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ANALYSIS OF SOIL CEMENT MIX DESIGN

by

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Preliminary Report

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INTRODUCTION

Since 1959, cement stabilized sand bases have been constructed to a considerable extent by the Department of Highways of Alberta. Locally available alluvial and aeolian sand deposits have been used as substitutes for conventional gravels. (Ref. 1, 2). The quality control data and observations during the construction of these base courses revealed significant heterogeneities of the sands obtained from the various borrow pits. (Ref. 3). The generally used laboratory techniques for the mix design of soil cement are usually time consuming. Design charts by means of which the cement requirements of a sand could be readily estimated from the sand grading charts would be of immense use, as such charts would permit realistic adjustments to the construction cement contents without field testing.

Hutchinson (Ref. 3) has attempted a graphical model of shear strength development, basing on triaxial tests carried out on 11 sands. The basis for the graphical model was a set of two empirical equations relating the grading modulus and the values of "A" and "N" of the well known Feret's strength equation. However, his charts were only for predicting the cohesive strength developed. He suggested that a variety of sands from a wider geographical area be tested, to develop mixture design charts which could be applied to cement stabilized sand mixtures in general.

Over a 100 different sands from various sources have been used in soil cement base construction in Alberta. An extensive evaluation and testing programme has been conducted by the Department and by the Alberta Cooperative Highway Research programme since inception of this type of construction within the province. The sand-cement mixture designs are based upon ASTM standard tests modified in some instances. Data is available of the granulometric properties of all these sands. In general, the majority of these sands can be classified as granular materials namely A-1, A-3, and A-2 groups in the AASHO classification of Highway Subgrade Materials. (Granular materials are those containing 35% or less of total sample passing No. 200 sieve - PCA Soil Primer). In the data presented in this analysis the sand pit numbers such as SAS-A90 are used to identify the sands.

Only three sands obtained from the pit numbers SAS-A38, SAS-A39 and SAS-A98 contain over 35% passing No. 200 sieve and come under silt-clay materials.

The portland cement used had a 7-day cube strength of 3400 psi. All cement contents have been expressed by weight of air-dry sand.

The grain size characteristics of the sands have been determined with a sieve series in which the diameter of successively smaller sieve openings, decreases by one half. The relative surface area per unit weight of spherical particles having the same specific gravity varies inversely with the diameter of the particles. Therefore, the surface area per gram of sand retained within a given sieve interval of the

sieve series may conveniently be assumed to be double that of the previous coarser sieve interval. The grading modulus is calculated from the sum of the products of the weight percent retained in each sieve interval, and the corresponding surface area factor, divided by 100; and the computations have been made exactly as done by Hutchinson. The data pertaining to the granulometric properties of the sands used in the study is furnished in Appendix A.

SOIL-CEMENT DESIGN DATA

The design data comprising of the sand source number, grading modulus, cement content percent by weight, the compressive strength (psi) at 7 days, 28 days and after 7-day freeze-thaw, average density (lbs per c. ft.), and freeze-thaw loss(percent) is presented in Appendix B. The cement to voids ratios were computed and are also included in the tabulation. Compressive strength as reported in D.H.A. laboratory sheets have been corrected by a factor of x 1.3071 throughout. (Ref. U.S. Bureau of Reclamation "concrete manual" 5th Edition 1951, Fig. 164).

GRANULOMETRIC CONSIDERATIONS

Compressive strength development is a function of cement content, and type, density and grading of the mineral aggregate, particle shape, and surface texture and environmental conditions. (Ref. 4)

Larnach (Ref. 5) has shown that the unconfined compressive strengths developed by a sand stabilized with portland cement may be defined by Feret's Strength Law which is:

$$S = A\,(C/V)^N$$

where S is the unconfined compressive strength psi

A essentially the strength of the cement, but influenced by material and packing

C is the absolute volume of cement

V is the absolute volume of voids in the sand,

and N a constant depending on material and geometrical factors

Hutchinson's analysis of the shear strength characteristics of a variety of cement stabilized sand mixtures indicated that the factor N was related to the grading modulus by the relationship

$N = 3.37 - 1.131 \log_{10} GM$, and the factor A, presumably dependent also on cement type and curing environment was related by

$A = 1050\ N^{2.34}$.

In order to assess the influence of the grading modulus on other properties, the data has been regrouped into various groups of grading modulus in intervals of 5, such as 2.6 to 7.5, 7.6 to 12.5 and so on. The data arranged in increasing order of grading modulii, is shown in Appendix C.

The unconfined compressive strengths developed by each sand at 7 days, in this data can be defined by Feret's equation which was fitted to the experimental data for each sand according to the least squares criterion. The coefficients obtained for each sand have been tabulated as shown in Appendix D. The values obtained for A and N

do not seem to have any trend with respect to the grading modulus of the sand. The maximum and minimum values of N obtained in this data were 2.4455 and .7017 respectively. The values of A varied too erratically to indicate any trend.

Next, the compressive strength values (7 day) and the corresponding C/V values of all sands lying in a grading modulus range were fitted by least squares criterion and the A and N values for groups together with the correlation coefficients are presented as shown in Table 1. Even now, on careful examination of the tabulated values, it could be said that neither the values of N nor A indicated any definite trend with respect to the grading modulus.

Then the 16 pairs of values of A and N were tried to be fitted by least squares, which yielded an equation

$A = 3626\ N^{2.82}$ with a correlation coefficient of .9736. Contrary to what was reported by Hutchinson, N. and G.M.were not related at all.

The erratic behavior of A and N with respect to the grading modulus may be explained as follows. 'A' in Feret's strength law is defined as the strength of the cement essentially, but influenced by the material and packing. Grading modulus, obviously, does not reflect either of these characteristics. N is said to be a constant depending on material and geometrical factors. It is doubtful whether the grading modulus takes care of the geometrical factors like shape, surface texture

TABLE 1

ANALYSIS BASED ON GRADING MODULUS RANGES

Calculation of A and N values from $S = A(C/V)^N$ based on 7-day strengths. Least squares method.

Sl. No.	G.M. Range	Sand Source Nos. in the Group	Group Values		No. of Data Points	Correlation Coefficient 'r'
			N	A		
1.	7.6-12.5	23,121,123,159,77,46	1.060	3,511	18	.6383
2.	12.6-17.5	61,107,55,80,103,29,122,125	1.376	6,277	24	.6253
3.	17.6-22.5	101,89,203,64,62,99,106,69	1.637	14,668	29	.8599
4.	22.6-27.5	49,91,160,32,114,35,120	2.302	43,987	21	.8014
5.	27.6-32.5	96,22,119,124,118,78,116,72,100, 141,82	1.644	15,282	36	.9605
6.	32.6-37.5	47,63,93,95,108,145,53,71,41,75, 102,204,28,143,140	1.339	7,186	50	.8540
7.	37.6-42.5	81,43,110,115,92,60,166,87,147, 67,88,83,57,74,76	1.398	9,116	46	.8814
8.	42.6-47.5	48,34,207,79,56,149,54,36,84,65, 50,112	1.596	14,932	41	.9630
9.	47.6-52.5	70,94,33,90,104,44	1.276	6,379	25	.8879
10.	52.6-57.5	109,113,86,105,66	1.099	4,713	17	.8553
11.	57.6-62.5	68,45,155,30,42	1.488	9,753	16	.9744

TABLE 1 (continued)

Sl. No.	G.M. Range	Sand Source Nos. in the Group	Group Values		No. of Data Points	Correlation Coefficient 'r'
			N	A		
12.	62.6-67.5	97	.8450	2,618	3	.9929
13.	67.6-72.5	167,209,152,206	.8670	3,261	13	.9137
14.	72.6-77.5	40,117,39	1.223	6,719	10	.9337
15.	77.6-82.5	98,85	1.143	4,920	6	.9796
16.	92.6-97.5	38	1.667	20,112	3	.9999

From the above, for 16 pairs of 'A' and 'N' values, by least squares fit,

$$A = 3626N^{2.82}$$

with a correlation coefficient (r) of 0.9736.

and so on. Therefore, the granulometric properties of the sands as defined in terms of the grading modulus, are not satisfactory. The grading modulus is not a clear reflection even of the grading of a material because of the weightage factors given for the different sieves. From the definition of grading modulus, it may be noticed that it is highly susceptible to the percentage of materials passing sieve Nos. 50, 100 and 200 as the weightage factors for these sieves are high. A low G.M. may only mean coarse aggregate and a high G.M., more of finer fractions. A well graded material will have an intermediate value of G.M. Two different materials having the same G.M. may not have the same grading. Therefore, G.M. which is not truly representative of the gradation even, cannot be a satisfactory criterion for assessing the development of unconfined compressive strength of soil-cement mixtures.

ANALYSIS OF THE DATA BASED ON DENSITY

Housel, Catton, Felt (Ref. 6, 7, 8) and many other investigators have shown that maximum density of soil-cement is a significant factor in the design and performance of soil-cement construction, and it is also generally accepted that a densely compacted material has necessarily high compressive strength. Housel has further stated that the consistent relation between density and mechanical analysis is yet another important factor. Variation in texture and grading is quite accurately reflected in the compacted density which gives a measure of the total void content in the mix. The variation in the density can be predicted from the comparison between the ideal gradings and the actual

grading and this is facilitated by the Public Roads Gradation Chart. (Ref. 9).

This chart enables the plotting of the gradations of the different sands, providing at the same time a comparison with the theoretical maximum density grading corresponding to the particular maximum size of the particle of the sand under consideration. The gradations of the sands used in the soil-cement base construction in Alberta are presented. (Appendix E). Some of them have been plotted on the Public Roads Gradation Chart and are appended (Appendix F). The gradation lines of the sands in general, lie on either side of the maximum density line. The sands, which have their gradations farther away from the maximum density line result in low densities; and those which lie nearest give high densities. Grading modulus, as a factor not representing the grading and density, is clarified by these plots.

The Public Roads Gradation Chart enables evaluation as to the density that may be obtainable with a particular grading and also to adjust the gradings so as to give higher densities whenever it is possible. The density obtainable with a particular sand being a more reliable criterion concerning the grading, than the G.M., the data has been arranged in the increasing order of densities of the different sands. (Appendix G).

(a) RELATION BETWEEN UNCONFINED COMPRESSIVE STRENGTH AND C/V

The unconfined compressive strength values and corresponding C/V values of all sands lying in a density range were fitted by least

squares criterion and the 'A' and 'N' values for groups together with the correlation coefficients are presented as shown in Table 2.

Out of the 7 density groups, in 5 groups the value of N has a definite trend with respect to density whereas in 2 groups it is erratic.

The 5 pairs of values of A and N are related by least squares criterion which resulted in the equation.

$A = 3672\ N^{2.77}$ with a correlation coefficient of .9798, standard error of 1066 and a modified standard error of 1376.

In an attempt to relate N to density - a term defined as logarithm of mean density has been used.

Disregarding the two groups in which the value of N showed erratic behavior, with the other five groups a relation of the form

$$N = 8.26\ \log_{10}(\text{Mean Density}) - 15.59$$

could be established with a correlation coefficient of .9750 and a standard error of .0436 and modified standard error of .0563.

These two relationships enable the unconfined compressive strength to be evaluated for particular values of C/V if the maximum density for the sand is determined.

A graphical model (Fig. 1) has been prepared based on these two equations, to read the unconfined compressive strengths against values of

TABLE 2

ANALYSIS BASED ON DENSITY RANGES

Calculation of A & N values from $S = A(C/V)^N$ based on 7-day compressive strengths. Least squares method.

Sl. No.	Density Range	Sand Source Nos. in the Group	Group Values		Log. Mean Density	No. of data Points	Correlation Coefficient 'r'
			N	A			
1.	101 - 105	54,95,167	.9870	3,858	2.0128	11	.8902
2.	106 - 110	33,38,40,57,85,94,105,155,206	1.2260	6,341	2.0334	31	.9060
3.	111 - 115	28,30,32,35,36,39,42,44,50,53, 77,86,89,91,97,98,104,106,113, 117,143,152,204,207	1.4350	8,582	2.0531	75	.6989
4.	116 - 120	23,34,43,45,48,49,60,63,64,65, 67,68,69,71,72,74,75,76,79,80, 81,88,90,92,99,102,103,118,119, 124,140,141,145,147,149,160,209	1.5660	11,663	2.0719	122	.8176
5.	121 - 125	29,46,47,55,61,66,70,83,84,87, 93,96,100,109,110,112,114,115, 116,120,166	1.1670	5,112	2.0899	71	.6894
6.	126 - 130	22,56,62,78,82,101,159	1.7830	21,579	2.1072	23	.9809
7.	131 - 135	41,107,108,121,122,123,125,203	1.3790	10,163	2.1239	25	.9327

For 5 pairs of values of A and N, $A = 3672\ N^{2.77}$ with a correlation coefficent (r) of 0.9798, standard error of 1066 and a modified standard error of 1376

and $N = 8.26 \log_{10}$ (Mean Density) - 15.59 with a correlation coefficient of .9750, standard error of .0436 and a modified standard error of .0563

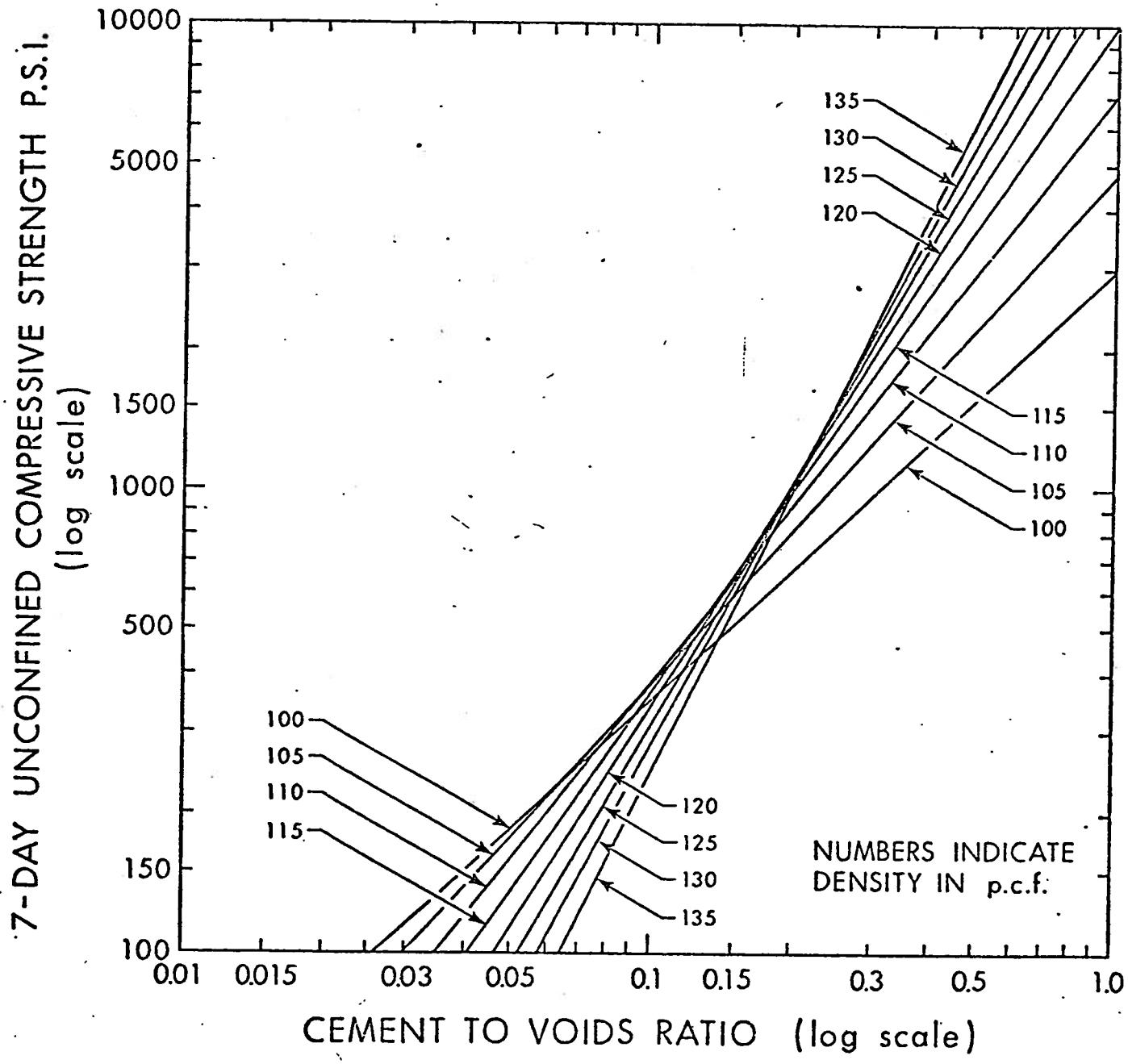


FIG. 1 STRENGTH VS C/V RATIO FOR DIFFERENT DENSITIES

C/V for various densities. From the graph, it can be seen that the strength values are higher for low density than for high density groups for the same value of C/V, up to C/V values of .14 to .15. For C/V values beyond .15, it is noticed that higher the density, greater is the compressive strength for the same value of C/V. The trend becomes more and more distinct with increasing values of C/V. This can be explained from the fact that the factor C/V takes care of both cement content and density of a soil-cement mixture. In low density groups, the percent cement content is higher than for high density groups, at the same value of C/V. From the standpoint of strength, the charts in general suggest that there is an optimum value of C/V for any particular density to produce the maximum strength. The chart enables the strength to be read out for a particular C/V value for any sand whose density is known. (The variation in the density with cement is assumed to be negligible in this connection).

(b) RELATION BETWEEN UNCONFINED COMPRESSIVE STRENGTH AND CEMENT CONTENT

In the previous analysis, it is clear that C/V covers the two variables in a soil cement mix, namely cement content and density. As all the data has been grouped into density ranges, it was felt appropriate to study the direct relationship of strength to the cement content.

By linear regression, coefficients have been computed for the relation between unconfined compressive strength and the cement content and are tabulated (Table 3).

TABLE 3

Relation between 7-day unconfined compressive strength and cement content, by linear regression. (Based on Density Ranges.)

Sl. No.	Density Range lbs/c.ft.	Sand Source Nos. in the Group	Slope	Intercept	No. of Data Points	Correlation Coefficient 'r'	r^2	Standard Err of Estimate
1.	101-105	54,95,167	44.64	14.19	11	.8855	.7830	56.38
2.	106-110	33,38,40,57,85,94,105,155,206	54.93	- 48.58	31	.9187	.8420	51.65
3.	111-115	28,30,32,35,36,39,42,44,50,53, 77,86,89,91,97,98,104,106,113, 117,143,152,204,207	62.72	-103.03	75	.7174	.5140	118.28
4.	116-120	23,34,43,45,48,49,60,63,64,65, 67,68,69,71,72,74,75,76,79,80, 81,88,90,92,99,102,103,118,119, 124,140,141,145,147,149,160,209	83.78	-184.46	122	.8019	.6430	130.74
.	121-125	29,46,47,55,61,66,70,83,84,87, 93,96,100,109,110,112,114,115, 116,120,166	71.83	- 14.78	71	.7174	.5140	147.03
.	126-130	22,56,62,78,82,101,159	145.93	-295.37	23	.9885	.9760	49.64
.	131-135	41,107,108,121,122,123,125,203	143.06	- 72.54	25	.8202	.6720	191.22

By means of the coefficients obtained, a design chart has been prepared as shown in Figure 2 connecting the unconfined compressive strength with the cement content, for various density ranges.

From the design chart, it can be noticed that for low density ranges, particularly from 100 to 115 lbs/c.ft, the increase in strength with increase of cement content is not significant, whereas in the 115-125 lbs/c.ft range, the variation is more significant. In the high density range of 125-135 lbs/c.ft the increase in strength for any increase in cement content is highly significant.

(c) RELATION BETWEEN CEMENT CONTENT AND FREEZE-THAW LOSS

From experience with the sandy soils used in Alberta the freeze-thaw test is considered to be a governing criterion for cement content of soil-cement mixes. (Ref. 1).

Circeo, Davidson and David (Ref. 10) reported that a strong logarithmic relationship was found to exist between the cement content, and the freeze-thaw loss of a soil-cement mixture. By correlation, they established that two freeze-thaw tests would reveal the logarithmic relationship for any soil type.

The data of cement contents by weight and the freeze-thaw losses for each density range was analyzed by correlation analysis and is presented in Table 4.

