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# VARIABILITY OF AN EXPANSIVE CLAY DEPOSIT

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ABSTRACT

The city of Regina, Saskatchewan, Canada, is located on a large deposit of highly plastic expansive proglacial lake sediments. Numerous site investigations in this city have resulted in the accumulation an extensive amount of data on the classification properties, volume-weight relationships, volume change characteristics, and undrained shea strength properties of these sediments. Statistical analysis of the da shows relatively low dispersion tendencies except in the cases where th frequency distributions become multimodal (i.e., generally with depth). In these situations, more than one distinct soil type is incorporated into the sample, rendering some of the other statistical properties of limited value. The most pronounced dispersion and variability is exhibited by the frequency curves for the unconfined shear strength. Examination of the one-dimensional consolidation tests shows that it is necessary to correct for sample disturbance to obtain meaningful information on the insitu state of stress. Limited interpretations were performed for most of the other data.

## INTRODUCTION

The city of Regina, Saskatchewan, Canada, is underlain by proglaci lake sediments in the order of 40 feet (12 metres) in thickness. No continuous water table is evident in the lacustrine sediments and the upper portion of the deposit is highly desiccated and fissured. The most serious foundation problem in the city of Regina is the heaving of light structures founded in the upper expansive soil. Glacial till lies below the lacustrine sediments. Boreholes for foundation investigations are generally carried through the lacustrine sediments and well into the glacial till. Over the years, hundreds of testholes have beer advanced through the Regina lake sediments, most of them in the downtow area (Figure 1). Similar sub-surface investigation procedures and laboratory testing programs between the investigations provided a good

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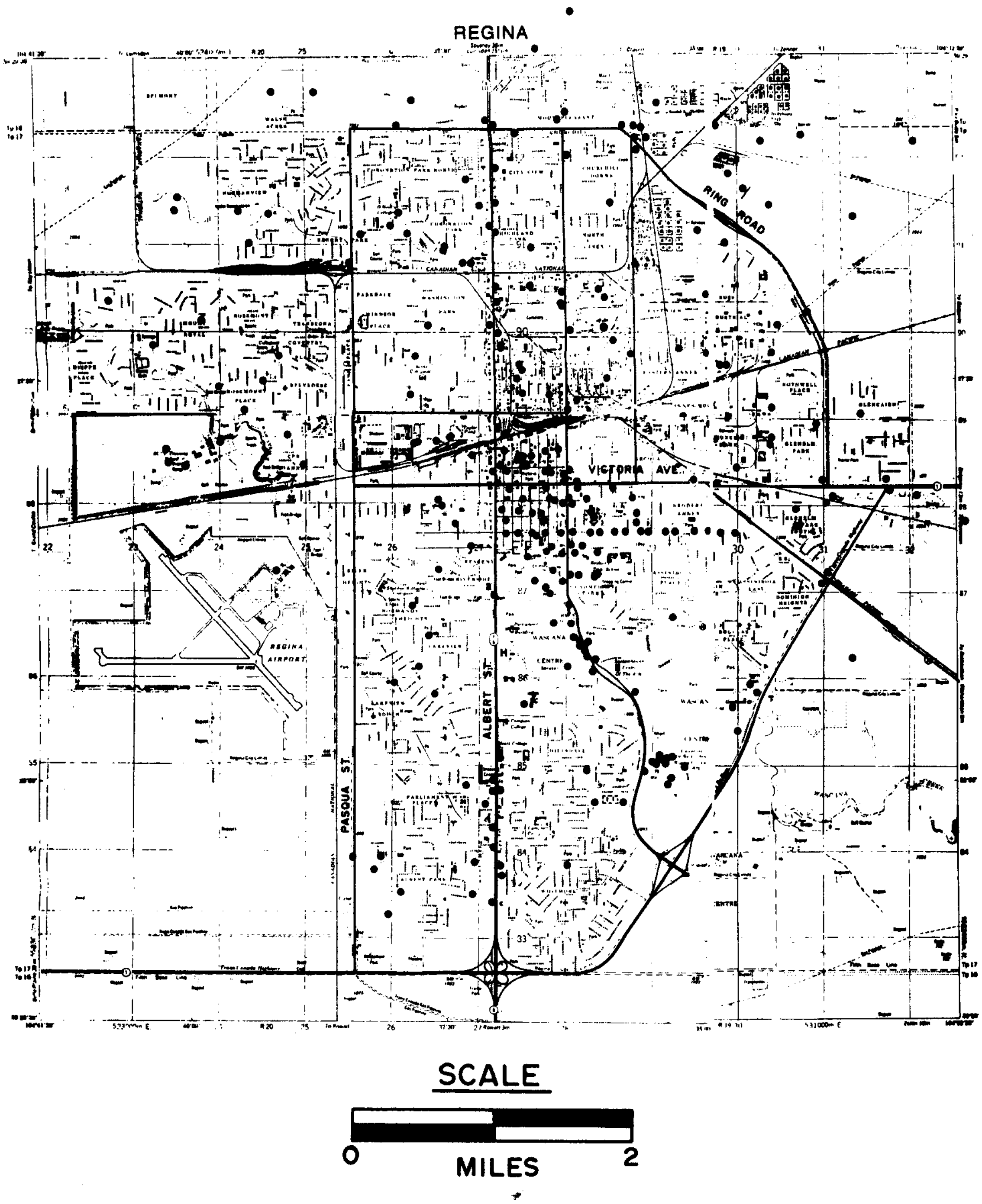


Figure 1 Test Hole Locations in Regina City

opportunity for performing statistical analyses on the soil properties.

Statistical evaluation of soil properties provides the engineer with a valuable indication of the "central" and "dispersion" tendencies of the soil properties of a deposit (Fredlund and Dahlman, 1969). The results reflect the general trend of the properties and provide a preliminary knowledge about the soil characteristics in an area. Individual site investigations are always required for each area under consideration since the statistics can only be used as an aid in arriving at valid assessments and relationships. Moreover, the statistical analysis of a large number of tests can provide insight into improved procedures for the interpretation of a test. Such is the case in this study for the one-dimensional consolidation tests performed on the expansive Lake Regina sediments.

