# CORRELATIONS AND COMPARISONS BETWEEN THE CASAGRANDE LIQUID LIMIT DEVICE AND THE FALL CONE

by

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## ABSTRACT

The standard method of liquid limit determination within the U.S. at the present time is specified by ASTM Method 423 and performed by means of the Casagrande liquid limit cup. Because of the numerous variables intrinsic to operator technique, theory, and the testing apparatus, many countries have adopted an alternate means of liquid limit determination. This alternate method employs a cone penetrometer, or fall cone, and relies on cone penetration theory.

The theory and historical development of both methods are briefly overviewed. The testing program included liquid limit tests (Casagrande and Fall Cone) as well as simple strength tests (Hand-held Torvane and Pocket Penetrometer) on a variety of soils. Sensitivity to operator technique, type of grooving tool utilized, effect of soil quantity, water content range, etc. were among the variables investigated.

The fall cone appears to be a reasonable alternative to the Casagrande liquid limit device. The cone is as easy if not easier to use. It expands the testable range of soils (with regard to liquid limit) to include soils of a lower plasticity range than are capable of being handled by the Casagrande cup, and liquid limit determination by means of the cone would eliminate many of the subjective variables associated with the Casagrande device.

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# LIST OF SYMBOLS, NOTATIONS, AND ABBREVIATIONS

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| BS | British Standard |
| $C_p$ | Cone Penetration Depth |
| K | Function of cone angle for Hansbo's strength: penetration relationship |
| LL | Liquid Limit |
| PI | Plasticity Index |
| PL | Plastic Limit |
| Q | Cone Mass |
| SL | Shrinkage Limit |
| Su | Shear Strength |
| W | Water Content |
| $W_L$ | Liquid Limit |
| $W_L$ (Casagrande) | Conventional Liquid Limit determined by means of the Casagrande Device |
| $W_L$ (Cone) | Liquid Limit determined by the Cone |
| $W_L^V$ | Vasilev Liquid Limit |
| $\beta$ | Cone apex angle |
| $\sigma$ | Normal stress |
| $\tau$ | Shear stress |

# 1. INTRODUCTION

At present, the standard method of liquid limit in the United States is performed by means of the Casagrande liquid limit cup in accordance with ASTM Meth D423. Liquid limit is simply defined as the water content at which a groove of specified dimension closes along a length of one half inch resulting from the impact of 25 strikes of the Casagrande cup.

This test is in actuality a dynamic shear test since soils of different liquid limits may exhibit slight differences in behavior in response to shaking. Furthermore, the Casagrande test tends to yield a variety of results when performed by different operators particularly when those operators are from different testing laboratories.

On account of the large number of variables intrinsic to operator technique and the testing apparatus, many countries have adopted the cone penetrometer, or fall cone, as an alternate method of liquid limit determination. A literature search reveals a number of articles discussing this alternate method, however, other than cone tests performed by Georgia Institute of Technology (discussed by Sowers in the final section of ASTM's Symposium on Liquid Limits, 1959), the major research efforts have taken place outside the United States. The following report discusses test results from this study, and, when appropriate, interjects results, plots, and correlations reported by others.

The testing program consisted of a number of tests (Casagrande liquid limit tests, fall cone liquid limit tests, hand held torvane, and pocket penetrometer strength tests) performed on a variety of soils.

After a brief introduction to the basic definitions, underlying theory, and strength concepts; Chapter 2 proceeds to investigate numerous variables associated with the Casagrande cup. Topics discussed include basic flow curve relations, strength at liquid limit, grooving tool variation, effect of soil quantity, sensitivity to operator technique, etc.

A similar investigation was performed concerning fall cone relations following some basic penetration theory and an historical development of the fall cone. Correlations between the cone and Casagrande liquid limits are determined and necessary calibrations established. Also discussed are sensitivity to operator technique, water content test range, strength to cone penetration relation, variation of cone weight, etc.

Comparisons are made with regard to the advantages and disadvantages of each method of liquid limit determination, and, based upon these pros and cons, conclusions drawn.

# 2. CASAGRANDE LIQUID LIMIT DEVICE

## 2.1 HISTORY, THEORY, AND DEFINITIONS

Liquid Limit has proven to be an extremely useful correlative value in the field of soil mechanics. Liquid limit applications include Casagrande's Plasticity Chart, the activity chart proposed by Skempton, and the Bjerrum's sensitivity liquidity relation.

In 1911 Atterberg suggested the principle upon which the Casagrande cup would soon be based. This was a simple hand test employing an evaporating dish.

In the early 1900's Atterberg established the limits of consistency and definitions as follows:

- Upper Limit of Viscous Flow - Clay and water flow as a fluid.
- Flow Limit - Lower Limit of Viscous Flow which occurs when two halves of a soil pat just touch (but don't flow together) under several sharp blows.
- Sticky limit - Loss of adhesion therefore soil no longer sticks to objects.
- Roll-out limit - Lower Limit of Plastic state; Plastic Limit; Soil crumbles when rolled into a thread.
- Shrinkage limit - Lower Limit of Volume Change; No volume loss with further moisture loss.
- Cohesion limit - Soil grains no longer cohere to each other.

Atterberg defined plasticity as "capable of being shaped." He concluded that soil which is plastic could be rolled out into threads and that the difference between liquid and roll out limits best described the degree of plasticity. This difference he labeled as the plastic limit.

In time the procedure became refined (Casagrande 1932) and, excepting a standard grooving tool, became ASTM specified around that time. The consistency measurements were renamed and reduced in number to:

- Liquid Limit = flow limit = water content at which the soil ceases to flow as a liquid.
- Plastic Limit = Roll-out limit = water content below which soil cannot be rolled out into a thread.
- Shrinkage Limit = Shrinkage Limit as previously defined.
- Plasticity Index = PI as previously defined.

The possible states of clay are best explained diagramatically by figure 2-1 taken from Head's Manual of Soil Testing.

At present, the U.S. standard liquid limit test is performed according to ASTM Meth D423 by means of the Casagrande Liquid Limit device illustrated in figure 2-2. The plot of water content vs. log of number of blows following the procedure outlined by ASTM is referred to as the flow curve. Liquid limit is defined as the water content at which the groove between two soil halves closes for a length of one half inch as a result of twenty five blows of the Casagrande cup.

## 2.2 CASAGRANDE LIQUID LIMIT TESTING - GENERAL

### Flow Curves

Fifteen clays listed in Table 2-1a were tested by the author in accord with ASTM Meth D423 and the flow curves established for each. The clays used ranged from almost non

Portions of the text on the following page(s) are not legible in the original.

| Phase | SOLID STATE | SEMI-SOLID STATE | PLASTIC STATE | | LIQUID STATE | SUSPEN-SION |
|---|---|---|---|---|---|---|
| Water | ← Water content decreasing | | | | | |
| Limits | Dry soil | Shrinkage Limit SL | Plastic Limit PL | Sticky Limit | Liquid Limit LL | |
| | | | Plasticity Index PI | | | |
| Shrinkage | Volume constant | ← Volume decreasing | | | | |
| Condition | Hard to stiff | Workable | | Sticky | Slurry | Water-held (suspension) |
| Shear Strength ($kN/m^2$) | ← Shear strength increasing | | (~170) | (~1·7) | Negligible to nil | |
| Moisture Content | 0 | SL | PL | PI | LL | |

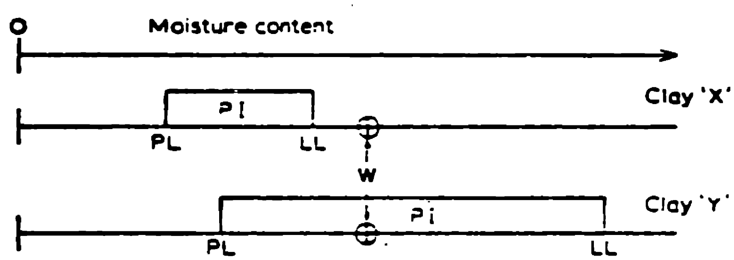
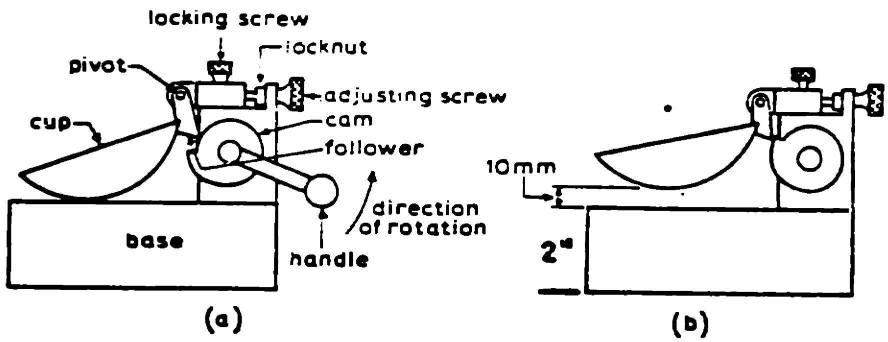



FIGURE 2 – 1 ATTERBERG LIMITS AND SOIL CONSISTENCY.
(FROM HEAD'S MANUAL OF SOIL TESTING)



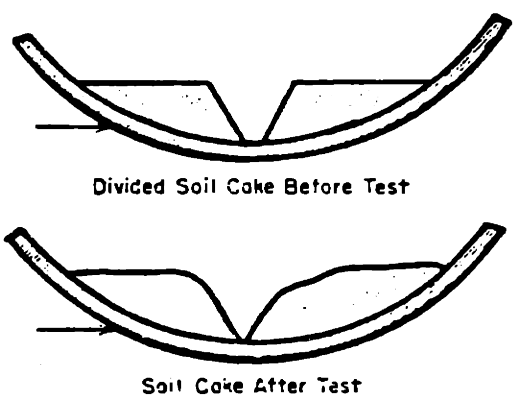




**FIGURE 2-2 CASAGRANDE LIQUID LIMIT DEVICE (FROM HEAD & ASTM).**

TABLE 2-1a DESCRIPTIONS OF CLAYS USED.

| | |
|---|---|
| 1 | Agrico Saddle Creek Mine Clay - Off-white (Cream/Ivory) Color. Highly Plastic. |
| 2 | Bentonite 200 - Very light gray. Very highly Plastic. Mixed from powder. |
| 3 | Boston Blue Clay - Gray. Mixed from powder. |
| 4 | CF Mining - Light tan/beige to grayish. Highly Plastic. |
| 5 | Gray Clay - Medium gray clay |
| 6 | Ideal - Grayish Clay with numerous sand Seams/Foreign Particles. |
| 7 | Modeling Clay - Reddish/Rust Color, Plastic. Slightly Grainy (Silt Particles). |
| 8 | Venezuelan C1S10 - Gray. |
| 9 | Venezuelan C2S43 - Gray with tiny shell fragments |
| 10 | Venezuelan C3S17 - Gray. |
| 11 | Vicksburg Buckshot Clay - Brown. From powder. |
| 12 | 30/70 - 30% Vicksburg Buckshot Clay & 70% Bin No.2. Grainy with silt. From powder. |
| 13 | 70/30 - 70% Vicksburg Buckshot Clay & 30% Bentonite. Mixed from powder. |
| 14 | Bin No12 - Brownish/gray clay. Plastic. |
| 15 | Bin No 39 - Brown clay. Some grains. |
| - | Bin No 2 - Silty, Low plasticity soil |

TABLE 2-1b DESCRIPTIONS OF CLAYS USED.

| | |
|---|---|
| 2a | Bentonite - Very light gray. Very highly plastic. Mixed from pellets. |
| 3a | Boston Blue Clay - Gray. Mixed from powder. |
| 6a | Ideal Clay - Grayish clay with numerous sand seams/foreign particles. |
| 7a | Modeling Clay - Reddish/Rust Color. Plastic. Slightly Grainy. (Silt particles). |
| 11a | Vicksburg Buckshot Clay - Brown. From Powder. |
| 12a | 30/70 Mix - 30% Vicksburg Buckshot & 70% Bin No 2. Grainy with silt. From powder. |
| 17a | Chicago Clay - Yellow Brown with Sand Seams. |

plastic to highly plastic. Figures 2-3 and 2-4 show water content (ordinate) vs. log of number of blows (abscissa) to plot as a straight line in all instances. Liquid limit is defined as that water content corresponding to 25 blows (the vertical dashed line). As liquid limit increases in magnitude, flow curves tend to become increasingly steeper. Casagrande measured the slope of the curve by the flow index. This value is simply the difference in water content across one cycle of semi log paper. Referring again to figures 2-3 and 2-4, when the soils are subjected to drying, i.e., a drop in water content, the increase of shearing resistance, (to be discussed in the following section), will be faster for soil 12 than for soil 2.

Shear Strength

As discussed by Casagrande in Public Roads (1931), these flow curves represent the relation between water content and viscous resistance or shearing resistance of remolded soils where the latter is measured indirectly via blow count. The shearing resistance is simply the force resisting deformation of the sides of the groove. Clearly all factors affecting shear strength then affect liquid limit: soil structure, degree of drying, particle size and shape (Casagrande (1926) referenced by Seed et al (1964)). The impact of the cup sets up a dynamic stress within the soil which in turn results in shear. The end result is analagous to a miniature landslide.

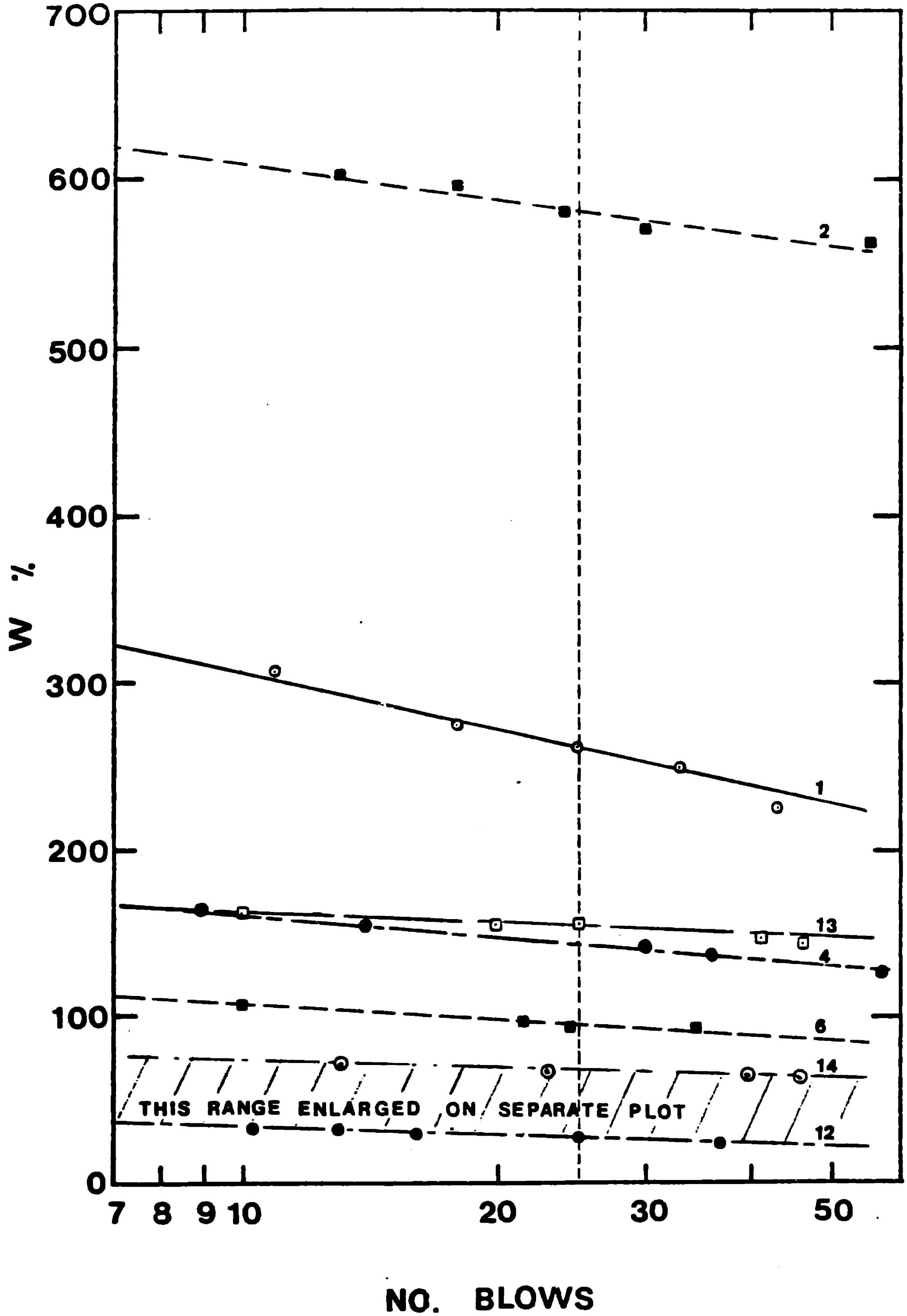



FIGURE 2-3 CASAGRANDE DEVICE: WATER CONTENT VS. NUMBER OF BLOWS.

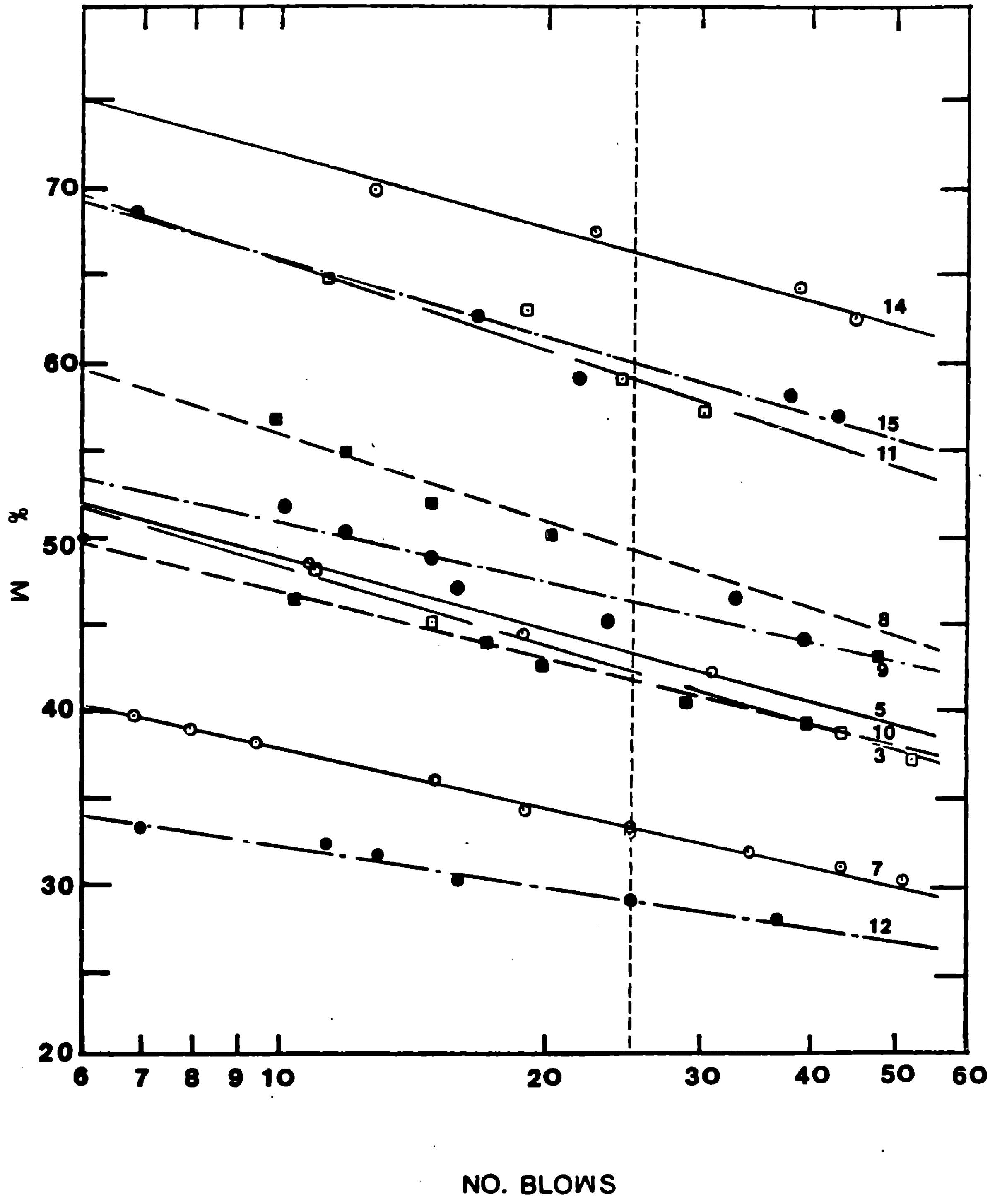



FIGURE 2 – 4 CASAGRANDE DEVICE: WATER CONTENT VS. NUMBER OF BLOWS FOR LOW PLASTICITY CLAYS.

Casagrande (1931) defined liquid limit as the water content at which the soil possesses twenty-five grams per square centimeter shear strength, however, there appears to exist little agreement among authors concerning shear strength values exhibited at liquid limit. A list of these values along with respective sources has been compiled in table 2-2.

Such a variation in liquid limit strengths can be accounted for and explained by the following observations:

## Strength Testing

Two simple strength tests were performed on each of the soil samples: One with the pocket penetrometer and the other with the hand held torvane. Figures 2-5 and 2-6 depict strength test results in the form of log of strength vs. log of water content where each line is representative of a different soil. Circled points indicate the strength corresponding to liquid limit. This strength value is not a constant. Rather there exists a range of strengths corresponding to liquid limit. High liquid limit soils tend to exhibit lower shear strengths and low liquid limit soils, higher shear strengths. The equation associated with the relation is of the form log Su - m(log w) = constant where Su = shear strength, w = water content, and m = the slope. The resulting correlations for the acquired data are -.8617 and -.9188 for the

TABLE 2-2 VARIOUS VALUES QUOTED FOR SHEAR STRENGTH POSSESSED AT LIQUID LIMIT.

| | kN/m² | g/cm² | psi | TSF |
|---|---|---|---|---|
| Casagrande | 1-3 | | | .104-.313 |
| Vasilev | 8.5 | | | .887 |
| Eden (ASTM) | | | .11-.32<br>.2 | .758-2.21<br>1.38 |
| Mitchell | (2-3) | 20-30 | | .209-.313 |
| Sowers | 1.5-3.0 | 15-30 | | .157-.313 |
| Wroth & Wood (1976) | 1.3-2.4<br>1.7 mean | 17 | | .177 |
| Wroth & Wood (1978) | 2.65 | 27 | | .277 |
| Norman<br>ref. by Wroth & Wood | .8-1.6 | 8-16 | | .084-.167 |
| ASTM<br>ref. by Wroth & Wood | 1.1-2.3 | 11-23 | | .115-.240 |
| Skempton/Northey<br>ref. by Wroth & Wood | .7-1.75 | | .1-.25 | .073-1.75 |
| Skopek/Ter-Stepanian<br>ref. by Wroth & Wood | 1-3 | | | .104-.313 |

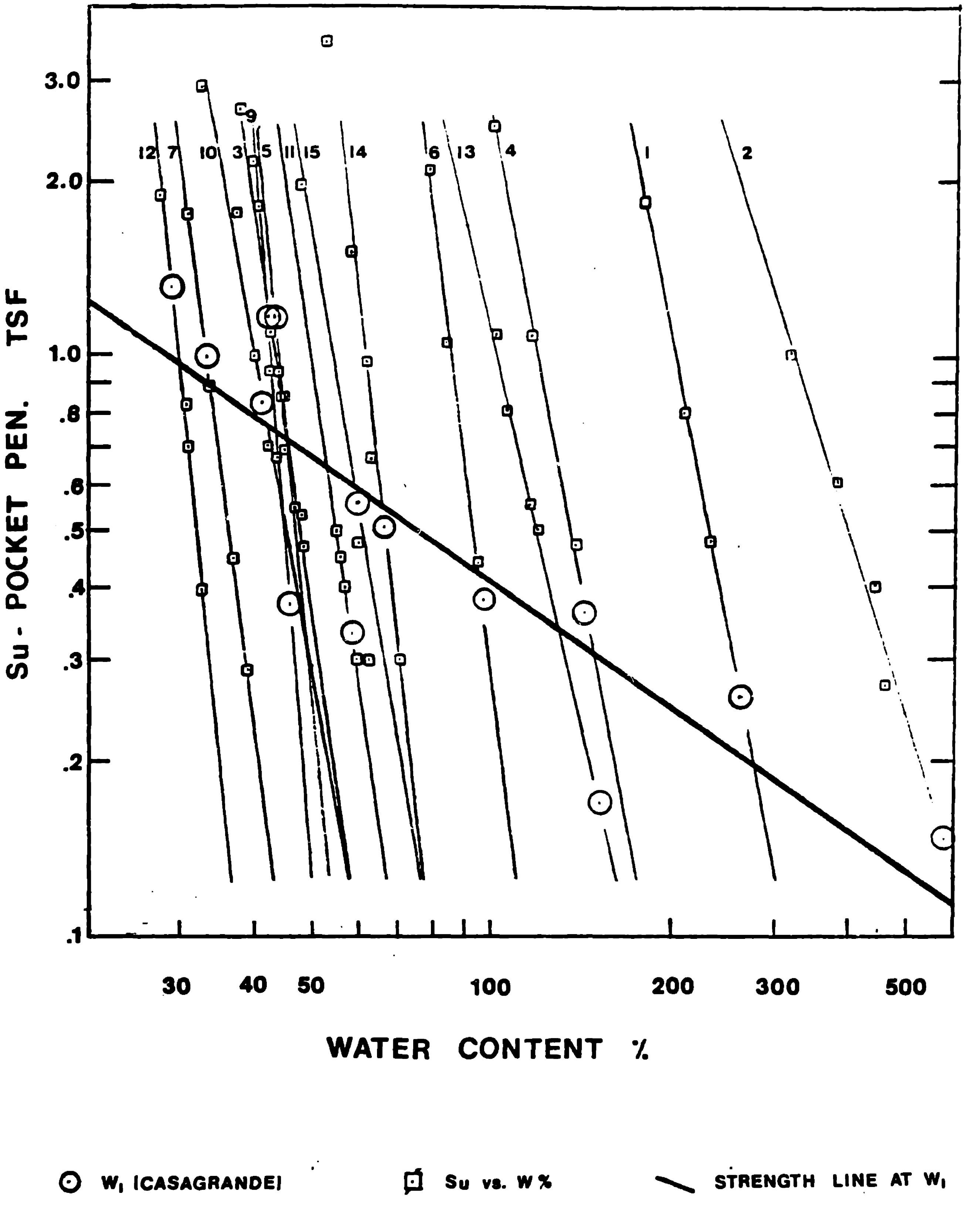



FIGURE 2 - 5 WATER CONTENT VS. SHEAR STRENGTH FROM POCKET PENETROMETER. CIRCLED POINTS INDICATE LIQUID LIMITS AS DETERMINED VIA CASAGRANDE DEVICE.

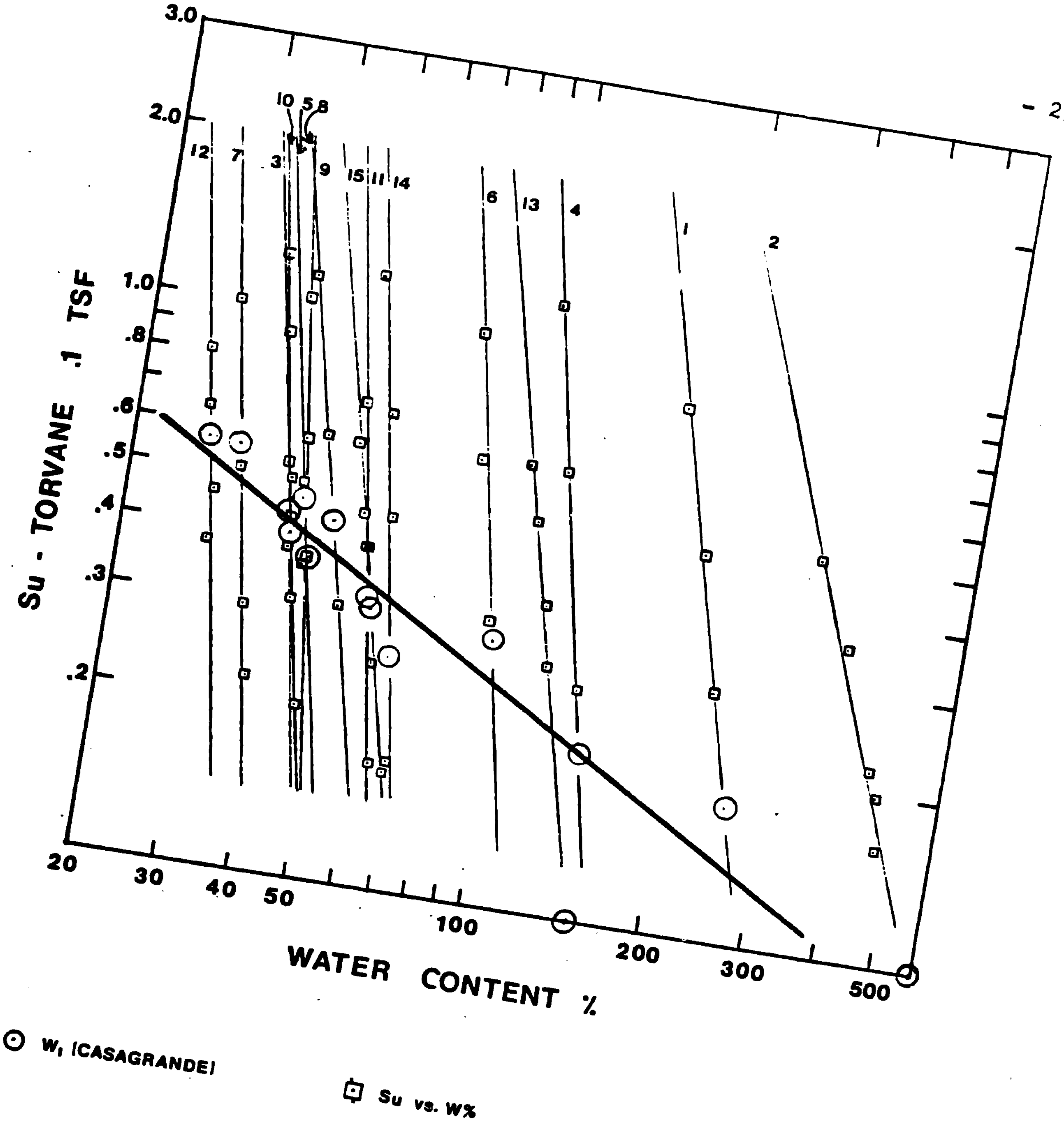



FIGURE 2 - 6 WATER CONTENT VS. SHEAR STRENGTH FROM TORVANE. CIRCLED POINTS INDICATE LIQUID LIMITS AS DETERMINED VIA CASAGRANDE DEVICE.

penetrometer and torvane respectively. Casagrande (1958) suggested the possibility that lower liquid limit clays might exhibit a slight degree of dilatency thus accounting for their apparent higher shear strengths.

Regardless of cause, there does exist a definite correlation between liquid limit and shear strength as previously demonstrated by figures 2-5 and 2-6. This relationship will be re-examined in instances where liquid limit is determined by means of the fall cone as opposed to the standard Casagrande device.

One might question the use of limits as a means by which to determine strength; i.e., if the purpose is strength determination, why not use a strength test? Although this would be more accurate, it involves far more complex apparatus thus defeating the purpose of simplicity, the main feature of the liquid limit tests.

## 2.3 VARIABLES ASSOCIATED WITH THE CASAGRANDE LIQUID LIMIT DEVICE

### Brief Outline of Limitations

Casagrande himself commented on the inadequacies of his own liquid limit test as described by ASTM Meth D423.

Some of the liquid limit device's shortcomings, many of which were investigated by the author, are outlined as follows:

- Lack of uniformity in apparatus and methods employed.
- In reality, ASTM Meth D423 is a dynamic shear test.

- Problems are encountered when dealing with low plasticity soils.

  - Soils containing sands create extreme difficulties when cutting grooves.

  - Low plasticity soils frequently slide rather than flow.

  - Low plasticity soils tend to segregate into their water and soil constituents with shock resulting in a non uniform water content. This in turn is reflected in the flow.

- Bench or table upon which apparatus stands affects apparent liquid limit. (Although variation in liquid limit results is minimized by rubber feet.)

- Sensitivity to minor differences in the physical apparatus:

  - Grooving tool

    a. type

    b. change in dimensions due to wear

  - Hardness, size, and resiliency variations of the base

  - Cam Shape

  - Surface/Wear of cup interior

- Sensitivity to operator technique: A considerable number of the variables require judgment hence increasing the room for error.

  - Estimation of quantity/depth of soil

  - Proper estimation of the timing of 2 blows per second

  - Proper Construction of Groove

    a. groove alignment

    b. proper orientation of grooving tool relative to cup otherwise incorrect groove depth

  - Estimation of one half inch closure. Many discontinue blows upon initial contact of opposite sides.

  - Soil sample from which the water content is to be determined must be taken perpendicular to the groove otherwise not a truly representative sample.

- Carelessness; i.e., hurriedly performing the process and improper cleaning between tests. This alters the apparent dimensions of the grooving tool, thus leading to incorrect groove width, depth, etc.

Dynamic Test

The Casagrande test is in actuality a dynamic shear test for determination of water content of a remolded soil when the shear strength is in a particular vicinity. According to Casagrande (1958), the basis of comparison for fine grain soils which react differently to shaking is not uniform; i.e., the dynamic factor isn't related to shear strength in the same manner for different soils. In order to eliminate this dynamic effect, Casagrande suggested that his liquid limit test be replaced by a direct simple shear test, static penetration test, or squeeze test. Interest in the search for such alternate methods was renewed following publication of Casagrande's comments.

Sandy Soils

One major drawback of the Casagrande device is its inadequacy when dealing with sandy soils. In such soils, the shearing resistance encountered during the grooving process exceeds the adhesion and friction between the surface of the brass cup and the soil. As a result, the entire soil sample is carried away upon attempting to form the groove. Such was the case with the sample obtained from Bin No. 2. See table 2-1a. No groove could be formed. In instances as these, no liquid limit value can be determined, thus the liquid limit is assumed to be the same as the plastic limit; i.e., PI = 0. Stefanoff (1958) argues that although such PI values are frequently small in magnitude, they may not necessarily be zero.

Because the Casagrande device is of a dynamic nature, soils of low plasticity will naturally tend to liquefy upon impact. Thus they have a tendency to close the groove through slipping rather than through plastic flow. In many instances, this sliding along the cup surface is extremely difficult to discern.

## Conforming to ASTM Specifications

ASTM specifies both the apparatus and test procedure to be used in determination of Atterberg Limits; nevertheless, a considerable lack of uniformity has been found to be in existence. In 1956, Section B, Atterberg Limits of Subcommittee D-18 on Soils for Engineering Purposes conducted a survey which showed 20% of the U.S. labs to be using a grooving tool other than the one specified by ASTM. Furthermore, more than 50% of these labs employed the one-point shortcut method. Ironically enough, the majority of this deviatory 20% were directed by members of ASTM Committee D-18. Assuming the results of this survey to be typical, it would seem beneficial to employ a liquid limit test for which the results are a function of a minimal number of variables. A variety of Casagrande Liquid Limit device variables (including variation of grooving tool) are discussed in the following sections.

## Grooving Tool

In Atterberg's time, the groove was simply produced by means of a spatula while conforming as closely as possible to given dimensions specifying soil depth and groove width at top and bottom.

Although ASTM specifies one particular grooving tool, at present, two and occasionally three different types of grooving tools can be found in a typical soil testing laboratory. Each of the three tool types seen in figure 2-7 has its own distinct advantages and disadvantages.

In 1932 Casagrande introduced a flat grooving tool with flanges on the sides. This tool, used and preferred by many, has the advantage that the flanges trim down the soil surface such that the specified 1 cm soil thickness is never exceeded. Some disadvantages are as follows: Although close, the dimensions of the resulting groove do not conform with ASTM specifications. As a result, the liquid limit determined may be incorrect. When forming the groove in a low plasticity clay, the Casagrande tool frequently tears the sides of the groove. Furthermore, it has a tendency to compress the soil beneath the flanges; and, finally, some operators find it difficult to keep this grooving tool perpendicular to the cup.

The standard ASTM grooving tool developed by the U.S. Bureau of Public Roads around that same time is long, curved and wedge shaped. This tool maintains the proper dimensions longer than the other tool types inasmuch as its long grooving tongue wears relatively slowly. The major disadvantage is its tendency to cause low plasticity soils to separate into two parts via sliding outward (i.e., away from the groove) along the cup surface.

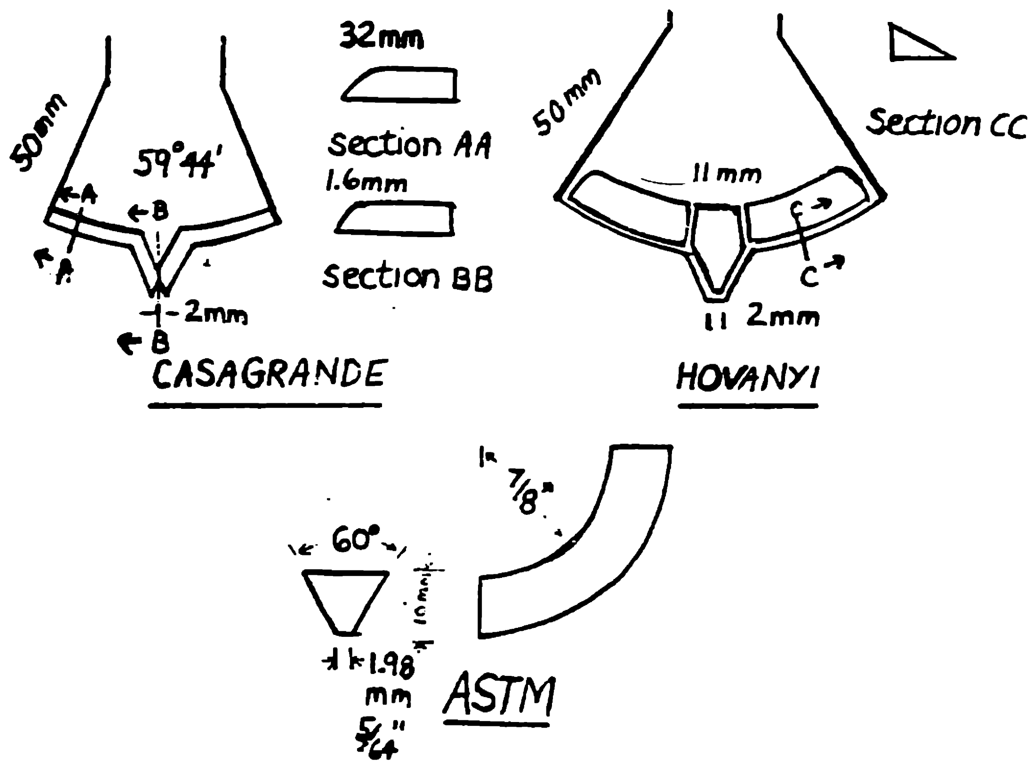



FIGURE 2 - 7 THREE TYPES OF GROOVING TOOLS. (FROM MITCHELL: ASTM SYMPOSIUM ON ATTERBERG LIMITS 1959)

Both of the above tools frequently cause the entire soil cake to move in the direction of grooving tool movement. Again, the slipping is more pronounced in low plasticity soils and this slipping is not always readily apparent.

Hovanyi introduced yet another tool type which trims the sample to the proper depth by means of a double cutting edge. The Hovanyi tool creates a properly dimensioned groove providing a clean razor-blade cut, and the detached portion simply falls out of the cup upon tilting. This tool frequently allows for liquid limit determinations in instances where the standard and Casagrande tools can provide none. Unfortunately, the grooving tongue's sharp edges wear very easily thus giving rise to a wide groove of decreased depth. For just 1 mm of wear in the height of this tool, the groove width will increase from 2 to 4 mm. Such an alteration in groove dimensions can result in an increase in apparent liquid limit as is discussed shortly. Stefanoff 1958 claims the apparent liquid limit can increase by as much as 15% for such a situation.

A comparison of liquid limits as determined by both the Casagrande and standard ASTM tool for modeling clay and Boston Blue clay can be seen in table 2-3. Figures 2-8 and 2-9 demonstrate the water content: blowcount relationship from which these table values were derived.

For both soil types examined (Boston Blue Clay and Modeling Clay), the Casagrande tool yields a slightly higher liquid limit than does the ASTM standard grooving tool (which tends to make a deeper groove). This observation agrees with the

TABLE 2 – 3 LIQUID LIMIT AS A FUNCTION OF GROOVING TOOL AND SOIL QUANTITY.

| MODELING CLAY | | |
|---|---|---|
| | $w_L$ % Standard ASTM Grooving Tool | $w_L$ % Casagrande Grooving Tool |
| Proper Soil Quantity | 32.8 | 35.4 |
| Too Much Soil | 32.6 | |
| Too Little Soil | 35.5 | |

| BOSTON BLUE CLAY | | |
|---|---|---|
| | $w_L$ % ASTM | $w_L$ % CAS. |
| Proper Soil Quantity | 41.8 | 43.8 |
| Too Much Soil | 37.3 | |
| Too Little Soil | 44.8 | |

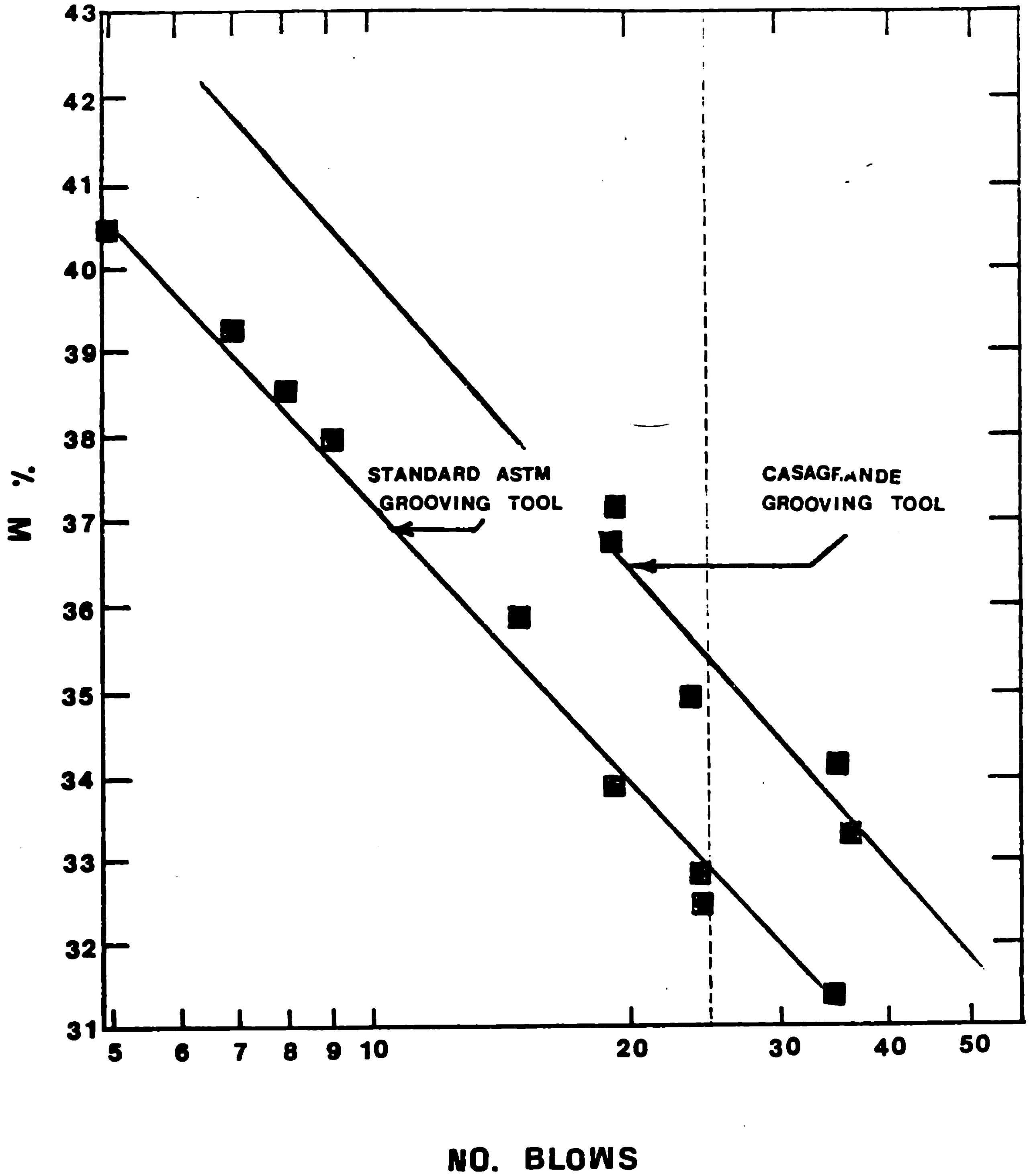



FIGURE 2 – 8 VARYING GROOVING TOOL. MODELING CLAY.

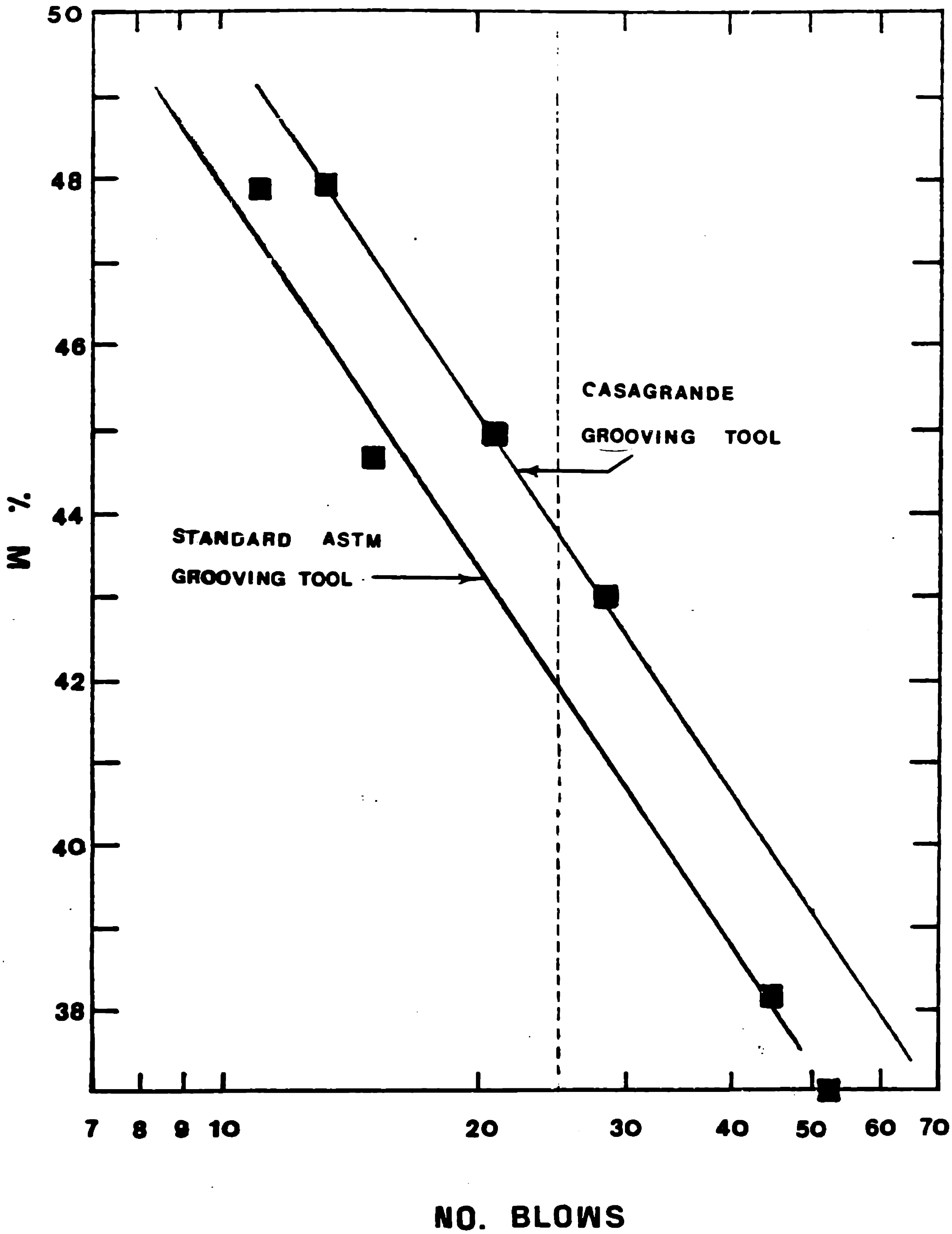



FIGURE 2-9 VARYING GROOVING TOOL. BOSTON BLUE CLAY.

results of the U.S. Army Engineer Waterways Experiment Station tests (Mitchell: ASTM Symposium on Atterberg Limits - 1959).

When testing for compliance with specifications, the proper grooving tool is extremely important since small differences in liquid limit can mean passing or failure of a particular material. For most other purposes--such as soil identification--even if all three tools were used interchangeably, the small variations in liquid limit values would have relatively little effect upon overall results.

Soil Quantity

As would be expected, differences in liquid limit are a function of soil quantity.