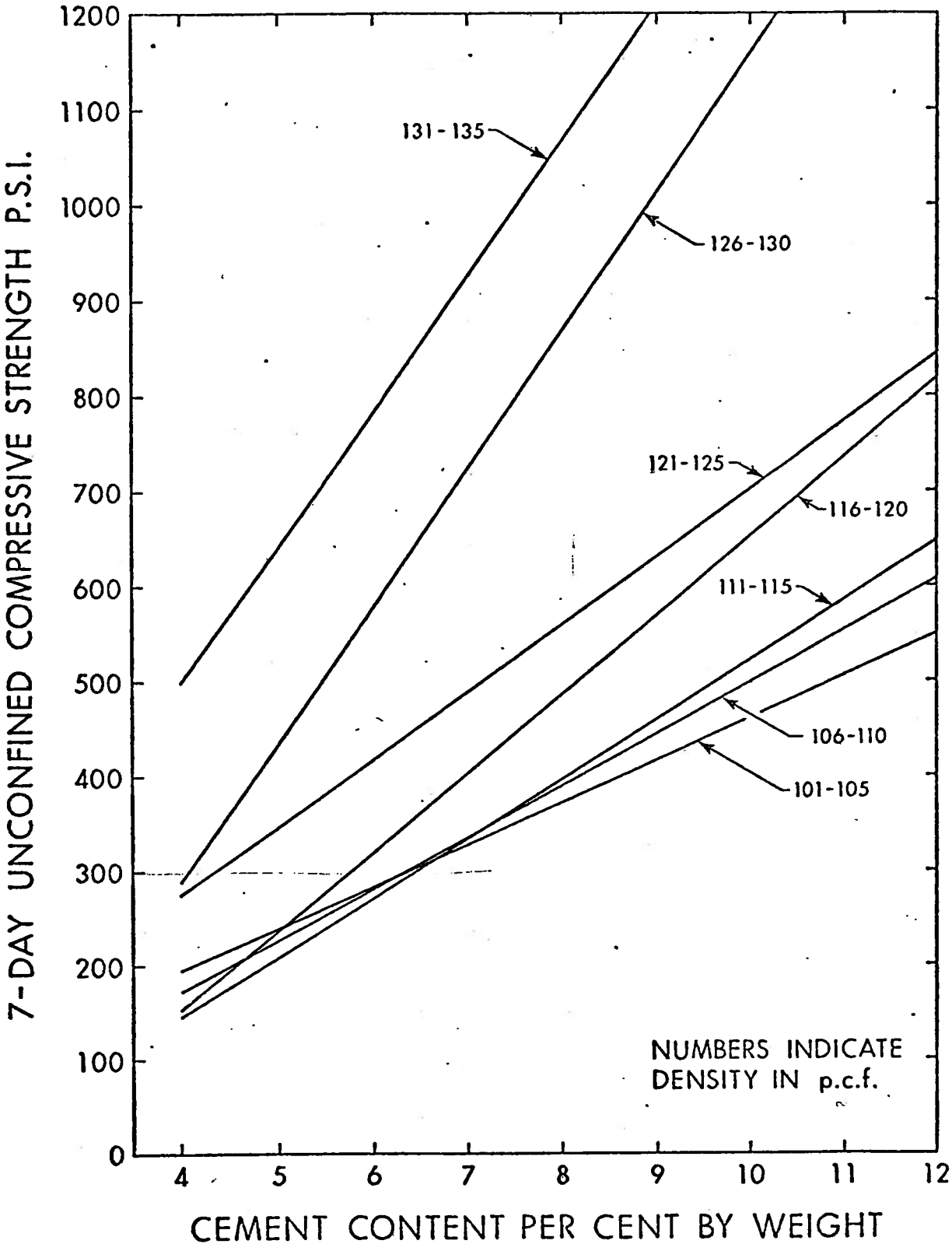


FIG. 2 STRENGTH VS. CEMENT CONTENT FOR DIFFERENT DENSITIES

TABLE 4

RELATION BETWEEN CEMENT CONTENT BY WEIGHT AND FREEZE-THAW LOSS

Log C = A + B Log L

(Linear Regression)

Sl. No.	Density Range lbs/c.ft.	Sand Source Nos. in the Group	Slope B	Intercept A	No.of Data Pts.	Correlation Coefficient r	r^2	Standard Error of Estimate	
								Log C	Cement Content
1.	101-105	54,95,167	-.2070	.9430	10	-.9636	.9285	.0360	1.086
2.	106-110	38,40,57,85,94,105,155,206	-.1687	.9675	27	-.7758	.6018	.0779	1.196
3.	111-115	28,30,32,35,36,39,42,44 50,53,77,86,89,91,97,98 104,106,113,117,143,152, 204,207	-.1951	.9585	70	-.8610	.7413	.0497	1.121
4.	116-120	23,34,43,45,48,49,60,63 64,65,67,68,69,71,72,74 75,76,79,80,81,88,90,92 99,102,103,118,119,124,140 141,145,147,149,160,209	-.2031	.9148	116	-.8539	.7291	.0619	1.153
5.	121-125	29,46,47,55,61,66,70,83 84,87,93,96,100,109,110, 112,114,115,116,120,166	-.1881	.8918	66	-.8237	.6784	.0730	1.183
6.	126-130	22,56,62,78,82,101,159	-.2561	.8002	23	-.8936	.7985	.0705	1.176
7.	131-135	41,107,108,121,122,123, 125,203	-.2552	.7487	23	-.8036	.6457	.1139	1.300

From this analysis, a chart has been prepared relating the cement content and freeze-thaw losses for the different density ranges, so that the cement content needed for a specified freeze-thaw loss for any sand producing a particular density, could be read out from the chart. (Fig. 3).

CEMENT CONTENT REQUIREMENTS OF VARIOUS SANDS

The Portland Cement Association specify that a soil-cement mixture having a compressive strength that is approximately 300 lbs. per sq. in. or more at 7 days, and that is increasing, will pass the wet-day and freeze-thaw tests satisfactorily. (Ref. 11).

Dacyszyn (Ref. 1) stated that generally 2 to 3 percent of freeze-thaw loss is acceptable for soil-cement mix design.

With these two criteria the cement requirements of the sands analyzed have been read out from the charts and tabulated as shown in Table 5.

The actual recommended average cement contents have also been extracted from the D.H.A. designs and tabulated for comparison.

It is observed that the cement requirement from the consideration of the freeze-thaw loss is usually more than that needed to produce an unconfined compressive strength of 300 psi at 7 days.

The recommended cement contents of the D.H.A. are found to be

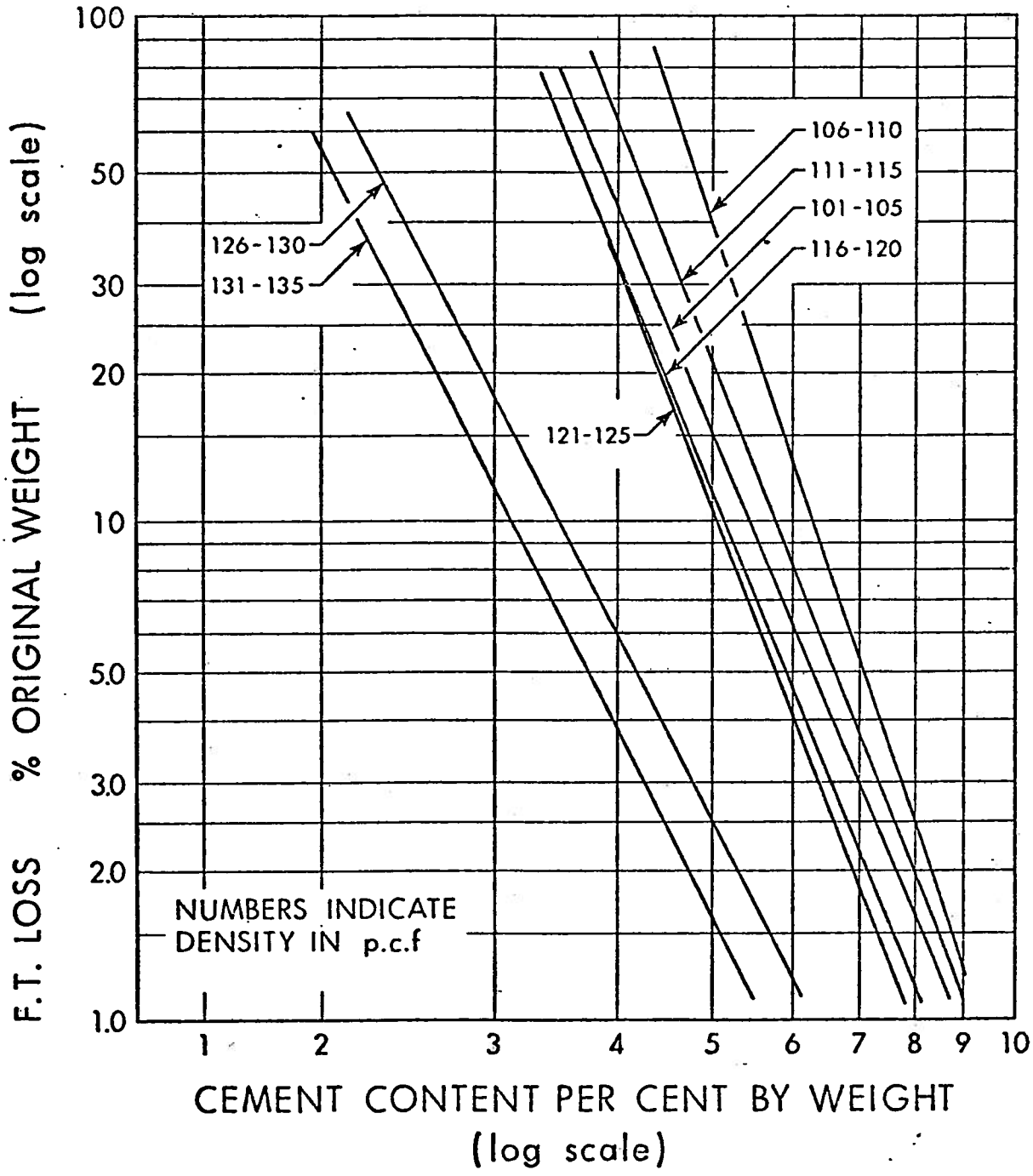


FIG. 3 FREEZE-THAW LOSS VS. CEMENT CONTENT FOR DIFFERENT DENSITIES

TABLE 5

CEMENT REQUIREMENTS

Sl. No.	Density Range lbs/c.ft.	Required Cement Content Based on		Recommended Cement Content as per D.H.A. (Av. values)
		300 psi 7 day comp.strength	2 to 3% F.T. Loss	
1.	101-105	6.5	7.5-8.2	8.67
2.	106-110	6.5	7.6-8.2	8.2
3.	111-115	6.5	7.6-8.2 slightly modified	8.03
4.	116-120	5.65	6.5-7.0	6.92
5.	121-125	4.2	6.4-7.0	6.41
6.	126-130	4.1	4.7-5.3	5.3
7.	131-135	Less than 4	4.2-4.75	3.72

quite in agreement with those suggested by the charts except in one density range namely 131-135 lbs/c.ft.

The densities as have been used in the development of the charts are laboratory densities, and since the cement contents suggested by the charts are based on these, it should be clear that they will be valid only in case the field densities are almost the same as laboratory densities; or otherwise the cement contents have to be adjusted to the density attained.

USE OF THE CHARTS

For any particular sand, if the laboratory density can be determined, the cement content required to produce a desired strength, as well as the cement content for a particular freeze-thaw loss can be determined. Once the cement content has been fixed up, the probable strength that may be developed can be verified from the graph relating unconfined compressive strength and C/V.

Thus these graphs enable realistic adjustments to the construction cement contents without much field testing.

LIMITATIONS OF THESE CHARTS

The analysis has all been based on actual mix design data of the Department of Highways of Alberta and can be considered as of reliable guidance for quick field adjustments.

In most of the cases, it can be seen from the data that the strengths at 28 days indicated a general increase over the 7 day strengths. Except in a few cases, even the compressive strength after freeze-thaw loss indicated an increase over the 7 day strengths. The compressive strengths also showed an increase with the increase in density attainable with the sands, the cement content being the same.

Anderegg (Ref. 12) discussing about the factors affecting the development of compressive strength stated that the amount of cement hydrated, the properties of the aggregate including especially the surface condition, workability of the mix and structural features including the arrangement of particles and the keying effect of large particles are all factors important in the order cited.

Felt (7) stated that sandy soils too, may react differently with cement depending upon their chemical make up and surface chemical properties. Other important factors which have pronounced influence on the physical properties of soil-cement mixtures include the water added and the density to which the mixture is compacted.

Since all these factors cannot be covered in the analysis, the charts developed have their limitations.

CONCLUSIONS

The following conclusions have been drawn from the analysis and discussion.

(1) The grading modulus of sand is not a reliable criterion for the design of soil-cement mixes.

(2) The density attainable of the sand provides a more reliable criterion for the design.

(3) The Public Roads Gradation Chart gives an indication of the density attainable with a particular sand, when the gradation of the sand is plotted on the chart.

(4) The charts developed from the analysis contained in this paper, are useful for quick adjustments of the construction cement contents without much field testing. They are particularly useful for the Alberta sands and may have general application even for other areas.

ACKNOWLEDGEMENTS

The report is based on the Soil-cement Mix Design Data, collected as a part of Project K 114 B of the Alberta Cooperation Highway Research program. The authors express their thankfulness to Mr. B.P. Shields for permission to use the data and for the suggestions he has offered.

LIST OF APPENDICES

APPENDIX A

GRANULOMETRIC PROPERTIES OF THE SANDS

GRANULOMETRIC PROPERTIES OF THE SANDS

Sl. No.	Sand Source No.	Percentage by weight retained on each sieve interval								Grading Modulus
		3/4 #4	#4 #8	#8 #16	#16 #30	#30 #50	#50 #100	#100 #200	passing 200	
		Surface area factors								
		1	2	4	8	16	32	64	128	
1.	22	15	6	8	18	23	14	2.8	13.2	28.8
2.	23	11	18	26	28	13.4	2.6	0.6	0.4	7.6
3.	28	-	2	1	5	36	39	5	12	37.2
4.	29	4	4	9	42	29	7.2	1.6	3.2	15.8
5.	30	-	0.1	0.1	0.8	7.0	37	34	21	61.6
6.	32	-	0.2	0.3	6.5	52.0	34.6	3.3	3.1	25.7
7.	33	-	-	0.1	0.1	2.8	53.0	38.4	5.6	49.2
8.	34	-	-	0.2	0.8	15.0	48.0	30.2	5.8	43.4
9.	35	-	2.0	2.0	7.0	38.0	43.0	6	2	26.9
10.	36	-	0.3	0.2	1.5	24	35	30.5	8.5	45.6
11.	38	-	0.1	0.1	0.1	0.1	6.6	41.0	52.0	94.9
12.	39	0.6	0.1	0.1	0.3	5.9	27.0	24.0	41.0	77.4
13.	40	0.7	0.2	0.1	0.2	1.8	29.0	37.0	31.0	72.9
14.	41	-	8.0	7.0	6.0	6.0	7.0	6.0	22.0	36.1
15.	42	-	-	0.1	0.2	4.7	32.0	47.0	16.0	61.6
16.	43	-	-	-	2.0	22.0	54.0	15.0	7.0	39.6
17.	44	-	0.1	0.1	0.1	7.7	56.0	21.0	15.0	51.8
18.	45	-	1	0	3.0	10.0	40.0	24.0	22.0	58.2
19.	46	3.0	3.0	8.0	50.0	30.2	4.7	0.6	0.5	11.7
20.	47	6.0	3.0	5.0	9.0	26.0	32.0	10.7	8.3	32.8
21.	48	-	-	0.2	0.8	24.0	50.0	13.5	11.5	43.2
22.	49	-	6.0	3.0	17.0	39.0	19.0	4.0	5.0	22.9
23.	50	-	-	0.2	0.8	19.0	67.0	11.4	1.6	47.3
24.	53	-	-	-	1.0	19.0	63.0	16.0	1.0	34.8
25.	54	-	-	-	-	5.0	55.0	38.0	2.0	45.2
26.	55	7.0	3.0	1.0	34.0	40.0	6.0	3.0	1.0	14.3
27.	56	-	2.0	3.0	8.0	22.0	30.0	22.0	13.0	44.6
28.	57	-	-	-	2.0	8.0	73.0	7.0	10.0	42.0
29.	60	-	-	-	1.0	21.0	51.0	22.0	5.0	40.2
30.	61	-	29.0	7.0	18.0	33.0	10.0	2.0	0.8	13.4
31.	62	6.0	5.0	6.0	17.0	35.0	23.0	5.6	2.4	21.3
32.	63	-	1.0	1.0	7.0	33.0	44.0	8.0	6.0	32.8
33.	64	-	2.0	3.0	2.0	65.0	26.0	0.8	1.2	21.1
34.	65	-	-	-	1.0	20.0	43.0	24.8	11.2	47.2
35.	66	-	-	-	3.0	23.0	32.0	17.0	25.0	57.0
36.	67	-	-	1.0	2.0	19.0	55.0	14.8	8.2	40.8
37.	68	-	0.5	0.5	3.0	19 0	34.0	18.0	25.0	57.7
38.	69	-	7.0	13.0	16.0	30.0	24.0	7.3	2.7	22.5
39.	70	-	0.2	0.3	3.5	20.0	35.0	30.3	10.7	47.8
40.	71	-	2.0	4.0	10.0	40.0	27.0	3.0	14.0	36.0
41.	72	-	0.1	0.1	3.8	44.0	36.0	14.0	2.0	30.4
42.	74	-	1.0	1.0	1.0	17.0	46.0	31.0	4.0	42.1
43.	75	-	-	0.8	9.0	39.0	33.0	7.0	11.0	36.1
44.	76	-	0.1	0.9	5.0	33.0	33.0	15.0	13.0	42.5
45.	77	-	3.0	5.0	18.0	49.0	16.0	4.3	1.7	11.6

Sl. No.	Sand Source No.	Percentage by weight retained on each sieve interval								Grading Modulus
		3/4 #4	#4 #8	#8 #16	#16 #30	#30 #50	#50 #100	#100 #200	passing 200	
		Surface area factors								
		1	2	4	8	16	32	64	128	
46.	78	-	13.0	6.0	15.0	28.0	21.0	7.2	9.8	30.0
47.	79	-	-	-	-	20.0	40.0	35.0	5.0	44.2
48.	80	-	2.0	5.0	32.0	52.0	8.0	0.4	0.6	14.7
49.	81	-	3.0	3.0	6.0	20.0	40.0	13.0	10.0	37.8
50.	82	-	6.0	6.0	9.0	25.0	27.0	9.3	9.7	32.0
51.	83	-	3.0	4.0	8.0	21.0	33.0	14.0	14.0	41.6
52.	84	-	1.0	1.0	3.0	17.0	49.0	12.0	15.0	45.6
53.	85	-	0.1	0.1	0.1	0.7	20.0	44.0	35.0	79.5
54.	86	-	0.1	0.1	0.8	8.0	39.0	39.0	13.0	55.4
55.	87	-	7.0	7.0	9.0	18.0	28.0	16.0	15.0	40.4
56.	88	-	1.0	2.0	9.0	32.0	30.0	12.0	14.0	41.1
57.	89	-	0.2	1.8	33.0	53.0	8.0	0.9	3.1	18.3
58.	90	-	-	1.0	5.0	22.0	38.0	16.0	18.0	49.4
59.	91	-	-	0.1	4.9	68.0	22.0	2.4	2.6	23.2
60.	92	-	0.3	0.3	1.6	18.6	54.0	18.9	6.1	40.1
61.	93	-	3.0	6.0	25.0	27.0	21.0	5.0	13.0	33.2
62.	94	-	0.2	0.3	1.5	39.0	30.0	8.0	21.0	48.0
63.	95	-	19.0	1.0	1.0	36.0	26.0	4.0	13.0	33.8
64.	96	-	6.0	7.0	14.0	30.0	31.0	5.6	6.4	28.0
65.	97	-	-	0.1	0.8	4.1	33.0	40.0	22.0	65.0
66.	98	-	-	0.1	0.1	3.8	26.0	32.0	38.0	78.1
67.	99	-	5.0	3.0	10.0	46.0	31.1	2.3	2.6	21.4
68.	100	-	12.0	3.0	10.0	28.0	30.0	10.3	6.7	30.4
69.	101	-	25.0	13.0	17.0	23.0	15.0	3.0	4.0	18.0
70.	102	-	5.0	2.0	6.0	19.0	46.0	15.6	6.4	36.6
71.	103	-	2.0	9.0	41.0	35.0	10.0	0.9	2.1	15.7
72.	104	-	-	0.1	0.2	12.7	52.0	22.0	13.0	49.4
73.	105	-	-	-	0.1	0.1	35.8	53.0	11.0	55.5
74.	106	-	5.0	3.0	2.0	5.0	17.0	7.2	7.8	22.3
75.	107	-	33.0	20.0	17.0	16.0	9.0	1.3	3.7	13.7
76.	108	-	24.0	14.0	14.0	14.0	10.0	6.0	18.0	30.4
77.	109	1.0	1.0	2.0	5.0	27.0	26.0	9.0	29.0	53.5
78.	110	5.0	3.0	6.0	13.0	25.0	20.0	8.0	20.0	39.9
79.	112	4.0	2.0	5.0	11.0	24.0	22.0	6.0	26.0	47.5
80.	113	-	-	-	1.0	12.0	47.0	22.0	18.0	54.9
81.	114	-	5.0	5.0	24.0	38.0	16.0	4.8	7.2	25.7
82.	115	-	2.0	4.0	8.0	22.0	37.0	11.0	13.0	40.0
83.	116	0.5	0.5	5.0	22.0	37.0	20.0	5.2	9.8	30.2
84.	117	-	0.1	0.1	0.2	2.6	26.0	38.0	33.0	75.3
85.	118	-	6.0	5.0	6.0	33.0	36.0	9.3	4.7	29.6
86.	119	-	9.0	3.0	3.0	32.0	35.0	8.0	5.0	28.8
87.	120	-	12.0	4.0	8.0	31.0	33.0	8.0	4.0	27.0
88.	121	-	63.0	12.0	12.0	6.0	4.0	0.0	3.0	8.8
89.	122	-	34.0	14.0	18.0	18.0	9.0	2.5	4.5	15.8
90.	123	-	59.0	18.0	9.0	6.0	3.0	1.1	3.9	10.2

