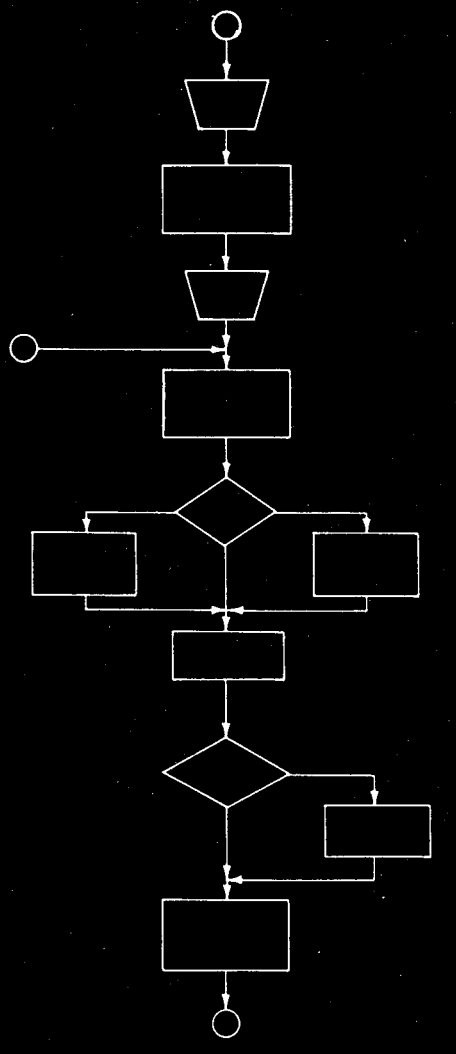

Soils tests computer programs

A Water Resources Technical Publication

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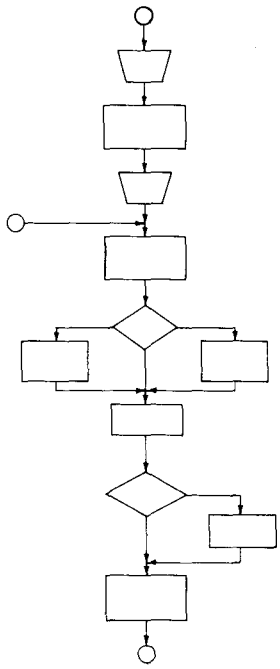

Soils tests computer programs

by Paul C. Knodel

Soils Engineering Branch
Division of Research
Office of Chief Engineer

UNITED STATES DEPARTMENT OF THE INTERIOR
STEWART L. UDALL, *Secretary*

BUREAU OF RECLAMATION
FLOYD E. DOMINY, *Commissioner*

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 programed 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.

Research Report No. 3, "Soils Tests Computer Programs," in the Water Resources Technical Publications series, is based on material first made available in the Bureau's internal Report No. EM–713, issued in limited quantity by the Soils Engineering Branch, Division of Research, Office of the Chief Engineer, Denver, Colo.

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

γ_d = the dry density in pcf (gm/cc),
γ_{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

[1] Earth Manual (First Edition, Revised), U.S. Department of the Interior, Bureau of Reclamation; U.S. Government Printing Office.

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 ¾-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 1/20-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:

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

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

$$k=\frac{V}{At}\div\frac{H_{wc}\text{ (for constant head)}}{L}$$

or

$$k=\frac{VL}{AtH_{wc}}$$

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_{wc}=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:

$$k=\frac{A_pL_s}{A_s}\times\frac{1.0}{t}\log_e\frac{H_i}{H_f}$$

where

k=permeability rate (ft/yr), (cm/sec)
A_p=area of standpipe supplying water (sq in.), (sq cm)
A_s=area of soil specimen (sq in.), (sq cm)
L_s=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 φ, 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 $s=c+\sigma \tan \varphi$; or on an effective stress basis $s=c+(\sigma-u) \tan \varphi$ where c is the cohesion, σ 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 ($\tan \varphi$ 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 ($\tan \varphi$) 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-pressuring. 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 electro-plotter 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:

$$\sum xy = a\sum x + b\sum x^2 \qquad (1)$$

$$\sum y = aN + b\sum x \qquad (2)$$

Rearrange into typical quadratic form

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

$$aN + b\sum x - \sum y = 0$$

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 φ). 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 φ 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 programed 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

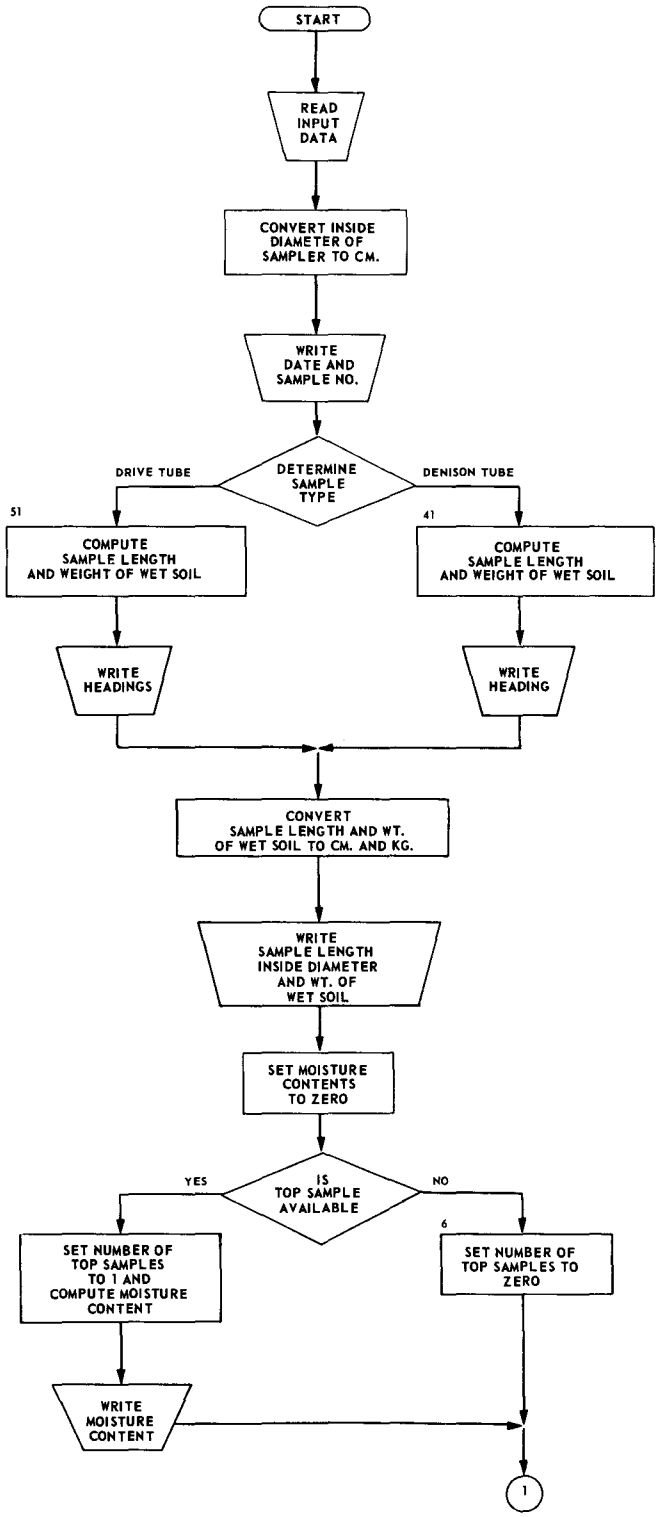
The flow chart shows the order in which calculations and decisions are made when writing each of the programs. The listing shows the order of the Fortran II statements used for each of the various soil test programs, and the variable names and definitions are used to identify each variable used in each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

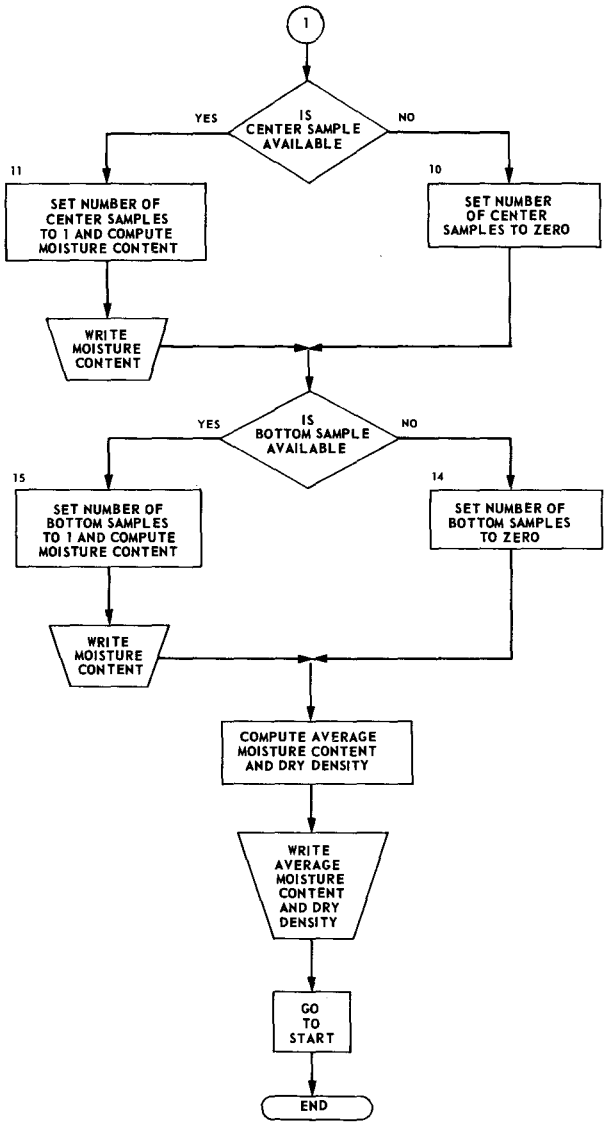
Natural moisture-density
Gradation analysis
Soil consistency (Atterberg limits)
Proctor compaction
Constant-head permeability-settlement
Falling-head permeability
Triaxial shear
One-dimensional consolidation
Sliding factor and direct shear, least squares

205-616 O—66——2

SHEET 1 OF 2

FLOW CHART
NATURAL MOISTURE-DENSITY TEST




1
IS CENTER SAMPLE AVAILABLE
YES
NO
11
SET NUMBER OF CENTER SAMPLES TO 1 AND COMPUTE MOISTURE CONTENT
10
SET NUMBER OF CENTER SAMPLES TO ZERO
WRITE MOISTURE CONTENT
IS BOTTOM SAMPLE AVAILABLE
YES
NO
15
SET NUMBER OF BOTTOM SAMPLES TO 1 AND COMPUTE MOISTURE CONTENT
14
SET NUMBER OF BOTTOM SAMPLES TO ZERO
WRITE MOISTURE CONTENT
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,WST,TF,DTW,DTT,DTB
 2 FORMAT (4A4,7F8.3)
   READ INPUT TAPE 5,3,W1,W2,W3,W4,W5,W6,W7,W8,W9
 3 FORMAT (9F8.3)
   TID1=TID*2.54
   WRITE OUTPUT TAPE 6,4,D1,D2,S1,S2
 4 FORMAT (1H1 8X,7H DATE   2A4,16X,12H SAMPLE NC.  2A4 /////)
   IF (DTW)41,41,51
41 SL =TL
   WS =WST-(TL*TF)
   WRITE OUTPUT TAPE 6,5
 5 FORMAT (9X,50H IN-PLACE MOISTURE-DENSITY CF SCIL 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,TID1,TID,WS1,WS
540FORMAT(////// 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
   WATERT=((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
   DRYDEN=WS/((SL*(TID*TID/144.0)*0.785398)*((WATER/100.0)+1.0))
   GRAMCC=DRYDEN*0.0160185
```

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

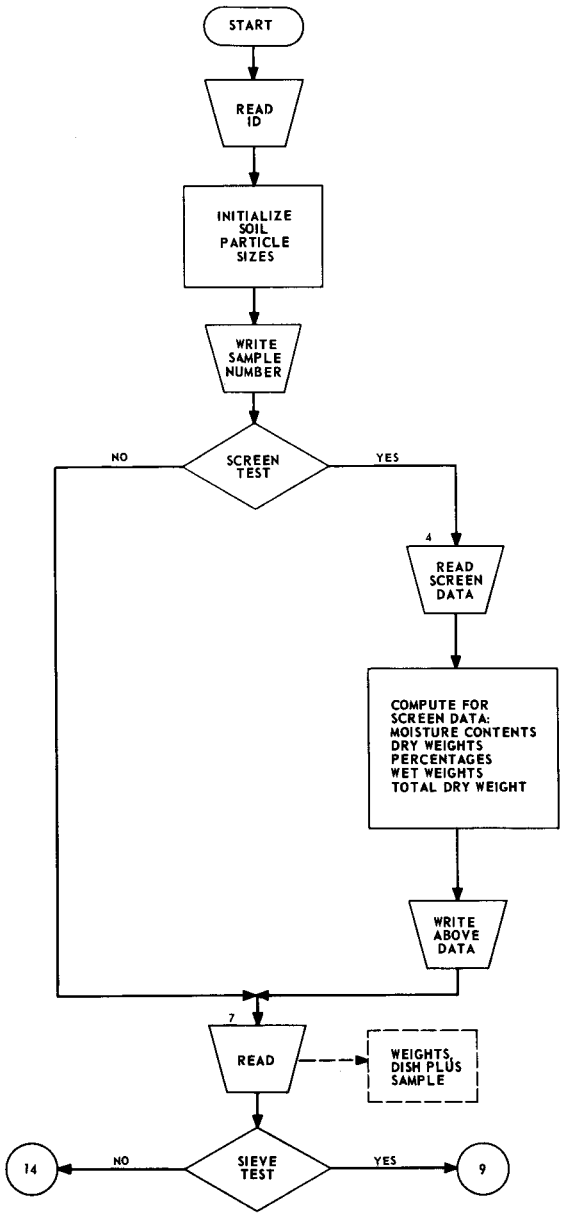
   WRITE OUTPUT TAPE 6,18,WATER,GRAMCC,DRYDEN
180FORMAT(////// 9X,41H AVERAGE MOISTURE (PERCENT OF DRY WGT) =  F8.4
  1 // 9X,15H DRY DENSITY =  F8.4,12H GRAMS/CC = F8.4,11H LBS/CU.FT.)
   GO TO 1
   END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
```

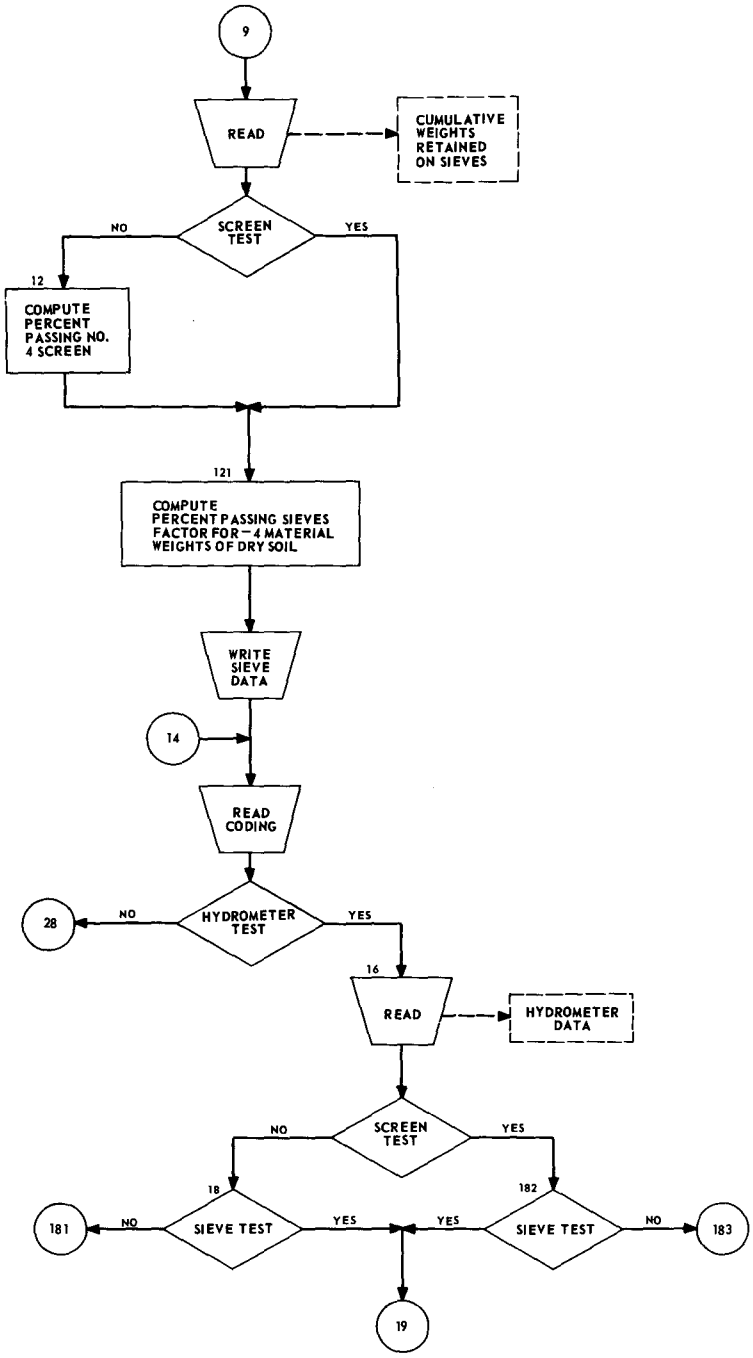
NATURAL MOISTURE-DENSITY TEST FOR DENISON AND DRIVE TUBE SAMPLES

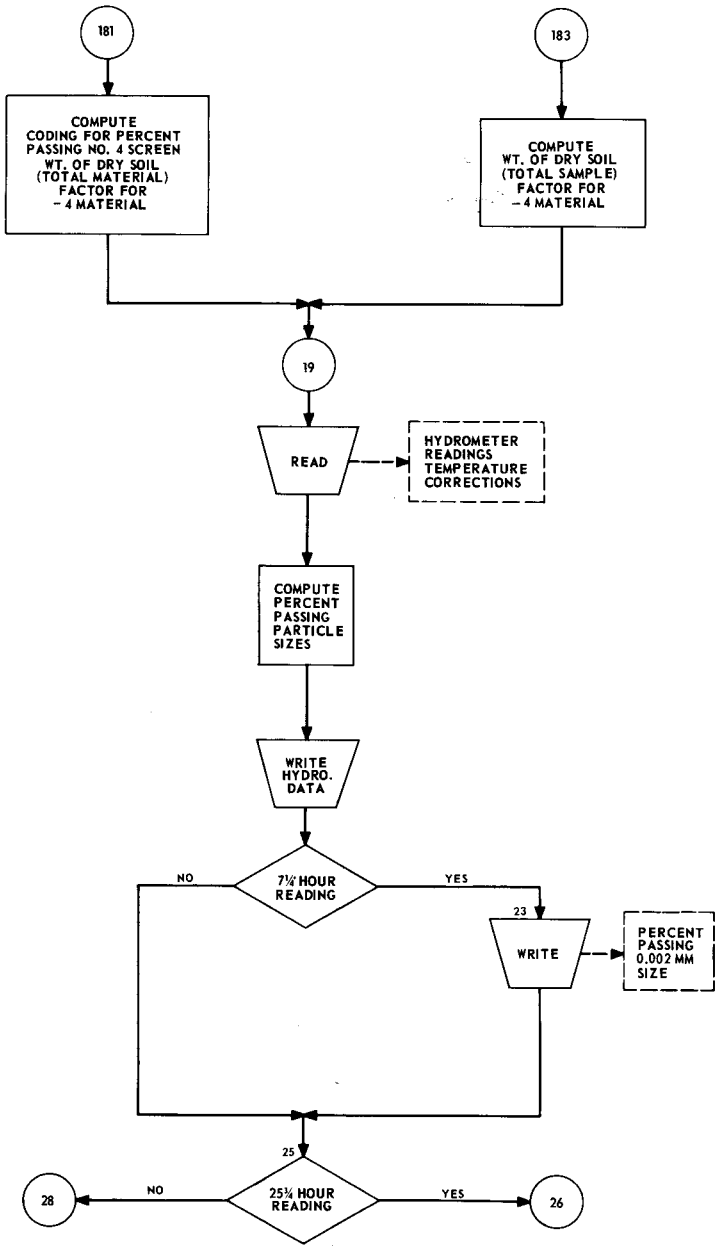
Variable name	Definition	Variable name	Definition
BOT	Number of moisture samples from bottom of soil sample, 0 or 1.	W3	Weight of dish used for moisture sample from top of soil sample (gm).
CEN	Number of moisture samples from center of soil sample, 0 or 1.	W4	Weight of dish and wet soil from center of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

