.8
No. 8	5.7	2.1	3.5	0	.5
No. 16	5.2	1.9	2.4	0	.4
No. 30	4.6	1.9	1.8	-.1	.3
No. 50	3.8	1.8	1.3	-.1	.2
No. 100	2.7	1.4	1.1	-.1	.1
No. 200	1.6	.7	.7	-.2	.1

Note: Average degradations are reduced to one compacted mold basis and are weighted for sample portion actually compacted.

Note: Number of Comparative Gradations is shown under Laboratory Number.

of molds compacted and portion of sample actually used. Since a portion of the material was lost through mixing and testing, some of the results are approximate but they do give a clear comparison of the different compaction methods. In the maximum relative densities (vibrated) on the dense graded material, the slight apparent negative degradations are believed due to the loss of small quantities of dust during vibration. This gives some indication of the limitations of determination of comparative gradations. Some particle breakdown is to be expected from the sieving operation itself, even though limited to five minutes of mechanical shaking. As expected, the vibrated density achieved compaction with much less particle degradation than the other compaction methods, while the T-99 method showed much the greatest breakdown for comparable samples.

For the open graded material dry maximum relative densities were approximately the same as those run wet and were somewhat below cone densities. However, for the dense graded materials wet maximum densities are considerably higher than dry maximums. This is believed to be due to a lubricating effect of the wet fines under these conditions in the dense graded material.

The maximum dry density to which the material can be compacted without large-scale degradation ranges from about 65 to 77 pcf (on the order of one cyd per ton) for the dense graded material and 50 to 60 pcf (about 1-1/3 cyd per ton) for the open graded blend. While it can be compacted more, there appears to be little point in so doing.

California Bearing Ratio (CBR) Tests.-

California Bearing Ratio Tests based on AASHO T-193-63 were run on both the dense graded and open graded materials. For each type, quartered samples were first used in a group of three soaked tests at differing blow counts and a group of three unsoaked tests at varying moisture contents and a constant blow count believed sufficient for good compaction. Following the initial soaked tests at 10, 30 and 75 blows per layer on the open graded material, it was felt that 30 blows would not provide sufficient compaction and the constant blow count tests were run at the 56 blows per layer common to the 6-inch Proctor compaction methods. Gradations were not run on each quartered CBR test sample but these should fall within or very close to the respective bands shown in Figure 1. However, somewhat erratic compaction results are noted, such as the slightly higher density at 30 than at 75 blows per layer for the soaked dense graded material, and subsequent CBR tests were run with material recombined to uniform gradations. These included unsoaked groups of three with a slight excess of water and the same blow counts used in the initial soaked groups as well as soaked and unsoaked tests at maximum vibrated densities for each material type. See Figures 2(b) and 2(d) for a summary of the compactions achieved for these tests.

A summary of CBR test results is presented in Table 2. As can be seen, a wide range of values is obtained for the dense graded material, depending on compaction amount and compaction method. Low to moderate CBR values resulted from impact compaction with higher moisture contents giving greater compaction but slightly lower CBR values than the dry test. It is noted that somewhat higher results were obtained from the soaked than the

Table 2

SUMMARY OF CBR RESULTS

SAMPLE I.D.	SOAKED OR UNSOAKED	COMPACTION EFFORT BLOWS PER LAYER	DRY DENSITY AS MOLDED, pcf	MOISTURE CONTENT AS MOLDED % dry wt	SWELL, PERCENT OF ORIGINAL LENGTH	CBR AT 0.1 IN. PENETRATION	CBR AT 0.2 IN. PENETRATION
71S-518 DENSE GRADED (Crusher Run)	SOAKED (Quartered Samples)	10	64.0	19.5	0.00	8.5	11.1
		30	73.0	19.4	-0.04	21.3	30.2
		75	71.8	19.1	0.00	30.0	40.5
	SOAKED (Uniform Gradation)	Maximum Vibrated	69.2	0	-0.07	57.7	75.3
	UNSOAKED (Uniform Gradation)	10	66.0	18.5	-	7.0	9.7
		30	68.6	18.9	-	13.9	18.7
		75	72.8	18.2	-	21.7	28.9
		Maximum Vibrated	71.8	0	-	71.0	87.1
		Maximum Vibrated	67.0	0	-	57.0	72.2
	UNSOAKED (Quartered Samples)	30	65.3	0	-	25.7	32.7
		30	70.0	8.1	-	21.6	27.6
		30	73.3	16.4	-	21.6	27.5
71S-1778 OPEN GRADED	SOAKED (Quartered Samples)	10	47.5	16.5	0.00	6.8	8.9
		30	50.7	17.2	-0.04	8.5	10.1
		75	54.5	17.5	-0.20	9.8	12.9
	SOAKED (Uniform Gradation)	Maximum Vibrated	50.5	0	-0.07	6.8	9.1
	UNSOAKED (Uniform Gradation	10	53.1	13.9	-	5.5	7.0
		30	57.1	13.0	-	8.3	10.1
		75	59.5	14.9	-	13.2	15.4
		Maximum Vibrated	51.1	0	-	8.3	10.3
	UNSOAKED (Quartered Samples)	56	52.9	0	-	13.2	17.5
		56	59.8	7.5	-	18.2	21.9
		56	54.8	14.5	-	14.0	18.0

corresponding unsoaked tests for this material. Remarkably high CBR values were obtained from the vibrated dense graded material with densities on the order of those obtained by impact compaction. For this gradation, vibratory compaction appears to provide better particle interlock with much less degradation.

For the open graded material CBR results are lower and vary over a much smaller range than for the dense graded material. Vibrating does not provide better CBR results. With good compaction, CBR results indicate this material should be adequate for a subgrade type application requiring better load distribution than the dense graded material.