ASTM specifies this quantity by "trim it to a depth of 1 cm at the point of maximum thickness." Unless this sample depth is actually measured--which is seldom standard procedure--such an estimate tends to yield additional variation in liquid limit values. For the standard ASTM grooving tool, figures 2-10 and 2-11 show liquid limits to be lower and higher than the actual liquid limit for too much (65±5 grams) and too little (25±5 grams) soil respectively. Table 2-3 summarizes the results determined from the above figures. The explanation is as follows:

Too much soil results in a deeper groove requiring the soil to possess a higher shear strength to withstand the 25 blows. Shear strength varies inversely with water content, thus the result is an apparent lower liquid limit. This same reasoning simply applies in reverse for too little soil, thus accounting for the apparent higher liquid limit.

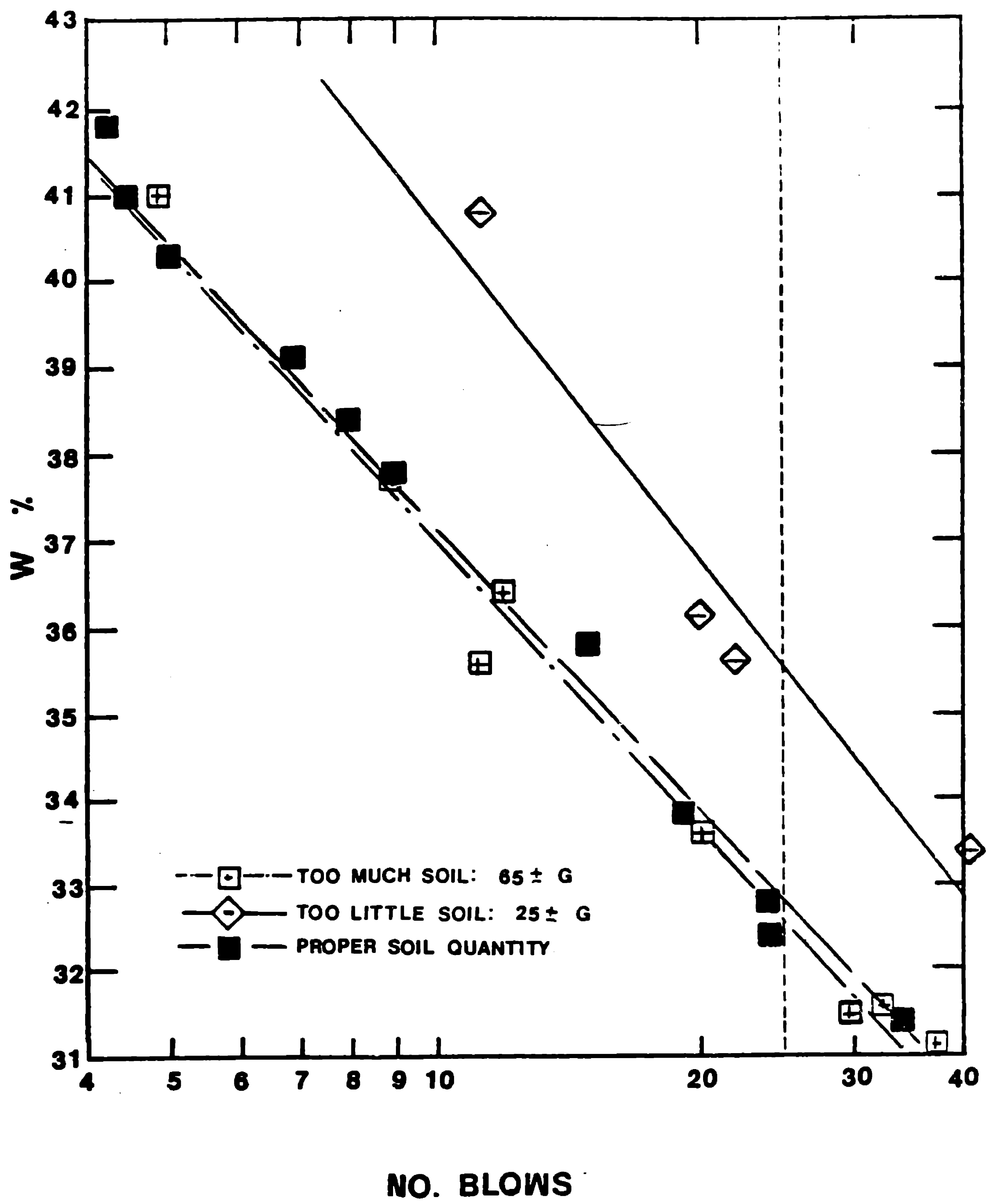



FIGURE 2-10 INFLUENCE OF SOIL QUANTITY ON CASAGRANDE LIQUID LIMIT FOR MODELING CLAY.

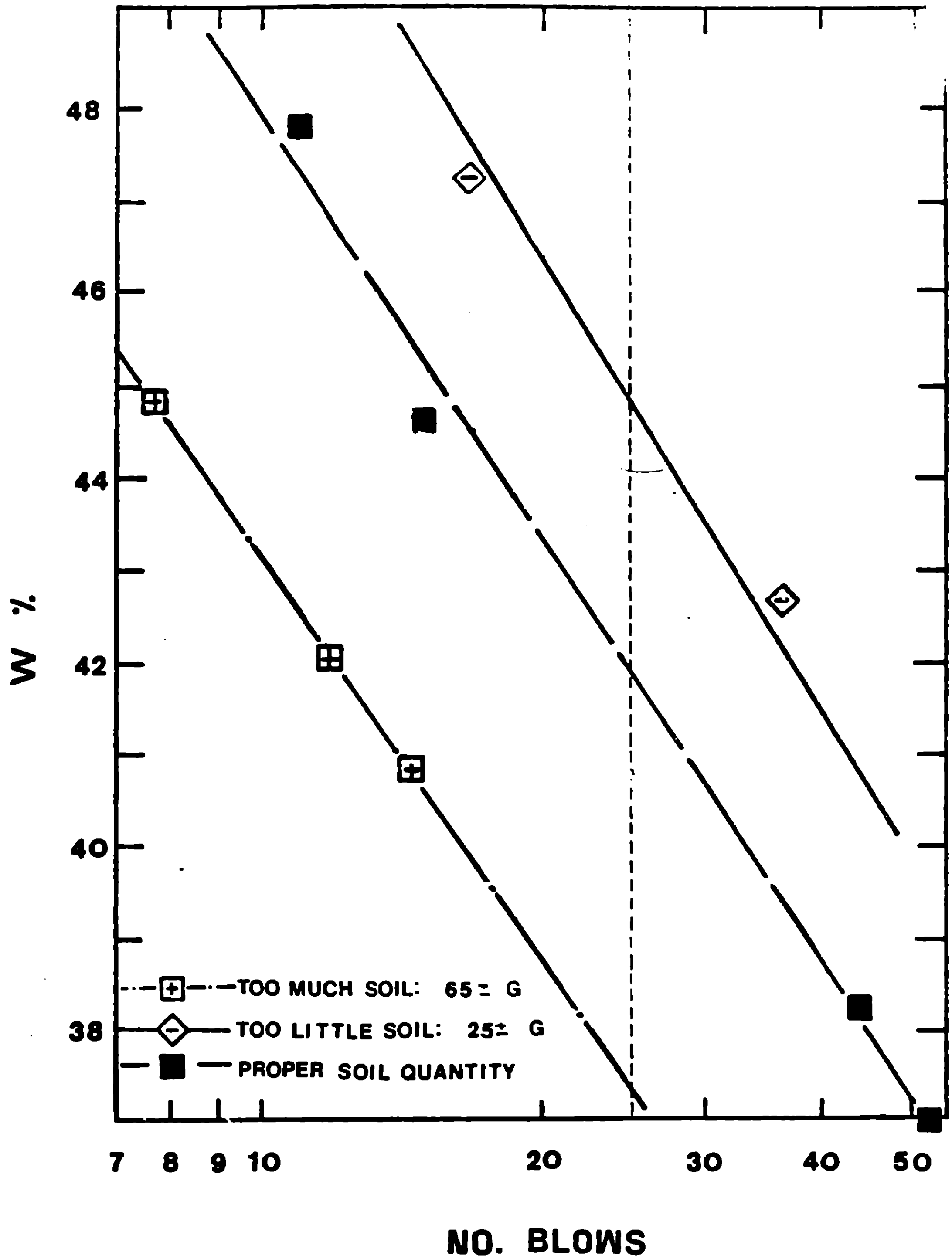



FIGURE 2 – 11 INFLUENCE OF SOIL QUANTITY ON CASAGRANDE LIQUID LIMIT FOR BOSTON BLUE CLAY.

In essence, the entire negatively sloping line representing water content vs. log number of blows is simply translated to the left for soil samples in excess of ASTM's suggested 1 cm thickness and to the right for samples measuring noticeably less than 1 cm at their point of maximum thickness.

Impact Rate

Although blowcount rate is specified by ASTM to be two blows per second, in actuality this rate should be considered a variable.

Figure 2-12 shows water content vs. log number of blows for three rates: one blow per second, two blows per second, and three blows per second. The water content corresponding to twenty five blows is not a constant but rather ranges from 33.5 for one blow per second to 32.6 for three blows per second. Thus, liquid limit appears to be a function of rate of impact; however, further testing on additional clays is suggested before drawing any specific conclusions.

Dependence of Liquid Limit Upon Test Range

The dependence of Liquid Limit upon the range within which the tests are performed is exemplified by figure 2-13. The results of this test show that, although liquid limit is a function of the test range, the dependence upon range is minimal.

Figure 2-13 shows the span ranging from 5-50 blow counts to yield a liquid limit of 32.84, whereas that span confined to the 15-50 blow count range yields a liquid limit of 32.77. The

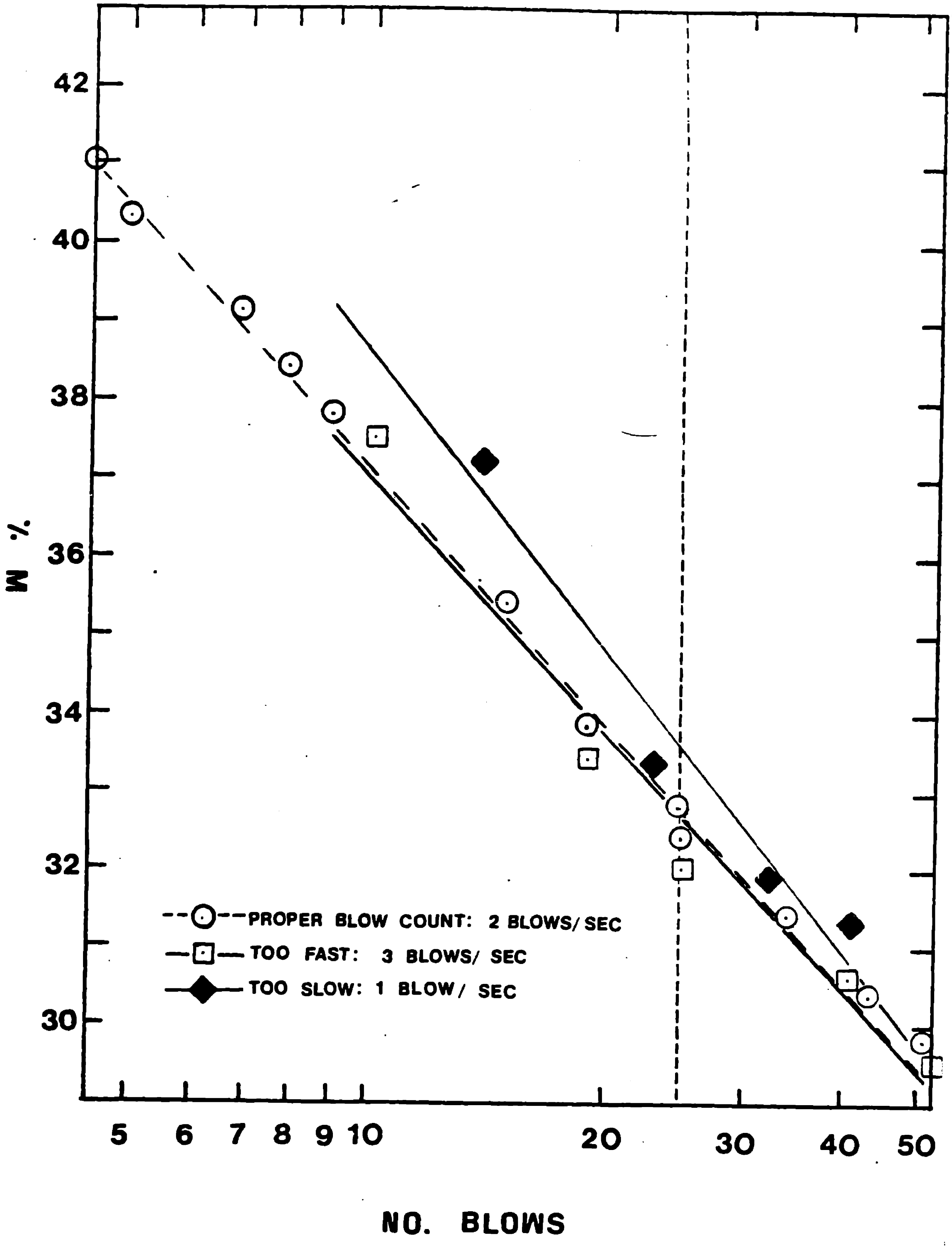



FIGURE 2 - 12 CASAGRANDE DEVICE: VARYING BLOW COUNT RATE FOR MODELING CLAY.

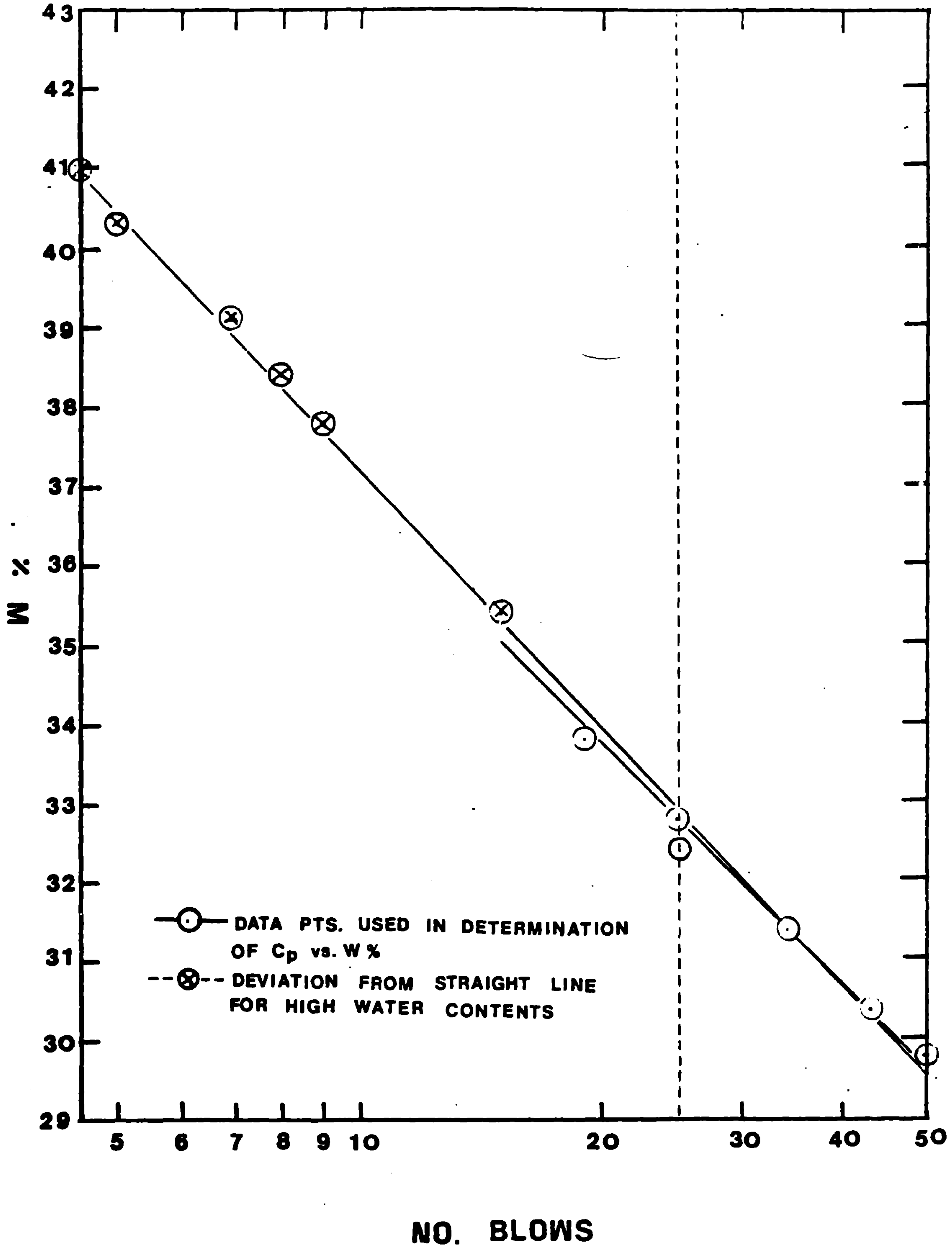



FIGURE 2-13 DEPENDENCY OF LIQUID LIMIT UPON RANGE WITHIN WHICH TESTS ARE PERFORMED FOR CASAGRANDE DEVICE. MODELING CLAY.

slope of the latter is not quite as steep as that of the former. ASTM suggests a blow count range of 15-35 impacts and Lambe suggests 10-40.

Grooving Tool Motion

ASTM Meth D423 does not indicate a preferred direction of motion in forming the groove. Morris (symposium on Atterberg Limits, 1959) found 85% of his tests to result in a higher apparent liquid limit value for motion away from as opposed to toward the operator. Furthermore, the direction of the former yielded liquid limits 3% higher than did the latter.

Operator Technique

The Casagrande liquid limit test tends to yield a wide variety of liquid limit results when performed by different operators. With the introduction of different testing apparatus, this variation becomes even wider when these different operators come from different laboratories. A broad spectrum of variables is intrinsic to the combination of operator technique plus the testing apparatus, consequently nearly everyone rates liquid limit's sensitivity to operator technique as one of the major drawbacks of the Casagrande device.

This study included a brief look at liquid limit variation as a function of operator technique.

Four different operators ran a set of liquid limit tests on the same soil sample--a light tan plastic clay from MIT's Bin No. 12--in accordance with ASTM Meth D423. Results of the above test are depicted by figure 2-14. Liquid limits were 64, 65.9, 66.6, and 67.1 with an average value of 65.9 and a difference between moisture content extremes of 3.1 percentage points. (Nearly 5% in terms of relative percentages of the liquid limits.)

Presumably each set of data can individually be considered valid: Three of the four lines are nearly parallel and correlations for each of the four lines are quite reasonable.

Throughout the period of existence of the Casagrande cup, numerous more extensive experiments performed with regard to operator technique have been cited in the literature:

Sherwood and Ryley (1970) mention the variation in liquid limits resulting from a series of tests performed on three soils by forty laboratories in accordance with BS 1377. They report the spread in liquid limits resulting from American testing to be even greater.

A set of liquid limit check tests performed by nine commercial laboratories on three soil samples was discussed in detail by Dawson (ASTM Symposium on Atterberg Limits, 1959). A condensed summary of the results is as follows:

| Sample | low | high | average |
|---|---|---|---|
| A | 20 | 30 | 25 |
| B | 65 | 70 | 67 |
| C | 58 | 71 | 62 |

The range in liquid limits is considerable. Even more noteworthy are the following observations:

1) No set of results was consistently high.

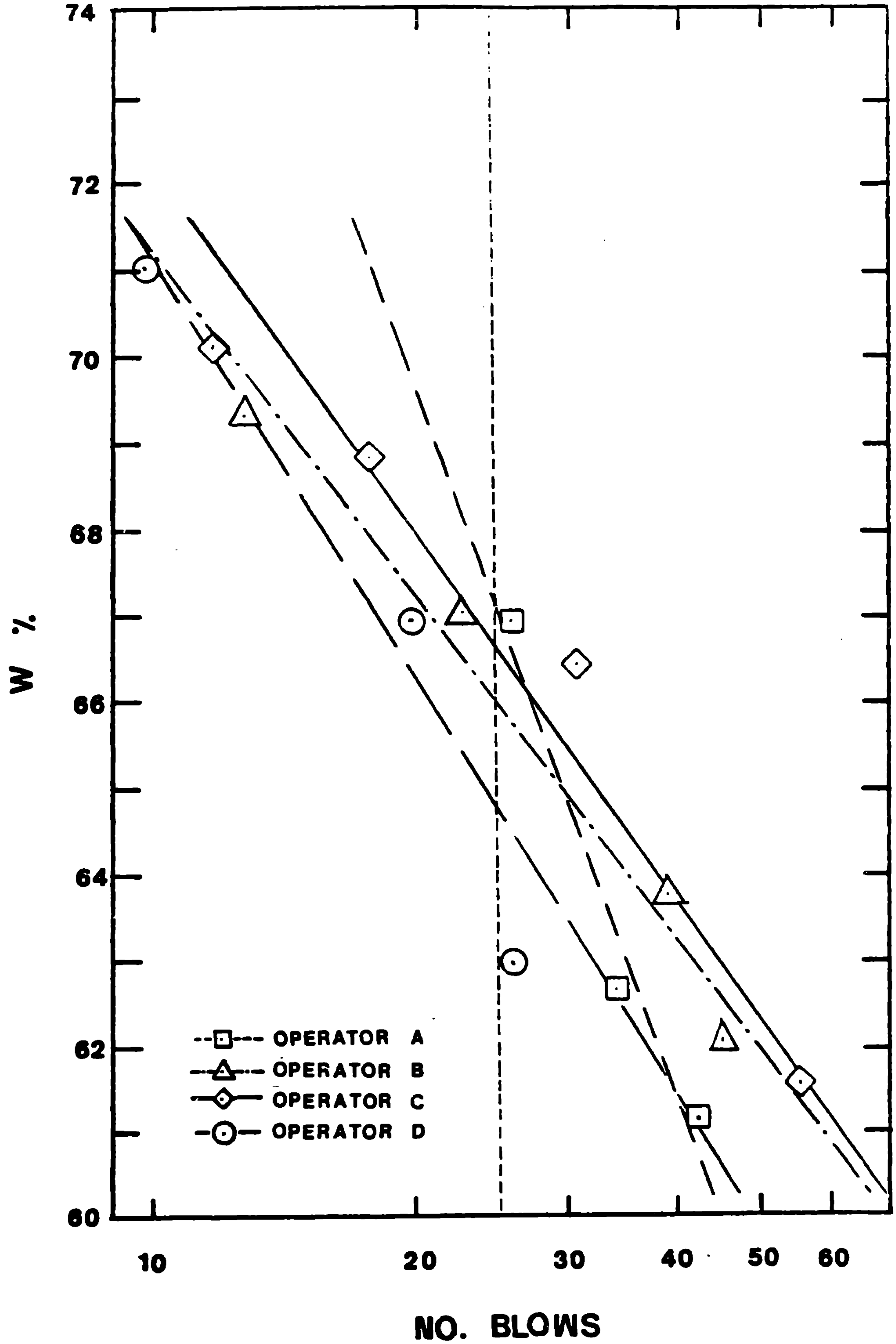



FIGURE 2-14 INFLUENCE OF OPERATOR TECHNIQUE ON LIQUID LIMIT USING CASAGRANDE DEVICE.

2) No set of results was consistently low.

3) No set of results fell near the average on the three tests.

The National Bureau of Standards employs a statistical method for analyzing discrepancies among operators using the same testing procedure. (Tech News Bulletin, 1959, referenced by Dawson):

Three operators ran duplicate tests on similar samples. An even distribution of points would indicate random errors. On the contrary, figure 2-15 from Dawson shows the points to congregate toward the upper right and lower left quadrants. Furthermore, a circle of 2.5 standard deviations radius centered on the intersection of the medians would indicate no constant errors if 95% of the points fell within this circle. Although 89% (8 of the 9 points) does fall short of 95%, it can still be assumed that there is no gross constant error in their method. The operator represented by the solid points obtained results higher than the average, and the operator represented by triangles, lower.

Figure 2-16, also from Dawson, depicts the results of twenty tests performed on one sample by a single operator over a period of time. Results from two consecutive tests plot as one point; i.e., test 1 liquid limit and test 2 liquid limit plot as the abscissa and ordinate respectively. Again the points congregate in the upper right and lower left quadrants eliminating random errors. Nine of the ten points fall within the indicated circle, thus no substantial constant error.

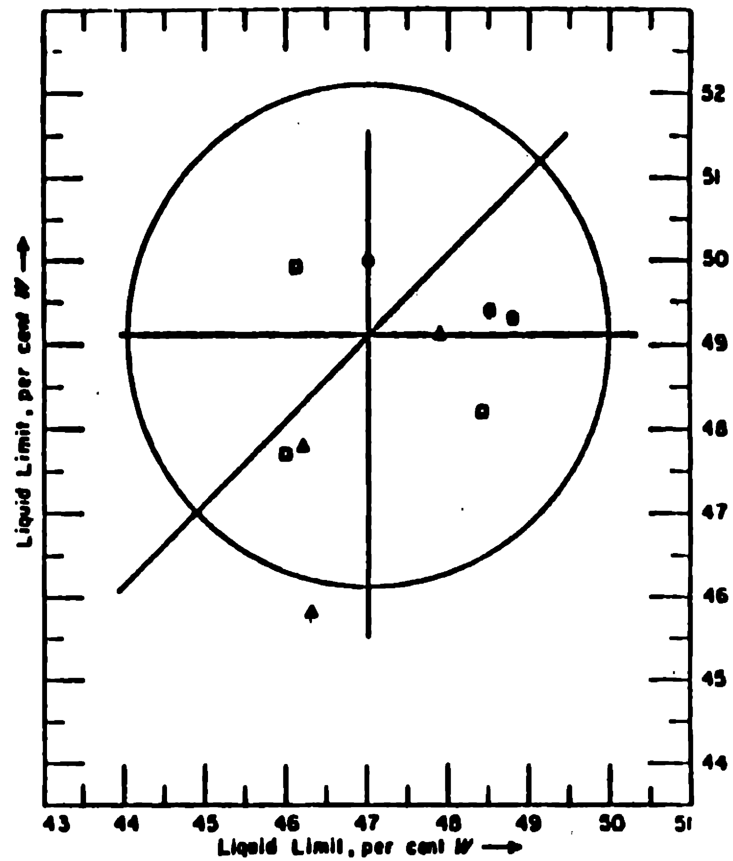



FIGURE 2 – 15  DATA ANALYSIS FOR THREE DIFFERENT OPERATORS. (FROM TECH NEWS BULLETIN, 1959. REF. BY DAWSON).

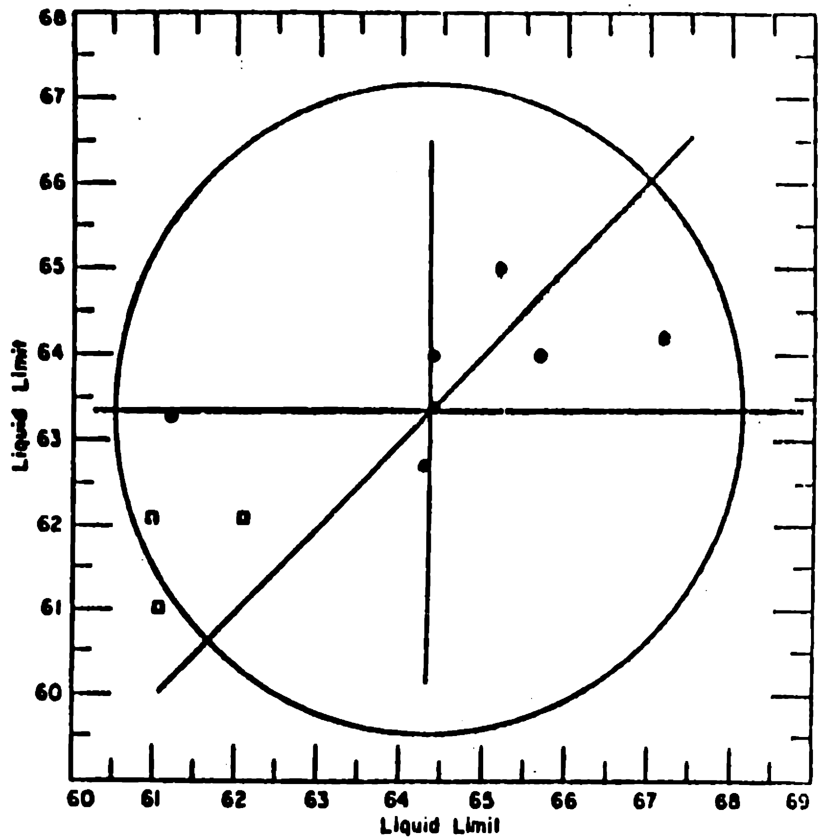



FIGURE 2 – 16  DATA ANALYSIS FOR A SINGLE OPERATOR. (FROM TECH NEWS BULLETIN, 1959. REF. BY DAWSON).

In both instances, such a variation in liquid limit (range of 44% to 52% in case 1, and 59.7% to 68% in case 2) without the elimination of random or constant errors indicates the need for more careful examination and construction of the test procedure.

Morris of Morris et al., (ASTM Symposium on Atterberg Limits, 1959) headed a study concerning liquid limit test variables. Manhattan College and Cornell University independently conducted a series of tests in accord with both ASTM Meth D423 and additional restrictions/guidelines such as direction of grooving tool motion, etc. Data was compared and assumed valid based upon parallel results in most instances. Nevertheless, with particular combinations of variables, Morris concluded liquid limits could vary up to 30%.

2.4 MISCELLANEOUS

Tempering

Tests performed following a period of tempering yield considerably different liquid limit results than do tests run immediately upon mixing or shortly thereafter.

The greatest rate of change occurs during the first hour following mixing. This rate of change declines, and following approximately eight hours of tempering, liquid limit can be assumed to be constant. Garneau and LeBihan (1977) suggest 10 hours of tempering, and Head suggests 24 hours.

All soil specimens used in this study were thus allowed to temper for a minimum of 24 hours following an initial thorough mixing.

Thixotropic Soils

Certain thixotropic materials are known to rapidly regain strength following remolding. At first this might appear to be the case with the grooving action of the ASTM and Casagrande grooving tools; however, since such strength is just as rapidly lost upon vibration, it is lost with the first strike of the cup.

# 3. FALL CONE

## 3.1 INTRODUCTION

Upon completion of the Casagrande testing, each of the fifteen soils was subjected to further liquid limit testing--this time with the cone penetrometer or fall cone. In contrast to liquid limit determination through shear stress induced by impact, the fall cone utilizes cone penetration and corresponding penetration theory. Liquid limit determination is dependent upon the relation between shear strength and penetration resistance (independent of imposed stress or strain).

## 3.2 THEORY

Cone penetration results in small-scale heaving immediately about the cone. This heave volume is considerably less than that of the resulting hole implying the disturbance to be a complicated phenomenon. Although a true theoretical explanation is apparently quite complex, based upon approximations, the basic concept underlying fall cone penetration is summarized as follows:

Increased cone penetration depth clearly increases soil/cone contact surface area thus reducing the applied pressure. Neglecting dynamics, the cone will eventually attain a penetration depth at which the applied pressure or bearing stress equals the soil's bearing capacity. This depth at which further penetration is refused is simply an indication of the material's resistance to penetration.

Normal and shear stresses $\sigma$ and $\tau$ act on the cone element of figure 3-1a as shown. These stresses vary in magnitude as a function of the surrounding clay deformation. Figures 3-1b and 3-1c depict an approximated stress variation and an assumed plastic zone configuration. The plastic zone reaches a maximum width at maximum stress. Surface stresses never reach failure, hence the plastic zone does not occur on the surface. The greater the cone angle, the greater both the deformation and tangent angle $\beta$ .

Hansbo (1957) states that gas bubbles and dilatency account for only a very small volume of the strained/displaced clay. He accounts for the strain associated with figure 3-1c (from Hansbo taken from Nadai, 1931) as follows: Some clay flows plastically upward along the cone surface resulting in the aforementioned visible heave. This, in turn, results in a horizontal straining of the elastic clay surrounding the plastic region. Frequently this is accompanied by slip along surface AB due to resulting pressure increases.

Hansbo's experimental testing concerning the validity of the concept as applied to the fall cone showed reasonable agreement with theory.

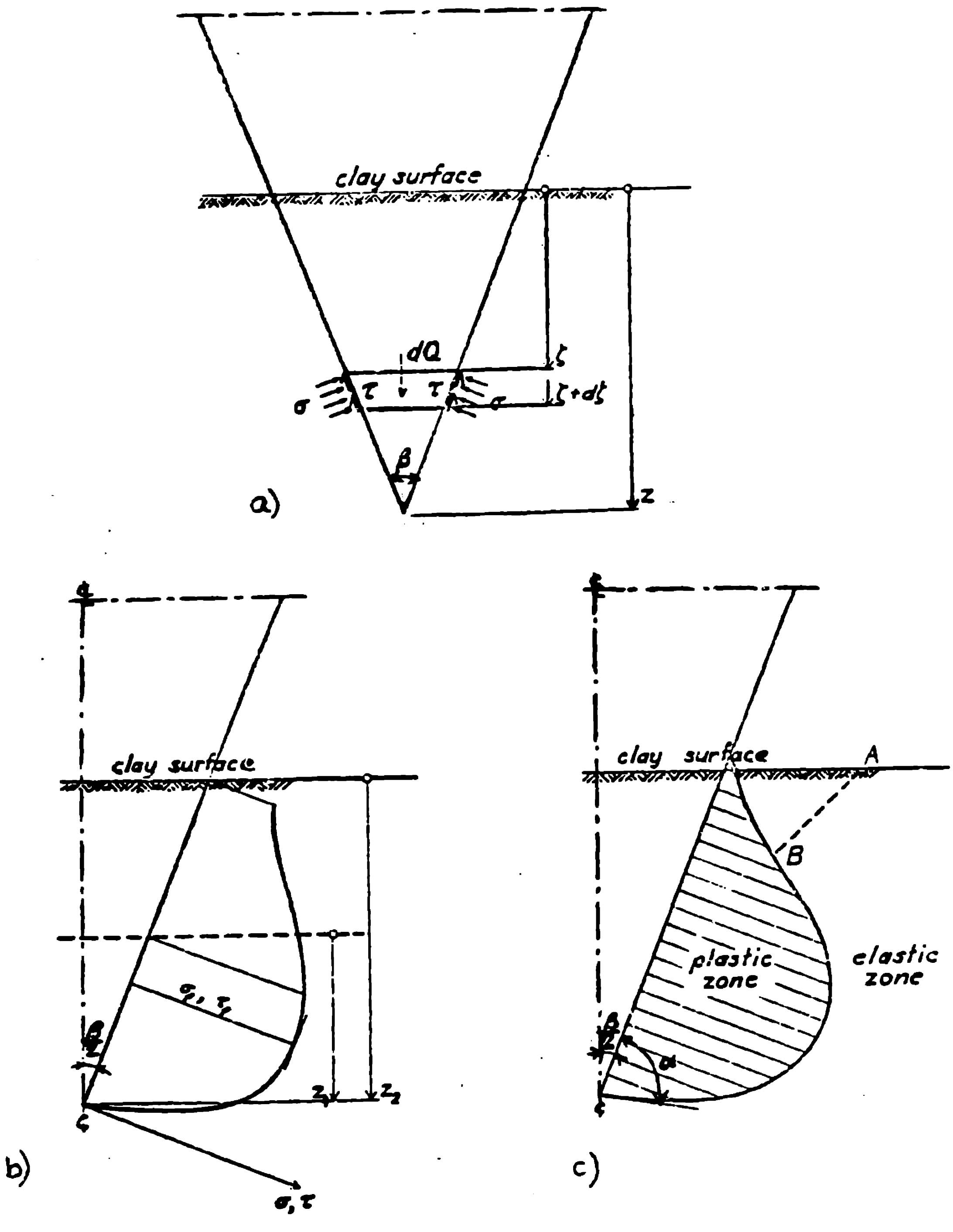



FIGURE 3 - 1: a) FORCES ACTING ON CONE DURING PENETRATION.
b) ASSUMED STRESS VARIATION
c) ASSUMED PLASTIC ZONE CONFIGURATION DURING PENETRATION. (FROM HANSBO 1957)

## 3.3 HISTORY--DEVELOPMENT OF FALL CONE THROUGH PRESENT DAY USE

General

Variations of the fall cone were independently conceived in various parts of the world by the Swedish Railroad Commission (1914-1922), by Dr. Charles Terzaghi (1923 in Constantinople), and by by Dr. E. M. Kindle (1925 in Ottowa, Canada). Although studies began independently, the basic apparatus used is similar and results fairly consistent.

Swedish Fall Cone

In the early 1900's, Sweden was being plagued with numerous landslides; therefore, a commission was appointed by the Royal Board of Swedish State Railways to investigate potential risk and stabilization methods. Here it was agreed to devise some method for experimentally determining the relative strengths of clays. On June 30, 1915, John Olssen, secretary, presented the Swedish Fall Cone before the commission. This cone was simply a free falling adaptation of the existing Swedish Brinell Hardness test which employed a ball being pressed into the test material. A cone, cylinder, and sphere had all been considered as the penetrating object; however, the cone was selected on account of its geometrically similar impression being independent of depth. Cones of various weights and apex angles were evaluated for determination of relative strengths, soil consistency (defined as resistance to flow measured in terms of a cone weight yielding

10 mm penetration for a 60 gram 60° cone). Although the engineers of the Swedish Railroad Commission developed no actual correlations with liquid limit, the fineness number would later be found to roughly correlate to Casagrande's Atterberg Liquid Limit (1932).

Terzaghi's Investigations

In 1927 Terzaghi wrote a paper on his attempt to relate shear strength with cone penetration. His investigations revealed today's well know fact that, for samples of the same water content and density, penetration depth of the remolded sample is markedly greater than that of the undisturbed sample. This observation is illustrated by figure 3-2 (Terzaghi, 1927).

Terzaghi's above observations along with the origin of the Casagrande Liquid Limit device (1932) put a temporary damper on fall cone investigations in America, and research efforts began to take root in the USSR.

USSR and Bulgaria

No data is available on the USSR's early use of the Vicat needle and narrow cones in an attempt to simplify liquid limit determination. In 1949 the USSR adopted and standardized the Vasilev method. Liquid limit was defined by a 10 mm penetration within 5 seconds of a 70 gram 30° brass cone.

This Vasilev method was soon after adopted by Bulgaria.

The relationship between the cup and Vasilev cone was shown by Skopek and Ter-Stepanian to be linear up to a liquid limit of 100%. This relationship is illustrated by figure 3-3.

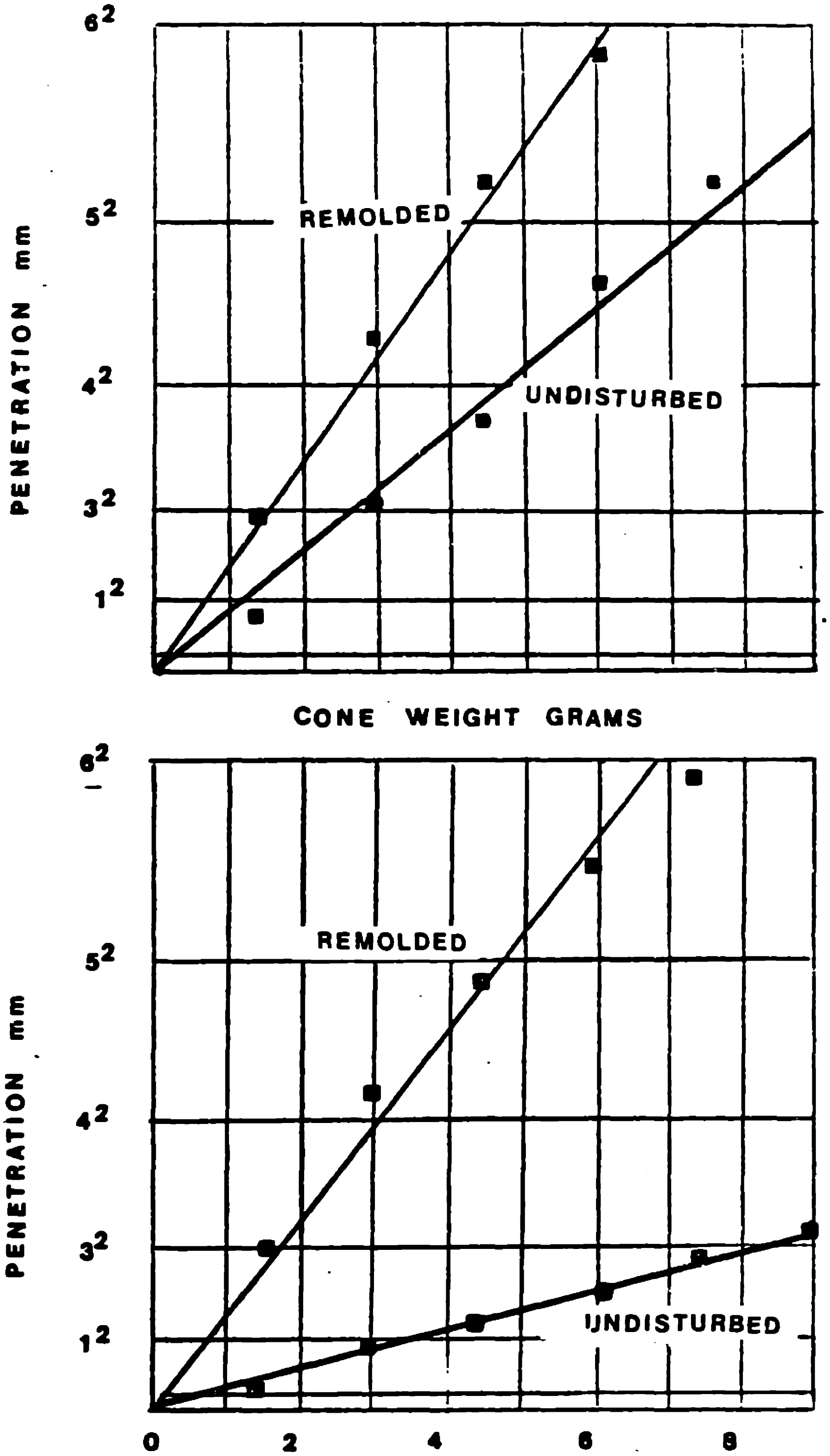



FIGURE 3-2 RELATION BETWEEN WEIGHT ACTING ON CONE AND SQUARE OF PENETRATION OF THE CONE INTO SAMPLES. (FROM TERZAGHI 1927).

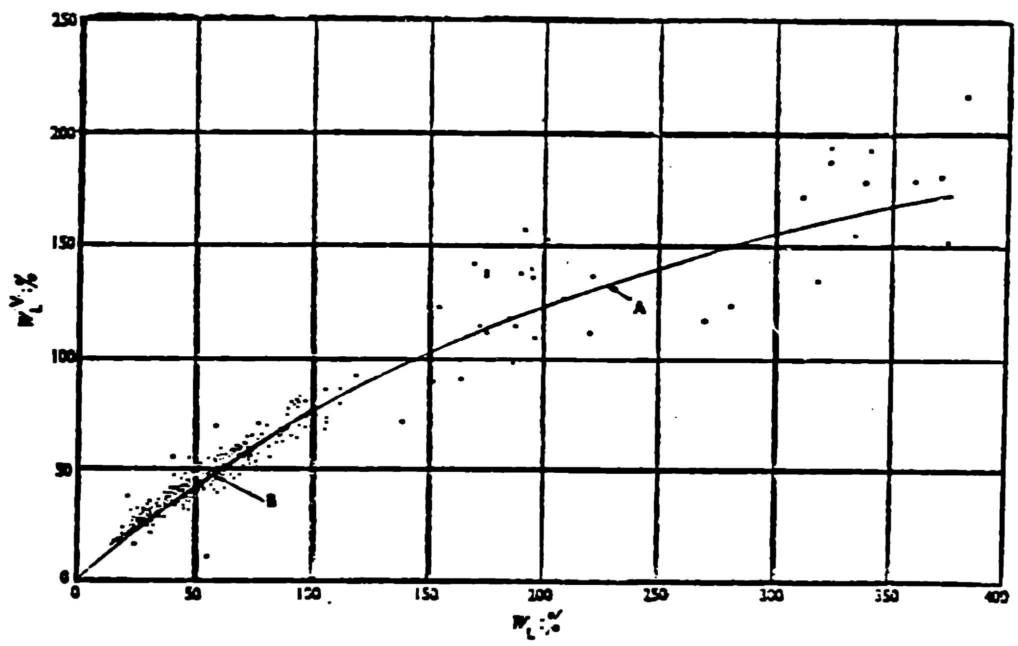



FIGURE 3 – 3 LIQUID LIMIT $W_L^V$ ACCORDING TO VASILEV AGAINST $W_L$ ACCORDING TO CASSAGRANDE. REGRESSION CURVE LINE A IS FOR THE WHOLE SET, AND REGRESSION STRAIGHT LINE B FOR SOILS WITH $20\% < W_L < 100\%$. (AFTER SKOPEK & TER-STEPANIAN 1975).

Indian Cone

Developed by the Indian Central Road Research Institute in the 1950's, the Indian Cone consists of a 31$^{o}$ cone weighing 148 grams and measuring 1.2 inches in length. The liquid limit is defined by a penetration of 25 mm. An excellent correlation exists between the liquid limit determined by the Indian cone and that from the Casagrande device (as outlined in Meth D 423) for liquid limits greater than 25%. For values less than 25%, this method yields higher liquid limit values than does the cup.

Georgian Institute of Technology Cone

In the 1950's a variety of tests were performed by Georgia Institute of Technology in an effort to find a simple liquid limit test. Impressed by the great success of the Vasilev cone in the USSR and Bulgaria, Georgia Tech commenced a cone penetration testing program to investigate the effects of varying cone weight, angle, and soil water content. The relation between Liquid Limits determined via the Georgia cone and Casagrande device is shown in figure 3-4. Georgia's cone, along with the Indian and USSR cones discussed above are illustrated in figure 3-5.

Various Cone Penetrometer Tests

The French cone, a modified bitumen cone, has been shown to correlate well with the Casagrande liquid limit device for liquid limits up to 100%.

At the present time, numerous countries make frequent or at least occasional/supplemental use of the fall cone. Among these are Great Britain, Canada, and Brazil.

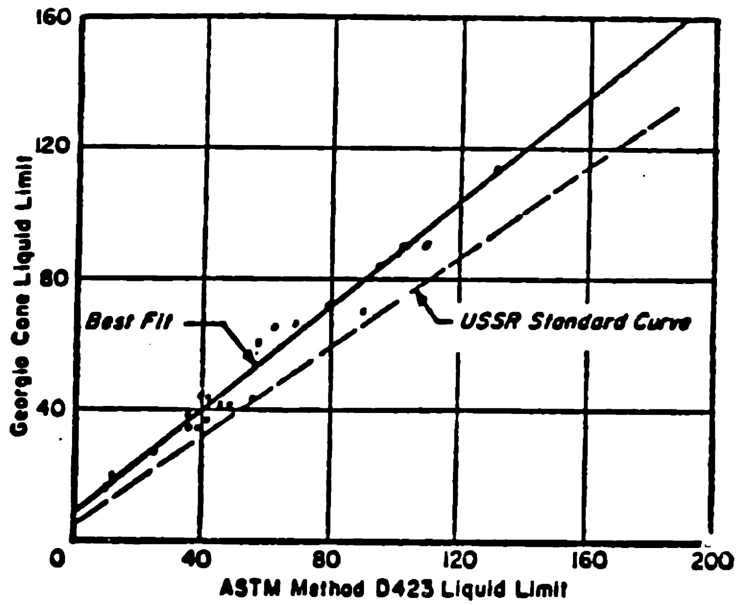



FIGURE 3 — 4 GEORGIA CONE LIQUID LIMIT VS. THE CONVENTIONAL LIQUID LIMIT DETERMINED BY MEANS OF THE CASAGRANDE DEVICE. (FROM SOWERS ET AL., 1959)

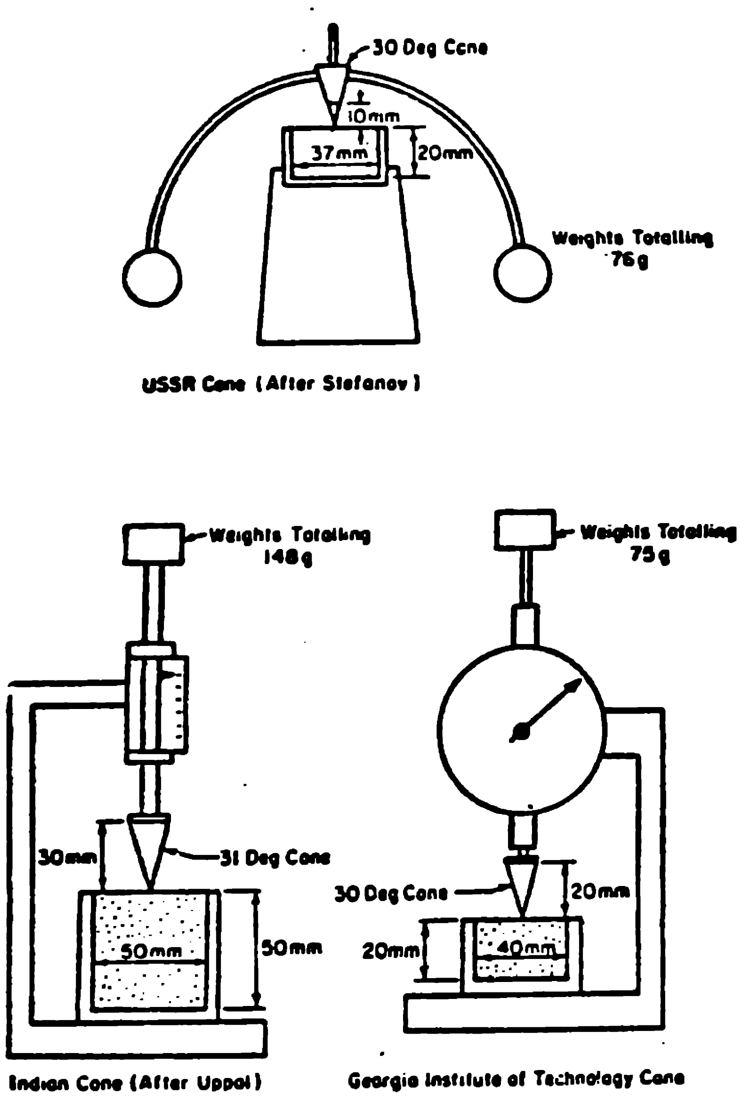



FIGURE 3 – 5 VARIOUS CONE PENETROMETERS FOR THE LIQUID LIMIT TEST. (FROM SOWERS: ASTM SYMPOSIUM ON LIQUID LIMITS 1959)

## 3.4 FALL CONE

Apparatus and Testing Program

The cone penetrometer tests constituting this investigation were performed in accord with the standard cone procedure which is suggested and outline by Sowers in ASTM's Symposium on Atterberg Limits (1959).

