Soils tests
computer programs

A Water Resources
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Soils tests computer programs

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Division of Research
Office of Chief Engineer
In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

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PREFACE

Although routine in procedure, computations of standard soils test data are time consuming. But soils test data can be programmed and processed by computer methods to save time and manpower. Automatic data processing also permits broader application of the science of soil mechanics to provide more comprehensive information from a given set of test data.

Soils Tests Computer Programs are designed and written for soils testing laboratories having access to data processing facilities. This publication will be useful to soils testing personnel in setting up and writing computer programs; conversely, it will benefit data processing offices having little or no knowledge of soils tests procedures.

Nine standard soils tests are described, and computer programs for each presented with essential flow diagrams, punch-card data, and printed read outs.

Since January 1964, all data from the standard soils tests conducted in the Bureau of Reclamation’s Soils Engineering Laboratories have been processed from programs written in Fortran II language, and with very minor changes have been converted to the Automath 1800 language.


Included in this publication is an informative abstract and list of descriptors, or keywords, and “identifiers”. The abstract was prepared as part of the Bureau of Reclamation’s program of indexing and retrieving the literature of water resources development. The descriptors were selected from the Thesaurus of Descriptors, which is the Bureau’s standard for listings of keywords.

Acknowledgments

This publication was written and the material compiled by Paul C. Knodel, Soils Engineering Branch. P. F. Enger and V. B. Hartman assisted in writing some of the programs and C. W. Corcoran, Division of Data Processing, reviewed the computer programs and arranged the flow diagram layouts.
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INTRODUCTION

In keeping with the trend toward automation, computer programs have been written to perform the calculations for numerous soils tests performed in the Soils Laboratory. This publication presents a short description of each test programed and describes some of the special features of each. All of these electronic computer programs were written in Fortran II language. With very minor changes, all of the programs have since been converted to the Automath 1800 language.

The test programs written and currently in use are: (1) natural moisture-density; (2) gradation analysis; (3) soil consistency (Atterberg limits); (4) Proctor compaction; (5) constant-head permeability-settlement; (6) falling-head permeability; (7) triaxial shear; (8) one-dimensional consolidation; and (9) a method of computing least squares for the sliding factor and direct shear test.

Wherever applicable, the output data from the computer program show both British and metric units, with conversions from British to metric system being made in accordance with ASTM Metric Practice Guide issued January 1964.

A flow chart, a listing of each computer program, and a list of variable names and their definitions are found in appendix A. A typical test including both input and output data for each test programed is shown in appendix B.

Whenever a moisture content is required for calculating any of the following discussed tests, it is obtained by the methods described in “ASTM Designation D2216–63T, Moisture Content of Soil, Laboratory Determination of.”
DISCUSSION

Natural Moisture-Density Test for Denison and Drive Tube Samples

The unit weight of a soil, expressed in pounds per cubic foot (gms per cc), as it exists in a natural deposit is called the natural or inplace density. The weight of a unit volume of soil is an easily determined property; consequently, it has become the basic parameter to which many other performance characteristics are related; therefore, numerous tests are performed and the relatively simple and repetitive computation is appropriate for computer processing. The natural density may be determined either by measuring the weight and the volume of an undisturbed sample of the material or by weighing the material removed from an excavation or test boring of known volume. The natural or inplace density is usually expressed as a dry density. The dry density is computed from the wet density and the water content using the formula:

\[ \gamma_d = \frac{\gamma_{wet}}{1 + w} \]

where

- \( \gamma_d \) = the dry density inpcf (gm/cc),
- \( \gamma_{wet} \) = the wet density in pcf (gm/cc), and
- \( w \) = the water content (computed as a percentage of the dry weight of the soil) of the soil specimen expressed as a decimal fraction.

Both the natural water content and dry density are determined for either undisturbed Denison or open-end drive tube samples. Data from as many as three separate moisture samples from a given tube sample may be entered in the computer. These water contents are computed and the output is printed as a single water content from the top, center, or bottom of the sample, and as an average of either the one, two, or three water contents, depending upon the input data reported. The average water content is then used to compute the natural dry density of the soil sample, using the above equation.

Gradation Analysis of Soils

Gradation is a descriptive term which refers to the distribution and size of grains in a soil. The amounts of the various sizes of grains present in a soil can be determined in the laboratory by means of sieving for the coarse grains and by sedimentation (wet mechanical analysis) for the fines. The laboratory results are usually presented in the form of a cumulative grain-size curve in which particle sizes are plotted as abscissae to a logarithmic scale with respect to percentage, by dry weight, of the total sample plotted as ordinates to a linear scale. For soils consisting mainly of coarse grains, the grain-size distribution, when considered with particle shape and hardness, permits a reasonably good estimate of the physical properties of the material, and the test is therefore called an index test. Since the gradation of a soil affects to varying degrees its shear strength, permeability, compressibility, workability, and cohesive strength, it is one of the first properties determined on a large number of soil samples in the laboratory. Further advantage of computer data processing is to be realized by machine plotting of the output data. The gradation test procedures are outlined in Designations E-5 and E-6 of the Earth Manual 1 and are similar to "ASTM Designation D422-63, Grain-Size Analysis of Soils." The U.S. Bureau of Reclamation reports the test on the No. 4 sieve size instead of the 10.

The computer program for computing results of the gradation test is designed to accept any one, any combination, or all, of the three parts of the gradation test: (1) screen test, 5-inch to No. 4 (127 mm to 4.76 mm); (2) sieve test, No. 4 to No. 200 (4.76 mm to 0.074 mm); and (3) hydrometer test, sedimentation of minus No. 200 (0.074 mm) grain size. Computations are made on the dry weight basis and print-out data are

expressed in percent of total sample passing given particle sizes.

**Soil Consistency Tests (Atterberg Limits)**

A typical soil mass has three constituents—soil grains, air, and water. The physical properties of most fine-grained soils are greatly affected by the water content of the soil. Four states can be recognized for describing the consistency of a soil. These are: (1) liquid state, (2) plastic state, (3) semisolid state, and (4) solid state. These states of consistency are all related to the water content of the soil (based on the oven-dry weight of soil). Although the transition between each of the states is gradual, test conditions have been established to delineate the water content at a reasonably precise point in the transition from one state of consistency to another. These water contents are referred to as the liquid limit, plastic limit, and shrinkage limit. The plasticity index of a soil is defined as the difference between liquid and plastic limits and represents the water content range within which the soil is plastic.

Since the Atterberg limits test values are indicative of the physical properties of the fine-grained soils and the fine-grained portion of coarse-grained soils, they are determined on a large number of samples. This is particularly in evidence where potentially expansive or potentially subsiding soils problems are to be considered.

The computer program for this test is written to accept zero, one, or two water content determinations for each of the limits (LL, PL, and SL). The output data include individual water contents for each limit and also the average of two water contents for any given limit. The output, of course, is dependent upon the input data supplied. If only one water content is determined for a given limit, it is the only water content reported.

The Atterberg limits tests are performed as outlined in Designation E–7 of the Earth Manual. ASTM designations for Atterberg limits tests are: D423–61T, Liquid Limit of Soils; D424–59, Plastic Limit and Plasticity Index of Soils; and D427–61, Shrinkage Factors of Soils.

**Proctor Compaction Test**

The Proctor compaction test is a procedure for determining the water content-dry density relationship of a soil when the soil is compacted by a constant effort (energy level) to a constant volume. The Proctor maximum dry density is the greatest dry weight in pounds per cubic foot (gm/cc) obtained by this procedure. The water content at the maximum dry density is termed the optimum water content. These two values are obtained from a water content-dry density plot of at least five separate compaction trials at varying water contents. The penetration resistance of the compacted soil may be obtained during the compaction test and is a measure of the firmness of the soil.

This test is normally performed on the portion of a soil passing the No. 4 (4.76 mm) sieve size, or it may be performed on the material passing the ½-inch (19.1 mm) screen.

The Proctor compaction test is usually performed on a lesser number of samples than either the gradation or Atterberg limits tests. However, there is a greater volume of computation for each test. The feature of machine plotting of computed output data is available for this test. The procedure for performing the Proctor compaction test is outlined in Designation E–11 of the Earth Manual. The ASTM Designations are D698–64T, Moisture-Density Relations of Soils, Using 5.5-pound Rammer and 12-inch Drop; and D1558–63, Moisture-Penetration Resistance Relations of Fine-Grained Soils. For the compaction test, the U.S. Bureau of Reclamation uses a ½-cubic-foot mold and an 18-inch drop.

The recorded data obtained during performance of the test and the appropriate constants are entered in the computer which calculates and prints out values of wet density, penetration resistance, water content (percent of dry weight), and dry density for as many as eight separate compaction trials. By assuming the dry density-water content curve to be a parabola whose axis is vertical and having the vertex of the parabola correspond to the Proctor maximum dry density and optimum water content, it is proposed to have the computer fit a parabolic curve through the values obtained from the compaction trials and then determine the maximum dry density and optimum water content from this fitted curve. The above assumption for use of a parabola is in accordance with the rapid method of compaction control, Designation E–25 of the Earth Manual.
**Constant-Head Permeability-Settlement Test**

The permeability-settlement test is a method used to determine the coefficient of permeability in ft/yr (cm/sec), and the amount of settlement in percent, of remolded or undisturbed soil samples. The permeability and settlement of a soil specimen are determined according to the procedures specified in Designations E-13 and E-14 of the Earth Manual.

The percent settlement and the permeability rate for both fine-grained and gravelly soils are calculated by the computer, using these basic formulas:

\[
\text{Settlement, percent} = \left( \frac{\text{Settlement (inches)}}{\text{Initial specimen thickness (inches)}} \right) \times 100
\]

and coefficient of permeability, ft/yr (cm/sec),

\[
k = \frac{V}{At} \frac{H_{\text{oc}}}{L} \quad \text{(for constant head)}
\]

or

\[
k = \frac{VL}{AtH_{\text{oc}}}
\]

where

- \(k\) = coefficient of permeability, in feet per year (cm/sec)
- \(V\) = volume of discharge, cubic feet (cc) in time \(t\)
- \(L\) = thickness (or length) of specimen, in feet (cm)
- \(A\) = area of specimen, in square feet (sq/cm)
- \(t\) = elapsed time during measurement, in years, and
- \(H_{\text{oc}}\) = constant head = difference between headwater and tailwater levels, in feet (cm).

Two different types of head tanks are used in the laboratory for the permeability-settlement test. For fine-grained soils the head tank calibration reads in ascending order from top to bottom and for gravelly soils the head tank calibration reads in descending order from top to bottom. The head tanks are assigned numbers and the computer program is written to select the correct method of performing the calculations for each head tank depending upon its assigned number or code. Since the calculations for the permeability-settlement test are of a repetitive nature, they are well suited to processing by electronic computer methods.

The data output includes load (psi), (kg/sq cm); consolidated dry density (pcf), (gm/cc), settlement (percent), head (feet), hydraulic gradient (ft/ft), hours between each reading, total elapsed time from beginning of test, and coefficient of permeability (ft/yr), (cm/sec). An asterisk after values of output data indicates that reading to be a nontest value; that is, lines were bled, the head tank ran dry, the head was changed, etc.

**Falling-Head Permeability Test**

Although the permeability rate of a soil specimen using a falling head under any given load is usually applied to tests performed in a one-dimensional consolidometer, the computer program may be used to compute data from any test using the falling-head technique. The basic formula for computing the permeability rate with the falling-head supply and constant tailwater level is:

\[
k = \frac{A_p L_t}{A_t} \times 1.0 \frac{H_i}{H_f} \log_e \frac{H_t}{H_f}
\]

where

- \(k\) = permeability rate (ft/yr), (cm/sec)
- \(A_p\) = area of standpipe supplying water (sq in.), (sq cm)
- \(A_t\) = area of soil specimen (sq in.), (sq cm)
- \(L_t\) = length of soil specimen (ft), (cm)
- \(H_i\) = initial head (difference between headwater and tailwater, measured) (in.), (cm)
- \(H_f\) = final head (in.), (cm)
- \(t\) = elapsed time (yrs).

The computer program solves the above equation to obtain the permeability rate. The data, as they are entered on standard laboratory forms, are shown in appendix B. The print-out of information includes permeability rate in ft/yr and cm/sec and the average hydraulic gradient under which the permeability value was determined.

The test is performed following the procedures outlined in Designation E-15 of the Earth Manual.

**Triaxial Shear Test**

When a comparison is made to other materials, such as concrete or steel, soil has very low strength.
Compared to the maximum soil strength that may be found, there is a considerable variation both from soil to soil and within a given soil type depending on how it was naturally deposited or placed as fill.

The engineering computations concerned with the strength of a soil are appropriately related to the shearing strength. That is, the resistance to sliding of one mass of soil against another. The shearing strength of a soil is made up of two parts; one part is dependent upon the stress normal to the shearing plane as related to the internal friction, expressed in terms of the angle \( \phi \), and the other part independent of the normal stress, referred to as the cohesion, \( c \). On a total stress basis the shearing strength of a soil, \( s \), may be expressed as \( s = c + \sigma \tan \phi \); or on an effective stress basis \( s = c + (\sigma - u) \tan \phi \) where \( c \) is the cohesion, \( \sigma \) is the normal stress on the sliding surface, and \( u \) is the measured pore-water pressure. The triaxial shear test is a method of obtaining values of these parameters, generally on an effective-stress basis.

The variations in the triaxial shear test procedures and the required measurements and observations to be made are outlined in Designation E-17 of the Earth Manual. The computer program for the triaxial shear test is written to accept data for any of the shear tests described in Designation E-17. The calculations are made by the computer and the shear values (\( \tan \phi \) and \( c \)) are determined from the data at the point of specimen failure, fixed in the program as the maximum stress ratio, \( \frac{\bar{\sigma}_1 - \bar{\sigma}_3}{\bar{\sigma}_3} \).

The method of least squares is an integral part of the computer program for the triaxial shear test and is used to determine the coefficient of internal friction (\( \tan \phi \)) and the cohesion, \( c \). The theory of least squares is discussed more fully under Sliding Factor and Direct Shear Least Squares. Since the calculations for the triaxial shear test are quite lengthy, they are especially well suited for processing on the computer. The process of hand checking the calculations is eliminated and a substantial saving in manpower is realized when considering an entire shear test.

Part of the output from the computer is in the form of punched cards. These cards are called for by a coding on the input data and are used for plotting some of the required test curves using a Benson-Lehner electroplotter. Page 125, appendix B, shows plots drawn by the electroplotter for a typical triaxial shear test.

The printed output data for the triaxial shear test are shown in appendix B. In addition to the values of the parameter \( \tan \phi \) and \( c \), the output data include the void ratio (\( e \)), dry density, stress ratio, and computed pore pressure for each point of observation during the shear test. The major principal effective stress, the normal, as abscissa, and shear, as ordinate, stresses are also computed for each observation made for each test specimen.

Failure is defined as the stress condition which exists when the ratio of the major principal effective stress, \( \bar{\sigma}_1 \), to the minor principal effective stress, \( \bar{\sigma}_3 \), is a maximum. When using the method of testing in which the lateral effective stress is held constant throughout the test the maximum principal stress ratio \( \frac{\bar{\sigma}_1}{\bar{\sigma}_3} \) occurs at the same point as the maximum deviator stress, \( \bar{\sigma_1} - \bar{\sigma}_3 \). When the maximum stress ratio is not considered to be the failure point of a given soil specimen, as is especially true for a fat clay (CH) soil which shows creep, an additional failure point analysis is examined. This method computes for every increment of axial strain, the slope of the stress-strain curve. When the slope of this line becomes 12° or less from the horizontal, the specimen is considered to have failed. The 12° figure is arbitrary, and is somewhat conservative, but is more realistic than including a large indicated creep strength. On a more brittle material the maximum stress ratio failure will coincide to that given by this method because the stress-strain curve has an initial steep slope from the horizontal and rapidly becomes nearly flat or negative within a small increment of strain.

Input data consisting of selected values of deviator stress and lateral stress other than those determined by the program may be entered to the least squares routine portion of the program to yield corresponding values of \( \tan \phi \) and \( c \). This feature gives more flexibility to the program. See pages 123 and 124, appendix B.

One-Dimensional Consolidation Test

The one-dimensional consolidation test is a method for determining the rate and magnitude of consolidation of undisturbed and remolded fine-grained soils, when restrained laterally and
loaded and drained axially. The coefficient of permeability and any volume change caused by varying the water content of the soil while under a selected loading may also be determined.

This same apparatus may be used to determine the expansive characteristics of a soil by varying the test procedure to simulate a given set of conditions. Designation E-15 of the Earth Manual outlines the procedures to be used in performing these tests.

Three different types of apparatus are used in the Soils Laboratory to perform one-dimensional consolidation tests. They are: platform scales (dead weight), pneumatically loaded, and pneumatically loaded with provisions for back-pressure. The dial gages currently used to measure axial movement during the test rotate in opposite directions on the different machine types; therefore, each machine is assigned a number and this loading unit number is then used to code the calculations in the computer program.

Data from the falling-head permeability test may also be included and computed with the consolidation test data.

The printed output from the computer program shows a consolidation in percent for each timed reading of each load increment. A summary is then printed out showing the load (psi and kg/sq cm), void ratio (e), dry density (pcf and gm/cc), and maximum consolidation (positive values) or expansion (negative values) in percent for each load increment applied to the specimen. A further summary shows dry density (pcf), (gm/cc); moisture content (percent) and degree of saturation (percent) for the initial, maximum load, and expanded conditions of the soil specimen.

Although punchcards for use on the electroplotter are not being called for as output at present, with minor changes in the program they could be obtained. These cards would be used to plot time versus consolidation, load versus consolidation, and void ratio versus log load curves.

This program has been used more extensively than any other in the Soils Engineering Branch. Therefore, the very favorable experience in manpower savings has encouraged the development of programs for other tests. A complete program listing is shown in appendix A, and sample sets of input and output data are included in appendix B.

### Sliding Factor and Direct Shear Least Squares

Although there is no formal designation in the Earth Manual for the sliding factor-direct shear test, the procedure is occasionally used to determine sliding friction factors between concrete mortar and soil for the design of concrete spillway aprons and other similar structures. It may also be used to determine sliding friction factors of soil on soil.

The least squares method of fitting a straight line through points obtained as test data is then used to determine the parameters of the slope and intercept of the sliding friction in a manner similar to that used to determine the position of the tangent line envelope and cohesion intercept for the triaxial shear test.

Computation of the straight-line average of two variables is done by the least squares method. This method accomplishes two objectives:

1. The sum of the vertical deviations of the observed values from the fitted straight-line equals zero. That is, if a vertical line were drawn from each observed Y value to the fitted line, the vertical lines extending upward from the fitted line would exactly balance those extending downward.

2. The sum of the squares of all these vertical deviations is less than the sum of the squared deviations from any other fitted straight line.

It is because of these characteristics that this method of fitting is called the "Method of Least Squares."

Two normal equations are used for fitting a straight line which involve the constants $a$ and $b$. In this fitting, the values of $a$ and $b$ must be determined from laboratory data obtained from the direct shear test. Consequently, two equations must be obtained and solved simultaneously.

Using the two equations:

$$
\sum xy = a \sum x + b \sum x^2
$$

$$
\sum y = a \sum N + b \sum x
$$

Rearrange into typical quadratic form

$$
a \sum x + b \sum x^2 - \sum xy = 0
$$

$$
a N + b \sum x - \sum y = 0
$$
and solve simultaneously to obtain

\[ b = \frac{N \sum xy - \sum x \sum y}{N \sum x^2 - (\sum x)^2} \]

where \( b \) is the slope of the fitted line, or in this case it becomes the more common term, tangent phi (tan \( \phi \)). From Equation (2) above then,

\[ a = \frac{\sum y - b \sum x}{N} \]

where \( a \) is the \( Y \) intercept or in this case, the cohesion. \( X \) is defined as the normal stress and \( Y \) as the shear stress. These values are obtained as data from the direct shear test. \( N \) is the total number of points \((x, y)\) obtained from testing a given soil specimen.

This computer program is written to accept up to 10 values each of \( x \) and \( y \) obtained from testing any given soil specimen. The two equations (1) and (2) are solved simultaneously and the tan \( \phi \) and cohesion are obtained and printed as output data.
SUMMARY

It is anticipated that these programs for processing Soils Engineering Branch test data will be of considerable continuing value in achieving manpower savings. The time spent in initial preparation and adjustments to the programs is small when compared to the increased efficiency in processing future test data. With the accurate output provided by the computer, checking of test data has been reduced to the input data only. Many computations using manual methods are time consuming and are avoided unless absolutely necessary. When using electronic data processing methods, more complete output data may be obtained from the same amount of original input test data. An excellent example of this is the triaxial shear test in which the void ratio, dry density, and vector points are computed for each observation.

Since the punchcards of all original test data are kept on file in the Soils Laboratory for a reasonable length of time, several operations may be performed with the data without punching additional cards. If errors are found in original data, they may be corrected (usually one card) and the test recomputed. Sometimes it is desirable to compare test results by computing the triaxial shear test using different sets (measured or computed) of pore pressures. This is easily accomplished by changing the coding on one card of input data and reprocessing the test. All the test programs have been written to be quite flexible and with minor changes to input data, test comparisons or additional analysis of test data may be made.

Current developments for the Soils Engineering Laboratory include electronic data acquisition systems first, for both the triaxial shear and one-dimensional consolidation tests, and later for other tests. The acquisition system will have the data output on magnetic tape and will generate an increased volume of test data. Therefore, these computer programs will become an integral part of the overall data handling process that is essential in manpower savings.