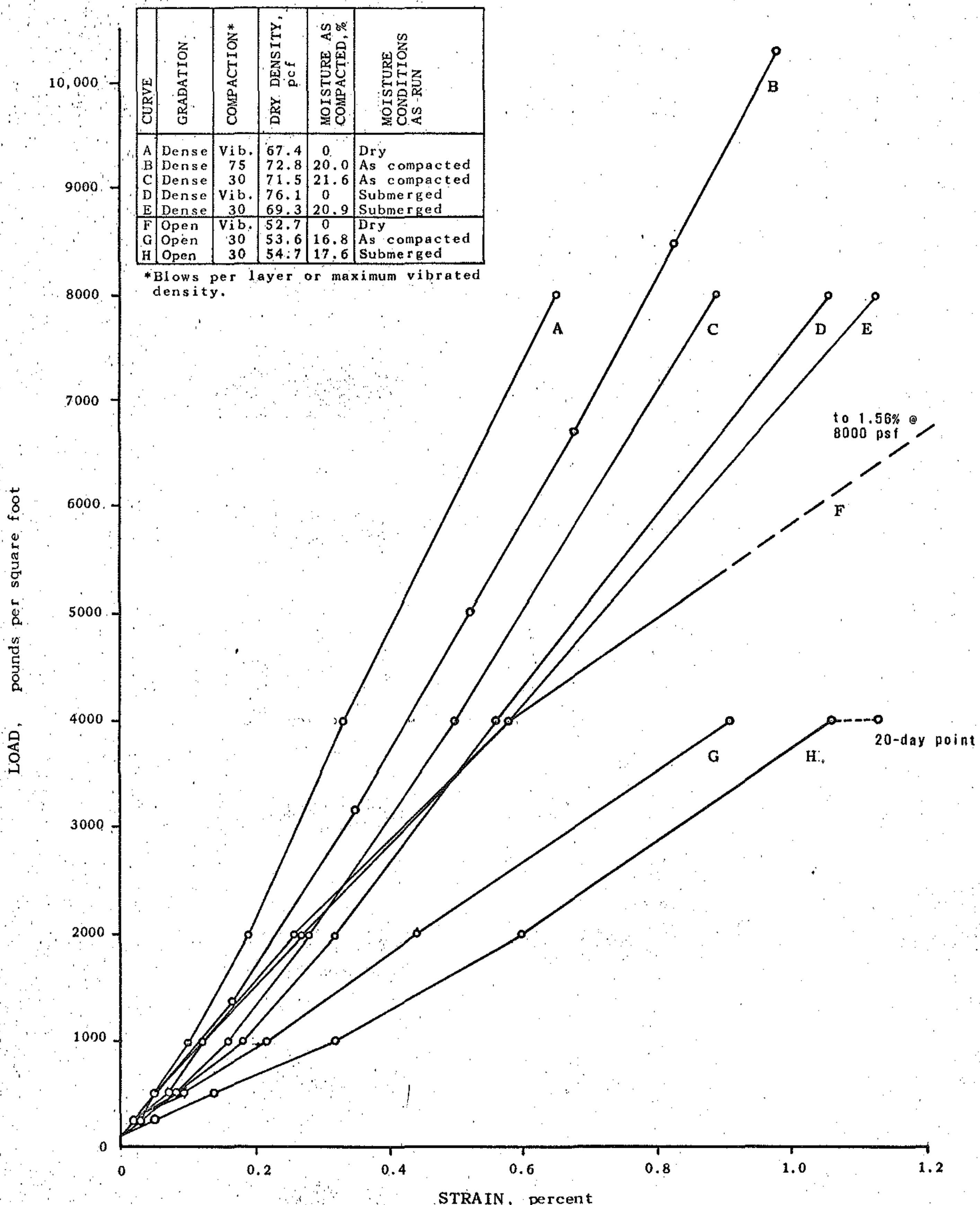
Shrinkages (negative swells) as shown by the soaked CBR procedure should be negligible for both gradation types.

Compressibility Tests.-

Eight one-dimensional compressibility tests were run on this material to learn something of its compressibility characteristics. For five of these tests, the material was compacted into a 6-in. diameter by 4.59-in. high cylindrical stainless steel mold in three layers using a 5.5-lb Proctor hammer and 12-in. drop. For the other three, compaction was to maximum vibrated density. The specimen was free to drain at the bottom and top of sample. Incremental loads were applied through a CBR spacer plate and compression-time records were kept for each load increment until movement became negligible. Both the dense graded and open graded blends (recombined uniform gradations) were run dry, at the maximum moistures they would retain, and also submerged. Compaction at 30 blows per layer resulted in densities slightly greater than maximum cone densities, probably primarily due to greater particle degradation in the compaction process. In addition, one test was run on the wet crusher-run material compacted at 75 blows per layer. This achieved only slightly higher compaction and lower compressibility than the corresponding 30 blows per layer sample. Not enough gain is made to warrant the additional compactive effort with its attendant particle breakdown.

The vibrated samples were vibrated dry and achieved good compaction. The two compressed dry showed considerably improved compressibilities over their wet counterparts while the dense graded sample compressed submerged was somewhat worse from 2000 psf down but better above.

Densities as tested are shown graphically in Figures 2(b) and 2(d) as they compare with other Lakelite compactions. Test



CURVE	GRADATION	COMPACTION*	DRY DENSITY, pcf	MOISTURE AS COMPACTED, %	MOISTURE CONDITIONS AS RUN
A	Dense	Vib.	67.4	0	Dry
B	Dense	75	72.8	20.0	As compacted
C	Dense	30	71.5	21.6	As compacted
D	Dense	Vib.	76.1	0	Submerged
E	Dense	30	69.3	20.9	Submerged
F	Open	Vib.	52.7	0	Dry
G	Open	30	53.6	16.8	As compacted
H	Open	30	54.7	17.6	Submerged

*Blows per layer or maximum vibrated density.

Figure 3

ONE DIMENSIONAL COMPRESSIBILITY RESULTS

values are shown in the reports of tests and are shown graphically in Figure 3.

For the 30 blow per layer samples, maximum compressions on the order of one percent were recorded, at 8000 psf for the crusher run and 4000 psf for the open graded. The submerged samples did show slightly greater compressibilities than the corresponding wet samples.

The 4000 psf load was maintained for twenty days on the submerged open graded (30 blow per layer) material. During this time strain increased from 1.06 to 1.13 percent with movement during the last six-day period too small for meaningful measurement. Since this was the most compressible of the samples tested, likelihood of significant or damaging progressive settlement is small.

The compression of this material is limited in amount and for the most part occurs rapidly, so should not be a problem in lightweight fill applications.