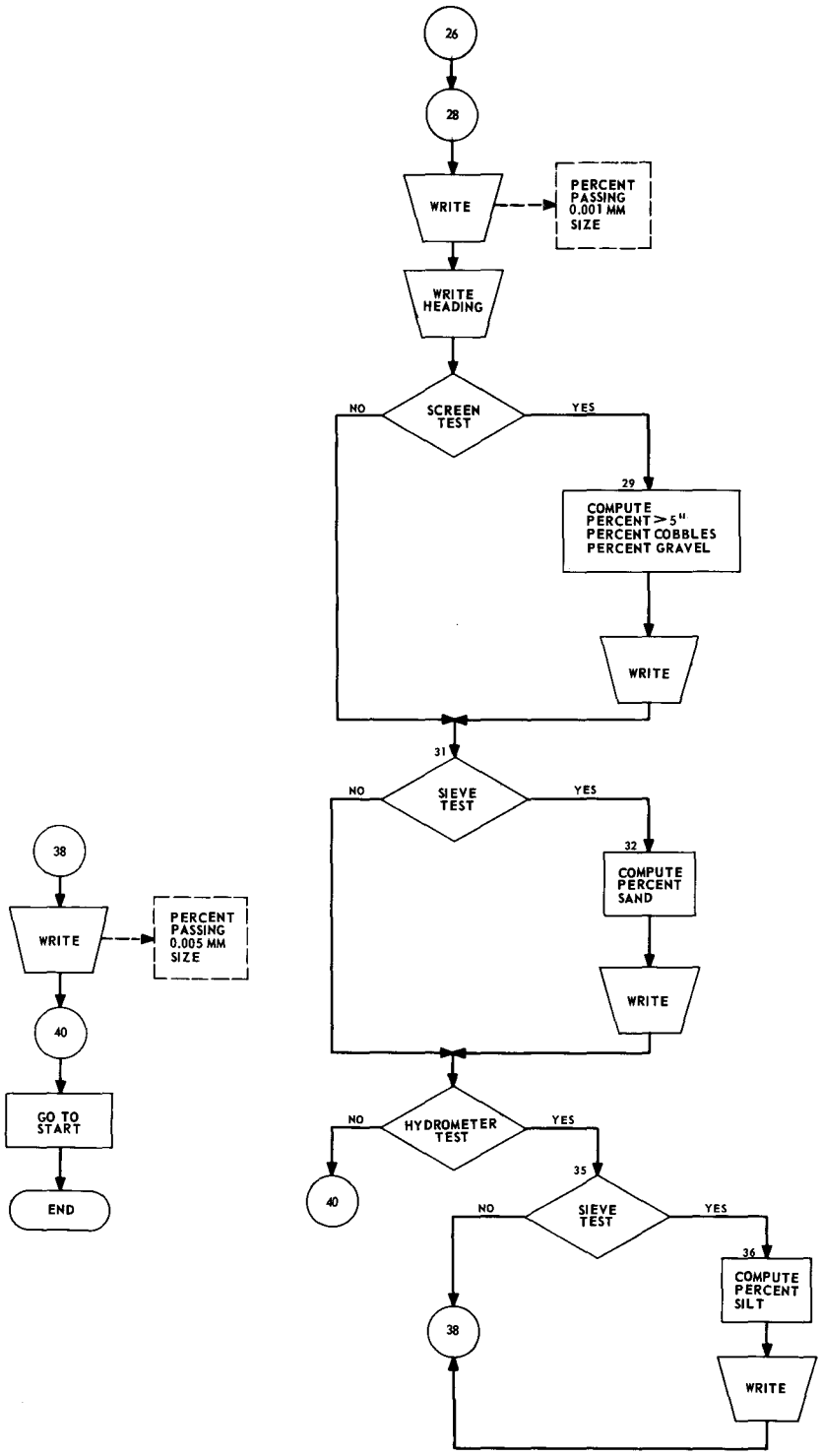
SHEET 1 OF 4

FLOW CHART
GRADATION ANALYSIS




9
READ
CUMULATIVE WEIGHTS RETAINED ON SIEVES
SCREEN TEST
NO
YES
12
COMPUTE PERCENT PASSING NO. 4 SCREEN
121
COMPUTE PERCENT PASSING SIEVES FACTOR FOR −4 MATERIAL WEIGHTS OF DRY SOIL
WRITE SIEVE DATA
14
READ CODING
HYDROMETER TEST
NO
28
YES
16
READ
HYDROMETER DATA
SCREEN TEST
NO
YES
18
182
SIEVE TEST
NO
181
YES
YES
SIEVE TEST
NO
183
19


181
183
COMPUTE CODING FOR PERCENT PASSING NO. 4 SCREEN WT. OF DRY SOIL (TOTAL MATERIAL) FACTOR FOR -4 MATERIAL
COMPUTE WT. OF DRY SOIL (TOTAL SAMPLE) FACTOR FOR -4 MATERIAL
19
READ
HYDROMETER READINGS TEMPERATURE CORRECTIONS
COMPUTE PERCENT PASSING PARTICLE SIZES
WRITE HYDRO. DATA
NO
7¼ HOUR READING
YES
23
WRITE
PERCENT PASSING 0.002 MM SIZE
25
28
NO
25¾ HOUR READING
YES
26


26
28
WRITE
PERCENT PASSING 0.001 MM SIZE
WRITE HEADING
NO
SCREEN TEST
YES
29
COMPUTE PERCENT > 5" PERCENT COBBLES PERCENT GRAVEL
WRITE
31
NO
SIEVE TEST
YES
32
COMPUTE PERCENT SAND
WRITE
38
WRITE
PERCENT PASSING 0.005 MM SIZE
40
GO TO START
END
NO
HYDROMETER TEST
YES
40
35
NO
SIEVE TEST
YES
36
COMPUTE PERCENT SILT
38
WRITE

```
      MECHANICAL ANALYSIS (GRADATION) TEST

    1 READ INPUT TAPE 5,2,SCREEN,SAM,SAMP,SAMPLE
    2 FORMAT (F4.0,12X,3A4)
      D1=127.
      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
      WRITE OUTPUT TAPE 6,3,SAM,SAMP,SAMPLE
   30FORMAT (1H1,4X,37H MECHANICAL ANALYSIS (GRADATION) TEST , 6X, 11H
    1SAMPLE NO  3A4 // )
      IF (SCREEN-1.0)7,4,4
    4 READ INPUT TAPE 5,5,DAT1,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+(WAG/100.))
      BG = AG/(1.0+(WAG/100.))
      CG = AP/(1.0+(WAP/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
      CGC1=CGC*0.45359237
      AP1=AP*0.45359237
     OWRITE OUTPUT TAPE 6,52,DAT1,DATE1,ATC1,ATC,AT1,AT,CT1,CT,WAD,WAG,
     1WAP
  520FORMAT (4X, 6H DATE ,2A4,3X,27H *****SCREEN ANALYSIS***** , /
     14X,42H WET WGT-TOTAL SAMPLE (BEFORE SCREENING) =,F8.3,5H KG =,
     2F8.2,4H LBS,/ 4X,42H WET WGT-TOTAL SAMPLE (AFTER  SCREENING) =,
     3F8.3,5H KG =,F8.2,4H LBS,/ 4X,42H DRY WGT-TOTAL SAMPLE
     4         =,F8.3,5H KG =,F8.2,4H LBS,    / 4X,26H MOISTURE (PERCENT),
     5 +3/4=,F7.3,13H , -3/4,+NO4=,F7.3,8H , -NO4=,F7.3 / )
     OWRITE 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
   60FORMAT (7X,44H DRY WEIGHT          DRY WEIGHT          SCREEN/8X,64H
     1RETAINED            PASSING            SIZE       PERCENT OF TOTAL/
     26X,66H KG        LBS        KG        LBS      IN       MM     DRY WGT P
     3ASSING/4X,F8.3,F9.2,2X,F8.3,F9.2,3X,5H 5    ,F6.1,5X,F8.4,/ 23X,
     4F8.3,F9.2,3X,5H 3    ,F6.1,5X,F8.4,/ 7X,16H WET WEIGHT      ,F8.3,
     5F9.2,1X,7H 1-1/2 ,F6.1,5X,F8.4,/ 8X,8H PASSING,7X,F8.3,F9.2,2X,6H
     63/4   ,F6.1,5X,F8.4,/ 6X,3H KG,6X,8H LBS      ,F8.3,F9.2,8H   3/8   ,
     7F7.2,4X,F8.4,/4X,F8.3,F9.2,2X,F8.3,F9.2,8H   NO 4 ,F7.2,4X,F8.4//)
    7 READ INPUT TAPE 5,8,SIEVE,DGA,RDW,RWW,RDS
    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 - 1.0)12,121,121
   12 DG=DGA
  121 RW=RDW-RWW
      RS=RDS-RWW
      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
     OWRITE OUTPUT TAPE 6,13,DAT2,DATE2,DG,DGRW,RW,RS,D7,SA,D8,SB,D9,SC,
     1D10,SD,D11,SE,D12,SG,RH
  130FORMAT (4X,6H DATE ,2A4,3X,25H *****SIEVE ANALYSIS*****/,4X,
```

MECHANICAL ANALYSIS (GRADATION) TEST

```
  133H PERCENT OF DRY WGT PASSING NO 4=,F8.4,13H, FACTOR (F)=,F8.5,/
  2       ,4X,46H DRY WEIGHT OF TOTAL SAMPLE (W)     (GRAMS) = , F8.2
  3/  4X,46H DRY WEIGHT OF SAMPLE TO BE SIEVED, (GRAMS) = ,F8.2, /
  438X,34H SIEVE  PARTICLE  PERCENT OF TOTAL / 40X,32H NO   DIA (MM)
  5  DRY WGT PASSING / 41X,2H 8,5X,F6.3,5X,F8.4,/ 40X,3H 16,5X,F6.3,
  65X,F8.4,/ 40X,3H 30,5X,F6.3,5X,F8.4,/ 7X,11H DRY WEIGHT,22X,3H 50,
  75X,F6.3,5X,F8.4,/ 8X, 9H RETAINED,22X,4H 100,5X,F6.3,5X,F8.4, / 9X
  8,8H (GRAMS),22X,4H 200,5X,F6.3,5X,F8.4,/
  99X,F8.3,22X,4H PAN // )
 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
 160READ INPUT TAPE 5,17,DAT3,DATE3,HS,H,HDAA,HDA1,HDA2,HW1,
   1HW2,HW3,HW4,HW5
 17 FORMAT (2A4,2X,A6,4X,A4,4X,A4,2A4,5A4)
    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
   0WRITE OUTPUT TAPE 6,21,DAT3,DATE3,DG,DGRW,RW,HW1,HW2,HW3,HW4,HW5,
   1HDAA,HDA1,HDA2,HS,H
 210FORMAT (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
 220FORMAT (38X,34H TIME   PARTICLE  PERCENT OF TOTAL / 36X,36H ELAPSE
   1D  DIA (MM)   DRY WGT PASSING / 38X,10H 1 MIN    ,F6.3,5X,F8.4, /
   238X,10H 4 MIN    ,F6.3,5X,F8.4,/ 37X,11H 19 MIN    ,F6.3,5X,F8.4,/
   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
 300FORMAT (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
 330FORMAT (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 GO TO 1
    END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
```

Variable name	Definition
AA	Wet weight retained on 5-inch screen (lb).
AB	Wet weight retained on 3-inch screen (lb).
AC	Wet weight retained on 1½-inch screen (lb).
AD	Wet weight retained on ¾-inch screen (lb).
ADX	Pan+wet soil for moisture determination of +¾-inch soil.
ADY	Pan+dry soil for moisture determination of +¾-inch soil.
ADZ	Pan weight for moisture determination of +¾-inch soil.
AE	Wet weight retained on ⅜-inch screen (lb).
AG	Wet weight retained on No. 4 screen (lb).
AGX	Pan+wet soil for moisture determination of −¾ inch, +No. 4 soil.
AGY	Pan+dry soil for moisture determination of −¾ inch, +No. 4 soil.
AGZ	Pan weight for moisture determination of −¾-inch, +No. 4 soil.
AP	Wet weight of −No. 4 soil (lb).
AP1	Wet weight of −No. 4 soil (kg).
APX	Pan+wet soil for moisture determination of −No. 4 soil.
APY	Pan+dry soil for moisture determination of −No. 4 soil.
APZ	Pan weight for moisture determination of −No. 4 soil.
ART	Wet weight of +No. 4 soil (lb).
AT	Wet weight of total sample (lb).
AT1	Wet weight of total sample (kg).
ATC	Wet weight of total sample before screening (lb).
ATC1	Wet weight of total sample before screening (kg).
BA	Dry weight retained on 5-inch screen (lb).
BA1	Dry weight retained on 5-inch screen (kg).
BB	Dry weight retained on 3-inch screen (lb).
BC	Dry weight retained on 1½-inch screen (lb).
BD	Dry weight retained on ¾-inch screen (lb).
BE	Dry weight retained on ⅜-inch screen (lb).
BG	Dry weight retained on No. 4 screen (lb).
CA	Dry weight passing 5-inch screen (lb).
CA1	Dry weight passing 5-inch screen (kg).
CB	Dry weight passing 3-inch screen (lb).
CB1	Dry weight passing 3-inch screen (kg).
CC	Dry weight passing 1½-inch screen (lb).
CC1	Dry weight passing 1½-inch screen (kg).
CD	Dry weight passing ¾-inch screen (lb).
CD1	Dry weight passing ¾-inch screen (kg).
CE	Dry weight passing ⅜-inch screen (lb).
CE1	Dry weight passing ⅜-inch screen (kg).
CG	Dry weight of total −No. 4 soil (lb).
CG1	Dry weight of total −No. 4 soil (kg).
CGC	Dry weight passing No. 4 screen (lb).
CGC1	Dry weight passing No. 4 screen (kg).
COBBLE	Percent cobbles.
CRT	Total dry weight of +No. 4 soil (lb).
CT	Total dry weight of sample (lb).
CT1	Total dry weight of sample (kg).
D1 through D18	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.
DA	Passing 5-inch screen (%).
DB	Passing 3-inch screen (%).

Variable name	Definition
DC	Passing 1½-inch screen (%).
DD	Passing ¾-inch screen (%).
DE	Passing ⅜-inch screen (%).
DG	Passing No. 4 screen (%).
DAT1	
DATE1	Date screen test was performed.
DAT2	
DATE2	Date sieve test was performed.
DAT3	
DATE3	Date hydrometer test was performed.
DGA	Coding used for percent passing No. 4 screen.
DGH	Coding used for percent passing No. 4 screen.
DGRW	Factor used to compute percent passing for —No. 4 material; (percent passing No. 4)/(weight of sample to be sieved).
GRAVEL	Percent gravel.
H	Hydrometer number.
HDAA	Ml. of dispersing agent used in sample.
HDA1	Dispersing agent used.
HDA2	
HS	Starting time for hydrometer test.
HW1 through HW5	Time hydrometer test mixed and type of mixer used.
HYDROM	Coding used to determine whether hydrometer test was performed.
OVER	Percent oversize material; +5 inch.
RA	Cumulative weight retained on No. 8 sieve.
RB	Cumulative weight retained on No. 16 sieve.
RC	Cumulative weight retained on No. 30 sieve.
RD	Cumulative weight retained on No. 50 sieve.
RDS	Dish + dry soil to be sieved (gm).
RDW	Dish + dry soil before hydrometer test (gm).
RDWH	Coding used for dish + dry soil only if no sieve test is to be performed.
RE	Cumulative weight retained on No. 100 sieve.
RG	Cumulative weight retained on No. 200 sieve.
RH	Cumulative weight retained on pan.
RS	Dry soil to be sieved—after hydrometer test (gm).
RW	Dry soil, total sample to be sieved (gm).
RWW	Dish weight, total sample to be sieved (gm).
RWWH	Coding used for dish weight only if no sieve test is to be performed.
SA	Passing No. 8 sieve (%).
SAM	
SAMP	Sample number.
SAMPLE	
SAND	Percent sand.
SB	Passing No. 16 sieve (%).
SC	Passing No. 30 sieve (%).
SCREEN	Coding used to determine whether screen test was performed.
SD	Passing No. 50 sieve (%).
SE	Passing No. 100 sieve (%).
SG	Passing No. 200 sieve (%).
SIEVE	Coding used to determine whether sieve test was performed.
SILT	Percent silt.
TA	1 minute hydrometer reading.
TB	4 minute hydrometer reading.
TC	19 minute hydrometer reading.
TD	60 minute hydrometer reading.
TE	7 hour 15 minute hydrometer reading.
TG	25 hour 45 minute hydrometer reading.
UA	Temperature correction for 1 minute hydrometer reading.
UB	Temperature correction for 4 minute hydrometer reading.
UC	Temperature correction for 19 minute hydrometer reading.
UD	Temperature correction for 60 minute hydrometer reading.

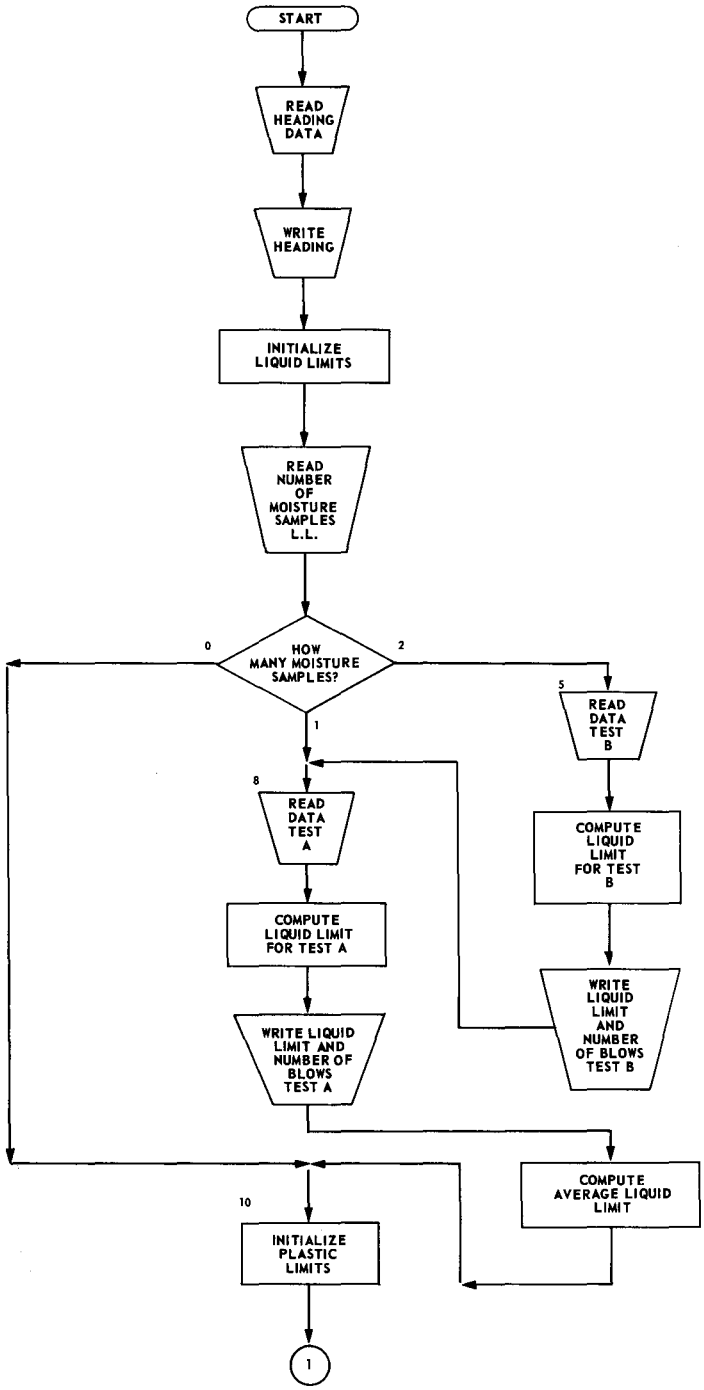
MECHANICAL ANALYSIS (GRADATION) TEST—Continued

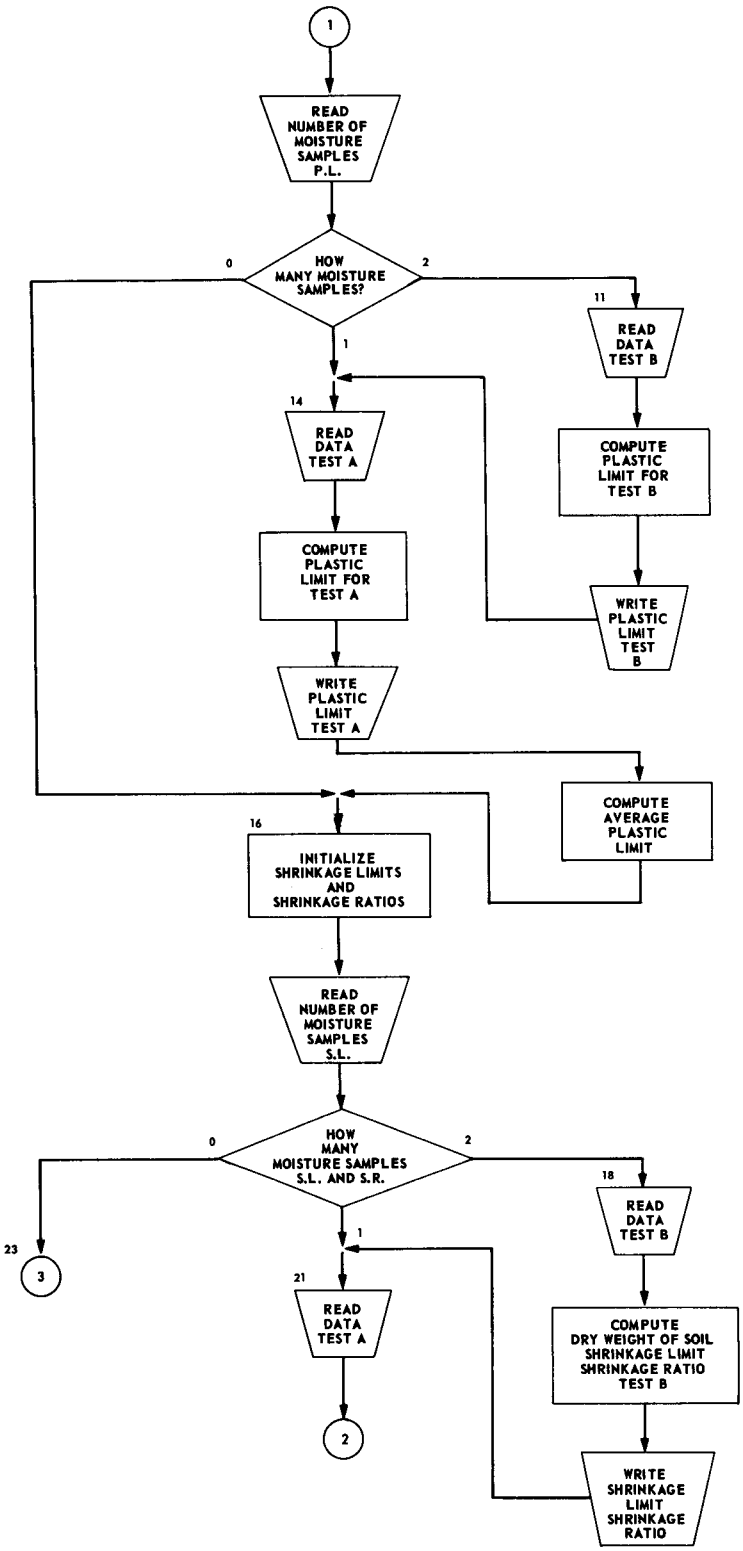
Variable name	Definition	Variable name	Definition
UE	Temperature correction for 7 hour 15 minute hydrometer reading.	VE	Percent passing 0.002 mm particle size.
UG	Temperature correction for 25 hour 45 minute hydrometer reading.	VG	Percent passing 0.001 mm particle size.
VA	Percent passing 0.037 mm particle size.	WAD	Moisture content of +¾-inch material (%).
VB	Percent passing 0.019 mm particle size.	WAG	Moisture content of −¾-inch, +No. 4 material (%).
VC	Percent passing 0.009 mm particle size.	WAP	Moisture content of −No. 4 material (%).
VD	Percent passing 0.005 mm particle size.		