Tests to be programmed in the future include: specific gravity, relative density, a settlement analysis, a stability analysis, and a falling-head permeability test where both the headwater and tailwater fluctuate. The greatest use for the last mentioned test will be in conjunction with high-pressure permeability studies, although the procedure may also be used to process low-pressure test data. It is also planned to place increased emphasis on the use of the mechanical plotter which operates on punchcard computer output to make even more complete use of automated equipment.
APPENDIX A

FLOW CHART, LISTING OF PROGRAM, VARIABLE NAMES AND DEFINITIONS

The flow chart shows the order in which calculations and decisions are made when writing each of the programs. The listing shows the order of the Fortran II statements used for each of the various soil test programs, and the variable names and definitions are used to identify each variable used in each of the computer programs for the following tests:

- Natural moisture-density
- Gradation analysis
- Soil consistency (Atterberg limits)
- Proctor compaction
- Constant-head permeability-settlement
- Falling-head permeability
- Triaxial shear
- One-dimensional consolidation
- Sliding factor and direct shear, least squares
NATURAL MOISTURE-DENSITY TEST

FLOW CHART

1. SET NUMBER OF TOP SAMPLES TO 1 AND COMPUTE MOISTURE CONTENT.
2. IF SAMPLE AVAILABLE, COMPUTE CONTENT.
3. SET SAMPLE CONTENTS TO ZERO.
4. COMPUTE LENGTH AND DENSITY OF WET SAMPLE.
5. WRITE READINGS.
6. RECORD DATA.
7. WRITE DATA.
8. COMPUTE WET SAMPLE TO GET.
9. COMPLETE WET SAMPLE TO GET.
10. WRITE DATA.
11. RECORD DATA.
12. WRITE DATA.
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YES

IS CENTER SAMPLE AVAILABLE

SET NUMBER OF CENTER SAMPLES TO 1 AND COMPUTE MOISTURE CONTENT

WRITE MOISTURE CONTENT

NO

16

SET NUMBER OF CENTER SAMPLES TO ZERO

11

WRITE MOISTURE CONTENT

YES

IS BOTTOM SAMPLE AVAILABLE

15

SET NUMBER OF BOTTOM SAMPLES TO 1 AND COMPUTE MOISTURE CONTENT

WRITE MOISTURE CONTENT

NO

14

SET NUMBER OF BOTTOM SAMPLES TO ZERO

COMPUTE AVERAGE MOISTURE CONTENT AND DRY DENSITY

WRITE AVERAGE MOISTURE CONTENT AND DRY DENSITY

GO TO START

END
IN-PLACE MOISTURE-DENSITY OF SOIL IN DENISON TUBE

1 READ INPUT TAPE 5,2,S1,S2,D1,D2,TL,TID,WS,TF,DTW,DTT,DTB
2 FORMAT (4A4,7F8.3)
   READ INPUT TAPE 5,3,W1,W2,W3,W4,W5,W6,W7,W8,WS
3 FORMAT (9F8.3)
   TID=TID*2.54
   WRITE OUTPUT TAPE 6,4,D1,D2,S1,S2
4 FORMAT (IH1 8X,7H DATE 2A4,16X,12H SAMPLE NC. 2A4 /// /)
   IF (DFW)41,41,51
41 SL =TL
   WS =WST-(TL*TF)
   WRITE OUTPUT TAPE 6,5
5 FORMAT (9X,50H IN-PLACE MOISTURE-DENSITY CF SOIL IN DENISON TUBE )
   GO TO 53
51 SL =TL-DTT-DTB
   WS =WST-DTW
   WRITE OUTPUT TAPE 6,52
52 FORMAT (9X,48H IN-PLACE MOISTURE-DENSITY CF SOIL IN DRIVE TUBE)
53 SL1=SL*30.48
   WS1=WS*0.45359237
   WRITE OUTPUT TAPE 6,54,SL1,SL,TID,L,TIO,WS1,WS
54 FORMAT(/// // 9X,19H SAMPLE LENGTH = F8.3,10H CM. = F8.3,4H
   1FT. // 9X,19H SAMPLE DIAMETER= F8.3,10H CM. = F8.3,4H IN. //
   29X,19H WET SOIL WEIGHT = F8.3,10H KG. = F8.3,4H LBS. // /// /)
   WATERT=0.0
   WATERM=0.0
   WATERB=0.0
   IF (W1>6,6,7)
6 TOP=0.0
   GO TO 9
7 TOP=1.0
   WATERT1=((W1-W2)/(W2-W3))*100.0
   WRITE OUTPUT TAPE 6,8,WATERT
8 FORMAT(9X,37H WATER----TOP (PERCENT OF DRY WGT) = F8.4 // )
9 IF (W4)10,10,11
10 CEN=0.0
   GO TO 13
11 CEN=1.0
   WATERM=((W4-W5)/(W5-W6))*100.0
   WRITE OUTPUT TAPE 6,12,WATERM
12 FORMAT(9X,37H WATER-MIDDLE (PERCENT OF DRY WGT) = F8.4 // )
13 IF (W7)14,14,15
14 BOT=0.0
   GO TO 17
15 BOT=1.0
   WATERB=((W7-W8)/(W8-W9))*100.0
   WRITE OUTPUT TAPE 6,16,WATERB
16 FORMAT(9X,37H WATER-BOTTOM (PERCENT OF DRY WGT) = F8.4 // )
17 QOM=TOP+CEN+BOT
   WATER=(WATERT+WATERM+WATERB)/QOM
   DRYDEN1=WS/((SL*(TID*TID/144.0)*0.785398)*((WATER/100.0)+1.0))
   GRAMCC=DRYDEN0.0160185
**IN-PLACE MOISTURE-DENSITY OF SOIL IN DENISON TUBE**

WRITE OUTPUT TAPE 6, 18, WATER, GRAMCC, DRYDEN
18 FORMAT(111111 9X, 41H AVERAGE MOISTURE (PERCENT OF DRY WGT) = F8.4
1 // 9X, 15H DRY DENSITY = F8.4, 12H GRAMS/CC = F8.4, 11H LBS/CU. FT.)
GO TO 1
END(1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0)

NATURAL MOISTURE-DENSITY TEST FOR DENISON AND DRIVE TUBE SAMPLES

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
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<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOT</td>
<td>Number of moisture samples from bottom of soil sample, 0 or 1.</td>
<td>W3</td>
<td>Weight of dish used for moisture sample from top of soil sample (gm).</td>
</tr>
<tr>
<td>CEN</td>
<td>Number of moisture samples from center of soil sample, 0 or 1.</td>
<td>W4</td>
<td>Weight of dish and wet soil from center of soil sample (gm).</td>
</tr>
<tr>
<td>D1</td>
<td>Date test was performed.</td>
<td>W5</td>
<td>Weight of dish and dry soil from center of soil sample (gm).</td>
</tr>
<tr>
<td>D2</td>
<td></td>
<td>W6</td>
<td>Weight of dish used for moisture sample from center of soil sample (gm).</td>
</tr>
<tr>
<td>DRYDEN</td>
<td>Dry density of soil sample (pcf).</td>
<td>W7</td>
<td>Weight of dish and wet soil from bottom of soil sample (gm).</td>
</tr>
<tr>
<td>DTB</td>
<td>Drive tube empty end length-bottom (ft).</td>
<td>W8</td>
<td>Weight of dish and dry soil from bottom of soil sample (gm).</td>
</tr>
<tr>
<td>DTT</td>
<td>Drive tube empty end length-top (ft).</td>
<td>W9</td>
<td>Weight of dish used for moisture sample from bottom of soil sample (gm).</td>
</tr>
<tr>
<td>DTW</td>
<td>Drive tube weight (lb).</td>
<td>WATER</td>
<td>Average moisture content of sample—includes moisture from top, center, and bottom, if obtained (%).</td>
</tr>
<tr>
<td>GRAMCC</td>
<td>Dry density of soil sample (gm/cc).</td>
<td>WATERB</td>
<td>Moisture content of bottom of sample (%).</td>
</tr>
<tr>
<td>QOM</td>
<td>Total number of moisture samples obtained—1, 2, or 3.</td>
<td>WATERM</td>
<td>Moisture content of center of sample (%).</td>
</tr>
<tr>
<td>S1</td>
<td>Sample number.</td>
<td>WATERT</td>
<td>Moisture content of top of sample (%).</td>
</tr>
<tr>
<td>S2</td>
<td></td>
<td>WS</td>
<td>Total wet soil in sample (lb).</td>
</tr>
<tr>
<td>SL</td>
<td>Sample length (ft).</td>
<td>WS1</td>
<td>Total wet soil in sample (kg).</td>
</tr>
<tr>
<td>SL1</td>
<td>Sample length (cm).</td>
<td>WST</td>
<td>Weight of tube and wet soil (lb).</td>
</tr>
<tr>
<td>TF</td>
<td>Denison tube factor (lb/ft).</td>
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<tr>
<td>TID</td>
<td>Inside diameter of Denison or drive tube (in.).</td>
<td></td>
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</tr>
<tr>
<td>TID1</td>
<td>Inside diameter of Denison or drive tube (cm).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL</td>
<td>Tube length (ft).</td>
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<tr>
<td>TOP</td>
<td>Number of moisture samples from top of soil sample, 0 or 1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W1</td>
<td>Weight of dish and wet soil from top of soil sample (gm).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W2</td>
<td>Weight of dish and dry soil from top of soil sample (gm).</td>
<td></td>
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</tbody>
</table>

15
FLOW CHART
GRADATION ANALYSIS

START
READ ID

INITIALIZE SOIL PARTICLE SIZES

WRITE SAMPLE NUMBER

SCREEN TEST

READ SCREEN DATA

COMPUTES FOR SCREEN DATA, MOISTURE CONTENTS, DRY WEIGHTS, PERCENTAGES, WET WEIGHTS, TOTAL DRY WEIGHT

WRITE ABOVE DATA

READ WEIGHTS, DRY PLUS SAMPLE

SIEVE TEST

14 NO 9 YES
COMPUTE CODING FOR PERCENT PASSING NO. 4 SCREEN WT. OF DRY SOIL (TOTAL MATERIAL) FACTOR FOR -4 MATERIAL

HYDROMETER READINGS TEMPERATURE CORRECTIONS

COMPUTE PERCENT PASSING PARTICLE SIZES

WRITE HYDRO DATA

72 HOUR READING

WRITE

PERCENT PASSING 0.002 MM SIZE

25

26

35

25/25 HOUR READING

YES

NO

26

18
MECHANICAL ANALYSIS (GRADATION) TEST

1 READ INPUT TAPE 5,2,SCREEN,SAM,SAMP,SAMPLE
2 FORMAT (F4.0,12X,3A4)
   D1=12.7
   D2=76.2
   D3=38.1
   D4=19.1
   D5=9.52
   D6=4.76
   D7=2.380
   D8=1.190
   D9=0.590
   D10=0.297
   D11=0.149
   D12=0.074
   D13=0.037
   D14=0.019
   D15=0.009
   D16=0.005
   D17=0.002
   D18=0.001
3 WRITE OUTPUT TAPE 6,3,SAM,SAMP,SAMPLE
   30 FORMAT (1HI,4X,37H MECHANICAL ANALYSIS (GRADATION) TEST , 6X, 11H
   ISAMPLE NO 3A4 )
4 IF (SCREEN-1.0)7,4,4
5 READ INPUT TAPE 5,5,DA1,DATE1,ATC,AA,AB,AC,AD,AE,AG,AP
   5 FORMAT (2A4,8F8.2)
   READ INPUT TAPE 5,51,ADX,ADY,ADZ,AGX,AGY,AGZ,APX,APY,APZ
  51 FORMAT (9F8.2)
   WAD=(ADX-ADY)*100./(ADY-ADZ)
   WAG=(AGX-AGY)*100./(AGY-AGZ)
   WAP=(APX-APY)*100./(APY-APZ)
  BA = AA/(1.0+(WAD/100.))
  BB = AB/(1.0+(WAD/100.))
  BC = AC/(1.0+(WAD/100.))
  BD = AD/(1.0+(WAD/100.))
  BE = AE/(1.0+(WAD/100.))
  BG = AG/(1.0+(WAD/100.))
  CG = AP/(1.0+(WAD/100.))
  CRT= BA+BB+BC+BD+BE+BG
  CT = CRT + CG
  CA = CT - BA
  CB = CA - BB
  CC = CB - BC
  CD = CC - BD
  CE = CD - BE
  CGC= CE - BG
  DA = (CA/CT)*100.
  DB = (CB/CT)*100.
  DC = (CC/CT)*100.
  DD = (CD/CT)*100.
  DE = (CE/CT)*100.
MECHANICAL ANALYSIS (GRADATION) TEST

DG = (CG/CT) * 100.
ART = AA + AB + AC + AD + AE + AG
AT = ART + AP
ATC1 = ATC * 0.45359237
AT1 = AT * 0.45359237
CT1 = CT * 0.45359237
BA1 = BA * 0.45359237
CA1 = CA * 0.45359237
CB1 = CB * 0.45359237
CC1 = CC * 0.45359237
CD1 = CD * 0.45359237
CE1 = CE * 0.45359237
CG1 = CG * 0.45359237
CGCl = CGC * 0.45359237
AP1 = AP * 0.45359237

WRITE OUTPUT TAPE 6, 52, DAT1, DATE1, ATC1, ATC, AT1, AT, CT1, CT, WAD, WAG, 1WAP


WRITE OUTPUT TAPE 6, 6, BA1, BA, CA1, CA, D1, DA, CB1, CB, D2, DB, CC1, CC, D3, 1DC, CD1, CD, D4, DD, CE1, CE, D5, DE, AP1, AP, CG1, CG, D6, DG


7 READ INPUT TAPE 5, 8, SIEVE, DGA, RDW, RW, RWS

8 FORMAT (F4.0, 12X, F8.2, 8X, 3F8.2)

IF (SIEVE = .1) 14, 9, 9

9 READ INPUT TAPE 5, 11, DAT2, DATE2, RA, RB, RC, RD, RE, RG, RH

11 FORMAT (2A4, 7F8.2)

IF (SCREEN = .1) 12, 121, 121

12 DG = DGA

121 RW = RDW - RW
RS = RDS - RW
DGRW = DG/RW
SA = (RW - RA) * DGRW
SB = (RW - RB) * DGRW
SC = (RW - RC) * DGRW
SD = (RW - RD) * DGRW
SE = (RW - RE) * DGRW
SG = (RW - RG) * DGRW

WRITE OUTPUT TAPE 6, 13, DAT2, DATE2, DG, DGRW, RW, RS, D7, SA, D8, SB, D9, SC, 1D10, SD, D11, SE, D12, SG, RH

130 FORMAT (14X, 6H DATE, 2A4, 3X, 25H *****SIEVE ANALYSIS***** /, 4X,
MECHANICAL ANALYSIS (GRADATION) TEST


14 READ INPUT TAPE 5, 15, HYDROM, DGH, RDWH, RWWH
15 FORMAT (F4.0, 12X, F8.2, 8X, 2F8.2)
   IF (HYDROM = 1.) 28, 16, 16
16 READ INPUT TAPE 5, 17, DAT3, DATE3, HS, H, HDAA, HDA1, HDA2, HW1,
   HW2, HW3, HW4, HW5
17 FORMAT (2A4, 2X, A6, 4X, A4, 4X, A4, 2A4, 3A4)
   IF (SCREEN = 1.) 18, 182, 182
18 IF (SIEVE = 1.) 181, 19, 19
181 DG = DGH
   RW = RDWH - RWWH
   DGRW = DG/RW
   GO TO 19
182 IF (SIEVE = 1.) 183, 19, 19
183 RW = RDWH - RWWH
   DGRW = DG/RW
19 READ INPUT TAPE 5, 20, TA, TB, TC, TD, TE, TG
   READ INPUT TAPE 5, 20, UA, UB, UC, UD, UE, UG
20 FORMAT (6F8.1)
   VA = (TA - UA) * DGRW
   VB = (TB - UB) * DGRW
   VC = (TC - UC) * DGRW
   VD = (TD - UD) * DGRW
   VE = (TE - UE) * DGRW
   VG = (TG - UG) * DGRW
   WRITE OUTPUT TAPE 6, 21, DAT3, DATE3, DG, DGRW, RW, HW1, HW2, HW3, HW4, HW5,
   HDAA, HDA1, HDA2, HS, H
210 FORMAT (4X, 6H DATE, 2A4, 3X, 30H **** HYDROMETER ANALYSIS***** / 4X,
   133H PERCENT OF DRY WGT PASSING NO 4 = , F8.4, 13H, FACTOR (F) = , F8.5, /
   24X, 45H DRY WEIGHT OF TOTAL SAMPLE (W) (GRAMS) = , F8.2, /
   35X, 5A4, 9H USING , A4, 4H ML, 2A4, 4 / 4X, 15H STARTING TIME, A6, 5X, 15H HYDROMETER NO, A4 //)
   WRITE OUTPUT TAPE 6, 22, D13, VA, D14, VB, D15, VC, D16, VD
220 FORMAT (38X, 34H TIME PARTICLE PERCENT OF TOTAL / 36X, 36H ELAPSE
   337X, 11H 60 MIN , F6.3, 5X, F8.4, /)
   IF (TE = 1.) 25, 25, 23
23 WRITE OUTPUT TAPE 6, 24, D17, VE
24 FORMAT (32X, 16H 7 HR 15 MIN , F6.3, 5X, F8.4, /)
25 IF (TG = 1.) 28, 28, 26
26 WRITE OUTPUT TAPE 6, 27, D18, VG
27 FORMAT (31X, 17H 25 HR 45 MIN , F6.3, 5X, F8.4, //)
28 WRITE OUTPUT TAPE 6, 281
MECHANICAL ANALYSIS (GRADATION) TEST

281 FORMAT (4X,32H GRAIN SIZE FRACTIONS IN PERCENT / )
   IF (SCREEN-1.0) 31,29,29
29 OVER = 100. - DA
   COBBLE = DA - DB
   GRAVEL = DB - DG
   WRITE OUTPUT TAPE 6, 30, OVER, COBBLE, GRAVEL
300 FORMAT (7X,37H OVERSIZE (LARGER THAN 5 INCHES) ,F8.4/,7X,37H
   1COBBLES (3 INCHES TO 5 INCHES) ,F8.4/,7X,37H GRAVEL (NO 4 S
   2IZE TO 3 INCHES) ,F8.4/,)
31 IF (SIEVE - 1.0) 34, 32, 32
32 SAND = DG - SG
   WRITE OUTPUT TAPE 6, 33, SAND, SG
330 FORMAT (7X, 37H SAND (0.074 MM TO NO 4 SIZE) ,F8.4/,7X,37H
   1 SILT TO CLAY (SMALLER THAN 0.074 MM),F8.4/,)
34 IF (HYDROM - 1.0) 40, 35, 35
35 IF (SIEVE - 1.0) 38, 36, 36
36 SILT = SG - VD
   WRITE OUTPUT TAPE 6, 37, SILT
37 FORMAT (7X, 29H SILT (0.005 MM TO 0.074 MM) ,F8.4/, )
38 WRITE OUTPUT TAPE 6, 39, VD
39 FORMAT (7X, 29H CLAY (SMALLER THAN 0.005 MM) ,F8.4)
40 GOTO 1
   END(1,0,0,0,0,1,0,0,0,0,0,0)
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Wet weight retained on 5-inch screen (lb).</td>
<td>BC</td>
<td>Dry weight retained on 1½-inch screen (lb).</td>
</tr>
<tr>
<td>AB</td>
<td>Wet weight retained on 3-inch screen (lb).</td>
<td>BD</td>
<td>Dry weight retained on ¾-inch screen (lb).</td>
</tr>
<tr>
<td>AC</td>
<td>Wet weight retained on 1½-inch screen (lb).</td>
<td>BE</td>
<td>Dry weight retained on ¾-inch screen (lb).</td>
</tr>
<tr>
<td>AD</td>
<td>Wet weight retained on ¾-inch screen (lb).</td>
<td>BG</td>
<td>Dry weight retained on No. 4 screen (lb).</td>
</tr>
<tr>
<td>ADX</td>
<td>Pan+wet soil for moisture determination of + ¾-inch soil.</td>
<td>CA</td>
<td>Dry weight passing 5-inch screen (lb).</td>
</tr>
<tr>
<td>ADY</td>
<td>Pan+dry soil for moisture determination of + ¾-inch soil.</td>
<td>CA1</td>
<td>Dry weight passing 5-inch screen (kg).</td>
</tr>
<tr>
<td>ADZ</td>
<td>Pan weight for moisture determination of + ¾-inch soil.</td>
<td>CB</td>
<td>Dry weight passing 3-inch screen (lb).</td>
</tr>
<tr>
<td>AE</td>
<td>Wet weight retained on ¾-inch screen (lb).</td>
<td>CB1</td>
<td>Dry weight passing 3-inch screen (kg).</td>
</tr>
<tr>
<td>AG</td>
<td>Wet weight retained on No. 4 screen (lb).</td>
<td>CC</td>
<td>Dry weight passing 1½-inch screen (lb).</td>
</tr>
<tr>
<td>AGX</td>
<td>Pan+wet soil for moisture determination of − ¾ inch, + No. 4 soil.</td>
<td>CC1</td>
<td>Dry weight passing 1½-inch screen (kg).</td>
</tr>
<tr>
<td>AGY</td>
<td>Pan+dry soil for moisture determination of − ¾ inch, + No. 4 soil.</td>
<td>CD</td>
<td>Dry weight passing ¾-inch screen (lb).</td>
</tr>
<tr>
<td>AGZ</td>
<td>Pan weight for moisture determination of − ¾-inch, + No. 4 soil.</td>
<td>CD1</td>
<td>Dry weight passing ¾-inch screen (kg).</td>
</tr>
<tr>
<td>AP</td>
<td>Wet weight of − No. 4 soil (lb).</td>
<td>CE</td>
<td>Dry weight passing ¾-inch screen (lb).</td>
</tr>
<tr>
<td>AP1</td>
<td>Wet weight of − No. 4 soil (kg).</td>
<td>CE1</td>
<td>Dry weight passing ¾-inch screen (kg).</td>
</tr>
<tr>
<td>APX</td>
<td>Pan+wet soil for moisture determination of − No. 4 soil.</td>
<td>CG</td>
<td>Dry weight of total − No. 4 soil (lb).</td>
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<tr>
<td>APY</td>
<td>Pan+dry soil for moisture determination of − No. 4 soil.</td>
<td>CG1</td>
<td>Dry weight of total − No. 4 soil (kg).</td>
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<tr>
<td>APZ</td>
<td>Pan weight for moisture determination of − No. 4 soil.</td>
<td>CGC</td>
<td>Dry weight passing No. 4 screen (lb).</td>
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<tr>
<td>ART</td>
<td>Wet weight of + No. 4 soil (lb).</td>
<td>CGC1</td>
<td>Dry weight passing No. 4 screen (kg).</td>
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<tr>
<td>AT</td>
<td>Wet weight of total sample (lb).</td>
<td>COBBLE</td>
<td>Percent cobbles.</td>
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<tr>
<td>AT1</td>
<td>Wet weight of total sample (kg).</td>
<td>CRT</td>
<td>Total dry weight of + No. 4 soil (lb).</td>
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<tr>
<td>ATC</td>
<td>Wet weight of total sample before screening (lb).</td>
<td>CT</td>
<td>Total dry weight of sample (lb).</td>
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<tr>
<td>ATC1</td>
<td>Wet weight of total sample before screening (kg).</td>
<td>CT1</td>
<td>Total dry weight of sample (kg).</td>
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<tr>
<td>BA</td>
<td>Dry weight retained on 5-inch screen (lb).</td>
<td>D1 through D18</td>
<td>Soil particle sizes in (mm); D1 = 5 inches = 127 mm; D18 = 0.001 mm = particle size in suspension at 25 hr 45 min reading of hydrometer test.</td>
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<tr>
<td>BA1</td>
<td>Dry weight retained on 5-inch screen (kg).</td>
<td>DA</td>
<td>Passing 5-inch screen (%).</td>
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<tr>
<td>BB</td>
<td>Dry weight retained on 3-inch screen (lb).</td>
<td>DB</td>
<td>Passing 3-inch screen (%).</td>
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<tr>
<td>DC</td>
<td>Passing 1¼-inch screen (%)</td>
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<tr>
<td>DD</td>
<td>Passing ¾-inch screen (%)</td>
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<tr>
<td>DE</td>
<td>Passing ⅞-inch screen (%)</td>
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<tr>
<td>DG</td>
<td>Passing No. 4 screen (%)</td>
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<tr>
<td>DAT1</td>
<td>Date screen test was performed</td>
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<tr>
<td>DATE1</td>
<td>Date sieve test was performed</td>
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<tr>
<td>DATE2</td>
<td>Date hydrometer test was performed</td>
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<tr>
<td>DGA</td>
<td>Coding used for percent passing No. 4 screen</td>
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<td>DGH</td>
<td>Coding used for percent passing No. 4 screen</td>
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<tr>
<td>DGRW</td>
<td>Factor used to compute percent passing for —No. 4 material; (percent passing No. 4)/(weight of sample to be sieved)</td>
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<tr>
<td>GRAVEL</td>
<td>Percent gravel</td>
<td></td>
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<td>H</td>
<td>Hydrometer number</td>
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<tr>
<td>HDAA</td>
<td>Ml. of dispersing agent used in sample</td>
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<td>HDA1</td>
<td>Dispersing agent used</td>
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<td>HDA2</td>
<td>Dispersing agent used</td>
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<td>HS</td>
<td>Starting time for hydrometer test</td>
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<td>HW1</td>
<td>Time hydrometer test mixed and type of mixer used</td>
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<td>HW5</td>
<td>Coding used to determine whether hydrometer test was performed</td>
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<tr>
<td>HYDROM</td>
<td>Percent oversize material; +5 inch</td>
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<tr>
<td>OVER</td>
<td>Cumulative weight retained on No. 8 sieve</td>
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<tr>
<td>RA</td>
<td>Cumulative weight retained on No. 16 sieve</td>
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<tr>
<td>RB</td>
<td>Cumulative weight retained on No. 30 sieve</td>
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<tr>
<td>RC</td>
<td>Cumulative weight retained on No. 50 sieve</td>
<td></td>
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<tr>
<td>RD</td>
<td>Dish + dry soil to be sieved (gm)</td>
<td></td>
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<tr>
<td>RDWH</td>
<td>Coding used for dish + dry soil only if no sieve test is to be performed</td>
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**Analysis (Gradation) Test—Continued**

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<tr>
<td>RE</td>
<td>Cumulative weight retained on No. 100 sieve</td>
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<td>RG</td>
<td>Cumulative weight retained on No. 200 sieve</td>
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<tr>
<td>RH</td>
<td>Cumulative weight retained on pan</td>
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<td>RS</td>
<td>Dry soil to be sieved—after hydrometer test (gm)</td>
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<tr>
<td>RW</td>
<td>Dry soil, total sample to be sieved (gm)</td>
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<tr>
<td>RWW</td>
<td>Dish weight, total sample to be sieved (gm)</td>
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<tr>
<td>RWWH</td>
<td>Coding used for dish weight only if no sieve test is to be performed</td>
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<td>SA</td>
<td>Passing No. 8 sieve (%)</td>
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<td>SAM</td>
<td>Sample number</td>
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<td>SAMP</td>
<td>Sample number</td>
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<td>SAND</td>
<td>Percent sand</td>
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<td>SB</td>
<td>Passing No. 16 sieve (%)</td>
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<td>SC</td>
<td>Passing No. 30 sieve (%)</td>
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<td>SCREEN</td>
<td>Coding used to determine whether screen test was performed</td>
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<td>SD</td>
<td>Passing No. 50 sieve (%)</td>
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<td>SE</td>
<td>Passing No. 100 sieve (%)</td>
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<tr>
<td>SG</td>
<td>Passing No. 200 sieve (%)</td>
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<td>Coding used to determine whether sieve test was performed</td>
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<td>Percent silt</td>
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<td>TA</td>
<td>1 minute hydrometer reading</td>
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<td>TB</td>
<td>4 minute hydrometer reading</td>
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<tr>
<td>TC</td>
<td>19 minute hydrometer reading</td>
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<tr>
<td>TD</td>
<td>60 minute hydrometer reading</td>
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<tr>
<td>TE</td>
<td>7 hour 15 minute hydrometer reading</td>
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<tr>
<td>TG</td>
<td>25 hour 45 minute hydrometer reading</td>
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<tr>
<td>UA</td>
<td>Temperature correction for 1 minute hydrometer reading</td>
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<tr>
<td>UB</td>
<td>Temperature correction for 4 minute hydrometer reading</td>
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<tr>
<td>UC</td>
<td>Temperature correction for 19 minute hydrometer reading</td>
</tr>
<tr>
<td>UD</td>
<td>Temperature correction for 60 minute hydrometer reading</td>
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<tr>
<td>Variable name</td>
<td>Definition</td>
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<td>---------------</td>
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<tr>
<td>UE</td>
<td>Temperature correction for 7 hour 15 minute hydrometer reading.</td>
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<tr>
<td>UG</td>
<td>Temperature correction for 25 hour 45 minute hydrometer reading.</td>
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<tr>
<td>VA</td>
<td>Percent passing 0.037 mm particle size.</td>
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<tr>
<td>VB</td>
<td>Percent passing 0.019 mm particle size.</td>
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<tr>
<td>VC</td>
<td>Percent passing 0.009 mm particle size.</td>
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<tr>
<td>VD</td>
<td>Percent passing 0.005 mm particle size.</td>
</tr>
<tr>
<td>VE</td>
<td>Percent passing 0.002 mm particle size.</td>
</tr>
<tr>
<td>VG</td>
<td>Percent passing 0.001 mm particle size.</td>
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<tr>
<td>WAD</td>
<td>Moisture content of +¾-inch material (%).</td>
</tr>
<tr>
<td>WAG</td>
<td>Moisture content of −¾-inch, +No. 4 material (%).</td>
</tr>
<tr>
<td>WAP</td>
<td>Moisture content of −No. 4 material (%).</td>
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</table>
FLOW CHART

SOIL CONSISTENCY (ATTERBERG LIMITS) TESTS

START

READ HEADING DATA

WRITE HEADING

INITIALIZE LIQUID LIMITS

READ NUMBER OF MOISTURE SAMPLES L.L.