The fall cone apparatus used (depicted in figure 3-6) was in actuality the cone penetrometer specified by ASTM Meth D217 for tests on lubricating grease; however, the cone was specially adapted for liquid limit testing: 75 gram stainless steel cone with $30^{o}$ point. (Great Britain used the same apparatus for liquid limit testing - BS 1377 - as for bituminous material testing - BS 4691 - (Head).) The steel cone is positioned such that the apex just touches the soil surface. It is then allowed to fall freely enabling the operator to read the cone penetration depth directly off the gauge.

A similar series of cone penetrometer tests was performed on a different set of soils; however, a $60^{o}$ plexiglass cone weighing 100 grams was used in lieu of the standard cone specified by ASTM.

In the same manner as with the Casagrande cup, each soil was tested over a range of water contents.

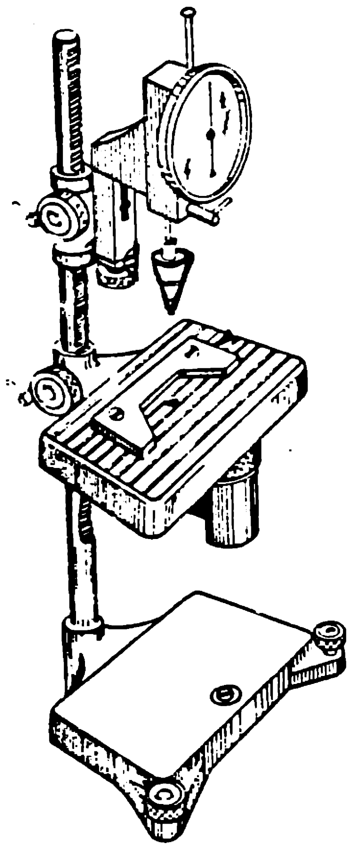


FIGURE 3 - 6 PENETROMETER USED. (SKETCH TAKEN FROM ASTM PENETROMETER FOR LUBRICATING GREASE).

Relationship Between Cone Penetration and Water Content

In order to determine the best relation between water content and penetration depth, data were plotted, equations established, and correlation values obtained for the possible relations listed in table 3-1. (Possibilities examined include a linear relation, log of water content vs. cone penetration, and log of cone penetration vs. water content.)

For figures 3-7 through 3-12 discussed in the above table, each line is representative of a different soil. Again, numbers at the top of each line refer to tables 2-1a and 2-1b which list and describe each soil sample. The standard liquid limit as determined by the Casagrande liquid limit device is superimposed on each line and is indicated by the circled points.

Stefanoff (1958) of Bulgaria showed the best relation between water content and cone penetration depth to be a logarithmic one. He defined the correlation with standard Casagrande liquid limit by the equation $W_{L(cas)} = 1.449\ W_{L(cone)} - 7.4$ (or $W_{L(cone)} = .69\ W_{L(cas)} + 5.1$) with a correlation coefficient of .964.

The correlation values for log of penetration vs. water content or log of water content vs. penetration evolving from this study were not as good as those from the simple linear relation: penetration vs. water content for lower liquid limit soils.

Some advocates of the linear relationship include Sowers, Sherwood and Ryley, Skopek and Ter-Stepanian, Littleton and Farmilo.

TABLE 3 – 1 CORRELATION COEFFICIENTS FOR VARIOUS POSSIBLE CONE PENETRATION : WATER CONTENT RELATIONSHIPS.

| Figure | Cone Angle ° | Relation | Correlation Coefficient |
|---|---|---|---|
| 3-7 | 30° steel | Cone Penetration vs. Water Content | — |
| 3-7 (enlarged in 3-8) | 30° steel | Cp vs. W% for Lower Liquid Limit Soils | .9262 |
| 3-7 | 30° steel | Cp vs. W% for Higher Liquid Limit Soils | .6776 |
| — | 30° steel | Log Cone Penetration vs. Water Content | .7420 |
| 3-9 | 30° steel | Log Water Content vs. Cone Penetration | .8971 |
| 3-10 | 60° plexiglass | Cone Penetration vs. Water Content | — |
| 3-10 (enlarged in 3-11) | 60° plexiglass | Cp vs. w% for Lower Liquid Limit Soils | .9201 |
| 3-10 | 60° plexiglass | Cp vs. w% for Higher Liquid Limit Soils | (1.0 : only 1 high liquid limit soil) |
| — | 60° plexiglass | Log Cone Penetration vs. Water Content | .9430 |
| 3-12 | 60° plexiglass | Log Water Content vs. Cone Penetration | .9908 |

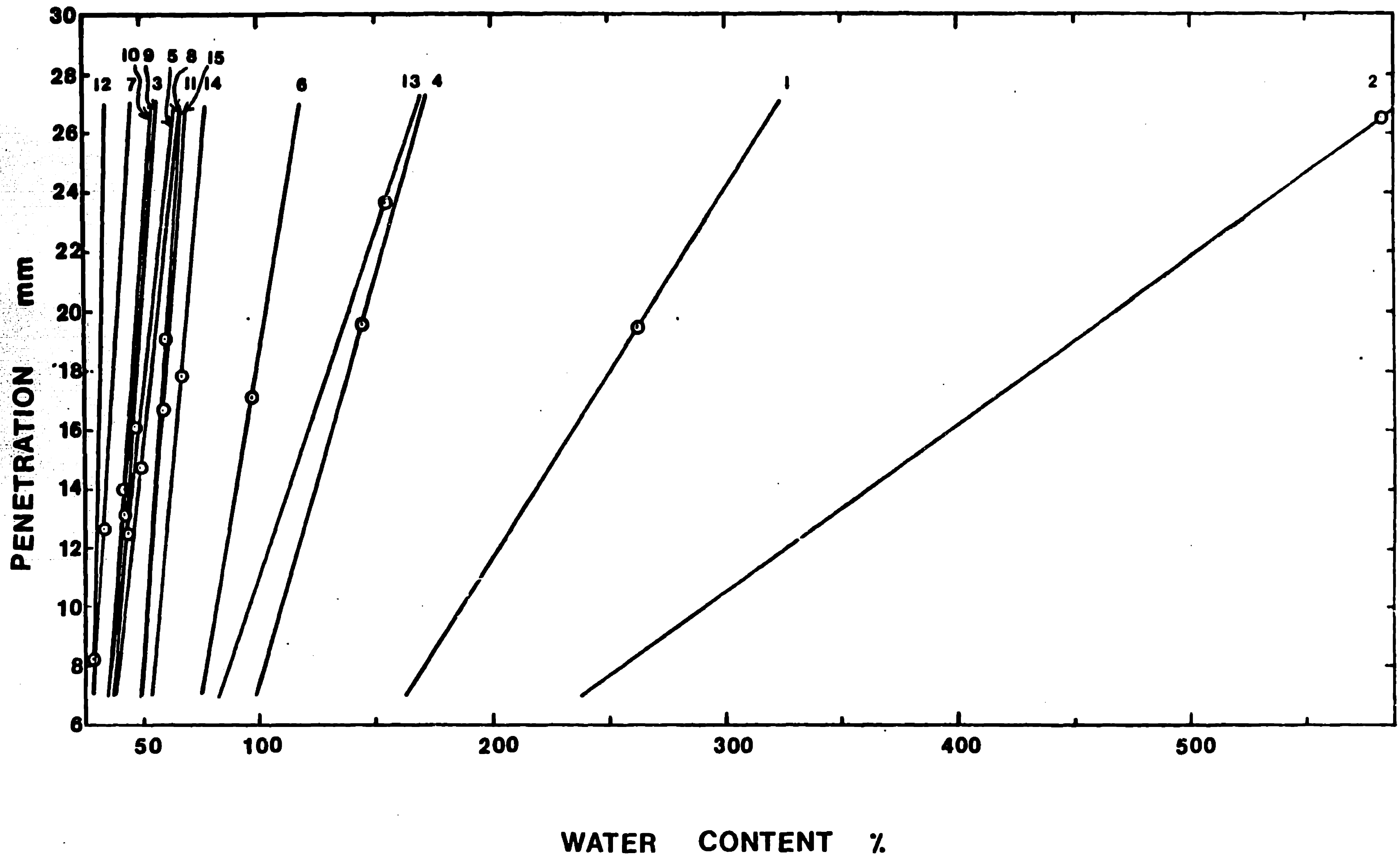



FIGURE 3 - 7 CONE PENETRATION VS. WATER CONTENT. (30° CONE)

Concerning the linear/logarithmic discrepancy, figure 3-13 depicts water content vs. penetration based upon numerous individual tests taken over a large range of water contents. The relation does tend to curve; however, the deviation from linear comes significantly into effect only for water contents higher than the liquid limit. This figure, particularly within this critical range, exhibits a greater degree of linearity than does figure 3-14, the comparable plot for the Casagrande device in which water content is plotted against blowcount. Figures 3-15 and 2-13 are identical to the aforementioned figures with one exception, that being penetration and number of blows are plotted to the log scale. Once again, there does exist a deviation from linear. Naturally, this deviation for the Casagrande cup remains considerably more pronounced than that of the cone for the same water content range.

Figures 3-8 and 3-11 are simply enlargements of the lower liquid limit range of the more inclusive figures 3-7 and 3-10. Although most countries which have adopted the cone penetrometer tests as the standard means of liquid limit determination define liquid limit as a constant penetration depth such as ten or twenty milimeters (see tables 3-2a and 3-2b), it can be seen that there is a definite trend toward increasing penetration with increasing liquid limit. Low liquid limit soils tend to yield low penetration values, and high liquid limit soils, high penetration values.

The heavy diagonal lines of figures 3-8 and 3-11 represent

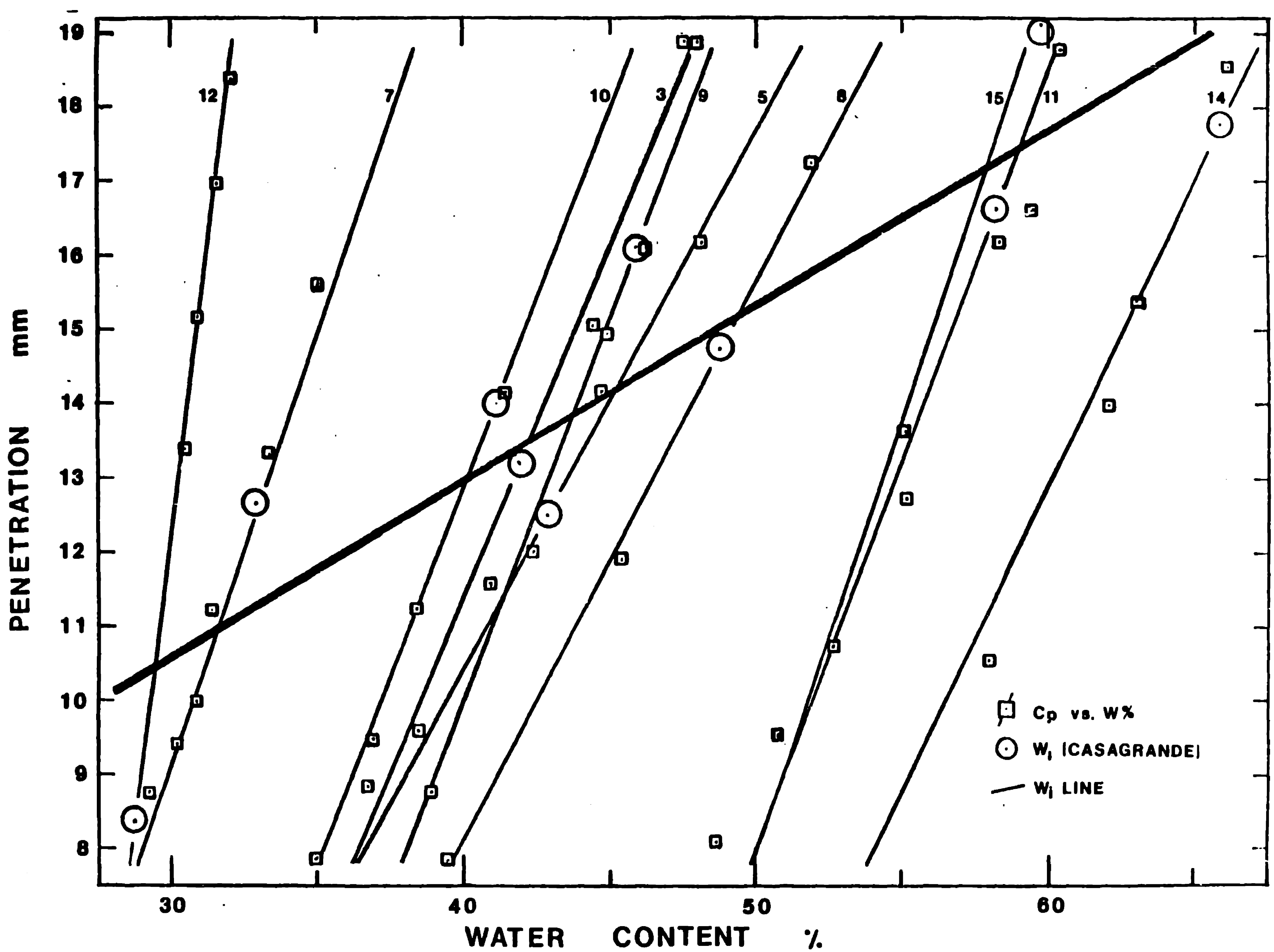



**FIGURE 3 – 8** LIQUID LIMIT LINE. RELATION AMONG CONE PENETRATION, WATER CONTENT, AND LIQUID LIMIT FOR LOW PLASTICITY CLAYS. (30° CONE)

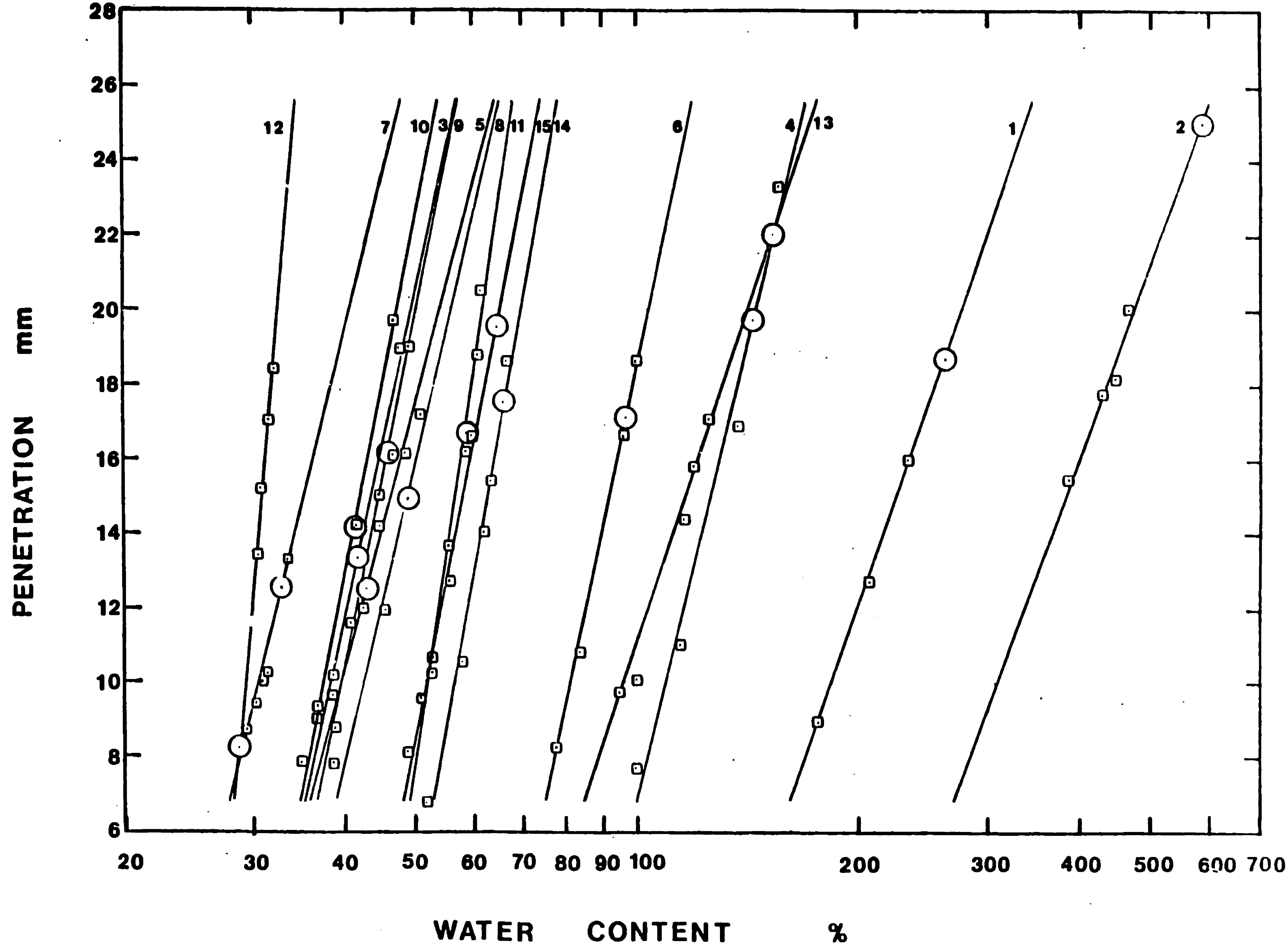



FIGURE 3 - 9 CONE PENETRATION VS. LOG WATER CONTENT. (30° CONE)

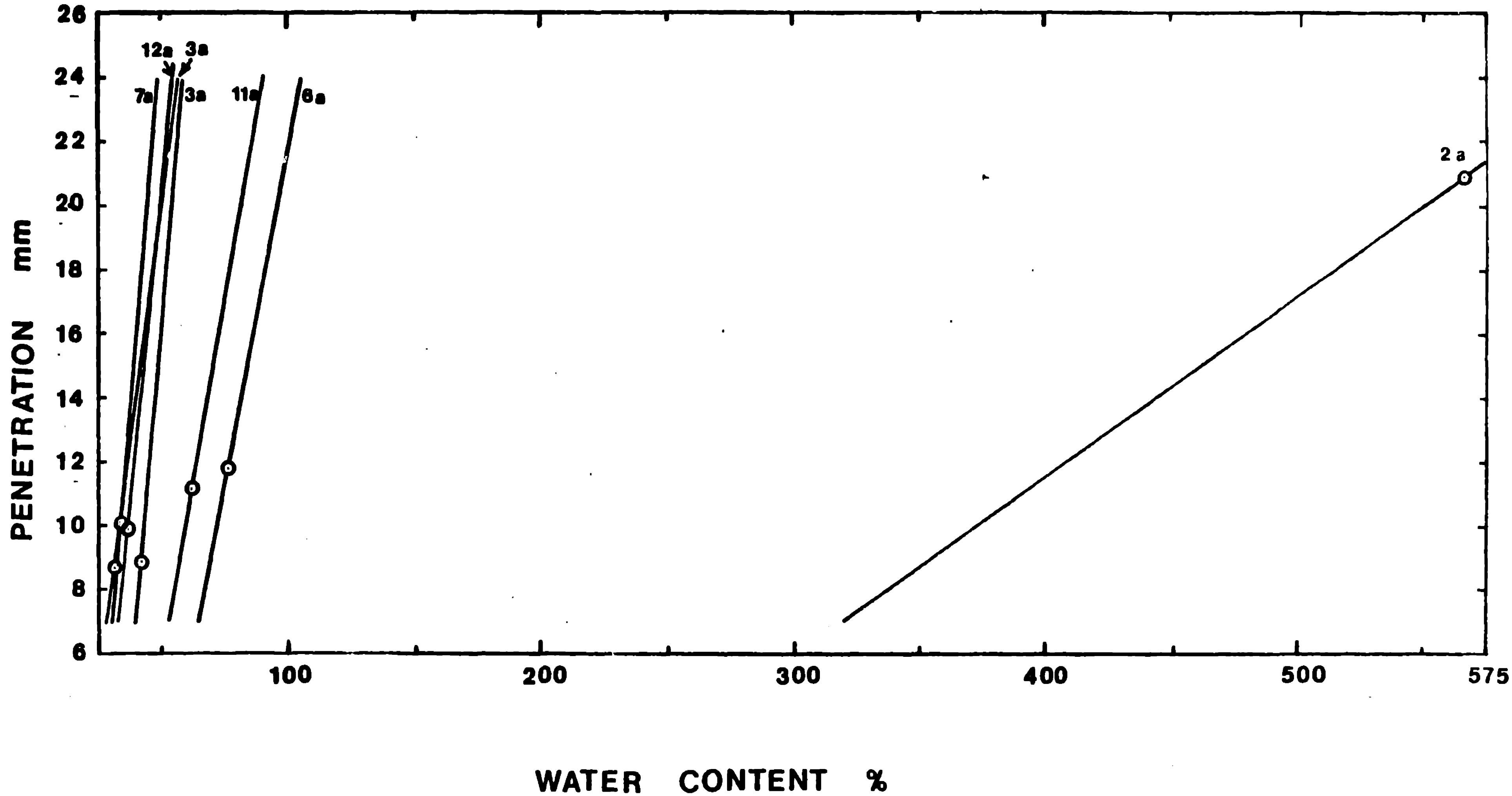



FIGURE 3 - 10 CONE PENETRATION VS. WATER CONTENT. (60° CONE)

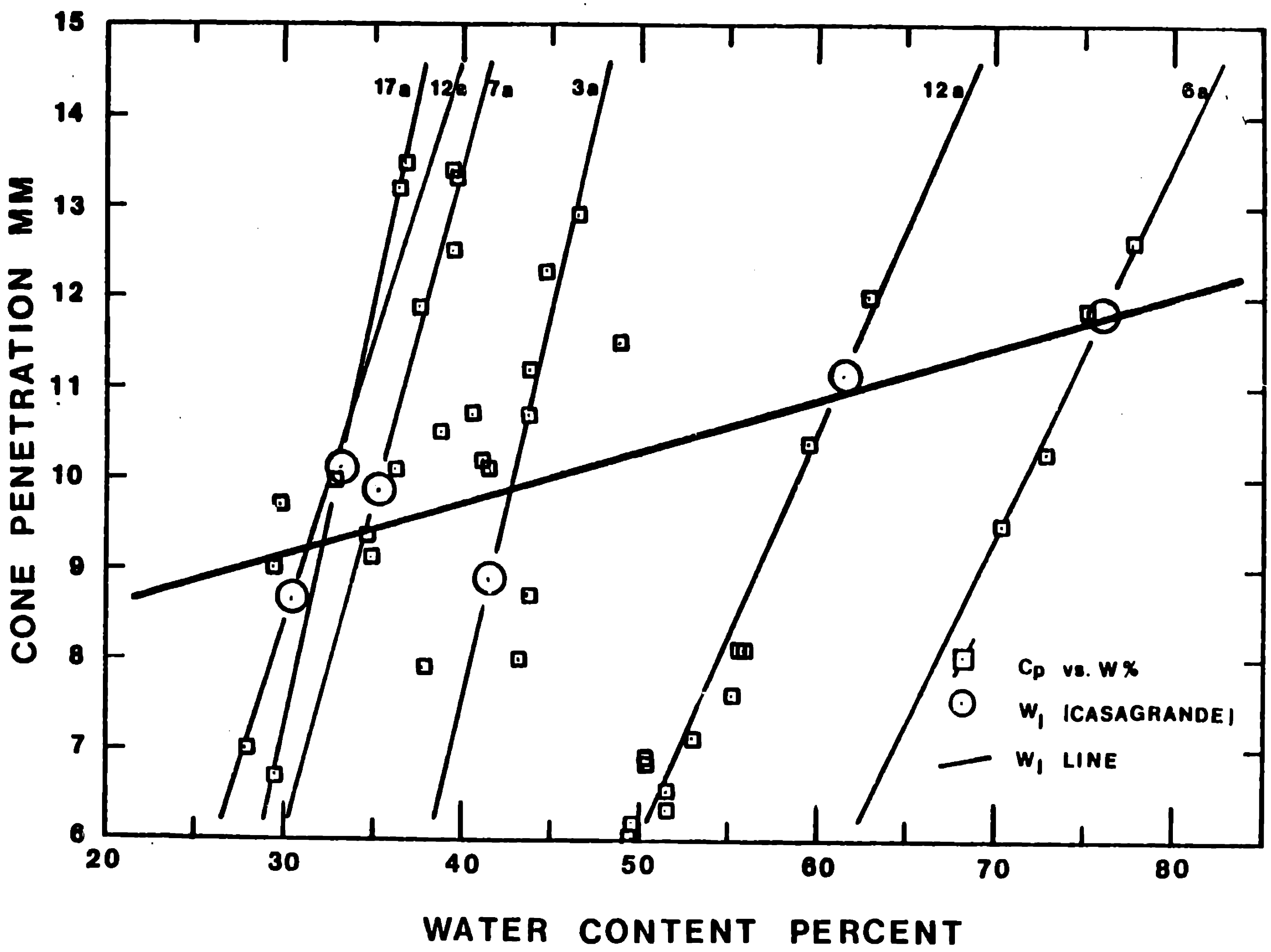



FIGURE 3-11 LIQUID LIMIT LINE. RELATION AMONG CONE PENETRATION, WATER CONTENT, AND LIQUID LIMIT FOR LOW PLASTICITY CLAYS. (60° CONE)

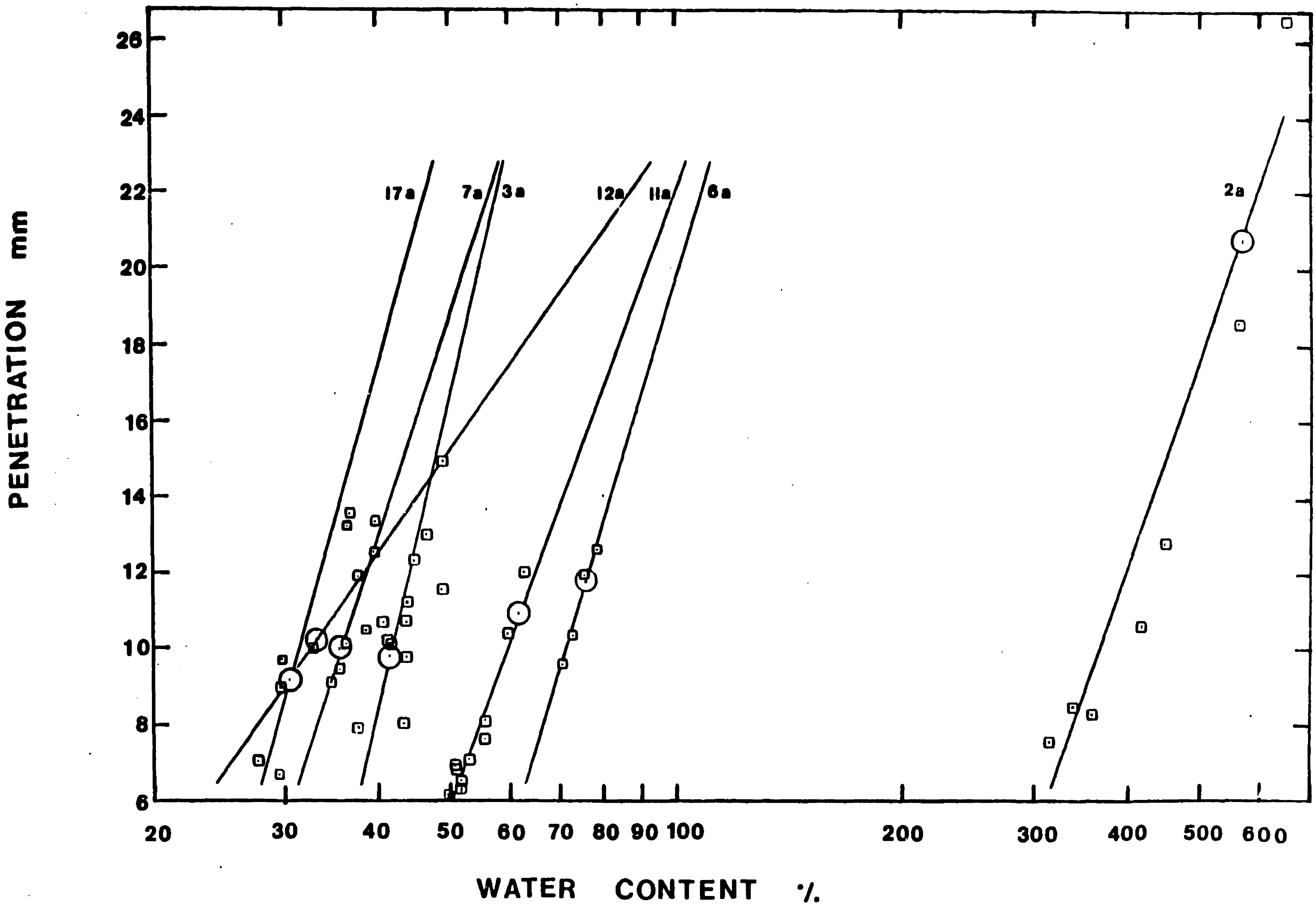



FIGURE 3 – 12 CONE PENETRATION VS LOG WATER CONTENT. (60° CONE)

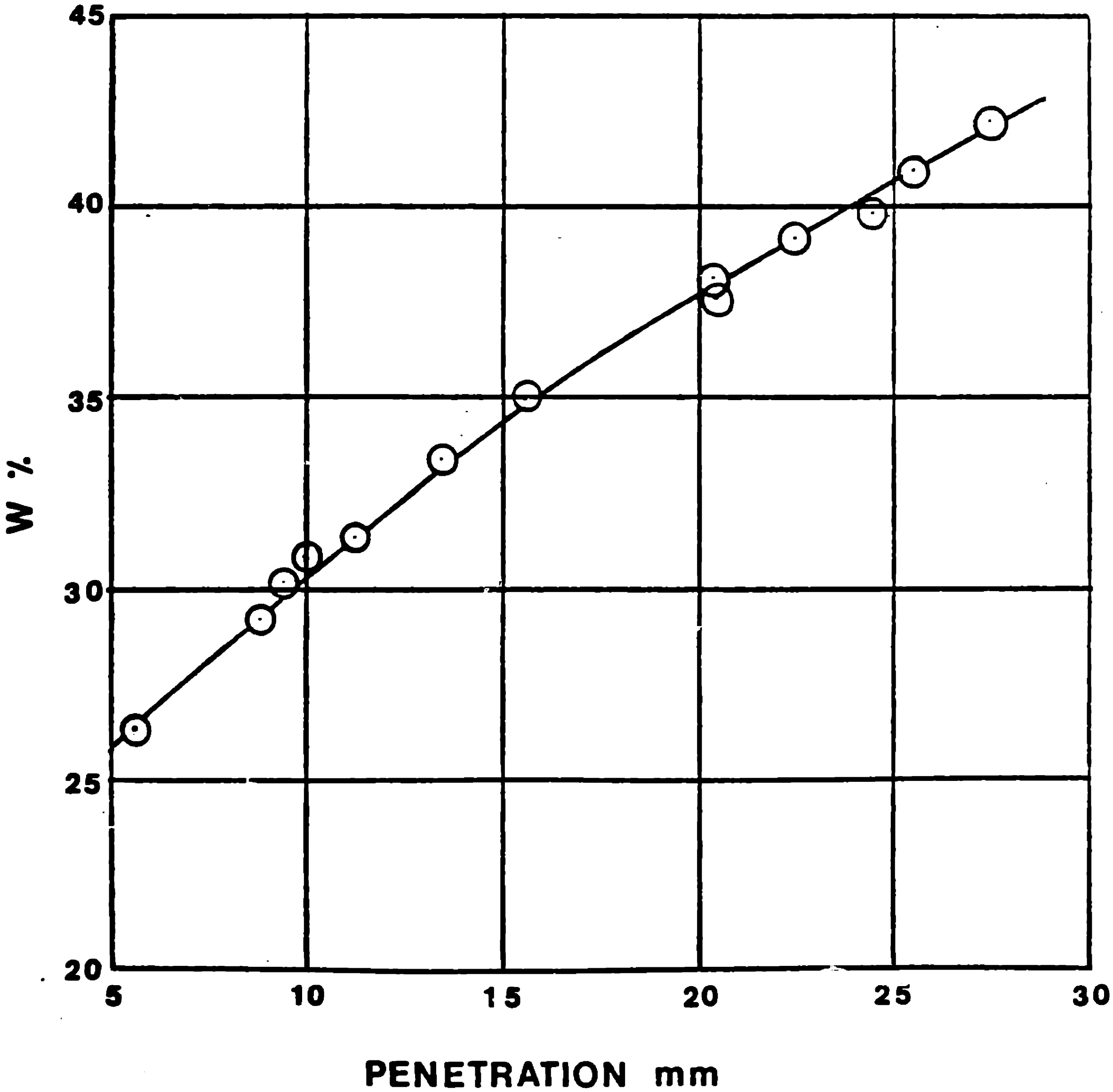



FIGURE 3-13 FALL CONE: WATER CONTENT VS. CONE PENETRATION DEPTH FOR MODELING CLAY. (30° CONE)

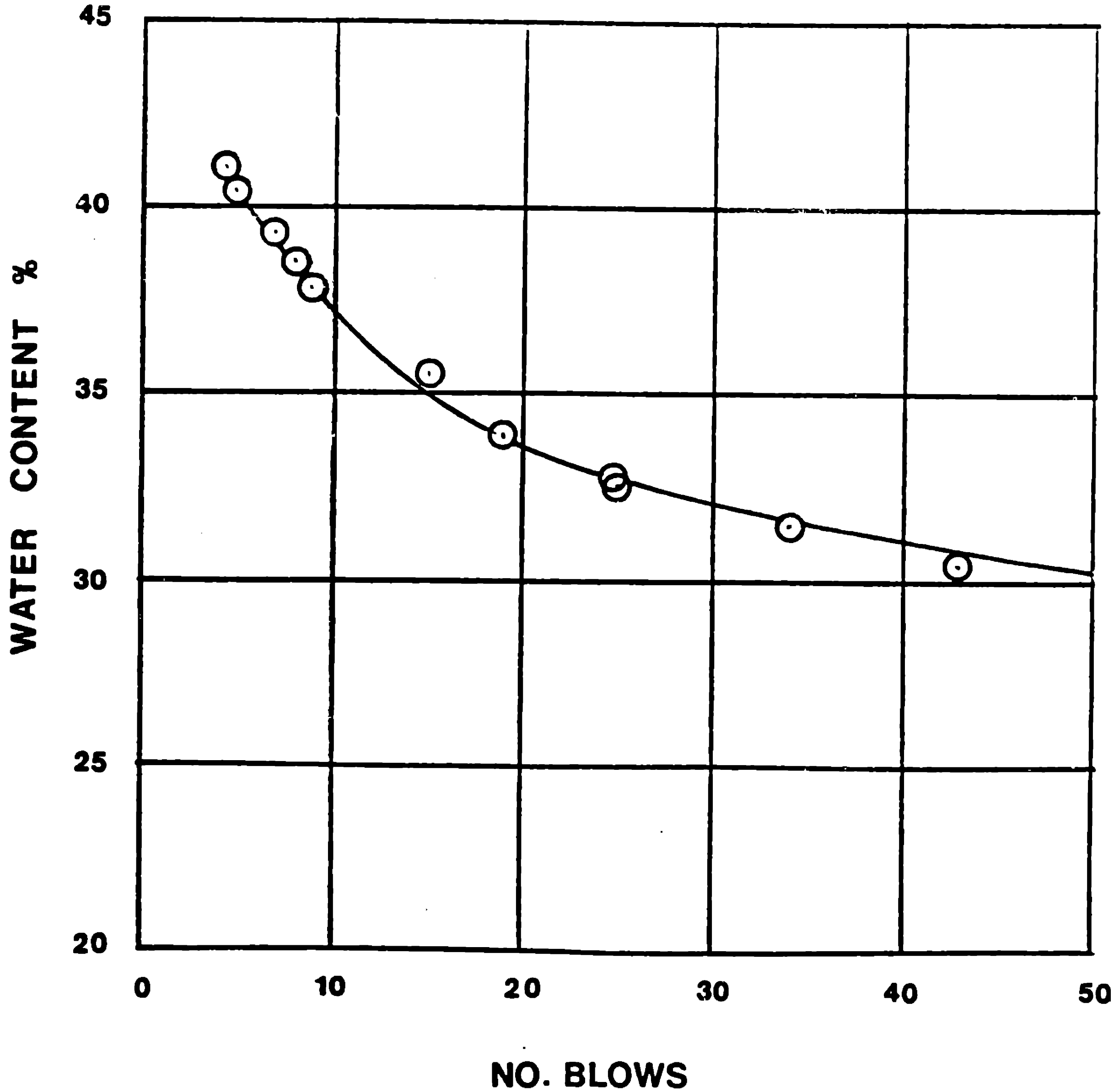



FIGURE 3 - 14 CASAGRANDE DEVICE: WATER CONTENT VS. NUMBER OF BLOWS FOR MODELING CLAY.

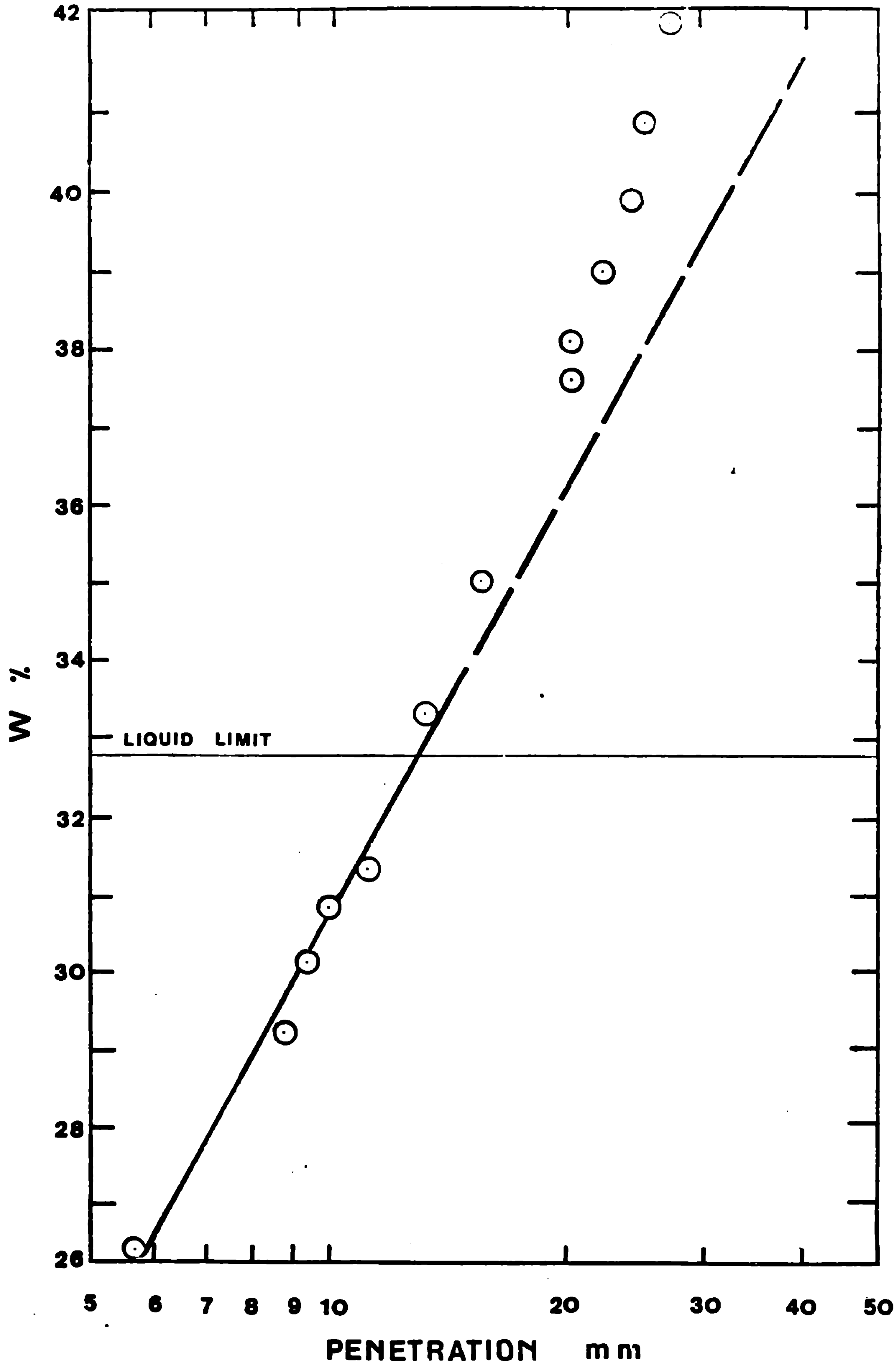



FIGURE 3 – 15 DEPENDENCY OF LIQUID LIMIT UPON RANGE WITHIN WHICH TESTS ARE PERFORMED FOR FALL CONE. MODELING CLAY. (30° CONE)

TABLE 3 – 2. SPECIFICATIONS FOR VARIOUS LIQUID LIMIT TESTS. (FROM LITTLETON & FARMILO 1977).

| Country & Date | Cone Angle, Degrees | Length mm | Material Type | Weight grams | Cup Diameter mm | Cup Depth mm | LL mm |
|---|---|---|---|---|---|---|---|
| U.S.S.R. Vasilev 1949 | 30 | 25 | Brass | 76 | 37 | 20 | 10 |
| Indian 1953 | 31 | 30.48 | Metallic | 148 | 50 | 50 | 25 |
| Georgia Institute 1951 | 30 | 20.0 | Stainless Steel | 75 | 40 | 20 | 10 |
| BS 1377 1975 | 30 | 35.0 | Stainless Steel or Duralumin | 80 | 55 | 40 | 20 |

TABLE 3-2b SPECIFICATIONS FOR ADDITIONAL LIQUID LIMIT TESTS (FROM SHERWOOD & RYLEY 19 )

| Country & Date | Cone Angle, Degrees | Weight of Cone grams | liquid Limit mm |
|---|---|---|---|
| Sweden | 60° | 60 | 10 |
| Bulgaria | 30° | 76 | 10 |
| Yugoslavia & East Germany | 30° | 76 | 10 |
| France | 30° | 80 | Apparatus calibrated against Casagrande apparatus |

the regression lines of liquid limit as determined by means of ASTM Meth D423. For the standard 30° steel cone, the intersection of this line with the penetration vs. water content lines for the individual soil samples yields the calibrated liquid limit values listed in table 3-3.

Cone Penetration's Sensitivity to Small Variations in Water Content

It should be noted that penetration depth is extremely sensitive to small water content variations thus accounting for the apparent poor relation of figures 3-8 and 3-11. This concept of small-water-content-changes effectuating relatively large changes in penetration is demonstrated by the relations expressed in figures 3-16, 3-17, and 3-18.

The first is a plot of liquid limit vs. the ratio of water content change to the corresponding penetration change. This figure illustrates that small water content changes are accompanied by large penetration changes. Furthermore, this change increases with increasing water contents.

Figures 3-17 and 3-18 for the 30° and 60° respectively represent the direct relation between the standard Casagrande liquid limit and the calibrated cone liquid limit values as designated by the heavy diagonal line in figures 3-8 and 3-11. A 45° line representative of an ideal one-to-one correspondence was superimposed on the above figures. It should be noted that the departure of circled points from this 45° line is minimal thus demonstrating that, based upon limited testing, the relation

**TABLE 3 – 3 CONVENTIONAL LIQUID LIMIT, CONE CALIBRATED LIQUID LIMIT, AND W% CORRESPONDING TO CONE PENETRATION OF 10 mm FOR LOWER LIQUID LIMIT SOILS.**

| Soil Identification No. and Soil Name | Standard Liquid Limit (Casagrande) ω% | Liquid Limit from Cone Calibration ω% | ω% at 10 mm cone Penetration |
|---|---|---|---|
| 3 Boston Blue Clay | 41.8 | 42.1 | 38.4 |
| 5 Gray Clay | 42.8 | 45.1 | 39.2 |
| 7 Modeling Clay | 32.8 | 31.3 | 30.5 |
| 8 Venezuelan Clay - C1510 | 48.7 | 49.2 | 42.4 |
| 9 Venezuelan Clay - C2S43 | 45.8 | 43.5 | 39.8 |
| 10 Venezuelan Clay - C3S17 | 41.1 | 40.2 | 37.2 |
| 11 Vicksburg Buckshot Clay | 58.2 | 59.0 | 51.5 |
| 12 30/70 Mix 30% VBC, 70% Bin No 2 | 26.7 | 29.3 | 29.2 |
| 14 Bin No. 12 | 65.9 | 68.4 | 56.4 |
| 15 Bin No. 39 | 59.5 | 57.9 | 51.6 |

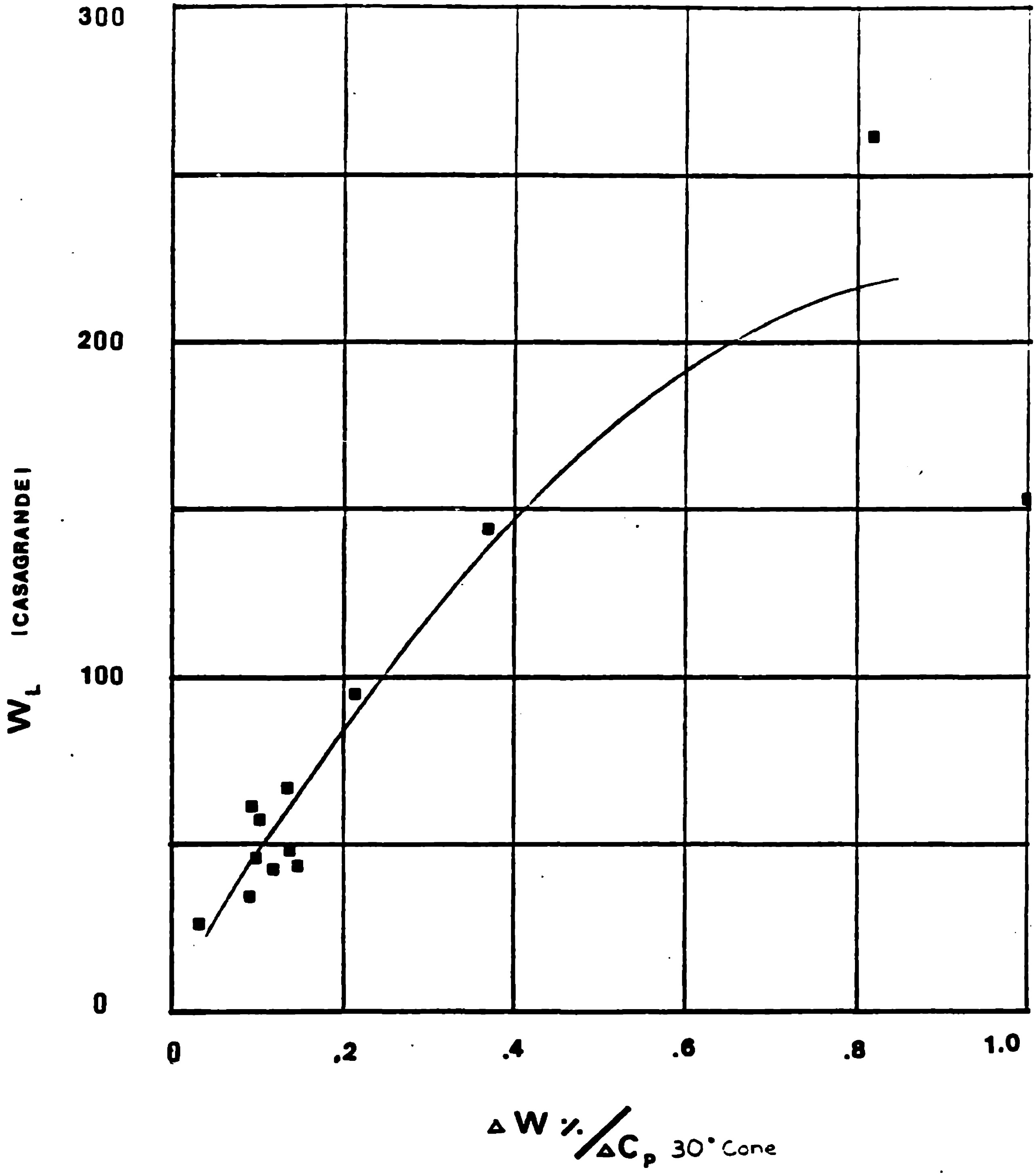



FIGURE 3-16 CHANGE IN WATER CONTENT WITH PENETRATION CHANGE.