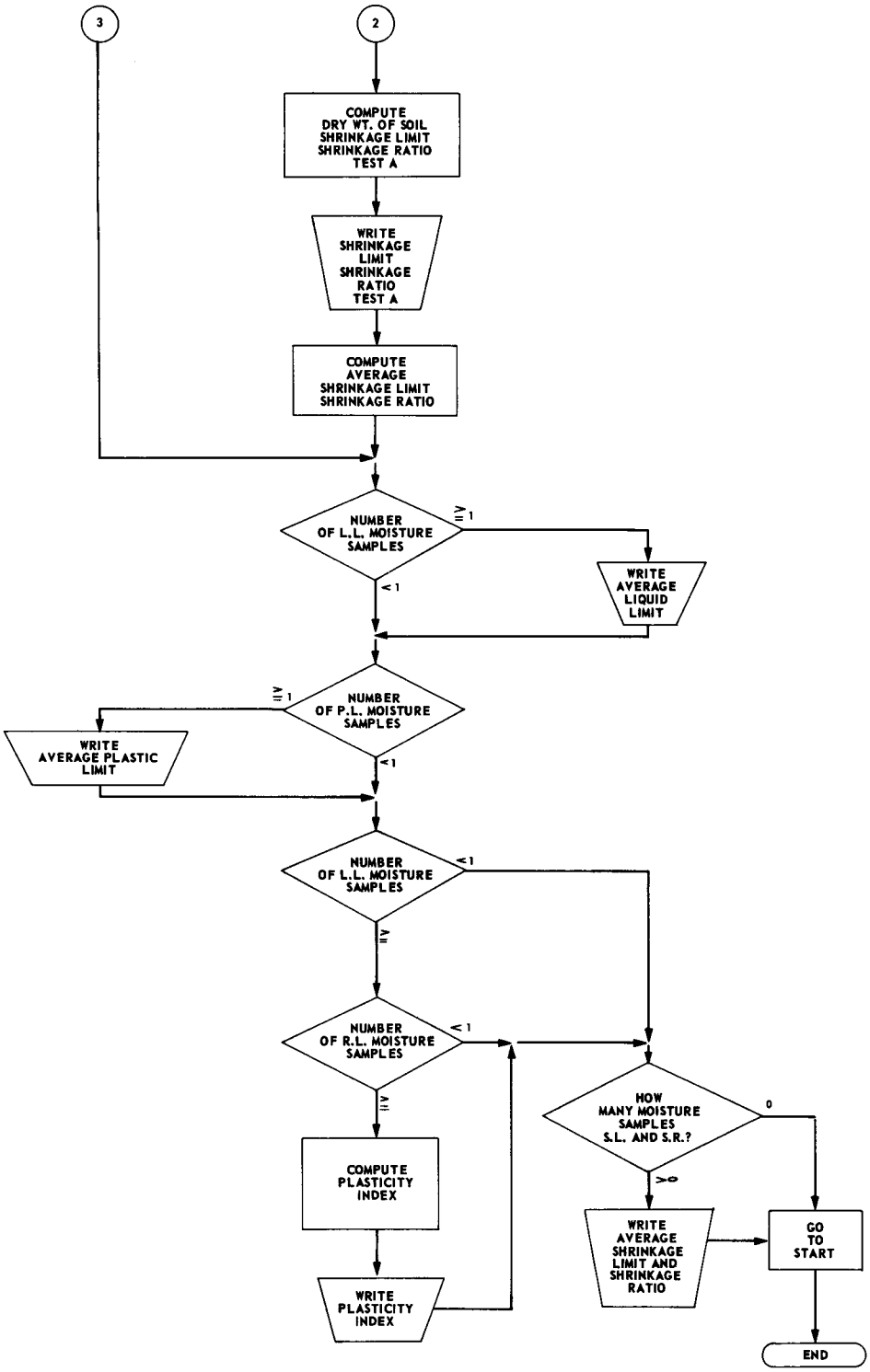
SHEET 1 OF 3

FLOW CHART

SOIL CONSISTENCY (ATTERBERG LIMITS) TESTS




1
READ NUMBER OF MOISTURE SAMPLES P.L.
HOW MANY MOISTURE SAMPLES?
0
2
1
11
READ DATA TEST B
14
READ DATA TEST A
COMPUTE PLASTIC LIMIT FOR TEST B
COMPUTE PLASTIC LIMIT FOR TEST A
WRITE PLASTIC LIMIT TEST B
WRITE PLASTIC LIMIT TEST A
COMPUTE AVERAGE PLASTIC LIMIT
16
INITIALIZE SHRINKAGE LIMITS AND SHRINKAGE RATIOS
READ NUMBER OF MOISTURE SAMPLES S.L.
HOW MANY MOISTURE SAMPLES S.L. AND S.R.
0
2
18
READ DATA TEST B
23
3
1
21
READ DATA TEST A
COMPUTE DRY WEIGHT OF SOIL SHRINKAGE LIMIT SHRINKAGE RATIO TEST B
2
WRITE SHRINKAGE LIMIT SHRINKAGE RATIO


3
2
COMPUTE DRY WT. OF SOIL SHRINKAGE LIMIT SHRINKAGE RATIO TEST A
WRITE SHRINKAGE LIMIT SHRINKAGE RATIO TEST A
COMPUTE AVERAGE SHRINKAGE LIMIT SHRINKAGE RATIO
NUMBER OF L.L. MOISTURE SAMPLES
≥ 1
< 1
WRITE AVERAGE LIQUID LIMIT
NUMBER OF P.L. MOISTURE SAMPLES
≥ 1
< 1
WRITE AVERAGE PLASTIC LIMIT
NUMBER OF L.L. MOISTURE SAMPLES
< 1
≥ 1
NUMBER OF R.L. MOISTURE SAMPLES
< 1
≥ 1
COMPUTE PLASTICITY INDEX
WRITE PLASTICITY INDEX
HOW MANY MOISTURE SAMPLES S.L. AND S.R.?
0
> 0
WRITE AVERAGE SHRINKAGE LIMIT AND SHRINKAGE RATIO
GO TO START
END

CONSISTENCY (ATTERBERG) LIMITS TEST

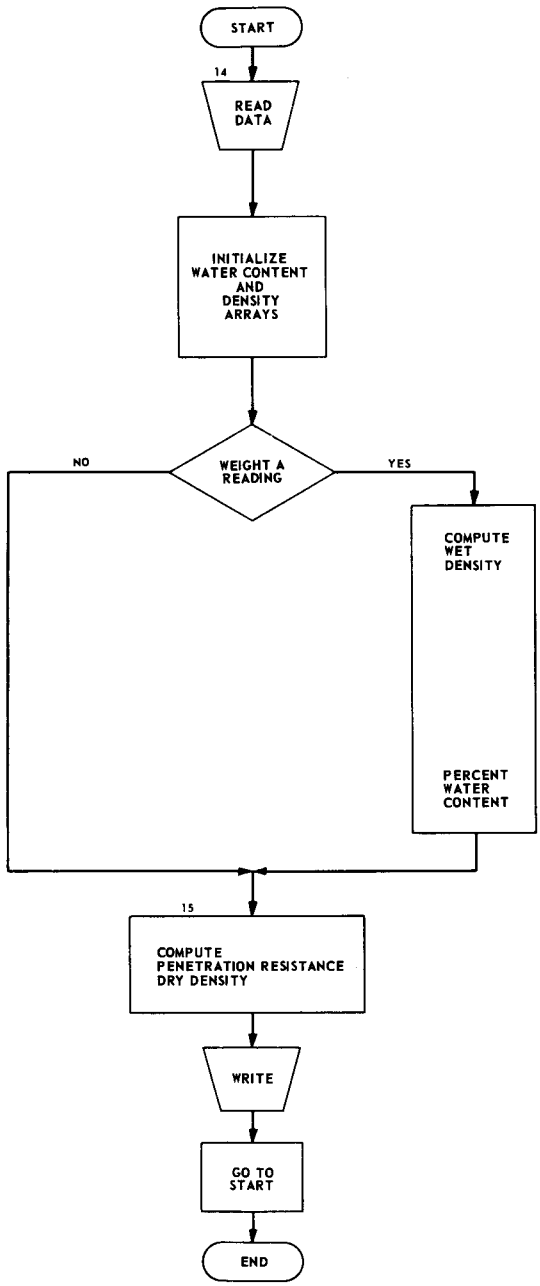
```
 1 READ INPUT TAPE 5, 2, SAM, SAMPLE, DAT, DATE
 2 FORMAT (4A4)
   WRITE OUTPUT TAPE 6, 3, SAM, SAMPLE, DAT, DATE
 30FORMAT (1H1, 10X, 37H  CONSISTENCY (ATTERBERG) LIMITS TEST/// 10X,
  115H  SAMPLE NO    2A4 // 10X, 8H  DATE  2A4 ///)
   BLL = 0.0
   ALL = 0.0
   CLL = 0.0
   READ INPUT TAPE 5, 4, QOMLL
 4 FORMAT (F4.0)
   IF (QOMLL - 1.0) 10, 8, 5
 5 READ INPUT TAPE 5, 6, WSDLLB, DSDLLB, DLLB, BLLB
 6 FORMAT (3F8.4, F8.0)
   BLL = ((WSDLLB-DSDLLB)*100.0*(0.04*BLLB)**0.12)/(DSDLLB-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
   APL = 0.0
   CPL = 0.0
   READ INPUT TAPE 5, 4, QOMPL
   IF (QOMPL - 1.0) 16, 14, 11
11 READ INPUT TAPE 5, 12, WSDPLB, DSDPLB, DPLB
12 FORMAT (3F8.4)
   BPL = ((WSDPLB-DSDPLB)*100.0)/(DSDPLB-DPLB)
   WRITE OUTPUT TAPE 6, 13, BPL
13 FORMAT (12X, 8H PL-B = F8.4 )
14 READ INPUT TAPE 5, 12, WSDPLA, DSDPLA, DPLA
   APL = ((WSDPLA-DSDPLA)*100.0)/(DSDPLA-DPLA)
   WRITE OUTPUT TAPE 6, 15, APL
15 FORMAT (12X, 8H PL-A = F8.4 // )
   CPL=(BPL + APL)/QOMPL
16 BSL = 0.0
   BSR = 0.0
   ASL = 0.0
   ASR = 0.0
   CSL = 0.0
   CSR = 0.0
17 READ INPUT TAPE 5, 4, QOMSL
   IF (QOMSL - 1.0) 23, 21, 18
18 READ INPUT TAPE 5, 19, WSDSLB, DSDSLB, DSLB, VB, VOB
19 FORMAT (5F8.4)
   DRYB=DSDSLB-DSLB
   BSL = (((WSDSLB-DSDSLB)*100.0)/DRYB)-(((VB-VOB)*100.0)/DRYB)
   BSR = DRYB / VOB
   WRITE OUTPUT TAPE 6, 20, BSL, BSR
20 FORMAT (12X, 8H SL-B = F8.4, 10X, 9H SR-B  = F8.4 )
```

```
   CONSISTENCY (ATTERBERG) LIMITS TEST

21 READ INPUT TAPE 5, 19, WSDSLA, DSDSLA, DSLA, VA, VOA
   DRYA=DSDSLA-DSLA
   ASL = (((WSDSLA-DSDSLA)*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 (1H0 14X, 27H   LIQUID LIMIT     (LL) = F8.4 )
26 IF (QOMPL -1.0) 29, 27, 27
27 WRITE OUTPUT TAPE 6, 28, CPL
28 FORMAT (1H0 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 (1H0 14X, 27H   PLASTICITY INDEX (PI) = F8.4 )
33 IF (QOMSL -1.0)  1, 34, 34
34 WRITE OUTPUT TAPE 6, 35, CSL
35 FORMAT (1H0 14X, 27H   SHRINKAGE LIMIT  (SL) = F8.4 )
36 WRITE OUTPUT TAPE 6, 37, CSR
37 FORMAT (1H0 14X, 27H   SHRINKAGE RATIO  (SR) = F8.4 )
38 GO TO 1
   END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
```

Variable name	Definition
ALL	Liquid limit—A (%).
APL	Plastic limit—A (%).
ASL	Shrinkage limit—A (%).
ASR	Shrinkage ratio—A (%).
BLL	Liquid limit—B (%).
BLLA	Number of blows for LL test A.
BLLB	Number of blows for LL test B.
BPL	Plastic limit—B (%).
BSL	Shrinkage limit—B (%).
BSR	Shrinkage ratio—B (%).
CLL	Liquid limit—Average of A and B (%).
CPL	Plastic limit—Average of A and B (%).
CSL	Shrinkage limit—Average of A and B (%).
CSR	Shrinkage ratio—Average of A and B (%).
DAT	Date test was performed.
DATE	
DLLA	Dish weight used to obtain moisture for LL–A (gm).
DLLB	Dish weight used to obtain moisture for LL–B (gm).
DPLA	Dish weight used to obtain moisture for PL–A (gm).
DPLB	Dish weight used to obtain moisture for PL–B (gm).
DRYA	Dry weight of soil used in SL–A test (gm).
DRYB	Dry weight of soil used in SL–B test (gm).
DSDLLA	Weight of dish and dry soil used to obtain moisture for LL–A (gm).
DSDLLB	Weight of dish and dry soil used to obtain moisture for LL–B (gm).
DSDPLA	Weight of dish and dry soil used to obtain moisture for PL–A (gm).
DSDPLB	Weight of dish and dry soil used to obtain moisture for PL–B (gm).
DSDSLA	Weight of dish and dry soil used to obtain moisture for SL–A (gm).
DSDSLB	Weight of dish and dry soil used to obtain moisture for SL–B (gm).
DSLA	Dish weight used to obtain moisture for SL–A (gm).
DSLB	Dish weight used to obtain moisture for SL–B (gm).
PI	Plasticity index (%).
QOMLL	Number of moisture samples taken for LL test, zero, one, or two.
QOMPL	Number of moisture samples taken for PL test, zero, one, or two.
QOMSL	Number of moisture samples taken for SL test, zero, one, or two.
SAM	Sample No.
SAMPLE	
VA	Volume of shrinkage dish used for SL test A (cc).
VB	Volume of shrinkage dish used for SL test B (cc).
VOA	Volume of dry soil—SL test A (cc).
VOB	Volume of dry soil—SL test B (cc).
WSDLLA	Weight of dish and wet soil used to obtain moisture for LL–A (gm).
WSDLLB	Weight of dish and wet soil used to obtain moisture for LL–B (gm).
WSDPLA	Weight of dish and wet soil used to obtain moisture for PL–A (gm).
WSDPLB	Weight of dish and wet soil used to obtain moisture for PL–B (gm).
WSDSLA	Weight of dish and wet soil used to obtain moisture for SL–A (gm).
WSDSLB	Weight of dish and wet soil used to obtain moisture for SL–B (gm).

FLOW CHART
PROCTOR COMPACTION TEST

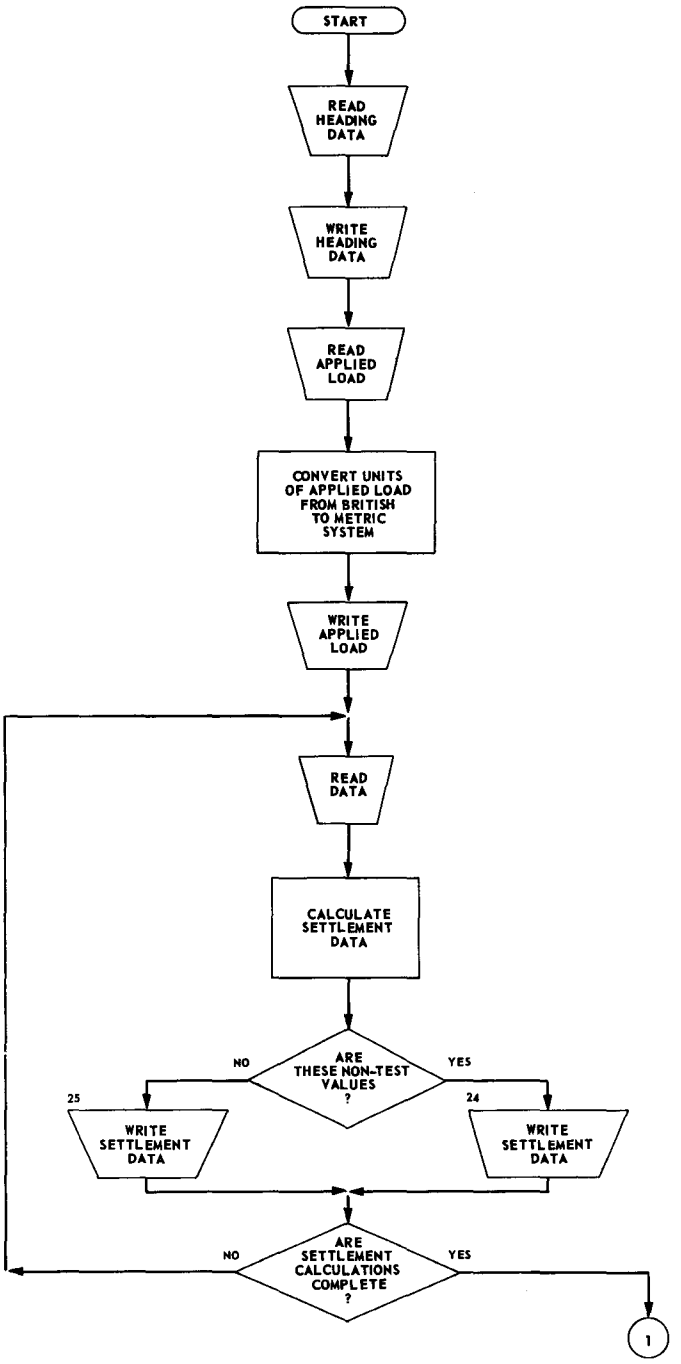


```
C     PROCTOR COMPACTION TEST
      DIMENSION  WS(8),WTD(8),A(8),PRN(8),AR(8),PR(8),B(8),WD(8),DDS(8),
     1D(8),WC(8),DD(8),C(8)
   14 DATA  (WTD(I),WC(I),I=1,8),Z / 16*0.0, 0.0160185/
      READ INPUT TAPE 5, 1, SAMP,SAMP1,DATE,DAT1,CYLVOL,CYLWT
      WRITE OUTPUT TAPE 6, 2, SAMP,SAMP1,DATE,DAT1
      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),(D(I),I=1,8)
      DO 15 I=1,8
      IF(WS(I).LT.1.0)GOTO15
      WTD(I)=(WS(I)-CYLWT)*CYLVOL
      WC(I)= (WD(I)-DDS(I))/(DDS(I)-D(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(6,8) (PR(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)
   20FORMAT (1H1,22X,24H EARTH MATERIALS TESTING / 21X,25H  PROCTOR COM
    1PACTION TEST // 15X, 12H SAMPLE NO  ,2A4, 4X, 7H DATE  ,2A4 /// 67
    2H    TEST NO              1      2      3      4      5      6      7
    38  // )
    3 FORMAT(8F8.3/8F8.0/8F8.0/(8F8.3))
    4 FORMAT (20HWET DENSITY      PCF ,8F6.1, /)
    5 FORMAT (20HWET DENSITY    GM/CC ,8F6.3, //)
    8 FORMAT (20HPENET. RES.      PSI ,8F6.0, /)
    9 FORMAT (20HPENET. RES. KG/SQCM ,8F6.1, //)
   11 FORMAT (20HWATER CONTENT    PCT ,8F6.2, //)
   12 FORMAT (20HDRY DENSITY      PCF ,8F6.1, /)
   13 FORMAT (20HDRY DENSITY    GM/CC ,8F6.3, )
      END
```