HOW MANY MOISTURE SAMPLES?

0

1

READ DATA

A

COMPUTE LIQUID LIMIT FOR TEST A

WRITE LIQUID LIMIT AND NUMBER OF BLOWS TEST A

10

INITIALIZE PLASTIC LIMITS

5

READ DATA

B

COMPUTE LIQUID LIMIT FOR TEST B

WRITE LIQUID LIMIT AND NUMBER OF BLOWS TEST B

10

INITIALIZE AVERAGE LIQUID LIMIT
CONSISTENCY (ATTERBERG) LIMITS TEST

1 READ INPUT TAPE 5, 2, SAM, SAMPLE, DAT, DATE
2 FORMAT (4A4)
   WRITE OUTPUT TAPE 6, 3, SAM, SAMPLE, DAT, DATE
3 FORMAT (1H1, 10X, 37H CONSISTENCY (ATTERBERG) LIMITS TEST/// 10X,
   115H SAMPLE NO 2A4 // 10X, 8H DATE 2A4 ///)
   BLL = 0.0
   ALL = 0.0
   CLL = 0.0
   READ INPUT TAPE 5, 4, QOMLL
4 FORMAT (F4.0)
   IF (QOMLL - 1.0) 10, 8, 5
5 READ INPUT TAPE 5, 6, WSDLBB, DSDLBB, DLLB, BLLB
6 FORMAT (3F8.4, F8.0)
   BLL = ((WSDLBB-DSDLBB)*100.0*(0.04*BLLB)**0.12)/(DSDLBB-DLLB)
   WRITE OUTPUT TAPE 6, 7, BLL, BLLB
7 FORMAT (12X, 8H LL-B = F8.4, 10X, 9H BLOWS = F8.0)
8 READ INPUT TAPE 5, 6, WSDLLA, DSDLLA, DLLA, BLLA
   ALL = ((WSDLLA-DSDLLA)*100.0*(0.04*BLLA)**0.12)/(DSDLLA-DLLA)
   CLL = (BLL + ALL) / QOMLL
   WRITE OUTPUT TAPE 6, 9, ALL, BLLA
9 FORMAT (12X, 8H LL-A = F8.4, 10X, 9H BLOWS = F8.0)
10 BPL = 0.0
11 APL = 0.0
12 CPL = 0.0
   READ INPUT TAPE 5, 4, QOMPL
   IF (QOMPL - 1.0) 16, 14, 11
13 READ INPUT TAPE 5, 12, WSDLPLB, DSDLPLB, DPLB
14 FORMAT (3F8.4)
   BPL = ((WSDLPLB-DSDLPLB)*100.0)/(DSDLPLB-DPLB)
   WRITE OUTPUT TAPE 6, 13, BPL
15 FORMAT (12X, 8H PL-B = F8.4)
16 READ INPUT TAPE 5, 12, WSDLPLA, DSDLPLA, DPLA
   APL = ((WSDLPLA-DSDLPLA)*100.0)/(DSDLPLA-DPLA)
   WRITE OUTPUT TAPE 6, 15, APL
17 FORMAT (12X, 8H PL-A = F8.4)
   CPL=(BPL + APL)/QOMPL
18 BSL = 0.0
19 BSR = 0.0
20 ASL = 0.0
21 ASR = 0.0
22 CSL = 0.0
23 CSR = 0.0
24 READ INPUT TAPE 5, 4, QOMSL
   IF (QOMSL - 1.0) 23, 21, 18
25 READ INPUT TAPE 5, 19, WSDSLLB, DSDSLLB, DSLB, VB, VOB
26 FORMAT (5F8.4)
   DRYB=DSDSLLB-DSLB
   BSL = (((WSDSLLB-DSDSLLB)*100.0)/DRYB)-(((VB-VOB)*100.0)/DRYB)
   BSR = DRYB / VOB
   WRITE OUTPUT TAPE 6, 20, BSL, BSR
27 FORMAT (12X, 8H SL-B = F8.4, 10X, 9H SR-B = F8.4)
CONSISTENCY (ATTERBERG) LIMITS TEST

21 READ INPUT TAPE 5, 19, WSDSL, DSDSL, DSLA, VA, VOA
   DRYA=DSDSL-DSLA
   ASL = (((WSDSL-DSDSL)*100.0)/DRYA)-(((VA-VOA)*100.0)/DRYA)
   ASR = DRYA / VOA
   WRITE OUTPUT TAPE 6, 22, ASL, ASR
22 FORMAT (12X, 8H SL-A = F8.4, 10X, 9H SR-A = F8.4 // )
   CSL = (BSL + ASL)/QOMSL
   CSR = (BSR + ASR)/QOMSL
23 IF (QOMLL -1.0) 26, 24, 24
24 WRITE OUTPUT TAPE 6, 25, CLL
25 FORMAT (1HO 14X, 27H LIQUID LIMIT (LL) = F8.4 )
26 IF (QOMPL -1.0) 29, 27, 27
27 WRITE OUTPUT TAPE 6, 28, CPL
28 FORMAT (1HO 14X, 27H PLASTIC LIMIT (PL) = F8.4 )
29 IF (QOMLL -1.0) 33, 30, 30
30 IF (QOMPL -1.0) 33, 31, 31
31 PI = CLL - CPL
   WRITE OUTPUT TAPE 6, 32, PI
32 FORMAT (1HO 14X, 27H PLASTICITY INDEX (PI) = F8.4 )
33 IF (QOMSL -1.0) 1, 34, 34
34 WRITE OUTPUT TAPE 6, 35, CSL
35 FORMAT (1HO 14X, 27H SHRINKAGE LIMIT (SL) = F8.4 )
36 WRITE OUTPUT TAPE 6, 37,CSR
37 FORMAT (1HO 14X, 27H SHRINKAGE RATIO (SR) = F8.4 )
38 GO TO 1
   END(1,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0)
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ALL</td>
<td>Liquid limit—A (%)</td>
<td>DSDSLA</td>
<td>Weight of dish and dry soil used to obtain moisture for SL-A (gm)</td>
</tr>
<tr>
<td>APL</td>
<td>Plastic limit—A (%)</td>
<td>DSDSLB</td>
<td>Weight of dish and dry soil used to obtain moisture for SL-B (gm)</td>
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<tr>
<td>ASL</td>
<td>Shrinkage limit—A (%)</td>
<td>DSLA</td>
<td>Dish weight used to obtain moisture for SL-A (gm)</td>
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<tr>
<td>ASR</td>
<td>Shrinkage ratio—A (%)</td>
<td>DSLB</td>
<td>Dish weight used to obtain moisture for SL-B (gm)</td>
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<tr>
<td>BLL</td>
<td>Liquid limit—B (%)</td>
<td>PI</td>
<td>Plasticity index (%)</td>
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<td>Number of blows for LL test A.</td>
<td>QOMLL</td>
<td>Number of moisture samples taken for LL test, zero, one, or two.</td>
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<td>BLLB</td>
<td>Number of blows for LL test B.</td>
<td>QOMPL</td>
<td>Number of moisture samples taken for PL test, zero, one, or two.</td>
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<td>BPL</td>
<td>Plastic limit—B (%)</td>
<td>QOMSL</td>
<td>Number of moisture samples taken for SL test, zero, one, or two.</td>
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<td>BSL</td>
<td>Shrinkage limit—B (%)</td>
<td>SAM</td>
<td>Sample No.</td>
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<tr>
<td>BSR</td>
<td>Shrinkage ratio—B (%)</td>
<td>VA</td>
<td>Volume of shrinkage dish used for SL test A (cc)</td>
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<td>CLL</td>
<td>Liquid limit—Average of A and B (%)</td>
<td>VB</td>
<td>Volume of shrinkage dish used for SL test B (cc)</td>
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<td>CPL</td>
<td>Plastic limit—Average of A and B (%)</td>
<td>VOA</td>
<td>Volume of dry soil—SL test A (cc)</td>
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<td>CSL</td>
<td>Shrinkage limit—Average of A and B (%)</td>
<td>VOB</td>
<td>Volume of dry soil—SL test B (cc)</td>
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<td>CSR</td>
<td>Shrinkage ratio—Average of A and B (%)</td>
<td>WSDLLA</td>
<td>Weight of dish and wet soil used to obtain moisture for LL-A (gm)</td>
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<td>DAT</td>
<td>Date test was performed.</td>
<td>WSDLLB</td>
<td>Weight of dish and wet soil used to obtain moisture for LL-B (gm)</td>
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<tr>
<td>DATE</td>
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<td>WSDPLA</td>
<td>Weight of dish and wet soil used to obtain moisture for PL-A (gm)</td>
</tr>
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<td>DLLA</td>
<td>Dish weight used to obtain moisture for LL-A (gm)</td>
<td>WSDPLB</td>
<td>Weight of dish and wet soil used to obtain moisture for PL-B (gm)</td>
</tr>
<tr>
<td>DLLB</td>
<td>Dish weight used to obtain moisture for LL-B (gm)</td>
<td>WSDSLA</td>
<td>Weight of dish and wet soil used to obtain moisture for SL-A (gm)</td>
</tr>
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<td>DPLA</td>
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<td>WSDSLB</td>
<td>Weight of dish and wet soil used to obtain moisture for SL-B (gm)</td>
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<td>Dry weight of soil used in SL-A test (gm)</td>
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<td>DRYB</td>
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FLOW CHART
PROCTOR COMPACTION TEST

START

READ DATA

INITIALIZE WATER CONTENT AND DENSITY ARRAYS

WEIGHT A READING

NO

YES

COMPUTE WET DENSITY

PERCENT WATER CONTENT

COMPUTE PENETRATION RESISTANCE DRY DENSITY

WRITE

GO TO START

END

14
PROGRAM: PRCOMP

DATA (WDT(I), WC(I), I=1,8), Z / 16 # 0.0, 0.0160185 /
READ INPUT TAPE 5, 1. SAMP, SAMP1, DATE, DAT1, CYLWT
WRITE OUTPUT TAPE 6, 2. SAMP, SAMP1, DATE, DAT1
READ (5,3) (WS(I), I=1,8), (PRN(I), I=1,8), (AR(I), I=1,8), (WD(I), I=1,8)
1. (DDS(I), I=1,8), (ID(I), I=1,8)
DO 15 I = 1,8
IF (WS(I) / LT 1.0) GOTO 15
WDT(I) = (WS(I) - CYLWT) * CYLWT
WC(I) = (WD(I) - DTS(I)) / (DDS(I) - ID(I)) * 100.0
15 CONTINUE
DO 16 I = 1,8
PR(I) = PRN(I) * AR(I)
B(I) = PR(I) * 0.070307
DD(I) = WTD(I) / (1.0 + (WC(I) / 100.0))
C(I) = DD(I) * Z
16 A(I) = WTD(I) * Z
WRITE (6,4) (WTD(I), I=1,8)
WRITE (6,5) (A(I), I=1,8)
WRITE (6,9) (B(I), I=1,8)
WRITE (6,11) (WC(I), I=1,8)
WRITE (6,12) (DD(I), I=1,8)
WRITE (6,13) (C(I), I=1,8)
GO TO 14
1 FORMAT (4A4,2F8.2)
20 FORMAT (1H1,22X,24H EARTH MATERIALS TESTING / 21X,25H PROCTOR COMP.
ACTION TEST // 15X, 12H SAMPLE NO, 2A4, 4X, 7H DATE *2A4 // 67
2H TEST NO 1 2 3 4 5 6 7
38 //)
3 FORMAT (8F8.3,8F8.0/8F8.3,8F8.3)
4 FORMAT (20HWET DENSITY PCF + F8.1, +)
5 FORMAT (20HWET DENSITY GM/CC + F8.3, +)
8 FORMAT (20HPENET. RES. PSI + F8.0, +)
9 FORMAT (20HPENET. RES. KG/SQCM + F8.1, +)
11 FORMAT (20HWATER CONTENT PCT + F8.2, +)
12 FORMAT (20HDRY DENSITY PCF + F8.1, +)
13 FORMAT (20HDRY DENSITY GM/CC + F8.3, +)
END
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 through A8</td>
<td>Wet density for each test No. 1 through 8 (gm/cc.)</td>
<td>PR1 through PR8</td>
<td>Penetration resistance for each test No. 1 through 8 (psi).</td>
</tr>
<tr>
<td>AR1 through AR8</td>
<td>Average reading obtained on penetration resistance scale for each test No. 1 through 8 (lbs).</td>
<td>PRN1 through PRN8</td>
<td>Penetration resistance needle No. used for each test No. 1 through 8, Needle No. 1=1 in.², 10=½ in.², 20=¼ in.², 40=¼ in.²</td>
</tr>
<tr>
<td>B1 through B8</td>
<td>Penetration resistance for each test No. 1 through 8 (kg/sq cm).</td>
<td>SAMP</td>
<td>Sample No. of soil specimen being tested.</td>
</tr>
<tr>
<td>C1 through C8</td>
<td>Dry density for each test No. 1 through 8 (gm/cc).</td>
<td>SAMP1 through WC8</td>
<td>Final water content for each test No. 1 through 8 (%)</td>
</tr>
<tr>
<td>CYLWOL</td>
<td>Cylinder volume 20.0=½ cu ft mold. 30.0=¾ cu ft mold.</td>
<td>WD1 through WD8</td>
<td>Weight of dish and wet soil for each test No. 1 through 8 (gm).</td>
</tr>
<tr>
<td>CYLWT</td>
<td>Cylinder weight (lb).</td>
<td>WS1 through WS8</td>
<td>Weight of cylinder and wet soil for each test No. 1 through 8 (lb).</td>
</tr>
<tr>
<td>D1 through D8</td>
<td>Weight of dish for moisture sample for each test No. 1 through 8 (gm).</td>
<td>WTD1 through WTD8</td>
<td>Wet density for each test No. 1 through 8 (pcf).</td>
</tr>
<tr>
<td>DATE</td>
<td>Date test was performed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAT1 through DD8</td>
<td>Dry density for each test No. 1 through 8 (pcf).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDS1 through DDS8</td>
<td>Weight of dish and dry soil for moisture sample for each test No. 1 through 8 (gm).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FLOW CHART
CONSTANT-HEAD PERMEABILITY TEST

START

READ HEADING DATA

WRITE HEADING DATA

READ APPLIED LOAD

CONVERT UNITS OF APPLIED LOAD FROM BRITISH TO METRIC SYSTEM

WRITE APPLIED LOAD

READ DATA

CALCULATE SETTLEMENT DATA

ARE THESE NON-TEST VALUES?

YES

WRITE SETTLEMENT DATA

NO

ARE SETTLEMENT CALCULATIONS COMPLETE?

YES

WRITE SETTLEMENT DATA

NO

25
CONSTANT HEAD PERMEABILITY TEST

ODIMENSION DIALA(15C),DIALB(150),CDD(150),HTR(150),AVG(150),
1ETBR(150),CDDC(150),HWC(150),NTV(150)
210READ INPUT TAPE 5, 1, SAMP, SAMP1, DATP, DATP1, DATR, DATRI, NHT, CALF,
1NCYL, N, PDD, SA, STI
1 FORMAT (6A4,4X,I4,F8.2,2I4, F8.2,2F8.4)
WRITE OUTPUT TAPE 6, 2
2 FORMAT (1H1, 21X, 24H EARTH MATERIALS TESTING)
WRITE OUTPUT TAPE 6, 3
3 FORMAT (19X, 29H PERMEABILITY-SETTLEMENT TEST)
WRITE OUTPUT TAPE 6, 4, SAMP, SAMP1, DATP, DATP1, DATR, DATRI
4 FORMAT (1HO, 10HSAMPLE NO ,2A4, 3X, 13H DATE PLACED ,2A4, 3X,
114H DATE REMOVED ,2A4)
WRITE OUTPUT TAPE 6, 5, NCYL, NHT
5 FORMAT (1HO, 13H CYLINDER NO ,I4, 6X, 14H HEAD TANK NO ,I4)
WRITE OUTPUT TAPE 6, 6
6 FORMAT (1HO, 8X,4HLOAD,16X,12HCONSOLIDATED,10X,10HSETTLEMENT)
WRITE OUTPUT TAPE 6, 7
7 FORMAT ( 29X, 11HCRY DENSITY)
WRITE OUTPUT TAPE 6, 18
18 FORMAT (5X,14HPSI KG/SQCM,8X,14HPCF GM/CC,11X,7H PERCENT//)
QREAD INPUT TAPE 5, 8, ETBR(I), HWC(I), ALCAD, DIALA(I), DIALB(I),
1HTR(I)
  PRESK = ALOAD * 0.070307
WRITE OUTPUT TAPE 6, 22, ALOAD, PRESK
22 FORMAT (2X, F7.2, 4X, F6.2)

SETTLEMENT DATA CALCULATION LOOP
C
DO 10 I = 2, N
QREAD INPUT TAPE 5, 8, ETBR(I), HWC(I), ALCAD, DIALA(I), DIALB(I),
1HTR(I), NTV(I)
8 FORMAT (16X, 3F8.2, 2F8.4, F8.2, I4)
  DDA = DIALA(I) - DIALA(1)
  DBB = DIALB(I) - DIALB(1)
  AVG(I) = (DDA + DBB) / 2.0
  SETT = AVG(I) / STI * 100.0

  CDD(I) = PDD / ((100.0 - SETT) / 100.0)
CDDC(I) = CDD(I) * 0.0160185
  PRESK = ALOAD * 0.070307
IF(INTV(I)) 24, 24, 25
25 WRITE OUTPUT TAPE 6, 26, ALOAD, PRESK, CDD(I), CDDC(I), SETT
26 FORMAT (2X,F7.2,4X,F6.2,5X,F8.2,3X,F8.4,7X,F8.2,3X,1H*)
   GO TO 10
24 WRITE OUTPUT TAPE 6, 9, ALOAD, PRESK, CDD(I), CDDC(I), SETT
9 FORMAT (2X,F7.2,4X,F6.2,5X,F8.2,3X,F8.4,7X,F8.2)
10 CONTINUE

PERMEABILITY TEST DATA AND COMPUTATIONS
C
WRITE OUTPUT TAPE 6, 19, SAMP, SAMP1

38
CONSTANT HEAD PERMEABILITY TEST

19 FORMAT (1H1, 3X, 2A4, 5X, 28HPERMEABILITY-SETTLEMENT TEST)
WRITE OUTPUT TAPE 6, 11
110 FORMAT (1H0, 4X, 4HHEAD, 5X, 9HYDRAULIC, 3X, 5HHOURS, 7X, 5HTOTAL, 8X, 14HC
10EFFICIENT OF)
WRITE OUTPUT TAPE 6, 12
120 FORMAT (14X, 8HGRADIENT, 2X, 7HBETWEEN, 5X, 7HELAPSED, 8X, 12HPERMEABILITY)
WRITE OUTPUT TAPE 6, 13
130 FORMAT (5X, 2HT, 8X, 5HFT/FT, 4X, 8HREADINGS, 2X, 13HTIME IN HOURS, 3X, 5H
1FT/YR, 5X, 6HC/SEC //)

C C C
PERMEABILITY COMPUTATION LOOP
C

TET = 0.0
TET = TET + ETBR(1)
WRITE OUTPUT TAPE 6, 23, ETBR(1), TET
23 FORMAT (25X, F6.1, 3X, F8.1)
N = N + 1
DO 20 J = 2, N
TET = TET + ETBR(J)
IF (NHT - 20) 14, 14, 15
14 R = HTR(J-1) - HTR(J)
GO TO 16
15 R = HTR(J) - HTR(J-1)
16 CST = STI - AVG(J)
FCST = CST / 12.0
T = ETBR(J) / 8760.0
V = R * CALF / 28320.0
A = SA / 144.0
PERM = V * FCST / (A * T * HWC(J))
IF (PERM) 27, 27, 28
27 PERM = 0.0
28 PCM = PERM * 0.000000966
HG = HWC(J) / FCST
IF (NTV(J)) 29, 29, 30
29 WRITE OUTPUT TAPE 6, 17, HWC(J), HG, ETBR(J), TET, PERM, PCM
17 FORMAT (1X, F8.2, 4X, F8.3, 4X, F6.1, 3X, F8.1, 4X, F8.2, 2X, E10.3)
GO TO 20
30 PERM = 0.0
PCM = 0.0
WRITE OUTPUT TAPE 6, 31, HWC(J), HG, ETBR(J), TET, PERM, PCM
31 FORMAT (1X, F8.2, 4X, F8.3, 4X, F6.1, 3X, F8.1, 4X, F8.2, 2X, E10.3, 2X, 1H*)
GO TO 21
END(1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)
### CONSTANT-HEAD PERMEABILITY TEST

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
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<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Area of soil specimen being tested (sq ft).</td>
<td>HTR</td>
<td>Head tank readings during test.</td>
</tr>
<tr>
<td>ALOAD</td>
<td>Load applied to soil specimen (psi).</td>
<td>HWC</td>
<td>Head under which permeability rate was obtained (ft).</td>
</tr>
<tr>
<td>AVG</td>
<td>Average movement of dials A and B for each reading obtained.</td>
<td>N</td>
<td>Total number of readings obtained on specimen.</td>
</tr>
<tr>
<td>CALF</td>
<td>Calibration factor for head tank (cu in./in.).</td>
<td>NCYL</td>
<td>Permeability cylinder number.</td>
</tr>
<tr>
<td>CDD</td>
<td>Consolidated dry density at any point during test (pcf).</td>
<td>NHT</td>
<td>Head tank number.</td>
</tr>
<tr>
<td>CDDC</td>
<td>Same as CDD except in (gm/cc).</td>
<td>NTV</td>
<td>Used to indicate nontest values, bleeding lines, head tank out of water, etc.</td>
</tr>
<tr>
<td>CST</td>
<td>Consolidated specimen length (in.).</td>
<td>PCM</td>
<td>Coefficient of permeability (cm/sec).</td>
</tr>
<tr>
<td>DATP</td>
<td>Date test was placed.</td>
<td>PDD</td>
<td>Placement dry density (pcf).</td>
</tr>
<tr>
<td>DATP1</td>
<td>Date test was removed.</td>
<td>PERM</td>
<td>Coefficient of permeability (ft/yr).</td>
</tr>
<tr>
<td>DATR</td>
<td>Date test was removed.</td>
<td>PRESK</td>
<td>Load applied to soil specimen (kg/sq cm).</td>
</tr>
<tr>
<td>DDA</td>
<td>Difference in successive dial A readings from no load reading.</td>
<td>R</td>
<td>Difference between each successive head tank reading.</td>
</tr>
<tr>
<td>DDB</td>
<td>Difference in successive dial B readings from no load reading.</td>
<td>SA</td>
<td>Area of soil specimen (sq in.).</td>
</tr>
<tr>
<td>DIALA</td>
<td>Dial A readings during test—to determine settlement or specimen length.</td>
<td>Samp</td>
<td>Sample number.</td>
</tr>
<tr>
<td>DIALB</td>
<td>Same as DIALA, except is for dial B.</td>
<td>SAMP1</td>
<td>Settlement of soil specimen due to applied load and wetting (%).</td>
</tr>
<tr>
<td>ETBR</td>
<td>Elapsed time between test readings (hr).</td>
<td>STI</td>
<td>Initial specimen thickness (in.).</td>
</tr>
<tr>
<td>FCST</td>
<td>Consolidated specimen length (ft).</td>
<td>T</td>
<td>Elapsed time between each test reading (yr).</td>
</tr>
<tr>
<td>HG</td>
<td>Hydraulic gradient under which permeability rate was obtained (ft/ft).</td>
<td>TET</td>
<td>Total elapsed time from beginning of test (hr).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V</td>
<td>Volume of water discharged through soil sample for each successive reading (cu ft).</td>
</tr>
</tbody>
</table>
FLOW CHART
FALLING-HEAD PERMEABILITY TEST

START

READ INPUT DATA

WRITE READING

COMPUTE AREA AND LENGTH OF SOIL SPECIMEN

READ ELAPSED TIME AND TUBE READING

COMPUTE ELAPSED TIME IN YEARS DIFFERENCE IN INITIAL AND SUCCESSIVE TUBE READINGS FINAL HEAD OF WATER DIFFERENCE IN PERMEABILITY RATE "K" (FT/yr)

TEST PERMEABILITY

SET PERMEABILITY RATE TO ZERO

CONVERT PERMEABILITY RATE "K" TO IPC/SEC AND COMPUTE AVERAGE HYDRAULIC GRADIENT

WRITE PERMEABILITY RATE AND HYDRAULIC GRADIENT

HAVE ALL TUBE READINGS BEEN PROCESSED?