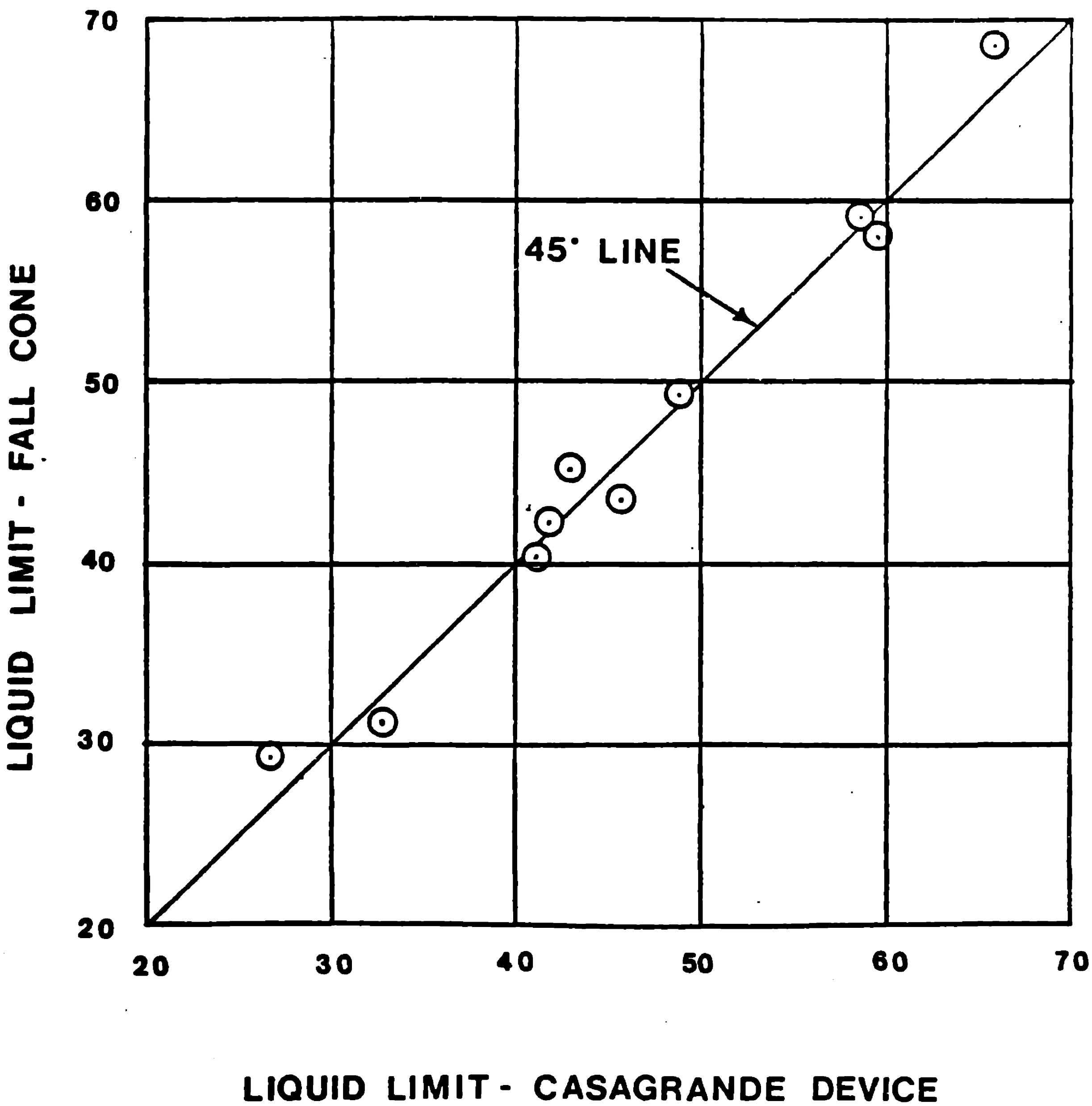



FIGURE 3 – 17 RELATION BETWEEN LIQUID LIMITS DETERMINED BY CASAGRANDE DEVICE AND BY CONE USING CALIBRATION. (30° CONE)

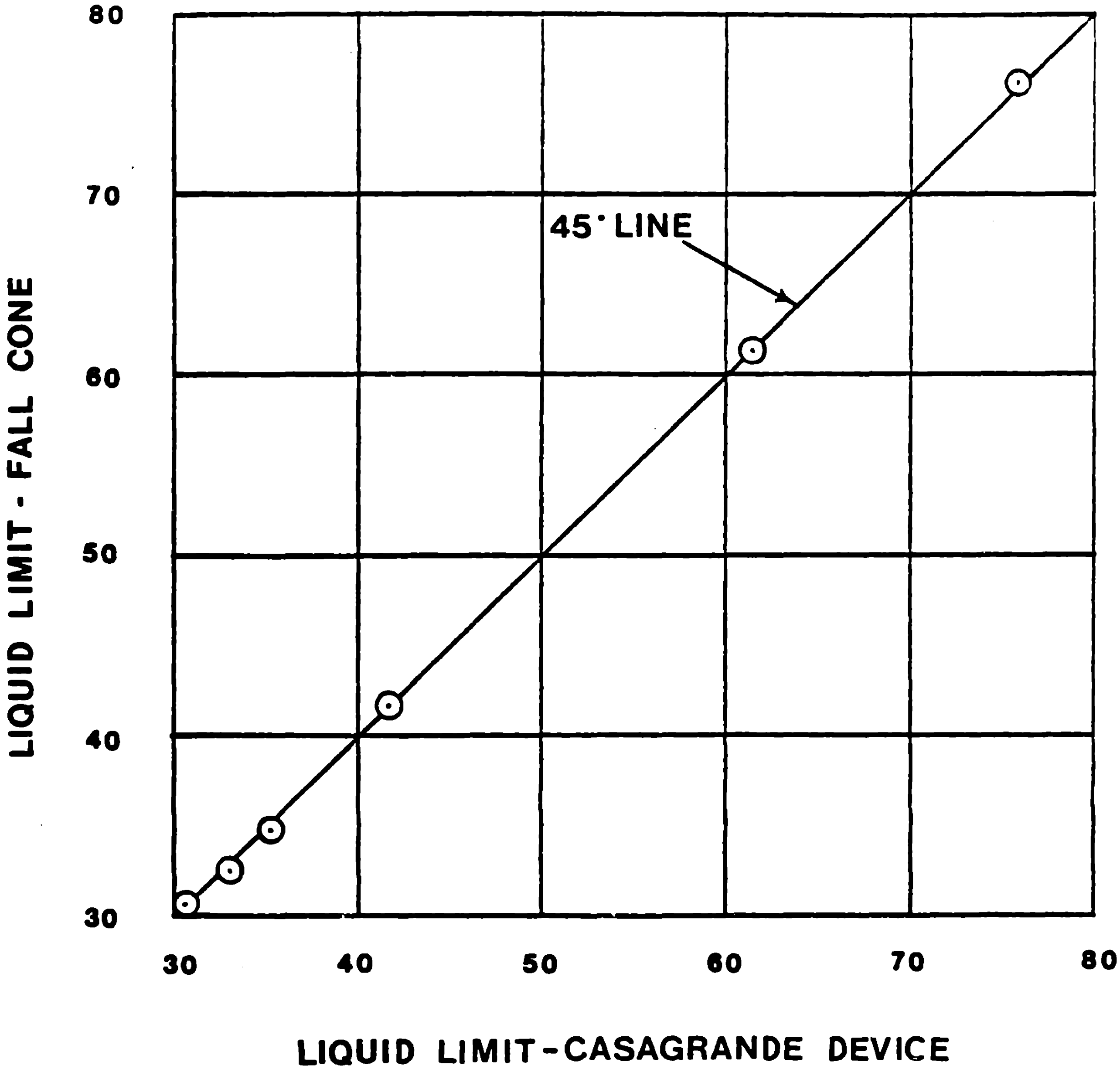



FIGURE 3—18 RELATION BETWEEN LIQUID LIMITS DETERMINED BY CASAGRANDE DEVICE AND BY CONE USING CALIBRATION. (60° CONE)

between the standard Casagrande liquid limit and that calibrated from the fall cone is a good one.

Water Content Corresponding to a Constant Penetration Depth

With the exception of the French method which employs a calibration of cone penetration, Casagrande liquid limit, and moisture content; most countries define liquid limit by the water content at a given penetration depth. The relation between Casagrande liquid limit and the water content corresponding to a cone penetration of 10 mm for the 30° cone is shown by figure 3-19. In this study, liquid limit defined by the 10 mm penetration was less than the corresponding standard liquid limit as determined by means of the Casagrande cup for soils with liquid limits greater than approximately 29. For soils with liquid limits less than 29, just the opposite held. Thus, for soils with liquid limits in the vicinity of 29, both the Casagrande cup and fall cone (constant 10 mm penetration) could be considered to yield similar values. These results are in agreement with previously discussed figure 3-4 from Sowers (1959).

In essence this changes the accepted (Atterberg's) definition of liquid limit.

Strength

Hansbo (1957) developed the relation $Su = 98\ KQ/C_p^2$ where:

Su = shear strength

K = f(cone angle) = .1 for 30° cone

Q = cone mass in grams

$C_p$ = penetration depth in mm

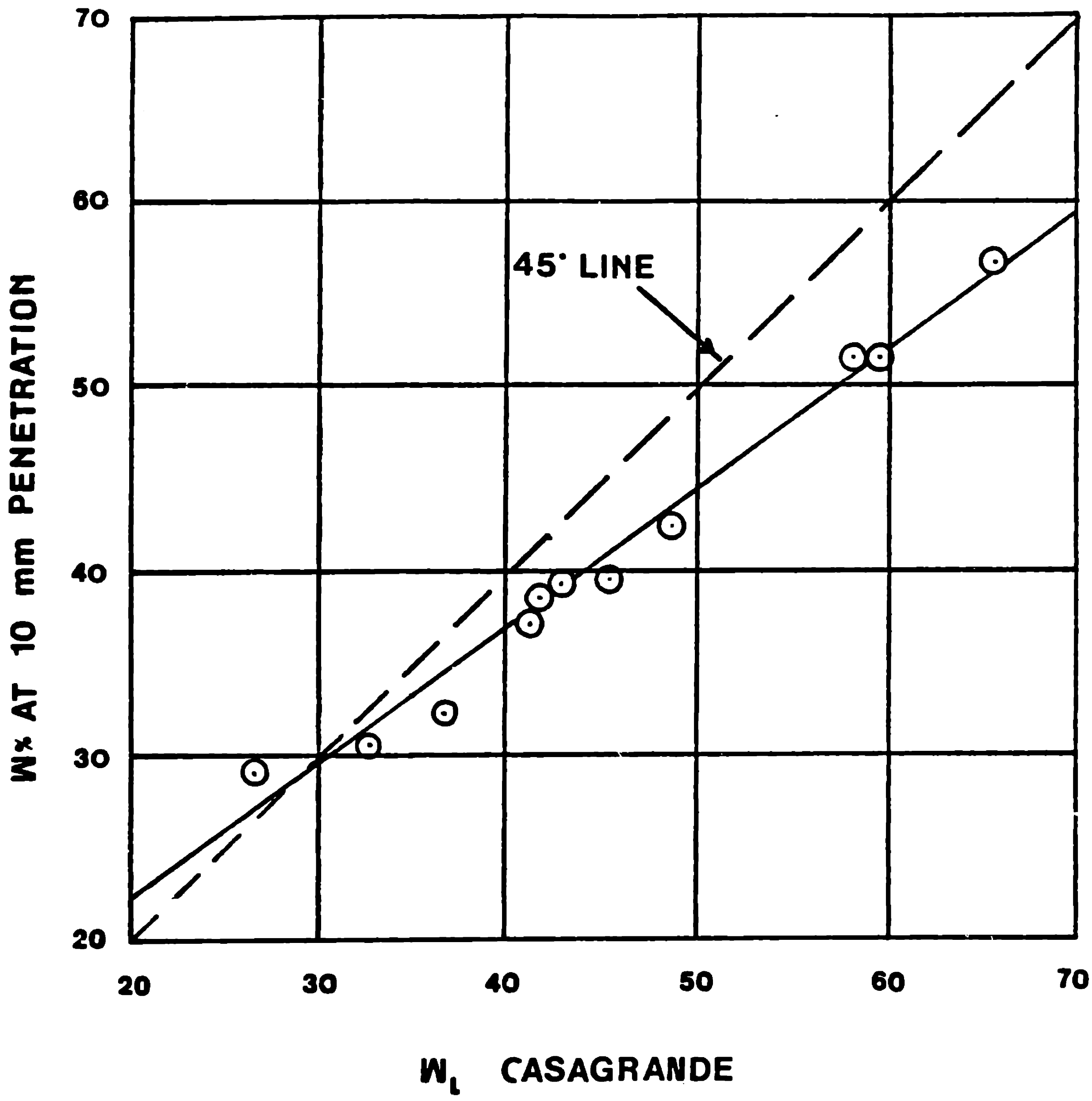



FIGURE 3-19 CASAGRANDE LIQUID LIMIT VS. WATER CONTENT CORRESPONDING TO A CONE PENETRATION OF 10 mm. 30° (CONE)

Random pairs of strength and penetration values corresponding to matching water contents were selected from figures 2-6 and 3-8 respectively. Holding cone angle and weight constant, these pairs of strength and penetration values were substituted into the above equation in rewritten form. In each instance, multiplication of shear strength and the square of penetration yielded approximately the same value thus verifying the validity of $S_u \cdot C_p^2$ = constant.

Strength at Calibrated Liquid Limit

Figures 3-20 and 3-21 depict the logarithmic relation between water content and shear strength where strength was determined by means of the pocket penetrometer and hand held torvane respectively. The heavy diagonal line represents the best fit for strength at the liquid limit for each soil. These figures are analagous to previously discussed figures 2-5 and 2-6; however, in this instance, circled points indicate liquid limit determined from the cone calibration line (figures 3-8 and 3-11) as opposed to the conventional Casagrande liquid limit. The slope of the strength line corresponding to cone calibrated liquid limits is considerably steeper than the comparable Casagrande strength line, and is applicable only for the lower liquid limit range; however, the correlation is very good.

Cone Weight

Three series of tests were performed on modeling clay each with a different weight cone. The resulting penetration vs. water content plots for $W_1$, $W_2$, and $W_3$ are nearly parallel to each other

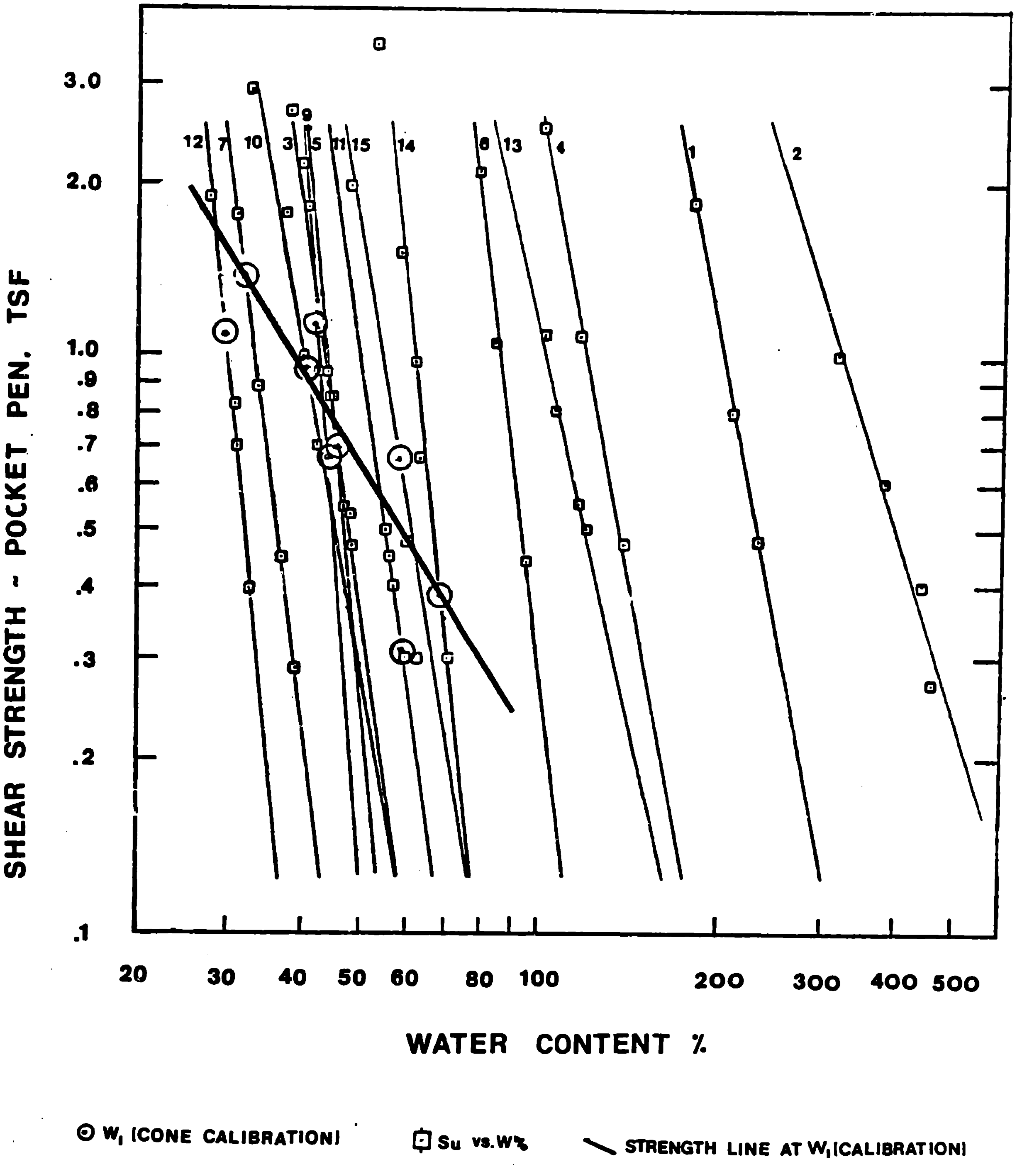



FIGURE 3-20 WATER CONTENT VS. SHEAR STRENGTH FROM POCKET PENETROMETER. CIRCLED POINTS INDICATE LIQUID LIMITS AS DETERMINED VIA CONE CALIBRATION.

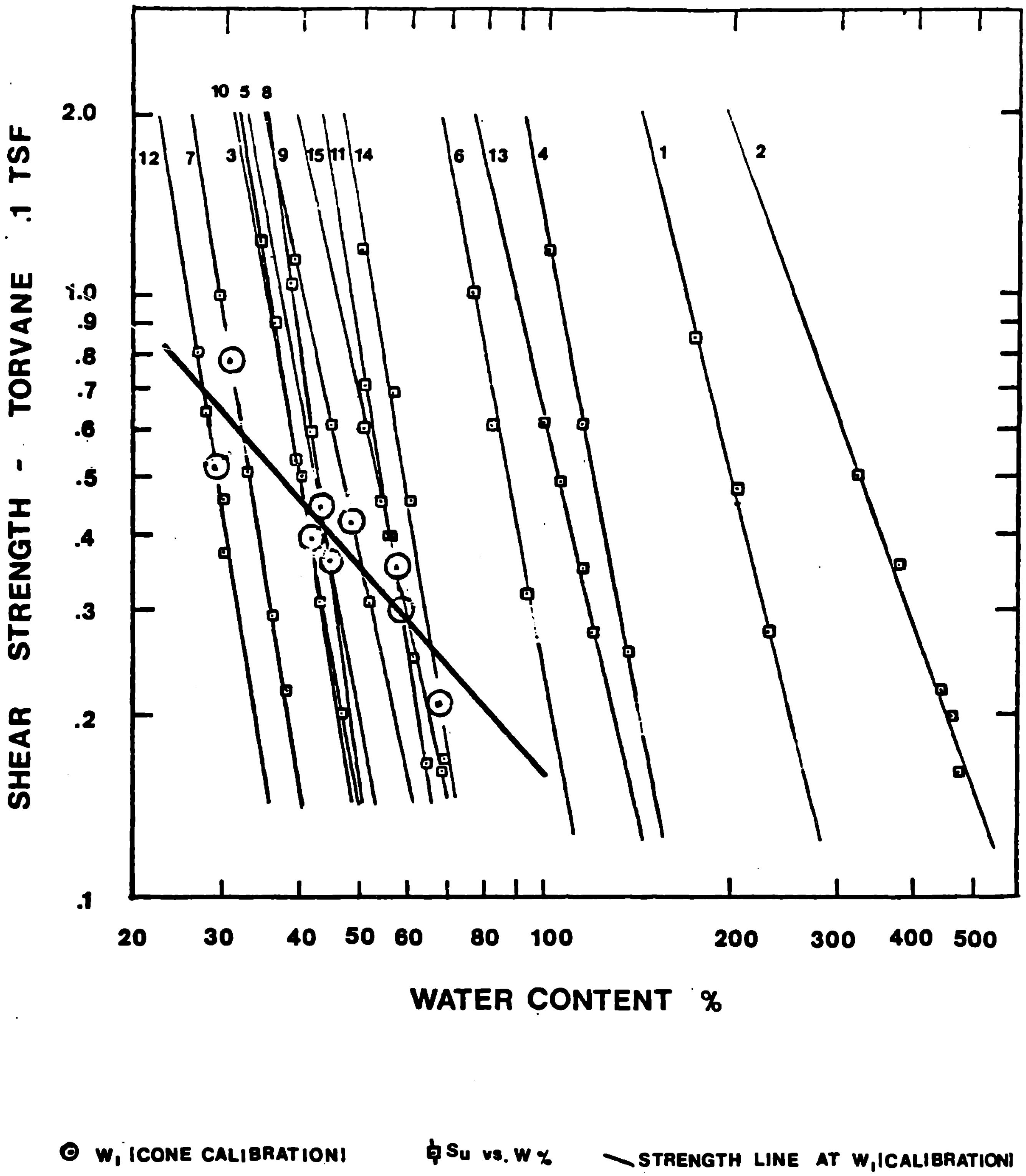



FIGURE 3-21 WATER CONTENT VS. SHEAR STRENGTH FROM TORVANE. CIRCLED POINTS INDICATE LIQUID LIMITS AS DETERMINED VIA CONE CALIBRATION.

as seen by figure 3-22 and noted by similar slope values in the following equations corresponding to the various cone weights:

$$75 \text{ grams: } W = 10.144 \log C_p - 15.82$$

$$150 \text{ grams: } W = 10.148 \log C_p - 19.98$$

$$225 \text{ grams: } W = 9.53 \log C_p - 19.26$$

Figure 3-23 was determined from the results plotted in the above figure. For any cone penetration value corresponding to the standard 30° cone, figure 3-23 shows the penetration at that same water content corresponding to cones of other weights. The significance of a relation such as determined above is as follows: For medium or stiff clays with very small penetration values, accuracy plays an extremely important role. The error can represent a relatively large percentage of the total penetration (i.e., an error of 1 mm represents a much greater percentage error in a clay where the correct penetration is 30 mm than an error of equal magnitude in a clay of 130 mm penetration). Such complications can be alleviated by employing a heavier cone. Holding the cone angle constant, increasing the weight by a factor of say two or three results in a multiplication of penetration depth as is illustrated by this figure. This has been shown to apply for soils of strengths up to 20 tons per square meter.

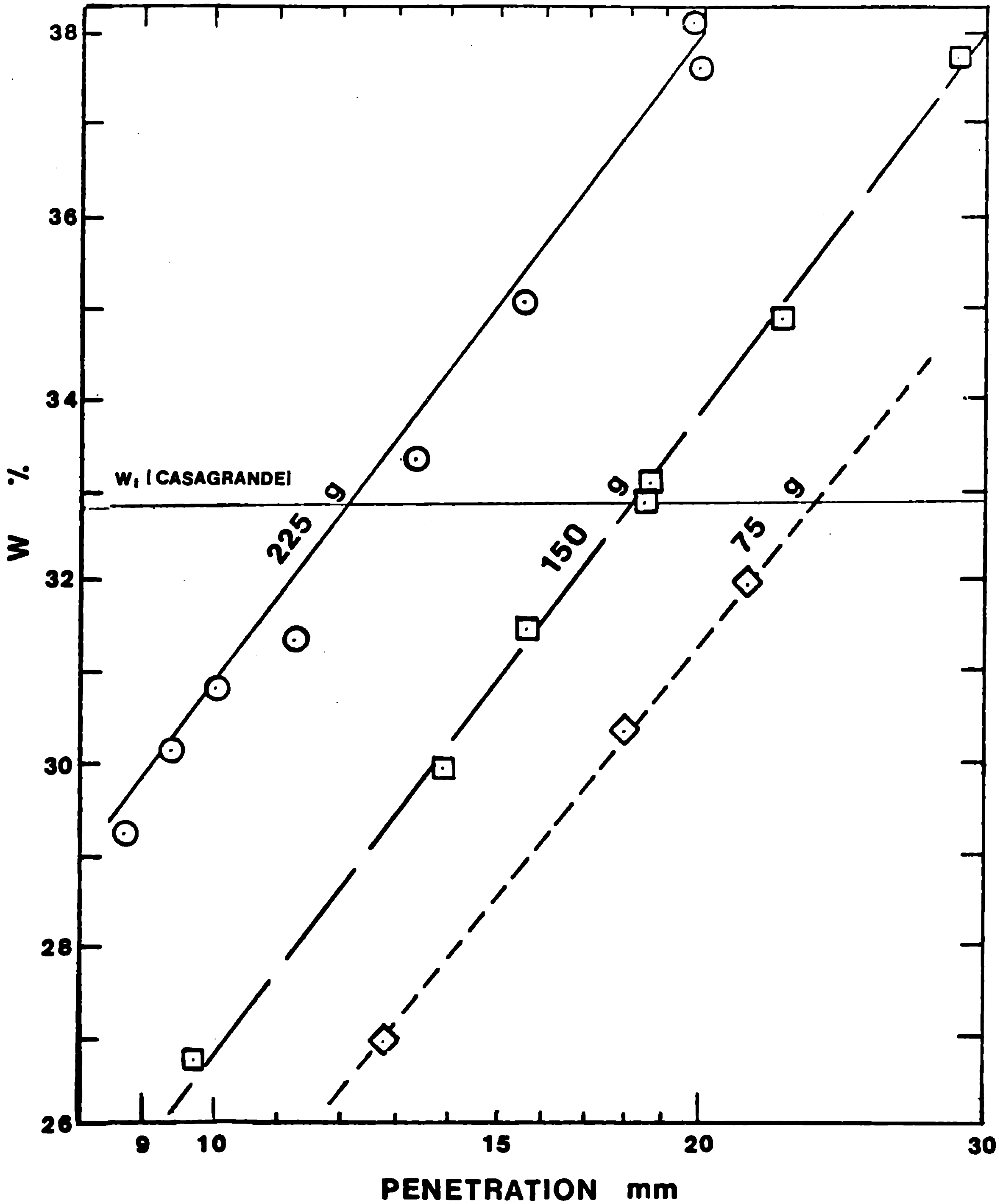



FIGURE 3-22

RELATION BETWEEN WATER CONTENT AND CONE PENETRATION FOR 75, 150, AND 225 GRAM CONES IN MODELING CLAY (30° CONE)

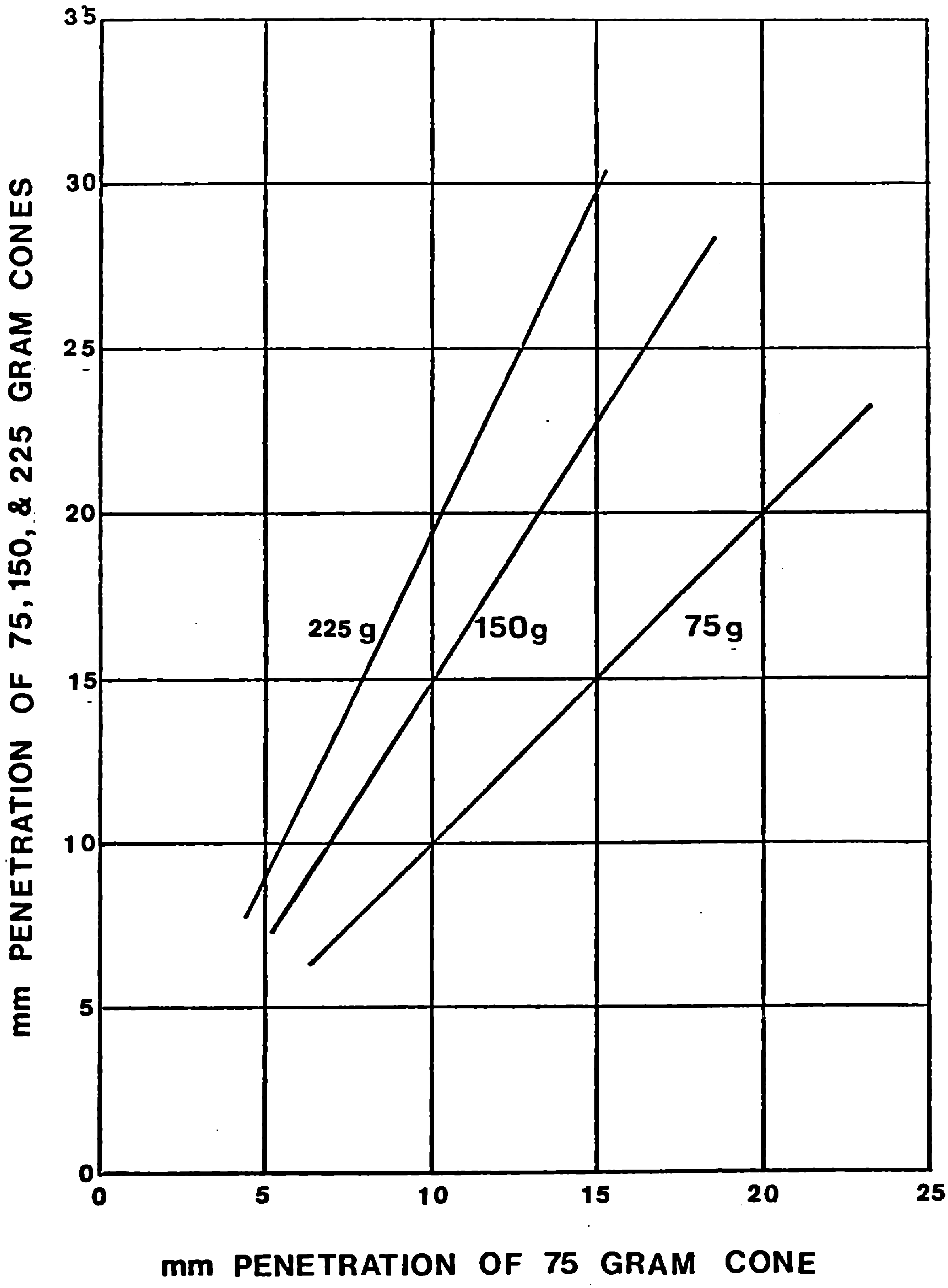



FIGURE 3-23 PENETRATION DEPTHS OF 75, 150, AND 225 GRAM CONES AS A FUNCTION OF PENETRATION DEPTH OF 75 GRAM CONE. TEST RESULTS FOR MODELING CLAY. (30° CONE)

## 3.5 VARIABLES ASSOCIATEDS WITH THE FALL CONE

### Limitations

The fall cone, too, possesses shortcomings of its own; however, the variables associated with this piece of apparatus are more limited in number than those associated with the Casagrande device. Furthermore, many can be compensated for.

Penetration time, point sharpness, soil stiffness, surface texture of the cone, and operator technique are among the variables which may have some effect on repeatability.

### Point Sharpness

A damaged or worn point will result in misleading penetrtion readings, thus an overestimation of shear strength.

Hansbo states that this can be compensated for by adjusting the worn cone into such a position that its geometric apex and the soil surface coincide. He does not mention whether this compensation might introduce any possibility of dynamic effects during the initial free fall. In time, repeated use will naturally result in normal wear; however, this wear of an initially sharp apex can be accelerated by heavy use in sandy soils.

### Soil Stiffness

As previously discussed, medium or stiff clays yield very small penetration values allowing for the possibility of considerable error. Again, this can be compensated for by simply increasing the weight accordingly.

Surface Texture of the Cone

Stated by Terzaghi, penetration is a function of cohesion of the material as well as friction between the cone surface and soil; however, Sherwood and Ryley concluded the surface texture of the cone has only a minimal effect.

Penetration Time

Penetration time, incorporated into the definition of liquid limit determined by the cone, was investigated as a part of this study. The cone is allowed to penetrate for a period of ten seconds acording to ASTM Symposium on Liquid Limits (Sowers 1959). Some other countries specify longer or shorter period of penetration.

The method employed for examining penetration time is quite simple. The cone was released for just one ± second after which time the penetration depth was taken from the depth indicator gauge. The cone was released from the penetration depth corresponding to one second for an additional nine seconds and the ten second penetration depth determined. A third unclamping starting from the ten second position for twenty additional seconds allowed for a final thirty second reading.

In most instances, the penetration depth remained constant, or nearly so, with time. The only exception to this observation occurred with a silty soil possessing a very low liquid limit.

In all probability, the pores were large enough to allow water to flow under the weight of the cone resulting in an increasing water content, thus an even greater penetration depth.

Dependence of Liquid Limit Upon Test Range

Figure 3-15 depicts water content vs. log of penetration for a set of fall cone tests performed on modeling clay. Cone penetration was determined over a wide range of water contents. For water contents higher than the liquid limit, there is a definite deviation from a straight line. The solid line beneath the horizontal Casagrande liquid limit line shows the linear relation, and the dashed line is simply the continuation of such a linear relation.

This deviation from a straight line relation is considerably more pronounced for the fall cone than the comparable figure 2-13 for the Casagrande liquid limit device. Such a deviation introduces a possible disadvantage in utilizing the cone as opposed to the Casagrande device for liquid limit determination. Should all the data points from testing fall above the Casagrande liquid limit value, the liquid limit determined via cone calibration will be incorrect.

Operator Technique

Three different operators each performed a separate set of cone penetrometer liquid limit tests on MIT's Bin No. 12 (identified as soil no. 14 on the table of soils used, Table 2-1a). The test was performed in accord with ASTM STP No. 254 (Sowers, 1959). The soil was taken from the same bin as that used for the Casagrande liquid limit device operator technique study.

Figure 3-24 illustrates the results in the form of water

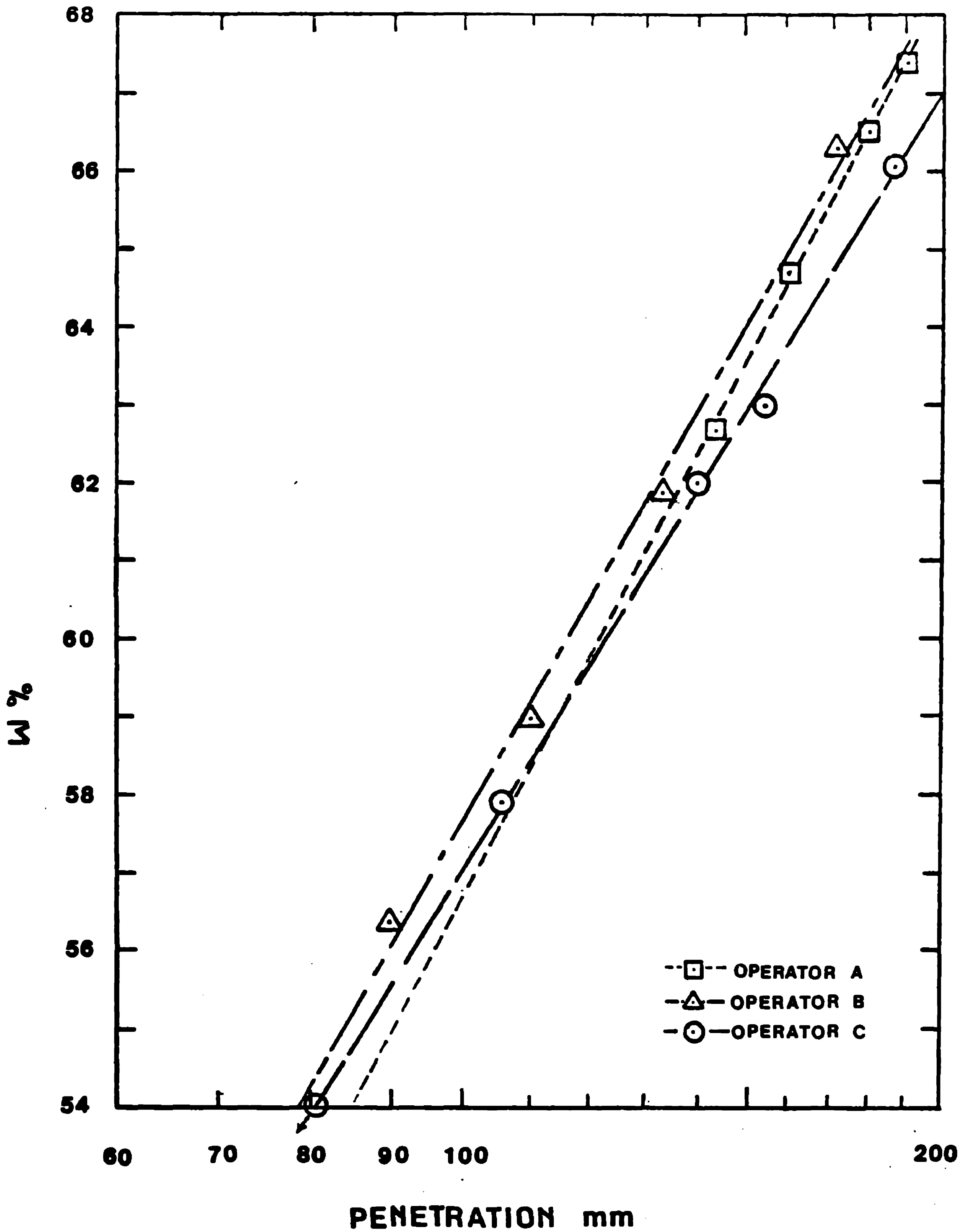
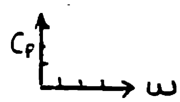



FIGURE 3-24 INFLUENCE OF OPERATOR TECHNIQUE ON LIQUID LIMIT FOR THE FALL CONE. BIN NO. 12.

content vs. log of cone penetration. The three lines fall within a cluster and appear to be nearly parallel. Individual operator results are presumably valid inasmuch as correlations corresponding to each operator are excellent. Table 3-4 presents a more detailed summary of results and allows for simple comparisons among the three operators with regard to penetration depth at the conventional Casagrande liquid limit, liquid limit as defined by a constant penetration depth of 10 mm, and the calibrated liquid limit based upon the cone calibration established earlier. Maximum deviations from average values have been determined, and they, too, are presented as a part of this table. All tabulated values have been calculated for a linear relation (water content to cone penetration) as well as the semilogarithmic relation depicted back in figure 3-24. The maximum percentage deviations ranged from 1% to 5%. Some of the error can most likely be accounted for due to cone penetration's sensitivity to changes in water content discussed earlier in this chapter. In general, it can be said that the agreement among various liquid limit and cone penetration values is very good.

**TABLE 3-4 SULTS FROM OPERATOR TECHNIQUE INVESTIGATIONS
THE FALL CONE.**

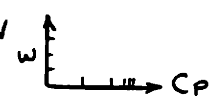
LINEAR RELATION




| | Correlation | Slope | Cp (mm) at $w_{L(cas)}$ = 65.9 | W% at Cp = 10 mm | $W_L$ at intersection with calibration line * |
|---|---|---|---|---|---|
| Operator A | 0.9974 | 9.96 | 17.4 | 58.5 | 68.2 |
| Operator B | 0.9998 | 8.27 | 16.7 | 57.8 | 70.0 |
| Operator C | 0.9917 | 8.15 | 17.7 | 56.4 | 68.4 |
| Average | | | 17.3 | 57.6 | 68.9 |
| Maximum Deviation From Average | | | 0.6 | 1.2 | 1.1 |
| Maximum % Deviation From Average | | | 3% | 2% | 1.7% |

* equation of calibration line:
$Cp = 2.385\,w + 34.18$

SEMI LOGARITHMIC RELATION




| | Correlation | Slope | Cp (mm) at $w_{L(cas)}$ = 65.9 | w % at Cp = 10 mm | — |
|---|---|---|---|---|---|
| Operator A | 0.994 | 16.5 | 17.3 | 56.9 | |
| Operator B | 0.9967 | 15.2 | 17.0 | 57.9 | |
| Operator C | 0.993 | 14.1 | 18.5 | 57.2 | |
| Average | | | 17.6 | 57.3 | |
| Maximum Deviation From Average | | | 0.9 | 0.6 | |
| Maximum % Deviation From Average | | | 5% | 1% | |

# 4. COMPARISONS

## 4.1 GENERAL

Based upon observation, test results for the two methods of liquid limit determination discussed in chapters 2 and 3, and from discussions in the existing literature, the following comparisons can be made.

## 4.2 TIME REQUIRED TO PERFORM TESTS

A number of authors state the length of time necessary to perform a fall cone test is considerably shorter than a comparable Casagrande liquid limit test. In the ASTM Symposium on Liquid Limits, Eden writes that a liquid limit test performed on the fall cone requires even less time than does the Casagrande one-point liquid limit test.

The author found the time required for an entire fall cone test to range from slightly shorter to the same as that required for the standard Casagrande test.

Based upon the fact a substitute fall cone was utilized, it is possible that a true fall cone--intended to be used for soils--could be even more efficient.

## 4.3 APPARATUS

Most authors cite less dependence upon apparatus design to be an advantage of the fall cone over the Casagrande cup: The grooving tool becomes worn thus altering the dimensions of the groove. Through constant use, the cup frequently develops a permanent groove. The height of the cup's point of impact should ideally be checked before each use. Essentially the only part of the fall cone apparatus to exhibit signs of wear is the cone's apex, and, if necessary, this can be compensated for by lining up the geometric apex with the soil surface.

## 4.4 VARIATION OF OPERATOR

In nearly all instances, any applicable literature claims the cone penetrometer to possess a much higher degree of repeatability than does the conventional Casagrande test with different operators.

The Casagrande device is considerably more subjective than the cone. Judgment of the many variables is essential for the conventional method: One must estimate proper soil quantity, form a straight and centered groove, and estimate one half inch closure.

Each method requires care to prevent entrapment of air bubbles within the sample to be tested.

Both methods involve the concept of time; however, one would most likely find it easier to depress a cone release clamp for a period of 5 seconds than to estimate and maintain a constant blowcount rate of two blows per second. Furthermore, in addition to simplicity, as was discussed in chapters 2 and 3, there was virtually no difference in liq. lt. whether a cone was released for one second or thirty whereas, even though slight, there is some variation in apparent liquid limit for differing impact rates.

Therefore, in this instance, the fall cone has a definite advantage over the Casagrande device in that it nearly eliminates factors of judgment.

## 4.5 REPEATABILITY

Coefficients of correlation for both water content vs. log of blowcount and water content vs. cone penetration on each of the fifteen soils were excellent, however, those associated with the latter surpassed the correlations corresponding to the former by 50%. Cone correlation coefficients were better than the Casagrande Correlations for nine soils. The opposite was the case for the remaining 6 soils.

## 4.6 SANDY, LOW PLASTICITY SOILS

With the Casagrande device, water frequently bleeds from sandy low plasticity soils -- in response to shock -- thus causing the water content to be nonuniform. The cone penetrometer eliminates the impact associated with the Casagrande cup. Although use of the cone overcomes nonuniform moisture distribution resulting from the striking of the cup, a similar phenomenon can still occur in extremely low plasticity soils. In such soils, water occasionally tends to migrate toward the surface as it is being smoothed in preparation for testing. Therefore, although the cone expands the testable range for liquid limit to include a lower plasticity range of soils than can be handled by the Casagrande cup, it does not totally eliminate nonuniform moisture content due to water bleeding out from the soil pores.

## 4.7 MISCELLANEOUS FACTORS AFFECTING LIQUID LIMIT TEST RESULTS

### Uniformity of Mixing

Proper determination of liquid limit is largely a function of uniformity of mixing. Fat clays, in particular, create mixing problems. Clearly, a poorly mixed soil sample is more likely to yield incorrect results regardless of apparatus used; therefore, the fall cone has no advantage over the Casagrande device and vice versa in this instance.

Humidity

The humidity of the surrounding air, too, affects the liquid limit results of both the Fall cone and the Casagrande liquid limit device. Dry days, in particular, cause the soil sample to dry out with time. This results in either a successively increasing number of blows per run or decreasing penetrometer readings. In this study, this effect was hopefully minimized by working as rapidly as possible while still trying to maintain as great a degree of accuracy as possible. Again, in this instance, neither the Casagrande device nor the Fall Cone has any advantage over the other.

## 5. CONCLUSION

By no means do the limited results from this study or those from the associated literature search overwhelmingly point to the cone as being superior to the cup or vice versa. In most instances, both pieces of apparatus yielded fairly good test results. Nevertheless, the conventional method has numerous variables associated with it, and clearly, potential drawbacks are a function of these variables. In contrast, the Fall cone has a minimum of limitations. The cone eliminates most variables -- many of which could be considered shortcomings -- associated with the Casagrande cup.

Perhaps the biggest advantage of the cone penetrometer over the cup is its elimination of the many variables intrinsic to operator technique and the testing apparatus. As stated by Garneau (1977), the Fall cone may well represent "an answer to Casagrande's wishes to replace the classical liquid limit device by a method or apparatus that would be simple and free of operational influences." The cone is certainly easy to operate. The length of time required per run is comparable to -- if not shorter than -- the time required to run the conventional liquid limit test. Furthermore, it eliminates the subjectivity associated with the conventional method. This was demonstrated by the results from various random operators performing appropriate liquid limit tests with the cone and the Casagrande cup. The dispersion of apparent liquid limits through use of the cup was considerably greater than that associated with the cone. Thus, use of the cone would improve liquid limit agreement among operators from various labs. As was exemplified by correlations between water content and penetration/blow count, even repeatability of results from individual runs by one operator were better for the cone than for the cup.

Since liquid limit is a correlative value associated with the statics of soils, it only seems reasonable that it should be determined by a static test. The repeated impact of a cup against its base is in actuality a dynamic shear test -- far from a static procedure. The dynamic effect may not be totally eliminated, however, the gentle penetration of a 75 gram steel cone seems far less dynamic in nature than the repeated striking of a soil-filled cup against its base.

The expansion of soils capable of being tested for liquid limit into a lower plasticity range constitutes a third major advantage of the cone over the cup. Some low plasticity soils not capable of being tested for liquid limit on account of sliding within the cup rather than flowing plastically can now be tested with the cone penetrometer.

In conclusion, not only has the cone penetrometer demonstrated itself to be capable of reproducing liquid limit test results in reasonable agreement with ASTM Meth D423, but it appears to be worthy of additional study for its use as an alternative to the Casagrande liquid limit device in that it eliminates numerous shortcomings associated with the conventional method.

# APPENDICES

Portions of the text on the following page(s) are not legible in the original.

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE March 11 & 13, 1981

TESTED BY Tim Dean

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (32) | 2 (31.3) | 3 (26) | 28 4 (23) | 5 (22.3) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 32,32,32 | 33,30,31 | 25,26,27 | 25,17,21,24 | 22,21,24 |
| CONTAINER NO. | H-7 | C-11 | MP4 | 200 | 2 |
| WT. CONTAINER + WET SOIL IN g | 16.613 | 19.005 | 20.142 | 22.775 | 22.886 |
| WT. CONTAINER + DRY SOIL IN g | 12.151 | 13.169 | 13.290 | 13.689 | 14.350 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 11.765 | 12.129 | 12.123 | 12.153 | 12.951 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 432 | 561 | 587 | 592 | 610 |

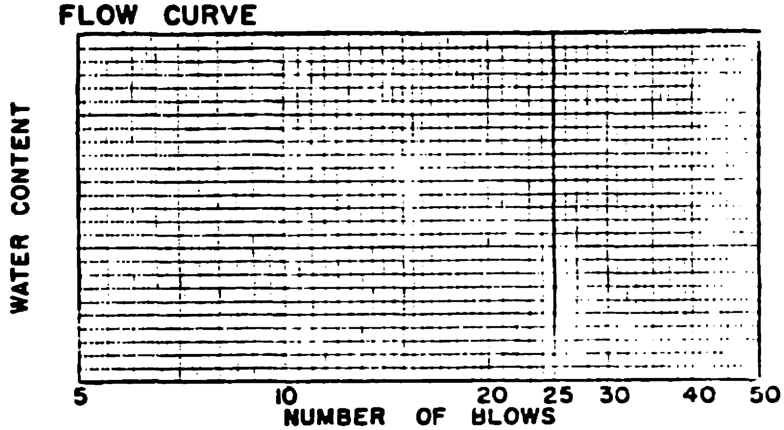
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

(con't)

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE March 11 & 13, 1981

TESTED BY Tim Dean

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 10.8 | 27.7 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 10,10,11,11,12 | 8,8,7 | | | |
| CONTAINER NO. | 564 | X-9 | | | |
| WT. CONTAINER + WET SOIL IN g | 25.056 | 19.512 | | | |
| WT. CONTAINER + DRY SOIL IN g | 14.770 | 12.983 | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.129 | 11.872 | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 627 | 587 | | | |

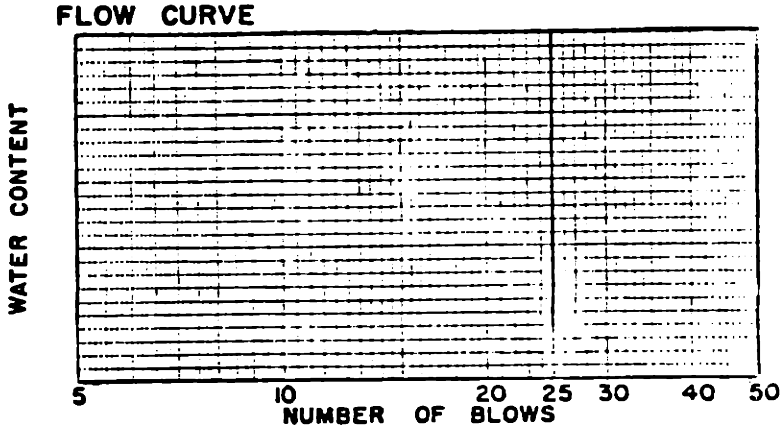
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

CONE
60° Plexiglass

SOIL SAMPLE Bentonite

TEST NO.