At present, most of soil mechanics is based on a deterministic approach. However, one of the active areas of research in geotechnical engineering pertains to the application of the probability theory to geotechnical problems. In this case the soil properties must be represented as a stochastic distribution. The "central" and "dispersion" tendencies provide the necessary input to the analysis. Even in the case when a deterministic approach is used, it is useful to perform a "sensitivity" type of analysis where the soil properties are varied and their effect upon the solution is studied. Again the statistical soil properties provide useful data on the probable variability of each soil property.

The objective of the paper is to quantify the "central" and "dispersion" tendencies of an expansive clay deposit and also provide some interpretation of the statistical soil properties.

## DEFINITION OF STATISTICAL TERMS

The behavior of a "sample" taken from a "population" can be described in terms of its central tendencies, dispersion tendencies, asymmetry and peakedness. One or more measures of each of the above properties provides a complete understanding of the frequency distribution. In this study an attempt has been made to use the most commonly used statistical properties (Neville and Kennedy, 1964).

Measures of Central Tendencies:

(i) Mean: the summation of all observations divided by the number of observations.

(ii) Median: the middle observation (or the arithmetic mean of the two middle observations) when the observations are arranged in order of their magnitude.

(iii) Mode: the value which occurs with the greatest frequency. The value chosen for the mode may depend upon the number of observations and the class interval used in the analysis.

Measures of Dispersion Tendencies:

(i) Standard Deviation: the square root of the mean of the squares of the deviations from the mean. One standard deviation on either side of the mean on a normal distribution curve encloses 68.3 percent of the observations.

(ii) Coefficient of Variation: is equal to the standard deviation divided by the mean. It is independent of the units of the variable under consideration and useful when comparing frequency distributions.

(iii) Ninety-five Percent Confidence Interval: the range of values which enclose 95 percent of the observations.

For a symmetrical (i.e., normal) distribution curve, the 95 percent confidence limits are equal to plus or minus 1.96 times the standard deviation. As the distribution becomes skewed, this range becomes progressively less accurate. For this reason, the 95 percent confidence limits have been computed on the basis of the actual sample of observations. In other words, 2.5 percent of the observations were omitted from both ends of the actual sample to obtain the 95 percent confidence limits.

Skewness is the degree of asymmetry or is a measure of the departure from symmetry of a frequency distribution. If the frequency curve has a longer "tail" to the right of the central maximum than to the left, the distribution is said to be skewed to the right or to have a positive skewness. If the reverse is true, it is said to be skewed to the left or to have a negative skewness. The measure of skewness is sometimes called the third moment and will take on a value of zero when the distribution curve is perfectly symmetric.

Kurtosis is the degree of peakedness of a frequency distribution, and is computed as the fourth moment of the deviations about the mean expressed in dimensionless form. Since the value is equal to three for a normal distribution, kurtosis is herein defined as the dimensionless form of the fourth moment minus three. Therefore, kurtosis is positive for a high-peaked distribution and negative for a flat-topped distribution and zero for a normal distribution.

The statistical analysis of the geotechnical properties is presented in several forms. The table in Appendix A summarizes all the statistical geotechnical properties for various depth increments. Several of the frequency histograms are shown and analyzed. To assist in the rapid interpretation of the statistical properties with depth, a diagrammatic representation of the frequency distribution curve is used (Figure 2). The 95 percent confidence limits are plotted to form the base of the triangle. The mode becomes the x-coordinate for the apex. The y-coordinate of the apex is established by setting zero kurtosis at some standard value, and plotting a plus or minus kurtosis to some predetermined scale. The median can be plotted on the base of the triangle and the slope of the line passing from the median through the mode gives an indication of skewness. The mean is plotted as a dashed vertical line and also printed on the figure. In this way, a plot of several distribution curves versus some other variable such as depth, allows a rapid examination of the statistical properties.

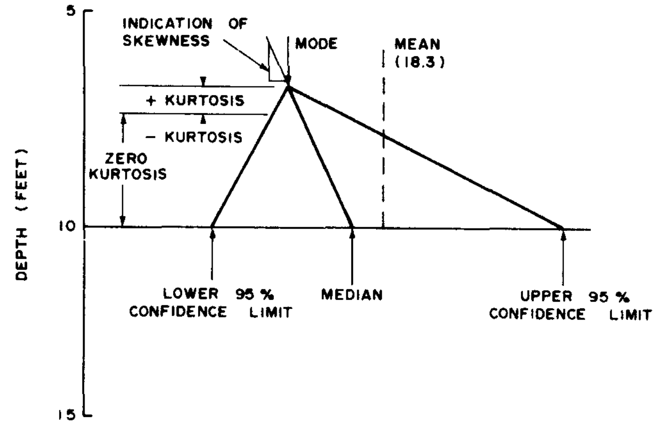


Figure 2 Diagrammatic Representation of a Frequency Distribution Curve

## PHYSICAL FEATURES OF THE REGINA AREA

The climate of the Regina area may be classed as a semi-arid to sub-humid type. The temperature varies widely from summer to winter, averaging about +15°C. The precipitation in Regina varies from about 12 inches (30 cm) to nearly 18 inches (46 cm), with snow contributing about 25 percent of the year's total. The relatively arid condition gives rise to a pore-water pressure deficiency in the lacustrine sediments.

The city of Regina is located near the center of the Assiniboine River Plain and has a local relief less than ten feet (3 metres), except for the Qu'Appelle and Arm River channels and associated tributaries (Figure 3). The bedrock below the Regina area was covered by ice during the Pleistocene Epoch. As a result, glacial till immediately overlies the shale which, in turn, is overlain by lacustrine silts and clays.