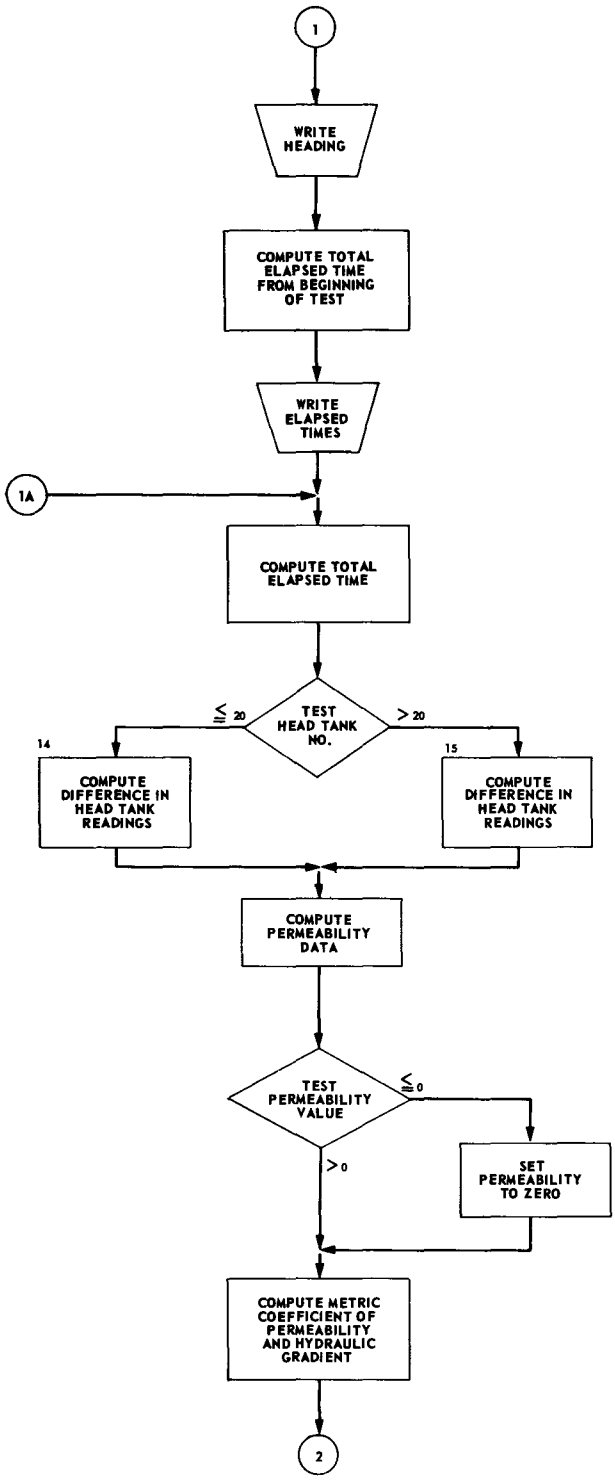
PROCTOR COMPACTION

Variable name	Definition	Variable name	Definition
A1 through A8	Wet density for each test No. 1 through 8 (gm/cc.)	PR1 through PR8	Penetration resistance for each test No. 1 through 8 (psi).
AR1 through AR8	Average reading obtained on penetration resistance scale for each test No. 1 through 8 (lbs).	PRN1 through PRN8	Penetration resistance needle No. used for each test No. 1 through 8, Needle No. 1=1 in.^{2}, 10=$\frac{1}{10}$ in.^{2}, 20=$\frac{1}{20}$ in.^{2}, 40=$\frac{1}{40}$ in.^{2}
B1 through B8	Penetration resistance for each test No. 1 through 8 (kg/sq cm).	SAMP	Sample No. of soil specimen being tested.
C1 through C8	Dry density for each test No. 1 through 8 (gm/cc).	SAMP1	
CYLVOL	Cylinder volume 20.0=$\frac{1}{20}$ cu ft mold. 30.0=$\frac{1}{30}$ cu ft mold.	WC1 through WC8	Final water content for each test No. 1 through 8 (%).
CYLWT	Cylinder weight (lb).	WD1 through WD8	Weight of dish and wet soil for moisture sample for each test No. 1 through 8 (gm).
D1 through D8	Weight of dish for moisture sample for each test No. 1 through 8 (gm).	WS1 through WS8	Weight of cylinder and wet soil for each test No. 1 through 8 (lb).
DATE	Date test was performed.		
DAT1			
DD1 through DD8	Dry density for each test No. 1 through 8 (pcf).	WTD1 through WTD8	Wet density for each test No. 1 through 8 (pcf).
DDS1 through DDS8	Weight of dish and dry soil for moisture sample for each test No. 1 through 8 (gm).		

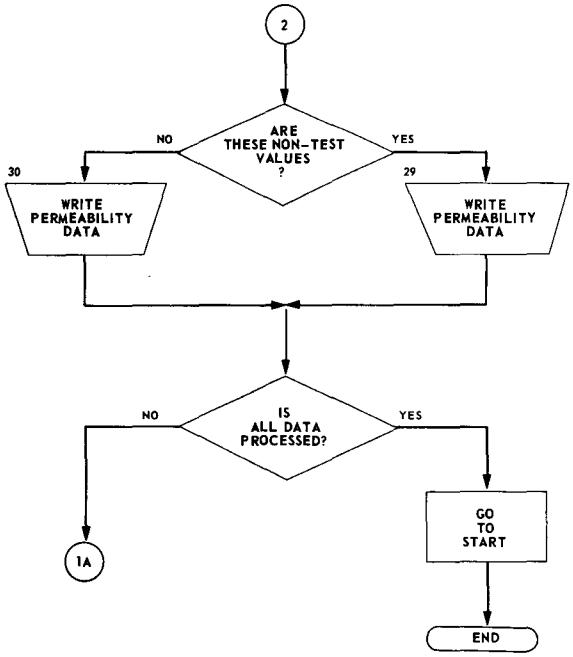
FLOW CHART
CONSTANT-HEAD PERMEABILITY TEST



SHEET 2 OF 3



SHEET 3 OF 3



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      CONSTANT HEAD PERMEABILITY TEST

     0DIMENSION  DIALA(150),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,DATR1,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,DATR1
   40FORMAT (1H0, 10HSAMPLE NO ,2A4, 3X, 13H DATE PLACED ,2A4, 3X,
     114H DATE REMOVED ,2A4)
      WRITE OUTPUT TAPE 6, 5, NCYL,NHT
    5 FORMAT (1H0, 13H CYLINDER NO ,I4, 6X, 14H HEAD TANK NO ,I4)
      WRITE OUTPUT TAPE 6, 6
    6 FORMAT (1H0, 8X,4HLOAD,16X,12HCONSOLIDATED,10X,10HSETTLEMENT)
      WRITE OUTPUT TAPE 6, 7
    7 FORMAT ( 29X, 11HDRY DENSITY)
      WRITE OUTPUT TAPE 6, 18
   18 FORMAT (5X,14HPSI    KG/SQCM,8X,14HPCF      GM/CC,11X,7HPERCENT//)
     0READ INPUT TAPE 5, 8, ETBR(1), HWC(1), ALOAD, DIALA(1), DIALB(1),
     1HTR(1)
      PRESK = ALOAD * 0.070307
      WRITE OUTPUT TAPE 6, 22, ALOAD, PRESK
   22 FORMAT (2X, F7.2, 4X, F6.2)
C
C     SETTLEMENT DATA CALCULATION LOOP
C
      DO 10 I = 2, N
     0READ INPUT TAPE 5, 8, ETBR(I), HWC(I), ALOAD, DIALA(I), DIALB(I),
     1HTR(I), NTV(I)
    8 FORMAT (16X, 3F8.2, 2F8.4,  F8.2, I4)
      DDA = DIALA(I) - DIALA(1)
      DDB = DIALB(I) - DIALB(1)
      AVG(I) = (DDA + DDB) / 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(NTV(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
C
C     PERMEABILITY TEST DATA AND COMPUTATIONS
C
      WRITE OUTPUT TAPE 6, 19, SAMP, SAMP1
```

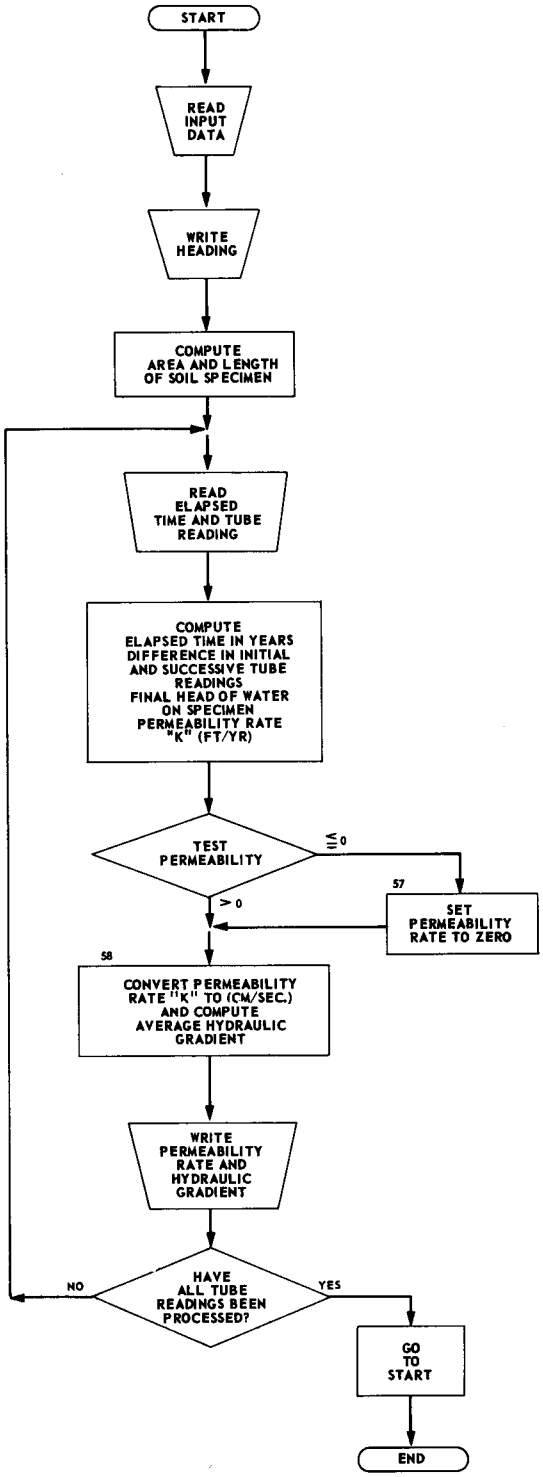
```
      CONSTANT HEAD PERMEABILITY TEST

   19 FORMAT (1H1,3X,2A4,5X,28HPERMEABILITY-SETTLEMENT TEST)
      WRITE OUTPUT TAPE 6, 11
  110FORMAT (1H0,4X,4HHEAD,5X,9HHYDRAULIC,3X,5HHOURS,7X,5HTOTAL,8X,14HC
     1OEFFICIENT OF)
      WRITE OUTPUT TAPE 6, 12
  120FORMAT (14X,8HGRADIENT,2X,7HBETWEEN,5X,7HELAPSED,8X,12HPERMEABILIT
     1Y)
      WRITE OUTPUT TAPE 6, 13
  130FORMAT (5X,2HFT,8X,5HFT/FT,4X,8HREADINGS,2X,13HTIME IN HOURS,3X,5H
     1FT/YR,5X,6HCM/SEC //)
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*)
   20 CONTINUE
      GO TO 21
      END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
```

CONSTANT-HEAD PERMEABILITY TEST

Variable name	Definition	Variable name	Definition
A	Area of soil specimen being tested (sq ft).	HTR	Head tank readings during test.
ALOAD	Load applied to soil specimen (psi).	HWC	Head under which permeability rate was obtained (ft).
AVG	Average movement of dials A and B for each reading obtained.	N	Total number of readings obtained on specimen.
CALF	Calibration factor for head tank (cu in./in.).	NCYL	Permeability cylinder number.
CDD	Consolidated dry density at any point during test (pcf).	NHT	Head tank number.
CDDC	Same as CDD except in (gm/cc).	NTV	Used to indicate nontest values, bleeding lines, head tank out of water, etc.
CST	Consolidated specimen length (in.).	PCM	Coefficient of permeability (cm/sec).
DATP	Date test was placed.	PDD	Placement dry density (pcf).
DATP1		PERM	Coefficient of permeability (ft/yr).
DATR	Date test was removed.	PRESK	Load applied to soil specimen (kg/sq cm).
DATR1			
DDA	Difference in successive dial A readings from no load reading.	R	Difference between each successive head tank reading.
DDB	Difference in successive dial B readings from no load reading.	SA	Area of soil specimen (sq in.).
DIALA	Dial A readings during test—to determine settlement or specimen length.	SAMP	Sample number.
		SAMP1	
		SETT	Settlement of soil specimen due to applied load and wetting (%).
DIALB	Same as DIALA, except is for dial B.	STI	Initial specimen thickness (in.).
ETBR	Elapsed time between test readings (hr).	T	Elapsed time between each test reading (yr).
FCST	Consolidated specimen length (ft).	TET	Total elapsed time from beginning of test (hr).
HG	Hydraulic gradient under which permeability rate was obtained (ft/ft).	V	Volume of water discharged through soil sample for each successive reading (cu ft).

FLOW CHART
FALLING-HEAD PERMEABILITY TEST



FALLING HEAD PERMEABILITY FOR CONSOLIDOMETERS

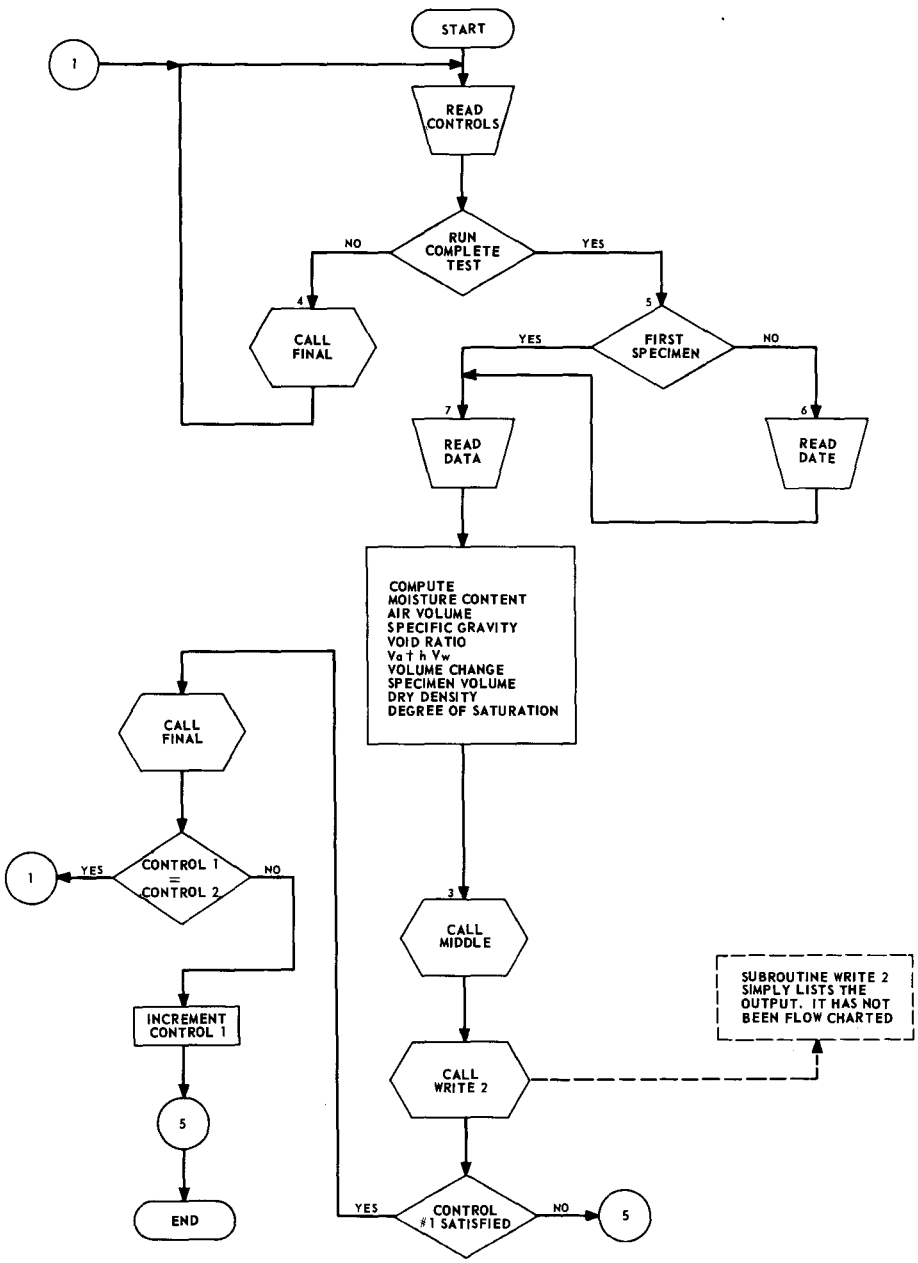
```
410READ INPUT TAPE 5, 19, SAMP,SAMP1,NSPEC,LUN2,DATE,DATE2,DSPEC,
  1SPECL
19 FORMAT(2A4, 2I4, 2A4, F8.2, F8.4)
   READ INPUT TAPE 5, 52, H1, TI, N2, AP, TC
52  FORMAT(2F8.2, I8, 2F8.4)
   WRITE OUTPUT TAPE 6, 53, SAMP, SAMP1, NSPEC, DATE, DATE2, LUN2
530FORMAT(1H1, 18X, 31H FALLING HEAD PERMEABILITY TEST // 10X, 13H SA
  1MPLE NO.  ,2A4, 7X, 15H SPECIMEN NO.  , I4   // 10X, 7H DATE  ,2A4
  2, 9X, 19H LOADING UNIT NO.  ,I4 // 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 = H1 + (TC * DTR)
   PERM = (AP * SLF / AS) * (1.0 / ETY) * LOGF(H1 / HF)
   IF(PERM) 57, 57, 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