Sl. No.	Sand Source No.	Percentage by weight retained on each sieve interval								Grading Modulus
		3/4 #4	#4 #8	#8 #16	#16 #30	#30 #50	#50 #100	#100 #200	passing 200	
		Surface area factors								
		1	2	4	8	16	32	64	128	
91.	124	-	3.0	2.0	8.0	35.0	38.0	9.2	4.8	28.8
92.	125	-	31.0	14.0	19.0	19.0	10.0	2.6	4.4	16.2
93.	140	-	3.0	1.0	5.0	6.0	66.0	15.0	4.0	37.3
94.	141	-	4.0	1.0	6.0	35.0	34.0	14.0	4.0	31.2
95.	143	-	-	0.1	0.2	25.7	53.0	16.8	4.2	37.2
96.	145	-	6.0	1.0	1.0	24.0	49.0	15.0	4.0	34.5
97.	147	-	-	-	1.0	23.0	51.0	18.0	7.0	40.6
98.	149	-	4.0	2.0	4.0	36.0	28.0	6.0	20.0	44.6
99.	152	-	-	-	-	3.0	32.0	36.0	29.0	70.9
100.	155	-	-	0.7	0.6	1.7	36.0	47.0	14.0	60.0
101.	159	-	46.0	17.0	22.0	7.0	3.0	0.9	4.1	11.3
102.	160	-	3.0	1.0	3.0	56.0	31.0	2.0	4.0	25.6
103.	166	-	1.0	4.0	11.0	33.0	24.0	13.0	14.0	40.2
104.	167	-	0.6	0.4	1.0	1.0	28.0	46.0	23.0	68.1
105.	203	-	28.0	10.0	15.0	16.0	19.0	8.2	3.8	21.0
106.	204	-	1.0	1.0	23.0	22.0	53.0	14.5	5.5	37.1
107.	206	-	-	-	-	1.0	22.0	55.0	23.0	71.8
108.	207	-	-	-	2.0	21.0	51.0	14.6	11.4	43.8
109.	209	-	1.0	1.0	1.0	9.0	30.0	26.0	32.0	68.8

APPENDIX B

SOIL CEMENT DESIGN DATA ARRANGED IN THE ORDER OF SAND SOURCE NUMBERS

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
1	22	28.8	4.0	304.5	373.8	279.7	127.7	2.2	0.0930
1	22	28.8	6.0	556.7	793.3	662.5	128.7	0.9	0.1339
1	22	28.8	8.0	965.6	1250.8	1046.0	130.3	0.4	0.1746
2	23	7.6	6.0	112.4	221.2	214.3	118.3	2.3	0.1016
2	23	7.6	8.0	181.7	415.6	423.4	120.6	1.5	0.1357
2	23	7.6	10.0	278.4	711.0	580.2	123.4	1.3	0.1720
3	28	37.2	6.0	128.0	267.9	211.6	112.6	4.0	0.0883
3	28	37.2	8.0	215.6	445.7	287.5	114.2	1.8	0.1163
3	28	37.2	10.0	274.5	675.7	440.3	114.9	1.1	0.1406
4	29	15.8	7.0	94.1	364.7	164.6	120.1	13.3	0.1206
4	29	15.8	9.0	159.4	627.4	279.7	122.5	1.5	0.1557
4	29	15.8	11.0	256.2	938.4	362.0	124.0	1.9	0.1869
5	30	61.6	7.0	311.1	486.2	393.3	114.2	2.5	0.1050
5	30	61.6	9.0	439.0	653.5	586.6	114.8	1.2	0.1300
5	30	61.6	11.0	625.9	802.5	750.1	115.4	0.9	0.1530
6	32	25.7	7.0	113.7	269.2	135.9	111.1	8.2	0.0970
6	32	25.7	9.0	185.6	444.4	214.3	113.4	4.5	0.1260
6	32	25.7	11.0	282.3	670.5	380.3	115.0	1.0	0.1520
7	33	49.2	8.0	339.8	550.2	497.8	108.8	0.2	0.1030
7	33	49.2	10.0	495.2	758.1	744.9	110.3	0.3	0.1270
7	33	49.2	12.0	598.5	1091.3	977.4	111.5	0.4	0.1500
8	34	43.4	7.0	418.1	603.8	543.7	116.8	2.0	0.1090
8	34	43.4	9.0	614.2	886.2	743.5	117.8	0.6	0.1380
8	34	43.4	11.0	818.1	1224.7	1078.0	119.3	0.6	0.1660
9	35	26.9	7.0	406.4	562.0	512.3	113.9	1.3	0.1040
9	35	26.9	9.0	603.7	818.2	729.1	115.1	1.2	0.1310
9	35	26.9	11.0	899.1	1223.4	1030.0	116.4	0.5	0.1570
10	36	45.6	6.0	288.8	368.6	363.9	111.3	2.0	0.0860
10	36	45.6	8.0	443.0	571.1	558.0	111.9	1.0	0.1100
10	36	45.6	10.0	640.3	777.7	772.3	112.7	1.0	0.1340
11	38	94.9	7.0	330.6	424.8	347.6	105.5	2.3	0.0850
11	38	94.9	9.0	474.3	526.7	466.6	106.0	2.6	0.1060
11	38	94.9	11.0	637.7	704.5	631.1	106.6	1.2	0.1260
12	39	77.4	5.0	257.4	385.9	----	111.5	25.7	0.0740
12	39	77.4	7.0	365.9	501.9	354.2	112.3	2.4	0.1000
12	39	77.4	9.0	512.3	628.7	573.7	113.0	1.3	0.1240
13	40	72.9	5.0	219.6	303.2	228.7	108.1	4.2	0.0670
13	40	72.9	7.0	331.9	426.1	373.8	109.1	2.8	0.0920
13	40	72.9	9.0	543.7	599.9	554.2	110.2	1.0	0.1170
14	41	36.1	3.0	317.6	475.7	----	133.1	21.8	0.0856
14	41	36.1	5.0	497.8	683.6	530.6	133.6	2.5	0.1337
14	41	36.1	7.0	721.3	980.3	773.6	133.5	1.1	0.1730
15	42	61.6	8.0	380.3	565.9	413.0	112.3	1.8	0.1110
15	42	61.6	10.0	544.9	721.4	652.1	113.7	0.9	0.1370
15	42	61.6	12.0	649.5	995.9	831.2	114.7	0.0	0.1610
16	43	39.6	7.0	284.9	432.6	307.1	113.6	2.8	0.1030
16	43	39.6	9.0	422.1	592.0	473.1	115.8	1.5	0.1330
16	43	39.6	11.0	625.9	938.4	746.1	117.1	0.6	0.1590
17	44	51.8	6.0	162.0	307.1	224.8	110.6	3.8	0.0940
17	44	51.8	8.0	277.0	483.6	390.7	111.9	1.8	0.1100
17	44	51.8	10.0	409.0	701.9	661.3	113.6	0.5	0.1370
18	45	58.2	6.0	344.9	478.4	282.3	118.2	15.3	0.1020
18	45	58.2	8.0	470.4	696.6	577.6	119.4	1.7	0.1320
18	45	58.2	10.0	590.6	978.9	777.5	119.9	1.1	0.1590

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
19	46	11.7	8.0	277.0	386.9	322.8	118.1	1.2	0.1280
19	46	11.7	10.0	466.6	786.8	611.5	123.3	0.6	0.1680
19	46	11.7	12.0	569.8	1090.0	956.6	123.4	0.4	0.1970
20	47	32.8	6.0	348.9	581.6	457.4	122.7	1.2	0.1140
20	47	32.8	8.0	584.1	965.9	740.9	124.7	0.6	0.1510
20	47	32.8	10.0	899.1	1246.9	1167.0	126.2	0.0	0.1850
21	48	43.2	6.0	294.1	386.8	337.1	113.2	2.5	0.0900
21	48	43.2	8.0	435.1	601.2	507.0	115.3	1.2	0.1200
21	48	43.2	10.0	582.8	801.2	705.7	115.9	0.4	0.1440
22	49	22.9	5.0	120.2	196.0	107.2	114.8	32.1	0.0800
22	49	22.9	7.0	264.0	401.2	270.5	117.5	4.3	0.1130
22	49	22.9	9.0	448.2	605.1	512.3	119.9	2.3	0.1470
23	50	47.3	8.0	355.5	----	445.7	109.2	1.9	0.1040
23	50	47.3	10.0	524.0	----	660.0	111.5	1.5	0.1300
23	50	47.3	12.0	730.5	----	942.1	113.0	0.3	0.1550
24	53	34.8	8.0	371.1	598.6	441.7	113.2	2.3	0.1140
24	53	34.8	10.0	525.3	858.7	675.6	114.8	1.2	0.1400
24	53	34.8	12.0	611.5	1070.4	981.3	114.9	0.0	0.1620
25	54	45.2	8.0	284.9	529.3	399.8	102.7	1.1	0.0890
25	54	45.2	10.0	401.2	758.0	590.6	104.1	0.3	0.1220
25	54	45.2	12.0	568.4	933.1	803.7	105.6	0.0	0.1400
26	55	14.3	6.0	264.0	418.2	264.0	119.4	6.2	0.1050
26	55	14.3	8.0	419.5	722.7	544.9	122.2	0.5	0.1420
26	55	14.3	10.0	603.7	1100.5	829.9	123.5	0.4	0.1730
27	56	44.6	7.0	710.9	926.7	782.7	124.4	1.1	0.1350
27	56	44.6	9.0	968.3	1300.5	1072.0	125.5	0.7	0.1690
27	56	44.6	11.0	1250.0	1701.7	1525.0	126.7	0.1	0.2010
28	57	42.0	6.0	244.3	377.7	311.1	104.8	4.0	0.0730
28	57	42.0	8.0	395.9	564.6	492.6	106.6	1.7	0.0980
28	57	42.0	10.0	573.7	784.2	716.1	108.3	0.7	0.1210
29	60	40.2	8.0	671.7	810.3	760.5	118.9	1.1	0.1310
29	60	40.2	10.0	867.8	1083.5	942.1	120.2	0.5	0.1600
29	60	40.2	12.0	1144.0	1373.7	1250.0	120.4	0.2	0.1830
30	61	13.4	5.0	241.7	348.9	294.1	119.5	2.4	0.0890
30	61	13.4	7.0	504.4	778.9	581.6	122.0	0.9	0.1270
30	61	13.4	9.0	846.8	1116.2	1007.0	124.5	0.4	0.1650
31	62	21.3	4.0	228.0	316.3	267.9	120.1	4.0	0.0750
31	62	21.3	6.0	543.7	691.4	622.0	123.7	1.2	0.1170
31	62	21.3	8.0	918.7	1131.9	1046.0	126.1	0.7	0.1570
31	62	21.3	10.0	1261.0	1538.3	1293.0	127.6	0.3	0.1920
32	63	32.8	7.0	384.1	515.0	416.9	115.9	1.9	0.1090
32	63	32.8	9.0	594.6	862.6	700.4	118.4	1.1	0.1410
32	63	32.8	11.0	798.4	1240.3	1013.0	119.3	0.4	0.1680
33	64	21.1	5.0	261.0	354.1	287.5	116.2	4.1	0.0830
33	64	21.1	7.0	522.8	648.2	534.4	119.7	1.4	0.1200
33	64	21.1	9.0	738.2	929.3	755.3	120.8	1.1	0.1500
33	64	21.1	11.0	1061.0	1280.8	1149.0	122.5	0.4	0.1810
34	65	47.2	5.0	299.0	435.2	367.2	116.3	2.5	0.0830
34	65	47.2	7.0	505.0	675.7	606.3	117.1	1.3	0.1120
34	65	47.2	9.0	695.0	908.4	866.4	117.7	0.7	0.1390
34	65	47.2	11.0	956.0	1180.2	1091.0	118.3	0.1	0.1640
35	66	57.0	4.0	351.6	428.7	248.3	121.2	24.9	0.0780
35	66	57.0	6.0	501.0	648.2	520.1	121.7	1.4	0.1110
35	66	57.0	8.0	679.0	918.8	768.5	122.2	0.7	0.1420

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
36	67	40.8	5.0	249.0	342.4	288.8	113.3	4.1	0.0770
36	67	40.8	7.0	441.0	521.5	511.0	115.7	1.8	0.1080
36	67	40.8	9.0	616.0	798.6	761.9	117.3	0.6	0.1380
36	67	40.8	11.0	858.0	1073.0	1127.0	118.9	0.3	0.1660
37	68	57.7	5.0	332.0	462.7	264.0	120.3	20.3	0.0920
37	68	57.7	7.0	473.0	640.4	503.1	121.0	1.0	0.1240
37	68	57.7	9.0	619.0	814.3	674.2	121.3	0.3	0.1520
38	69	22.5	7.0	457.0	585.5	411.6	118.3	2.5	0.1160
38	69	22.5	9.0	677.0	893.9	717.4	118.9	0.8	0.1430
38	69	22.5	11.0	815.0	1164.5	879.4	118.8	0.4	0.1660
39	70	47.8	5.0	283.0	409.0	333.2	118.2	2.5	0.0870
39	70	47.8	7.0	512.0	730.6	615.5	120.7	0.7	0.1230
39	70	47.8	9.0	701.0	1088.7	921.2	121.4	0.4	0.1520
39	70	47.8	11.0	1060.0	1407.6	1263.0	122.7	0.1	0.1820
40	71	36.0	5.0	352.0	407.8	176.4	117.7	31.9	0.0860
40	71	36.0	7.0	473.0	593.4	419.5	118.5	3.2	0.1160
40	71	36.0	9.0	662.0	807.7	700.4	119.3	0.2	0.1450
41	72	30.4	5.0	249.0	286.2	286.2	114.6	3.6	0.0790
41	72	30.4	7.0	450.0	590.8	541.1	117.5	1.5	0.1130
41	72	30.4	9.0	703.0	961.9	837.7	119.1	0.5	0.1440
41	72	30.4	11.0	978.0	1347.5	1212.0	120.7	0.0	0.1740
42	74	42.1	6.0	351.0	497.9	471.8	113.8	2.6	0.0910
42	74	42.1	8.0	501.0	771.1	726.6	115.3	0.9	0.1200
42	74	42.1	10.0	666.0	1039.0	920.0	116.6	0.3	0.1470
42	74	42.1	12.0	812.0	1368.4	1218.0	117.5	0.0	0.1710
43	75	36.1	5.0	292.0	439.1	384.1	119.7	3.9	0.0910
43	75	36.1	7.0	464.0	708.4	607.7	120.9	1.7	0.1240
43	75	36.1	9.0	658.0	981.6	896.4	121.6	1.0	0.1530
44	76	42.5	4.0	290.0	414.3	104.6	119.6	50.1	0.0740
44	76	42.5	6.0	477.0	632.6	406.4	121.5	5.3	0.1110
44	76	42.5	8.0	628.0	837.8	623.3	122.1	1.1	0.1420
44	76	42.5	10.0	762.0	1027.3	819.4	122.3	0.5	0.1680
45	77	11.6	6.0	316.0	410.4	159.4	114.3	36.4	0.0920
45	77	11.6	8.0	393.0	588.2	358.1	114.7	3.3	0.1180
45	77	11.6	10.0	545.0	792.0	548.8	115.5	1.0	0.1430
46	78	30.0	4.0	299.0	414.3	329.4	125.6	2.4	0.0680
46	78	30.0	6.0	555.0	751.5	675.6	127.5	1.2	0.1300
46	78	30.0	8.0	939.0	1323.9	1069.0	128.6	0.7	0.1680
47	79	44.2	5.0	306.0	372.5	317.6	114.2	5.2	0.0790
47	79	44.2	7.0	487.0	586.8	504.4	115.8	1.6	0.1090
47	79	44.2	9.0	695.0	873.1	701.8	117.4	0.4	0.1380
47	79	44.2	11.0	885.0	1151.5	883.3	118.3	0.0	0.1640
48	80	14.7	6.0	164.0	281.0	185.6	113.2	3.7	0.0900
48	80	14.7	8.0	280.0	546.3	393.3	115.6	1.8	0.1210
48	80	14.7	10.0	453.0	795.9	688.7	117.7	0.6	0.1510
49	81	37.8	5.0	331.0	469.0	333.2	118.3	2.6	0.0870
49	81	37.8	7.0	504.0	709.7	569.8	119.3	1.1	0.1190
49	81	37.8	9.0	663.0	950.2	784.1	119.8	0.8	0.1460
50	82	32.0	5.0	447.0	567.2	471.8	125.2	2.4	0.1050
50	82	32.0	7.0	731.0	931.9	748.9	126.6	1.0	0.1440
50	82	32.0	9.0	961.0	1224.7	1120.0	126.5	0.5	0.1730
51	83	41.6	4.0	275.0	350.3	248.3	119.1	--	0.0730
51	83	41.6	6.0	447.0	613.0	462.6	122.1	2.7	0.1130
51	83	41.6	8.0	672.0	848.0	649.5	123.5	1.3	0.1470

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
51	83	41.6	10.0	884.0	1080.0	913.5	124.4	0.8	0.1770
52	84	45.6	4.0	292.0	359.4	321.5	119.0	— —	0.0730
52	84	45.6	6.0	460.0	562.0	530.6	120.4	2.1	0.1080
52	84	45.6	8.0	670.0	844.3	803.7	121.3	1.0	0.1390
52	84	45.6	10.0	854.0	1120.0	1010.0	121.9	0.4	0.1670
53	85	80.0	6.0	297.0	338.5	283.6	109.7	2.5	0.0820
53	85	80.0	8.0	392.0	559.4	467.8	110.5	1.5	0.1070
53	85	80.0	10.0	501.0	717.5	654.6	111.1	0.9	0.1290
54	86	55.4	7.0	305.0	524.1	405.2	113.8	2.6	0.1040
54	86	55.4	9.0	511.0	720.1	551.4	114.5	1.4	0.1290
54	86	55.4	11.0	610.0	850.9	696.5	115.6	0.5	0.1540
55	87	40.4	5.0	383.0	513.6	409.0	121.2	3.6	0.0940
55	87	40.4	7.0	587.0	794.7	682.2	122.4	1.2	0.1280
55	87	40.4	9.0	826.0	1071.7	931.7	123.2	0.7	0.1600
56	88	41.1	5.0	257.0	393.4	312.3	118.6	8.4	0.0860
56	88	41.1	7.0	402.0	615.6	535.8	120.3	1.7	0.1220
56	88	41.1	9.0	583.0	841.7	722.6	120.9	1.1	0.1500
57	89	18.3	6.0	187.0	240.5	234.0	112.0	5.8	0.0870
57	89	18.3	8.0	334.0	461.4	403.8	114.3	2.1	0.1170
57	89	18.3	10.0	489.0	823.4	704.4	116.1	0.8	0.1450
58	90	49.4	5.0	247.0	331.9	301.8	120.2	4.1	0.0920
58	90	49.4	7.0	387.0	533.3	494.0	120.7	2.0	0.1230
58	90	49.4	9.0	565.0	692.7	718.8	121.5	1.1	0.1530
59	91	23.2	6.0	107.0	214.4	177.7	111.5	4.6	0.0860
59	91	23.2	8.0	222.0	390.8	304.5	113.5	2.7	0.1150
59	91	23.2	10.0	377.0	546.3	480.8	115.9	1.6	0.1440
60	92	40.1	8.0	243.0	388.1	292.7	114.1	1.5	0.1160
60	92	40.1	10.0	368.0	612.9	407.8	115.7	0.9	0.1440
60	92	40.1	12.0	466.0	802.5	650.7	116.5	0.4	0.1680
61	93	33.2	4.0	207.0	354.2	166.0	121.7	39.9	0.0790
61	93	33.2	6.0	370.0	612.9	409.0	123.1	1.7	0.1160
61	93	33.2	8.0	514.0	875.7	620.7	124.2	0.9	0.1490
61	93	33.2	10.0	698.0	1271.7	931.7	124.8	0.5	0.1790
62	94	48.0	4.0	210.0	249.6	128.0	107.4	38.8	0.0540
62	94	48.0	6.0	289.0	397.3	202.5	108.1	33.2	0.0790
62	94	48.0	8.0	371.0	526.7	334.5	108.5	25.3	0.1020
62	94	48.0	10.0	484.0	666.6	375.1	109.6	1.5	0.1250
62	94	48.0	12.0	556.0	761.9	520.1	110.0	0.9	0.1450
63	95	33.8	4.0	172.0	202.6	130.7	102.9	29.1	0.0490
63	95	33.8	6.0	288.0	317.6	206.5	104.1	11.8	0.0720
63	95	33.8	8.0	337.0	414.3	275.7	104.4	1.7	0.0930
63	95	33.8	10.0	387.0	488.8	369.8	104.4	0.6	0.1110
64	96	28.0	4.0	331.0	446.9	223.5	124.5	27.4	0.0850
64	96	28.0	6.0	498.0	624.7	433.8	125.7	3.1	0.1240
64	96	28.0	8.0	622.0	814.2	695.2	125.7	1.2	0.1550
64	96	28.0	10.0	776.0	1035.1	824.5	126.0	1.2	0.1850
65	97	65.0	6.0	336.0	396.0	318.8	112.1	4.9	0.0570
65	97	65.0	8.0	401.0	568.5	462.6	112.4	1.5	0.1120
65	97	65.0	10.0	489.0	708.4	565.8	112.9	0.3	0.1350
66	98	78.1	5.0	252.0	297.9	269.3	112.6	26.9	0.0760
66	98	78.1	7.0	342.0	454.8	380.3	112.7	2.9	0.1010
66	98	78.1	9.0	427.0	601.2	475.6	112.8	1.2	0.1240
67	99	21.4	6.0	188.0	273.2	227.4	114.2	3.9	0.0920
67	99	21.4	8.0	292.0	469.2	414.3	116.2	2.0	0.1220