The thickness of the lacustrine silts and clays is in the order of 40 feet (12 metres) below Regina city. The Regina clay deposit generally consists of a dark brown clay unit near the ground surface. It becomes light, greyish brown and siltier with depth. Sometimes the silty unit extends down to the underlying glacial till and sometimes reverts back to a clay unit which overlies the till. The silty unit becomes thicker as the Condie Moraine is approached towards the northeast. A typical cross-section of the surficial stratigraphy is shown in Figure 4. The upper portion of the Regina clay has a crumbly, nuggetty macro-structure. The nuggest become larger, grading to a fissured, slicken-sided mass below approximately ten feet (3 metres).

## PRESENTATION AND DISCUSSION OF SOIL PROPERTIES

The system for analyzing the laboratory test data is based on the geological evidence that lateral similarity of soil properties generally

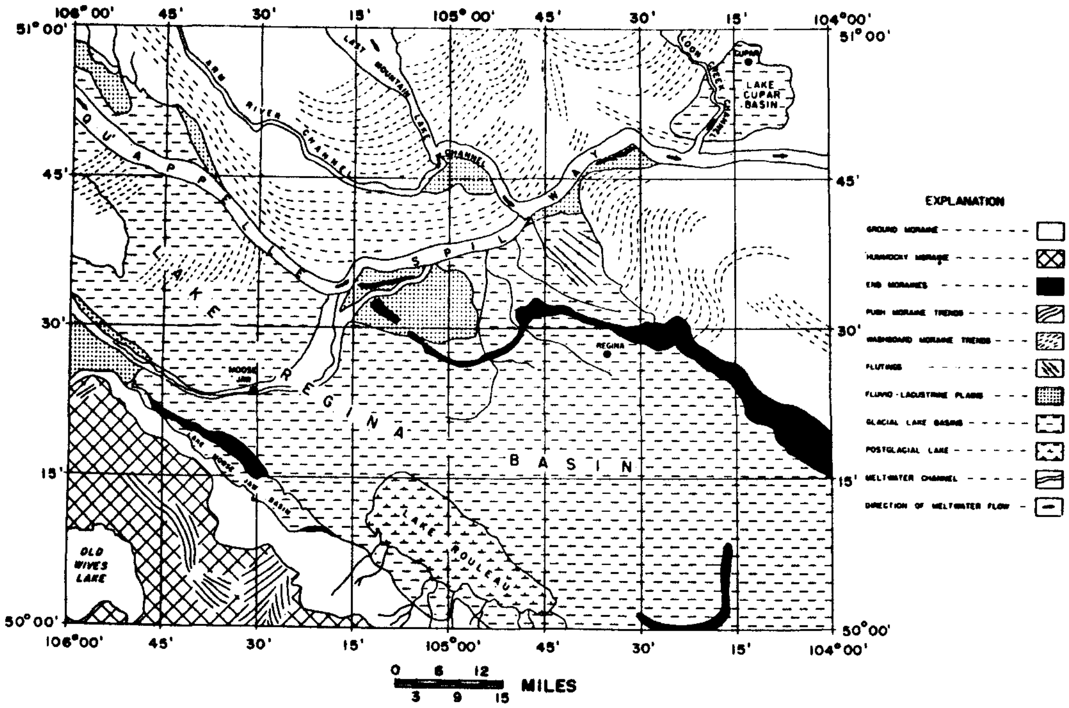


Figure 3 Final Stages of the Glacial History of the Regina Area (From Christiansen, 1961)

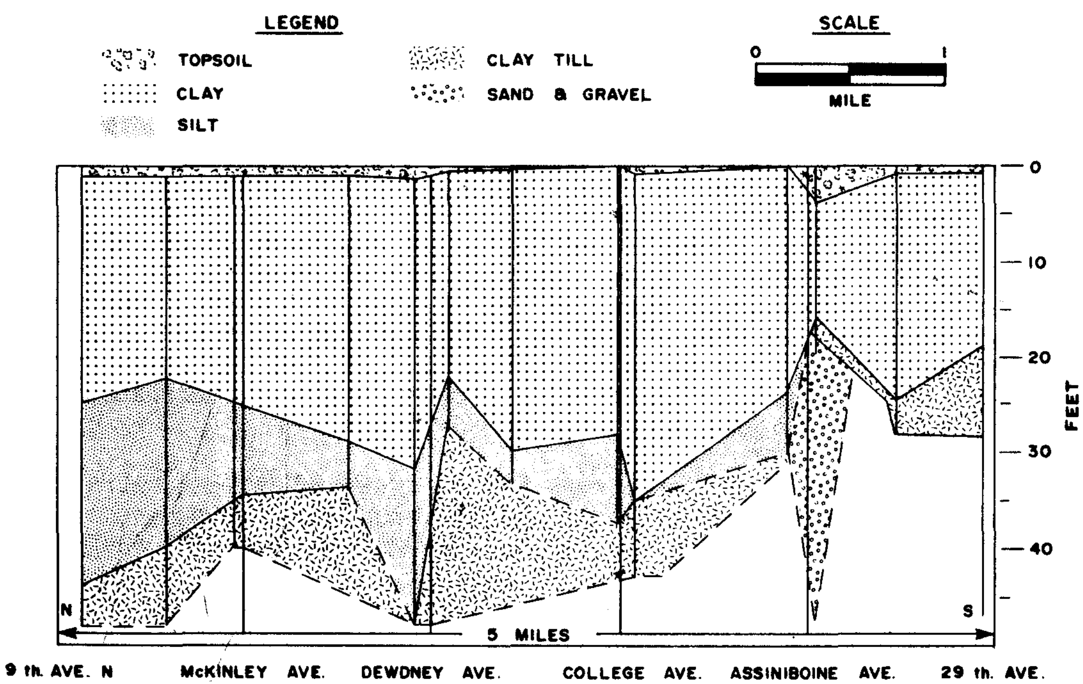


Figure 4 Stratigraphic Cross-Section Along or Near Albert St., Regina, N.-S. Line (From Fredlund, 1975)

exists. Vertical variability of soil properties can be analyzed with respect to depth below ground surface provided the depth of the sediments do not vary significantly and distinct divisions within the stratigraphy do not occur.