An additional test was run in which a sample of the open graded material was vibrated in a CBR mold and set up to soak for three weeks under approximately 200 pcf surcharge. At the end of three weeks, particle degradation was negligible, as shown:

Gradation, % Passing Basis

Sieve	Before	After
3/4"	100	100
1/2"	89.8	90.3
3/8"	73.8	74.2
No. 4	9.4	10.3
No. 8	3.3	3.5
No. 16	2.5	2.6
No. 30	2.1	2.2
No. 50	1.7	1.7
No. 100	1.3	1.2
No. 200	.9	0.7

This is on the order of degradation that might be expected from the vibratory compaction and sieving.

Triaxial Tests.-

Triaxial tests were performed on 4-in. diameter by 10-in. length samples of both the open and dense graded materials. These samples were recombined to uniform gradation after the overall sample had been separated on the various sieves. The samples were tested dry and at initial densities approximating maximum relative densities as shown graphically in Figures 2(b) and 2(d). A summary of the test results is shown in Figure 4. The angle of internal friction was 41° for the open graded material and 45° for the crusher run or dense graded material. These values indicate a high degree of internal stability for both gradations as might be expected from a material having the irregular shape and great interlocking effect that Lakelite has. Even higher angles of internal friction should be expected at greater densities.

Specific Gravities and Absorption.-

This material is characterized by many voids incorporated throughout its structure. As particles are broken down, more of these voids will be exposed on the surface where they can be filled with water when in a submerged condition.

Specific gravities have been run by the MDSH method (small gravity bottle) on the material passing the No. 4 sieve and by AASHO T-85 and also a large gravity bottle method on the material retained on the No. 4 sieve. Gravities on the coarser material vary greatly depending on the method of determination, definition, and on the method of saturating the sample. T-85 in which the sample is saturated by submerging for 24 hours yielded the lowest specific gravities (1.49 and 1.50 bulk, dry basis). The gravity bottle methods, in which vacuum is applied to the samples, gave much higher results. The highest value, 2.56, came from the coarse aggregate after being subjected to 30 in. (gage) of mercury vacuum for one hour and then submerged in water for 24 hours. This value suggests that the mineral matter of which the Lakelite is comprised has a specific gravity close to that expected from common stone materials and that density reductions depend almost entirely on the irregular porous structure. In a dry or limited water situation this weight savings can be very great. In very wet situations less weight savings can be expected.

The coarser particles, retained on No. 4 sieve, are extremely porous and will absorb widely varying amounts of water depending on length of exposure and pressures involved. This is apparent from the deviations of specific gravities obtained by different methods for this material. It also makes it difficult to estimate the extent to which voids would be filled in a submerged or wet field application.

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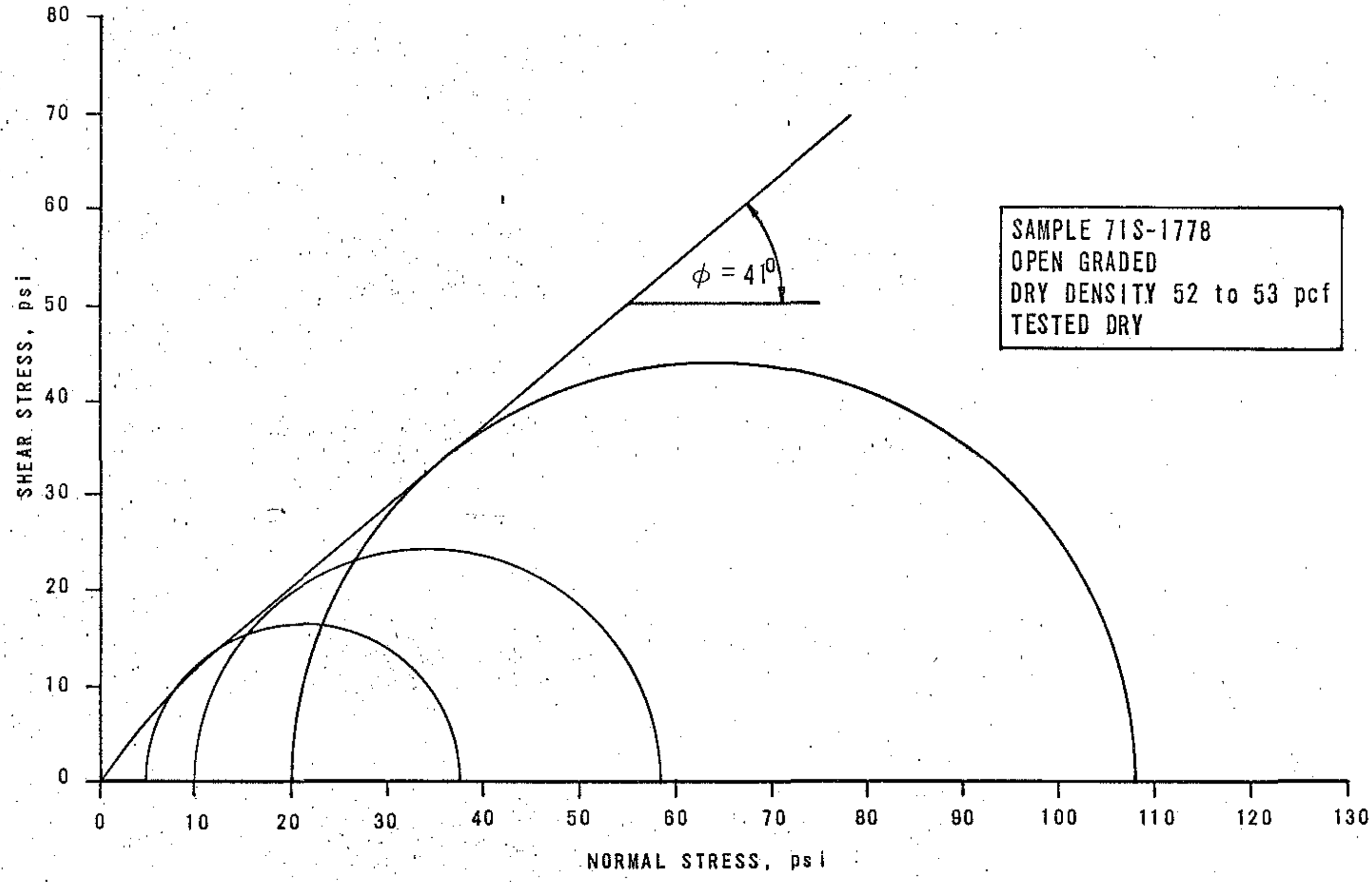