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
67	99	21.4	10.0	478.0	735.8	633.7	119.1	1.0	0.1560
67	99	21.4	12.0	658.0	1015.5	885.9	120.9	0.3	0.1850
68	100	30.4	4.0	189.0	346.4	311.1	121.3	2.9	0.0780
68	100	30.4	6.0	385.0	618.2	529.3	123.7	1.2	0.1170
68	100	30.4	8.0	658.0	977.6	863.8	125.7	0.8	0.1550
68	100	30.4	10.0	925.0	1398.5	1220.0	126.4	0.6	0.1860
69	101	18.0	3.0	192.0	313.7	211.6	126.5	7.1	0.0700
69	101	18.0	5.0	444.0	588.1	543.7	129.1	1.4	0.1180
69	101	18.0	7.0	725.0	1066.5	997.0	130.8	1.1	0.1610
69	101	18.0	9.0	1035.0	1505.7	1461.0	131.9	0.2	0.2000
70	102	36.6	5.0	161.0	243.1	198.6	115.9	6.2	0.0820
70	102	36.6	7.0	290.0	440.5	355.5	117.6	2.5	0.1140
70	102	36.6	9.0	417.0	724.1	588.0	119.4	1.2	0.1450
70	102	36.6	11.0	622.0	1033.8	866.4	120.7	0.7	0.1740
71	103	15.7	6.0	163.0	376.4	266.5	115.3	3.5	0.0940
71	103	15.7	8.0	266.0	569.9	465.1	118.1	1.8	0.1280
71	103	15.7	10.0	421.0	771.1	679.5	119.2	1.1	0.1560
72	104	49.4	6.0	313.0	479.7	389.4	112.9	3.5	0.0890
72	104	49.4	8.0	430.0	633.9	546.3	114.2	1.5	0.1170
72	104	49.4	10.0	565.0	786.8	693.9	115.4	0.7	0.1430
73	105	55.5	6.0	248.0	333.2	304.5	106.9	6.9	0.0770
73	105	55.5	8.0	337.0	479.7	450.8	107.6	2.7	0.1000
73	105	55.5	10.0	432.0	637.8	585.5	108.7	1.9	0.1220
73	105	55.5	12.0	565.0	793.3	744.9	109.5	1.4	0.1430
74	106	22.3	6.0	298.0	457.5	341.0	110.3	5.3	0.0835
74	106	22.3	8.0	330.6	482.3	424.7	111.2	2.8	0.1084
74	106	22.3	10.0	390.7	559.4	452.2	111.5	1.6	0.1301
74	106	22.3	12.0	449.5	606.5	491.4	111.7	1.5	0.1500
75	107	13.7	4.0	342.0	530.6	446.9	130.9	5.8	0.1030
75	107	13.7	6.0	649.0	982.9	845.5	132.6	1.6	0.1510
75	107	13.7	8.0	1083.0	1500.4	1314.0	134.1	2.1	0.1960
76	108	34.4	3.0	319.0	449.6	202.5	131.8	38.3	0.0830
76	108	34.4	5.0	475.0	691.4	504.4	132.1	3.5	0.1290
76	108	34.4	7.0	641.0	952.8	778.7	131.5	0.9	0.1650
76	108	34.4	9.0	823.0	1208.9	1020.0	131.9	0.8	0.2000
77	109	53.5	4.0	292.0	382.9	250.9	123.2	28.9	0.0820
77	109	53.5	6.0	401.0	513.7	307.1	122.4	3.6	0.1130
77	109	53.5	8.0	450.0	677.0	448.2	122.6	1.2	0.1430
77	109	53.5	10.0	540.0	765.9	534.4	123.0	1.0	0.1710
78	110	39.9	4.0	261.3	297.9	----	124.0	54.5	0.0837
78	110	39.9	6.0	381.6	401.2	312.3	124.2	14.1	0.1184
78	110	39.9	8.0	467.8	522.8	398.6	124.4	1.9	0.1494
79	112	47.5	4.0	312.3	405.2	294.1	124.5	30.0	0.0849
79	112	47.5	6.0	413.0	590.8	389.4	125.5	4.5	0.1226
79	112	47.5	8.0	520.1	716.2	606.3	125.5	1.7	0.1537
79	112	47.5	10.0	620.7	843.0	709.6	125.3	1.1	0.1903
80	113	54.9	6.0	317.6	458.8	405.2	112.8	3.1	0.0887
80	113	54.9	8.0	524.0	707.0	611.5	114.3	1.3	0.1166
80	113	54.9	10.0	731.8	963.2	845.5	115.0	1.0	0.1410
81	114	25.7	5.0	299.2	386.9	367.2	120.1	2.7	0.0913
81	114	25.7	7.0	556.7	704.4	671.7	121.4	1.3	0.1247
81	114	25.7	9.0	757.8	1113.6	976.1	122.8	0.6	0.1569
82	115	40.0	5.0	381.6	497.9	312.3	120.7	4.5	0.0928
82	115	40.0	7.0	512.3	709.7	525.3			

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
82	115	40.0	9.0	737.0	947.6	757.8	122.2	1.0	0.1546
83	116	30.2	5.0	334.5	458.8	362.0	121.2	2.3	0.0940
83	116	30.2	7.0	525.3	743.7	623.3	122.7	1.2	0.1289
83	116	30.2	9.0	773.6	1104.4	963.2	124.4	1.1	0.1633
84	117	75.3	5.0	375.1	375.1	304.5	114.1	8.3	0.0784
84	117	75.3	7.0	480.8	567.2	462.6	114.1	1.5	0.1041
84	117	75.3	9.0	578.9	738.4	558.0	114.6	0.9	0.1288
84	117	75.3	11.0	585.5	931.9	682.2	114.9	0.3	0.1511
85	118	29.6	6.0	328.0	483.6	456.0	116.6	2.0	0.0974
85	118	29.6	8.0	550.1	----	708.2	118.9	0.8	0.1302
85	118	29.6	10.0	827.1	----	998.4	120.6	0.6	0.1608
86	119	28.8	6.0	348.9	562.0	450.8	118.2	2.1	0.1014
86	119	28.8	8.0	589.3	----	763.2	120.5	1.0	0.1354
86	119	28.8	10.0	898.9	----	1095.0	123.0	0.8	0.1704
87	120	27.0	6.0	364.6	524.1	454.7	120.5	1.4	0.1075
87	120	27.0	8.0	613.0	----	740.9	122.0	0.8	0.1406
87	120	27.0	10.0	870.4	----	1073.0	123.3	0.3	0.1717
88	121	8.8	2.0	201.2	253.6	172.5	130.3	15.5	0.0544
88	121	8.8	4.0	524.0	----	560.7	133.8	1.1	0.1121
88	121	8.8	6.0	943.4	----	1121.0	135.6	0.7	0.1641
89	122	15.8	2.0	181.7	303.0	----	131.5	60.0	0.0566
89	122	15.8	4.0	504.4	----	666.5	134.0	1.3	0.1128
89	122	15.8	6.0	1052.0	----	1287.0	136.0	0.7	0.1662
90	123	10.2	2.0	202.5	295.4	----	131.7	17.0	0.0569
90	123	10.2	4.0	588.2	691.4	614.2	134.4	0.8	0.1143
90	123	10.2	6.0	1052.0	----	1200.0	136.0	0.8	0.1662
91	124	28.8	7.0	359.3	602.5	535.5	115.9	1.3	0.1088
91	124	28.8	9.0	552.7	874.3	734.3	117.6	0.9	0.1383
91	124	28.8	11.0	904.2	1219.4	1103.0	119.8	0.2	0.1692
92	125	16.2	3.0	258.7	432.6	415.6	132.2	2.2	0.0832
92	125	16.2	5.0	622.0	----	875.6	133.3	1.2	0.1325
92	125	16.2	7.0	1120.0	----	1486.0	136.3	0.4	0.1881
93	140	37.3	7.0	311.1	413.0	343.8	116.2	1.1	0.1096
93	140	37.3	9.0	479.6	703.2	539.8	117.7	0.2	0.1386
93	140	37.3	11.0	769.6	----	841.6	119.6	0.0	0.1684
94	141	31.2	7.0	317.6	401.2	371.1	117.0	1.1	0.1117
94	141	31.2	9.0	500.5	----	606.3	119.2	0.8	0.1437
94	141	31.2	11.0	680.8	----	844.1	120.0	0.2	0.1700
95	143	37.2	8.0	356.8	495.3	418.1	111.5	1.2	0.1092
95	143	37.2	10.0	513.6	----	594.6	113.5	0.5	0.1362
95	143	37.2	12.0	620.7	----	808.9	114.9	0.2	0.1611
96	145	34.5	8.0	367.2	601.2	465.1	115.0	0.9	0.1135
96	145	34.5	10.0	594.6	----	678.2	116.2	0.7	0.1450
96	145	34.5	12.0	735.7	----	929.2	118.4	0.2	0.1743
97	147	40.6	5.0	232.6	341.1	273.1	112.4	3.8	0.0752
97	147	40.6	7.0	406.4	554.1	435.1	114.6	1.6	0.1054
97	147	40.6	9.0	576.2	867.8	714.8	116.7	0.3	0.1354
97	147	40.6	11.0	792.0	1190.7	1066.0	117.9	0.0	0.1619
98	149	44.6	3.0	111.1	148.9	119.0	113.2	26.1	0.0486
98	149	44.6	5.0	218.2	299.3	236.5	115.1	2.9	0.0804
98	149	44.6	7.0	329.4	488.8	419.5	116.2	1.5	0.1096
98	149	44.6	9.0	514.8	748.9	687.4	118.4	0.4	0.1409
99	152	70.9	6.0	371.1	463.9	338.5	114.6	6.4	0.0927
99	152	70.9	8.0	431.2	597.2	427.3	115.5	3.0	0.1199

S.NO.	SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
				7 DAY	28 DAY	7 DAY F.T.			
99	152	70.9	10.0	533.2	767.2	520.1	115.8	1.4	0.1436
100	155	60.0	5.0	175.1	232.6	211.6	109.2	23.5	0.0695
100	155	60.0	7.0	286.2	369.9	312.3	110.6	5.5	0.0958
100	155	60.0	9.0	355.5	533.3	445.7	111.6	1.1	0.1202
100	155	60.0	11.0	538.4	739.8	648.2	113.0	0.1	0.1448
101	159	11.3	3.0	146.3	254.8	----	125.7	56.9	0.0692
101	159	11.3	5.0	437.7	687.5	538.4	129.2	1.3	0.1173
101	159	11.3	7.0	622.0	1292.6	1087.0	130.7	0.3	0.1598
102	160	25.6	6.0	189.5	236.6	219.6	112.7	4.2	0.0885
102	160	25.6	8.0	355.5	431.3	394.7	115.4	2.4	0.1197
102	160	25.6	10.0	534.4	656.1	631.1	117.4	1.4	0.1491
103	166	40.2	5.0	372.4	571.1	350.1	121.6	25.8	0.0950
103	166	40.2	7.0	551.4	854.8	695.2	122.5	2.7	0.1282
103	166	40.2	9.0	773.6	1107.0	929.2	123.5	1.1	0.1596
104	167	68.1	5.0	278.4	334.6	262.6	102.5	12.8	0.0593
104	167	68.1	7.0	392.0	507.1	385.5	103.2	2.7	0.0807
104	167	68.1	9.0	476.9	680.9	500.5	104.0	0.9	0.1012
104	167	68.1	11.0	588.0	927.9	670.4	104.6	0.7	0.1202
105	203	21.0	3.0	359.3	475.7	429.9	128.8	3.6	0.0748
105	203	21.0	5.0	855.9	1120.0	1011.0	131.5	1.5	0.1255
105	203	21.0	7.0	1449.0	1934.0	1807.0	132.6	0.8	0.1685
106	204	37.1	5.0	228.7	----	----	110.9	--	0.0725
106	204	37.1	7.0	429.9	606.4	492.6	112.2	2.9	0.0995
106	204	37.1	9.0	641.6	937.1	807.6	114.1	0.8	0.1273
106	204	37.1	11.0	921.2	1425.9	1132.0	115.8	0.7	0.1543
107	206	71.8	6.0	352.9	495.3	436.4	107.3	8.6	0.0778
107	206	71.8	8.0	474.3	675.7	584.1	108.7	2.2	0.1023
107	206	71.8	10.0	615.5	971.8	807.6	109.0	1.0	0.1231
108	207	43.8	6.0	257.4	397.3	431.2	109.5	4.3	0.0820
108	207	43.8	8.0	444.3	674.4	660.0	111.2	1.6	0.1084
108	207	43.8	10.0	742.2	968.4	1061.0	112.7	0.6	0.1338
109	209	68.8	5.0	362.0	445.7	364.6	116.8	30.4	0.0839
109	209	68.8	7.0	491.4	614.3	491.4	116.8	3.8	0.1112
109	209	68.8	9.0	605.0	846.9	669.1	117.4	1.5	0.1376

APPENDIX C

SOIL CEMENT DESIGN DATA ARRANGED IN INCREASING ORDER OF GRADING MODULII

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
23	7.6	6.0	112.4	221.2	214.3	118.3	2.3	0.1016
23	7.6	8.0	181.7	415.6	423.4	120.6	1.5	0.1357
23	7.6	10.0	278.4	711.0	580.2	123.4	1.3	0.1720
121	8.8	2.0	201.2	253.6	172.5	130.3	15.5	0.0544
121	8.8	4.0	524.0	----	560.7	133.8	1.1	0.1121
121	8.8	6.0	943.4	----	1121.0	135.6	0.7	0.1641
123	10.2	2.0	202.5	295.0	----	131.7	17.0	0.0569
123	10.2	4.0	588.2	691.4	614.2	134.4	0.8	0.1143
123	10.2	6.0	1052.0	----	1200.0	136.0	0.8	0.1662
159	11.3	3.0	146.3	254.8	----	125.7	56.9	0.0582
159	11.3	5.0	437.7	687.5	538.4	129.2	1.3	0.1173
159	11.3	7.0	622.0	1292.6	1087.0	130.7	0.3	0.1598
77	11.6	6.0	316.0	410.4	159.4	114.3	36.4	0.0920
77	11.6	8.0	393.0	588.2	358.1	114.7	3.3	0.1180
77	11.6	10.0	545.0	792.0	548.8	115.5	1.0	0.1430
46	11.7	8.0	277.0	386.9	322.8	118.1	1.2	0.1280
46	11.7	10.0	466.6	786.8	611.5	123.3	0.6	0.1680
46	11.7	12.0	569.8	1090.0	956.6	123.4	0.4	0.1970
61	13.4	5.0	241.7	348.9	294.1	119.5	2.4	0.0890
61	13.4	7.0	504.4	778.9	581.6	122.0	0.9	0.1270
61	13.4	9.0	846.8	1116.2	1007.0	124.5	0.4	0.1650
107	13.7	4.0	342.0	530.6	446.9	130.9	5.8	0.1030
107	13.7	6.0	649.0	982.9	845.5	132.6	1.6	0.1510
107	13.7	8.0	1083.0	1500.4	1314.0	134.1	2.1	0.1960
55	14.3	6.0	264.0	418.2	264.0	119.4	6.2	0.1050
55	14.3	8.0	419.5	722.7	544.9	122.2	0.5	0.1420
55	14.3	10.0	603.7	1100.5	829.9	123.5	0.4	0.1730
80	14.7	6.0	164.0	281.0	185.6	113.2	3.7	0.0900
80	14.7	8.0	280.0	546.3	393.3	115.6	1.8	0.1210
80	14.7	10.0	453.0	795.9	688.7	117.7	0.6	0.1510
103	15.7	6.0	163.0	376.4	266.5	115.3	3.5	0.0940
103	15.7	8.0	266.0	569.9	465.1	118.1	1.8	0.1280
103	15.7	10.0	421.0	771.1	679.5	119.2	1.1	0.1560
29	15.8	7.0	94.1	364.7	164.6	120.1	13.3	0.1206
29	15.8	9.0	159.4	627.4	279.7	122.5	1.5	0.1557
29	15.8	11.0	256.2	938.4	362.0	124.0	1.9	0.1869
122	15.8	2.0	181.7	303.0	----	131.5	60.0	0.0566
122	15.8	4.0	504.4	----	666.5	134.0	1.3	0.1128
122	15.8	6.0	1052.0	----	1287.0	136.0	0.7	0.1662
125	16.2	3.0	258.7	432.6	415.6	132.2	2.2	0.0832
125	16.2	5.0	622.0	----	875.6	133.3	1.2	0.1325
125	16.2	7.0	1120.0	----	1486.0	136.3	0.4	0.1881
101	18.0	3.0	192.0	313.7	211.6	126.5	7.1	0.0700
101	18.0	5.0	444.0	588.1	543.7	129.1	1.4	0.1180
101	18.0	7.0	725.0	1066.5	997.0	130.8	1.1	0.1610
101	18.0	9.0	1035.0	1505.7	1461.0	131.9	0.2	0.2000
89	18.3	6.0	187.0	240.5	234.0	112.0	5.8	0.0870
89	18.3	8.0	334.0	461.4	403.8	114.3	2.1	0.1170
89	18.3	10.0	489.0	823.4	704.4	116.1	0.8	0.1450
203	21.0	3.0	359.3	475.7	429.9	128.8	3.6	0.0748
203	21.0	5.0	855.9	1120.0	1011.0	131.5	1.5	0.1255
203	21.0	7.0	1449.0	1934.0	1807.0	132.6	0.8	0.1686
64	21.1	5.0	261.0	354.1	287.5	116.2	4.1	0.0830
64	21.1	7.0	522.8	648.2	534.4	119.7	1.4	0.1200

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
64	21.1	9.0	738.2	929.3	755.3	120.8	1.1	0.1500
64	21.1	11.0	1061.0	1280.8	1149.0	122.5	0.4	0.1810
62	21.3	4.0	228.0	316.3	267.9	120.1	4.0	0.0750
62	21.3	6.0	543.7	691.4	622.0	123.7	1.2	0.1170
62	21.3	8.0	918.7	1131.9	1046.0	126.1	0.7	0.1570
62	21.3	10.0	1261.0	1538.3	1293.0	127.6	0.3	0.1920
99	21.4	6.0	188.0	273.2	227.4	114.2	3.9	0.0920
99	21.4	8.0	292.0	469.2	414.3	116.2	2.0	0.1220
99	21.4	10.0	478.0	735.8	633.7	119.1	1.0	0.1560
99	21.4	12.0	658.0	1015.5	885.9	120.9	0.3	0.1850
106	22.3	6.0	298.0	457.5	341.0	110.3	5.3	0.0835
106	22.3	8.0	330.6	482.3	424.7	111.2	2.8	0.1084
106	22.3	10.0	390.7	559.4	452.2	111.5	1.6	0.1301
106	22.3	12.0	449.5	606.5	491.4	111.7	1.5	0.1500
69	22.5	7.0	457.0	585.5	411.6	118.3	2.5	0.1160
69	22.5	9.0	677.0	893.9	717.4	118.9	0.8	0.1430
69	22.5	11.0	815.0	1164.5	879.4	118.8	0.4	0.1660
49	22.9	5.0	120.2	196.0	107.2	114.8	32.1	0.0800
49	22.9	7.0	264.0	401.2	270.5	117.5	4.3	0.1130
49	22.9	9.0	448.2	605.1	512.3	119.9	2.3	0.1470
91	23.2	6.0	107.0	214.4	177.7	111.5	4.6	0.0860
91	23.2	8.0	222.0	390.8	304.5	113.5	2.7	0.1150
91	23.2	10.0	377.0	546.3	480.8	115.9	1.6	0.1440
160	25.6	6.0	189.5	236.6	219.6	112.7	4.2	0.0885
160	25.6	8.0	355.5	431.3	394.7	115.4	2.4	0.1197
160	25.6	10.0	534.4	656.1	631.1	117.4	1.4	0.1491
32	25.7	7.0	113.7	269.2	135.9	111.1	8.2	0.0970
32	25.7	9.0	185.6	444.4	214.3	113.4	4.5	0.1250
32	25.7	11.0	282.3	670.5	380.3	115.0	1.0	0.1520
114	25.7	5.0	299.2	386.9	367.2	120.1	2.7	0.0913
114	25.7	7.0	556.7	704.4	671.7	121.4	1.3	0.1247
114	25.7	9.0	757.8	1113.6	976.1	122.8	0.6	0.1569
35	26.9	7.0	406.4	562.0	512.3	113.9	1.3	0.1040
35	26.9	9.0	603.7	818.2	729.1	115.1	1.2	0.1310
35	26.9	11.0	899.1	1223.4	1030.0	116.4	0.5	0.1570
120	27.0	6.0	364.6	524.1	454.7	120.5	1.4	0.1075
120	27.0	8.0	613.0	----	740.9	122.0	0.8	0.1406
120	27.0	10.0	870.4	----	1073.0	123.3	0.3	0.1717
96	28.0	4.0	331.0	446.9	223.5	124.5	27.4	0.0850
96	28.0	6.0	498.0	624.7	433.8	125.7	3.1	0.1240
96	28.0	8.0	622.0	814.2	695.2	125.7	1.2	0.1550
96	28.0	10.0	776.0	1035.1	824.5	126.0	1.2	0.1850
22	28.8	4.0	304.5	373.8	279.7	127.7	2.2	0.0930
22	28.8	6.0	556.7	793.3	662.5	128.7	0.9	0.1339
22	28.8	8.0	965.6	1250.8	1046.0	130.3	0.4	0.1746
119	28.8	6.0	348.9	562.0	450.8	118.2	2.1	0.1014
119	28.8	8.0	589.3	----	763.2	120.5	1.0	0.1354
119	28.8	10.0	898.9	----	1095.0	123.0	0.8	0.1704
124	28.8	7.0	359.3	602.5	535.5	115.9	1.3	0.1098
124	28.8	9.0	552.7	874.3	734.3	117.6	0.9	0.1383
124	28.8	11.0	904.2	1219.4	1103.0	119.8	0.2	0.1692
118	29.6	6.0	328.0	483.6	456.0	116.6	2.0	0.0974
118	29.6	8.0	550.1	----	708.2	118.9	0.8	0.1302
118	29.6	10.0	827.1					