GO TO START

END
Falling Head Permeability for Consolidometers

READ INPUT TAPE 5, 19, SAMP, SAMP1, NSPEC, LUN2, DATE, DATE2, DSPEC, SPEC
19 FORMAT(2A4, 2A4, 2A4, F8.2, F8.4)
   READ INPUT TAPE 5, 52, H1, TI, N2, AP, TC
52 FORMAT(2F8.2, 18, 2F8.4)
   WRITE OUTPUT TAPE 6, 53, SAMP, SAMP1, NSPEC, DATE, DATE2, LUN2
   AS = 3.141593 * DSPEC * DSPEC / 4.0
   SLF = SPECL / 12.0
   DO 54 I = 1, N2
   READ INPUT TAPE 5, 55, ETM, TR
55 FORMAT(F8.0, F8.2)
   ETY = ETM / (160.0 * 8760.0)
   DTR = TI - TR
   HF = H1 + (TC * DTR)
   PERM = (AP * SLF / AS) * (1.0 / ETY) * LOGF(H1 / HF)
   IF(PERM) 57, 51, 58
57 PERM = 0.0
58 PERMC = PERM * 0.00000097
   AHG = ((H1 + HF) / 2.0) / SPECL
   WRITE OUTPUT TAPE 6, 56, PERM, PERMC, AHG
56 FORMAT(1H0, 6X, F10.4, 3X, E11.4, 14X, F8.3)
54 CONTINUE
   GO TO 41
END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
## FALLING-HEAD PERMEABILITY TEST

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
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<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHG</td>
<td>Average hydraulic gradient.</td>
<td>N2</td>
<td>Total number of tube readings obtained.</td>
</tr>
<tr>
<td>AP</td>
<td>Area of water supply standpipe (sq. in.).</td>
<td>NSPEC</td>
<td>Specimen number.</td>
</tr>
<tr>
<td>AS</td>
<td>Area of soil specimen (sq. in.).</td>
<td>PERM</td>
<td>Permeability rate “k” (ft/yr).</td>
</tr>
<tr>
<td>DATE</td>
<td>Date permeability test was performed.</td>
<td>PERMC</td>
<td>Permeability rate “k” (cm/sec).</td>
</tr>
<tr>
<td>DATE2</td>
<td></td>
<td>SAMP</td>
<td>Sample number.</td>
</tr>
<tr>
<td>DSPEC</td>
<td></td>
<td>SAMP1</td>
<td></td>
</tr>
<tr>
<td>DTR</td>
<td>Difference in initial water tube readings obtained during the test.</td>
<td>SLF</td>
<td>Length of soil specimen being tested (ft).</td>
</tr>
<tr>
<td>ETM</td>
<td>Total elapsed time from beginning of test (min).</td>
<td>SPECL</td>
<td>Length of soil specimen being tested (in.).</td>
</tr>
<tr>
<td>ETY</td>
<td>ETM in years.</td>
<td>TC</td>
<td>Water tube constant (divisions are not spaced on even inches or fractions of inches)—(divisions per inch).</td>
</tr>
<tr>
<td>H1</td>
<td>Initial head of water on specimen (in.).</td>
<td>TI</td>
<td>Initial tube reading.</td>
</tr>
<tr>
<td>HF</td>
<td>Final head of water on specimen (in.).</td>
<td>TR</td>
<td>Tube readings during test.</td>
</tr>
<tr>
<td>LUN2</td>
<td>Loading unit number in which test was performed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FLOW CHART
TRIAXIAL SHEAR TEST

START

READ CONTROLS

BEGIN COMPLETE TEST

CALL FINAL

READ DATA

CALL FINAL

CALL MIDDLE

INCREMENT CONTROL 1

CALL WRITE 2

YES CONTROLS SATISFIED NO 5

READ SPECIMEN

FIRST SPECIMEN

NO

YES

READ DATA

BEGIN COMPLETE TEST

CALL FINAL

READ SPECIMEN

OUTPUT HAS NOT BEEN FLOW CHARTED

COMPUTE MOISTURE CONTENT
AIR VOLUME
SPECIFIC GRAVITY
VOID RATIO
Vd t h Pa
VOLUME CHANGE
SPECIMEN VOLUME
DRY DENSITY
DEGREE OF SATURATION

SUBROUTINE WRITE 2
SIMPLY LISTS THE
OUTPUT. IT HAS NOT
BEEN FLOW CHARTED

44
FLOW CHART
SUBROUTINE MIDDLE

1. START
2. READ CONTROLS
3. INITIALIZE VARIABLES
4. INCREMENT COUNTER 1
5. APPLIED PRESSURE MINS
   - YES
   - NO
   7. SET CONTROL K - 1

   8. COMPUTE
      DEVIATOR GAGE CORRECTION, DIFFERENCE IN AXIAL DIAL READINGS, CORRECTED DEVIATOR READING, DEVIATOR LOAD.

   9. YES
   10. CONTROL K = 0

   11. COMPUTE
        VOLUME TUBE CHANGE, PISTON VOLUME, CORRECTED DEVIATOR READING, DEVIATOR LOAD.

   12. NO

13. NO

14. SET EQUAL TO ZERO, DIFFERENCE IN AXIAL DIAL READING, DEVIATOR LOAD, DEVIATOR GAGE CORRECTION, PISTON VOLUME, CORRECTED DEVIATOR READING, VOLUME TUBE CHANGE.

15. YES

16. COMPUTE
    VOLUME TUBE CHANGE, PISTON VOLUME

17. 321

18. YES
19. CONTROL K = COUNTER 1

20. NO

21. COMPUTE
    VOLUME TUBE CHANGE, PISTON VOLUME, CORRECTED DEVIATOR READING, DEVIATOR LOAD.
NO

CONTROL 1 > APPLIED PRESSURE

NO

CONTROL 2 > APPLIED PRESSURE

NO

CONTROL 3 > APPLIED PRESSURE

YES

COMPUTE VOLUME CORRECTION

YES

COMPUTE VOLUME CORRECTION

COMPUTE VOLUME CHANGE, SPECIMEN VOLUME AND LENGTH AT ANY POINT, MEAN AREA

COMPUTE THE DIFFERENCE IN SUCCESSIVE DRAINAGE TUBE READINGS

PREVIOUS DRAINAGE TUBE READING > 0

NO

CURRENT READING > 0

YES

SET THE DIFFERENCE IN SUCCESSIVE DRAINAGE TUBE READINGS TO ZERO

NO

YES

46
STORE FIRST MAXIMUM STRESS RATIO
SET COUNTER M EQUAL TO I
SET I EQUAL TO 1

COMPUTE TEMPERATURE CORRECTION

YES

I EQUAL NO. OF TESTS

NO

33

DOES L EQUAL 2

YES

STORE FIRST MAXIMUM STRESS RATIO
SET COUNTER M

NO

COMPUTE TOTAL DRAINAGE

RETURN
FLOW CHART
SUBROUTINE FINAL

START

INITIALIZE SUMMATIONS

RUN COMPLETE TEST

READ SPEC. ID

READ REMAINING DATA

NORMAL TEST

WRITE HEADINGS

RUN COMPLETE TEST

WRITE SHEAR STRESS EFFECTIVE STRESS

WRITE

RETURN

COMPUTE COHESION ANGLE PHI

COMPUTE COHESION

49
* * * AUTOMATH 1800 SOURCE PROGRAM LISTING* * *

EFN PROGRAM: TRIAXS JOB: 1210BCTRIAXIAL

C

DIMENSION SPCTA(3), CONTA(3), SPCTW(3), CONTL(3), WLSC(3), WLS(3), SV(3)
1, DRYDEN(3), SoILV(3), WATERV(3), AIRV(3), VOIDR(3), DGSAT(3), NOREE(10)
2, ALPRR(3), VTHCHG(3), VOLTR(3), VCUBIN(3), VOLCB(3), DT1R(99),
3, 3CRVCH(99), SPVAPT(99), DEVGC(99), DIFADR(99), AXDLR(99), CDEV(99),
4, 4DEVGR(99), DVLQAN(99), PSTVOL(99), SLATA(99), ARMEAN(99), 1CUIN(99),
5, 5D2CUD(99), DT2R(99), PERCV(99), E(99), DNSTY(99), SRAIT(99,10),
6, FSTMAX(10), N(10), ASTRAL(99), TANDEG(99), DELTAV(99), POEPR(99), BPPPR
7(99), TAU3(99,10), DSTRES(99), COMPPP(99), TUPPR(99), ZNSPPR(99), TAU1(1
80), TAU1SQ(10), TAU3SQ(10), AVGTAU(99), SINTAU(99), ABSISA(99), ORDINT(99)
99, NOSAMP(4), DATE(4,10), NOSPEC(10), DRYWTS(3)

COMMON NOSAMP, NOSPEC, NOMACH, NOREEED, SPCTA, CONTA, SPCTW, CONTL, FMCONT
1, SPGRAV, TEMP1, TOTTRA, DELTAV, DNSTY, COMPPP, E, NOSIT, DWRTRIM, ZMC, AIRV
2, VAVHWW, VOIDSR, VCASAT, SV, DRYDEN, VOIDR, DGSAT, STRNRTIMR, TEMP, WTFCAC
3, TVOLR, POEPR, SRATIO, DSTRES, SPVAPT, AABPR, AWBPR, SLNGTH, BAROP, ALPRR,
4, 4DEVGR, AXDLR, VOLTR, DT1R, DT2R, TPBPPR, BPPPR, POE, CORCH, TAU3, DATE,
5, ZNSPPR, M, NREAD, N, FSTMAX, TANDEG, ASTRAL, DEVGC1, DEVGC2, TEMPCO, PSTFAC
6, DTFAC, VO, JJ, II, IPATH, PERCV, PUNCH, M1, ZMPES(99,10), CORDEV(10)
1 READ INPUT TAPE 5,2, NOSIT, (DATE(I,M), I=1,4), IPATH, NOTOT, PUNCH
2 FORMAT(110,4A5,2110,F10.0)
3 M1=1
4 CALL FINAL
5 DO 3 M=M1, NOSIT
6 IF(M=1)7,7,6
7 READ INPUT TAPE 5,2, IT, (DATE(I,M), I=1,4)
8 7 READ INPUT TAPE 5,100, NOSAMP, NOSPEC(M), NOMACH, NOREEED(M)
9 100 FORMAT(4A5,3110)
10 READ INPUT TAPE 5,101, (SPCTA(I), CONTA(I), SPCTW(I), CONTL(I), I=1,3D
1)
11 FORMAT(4F10.4)
12 READ INPUT TAPE 5,102, FMCONT, SPGRAV, DWTRIM
13 FORMAT(3F10.4)
14 READ INPUT TAPE 5,104, STRANR, TEMP, TEMP1, WTFCAC, SLNGTH
15 READ INPUT TAPE 5,104, AABPR, AWBPR, BAROP, POE, TVOLR, NOVOLT
16 FORMAT(5F10.4,1I10)
17 READ INPUT TAPE 5,105, DEVGC1, DEVGC2, TEMPCO, PSTFAC, DTFAC, VO, JJ, II
18 FORMAT(6F10.4,2I5)
19 NOREAD=NOREEED(M)
20 READ INPUT TAPE 5,106, (ALPRR(I), DEVGR(I), AXDLR(I), VOLTR(I), DT1R
1(I), DT2R(I), TPBPPR(I), BPPPR(I), ZNSPPR(I), I=1, NOREAD)
21 FORMAT(2F10.2,2F5.3,3F5.2,3F10.2)
22 ZIWWS=SPCTA(1)-CONTA(1)
23 FWS=SPCTA(2)-CONTA(2)
24 DRYWTS(2)=FWS/(1.0+0.010*FMCONT)
25 DRYWTS(3)=DRYWTS(2)
26 DRYWTS(1)=DRYWTS(2)-DWTRIM
27 ZMC=(ZIWWS/DRYWTS-1.0)*100.0
28 ASOILD=62.43*SPGOS
29 DO 8 I=1,3
30
AUTOMATH 1800 SOURCE PROGRAM LISTING

PROGRAM TRIAXS  JOB: 1210BCTRIAXIAL

IF(ISPTCA(I))=10.10.9
10 WLS(C(I))=0
   WLS(I)=0.0
   SV(I)=0.0
   DRYDEN(I)=0.0
   SOILV(I)=0.0
   WATERV(I)=0.0
   WWWTS=0.0
   WMTMC=0.0
   AIRV(I)=0.0
   VOIDR(I)=0.0
   GO TO 8
9 WLS(I)=SPCTA(I)-SPCTW(I)
   WLS(I)=WLS(I)-CONL(I)
   SV(I)=WLS(I)/16.35
   DRYDEN(I)=DRYWT(I)/62.290/WLS(I)
   SOILV(I)=DRYDEN(I)/ASOLVD*100.0
   GO TO (1000,1001,1002),I
1000 WATERV(I)=DRYDEN(I)*ZIMC/62.29
   GO TO 1003
1001 WATERV(I)=DRYDEN(I)*FMCONT/62.29
   WWWTS =SPCTA(3)-CONTA(3)
   WMTMC=(WWWTS/DRYWT(I)-1.0)*100.0
   GO TO 1003
1002 WATERV(I)=DRYDEN(I)*WMTMC/62.29
1003 AIRV(I)=100.0-SOILV(I)-WATERV(I)
   VOIDI(I)=100.0/SOILV(I)-1.0
G6SAT(I)=WATERV(I)*100.0/(100.0-SOILV(I))
   HVW= 0.02*WATERV(I)
   VAVHV=AIRV(I)+HVW
   VOIDRS=SPGRAV*ZIMC/100.0
   VCSAT=(VOIDR(I)-VOIDRS)/(1.0+VOIDR(I))*100.0
   M=M
   CALL MIDDLE
   CALL WRITE2
3 CONTINUE
   RETURN
IF(NOSIT-NOSIT)1,1,11
11 NOSIT=NOSIT+1
   M=M+1
   GO TO 5
END
SUBROUTINE MIDDLE

ODIMENSION SPTA(3), CONTA(3), SPCTW(3), CONTL(3), WLSC(3), WLS(1), SVO(3), DRYDEN(3), SOILV(3), WATERV(3), AIRV(3), VOIDR(3), DGSAT(3), NOREAD(10), 2, ALPRR(99), VTCHNG(99), VOLTIR(99), VCUIN(99), VOLCB(99), DTIR(99), 3CORVCH(99), SPVAPT(99), DEVGC(99), DIFADR(99), AXLDR(99), CDEVV(99), 4DEVGR(99), DLVLOAD(99), PSTVOL(99), SLATAP(99), ARMEN(99), D1CUI(99), 5D2CUI(99), DTIR(99), PERCVC(99), E(99), DENSTY(99), SRAIT(99, 10), 6FSTMAX(10), N(10), ASTRAN(99), TANDEG(99), DELTAV(99), POREPR(99), BPPPR 7(99), TAU3(99, 10), DSTRES(99), COMPPP(99), TPPPR(99), ZNSPPR(99), TAU1(1), 8TAU1SQ(10), TAU3SQ(10), AVGTAU(99), SINTAU(99), ABSISA(99), ORDINT(99, 99), NOSAMP(4), DATE(4, 10), NOSPEC(10)

OCOMMON NOSAMP, NOSPEC, NOMACH, NOREAD, SPTA, CONTA, SPCTW, CONTL, FMCONT 1, SPGRV, TEMPL, TOTDBA, DELTAV, DENSTY, COMPPP, E, NOSIT, DWTRIM, ZMC, AIRV 2, VAHYV, VOIDR, VCSAT, SV, DRYDEN, VOIDR, DGSAT, STRANR, NTIMR, TEMP, WTCFAC 3, TVOLR, POREPR, SRATIO, DSTRES, SVAPT, AABPR, AWBPR, SLNTH, BAROP, ALPRR, 4DEVGR, AXLDR, VOLTIR, DTIR, DTIR, TPPPR, BPPPR, PORE, CORVCH, TAU3, DATE, 5ZNSPPR, M, NOREAD, N, FSTMAX, TANDEG, ASTRAN, DEVGC1, DEVGC2, TEMPCO, PSTFAC 6, DTFC, VO, JJ, II, 1, PATH, PERCV, PUNCH, M1, ZMPES(99, 10), CORDEV(10)

SQtF(X) = SQRT(X)
ABSF(X) = ABS(X)
ATANF(X) = ATAN(X)

READ INPUT TAPE 5, 300, 4ABLE, AB1, AB2, BAKER, BAK1, BAK2, CHARLY, CHAR1, 1CHAR2, DOGY1, DOGY2, BOS5

300 FORMAT(7, 1, 2F6.5, 1F6.1, 2F6.5, 1F6.1, 2F6.5, 1F6.1, 2F6.5, 1F6.1, 2F6.5, 1F6.1, 2F6.5, 1F6.1, 2F6.5)

L = 1
AXSTRS = 0.0
TOT1CU = 0.0
TOT2CU = 0.0
I = 0
J = 1
K = 0
XX = NOREAD - 1
TEMPCO = TEMPCO + (TEMP - TEMP1) / XX
TEMPCO = 0.0

33 I = I + 1
IF(ALPRR(I)) 7, 8, 8
8 Y = SIGN(1.0, ALPRR(I))
IF(Y) 7, 31, 31
7 K = I
ALPRR(I) = ABSF(ALPRR(I))
GO TO 70

31 IF(K) 10, 10, 70
70 DEVGC1(I) = DEVGC1 + ALPRR(I) + DEVGC2
DIFADR(I) = AXLDR(K) - AXLDR(I)
CDEVV(I) = DEVR(I) - DEVGC1(I)
DLVLOAD(I) = DEVR(I) + WTCFAC
IF(I) 351, 351, 32

351 VTCHNG(I) = VO - VOLTIR(I)
PSTVOL(I) = PSTFAC * (AXDLR(I) - AXLDR(I - 1)) * (-1.0)
J = 2
CDEVV(I) = 0.0
**AUTOMATH 1800 SOURCE PROGRAM LISTING**

EFN PROGRAM: MIDDLE

**JOB: 1210BCTRIAXIAL**

```
DVLOAD(I) = 0.0
GO TO 304

32 VTCHNG(I) = TVOLR - VOLTR(I) + VTCHNG(K)
PSTVOL(I) = PSTFAC * DIFADR(I) + PSTVOL(K)
GO TO 304

10 DEVGC(I) = 0.0
PSTVOL(I) = 0.0
DVLOAD(I) = 0.0
CDEVR(I) = 0.0
DIFADR(I) = 0.0
VTCHNG(I) = 0 - VOLTR(I)

304 VCUBIN(I) = BOSS * VTCHNG(I)
IF (ABLE = ALPRT(I)) 15, 14, 14

14 VOLCB(I) = AB1 * ALPRT(I) + AB2
GO TO 306

15 IF (BAKER - ALPRT(I)) 17, 16, 16
16 VOLCB(I) = BAK1 * (ALPRT(I) - ABLE) + BAK2
GO TO 306

17 IF (CHARLY - ALPRT(I)) 19, 18, 18
18 VOLCB(I) = CHAR1 * (ALPRT(I) - BAKER) + CHAR2
GO TO 306

19 VOLCB(I) = DOGY1 * (ALPRT(I) - CHARLY) + DOGY2

306 CORVCH(I) = PSTVOL(I) + VCUBIN(I) + VOLCB(I) + TEMPCO

78 SPVAPT(I) = SV(I) * CORVCH(I)
SLATAP(I) = SLENGTH - ABSF(DIFADR(I))
ARMEAN(I) = SPVAPT(I) / SLATAP(I)

74 IF (I - I) 38, 38, 744
744 IF (DT1R(I - I)) 38, 38, 30
30 IF (DT1R(I)) 38, 38, 45
38 D1CUIN(I) = 0.0
D2CUIN(I) = 0.0
GO TO 46

45 D1CUIN(I) = (DT1R(I - I) - DT1R(I)) * DTFAC
D2CUIN(I) = (DT2R(I - I) - DT2R(I)) * DTFAC

46 TOT1CU = TOT1CU + D1CUIN(I)
TOT2CU = TOT2CU + D2CUIN(I)
PERCV(I) = (SV(I) - SPVAPT(I)) / SV(I) * 100.0
EPS(1) = EORR(I - (1.0 - EORR(I)) * PERCV(I) / 100.0)
DENSTY(I) = DRYDEN(I) * 100.0 / (100.0 - PERCV(I))
IF (K) 75, 75, 37

75 DSTRES(I) = 0.0
TANDEG(I) = 0.0
TAU3(I, M) = 0.0
ASTRAN(I) = 0.0
DELTA(I) = 0.0
POREPR(I) = BPPPR(I) * AABPR
SRATIO(I, M) = 0.0
IF (ALPRT(I)) 766, 76, 766

37 DSTRES(I) = DVLOAD(I) / ARMEAN(I)
ASTRAN(I) = ABSF(DIFADR(I) * 100.0 / SLENGTH)
DELTA(I) = (SPVAPT(K) - SPVAPT(I)) / SPVAPT(K) * 100.0
```
EfN