Initially the city was divided into four quadrants, but the soil property statistics were not significantly different (Cheng, 1977). Therefore, the entire city area was analyzed as one unit. The statistical properties presented, indicate the lateral and vertical variability of the soil properties.

The soil properties have been divided in four categories; classification, volume-weight relationships, volume change characteristics and shear strength properties.

## CLASSIFICATION PROPERTIES

### Mineralogical Composition and Exchange Capacities

The average of approximately twenty-five X-ray diffraction tests indicates that Regina clay consists of 53 percent montmorillonite, 35 percent illite and 12 percent kaolinite (Gardiner, 1965; Fredlund, 1975). Seventy-five percent of the available positions around the soil particle are occupied by calcium cations. The soil can be classified as a calcium montmorillonitic clay. The soil has an average cation exchange capacity of 31.7 milli-equivalents per 100 grams of dry soil.

### Grain Size Distribution

The average of numerous hydrometer analyses show an average of 50 percent clay sizes, 38 percent silt sizes and 3 percent sand sizes for Regina clay (Fredlund, 1975).

### Atterberg Limits

Graphical representations of the frequency distributions for the liquid limit and plastic limit tests are shown in Figure 5. The mean liquid limit ranges from 74.5 near surface to 51.6 percent at a depth of 25 feet (7.5 metres). At the 15-foot (4.5-metre) depth the frequency distribution becomes bimodal, indicating the combining of data from two distinct soil types (i.e., the highly plastic clay and the silty soil). The dispersion tendencies also show an increase with depth. The frequency distributions show that silt is encountered at 15 feet (4.5 metres) and becomes the dominant soil type at 20 feet (6 metres) and below. The mean plastic limits also indicate a gradual decrease with depth, ranging from 28.6 percent and 22.0 percent.

Frequency distribution curves for the upper 20 feet (6 metres) are skewed slightly to the left while the remainder are skewed slightly to the right. Most of the curves are less peaked than a normal distribution curve.

Figures 6 and 7 show the liquid limit and plastic limit histograms, respectively, for the 5-foot (1.5 metre) (average) depth. The liquid limit frequency distribution curve is close to a normal distribution. All central tendency measurements are approximately the same. The

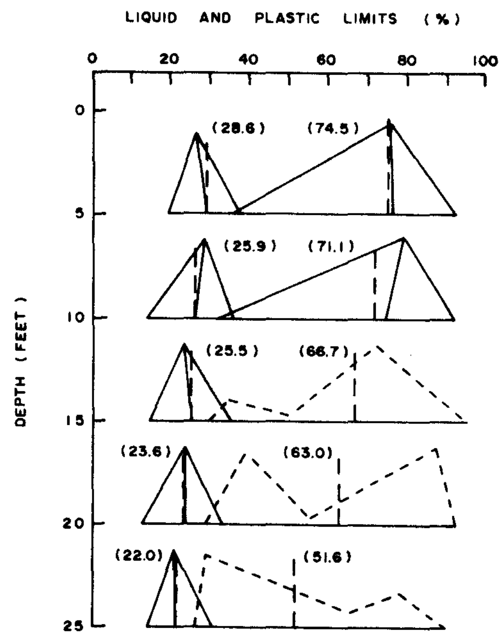


Figure 5 Liquid and Plastic Limit Frequency
Distributions Versus Depth

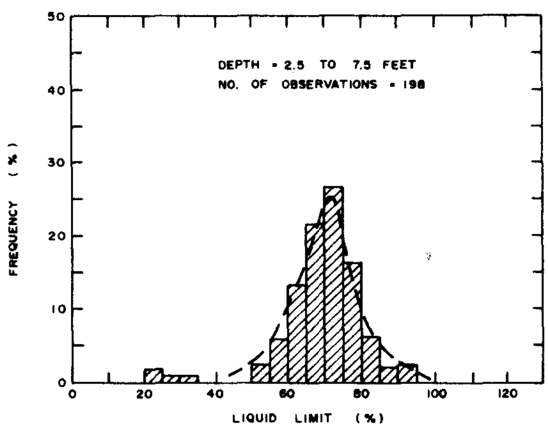


Figure 6 Liquid Limit Histogram (Average Depth of 5 Feet)

dispersion tendencies are low. The frequency distribution is skewed slightly to the left and is more peaked than a normal distribution curve.

The plastic limit frequency distribution curve shows that all central tendency measurements are approximately the same. The dispersion measurements are low. The skewness and kurtosis are approximately equal to those of a normal distribution curve.

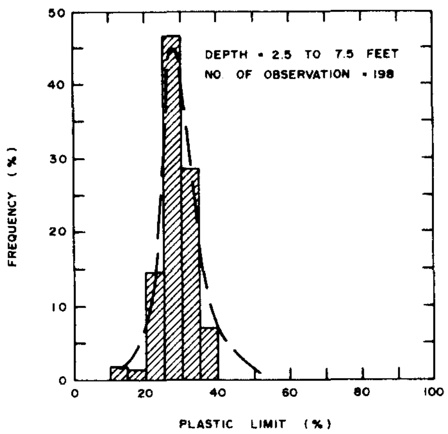


Figure 7 Plastic Limit Histogram (Average Depth of 5 Feet)

Figures 8 and 9 show the liquid and plastic limit histograms, respectively, for the 15-foot (4.5-metre) (average) depth. The distribution curves become bimodal due to the mixing of the silt and clay portions of the lacustrine sediments. The modal values are the only central tendency measurements that have significance.

The plastic limit distribution curve (Figure 9) shows only one mode. However, the dispersion is increased slightly due to the mixing of the silt and clay.

According to the plasticity chart, the soil can be classified as a medium to high plastic inorganic clay. The medium plastic soil is the silty portion while the highly plastic soil is commonly referred to as Regina clay.