.OCATION

DATE March 11, 1981

BORING NO. SAMPLE DEPTH

TESTED BY Lee Kachroo

SAMPLE NO.

| DETERMINATION NO. | 1 (85) | 2 (78) | 3 (106) | 4 (128) |
|---|---|---|---|---|
| Cone Pen to mm | 85, 85, 84 | 77, 78, 78 | 107, 105, 107 | 128, 128 |
| CONTAINER NO. | O-5 | B2 | N-1 | 67 |
| WT. CONTAINER + WET SOIL IN g | 21.495 | 19.906 | 20.520 | 20.868 |
| WT. CONTAINER + DRY SOIL IN g | 14.375 | 14.035 | 13.902 | 11.757 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.267 | 12.156 | 12.093 | 9.702 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 337 | 312 | 366 | 443 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RE RKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Apr 24, 1981

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (83) | 184, 2 (186) | 3 (266) | 4 |
|---|---|---|---|---|
| Pen 1/10 mm | 84, 79, 82, 86 | 190, 185, 183 | 269, 264, 265 | |
| CONTAINER NO. | D6 | AAA | C5 | |
| WT. CONTAINER + WET SOIL IN g | 29.840 | 29.489 | 36.260 | |
| WT. CONTAINER + DRY SOIL IN g | 25.825 | 21.467 | 26.454 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 24.706 | 20.034 | 24.933 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 359 | 560 | 645 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | E VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 11, 1981

TESTED BY Lee Kachroo

| DETERMINATION NO. | 1 (1.5) | 2 (1.2) | 3 (1.0) | 4 (.5) |
|---|---|---|---|---|
| Rdg TSF | 1.5, 1.4, 1.5 | 1.25, 1.25 | 1.0, .95, 1.0 | .5, .5 |
| CONTAINER NO. | 05 | B2 | N1 | 67 |
| WT. CONTAINER + WET SOIL IN g | 21.495 | 19.906 | 20.520 | 20.868 |
| WT. CONTAINER + DRY SOIL IN g | 14.375 | 14.035 | 13.902 | 11.757 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.267 | 12.156 | 12.093 | 9.702 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 337 | 312 | 366 | 443 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Mar 11, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (2.0) | 2 (1.4) | 1.1 3 (1.1) | 4 (0.6) |
|---|---|---|---|---|
| Rdg TSF | 1.9, 2.0, 2.0 | 1.4, 1.4, 1.4 | 1.1, 1.0, 1.2 | .6, .6, .6 |
| CONTAINER NO. | R15 | 004 | D-7 | 12 |
| WT. CONTAINER + WET SOIL IN g | 18.714 | 24.318 | 19.863 | 24.924 |
| WT. CONTAINER + DRY SOIL IN g | 12.512 | 14.805 | 12.760 | 14.525 |
| WT. WATER, $W_w$, IN g | 6.202 | 9.513 | 7.103 | 10.3[illegible] |
| WT. CONTAINER IN g | 10.505 | 12.026 | 10.784 | 12.082 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 309 | 342 | 352 | [illegible] |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RE[illegible]KS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY



## ATTERBERG LIMITS

SOIL SAMPLE Boston BlueClay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

$w_p$: April 8, 1981

TEST NO.

DATE $w_L$: Feb 11, 1981

TESTED BY Tim Dean

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 212 | S40 | 2 | | | |
| WT. CONTAINER + WET SOIL IN g | 14.471 | 15.448 | 16.000 | | | |
| WT. CONTAINER + DRY SOIL IN g | 14.018 | 15.013 | 15.405 | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.202 | 13.176 | 12.949 | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 24.9 | 23.7 | 24.2 | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (26) | 2 (24) | 3 (19) | 4 (15) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 26, 26 | 24, 23 | 17, 20, 21 | 15, 15 | |
| CONTAINER NO. | A-26 | A-60 | 66 (604) | 42 (N-13) | |
| WT. CONTAINER + WET SOIL IN g | 17.115 | 12.381 | 20.355 | 22.092 | |
| WT. CONTAINER + DRY SOIL IN g | 15.562 | 10.712 | 17.897 | 18.497 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 11.671 | 6.614 | 12.025 | 10.213 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 39.9 | 40.7 | 41.9 | 43.4 | |

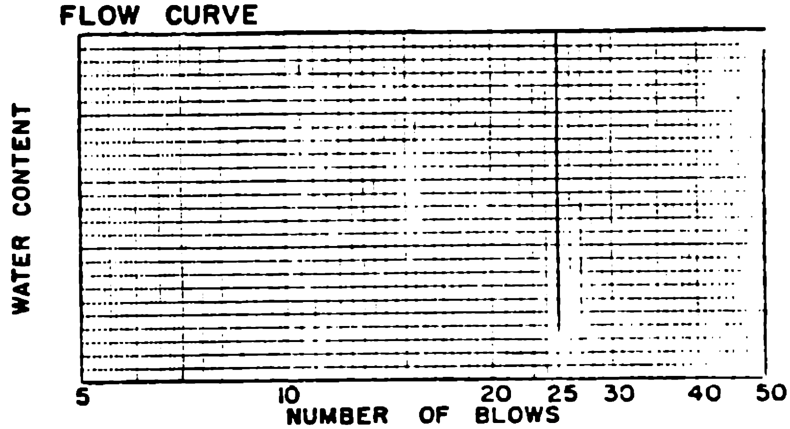
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_L - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE April 8, 1981

TESTED BY Rich Furman

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | X-5 | T-79 | T-76 | | | |
| WT. CONTAINER + WET SOIL IN g | 25.221 | 22.779 | 24.908 | | | |
| WT. CONTAINER + DRY SOIL IN g | 23.812 | 21.882 | 23.582 | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 18.109 | 18.184 | 18.269 | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 24.7 | 24.3 | 24.9 | | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

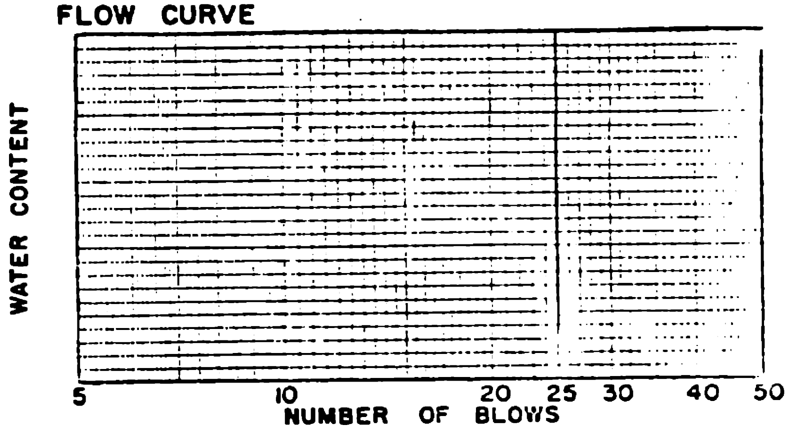
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE BPC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE Feb 11, 1981

TESTED BY Tim Dean

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (26) | 2 (24) | 3 (19) | 4 (15) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 26, 26 | 24, 23 | 17, 20, 21 | 15, 15 | |
| CONTAINER NO. | A-26 | A-60 | 66 (C04) | 42 (N-13) | |
| WT. CONTAINER + WET SOIL IN g | 17.115 | 12.381 | 20.355 | 22.092 | |
| WT. CONTAINER + DRY SOIL IN g | 15.562 | 10.712 | 17.897 | 18.497 | |
| WT. WATER, $W_w$, IN g | 1.553 | 1.669 | 2.458 | 3.595 | |
| WT. CONTAINER IN g | 11.671 | 6.614 | 12.025 | 10.213 | |
| WT. DRY SOIL, $W_s$, IN g | 3.891 | 4.098 | 5.872 | 8.284 | |
| WATER CONTENT w, IN % | 39.9 | 40.7 | 41.9 | 43.4 | |

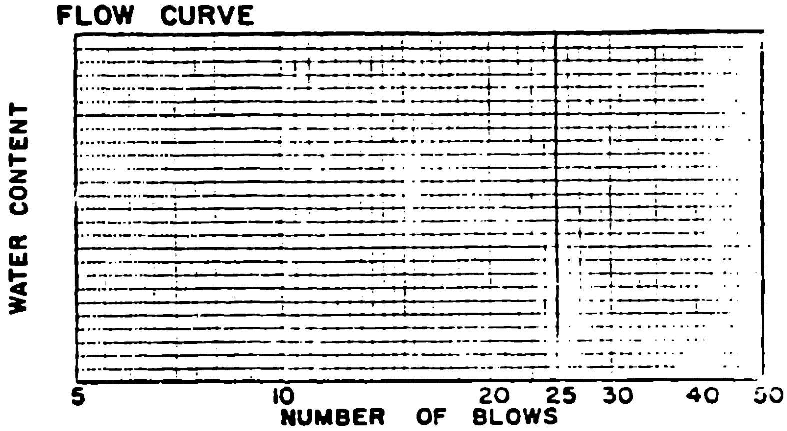
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE February 1981

TESTED BY Edrick Van Beuzekom

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (28) | 2 (19) | 3 (15) | 4 (12) | 5 (40) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 26,28,29,30 | 19,18,19 | 16,14,15,16 | 12 12 12 | 39, 41, 39 |
| CONTAINER NO. | 2-7 | B-1 | B-2 | 02 | 5-29 |
| WT. CONTAINER + WET SOIL IN g | 31.428 | 29.276 | 27.461 | 31.376 | 45.138 |
| WT. CONTAINER + DRY SOIL IN g | 24.206 | 23.739 | 22.698 | 25.228 | 36.348 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 6.813 | 11.136 | 12.143 | 12.143 | 13.230 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 39.2 | 43.9 | 45.1 | 47 | 38 |

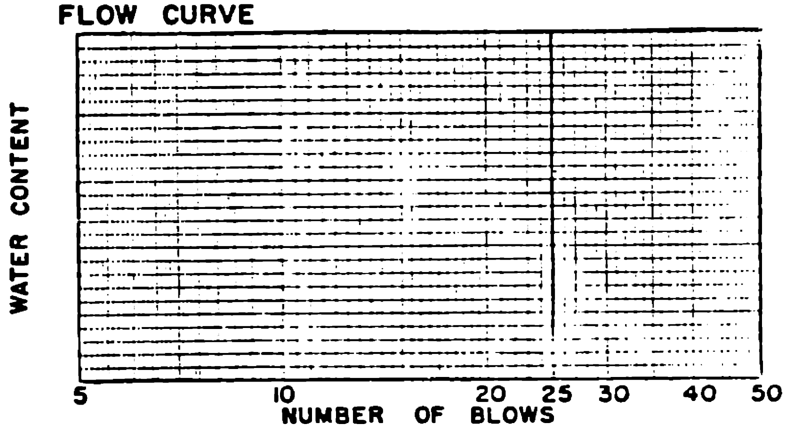
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUDED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 23 & 24, 1981

TESTED BY Tim Dean & Edrick van Beuzekom

| DETERMINATION NO. | 133, 1 (129) | 109, 2 (112) | 99, 3 (102) | 85, 4 (87) |
|---|---|---|---|---|
| Pen 1/10 mm | 128, 124, 131, | 116, 111, 110 | 99, 106, 102, | 81, 86, 94, |
| CONTAINER NO. | 12 | H-7 | 77 or 6 | O-21 |
| WT. CONTAINER + WET SOIL IN g | 23.610 | 27.708 | 18.354 | 24.708 |
| WT. CONTAINER + DRY SOIL IN g | 19.958 | 22.855 | 14.872 | 20.914 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.083 | 11.777 | 6.402 | [illegible] |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 46.4 | 43.8 | 41.1 | [illegible] |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (101) | 2 (107) | 3 (115) | 4 (123) |
|---|---|---|---|---|
| Pen 1/10 mm | 102, 99, 101 | 109.5, 105 | 115, 114 | 120, 124, 124 |
| CONTAINER NO. | D-21 | S73 | B-2 | W-5 |
| WT. CONTAINER + WET SOIL IN g | 18.977 | 19.478 | 23.101 | 20.725 |
| WT. CONTAINER + DRY SOIL IN g | 16.987 | 17.633 | 19.771 | 18.482 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.218 | 13.092 | 12.149 | 13.470 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 41.7 | 40.6 | 43.7 | 44.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb. 1981

TESTED BY Maureen Kestler

| DETERMINATION NO. | 77, 81.5 (79) | 75, 2 (80) | 3 (107) | (149) |
|---|---|---|---|---|
| Pen 1/10 MM | 83.5, 77, 82, | 82, 80, 87, | 107.5, 107.5 | 148, 151, 146.5 |
| CONTAINER NO. | N13 | Z-3 | W-5 | S-4 |
| WT. CONTAINER + WET SOIL IN g | 16.621 | 24.123 | 24.400 | 21.047 |
| WT. CONTAINER + DRY SOIL IN g | 14.864 | 20.517 | 21.074 | 18.350 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.218 | 12.146 | 13.477 | 12.813 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 37.8 | 43.1 | 43.8 | 48.7 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 23 & 24, 1981

TESTED BY Tim Dean & Edrick van Beuzekom

| DETERMINATION NO. | 1 (1.4) | 2 (1.[illegible]) | 3 (0.9) | .55, 4 (0.5) |
|---|---|---|---|---|
| Rdg TSF | 1.5, 1.3, 1.4 | .9, 1.1, 1.0 | 1.0, 0.8, 1.0 | .45, .55, .45, |
| CONTAINER NO. | A-3 | Z-3 | 004 | 2 |
| WT. CONTAINER + WET SOIL IN g | 24.128 | 20.169 | 24.284 | 24.107 |
| WT. CONTAINER + DRY SOIL IN g | 19.225 | 17.906 | 20.580 | 20.614 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 7.322 | 12.133 | 12.028 | 12.956 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 41.2 | 39.2 | 43.3 | 45.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (1.1) | 2 (1.0) | 3 (.73) | 4 (.6) |
|---|---|---|---|---|
| Rdg 1/10 mm | 1.1, 1.1 | .9, 1.0, 1.0 | .75, .72 | .6, .6 |
| CONTAINER NO. | MP-4 | S6 | Z-7 | S-35 |
| WT. CONTAINER + WET SOIL IN g | 17.137 | 28.209 | 14.329 | 39.871 |
| WT. CONTAINER + DRY SOIL IN g | 15.681 | 23.735 | 12.064 | 31.833 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.119 | 13.160 | 6.817 | 13.924 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 40.7 | [illegible].3 | 43.2 | 44.9 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb, 1981

TESTED BY Maureen Kestler

| DETERMINATION NO. | 2.0, 1.75 (1.8) | 2 (1.3) | 3 (.87) | 4 (.13) |
|---|---|---|---|---|
| Rdg TSF | 1.8, 1.75, 1.8 | 1.3, 1.3, 1.3 | .85, .9, .85 | .1, .2, .1 |
| CONTAINER NO. | [illegible] | 212 | S75 (2) | D 21 |
| WT. CONTAINER + WET SOIL IN g | 16.072 | 23.066 | 24.800 | 21.915 |
| WT. CONTAINER + DRY SOIL IN g | 1[illegible] | 19.920 | 21.586 | 18.728 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 7.[illegible]29 | 12.208 | 12.965 | 12.222 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 38.6 | 40.8 | 37.3 | 49.0 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | S VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 23 & 24, 1981

TESTED BY Tim Dean & Edrick van Beuzekom

| DETERMINATION NO. | 1 (2.0) | 1.8, 1.7, 2 (1.7) | 3 (1.0) | 4 (1.0) |
|---|---|---|---|---|
| Rdg TSF | 2.2, 1.9, 2.0 | 1.5, 1.6, 1.7 | 1.1, 1.0, 0.9, 1.1 | 1.0, 1.0, 1.0 |
| CONTAINER NO. | N-1 | R-15 | 212 | S73 |
| WT. CONTAINER + WET SOIL IN g | 20.704 | 28.586 | 29.888 | 24.392 |
| WT. CONTAINER + DRY SOIL IN g | 18.276 | 23.324 | 24.588 | 20.870 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.194 | 10.510 | 12.213 | 13.095 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 39.9 | 41.1 | 42.8 | 45.3 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (2.3) | 2 (2.0) | 3 (1.6) | 4 (1.3) |
|---|---|---|---|---|
| Rdg TSF | 2.4, 2.2, 2.4 | 2.0, 2.0 | 1.6, 1.5 | 1.3, 1.3 |
| CONTAINER NO. | R-15 | N-1 | N-13 | S-40 |
| WT. CONTAINER + WET SOIL IN g | 18.224 | 19.709 | 18.447 | 28.240 |
| WT. CONTAINER + DRY SOIL IN g | 15.988 | 17.462 | 15.943 | 23.544 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.507 | 12.192 | 10.218 | 13.181 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 40.8 | 42.6 | 44.3 | 45.3 |

SULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 1981

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (4.4) | 2 (2.9) | 3 (1.8) | 4 (1.0) |
|---|---|---|---|---|
| Rdg TSF | 4.4, 4.6 | 2.9, 2.9, 2.9 | 1.8, 1.8, 1.8 | 1.0, 1.0 |
| CONTAINER NO. | R 15 | 35 | B-1 | B-2 |
| WT. CONTAINER + WET SOIL IN g | 19.343 | 18.285 | 21.235 | 19.595 |
| WT. CONTAINER + DRY SOIL IN g | 16.960 | 16.406 | 18.195 | 17.162 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.451 | 11.720 | 11.145 | 12.156 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 36.6 | 40.1 | 43.1 | 48.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE 60° Plexiglass

SOIL SAMPLE [illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 22, 1981

TESTED BY Tim Dean

| DETERMINATION NO. | 1 (95) | 2 (103) | 3 (119) | 127, 4 (126) |
|---|---|---|---|---|
| Cone Pen 1/10 mm | 92,98,97,92 | 103,107,104,99 | 121,117,117,119 | 124,122,131, |
| CONTAINER NO. | L-19 | N-13 | CP-5 | 2 AC |
| WT. CONTAINER + WET SOIL IN g | 21,694 | 18,023 | 20,151 | 17,826 |
| WT. CONTAINER + DRY SOIL IN g | 16,638 | 14,736 | 16,593 | 15,023 |
| WT. WATER, $W_w$, IN g | 5,056 | 3,287 | 3,558 | 2,803 |
| WT. CONTAINER IN g | 9,443 | 10,225 | 11,856 | 11,461 |
| WT. DRY SOIL, $W_s$, IN g | 7,195 | 4,511 | 4,737 | 3,562 |
| WATER CONTENT w, IN % | 70,3 | 72.9 | 75.1 | 78.7 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE March 1981

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | T10 | X2 | T30/X5 | T76 | KSI T48 | |
| WT. CONTAINER + WET SOIL IN g | 20.898 | 20.560 | 20.803 | 21.986 | 22.870 | |
| WT. CONTAINER + DRY SOIL IN g | 20439 | 20.125 | 20.323 | 21.334 | 22.104 | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 18.242 | 18.034 | 18.196 | 18.259 | 18.288 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 20.9 | 20.8 | 22.6 | 21.2 | 20.0 | |

### LIQUID LIMIT

| DETERMINATION NO. | 41,44, 1 (42) | 2 (23) | 3 (19) | 4 (16) | 5 (14) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 36,42,49,44,42 | 22,22,23,24 | 19,19,17,20 | 14,18,16,16,17 | 12,13,14,14,15 |
| CONTAINER NO. | T10 | T-76 | T-85 | A8 | Y7 |
| WT. CONTAINER + WET SOIL IN g | 39.450 | 40.217 | 42.474 | 40.228 | 44.914 |
| WT. CONTAINER + DRY SOIL IN g | 34.257 | 34.495 | 36.072 | 34.656 | 37.632 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 18.242 | 18.273 | 18.238 | 19.473 | 18.192 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 32.4 | 35.3 | 35.9 | 36.7 | 37.3 |

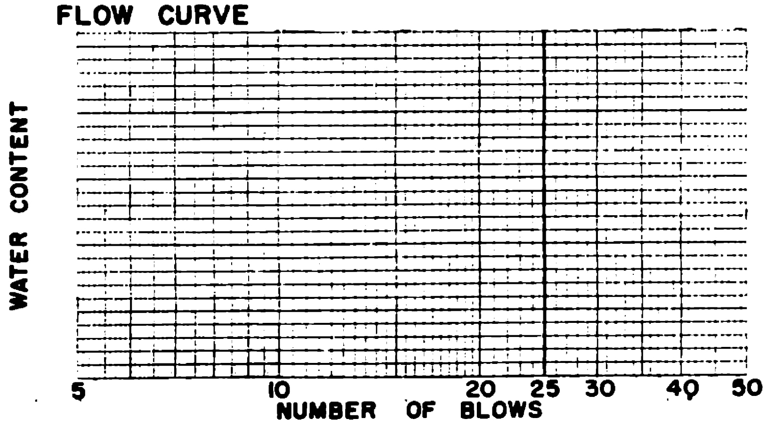
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 21.1 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. ______ SAMPLE DEPTH ______

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE March 18, 1982

TESTED BY Tim Dean

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT $w$, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | (24.3) | 2 (24.3) | 3 (24) | (14.7) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 23, 23, 27 | 23, 24, 27 | 24, 24, 24 | 15, 15, 14 | |
| CONTAINER NO. | W5 | S-6 | S4 | 535 | |
| WT. CONTAINER + WET SOIL IN g | 25.947 | 30.680 | 28.373 | 28.744 | |
| WT. CONTAINER + DRY SOIL IN g | 22.658 | 26.034 | 24.301 | 24.658 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.474 | 13.209 | 12.799 | 13.954 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT $w$, IN % | 35.8 | 36.2 | 35.4 | 38.2 | |

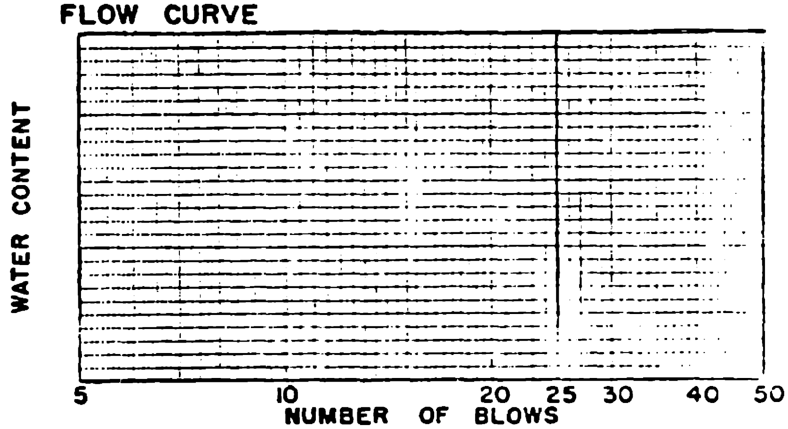
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 1981

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (58) | 2 (94) | 104 3 (119) | (125) 4 | (134) |
|---|---|---|---|---|---|
| Penetration 1/10 mm | 60, 58, 60, 56 | 92, 94, 94, 94 | 119, 117, 12[illegible], 119 | 125, 124, [illegible], [illegible] | [illegible], 135, 13[illegible], 134 |
| CONTAINER NO. | KS1 T48 | T73 | X2 | X-5 | AAA |
| WT. CONTAINER + WET SOIL IN g | 35.064 | 33.1 | 37.987 | 36.522 | 39.943 |
| WT. CONTAINER + DRY SOIL IN g | 31.259 | 29.256 | 32.535 | 31.316 | 34.315 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 18.291 | 18.122 | 18.031 | 18.108 | 20.027 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 29.3 | 34.5 | 37.6 | 39.4 | 39.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 18, 1981

TESTED BY Edrick van Beuzekom

| DETERMINATION NO. | 1 (91) | 2 (101) | 3 (133) | 4 |
|---|---|---|---|---|
| Pen. 1/10 mm | 90, 94, 94, 86 | 106, 101, 97, 101 | 135, 132, 132, 130 | |
| CONTAINER NO. | X-9 | A3 | O-5 | |
| WT. CONTAINER + WET SOIL IN g | 28.705 | 26.026 | 31.923 | |
| WT. CONTAINER + DRY SOIL IN g | 24.363 | 21.063 | 26.326 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.872 | 7.315 | 12.226 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 34.8 | 36.1 | 39.7 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B. VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE [illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE [illegible]

TESTED BY [illegible]

| DETERMINATION NO. | 1 (1.0) | 2 (.75) | 3 (.4) | 4 |
|---|---|---|---|---|
| Rdg TSF | 1.2, 1.2, .8, .9 | .75, .75, .75 | .4, .4, .3, .4 | |
| CONTAINER NO. | 02 | 23 | A12 | |
| WT. CONTAINER + WET SOIL IN g | 20.790 | 33.841 | 28.103 | |
| WT. CONTAINER + DRY SOIL IN g | 3.002 | 28.123 | 23.370 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.134 | 12.130 | 11.401 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 34.7 | 39.8 | 39.5 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 18, 1981

TESTED BY Lee Kachroo

| DETERMINATION NO. | 1 (1.4) | 2 (.8) | 3 (.55) | 4 |
|---|---|---|---|---|
| Rdg TSF | 1.3, 1.4, 1.4 | .8, .75, .8 | .6, .5, .55 | |
| CONTAINER NO. | 540 | N13 | 212 | |
| WT. CONTAINER + WET SOIL IN g | 29.724 | 28.624 | 32.120 | |
| WT. CONTAINER + DRY SOIL IN g | 25.423 | 23.649 | 26.638 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 13.176 | 10.215 | 12.204 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 35.1 | 37.6 | 38.0 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Vicksburg Buckshot Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$:

TEST NO.

DATE 1981

TESTED BY Edrick van Beuzekom

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | A-3 | 41 | E15021 | | | |
| WT. CONTAINER + WET SOIL IN g | 11.228 | 15.869 | 19.378 | | | |
| WT. CONTAINER + DRY SOIL IN g | 10.332 | 15.000 | 17.801 | | | |
| WT. WATER, $W_w$, IN g | .896 | .869 | 1.577 | | | |
| WT. CONTAINER IN g | 7.315 | 11.976 | 12.203 | | | |
| WT. DRY SOIL, $W_s$, IN g | 3.017 | 3.024 | 5.598 | | | |
| WATER CONTENT w, IN % | 29.7 | 28.7 | 28.2 | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

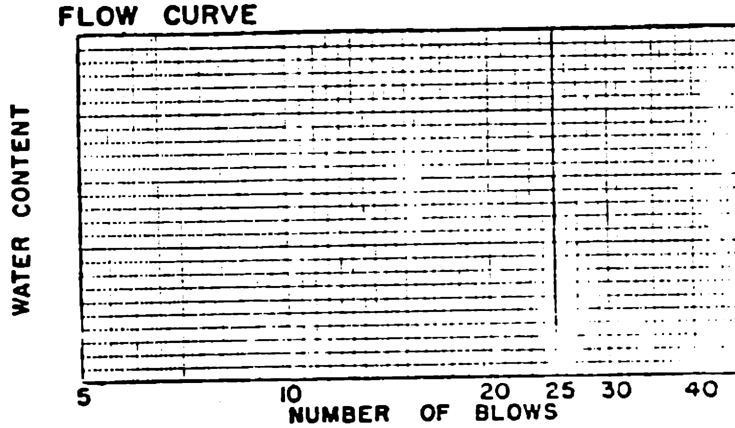
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Vicksburg Buckshot Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE April 1 & 8, 1981

TESTED BY Tim Dean & Lee Kachroo

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | D6 | Y-5 | AAA | H10 | | |
| WT. CONTAINER + WET SOIL IN g | 26.669 | 20.772 | 22.296 | 27.119 | | |
| WT. CONTAINER + DRY SOIL IN g | 26.314 | 20.332 | 21.880 | 26.642 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 24.708 | 18.347 | 20.030 | 24.628 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 22.1 | 22.2 | 22.5 | 23.7 | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (25.7) | 2 (17.7) | 3 (24.3) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 25, 26, 26 | 17, 18, 17 | 27, 23, 25, 24 | | |
| CONTAINER NO. | S6 | L-28 | T47 | | |
| WT. CONTAINER + WET SOIL IN g | 26.384 | 19.164 | 28.377 | | |
| WT. CONTAINER + DRY SOIL IN g | 21.427 | 15.624 | 24.605 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.168 | 9.999 | 18.352 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 60.0 | 62.9 | 60.3 | | |

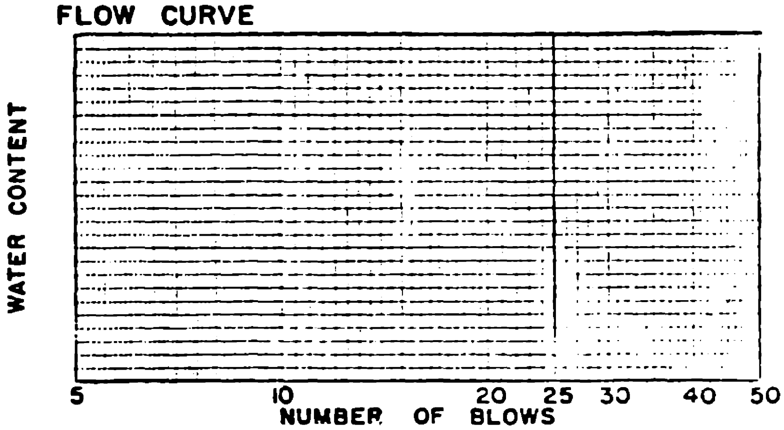
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 22.62 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE Feb 11, 1981

TESTED BY Lee Kachroo

### LASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (38) | 2 (28) | 3 (18) | 4 (11) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 37, 38, 39 | 27, 28, 28 | 19, 17, 19 | 12, 11, 11 | |
| CONTAINER NO. | S64 | 34 | MP4 | S73 | |
| WT. CONTAINER + WET SOIL IN g | 32.543 | 23.641 | 28.460 | 35.514 | |
| WT. CONTAINER + DRY SOIL IN g | 25.115 | 18.987 | 22.566 | 26.644 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.137 | 12.237 | 12.136 | 13.097 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 6[illegible] | 6[illegible] | [illegible] | 6[illegible] | |

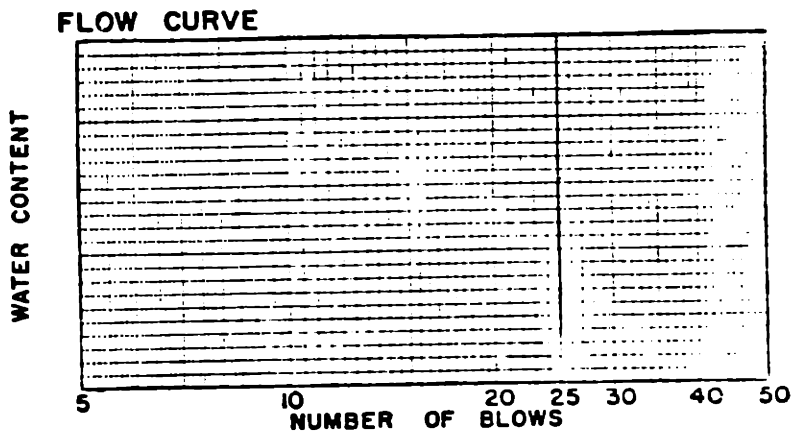
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE Feb 11, 1981

TESTED BY Rich Furman

### ASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### QUID LIMIT

| DETERMINATION NO. | 1 (36) | 2 (28) | 3 (22) | 4 (17) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 35,36,37 | 27,28,29 | 21,22,23 | 16,17,17 | |
| CONTAINER NO. | O-5 | B-1 | A3 | B-2 | |
| WT. CONTAINER + WET SOIL IN g | 28.758 | 29.495 | 22.051 | 30.084 | |
| WT. CONTAINER + DRY SOIL IN g | 22.773 | 22.745 | 16.504 | 23.454 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.226 | 11.178 | 7.321 | 12.147 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 56.7 | 58.3 | 60.4 | 58.6 | |

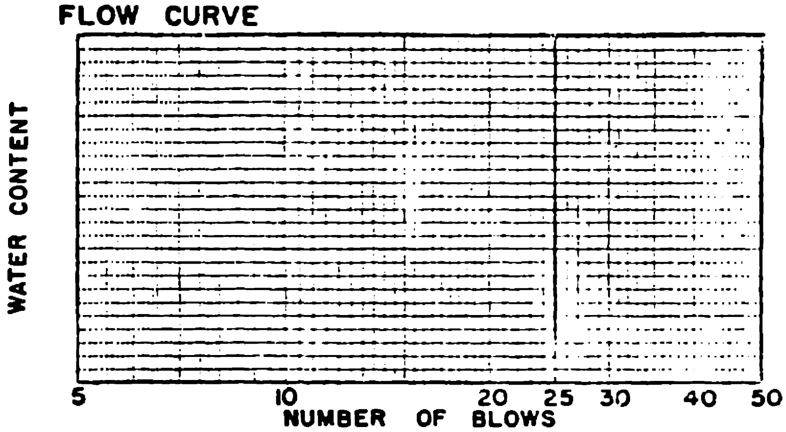
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_L - w_p}$

### IRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### ESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

EMARKS

# ATTERBERG LIMITS

Vicksburg Buckshot

Winter/Spring 1981

Results from Plastic Limit Tests:

| $w_P$ % |
|---|
| 22.1 |
| 22.2 |
| 22.5 |
| 23.7 |

Additional Liquid Limit Test Results from Casagrande Device:

| No. Blows: | $w_L$ % |
|---|---|
| 17 | 58.6 |
| 25 | 60 |
| 32 | 66 |
| 11 | 70 |
| 12 | 65 |
| 14 | 64 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE 60° Plexiglas

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 18, 1981

TESTED BY Lee Kachroo

| DETERMINATION NO. | 1 (61) | 2 (65) | 3 (69) | 4 (81) |
|---|---|---|---|---|
| Pen 1/10 mm | 59,59,66,60 | 62,66,66 | 69,71,66 | 85,76,81 |
| CONTAINER NO. | W-1 | 004 | B2 | B-1 |
| WT. CONTAINER + WET SOIL IN g | 24.430 | 22.626 | 19.582 | 23.674 |
| WT. CONTAINER + DRY SOIL IN g | 20.620 | 19.021 | 17.096 | 19.200 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.934 | 12.023 | 12.145 | 11.142 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 49.6 | 51.5 | 50.2 | 55.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 18, 1982

TESTED BY Rich Furman & Lee Kachroo

| DETERMINATION NO. | 1 (60) | 2 (63) | 3 (68) | 4 (81) |
|---|---|---|---|---|
| Pen 1/10 mm | 59, 59, 65, 60 | 62, 60, 66 | 69, 71, 66 | 85, 76, 81 |
| CONTAINER NO. | W-1 | 004 | B-2 | B-1 |
| WT. CONTAINER + WET SOIL IN g | 24.430 | 22.626 | 19.582 | 23.674 |
| WT. CONTAINER + DRY SOIL IN g | 20.620 | 19.021 | 17.096 | 19.200 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.939 | 12.023 | 12.145 | 11.142 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 49.6 | 51.5 | 50.2 | 55.5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY



CONE

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1982

TESTED BY Tim Dean & Edrick van Beuzeko

| DETERMINATION NO. | 1 (71.2) | 2 (76) | 3 (104) | 4 (120) |
|---|---|---|---|---|
| Penetr'n 1/10 mm | 70, 75, 69, 71 | 77, 75, 76 | 105, 97, 110, 105 | 119, 122, 118 |
| CONTAINER NO. | 212 | 23 | N2 | 13 |
| WT. CONTAINER + WET SOIL IN g | 25.408 | 21.618 | 21.080 | 50.111 |
| WT. CONTAINER + DRY SOIL IN g | 20.830 | 18.246 | 16.957 | 40.337 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.200 | 12.130 | 10.028 | 24.783 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 53.0 | 55.1 | 59.5 | 62.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENET[illegible]ER

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 18, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (1.6) | 2 (1.5) | 3 (1.2) | 4 (1.1) |
|---|---|---|---|---|
| Rdg TSF | 1.6, 1.6, 1.5 | 1.5, 1.5 | 1.2, 1.2 | 1.1, 1.1 |
| CONTAINER NO. | 12 | D-7 | T-1 | 34 |
| WT. CONTAINER + WET SOIL IN g | 25.811 | 21.164 | 36.834 | 25.350 |
| WT. CONTAINER + DRY SOIL IN g | 21.215 | 17.697 | 32.575 | 20.085 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.124 | 10.809 | 24.388 | 12.236 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 50.5 | 50.3 | 52 | 67.1 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RE RKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1981

TESTED BY Tim Dean & Edrick von Beuzekom

| DETERMINATION NO. | 1 (1.1) | 2 (0.7) | 3 (0.53) | 4 (.3) |
|---|---|---|---|---|
| Rdg TSF | 0.9, 1.1, 1.2, 1.2 | 0.7, 0.7, 0.7 | 0.5, 0.6, 0.5 | .4, .3, .3 |
| CONTAINER NO. | 12 | 02 | X-9 | 848 |
| WT. CONTAINER + WET SOIL IN g | 27.305 | 23.013 | 25.167 | 41.171 |
| WT. CONTAINER + DRY SOIL IN g | 22.035 | 19.126 | 20.240 | 34.874 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.078 | 12.140 | 11.738 | 24.446 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 52.9 | 55.6 | 58.0 | 60.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 22, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (.57) | 2 (.5) | 3 | 4 |
|---|---|---|---|---|
| Rdg TSF | .55, .55, .6 | .5, .5, .5 | | |
| CONTAINER NO. | D-7 | S64 | | |
| WT. CONTAINER + WET SOIL IN g | 14.670 | 18.914 | | |
| WT. CONTAINER + DRY SOIL IN g | 13.215 | 16.725 | | |
| WT. WATER, $W_w$, IN g | 1.455 | 2.189 | | |
| WT. CONTAINER IN g | 10.789 | 13.131 | | |
| WT. DRY SOIL, $W_s$, IN g | 2.426 | 3.594 | | |
| WATER CONTENT w, IN % | 59.9 | 60.9 | | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 18, 1981

TESTED BY Lee Kachroo &
Rich Furman

| DETERMINATION NO. | 1 (3.7) | 2 (3.2) | 3 (2.6) | 4 (2.[illegible]) |
|---|---|---|---|---|
| Rdg TSF | 3.6, 3.7, 3.7 | 3.1, 3.25, 3.2 | 2.55, 2.7, 2.5 | 2.25, 2.2 |
| CONTAINER NO. | C-116 | S-73 | R-15 | Z-3 |
| WT. CONTAINER + WET SOIL IN g | 25.291 | 31.490 | 2[illegible].004 | 25.818 |
| WT. CONTAINER + DRY SOIL IN g | 20.909 | 25.377 | 20.014 | 20.943 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.196 | 13.089 | 10.508 | 12.138 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 50.3 | 49.7 | 52.5 | 55.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Feb 25, 1981

TESTED BY Tim Dean & Edrick van Beuzek

| DETERMINATION NO. | 1 (2.3) | 2 (1.6) | 3 (1.2) | 4 (1.2) |
|---|---|---|---|---|
| Rdg TSF | 2.3, 2.4, 2.3 | 1.6, 1.7, 1.6 | 1.2, 1.2, 1.3 | 1.2, 1.2, 1.2 |
| CONTAINER NO. | L-19 | B-1 | C-7 | S4 |
| WT. CONTAINER + WET SOIL IN g | 17.958 | 23.129 | 28.658 | 23.881 |
| WT. CONTAINER + DRY SOIL IN g | 15.923 | 18.841 | 22.023 | 19.718 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.085 | 11.132 | 10.803 | 12.802 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 53.0 | 55.6 | 59.1 | 60.1 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Apr 22, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (1.) | 2 (.9) | 3 | 4 |
|---|---|---|---|---|
| Rdg TSF | 1.0, 1.1, 1.0 | .9, .9, .9 | | |
| CONTAINER NO. | 32 | Y-6 | | |
| WT. CONTAINER + WET SOIL IN g | 17.175 | 19.075 | | |
| WT. CONTAINER + DRY SOIL IN g | 15.301 | 15.809 | | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.215 | 10.462 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 60.7 | 67.7 | | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 30% VBC
70% silt

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE April 8, 198?
TESTED BY Rich Furman

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | T48 | X-2 | T-13 | T-4 | T-26 | |
| WT. CONTAINER + WET SOIL IN g | 24.063 | 24.452 | 24.934 | 22.849 | 24.926 | |
| WT. CONTAINER + DRY SOIL IN g | 23.142 | 23.465 | 23.892 | 22.109 | 23.878 | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 18.288 | 18.030 | 18.365 | 18.254 | 18.358 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 18.9% | 18.2 | 18.9 | 19.2 | 18.9 | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

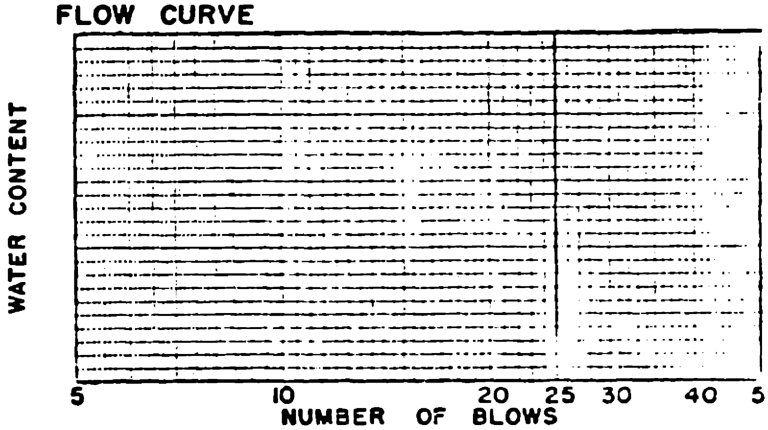
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUDED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE April 6, 1981

TESTED BY Lee Kachroo

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | X3 | Y-4 | C-25 | | | |
| WT. CONTAINER + WET SOIL IN g | 25.757 | 26.433 | 29.466 | | | |
| WT. CONTAINER + DRY SOIL IN g | 24.572 | 25.144 | 28.053 | | | |
| WT. WATER, $W_w$, IN g | 1.185 | 1.289 | 1.413 | | | |
| WT. CONTAINER IN g | 18.372 | 18.394 | 20.540 | | | |
| WT. DRY SOIL, $W_s$, IN g | 6.20 | 6.750 | 7.513 | | | |
| WATER CONTENT w, IN % | 19.1 | 19.1 | 18.8 | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

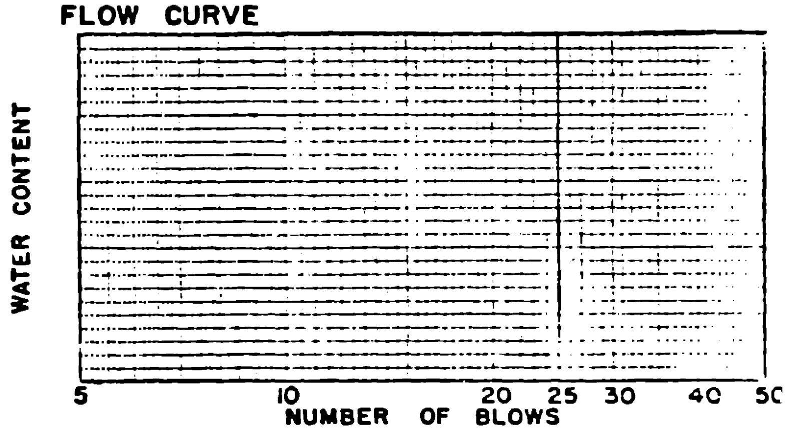
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 30% VBC
70% Silt
LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE March 4, 1981
TESTED BY Tim Dean

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (26.3) | 2 (24.3) | 3 (21) | 4 (18.3) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 26, 24, 29 | 23, 26, 24 | 19, 20, 24 | 18, 18, 19 | |
| CONTAINER NO. | R-15 | D-21 | S-46 | S-40 | |
| WT. CONTAINER + WET SOIL IN g | 21.179 | 19.615 | 23.698 | 25.666 | |
| WT. CONTAINER + DRY SOIL IN g | 18.794 | 17.942 | 21.240 | 22.924 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.522 | 12.217 | 13.029 | 13.222 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 28.8 | 29.2 | 29.9 | 30.7 | |

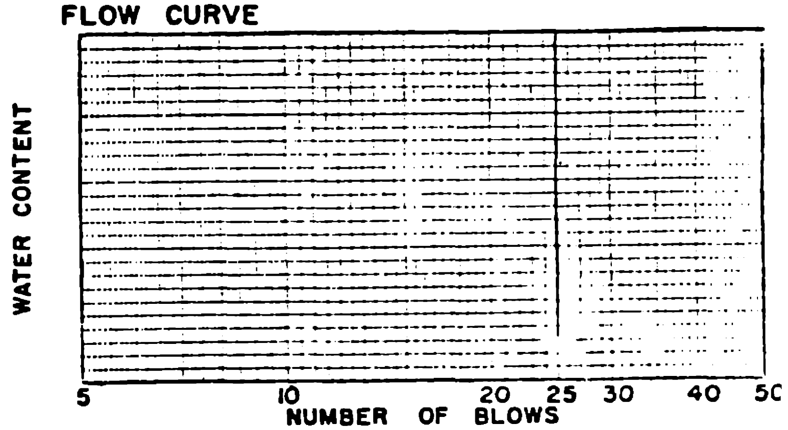
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 30% VBC
70% S[illegible]

LOCATION ______

BORING NO. ______ SAMPLE DEPTH ______

SAMPLE NO. ______

SPECIFIC GRAVITY, $G_s$, ______

TEST NO. ______

DATE April 8, 1981

TESTED BY Lee Kachroo

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (20) | 2 (22) | 3 (37) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 20, 21, 20 | 23, 22, 22 | 36, 36, 37 | | |
| CONTAINER NO. | S73 | T10 | W2 | | |
| WT. CONTAINER + WET SOIL IN g | 26.166 | 40.943 | 34.872 | | |
| WT. CONTAINER + DRY SOIL IN g | 23.250 | 35.512 | 29.735 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.079 | 18.231 | 12.808 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 28.6 | 31.4 | 30.3 | | |

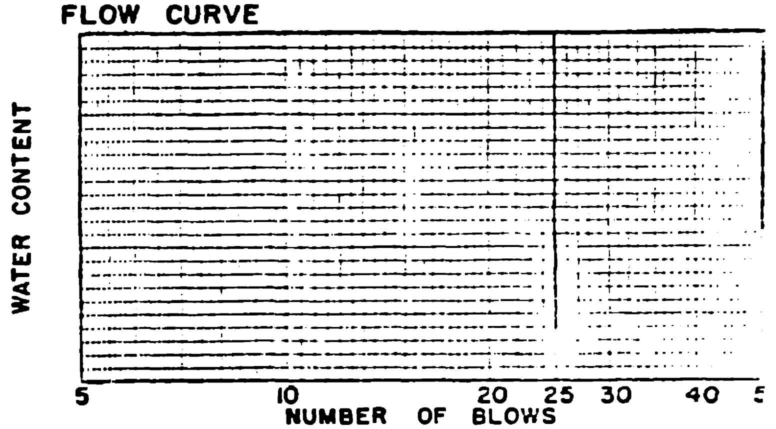
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 30% VBC
70% Silt
LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE April, 1981
TESTED BY Rich Furman

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (40) | 2 (27) | 3 (17) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 40,40,40 | 24,29,28,26 | 16,18,20,17 | | |
| CONTAINER NO. | 212 | 2 | S-40 | | |
| WT. CONTAINER + WET SOIL IN g | 32.869 | 31.205 | 24.070 | | |
| WT. CONTAINER + DRY SOIL IN g | 28.050 | 26.799 | 21.359 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.903 | 12.945 | 13.175 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 30.4 | 31.8 | 33.1 | | |

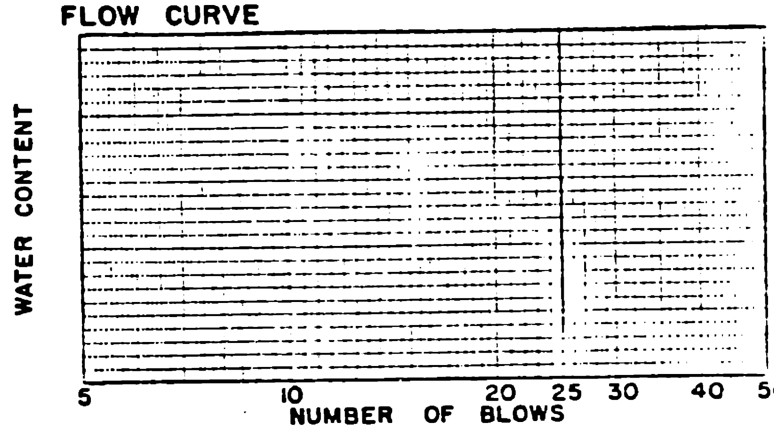
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# ATTERBERG LIMITS

30/70 Mixture                Winter/Spring 1961

Additional Liquid Limit Test Results from Casagrande Device:

| No. Blows | | $w_L$ % |
|---|---|---|
| 31.5 | ——— | 28.2 |
| 20 | ——— | 29.9 |
| 17.8 | ——— | 30.1 |
| 24 | ——— | 29.9 |
| 18 | ——— | 30.9 |
| 14 | ——— | 31.8 |
| 39.5 | ——— | 29.1 |
| 33 | ——— | 29.4 |

Additional Results from Plastic Limit Tests

| $w_p$ % |
|---|
| 19.5 |
| 19.0 |
| 18.0 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE plexiglass 60° [illegible]

SOIL SAMPLE 70% Silt
30% [illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Winter/Spring 1981

TESTED BY Edrick van Beuzekom

| DETERMINATION NO. | 1 (70) | 2 (90) | 3 (97) | 4 (105) |
|---|---|---|---|---|
| Rdg. 1/10 mm | 66,71,76,70 | 85,92,90,92 | 99,95,94,100 | 105,107,104 |
| CONTAINER NO. | MP-4 | N 13 | X-9 | H-7 |
| WT. CONTAINER + WET SOIL IN g | 28.596 | 29.575 | 25.604 | 32.975 |
| WT. CONTAINER + DRY SOIL IN g | 25.015 | 25.177 | 22.459 | 27.087 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.128 | 10.221 | 11.875 | 11.764 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 27.8 | 29.7 | 29.7 | 38.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE
60° plexiglass

consecutive cone penetration trials to examine variation in penetration values

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 1, 1981

TESTED BY Tim Dean

| DETERMINATION NO. | 1 | 2 | 3 | | 4 |
|---|---|---|---|---|---|
| cone pen 1/10 mm | (103.5) | (107) | (102.5) | (94) | (96) |
| CONTAINER NO. | 44 | | | | S-56 |
| WT. CONTAINER + WET SOIL IN g | 33.063 | | | | 32.337 |
| WT. CONTAINER + DRY SOIL IN g | 28.374 | | | | 28.042 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.226 | | | | 13.814 |
| WT. DRY SOIL, $W_s$, IN g | | (interpolated | w's): | | |
| WATER CONTENT w, IN % | 31.0 | (30.8) | (30.6) | (30.4) | 30.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

CONE
60° plexiglass

Consecutive cone penetration trials to examine variation in penetration values

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 | 2 | 3 | | 4 |
|---|---|---|---|---|---|
| Conepen 1/10 mm | 110 | 107 | 107 | 105 | 111 |
| CONTAINER NO. | L-19 | | | | D-7 |
| WT. CONTAINER + WET SOIL IN g | 23.019 | | | | 19.175 |
| WT. CONTAINER + DRY SOIL IN g | 19.751 | | | | 17.162 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 9.427 | | | | 10.787 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 31.7 | (31.68) | (31.65) | (31.63) | 31.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE
60° lexiglass

Consecutive cone penetration trials to examine variation in penetration values

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 1, 1981

TESTED BY Lee Kachroo

| DETERMINATION NO. | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| | 110 | 114 | 110 | 109 | 110 |
| CONTAINER NO. | S73 | | | | [illegible] |
| WT. CONTAINER + WET SOIL IN g | 30.997 | | | | [illegible] |
| WT. CONTAINER + DRY SOIL IN g | 26.646 | | | | 21.068 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.097 | | | | 12.808 |
| WT. DRY SOIL, $W_s$, IN g | | interpolated | w%'s | ' | |
| WATER CONTENT w, IN % | 32% | (31.8) | (31.6) | (31.4) | 31.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE
60° plexiglass

consecutive cone penetration trials to examine variation in penetration values

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April, 1981

TESTED BY

| DETERMINATION NO. | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| cone pen 1/10 mm | 111 | 107.5 | 106.5 | 108 | 108 |
| CONTAINER NO. | S64 | | | | S-51 |
| WT. CONTAINER + WET SOIL IN g | 27.051 | | | | 38.63 |
| WT. CONTAINER + DRY SOIL IN g | 23.752 | | | | 32.976 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.124 | | | | 13.977 |
| WT. DRY SOIL, $W_s$, IN g | | (interpolated w%'s): | | | |
| WATER CONTENT w, IN % | 31.0 | (30.7) | (30.4) | (30.1) | 29.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE
60° plexiglass

Consecutive cone penetration trials to examine variation in penetration values

SOIL SAMPLE 303 VBC
[illegible]

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.