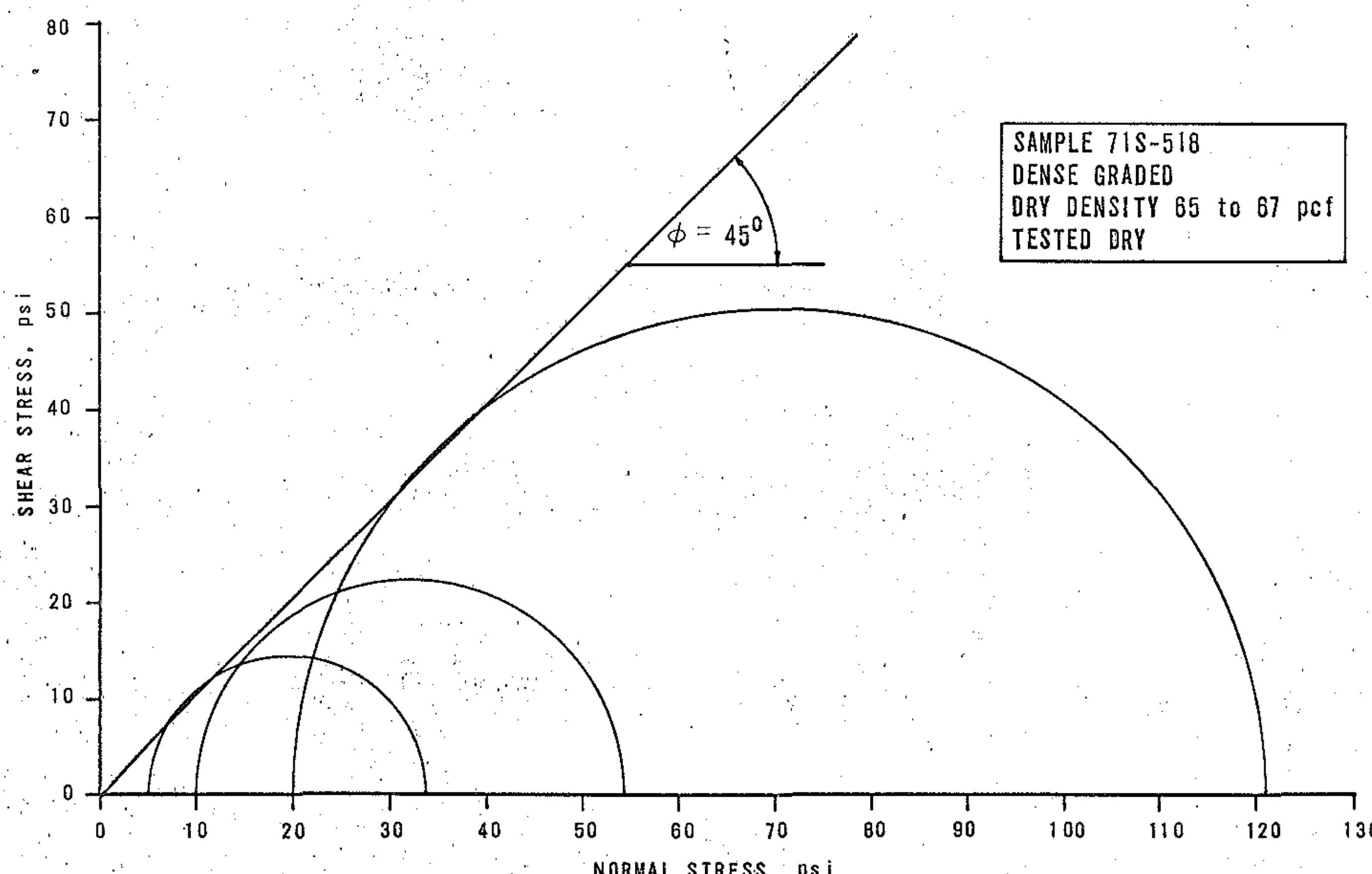

Figure 4
SUMMARY OF TRIAXIAL TEST RESULTS

The open graded material can retain up to about 17 percent water and the crusher run gradation can retain approximately 21 percent after mixing and brief draining.

In a submerged situation, more of the aggregate voids will be filled as water head increases but the porous skeletal structure will still provide significant weight savings.

Capillary Rise.-

Texturally, the dense graded material would fall in a "sandy gravel" category and the open graded material would be a "gravel." Either gradation can be expected to be readily drainable. Capillary rise was checked for the crusher run material (recombined uniform gradation) in a 2-in. diameter open-glass tube at approximately 90 percent of maximum dry vibrated density. This was equivalent to 50 percent Relative Density or about 85 percent Michigan Cone Density. This test showed a low rise as shown below only slightly greater than might be expected in a medium sand.

Elapsed Time (hrs)	Capillary Rise (in.)
6	4.1
48	6.0
240	9.0
720	11.4

While this rise would probably have been higher had we been able to achieve greater compaction in the tube, capillarity is not expected to be a problem.

* * *

Other miscellaneous test results run prior to this study (Los Angelec C Abrasion, Magnesium Sulphate Soundness) show nothing that should prevent the use of Lakelite as a lightweight fill. Our loss on ignition results were higher than those reported by Saxer, but indicate no problems.

Limited experience to date shows that gradations have been quite consistent and as represented by the producer. He would have the capability of providing the material in either of the gradations tested or with a larger top size if desired for the quantities of material that might be utilized in an embankment application. Available approximate prices are $6.25 per ton for the fine and medium gradations and $7.25 per ton for the coarse gradation at the plant. Shipping is available by truck, rail, or self-unloading boat.

Conclusions and Recommendations.-

1. Triaxial test values indicate a high degree of internal stability for this material in both gradations.

2. California Bearing Ratios, with concentrated loading, are satisfactory for well compacted material but indicate the need for a well distributed load, especially for the open graded material. Vibrated dense graded material achieved good results in this test. CBR shrinkages were negligible.

3. Compressibility is satisfactorily low for both gradations and occurs rapidly. It is on the order of twice as great in the open graded as in the dense graded material and for each is somewhat greater submerged.

4. Indicated specific gravities vary widely depending on definition and the extent voids are filled with water. Vacuum saturated values suggest that "Lakelite" weight savings depend almost entirely on its porous structure.