PROGRAM: MIDDLE

JOB: 1210BCTRIAXIAL

OTANDEG(I)=180. * ATANF((DSTRES(I,1)-DSTRES(I-1))/ASTRAN(I)-ASTRAN
1(I-1))/3.1415926

766 POREPR(I)=BPPPR(I)+AABPR
IF(PORE) 42,43,44
42 TAU3(I,M)=ALPRR(I)-POREPR(I)
GO TO 76
43 TAU3(I,M)=ALPRR(I)-TPPRR(I)
GO TO 76
44 TAU3(I,M)=ALPRR(I)-ZNSPRR(I)
76 COMPPP(I)=BAROP*PERCVC(I)/(VAHVV=PERCVC(I))
SRATIO(I,M)=DSTRES(I)/TAU3(I,M)
ZMPES(I,M)=TAU3(I,M)+DSTRES(I)
IF(AXSTRS=SRATIO(I,M)) 40,39,39
39 GO TO (41,40)*L
41 FSTMAX(M)=AXSTRS
CORDEV(M) = DSTRES(I-1)
N(M)=I-1
L=2
40 AXSTRS=SRATIO(I,M)
TEMPCO=TEMPCO+TEMP
6 CONTINUE
IF(I.NE.NOREAD) GO TO 33
IF(L-2) 352,353,353
352 FSTMAX(M)=AXSTRS
N(M)=NOREAD
353 TOTDRA=TOT1CU+TOT2CU
RETURN
END
AUTOMATH SOURCE PROGRAM LISTING

PROGRAM: PROG03
JOB: 1210BCTRIAXIAL

SUBROUTINE WRITE2

ODIMENSION SPCTA(3),SPCA(3),SPCTW(3),SPL(3),SPL(3),SPL(3)
1,DRYDEN(3),SOIL(3),WATER(3),AIR(3),VOIDR(3),DG2(3)
2,ALPRR(99),VTCHNG(99),VOLTIR(99),VOLCB(99),DTIR(99)
3CORYCH(99),SPVAP(99),DEVGC(99),DIFADR(99),AXDLR(99)
4,DEVR(99),DVLOAD(99),PSTVOL(99),SLATAP(99),ARMEAN(99),DTICUN(99)
5,5D2UIN(99),DT2R(99),PERVC(99),E(99),DENSTY(99),SRATIO(99,10)
6,6FSTMAX(10),N(10),ASTRAN(99),TANDEG(99),DELTAV(99),POREPR(99),BPPR
7(99),TAU3(99,10),DSTRES(99),COMPP(99),TPPR(99),NSENSR(99),TAU1(1
80),TAU1SQ(10),TAU3SQ(10),AVGT(99),SINTA(99),ABSISA(99),ORDINT(99)
99,10,NOSAMP(4),DATE(4,10),NOSPEC(10),IX(5,50),K(5)
10COMMON NOSAMP,NOSPEC,NOMACH,NOREED,SPCTA,SPCA,SPCTW,SPL,FMCONT
1,SPGRAV,TEMP1,TOTDRA,DELTA,DENSTY,COEFF,E,DWTRIM,TRIM
2,VAHVM,VOIDR,SCAT,SV,DRYDEN,VOIDR,GSAT,STRAINS,TIMR,TEMP,TCFAC
3,TVOLM,PREPR,SRATIO,DSTRES,SPVAP,SPR,AMPR,ALPRR,AMPR
4,DEVR,AIDLR,VOLTIR,DTIR,DT2R,TPPRR,POREPR,PORE,COND,TAU3,DATE
5,5ZNSPR,M,NOEAD,M,FSTMAX,TANDEG,ASTRAN,DEVGC1,DEVGC2,TEMPCO,PSTFAC
6,6DFAC,VOJ,JUJ,IPATH,PERC,UCUBN,UX,ZMPES(99,10),CORDEV(10)

WRITE OUTPUT TAPE 6,1,(DATE(1,M),I=1,4)

10FORMAT(1H1,48X,24SOILS ENGINEERING BRANCH/47X,28HTRIAXIAL SHEAR T
EST RESULTS /5OX, 4A5/)
WRITE OUTPUT TAPE 6,2,NOSAMP,NOSPEC(M),NOMACH

20FORMAT(35X,50HSPECIMEN NUMBER SPECIMEN NUMBER MACHINE NUMBER//
130X,4A5,5X,15,16X,12//)
A1=16.367064
A2=0.07035612
A3=0.0160185
WRITE OUTPUT TAPE 6,3,ZM,FMCONT,AIRV(1),
1
SPGRAV,VOIDR,VAHVM,VSAT
3 FORMAT(3X,58HPERCENT MOISTURE CONTENT PERCENT AIR VOLUME SP
1ECIFIC 9X,10HPERCENT RATIO 9X,7HVA+HOMICX,18PERCENT VOL CHANGE 6X,17
2HINITIAL FINAL12X,THINITIAL 11X,7HGRAVITY 9X,13HAT SATURATION
37X,7HPERCENT 8X,13HAT SATURATION //F12.2,F11.2,11X,F7.2,10X,F8.2,
411X,F7.4,11X,F7.2,11X,F7.2 //)
B1=A1*SV(1)
B2=A2*DRYDEN(1)
B3=A3*SV(2)
B4=A3*DRYDEN(2)
B5=A5*SV(3)
B6=A3*DRYDEN(3)
WRITE OUTPUT TAPE 6,5,SV(1),B1,DRYDEN(1),B2,VOIDR(1),DG2(1)
1
2,SV(2),B3,DRYDEN(2),B4,VOIDR(2),DG2(2)
3,SV(3),B5,DRYDEN(3),B6,VOIDR(3),DG2(3)
5 FORMAT(25X,15HSPECIMEN VOLUME 12X,11HDRY DENSITY 13X,4HVOD 10X
19DEGREE OF/25X,6HCUTX,7X,2HCCX,10X,3HPFCBX,5HHR/CC9X,5HRAT10X
2,10HAT SATURATION//16X,7HINITIAL F7.3,F11.2,F13.2,11X,F7.2,10X,
3F7.2/16X,7HFINAL F7.3,F11.2,F13.2,11X,F7.2,10X,
4F7.2/16X,7HWFETTED F7.3,F11.2,F13.2,11X,F7.2,10X,
5F7.2/)
WRITE OUTPUT TAPE 6,8
8 FORMAT(68HPERCENT VOLUME CHANGE DEVIATOR STRESS PE
EFN PROGRAM: WRITE2 JOB: 121OBCTRIAXIAL

1RCENT STRESS 20X, 13HPORE PRESSURE /6X,20HTOTAL DURING SHEAR
2 25X, 6HSTRAIN 6X,5HRATIO 16X,3HTOP 15X, 6HBOTTOM/30X,15HPSI K
3GSCM 34X,34HPSI, KGSCM PSI, KGSCM /

DO 9 I=1,NOREAD
B1=DSTRES (I )*A2
B2=TPPRR(I )*A2
B3=IBPPPRR(I )*A2
WRITE(6,10) PERCVC(I ),DELTAVI(I ),DSTRES(I ),B1,ASTRANCI ),SRATIOI(I,M)
1 ) ,TPPRR(I ),B2,IBPPPRR(I ),B3
9 CONTINUE
WRITE OUTPUT TAPE 6,1,(DATE(I,M),I=1,4)
WRITE OUTPUT TAPE 6,2,NOSAMP,NOSPEC(M),NOMACH
WRITE OUTPUT TAPE 6,11
11 FORMAT(10X+16HLATERAL PRESSURE 15X,15HSPECIMEN VOLUME 6X,5HANGLE
16X,12HCOMPURE PORE 11X,7HDENSITY 10X,4HYOID/5X,7HAPPLIED 11X,9HEFF
2ECTIVE 10X,12HAT ANY POINT 9X,2HIN 10X,8HPRESSURE 30X,5HRATIO/3X,
351HPSI, KGSCM PSI, KGSCM CC7X,47HDEGREE
45 PSI, KGSCM PCF, GR/CC /

DO 12 I=1,NOREAD
B1=ALPRR(I )*A2
B2=TAU3(I,M )*A2
B3=SPVAPT(I )*A1
B4=COMPPP(I )*A2
B5=DENSTY(I )*A3
WRITE(6,13) ALPRR(I ),B1,TAU3(I ,M),B2,SPVAPT(I ),B3,TANDEG(I ),COMPP
1(P(I ),B4,DENSTY(I ),B5,E(I ))
1.3,F11.4)
12 CONTINUE
WRITE OUTPUT TAPE 6,14,STRANR,TOTDRA
14 FORMAT(/42X9HSTRAIN RATE TOTAL DRAINAGE/43XF7.3,09XF7.3)
16 DD=10.0
NOREAD=NOREAD-1
17 DO 18 I=1,NOREAD
IXC1,I)=100.0*ASTRAN(I )+0.50
IXC2,I)=100.0*PERCVC(I )+0.50
IXC3,I)=DD*DSTRES I ) +0.50
IXC4,I)=100.0*POREPRR(I )+0.50
IXC5,I)=100.0*COMPPP(I )+0.50
IF(I-1)23,23,24
23 IPU=03
GO TO 25
24 IPU=00
25 DO 19 J=1,5
IF(IX,J,I))20,21,21
20 K(J)=-1
GO TO 19
21 K(J)=11
19 CONTINUE
**AUTOMATH 1800 SOURCE PROGRAM LISTING**

**PROGRAM: WRITE2**

```fortran
0 WRITE OUTPUT TAPE 7,22, I,NOSPEC(M),K(1),IX(1+1),K(2),IX(2+1),IPU,
  1K(3),IX(3+1),K(4),IX(4+1),K(5),IX(5+1)
22 FORMAT(2I5,2(4X,I2,I4),8X,I2,10X,3(4X,I2,I4))
18 CONTINUE
IPU=08
I=NOREAD
0 WRITE OUTPUT TAPE 7,22, I,NOSPEC(M),K(1),IX(1+1),K(2),IX(2+1),IPU,
  1K(3),IX(3+1),K(4),IX(4+1),K(5),IX(5+1)
26 CONTINUE
RETURN
END
```
SUBROUTINE FINAL

0DIMENSION SPCTA(3) CONTAV 3) SPCTW (3) CONT (3) WLS C3) WLS (3) SV (3)
1) DRYDEN (3) SOILV (3) WATERV (3) AIRV (3) VOIDR (3) DGSAT (3) NOREED (10)
2) ALPRR (99) VTCHNG (99) VOLBR (99) VCUBIN (99) VOLLB (99) DT1R (99)
3) CROVC (99) SPPAFT (99) DFCGC (99) DIFADR (99) AXDLR (99) CDEVR (99)
4) DEXTGR (99) DVLOAD (99) PSTVAL (99) SLTAP (99) AMEAN (99) DMCUIN (99)
5) D2CUIN (99) DT2R (99) PRCV (99) E (99) DENSITY (99) SRATIO (99, 10)
6) FSTMAX (10) N (10) ASTRAN (99) TANG (99) DELTAV (99) PREP (99) BPPPR
7) TAU3 (99) TAU6 (99) DSTRES (99) COMPP (99) TPRR (99) ZNSPRR (99) TAU1 (1)
8) TAU1SQ (10) TAU6SQ (10) AVGTAU (99) SINTAU (99) ABINS (99) ORDINT (99)
9) NOSAMP (4) DATE (4, 10) NOSPEC (10) I (5, 50) K (5)

COMMON NOSAMP, NOSPEC, NAMACH, NOREED, SPCTA, CONTAV, SPCTW, CONTO, FMCONT
1) SPGRV, TEM1, TOTDRA, DELTAV, DENSY, COMPP, E, NOSIT, DWMR, TIM1, AIRV
2) VHAVW, VOIDR, VCSAT, SV, DRYDEN, VOIDR, DGSAT, STRANR, NTIMR, TEMP, WTFCAC
3) TVOLR, PREP, SRATIO, DSTRES, SPVAPTI, AABPR, ABWR, SLGTH, BAROP, ALPRR
4) DEXTGR, AXDLR, VOLBR, DT1R, DT2R, TPRR, BPPPR, PORE, CROVC, TAU3, DATE
5) ZNSPRR, M, NOREED, N, FSTMAX, TANDEG, ASTRAN, DEVGC1, DEVGC2, TEMPCO, PSTFAC
6) DTFAC, VO, J, I, I, IPATH, PERCV, PUNCH, M1, ZMPE99, 99, 10, CORDEV (10)

SQRTF(X) = SQRT(X)

SQR(X) = ATAN(X)

COSF(X) = COS(X)

SINF(X) = SIN(X)

TODAY = 6TH TEST

SUMT1 = 0

SUMT15 = 0

SUMT3 = 0

SUMT35 = 0

IF (IPATH = 2) 11, 12, 12

11 DO 3 M = 1, NOSIT

3 N(M) = M

READ INPUT TAPE 5, 4, NOSAMP, NAMACH

4 FORMAT (4A5, 110)

NOSPEC = 0

READ INPUT TAPE 5, 5, (CORDEV (M), TAU3 (M, M), M = 1, NOSIT)

5 FORMAT (2F10.3)

12 DO 50 M = 1, NOSIT

J = N(M)

IF (J = 1) 69, 70, 70

70 Y = SQRTF ((CORDEV1/2, 0) ** 2 / (1, 0 + TANPHI ** 2))

X = CORDEV1/2 / Y * TANPHI

COMES = Y * TANPHI (X + TAU3 (J, 1))

GO TO 71

69 TAU1 (M) = CORDEV (M) * TAU3 (J, M)

TAU1SQ (M) = TAU1 (M) ** 2

TAU3SQ (M) = TAU3 (J, M) ** 2

SUMT1 = SUMT1 + TAU1 (M)

SUMT15 = SUMT15 + TAU1 (M) ** 2

SUMT3 = SUMT3 + TAU3 (J, M)

50 SUMT35 = SUMT35 + TAU3 (J, M) ** 2

NOSIT = NOSIT

A = SQRTF ((OOSIT * SUMT15 - SUMT1 ** 2) / (OOSIT * SUMT35 - SUMT3 ** 2))
**AUTOMATH 1800 SOURCE PROGRAM LISTING**

**PROGRAM: FINAL**

**SOURCE PROGRAM JOB:**

**LISTING**

```
COHESN = (SUMT1-A*SUMT3)/(OOSIT*2.*SQRTF(A))
TANPHI = (A-1.)/(2.*SQRTF(A))
PHI = ATANF(TANPHI)*180.0/3.1415926
IPHI = PHI
HPHI = IPHI
ZMIN = (PHI-HPHI)*60.0
ONEC2B = 1.0-COSF(3.1415926/2.0-ATANF(TANPHI))
SIN2B = SINF(3.1415926/2.0-ATANF(TANPHI))

71 DO 51 M=M1+NOSIT
    WRITE OUTPUT TAPE 6,1.(DATE(I,M)*I=1,4).TODAY
10 FORMAT(1H1,43X,24HSOILS ENGINEERING BRANCH/41X,27HTRIAXIAL SHEAR TEST RESULTS/45X,4A5/52X,5A6/A)
    WRITE OUTPUT TAPE 6,2,NOSAMP,NOSPEC(M),NOMACH
20 FORMAT(29X,50HSAMPLE NUMBER SPECIMEN NUMBER MACHINE NUMBER/)
    IF(IPATH=2)8,7,7
7 NOREAD=NOREED(M)
    WRITE OUTPUT TAPE 6,68
68 FORMAT(13X,67HMAJOR PRINCIPAL EFFECTIVE STRESS SHEAR STRESS/1 NORMAL STRESS / 25X,12H BAR SIGMA 1,13X, 8HABSCISSA,10X,8HORDINAT 2E// 22X, 58H PSI KGSQMCM PSI KGSQMCM PSI KG 3SQCM/) DO 52 I=1,NOREAD
    AVGTAU(I)=DSTRES(I)/2.
    SINTAU(I)=ONEC2B*AVGTAU(I)
    ABSISA(I)=TAU3(I,M)+SINTAU(I)
    ORDINT(I)=SIN2B*AVGTAU(I)
    B1=0.07035812*ABSISA(I)
    B2=0.07035812*ORDINT(I)
    B3=0.07035812*ZMPFS(I,M)
    WRITE (6,53) ZMPFS(I,M),B3,ABSISA(I),B1,ORDINT(I),B2
52 CONTINUE
51 CONTINUE
8 B1=0.0705812*COHESN
    WRITE OUTPUT TAPE 6,61,COHESN,B1,TANPHI,IPHI,ZMIN
610 FORMAT(/33X8HCOHESN10X7HTANGENT9X9HANGLE PHI/30X4HPSI,5X5HKGSQMCM 19X,3HPHI9X4HDEG,6X4HMIN.//28XF6.2,4XF6.3,6XF8.5,7X13,7X,F5.1)
    RETURN
END
```
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AABPR</td>
<td>Applied air back pressure (psi).</td>
<td>DGSAT</td>
<td>Degree of saturation for initial, wetted, or final condition (%)</td>
</tr>
<tr>
<td>ABSISA</td>
<td>Normal stress for each point during test (psi).</td>
<td>DIFADR</td>
<td>Difference in successive axial dial readings during shear test.</td>
</tr>
<tr>
<td>AIRV</td>
<td>Air volume in soil specimen for initial, wetted, or final condition (cu. in.).</td>
<td>DRYDEN</td>
<td>Dry density of soil specimen for initial, wetted, or final condition (pcf).</td>
</tr>
<tr>
<td>ALPRA</td>
<td>Applied lateral pressure reading for each point during test (psi).</td>
<td>DRYWTS</td>
<td>Dry weight of soil specimen (gm).</td>
</tr>
<tr>
<td>ARMEAN</td>
<td>Mean area of soil specimen for each point during shear test (sq. in.).</td>
<td>DSTRES</td>
<td>An array containing deviator stresses for all specimens in the test.</td>
</tr>
<tr>
<td>ASOLID</td>
<td>Absolute soil density (pcf).</td>
<td>DTFAC</td>
<td>Drainage tube factor (cu in./in.).</td>
</tr>
<tr>
<td>ASTRAN</td>
<td>Axial strain for each point during test (%).</td>
<td>DT1R</td>
<td>Drain tube readings for left drain tube.</td>
</tr>
<tr>
<td>AVGTAU</td>
<td>Deviator stress for each point during test (psi).</td>
<td>DT2R</td>
<td>Drain tube readings for right drain tube.</td>
</tr>
<tr>
<td>AWBPR</td>
<td>Applied water back pressure (psi).</td>
<td>DVLOAD</td>
<td>An array containing deviator loads (lb).</td>
</tr>
<tr>
<td>AXDLR</td>
<td>Axial dial reading for each point during test.</td>
<td>DWTRIM</td>
<td>Dry weight of trimmings from wetted specimen (gm).</td>
</tr>
<tr>
<td>AXSTRS</td>
<td>A variable set equal to the first maximum stress ratio.</td>
<td>D1CUIN</td>
<td>Arrays containing the difference in successive readings of Drain Tubes No. 1 and 2 (cu in.).</td>
</tr>
<tr>
<td>BAROP</td>
<td>Barometric pressure while test was performed (psi).</td>
<td>D2CUIN</td>
<td>Void ratio at any point during test (e).</td>
</tr>
<tr>
<td>BPPPR</td>
<td>Bottom plate pore pressure readings (psi).</td>
<td>E</td>
<td>Moisture content of soil specimen at final condition (%).</td>
</tr>
<tr>
<td>CDEVR</td>
<td>Corrected deviator readings (lb).</td>
<td>FMCONT</td>
<td>Corrected volume change during test (cu in.).</td>
</tr>
<tr>
<td>COHESN</td>
<td>Cohesion of soil sample obtained from least squares routine (psi).</td>
<td>FSTMAX</td>
<td>First maximum value of stress ratio.</td>
</tr>
<tr>
<td>COMPPP</td>
<td>Computed pore pressure for each point of test (psi).</td>
<td>FWWS</td>
<td>Final wet weight of soil specimen (gm).</td>
</tr>
<tr>
<td>CONTA</td>
<td>Weight of specimen container in air for initial, wetted, or final condition (gm).</td>
<td>HPHI</td>
<td>Angle PHI from least squares routine to nearest degree.</td>
</tr>
<tr>
<td>CONTL</td>
<td>Weight loss of specimen container (gm).</td>
<td>HWV</td>
<td>Henry’s constant times the initial water volume.</td>
</tr>
<tr>
<td>CORVCH</td>
<td>Corrected volume change during test (cu in.).</td>
<td>II</td>
<td>A constant used to determine initial specimen volume.</td>
</tr>
<tr>
<td>DATE</td>
<td>Change in volume during shear (cu in.).</td>
<td>IPATH</td>
<td>A coding used to calculate either entire shear test or just least squares.</td>
</tr>
<tr>
<td>DELTAV</td>
<td>Density of soil specimen for any point during test (pcf).</td>
<td>I PHI</td>
<td>Change HPHI to fixed point notation.</td>
</tr>
<tr>
<td>DENVGC</td>
<td>Deviator correction due to applied lateral pressure (lb).</td>
<td>IX</td>
<td>An array used when punching cards for output.</td>
</tr>
<tr>
<td>DENVGC1</td>
<td>Same as DENVGC.</td>
<td>J</td>
<td>A variable used to distinguish before touch values from after touch values.</td>
</tr>
</tbody>
</table>
### TRIAXIAL SHEAR TEST—Continued

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>A variable used to identify touch values.</td>
<td>SRATIO</td>
<td>Stress ratio at any point ( \left( \frac{\sigma_1 - \sigma_2}{\sigma_3} \right) ).</td>
</tr>
<tr>
<td>L</td>
<td>A variable indicating whether a first maximum of stress ratio has been reached.</td>
<td>STRANR</td>
<td>Strain rate at which test was performed (in./min).</td>
</tr>
<tr>
<td>N</td>
<td>An array containing variables to indicate which stress ratio is the first maximum.</td>
<td>SV</td>
<td>Specimen volume for initial, final, or wetted condition (cu. in.).</td>
</tr>
<tr>
<td>NOMACH</td>
<td>Machine number in which test was performed.</td>
<td>TANDEG</td>
<td>Angle in degrees (( \angle = \tan^{-1} ) is deviator stress/percent axial strain).</td>
</tr>
<tr>
<td>NOREAD</td>
<td>Total number of readings taken on specimen.</td>
<td>TANPHI</td>
<td>Tangent of Angle ( \phi ) from least squares.</td>
</tr>
<tr>
<td>NOREED</td>
<td>An array with the number of readings taken on all specimens in the test.</td>
<td>TEMP</td>
<td>Temperature at beginning of test (°F).</td>
</tr>
<tr>
<td>NOSAMP</td>
<td>Sample number.</td>
<td>TEMP1</td>
<td>Temperature at end of test (°F).</td>
</tr>
<tr>
<td>NOSIT</td>
<td>Number of specimens used to determine tan ( \phi ).</td>
<td>TEMPCO</td>
<td>Temperature correction factor and temperature correction.</td>
</tr>
<tr>
<td>NOSPEC</td>
<td>Specimen number.</td>
<td>TOTDRA</td>
<td>Total drainage from specimen (cu. in.).</td>
</tr>
<tr>
<td>NOTOT</td>
<td>Total number of specimens in tests.</td>
<td>TOT1CU</td>
<td>Total drainage from drain tube No. 1 (cu. in.).</td>
</tr>
<tr>
<td>NOVOLT</td>
<td>Volume tube number; Left=1; Right=2.</td>
<td>TOT2CU</td>
<td>Total drainage from drain tube No. 2 (cu. in.).</td>
</tr>
<tr>
<td>OOSIT</td>
<td>Change NOTOT to floating point notation.</td>
<td>TPPPR</td>
<td>Top plate pore pressure readings.</td>
</tr>
<tr>
<td>ORDINT</td>
<td>Shear stress for each point during test (psi).</td>
<td>TVOLR</td>
<td>Volume tube reading at touch.</td>
</tr>
<tr>
<td>PERCVVC</td>
<td>Volume change (total) (%)</td>
<td>VAHVW</td>
<td>Initial air volume + HVW.</td>
</tr>
<tr>
<td>PHI</td>
<td>Same as HPHI.</td>
<td>VCSAT</td>
<td>Percent volume change needed to obtain 100-percent saturation.</td>
</tr>
<tr>
<td>PORE</td>
<td>Coding used to determine how effective lateral pressure is to be computed.</td>
<td>VCUBIN</td>
<td>Volume tube change during shear test (cu. in.).</td>
</tr>
<tr>
<td>POREPR</td>
<td>An array containing the pore pressure used to calculate effective lateral pressure.</td>
<td>VO</td>
<td>Initial volume tube reading.</td>
</tr>
<tr>
<td>PSTFAC</td>
<td>Load piston area factor (correction to specimen volume) (cu. in./in.).</td>
<td>VOIDR</td>
<td>Initial, final, or wetted void ratio.</td>
</tr>
<tr>
<td>PSTVOL</td>
<td>Load piston volumes (cu in.).</td>
<td>VOIDRS</td>
<td>Void ratio at complete saturation.</td>
</tr>
<tr>
<td>SLATAP</td>
<td>Specimen length at any point during test (in.).</td>
<td>VOLCB</td>
<td>Volume correction due to applied lateral pressure.</td>
</tr>
<tr>
<td>SLNGTH</td>
<td>Initial specimen length (in.).</td>
<td>VOLTIR</td>
<td>Volume tube readings during test.</td>
</tr>
<tr>
<td>SOILV</td>
<td>Initial, final, or wetted soil volume (cu in.).</td>
<td>VTPCHNG</td>
<td>Difference in successive volume tube readings from initial reading before touch, and from drained reading at touch during remainder of test.</td>
</tr>
<tr>
<td>SPCTA</td>
<td>Container weight in air (gm).</td>
<td>VTNOUCH</td>
<td>Specimen volume at touch (cu. in.).</td>
</tr>
<tr>
<td>SPCTW</td>
<td>Container weight in water (gm).</td>
<td>WATERV</td>
<td>Initial, final, or wetted water volume in soil specimen (cu. in.).</td>
</tr>
<tr>
<td>SPGRAW</td>
<td>Specific gravity of soil specimen.</td>
<td>WETMC</td>
<td>Wetted moisture content (%).</td>
</tr>
<tr>
<td>SPVAPT</td>
<td>Specimen volume at any point during test (cu. in.).</td>
<td>WLS</td>
<td>Initial, final, or wetted weight loss of specimen (gm).</td>
</tr>
<tr>
<td>Variable name</td>
<td>Definition</td>
<td>Variable name</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>WLSC</td>
<td>Initial, final, or wetted weight loss of specimen + container (gm).</td>
<td>ZIMC</td>
<td>Initial moisture content (%)</td>
</tr>
<tr>
<td>WTCCFAC</td>
<td>Weighing capsule factor (used to convert deviator reading to deviator load in pounds).</td>
<td>ZIWWS</td>
<td>Wet weight of specimen (gm).</td>
</tr>
<tr>
<td>WWWTS</td>
<td>Wetted net weight of soil specimen (gm).</td>
<td>ZMIN</td>
<td>Minutes of angle $\phi$ determined in least squares.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSPPR</td>
<td>Insert pore pressure readings.</td>
</tr>
</tbody>
</table>
ONE-DIMENSIONAL CONSOLIDATION TEST