## VOLUME-WEIGHT PROPERTIES

The specific gravity of Regina clay is generally between 2.79 and 2.83.

### Water Content

The statistical properties on the natural water contents are shown in Figure 10. The histograms for the 5-foot (1.5-metre) and 10-foot (3-metre) depths are shown in Figures 11 and 12, respectively. The mean water contents are constant at approximately 29 percent in the upper 10 feet (3 metres). There is a gradual decrease with depth to a water content of 23 percent at 30 feet (9 metres). The dispersion properties are low in the upper 10 feet (3 metres), increasing with depth. The dispersion effects due to seasonal variations are not discernable. The frequency distribution curves become bimodal below a depth of 20 feet (6 metres), showing the separation of the silt and clay. Most of the frequency distributions are skewed to the left of their central maxima. The frequency distribution curves down to 10 feet (3 metres) are more peaked than a normal distribution curve, whereas the remaining curves show a negative kurtosis. The dispersion properties increase with depth. Most of the statistical properties, including skewness and kurtosis,

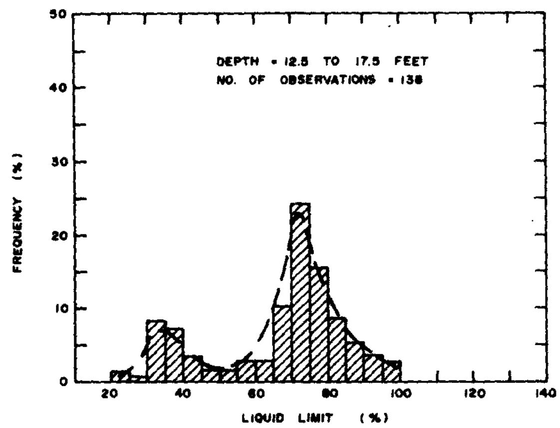


Figure 8  Liquid Limit Histogram (Average Depth of 15 Feet)

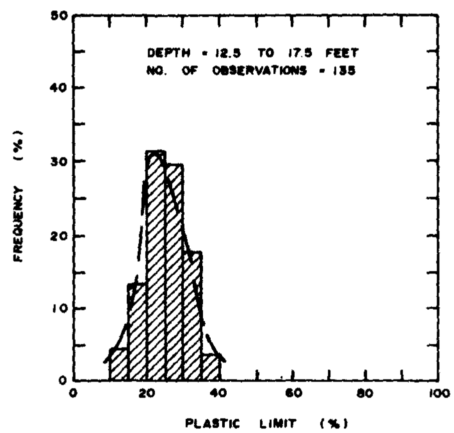


Figure 9  Plastic Limit Histogram (Average Depth of 15 Feet)

become meaningless when the frequency distribution is bimodal.

Dry Density

Figure 11 shows the frequency distributions of dry density versus average depth below ground surface. The mean dry density ranges between 93.0 and 100.6 pound per cubic foot (14.6 and 15.8 kN/m$^3$). The dispersion results are low for the upper 10 feet (3 metres), becoming larger with depth.

Void Ratio

The void ratios for the statistical analysis were obtained from a limited number of one-dimensional consolidation tests. The mean void ratios at the 200 pound per square foot (9.6 kPa) loading range are between 0.99 and 0.95, showing a slight decrease with depth.

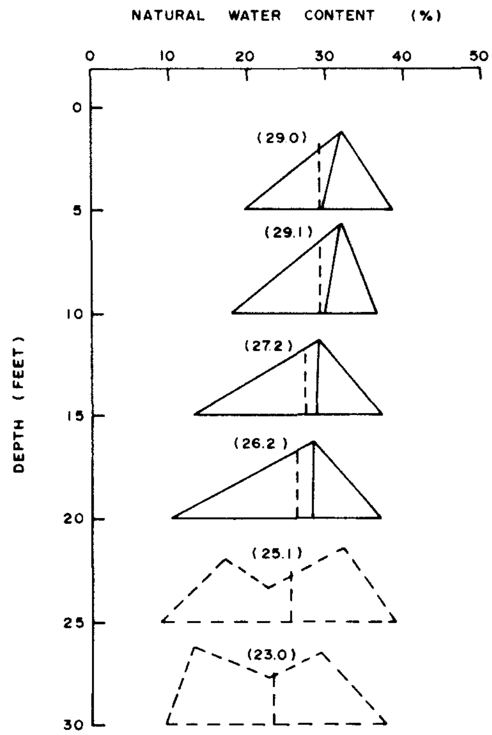


Figure 10 Natural Water Content Frequency Distributions Versus Depth

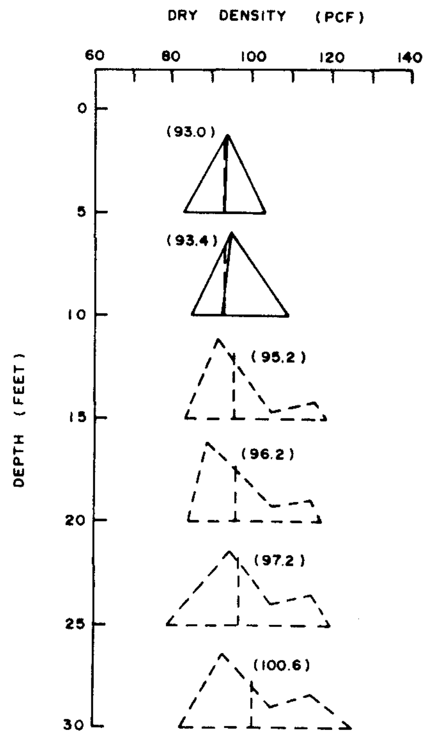


Figure 11 Dry Density Frequency Distributions Versus Depth

Degree of Saturation

Degrees of saturation were obtained from one-dimensional consolidation tests. The mean degree of saturation in the upper 30 feet (9 metre showed a gradual increase with depth and ranged from 90 to 95 percent. The standard deviation was 7.2 percent at a depth of 10 feet (3 metres) and 3.6 perce at a depth of 20 feet (6 metres).