5. The two tested gradations of this material can be compacted to rather wide ranges of densities with varying particle degradation depending on the compaction method and effort. For good compaction with minimum degradation relatively light vibratory equipment and 9-in. layers is recommended.

6. A minimum density of 80 percent relative density is recommended if field vibratory compaction can be used. This will avoid unnecessarily breaking down material for which sufficient compaction has been attained. Maximum densities can be approximated from cone densities for field control if necessary.

7. Particle breakdown as shown under long-term soaking is negligible.

8. Capillary rise for the dense-graded material is low and should not present a problem.

9. Results of other miscellaneous tests, while worse than for a sound natural aggregate, should be satisfactory for lightweight fill use.

10. Since the dense graded or crusher run material is unscreened, greatest uniformity would be achieved by stockpiling in layers and removing full depth.

Results of the testing program show no reasons why this material in either gradation should not be suitable for lightweight fill. The open graded material, going to a higher top size if desired, would minimize weight of fill at some sacrifice of compressibility and stability and would require better load distribution. The crusher run or dense graded material will provide greatest stability and least compressibility with some increase in unit weight and is preferred where the additional weight can be accepted.

Form 1801 (Rev. 5/70)
(General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Sheet 1 of 5 **REPORT OF TEST**

Control Section Identification	General
Job No.	
Laboratory No.	718-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)
Date sampled May 7, 1971 Date received May 10, 1971
Source of material Construction Aggregates Inc., Grand Haven, Michigan
Sampled from Belt Between Crusher and Screens Quantity Represented --
Submitted by A. P. Chritz, Testing Laboratory Section
Intended use Laboratory investigation Specification 1970 Std Specs

TEST RESULTS

Test	Test Method	When Tested	PERCENT PASSING SIEVE SIZES 1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No 30	No. 50	No. 100	No 200
		Original	100.0	99.0	93.1	84.2	54.7	37.9	26.5	18.2	12.4	8.5	5.8
A	T-99	Before	100.0	99.5	91.9	80.3	50.4	32.6	21.2	13.2	8.1	4.6	2.4
		After	100.0	100.0	97.7	90.9	64.6	45.9	33.2	23.2	16.1	9.8	5.0
B	T-99	Before	100.0	99.7	95.8	88.4	61.7	42.9	28.8	18.5	11.5	6.3	3.1
		After	100.0	100.0	99.6	97.8	78.4	57.6	42.3	30.9	22.1	14.6	8.3
A	Cone	Before	100.0	99.2	95.0	87.6	58.0	39.8	27.2	17.0	10.2	5.9	2.9
		After	100.0	99.4	95.7	88.5	60.4	41.4	27.9	17.5	10.7	6.2	3.0
B	Cone	Before	100.0	99.9	96.5	90.3	64.1	45.1	30.6	19.4	11.8	6.7	3.2
		After	100.0	100.0	98.1	92.8	69.1	51.1	36.8	25.7	17.8	10.6	5.5
A	Relative Density	Before	100.0	99.2	90.6	80.4	49.0	31.9	21.5	13.9	8.6	5.0	2.5
		After	100.0	99.6	91.4	81.0	48.8	30.9	21.2	13.4	8.0	4.3	1.9
C	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	93.8	84.4	55.4	37.1	24.9	16.9	10.0	6.0	2.8
D	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	94.0	85.2	55.6	37.2	24.8	16.6	9.7	5.7	2.6
E	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	93.5	84.9	55.1	37.5	25.6	17.1	10.2	6.1	2.9
	CBR	Before	100.0	98.9	95.2	87.7	61.7	42.6	28.9	17.7	10.5	5.9	3.8
	*Recombined Uniform Gradation		100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0

REMARKS: *This gradation used for tests where noted.

cc:
File
Soils Analysis
P.D. Sullivan
MC

Signed Max N. Clyde
Engineer of Testing and Research

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

AASHO T-85 (Retained No. 4)

Absorption	14.5%
Bulk Specific Gravity, dry basis	1.50
Apparent Specific Gravity	1.92

Gravity Bottle Method (Recombined Uniform Gradation, Retained No. 4)

Submerged 15 min with 35 cm Hg Vacuum	2.03
Vacuum Saturated (30" + Hg Vacuum one hour before water introduced)	2.56

MDSH Gravity (Passing No. 4) 2.47

Loss on Ignition, percent by weight, passing No. 4 6.6
passing No. 40 8.1 & 8.1

AASHO T-99, Method "C" Mod

Test A (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
10.9	71.1
13.6	73.6
15.7	76.8
17.5	78.6
18.2	80.5

Free water in bottom of mold last frame

Test B (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
7.9	76.1
9.9	77.4
12.9	80.5
14.8	82.4

Signed Max N. Clyde
Engineer of Testing and Research

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Sheet 3 of 5

REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)

Date sampled ______ Date received ______

Source of material ______

Sampled from ______ Quantity Represented ______

Submitted by ______

Intended use ______ Specification ______

TEST RESULTS

MDSH Cone Density

Test A (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
0.1	77.2
5.6	76.9
10.6	75.6
16.4	75.2
20.3	76.8

Test B (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
0.2	76.8
4.0	79.9
9.4	80.5
13.6	83.6
16.9	86.1

Test C (Individual Tests) - Recombined uniform gradation

Water, % Dry Soil	Dry Density, pcf
0.2	73.0
7.8	72.4
14.3	69.9
20.3	67.8

RELATIVE DENSITY OF COHESIONLESS SOILS - ASTM D 2049-69

Tabulation of Dry Densities, pcf

	QUARTERED SAMPLES		RECOMBINED UNIFORM GRADATION		
	TEST A	TEST B	TEST C	TEST D	TEST E
Minimum	54.3	--	58.4	53.0	57.8
Maximum, Dry Method	65.4	66.6	73.1	64.9	71.0
Maximum, Wet Method	73.4	77.9	74.7	70.9	74.1

Signed [signature]
Engineer of Testing and Research

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Sheet 4 of 5 **REPORT OF TEST**

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)