1. INITIAL MOISTURE CONTENT OF SOIL SPECIMEN
2. WEIGHT OF DRY SOIL SAMPLE AFTER TEST
3. SET TO ZERO MAX. % CONSOLIDATION UNDER A GIVEN LOAD
4. MAX. APPLIED LOAD G
5. READ ALL INITIAL DIAL READINGS
6. READ READING OF DIAL AT ANY POINT
7. COMPUTE DIFFERENCE IN DIAL READINGS AND % CONSOLIDATION AT ANY POINT
8. COMPUTE DIAL READINGS
9. COMPUTE CORRECTED DIAL READINGS
10. COMPUTE DIFFERENCE IN CORRECTED DIAL READINGS AND % CONSOLIDATION AT ANY POINT
11. COMPUTE Specimen Hkickness
12. COMPUTE SHEET AREA AND WEIGHT OF WET SOIL
13. COMPUTE INITIAL SPECIMENT Hkickness
14. INITIAL MOISTURE CONTENT OF SOIL SPECIMEN
15. SHEET AREA OF ORY SOIL
16. TOTAL ORY WT. OF SPECIMEN AFTER TEST
17. HEIGHT OF SOIL SPECIMEN
18. INITIAL DIAL READINGS
19. MAX. APPLIED LOAD G
20. READ READING OF DIAL AT ANY POINT
21. COMPUTE CORRECTED DIAL READINGS
GAREALLTHE
READINGSFOR THIS
PRESSURE
PROCESSED
NO
YES
COMPUTE,
DIFFERENCEINSUCCESSIVEFINALDIAL
READINGSFOREACHLOADFROMDIAL
READINGSWITHTSEATINGLOAD
ONSPECIMEN

SHEET 3 OF 6

< 200

TEST LOADING UNIT NO.

200

TEST LOADING UNIT NO.

INSOIL SPECIMEN

COMPUTE: DIFFERENCE IN
SUCCESSIVE FINAL DIAL
READINGS FOR EACH LOAD FROM DIAL
READINGS WITH SEATING LOAD
ON SPECIMEN

< 200

TEST LOADING UNIT NO.

≥ 200

TEST LOADING UNIT NO.

≥ 500

CHANGE SIGN OF
% CONSOLIDATION
AT ANY POINT

ARE ALL THE
READINGS FOR THIS
PRESSURE
PROCESSED

NO
YES

COMPUTE: HEIGHT OF SOIL
SPECIMEN AT
FINAL DIAL
READING

COMPUTE:
HEIGHT OF SOIL
SPECIMEN AT
FINAL DIAL
READING

COMPUTE:
HEIGHT OF SOIL
SPECIMEN AT
FINAL DIAL
READING

COMPUTE:
HEIGHT OF SOIL
SPECIMEN AT
FINAL DIAL
READING

COMPUTE AT FINAL DIAL READING
VOIDS IN SOIL SPECIMEN
VOID RATIO
DRY DENSITY (PCF AND GM/CC)
% CONSOLIDATION

3
WRITE SAMPLE NO. APPLIED LOAD AND % CONSOLIDATED

WRITE ELAPSED TIME AND % CONSOLIDATION AT A POINT

TEST % CONSOLIDATION AT A POINT

\[ \frac{\text{MAX. APPLIED LOAD WITH APPLIED LOAD}}{\text{MAX. APPLIED LOAD W/TH APPLIED LOAD}} \]

SET MAX. % CONSOLIDATION UNDER A GIVEN LOAD

SET MAX. % CONSOLIDATION EQUAL TO % CONSOLIDATION

HAVE ALL % CONSOLIDATIONS BEEN PROCESSED?

\[ \text{COMPUTE MAX. APPLIED LOAD W/TH APPLIED LOAD} \]

\[ \text{MAX. APPLIED LOAD HEIGHT OF SOIL SPECIMEN AT MAX. % CONSOLIDATION} \]

\[ \text{VOID RATIO AT MAX. % CONSOLIDATION AIR Voids AT MAX. % CONSOLIDATION} \]

HAVE ALL LOADS BEEN PROCESSED?

\[ \text{COMPARE MAX. APPLIED LOAD W/TH APPLIED LOAD} \]

\[ \text{COMPARE MAX. APPLIED LOAD W/TH APPLIED LOAD} \]

\[ \text{COMPARE MAX. APPLIED LOAD W/TH APPLIED LOAD} \]

\[ \text{COMPARE MAX. APPLIED LOAD W/TH APPLIED LOAD} \]
COMPUTE absolue % consolidation % rebound

COMPUTE for initial, expanded and max. load conditions
  dry density
  height of H2O in soil specimen
  weight of air in soil specimen
  degree of saturation

WRITE heading

WRITE data

IS all data written?

WRITE remaining data

CHECK no. of permeability tests

GO TO start
COMPUTE ELPASED TIME IN YEARS
DIFFERENCE IN INITIAL AND SUCCESSIVE TUBE READINGS
FINAL HEAD OF WATER ON Specimen
PERMEABILITY RATE "k" (FT/YR)

TEST PERMEABILITY

WRITE PERMEABILITY RATE AND HYDRAULIC GRADIENT

Have ALL TUBE READINGS BEEN PROCESSED?

No

Yes

GO TO START

END

COMPUTE AREA AND LENGTH OF SOIL SPECIMEN

READ ElPASED TIME AND TUBE READING

COMPUTE ELAPSED TIME IN YEARS
DIFFERENCE IN INITIAL AND SUCCESSIVE TUBE READINGS
FINAL HEAD OF WATER ON SPECIMEN
PERMEABILITY RATE "k" (FT/YR)

TEST PERMEABILITY

SET PERMEABILITY RATE TO ZERO

Convert PERMEABILITY RATE "k" (FT/YR) TO (CM/SEC)

AND OBTAIN AVERAGE HYDRAULIC GRADIENT

WRITE PERMEABILITY RATE AND HYDRAULIC GRADIENT

HAVE ALL TUBE READINGS BEEN PROCESSED?

No

Yes

GO TO START
ONE DIM CONSOLIDATION

DIMENSION P(50), ET(100), DR1(100), D(100), DDR1(100), PCON(100), CONM1(50), VR(50), DD(50), DDC(50), H(50), VOID(50), ETL(100), PL(50), PKMS(50)

C READ ALL ONE VALUE INPUT

330 READ INPUT TAPE 5, 1, NS, NS1, NSP, NST, NST1, NCI, LUN, NDP, NDP1
1, CH, CD, SPG

1 FORMAT (2A4, I4, 4X, 2A4, 2I4, 2A4, 3F8.2)

1 READ INPUT TAPE 5, 2, WSR, WSRC, DR2, DR3, NDO, NDC1, NCWE, NCWE1, NCTS, IINCST1

2 FORMAT (4F8.0, 6A4)

1 READ INPUT TAPE 5, 3, WWSC, DWSC, WTCGM, WCTS, DWSP

3 FORMAT (5F8.2)

C WRITE INPUT OUTPUT DATA

30 WRITE OUTPUT TAPE 6, 4, NS, NS1, NSP, NST, NST1, NDP, NDP1, NDO, IND01, SPG, CD, CH

40 FORMAT (1H1, 19X, 24H EARTH MATERIALS TESTING // 15X, 35H ONE-DIMENSIONAL CONSOLIDATION TEST // 11H SAMPLE NO ,2A4, 5X, 11H SPECIMEN NO
20, 14, 5X, 15H SPECIMEN TYPE ,2A4, // 12H DATE PLACED ,2A4, 3X, 13H DATE REMOVED ,2A4, 3X, 16H SPECIFIC GRAVITY, F5.2, // 19H SPECIMEN DIAMETER = F5.2, 34H IN.

CAI = 3.14159 / 4.0 * (CD * CD)
CAC = CAI * 6.4516

WWS = WSR - WSRC

IF(LUN - 200) 9, 8, 13

9 HI = CH + (DR3 - DR2)

WRITE OUTPUT TAPE 6, 37, LUN

37 FORMAT (16X, 29H TEST PERFORMED IN SCALE NO , I4)

GO TO 10

39 HI = CH + (DR3 - DR2)

WRITE OUTPUT TAPE 6, 40, LUN

40 FORMAT (16X, 30H TEST PERFORMED IN ANTEUS NO , I4)

GO TO 10

8 HI = CH + (DR2 - DR3)

WRITE OUTPUT TAPE 6, 38, LUN

38 FORMAT (16X, 30H TEST PERFORMED IN CONBEL NO , I4)

10 WW = WWSC - DWSC

DWS = DWSC - WTCGM

DMC = ( WW / DWS ) * 100.0

DWSS = DWSP - WCTS

TDW = DWS + DWSS

H0 = TDW / ( CAC * SPG * 2.54)

WI = (-1.0 + WWS / TDW ) * 100.0

AC = CAI / 144.0

C = (453.6 * AC) / 12.0

DMAX = 0.0

AMAX = 0.0

PMAX = 0.0

BMAX = 0.0

CMAX = 0.0

C READ IN MULT VALUES AND CAL
ONE DIM CONSOLIDATION

READ INPUT TAPE 5, 11, N, NSEAT, KFPERM
11 FORMAT (3I4)
   DO 12 J = 1, N
      READ INPUT TAPE 5, 15, P(J), M, CORR
15 FORMAT (F8.0, I4, 4X, F8.4)
      PKMS (J) = P (J) * 0.070307
      C M IS THE NUMBER OF TIME READINGS FOR ANY ONE PRESSURE
   DO 16 I = 1, M
      READ INPUT TAPE 5, 17, ET(I), DR1(I)
      IF(LUN = 200) 91, 90, 14
14 IF(LUN = 500) 90, 91, 91
      D(I) = DR1(I) - CORR
      GO TO 92
   91 D(I) = DR1(I) + CORR
   92 DDR1(I) = DR3 - D(I)
      PCON(I) = (DDR1(I) / HI) * 100.0
      IF(LUN = 200) 16, 61, 28
   28 IF(LUN = 500) 61, 16, 16
      PCON(I) = (-PCON(I))
   16 CONTINUE
17 FORMAT (2F8.0)
   500 DSDR = DR3 - D(M)
      IF(LUN = 200) 101, 100, 36
   36 IF(LUN = 500) 100, 101, 101
   101 H(J) = HI - DSDR
      GO TO 102
   100 H(J) = HI + DSDR
   102 VOID(J) = H(J) - HO
      VR(J) = VOID(J) / HO
      DDC(J) = DD(J) / (C * H(J))
      CONM(J) = PCON(M)
   WRITE OUTPUT TAPE 6, 93, NS, NS1
93 FORMAT (1Ho, 2A4)
   WRITE OUTPUT TAPE 6, 18, P(J), CONM(J), DD(J), VR(J)
18 FORMAT (6HLOAD =, F8.2, 29H PSI CONSOLIDATION = ,F8.4, 8H 1 PERCENT / 13HDY DENSITY =,F7.2, 23H PCF VOID RATIO =,F7.4, 2/1 10X, 13H TIME IN SEC., 10X, 14H PERCENT CONS.)
   DO 21 K = 1, M
      WRITE OUTPUT TAPE 6, 20, ET(K), PCON(K)
20 FORMAT ( 14X, F8.0, 15X, F8.3)
   IF(PCON(K)) 21, 21, 50
50 IF(AMAX - PCON(K)) 22, 22, 21
   AMAX = PCON(K)
21 CONTINUE
   IF (PMAX - P(J)) 23, 23, 12
   PMAX = P(J)
   BMAX = H(J)
   CMAX = VR(J)
   DMAX = VOID(J)
12 CONTINUE
   IF(AMAX) 51, 51, 5
ONE DIM CONSOLIDATION

51 REB = 0.0
GO TO 24
5 IF(PCON(M)) 7, 7, 6
7 ACON = (-PCON(M))
REB = ((AMAX + ACON) / AMAX) * 100.0
GO TO 24
6 REB = ((AMAX - PCON(M)) / AMAX) * 100.0
24 DDI = TDW / (C * HI)
HW = ((TDW * WI) / (CAC * 2.54)) / 100.0
HA = HI - HO - HW
DSI = (HW * 100.0) / (HI - HO)
DSIP = (SPG * WI) / VR(1)
EXDD = TDW / (C * H(NSEAT))
EHW = ((TDW * DMC) / (CAC * 2.54)) / 100.0
EHA = H(N) - HO - EHW
EDS = (EHW * 100.0) / (H(NSEAT) - HO)
EDSP = (SPG * DMC) / VR(NSEAT)
DDML = TDW / (C * BMX)
HWM = BMX - HO - EHA
CMLM = (HWM * CAC * 254.0) / TDW
DSML = (HWM * 100.0) / DMAX
DSML2 = (SPG * CMLM) / CMAX
WRITE OUTPUT TAPE 6, 25
250FORMAT(1HO, TX, 60H LOAD VOID RATIO DRY DENSITY C
1NSOLIDATION / 64H PSI KG/SQCM PCF GM
2/Cc PERCENT )
DO 26 L = 1, N
WRITE OUTPUT TAPE 6, 27, P(L), PKMS(L), VR(L), DD(L), DDC(L), CONM(L)
27 FORMAT(2X,F8.2,2X,F8.3,4X,F8.5,4X,F6.2,3X,F5.3,7X,F7.2)
26 CONTINUE
WRITE OUTPUT TAPE 6, 29, REB
29 FORMAT(1HO, 10H REBOUND = , F7.2, 8H PERCENT)
WRITE OUTPUT TAPE 6, 30
30 FORMAT (1HO, 29X, 8H INITIAL, 4X, 9H MAX LOAD, 4X, 9H EXPANDED)
WRITE OUTPUT TAPE 6, 31, DDI, DDML, EXDD
31 FORMAT (1HO, 12H DRY DENSITY, 17X, F8.3, 5X, F8.3, 5X, F8.3)
WRITE OUTPUT TAPE 6, 32, WI, CMLM, DMC
32 FORMAT (1HO, 17H MOISTURE CONTENT, 12X, F8.3, 5X, F8.3, 5X, F8.3)
WRITE OUTPUT TAPE 6, 34, DSI, DSML, EDS
340FORMAT (1HO, 21H DEGREE OF SATURATION, 8X, F8.3, 5X, F8.3, 5X,
1F8.3)
WRITE OUTPUT TAPE 6, 35, DSIP, DSML2, EDSP
350FORMAT (1HO, 24H DEGREE OF SATURATION CK, 5X, F8.3, 5X, F8.3, 5X,
1F8.3)
WRITE OUTPUT TAPE 6, 36, KFPERM
33, 33, 42
C FALLING HEAD PERMEABILITY FOR CONSOLIDOMETERS
42 L = 0
410READ INPUT TAPE 5, 19, SAMP, SAMP1, NSPEC, LUN2, DATE, DATE2, DSPEC,
1SPECL
19 FORMAT(2A4, 214, 2A4, F8.2, F8.4)
READ INPUT TAPE 5, 52, H1, TI, N2, AP, TC
52 FORMAT(2F8.2, I8, 2F8.4)
ONE DIM CONSOLIDATION

WRITE OUTPUT TAPE 6, 53, SAMP, SAMP1, NSPEC, DATE, DATE2, LUN2
530FORMAT(1H1, 18X, 31H FALLING HEAD PERMEABILITY TEST // 10X, 13H SA
1MPL No. ,2A4, 7X, 15H SPECIMEN No. ,14 // 10X, 7H DATE ,2A4
2, 9X, 19H LOADING UNIT No. ,14 // 10X, 13H PERMEABILITY , 12X,
327H AVERAGE HYDRAULIC GRADIENT // 8X, 17H FT/YR CM/SEC //)
AS = 3.141593 * DSPEC * DSPEC / 4.0
SLF = SPECL / 12.0
DO 54 I = 1, N2
READ INPUT TAPE 5, 55, ETM, TR
55 FORMAT(F8.0, F8.2)
ETY = ETM / (60.0 * 8760.0)
DTR = TI - TR
HF = HI + (TC * DTR)
PERM = (AP * SLF / AS) * (1.0 / ETY) * LOGF(HI / HF)
IF(PERM) 57, 57, 58
57 PERM = 0.0
58 PERMC = PERM * 0.000000097
AHG = ((HI + HF) / 2.0) / SPECL
WRITE OUTPUT TAPE 6, 56, PERM, PERMC, AHG
56 FORMAT(1HO, 6X, F10.4, 3X, E11.4, 14X, F8.3)
54 CONTINUE
L = L + 1
IF(KFPERM - L) 33, 33, 41
END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0)
# ONE-DIMENSIONAL CONSOLIDATION TEST

<table>
<thead>
<tr>
<th>Variable name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Soil specimen area (sq ft).</td>
<td>DR1</td>
<td>Dial readings during test.</td>
</tr>
<tr>
<td>ACON</td>
<td>Absolute value of percent consolidation.</td>
<td>DR2</td>
<td>Dial reading with gage ring in place.</td>
</tr>
<tr>
<td>AHG</td>
<td>Average hydraulic gradient for permeability test.</td>
<td>DR3</td>
<td>Dial reading with seating load on specimen.</td>
</tr>
<tr>
<td>AMAX</td>
<td>Maximum percent consolidation under a given loading.</td>
<td>DSDR</td>
<td>Difference in successive Final dial readings for each load from dial reading with seating load on specimen.</td>
</tr>
<tr>
<td>AP</td>
<td>Area of standpipe for permeability test (sq. in.).</td>
<td>DSI</td>
<td>Initial degree of saturation (%).</td>
</tr>
<tr>
<td>AS</td>
<td>Area of soil specimen for permeability test (sq. in.).</td>
<td>DSIP</td>
<td>Initial degree of saturation (check) (%).</td>
</tr>
<tr>
<td>BMAX</td>
<td>Height of soil specimen at maximum percent consolidation under a given loading (in.).</td>
<td>DSML</td>
<td>Maximum load degree of saturation (%).</td>
</tr>
<tr>
<td>C</td>
<td>Constant used to compute dry density.</td>
<td>DSML2</td>
<td>Maximum load degree of saturation (check) (%).</td>
</tr>
<tr>
<td>CAC</td>
<td>Soil specimen area (sq cm).</td>
<td>DSPEC</td>
<td>Specimen diameter for permeability test (in.).</td>
</tr>
<tr>
<td>CAI</td>
<td>Soil specimen area (sq in.).</td>
<td>DTR</td>
<td>Difference in successive water standpipe readings from initial reading—for permeability test.</td>
</tr>
<tr>
<td>CD</td>
<td>Container diameter (in.).</td>
<td>DWS</td>
<td>Dry weight of entire specimen after test (gm) ( \omega_d ).</td>
</tr>
<tr>
<td>CH</td>
<td>Container height (in.).</td>
<td>DWSC</td>
<td>Dry weight of entire specimen plus container after test (gm) ( \omega_d ).</td>
</tr>
<tr>
<td>CMAX</td>
<td>Void ratio at maximum percent consolidation under a given loading.</td>
<td>DWSP</td>
<td>Dry weight of container plus soil adhering to specimen ring, trimmed from specimen, and washed from porous stones (gm)**.</td>
</tr>
<tr>
<td>CMLM</td>
<td>Moisture content of soil specimen under maximum load (%).</td>
<td>DWSS</td>
<td>Same as DWSP except weight of dry soil only (gm)**.</td>
</tr>
<tr>
<td>CONM</td>
<td>Consolidation at final reading for each load (%).</td>
<td>EDS</td>
<td>Expanded degree of saturation (%).</td>
</tr>
<tr>
<td>CORR</td>
<td>Correction applied to each dial reading under each loading—due to deflection in stones.</td>
<td>EDSP</td>
<td>Expanded degree of saturation (check) (%).</td>
</tr>
<tr>
<td>D</td>
<td>Corrected dial reading.</td>
<td>EHA</td>
<td>Height of air in specimen under expanded conditions (in.).</td>
</tr>
<tr>
<td>DATE</td>
<td>Date permeability test performed.</td>
<td>EHW</td>
<td>Height of water in specimen under expanded conditions (in.).</td>
</tr>
<tr>
<td>DATE2</td>
<td>Date permeability test performed.</td>
<td>ET</td>
<td>Elapsed time from initial dial reading to each successive dial reading for each load (seconds).</td>
</tr>
<tr>
<td>DD</td>
<td>Dry density at final dial reading for each load (pcf).</td>
<td>ETM</td>
<td>Elapsed time in minutes from initial water standpipe reading to each successive tube reading—permeability test.</td>
</tr>
<tr>
<td>DDC</td>
<td>Dry density at final dial reading for each load (gm/cc).</td>
<td>ETY</td>
<td>ETM in years.</td>
</tr>
<tr>
<td>DDI</td>
<td>Initial dry density (pcf).</td>
<td>EXDD</td>
<td>Dry density under expanded conditions (pcf).</td>
</tr>
<tr>
<td>DDML</td>
<td>Dry density under maximum load (pcf).</td>
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<td></td>
</tr>
<tr>
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<td>Definition</td>
<td>Variable name</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>H</td>
<td>Height of soil specimen at final dial reading for each load (in.).</td>
<td>PCON</td>
<td>Percent consolidation at any point; consolidation is plus, expansion is minus.</td>
</tr>
<tr>
<td>HA</td>
<td>Height of air in specimen for initial conditions (in.).</td>
<td>PERM</td>
<td>Permeability rate (ft/yr).</td>
</tr>
<tr>
<td>H1</td>
<td>Initial head for permeability test (in.).</td>
<td>PERMC</td>
<td>Permeability rate (cm/sec).</td>
</tr>
<tr>
<td>HF</td>
<td>Final head for permeability test (in.).</td>
<td>PKMS</td>
<td>Applied load (kg/sq cm).</td>
</tr>
<tr>
<td>HI</td>
<td>Initial specimen thickness (in.) $h_i$.</td>
<td>PMAX</td>
<td>Maximum applied load (psi).</td>
</tr>
<tr>
<td>HO</td>
<td>Height of solids in soil specimen initially (in.) $h_o$.</td>
<td>REB</td>
<td>Percent rebound of soil specimen from maximum percent consolidation.</td>
</tr>
<tr>
<td>HW</td>
<td>Height of water in soil specimen initially (in.).</td>
<td>SAMP</td>
<td>Sample number—permeability.</td>
</tr>
<tr>
<td>HWM</td>
<td>Height of water in soil specimen under maximum load (in.).</td>
<td>SAMP1</td>
<td></td>
</tr>
<tr>
<td>KFPERM</td>
<td>No. of permeability tests performed on soil specimen.</td>
<td>SLF</td>
<td>Length of soil specimen for permeability test (ft).</td>
</tr>
<tr>
<td>LUN</td>
<td>Loading Unit No.; consolidation [0 \rightarrow 199 \text{ scales} ] [200 \rightarrow 499 \text{ conbels} ] [500 \rightarrow \text{ anteus}. ]</td>
<td>SPECL</td>
<td>Length of soil specimen for permeability test (in.).</td>
</tr>
<tr>
<td>LUN2</td>
<td>Loading Unit No.; permeability.</td>
<td>SPG</td>
<td>Specific gravity of soil being tested.</td>
</tr>
<tr>
<td>M</td>
<td>Number of timed readings for any given load.</td>
<td>TC</td>
<td>Tube constant of water standpipe for permeability test.</td>
</tr>
<tr>
<td>N</td>
<td>Total number of loads applied.</td>
<td>TDW</td>
<td>Total dry weight of soil specimen after test, includes soil specimen, trimmings, material from stones, etc. (gm).</td>
</tr>
<tr>
<td>N2</td>
<td>Total number of water standpipe readings for permeability test.</td>
<td>TI</td>
<td>Initial water standpipe reading—permeability.</td>
</tr>
<tr>
<td>NC1</td>
<td>Consolidation container number.</td>
<td>TR</td>
<td>Successive water standpipe readings during permeability test.</td>
</tr>
<tr>
<td>NCTS</td>
<td>Container number for moisture sample of material adhering to rings, stones, etc.</td>
<td>Voids</td>
<td>Voids in soil specimen at final reading for each load.</td>
</tr>
<tr>
<td>NCTS1</td>
<td>Container number for moisture sample of material after test is completed.</td>
<td>VR</td>
<td>Void ratio at final reading for each load.</td>
</tr>
<tr>
<td>NCWE</td>
<td>Container number for moisture sample of material adhering to rings, stones, etc.</td>
<td>WCTS</td>
<td>Weight of container for moisture sample for trimmings, material adhering to rings, etc. (gm)**.</td>
</tr>
<tr>
<td>NCWE1</td>
<td>Container number for moisture sample of material after test is completed.</td>
<td>WI</td>
<td>Initial moisture content of soil specimen (%) $w_i$.</td>
</tr>
<tr>
<td>NDO</td>
<td>Date test removed from consolidometer.</td>
<td>WSR</td>
<td>Weight of specimen ring, cover plates and wet soil, initial (gm).</td>
</tr>
<tr>
<td>ND01</td>
<td>Date test placed in consolidometer.</td>
<td>WSRC</td>
<td>Weight of specimen ring and cover plates (gm).</td>
</tr>
<tr>
<td>NDP</td>
<td>Sample number—consolidation.</td>
<td>WTCGM</td>
<td>Weight of container for moisture sample after test is removed from consolidometer (gm) $w_e$.</td>
</tr>
<tr>
<td>NDP1</td>
<td>Sample number—expanded conditions.</td>
<td>WW</td>
<td>Weight of water in sample, final (gm) $w_e$.</td>
</tr>
<tr>
<td>NS</td>
<td>Specimen number—consolidation.</td>
<td>WWS</td>
<td>Weight of wet soil in sample, final (gm).</td>
</tr>
<tr>
<td>NS1</td>
<td>Specimen number—permeability.</td>
<td>WWSC</td>
<td>Wet weight of specimen plus container, final (gm) $w_e$.</td>
</tr>
<tr>
<td>NSEAT</td>
<td>Specimen type (natural or remolded).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSP</td>
<td>Applied load (psi).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSPEC</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NST1</td>
<td></td>
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</tr>
</tbody>
</table>