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
78	30.0	4.0	299.0	414.3	329.4	125.6	2.4	0.0880
78	30.0	6.0	555.0	751.5	675.6	127.5	1.2	0.1300
78	30.0	8.0	939.0	1323.9	1069.0	128.6	0.7	0.1680
116	30.2	5.0	334.5	458.8	362.0	121.2	2.3	0.0940
116	30.2	7.0	525.3	743.7	623.3	122.7	1.2	0.1289
116	30.2	9.0	773.6	1104.4	963.2	124.4	1.1	0.1633
72	30.4	5.0	249.0	286.2	286.2	114.6	3.6	0.0790
72	30.4	7.0	450.0	590.8	541.1	117.5	1.5	0.1130
72	30.4	9.0	703.0	961.9	837.7	119.1	0.5	0.1440
72	30.4	11.0	978.0	1347.5	1212.0	120.7	0.0	0.1740
100	30.4	4.0	189.0	346.4	311.1	121.3	2.9	0.0780
100	30.4	6.0	385.0	618.2	529.3	123.7	1.2	0.1170
100	30.4	8.0	658.0	977.6	863.8	125.7	0.8	0.1550
100	30.4	10.0	925.0	1398.5	1220.0	126.4	0.6	0.1860
141	31.2	7.0	317.6	401.2	371.1	117.0	1.1	0.1117
141	31.2	9.0	500.5	-----	606.3	119.2	0.8	0.1437
141	31.2	11.0	680.8	-----	844.1	120.0	0.2	0.1700
82	32.0	5.0	447.0	567.2	471.8	125.2	2.4	0.1050
82	32.0	7.0	731.0	931.9	748.9	126.6	1.0	0.1440
82	32.0	9.0	961.0	1224.7	1120.0	126.5	0.5	0.1730
47	32.8	6.0	340.9	581.6	457.4	122.7	1.2	0.1140
47	32.8	8.0	584.1	965.9	740.9	124.7	0.6	0.1510
47	32.8	10.0	899.1	1246.9	1167.0	126.2	0.0	0.1850
63	32.8	7.0	304.1	515.0	416.9	115.9	1.9	0.1090
63	32.8	9.0	594.6	862.6	700.4	118.4	1.1	0.1410
63	32.8	11.0	798.4	1240.3	1013.0	119.3	0.4	0.1680
93	33.2	4.0	207.0	354.2	166.0	121.7	39.9	0.0790
93	33.2	6.0	370.0	612.9	409.0	123.1	1.7	0.1160
93	33.2	8.0	514.0	875.7	620.7	124.2	0.9	0.1490
93	33.2	10.0	698.0	1271.7	931.7	124.8	0.5	0.1790
95	33.8	4.0	172.0	202.6	130.7	102.9	29.1	0.0490
95	33.8	6.0	288.0	317.6	206.5	104.1	11.8	0.0720
95	33.8	8.0	337.0	414.3	275.7	104.4	1.7	0.0930
95	33.8	10.0	387.0	488.8	369.8	104.4	0.6	0.1110
108	34.4	3.0	319.0	449.6	202.5	131.8	38.3	0.0930
108	34.4	5.0	475.0	691.4	504.4	132.1	3.5	0.1290
108	34.4	7.0	641.0	952.8	770.7	131.5	0.9	0.1650
108	34.4	9.0	823.0	1208.9	1020.0	131.9	0.8	0.2000
145	34.5	8.0	367.2	601.2	465.1	115.0	0.9	0.1185
145	34.5	10.0	594.6	-----	678.2	116.2	0.7	0.1450
145	34.5	12.0	735.7	-----	929.2	118.4	0.2	0.1743
53	34.8	8.0	371.1	598.6	441.7	113.2	2.3	0.1140
53	34.8	10.0	525.3	858.7	675.6	114.8	1.2	0.1400
53	34.8	12.0	611.5	1070.4	981.3	114.9	0.0	0.1620
71	36.0	5.0	352.0	407.8	176.4	117.7	31.9	0.0860
71	36.0	7.0	473.0	593.4	419.5	118.5	3.2	0.1160
71	36.0	9.0	662.0	807.7	700.4	119.3	0.2	0.1450
41	36.1	3.0	317.6	475.7	----	133.1	21.8	0.0856
41	36.1	5.0	497.8	683.6	530.6	133.6	2.5	0.1337
41	36.1	7.0	721.3	980.3	773.6	133.5	1.1	0.1730
75	36.1	5.0	292.0	439.1	304.1	119.7	3.9	0.0910
75	36.1	7.0	464.0	708.4	607.7	120.9	1.7	0.1240
75	36.1	9.0	698.0	961.6	896.4	121.6	1.0	0.1530
102	36.6	5.0	161.0	243.1	198.6	115.9	6.2	0.0820

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
102	36.6	7.0	290.0	440.5	355.5	117.6	2.5	0.1140
102	36.6	9.0	417.0	724.1	588.0	119.4	1.2	0.1450
102	36.6	11.0	622.0	1033.8	866.4	120.7	0.7	0.1740
204	37.1	5.0	228.7	----	----	110.9	--	0.0725
204	37.1	7.0	429.9	606.4	492.6	112.2	2.9	0.0995
204	37.1	9.0	641.6	937.1	807.6	114.1	0.8	0.1273
204	37.1	11.0	921.2	1425.9	1132.0	115.8	0.7	0.1543
28	37.2	6.0	128.0	267.9	211.6	112.6	4.0	0.0883
28	37.2	8.0	215.6	445.7	287.5	114.2	1.8	0.1163
28	37.2	10.0	274.5	675.7	440.3	114.9	1.1	0.1406
143	37.2	8.0	356.8	495.3	418.1	111.5	1.2	0.1092
143	37.2	10.0	513.6	----	594.6	113.5	0.5	0.1362
143	37.2	12.0	620.7	----	808.9	114.9	0.2	0.1611
140	37.3	7.0	311.1	413.0	343.8	116.2	1.1	0.1096
140	37.3	9.0	479.6	703.2	539.8	117.7	0.2	0.1356
140	37.3	11.0	769.6	----	841.5	119.6	0.0	0.1654
81	37.8	5.0	331.0	459.0	333.2	115.3	2.5	0.0970
81	37.8	7.0	504.0	709.7	569.8	119.3	1.1	0.1195
81	37.8	9.0	663.0	950.2	784.1	119.8	0.8	0.1460
43	39.6	7.0	284.9	432.6	307.1	113.6	2.8	0.1030
43	39.6	9.0	422.1	592.0	473.1	115.8	1.5	0.1330
43	39.6	11.0	625.9	938.4	746.1	117.1	0.6	0.1590
110	39.9	4.0	261.3	297.9	----	124.0	54.5	0.0837
110	39.9	6.0	381.6	401.2	312.3	124.2	14.1	0.1184
110	39.9	8.0	467.8	522.8	398.6	124.4	1.9	0.1494
115	40.0	5.0	381.6	497.9	312.3	120.7	4.5	0.0928
115	40.0	7.0	512.3	709.7	525.3	121.3	1.8	0.1244
115	40.0	9.0	737.0	947.6	757.8	122.2	1.0	0.1546
92	40.1	8.0	243.0	388.1	292.7	114.1	1.5	0.1160
92	40.1	10.0	368.0	612.9	407.8	115.7	0.9	0.1440
92	40.1	12.0	466.0	802.5	650.7	116.5	0.4	0.1685
60	40.2	8.0	671.7	810.3	760.5	118.9	1.1	0.1310
60	40.2	10.0	867.8	1083.5	942.1	120.2	0.5	0.1600
60	40.2	12.0	1144.0	1373.7	1250.0	120.4	0.2	0.1830
166	40.2	5.0	372.4	571.1	350.1	121.6	25.8	0.0950
166	40.2	7.0	551.4	854.8	695.2	122.5	2.7	0.1282
166	40.2	9.0	773.6	1107.0	929.2	123.5	1.1	0.1595
87	40.4	5.0	383.0	513.6	409.0	121.2	3.6	0.0940
87	40.4	7.0	587.0	794.7	682.2	122.4	1.2	0.1230
87	40.4	9.0	826.0	1071.7	931.7	123.2	0.7	0.1600
147	40.6	5.0	232.6	341.1	273.1	112.4	3.8	0.0752
147	40.6	7.0	406.4	554.1	435.1	114.6	1.6	0.1054
147	40.6	9.0	576.2	867.8	714.8	116.7	0.3	0.1354
147	40.6	11.0	792.0	1190.7	1066.0	117.9	0.0	0.1619
67	40.8	5.0	249.0	342.4	288.8	113.3	4.1	0.0770
67	40.8	7.0	441.0	521.5	511.0	115.7	1.8	0.1080
67	40.8	9.0	616.0	798.6	761.9	117.3	0.6	0.1380
67	40.8	11.0	858.0	1073.0	1127.0	118.9	0.3	0.1660
88	41.1	5.0	257.0	393.4	312.3	118.6	8.4	0.0880
88	41.1	7.0	402.0	615.6	535.8	120.3	1.7	0.1220
88	41.1	9.0	583.0	841.7	722.6	120.9	1.1	0.1500
83	41.6	4.0	275.0	350.3	248.3	119.1	--	0.0730
83	41.6	6.0	447.0	613.0	462.6	122.1	2.7	0.1130
83	41.6	8.0	672.0	848.0	649.5	123.5	1.3	0.1470

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
83	41.6	10.0	884.0	1080.0	913.5	124.4	0.8	0.1770
57	42.0	6.0	244.3	377.7	311.1	104.8	4.0	0.0730
57	42.0	8.0	395.9	564.6	492.6	106.6	1.7	0.0980
57	42.0	10.0	573.7	784.2	716.1	108.3	0.7	0.1210
74	42.1	6.0	351.0	497.9	471.8	113.8	2.6	0.0910
74	42.1	8.0	501.0	771.1	726.6	115.3	0.9	0.1200
74	42.1	10.0	666.0	1039.0	920.0	116.6	0.3	0.1470
74	42.1	12.0	812.0	1368.4	1218.0	117.5	0.0	0.1710
76	42.5	4.0	290.0	414.3	104.6	119.6	50.1	0.0740
76	42.5	6.0	477.0	632.6	406.4	121.5	5.3	0.1110
76	42.5	8.0	628.0	837.8	623.3	122.1	1.1	0.1420
76	42.5	10.0	762.0	1027.3	819.4	122.3	0.5	0.1680
48	43.2	6.0	294.1	386.8	337.1	113.2	2.5	0.0900
48	43.2	8.0	435.1	601.2	507.0	115.3	1.2	0.1200
48	43.2	10.0	582.8	801.2	705.7	115.9	0.4	0.1440
34	43.4	7.0	418.1	603.8	543.7	116.8	2.0	0.1090
34	43.4	9.0	614.2	886.2	743.5	117.8	0.6	0.1380
34	43.4	11.0	818.1	1224.7	1078.0	119.3	0.6	0.1660
207	43.8	6.0	257.4	397.3	431.2	109.5	4.3	0.0820
207	43.8	8.0	444.3	674.4	660.0	111.2	1.6	0.1084
207	43.8	10.0	742.2	968.4	1061.0	112.7	0.6	0.1338
79	44.2	5.0	306.0	372.5	317.6	114.2	5.2	0.0790
79	44.2	7.0	487.0	586.8	504.4	115.8	1.6	0.1090
79	44.2	9.0	695.0	873.1	701.8	117.4	0.4	0.1380
79	44.2	11.0	885.0	1151.5	883.3	118.3	0.0	0.1640
56	44.6	7.0	710.9	926.7	782.7	124.4	1.1	0.1350
56	44.6	9.0	968.3	1300.5	1072.0	125.5	0.7	0.1690
56	44.6	11.0	1250.0	1701.7	1525.0	126.7	0.1	0.2010
149	44.6	3.0	111.1	148.9	119.0	113.2	26.1	0.0486
149	44.6	5.0	218.2	299.3	236.5	115.1	2.9	0.0804
149	44.6	7.0	329.4	488.8	419.5	116.2	1.5	0.1096
149	44.6	9.0	514.8	748.9	687.4	118.4	0.4	0.1409
54	45.2	8.0	284.9	529.3	399.8	102.7	1.1	0.0890
54	45.2	10.0	401.2	758.0	590.6	104.1	0.3	0.1220
54	45.2	12.0	568.4	933.1	803.7	105.6	0.0	0.1400
36	45.6	6.0	208.8	368.6	363.9	111.3	2.0	0.0860
36	45.6	8.0	443.0	571.1	558.0	111.9	1.0	0.1100
36	45.6	10.0	640.3	777.7	772.3	112.7	1.0	0.1340
84	45.6	4.0	292.0	359.4	321.5	119.0	——	0.0730
84	45.6	6.0	460.0	562.0	530.6	120.4	2.1	0.1080
84	45.6	8.0	670.0	844.3	803.7	121.3	1.0	0.1390
84	45.6	10.0	854.0	1120.0	1010.0	121.9	0.4	0.1670
65	47.2	5.0	299.0	435.2	367.2	116.3	2.5	0.0830
65	47.2	7.0	505.0	675.7	606.3	117.1	1.3	0.1120
65	47.2	9.0	695.0	908.4	866.4	117.7	0.7	0.1390
65	47.2	11.0	956.0	1180.2	1091.0	118.3	0.1	0.1640
50	47.3	8.0	355.5	----	445.7	109.2	1.9	0.1040
50	47.3	10.0	524.0	----	660.0	111.5	1.5	0.1300
50	47.3	12.0	730.5	----	942.1	113.0	0.3	0.1550
112	47.5	4.0	312.3	405.2	294.1	124.5	30.9	0.0849
112	47.5	6.0	418.0	590.8	389.4	125.5	4.5	0.1226
112	47.5	8.0	520.1	716.2	606.3	125.5	1.7	0.1537
112	47.5	10.0	670.7	843.0	709.6	125.3	1.1	0.1803
70	47.8	5.0	283.0	409.0	333.2	119.2	2.5	0.0870

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
70	47.8	7.0	512.0	730.6	615.5	120.7	0.7	0.1230
70	47.8	9.0	701.0	1088.7	921.2	121.4	0.4	0.1520
70	47.8	11.0	1060.0	1407.6	1263.0	122.7	0.1	0.1820
94	48.0	4.0	210.0	249.6	128.0	107.4	38.8	0.0540
94	48.0	6.0	289.0	397.3	202.5	108.1	33.2	0.0790
94	48.0	8.0	371.0	526.7	334.5	108.5	25.3	0.1020
94	48.0	10.0	484.0	666.6	375.1	109.6	1.5	0.1250
94	48.0	12.0	556.0	761.9	520.1	110.0	0.9	0.1450
33	49.2	8.0	339.8	550.2	497.8	109.8	0.2	0.1030
33	49.2	10.0	495.2	758.1	744.9	110.3	0.3	0.1270
33	49.2	12.0	598.5	1091.3	977.4	111.5	0.4	0.1500
90	49.4	5.0	247.0	331.9	301.8	120.2	4.1	0.0920
90	49.4	7.0	387.0	533.3	494.0	120.7	2.0	0.1230
90	49.4	9.0	565.0	692.7	718.8	121.5	1.1	0.1530
104	49.4	6.0	313.0	479.7	389.4	112.9	3.5	0.0890
104	49.4	8.0	430.0	633.9	546.3	114.2	1.5	0.1170
104	49.4	10.0	565.0	786.8	693.9	115.4	0.7	0.1430
44	51.8	6.0	162.0	307.1	224.8	110.6	3.8	0.0840
44	51.8	8.0	277.0	483.6	390.7	111.9	1.8	0.1100
44	51.8	10.0	409.0	701.9	661.3	113.6	0.5	0.1370
109	53.5	4.0	292.0	382.9	250.9	123.2	28.9	0.0820
109	53.5	6.0	401.0	513.7	307.1	122.4	3.6	0.1130
109	53.5	8.0	450.0	677.0	448.2	122.6	1.2	0.1430
109	53.5	10.0	540.0	765.9	534.4	123.0	1.0	0.1710
113	54.9	6.0	317.6	458.8	405.2	113.8	3.1	0.0887
113	54.9	8.0	524.0	707.0	611.5	114.3	1.3	0.1166
113	54.9	10.0	731.8	963.2	845.5	115.0	1.0	0.1419
86	55.4	7.0	305.0	524.1	405.2	113.8	2.6	0.1040
86	55.4	9.0	511.0	720.1	551.4	114.5	1.4	0.1290
86	55.4	11.0	610.0	850.9	696.5	115.6	0.5	0.1540
105	55.5	6.0	248.0	333.2	304.5	109.9	6.9	0.0770
105	55.5	8.0	337.0	479.7	450.8	107.6	2.7	0.1000
105	55.5	10.0	432.0	637.8	585.5	108.7	1.9	0.1220
105	55.5	12.0	565.0	793.3	744.9	109.5	1.4	0.1430
66	57.0	4.0	351.6	428.7	248.3	121.2	24.9	0.0780
66	57.0	6.0	501.0	648.2	520.1	121.7	1.4	0.1110
66	57.0	8.0	679.0	918.8	768.5	122.2	0.7	0.1420
68	57.7	5.0	332.0	462.7	264.0	120.3	20.3	0.0920
68	57.7	7.0	473.0	640.4	503.1	121.0	1.0	0.1240
68	57.7	9.0	619.0	814.3	674.2	121.3	0.3	0.1520
45	58.2	6.0	344.9	478.4	282.3	118.2	15.3	0.1020
45	58.2	8.0	470.4	696.6	577.6	119.4	1.7	0.1320
45	58.2	10.0	590.6	978.9	777.5	119.9	1.1	0.1590
155	60.0	5.0	175.1	232.6	211.6	109.2	23.5	0.0695
155	60.0	7.0	296.2	369.9	312.3	110.6	5.5	0.0958
155	60.0	9.0	355.5	533.3	445.7	111.6	1.1	0.1202
155	60.0	11.0	538.4	739.8	648.2	113.0	0.1	0.1448
30	61.6	7.0	311.1	486.2	393.3	113.2	2.5	0.1050
30	61.6	9.0	439.0	653.5	586.6	114.8	1.2	0.1300
30	61.6	11.0	625.9	802.5	750.1	115.4	0.9	0.1530
42	61.6	8.0	380.3	565.9	413.0	112.3	1.8	0.1110
42	61.6	10.0	544.9	721.4	652.1	113.7	0.9	0.1370

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
97	65.0	8.0	401.0	568.5	462.6	112.4	1.5	0.1120
97	65.0	10.0	489.0	708.4	565.8	112.9	0.3	0.1350
167	68.1	5.0	278.4	334.6	262.6	109.5	12.8	0.0593
167	68.1	7.0	392.0	507.1	385.5	103.2	2.7	0.0807
167	68.1	9.0	476.9	680.9	500.5	104.0	0.9	0.1012
167	68.1	11.0	588.0	927.9	670.4	104.6	0.7	0.1202
209	68.8	5.0	362.0	445.7	364.6	116.8	30.4	0.0839
209	68.8	7.0	491.4	614.3	491.4	116.8	3.8	0.1112
209	68.8	9.0	605.0	846.9	669.1	117.4	1.5	0.1376
152	70.9	6.0	371.1	463.9	338.5	114.6	6.4	0.0927
152	70.9	8.0	431.2	597.2	427.3	115.5	3.0	0.1199
152	70.9	10.0	533.2	767.2	520.1	115.8	1.4	0.1436
206	71.8	6.0	352.9	495.3	436.4	107.3	8.6	0.0778
206	71.8	8.0	474.3	675.7	584.1	109.7	2.2	0.1023
206	71.8	10.0	615.5	871.8	807.6	109.0	1.0	0.1231
40	72.9	5.0	219.6	303.2	228.7	106.1	4.2	0.0670
40	72.9	7.0	331.9	426.1	373.8	109.1	2.8	0.0920
40	72.9	9.0	543.7	599.9	554.2	110.2	1.0	0.1170
117	75.3	5.0	375.1	375.1	304.5	114.1	8.3	0.0784
117	75.3	7.0	480.8	567.2	462.6	114.1	1.5	0.1041
117	75.3	9.0	578.9	738.4	558.0	114.6	0.9	0.1288
117	75.3	11.0	585.5	931.9	682.2	114.9	0.3	0.1511
39	77.4	5.0	257.4	385.9	----	111.5	25.7	0.0740
39	77.4	7.0	365.9	501.9	354.2	112.3	2.4	0.1000
39	77.4	9.0	512.3	628.7	573.7	113.0	1.3	0.1240
98	78.1	5.0	252.0	297.9	269.3	112.6	26.9	0.0760
98	78.1	7.0	342.0	454.8	380.3	113.7	2.9	0.1010
98	78.1	9.0	427.0	601.2	475.6	112.8	1.2	0.1240
85	80.0	6.0	297.0	338.5	283.6	109.7	2.5	0.0820
85	80.0	8.0	392.0	559.4	467.8	110.5	1.5	0.1070
85	80.0	10.0	501.0	717.5	654.6	111.1	0.9	0.1290
38	94.9	7.0	330.6	424.8	347.6	105.5	2.3	0.0850
38	94.9	9.0	474.3	526.7	466.6	106.0	2.6	0.1060
38	94.9	11.0	637.7	704.5	631.1	106.6	1.2	0.1260

APPENDIX D

A AND N VALUES IN FERET'S STRENGTH EQUATION

BASED ON 7-DAY STRENGTHS

CALCULATION OF A & N VALUES IN

FERET'S STRENGTH EQUATION BASED ON 7-DAY STRENGTHS

Sl. No.	G.M. Range	Sand Source No.	A	N
1	7.6 - 12.5	23	5,716	1.721
2		46	9,255	1.699
3		77	2,231	.807
4		121	11,358	1.390
5		123	16,525	1.536
6		159	16,137	1.736
1	12.6 - 17.5	29	11,323	2.272
2		55	10,687	1.646
3		61	33,194	2.033
4		80	17,928	1.955
5		103	12,591	1.848
6		107	19,447	1.783
7		122	18,211	1.613
8		125	23,065	1.801
1	17.6 - 22.5	62	26,654	1.830
2		64	22,176	1.781
3		69	15,580	1.631
4		89	18,840	1.886
5		99	13,705	1.808
6		101	13,586	1.602
7		106	1,652	.702
8		203	30,248	1.712
1	22.6 - 27.5	32	12,380	2.015
2		35	30,793	1.918
3		49	29,111	2.169
4		91	43,516	2.447
5		114	19,369	1.732
6		120	23,358	1.863
7		160	24,002	1.993
1	27.6 - 32.5	22	22,632	1.822
2		72	20,310	1.738
3		78	20,871	1.755
4		82	14,260	1.536