Date sampled ______ Date received ______

Source of material ______

Sampled from ______ Quantity Represented ______

Submitted by ______

Intended use ______ Specification ______

TEST RESULTS

CALIFORNIA BEARING RATIO

Run at 64 psf Surcharge

COMPACTION EFFORT BLOWS PER LAYER	DRY DENSITY AS MOLDED pcf	MOISTURE CONTENT AS MOLDED, % dry wgt	SWELL, PERCENT OF ORIGINAL LENGTH	CBR AT 0.1 IN. PENETRATION	CBR AT 0.2 IN PENETRATION
Soaked, Quartered Samples					
10	64.0	19.5	0.00	8.5	11.1
30	73.0	19.4	-0.04	21.3	30.2
75	71.8	19.1	0.00	30.0	40.5
Soaked, Recombined Uniform Gradation					
Maximum Vibrated	69.2	0	-0.07	57.7	75.3
Unsoaked, Quartered Samples					
30*	65.3	0	-	25.7	32.7
30	70.0	8.1	-	21.6	27.6
30	73.3	16.4	-	21.6	27.5
Unsoaked, Recombined Uniform Gradation					
10	66.0	18.5	-	7.0	9.7
30	68.6	18.9	-	13.9	18.7
75	72.8	18.2	-	21.7	28.9
Maximum Vibrated	71.8	0	-	71.0	87.1
Maximum Vibrated	67.0	0	-	57.0	72.2

*Gradation tabulated on first page of this report.

ONE DIMENSIONAL COMPRESSIBILITY - Recombined Uniform Gradations

Note: Cylindrical steel mold, 6.00" diameter by 4.59" high.
Drainage permitted at bottom and top.

				Pressure, psf						
COM-PACTION	DRY DENSITY pcf	MOISTURE AS COM-PACTED %	MOISTURE AS RUN	0	250	500	1000	2000	4000	8000
30*	71.5	21.6 (Excess)	AS COM-PACTED	0	.02	.08	.16	.28	.50	.89
30*	69.3	20.9 (Excess)	SUB-MERGED	0	.02	.07	.12	.27	.58	1 13
VIBRATED MAXIMUM	67.4	0	DRY	0	.02	.05	.10	.19	.33	.65
VIBRATED MAXIMUM	76.1	0	SUB-MERGED	0	.03	.08	.18	.32	.56	1 06
Pressure, psf:				0	1370	3150	4940	6720	8500	10280
75*	72.8	20.0 (Excess)	AS COM-PACTED	0	.17	.35	.52	.68	.83	.98

*Blows per layer. 3 layers. 5.5-lb Proctor hammer. 12" drop.

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70) (General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

TRIAXIAL COMPRESSION TEST - DRY - Recombined Uniform Gradation (approx)

CONFINING PRESSURE, psi	DEVIATOR STRESS (AT FAILURE) psi	AXIAL STRAIN (AT FAILURE) percent	INITIAL DENSITY (APPROX) pcf
5	28.6	4.4	65
10	44.3	4.4	66
20	100.6	8.5	67

Angle of Internal Friction, $\phi = 45^{\circ}$.

CAPILLARY RISE - Recombined Uniform Gradation

Notes: 2" diameter glass tube
Approximate dry density, 62.3 pcf.

Elapsed Time, hours	Capillary Rise, inches
6	4.1
48	6.0
240	9.0
720	11.4

REMARKS: Tested for information.

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70)
(General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

 REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)
Date sampled May 7, 1971 Date received May 10, 1971
Source of material Construction Aggregates Inc., Grand Haven, Michigan
Sampled from Belt Between Crusher and Screens Quantity Represented --
Submitted by A. P. Chritz, Testing Laboratory Section
Intended use Laboratory investigation Specification 1970 Std Specs

TEST RESULTS

Test	Test Method	When Tested	PERCENT PASSING — SIEVE SIZES 1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No 30	No. 50	No. 100	No 200
		Original	100.0	99.0	93.1	84.2	54.7	37.9	26.5	18.2	12.4	8.5	5.8
A	T-99	Before	100.0	99.5	91.9	80.3	50.4	32.6	21.2	13.2	8.1	4.6	2.4
		After	100.0	100.0	97.7	90.9	64.6	45.9	33.2	23.2	16.1	9.8	5.0
B	T-99	Before	100.0	99.7	95.8	88.4	61.7	42.9	28.8	18.5	11.5	6.3	3.1
		After	100.0	100.0	99.6	97.8	78.4	57.6	42.3	30.9	22.1	14.6	8.3
A	Cone	Before	100.0	99.2	95.0	87.6	58.0	39.8	27.2	17.0	10.2	5.9	2.9
		After	100.0	99.4	95.7	88.5	60.4	41.4	27.9	17.5	10.7	6.2	3.0
B	Cone	Before	100.0	99.9	96.5	90.3	64.1	45.1	30.6	19.4	11.8	6.7	3.2
		After	100.0	100.0	98.1	92.8	69.1	51.1	36.8	25.7	17.8	10.6	5.5
A	Relative Density	Before	100.0	99.2	90.6	80.4	49.0	31.9	21.5	13.9	8.6	5.0	2.5
		After	100.0	99.6	91.4	81.0	48.8	30.9	21.2	13.4	8.0	4.3	1.9
C	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	93.8	84.4	55.4	37.1	24.9	16.9	10.0	6.0	2.8
D	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	94.0	85.2	55.6	37.2	24.8	16.6	9.7	5.7	2.6
E	Relative Density	Before	100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0
		After	100.0	100.0	93.5	84.9	55.1	37.5	25.6	17.1	10.2	6.1	2.9
	CBR	Before	100.0	98.9	95.2	87.7	61.7	42.6	28.9	17.7	10.5	5.9	3.8
	*Recombined Uniform Gradation		100.0	100.0	93.0	84.0	55.0	37.0	25.0	17.0	10.0	6.0	3.0

REMARKS: *This gradation used for tests where noted.

cc:
File
Soils Analysis
P.D. Sullivan
MC

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70)
(General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

AASHO T-85 (Retained No. 4)

Absorption	14.5%
Bulk Specific Gravity, dry basis	1.50
Apparent Specific Gravity	1.92

Gravity Bottle Method (Recombined Uniform Gradation, Retained No. 4)

Submerged 15 min with 35 cm Hg Vacuum	2.03
Vacuum Saturated (30" + Hg Vacuum one hour before water introduced)	2.56

MDSH Gravity (Passing No. 4)	2.47
Loss on Ignition, percent by weight, passing No. 4	6.6
passing No. 40	8.1 & 8.1