## VOLUME CHANGE CHARACTERISTICS

The one-dimensional consolidation tests were analyzed to give an indication of the stress history of the deposit and its deformation characteristics. All available consolidation data was analyzed according to depth below ground surface. Compressive indices were measured on the steepest portion of the consolidation curve (i.e., 6000 to 16,000 pounds per square foot) (290 to 770 kPa). The mean value shows a slightly increasing compressive index for the upper 30 feet (9 metres) with all values in the low to medium compressive range, reflecting the effect of desiccation. The frequency distributions for the swelling indices for various depths are presented in Figure 12. The mean swellin index is consistent at 0.065 with depth. Figure 13 presents a graphical frequency distribution for the uncorrected swelling pressures along with the mean corrected swelling pressures. The corrections are to compensat for sample disturbance according to the procedure proposed by Fredlund et al (1980). The uncorrected mean swelling pressures show a decreasing trend with depth. The corrections for sample disturbance result in a substantial increase in the swelling pressure. For example, the mean uncorrected swelling pressure at a depth of 10 feet (3 metres) is 1540 pounds per square foot (73.6 kPa) and it increases to 3400 pounds per square foot (162.6 kPa) when corrected for sample disturbance.

Consolidation curves have been constructed for the Regina clay at various depths below ground surface by averaging the void ratios under various applied loads. Figures 14, 15 and 16 show the void ratio versus

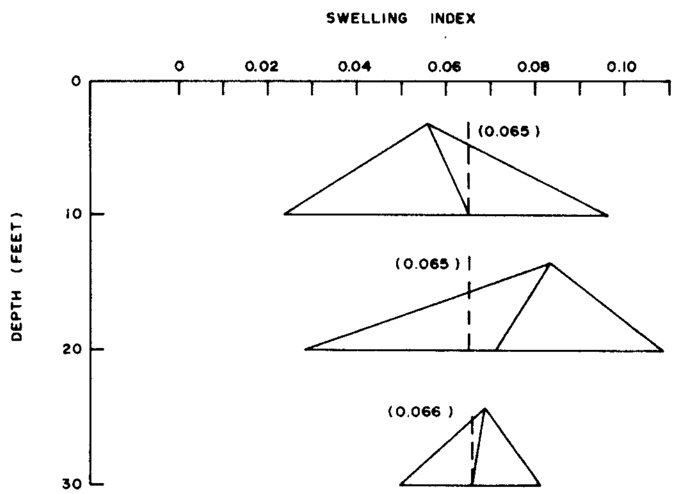


Figure 12 Swelling Index Frequency Distributions Versus Depth

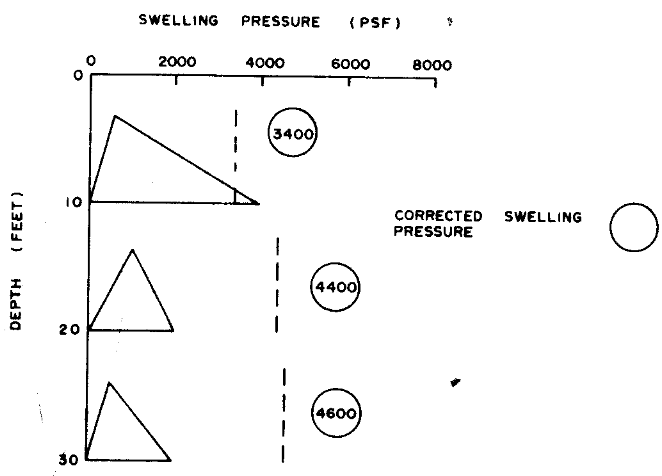


Figure 13 Swelling Pressures Versus Depth

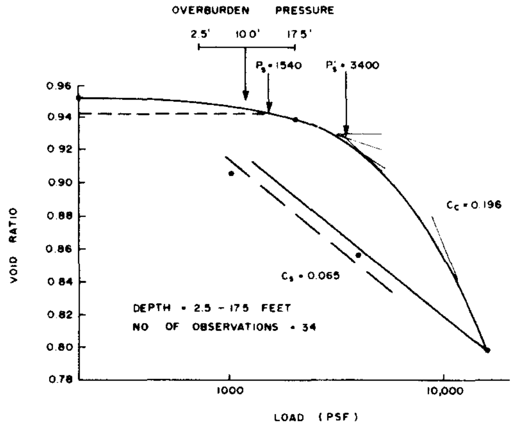


Figure 14 Void Ratio Versus Log. Pressure Curve For Regina Clay (Average Depth of 10 Feet)

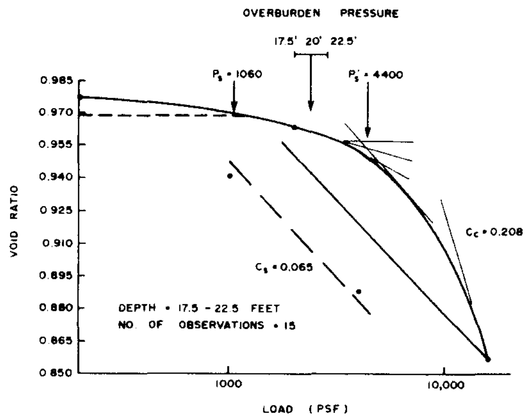


Figure 15 Void Ratio Versus Log. Pressure Curve For Regina Clay (Average Depth of 20 Feet)