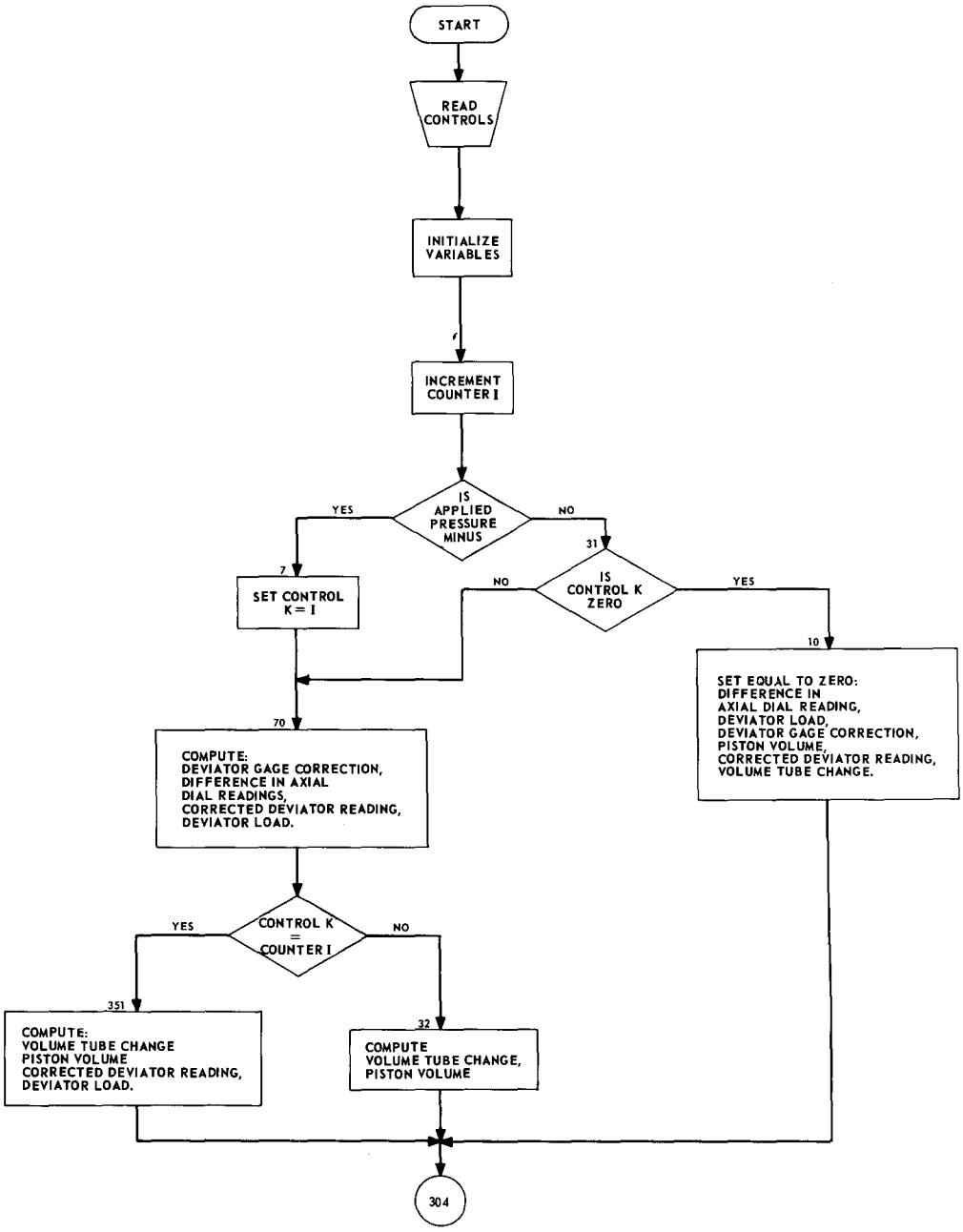
Variable name	Definition	Variable name	Definition
AHG	Average hydraulic gradient.	N2	Total number of tube readings obtained.
AP	Area of water supply standpipe (sq. in.).	NSPEC	Specimen number.
AS	Area of soil specimen (sq. in.).	PERM	Permeability rate "k" (ft/yr).
DATE	Date permeability test was performed.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

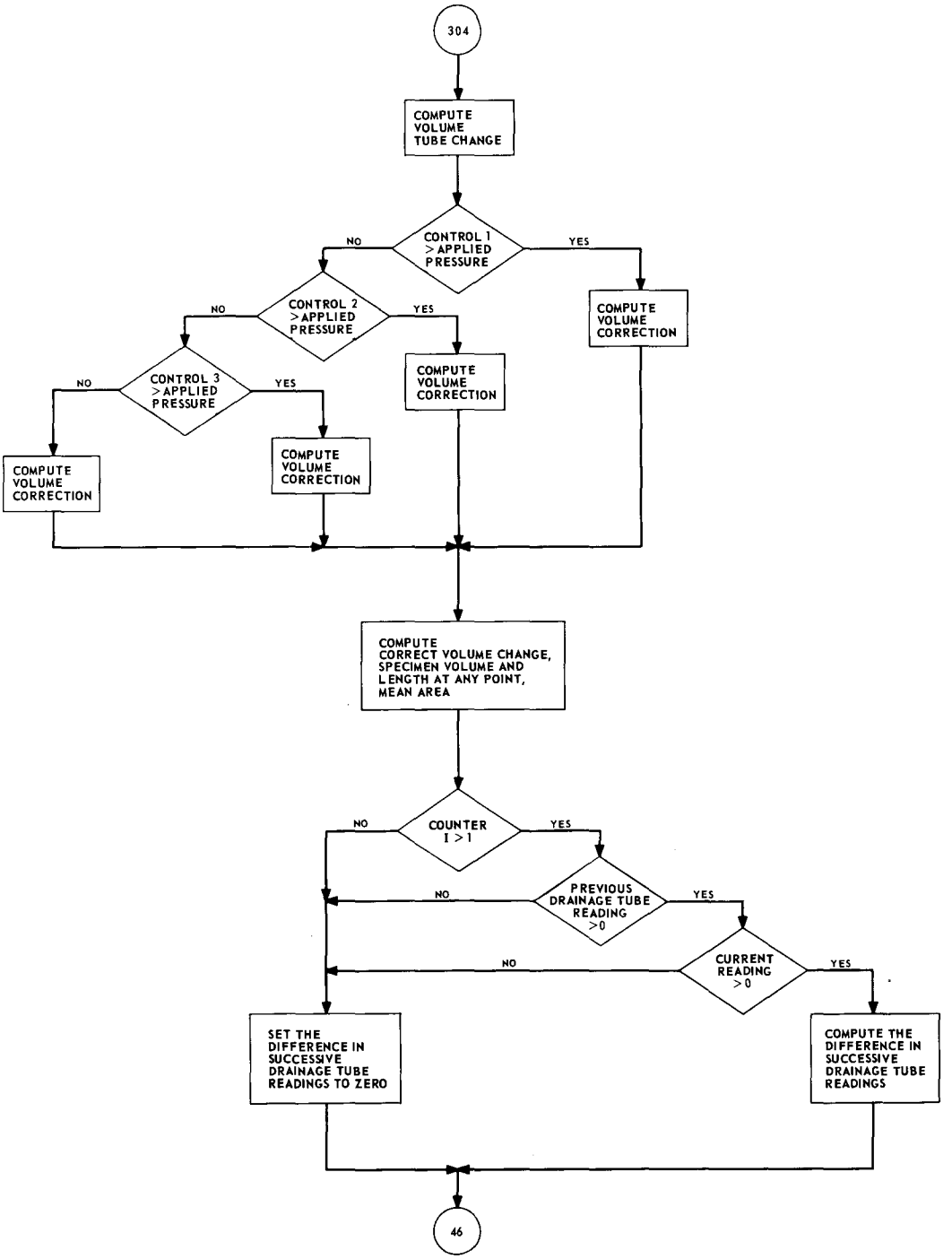
205-616 O—66——4

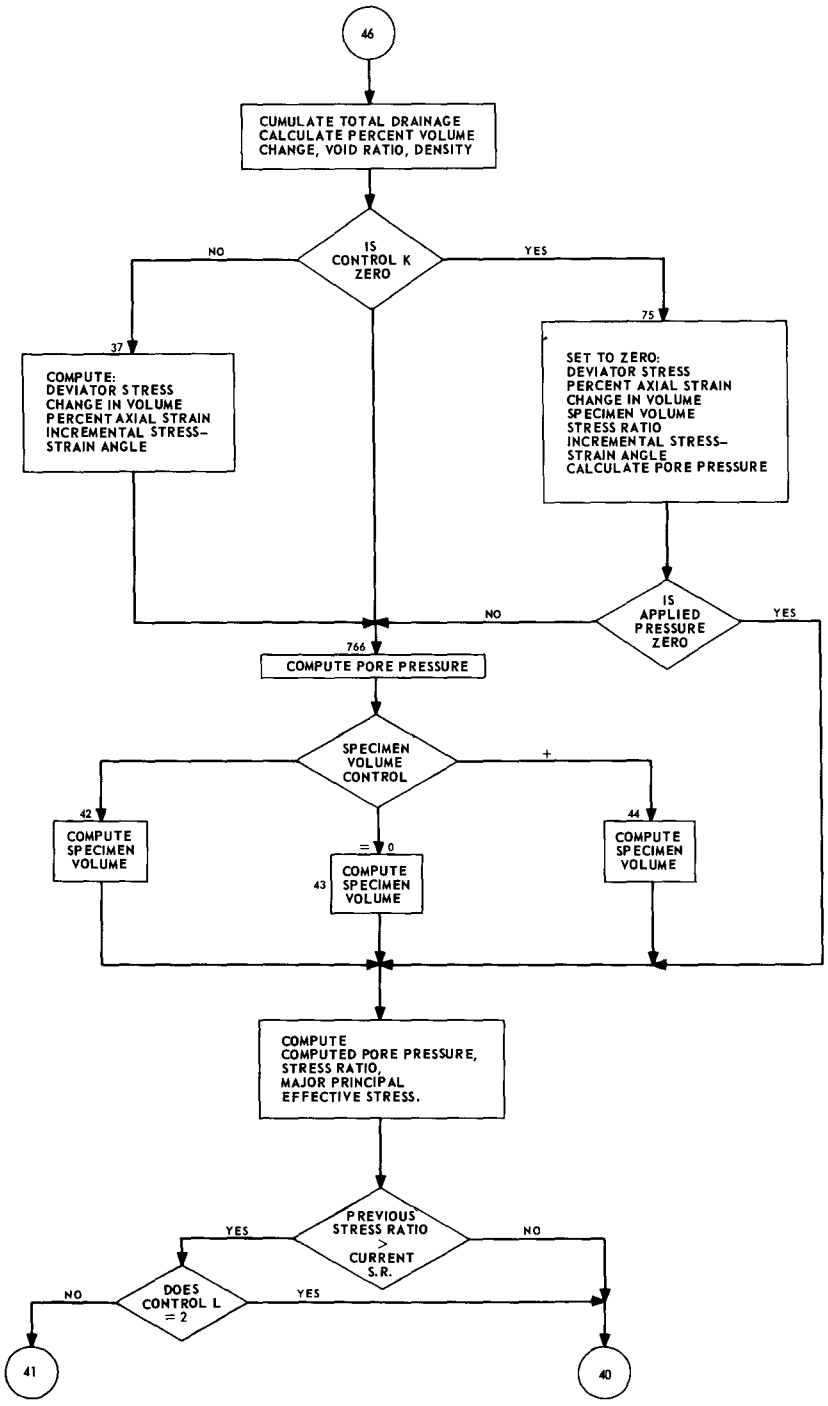
FLOW CHART
TRIAXIAL SHEAR TEST

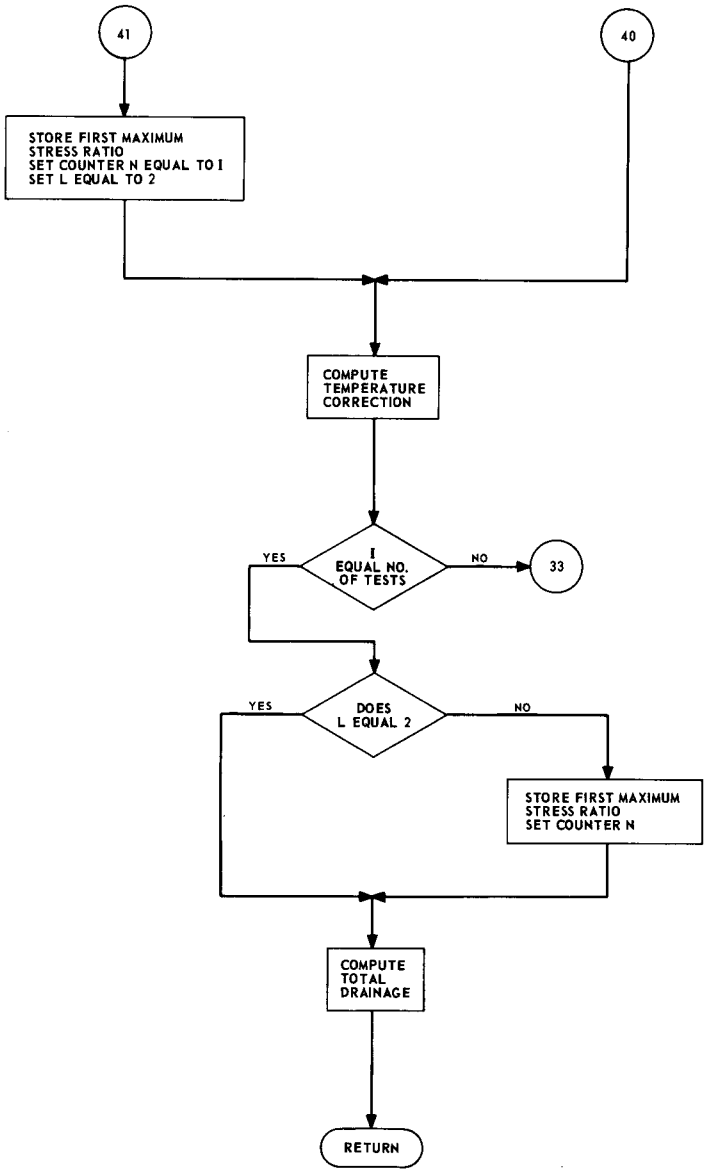


FLOW CHART
SUBROUTINE MIDDLE

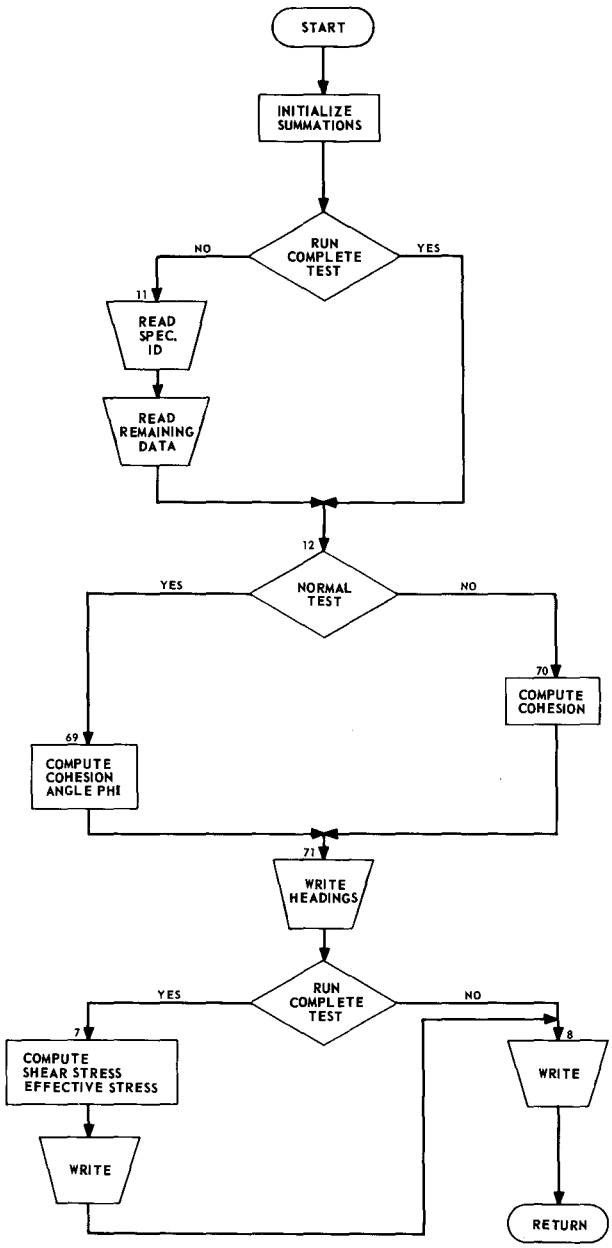



304
COMPUTE VOLUME TUBE CHANGE
CONTROL 1 > APPLIED PRESSURE
NO
YES
COMPUTE VOLUME CORRECTION
CONTROL 2 > APPLIED PRESSURE
NO
YES
COMPUTE VOLUME CORRECTION
CONTROL 3 > APPLIED PRESSURE
NO
YES
COMPUTE VOLUME CORRECTION
COMPUTE VOLUME CORRECTION
COMPUTE CORRECT VOLUME CHANGE, SPECIMEN VOLUME AND LENGTH AT ANY POINT, MEAN AREA
COUNTER I > 1
NO
YES
PREVIOUS DRAINAGE TUBE READING >0
NO
YES
CURRENT READING >0
NO
YES
SET THE DIFFERENCE IN SUCCESSIVE DRAINAGE TUBE READINGS TO ZERO
COMPUTE THE DIFFERENCE IN SUCCESSIVE DRAINAGE TUBE READINGS
46


46
CUMULATE TOTAL DRAINAGE
CALCULATE PERCENT VOLUME
CHANGE, VOID RATIO, DENSITY
IS
CONTROL K
ZERO
NO
YES
37
COMPUTE:
DEVIATOR STRESS
CHANGE IN VOLUME
PERCENT AXIAL STRAIN
INCREMENTAL STRESS-
STRAIN ANGLE
75
SET TO ZERO:
DEVIATOR STRESS
PERCENT AXIAL STRAIN
CHANGE IN VOLUME
SPECIMEN VOLUME
STRESS RATIO
INCREMENTAL STRESS-
STRAIN ANGLE
CALCULATE PORE PRESSURE
IS
APPLIED
PRESSURE
ZERO
NO
YES
766
COMPUTE PORE PRESSURE
SPECIMEN
VOLUME
CONTROL
+
42
COMPUTE
SPECIMEN
VOLUME
= 0
43
COMPUTE
SPECIMEN
VOLUME
44
COMPUTE
SPECIMEN
VOLUME
COMPUTE
COMPUTED PORE PRESSURE,
STRESS RATIO,
MAJOR PRINCIPAL
EFFECTIVE STRESS.
PREVIOUS
STRESS RATIO
>
CURRENT
S.R.
YES
NO
DOES
CONTROL L
= 2
NO
YES
41
40


41
40
STORE FIRST MAXIMUM
STRESS RATIO
SET COUNTER N EQUAL TO I
SET L EQUAL TO 2
COMPUTE
TEMPERATURE
CORRECTION
YES
I
EQUAL NO.
OF TESTS
NO
33
YES
DOES
L EQUAL 2
NO
STORE FIRST MAXIMUM
STRESS RATIO
SET COUNTER N
COMPUTE
TOTAL
DRAINAGE
RETURN