AASHO T-99, Method "C" Mod

Test A (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
10.9	71.1
13.6	73.6
15.7	76.8
17.5	78.6
18.2	80.5

Free water in bottom of mold last frame

Test B (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
7.9	76.1
9.9	77.4
12.9	80.5
14.8	82.4

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70) (General)

STATE OF MICHIGAN

DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)

Date sampled ________ Date received ________

Source of material ________

Sampled from ________ Quantity Represented ________

Submitted by ________

Intended use ________ Specification ________

TEST RESULTS

MDSH Cone Density

Test A (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
0.1	77.2
5.6	76.9
10.6	75.6
16.4	75.2
20.3	76.8

Test B (Series) - Quartered Sample

Water, % Dry Soil	Dry Density, pcf
0.2	76.8
4.0	79.9
9.4	80.5
13.6	83.6
16.9	86.1

Test C (Individual Tests) - Recombined uniform gradation

Water, % Dry Soil	Dry Density, pcf
0.2	73.0
7.8	72.4
14.3	69.9
20.3	67.8

RELATIVE DENSITY OF COHESIONLESS SOILS - ASTM D 2049-69

Tabulation of Dry Densities, pcf

	QUARTERED SAMPLES		RECOMBINED UNIFORM GRADATION		
	TEST A	TEST B	TEST C	TEST D	TEST E
Minimum	54.3	- -	58.4	53.0	57.8
Maximum, Dry Method	65.4	66.6	73.1	64.9	71.0
Maximum, Wet Method	73.4	77.9	74.7	70.9	74.1

Signed Max N. Clyde
Engineer of Testing and Research

STATE OF MICHIGAN

DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

 REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)

Date sampled ______ Date received ______

Source of material ______

Sampled from ______ Quantity Represented ______

Submitted by ______

Intended use ______ Specification ______

TEST RESULTS

CALIFORNIA BEARING RATIO

Run at 64 psf Surcharge

COMPACTION EFFORT BLOWS PER LAYER	DRY DENSITY AS MOLDED pcf	MOISTURE CONTENT AS MOLDED, % dry wgt	SWELL, PERCENT OF ORIGINAL LENGTH	CBR AT 0.1 IN. PENETRATION	CBR AT 0.2 IN PENETRATION
Soaked, Quartered Samples					
10	64.0	19.5	0.00	8.5	11.1
30	73.0	19.4	-0.04	21.3	30.2
75	71.8	19.1	0.00	30.0	40.5
Soaked, Recombined Uniform Gradation					
Maximum Vibrated	69.2	0	-0.07	57.7	75.3
Unsoaked, Quartered Samples					
30*	65.3	0	-	25.7	32.7
30	70.0	8.1	-	21.6	27.6
30	73.3	16.4	-	21.6	27.5
Unsoaked, Recombined Uniform Gradation					
10	66.0	18.5	-	7.0	9.7
30	68.6	18.9	-	13.9	18.7
75	72.8	18.2	-	21.7	28.9
Maximum Vibrated	71.8	0	-	71.0	87.1
Maximum Vibrated	67.0	0	-	57.0	72.2

*Gradation tabulated on first page of this report.

ONE DIMENSIONAL COMPRESSIBILITY - Recombined Uniform Gradations

Note: Cylindrical steel mold, 6.00" diameter by 4.59" high.
Drainage permitted at bottom and top.

COMPACTION	DRY DENSITY pcf	MOISTURE AS COMPACTED %	MOISTURE AS RUN	Pressure, psf						
				0	250	500	1000	2000	4000	8000
30*	71.5	21.6 (Excess)	AS COMPACTED	0	.02	.08	.16	.28	.50	.89
30*	69.3	20.9 (Excess)	SUBMERGED	0	.02	.07	.12	.27	.58	1 13
VIBRATED MAXIMUM	67.4	0	DRY	0	.02	.05	.10	.19	.33	.65
VIBRATED MAXIMUM	76.1	0	SUBMERGED	0	.03	.08	.18	.32	.56	1.06
Pressure, psf:				0	1370	3150	4940	6720	8500	10280
75*	72.8	20.0 (Excess)	AS COMPACTED	0	.17	.35	.52	.68	.83	98

*Blows per layer, 3 layers, 5.5-lb Proctor hammer, 12" drop.

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70) (General)

STATE OF MICHIGAN

DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-518
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Dense Graded)

Date sampled ______ Date received ______

Source of material ______

Sampled from ______ Quantity Represented ______

Submitted by ______

Intended use ______ Specification ______

TEST RESULTS

TRIAXIAL COMPRESSION TEST - DRY - Recombined Uniform Gradation (approx)

CONFINING PRESSURE psi	DEVIATOR STRESS (AT FAILURE) psi	AXIAL STRAIN (AT FAILURE) percent	INITIAL DENSITY (APPROX) pcf
5	28.6	4.4	65
10	44.3	4.4	66
20	100.6	8.5	67

Angle of Internal Friction, $\phi = 45^{\circ}$.

CAPILLARY RISE - Recombined Uniform Gradation

Notes: 2" diameter glass tube
Approximate dry density, 62.3 pcf.

Elapsed Time, hours	Capillary Rise, inches
6	4.1
48	6.0
240	9.0
720	11.4

REMARKS: Tested for information.

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70)
(General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS
TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-1778
Date	June 14, 1972

 REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Open Graded)
Date sampled September 8, 1971 Date received September 8, 1971
Source of material Construction Aggregates Inc., Grand Haven, Michigan
Sampled from Stockpiles at plant Quantity Represented --
Submitted by P. H. Marttila, Testing Laboratory Section
Intended use Laboratory investigation Specification 1970 Std Specs