Sl. No.	G.M. Range	Sand Source No.	A	N
5		96	4,770	1.083
6		100	19,915	1.829
7		116	11,881	1.513
8		118	23,757	1.841
9		119	22,598	1.823
10		124	35,538	2.081
11		141	16,947	1.815
1	32.6 - 37.5	28	7,298	1.658
2		41	5,254	1.148
3		47	23,734	1.948
4		53	8,574	1.439
5		63	16,335	1.692
6		71	6,511	1.197
7		75	12,176	1.559
8		93	8,625	1.469
9		95	3,490	.983
10		102	13,129	1.762
11		108	4,459	1.070
12		140	31,698	2.099
13		143	8,693	1.435
14		145	18,120	1.810
15		204	28,157	1.828
1	37.6 - 42.5	43	16,489	1.794
2		57	20,083	1.686
3		60	16,024	1.569
4		67	14,693	1.587
5		74	8,575	1.335
6		81	8,767	1.342
7		83	8,433	1.319
8		87	11,502	1.441
9		88	10,215	1.521
10		92	11,072	1.768
11		110	3,241	1.012
12		115	7,697	1.274
13		147	13,835	1.577
14		166	10,045	1.403
1	42.6 - 47.5	34	14,451	1.597
2		36	23,401	1.793
3		48	9,515	1.447
4		50	20,904	1.802

Sl. No.	G.M. Range	Sand Source No.	A	N
5		54	9,226	1.449
6		56	12,077	1.416
7		65	19,781	1.683
8		76	6,258	1.177
9		79	12,430	1.460
10		84	8,725	1.305
11		149	7,941	1.419
12		207	55,057	2.152
1	47.6 - 52.5	33	10,909	1.518
2		44	17,921	1.897
3		70	20,047	1.750
4		90	11,776	1.622
5		94	3,776	.999
6		104	6,253	1.241
7		112	2,865	.907
1	52.6 - 57.5	66	5,648	1.092
2		86	18,181	1.788
3		105	7,019	1.311
4		109	2,231	.807
5		113	25,103	1.803
1	57.6 - 62.5	30	19,581	1.845
2		42	9,419	1.453
3		45	5,472	1.211
4		68	6,320	1.237
5		155	8,676	1.466
1	62.6 - 67.5	65	2,618	.845
1	67.6 - 72.5	152	2,513	.811
2		167	5,269	1.039
3		206	7,529	1.202
4		209	4,789	1.041
1	72.6 - 77.5	39	7,950	1.323
2		40	16,530	1.609
3		117	2,382	0.716
1	77.6 - 82.5	85	5,183	1.147
2		98	4,043	1.077
1	92.6 - 97.5	38	20,112	1.667

APPENDIX E

GRADATIONS OF THE SANDS

GRADATIONS OF THE SANDS USED IN SOIL-CEMENT BASES IN ALBERTA

Sl. No.	Sand Source No.	Percent passing each sieve									% Less than .05 mm	G. M.
		3/4"	3/8"	4	8	16	30	50	100	200		
1.	22	100	-	85	79	71	53	30	16	13.2	Nil	28.8
2.	23	-	-	89	71	45	17	3.6	1.0	0.4	0.2	7.6
3.	28	100	-	98	97.7	97.1	92.4	56.4	17.0	12.0	10.0	37.2
4.	29	-	-	96	92	83	41	12	4.8	3.2	3.0	15.8
5.	30	-	-	100	99.9	99.8	99	92	55	21	7.0	61.6
6.	32	-	-	100	99.8	99.5	93	41	6.4	3.1	3.0	25.7
7.	33	-	-	-	100	99.9	99.8	97	44.0	5.6	5.0	49.2
8.	34	-	-	-	100	99.8	99.0	84	36.0	5.8	5.0	43.4
9.	35	-	-	-	98	96	89	51	8	2	Nil	26.9
10.	36	-	-	100	99.7	99.5	98	74	39	8.5	5.0	45.6
11.	38	-	-	100	99.9	99.8	99.7	99.6	93	52	25.0	94.9
12.	39	100	-	98.4	98.3	98.2	97.9	92.0	65.0	41.0	30.0	77.4
13.	40	100	-	99.3	99.1	99.0	98.8	97.0	68.0	31.0	20.0	72.9
14.	41	95	-	62.0	54.0	47.0	41.0	35.0	28.0	22.0	17.0	36.1
15.	42	-	-	-	100	99.9	99.7	95.0	63.0	16.0	5.0	61.6
16.	43	-	-	100	99.9	99.8	98.0	76.0	22.0	6.5	3.0	39.6
17.	44	-	-	100	99.9	99.8	99.7	92.0	36.0	15.0	8.0	51.8
18.	45	-	-	100	99.3	98.5	96.0	86.0	46.0	22.0	16.0	58.2
19.	46	100	-	97	94.0	86.0	36.0	5.8	1.1	0.5	Nil	11.7
20.	47	100	-	94	91.0	86.0	77.0	51.0	19.0	8.3	5.0	32.8
21.	48	-	-	-	100.0	99.8	99.0	75.0	25.0	11.5	10.0	43.2
22.	49	100	-	93	87.0	84.0	67.0	28.0	9.0	5.0	5.0	22.9
23.	50	-	-	-	100.0	99.8	99.0	80.0	13.0	1.6	Nil	47.3
24.	53	-	-	-	-	100.0	99.0	80.0	17.0	1.0	Nil	34.8
25.	54	-	-	-	-	-	100.0	95.0	40.0	2.0	Nil	45.2
26.	55	95	-	88.0	85.0	84.0	50.0	10.0	4.0	1.0	Nil	14.3
27.	56	-	-	100.0	98.0	95.0	87.0	65.0	35.0	13.0	8.0	44.6
28.	57	-	-	-	-	100.0	98.0	90.0	17.0	10.0	8.0	42.0
29.	60	-	-	-	-	100.0	99.0	78.0	27.0	5.0	1.0	40.2
30.	61	95.0	-	78.0	71.0	64.0	46.0	13.0	2.3	0.8	Nil	13.4
31.	62	100.0	-	94.0	89.0	83.0	66.0	31.0	8.0	2.4	2.0	21.3
32.	63	-	-	-	99.0	98.0	91.0	58.0	14.0	6.0	5.0	32.8
33.	64	-	-	100.0	98.0	95.0	93.0	28.0	2.0	1.2	Nil	21.1
34.	65	-	-	-	-	100.0	99.0	79.0	36.0	11.2	5.0	47.2
35.	66	-	-	-	-	100.0	97.0	74.0	42.0	25.0	20.0	57.0
36.	67	-	-	-	100	99.0	97.0	78.0	23.0	8.2	5.0	40.8
37.	68	-	-	100.0	99.5	99.0	96.0	77.0	43.0	25.0	21.0	57.7
38.	69	-	-	100.0	93.0	80.0	64.0	34.0	10.0	2.7	Nil	22.5
39.	70	-	-	100.0	99.8	99.5	96.0	76.0	41.0	10.7	6.0	47.8
40.	71	-	-	100.0	98.0	94.0	84.0	44.0	17.0	14.0	12.0	36.0
41.	72	-	-	100.0	99.9	99.8	96.0	52.0	16.0	2.0	Nil	30.4
42.	74	-	-	-	100.0	99.0	98.0	81.0	35.0	4.0	Nil	42.1
43.	75	-	-	100.0	99.8	99.0	90.0	51.0	18.0	11.0	10.0	36.1
44.	76	-	-	100	99.9	99.0	94.0	61.0	28.0	13.0	8.0	42.5
45.	77	100	-	97	94.0	89.0	71.0	22.0	6.0	1.7	Nil	11.6

Sl. No.	Sand Source No.	Percent passing each sieve									% Less than .05 mm	G.M.
		3/4"	3/8"	4	8	16	30	50	100	200		
46.	78	100	-	93	87.0	81.0	66.0	38.0	17.0	9.8	6.0	30.0
47.	79	-	-	-	-	-	100.0	80.0	40.0	5.0	2.0	44.2
48.	80	-	-	100	98.0	93.0	61.0	9.0	1.0	0.6	Nil	14.7
49.	81	100	-	94.0	92.0	89.0	83.0	63.0	23.0	10.0	8.0	37.8
50.	82	100	-	92.0	86.0	80.0	71.0	46.0	19.0	9.7	6.0	32.0
51.	83	100	-	97.0	94.0	90.0	82.0	61.0	28.0	14.0	8.0	41.6
52.	84	100	-	98.0	97.0	96.0	93.0	76.0	27.0	15.0	10.0	45.6
53.	85	-	-	100.0	99.9	99.8	99.7	99.0	79.0	35.0	18.0	79.5
54.	86	-	-	100.0	99.9	99.8	99.0	91.0	52.0	13.0	3.0	55.4
55.	87	-	-	100.0	93.0	86.0	77.0	59.0	31.0	15.0	10.0	40.4
56.	88	-	-	100.0	99.0	97.0	88.0	56.0	26.0	14.0	9.0	41.1
57.	89	-	-	100.0	99.8	98.0	65.0	12.0	4.0	3.1	3.0	18.3
58.	90	-	-	100.0	99.6	99.0	94.0	72.0	34.0	18.0	14.0	49.4
59.	91	-	-	-	100.0	99.9	95.0	27.0	5.0	2.6	2.0	23.2
60.	92	99.8	-	99.8	99.5	99.2	97.6	79.0	25.0	6.1	3.0	40.1
61.	93	-	-	100.0	97.0	91.0	66.0	39.0	18.0	13.0	12.0	33.2
62.	94	-	-	100.0	99.8	99.5	98.0	59.0	29.0	21.0	18.0	48.0
63.	95	-	-	81.0	81.0	80.0	79.0	43.0	17.0	13.0	11.0	33.8
64.	96	-	-	100.0	94.0	87.0	73.0	43.0	12.0	6.4	6.0	28.0
65.	97	-	-	-	100.0	99.9	99.1	95.0	62.0	22.0	15.0	65.0
66.	98	-	-	-	100.0	99.9	99.8	96.0	70.0	38.0	31.0	78.1
67.	99	99.5	-	97.0	95.0	92.0	82.0	36.0	4.9	2.6	2.5	21.4
68.	100	97.0	-	92.0	88.0	85.0	75.0	47.0	17.0	6.7	5.0	30.4
69.	101	95.0	-	83.0	75.0	62.0	45.0	22.0	7.0	4.1	3.0	18.0
70.	102	99.0	-	97.0	95.0	93.0	87.0	68.0	22.0	6.4	5.0	36.6
71.	103	-	-	100.0	98.0	89.0	48.0	13.0	3.0	2.1	2.0	15.7
72.	104	-	-	-	100.0	99.9	99.7	87.0	35.0	13.0	9.0	49.4
73.	105	-	-	-	-	100.0	99.9	99.8	64.0	11.0	4.0	55.5
74.	106	100	70.0	47.0	42.0	39.0	37.0	32.0	15.0	7.8	7.0	22.3
75.	107	100	-	80.0	67.0	47.0	30.0	14.0	5.0	3.7	3.0	13.7
76.	108	100	95.0	86.0	76.0	62.0	48.0	34.0	24.0	18.0	17.0	34.4
77.	109	100	-	98.7	98.0	96.0	91.0	64.0	38.0	29.0	27.0	53.5
78.	110	100	-	95.0	92.0	86.0	73.0	48.0	28.0	20.0	18.0	39.9
79.	112	100	-	96.0	94.0	89.0	78.0	54.0	32.0	26.0	23.0	47.5
80.	113	-	-	100.0	99.9	99.8	99.5	87.0	40.0	18.0	14.0	54.9
81.	114	99	-	95.0	95.0	90.0	65.0	28.0	12.0	7.2	6.0	25.7
82.	115	100	-	97.0	95.0	91.0	83.0	61.0	24.0	13.0	10.0	40.0
83.	116	100	-	99.5	99.0	94.0	72.0	35.0	15.0	9.8	7.0	30.2
84.	117	-	-	100.0	99.9	99.8	99.6	97.0	71.0	33.0	25.0	75.3
85.	118	100	-	96.0	94.0	89.0	83.0	50.0	14.0	4.7	3.0	29.6
86.	119	100	96.0	93.0	91.0	88.0	80.0	48.0	13.0	5.0	3.0	28.8
87.	120	100	-	91.0	88.0	84.0	76.0	45.0	12.0	4.0	3.0	27.0
88.	121	100	72.0	50.0	37.0	25.0	13.0	7.0	3.0	3.0	3.0	8.8
89.	122	100	87.0	77.0	66.0	52.0	34.0	16.0	7.0	4.5	4.0	15.8
90.	123	100	71.0	53.0	41.0	23.0	14.0	8.0	5.0	3.9	3.3	10.2

Sl. No.	Sand Source No.	Percent passing each sieve 3/4"	3/8"	4	8	16	30	50	100	200	% Less than .05 mm	G.M.
91.	124	100	-	98.0	97.0	95.0	87.0	52.0	14.0	4.8	3.0	28.8
92.	125	100	89.0	80.0	69.0	55.0	36.0	17.0	7.0	4.4	4.0	16.2
93.	140	100	99.0	98.0	97.0	96.0	91.0	85.0	19.0	4.0	3.0	37.3
94.	141	100	98.0	96.0	94.0	93.0	87.0	52.0	18.0	4.0	3.0	31.2
95.	143	-	-	-	100.0	99.9	99.7	74.0	21.0	4.2	4.0	37.2
96.	145	100	98.0	96.0	94.0	93.0	92.0	68.0	19.0	4.0	3.7	34.5
97.	147	-	-	100.0	99.9	99.8	99.0	76.0	25.0	7.2	4.0	40.6
98.	149	100	-	98.0	96.0	94.0	90.0	54.0	26.0	20.0	19.0	44.6
99.	152	-	-	-	100.0	99.8	99.7	97.0	65.0	29.0	20.0	70.9
100.	155	-	-	-	100.0	99.3	98.7	97.0	61.0	14.0	8.0	60.0
101.	159	100	80.0	67.0	54.0	37.0	15.0	8.0	5.0	4.1	4.0	11.3
102.	160	100	-	98.0	97.0	96.0	93.0	37.0	6.0	3.7	3.0	25.6
103.	166	-	-	100.0	99.0	95.0	84.0	51.0	27.0	14.0	10.0	40.2
104.	167	-	-	100.0	99.4	99.0	98.0	97.0	69.0	23.0	18.0	68.1
105.	203	-	-	79.0	72.0	62.0	47.0	31.0	12.0	3.8	2.0	21.0
106.	204	-	-	100.0	99.0	98.0	95.0	73.0	20.0	5.5	3.0	37.1
107.	206	-	-	-	-	-	100.0	99.0	78.0	23.0	16.0	71.8
108.	207	-	-	-	-	100.0	98.0	77.0	26.0	11.4	8.0	43.8
109.	209	-	-	100	99.0	98.0	97.0	88.0	58.0	32.0	19.0	68.8

APPENDIX F

TYPICAL GRADATIONS OF FEW SANDS PLOTTED ON PUBLIC ROADS GRADATION CHARTS

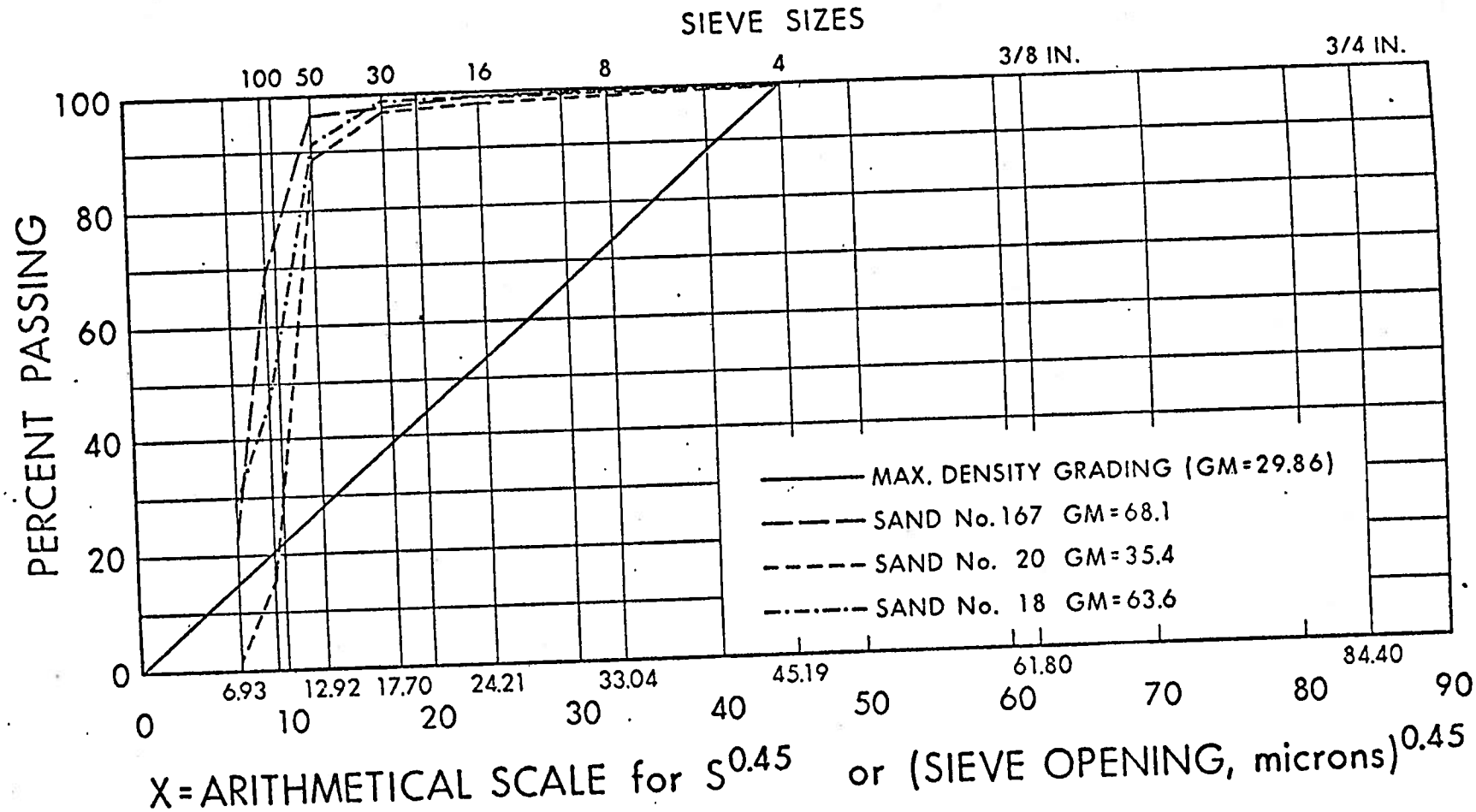


FIG. F-1 GRADATIONS OF SANDS GIVING DENSITIES OF 100-105 lbs./c.ft.

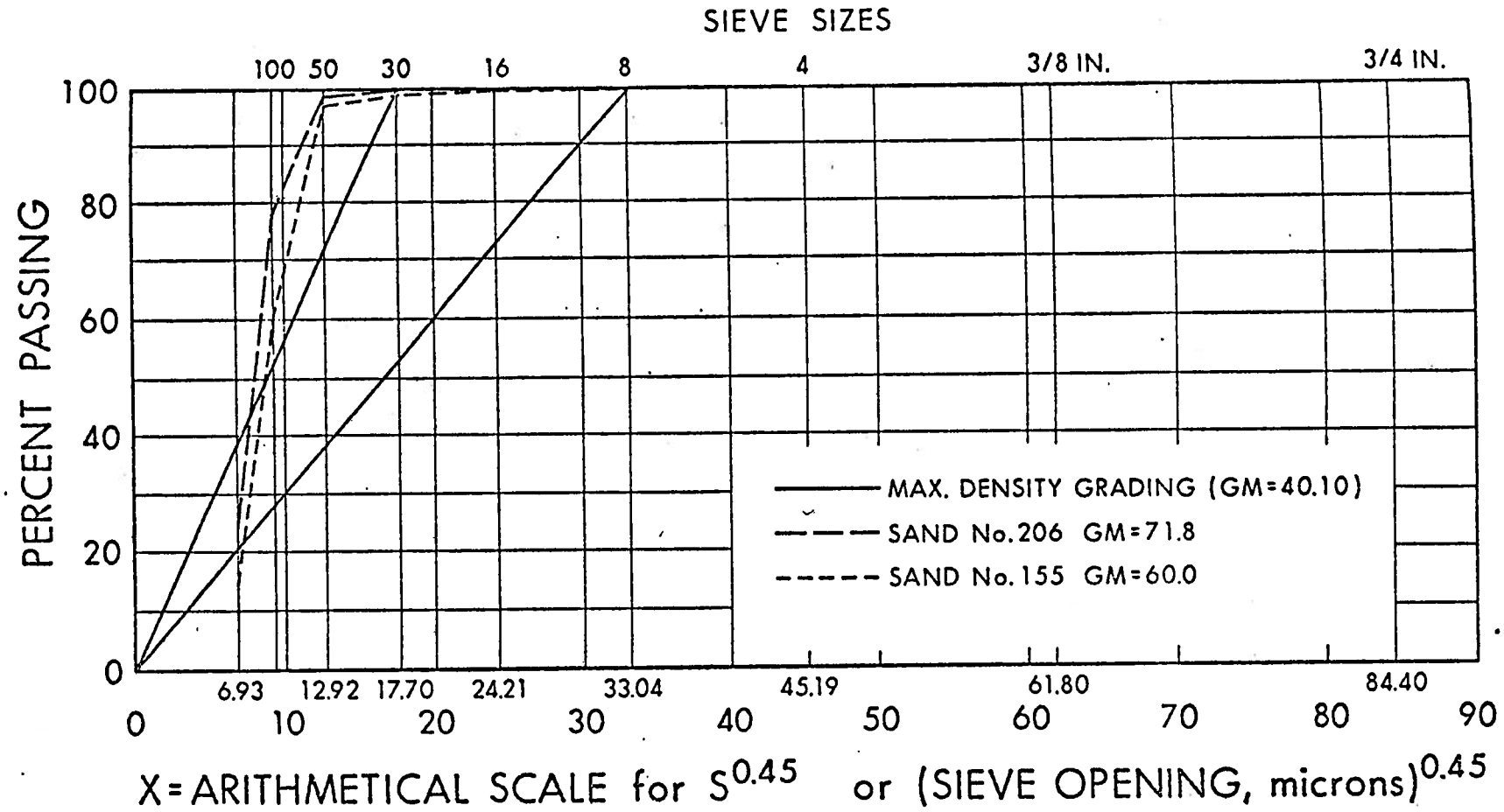


FIG. F-2 GRADATIONS OF SANDS GIVING DENSITIES OF 106-110 lbs./c.ft.