FLOW CHART
SUBROUTINE FINAL



```
C     MAIN PROGRAM
     0DIMENSION  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),NOREED(10
     2),ALPRR(99),VTCHNG(99),VOLT1R(99),VCUBIN(99),VOLCB(99),DT1R(99),
     3CORVCH(99),SPVAPT(99),DEVGC(99),DIFADR(99),AXDLR(99),CDEVR(99),
     4DEVGR(99),DVLOAD(99),PSTVOL(99),SLATAP(99),ARMEAN(99),D1CUIN(99),
     5D2CUIN(99),DT2R(99),PERCVC(99),E(99),DENSTY(99),SRATIO(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
     80),TAU1SQ(10),TAU3SQ(10),AVGTAU(99),SINTAU(99),ABSISA(99),ORDINT(99
     99),NOSAMP(4),DATE(4,10),NOSPEC(10),DRYWTS(3)
     0COMMON  NOSAMP,NOSPEC,NOMACH,NOREED,SPCTA,CONTA,SPCTW,CONTL,FMCONT
     1,SPGRAV,TEMP1,TOTDRA,DELTAV,DENSTY,CÓMPPP,E,NOSIT,DWTRIM,ZIMC,AIRV
     2,VAHVW,VOIDRS,VCSAT,SV,DRYDEN,VOIDR,DGSAT,STRANR,NTIMR,TEMP,WTCFAC
     3,TVOLR,POREPR,SRATIO,DSTRES,SPVAPT,AABPR,AWBPR,SLNGTH,BAROP,ALPRR,
     4DEVGR,AXDLR,VOLT1R,DT1R,DT2R,TPPPR,BPPPR,PORE,CORVCH,TAU3,DATE,
     5ZNSPPR,M,NOREAD,N,FSTMAX,TANDEG,ASTRAN,DEVGC1,DEVGC2,TEMPCO,PSTFAC
     6,DTFAC,VO,JJ,II,IPATH,PERCVC,PUNCH,M1,ZMPES(99,10),CORDEV(10)
    1 READ INPUT TAPE 5,2,NOSIT,(DATE(I,1),I=1,4),IPATH,NOTOT,PUNCH
    2 FORMAT(I10,4A5,2I10,F10.0)
      M1=1
      IF(IPATH-2)4,5,5
    4 CALL FINAL
      GO TO 1
    5 DO 3 M=M1,NOSIT
      IF(M-1)7,7,6
    6 READ INPUT TAPE 5,2,    IT,(DATE(I,M),I=1,4)
    7 READ INPUT TAPE 5,100,NOSAMP,NOSPEC(M),NOMACH,NOREED(M)
  100 FORMAT ( 4A5,3I10)
      READ INPUT TAPE   5,101,(SPCTA(I),CONTA(I),SPCTW(I),CONTL(I),I=1,3D
     1)
  101 FORMAT (4F10.4)
      READ INPUT TAPE 5,102,FMCONT,SPGRAV,DWTRIM
  102 FORMAT (3F10.4)
      READ INPUT TAPE 5,104,STRANR,TEMP,TEMP1,WTCFAC,SLNGTH
      READ INPUT TAPE 5,104,AABPR,AWBPR,BAROP,PORE,TVOLR ,NOVOLT
  104 FORMAT (5F10.4, 1I10)
      READ INPUT TAPE 5,105,DEVGC1,DEVGC2,TEMPCO,PSTFAC,DTFAC,VO,JJ,II
  105 FORMAT(6F10.4,2I5)
      NOREAD=NOREED(M)
     0READ INPUT TAPE 5,106,(ALPRR(I), DEVGR(I),AXDLR(I),VOLT1R(I),DT1R
     1(I),DT2R(I),TPPPR(I),BPPPR(I),ZNSPPR(I), I=1,NOREAD)
  106 FORMAT (2F10.2,F5.3,3F5.2,3F10.2)
      ZIWWS=SPCTA(1)-CONTA(1)
      FWWS=SPCTA(2)-CONTA(2)
      DRYWTS(2)=FWWS/(1.0+0.010*FMCONT)
      DRYWTS(3)=DRYWTS(2)
      DRYWTS(1)=DRYWTS(2)+DWTRIM
      ZIMC=(ZIWWS/DRYWTS-1.0)*100.0
      ASOILD=62.43*SPGRAV
      DO 8 I=1,3
```

```
      IF(SPCTA(I))10,10,9
   10 WLSC(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
      WETMC=0.0
      AIRV(I)=0.0
      VOIDR(I)=0.0
      GO TO 8
    9 WLSC(I)=SPCTA(I)-SPCTW(I)
      WLS(I)=WLSC(I)-CONTL(I)
      SV(I)=WLS(I)/16.35
      DRYDEN(I)=DRYWTS(I)*62.290/WLS(I)
      SOILV(I)=DRYDEN(I)/ASOILD*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)
      WETMC=(WWWTS/DRYWTS(I)-1.0)*100.0
      GO TO 1003
 1002 WATERV(I) = DRYDEN(I) *WETMC / 62.29
 1003 AIRV(I)=100.0-SOILV(I)-WATERV(I)
      VOIDR(I)=100.0/SOILV(I)-1.0
    8 DGSAT(I)=WATERV(I)*100.0/(100.0-SOILV(I))
      HVW=  0.02*WATERV(1)
      VAHVW=AIRV(1)+HVW
      VOIDRS=SPGRAV*ZIMC/100.0
      VCSAT=(VOIDR(1)-VOIDRS)/(1.0+VOIDR(1))*100.0
      M=M
      CALL MIDDLE
      CALL WRITE2
    3 CONTINUE
      CALL FINAL
      IF(NOTOT-NOSIT)1,1,11
   11 NOSIT=NOSIT+1
      M1=NOSIT
      GO TO 5
      END
```

```
      SUBROUTINE MIDDLE
     0DIMENSION  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),NOREED(10
     2),ALPRR(99),VTCHNG(99),VOLT1R(99),VCUBIN(99),VOLCB(99),DT1R(99),
     3CORVCH(99),SPVAPT(99),DEVGC(99),DIFADR(99),AXDLR(99),CDEVR(99),
     4DEVGR(99),DVLOAD(99),PSTVOL(99),SLATAP(99),ARMEAN(99),D1CUIN(99),
     5D2CUIN(99),DT2R(99),PERCVC(99),E(99),DENSTY(99),SRATIO(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
     80),TAU1SQ(10),TAU3SQ(10),AVGTAU(99),SINTAU(99),ABSISA(99),ORDINT(99
     99),NOSAMP(4),DATE(4,10),NOSPEC(10)
     0COMMON  NOSAMP,NOSPEC,NOMACH,NOREED,SPCTA,CONTA,SPCTW,CONTL,FMCONT
     1,SPGRAV,TEMP1,TOTDRA,DELTAV,DENSTY,COMPPP,E,NOSIT,DWTRIM,ZIMC,AIRV
     2,VAHVW,VOIDRS,VCSAT,SV,DRYDEN,VOIDR,DGSAT,STRANR,NTIMR,TEMP,WTCFAC
     3,TVOLR,POREPR,SRATIO,DSTRES,SPVAPT,AABPR,AWBPR,SLNGTH,BAROP,ALPRR,
     4DEVGR,AXDLR,VOLT1R,DT1R,DT2R,TPPPR,BPPPR,PORE,CORVCH,TAU3,DATE,
     5ZNSPPR,M,NOREAD,N,FSTMAX,TANDEG,ASTRAN,DEVGC1,DEVGC2,TEMPCO,PSTFAC
     6,DTFAC,VO,JJ,II,IPATH,PERCVC,PUNCH,M1,ZMPES(99,10),CORDEV(10)
      SQRTF(X)=SQRT(X)
      ABSF(X)=ABS(X)
      ATANF(X)=ATAN(X)
     0READ INPUT TAPE 5,300,ABLE,AB1,AB2,BAKER,BAK1,BAK2,CHARLY,CHAR1,
     1CHAR2,DOGY1,DOGY2,BOSS
  300 FORMAT(F7.1,2F6.5,F6.1,2F6.5,F6.1,2F6.5,3F6.5)
      L=1
      AXSTRS=0.0
      TOT1CU=0.0
      TOT2CU=0.0
      I = 0
      J=1
      K=0
      XX=NOREAD-1
      TEMP=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 DEVGC(I)=DEVGC1*ALPRR(I)+DEVGC2
      DIFADR(I)=      AXDLR(K)-AXDLR(I)
      CDEVR(I)=DEVGR(I)-DEVGC(I)
      DVLOAD(I)=CDEVR(I)*WTCFAC
      IF(I-K)351,351,32
  351 VTCHNG(I)=VO -VOLT1R(I)
      PSTVOL(I)=PSTFAC*(AXDLR(I)-AXDLR(I-1))*(-1.0)
      J=2
      CDEVR(I)=0.0
```

```
      DVLOAD(I)=0.0
      GO TO 304
   32 VTCHNG(I)=TVOLR -VOLT1R(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)=VO -VOLT1R(I)
  304 VCUBIN(I)=BOSS*VTCHNG(I)
      IF(ABLE-ALPRR(I))15,14,14
   14 VOLCB(I)=AB1*ALPRR(I)+AB2
      GO TO 306
   15 IF(BAKER-ALPRR(I))17,16,16
   16 VOLCB(I)=BAK1*(ALPRR(I)-ABLE)+BAK2
      GO TO 306
   17 IF(CHARLY-ALPRR(I))19,18,18
   18 VOLCB(I)=CHAR1*(ALPRR(I)-BAKER)+CHAR2
      GO TO 306
   19 VOLCB(I)=DOGY1*(ALPRR(I)-CHARLY)+DOGY2
  306 CORVCH(I)=PSTVOL(I)+VCUBIN(I)+VOLCB(I)+TEMPCO
   78 SPVAPT(I)=SV(II)+CORVCH(I)
      SLATAP(I)=SLNGTH-ABSF(DIFADR(I))
      ARMEAN(I)=SPVAPT(I)/SLATAP(I)
   74 IF(I-1)38,38,744
  744 IF(DT1R(I-1)) 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-1)-DT1R(I))*DTFAC
      D2CUIN(I)=(DT2R(I-1)-DT2R(I))*DTFAC
   46 TOT1CU=TOT1CU+D1CUIN(I)
      TOT2CU=TOT2CU+D2CUIN(I)
      PERCVC(I)=(SV(II)-SPVAPT(I))/SV(II)*100.0
      E(I)=VOIDR(1)-((1.0+VOIDR(1))*PERCVC(I)/100.0)
      DENSTY(I)=DRYDEN(1)*100.0/(100.0-PERCVC(I))
      IF(K)75,75,37
   75 DSTRES(I  )=0.0
      TANDEG(I)=0.0
      TAU3(I,M) =0.0
      ASTRAN(I)=0.0
      DELTAV(I)=0.0
      POREPR(I)=BPPPR(I)+AABPR
      SRATIO(I,M)=0.0
      IF (ALPRR(I)) 766,76,766
   37 DSTRES(I  )=DVLOAD(I)/ ARMEAN(I)
      ASTRAN(I)=ABSF(DIFADR(I)*100.0/SLNGTH)
      DELTAV(I)=(SPVAPT(K)-SPVAPT(I))/SPVAPT(K)*100.0
```

```
      OTANDEG(I)=180.*ATANF((DSTRES(I  )-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)-TPPPR(I)
      GO TO 76
   44 TAU3(I,M)=ALPRR(I)-ZNSPPR(I)
   76 COMPPP(I)=BAROP*PERCVC(I)/(VAHVW-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
```

```
      SUBROUTINE WRITE2
     0DIMENSION  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),NOREED(10
     2),ALPRR(99),VTCHNG(99),VOLT1R(99),VCUBIN(99),VOLCB(99),DT1R(99),
     3CORVCH(99),SPVAPT(99),DEVGC(99),DIFADR(99),AXDLR(99),CDEVR(99),
     4DEVGR(99),DVLOAD(99),PSTVOL(99),SLATAP(99),ARMEAN(99),D1CUIN(99),
     5D2CUIN(99),DT2R(99),PERCVC(99),E(99),DENSTY(99),SRATIO(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
     80),TAU1SQ(10),TAU3SQ(10),AVGTAU(99),SINTAU(99),ABSISA(99),ORDINT(99
     99),NOSAMP(4),DATE(4,10),NOSPEC(10),IX(5,50),K(5)
     0COMMON  NOSAMP,NOSPEC,NOMACH,NOREED,SPCTA,CONTA,SPCTW,CONTL,FMCONT
     1,SPGRAV,TEMP1,TOTDRA,DELTAV,DENSTY,COMPPP,E,NOSIT,DWTRIM,ZIMC,AIRV
     2,VAHVW,VOIDRS,VCSAT,SV,DRYDEN,VOIDR,DGSAT,STRANR,NTIMR,TEMP,WTCFAC
     3,TVOLR,POREPR,SRATIO,DSTRES,SPVAPT,AABPR,AWBPR,SLNGTH,BAROP,ALPRR,
     4DEVGR,AXDLR,VOLT1R,DT1R,DT2R,TPPPR,BPPPR,PORE,CORVCH,TAU3,DATE,
     5ZNSPPR,M,NOREAD,N,FSTMAX,TANDEG,ASTRAN,DEVGC1,DEVGC2,TEMPCO,PSTFAC
     6,DTFAC,VO,JJ,II,IPATH,PERCVC,PUNCH,M1,ZMPES(99,10),CORDEV(10)
      WRITE OUTPUT TAPE 6,1,(DATE(I,M),I=1,4)
    10FORMAT(1H1,48X,24HSOILS ENGINEERING BRANCH/47X,28HTRIAXIAL SHEAR T
     1EST RESULTS /50X, 4A5/)
      WRITE OUTPUT TAPE 6,2,NOSAMP,NOSPEC(M),NOMACH
    20FORMAT(35X,50HSAMPLE NUMBER    SPECIMEN NUMBER    MACHINE NUMBER//
     130X,4A5,5X,I5,16X,I2//)
      A1=16.387064
      A2=0.07035812
      A3=0.0160185
      WRITE OUTPUT TAPE 6,3,ZIMC,FMCONT,AIRV(1),
     1                      SPGRAV,VOIDRS,VAHVW,VCSAT
    3 FORMAT( 3X,58HPERCENT MOISTURE CONTENT   PERCENT AIR VOLUME     SP
     1ECIFIC 9X,10HVOID RATIO 9X,7HVA+H*VW6X,18HPERCENT VOL CHANGE 6X,17
     2HINITIAL     FINAL12X,7HINITIAL 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=A3*DRYDEN(1)
      B3=A1*SV(2)
      B4=A3*DRYDEN(2)
      B5=A1*SV(3)
      B6=A3*DRYDEN(3)
      WRITE OUTPUT TAPE 6,5,SV(1),B1,DRYDEN(1),B2,VOIDR(1),DGSAT(1)
     1                     ,SV(2),B3,DRYDEN(2),B4,VOIDR(2),DGSAT(2)
     2                     ,SV(3),B5,DRYDEN(3),B6,VOIDR(3),DGSAT(3)
    5 FORMAT(  25X,15HSPECIMEN VOLUME 12X,11HDRY DENSITY 13X,4HVOID 10X,
     19HDEGREE OF/ 25X, 6HCU.IN.7X,2HCC 10X,3HPCF8X,5HGR/CC9X,5HRATIO10X
     2,10HSATURATION// 16X,7HINITIAL F7.3,F11.2,F13.2, F12.2, F14.4,10X,
     3F7.2/            16X,7HFINAL   F7.3,F11.2,F13.2, F12.2, F14.4,10X,
     4F7.2/            16X,7HWETTED  F7.3,F11.2,F13.2, F12.2, F14.4,10X,
     5F7.2//)
      WRITE OUTPUT TAPE 6,8
    8 FORMAT(    68H    PERCENT VOLUME CHANGE     DEVIATOR STRESS     PE
```

```
    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=TPPPR(I)*A2
     B3=BPPPR(I)*A2
     WRITE(6,10)  PERCVC(I),DELTAV(I),DSTRES(I),B1,ASTRAN(I),SRATIO(I,M
    1 ),TPPPR(I),B2,BPPPR(I),B3
   10 FORMAT (2F11.3, F13.3, F9.3, F11.2, F12.3,F15.2,F10.3,F10.2,F10.3)
    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,12HCOMPUTE PORE 11X,7HDENSITY 10X,4HVOID/5X,7HAPPLIED 11X,9HEFF
    2ECTIVE 10X,12HAT ANY POINT 9X,2HIN 10X,8HPRESSURE 30X,5HRATIO/3X,
    351HPSI.    KGSCM     PSI.     KGSCM      CU.IN.     CC7X,47HDEGREE
    4S     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
    1P(I),B4,DENSTY(I),B5,E(I)
   13 FORMAT(F7.2,F9.3,F9.2,F10.3,F11.3,F10.2,F11.3,F11.2,F10.3,F11.2,F9
    1.3,F11.4)
   12 CONTINUE
     WRITE OUTPUT TAPE 6,14,STRANR,TOTDRA
   14 FORMAT(//42X29HSTRAIN RATE    TOTAL DRAINAGE/43XF7.3,09XF7.3)
     IF(PUNCH) 16,26,26
   16 DD=10.0
     NOREAD=NOREAD-1
   17 DO 18 I=1,NOREAD
     IX(1,I)=100.0*ASTRAN(I)+0.50
     IX(2,I)=100.0*PERCVC(I)+0.50
     IX(3,I)=DD*DSTRES(I  ) +0.50
     IX(4,I)=100.0*POREPR(I)+0.50
     IX(5,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
```

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

```
      SUBROUTINE FINAL
     0DIMENSION  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),NOREED(10
     2),ALPRR(99),VTCHNG(99),VOLT1R(99),VCUBIN(99),VOLCB(99),DT1R(99),
     3CORVCH(99),SPVAPT(99),DEVGC(99),DIFADR(99),AXDLR(99),CDEVR(99),
     4DEVGR(99),DVLOAD(99),PSTVOL(99),SLATAP(99),ARMEAN(99),D1CUIN(99),
     5D2CUIN(99),DT2R(99),PERCVC(99),E(99),DENSTY(99),SRATIO(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
     80),TAU1SQ(10),TAU3SQ(10),AVGTAU(99),SINTAU(99),ABSISA(99),ORDINT(99
     99),NOSAMP(4),DATE(4,10),NOSPEC(10),IX(5,50),K(5)
     0COMMON  NOSAMP,NOSPEC,NOMACH,NOREED,SPCTA,CONTA,SPCTW,CONTL,FMCONT
     1,SPGRAV,TEMP1,TOTDRA,DELTAV,DENSTY,COMPPP,E,NOSIT,DWTRIM,ZIMC,AIRV
     2,VAHVW,VOIDRS,VCSAT,SV,DRYDEN,VOIDR,DGSAT,STRANR,NTIMR,TEMP,WTCFAC
     3,TVOLR,POREPR,SRATIO,DSTRES,SPVAPT,AABPR,AWBPR,SLNGTH,BAROP,ALPRR,
     4DEVGR,AXDLR,VOLT1R,DT1R,DT2R,TPPPR,BPPPR,PORE,CORVCH,TAU3,DATE,
     5ZNSPPR,M,NOREAD,N,FSTMAX,TANDEG,ASTRAN,DEVGC1,DEVGC2,TEMPCO,PSTFAC
     6,DTFAC,VO,JJ,II,IPATH,PERCVC,PUNCH,M1,ZMPES(99,10),CORDEV(10)
      SQRTF(X)=SQRT(X)
      ATANF(X)=ATAN(X)
      COSF(X)=COS(X)
      SINF(X)=SIN(X)
      TODAY=6H TEST
      SUMT1=0.
      SUMT1S=0.
      SUMT3=0.
      SUMT3S=0.
      IF(IPATH-2)11,12,12
   11 DO 3 M=1,NOSIT
    3 N(M)=M
      READ INPUT TAPE 5,4,NOSAMP,NOMACH
    4 FORMAT(4A5,I10)
      NOSPEC=0
      READ INPUT TAPE 5,5,(CORDEV(M),TAU3(M,M),M=1,NOSIT)
    5 FORMAT(2F10.3)
   12 DO 50 M=M1,NOSIT
      J= N(M)
      IF(M1-2) 69,70,70
   70 Y=SQRTF((CORDEV(1)/2.0)**2/(1.0 + TANPHI**2))
      X=CORDEV(1)/2.0-Y*TANPHI
      COHESN=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)
      SUMT1S=SUMT1S+TAU1(M)**2
      SUMT3=SUMT3+TAU3(J,M)
   50 SUMT3S=SUMT3S+TAU3(J,M)**2
      OOSIT = NOSIT
      A=SQRTF((OOSIT*SUMT1S-SUMT1**2)/(OOSIT*SUMT3S-SUMT3**2))
```

```
      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
    1OFORMAT(1H1,43X,24HSOILS ENGINEERING BRANCH/41X,27HTRIAXIAL SHEAR T
     1EST RESULTS/45X,4A5/52X,A6,//)
      WRITE OUTPUT TAPE 6,2,NOSAMP,NOSPEC(M),NOMACH
    2OFORMAT(29X,50HSAMPLE NUMBER    SPECIMEN NUMBER    MACHINE NUMBER//
     125X,4A5,5X,I5,16X,I2//)
      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        KGSQCM       PSI     KGSQCM      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*ZMPES(I,M)
      WRITE(6,53) ZMPES(I,M),B3,ABSISA(I),B1,ORDINT(I),B2
   53 FORMAT(19X,F8.2,5X,F8.3,F11.2,F10.3,F10.2,F10.3)
   52 CONTINUE
   51 CONTINUE
    8 B1=0.0705812*COHESN
      WRITE OUTPUT TAPE 6,61,COHESN,B1,TANPHI,IPHI,ZMIN
   61OFORMAT(//33X8HCOHESION10X7HTANGENT9X9HANGLE PHI/30X4HPSI,5X5HKGSCM
     19X,3HPHI9X4HDEG,6X4HMIN,//28XF6.2,4XF6.3,6XF8.5,7XI3,7X,F5.1)
      RETURN
      END
```

Variable name	Definition
AABPR	Applied air back pressure (psi).
ABSISA	Normal stress for each point during test (psi).
AIRV	Air volume in soil specimen for initial, wetted, or final condition (cu. in.).
ALPRR	Applied lateral pressure reading for each point during test (psi).
ARMEAN	Mean area of soil specimen for each point during shear test (sq. in.).
ASOLID	Absolute soil density (pcf).
ASTRAN	Axial strain for each point during test (%).
AVGTAU	Deviator stress for each point during test (psi).
AWBPR	Applied water back pressure (psi).
AXDLR	Axial dial reading for each point during test.
AXSTRS	A variable set equal to the first maximum stress ratio.
BAROP	Barometric pressure while test was performed (psi).
BPPPR	Bottom plate pore pressure readings (psi).
CDEVR	Corrected deviator readings (lb).
COHESN	Cohesion of soil sample obtained from least squares routine (psi).
COMPPP	Computed pore pressure for each point of test (psi).
CONTA	Weight of specimen container in air for initial, wetted, or final condition (gm).
CONTL	Weight loss of specimen container (gm).
CORVCH	Corrected volume change during test (cu. in.).
DATE	Date test was performed.
DELTAV	Change in volume during shear (cu in.).
DENSTY	Density of soil specimen for any point during test (pcf).
DEVGC	Deviator correction due to applied lateral pressure (lb).
DEVGC1	Same as DEVGC.
DEVGC2	Same as DEVGC.
DEVGR	Deviator gage readings during test (lb).
DGSAT	Degree of saturation for initial, wetted, or final condition (%).
DIFADR	Difference in successive axial dial readings during shear test.
DRYDEN	Dry density of soil specimen for initial, wetted, or final condition (pcf).
DRYWTS	Dry weight of soil specimen (gm).
DSTRES	An array containing deviator stresses for all specimens in the test.
DTFAC	Drainage tube factor (cu in./in.).
DT1R	Drain tube readings for left drain tube.
DT2R	Drain tube readings for right drain tube.
DVLOAD	An array containing deviator loads (lb).
DWTRIM	Dry weight of trimmings from wetted specimen (gm).
D1CUIN D2CUIN	Arrays containing the difference in successive readings of Drain Tubes No. 1 and 2 (cu in.).
E	Void ratio at any point during test (*e*).
FMCONT	Moisture content of soil specimen at final condition (%).
FSTMAX	First maximum value of stress ratio.
FWWS	Final wet weight of soil specimen (gm).
HPHI	Angle PHI from least squares routine to nearest degree.
HVW	Henry's constant times the initial water volume.
II	A constant used to determine initial specimen volume.
IPATH	A coding used to calculate either entire shear test or just least squares.
IPHI	Change HPHI to fixed point notation.
IX	An array used when punching cards for output.
J	A variable used to distinguish before touch values from after touch values.