TEST RESULTS

Test	Test Method	When Tested	PERCENT PASSING SIEVE SIZES 3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
A	Cone	Before	100.0	92.5	78.0	13.7	6.0	4.9	4.2	3.5	2.4	1.3
		After	100.0	95.0	84.7	25.9	12.2	9.0	7.3	6.0	4.4	2.5
B	Cone	Before	100.0	95.7	82.6	13.1	5.3	4.1	3.5	3.3	2.1	1.1
		After	100.0	96.6	86.7	23.1	10.4	7.7	6.2	5.0	3.7	2.1
A	Relative Density	Before	100.0	89.0	69.3	4.5	0.8	0.7	0.7	0.6	0.5	0.4
		After	100.0	88.2	68.3	6.5	1.7	1.5	1.3	1.1	0.9	0.6
B	Relative Density	Before	100.0	92.0	74.4	7.9	2.1	1.5	1.4	1.2	1.0	0.6
		After	100.0	92.0	75.8	9.4	3.1	2.3	2.0	1.7	1.2	0.7
C	Relative Density	Before	100.0	86.4	64.6	6.8	2.6	2.2	1.9	1.6	1.1	0.6
		After	100.0	86.5	65.4	8.1	3.4	2.8	2.3	1.9	1.3	0.7
D	Relative Density	Before	100.0	89.8	73.8	9.4	3.2	2.4	2.0	1.6	1.3	0.9
		After	100.0	90.9	75.5	10.1	4.3	3.4	2.8	2.2	1.5	0.9
	Portion of Original Sample		100.0	92.2	78.4	14.9	6.7	5.6	4.9	4.2	3.2	1.8
	*Recombined Uniform Gradation		100.0	90.0	75.0	10.0	4.0	3.0	2.5	2.0	1.5	1.0

REMARKS: *This gradation is used for tests where noted.

cc:
File

Soils Analysis
P.D. Sullivan
MC

Signed Max N. Clyde
Engineer of Testing and Research

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

 REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-1778
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Open Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

AASHO T-85 (Recombined Uniform gradation, retained No. 4)

Absorption	12.5%
Bulk Specific Gravity, dry basis	1.49
Apparent Specific Gravity	1.83

Gravity Bottle Method (Recombined uniform gradation, retained No. 4)

Submerged 15 min with 35 cm Hg Vacuum	2.09

MDSH Cone Density

Test A (Series) - Quartered Sample / Test B (Series) - Quartered Sample

Test A Water, % Dry Soil	Test A Dry Density, pcf	Test B Water, % Dry Soil	Test B Dry Density pcf
0.0	56.2	0.0	54.9
5.9	59.3	4.9	58.7
11.0	59.9	10.9	61.2
13.1	64.9	14.2	61.2

Test C (Individual Tests) - Recombined uniform gradation

Water, % Dry Soil	Dry Density pcf
0.1	55.7
7.7	53.8
11.3	54.9
16.2	52.2

Signed Max N. Clyde
Engineer of Testing and Research

Form 1801 (Rev. 5/70)
(General)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

Control Section Identification	General
Job No.	
Laboratory No.	71S-1778
Date	June 14, 1972

REPORT OF TEST

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Open Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

RELATIVE DENSITY OF COHESIONLESS SOILS - ASTM D2049-69

Tabulation of Dry Densities, pcf

	TEST A QUARTERED SAMPLE	TEST B QUARTERED SAMPLE	TEST C QUARTERED SAMPLE	TEST D UNIFORM GRADATION (Approx)
Minimum	43.7	44.6	43.4	44.5
Maximum, Dry Method	48.1	49.6	48.8	52.0
Maximum, Wet Method	--	48.7	50.2	--

CALIFORNIA BEARING RATIO

Run at 64 psf Surcharge

COMPACTION EFFORT BLOWS PER LAYER	DRY DENSITY AS MOLDED, pcf	MOISTURE CONTENT AS MOLDED, % dry wgt	SWELL, PERCENT OF ORIGINAL LENGTH	CBR AT 0.1 IN. PENETRATION	CBR AT 0.2 IN. PENETRATION
Soaked, Quartered Samples					
10	47.5	16.5	0.0	6.8	8.9
30	50.7	17.2	-0.04	8.5	10.1
75	54.5	17.5	-0.20	9.8	12.9
Unsoaked, Quartered Samples					
56	52.9	0	--	13.2	17.5
56	59.8	7.5	--	18.2	21.9
56	54.8	14.5	--	14.0	18.0
Unsoaked, Recombined Uniform Gradation					
10	53.1	13.9	--	5.5	7.0
30	57.1	13.0	--	8.3	10.1
75	59.5	14.9	--	13.2	15.4
Maximum Vibrated	51.1	0	--	8.3	10.3
Soaked, Recombined Uniform Gradation					
Maximum Vibrated	50.5	0	-0.07	6.8	9.1

Signed Max N. Clyde
Engineer of Testing and Research

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

TESTING AND RESEARCH DIVISION
TESTING LABORATORY SECTION

UNIVERSITY OF MICHIGAN
ANN ARBOR

 REPORT OF TEST

Control Section Identification	General
Job No.	
Laboratory No.	71S-1778
Date	June 14, 1972

Report on sample of SINTERED CLAY AGGREGATE (Lakelite, Open Graded)
Date sampled ______ Date received ______
Source of material ______
Sampled from ______ Quantity Represented ______
Submitted by ______
Intended use ______ Specification ______

TEST RESULTS

ONE DIMENSIONAL COMPRESSIBILITY - Recombined Uniform Gradations

Note: Cylindrical steel mold, 6.00" diameter by 4.59" high.
Drainage permitted at bottom and top.

Tabulation of Strains, percent

				Pressure, psf						
COMPACTION	DRY DENSITY pcf	MOISTURE AS COMPACTED %	MOISTURE AS RUN	0	250	500	1000	2000	4000	8000
30*	53.6	16.8 (Excess)	AS COMPACTED	0	.02	.09	.22	.44	.91	--
30*	54.7	17.6 (Excess)	SUBMERGED	0	.05	.14	.32	.60	1.06**	--
VIBRATED MAXIMUM	52.7	0	0	0	.02	.05	.12	.26	.58	1.56

*Blows per layer, 3 layers, 5.5-lb Proctor hammer, 12" drop.
**Increased to 1.13 after 20 days at load. Movement not determinable for last 6 days.

TRIAXIAL COMPRESSION TEST - DRY - Recombined Uniform Gradation (approx)

CONFINING PRESSURE, psi	DEVIATOR STRESS (AT FAILURE) psi	AXIAL STRAIN (AT FAILURE) percent	INITIAL DENSITY (APPROX) pcf
5	32.5	6.3	52
10	48.8	5.7	53
20	88.0	8.0	53

Angle of Internal Friction, $\phi = 41^{\circ}$.

REMARKS: Tested for information.

Signed Max N. Clyde
Engineer of Testing and Research