TEST NO.
DATE April, 1981
TESTED BY Edrick van Beuzekom

| DETERMINATION NO. | 1 | 2 | 3 | | 4 |
|---|---|---|---|---|---|
| cone pen 1/10 mm | (107) | (115) | (106) | (111) | (115) |
| CONTAINER NO. | Y-1 | | | | N-13 |
| WT. CONTAINER + WET SOIL IN g | 16.475 | | | | 24.098 |
| WT. CONTAINER + DRY SOIL IN g | 14.790 | | | | 20.777 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 9.531 | | | | 10.212 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 32.0 | (31.85) | (31.7) | (31.55) | 31.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

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# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## DROP CONE

60° Plexiglass

Dropped from 1 cm *

SOIL SAMPLE 30/70 Mix

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 22, 1981

TESTED BY Lee Kachroo

| | Normal | Dropped | Dropped | Dropped |
|---|---|---|---|---|
| DETERMINATION NO. | 1 | 2 (245) | 3 (2[illegible]) | 4 (2[illegible]) |
| Pen 1/10 mm | 136,132,132,136 | 243,248,243 | 225,228,228 | 235,234,245 |
| CONTAINER NO. | B-2 | 009 | 35 | S79 |
| WT. CONTAINER + WET SOIL IN g | 23.854 | 21.027 | 22.957 | 28.320 |
| WT. CONTAINER + DRY SOIL IN g | 20.737 | 18.312 | 20.296 | 24.538 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.159 | 12.093 | 11.650 | 13.227 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 36.3 | 43.7 | 30.8 | 33.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

DROP CONE 60° plexiglass
Dropped from 1cm*

SOIL SAMPLE 30/70 Mix

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 15, 1981

TESTED BY Tim Dean

| DETERMINATION NO. | 1 (93.8) | 2 (100.8) | 3 (103.8) | 4 (121.3) |
|---|---|---|---|---|
| Cone Pen 1/10 mm | 91, 93, 95, 96 | 96, 102, 101, 104 | 111, 86, 111, 103, 108 | 125, 123, 118, 119 |
| CONTAINER NO. | S-79 | S-51 | S-56 | T-79 |
| WT. CONTAINER + WET SOIL IN g | 24.299 | 27.555 | 30.203 | 37.912 |
| WT. CONTAINER + DRY SOIL IN g | 21.910 | 24.604 | 26.557 | 33.392 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 13.215 | 13.982 | 13.811 | 18.179 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 26.7 | 27.8 | 28.6 | 29.7 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE 30% VBC
70% Silt

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 4, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (1.3) | 2 (.75) | 3 (.7) | 4 (1.0) |
|---|---|---|---|---|
| Pen. Reading TSF | 1.3, 1.3, 1.3 | .75, .75, .75 | .7, .7, .69 | .9, 1.0, 1.0 |
| CONTAINER NO. | A3 | B-2 | O-5 | B-1 |
| WT. CONTAINER + WET SOIL IN g | 20.477 | 28.465 | 22.405 | 26.758 |
| WT. CONTAINER + DRY SOIL IN g | 17.626 | 24.707 | 20.030 | 23.194 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 7.313 | 12.160 | 12.247 | 11.118 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 27.6 | 30.0 | 30.5 | 29.5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

SOIL SAMPLE 30[illegible] VBC

[illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 4, 1981

TESTED BY Rich Furman

| DETERMINATION NO. | 1 (3.0) | 2 (1.[illegible]) | 3 (1.5) | 4 (1.4) |
|---|---|---|---|---|
| Torv. Reading TSF | 3.0, 3.0, 3.0 | 1.9, 2.0, 1.95 | 1.5, 1.5, 1.5 | 1.4, 1.4, 1.3 |
| CONTAINER NO. | N-1 | 12 | 004 | D-7 |
| WT. CONTAINER + WET SOIL IN g | 27.633 | 31.165 | 27.934 | 23.042 |
| WT. CONTAINER + DRY SOIL IN g | 24.287 | 26.836 | 24.221 | 20.181 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.200 | 12.076 | 12.044 | 10.705 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 27.7% | 29.3% | 30.5% | 30.2% |

SULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | S VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE Chicago Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE April 22, 1981

TESTED BY Maureen Kestler

## .STIC LIMIT

| ETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| ONTAINER NO. | T77 | T10 | Y-5 | C-5 | | |
| T. CONTAINER + WET SOIL IN g | 22.506 | 20.668 | 23.154 | 28.893 | | |
| T. CONTAINER + DRY SOIL IN g | 21.927 | 20.313 | 22.465 | 28.312 | | |
| T. WATER, $W_w$, IN g | | | | | | |
| T. CONTAINER IN g | 18.524 | 18.240 | 18.340 | 24.918 | | |
| T. DRY SOIL, $W_s$, IN g | | | | | | |
| ATER CONTENT w, IN % | 17.0 | 17.1 | 16.7 | 17.1 | | |

## UID LIMIT

dried out while performing test ∴ leaned heavily on last tests

| ETERMINATION NO. | 35, 37, 1 ([illegible]) | 25, 28, 2 (35) | 19, 20, 3 ([illegible]) | 4 (11) | 5 |
|---|---|---|---|---|---|
| O. OF BLOWS | 44, 45, 46, 48 | 33, 34, 32, 37 | 22, 23, 24 | 11, 11, 11 | |
| ONTAINER NO. | T41 | AAA | X1 | D6 | |
| T. CONTAINER + WET SOIL IN g | 29.752 | 30.696 | 40.424 | 40.912 | |
| T. CONTAINER + DRY SOIL IN g | 27.093 | 28.131 | 36.423 | 36.557 | |
| T. WATER, $W_w$, IN g | | | | | |
| T. CONTAINER IN g | 18.218 | 20.028 | 24.392 | 24.702 | |
| T. DRY SOIL, $W_s$, IN g | | | | | |
| ATER CONTENT w, IN % | 30.0 | 31.7 | 33.3 | 36.7 | |

WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## RINKAGE LIMIT

| ETERMINATION NO. | 1 | 2 |
|---|---|---|
| NDISTUBED OR EMOLDED SOIL PAT | | |
| T. DRY SOIL PAT, $W_s$, IN g | | |
| T. CONTAINER + HG. IN g | | |
| T. CONTAINER IN g | | |
| T. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE

WATER CONTENT

5 10 20 25 30 40 50

NUMBER OF BLOWS

## SULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 17 | | | | | | | | |

MARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE Chicago Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Spring 1981

TESTED BY Edrick van Beuzekom

| DETERMINATION NO. | 1 (67) | 102, 2 (100) | 135, 3 (135) | 4 |
|---|---|---|---|---|
| Pen 1/10 mm | 68, 59, 68, 72 | 94, 103, 102 | 128, 139, 13[illegible] | |
| CONTAINER NO. | N-2 | VI | S-56 | |
| WT. CONTAINER + WET SOIL IN g | 17.273 | 27.328 | 41.460 | |
| WT. CONTAINER + DRY SOIL IN g | 15.625 | 23.670 | 34.039 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.031 | 12.499 | 13.814 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 29.5 | 32.7 | 36.7 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Agrico Saddle Crk. Mine

TEST NO.

LOCATION

DATE May 28, 1982

BORING NO. SAMPLE DEPTH

TESTED BY Maureen Kestler

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | B2 | 75 | N1 | | | |
| WT. CONTAINER + WET SOIL IN g | 12.903 | 10.261 | 13.702 | | | |
| WT. CONTAINER + DRY SOIL IN g | 12.560 | 9.933 | 12.982 | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.140 | 9.550 | 12.175 | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 81.7 | 85.6 | 89.2 | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (43) | 2 (33) | 3 (25) | 4 (18) | 5 (11) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 46,44,42,42 | 33,33 | 25,24,25 | 18,16,18 | 12,10,12,12 |
| CONTAINER NO. | 05 | 212 | D20 | B11 | N12 |
| WT. CONTAINER + WET SOIL IN g | 19.053 | 19.554 | 18.241 | 16.868 | 18.492 |
| WT. CONTAINER + DRY SOIL IN g | 14.266 | 14.288 | 13.019 | 13.468 | 13.982 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.219 | 12.181 | 11.021 | 12.234 | 12.442 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 233.9 | 249.9 | 261 | 275.5 | 307.1 |

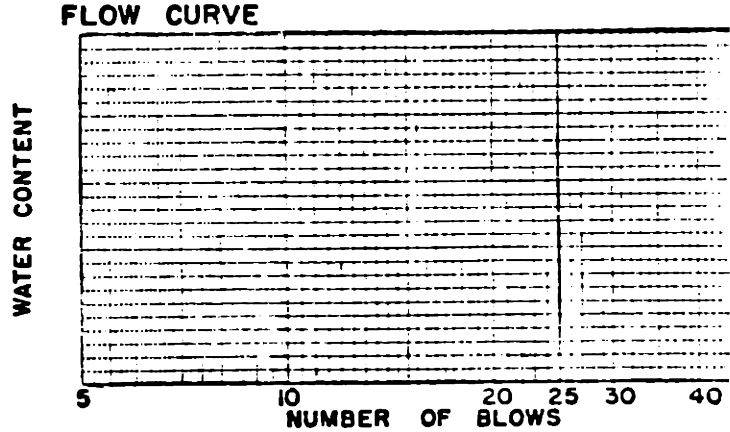
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUDED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 85 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE Agrico Saddle
Crk. Mine

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 28, 1982

TESTED BY Maureen Kestler

| | 89 89 (89.5) | 127 (127) | (160) | |
|---|---|---|---|---|
| DETERMINATION NO. | 88 88 88 | 128 2 127 | 160 3 160 | 4 |
| Penetration 1/10 MM | 91 91 | 126.5 126.5 | 160 160 | |
| CONTAINER NO. | X6 | 36 | 67 | |
| WT. CONTAINER + WET SOIL IN g | 16.542 | 17.352 | 13.535 | |
| WT. CONTAINER + DRY SOIL IN g | 13.757 | 13.849 | 10.848 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.178 | 12.157 | 9.699 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 176.4 | 207.0 | 233.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RF RKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# PENETROMETER

SOIL SAMPLE Agrico Saddle
Crk [illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE Fri, May 28, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (1.84) | 2 (.82) | 3 (.48) | 4 |
|---|---|---|---|---|
| | 1.9, 1.8, 1.8, 1.9 | .83, .82, .82 | .5, .47, .47 | |
| CONTAINER NO. | L-29 | 71 | VI | |
| WT. CONTAINER + WET SOIL IN g | 16.881 | 16.388 | 17.637 | |
| WT. CONTAINER + DRY SOIL IN g | 12.475 | 13.297 | 14.030 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.022 | 11.822 | 12.480 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 179.6 | 209.6 | 232.7 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## TORVANE

SOIL SAMPLE Agrico Saddle
[illegible]

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.

TEST NO.
DATE Fri, May 28, 1982
TESTED BY Maureen Kestler

| DETERMINATION NO. | 3.4 1 (3.4) | 1.95, 2 2.1 (1.9) | 3 (1.1) | 4 |
|---|---|---|---|---|
| | 3.6, 3.4, 3.5 | 2.0, 2.0, 1.85 | 1.2, 1.2, 1.1 | |
| CONTAINER NO. | 2 | 215 | 28 | |
| WT. CONTAINER + WET SOIL IN g | 16.597 | 17.723 | 16.985 | |
| WT. CONTAINER + DRY SOIL IN g | 13.677 | 13.820 | 13.696 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.032 | 11.942 | 12.288 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 177.5 | 207.8 | 233.6 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# ATTERBERG LIMITS

SOIL SAMPLE *Bentonite 200 Volclay*

LOCATION ______

BORING NO. ______ SAMPLE DEPTH ______

SAMPLE NO. ______

SPECIFIC GRAVITY, $G_s$, ______

TEST NO. ______

DATE *May 8, May 19, May 20, 1982*

TESTED BY *Maureen Kestler*

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 |
|---|---|---|---|
| CONTAINER NO. | 03 | 55 | |
| WT. CONTAINER + WET SOIL IN g | 12.256 | 12.534 | |
| WT. CONTAINER + DRY SOIL IN g | 12.230 | 12.413 | |
| WT. WATER, $W_w$, IN g | .026 | .121 | |
| WT. CONTAINER IN g | 12.145 | 12.044 | |
| WT. DRY SOIL, $W_s$, IN g | .085 | .369 | |
| WATER CONTENT w, IN % | 30.6 | 32.8 | |

| 1 | 2 | 3 |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (55) | 2 (30) | 3 (23.8) | 4 ([illegible]) | 5 (13) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 55,55,55,55,55 | 30,30,30 | 25,20,24,24,26 28,28 | 18,18,18 | 16,12,13,13,13,13 |
| CONTAINER NO. | D7 | Z1 | B11 | L29 | 2 |
| WT. CONTAINER + WET SOIL IN g | 22.225 | 23.962 | 24.276 | 20.811 | 25.666 |
| WT. CONTAINER + DRY SOIL IN g | 12.511 | 13.630 | 14.000 | 11.567 | 13.971 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.786 | 11.825 | 12.231 | 10.019 | 12.032 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 563 | 572 | 581 | 597 | 603 |

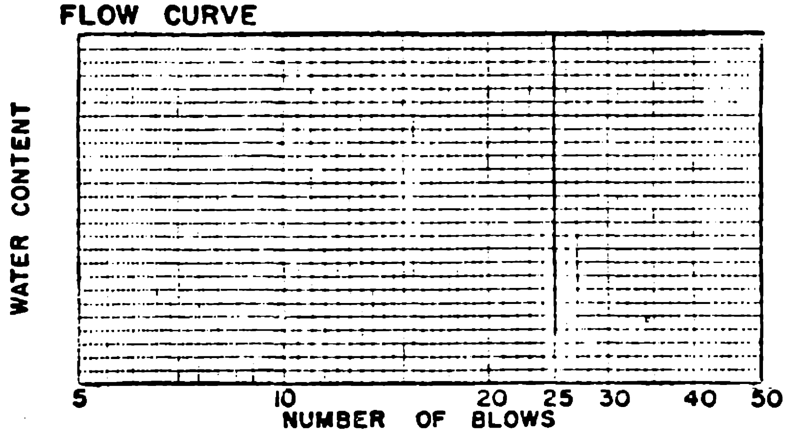
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

## REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE Bentonite

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 19, 1982, May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (155.5) | 177 2 (177) | 3 (182) | 4 (200) |
|---|---|---|---|---|
| Penetration 1/10 mm | 155, 155, 155.5, 155.5 | 182, 177, 177 | 180, 182.5, 183 | 201, 200, 201 |
| CONTAINER NO. | C9 | Z3 | S7S (2) | B52 |
| WT. CONTAINER + WET SOIL IN g | 32.075 | 18.791 | 21.700 | 36.970 |
| WT. CONTAINER + DRY SOIL IN g | 22.517 | 13.385 | 14.562 | 27.044 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 20.044 | 12.123 | 12.952 | 24.903 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 386.5 | 428 | 443.3 | 463.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# CONE
## TIME FOR PENETRATION:

Bentonite

May 2, 1982
Maureen Kestler

| | |
|---|---|
| Penetration Depth at the end of 1st second (1/10 mm) | 177 |
| Penetration Depth following an additional 9 seconds i.e., 10 second reading (1/10 mm) | 177 |
| Penetration Depth following an additional 20 seconds i.e., 30 second reading (1/10 mm) | 177 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## Penetrometer

SOIL SAMPLE Bentonite 200

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 19, May 20, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (1.0) | 2 (.6) | 3 (.4) | 4 (.27) |
|---|---|---|---|---|
| Reading TSF | 1.0, 1.0- | .6, .65 | .4, .4 | .3, .27, .25 |
| CONTAINER NO. | 03 | S62 | S40 | A3 |
| WT. CONTAINER + WET SOIL IN g | 21.440 | 21.125 | 23.021 | 36.735 |
| WT. CONTAINER + DRY SOIL IN g | 14.358 | 14.448 | 14.980 | 26.825 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.138 | 12.717 | 13.176 | 24.679 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 319 | 385.7 | 445.7 | 461.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## Torvane

SOIL SAMPLE Bentonite 200

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 19 & 20, 1982

TESTED BY Maureen Kestler

INITIAL READING 0.1 ∴ SUBTRACT .1 FOR AVG.

| TERMINATION NO. | 2.1 1 (2.0) | 1.42 2 (1.42) | 3 (.9) | 4 (.8) |
|---|---|---|---|---|
| eading TSF | 2.1, 2.0, 2.1, 2.1 | 1.53, 1.5, 1.5, 1.55 | 1.0, 1.0 | .9, .9 |
| ONTAINER NO. | D20 | T10 | T93 | C5 |
| T. CONTAINER + WET SOIL IN g | 18.610 | 31.189 | 34.309 | 35.733 |
| T. CONTAINER + DRY SOIL IN g | 12.809 | 20.909 | 21.158 | 26.835 |
| T. WATER, $W_w$, N g | 5.801 | | | |
| . CONTAINER IN g | 11.023 | 18.229 | 18.192 | 24.904 |
| . DRY SOIL, $W_s$, g | 1.786 | | | |
| TER CONTENT w, % | 325 | 383.6 | 443.4 | 460.8 |

T SUMMARY

| STIC IMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Boston Blue Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 7, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | T93 | X-3 (T64) | T10 | T40 | | |
| WT. CONTAINER + WET SOIL IN g | 20.164 | 20.671 | 20.640 | 21.547 | | |
| WT. CONTAINER + DRY SOIL IN g | 19.808 | 20.257 | 20.205 | 20.936 | | |
| WT. WATER, $W_w$, IN g | .356 | .414 | .435 | .611 | | |
| WT. CONTAINER IN g | 18.187 | 18.374 | 18.233 | 18.202 | | |
| WT. DRY SOIL, $W_s$, IN g | 1.621 | 1.883 | 1.972 | 2.734 | | |
| WATER CONTENT w, IN % | 22.0 | 22.0 | 22.1 | 22.3 | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (52) | 2 (43.6) | 3 (15) | 4 (11) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 51 53 52 | 45 42 ~~44~~ | 15 15 | 10 11 11 11 | |
| CONTAINER NO. | D20 | N1 | D7 | S73 | |
| WT. CONTAINER + WET SOIL IN g | 22.482 | 21.965 | 23.528 | 23.895 | |
| WT. CONTAINER + DRY SOIL IN g | 19.406 | 19.259 | 19.597 | 20.392 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 11.043 | 12.177 | 10.790 | 13.065 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 36.8 | 38.2 | 44.6 | 47.8 | |

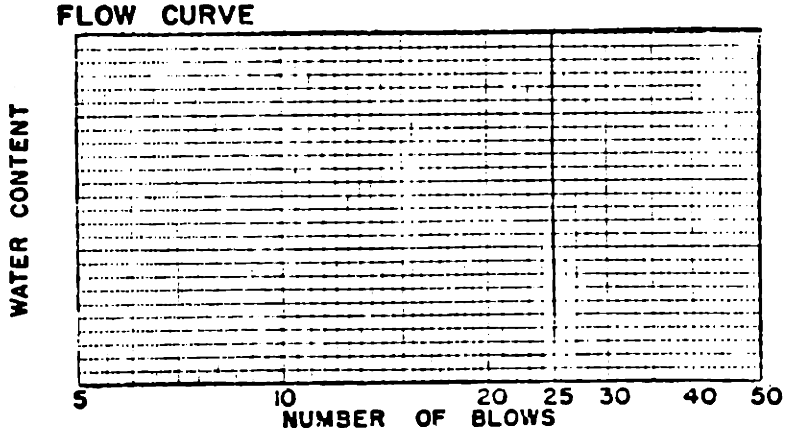
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 22.1 | | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

CASAGRANDE GROOVING TOOL

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE June 23, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (26.5) | 2 (21) | 3 (13.3) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 29, 28 | 20, 21 | 13, 14, 13 | | |
| CONTAINER NO. | S93 | S42 | S7S / 2 | | |
| WT. CONTAINER + WET SOIL IN g | 24.800 | 22.212 | 25.233 | | |
| WT. CONTAINER + DRY SOIL IN g | 21.491 | 19.460 | 21.253 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.771 | 13.337 | 12.949 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 42.9 | 44.9 | 47.9 | | |

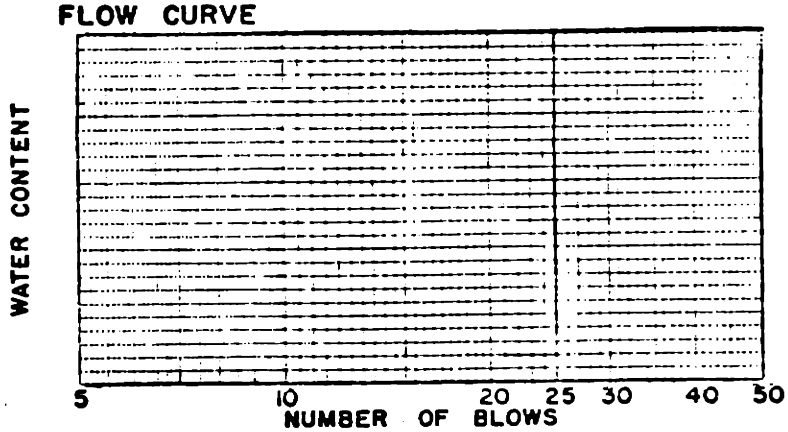
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

STD ASTM GROOVING TOOL.
SOIL QUANTITY:
TOO MUCH.

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO. 65 ± 5 grams

DATE March 2:t, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (14.5) | 2 (11.8) | 3 (7.7) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 15, 15, 14, 14 | 13, 9, 10, 13, 12, 14 | 8, 8, 7 | | |
| CONTAINER NO. | L-29 | B-2 | A-3 | | |
| WT. CONTAINER + WET SOIL IN g | 22.247 | 25.782 | 17.047 | | |
| WT. CONTAINER + DRY SOIL IN g | 18.704 | 21.753 | 14.035 | | |
| WT. WATER, $W_w$, IN g | 3.543 | 4.029 | 3.012 | | |
| WT. CONTAINER IN g | 10.016 | 12.151 | 7.313 | | |
| WT. DRY SOIL, $W_s$, IN g | 8.688 | 9.602 | 6.722 | | |
| WATER CONTENT w, IN % | 40.8 | 42.0 | 44.8 | | |

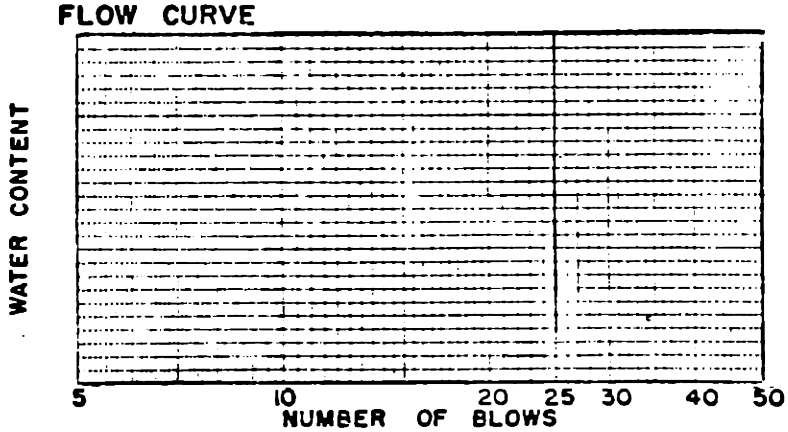
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

ASTM STD GRVG TOOL
SOIL QUANTITY:
TOO LITTLE
2.5 ± 5 grams

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE June 23, 1982

TESTED BY

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (36) | 2 (16.2) | 3 (15) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 36, 36 | 18, 16, 16 | 15, 15 | | |
| CONTAINER NO. | S73 | S64 | 4/S6 | | |
| WT. CONTAINER + WET SOIL IN g | 19.328 | 18.912 | 21.635 | | |
| WT. CONTAINER + DRY SOIL IN g | 17.461 | 17.055 | 18.768 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 13.058 | 13.123 | 13.190 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 42.4 | 47.2 | 51.4 | | |

WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE

WATER CONTENT

5 10 20 25 30 40 50
NUMBER OF BLOWS

### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 7, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (88.7) | 2 (95) | 151,151 3 (150.4) | 4 (189.7) |
|---|---|---|---|---|
| Penetration 1/10 mm | 91, 88, 89, 87 | 95, 96, 97 | 153, 151, 146 | 188, 189, 189 |
| CONTAINER NO. | 46 | R13 | S6 (4) | T85 |
| WT. CONTAINER + WET SOIL IN g | 22.117 | 19.658 | 23.620 | 30.637 |
| WT. CONTAINER + DRY SOIL IN g | 19.437 | 17.165 | 20.416 | 26.630 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.116 | 10.665 | 13.190 | 18.168 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 36.6 | 38.4 | 44.3 | 47.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 24 & May 7, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.66) | 2 (1.8) | 3 (.94) | 4 (.85) |
|---|---|---|---|---|
| Pen. Reading TSF | 2.75, 2.6, 2.7, 2.6 | 1.7, 1.8, 1.9 | .94, .94, .94 | .85, .85 |
| CONTAINER NO. | N 12 | Z 5 | 46 | 2 |
| WT. CONTAINER + WET SOIL IN g | 29.344 | 28.008 | 26.178 | 30.080 |
| WT. CONTAINER + DRY SOIL IN g | 24.771 | 22.835 | 22.039 | 24.665 |
| WT. WATER, $W_w$, IN g | | | 4.139 | 5.415 |
| WT. CONTAINER IN g | 12.433 | 9.557 | 12.116 | 12.401 |
| WT. DRY SOIL, $W_s$, IN g | | | 9.923 | 12.264 |
| WATER CONTENT w, IN % | 37.1 | 40.0 | 41.7 | 44.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER (cont)

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 24 & May 7, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (.47) | 2 (.55) | 3 | 4 |
|---|---|---|---|---|
| Pen. Reading TSF | .45, .48 | .55, .55 | | |
| CONTAINER NO. | W-4 | W7/A2 | | |
| WT. CONTAINER + WET SOIL IN g | 23.192 | 29.945 | | |
| WT. CONTAINER + DRY SOIL IN g | 19.098 | 24.823 | | |
| WT. WATER, $W_w$, IN g | 4.094 | | | |
| WT. CONTAINER IN g | 10.511 | 13.984 | | |
| WT. DRY SOIL, $W_s$, IN g | 8.587 | | | |
| WATER CONTENT w, IN % | 47.7% | 47.3 | | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

-.25 initial reading

SOIL SAMPLE BBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 24, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 2.27 - 0.25 (2.0[illegible]) | 1.77 - .25 (1.52) | 1.5 - 0.25 (1.25) | 1.07 - 0.25 = (0.82) |
|---|---|---|---|---|
| Torvane Rdg TSF | 2.25, 2.1, 2.[illegible], 2.2, 2.3, 2.4 | 1.8, 1.75, 1.75 | 1.5, 1.5 | 1.1, 1.0, 1.1 |
| CONTAINER NO. | Z-5 | 05 | Z-2 | 24 |
| WT. CONTAINER + WET SOIL IN g | 25.82 | 21.366 | 25.080 | 27.613 |
| WT. CONTAINER + DRY SOIL IN g | 21.125 | 19.016 | 20.783 | 22.294 |
| WT. WATER, $W_w$, IN g | 4.695 | 2.85 | 4.297 | 5.319 |
| WT. CONTAINER IN g | 9.551 | 12.220 | 10.980 | 11.059 |
| WT. DRY SOIL, $W_s$, IN g | 11.574 | 6.796 | 9.803 | 11.235 |
| WATER CONTENT w, IN % | 40.6 | 41.9 | 43.8 | 47.3 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE CF Mining

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 28, 1982

TESTED BY Maureen Kestler

### LASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | S79 | S73 | S42 | S6 | | |
| WT. CONTAINER + WET SOIL IN g | 14.122 | 13.565 | 14.056 | 14.019 | | |
| WT. CONTAINER + DRY SOIL IN g | 13.875 | 13.438 | 13.868 | 13.805 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 13.202 | 13.058 | 13.336 | 13.164 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 36.7 | 33.42 | 35.34 | 33.39 | | |

### IQUID LIMIT

| DETERMINATION NO. | 1 (57) | 2 (36) | 3 (30) | 12, 14, 14 (14) | 5 (9) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 55 60 58 | 37 35 36 | 29, 28, 30, 30 | 16, 12, 14, 16, 16, 13 | 9, 9 |
| CONTAINER NO. | T76 | T60 | R13 | 36/71 | A77 |
| WT. CONTAINER + WET SOIL IN g | 26.956 | 24.007 | 19.550 | 20.223 | 14.129 |
| WT. CONTAINER + DRY SOIL IN g | 22.076 | 20.638 | 14.326 | 15.333 | 9.325 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 18.262 | 18.192 | 10.657 | 12.176 | 6.387 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 127.9 | 137.7 | 142.4 | 154.9 | 163.5 |

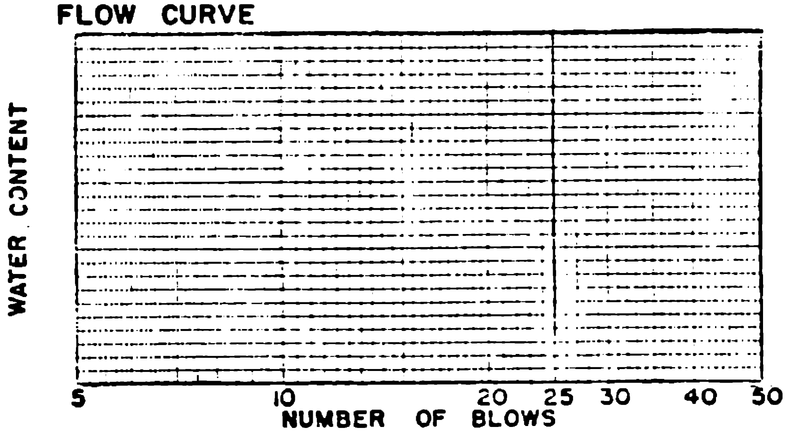
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### HRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUDED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### ESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 34.7 | | | | | | | | |

EMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE CF Mining

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 28, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (77) | 2 (110) | 169 3 (169) | 234.5 234 4 (233) |
|---|---|---|---|---|
| Penetration 1/10 mm | 75.5, 79.5, 77.5 | 111, 109.5, 109.5, 109.5 | 172, 169.5, 169 | 234.5, 232.5, |
| CONTAINER NO. | T67 | Y5 | A6 | |
| WT. CONTAINER + WET SOIL IN g | 23.581 | 25.075 | 18.034 | |
| WT. CONTAINER + DRY SOIL IN g | 20.945 | 21.472 | 14.230 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.293 | 18.328 | 11.450 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 99.4 | 114.6 | 136.8 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# CONE
# TIME FOR PENETRATION

CF Mining

May 28, 1982
Maureen Kestler

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Penetration Depth at the end of 1st second (1/10 mm) | 75.5 | 79.5 | 77.5 | 109.5 | 169.5 | 169 | 232.5 |
| Penetration Depth following an additional 9 seconds ie., 10 second reading (1/10 mm) | 75.5 | 79.5 | 77.5 | 109.5 | 169.5 | 169 | 232.5 |
| Penetration Depth following an additional 20 seconds ie., 30 second reading (1/10 mm) | 75.5 | 79.5 | 77.5 | 109.5 | 169.5 | 169 | 232.5 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE CF. Mining

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 28, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.45) | 2 (1.07) | 3 (.47) | 4 |
|---|---|---|---|---|
| Reading TSF | 2.2, 2.5, 2.6, 2.4 | 1.05, 1.4 | .47, .47 | |
| CONTAINER NO. | Y4 | V2/T68 | T83 | |
| WT. CONTAINER + WET SOIL IN g | 23.462 | 26.608 | 25.058 | |
| WT. CONTAINER + DRY SOIL IN g | 20.910 | 22.103 | 21.043 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.358 | 18.218 | 18.131 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 100 | 116.0 | 137.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

-.1 initial Reading

SOIL SAMPLE CF Mining

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 28, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 4.8 - .1 = 4.7 | 2.55 - 0.1 = 2.45 | 1.12 - 0.1 = 1.02 | 4 |
|---|---|---|---|---|
| Reading TSF | 4.95, 4.6, 4.8, 4.8 | 2.65, 2.55, 2.55 | 1.1, 1.15, 1.1 | |
| CONTAINER NO. | T47 | T88 | A1 | |
| WT. CONTAINER + WET SOIL IN g | 25.260 | 26.601 | 18.050 | |
| WT. CONTAINER + DRY SOIL IN g | 21.648 | 22.144 | 13.881 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.078 | 18.287 | 10.835 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 101.2 | 116 | 136.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE Gray Clay
60-62
[illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | R13 | A1 | A6 | 71/36 | | |
| WT. CONTAINER + WET SOIL IN g | 12.630 | 12.472 | 12.987 | 14.235 | | |
| WT. CONTAINER + DRY SOIL IN g | 12.260 | 12.163 | 12.704 | 13.859 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 10.655 | 10.834 | 11.448 | 12.175 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 23.05 | 23.25 | 22.53 | 22.33 | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (31) | 2 (19) | 10, 11, 3 (10.9) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 31, 31 | 18, 19, 19 | 10, 12, 11, 10, 12 | | |
| CONTAINER NO. | D3 | N1 | N12 | | |
| WT. CONTAINER + WET SOIL IN g | 18.351 | 18.319 | 24.822 | | |
| WT. CONTAINER + DRY SOIL IN g | 15.901 | 16.442 | 20.801 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.022 | 12.174 | 12.430 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 41.7 | 44.0 | 48.0 | | |

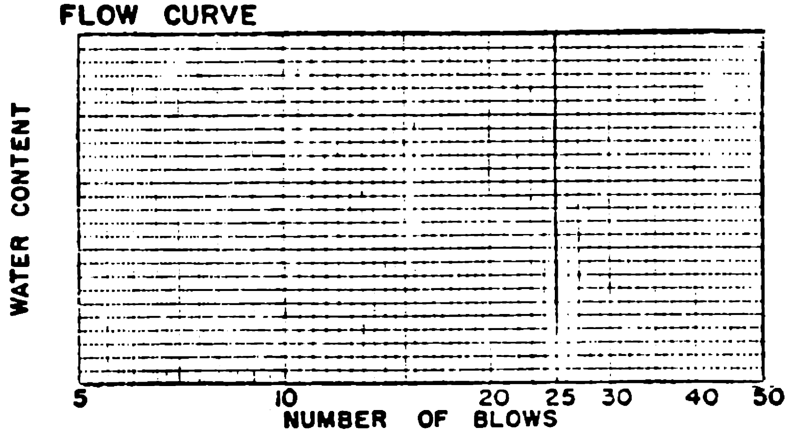
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 22.8 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Gray Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 119.5 (119.7) | (142) | (161.5) | 4 |
|---|---|---|---|---|
| Penetration 1/10 mm | 120, 119.5 | 140, 147, 140 | 162, 161 | |
| CONTAINER NO. | Z2 | Z5 | A4 | |
| WT. CONTAINER + WET SOIL IN g | 14.318 | 15.034 | 21.129 | |
| WT. CONTAINER + DRY SOIL IN g | 13.325 | 13.340 | 18.170 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.977 | 9.548 | 12.012 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 42.3 | 44.7 | 48.1 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Gray Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (.95) | 2 (.69) | 3 (.55) | 4 |
|---|---|---|---|---|
| Rdg. | .90, .95, 1.0 | .67, .7, .7 | .5, .55, .55 | |
| CONTAINER NO. | 2 | B2 | L198 | |
| WT. CONTAINER + WET SOIL IN g | 15.165 | 15.676 | 15.145 | |
| WT. CONTAINER + DRY SOIL IN g | 14.212 | 14.575 | 13.334 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.030 | 12.139 | 9.410 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 43.7 | 45.2 | 46.2 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

-.1 initial reading

SOIL SAMPLE Gray Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 2.07 - .1 = (1.97) | 1.53 - 0.1 = (1.43) | 1.1 - 0.1 = (1.0) | 4 |
|---|---|---|---|---|
| Rdg. TSF | 2.05, 2.1 | 1.5, 1.6, 1.5 | 1.1, 1.1 | |
| CONTAINER NO. | L-29 | B 11 | E 14 | |
| WT. CONTAINER + WET SOIL IN g | 14.237 | 17.615 | 21.918 | |
| WT. CONTAINER + DRY SOIL IN g | 12.973 | 15.959 | 18.711 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.019 | 12.230 | 12.086 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 42.8 | 44.4 | 48.4 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE Ideal BN1-S2

Some (ltd.) sand grains

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$ ,

TEST NO.

DATE Wed., May 19, 1982

TESTED BY Maureen Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | Z5 | Z2 | E14 | A6 | | |
| WT. CONTAINER + WET SOIL IN g | 10.413 | 11.839 | 12.922 | 13.172 | | |
| WT. CONTAINER + DRY SOIL IN g | 10.211 | 11.645 | 12.731 | 12.783 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 9.548 | 10.999 | 12.088 | 11.450 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 30.5 | 30.0 | 29.7 | 29.2 | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (34.3) | 2 (24.3) | 3 (21.5) | 4 (10) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 33,34,36 | 24,25,24 | 20,22,21,23 | 10,10 | |
| CONTAINER NO. | A4 | N1 | S64 | S6 | |
| WT. CONTAINER + WET SOIL IN g | 21.782 | 23.439 | 24.481 | 27.542 | |
| WT. CONTAINER + DRY SOIL IN g | 17.063 | 17.960 | 18.849 | 20.076 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.014 | 12.176 | 13.123 | 13.196 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 93.5 | 95.0 | 98.4 | 108.6 | |

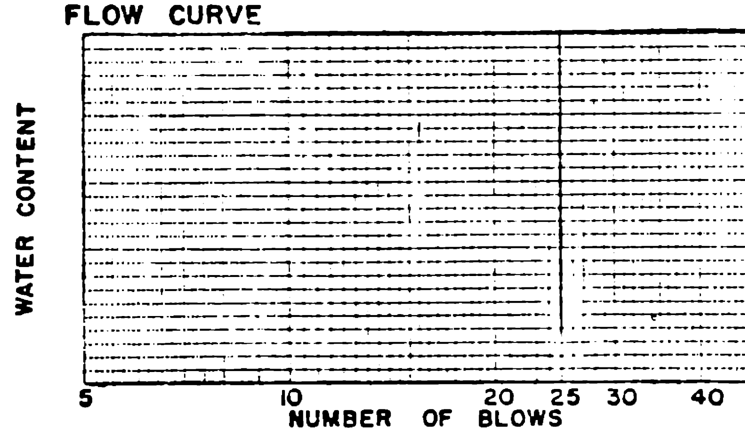
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 29.8 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Ideal

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 19, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (82.5) | 107.1 2 (108) | 3 (166) | 4 (186) |
|---|---|---|---|---|
| Penetration 1/10 mm | 83, 81.5, 83 | 107.5, 114, 111, 112.5, 114 | 166, 166 | 184.5, 186, 187.5 |
| CONTAINER NO. | Z3 | 05 | 46 | B2 |
| WT. CONTAINER + WET SOIL IN g | 17.044 | 16.444 | 22.156 | 21.762 |
| WT. CONTAINER + DRY SOIL IN g | 14.898 | 14.527 | 17.243 | 16.971 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.125 | 12.219 | 12.113 | 12.138 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 77.4 | 83.1 | 95.8 | 99.1 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE Ideal

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 19, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.07) | 2 (1.05) | 3 (.44) | 4 |
|---|---|---|---|---|
| Reading TSF | 2.2, 2.0, 2.0 | 1.1, 1.1, 1.05 | .42, .45 | |
| CONTAINER NO. | N 12 | 212 | L198 | |
| WT. CONTAINER + WET SOIL IN g | 20.902 | 18.856 | 19.129 | |
| WT. CONTAINER + DRY SOIL IN g | 17.198 | 15.817 | 14.400 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.430 | 12.182 | 9.418 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 77.7 | 83.6 | 94.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

TORVANE

* -.1 initial reading

SOIL SAMPLE Ideal

TEST NO.