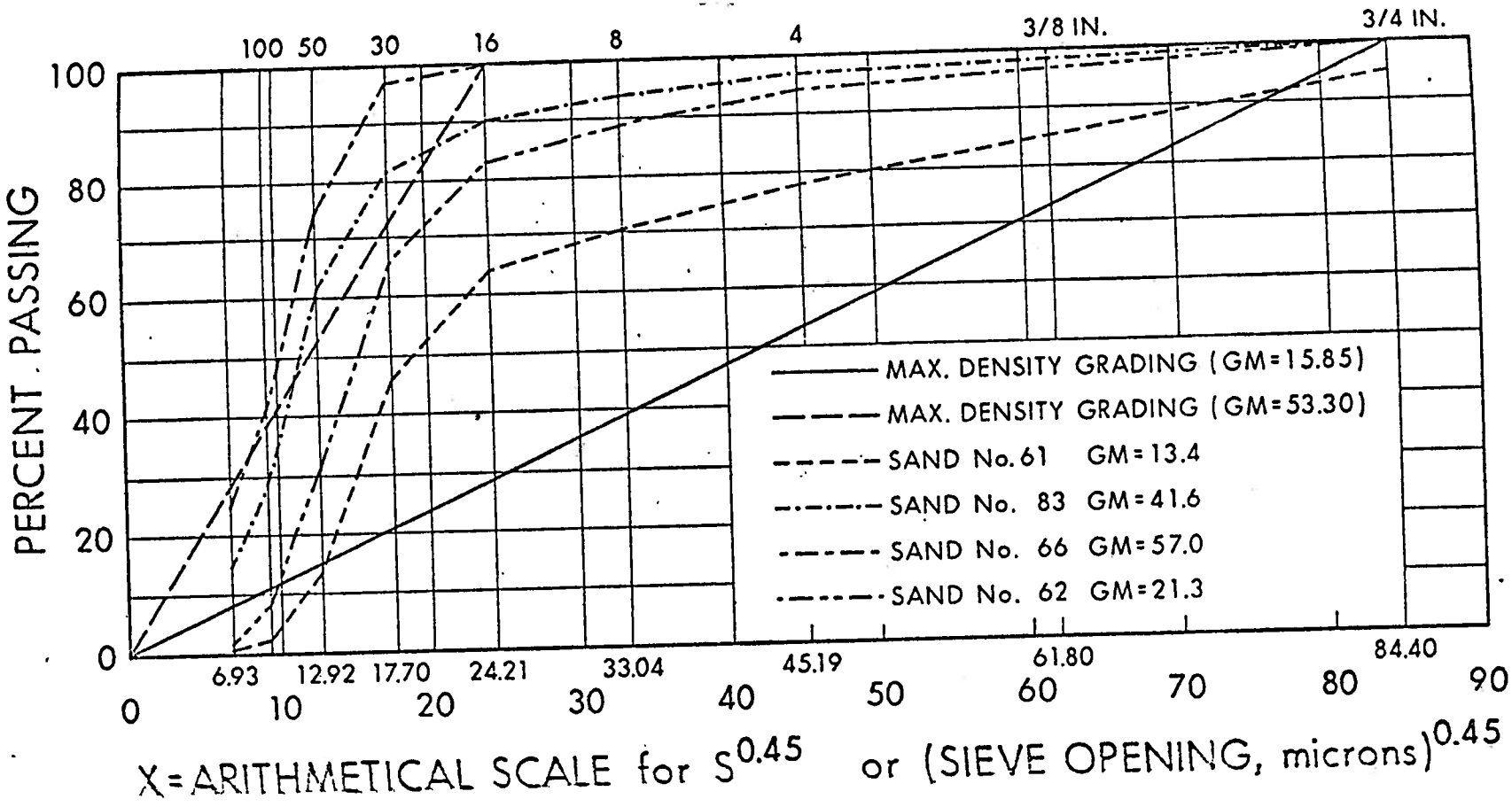


FIG. F-3 GRADATIONS OF SANDS GIVING DENSITIES OF 121-125 lbs./c.ft.

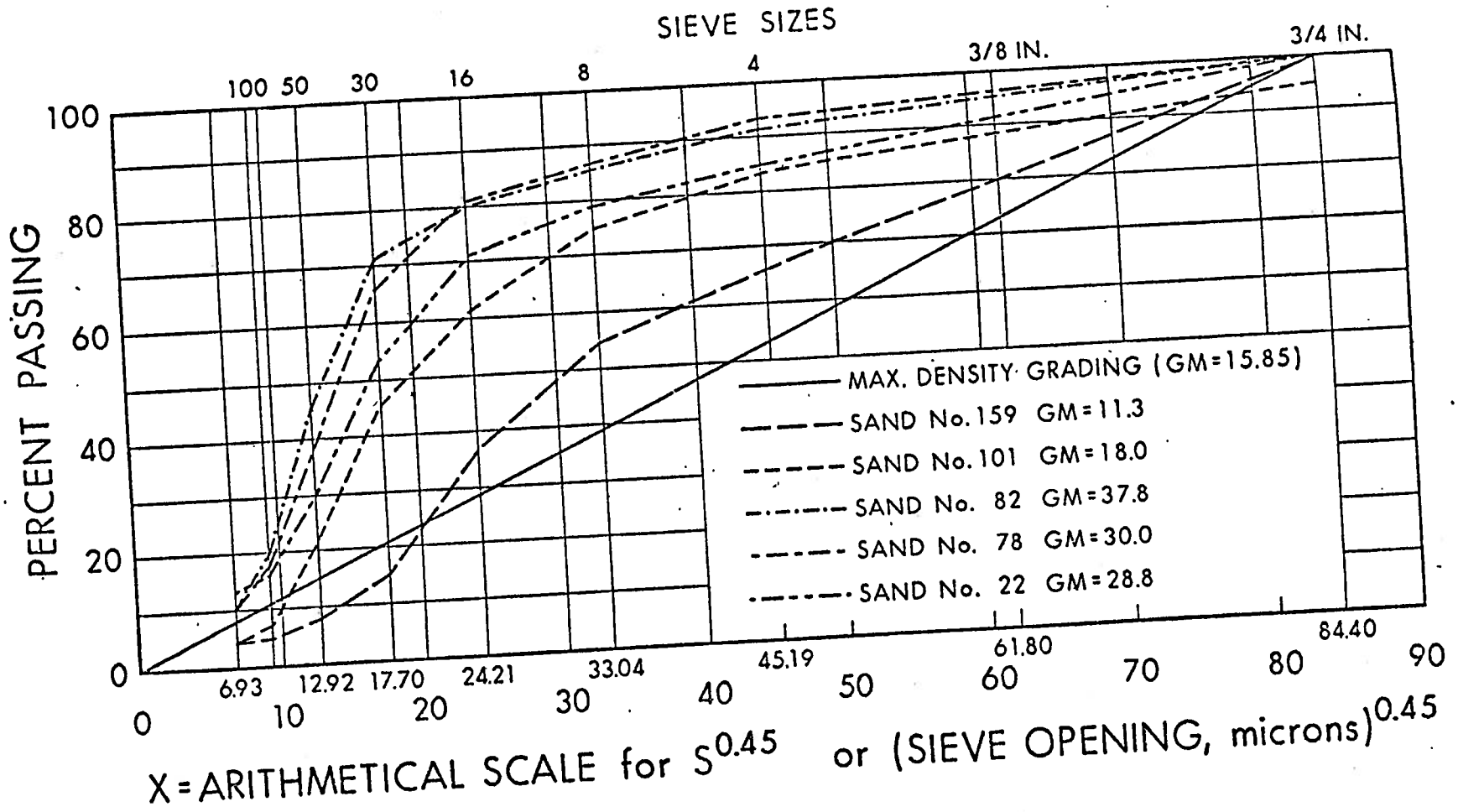


FIG. F-4 GRADATIONS OF SANDS GIVING DENSITIES OF 126-130 lbs.c.ft.

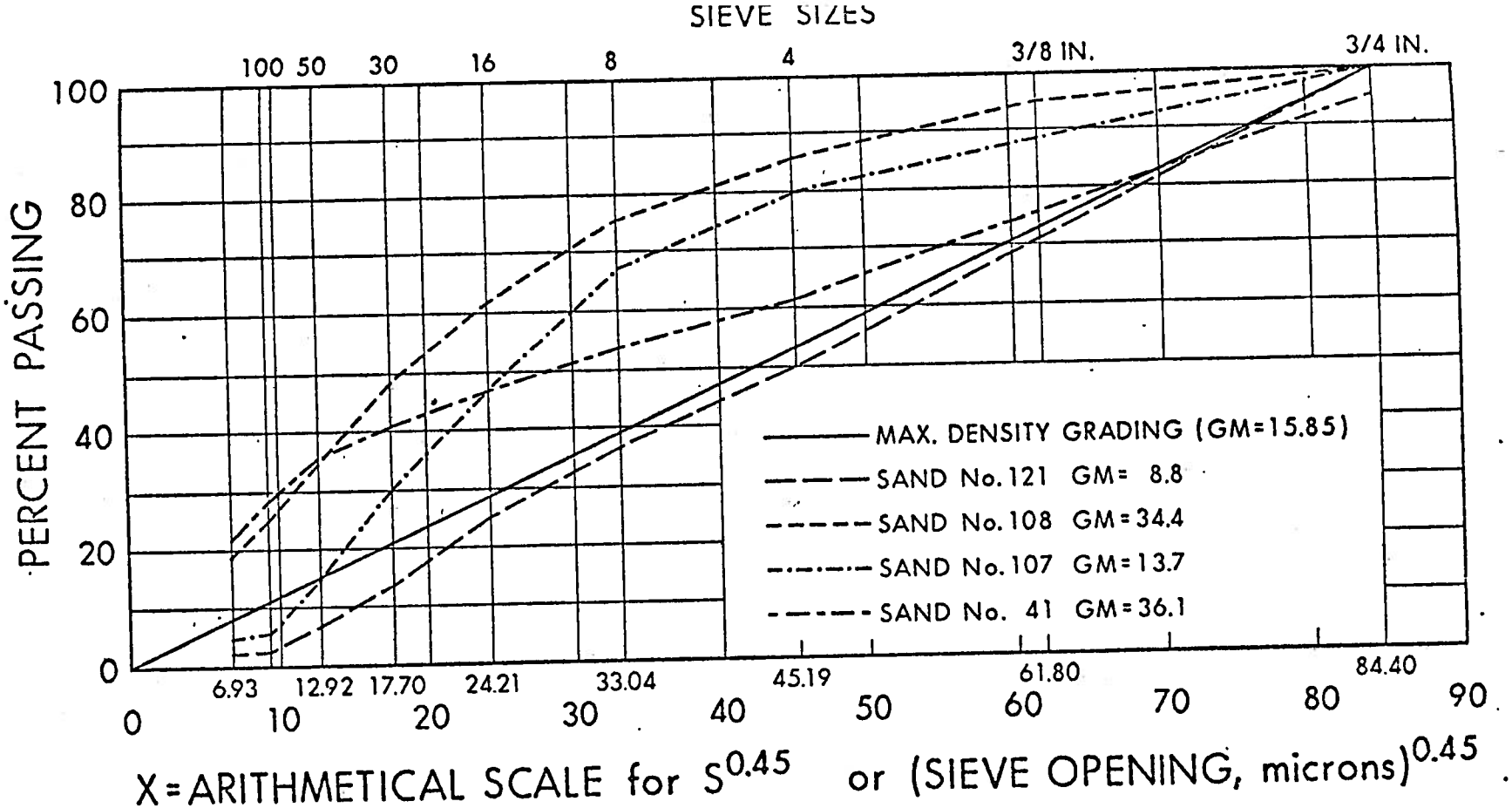


FIG. F-5 GRADATIONS OF SANDS GIVING DENSITIES OF 131-135 lbs./c.ft.

APPENDIX G

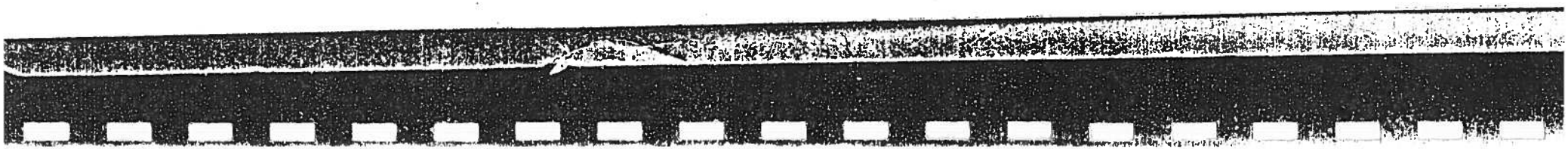
SOIL CEMENT DESIGN DATA ARRANGED IN INCREASING ORDER OF DENSITY GROUPS

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
54	45.2	8.0	284.9	529.3	399.8	102.7	1.1	0.0890
54	45.2	10.0	401.2	758.0	590.6	104.1	0.3	0.1220
54	45.2	12.0	568.4	933.1	803.7	105.6	0.0	0.1400
95	33.8	4.0	172.0	202.6	130.7	102.9	29.1	0.0490
95	33.8	6.0	288.0	317.6	206.5	104.1	11.8	0.0720
95	33.8	8.0	337.0	414.3	275.7	104.4	1.7	0.0930
95	33.8	10.0	387.0	488.8	369.8	104.4	0.6	0.1110
167	68.1	5.0	278.4	334.6	262.6	102.5	12.8	0.0593
167	68.1	7.0	392.0	507.1	385.5	103.2	2.7	0.0807
167	68.1	9.0	476.9	680.9	500.5	104.0	0.9	0.1012
167	68.1	11.0	588.0	927.9	670.4	104.6	0.7	0.1202
33	49.2	8.0	339.8	550.2	497.8	108.8	0.2	0.1030
33	49.2	10.0	495.2	758.1	744.9	110.3	0.3	0.1270
33	49.2	12.0	598.5	1091.3	977.4	111.5	0.4	0.1500
38	94.9	7.0	330.6	424.8	347.6	105.5	2.3	0.0850
38	94.9	9.0	474.3	526.7	466.6	106.0	2.6	0.1060
38	94.9	11.0	637.7	704.5	631.1	106.6	1.2	0.1260
40	72.9	5.0	219.6	303.2	228.7	108.1	4.2	0.0670
40	72.9	7.0	331.9	426.1	373.8	109.1	2.8	0.0920
40	72.9	9.0	543.7	599.9	554.2	110.2	1.0	0.1170
57	42.0	6.0	244.3	377.7	311.1	104.8	4.0	0.0730
57	42.0	8.0	395.9	564.6	492.6	106.6	1.7	0.0980
57	42.0	10.0	573.7	784.2	716.1	108.3	0.7	0.1210
85	80.0	6.0	297.0	338.5	283.6	109.7	2.5	0.0520
85	80.0	8.0	392.0	559.4	467.8	110.5	1.5	0.1070
85	80.0	10.0	501.0	717.5	654.6	111.1	0.9	0.1290
94	48.0	4.0	210.0	249.6	128.0	107.4	38.8	0.0540
94	48.0	6.0	289.0	397.3	202.5	108.1	33.2	0.0790
94	48.0	8.0	371.0	526.7	334.5	108.5	25.3	0.1020
94	48.0	10.0	484.0	666.6	375.1	109.6	1.5	0.1250
94	48.0	12.0	556.0	761.9	520.1	110.0	0.9	0.1450
105	55.5	6.0	248.0	333.2	304.5	106.9	6.9	0.0770
105	55.5	8.0	337.0	479.7	450.8	107.6	2.7	0.1000
105	55.5	10.0	432.0	637.8	585.5	108.7	1.9	0.1220
105	55.5	12.0	566.0	793.3	744.9	109.5	1.4	0.1430
155	60.0	5.0	175.1	232.6	211.6	109.2	23.5	0.0695
155	60.0	7.0	286.2	369.9	312.3	110.6	5.5	0.0958
155	60.0	9.0	355.5	533.3	445.7	111.6	1.1	0.1202
155	60.0	11.0	538.4	739.8	648.2	113.0	0.1	0.1448
206	71.8	6.0	352.9	495.3	436.4	107.3	8.6	0.0778
206	71.8	8.0	474.3	675.7	584.1	108.7	2.2	0.1023
206	71.8	10.0	615.5	871.8	807.6	109.0	1.0	0.1231
28	37.2	6.0	128.0	267.9	211.6	112.6	4.0	0.0883
28	37.2	8.0	215.6	445.7	287.5	114.2	1.8	0.1163
28	37.2	10.0	274.5	675.7	440.3	114.9	1.1	0.1406
30	61.6	7.0	311.1	486.2	303.3	114.2	2.5	0.1050
30	61.6	9.0	439.0	653.5	506.6	114.8	1.2	0.1300
30	61.6	11.0	625.9	802.5	750.1	115.4	0.9	0.1530
32	25.7	7.0	113.7	269.2	135.9	111.1	8.2	0.0970
[illegible]	[illegible]	[illegible]	[illegible]	444.4	214.3	113.4	4.5	0.1260
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	26.9	11.0	899.1	1223.4	1030.0	115.4	0.5	0.1570

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
36	45.6	6.0	288.8	368.6	363.9	111.3	2.0	0.0860
36	45.6	8.0	443.0	571.1	558.0	111.9	1.0	0.1100
36	45.6	10.0	640.3	777.7	772.3	112.7	1.0	0.1340
39	77.4	5.0	257.4	385.9	----	111.5	25.7	0.0740
39	77.4	7.0	365.9	501.9	354.2	112.3	2.4	0.1000
39	77.4	9.0	512.3	628.7	573.7	113.0	1.3	0.1240
42	61.6	8.0	380.3	565.9	413.0	112.3	1.8	0.1110
42	61.6	10.0	544.9	721.4	652.1	113.7	0.9	0.1370
42	61.6	12.0	649.5	995.9	831.2	114.7	0.0	0.1610
44	51.8	6.0	162.0	307.1	224.8	110.6	3.8	0.0840
44	51.8	8.0	277.0	483.6	390.7	111.9	1.8	0.1100
44	51.8	10.0	409.0	701.9	661.3	113.6	0.5	0.1370
50	47.3	8.0	355.5	----	445.7	109.2	1.9	0.1040
50	47.3	10.0	524.0	----	660.0	111.5	1.5	0.1300
50	47.3	12.0	730.5	----	942.1	113.0	0.3	0.1550
53	34.8	8.0	371.1	598.6	441.7	113.2	2.3	0.1140
53	34.8	10.0	525.3	858.7	675.6	114.6	1.2	0.1400
53	34.8	12.0	611.5	1070.4	981.3	114.9	0.0	0.1620
77	11.6	6.0	316.0	410.4	159.4	114.3	36.4	0.0920
77	11.6	8.0	393.0	588.2	358.1	114.7	3.3	0.1140
77	11.6	10.0	545.0	792.0	548.8	115.5	1.0	0.1430
86	55.4	7.0	305.0	524.1	405.2	113.8	2.6	0.1040
86	55.4	9.0	511.0	720.1	551.4	114.5	1.4	0.1290
86	55.4	11.0	610.0	850.9	696.5	115.6	0.5	0.1540
89	18.3	6.0	187.0	240.5	234.0	112.0	5.8	0.0870
89	18.3	8.0	334.0	461.4	403.8	114.3	2.1	0.1170
89	18.3	10.0	489.0	823.4	704.4	116.1	0.8	0.1450
91	23.2	6.0	107.0	214.4	177.7	111.5	4.6	0.0860
91	23.2	8.0	222.0	390.8	304.5	113.5	2.7	0.1150
91	23.2	10.0	377.0	546.3	480.8	115.9	1.6	0.1440
97	65.0	6.0	336.0	396.0	318.8	112.1	4.9	0.0870
97	65.0	8.0	401.0	568.5	462.6	112.4	1.5	0.1120
97	65.0	10.0	489.0	708.4	565.8	112.9	0.3	0.1350
98	78.1	5.0	252.0	297.9	269.3	112.6	26.9	0.0760
98	78.1	7.0	342.0	454.8	380.3	112.7	2.9	0.1010
98	78.1	9.0	427.0	601.2	475.6	112.8	1.2	0.1240
104	49.4	6.0	313.0	479.7	399.4	112.9	3.5	0.0990
104	49.4	8.0	430.0	633.9	546.3	114.2	1.5	0.1170
104	49.4	10.0	565.0	786.8	693.9	115.4	0.7	0.1430
106	22.3	6.0	298.0	457.5	341.0	110.3	5.3	0.0835
106	22.3	8.0	330.6	482.3	424.7	111.2	2.8	0.1084
106	22.3	10.0	390.7	559.4	452.2	111.5	1.6	0.1301
106	22.3	12.0	449.5	606.5	491.4	111.7	1.5	0.1500
113	54.9	6.0	317.6	458.8	405.2	112.8	3.1	0.0887
113	54.9	8.0	524.0	707.0	611.5	114.3	1.3	0.1166
113	54.9	10.0	731.8	963.2	845.5	115.0	1.0	0.1410
117	75.3	5.0	375.1	375.1	304.5	114.1	8.3	0.0794
117	75.3	7.0	480.8	567.2	462.6	114.1	1.5	0.1041
117	75.3	9.0	578.9	738.4	558.0	114.6	0.9	0.1288
117	75.3	11.0	585.5	931.9	682.2	114.9	0.3	0.1511
143	37.2	8.0	356.8	495.3	418.1	111.5	1.2	0.1092
143	37.2	10.0	513.6	----	594.6	113.5	0.5	0.1362
143	37.2	12.0	620.7	----	808.9	114.9	0.2	0.1611
152	70.9	6.0	371.1	463.9	338.5	114.6	6.4	0.0927