---

*Note: ** indicates a specific gravity of soil being tested.*
FLOW CHART
SLIDING FACTOR AND DIRECT SHEAR, LEAST SQUARES

START

READ HEADING DATA

WRITE HEADING

INITIALIZE SUMMATIONS OF STRESSES

READ INPUT DATA

WRITE TRIAL NO. NORMAL STRESS AND SHEAR STRESS

COMPUTE SUMMATIONS OF STRESSES

HAVE ALL TRIALS BEEN PROCESSED?

NO

COMPUTE SLOPE AND COHESION

WRITE SLOPE AND COHESION

GO TO START

END
DIRECT SHEAR LEAST SQUARES

DIMENSION X(10), Y(10), NT(10), D(10), E(10)

33 READ INPUT TAPE 5, 1, NS, NS1, NSP, N
1 FORMAT (2A4, I4)
 WRITE OUTPUT TAPE 6, 2, NS, NS1
2 FORMAT (1HI, 2IX, 11H SAMPLE NO , 2A4)
 WRITE OUTPUT TAPE 6, 3, NSP
3 FORMAT (1HO, 2IX, 13H SPECIMEN NO , I4)
 WRITE OUTPUT TAPE 6, 4
40 FORMAT (1HO, 3X, 9H TRIAL NO, 10X, 14H NORMAL STRESS, 10X,
  113H SHEAR STRESS)
 SUMX = 0.0
 SUMY = 0.0
 SUMXY = 0.0
 SUMX2 = 0.0
 DO 10 I = 1, N
 READ INPUT TAPE 5, 5, NT(I), X(I), Y(I)
5 FORMAT (18, 2F8.2)
 WRITE OUTPUT TAPE 6, 6, NT(I), X(I), Y(I)
6 FORMAT (6X, I4, 14X, F8.2, 16X, F8.2)
 D(I)=X(I) * Y(I)
 SUMXY = SUMXY + D(I)
 E(I)=X(I) * X(I)
 SUMX = SUMX + E(I)
 SUMX2 = SUMX + E(I)
 SUMY = SUMY + Y(I)
 SUMY = SUMY + Y(I)
10 CONTINUE
 AN = N
 SLOPE = (AN * SUMXY - SUMX * SUMY) / (AN * SUMX2 - SUMX * SUMX)
 COHN = (SUMY - SLOPE * SUMX) / AN
 WRITE OUTPUT TAPE 6, 7, SLOPE
7 FORMAT (1HO, 18X, 14H TANGENT PHI = , F8.5)
 WRITE OUTPUT TAPE 6, 8, COHN
8 FORMAT (1HO, 21X, 11H COHESION = , F8.4)
 GO TO 33
END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0)

205–616 0—60——6
### DIRECT SHEAR LEAST SQUARES

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Variable name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN</td>
<td>Change number of trials ($N$) from fixed to floating point notation.</td>
<td>SLOPE</td>
<td>Tangent of the angle of internal friction.</td>
</tr>
<tr>
<td>COHN</td>
<td>$Y$ intercept—cohesion (psi).</td>
<td>SUMX</td>
<td>Sum of the normal stresses for a complete test.</td>
</tr>
<tr>
<td>D</td>
<td>Shear stress multiplied by normal stress for a given trial.</td>
<td>SUMX2</td>
<td>Sum of the squared normal stresses.</td>
</tr>
<tr>
<td>E</td>
<td>Normal stress squared.</td>
<td>SUMXY</td>
<td>Sum of the shear stress multiplied by the normal stress for a complete test.</td>
</tr>
<tr>
<td>N</td>
<td>Number of trials for a given specimen.</td>
<td>SUMY</td>
<td>Sum of the shear stresses for a complete test.</td>
</tr>
<tr>
<td>NS</td>
<td>Sample number.</td>
<td>X</td>
<td>Normal stress (psi).</td>
</tr>
<tr>
<td>NS1</td>
<td>Specimen number.</td>
<td>Y</td>
<td>Shear stress (psi).</td>
</tr>
<tr>
<td>NSP</td>
<td>Trial number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT</td>
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</tr>
</tbody>
</table>
APPENDIX B

INPUT AND OUTPUT DATA FOR TYPICAL TESTS

The input shows the data as it is observed and recorded on standard laboratory forms. The output shows the data from the same test as it is received from the computer for each of the following tests:

- Natural moisture-density
- Gradation analysis
- Soil consistency (Atterberg limits)
- Proctor compaction
- Constant-head permeability-settlement
- Falling-head permeability
- Triaxial shear
- One-dimensional consolidation
- Sliding factor and direct shear, least squares
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Date</th>
<th>1/2 Tube Length (ft)</th>
<th>Tube I.D. (in)</th>
<th>Tube + Wet Soil (lbs)</th>
<th>Denison Tube Factor (lb/ft)</th>
<th>Drive Tube Weight (lbs)</th>
<th>Drive Tube Empty End Lengths (ft)</th>
<th>Drive Tube No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A:111-45</td>
<td>1/10-217-64</td>
<td>1/10-217-64</td>
<td>5.813</td>
<td>30.6</td>
<td>11.248</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Moisture from Top of Sample**

<table>
<thead>
<tr>
<th>Dish + Wet Soil (gms)</th>
<th>Dish + Dry Soil (gms)</th>
<th>Dish Weight (gms)</th>
<th>Dish + Wet Soil (gms)</th>
<th>Dish + Dry Soil (gms)</th>
<th>Dish Weight (gms)</th>
<th>Dish + Wet Soil (gms)</th>
<th>Dish + Dry Soil (gms)</th>
<th>Dish Weight (gms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>569.0</td>
<td>476.88</td>
<td>211.04</td>
<td>467.23</td>
<td>370.45</td>
<td>211.74</td>
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**Remarks**

<table>
<thead>
<tr>
<th>REMARKS</th>
<th></th>
<th></th>
</tr>
</thead>
</table>

**By** E.H., B.C. | Date | Checked P.K. | Sheet | Of |
IN-PLACE MOISTURE-DENSITY OF SOIL IN DENISON TUBE

SAMPLE LENGTH = 36.881 CM. = 1.21 CFT.
SAMPLE DIAMETER = 14.765 CM. = 5.813 IN.
WET SOIL WEIGHT = 13.195 KG. = 29.090 LBS

WATER--TOP (PERCENT OF DRY WGT) = 20.2088
WATER-BOTTOM (PERCENT OF DRY WGT) = 20.8223

AVERAGE MOISTURE (PERCENT OF DRY WGT) = 20.5156
DRY DENSITY = 1.7338 GRAMS/CC = 108.2396 LBS/CU.FT.
<table>
<thead>
<tr>
<th>USE BHUF STRIP</th>
<th>PROBLEM MA</th>
<th>JOB NO.</th>
</tr>
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<tbody>
<tr>
<td>CARDS</td>
<td>DETAIL</td>
<td>MECHANICAL ANALYSIS (GRADATION) TEST</td>
</tr>
<tr>
<td>COLORED</td>
<td>FEATURE</td>
<td>China Meadows Damsite</td>
</tr>
<tr>
<td>SAMPLE NO.</td>
<td>PROJECT</td>
<td>Lyman, Wyo.</td>
</tr>
<tr>
<td>RETURN TO</td>
<td>ROOM</td>
<td>BLDG.</td>
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<th>TOTAL WET WGT.</th>
<th>BFR. SCREENING</th>
<th>SAMPLE NO.</th>
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<tr>
<td>YES = 1 NO = 0</td>
<td>14.3G</td>
<td>1</td>
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<th>DATE</th>
<th>TOTAL WET WGT.</th>
<th>BFR. SCREENING</th>
<th>5&quot;</th>
<th>3&quot;</th>
<th>1½&quot;</th>
<th>3/4&quot;</th>
<th>3/8&quot;</th>
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<th>NO. 4</th>
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<tr>
<td>1.1-10-64</td>
<td>57.17</td>
<td>110.50</td>
<td>111.00</td>
<td>37.50</td>
<td>61.00</td>
<td>413.30</td>
<td>38.30</td>
<td>3643.50</td>
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<table>
<thead>
<tr>
<th>PAN + WET SOIL</th>
<th>PAN + DRY SOIL</th>
<th>PAN WEIGHT</th>
<th>PAN + WET SOIL</th>
<th>PAN + DRY SOIL</th>
<th>PAN WEIGHT</th>
<th>PAN + WET SOIL</th>
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<td>57.17</td>
<td>110.50</td>
<td>111.00</td>
<td>37.50</td>
<td>61.00</td>
<td>413.30</td>
<td>38.30</td>
<td>3643.50</td>
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<table>
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<tr>
<th>MOISTURE OF -3/4&quot; SOIL</th>
<th>MOISTURE OF -3/4&quot;, - NO. 4 SOIL</th>
<th>MOISTURE OF - NO. 4 SOIL</th>
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<td>PAN + DRY SOIL</td>
<td>PAN WEIGHT</td>
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<table>
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<tr>
<th>WGT. SIZES</th>
<th>WGT. RET. ON EACH SCREEN</th>
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<td>5&quot;</td>
<td>3&quot;</td>
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<table>
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<th>(FILL OUT ONLY IF NO SCREEN TEST)</th>
<th>TOTAL SAMPLE</th>
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<tbody>
<tr>
<td>YES = 1 NO = 0</td>
<td>% PASSING NO. 4</td>
<td>DISH + DRY SOIL</td>
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<td>110.50</td>
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<tr>
<th>DISH WEIGHT</th>
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<td>DISH + DRY SOIL</td>
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<td>57.17</td>
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<th>DISH WEIGHT</th>
<th>DISHNO.</th>
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<table>
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<td>DISH + DRY SOIL</td>
</tr>
<tr>
<td>1.1-10-64</td>
<td>57.17</td>
</tr>
</tbody>
</table>

<table>
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<th>DISH WEIGHT</th>
<th>DISHNO.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>57.17</td>
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</table>

<table>
<thead>
<tr>
<th>HYDR. TEST</th>
<th>(FILL OUT ONLY IF NO SCREEN OR SIEVE TESTS)</th>
<th>TOTAL SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES = 1 NO = 0</td>
<td>% PASSING NO. 4</td>
<td>DISH + DRY SOIL</td>
</tr>
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<td>1.2-16-64</td>
<td>13.66</td>
<td>9.60</td>
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<table>
<thead>
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<th>DISH WEIGHT</th>
<th>DISHNO.</th>
</tr>
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<td>1.2-16-64</td>
<td>13.66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL SAMPLE</th>
<th>CUMULATIVE SOIL WEIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISH + DRY SOIL</td>
<td>DISH + DRY SOIL</td>
</tr>
<tr>
<td>1.2-16-64</td>
<td>13.66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISH WEIGHT</th>
<th>DISHNO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2-16-64</td>
<td>13.66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HYDR. METER READINGS</th>
<th>HYDR. METER NO.</th>
<th>ML USED</th>
<th>DISPERGENT</th>
<th>TIME MIXED AND TYPE OF MIXER USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-14-64</td>
<td>81.53</td>
<td>44.2</td>
<td>128 CALGON 5 MINUTE MALIT MIXER</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY E.H. B.C. J.S.</td>
</tr>
</tbody>
</table>

| SHEET | OF |
**MECHANICAL ANALYSIS (GRADATION) TEST**

**SAMPLE NO.** 43G-1

**DATE 11-30-64**  

--- **SCREEN ANALYSIS** ---

| Wet Wgt-Tot. Sample (Before Screening) | = 261.723 KG | = 577.00 LBS |
| Wet Wgt-Tot. Sample (After Screening) | = 256.325 KG | = 565.10 LBS |

**DRY WGT-TOTAL SAMPLE** = 252.114 KG = 555.82 LBS

**MOISTURE (PERCENT), +3/4 = 0, -3/4, +NO4 = 0, -NO4 = 2.621**

**DRY WEIGHT**  

<table>
<thead>
<tr>
<th>Retained</th>
<th>Passing</th>
<th>Screen</th>
<th><strong>PERCENT OF TOTAL</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>KG</td>
<td>LBS</td>
<td>KG</td>
<td>LBS</td>
</tr>
<tr>
<td>4.763</td>
<td>10.50</td>
<td>247.351</td>
<td>545.32</td>
</tr>
<tr>
<td>242.362</td>
<td>534.32</td>
<td>3</td>
<td>76.2</td>
</tr>
</tbody>
</table>

**WET WEIGHT**

<table>
<thead>
<tr>
<th>Passage</th>
<th>KG</th>
<th>LBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>225.352</td>
<td>496.82</td>
<td>1-1/2</td>
</tr>
<tr>
<td>197.683</td>
<td>435.82</td>
<td>3/4</td>
</tr>
</tbody>
</table>

**DRYWGT-TOTALSAMPLE**  

<table>
<thead>
<tr>
<th>KG</th>
<th>LBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>164.881</td>
<td>363.50</td>
</tr>
</tbody>
</table>

**DATE 12-16-64**  

--- **SIEVE ANALYSIS** ---

**PERCENT OF DRY WGT PASSING NO 4 = 63.7290, FACTOR (F) = 0.93321**

**DRY WEIGHT OF TOTAL SAMPLE (W) (GRAMS) = 68.29**

**DRY WEIGHT OF SAMPLE TO BE SIEVED, (GRAMS) = 50.31**

<table>
<thead>
<tr>
<th>Sieve Particle</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Dia (MM)</td>
<td>Dry Wgt. Passing</td>
</tr>
<tr>
<td>16</td>
<td>1.190</td>
</tr>
<tr>
<td>15</td>
<td>0.590</td>
</tr>
</tbody>
</table>

**DATE 12-14-64**  

--- **HYDROMETER ANALYSIS** ---

**PERCENT OF DRY WGT PASSING NO 4 = 63.7290, FACTOR (F) = 0.93321**

**DRY WEIGHT OF TOTAL SAMPLE (W) (GRAMS) = 68.29**

**5 MINUTE MALT MIXER USING 125 ML CALGON**

**STARTING TIME 8.53**

<table>
<thead>
<tr>
<th>Time</th>
<th>Particle</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 MIN</td>
<td>0.037</td>
<td>15.9579</td>
</tr>
<tr>
<td>6 MIN</td>
<td>0.019</td>
<td>12.2251</td>
</tr>
<tr>
<td>19 MIN</td>
<td>0.009</td>
<td>9.4254</td>
</tr>
<tr>
<td>60 MIN</td>
<td>0.005</td>
<td>7.5590</td>
</tr>
</tbody>
</table>

**GRAIN SIZE FRACTIONS IN PERCENT**

| Oversize (Larger than 5 inches) | 1.8891 |
| Cobble (3 inches to 5 inches)   | 1.9791 |
| Gravel (No 4 Size to 3 inches)  | 32.4028|
| Sand (0.074 mm to No 4 Size)    | 46.2966|
| Silt to Clay (smaller than 0.074 mm) | 17.4324|

| Silt (0.005 mm to 0.074 mm) | 9.8734|
| Clay (smaller than 0.005 mm) | 7.5590|
## LABORATORY PUNCH CARD DATA

### USE
- **BUFF STRIP**
- **COLORED CARDS**

### PROBLEM
- **MA**
  - **DETAIl** MECHANICAL ANALYSIS (GRADATION) TEST
  - **FEATURE** Lake Mead Sediment Survey

### JOB NO.

### RETURN TO
- **ROOM**
- **BLDG.**
- **PHONE**

### SCREEN TEST
- **YES** = 1
- **NO** = 0
- **SAMPLE NO.**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOTAL WET WGT.</th>
<th>5&quot;</th>
<th>3&quot;</th>
<th>1½&quot;</th>
<th>3/4&quot;</th>
<th>3/8&quot;</th>
<th>NO. 4</th>
<th>-NO. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BFR. SCREENING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SCREEN SIZES

### MOISTURE OF -3/4" SOIL

### PAN + WET SOIL

### PAN WEIGHT

### PAN + DRY SOIL

### PAN WEIGHT

### PAN + WET SOIL

### PAN + DRY SOIL

### PAN WEIGHT

### SIEVE TEST
- **YES** = 1
- **NO** = 0
- **TOTAL SAMPLE**
- **TO BE SIEVED**
- **DISH NO.**

### HYDROM. TEST
- **YES** = 1
- **NO** = 0
- **DISH NO.**

### STARTING TIME

### HYDROMETER NO.

### ML. USED

### DISPERSING AGENT

### TIME MIXED AND TYPE OF MIXER USED

### HYDROMETER READINGS

### TEMPERATURE CORRECTION

### TEMPERATURE "C"

### TIME OF READING

### REMARKS

**BY E.H. B.C. J.S.**

**CHECKED** P.K.

**SHEET 1 OF 1**
MECHANICAL ANALYSIS (GRADATION) TEST

SAMPLE NO 41Q-131

DATE 1-18-65 *****HYDROMETER ANALYSIS*****

PERCENT OF DRY WGT PASSING NO 4=100.0000, FACTOR (F)= 2.00000

DRY WEIGHT OF TOTAL SAMPLE (W) (GRAMS) = 50.00

10 MINUTE MALT MIXER USING 125 ML CALGON

STARTING TIME 9.52

HYDROMETER NO 747

<table>
<thead>
<tr>
<th>TIME ELAPSED (MIN)</th>
<th>PARTICLE DIA (MM)</th>
<th>PERCENT OF TOTAL DRY WGT PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MIN</td>
<td>0.037</td>
<td>101.0000</td>
</tr>
<tr>
<td>4 MIN</td>
<td>0.019</td>
<td>98.0000</td>
</tr>
<tr>
<td>19 MIN</td>
<td>0.009</td>
<td>94.0000</td>
</tr>
<tr>
<td>60 MIN</td>
<td>0.005</td>
<td>82.4000</td>
</tr>
<tr>
<td>7 HR 15 MIN</td>
<td>0.002</td>
<td>63.6000</td>
</tr>
<tr>
<td>25 HR 45 MIN</td>
<td>0.001</td>
<td>52.2000</td>
</tr>
</tbody>
</table>

GRAIN SIZE FRACTIONS IN PERCENT
CLAY (SMALLER THAN 0.005 MM) 82.4000
**BUREAU OF RECLAMATION**

**LABORATORY PUNCH CARD DATA**

<table>
<thead>
<tr>
<th>USE ORANGE STRIP</th>
<th>PROBLEM</th>
<th>SOIL CONSISTENCY TEST</th>
<th>JOB NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLORED CARDS</td>
<td>DETAIL</td>
<td>(ONE-POINT LIQUID LIMIT METHOD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FEATURE</td>
<td>Panache Creek Detention Dam</td>
<td>RETURN TO</td>
</tr>
<tr>
<td></td>
<td>PROJECT</td>
<td>Central Valley</td>
<td>ROOM BLDG. PHONE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>43D-IX64</td>
<td>8-51-64</td>
</tr>
</tbody>
</table>

**NO. OF MOISTURES TAKEN FOR LL**

<table>
<thead>
<tr>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
<th>BLOWS USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7</td>
<td>1.25</td>
<td>6.28</td>
<td>20</td>
</tr>
</tbody>
</table>

**NO. OF MOISTURES TAKEN FOR PL**

<table>
<thead>
<tr>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9</td>
<td>1.75</td>
<td>6.44</td>
</tr>
<tr>
<td>1.7</td>
<td>1.5</td>
<td>6.123</td>
</tr>
</tbody>
</table>

**NO. OF MOISTURES TAKEN FOR SL**

<table>
<thead>
<tr>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
<th>VOL. SHRINK. DISH</th>
<th>VOL. DRY SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>2.25</td>
<td>1.123</td>
<td>14.85</td>
<td>5.175</td>
</tr>
</tbody>
</table>

**REMARKS**

BY L.A.R., DATE CHECKED P.K. SHEET 2 OF 2
CONSISTENCY (ATTERBERG) LIMITS TEST

SAMPLE NO  43D-X64

DATE  8-5-64

LL-A = 80.7663  BLOWS = 20
PL-B = 23.9963
PL-A = 23.4831
SL-A = 9.6774  SR-A = 1.9409

LIQUID LIMIT (LL) = 80.7663
PLASTIC LIMIT (PL) = 23.7397
PLASTICITY INDEX (PI) = 57.0266
SHRINKAGE LIMIT (SL) = 9.6774
SHRINKAGE RATIO (SR) = 1.9409
<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>DATE</th>
<th>NO. OF MOISURES TAKEN FOR LL</th>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
<th>BLOWS USED</th>
<th>FIRST TRY DISH BLOWS NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>43D-23</td>
<td>8-4-64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28 71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NO. OF MOISURES TAKEN FOR PL</th>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NO. OF MOISURES TAKEN FOR SL</th>
<th>DISH + WET SOIL</th>
<th>DISH + DRY SOIL</th>
<th>DISH WGT.</th>
<th>VOL. SHRINK. DISH</th>
<th>VOL. DRY SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REMARKS

BY L.A.R.