LOCATION

DATE May 19, 1982

BORING NO. SAMPLE DEPTH

TESTED BY Maureen Kestler

SAMPLE NO.

| DETERMINATION NO. | 4.15-.1=4.05 | 2.55-0.1=2.45 | 1.39-0.1=1.29 | 4 |
|---|---|---|---|---|
| Reading TSF | 4.1, 4.2, 4.2, 4.1 | 2.6, 2.55, 2.55 | 1.38, 1.40 | |
| CONTAINER NO. | 55 | 71 / 36 | MP4 | |
| WT. CONTAINER + WET SOIL IN g | 19.677 | 20.824 | 24.377 | |
| WT. CONTAINER + DRY SOIL IN g | 16.371 | 16.880 | 18.410 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.039 | 12.175 | 12.113 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 76.3 | 83.8 | 94.8 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE *Modeling Clay*

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE *May 24, 1982*

TESTED BY *Maureen Kestler*

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | NOT AS DRY | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | B2 | 55 | A4 | 46 eliminate | | |
| WT. CONTAINER + WET SOIL IN g | 14.776 | 14.398 | 14.397 | 15.171 | | |
| WT. CONTAINER + DRY SOIL IN g | 14.334 | 13.998 | 13.997 | 14.633 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.141 | 12.039 | 12.013 | 12.114 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 20.15 | 20.42 | 20.16 | 21.36 | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (50.3) | 2 (43) | 3 (34) | 4 (25) | 5 (19) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 52, 48, 51, 50 | 42, 43 | 33, 34, 34 | 25, 25 | 19, 19, 22, 19 |
| CONTAINER NO. | A1 | R13 | 71/36 | Z3 | 46 |
| WT. CONTAINER + WET SOIL IN g | 22.074 | 22.774 | 25.803 | 26.314 | 24.611 |
| WT. CONTAINER + DRY SOIL IN g | 19.496 | 19.948 | 22.546 | 22.845 | 21.453 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.836 | 10.654 | 12.173 | 12.125 | 12.114 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 29.8 | 30.4 | 31.4 | 32.4 | 33.8 |

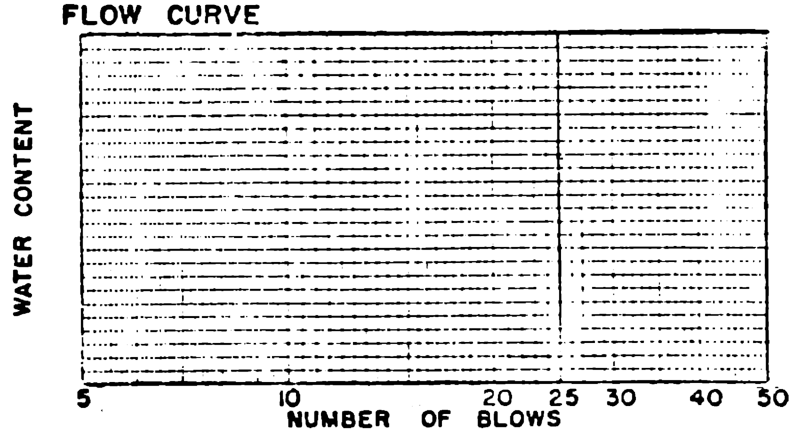
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUDED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 20.2 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Modeling Clay (con't)

TEST NO. ______

LOCATION ______

DATE May 24, 1982

BORING NO. ______ SAMPLE DEPTH ______

TESTED BY Maureen Kestler

SAMPLE NO. ______

SPECIFIC GRAVITY, $G_s$, ______

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (15) | 2 (9) | 3 (8) | 4 (7⁻) | (5) | 5 (4.5) |
|---|---|---|---|---|---|---|
| NO. OF BLOWS | 15, 15, 15⁻ | 9, 9 | 8, 8 | 7⁻, 7⁻ | 5, 5 | 4⁺, 5⁻ |
| CONTAINER NO. | S6 | 36 | 02 | T88 | S6 | 4.5, 4.5 S63/W2 |
| WT. CONTAINER + WET SOIL IN g | 25.990 | 23.825 | 22.706 | 31.157 | 24.561 | 25.035 |
| WT. CONTAINER + DRY SOIL IN g | 22.6 | 20.623 | 19.771 | 27.542 | 21.[illegible] | 21.480 |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 13.193 | 12.159 | 12.125 | 18.291 | 13.163 | 12.81 |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 35.4 | 37.8 | 38.4 | 39.1 | 40.3 | 41.0 |

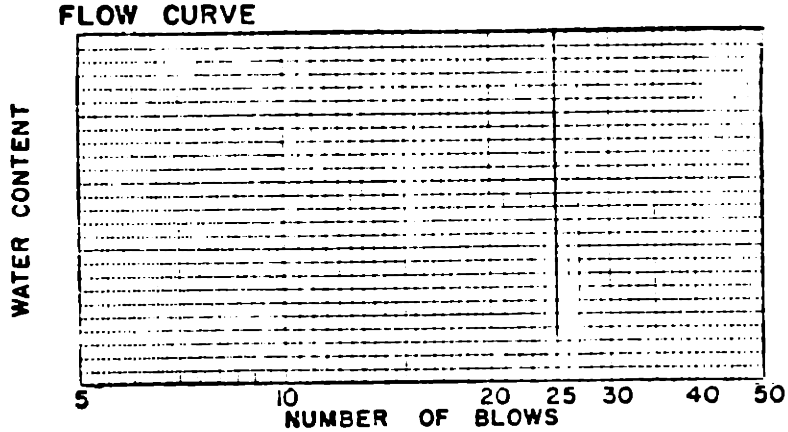
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS TEST FOR VARIATION OF [illegible] FOR A NO. OF RUNS

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 21, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | av. 24.[illegible] | 24.3 | 2[illegible].2 |
|---|---|---|---|
| NO. OF BLOWS | 25, 23, 25, 26, 25, 23, 26, 27, 25, 23 | 25, 25, 23, 23, 24, 27, 27, 24, 21, 24 | 24, 25, 23, 28, 26 |
| CONTAINER NO. | Z1 | Z2 | D20 |
| WT. CONTAINER + WET SOIL IN g | 25.752 | 20.037 | 24.610 |
| WT. CONTAINER + DRY SOIL IN g | 22.296 | 17.800 | 21.267 |
| WT. WATER, $W_w$, IN g | | | |
| WT. CONTAINER IN g | 11.826 | 10.979 | 11.026 |
| WT. DRY SOIL, $W_s$, IN g | | | |
| WATER CONTENT w, IN % | 33.01 | 32.80 | 32.64 |

WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

overall avg 32.8 = $w_L$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE

WATER CONTENT

5 10 20 25 30 40 50

NUMBER OF BLOWS

### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS FAST RATE

2½ - 3 Blows/Sec

SOIL SAMPLE Modeling Clay □

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 22, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (51.7) | 2 (40.5) | 3 (25) | 4 (19) | 5 (10.2) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 53,51,57 | 40,41,42 | 25,25 | 18,20,18,20 | 10,10.5,10 |
| CONTAINER NO. | L29 | 212 | 2 | A4 A1 | 215 |
| WT. CONTAINER + WET SOIL IN g | 20.223 | 27.637 | 24.5[illegible] | 24.562 | 25.253 |
| WT. CONTAINER + DRY SOIL IN g | 17.896 | 24.020 | 21.515 | 21.418 | 21.623 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.018 | 12.183 | 12.030 | 12.012 | 11.944 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 29.5 | 30.6 | 32.0 | 33.4 | 37.5 |

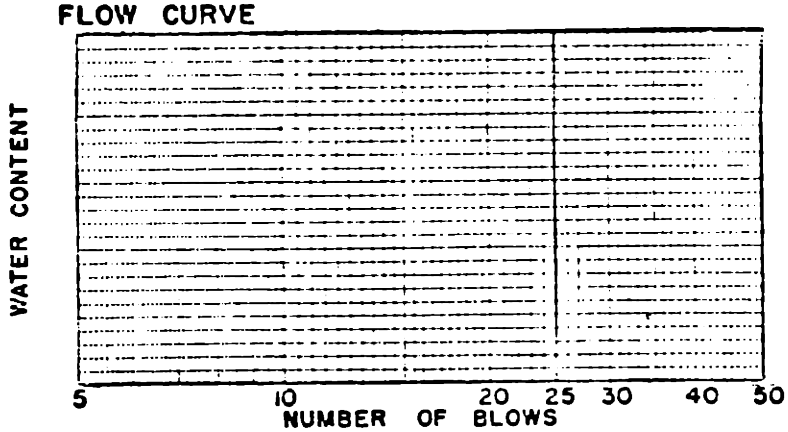
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS SLOW RATE OF IMPACT
1 Blow / sec

SOIL SAMPLE Modeling Clay ◊

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 22 & 24, 1982

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (40.7) | 2 (32) | 3 (23) | 4 (14) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 36,39,42,45,41 | 32, 32 | 23, 23 | 13, 15, 14 | |
| CONTAINER NO. | Z5 | L198 | 593 | 28 | |
| WT. CONTAINER + WET SOIL IN g | 20.666 | 22.392 | 27.648 | 21.992 | |
| WT. CONTAINER + DRY SOIL IN g | 18.000 | 19.252 | 24.185 | 19.363 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 9.547 | 9.410 | 13.776 | 12.293 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 31.3 | 31.9 | 33.3 | 37.2 | |

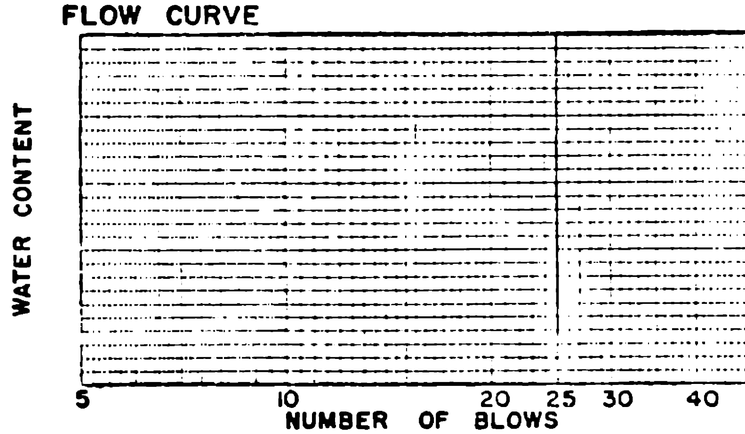
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

CASAGRANDE GROOVING TOOL

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE June 23 & 26, 1952

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (36) | 2 (35) | 3 (23.5) | 4 (19) | 5 (19) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 35, 37 | 29, 32, 35, 37 | 22, 25, 24 | 20, 19 | 20, 18, 19 |
| CONTAINER NO. | D3 | D20 | R13 | A77 | 2 |
| WT. CONTAINER + WET SOIL IN g | 18.27 | 16.036 | 16.138 | 12.978 | 21.416 |
| WT. CONTAINER + DRY SOIL IN g | 16.211 | 14.758 | 14.719 | 11.205 | 18.872 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.015 | 11.018 | 10.656 | 6.387 | 12.029 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 33.2 | 34.2 | 34.9 | 36.8 | 37.2 |

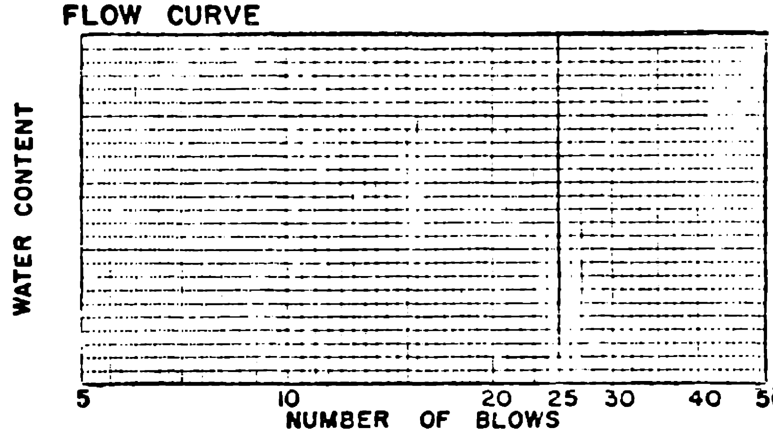
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

ASTM STD CASG TOOL.
SOIL QUANTITY: TOO MUCH

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO. 65 ± 5 grams

DATE June 23 & 26, 1982

TESTED BY Maureen Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 |
|---|---|---|---|---|---|
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

## LIQUID LIMIT

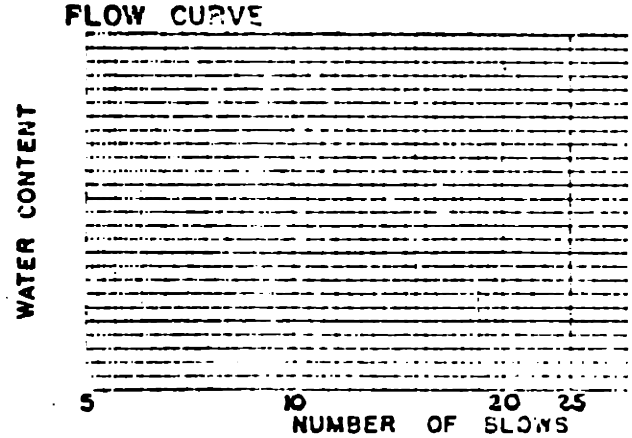
| DETERMINATION NO. | 1 (37) | 2 (32.5) | 3 (29.5) | 4 (20) |
|---|---|---|---|---|
| NO. OF BLOWS | 37, 37 | 33, 32 | 30, 29 | 21, 19, [illegible], 20 |
| CONTAINER NO. | 31 | 46 | B 52 | B2 |
| WT. CONTAINER + WET SOIL IN g | 29.3 | 27.615 | 38.066 | 30.415 |
| WT. CONTAINER + DRY SOIL IN g | 25.158 | 23.898 | 34.904 | 25.823 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.827 | 12.117 | 24.875 | 12.137 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 31.1 | 31.6 | 31.5 | 33.6 |

WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

## FLOW CURVE



MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS (cont) ASTM STD GRVG TOOL. SOIL QUANTITY: TOO MUCH 65±5 grams

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. ______ SAMPLE DEPTH ______

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE June 23 & 26, 1982

TESTED BY Maureen Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 |
|---|---|---|---|---|---|
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

## LIQUID LIMIT

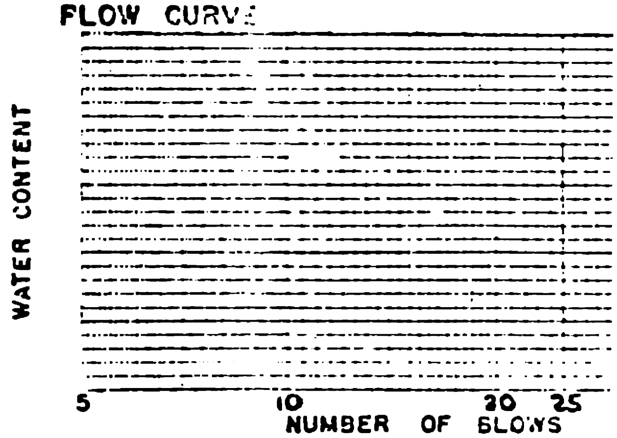
| DETERMINATION NO. | 1 (12) | 2 (11) | 3 (8.7) | 4 (4.9) |
|---|---|---|---|---|
| NO. OF BLOWS | 11,12,13 | 11,11 | 8,9,9 | 5,5 |
| CONTAINER NO. | T26 | 71 | A2 | 56/4 |
| WT. CONTAINER + WET SOIL IN g | 33.109 | 24.275 | 24.473 | 24.112 |
| WT. CONTAINER + DRY SOIL IN g | 29.166 | 21.107 | 20.979 | 20.939 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.329 | 12.178 | 11.701 | 13.192 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 36.4 | 35.5 | 37.7 | 41.0 |

WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

## FLOW CURVE



# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

STD GROOVING TOOL
SOIL QUANTITY:
TOO LITTLE
25 ± 5 grams

SOIL SAMPLE *Modeling Clay*

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE *May 31, 1982*

TESTED BY *Maureen Kestler*

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (11.3) | 2 (40.5) | 3 ([illegible]) | 4 (21) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 13, 11, 11 | 39, 43, 42, 37 | 19, 20 | 21, 21 | |
| CONTAINER NO. | T93 | C5 | T32 | R15 | |
| WT. CONTAINER + WET SOIL IN g | 25.179 | 31.913 | 26.853 | 17.128 | |
| WT. CONTAINER + DRY SOIL IN g | 23.144 | 30.169 | 24.590 | 15.391 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 18.160 | 24.907 | 18.317 | 10. 6 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 40.8 | 33.1 | 36.1 | 35.6 | |

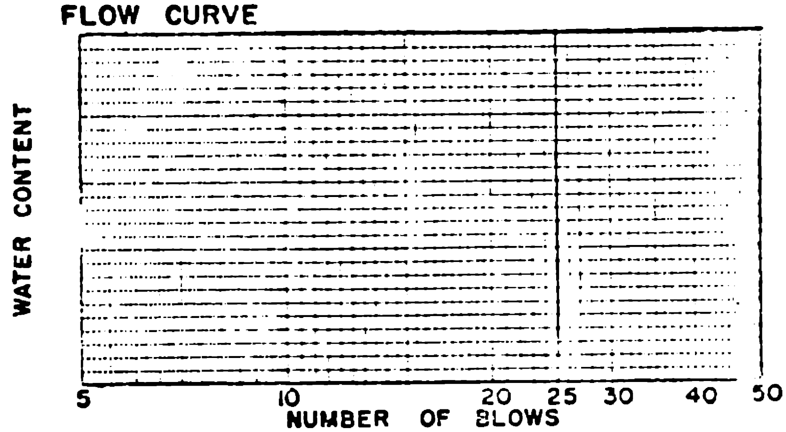
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 22 & 24, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | (56.5) | (87.5) | (94) | (100) |
|---|---|---|---|---|
| Penetration 1/10 mm | 57.5, 55.5 | 87, 88 | 93, 94, 95 | 100, 100 |
| CONTAINER NO. | A6 | A26 | 03 | A58 |
| WT. CONTAINER + WET SOIL IN g | 16.465 | 18.677 | 19.261 | 15.258 |
| WT. CONTAINER + DRY SOIL IN g | 15.419 | 17.084 | 17.613 | 13.315 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.450 | 11.636 | 12.138 | 6.961 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 26.4 | 29.2 | 30.1 | 30.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

Cone (con't)

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 22 & 24, 1932

TESTED BY Maureen Kestler

| DETERMINATION NO. | (112) | (133) | 155.5 153.5 (156.2) | (205) |
|---|---|---|---|---|
| Penetration $\frac{1}{10}$ mm | 112, 112 | 137, [illegible], 132 | 155.5, 159, [illegible], 155.5 | 206, 204 |
| CONTAINER NO. | 55 | S40 | S64 | 67 |
| WT. CONTAINER + WET SOIL IN g | 19.435 | 21.828 | 24.883 | 20.015 |
| WT. CONTAINER + DRY SOIL IN g | 17.670 | 19.665 | 21.835 | 17.199 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.039 | 13.176 | 13.122 | 9.701 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 31.3 | 33.3 | 35.0 | 37.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

CONE (con't)

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 22 & 24, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 203.7 | 225 | 244 | 255 | 274 |
|---|---|---|---|---|---|
| Penetration 1/10 mm | 204, 203, 204 | 224, 225.5 | 244, 244 | 255.4, 256.5 | 278 265 275 275 |
| CONTAINER NO. | T57 | S79 | S73 | T10 | S12 |
| WT. CONTAINER + WET SOIL IN g | 27.750 | 20.608 | 20.762 | 24.898 | 21.417 |
| WT. CONTAINER + DRY SOIL IN g | 25.140 | 18.528 | 18.565 | 22.963 | 19.020 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 18.290 | 13.202 | 13.059 | 18.229 | 13.337 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 38.1 | 39.1 | 39.9 | 40.9 | 42.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

Test for variation in Cone penetration during a number of runs.

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 21, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | (126) | (125) | | (120) |
|---|---|---|---|---|
| | 127.5, 127.5, 125.5, 125.5, 128, [illegible], 127, 122, 121, 125 | 126, 123, 123, 117, 121, 128, 132, 129, 128, 122.5 | | 122, 122.5, 118, 118, 118 |
| CONTAINER NO. | MP4 | X6 | V1 | 05 |
| WT. CONTAINER + WET SOIL IN g | 19.967 | 17.946 | 21.951 | 18.760 |
| WT. CONTAINER + DRY SOIL IN g | 18.023 | 16.487 | 19.584 | 17.135 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.117 | 12.181 | 12.482 | 12.221 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | Moisture contents off → | tests performed in humid room [illegible] | | [illegible] ...ers [illegible] correct |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE 150 grams (double wt)

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 24 & 31, 1982

TESTED BY Maureen Kestler

These 2 are from the same sample, 2nd is just a check of the 1st

| DETERMINATION NO. | [illegible] (156) | 2 (186) | 3 (186) | 4 (227) |
|---|---|---|---|---|
| Penetration 1/10 mm | 155, 153, 160 | 185, 187 | 185, 187 | 224, 227.5, 227.5 |
| CONTAINER NO. | B11 | N12 | B2 | S75 (2) |
| WT. CONTAINER + WET SOIL IN g | 20.930 | 21.695 | 19.736 | 24.610 |
| WT. CONTAINER + DRY SOIL IN g | 18.852 | 9.397 | 17.360 | 21.600 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.230 | 12.430 | 12.140 | 12.950 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 31.4 | 33.0 | 32.8 | 34.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE 150 grams (double wt)

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 24 & 31, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 91, (97.6) | 2 (138.8) | 3 (284) | 4 |
|---|---|---|---|---|
| Penetration $\frac{1}{10}$ mm | 101, 98, 95, 100 | 138, 141, 137.5 | 285, 283, 284 | |
| CONTAINER NO. | 55 | 24 | D3 | |
| WT. CONTAINER + WET SOIL IN g | 15.165 | 14.306 | 20.457 | |
| WT. CONTAINER + DRY SOIL IN g | 14.507 | 13.560 | 17.600 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.039 | 11.067 | 10.025 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 26.7 | 29.9 | 37.7 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY



CONE 225 gram cone

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE June 3, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (127) | 2 (180) | 3 (215) | 4 |
|---|---|---|---|---|
| Cone Reading $\frac{1}{10}$ mm | 125.5, 130, 127, 126.5 | 176, 180, 183, 181 | 222, 211, 214, 214 | |
| CONTAINER NO. | 23 | 03 | 24 | |
| WT. CONTAINER + WET SOIL IN g | 17.314 | 20.548 | 19.433 | |
| WT. CONTAINER + DRY SOIL IN g | 16.215 | 18.592 | 17.408 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.125 | 12.138 | 11.065 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 26.9 | 30.3 | 31.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 21, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | (1.75) | 2 (.88) | 3 (.45) | 4 (.29) |
|---|---|---|---|---|
| Reading TSF | 1.75 1.75 | .95, .87, .9 | .5, .45, .45 | .3 .3 |
| CONTAINER NO. | T76 | T93 | T60 | T47 |
| WT. CONTAINER + WET SOIL IN g | 33.132 | 29.909 | 32.085 | 30.397 |
| WT. CONTAINER + DRY SOIL IN g | 29.658 | 26.985 | 28.362 | 26.956 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.264 | 18.160 | 18.194 | 18.080 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 30.5 | 33.1 | 36.6 | 38.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | S VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

TORVANE — -.1 initial reading

SOIL SAMPLE Modeling Clay

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 21, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 4.0, 4.0 (3.95) | 2.15 - 0.1 = (2.05) | 1.25 - 0.1 = (1.15) | .98 - 0.1 = (.88) |
|---|---|---|---|---|
| Reading TSF | 4.05, 3.9, 3.75 | 2.15, 2.15 | 1.24, 1.26 | 1.1, .95 |
| CONTAINER NO. | T83 | T1 | T68 | T6 |
| WT. CONTAINER + WET SOIL IN g | 36.493 | 32.183 | 32.183 | 32.697 |
| WT. CONTAINER + DRY SOIL IN g | 32.259 | 28.687 | 28.450 | 28.686 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 18.132 | 18.329 | 18.221 | 18.278 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 30.0 | 33.1 | 36.5 | 38.5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Venezuelan CIS10

TEST NO. ______

LOCATION ______

DATE May 13 & 22, 1952

BORING NO. ______ SAMPLE DEPTH ______

TESTED BY Maureen Kestler

SAMPLE NO. ______

SPECIFIC GRAVITY, $G_s$, ______

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 05 | A4 | N12 | L198 | | |
| WT. CONTAINER + WET SOIL IN g | 14.523 | 14.077 | 14.079 | 11.078 | | |
| WT. CONTAINER + DRY SOIL IN g | 14.158 | 13.744 | 13.815 | 10.818 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.218 | 12.014 | 12.429 | 9.419 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 18.81 | 19.25 | 19.04 | 18.58 | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (47.7) | 2 (20.5) | 3 (15) | 10, 11, 4 (12) | 5 (10.0) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 47,49,47 | 20,21,20,21 | 15, 15 | 14,12,12,12,12 | 11,10,9,11,10 |
| CONTAINER NO. | D10/Z1 | R13 | D20 | T67 | A58 |
| WT. CONTAINER + WET SOIL IN g | 23.292 | 24.299 | 25.975 | 32.403 | 20.782 |
| WT. CONTAINER + DRY SOIL IN g | 19.756 | 19.774 | 20.912 | 27.446 | 15.805 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 11.825 | 10.656 | 11.034 | 18.307 | 6.965 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 44.6 | 49.6 | 51.3 | 54.2 | 56.2 |

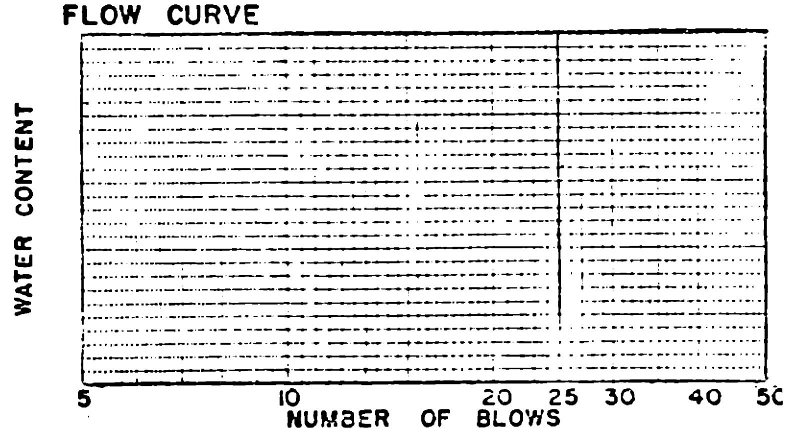
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 18.9 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Venez. C1510

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 18, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (78.3) | 2 (119) | 172.5, 3 (172.5) | 4 |
|---|---|---|---|---|
| Penetration 1/10 mm | 77.5, 79, 78.5 | 118.5, 119.5 | 174.5, 171, 172 | |
| CONTAINER NO. | B-11 | X-6 | 03 | |
| WT. CONTAINER + WET SOIL IN g | 17.289 | 18.912 | 20.365 | |
| WT. CONTAINER + DRY SOIL IN g | 15.860 | 16.825 | 17.554 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.230 | 12.117 | 12.138 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 39.4 | 45.3 | 51.9 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE Venez CS10

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 18 & 20, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.18) | 2 (1.0) | 3 (.48) | 4 |
|---|---|---|---|---|
| Reading TSF | 2.2, 2.13, 2.2 | 1.05, .95, .95 | .48, .48 | |
| CONTAINER NO. | A1 | L29 | D7 | |
| WT. CONTAINER + WET SOIL IN g | 19.459 | 18.294 | 20.568 | |
| WT. CONTAINER + DRY SOIL IN g | 17.009 | 15.715 | 17.236 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.815 | 10.018 | 10.784 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 39.6 | 45.3 | 51.6 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE — .1 initial reading

SOIL SAMPLE Venez C1S1D

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 18, May 20, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 4.7-.1 (4.6) | 2.55-0.1 (2.45) | 1.35-.1 (1.25) | 4 |
|---|---|---|---|---|
| Reading tsf | 4.65, 4.7, 4.75 | 2.55, 2.55 | 1.35, 1.35 | |
| CONTAINER NO. | A26 | 24 | 2 | |
| WT. CONTAINER + WET SOIL IN g | 20.691 | 25.080 | 26.174 | |
| WT. CONTAINER + DRY SOIL IN g | 18.123 | 20.714 | 21.323 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.635 | 11.084 | 12.031 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 39.6 | 45.3 | 52.2 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Venez C2S13
(same as [illegible])
LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE 1952
TESTED BY Maureen [illegible]

### STIC LIMIT

| TERMINATION NO. | 1 | 2 | 3 |
|---|---|---|---|
| ONTAINER NO. | 46 | 55 | V1 |
| T. CONTAINER + WET SOIL IN g | 13.680 | 14.824 | 15.701 |
| T. CONTAINER + DRY SOIL IN g | 13.372 | 14.285 | 15.064 |
| T. WATER, $W_w$, N g | | | |
| T. CONTAINER IN g | 12.114 | 12.040 | 12.484 |
| T. DRY SOIL, $W_s$, IN g | | | |
| ATER CONTENT w, N % | 24.48 | 24.0 | 24.7 |

### NATURAL WATER CONTENT

| | 1 | 2 | 3 |
|---|---|---|---|
| | 212 | 36/71 | |
| | 15.171 | 16.562 | |
| | 14.602 | 15.693 | |
| | | | |
| | 12.185 | 12.177 | |
| | | | |
| | 23.5 | 24.7 | |

### UID LIMIT

| TERMINATION NO. | 39,42, 1 (39.5) | 2 (33) | 3 (23.7) | 4 (16) | 5 (15) |
|---|---|---|---|---|---|
| O. OF BLOWS | 36, 41, 39 | 32, 32, 35 | 23, 24, 25 | 16, 16, 16 | 15, 15 |
| ONTAINER NO. | MP4 | T6 | A1 | MP4 | V2 |
| T. CONTAINER + WET SOIL IN g | 21.653 | 30.[illegible] | 26.[illegible] | 25.457 | 30.569 |
| T. CONTAINER + DRY SOIL IN g | 18.763 | 26.899 | 21.938 | 21.223 | 26.553 |
| T. WATER, $W_w$, IN g | | | | | |
| T. CONTAINER IN g | 12.129 | 18.278 | 10.817 | 12.128 | 18.221 |
| T. DRY SOIL, $W_s$, N g | | | | | |
| ATER CONTENT w, N % | 43.6 | 46.0 | 44.7 | 46.6 | 48.2 |

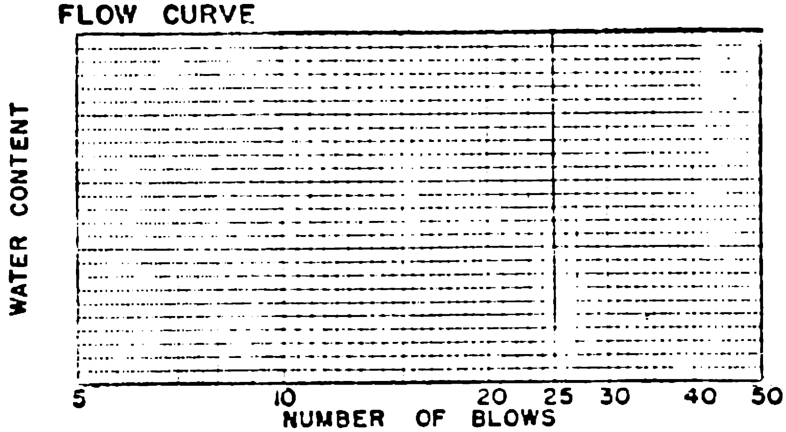
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### INKAGE LIMIT

| TERMINATION NO. | 1 | 2 |
|---|---|---|
| DISTURBED OR MOLDED SOIL PAT | | |
| T. DRY SOIL PAT, $W_s$, IN g | | |
| T. CONTAINER + HG. IN g | | |
| T. CONTAINER N g | | |
| T. HG. IN g | | |
| OL. SOIL PAT, V, IN cc | | |
| RINKAGE LIMIT, $w_s$, N % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### ULT SUMMARY

| LASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 24.3 | | | | | | | | |

ARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS ([illegible])

SOIL SAMPLE Venez C2S43

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE [illegible] 1982

TESTED BY [illegible]

### ASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### QUID LIMIT

| DETERMINATION NO. | 1 (12) | 2 (10.5) | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 12, 12 | 9, 11, 11, 11 | | | |
| CONTAINER NO. | N1 | 24 | | | |
| WT. CONTAINER + WET SOIL IN g | 23.499 | 23.604 | | | |
| WT. CONTAINER + DRY SOIL IN g | 19.723 | 22.743 | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.175 | 11.085 | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 49.9 | 51.1 | | | |

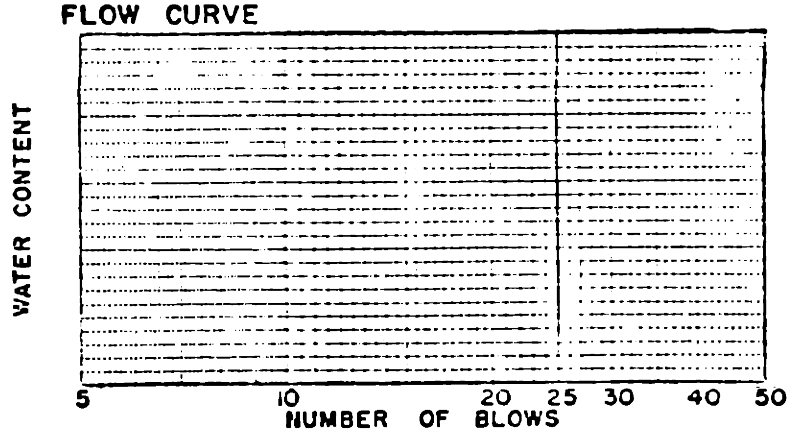
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### RINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### SULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

MARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Venez C2S43

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 14, & 18, 1962

TESTED BY Maureen Kester

| DETERMINATION NO. | 1 (87.5) | 115, 112, 2 (116) | 3 (149.3) | (161) | [illegible] |
|---|---|---|---|---|---|
| Penetration 1/10 mm | 86, 89, 87.5 | 121, 118, 116.5, 113.5 | 148.5, 150, [illegible] | 160, 161 | [illegible] |
| CONTAINER NO. | B11 | V1 | S40 | 46 | [illegible] |
| WT. CONTAINER + WET SOIL IN g | 14.783 | 17.636 | 20.715 | 19.889 | 20.[illegible]6 |
| WT. CONTAINER + DRY SOIL IN g | 14.071 | 16.140 | 18.377 | 17.415 | 17.719 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.234 | 12.485 | 13.175 | 12.113 | 12.139 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 38.8 | 40.9 | 44.9 | 46.5 | 43.0 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Venez C2S43

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 14, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.2) | 2 (1.1) | 3 (.67) | 4 |
|---|---|---|---|---|
| Rdg TSF | 2.2 | 1.1 | .67, .67 | |
| CONTAINER NO. | 2 | 36 | Z-5 | |
| WT. CONTAINER + WET SOIL IN g | 17.743 | 17.680 | 16.007 | |
| WT. CONTAINER + DRY SOIL IN g | 16.142 | 16.059 | 14.042 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.032 | 12.178 | 9.500 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 39.0 | 41.8 | 43.3 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

-.1 initial reading

SOIL SAMPLE Venez C2S43

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE

TESTED BY

| DETERMINATION NO. | 4.25-.1=4.15 | 2.47-.1=2.37 | 1.57-.1=1.47 | 4 |
|---|---|---|---|---|
| reading TSF | [illegible], 4.35, 4.23 | 2.4, 2.5, 2.5 | 1.6, 1.55, 1.57 | |
| CONTAINER NO. | 212 | R13 | S64 | |
| WT. CONTAINER + WET SOIL IN g | 16.032 | 19.309 | 22.519 | |
| WT. CONTAINER + DRY SOIL IN g | 14.961 | 16.763 | 19.614 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.184 | 10.658 | 13.125 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 38.6 | 41.7 | 44.8 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Venez C3S17

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 13, 1982.

TESTED BY Maureen Kestler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 05 | X6 | 55 | A4 | N12 | |
| WT. CONTAINER + WET SOIL IN g | 14.959 | 13.840 | 13.803 | 13.365 | 14.334 | |
| WT. CONTAINER + DRY SOIL IN g | 14.469 | 13.547 | 13.485 | 13.114 | 13.999 | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.221 | 12.178 | 12.042 | 12.017 | 12.431 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 21.8 | 21.4 | 22.0 | 22.9 | 21.4 | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (39.5) | 30 2 (29) | 3 (20) | 4 (17.21) | 5 (10.5) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 41,38,[illegible] | 28,29,29,29, | 20,20,20 | 17,16,18,18 | 11,10,10,11 |
| CONTAINER NO. | L29 | A58 | S73 | [illegible]42 | T76 |
| WT. CONTAINER + WET SOIL IN g | 19.319 | 15.9[illegible] | 23.1[illegible] | 25.482 | 30.091 |
| WT. CONTAINER + DRY SOIL IN g | 16.725 | 13.410 | 20.187 | 21.823 | 26.371 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 10.019 | 5.963 | 13.051 | 13.401 | 18.264 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 38.7 | 40.0 | 42.0 | 43.4 | 45.9 |

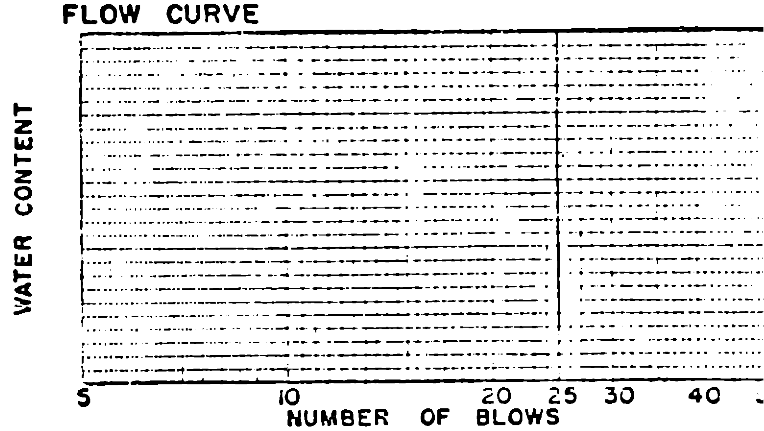
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 21.7 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Venez C 3517

TEST NO.

LOCATION

DATE May 13, 1982

BORING NO. SAMPLE DEPTH

TESTED BY Maureen Kestler

SAMPLE NO.

| DETERMINATION NO. | 77, 91, (73.2) | 91, 98, 2, (94.3) | 115, 3 (112.4) | 142, (141.8) | (196.5) |
|---|---|---|---|---|---|
| Penetration 1/10 mm | ~~74~~, 76, 80, 90, 77 | 98, 95, 93, 93, 98, 98 | 110, 112.5, 112 | 142, 142, 141 | 196.5, 196, 197 |
| CONTAINER NO. | Z1 | A1 | L19 | S79 | T10 |
| WT. CONTAINER + WET SOIL IN g | 15.329 | 16.090 | 15.750 | 20.647 | 27.667 |
| WT. CONTAINER + DRY SOIL IN g | 14.422 | 14.672 | 13.998 | 18.472 | 2[illegible].666 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 11.825 | 10.817 | 9.432 | 13.202 | 1[illegible].226 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 34.9 | 36.8 | 38.4 | 41.3 | [illegible].6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Venez C3S17

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 13, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (2.9) | 2 (1.76) | 3 (1.0) | 4 (.7) |
|---|---|---|---|---|
| Rdg. TSF | 3.0, 2.9, 2.9, 2.9 | 1.85, 1.75, 1.73 | 1.0, 1.0 | .7, .7 |
| CONTAINER NO. | D20 | A26 | 24 | S6 |
| WT. CONTAINER + WET SOIL IN g | 15.304 | 18.949 | 20.184 | 23.946 |
| WT. CONTAINER + DRY SOIL IN g | 14.207 | 16.983 | 17.586 | 20.777 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.785 | 11.638 | 11.089 | 13.164 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 32.1 | 36.8 | 40.0 | 41.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

TORVANE -.1 initial reading

SOIL SAMPLE Venez. C3517

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 13, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 5.0-.1 = (4.9) | 3.75-.1 = (3.65) | 2.22-.1 = (2.12) | 1.8-.1 = (1.7) |
|---|---|---|---|---|
| Rdg TSF | 5.0, 4.8, 4.95, 5.05 | 3.75, 3.75 | 2.15, 2.2, 2.25 | 1.7, 1.8, 1.95, 1.8 |
| CONTAINER NO. | D7 | A6 | S40 | W2 |
| WT. CONTAINER + WET SOIL IN g | 16.523 | 18.176 | 23.400 | 23.575 |
| WT. CONTAINER + DRY SOIL IN g | 15.048 | 16.373 | 20.518 | 20.413 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.785 | 11.455 | 13.175 | 12.809 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 34.6 | 36.7 | 39.2 | 41.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE Vicksburg Buckshot
Clay [illegible]

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE April 8, 13, 14, + 15 1982
TESTED BY Maureen Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | S40 | S63 w/k | S93 | S42 | | |
| WT. CONTAINER + WET SOIL IN g | 15.017 | 14.534 | 15.236 | 15.247 | | |
| WT. CONTAINER + DRY SOIL IN g | 14.697 | 14.234 | 14.980 | 14.915 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 13.172 | 12.814 | 13.770 | 13.340 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 20.92 | 21.13 | 21.16 | 21.08 | con't on next sheet | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

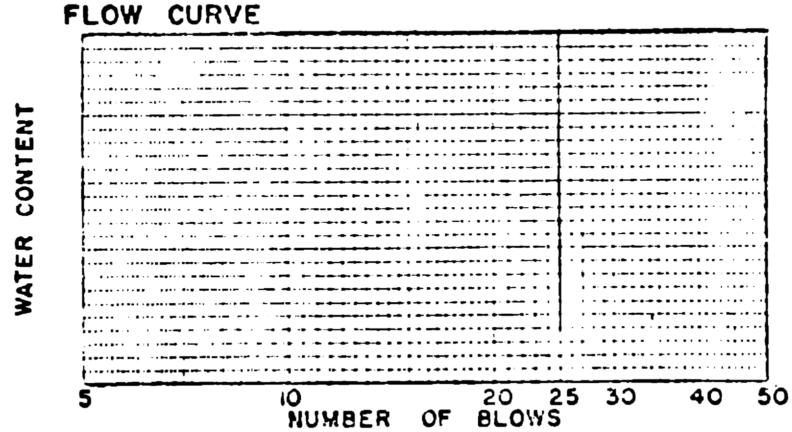
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**REMARKS**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE April 14 & May 7, 1982

TESTED BY Maureen Kelleher

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 212 | MP4 | B-11 | X-6 | | |
| WT. CONTAINER + WET SOIL IN g | 13.735 | 13.382 | 13.945 | 14.272 | | |
| WT. CONTAINER + DRY SOIL IN g | 13.460 | 13.168 | 13.655 | 13.927 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.186 | 12.120 | 12.235 | 12.181 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 21.6 | 20.4 | 20.4 | 19.8 | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 (20.3) | 2 ([illegible]) | 3 (14.3) | 4 (11.5) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 31, 30, 30 | 22, 26, 26, 25 | 15, 14, 13, 15 | 12, 11, 11, 12 | |
| CONTAINER NO. | L 29 | 55 | V1 | E 14 | |
| WT. CONTAINER + WET SOIL IN g | 20.362 | 25.240 | 22.586 | 22.301 | |
| WT. CONTAINER + DRY SOIL IN g | 16.624 | 20.374 | 18.711 | 18.310 | |
| WT. WATER, $W_w$, IN g | 3.738 | 4.866 | 3.875 | 3.991 | |
| WT. CONTAINER IN g | 10.023 | 12.047 | 12.494 | 12.094 | |
| WT. DRY SOIL, $W_s$, IN g | 6.601 | 8.327 | 6.217 | 6.216 | |
| WATER CONTENT w, IN % | 56.6 | 58.4 | 62.3 | 64.2 | |

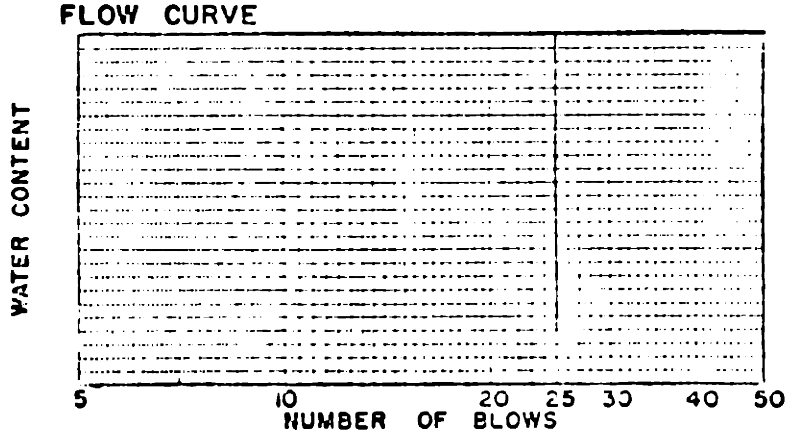
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 20.6 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE VBC

TEST NO.

LOCATION

DATE April 8,

BORING NO. / SAMPLE DEPTH

TESTED BY Maureen Kestler

SAMPLE NO. ~~(BALANCE)~~

** SCALE NOT WORKING PROPERLY ∴

| DETERMINATION NO. | 1 (146) | 2 (165) | 3 (139.5) | 4 |
|---|---|---|---|---|
| Penetration to mm | 146, 145, 147 | 163, 166, 167 | 140, 137, 139, 141 | THIS |
| CONTAINER NO. | 2 | 24-1 | N1 | SET OF |
| WT. CONTAINER + WET SOIL IN g | 19.746 | 18.085 | 19.433 | |
| WT. CONTAINER + DRY SOIL IN g | 16.735 | 14.123 | 16.852 | DATA |
| WT. WATER, $W_w$, IN g | 3.011 | 3.962 | 2.581 | |
| WT. CONTAINER IN g | 12.033 | 8.961 | 11.725 | NG |
| WT. DRY SOIL, $W_s$, IN g | 4.702 | 5.162 | 5.127 | |
| WATER CONTENT w, IN % | 64% | 76.8 | 50.3 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE (con't)

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 13, 14 & May 6 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | [illegible] | 2 (205.3) | 3 (188) | 4 (162) |
|---|---|---|---|---|
| Penetration to mm | 224, 224 | 206, 205, 205 | 189, 190, 185 | 162, 162 |
| CONTAINER NO. | Z1 | 2 | T93 | Y-5 |
| WT. CONTAINER + WET SOIL IN g | 26.764 | 24.501 | 26.088 | 27.145 |
| WT. CONTAINER + DRY SOIL IN g | 20.851 | 19.761 | 23.110 | 23.900 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.828 | 12.036 | 18.183 | 18.331 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 65.5 | 61.4 | 60.4 | 58.3 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE (con't)

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 13, 14 & May 6, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (136.3) | 126, 127.5 2 (127.3) | 3 (112.7) | 99, 95, 94 (95.5) |
|---|---|---|---|---|
| Penetration | 137, 136, 136 | 127, 128.5, 129.5 | 112, 114, 112 | 90.5, 99, 95.5, 93.5, |
| CONTAINER NO. | Z3 | L29 | 2 | Z3 |
| WT. CONTAINER + WET SOIL IN g | 18.001 | 20.262 | 21.694 | 21.793 |
| WT. CONTAINER + DRY SOIL IN g | 15.915 | 16.624 | 18.373 | 18.534 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.132 | 10.020 | 12.034 | 12.129 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 55.1 | 55.1 | 52.4 | 50.9 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

-.25

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE

TESTED BY Maureen Kestler

| DETERMINATION NO. | -.25= (.5) | .7 - .25 (.75) | .65 - .35 = .40 | .55 -.25 (.3) |
|---|---|---|---|---|
| Rdg. TSF | .75 | .7, .7, .7 | .65, .67, .7, .6 | .55 |
| CONTAINER NO. | 21 / D10 | 15 | L19 / L198 | 593 |
| WT. CONTAINER + WET SOIL IN g | 26.540 | 23.375 | 23.373 | 24.952 |
| WT. CONTAINER + DRY SOIL IN g | 21.333 | 18.917 | 18.321 | 20.800 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.330 | 10.886 | 9.398 | 13.774 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 54.8 | 55.5 | 56.6 | 59.1 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

## SOIL MECHANICS LABORATORY

TORVANE — -.25 initial reading

* The Balance Was Not working Properly

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 8, 1982

TESTED BY Maureen Kestler

∴ This data NG

| DETERMINATION NO. | 1.73-.25 = (1.48) | 1.9 - .25 = (1.65) | 1.83-.25 = (1.58) | 1.8-.25 = (1.55) |
|---|---|---|---|---|
| Rdg TSF | 1.7, 1.7, 1.8 | 1.9, 1.9 | 1.8, 1.9, 1.8, 1.8 | 1.7, 1.9 |
| CONTAINER NO. | 55 | 03 | 477 | 56 |
| WT. CONTAINER + WET SOIL IN g | 30.031 | 27.143 | 18.600 | 26.722 |
| WT. CONTAINER + DRY SOIL IN g | 23.514 | 21.801 | 14.295 | 22.004 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.043 | 12.147 | 6.384 | 13.166 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | [illegible] | 55.3 | 54.4 | 53.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY



## SOIL MECHANICS LABORATORY

TORVANE
-.25 initial reading

* The balance was not working properly
∴ this data NG
See next sheet for good data

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 8, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1.58-.25=1.33 | 1.52-.25=1.27 | 1.44-.25=1.19 | 4 |
|---|---|---|---|---|
| Rdg TSF | 1.55, 1.6 | 1.5, 1.55 | 1.4, 1.53, 1.4, ~~1.35, 1.2, 1.35~~ | |
| CONTAINER NO. | A58 | S63/W2 | 03 | |
| WT. CONTAINER + WET SOIL IN g | 19.410 | 22.138 | 27.659 | |
| WT. CONTAINER + DRY SOIL IN g | 15.083 | 18.763 | 21.774 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 6.613 | 12.818 | 12.143 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 51.1% | 56.8 | 61.1 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

This data good

-.1 initial reading

SOIL SAMPLE VBC

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE April 14 & May 6, 1982

TESTED BY Maureen Kessler

| DETERMINATION NO. | 2.93 - .1 = (2.83) | 2.55 - 0.1 = (2.45) | 1.93 - 0.1 = (1.83) | .77 - 0.1 = (.67) |
|---|---|---|---|---|
| Rdg TSF | 3.0, 2.8, 3.0 | 2.55, 2.55 | 1.95, 1.85, 2.0 | [illegible] |
| CONTAINER NO. | 55 | 03 | E14 | [illegible] |
| WT. CONTAINER + WET SOIL IN g | 26.06 | 26.800 | 27.302 | [illegible].040 |
| WT. CONTAINER + DRY SOIL IN g | 21.296 | 21.739 | 21.925 | 25.582 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.043 | 12.145 | 12.090 | 12.490 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 51.4 | 52.8 | 54.8 | 64.6 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE 30/70 Mix

TEST NO.

LOCATION

DATE May 11 & 12, 1982

BORING NO. SAMPLE DEPTH

TESTED BY Maureen Kestler

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 75 | 212 | 2 | A77 | | |
| WT. CONTAINER + WET SOIL IN g | 13.052 | 14.946 | 14.727 | 9.462 | | |
| WT. CONTAINER + DRY SOIL IN g | 12.541 | 14.533 | 14.328 | 9.000 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 9.551 | 12.184 | 12.033 | 6.385 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 17.1 | 17.6 | 17.4 | 17.66 | | |

## LIQUID LIMIT

| DETERMINATION NO. | ([illegible]) | (25) | (16) | (13) | (10.3) | (7) |
|---|---|---|---|---|---|---|
| NO. OF BLOWS | 35, 37, 33 | 25, 26, 24 | 17, 16, 15 | 13, 13 | 11, 10, 10 | 7, 7, 8, 6 |
| CONTAINER NO. | MP4 | E14 | L-29 | 5[illegible] | S73 | T-10 |
| WT. CONTAINER + WET SOIL IN g | 22.500 | 23.746 | 21.509 | 25.[illegible]88 | 27.211 | 30.308 |
| WT. CONTAINER + DRY SOIL IN g | 20.270 | 21.157 | 18.864 | 22.147 | 23.739 | 27.327 |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.117 | 12.092 | 10.018 | 12.640 | 13.072 | 18.229 |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 27.4 | 28.6 | 29.9 | 31.1 | 31.9 | 32.8 |

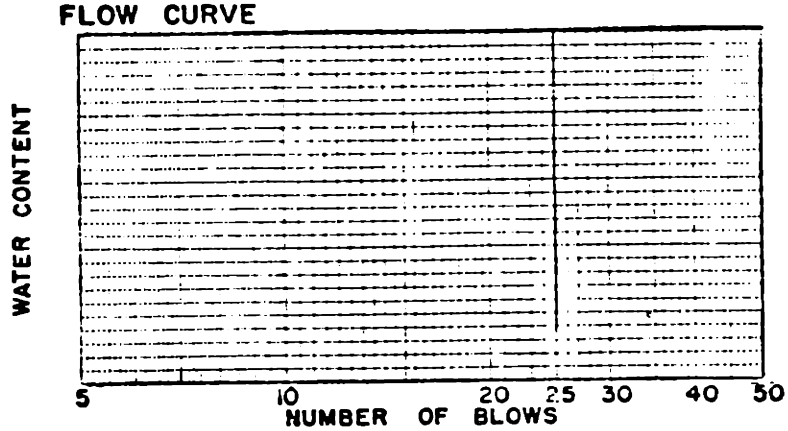
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 17.4 | | | | | | | | |

REMARKS

# SOIL MECHANICS LABORATORY

## CONE

SOIL SAMPLE 30/70

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 11, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (134) | 2 (152) | 3 (169.3) | 4 ([illegible]) |
|---|---|---|---|---|
| Penetration 1/10 mm | 133, 135 | 151, 152 | 168, 173, [illegible] | 180, 180, [illegible], 200, 186, 186, 189, 192 |
| CONTAINER NO. | D-7 | R13 | A77 | T-76 |
| WT. CONTAINER + WET SOIL IN g | 19.633 | 19.700 | 12.639 | 27.004 |
| WT. CONTAINER + DRY SOIL IN g | 17.570 | 17.570 | 11.140 | 24.888 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 10.788 | 10.663 | 6.389 | 18.275 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 30.4 | 30.8 | 31.6 | 32.0 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# CONE
## TIME FOR PENETRATION:

30/70

May 11, 1982
Maureen Kestler

| | | |
|---|---|---|
| Penetration Depth at the end of 1st second (1/10 mm) | 121.5 | 122.5 |
| Penetration Depth following an additional 9 seconds i.e., 10 second reading (1/10 mm) | 122.5 | 123.5 |
| Penetration Depth following an additional 20 seconds i.e., 30 second reading (1/10 mm) | 124 | 125 |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## PENETROMETER

SOIL SAMPLE 30/70

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 11, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 | 2 (.83) | 3 (.7) | 4 (.4) |
|---|---|---|---|---|
| Reading TSF | 1.9, 1.9 | .80, .85, .85 | .7, .7 | .4 .4 |
| CONTAINER NO. | 36 | D20 | S-64 | S-93 For Nos 9 |
| WT. CONTAINER + WET SOIL IN g | 24.633 | 21.833 | 27.451 | [illegible] |
| WT. CONTAINER + DRY SOIL IN g | 21.948 | 19.320 | 24.091 | 22.026 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.176 | 11.040 | 13.127 | 13.774 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 27.5 | 30.4 | 30.7 | 32.5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

TORVANE

SOIL SAMPLE 30/70

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

-.15 initial reading

TEST NO.