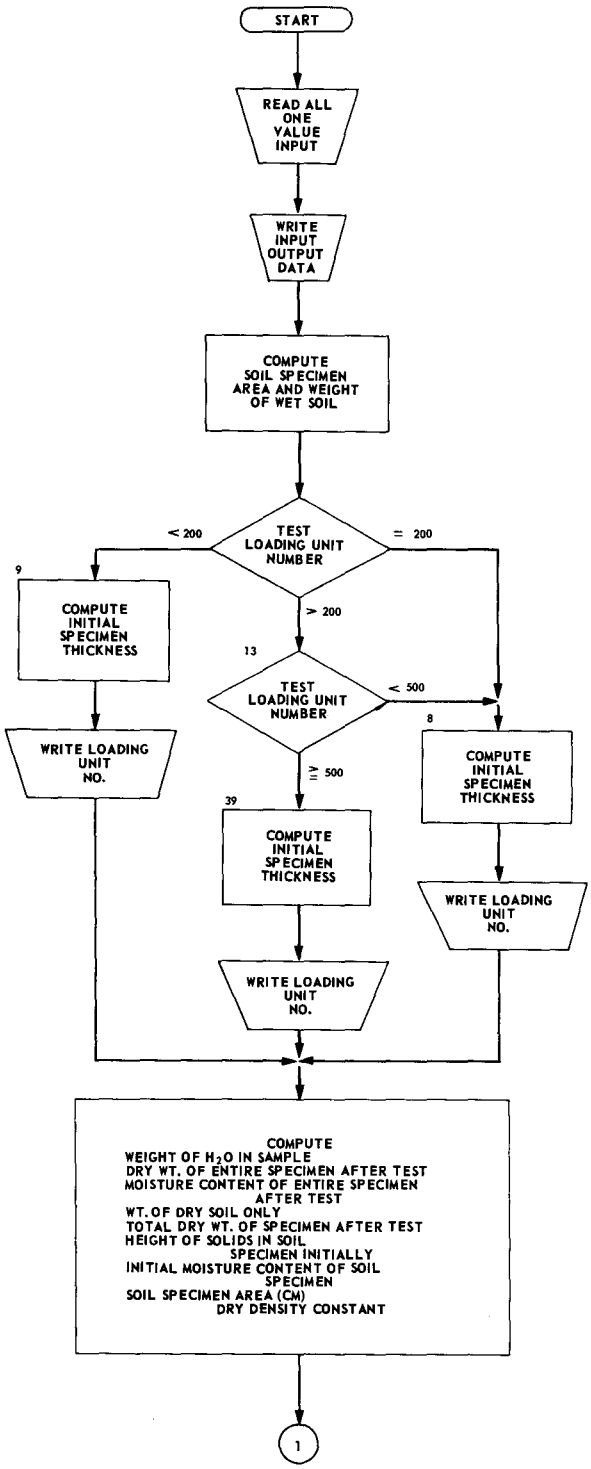
Variable name	Definition
K	A variable used to identify touch values.
L	A variable indicating whether a first maximum of stress ratio has been reached.
N	An array containing variables to indicate which stress ratio is the first maximum.
NOMACH	Machine number in which test was performed.
NOREAD	Total number of readings taken on specimen.
NOREED	An array with the number of readings taken on all specimens in the test.
NOSAMP	Sample number.
NOSIT	Number of specimens used to determine tan ϕ.
NOSPEC	Specimen number.
NOTOT	Total number of specimens in tests.
NOVOLT	Volume tube number; Left=1; Right=2.
OOSIT	Change NOTOT to floating point notation.
ORDINT	Shear stress for each point during test (psi).
PERCVC	Volume change (total) (%)
PHI	Same as HPHI.
PORE	Coding used to determine how effective lateral pressure is to be computed.
POREPR	An array containing the pore pressure used to calculate effective lateral pressure.
PSTFAC	Load piston area factor (correction to specimen volume) (cu. in./in.).
PSTVOL	Load piston volumes (cu in.).
SLATAP	Specimen length at any point during test (in.).
SLNGTH	Initial specimen length (in.).
SOILV	Initial, final, or wetted soil volume (cu in.).
SPCTA	Container weight in air (gm).
SPCTW	Container weight in water (gm).
SPGRAV	Specific gravity of soil specimen.
SPVAPT	Specimen volume at any point during test (cu. in.).
SRATIO	Stress ratio at any point $\left(\frac{\sigma_1-\sigma_3}{\sigma_3}\right)$.
STRANR	Strain rate at which test was performed (in./min).
SV	Specimen volume for initial, final, or wetted condition (cu. in.).
TANDEG	Angle in degrees (angle=$\tan^{-1}$ is deviator stress/percent axial strain).
TANPHI	Tangent of Angle ϕ from least squares.
TEMP	Temperature at beginning of test (°F).
TEMP1	Temperature at end of test (°F).
TEMPCO	Temperature correction factor and temperature correction.
TOTDRA	Total drainage from specimen (cu. in.).
TOT1CU	Total drainage from drain tube No. 1 (cu. in.).
TOT2CU	Total drainage from drain tube No. 2 (cu. in.).
TPPPR	Top plate pore pressure readings.
TVOLR	Volume tube reading at touch.
VAHVW	Initial air volume +HVW.
VCSAT	Percent volume change needed to obtain 100-percent saturation.
VCUBIN	Volume tube change during shear test (cu. in.).
VO	Initial volume tube reading.
VOIDR	Initial, final, or wetted void ratio.
VOIDRS	Void ratio at complete saturation.
VOLCB	Volume correction due to applied lateral pressure.
VOLT1R	Volume tube readings during test.
VTCHNG	Difference in successive volume tube readings from initial reading before touch, and from drained reading at touch during remainder of test.
VTOUCH	Specimen volume at touch (cu. in.).
WATERV	Initial, final, or wetted water volume in soil specimen (cu. in.).
WETMC	Wetted moisture content (%).
WLS	Initial, final, or wetted weight loss of specimen (gm).

TRIAXIAL SHEAR TEST—Continued

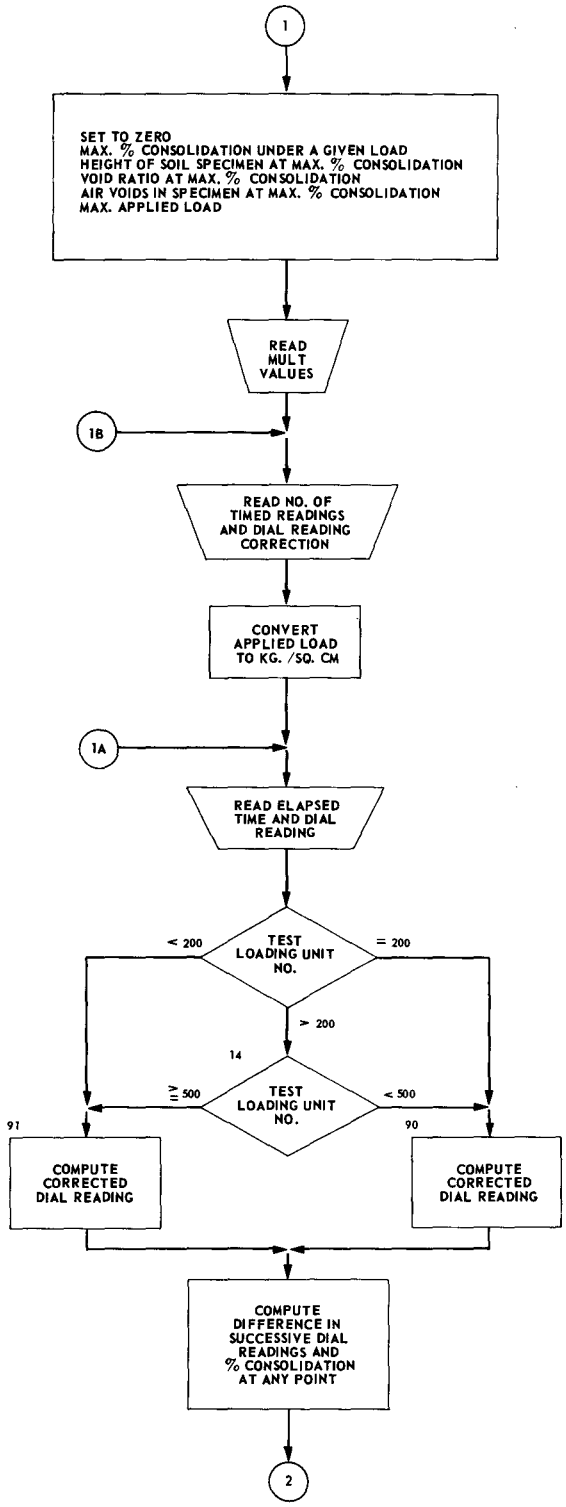
Variable name	Definition	Variable name	Definition
WLSC	Initial, final, or wetted weight loss of specimen + container (gm).	ZIMC	Initial moisture content (%).
WTCFAC	Weighing capsule factor (used to convert deviator reading to deviator load in pounds).	ZIWWS	Wet weight of specimen (gm).
WWWTS	Wetted net weight of soil specimen (gm).	ZMIN	Minutes of angle ϕ determined in least squares.
		ANSPPR	Insert pore pressure readings.

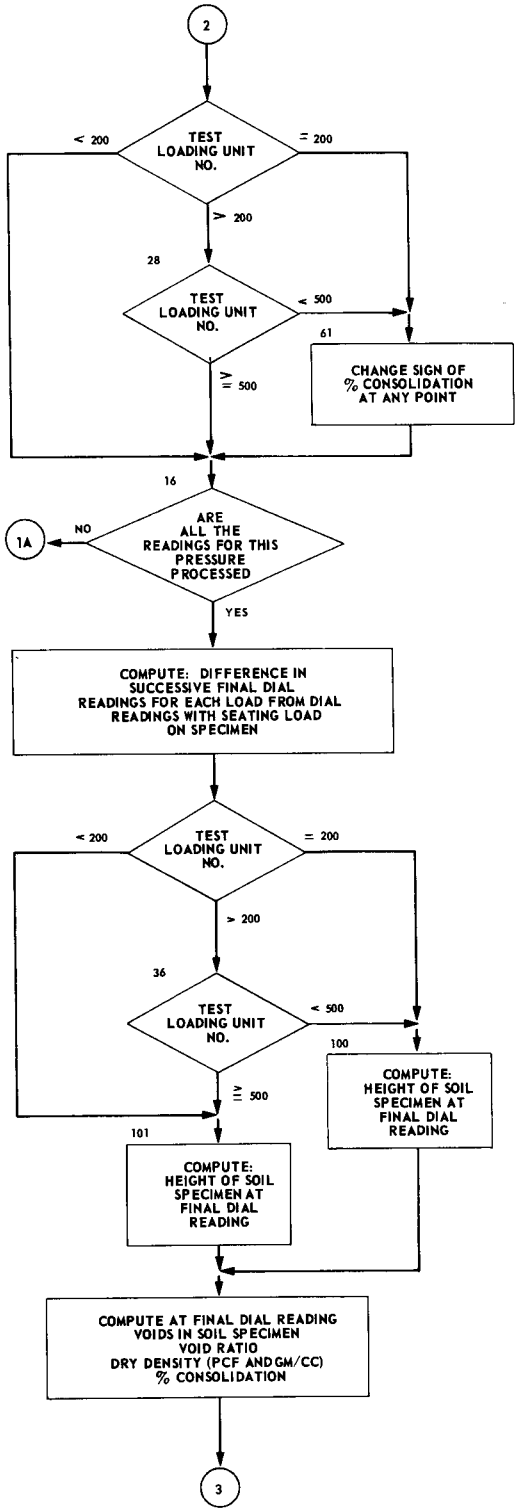
FLOW CHART
ONE-DIMENSIONAL CONSOLIDATION TEST

SHEET 1 OF 6

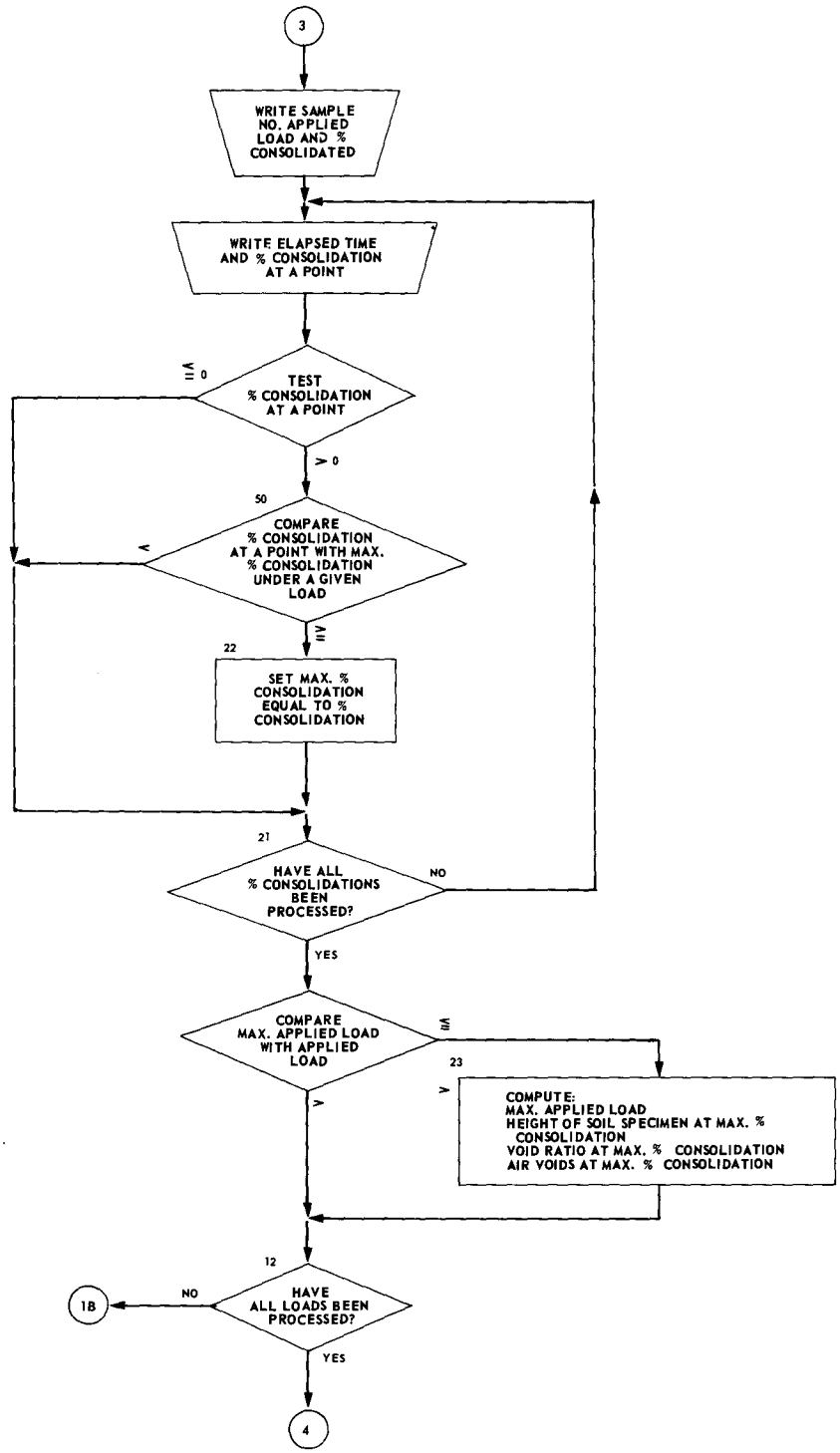


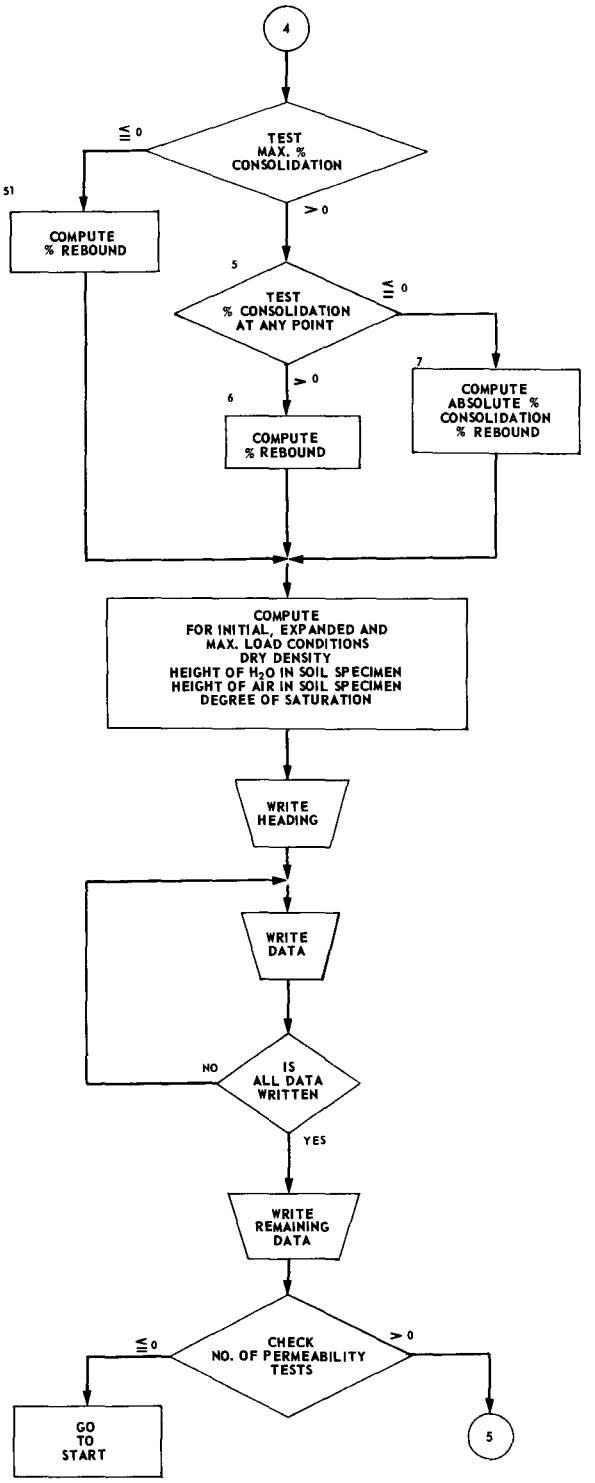
SHEET 2 OF 6

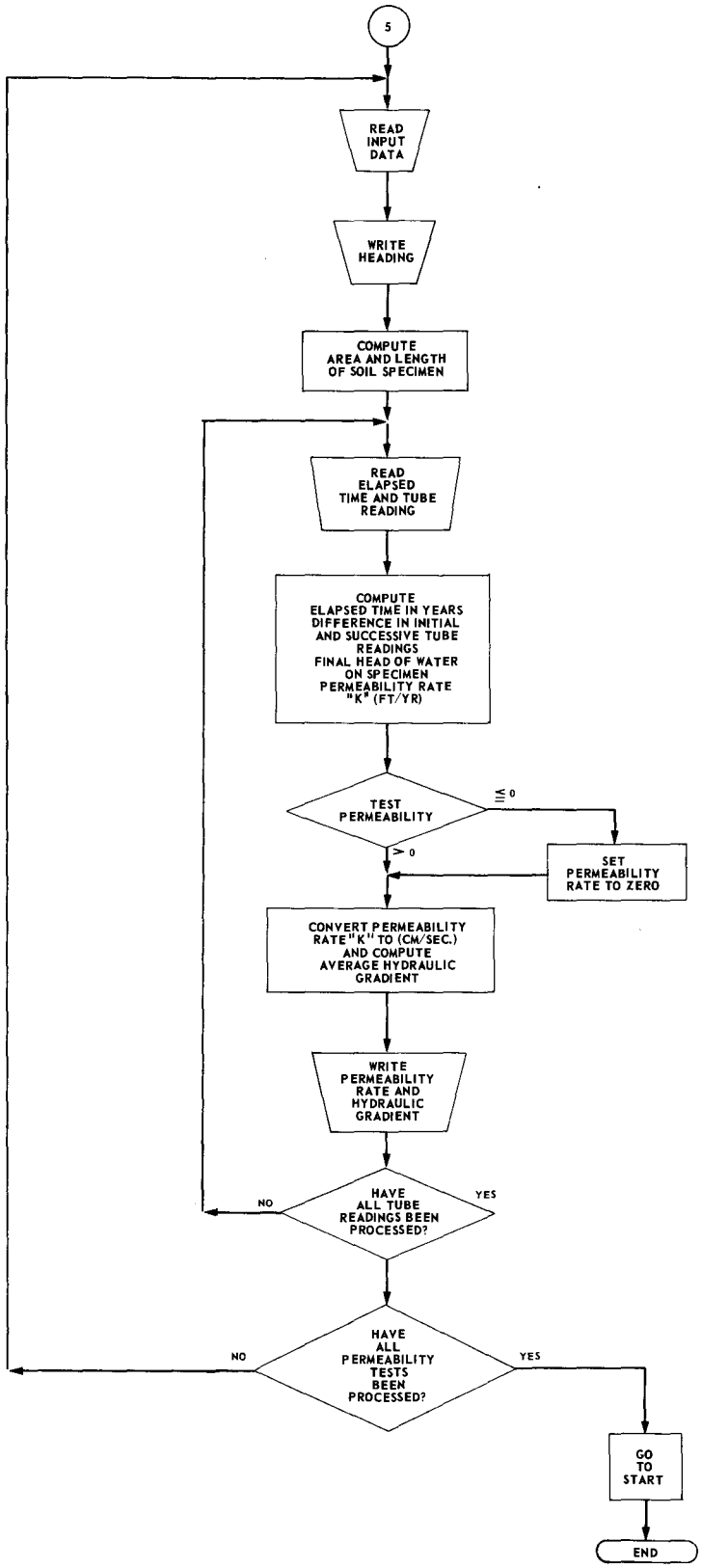



2
TEST LOADING UNIT NO.
< 200
= 200
> 200
28
TEST LOADING UNIT NO.
< 500
61
CHANGE SIGN OF % CONSOLIDATION AT ANY POINT
≥ 500
16
ARE ALL THE READINGS FOR THIS PRESSURE PROCESSED
NO
1A
YES
COMPUTE: DIFFERENCE IN SUCCESSIVE FINAL DIAL READINGS FOR EACH LOAD FROM DIAL READINGS WITH SEATING LOAD ON SPECIMEN
TEST LOADING UNIT NO.
< 200
= 200
> 200
36
TEST LOADING UNIT NO.
< 500
100
COMPUTE: HEIGHT OF SOIL SPECIMEN AT FINAL DIAL READING
≥ 500
101
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