DATE

CHECKED P.K.

SHEET 1 OF 2
<table>
<thead>
<tr>
<th>USE</th>
<th>PROBLEM</th>
<th>PRCOMP</th>
<th>JOB NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PINK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLORED CARDS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEATURE</td>
<td>China Meadows Damsite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROJECT</td>
<td>Lyman, Wyo.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DENSITY DETERMINATIONS**

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLE NO.</td>
<td>143G-2</td>
<td>12-17-64</td>
<td>12-17-64</td>
<td>12-17-64</td>
<td>12-17-64</td>
<td>12-17-64</td>
<td>12-17-64</td>
<td>12-17-64</td>
</tr>
<tr>
<td>CYL. VOL.* (cu. ft.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>CYL. WGT. (lb.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

**WATER CONTENT DETERMINATIONS**

<table>
<thead>
<tr>
<th>DISH NO.</th>
<th>211</th>
<th>22</th>
<th>51</th>
<th>74</th>
<th>39</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGT. DISH + WET SOIL</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>WGT. OF DISH</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

1. How fast does sample absorb water?  
   FAST: ✔️ MEDIUM: ✔️ SLOW: ✔️
2. Is difficulty encountered in mixing water with soil?  
   No
3. Are penetration needle readings reliable?  
   No - fair on pts. 3, 4, 5
4. At what test nos. is sample crumbly?  
   ✔️
5. Was bleeding noticed during test?  
   No  
   ✔️ If so, what test nos.?  
   ✔️
6. At what test nos. is sample spongy?  
   ✔️
7. Other comments

**BY E.H.**  
**DATE 12-17-64**  
**CHECKED P.K.**  
**SHEET 2 OF 5**
<table>
<thead>
<tr>
<th>TEST NO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>WET DENSITY PCF</td>
<td>0.1288</td>
<td>133.8</td>
<td>135.2</td>
<td>132.8</td>
<td>135.2</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>WET DENSITY GM/CC</td>
<td>0.2063</td>
<td>2.143</td>
<td>2.166</td>
<td>2.127</td>
<td>2.166</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>PENET. RES. PSI</td>
<td>0.3680</td>
<td>1280.</td>
<td>190.</td>
<td>116.</td>
<td>400.</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>PENET. RES. KG/SQCM</td>
<td>0.2587</td>
<td>90.0</td>
<td>13.4</td>
<td>8.2</td>
<td>28.1</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>WATER CONTENT PCT</td>
<td>0.9.82</td>
<td>12.16</td>
<td>14.05</td>
<td>16.03</td>
<td>13.50</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>DRY DENSITY PCF</td>
<td>0.117.3</td>
<td>119.3</td>
<td>118.5</td>
<td>114.4</td>
<td>119.1</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>DRY DENSITY GM/CC</td>
<td>0.1.879</td>
<td>1.911</td>
<td>1.899</td>
<td>1.833</td>
<td>1.908</td>
<td>0.</td>
<td>0.</td>
<td></td>
</tr>
</tbody>
</table>
### LABORATORY PUNCH CARD DATA

**USE**

- Blue Strip Cards

**COLORED CARDS**

- Punched

**DETAIL**

- Permeability - Settlement Test

**FEATURE**

- Starvation Dam

**PROJECT**

- Central Utah

**PROBLEM**

- PERMCH

**JOB NO.**

- #

**RETURN TO**

- Cards

**ROOM**

- Cent

**Bldg.**

- Cent

**PHONE**

- 1151, 1101, 1121, 1161, 1181, 1201, 1211, 1221, 1231, 1251, 1271, 1291, 1311, 1331, 1351, 1371, 1391, 1411, 1431, 1451, 1471, 1491, 1511, 1531, 1551, 1571, 1591, 1611, 1631, 1651, 1671, 1691, 1711, 1731, 1751, 1771, 1791, 1811

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Date Placed</th>
<th>Date Removed</th>
<th>Head Tank No.</th>
<th>Calibration Factor</th>
<th>Cyl. No.</th>
<th>Total No. of Rdg's</th>
<th>Placement Area (psi)</th>
<th>Density Thickness (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>370-X68</td>
<td>1-7-65</td>
<td>1-25-65</td>
<td>A1A</td>
<td>26.64</td>
<td>46</td>
<td>3.1</td>
<td>119.1</td>
<td>50.3</td>
</tr>
</tbody>
</table>

**Date**

- 1-7-65

**Hour Observed**

- 9.00

**Hours Between Readings**

- 0.0

**Head (ft.)**

- 10.0

**Load (psi)**

- 10.0

**Dial A**

- 0.359

**Dial B**

- 0.421

**Reading**

- 0.0

**After Non-Test Values**

- 1-11-65

**Hour Observed**

- 7.05

**Hours Between Readings**

- 0.27

**Load (psi)**

- 20.0

**Dial A**

- 0.367

**Dial B**

- 0.427

**Reading**

- 0.0

**Head Tank Reading (in.)**

- 1-12-65

**Hour Observed**

- 7.27

**Hours Between Readings**

- 0.27

**Load (psi)**

- 20.0

**Dial A**

- 0.367

**Dial B**

- 0.427

**Reading**

- 0.0

**Head Tank Reading (in.)**

- 1-13-65

**Hour Observed**

- 7.46

**Hours Between Readings**

- 0.27

**Load (psi)**

- 20.0

**Dial A**

- 0.367

**Dial B**

- 0.427

**Reading**

- 0.0

**Head Tank Reading (in.)**

- 1-14-65

**Hour Observed**

- 6.75

**Hours Between Readings**

- 0.27

**Load (psi)**

- 20.0

**Dial A**

- 0.367

**Dial B**

- 0.427

**Reading**

- 0.0

**Head Tank Reading (in.)**

- 1-15-65

**Hour Observed**

- 7.55

**Hours Between Readings**

- 0.27

**Load (psi)**

- 20.0

**Dial A**

- 0.367

**Dial B**

- 0.427

**Reading**

- 0.0

**Head Tank Reading (in.)**

<table>
<thead>
<tr>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY J.B.</td>
</tr>
<tr>
<td>DATE</td>
</tr>
<tr>
<td>Date</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
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Remarks: 37Q X 68

By: Date: Checked: Sheet: 2 of 2
## EARTH MATERIALS TESTING
### PERMEABILITY-SETTLEMENT TEST

**SAMPLE NO 37Q-X68**  
**DATE PLACED 1-7-64**  
**DATE REMOVED 1-25-65**

**CYLINDER NO 48**  
**HEAD TANK NO 414**

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<td>PROJECT Wichita, Kans.</td>
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<th>Specimen Unit</th>
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<th>Specimen Diameter (in)</th>
<th>Specimen Length (in)</th>
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<th>Initial</th>
<th>Initial Head</th>
<th>Initial Tube</th>
<th>Initial Standpipe Reading</th>
<th>Initial Constant Reading</th>
<th>Initial Area of Tube (sq in)</th>
<th>Initial Tube Readings</th>
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<td>3.87</td>
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**REMARKS**

**BY A.B.**

**DATE**

**CHECKED P.K.**

**SHEET 1 OF 1**
FALLING HEAD PERMEABILITY TEST

SAMPLE NO. 25J-X162                SPECIMEN NO. 1
DATE 07-20-64                      LOADING UNIT NO. 267

PERMEABILITY                     AVERAGE HYDRAULIC GRADIENT
FT/yr    CM/sec                     
0.0024   0.2286E-08                 14.214
0.0014   0.1341E-08                 14.196
0.0013   0.1255E-08                 14.164
0.0012   0.1135E-08                 14.149
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<th>NO. OF SPEC. FOR TAN Ø</th>
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<th>PATH 1 OR 2</th>
<th>TOTAL NO. OF SPEC. IN TEST</th>
<th>Punch Cards Required?</th>
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<td>Yes = 1</td>
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<td>No = 0</td>
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<th>INIT. WT. OF CONTAINER (GM)</th>
<th>INIT. WT. OF SPEC. + CONT. IN WATER (GM)</th>
<th>INIT. WT. LOSS OF CONTAINER (GM)</th>
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<td>897.7</td>
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<th>FINAL WT. OF CONTAINER (GM)</th>
<th>FINAL WT. OF SPEC. + CONT. IN WATER (GM)</th>
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<th>WETTED WT. LOSS OF CONTAINER (GM)</th>
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REMARKS

BY C.E.C.

DATE

CHECKED P.K.

SHEET 1 OF 4
BUREAU OF RECLAMATION

LAbORATORY PUNCH CARD DATA

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<th>BLDG.</th>
<th>PHONE</th>
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<table>
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<tr>
<th>STRAIN RATE (IN. PER MIN.)</th>
<th>INITIAL TEMP. (°F)</th>
<th>FINAL TEMP. (°F)</th>
<th>WEIGHING CAPSULE FACTOR</th>
<th>SPEC. LENGTH AT TOUCH</th>
<th>TIME OF READING</th>
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<th>APPLIED WATER BACK PRESSURE (PSI)</th>
<th>BAROMETRIC PRESSURE (PSI)</th>
<th>EFF. LATERAL PRESSURE</th>
<th>VOLUME TUBE NO. (LEFT: 1, RIGHT: 2)</th>
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<th>LOAD PISTON AREA FACTOR</th>
<th>DRAINAGE TUBE FACTOR</th>
<th>INITIAL VOLUME TUBE READING</th>
<th>SOIL VOLUME 1 OR 3</th>
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1/ (-1.0 IF APPLIED LATERAL - BOTTOM PORE PRESSURE - APPLIED AIR BACK PRESSURE)
1.0 IF APPLIED LATERAL - INSERT PORE PRESSURE
0.0 IF APPLIED LATERAL - TOP PORE PRESSURE

3/ INITIAL SOIL VOLUME
3/ WETTED SOIL VOLUME

REMARKS

BY DATE CHECKED SHEET 2 OF 4
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<th>DEVIATOR GAGE READING</th>
<th>AXIAL VOLUME READING</th>
<th>DRAIN TUBE READING TUBE 1</th>
<th>DRAIN TUBE READING TUBE 2</th>
<th>TOP PLATE PORE PRESSURE READING</th>
<th>BOTTOM PLATE PORE PRESSURE READING</th>
<th>INSERT PORE PRESSURE READING</th>
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**REMARKS**

**BY** | **DATE** | **CHECKED** | **SHEET 3 OF 4**
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<th>AXIAL DIAL READING</th>
<th>VOLUME TUBE READING</th>
<th>DRAIN TUBE READING TUBE 1</th>
<th>TUBE 2</th>
<th>TOP PLATE PORE PRESSURE READING</th>
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**REMARKS**

**BY**

**DATE**

**CHECKED**

**SHEET 4 OF 4**
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Punch Cards Required? Yes = 1 No = 0

PATH 1-LEAST SQUARES COMPUTATION ONLY
PATH 2-ENTIRE SHEAR TEST COMPUTATION
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<th>DRAINAGE TUBE FACTOR</th>
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(1.0 IF APPLIED LATERAL - INSERT PORE PRESSURE)

(0.0 IF APPLIED LATERAL - TOP PORE PRESSURE)

2/1-INITIAL SOIL VOLUME
3-WETTED SOIL VOLUME

REMARKS

BY DATE CHECKED SHEET 2 OF 3
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**REMARKS**

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**Remarks**

**By C.E.C.**
**Date**
**Checked P.k.**
**Sheet 1 of 3**
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<th>FINAL TEMP. (*F)</th>
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\]

\[
(1.0 \text{ IF APPLIED LATERAL - INSERT PORE PRESSURE})
\]

\[
(0.0 \text{ IF APPLIED LATERAL - TOP PORE PRESSURE})
\]

2. 1-INITIAL SOIL VOLUME
3. WETTED SOIL VOLUME

REMARKS

BY DATE CHECKED SHEET 2 OF 3
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**REMARKS**

**BY**

**DATE**

**CHECKED**

**SHEET 3 OF 3**
**BUREAU OF RECLAMATION**

**LABORATORY PUNCH CARD DATA**

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<td>WETTED WT. OF CONTAINER (GM)</td>
<td>WETTED WT. OF SPEC. + CONT. IN WATER (GM)</td>
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REMARKS

BY C.E.C. | DATE | CHECKED P.K. | SHEET 1 OF 4
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<th>STRAIN RATE (IN. PER MIN.)</th>
<th>INITIAL TEMP. (°F)</th>
<th>FINAL TEMP. (°F)</th>
<th>WEIGHING CAPSULE FACTOR</th>
<th>SPEC. LENGTH AT TOUCH</th>
<th>TIME OF READING</th>
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1. If Applied Lateral - Bottom Pore Pressure - Applied Air Back Pressure
2. If Applied Lateral - Insert Pore Pressure
3. If Applied Lateral - Top Pore Pressure

1. Initial Soil Volume
2. Wetted Soil Volume
3. Wetted Soil Volume

Remarks

By Date Checked Sheet 2 of 4
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<th>VOLUME TUBE READING</th>
<th>DRAIN TUBE READING</th>
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**REMARKS**

**BY DATE CHECKED SHEET 3 OF 4**
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<th>AXIAL DIAL READING</th>
<th>VOLUME TUBE READING</th>
<th>DRAIN TUBE READING TUBE 1</th>
<th>TUBE 2</th>
<th>TOP PLATE PORE PRESSURE READING</th>
<th>BOTTOM PLATE PORE PRESSURE READING</th>
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**REMARKS**

**BY**

**DATE**

**CHECKED**

**SHEET 4 OF 4**
### Soils Engineering Branch

**Triaxial Shear Test Results**

**Sample Number**: 36F-X673  
**Specimen Number**: 10  
**Machine Number**: 3

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<th>Final</th>
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- Deviator Stress
- Percent Stress
- Stress Ratio
- Pore Pressure
SOILS ENGINEERING BRANCH  
TRIAXIAL SHEAR TEST RESULTS  
10-14-64  

SAMPLE NUMBER  SPECIMEN NUMBER  MACHINE NUMBER  
36F-X673  10  3  

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<th>LATERAL PRESSURE</th>
<th>SPECIMEN VOLUME AT ANY POINT</th>
<th>ANGLE COMPUTE PORE PRESSURE</th>
<th>DENSITY</th>
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<td>PSI.  KGS CM</td>
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STRAIN RATE  TOTAL DRAINAGE .004  .000
SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-15-64

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<th>SPECIMEN NUMBER</th>
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<th>PERCENT AIR VOLUME</th>
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**SOILS ENGINEERING BRANCH**

**TRIAXIAL SHEAR TEST RESULTS**

**SAMPLE NUMBER**

**SPECIMEN NUMBER**

**MACHINE NUMBER**

36F-X673

20

3

**STRAIN RATE**

.004

**TOTAL DRAINAGE**

.000
## Soil Sampling and Engineering Branch Triaxial Shear Test Results

### 10-19-64

| Sample Number | Specimen Number | Machine Number | Percent Moisture Content | Specimen Volume | Dry Density | Void Ratio | Degree of Saturation | Percent Volume Change | Deviator Stress | Percent Strain | Stress Ratio | Pore Pressure | Top Pressure | Bottom Pressure |
|---------------|-----------------|----------------|--------------------------|-----------------|-------------|------------|----------------------|----------------------|-----------------|---------------|-------------|---------------|--------------|----------------|----------------|
| 36F-X673      | 40              | 3              | 18.00                    | 15.640          | 256.29      | 108.16     | 1.73                | .5526                | 87.80           | 90.87         | 1.75         | .5353         | 3.41         | 3.44            |
|               |                 |                | 18.04                    | 15.465          | 253.42      | 109.39     | 1.75                | .5353                | 90.87           | 90.87         | 1.75         | .5353         | 3.41         | 3.44            |
|               |                 |                | 4.34                     | 256.29          | 108.16      | 1.73       | .5526                | 87.80                | 90.87           | 90.87         | 1.75         | .5353         | 3.41         | 3.44            |

### Notes
- Percent Moisture Content: Initial 18.00, Final 18.04
- Percent Air Volume: Initial 4.34, Final 4.34, WETTED .00
- Specific Gravity: 2.69
- Void Ratio: .4841
- Percent Volume Change: Initial 18.00, Final 4.41
- Deviator Stress: Total .00, During Shear .00
- Percent Strain: Top .00, Bottom .00
- Stress Ratio: Top .00, Bottom .00
- Pore Pressure: Total .00, During Shear .00
- Top Pressure: .00, Bottom .00

### Additional Notes
- Triaxial shear test results for sample 36F-X673 on 10-19-64.
- Specimen volume data: Initial 15.640 cu.in., Final 15.465 cu.in., WETTED .00 cc.
- Dry density data: Initial 256.29pcf, Final 253.42pcf, WETTED .00 gr/cc.
- Void ratio data: Initial 1.73, Final 1.75, WETTED .00.
- Degree of saturation data: Initial 87.80, Final 90.87, WETTED .00.
- Percent volume change data: Initial 18.00, Final 4.41.
- Deviator stress data: Total .00, During Shear .00.
- Percent strain data: Top .00, Bottom .00.
- Stress ratio data: Top .00, Bottom .00.
- Pore pressure data: Total .00, During Shear .00.
- Top pressure data: .00, Bottom .00.
SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-19-64

SAMPLE NUMBER: 36F-X673
SPECIMEN NUMBER: 40
MACHINE NUMBER: 3

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SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-21-64
SAMPLE NUMBER 36F-X673
SPECIMEN NUMBER 50
MACHINE NUMBER 3

STRAIN RATE .004
TOTAL DRAINAGE .000
SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-14-64

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10-15-64  
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10-19-64
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**Specimen Number:** 50  
**Machine Number:** 3

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**By C.E.C.**

**Date**

**Checked P.K.**

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WT. OF SPEC. RING, COVER PLATES AND WET SOIL (G.M.)

WT. OF SPEC. RING AND COVER PLATES (G.M.)

DIAL READING WITH GAGE RING IN PLACE

DIAL READING WITH SEATING LOAD ON SPEC.

DATE OUT

CONTAINER NO. W0

CONTAINER NO. **

WET WT. OF SPEC. W0 (GMS.)

DRY WT. OF SPEC. W0 (GMS.)

WT. OF CONT. ** (GMS.)

DIAL READING WITH SEATING LOAD ON SPEC.

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REMARKS

BY A.B. DATE CHECKED PK. SHEET 1 OF
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REMARKS

BY [Signature]

DATE

CHECKED

SHEET 2 OF 12
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REMARKS

SAMPLE NO.
GAGE
BEAM
UNIT

BY
DATE
CHECKED
SHEET 3 OF 12
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REMARKS

BY

DATE

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REMARKS
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SAMPLE NO. ..........................
GAGE..............................
BEAM..............................
UNIT..............................

BY DATE CHECKED SHEET | 5 OF 12
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ELAPSED TIME IN SECONDS DIAL RD.

HRS MIN SEC

1 20
3 20
6 40
15 20
33 20
1 6 40
2 13 20
5 33 20
24 00 00

REMARKS

BY DATE CHECKED

JOB NO.

RETURN TO

LABORATORY PUNCH CARD DATA

BUREAU OF RECLAMATION

PROBLEM CONONEUSE

DIAL RD. 

GAGE

BEAM

UNIT

SAMPLE NO.

PUNCHCARD DATA

PHONE

SHEET 6 OF 12
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| ELAPSED TIME IN SECONDS | DIAL RDG. | | | |
|--------------------------|-----------|------------------|-------------|-------|------|------|
| 1                        | 0.11970   |                  |             |       |     |     |
| 1                        | 0.11971   |                  |             |       |     |     |
| 1                        | 0.11971   |                  |             |       |     |     |
| 2                        | 0.11971   |                  |             |       |     |     |
| 4                        | 0.11971   |                  |             |       |     |     |
| 2                        | 0.11972   |                  |             |       |     |     |
| 8                        | 0.11972   |                  |             |       |     |     |
| 2                        | 0.11972   |                  |             |       |     |     |
| 4                        | 0.11973   |                  |             |       |     |     |
| 6                        | 0.11973   |                  |             |       |     |     |
| 8                        | 0.11973   |                  |             |       |     |     |
| 13                       | 0.11973   |                  |             |       |     |     |
| 33                       | 0.11974   |                  |             |       |     |     |
| 1                        | 0.11973   |                  |             |       |     |     |
| 2                        | 0.11973   |                  |             |       |     |     |
| 3                        | 0.11973   |                  |             |       |     |     |
| 5                        | 0.11973   |                  |             |       |     |     |
| 24                       | 0.11974   |                  |             |       |     |     |

REMARKS

BY

DATE

CHECKED

SHEET 7 OF 12
## LABORATORY PUNCH CARD DATA

**USE**

**BUFF**

**COLORED CARDS**

**DETAIL**

**ONE-DIMENSIONAL CONSOLIDATION TEST DATA**

**PROJECT**

**RETURN TO**

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**SAMPLE NO.**

**GAGE**

**BEAM**

**UNIT**

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**HRS MIN SEC**

| 1 | 20 |
| 3 | 20 |
| 6 | 40 |
| 13| 20 |
| 33| 20 |

**REMARKS**

**BY**

**DATE**

**CHECKED**

**SHEET 8 OF 12**
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**Remarks**

*BY*  
*DATE*  
*CHECKED*  
*SHEET 9 OF 12*
## LABORATORY PUNCH CARD DATA

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**Sample No.**

**Gage.**

**Beam.**

**Unit.**

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**Remarks**

**By**

**Date**

**Checked**

**Sheet 10 of 12**
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**SAMPLE NO.**

**GAGE.**

**BEAM.**

**UNIT.**
**BUREAU OF RECLAMATION**

**LABORATORY PUNCH CARD DATA**

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<th>Date</th>
<th>Specimen Diameter (in)</th>
<th>Specimen Length (in)</th>
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<td>346</td>
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**REMARKS**

**BY**

**DATE**

**CHECKED**

**SHEET 12 OF 12**
# Earth Materials Testing

## One-Dimensional Consolidation Test

**Sample No:** 5K-101  
**Specimen No:** 1  
**Specimen Type:** Remolded

**Date Placed:** 10-30-64  
**Date Removed:** 11-12-64  
**Specific Gravity:** 2.65

**Specimen Diameter:** 4.25 in.  
**Specimen Height:** 1.25 in.

**Test Performed In:** Conbel No 346

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<th>Void Ratio</th>
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**Time in Sec.**  
4.  
76680.  
4.  
7.  
8.  
9.  
10.  
20.  
5.  
10.  
20.  
40.  
80.  
200.  
400.  
800.  
2000.  
4000.  
8000.  
20000.  
172800.  
4.  
10.  
20.  
40.  
80.  
138
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**5K-101**

LOAD = 25.00 PSI  
DRY DENSITY = 115.70 PCF

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**5K-101**

LOAD = 50.00 PSI  
DRY DENSITY = 115.76 PCF

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**5K-101**

LOAD = 100.00 PSI  
DRY DENSITY = 115.86 PCF

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<tr>
<th>TIME IN SEC.</th>
<th>PERCENT CONS.</th>
<th>CONSOLIDATION</th>
<th>VOID RATIO</th>
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205-616 0-66——10
5K-101
LOAD = 100.00 PSI
DRY DENSITY = 115.88 PCF
TIME IN SEC.
86404.
172800.
355600.
CONSOLIDATION = 0.2078 PERCENT
VOID RATIO = 0.4276

LOAD = 1.00 PSI
DRY DENSITY = 115.55 PCF
TIME IN SEC.
4.
86400.
CONSOLIDATION = -0.0799 PERCENT
VOID RATIO = 0.4317

LOAD = 0.35 PSI
DRY DENSITY = 115.38 PCF
TIME IN SEC.
4.
172800.
CONSOLIDATION = -0.2238 PERCENT
VOID RATIO = 0.4337

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REBOUND = 207.69 PERCENT

INITIAL MAX LOAD EXPANDED

DRY DENSITY
115.642 115.883 115.384
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**FALLING HEAD PERMEABILITY TEST**

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<tr>
<th>PERMEABILITY</th>
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<tr>
<td>FT/YR</td>
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