DATE May 11, 1982

TESTED BY

| DETERMINATION NO. | -.15 = 1 (3.22) | -.15 = 2 (2.55) | -.15 = 3 (1.83) | -.15 = 4 (1.5) |
|---|---|---|---|---|
| Rdg TSF | 3.37, 3.37 | 2.6, 2.6 | 2.0, 1.95, 2.0 | 1.67, 1.65 |
| CONTAINER NO. | O3 | Z-3 | T-93 | S6 |
| WT. CONTAINER + WET SOIL IN g | 21-114 | 27,437 | 33,485 | 29,146 |
| WT. CONTAINER + DRY SOIL IN g | 19,207 | 24,070 | 29,925 | 25,432 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12,146 | 12,128 | 18,178 | 13,162 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 27.0 | 28.2 | 30.3 | 30.3 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE 70/30 Mix
VBC/Bent

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.
SPECIFIC GRAVITY, $G_s$,

TEST NO.
DATE May 20 & 21, 1982
TESTED BY Maureen Kotter

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | L198 | N12 | B11 | 2 | | |
| WT. CONTAINER + WET SOIL IN g | 10.028 | 13.097 | 13.798 | 13.292 | | |
| WT. CONTAINER + DRY SOIL IN g | 9.912 | 12.979 | 13.498 | 13.046 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 9.418 | 12.432 | 12.237 | 12.032 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 23.48 | 21.57 | 23.79 | 24.26 | | |

### LIQUID LIMIT

| DETERMINATION NO. | ~~44,43,~~ 1 (46) | 42,41 2 (41) | 3 (25) | 4 (20) | 5 ( ) |
|---|---|---|---|---|---|
| NO. OF BLOWS | ~~42,36,40~~,38 | 32,34,29,33,38 | 25, 25 | 21,19,20,17,20,21 | 10,10,10 |
| CONTAINER NO. | E14 | 22 | A58 | 25 | 05 |
| WT. CONTAINER + WET SOIL IN g | 24.076 | 17.958 | 15.606 | 20.930 | 22.498 |
| WT. CONTAINER + DRY SOIL IN g | 17.007 | 13.796 | 10.322 | 14.011 | 16.138 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.088 | 10.980 | 6.963 | 9.547 | 12.220 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 144 | 148 | 157 | 155 | 162 |

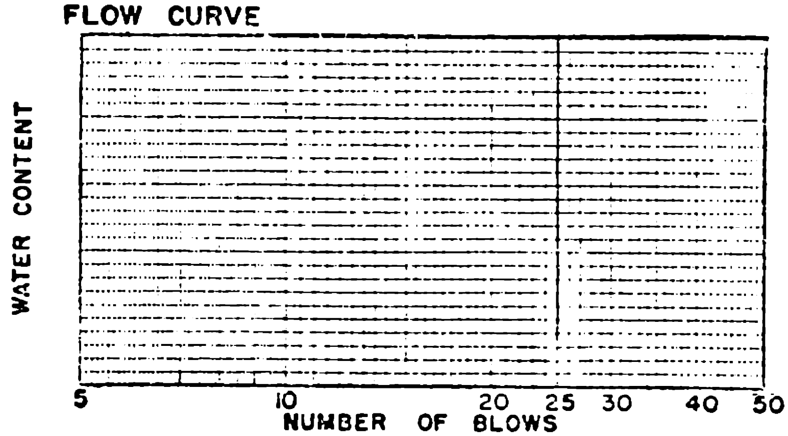
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 23.4 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE 70/30
Vicks/[illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 21, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (97) | 2 (111) | 3 (144) | (15[illegible]) | (171) |
|---|---|---|---|---|---|
| Penetration in mm | 97, 97 | 112, 111, 10[illegible], 113.5 | 144.5, 143 | 160, 157, 157 | 171, 171 |
| CONTAINER NO. | 46 | 23 | A4 | 55 | [illegible]2 |
| WT. CONTAINER + WET SOIL IN g | 19.446 | 17.970 | 18.750 | 16.329 | 21.483 |
| WT. CONTAINER + DRY SOIL IN g | 15.586 | 15.065 | 15.126 | 13.995 | 1[illegible].298 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.115 | 12.128 | 12.015 | 12.040 | 12.141 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 94.4 | 98.9 | 116 | 119 | 1[illegible].5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE 70/30
~~[illegible]~~

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.

TEST NO.
DATE May 20, 1982
TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (1.07) | 2 (.8) | 3 (.55) | 4 (.5) |
|---|---|---|---|---|
| Rdg TSF | 1.07, 1.07 | .78, .8?, .8 | .55, .55 | .51, .5 |
| CONTAINER NO. | 212 | V1 | X6 | MP4 |
| WT. CONTAINER + WET SOIL IN g | 20.819 | 20.045 | 19.832 | 21.597 |
| WT. CONTAINER + DRY SOIL IN g | 16.491 | 16.147 | 15.720 | 16.427 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.184 | 12.481 | 12.180 | 12.117 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 100.5 | 106 | 116 | 120 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

TORVANE

-.1 initial reading

SOIL SAMPLE UBC/[illegible]

[illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 2[illegible], 19[illegible]

TESTED BY [illegible]

| DETERMINATION NO. | 2.57-.1=(2.47) | 2.02-.1=(1.92) | 1.5-.1=(1.4) | 1.2-.1=(1.1) |
|---|---|---|---|---|
| Reading TSF | 2.5, 2.55, 2.7 | 2.15, 2.0, 2.0, 2.05 | 1.4, 1.5, 1.5 | 1.2, 1.2 |
| CONTAINER NO. | A26 | R13 | A6 | 71/36 |
| WT. CONTAINER + WET SOIL IN g | 18.951 | 18.875 | 20.434 | 21.848 |
| WT. CONTAINER + DRY SOIL IN g | 15.292 | 14.635 | 15.619 | 16.579 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 11.292 | 10.656 | 11.451 | 12.177 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 100 | 106.5 | 115.5 | 120 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$:

TEST NO.

DATE May 10 & 11, 1982

TESTED BY Maureen Kostler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | 23 | | E14 | 03 | | |
| WT. CONTAINER + WET SOIL IN g | 13.793 | 13.663 | 15.021 | 15.530 | | |
| WT. CONTAINER + DRY SOIL IN g | 13.493 | 13.371 | 14.517 | 14.925 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.125 | 12.031 | 12.093 | 12.140 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 21.9 | 21.8 | 20.8 | 21.7 | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (45) | 2 (39) | 3 (23) | 4 (13) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 35,41,47,45,45 | 36,39,39,40,39 | 23,23 | 14,13,13 | |
| CONTAINER NO. | B11 | 212 | V1 | W12 | |
| WT. CONTAINER + WET SOIL IN g | 24.653 | 20.314 | 23.015 | 22.[illegible] | |
| WT. CONTAINER + DRY SOIL IN g | 19.899 | 17.150 | 18.790 | 18.645 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.231 | 12.183 | 12.485 | 12.808 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 62.7 | 63.7 | 67.0 | 69.3 | |

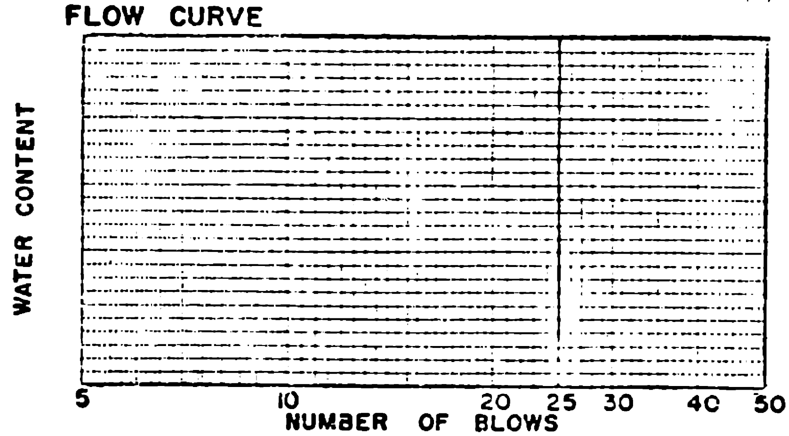
WATER-PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 21.7 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

Variation of Operator/ Sensitivity to Operator Technique

SOIL SAMPLE Bin No 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 17, 1952

TESTED BY Everett Grace

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (55) | 2 (31) | 3 (18) | 4 (12) | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 55 | 31 | 18 | 12 | |
| CONTAINER NO. | 8 | 10 | 11 | 9 | |
| WT. CONTAINER + WET SOIL IN g | 38.543 | 39.571 | 40.072 | 40.015 | |
| WT. CONTAINER + DRY SOIL IN g | 31.664 | 32.128 | 32.323 | 31.960 | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 20.475 | 20.918 | 21.058 | 20.475 | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 61.5 | 66.4 | 68.8 | 70.1 | |

WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE

WATER CONTENT

5 10 20 25 30 40 50

NUMBER OF BLOWS

### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS [illegible] TECHNIQUE

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 17, 1982

TESTED BY Patrick Lovejoy

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (42) | 2 (34) | 3 (26) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 42 | 34 | 26 | | |
| CONTAINER NO. | 1 | 2 | 3 | | |
| WT. CONTAINER + WET SOIL IN g | 36.13 | 43.035 | 35.853 | | |
| WT. CONTAINER + DRY SOIL IN g | 30.023 | 34.454 | 29.650 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 20.02 | 20.75 | 20.39 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 61.1 | 62.6 | 66.9 | | |

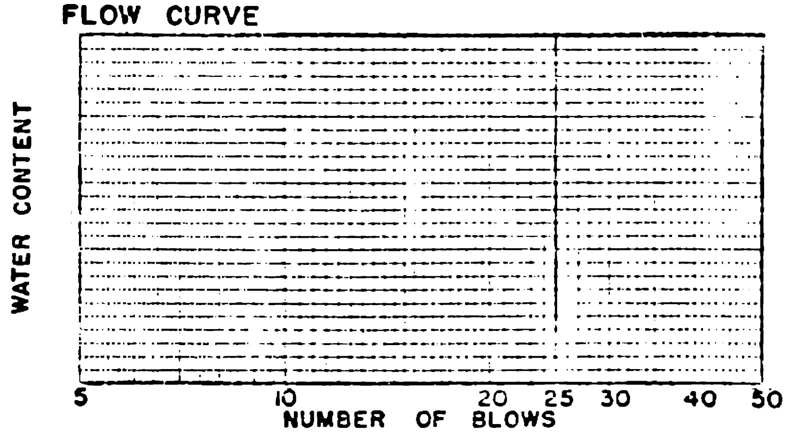
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_\ell - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

[illegible] 76
[illegible] TECHNIQUE

SOIL SAMPLE Bin No 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 17, 1952

TESTED BY R[illegible] Bishop

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | | | | | | |
| WT. CONTAINER + WET SOIL IN g | | | | | | |
| WT. CONTAINER + DRY SOIL IN g | | | | | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | | | | | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 (26) | 2 (20) | 3 (10) | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | 26 | 20 | 10 | | |
| CONTAINER NO. | 5 | 6 | 7 | | |
| WT. CONTAINER + WET SOIL IN g | 37.29 | 35.292 | 42.43 | | |
| WT. CONTAINER + DRY SOIL IN g | 30.938 | 29.395 | 33.600 | | |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 20.84 | 20.58 | 21.171 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 62.9 | 66.9 | 71.0 | | |

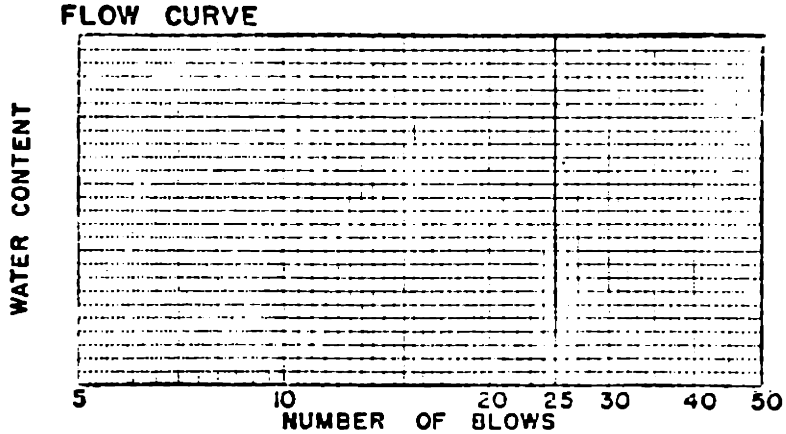
WATER—PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTUBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SENSITIVITY TO OPERATOR TECHNIQUE

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE June 25, 1982

TESTED BY Operator A

| DETERMINATION NO. | 1 (143) | 157 side 2 (160) | 3 (179) | 4 (19[illegible]) |
|---|---|---|---|---|
| Penetration in 1/10 mm | 142, 144 | 158.5" 156.5, 165, 163 | 180, 177 | 198, 184, 194, 186 |
| CONTAINER NO. | 36 | V1 | N12 | B-11 |
| WT. CONTAINER + WET SOIL IN g | 20.729 | 23.719 | 25.261 | 22.561 |
| WT. CONTAINER + DRY SOIL IN g | 17.428 | 19.304 | 20.137 | 18.404 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.162 | 12.475 | 12.436 | 12.232 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 62.7 | 64.7 | 66.5 | 67.4 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | S VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE SENSITIVITY TO OPERATOR TECHNIQUE

SOIL SAMPLE Bin No 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE

TESTED BY Operator B

| DETERMINATION NO. | 1 (89) | 2 (110) | 3 (133) | 4 (171) |
|---|---|---|---|---|
| Penetration in mm | 86.5, 91.3, 90 | 110.5, 109 | 137.5, 130, 132 | 170.5, 172 |
| CONTAINER NO. | A-1 | Z-8 | Z-2 | A-4 |
| WT. CONTAINER + WET SOIL IN g | 15.603 | 19.021 | 17.361 | 19.371 |
| WT. CONTAINER + DRY SOIL IN g | 13.885 | 16.522 | 14.918 | 16.435 |
| WT. WATER, $W_w$, IN g | 1.718 | 2.499 | 2.443 | 2.936 |
| WT. CONTAINER IN g | 10.839 | 12.287 | 10.972 | 12.008 |
| WT. DRY SOIL, $W_s$, IN g | 3.046 | 4.235 | | 4.427 |
| WATER CONTENT w, IN % | 56.4 | 59.0 | 61.9 | 66.3 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 10, 11, 1982

TESTED BY Maureen K[illegible]tler
(Operator C for sensitivity to operator technique)

| DETERMINATION NO. | 1 (67.5) | 2 (105.5) | 3 (140) | 154, ([illegible]) | (185.8) |
|---|---|---|---|---|---|
| Penetration $\frac{1}{10}$ mm | 67, 68 | 105, 106.5, 105 | 141, 139 | [illegible], 154, 155 | 188, 186, 183, 186 |
| CONTAINER NO. | N1 | V1 | N12 | 36/71 | 25 |
| WT. CONTAINER + WET SOIL IN g | 18.156 | 21.353 | 19.930 | 17.639 | 15.883 |
| WT. CONTAINER + DRY SOIL IN g | 16.116 | 18.102 | 17.059 | 15.527 | 13.359 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.179 | 12.485 | 12.430 | 12.176 | 9.549 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 51.8 | 57.9 | 62.0 | 63.0 | 66.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 10 & 11, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (3.45) 1.45 | 2 (1.5) | 3 (.97) | 4 (.3) |
|---|---|---|---|---|
| Rdg TSF | 3.3, 3.45, 3.45 | 1.5, 1.65, 1.5 | 1.0, .95 | .3, .3 |
| CONTAINER NO. | N 12 | X6 | N1 | S40 |
| WT. CONTAINER + WET SOIL IN g | 22.757 | 24.068 | 19.378 | 23.163 |
| WT. CONTAINER + DRY SOIL IN g | 19.242 | 19.742 | 16.940 | 19.050 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.435 | 12.180 | 12.175 | 13.173 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 51.6 | 57.2 | 61.7 | 70.0 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY



TORVANE

−.15 initial reading

SOIL SAMPLE Bin No. 12

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 10 & 11, 1982

TESTED BY Maureen

| DETERMINATION NO. | −.15 = 4.78 | 2.9 −.15 = 2.75 | 1.98 −.15 = 1.83 | .83 −.15 = .68 |
|---|---|---|---|---|
| Rdg TSF | 4.85, 5.0, 4.75, 5.1 | 2.9, 2.9, 2.9 | 1.95, 1.8, 2.0, 2.05, 1.95 | .8, .85, .85 |
| CONTAINER NO. | MP4 | 46 | MP4 | S79 |
| WT. CONTAINER + WET SOIL IN g | 22.381 | 24.396 | 25.952 | 24.611 |
| WT. CONTAINER + DRY SOIL IN g | 18.923 | 19.949 | 20.704 | 19.921 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.119 | 12.114 | 12.115 | 13.203 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 50.8 | 56.8 | 61.1 | 69.8 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

## ATTERBERG LIMITS

SOIL SAMPLE Bin No. 39

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE March 25 & [illegible] 1982

TESTED BY Maureen Koehler

### PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | R13 | L29 | 46 | D20 | | |
| WT. CONTAINER + WET SOIL IN g | 11.827 | 10.992 | 14.124 | 13.856 | | |
| WT. CONTAINER + DRY SOIL IN g | 11.616 | 10.818 | 13.762 | 13.339 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 10.667 | 10.021 | 12.119 | 11.042 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 22.2 | 21.8 | 22.0 | 22.5 | | |

### LIQUID LIMIT

| DETERMINATION NO. | 1 ( ) | 2 (38) | 3 (22) | 4 (17) | 5 (7) |
|---|---|---|---|---|---|
| NO. OF BLOWS | 44,43,43 | 38,38,38 | 22,22,22 | 15,17,17,17 | 7,7 |
| CONTAINER NO. | MP4 | 42 | 212 | 3 | 2 |
| WT. CONTAINER + WET SOIL IN g | 20.190 | 18.673 | 22.380 | 21.986 | 20.915 |
| WT. CONTAINER + DRY SOIL IN g | 17.282 | 16.128 | 18.612 | 17.962 | 17.317 |
| WT. WATER, $W_w$, IN g | | | | | |
| WT. CONTAINER IN g | 12.118 | 11.702 | 12.185 | 12.130 | 12.035 |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | 56.3 | 57.5 | 58.6 | 62.1 | 68.1 |

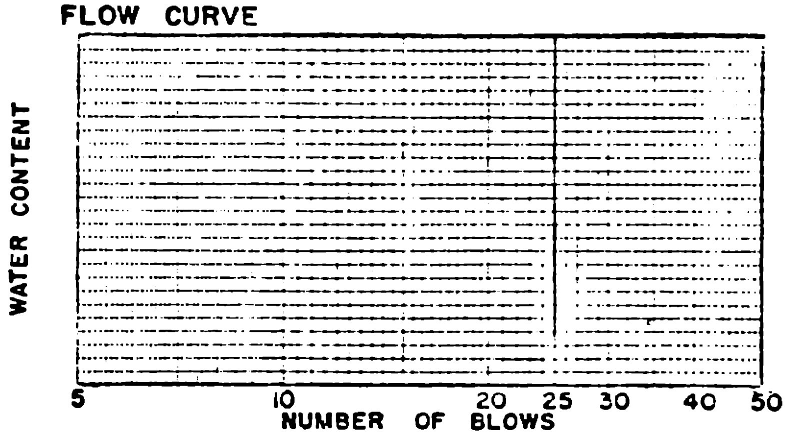
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

### SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

### FLOW CURVE




### RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 22.1 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Bin No. 39

LOCATION
BORING NO. SAMPLE DEPTH
SAMPLE NO.

TEST NO.
DATE May 9, 1982
TESTED BY Maureen Kestler

| DETERMINATION NO. | 94.92 1 (80.8) | 104.5, 2 (107.4) | 3 (166) | 4 (307) |
|---|---|---|---|---|
| Penetration | 81, 73, 79 | 110, 106, 103, 108.5 | 166, 166 | 307 |
| CONTAINER NO. | N1 | N12 | B11 | V1 |
| WT. CONTAINER + WET SOIL IN g | 18.639 | 20.454 | 18.874 | 23.630 |
| WT. CONTAINER + DRY SOIL IN g | 16.525 | 17.689 | 16.399 | 19.103 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.179 | 12.435 | 12.233 | 12.495 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 48.6 | 52.6 | 59.4 | 68.5 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Bin No 39

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 25, 1992

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (1.9) | 2 (.67) | 3 (.48) | 4 (.3) |
|---|---|---|---|---|
| Reading TSF | 1.87, 1.9, 1.9 | .63, .7 | .45, .5, .48 | .3, .3 |
| CONTAINER NO. | 55 | 03 | E14 | L29 |
| WT. CONTAINER + WET SOIL IN g | 25.664 | 20.687 | 22.579 | 21.875 |
| WT. CONTAINER + DRY SOIL IN g | 21.216 | 17.601 | 18.682 | 17.329 |
| WT. WATER, $W_w$, IN g | 4.448 | 3.086 | 3.897 | 4.546 |
| WT. CONTAINER IN g | 9.171 | 4.916 | 6.587 | 10.020 |
| WT. DRY SOIL, $W_s$, IN g | 12.045 | 12.145 | 12.095 | 7.309 |
| WATER CONTENT w, IN % | 48.5 | 62.8 | 59.2 | 62.2 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

## Torvane

SOIL SAMPLE Bin No 39

[illegible]

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE March 25, 1982

TESTED BY Maureen Kestler

.2 = initial reading for this run only. on different day

| DETERMINATION NO. | 1 (1.6) | 2 (1.6) | 3 (1.0) | 4 (.65) |
|---|---|---|---|---|
| Rdg TSF | 1.6, 1.5, 1.4, 1.6 | 1.8, 1.8 | 1.0, 1.0, 1.0 | .65, .65, .65 |
| CONTAINER NO. | E14 | X6 | B-11 | X6 |
| WT. CONTAINER + WET SOIL IN g | 24.146 | 29.601 | 26.510 | 28.225 |
| WT. CONTAINER + DRY SOIL IN g | 19.782 | 23.335 | 21.042 | 21.676 |
| WT. WATER, $W_w$, IN g | 4.364 | 6.260 | 5.468 | 6.549 |
| WT. CONTAINER IN g | 12.092 | 12.179 | 12.228 | 12.179 |
| WT. DRY SOIL, $W_s$, IN g | 7.69 | 11.156 | 8.814 | 9.497 |
| WATER CONTENT w, IN % | 56.7 | 56% | 62.0 | 68.9 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOIL MECHANICS LABORATORY

# ATTERBERG LIMITS

SOIL SAMPLE Bin No 2

silty

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

SPECIFIC GRAVITY, $G_s$,

TEST NO.

DATE May 12

TESTED BY M Simon Kestler

## PLASTIC LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| CONTAINER NO. | B11 | R13 | N1 | 46 | | |
| WT. CONTAINER + WET SOIL IN g | 16.310 | 13.317 | 16.895 | 15.983 | | |
| WT. CONTAINER + DRY SOIL IN g | 15.695 | 12.903 | 16.130 | 15.347 | | |
| WT. WATER, $W_w$, IN g | | | | | | |
| WT. CONTAINER IN g | 12.232 | 10.660 | 12.179 | 12.118 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | | |
| WATER CONTENT w, IN % | 17.8 | 18.5 | 19.4 | 19.7 | | |

## LIQUID LIMIT

| DETERMINATION NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| NO. OF BLOWS | | | | | |
| CONTAINER NO. | | | | | |
| WT. CONTAINER + WET SOIL IN g | silt/∴ unable | to | obtain | $w_L$ | |
| WT. CONTAINER + DRY SOIL IN g | | | | | |
| WT. WATER, $W_w$, IN g | | Slides | in cup | | |
| WT. CONTAINER IN g | | | | | |
| WT. DRY SOIL, $W_s$, IN g | | | | | |
| WATER CONTENT w, IN % | | | | | |

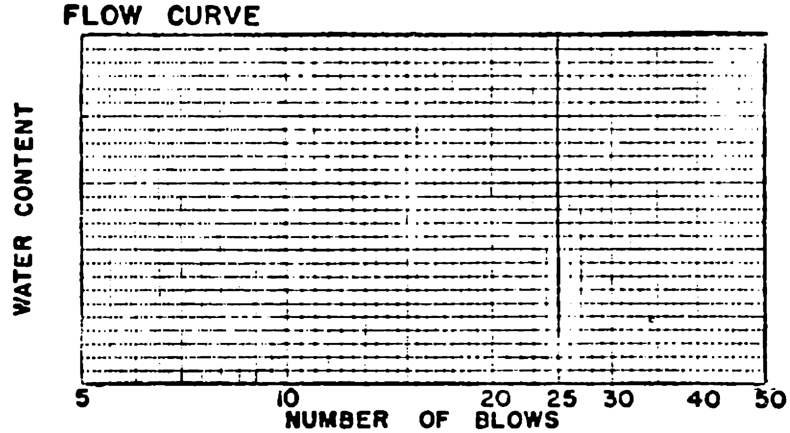
WATER–PLASTICITY RATIO, $B = \frac{w_n - w_p}{w_l - w_p}$

## SHRINKAGE LIMIT

| DETERMINATION NO. | 1 | 2 |
|---|---|---|
| UNDISTURBED OR REMOLDED SOIL PAT | | |
| WT. DRY SOIL PAT, $W_s$, IN g | | |
| WT. CONTAINER + HG. IN g | | |
| WT. CONTAINER IN g | | |
| WT. HG. IN g | | |
| VOL. SOIL PAT, V, IN cc | | |
| SHRINKAGE LIMIT, $w_s$, IN % | | |

$$w_s = \frac{\gamma_w V}{W_s} - \frac{G_T}{G_s}$$

## FLOW CURVE




## RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX | |
|---|---|---|---|---|---|---|---|---|
| 18.9 | | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

CONE

SOIL SAMPLE Bin No 2

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (74) | 2 (141) | 3 (225) | 4 (293) |
|---|---|---|---|---|
| Penetration to mm | 76, 72 | 141, 141 | 232, 222, 220 | 295, 285, 298 |
| CONTAINER NO. | 03 | 67 | VI | D20 |
| WT. CONTAINER + WET SOIL IN g | 16.718 | 24.623 | 32.232 | 27.137 |
| WT. CONTAINER + DRY SOIL IN g | 15.981 | 21.904 | 28.050 | 24.027 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.137 | 9.[illegible] | 12.478 | 11.023 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 19.2 | 22.3 | 23.00 | 23.9 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# CONE
## TIME FOR PENETRATION

Bin No. 2, silt

May 27, 1982
Maureen Kestler

| | | |
|---|---|---|
| Penetration Depth at the end of 1± second (1/10 mm) | 56 | 61 |
| Penetration Depth following an additional 9 seconds i.e., 10 second reading (1/10 mm) | 64 | 69 |
| Penetration Depth following an additional 20 seconds i.e., 30 second reading (1/10 mm) | 72 | 76 |

10 sec $C_{p_i} = 74$

$\Delta C_p = 21$ following tapping side of container

$10^+$ sec $C_{p_f} = 95$

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER

SOIL SAMPLE Bin No 2

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27 & 31, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1 (1.88) | 2 (1.55) | 3 (.95) | 4 (.35) |
|---|---|---|---|---|
| Rdg TSF | 2, 1.9, 1.7 | 1.6, 1.5 | 1.0, .9 | .35, .35 |
| CONTAINER NO. | 212 | 55 | O2 | MP4 |
| WT. CONTAINER + WET SOIL IN g | 22.536 | 28.261 | 20.653 | 29.440 |
| WT. CONTAINER + DRY SOIL IN g | 20.593 | 25.317 | 19.130 | 26.166 |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.182 | 12.037 | 12.126 | 12.115 |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 23 | 22.2 | 22.0 | 23.3 |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

[illegible]

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

PENETROMETER (con't)

SOIL SAMPLE Bin No 2

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27 & 31, 1982

TESTED BY

| DETERMINATION NO. | 1 (.34) | 2 (.3) | 3 | 4 |
|---|---|---|---|---|
| Rdg TSF | .37, .3 | .3, .3 | | |
| CONTAINER NO. | L198 | X6 | | |
| WT. CONTAINER + WET SOIL IN g | 17.382 | 32.023 | | |
| WT. CONTAINER + DRY SOIL IN g | 15.915 | 28.216 | | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 9.411 | 12.177 | | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 22.6 | 23.7 | | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

REMARKS

# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

## SOIL MECHANICS LABORATORY

TORVANE

-.2 initial reading

SOIL SAMPLE Bin No 2

LOCATION

BORING NO. SAMPLE DEPTH

SAMPLE NO.

TEST NO.

DATE May 27, 1982

TESTED BY Maureen Kestler

| DETERMINATION NO. | 1.2-.2=(1.0) | .7-.2=(.5) | .5-.2=(.3) | 4 |
|---|---|---|---|---|
| rdg TSF | 1.2, 1.2 | .75, .7, .8, .7 | .5, .55, .5 | |
| CONTAINER NO. | 78 | 36 | 02 | |
| WT. CONTAINER + WET SOIL IN g | 32.211 | 28.933 | 29.532 | |
| WT. CONTAINER + DRY SOIL IN g | 28.588 | 25.786 | 26.204 | |
| WT. WATER, $W_w$, IN g | | | | |
| WT. CONTAINER IN g | 12.238 | 12.156 | 12.124 | |
| WT. DRY SOIL, $W_s$, IN g | | | | |
| WATER CONTENT w, IN % | 22.2 | 23.1 | 23.6 | |

RESULT SUMMARY

| PLASTIC LIMIT | NATURAL WATER CONTENT | LIQUID LIMIT | SHRINKAGE LIMIT | B VALUE | PLASTICITY INDEX | TOUGHNESS INDEX | FLOW INDEX |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

RE RKS

Summary of Results from Std.
Casagrande Device,
Cone Penetrometer,
Pocket Penetrometer, &
Torvane Tests

**BENTONITE** Soil No 2a

| ATT. LTS. | | CONE | | PENETROM | | TOR VANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| 7.7 | 587 | 85 | 337 | 1.5 | 337 | 2.0 | 309 |
| 32 | 432 | 78 | 312 | 1.2 | 312 | 1.4 | 344 |
| 31.3 | 561 | 106 | 366 | 1.0 | 366 | 1.1 | 359 |
| 26 | 587 | 128 | 443 | 0.5 | 443 | 0.6 | 426 |
| 23 | 592 | 83 | 359 | | | | |
| 22.3 | 610 | 186 | 560 | | | | |
| 10.8 | 627 | 266 | 645 | | | | |
| 20 | 645 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| NoBlows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | BBC | | Soil No 3a | | | |
| 28 | 39.2 | 102 | 41.1 | 1.4 | 41.2 | 1.7 | 41.1 |
| 19 | 43.9 | 112 | 43.8 | 0.9 | 43.3 | 1.0 | 42.8 |
| 15 | 45.1 | 87 | 43.7 | 1.0 | 39.2 | 2.0 | 39.9 |
| 12 | 47.0 | 129 | 46.4 | 0.5 | 45.6 | 1.0 | 45.3 |
| 40 | 38 | 101 | 41.7 | 1.1 | 40.7 | 2.3 | 40.8 |
| 26 | 39.9 | 107 | 40.6 | 1.0 | 42.3 | 2.0 | 42.6 |
| 24 | 47 | 115 | 48.9 | .73 | 43.2 | 1.6 | 44.3 |
| 19 | 41.9 | 123 | 44.8 | .6 | 44.9 | 1.3 | 45.3 |
| 15 | 43.4 | 79 | 37.8 | 1.8 | 38.6 | 4.4 | 36.6 |
| $w_p$: | 24.2 | 80 | 43.1 | 1.3 | 40.8 | 2.9 | 40.1 |
| | 24.7 | 107 | 43.8 | .87 | 37.3 | 1.8 | 43.1 |
| | 24.3 | 149 | 48.7 | .13 | 49.0 | 1.0 | 48.6 |
| | 24.9 | | | | | | |
| | 24.9 | | | | | | |
| | 23.7 | | | | | | |
| | | | | IDEAL | Soil No 6a | | |
| $w_L$: | 76 | 95 | 70.3 | | | | |
| $w_p$: | 32 | 103 | 72.9 | | | | |
| | | 119 | 75.1 | | | | |
| | | 126 | 78.7 | | | | |

| ATT. LIQ. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No. Blows | w% | h mm | w% | TSF | w% | TSF | w% |
| | | MODELING | CLAY | | | Soil No 7a | |
| 24.3 | 35.8 | 91 | 34.8 | 1.0 | 34.7 | 1.4 | 35.1 |
| 24.3 | 36.2 | 101 | 36.1 | .75 | 35.8 | .8 | 37 |
| 14.7 | 38.2 | 133 | 39.7 | .4 | 39.5 | .55 | 38 |
| 24 | 35.4 | 58 | 29.3 | | | | |
| 42 | 32.4 | 94 | 34.5 | | | | |
| 23 | 35.3 | 119 | 37.6 | | | | |
| 19 | 35.9 | 125 | 39.4 | | | | |
| 16 | 36.7 | 134 | 39.4 | | | | |
| 14 | 37.3 | | | | | | |
| $w_p$: | 20.9 | | | | | | |
| | 20.8 | | | | | | |
| | 22.6 | | | | | | |
| | 21.2 | | | | | | |
| | 21.0 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | VICKSBURG | | BUCKSHOT | | Soil No IIa | |
| 28 | 63.4 | 60 | 49.6 | 1.6 | 50.5 | 3.7 | 50.3 |
| 18 | 64.8 | 63 | 51.5 | 1.5 | 50.3 | 3.2 | 49.7 |
| 11 | 66.2 | 68 | 50.2 | 1.2 | 52 | 2.6 | 52.5 |
| 38 | 62 | 81 | 55.5 | 1.1 | 67.1 | 2.4 | 55.4 |
| 36 | 56.7 | 65 | 51.5 | 1.1 | 52.9 | 2.3 | 53.0 |
| 28 | 58.3 | 61 | 49.6 | 0.7 | 55.6 | 1.6 | 55.6 |
| 22 | 60.4 | 81 | 55.8 | 0.5 | 58 | 1.2 | 59.1 |
| 17 | 58.6 | 69 | 50.2 | 0.3 | 60.2 | 1.2 | 60.1 |
| 25 | 60 | 71.2 | 53 | .57 | 59.9 | 1.3 | 60.7 |
| 32 | 66 | 76 | 55.1 | .5 | 60.9 | 0.9 | 67.7 |
| 11 | 70 | 104 | 59.5 | | | | |
| 12 | 65 | 120 | 62.8 | | | | |
| 14 | 64 | | | | | | |
| 24.3 | 60.3 | | | | | $w_p$: | 22.1 |
| 25.7 | 60 | | | | | | 22.2 |
| 17.7 | 62.9 | | | | | | 22.5 |
| $w_p$: in rt. col. | | | | | | | 23.7 |

| ATT. LIQ. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | W% | 1/10 mm | W% | TSF | W% | .1 TSF | W% |
| | | | 30/70 | MIXTURE | | Soil No 12 a | |
| 26.3 | 28.8 | 70 | 27.8 | 1.3 | 27.6 | 3.0 | 27.7 |
| 24.3 | 29.2 | 90 | 29.4 | .75 | 30 | 1.5 | 35 |
| 21.0 | 29.9 | 97 | 29.7 | .7 | 35 | 1.3 | 32 |
| 18.3 | 37 | 105 | 38.7 | 1.0 | 29.5 | 1.9 | 29.3 |
| 40 | 30.4 | 132 | 36.3 | | | | |
| 27 | 31.8 | 111 | 31.1 | | | | |
| 17 | 33.1 | 107.5 | 30.7 | | | | |
| 20 | 28.6 | 106.5 | 30.4 | | | $w_p$: | 18.9 |
| 37 | 30.3 | 108 | 30.1 | | | | 18.2 |
| 22 | 31.4 | 108 | 29.8 | | | | 18.9 |
| 20 | 29.9 | 103.5 | 31.0 | | | | 19.2 |
| 17.8 | 30.1 | 107 | 30.8 | | | | 18.9 |
| 24 | 29.9 | 102.5 | 30.6 | | | | 19.1 |
| 18 | 30.9 | 94 | 30.4 | | | | 19.1 |
| 14 | 31.8 | 96 | 30.2 | | | | 18.8 |
| 39.5 | 29.1 | | | | | | 19.5 |
| 33 | 29.4 | | | | | | 19.0 |
| 31.5 | 28.2 | | | | | | 18.0 |
| $w_p$: rt. column | | | | | | | |

| ATT. LTS. | | CONE | | PEN[illegible] | | TSF [illegible] | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | CHICAGO | | CLAY | | Soil No 17a | |
| 48 | 30 | 67 | 29.5 | | | | |
| 35 | 31.7 | 100 | 32.7 | | | | |
| 23 | 33.3 | 135 | 36.7 | | | | |
| 11 | 36.7 | | | | | | |
| $w_p$: | 17.0 | | | | | | |
| | 17.1 | | | | | | |
| | 16.7 | | | | | | |
| | 17.1 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No. Blows | W% | 1/10 mm | W% | TSF | W% | .1 TSF | W% |
| AGRICO SADDLE CRK MINE Soil No 1 | | | | | | | |
| 43 | 234 | 89.5 | 176.4 | 1.84 | 180 | 3.4 | 177.5 |
| 33 | 250 | 127 | 207 | .82 | 210 | 1.9 | 207.5 |
| 25 | 261 | 160 | 234 | .48 | 233 | 1.1 | 233.6 |
| 18 | 275.5 | | | | | | |
| 11 | 307 | | | | | | |
| $w_p$: | 81.7 | | | | | | |
| | 85.6 | | | | | | |
| | 89.2 | | | | | | |
| BENTONITE 200 VOL CLAY Soil No 2 | | | | | | | |
| 55 | 563 | 155.5 | 386.5 | 1.0 | 319 | 2.0 | 325 |
| 30 | 572 | 177 | 428 | .6 | 386 | 1.42 | 384 |
| 23.8 | 581 | 182 | 443 | .4 | 446 | .9 | 443 |
| 18 | 597 | 200 | 464 | .27 | 462 | .8 | 461 |
| 13 | 603 | | | | | .65 | 474 |
| $w_p$: | 30.6 | | | | | | |
| | 32.8 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM. | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | BBC | | Soil No 3 | | | |
| 52 | 36.8 | 88.7 | 36.6 | 2.66 | 37.1 | 2.02 | 40.6 |
| 43.6 | 38.2 | 96 | 38.4 | 1.8 | 40.0 | 1.52 | 41.9 |
| 15 | 44.6 | 150.4 | 44.3 | .94 | 41.7 | 1.25 | 43.8 |
| 11 | 47.8 | 188.7 | 47.4 | .85 | 44.2 | .82 | 47.3 |
| wp: | 22.0 | | | .85 | 44.0 | | |
| | 22.2 | | | .55 | 47.3 | | |
| | 22.1 | | | .47 | 47.7 | | |
| | 22.3 | | | | | | |
| | | CF | | MINING | | Soil No 4 | |
| 57 | 128 | 77 | 99.4 | 2.45 | 100 | 4.7 | 101 |
| 36 | 138 | 110 | 114.6 | 1.07 | 116 | 2.45 | 116 |
| 30 | 142 | 169 | 137 | .47 | 138 | 1.02 | 137 |
| 14 | 155 | 233 | 156 | | | | |
| 9 | 163.5 | | | | | | |
| wp: | 36.7 | | | | | | |
| | 33.42 | | | | | | |
| | 35.34 | | | | | | |
| | 33.39 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | GRAY | CLAY | Soil No 5 | | | |
| 31 | 41.7 | 120 | 42.3 | .95 | 43.7 | 1.97 | 42.8 |
| 19 | 44 | 142 | 44.7 | .69 | 45.2 | 1.43 | 44.4 |
| 10.9 | 48 | 161.5 | 48.1 | .55 | 46.2 | 1.0 | 48.4 |
| $w_p$: | 23.05 | | | | | | |
| | 23.25 | | | | | | |
| | 22.53 | | | | | | |
| | 22.33 | | | | | | |
| | | IDEAL | CLAY | | | Soil No 6 | |
| 34.3 | 93.5 | 82.5 | 77.4 | 2.07 | 77.7 | 4.05 | 76.3 |
| 24.3 | 95 | 108 | 83.1 | 1.05 | 83.6 | 2.45 | 83.8 |
| 21.5 | 98.4 | 166 | 95.8 | 0.44 | 94.9 | 1.29 | 94.8 |
| 10 | 108.6 | 186 | 99.1 | | | | |
| $w_p$: | 30.5 | | | | | | |
| | 30.0 | | | | | | |
| | 29.7 | | | | | | |
| | 29.2 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | MODELING | | CLAY | | Soil No 7 | |
| 50.3 | 29.8 | 56.5 | 26.4 | 1.75 | 30.5 | 3.95 | 30.0 |
| 43 | 30.4 | 87.5 | 29.2 | .88 | 33.1 | 2.05 | 33.1 |
| 34 | 31.4 | 94 | 30.1 | .45 | 36.6 | 1.15 | 36.5 |
| 25 | 32.4 | 100 | 30.8 | .29 | 38.8 | .88 | 38.5 |
| 24.9 | 32.8 | 112 | 31.3 | | | | |
| 19 | 33.8 | 133 | 33.3 | | | | |
| 15 | 35.4 | 156.2 | 35 | | | | |
| 9 | 37.8 | 205 | 37.6 | | | | |
| 8 | 38.4 | 203.7 | 38.1 | | | | |
| 6.9 | 39.1 | 225 | 39.1 | | | | |
| 5 | 40.3 | 244 | 39.9 | | | | |
| 4.5 | 41.0 | 255 | 40.9 | | | | |
| | | 274 | 42.2 | | | | |
| $w_p$: | 20.15 | | | | | | |
| | 20.42 | | | | | | |
| | 20.16 | | | | | | |
| | 21.36 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | VENEZ | | C1510 | | Soil No 8 | |
| 47.7 | 44.6 | 78.3 | 39.4 | 2.18 | 39.6 | 4.6 | 39.6 |
| 20.5 | 49.6 | 119 | 45.3 | 1.0 | 45.3 | 2.45 | 45.3 |
| 15 | 51.3 | 172.5 | 51.9 | .48 | 51.6 | 1.25 | 52.2 |
| 12 | 54.2 | | | | | | |
| 10 | 56.2 | | | | | | |
| $w_p$: | 18.81 | | | | | | |
| | 19.25 | | | | | | |
| | 19.04 | | | | | | |
| | 18.58 | | | | | | |
| | | VENEZ | | C2543 | | Soil No 9 | |
| 39.5 | 43.6 | 87.5 | 38.8 | 2.2 | 39.0 | 4.15 | 38.6 |
| 33.0 | 46.0 | 116 | 40.9 | 1.1 | 41.8 | 2.37 | 41.7 |
| 23.7 | 44.7 | 149.3 | 44.9 | .67 | 43.3 | 1.47 | 44.8 |
| 16 | 46.6 | 161 | 46.5 | | | | |
| 15 | 48.2 | 189 | 48.0 | | | $w_p$: | 24.48 |
| 12 | 49.9 | | | | | | 24.0 |
| 10.5 | 51.1 | | | | | | 24.7 |
| | | | | | | | 23.5 |
| $w_p$: see rt. col | | | | | | | 24.7 |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | VENEZ | | C3S17 | | Soil No 10 | |
| 39.5 | 38.7 | 78.2 | 34.9 | 2.9 | 32.1 | 4.9 | 34.6 |
| 29 | 40.0 | 94.3 | 36.8 | 1.76 | 36.8 | 3.65 | 36.7 |
| 20 | 42.0 | 112.4 | 38.4 | 1.0 | 40.0 | 2.12 | 39.2 |
| 17.3 | 43.4 | 141.8 | 41.3 | 0.7 | 41.6 | 1.7 | 41.6 |
| 10.5 | 45.9 | 196.5 | 46.6 | | | | |
| $w_p$: | 21.8 | | | | | | |
| | 21.4 | | | | | | |
| | 22.0 | | | | | | |
| | 22.9 | | | | | | |
| | 21.4 | | | | | | |
| | | VICKSBURG | | BUCKSHOT | | Soil No 11 | |
| 30.3 | 56.6 | 95.5 | 50.9 | .5 | 54.8 | 2.83 | 51.4 |
| 24.8 | 58.4 | 112.7 | 52.4 | .45 | 55.5 | 2.45 | 52.8 |
| 14.3 | 62.3 | 127.3 | 55.1 | .4 | 56.6 | 1.83 | 54.8 |
| 11.5 | 64.2 | 136.3 | 55.1 | .3 | 59.1 | .67 | 64.6 |
| $w_p$: | 21.6 | 162 | 58.3 | | | | |
| | 20.4 | 188 | 60.4 | | | | |
| | 20.4 | 205.3 | 61.4 | | | | |
| | 19.8 | | | | | | |

| ATT. LTS. | | CONE | | PENETRATION | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | W% | 1/10 mm | W% | TSF | W% | .1 TSF | W% |
| | | 30/70 VBC/BIN NO. 2 | | | | Soil No [illegible] | |
| 36.7 | 27.4 | 134 | 30.4 | 1.9 | 27.5 | 3.22 | 27 |
| 25 | 28.6 | 152 | 30.8 | .83 | 30.4 | 2.55 | 28.2 |
| 16 | 29.9 | 169.8 | 31.6 | .7 | 30.7 | 1.83 | 30.3 |
| 13 | 31.1 | 184 | 32 | .4 | 32.5 | 1.5 | 30.3 |
| 10.3 | 31.9 | | | | | | |
| 7 | 32.8 | | | | | | |
| $w_p$: | 17.1 | | | | | | |
| | 17.6 | | | | | | |
| | 17.4 | | | | | | |
| | 17.66 | | | | | | |
| | | 70/30 VBC/BENTONITE | | | | Soil No 13 | |
| 46 | 144 | 97 | 94.4 | 1.07 | 100.5 | 2.47 | 100 |
| 41 | 148 | 111 | 98.9 | .8 | 106 | 1.92 | 106.5 |
| 25 | 157 | 144 | 116 | .55 | 116 | 1.4 | 115.5 |
| 20 | 155 | 158 | 119 | .5 | 120 | 1.1 | 120 |
| 10 | 162 | 171 | 125 | | | | |
| $w_p$: | 23.48 | | | | | | |
| | 21.57 | | | | | | |
| | 23.79 | | | | | | |
| | 24.26 | | | | | | |

| ATT. LTS. | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| | | BIN NO. 12 | | | Soil No 14 | | |
| 45 | 62 | 67.5 | 51.8 | 3.45 | 51.6 | 4.70 | 50.8 |
| 39 | 63.7 | 105.5 | 57.9 | 1.5 | 57.2 | 2.75 | 56.8 |
| 23 | 67 | 140 | 62 | .97 | 61.7 | 1.83 | 61.1 |
| 13 | 69.3 | 154 | 63 | .3 | 70.0 | 0.68 | 69.8 |
| wp: | 21.9 | 185.8 | 66.2 | | | | |
| | 21.8 | | | | | | |
| | 20.8 | | | | | | |
| | 21.7 | | | | | | |
| | | BIN NO 39 | | | Soil No 15 | | |
| 43 | 56.3 | 80.8 | 48.6 | .3 | 62.2 | 1.6 | 56.7 |
| 38 | 57.3 | 107.4 | 52.6 | .48 | 59.2 | 1.6 | 56.0 |
| 22 | 58.6 | 166 | 59.4 | .67 | 62.8 | 1.0 | 62 |
| 17 | 62.1 | 307 | 68.5 | 1.9 | 48.5 | .65 | 68.9 |
| 7 | 68.1 | | | | | | |
| wp: | 22.0 | | | | | | |
| | 21.8 | | | | | | |
| | 22.0 | | | | | | |
| | 22.5 | | | | | | |

| ATT LTS | | CONE | | PENETROM | | TORVANE | |
|---|---|---|---|---|---|---|---|
| No Blows | w% | 1/10 mm | w% | TSF | w% | .1 TSF | w% |
| LIQUID LT TEST: | | BIN NO. 2 | | | | | |
| Cannot get any values. Too much like silt | | 293 | 23.9 | 1.88 | 23 | 1.0 | 22.2 |
| | | 225 | 23 | 1.55 | 22.2 | .5 | 23.1 |
| $w_p$: | 17.8 | 141 | 22.3 | .95 | 22 | .3 | 23.6 |
| | 18.5 | 74 | 19.2 | .35 | 23.3 | | |
| | 19.4 | | | .34 | 22.6 | | |
| | 19.7 | | | .3 | 23.7 | | |

| Soil No. | Soil Name | Correlation [illegible] Casagrande | Cone |
|---|---|---|---|
| 1 | Agrico Saddle Crk Mine | .9951 | .9967 |
| 2 | Bentonite | .9661 | .9933 |
| 3 | Boston Blue Clay | .9960 | .9984 |
| 4 | CF Mining | .9986 | .9978 |
| 5 | Gray Clay | .9930 | .9845 |
| 6 | Ideal Clay | .9831 | .9977 |
| 7 | Modeling Clay | .9929 | .9912 |
| 8 | Venezuelan C1S10 | .9836 | .9978 |
| 9 | Venezuelan C2S43 | .9110 | .9873 |
| 10 | Venezuelan C3S17 | .9959 | .9923 |
| 11 | Vicksburg Buckshot | .9971 | .9950 |
| 12 | 30/70 VBC/Bin No 2 | .9948 | .9873 |
| 13 | 70/30 VBC/Bentonite | .9434 | .9951 |
| 14 | Bin No. 12 | .9858 | .9993 |
| 15 | Bin No 39 | .9793 | .9999 |

Higher Correlation (Cone vs Cas.) underlined

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