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI 7 DAY	28 DAY	7 DAY F.T.	AV. DENSITY	F.T.LOSS	C/V
152	70.9	8.0	431.2	597.2	427.3	115.5	3.0	0.1199
152	70.9	10.0	533.2	767.2	520.1	115.8	1.4	0.1436
204	37.1	5.0	228.7	----	----	110.9	--	0.0725
204	37.1	7.0	429.9	606.4	492.6	112.2	2.9	0.0995
204	37.1	9.0	641.6	937.1	807.6	114.1	0.8	0.1273
204	37.1	11.0	921.2	1425.9	1132.0	115.8	0.7	0.1543
207	43.8	6.0	257.4	397.3	431.2	109.5	4.3	0.0320
207	43.8	8.0	444.3	674.4	660.0	111.2	1.6	0.1084
207	43.8	10.0	742.2	968.4	1061.0	112.7	0.6	0.1338
23	7.6	6.0	112.4	221.2	214.3	118.3	2.3	0.1016
23	7.6	8.0	181.7	415.6	423.4	120.6	1.5	0.1357
23	7.6	10.0	278.4	711.0	580.2	123.4	1.3	0.1720
34	43.4	7.0	418.1	603.8	543.7	116.8	2.0	0.1090
34	43.4	9.0	614.2	886.2	743.5	117.8	0.6	0.1389
34	43.4	11.0	818.1	1224.7	1078.0	119.3	0.6	0.1660
43	39.6	7.0	284.9	432.6	307.1	113.6	2.8	0.1030
43	39.6	9.0	422.1	592.0	473.1	115.8	1.5	0.1330
43	39.6	11.0	625.9	938.4	746.1	117.1	0.6	0.1590
45	58.2	6.0	344.9	478.4	282.3	118.2	15.3	0.1020
45	58.2	8.0	470.4	696.6	577.6	119.4	1.7	0.1320
45	58.2	10.0	590.6	978.9	777.5	119.9	1.1	0.1590
48	43.2	6.0	294.1	386.8	337.1	113.2	2.5	0.0900
48	43.2	8.0	435.1	601.2	507.0	115.3	1.2	0.1200
48	43.2	10.0	582.8	801.2	705.7	115.9	0.4	0.1440
49	22.9	5.0	120.2	196.9	107.2	114.8	32.1	0.0800
49	22.9	7.0	264.0	401.2	270.5	117.5	4.3	0.1130
49	22.9	9.0	448.2	605.1	512.3	119.9	2.3	0.1470
60	40.2	8.0	671.7	810.3	760.5	118.9	1.1	0.1310
60	40.2	10.0	867.8	1083.5	942.1	120.2	0.5	0.1600
60	40.2	12.0	1144.0	1373.7	1250.0	120.4	0.2	0.1830
63	32.8	7.0	384.1	515.0	416.9	115.9	1.9	0.1090
63	32.8	9.0	594.6	862.6	700.4	119.4	1.1	0.1410
63	32.8	11.0	798.4	1240.3	1013.0	119.3	0.4	0.1660
64	21.1	5.0	261.0	354.1	287.5	116.2	4.1	0.0830
64	21.1	7.0	522.8	648.2	534.4	119.7	1.4	0.1200
64	21.1	9.0	738.2	929.3	755.3	120.8	1.1	0.1500
64	21.1	11.0	1061.0	1280.8	1149.0	122.5	0.4	0.1810
65	47.2	5.0	299.0	435.2	367.2	116.3	2.5	0.0830
65	47.2	7.0	505.0	675.7	606.3	117.1	1.3	0.1120
65	47.2	9.0	695.0	908.4	866.4	117.7	0.7	0.1340
65	47.2	11.0	956.0	1180.2	1091.0	118.3	0.1	0.1640
67	40.8	5.0	249.0	342.4	288.8	113.3	4.1	0.0770
67	40.8	7.0	441.0	521.5	511.0	115.7	1.8	0.1080
67	40.8	9.0	616.0	798.6	761.9	117.3	0.6	0.1380
67	40.8	11.0	858.0	1073.0	1127.0	118.9	0.3	0.1660
68	57.7	5.0	332.0	462.7	264.0	120.3	20.3	0.0920
68	57.7	7.0	473.0	640.4	503.1	121.0	1.0	0.1240
68	57.7	9.0	619.0	814.3	674.2	121.3	0.3	0.1520
69	22.5	7.0	457.0	585.5	411.6	118.3	2.5	0.1160
69	22.5	9.0	677.0	893.9	717.4	118.9	0.8	0.1430
69	22.5	11.0	815.0	1164.5	879.4	118.8	0.4	0.1680
71	36.0	5.0	352.0	407.8	176.4	117.7	31.9	0.0960
71	36.0	7.0	473.0	593.4	419.5	118.5	3.2	0.1160
71	36.0	9.0	662.0	807.7	700.4	119.3	0.2	0.1450

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
72	30.4	5.0	249.0	286.2	286.2	114.6	3.6	0.0790
72	30.4	7.0	450.0	590.8	541.1	117.5	1.5	0.1130
72	30.4	9.0	703.0	961.9	837.7	119.1	0.5	0.1440
72	30.4	11.0	978.0	1347.5	1212.0	120.7	0.0	0.1740
74	42.1	6.0	351.0	497.9	471.8	113.8	2.6	0.0910
74	42.1	8.0	501.0	771.1	726.6	115.3	0.9	0.1200
74	42.1	10.0	666.0	1039.0	920.0	116.6	0.3	0.1470
74	42.1	12.0	812.0	1368.4	1218.0	117.5	0.0	0.1710
75	36.1	5.0	292.0	439.1	384.1	119.7	3.9	0.0910
75	36.1	7.0	464.0	708.4	607.7	120.9	1.7	0.1240
75	36.1	9.0	658.0	981.6	896.4	121.6	1.0	0.1530
76	42.5	4.0	290.0	414.3	104.6	119.6	50.1	0.0740
76	42.5	6.0	477.0	632.6	406.4	121.5	5.3	0.1110
76	42.5	8.0	628.0	837.8	623.3	122.1	1.1	0.1420
76	42.5	10.0	762.0	1027.3	819.4	122.3	0.5	0.1680
79	44.2	5.0	306.0	372.5	317.6	114.2	5.2	0.0790
79	44.2	7.0	487.0	586.8	504.4	115.8	1.6	0.1090
79	44.2	9.0	695.0	873.1	701.8	117.4	0.4	0.1380
79	44.2	11.0	885.0	1151.5	883.3	118.3	0.0	0.1640
80	14.7	6.0	164.0	281.0	185.6	113.2	3.7	0.0900
80	14.7	8.0	280.0	546.3	393.3	115.6	1.8	0.1210
80	14.7	10.0	453.0	795.9	688.7	117.7	0.6	0.1510
81	37.8	5.0	331.0	469.0	333.2	118.3	2.6	0.0870
81	37.8	7.0	504.0	709.7	569.8	119.3	1.1	0.1190
81	37.8	9.0	663.0	950.2	784.1	119.8	0.8	0.1460
88	41.1	5.0	257.0	393.4	312.3	118.6	8.4	0.0980
88	41.1	7.0	402.0	615.6	535.8	120.3	1.7	0.1220
88	41.1	9.0	583.0	841.7	722.6	120.9	1.1	0.1500
90	49.4	5.0	247.0	331.9	301.8	120.2	4.1	0.0920
90	49.4	7.0	387.0	533.3	494.0	120.7	2.0	0.1230
90	49.4	9.0	565.0	692.7	718.8	121.5	1.1	0.1530
92	40.1	8.0	243.0	388.1	292.7	114.1	1.5	0.1160
92	40.1	10.0	368.0	612.9	407.8	115.7	0.9	0.1440
92	40.1	12.0	466.0	802.5	650.7	116.5	0.4	0.1680
99	21.4	6.0	188.0	273.2	227.4	114.2	3.9	0.0920
99	21.4	8.0	292.0	469.2	414.3	116.2	2.0	0.1220
99	21.4	10.0	478.0	735.8	633.7	119.1	1.0	0.1560
99	21.4	12.0	658.0	1015.5	885.9	120.9	0.3	0.1850
102	36.6	5.0	161.0	243.1	198.6	115.9	6.2	0.0820
102	36.6	7.0	290.0	440.5	355.5	117.6	2.5	0.1140
102	36.6	9.0	417.0	724.1	588.0	119.4	1.2	0.1450
102	36.6	11.0	622.0	1033.8	866.4	120.7	0.7	0.1740
103	15.7	6.0	163.0	376.4	266.5	115.3	3.5	0.0940
103	15.7	8.0	266.0	569.9	465.1	118.1	1.8	0.1290
103	15.7	10.0	421.0	771.1	679.5	119.2	1.1	0.1560
118	29.6	6.0	328.0	483.6	456.0	116.6	2.0	0.0974
118	29.6	8.0	550.1	----	708.2	118.9	0.8	0.1302
118	29.6	10.0	827.1	----	998.4	120.6	0.6	0.1608
119	28.8	6.0	348.9	562.0	456.8	118.2	2.1	0.1014
119	28.8	8.0	589.3	----	763.2	120.5	1.0	0.1354
119	28.8	10.0	898.9	----	1095.0	123.0	0.8	0.1704
124	28.8	7.0	359.3	602.5	535.5	115.9	1.3	0.1088
124	28.8	9.0	552.7	874.3	734.3	117.6	0.9	0.1383
124	28.8	11.0	904.2	1219.4	1103.0	119.8	0.2	0.1692



SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
140	37.3	7.0	311.1	413.0	343.8	116.2	1.1	0.1096
140	37.3	9.0	479.6	703.2	539.8	117.7	0.2	0.1386
140	37.3	11.0	769.6	----	841.6	119.6	0.0	0.1684
141	31.2	7.0	317.6	401.2	371.1	117.0	1.1	0.1117
141	31.2	9.0	500.5	----	606.3	119.2	0.8	0.1437
141	31.2	11.0	680.8	----	844.1	120.0	0.2	0.1700
145	34.5	8.0	367.2	601.2	465.1	115.0	0.9	0.1185
145	34.5	10.0	594.6	----	678.2	116.2	0.7	0.1450
145	34.5	12.0	735.7	----	929.2	118.4	0.2	0.1743
147	40.6	5.0	232.6	341.1	273.1	112.4	3.8	0.0752
147	40.6	7.0	406.4	554.1	435.1	114.6	1.6	0.1054
147	40.6	9.0	576.2	867.8	714.8	116.7	0.3	0.1354
147	40.6	11.0	792.0	1190.7	1066.0	117.9	0.0	0.1619
149	44.6	3.0	111.1	148.9	119.0	113.2	26.1	0.0486
149	44.6	5.0	218.2	299.3	236.5	115.1	2.9	0.0804
149	44.6	7.0	329.4	488.8	419.5	116.2	1.5	0.1096
149	44.6	9.0	514.8	748.9	687.4	118.4	0.4	0.1409
160	25.6	6.0	189.5	236.6	219.6	112.7	4.2	0.0885
160	25.6	8.0	355.5	431.3	394.7	115.4	2.4	0.1197
160	25.6	10.0	534.4	656.1	631.1	117.4	1.4	0.1491
209	68.8	5.0	362.0	445.7	364.6	116.8	30.4	0.0939
209	68.8	7.0	491.4	614.3	491.4	116.8	3.8	0.1112
209	68.8	9.0	605.0	846.9	669.1	117.4	1.5	0.1376
29	15.8	7.0	94.1	364.7	164.6	120.1	13.3	0.1206
29	15.8	9.0	159.4	627.4	279.7	122.5	1.5	0.1557
29	15.8	11.0	256.2	938.4	362.0	124.0	1.9	0.1869
46	11.7	8.0	277.0	386.9	322.8	118.1	1.2	0.1290
46	11.7	10.0	466.6	786.8	611.5	123.3	0.6	0.1680
46	11.7	12.0	569.8	1090.0	956.6	123.4	0.4	0.1970
47	32.8	6.0	348.9	581.6	457.4	122.7	1.2	0.1140
47	32.8	8.0	584.1	965.9	740.9	124.7	0.6	0.1510
47	32.8	10.0	899.1	1246.9	1167.0	126.2	0.0	0.1850
55	14.3	6.0	264.0	418.2	264.0	119.4	6.2	0.1090
55	14.3	8.0	419.5	722.7	544.9	122.2	0.5	0.1420
55	14.3	10.0	603.7	1100.5	829.9	123.5	0.4	0.1730
61	13.4	5.0	241.7	348.9	294.1	119.5	2.4	0.0890
61	13.4	7.0	504.4	778.9	581.6	122.0	0.9	0.1270
61	13.4	9.0	846.8	1116.2	1007.0	124.5	0.4	0.1650
66	57.0	4.0	351.6	428.7	248.3	121.2	24.9	0.0780
66	57.0	6.0	501.0	648.2	520.1	121.7	1.4	0.1110
66	57.0	8.0	679.0	918.8	768.5	122.2	0.7	0.1420
70	47.8	5.0	283.0	409.0	333.2	118.2	2.5	0.0870
70	47.8	7.0	512.0	730.6	615.5	120.7	0.7	0.1230
70	47.8	9.0	701.0	1088.7	921.2	121.4	0.4	0.1520
70	47.8	11.0	1060.0	1407.6	1263.0	122.7	0.1	0.1820
83	41.6	4.0	275.0	350.3	248.3	119.1	--	0.0730
83	41.6	6.0	447.0	613.0	462.6	122.1	2.7	0.1130
83	41.6	8.0	672.0	848.0	649.5	123.5	1.3	0.1470
83	41.6	10.0	884.0	1080.0	913.5	124.4	0.8	0.1770
84	45.6	4.0	292.0	359.4	321.5	119.0	--	0.0730
84	45.6	6.0	460.0	562.0	530.6	120.4	2.1	0.1090
84	45.6	8.0	670.0	844.3	803.7	121.3	1.0	0.1390
84	45.6	10.0	854.0	1120.0	1010.0	121.9	0.4	0.1670
87	40.4	5.0	383.0	513.6	409.0	121.2	3.6	0.0940

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
87	40.4	7.0	587.0	794.7	682.2	122.4	1.2	0.1280
87	40.4	9.0	826.0	1071.7	931.7	123.2	0.7	0.1600
93	33.2	4.0	207.0	354.2	166.0	121.7	39.9	0.0790
93	33.2	6.0	370.0	612.9	409.0	123.1	1.7	0.1160
93	33.2	8.0	514.0	875.7	620.7	124.2	0.9	0.1490
93	33.2	10.0	698.0	1271.7	931.7	124.8	0.5	0.1790
96	28.0	4.0	331.0	446.9	223.5	124.5	27.4	0.0850
96	28.0	6.0	498.0	624.7	433.8	125.7	3.1	0.1240
96	28.0	8.0	622.0	814.2	695.2	125.7	1.2	0.1550
96	28.0	10.0	776.0	1035.1	824.5	126.0	1.2	0.1850
100	30.4	4.0	189.0	346.4	311.1	121.3	2.9	0.0760
100	30.4	6.0	385.0	618.2	529.3	123.7	1.2	0.1170
100	30.4	8.0	658.0	977.6	863.8	125.7	0.8	0.1550
100	30.4	10.0	925.0	1398.5	1220.0	126.4	0.6	0.1860
109	53.5	4.0	292.0	382.9	250.9	123.2	28.9	0.0820
109	53.5	6.0	401.0	513.7	307.1	122.4	3.6	0.1130
109	53.5	8.0	450.0	677.0	448.2	122.6	1.2	0.1430
109	53.5	10.0	540.0	765.9	534.4	123.0	1.0	0.1710
110	39.9	4.0	261.3	297.9	----	124.0	54.5	0.0837
110	39.9	6.0	381.6	401.2	312.3	124.2	14.1	0.1184
110	39.9	8.0	467.8	522.8	398.6	124.4	1.9	0.1494
112	47.5	4.0	312.3	405.2	294.1	124.5	30.0	0.0849
112	47.5	6.0	413.0	590.8	389.4	125.5	4.5	0.1226
112	47.5	8.0	520.1	716.2	606.3	125.5	1.7	0.1537
112	47.5	10.0	620.7	843.0	709.6	125.3	1.1	0.1803
114	25.7	5.0	299.2	386.9	367.2	120.1	2.7	0.0913
114	25.7	7.0	556.7	704.4	671.7	121.4	1.3	0.1247
114	25.7	9.0	757.8	1113.6	976.1	122.8	0.6	0.1569
115	40.0	5.0	381.6	497.9	312.3	120.7	4.5	0.0928
115	40.0	7.0	512.3	709.7	525.3	121.3	1.8	0.1244
115	40.0	9.0	737.0	947.6	757.8	122.2	1.0	0.1546
116	30.2	5.0	334.5	458.8	362.0	121.2	2.3	0.0940
116	30.2	7.0	525.3	743.7	623.3	122.7	1.2	0.1289
116	30.2	9.0	773.6	1104.4	963.2	124.4	1.1	0.1633
120	27.0	6.0	364.6	524.1	454.7	120.5	1.4	0.1075
120	27.0	8.0	613.0	----	740.9	122.0	0.8	0.1406
120	27.0	10.0	870.4	-----	1073.0	123.3	0.3	0.1717
166	40.2	5.0	372.4	571.1	350.1	121.6	25.8	0.0950
166	40.2	7.0	551.4	854.8	695.2	122.5	2.7	0.1282
166	40.2	9.0	773.6	1107.0	929.2	123.5	1.1	0.1596
22	28.8	4.0	304.5	373.8	279.7	127.7	2.2	0.0930
22	28.8	6.0	556.7	793.3	662.5	128.7	0.9	0.1339
22	28.8	8.0	965.6	1250.8	1046.0	130.3	0.4	0.1746
56	44.6	7.0	716.9	926.7	782.7	124.4	1.1	0.1350
56	44.6	9.0	968.3	1300.5	1072.0	125.5	0.7	0.1690
56	44.6	11.0	1250.0	1701.7	1525.0	126.7	0.1	0.2010
62	21.3	4.0	229.0	316.3	267.9	120.1	4.0	0.0750
62	21.3	6.0	543.7	691.4	622.0	123.7	1.2	0.1170
62	21.3	8.0	918.7	1131.9	1046.0	126.1	0.7	0.1570
62	21.3	10.0	1261.0	1538.3	1293.0	127.6	0.3	0.1920
78	30.0	4.0	299.0	414.3	329.4	125.6	2.4	0.0680
78	30.0	6.0	555.0	751.5	675.6	127.5	1.2	0.1300
78	30.0	8.0	939.0	1323.9	1069.0	128.6	0.7	0.1680
82	32.0	5.0	447.0	567.2	471.8	125.2	2.4	0.1050

SAND SOURCE	GRAD MOD	CEMENT %	COMPRESSIVE STRENGTH PSI			AV. DENSITY	F.T.LOSS	C/V
			7 DAY	28 DAY	7 DAY F.T.			
82	32.0	7.0	731.0	931.9	748.9	126.6	1.0	0.1440
82	32.0	9.0	961.0	1224.7	1120.0	126.5	0.5	0.1730
101	18.0	3.0	192.0	313.7	211.6	126.5	7.1	0.0700
101	18.0	5.0	444.0	588.1	543.7	129.1	1.4	0.1180
101	18.0	7.0	725.0	1066.5	997.0	130.8	1.1	0.1610
101	18.0	9.0	1035.0	1505.7	1461.0	131.9	0.2	0.2000
159	11.3	3.0	146.3	254.8	----	125.7	56.9	0.0682
159	11.3	5.0	437.7	687.5	538.4	129.2	1.3	0.1173
159	11.3	7.0	622.0	1292.6	1087.0	130.7	0.3	0.1598
41	36.1	3.0	317.6	475.7	----	133.1	21.8	0.0856
41	36.1	5.0	497.8	683.6	530.6	133.6	2.5	0.1337
41	36.1	7.0	721.3	980.3	773.6	133.5	1.1	0.1730
107	13.7	4.0	342.0	530.6	446.9	130.9	5.8	0.1030
107	13.7	6.0	649.0	982.9	845.5	132.6	1.6	0.1510
107	13.7	8.0	1083.0	1500.4	1314.0	134.1	2.1	0.1960
108	34.4	3.0	319.0	449.6	202.5	131.8	38.3	0.0830
108	34.4	5.0	475.0	691.4	504.4	132.1	3.5	0.1290
108	34.4	7.0	641.0	952.8	778.7	131.5	0.9	0.1650
108	34.4	9.0	823.0	1208.9	1020.0	131.9	0.8	0.2000
121	8.8	2.0	201.2	253.6	172.5	130.3	15.5	0.0544
121	8.8	4.0	524.0	----	560.7	133.8	1.1	0.1121
121	8.8	6.0	943.4	----	1121.0	135.6	0.7	0.1641
122	15.8	2.0	181.7	303.0	-----	131.5	60.0	0.0566
122	15.8	4.0	504.4	----	666.5	134.0	1.3	0.1128
122	15.8	6.0	1052.0	----	1287.0	136.0	0.7	0.1662
123	10.2	2.0	202.5	295.4	-----	131.7	17.0	0.0569
123	10.2	4.0	508.2	691.4	614.2	134.4	0.8	0.1143
123	10.2	6.0	1052.0	----	1200.0	136.0	0.8	0.1662
125	16.2	3.0	258.7	432.6	415.6	132.2	2.2	0.0832
125	16.2	5.0	622.0	----	875.6	133.3	1.2	0.1325
125	16.2	7.0	1120.0	----	1486.0	136.3	0.4	0.1881
203	21.0	3.0	359.3	475.7	429.9	128.8	3.6	0.0748
203	21.0	5.0	855.9	1120.0	1011.0	131.5	1.5	0.1255
203	21.0	7.0	1449.0	1934.0	1807.0	132.6	0.8	0.1686