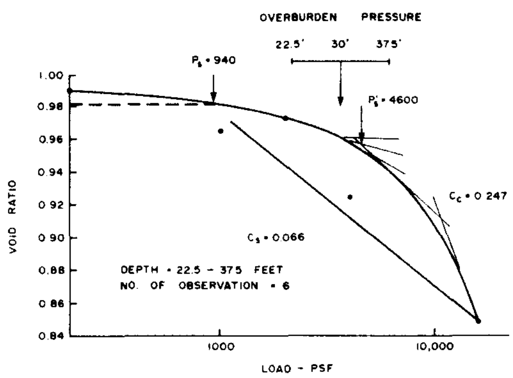


Figure 16 Void Ratio Versus Log. Pressure Curve For Regina Clay (Average Depth of 30 Feet)

logarithm of pressure curves for depths of 10, 20 and 30 feet (3, 6 and 9 metres). The total overburden pressure is shown on Figures 14 to 16 along with the uncorrected and corrected swelling pressures. At the 20 and 30 foot (6 and 9 metre) depths, the uncorrected swelling pressures are shown to be below the total pressure. A conventional interpretation would suggest that the soil is normally consolidated or under-consolidated. However, this cannot be the case since generally no water table exists in the lacustrine sediments. Rather, the soil is desiccated and dried throughout its entire depth. The magnitude of the natural water contents relative to the liquid and plastic limits also confirm the desiccated nature of the deposit. When the corrections for sample disturbance are applied to the consolidation curves, the swelling pressures exceed the overburden pressure and give an indication of the magnitude of the matrix suction in the soil. In other words, it is necessary to correct for sample disturbance in order to get a meaningful interpretation of the one-dimensional consolidation tests on an expansive soil.

## SHEAR STRENGTH PROPERTIES

The undrained strength obtained from unconfined compression tests was analyzed and the frequency distributions are plotted versus depth in Figure 17. All frequency distribution curves are unimodal and show a pronounced positive skewness at all depths. The soil shows a somewhat higher mean strength and increased dispersion at the surface.

Figure 18 shows the histogram for the 15 foot (4.5 metre) depth and demonstrates the strong positive skewness of the distribution. If the distribution curve is plotted as frequency versus the logarithm of the compressive strength, the curve reverts to essentially a normal distribution curve. This is reasonable since the logarithm of shear strength of a soil is linearly related to water content. The logarithmic dispersion properties of shear strength are of interest when using a probability type analysis.

## CONCLUDING REMARKS

The statistical analysis of the classification test data shows the Lake Regina sediments to be relatively uniform. The uniformity remains with depth provided the possibility of two soil types is taken into account. The volume-weight soil properties also show relatively low statistical dispersion values. It is not possible to observe the effects of seasonal changes in natural water content on the histograms near ground surface.

The consolidation test data show that it is necessary to apply a correction to account for the effect of sampling disturbance in order to obtain a meaningful interpretation of the insitu state of stress. The statistics on both the consolidation test data and the shear strength data show increased dispersion at all depths. These substantiate that small changes in natural water content can cause substantial changes in the insitu state of stress and the shear strength of the soil.

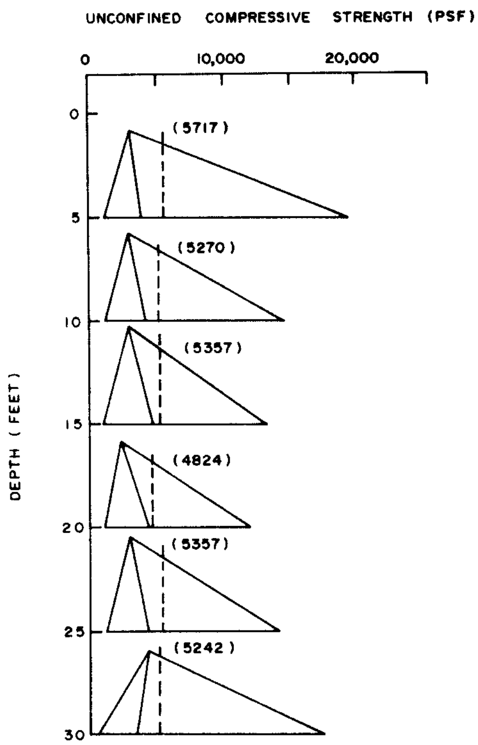


Figure 17 Unconfined Compressive Strength Frequency Distributions Versus Depth

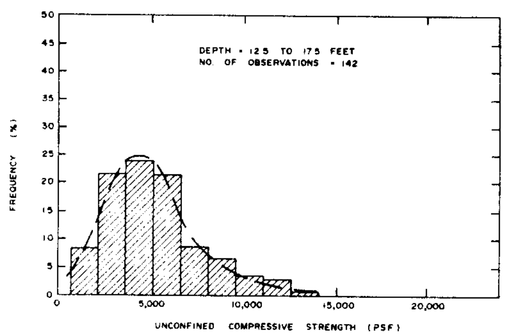


Figure 18 Unconfined Compressive Strength Histogram (Average Depth of 15 Feet)

TABLE 1

Statistics on Various Soil Properties

| Soil Property | Average Depth | No. of Observations | Mean | Median | Mode | Standard Deviation | Coefficient of Variation | 95 Percent Confidence Limits Lower | 95 Percent Confidence Limits Upper | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Liquid Limit | 5 | 198 | 74.5 | 75.7 | 75.0 | 11.2 | 15.0 | 35.6 | 92.2 | -1.4 | 4.0 |
| | 10 | 214 | 71.1 | 74.1 | 78.8 | 14.5 | 20.4 | 32.0 | 91.4 | -0.96 | 1.13 |
| | 15 | 138 | 66.7 | 72.0 | *35.0<br>*72.0 | 18.7 | 28.0 | 30.0 | 95.5 | **-0.73 | **-0.46 |
| | 20 | 137 | 63.0 | 68.5 | *39.7<br>*88.0 | 22.1 | 35.1 | 29.1 | 92.8 | **-0.21 | **-1.46 |
| | 25 | 106 | 51.6 | 42.0 | *29.0<br>*78.0 | 20.9 | 40.4 | 26.5 | 90.0 | ** 0.54 | **-1.15 |
| | 30 | 124 | 44.9 | 39.4 | *40.0<br>*65.0 | 15.8 | 35.2 | 28.5 | 80.7 | ** 1.23 | ** 0.50 |
| Plastic Limit | 5 | 198 | 28.6 | 28.6 | 26.0 | 4.6 | 16.2 | 19.0 | 37.0 | -0.38 | 0.84 |
| | 10 | 212 | 25.9 | 26.3 | 28.0 | 5.0 | 19.2 | 14.0 | 35.3 | -0.29 | -0.05 |
| | 15 | 135 | 25.5 | 25.3 | 23.7 | 5.5 | 21.5 | 15.0 | 35.35 | -0.07 | -0.37 |
| | 20 | 137 | 23.6 | 24.0 | 24.0 | 5.0 | 21.3 | 13.65 | 33.5 | -0.22 | -0.45 |
| | 25 | 104 | 22.0 | 21.9 | 21.0 | 4.6 | 20.7 | 14.25 | 30.85 | 0.28 | -0.34 |
| | 30 | 124 | 21.3 | 21.2 | 19.0 | 4.6 | 21.8 | 14.85 | 28.36 | 1.50 | 6.26 |
| Natural Water Content | 5 | 408 | 29.0 | 29.6 | 32.0 | 5.0 | 17.1 | 19.8 | 38.5 | 0.05 | 0.34 |
| | 10 | 375 | 29.1 | 29.9 | 32.0 | 5.0 | 17.0 | 18.0 | 36.5 | -0.35 | 3.56 |
| | 15 | 246 | 27.2 | 28.3 | 29.0 | 6.4 | 23.4 | 13.0 | 37.0 | -0.66 | -0.20 |
| | 20 | 289 | 26.2 | 28.0 | 28.0 | 7.4 | 28.1 | 10.4 | 37.1 | -0.74 | -0.01 |
| | 25 | 202 | 25.1 | 26.5 | *32.0<br>*17.0 | 8.8 | 35.0 | 8.8 | 38.7 | **-0.12 | **-0.82 |
| | 30 | 248 | 23.0 | 23.0 | *34.0 | 8.7 | 37.9 | 9.4 | 37.4 | ** 0.07 | **-1.21 |
| Dry Density | 5 | 175 | 93.0 | 92.6 | 94.0 | 5.7 | 6.1 | 83.1 | 103.5 | 0.27 | 0.27 |
| | 10 | 211 | 93.4 | 92.6 | 95.0 | 6.4 | 6.9 | 85.0 | 109.2 | 1.33 | 3.27 |
| | 15 | 146 | 95.2 | 92.4 | *92.0<br>*115.0 | 9.3 | 9.8 | 83.3 | 119.1 | ** 1.18 | ** 0.67 |
| | 20 | 167 | 96.2 | 93.1 | *89.0<br>*115.0 | 9.8 | 10.2 | 84.15 | 117.8 | ** 1.10 | ** 0.28 |
| | 25 | 106 | 97.2 | 94.2 | *117.5<br>*95.0 | 12.0 | 12.3 | 78.6 | 120.0 | ** 0.68 | **-0.49 |
| | 30 | 136 | 100.6 | 94.1 | *93.0 | 13.9 | 13.8 | 83.5 | 125.25 | ** 0.63 | **-0.93 |
| Void Ratio (200 PSF) | 10 | 34 | .952 | .948 | *.882<br>.982 | .106 | 11.13 | .77 | 1.32 | ** 1.077 | ** 2.929 |
| | 20 | 15 | .977 | .978 | .827 | .077 | 7.90 | .827 | 1.117 | .062 | - .112 |
| | 30 | 6 | .99 | .968 | .892 | .078 | 7.90 | .892 | 1.13 | 1.104 | 2.634 |
| Compressive Index | 10 | 34 | .197 | .181 | .180 | .059 | 29.9 | .120 | .39 | 1.291 | 2.202 |
| | 20 | 15 | .208 | .202 | .180 | .076 | 36.5 | .109 | .447 | 2.221 | 7.257 |
| | 30 | 6 | .247 | .202 | .160 | .079 | 32.0 | .160 | .330 | - .032 | -2.876 |
| Swelling Index | 10 | 32 | .065 | .062 | .056 | .015 | 23.1 | .024 | .097 | - .056 | .824 |
| | 20 | 13 | .065 | .071 | .083 | .023 | 35.4 | .028 | .109 | .015 | - .125 |
| | 30 | 5 | .066 | .067 | .069 | .014 | 21.2 | .05 | .082 | - .129 | -2.419 |
| Swelling Pressure | 10 | 34 | 1540 | 1220 | 600 | 1010 | 65.7 | 0.0 | 4000 | .706 | .416 |
| | 20 | 15 | 1060 | 1050 | 1040 | 724 | 68.3 | 0.0 | 2000 | - .157 | -1.133 |
| | 30 | 6 | 934 | 800 | 540 | 910 | 97.4 | 0.0 | 2000 | .305 | -2.031 |
| Unconfined Compressive Strength | 5 | 144 | 5720 | 4000 | 3100 | 4810 | 84.0 | 1190 | 19,170 | 1.72 | 2.50 |
| | 10 | 196 | 5270 | 4150 | 3100 | 3500 | 66.4 | 1320 | 14,560 | 1.57 | 2.93 |
| | 15 | 142 | 5360 | 4780 | 3100 | 3270 | 61.1 | 1180 | 13,200 | 1.86 | 5.45 |
| | 20 | 151 | 4820 | 4200 | 2500 | 2660 | 55.2 | 1180 | 12,050 | 1.43 | 2.21 |
| | 25 | 94 | 5360 | 4230 | 2890 | 3870 | 72.2 | 1330 | 14,060 | 1.97 | 5.1 |
| | 30 | 114 | 5240 | 3270 | 4100 | 4640 | 88.3 | 790 | 17,280 | 1.44 | 1.66 |

1 ft = 0.3048 metres
1 $lb/ft^2$ = 20.9 kPa
1 $lb/ft^3$ = 1.602 $Mg/m^3$

* Values picked from histograms
** Meaningless due to multimodal distribution

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