SHEET 4 OF 6


3
WRITE SAMPLE NO. APPLIED LOAD AND % CONSOLIDATED
WRITE ELAPSED TIME AND % CONSOLIDATION AT A POINT
TEST % CONSOLIDATION AT A POINT
≤ 0
> 0
50
COMPARE % CONSOLIDATION AT A POINT WITH MAX. % CONSOLIDATION UNDER A GIVEN LOAD
<
≥
22
SET MAX. % CONSOLIDATION EQUAL TO % CONSOLIDATION
21
HAVE ALL % CONSOLIDATIONS BEEN PROCESSED?
NO
YES
COMPARE MAX. APPLIED LOAD WITH APPLIED LOAD
≥
23
>
COMPUTE:
MAX. APPLIED LOAD
HEIGHT OF SOIL SPECIMEN AT MAX. % CONSOLIDATION
VOID RATIO AT MAX. % CONSOLIDATION
AIR VOIDS AT MAX. % CONSOLIDATION
12
HAVE ALL LOADS BEEN PROCESSED?
NO
18
YES
4


4
TEST MAX. % CONSOLIDATION
≦ 0
> 0
51
COMPUTE % REBOUND
5
TEST % CONSOLIDATION AT ANY POINT
≦ 0
> 0
6
COMPUTE % REBOUND
7
COMPUTE ABSOLUTE % CONSOLIDATION % REBOUND
COMPUTE FOR INITIAL, EXPANDED AND MAX. LOAD CONDITIONS DRY DENSITY HEIGHT OF H2O IN SOIL SPECIMEN HEIGHT OF AIR IN SOIL SPECIMEN DEGREE OF SATURATION
WRITE HEADING
WRITE DATA
NO
IS ALL DATA WRITTEN
YES
WRITE REMAINING DATA
CHECK NO. OF PERMEABILITY TESTS
≦ 0
> 0
GO TO START
5


5
READ INPUT DATA
WRITE HEADING
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 ON SPECIMEN PERMEABILITY RATE "K" (FT/YR)
TEST PERMEABILITY
≤ 0
> 0
SET PERMEABILITY RATE TO ZERO
CONVERT PERMEABILITY RATE "K" TO (CM/SEC.) AND COMPUTE AVERAGE HYDRAULIC GRADIENT
WRITE PERMEABILITY RATE AND HYDRAULIC GRADIENT
HAVE ALL TUBE READINGS BEEN PROCESSED?
NO
YES
HAVE ALL PERMEABILITY TESTS BEEN PROCESSED?
NO
YES
GO TO START
END

```
      ONE DIM CONSOLIDATION

      DIMENSION P(50),ET(100),DR1(100),D(100),DDR1(100),PCON(100),CONM
     1(50),VR(50),DD(50),DDC(50),H(50),VOIDS(50),ETL(100),PL(50),PKMS(50
     2)
C     READ ALL ONE VALUE INPUT
   330READ INPUT TAPE 5, 1, NS, NS1, NSP, NST, NST1, NC1, LUN, NDP, NDP1
     1, CH, CD, SPG
    1 FORMAT (2A4,I4,4X,2A4,2I4,2A4,3F8.2)
     OREAD INPUT TAPE 5, 2, WSR,WSRC,DR2,DR3,NDO,NDO1,NCWE,NCWE1,NCTS,
     1NCTS1
    2 FORMAT (4F8.0,6A4)
      READ INPUT TAPE 5, 3, WWSC, DWSC, WTCGM, WCTS, DWSP
    3 FORMAT (5F8.2)
C     WRITE INPUT OUTPUT DATA
     OWRITE OUTPUT TAPE 6, 4, NS, NS1, NSP, NST, NST1, NDP, NDP1, NDO,
     1NDO1, SPG, CD, CH
    40FORMAT (1H1, 19X, 24H EARTH MATERIALS TESTING / 15X, 35H ONE-DIMEN
     1SIONAL CONSOLIDATION TEST // 11HSAMPLE NO  ,2A4, 5X, 11HSPECIMEN N
     20,I4, 5X, 15HSPECIMEN TYPE  ,2A4, // 12HDATE PLACED ,2A4, 3X, 13HD
     3ATE REMOVED ,2A4, 3X, 16HSPECIFIC GRAVITY,F5.2, // 19HSPECIMEN DIA
     4METER =,F5.2, 34H IN.              SPECIMEN HEIGHT =,F5.2,4H IN.//)
      CAI= 3.14159 / 4.0  * (CD*CD)
      CAC =  CAI * 6.4516
      WWS =  WSR - WSRC
      IF(LUN - 200) 9, 8, 13
   13 IF(LUN -500) 8, 39, 39
    9 HI = CH + (DR3 - DR2)
      WRITE OUTPUT TAPE 6, 37, LUN
   37 FORMAT(16X, 29HTEST PERFORMED IN   SCALE NO ,I4)
      GO TO 10
   39 HI = CH + (DR3 - DR2)
      WRITE OUTPUT TAPE 6, 40, LUN
   40 FORMAT(16X, 30HTEST PERFORMED IN   ANTEUS NO ,I4)
      GO TO 10
    8 HI = CH + (DR2 - DR3)
      WRITE OUTPUT TAPE 6, 38, LUN
   38 FORMAT(16X, 30HTEST PERFORMED IN   CONBEL NO ,I4)
   10 WW =  WWSC - DWSC
      DWS =  DWSC - WTCGM
      DMC =  ( WW / DWS ) * 100.0
      DWSS = DWSP - WCTS
      TDW = DWS + DWSS
      HO =  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
   90 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
   61 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 VOIDS(J) = H(J) - HO
      VR(J) = VOIDS(J) / HO
      DD(J) = TDW / (C * H(J))
      DDC(J) = DD(J) * 0.0160185
      CONM(J) = PCON(M)
      WRITE OUTPUT TAPE 6, 93, NS, NS1
   93 FORMAT (1H0, 2A4 )
      WRITE OUTPUT TAPE 6, 18, P(J), CONM(J), DD(J), VR(J)
  180FORMAT(6HLOAD =,F8.2,29H PSI           CONSOLIDATION = ,F8.4,     8H
     1 PERCENT / 13HDRY DENSITY =,F7.2, 23H PCF       VOID RATIO =,F7.4,
     2// 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.C, 15X, F8.3)
      IF(PCON(K)) 21, 21, 50
   50 IF(AMAX - PCON(K)) 22, 22, 21
   22 AMAX = PCON(K)
   21 CONTINUE
      IF (PMAX - P(J)) 23, 23, 12
   23 PMAX = P(J)
      BMAX = H(J)
      CMAX = VR(J)
      DMAX = VOIDS(J)
   12 CONTINUE
      IF(AMAX) 51, 51, 5
```

```
      ONE DIM CONSOLIDATION

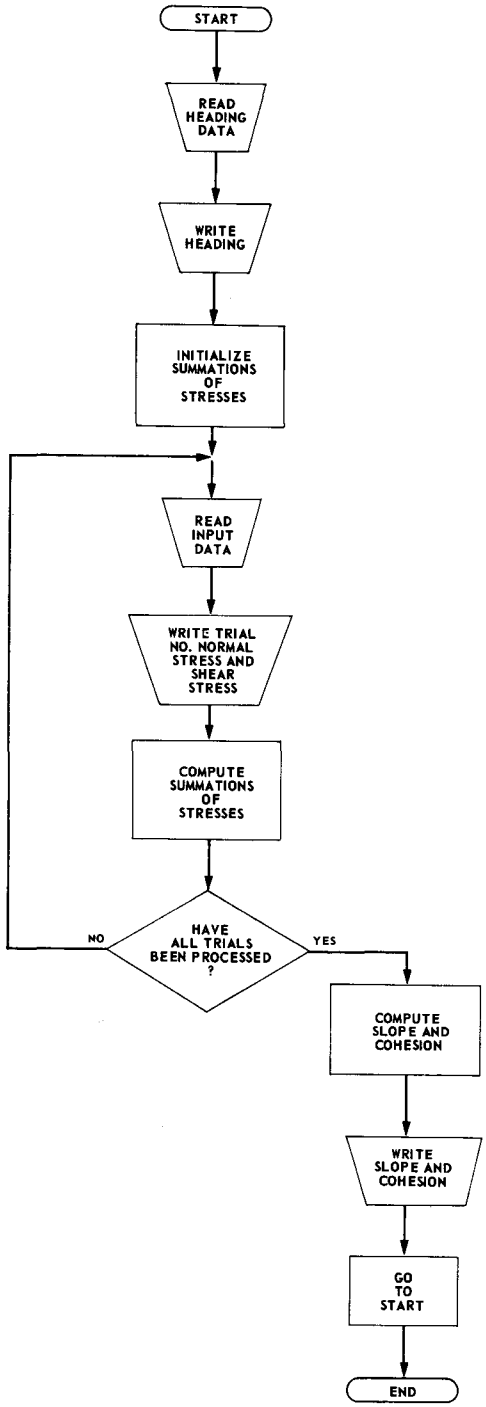
   51 REB = 0.0
      GO TO 24
    5 IF(PCON(M)) 7, 7, 6
    7 ACON = (-PCON(M))
      REB = ((AMAX + ACON) / AMAX) * 100.0
      GO TO 24
    6 REB = ((AMAX - PCON(M)) / AMAX) * 100.0
   24 DDI = TDW / (C * HI)
      HW =((TDW * WI) / (CAC * 2.54)) / 100.0
      HA = HI - HO - HW
      DSI = ( HW * 100.0 ) / ( 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 * BMAX)
      HWM = BMAX - HO - EHA
      CMLM =  (HWM * CAC * 254.0 ) / TDW
      DSML =  (HWM * 100.0) / DMAX
      DSML2 = (SPG * CMLM) / CMAX
      WRITE OUTPUT TAPE 6, 25
  250FORMAT(1H0, 7X, 60H LOAD          VOID RATIO     DRY DENSITY     C
     1ONSOLIDATION  / 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(1H0, 10H REBOUND = , F7.2, 8H PERCENT)
      WRITE OUTPUT TAPE 6, 30
   30 FORMAT (1H0, 29X, 8H INITIAL, 4X, 9H MAX LOAD, 4X, 9H EXPANDED)
      WRITE OUTPUT TAPE 6, 31, DDI, DDML, EXDD
   31 FORMAT (1H0, 12H DRY DENSITY, 17X, F8.3, 5X, F8.3, 5X, F8.3)
      WRITE OUTPUT TAPE 6, 32, WI, CMLM, DMC
   32 FORMAT (1H0, 17H MOISTURE CONTENT, 12X, F8.3, 5X, F8.3, 5X, F8.3)
      WRITE OUTPUT TAPE 6, 34, DSI, DSML, EDS
  340FORMAT (1H0, 21H DEGREE OF SATURATION, 8X, F8.3, 5X, F8.3, 5X,
     1F8.3)
      WRITE OUTPUT TAPE 6, 35, DSIP, DSML2, EDSP
  350FORMAT (1H0, 24H DEGREE OF SATURATION CK, 5X, F8.3, 5X, F8.3, 5X,
     1F8.3)
      IF(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, 2I4, 2A4, F8.2, F8.4)
      READ INPUT TAPE 5, 52, H1, TI, N2, AP, TC
   52  FORMAT(2F8.2, I8, 2F8.4)
```

```
   WRITE OUTPUT TAPE 6, 53, SAMP, SAMP1, NSPEC, DATE, DATE2, LUN2
530FORMAT(1H1, 18X, 31H FALLING HEAD PERMEABILITY TEST // 10X, 13H SA
  1MPLE NO.  ,2A4, 7X, 15H SPECIMEN NO.  , I4   // 10X, 7H DATE  ,2A4
  2, 9X, 19H LOADING UNIT NO.  ,I4 // 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 = H1 + (TC * DTR)
   PERM = (AP * SLF / AS) * (1.0 / ETY) * LOGF(H1 / HF)
   IF(PERM) 57, 57, 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
   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)
```

Variable name	Definition
AC	Soil specimen area (sq ft).
ACON	Absolute value of percent consolidation.
AHG	Average hydraulic gradient for permeability test.
AMAX	Maximum percent consolidation under a given loading.
AP	Area of standpipe for permeability test (sq. in.).
AS	Area of soil specimen for permeability test (sq. in.).
BMAX	Height of soil specimen at maximum percent consolidation under a given loading (in.).
C	Constant used to compute dry density.
CAC	Soil specimen area (sq cm).
CAI	Soil specimen area (sq in.).
CD	Container diameter (in.).
CH	Container height (in.).
CMAX	Void ratio at maximum percent consolidation under a given loading.
CMLM	Moisture content of soil specimen under maximum load (%).
CONM	Consolidation at final reading for each load (%).
CORR	Correction applied to each dial reading under each loading—due to deflection in stones.
D	Corrected dial reading.
DATE	Date permeability test performed.
DATE2	
DD	Dry density at final dial reading for each load (pcf).
DDC	Dry density at final dial reading for each load (gm/cc).
DDI	Initial dry density (pcf).
DDML	Dry density under maximum load (pcf).
DDR1	Difference in successive dial readings from dial reading with seating load on specimen.
DMAX	Air voids in soil specimen at maximum percent consolidation under a given load.
DMC	Moisture content of entire specimen after test (%).
DR1	Dial readings during test.
DR2	Dial reading with gage ring in place.
DR3	Dial reading with seating load on specimen.
DSDR	Difference in successive *Final* dial readings for each load from dial reading with seating load on specimen.
DSI	Initial degree of saturation (%).
DSIP	Initial degree of saturation (check) (%).
DSML	Maximum load degree of saturation (%).
DSML2	Maximum load degree of saturation (check) (%).
DSPEC	Specimen diameter for permeability test (in.).
DTR	Difference in successive water standpipe readings from initial reading—for permeability test.
DWS	Dry weight of entire specimen after test (gm) w_e.
DWSC	Dry weight of entire specimen plus container after test (gm) w_e.
DWSP	Dry weight of container plus soil adhering to specimen ring, trimmed from specimen, and washed from porous stones (gm)**.
DWSS	Same as DWSP except weight of dry soil only (gm)**.
EDS	Expanded degree of saturation (%).
EDSP	Expanded degree of saturation (check) (%).
EHA	Height of air in specimen under expanded conditions (in.).
EHW	Height of water in specimen under expanded conditions (in.).
ET	Elapsed time from initial dial reading to each successive dial reading for each load (seconds).
ETM	Elapsed time in minutes from initial water standpipe reading to each successive tube reading—permeability test.
ETY	ETM in years.
EXDD	Dry density under expanded conditions (pcf).

Variable name	Definition
H	Height of soil specimen at final dial reading for each load (in.).
HA	Height of air in specimen for initial conditions (in.).
H1	Initial head for permeability test (in.).
HF	Final head for permeability test (in.).
HI	Initial specimen thickness (in.) h_i.
HO	Height of solids in soil specimen initially (in.) h_o.
HW	Height of water in soil specimen initially (in.).
HWM	Height of water in soil specimen under maximum load (in.).
KFPERM	No. of permeability tests performed on soil specimen.
LUN	Loading Unit No.; consolidation 0→199 scales 200→499 conbels 500→ anteus.
LUN2	Loading Unit No.; permeability.
M	Number of timed readings for any given load.
N	Total number of loads applied.
N2	Total number of water standpipe readings for permeability test.
NC1	Consolidation container number.
NCTS NCTS1	Container number for moisture sample of material adhering to rings, stones, etc.
NCWE NCWE1	Container number for moisture sample of material after test is completed.
NDO NDO1	Date test removed from consolidometer.
NDP NDP1	Date test placed in consolidometer.
NS NS1	Sample number—consolidation.
NSEAT	Load number for expanded conditions.
NSP	Specimen number—consolidation.
NSPEC	Specimen number—permeability.
NST NST1	Specimen type (natural or remolded).
P	Applied load (psi).
PCON	Percent consolidation at any point; consolidation is plus, expansion is minus.
PERM	Permeability rate (ft/yr).
PERMC	Permeability rate (cm/sec).
PKMS	Applied load (kg/sq cm).
PMAX	Maximum applied load (psi).
REB	Percent rebound of soil specimen from maximum percent consolidation.
SAMP SAMP1	Sample number—permeability.
SLF	Length of soil specimen for permeability test (ft).
SPECL	Length of soil specimen for permeability test (in.).
SPG	Specific gravity of soil being tested.
TC	Tube constant of water standpipe for permeability test.
TDW	Total dry weight of soil specimen after test, includes soil specimen, trimmings, material from stones, etc. (gm).
TI	Initial water standpipe reading—permeability.
TR	Successive water standpipe readings during permeability test.
VOIDS	Voids in soil specimen at final reading for each load.
VR	Void ratio at final reading for each load.
WCTS	Weight of container for moisture sample for trimmings, material adhering to rings, etc. (gm)**.
WI	Initial moisture content of soil specimen (%) w_i.
WSR	Weight of specimen ring, cover plates and wet soil, initial (gm).
WSRC	Weight of specimen ring and cover plates (gm).
WTCGM	Weight of container for moisture sample after test is removed from consolidometer (gm) w_e.
WW	Weight of water in sample, final (gm) w_e.
WWS	Weight of wet soil in sample, final (gm).
WWSC	Wet weight of specimen plus container, final (gm) w_e.

FLOW CHART
SLIDING FACTOR AND DIRECT SHEAR, LEAST SQUARES



```
   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, 2I4)
   WRITE OUTPUT TAPE 6, 2, NS, NS1
 2 FORMAT (1H1, 21X, 11H SAMPLE NO , 2A4)
   WRITE OUTPUT TAPE 6, 3, NSP
 3 FORMAT (1H0, 21X, 13H SPECIMEN NO , I4)
   WRITE OUTPUT TAPE 6, 4
 40FORMAT (1H0, 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 (I8, 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)
   SUMX2 = SUMX2 + E(I)
   SUMX = SUMX + X(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 (1H0, 18X, 14H TANGENT PHI = , F8.5)
   WRITE OUTPUT TAPE 6, 8, COHN
 8 FORMAT (1H0, 21X, 11H COHESION = , F8.4)
   GO TO 33
   END(1,0,0,0,0,0,1,0,0,0,0,0,0,0,0)
```

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

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

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE PINK STRIP / COLORED CARDS		
	PROBLEM	JOB NO.
	DETAIL NATURAL MOISTURE AND DENSITY DETERMINATION	#
	FEATURE Meeks Cabin Dam	RETURN TO
	PROJECT Lyman, Wyo.	ROOM BLDG. PHONE

SAMPLE NO.	DATE	1/ TUBE LENGTH (ft)	TUBE I.D. (in)	TUBE + WET SOIL (lbs)	DENISON TUBE FACTOR (lb/ft)	DRIVE TUBE WEIGHT (lbs)	DRIVE TUBE EMPTY END LENGTHS TOP (ft)	DRIVE TUBE EMPTY END LENGTHS BOTTOM (ft)	DRIVE TUBE NO.
4L-45	10-27-64	1.21	5.813	30.6	1.248	.	.	.	

MOISTURE FROM TOP OF SAMPLE			MOISTURE FROM CENTER OF SAMPLE			MOISTURE FROM BOTTOM OF SAMPLE		
DISH + WET SOIL (gms)	DISH + DRY SOIL (gms)	DISH WEIGHT (gms)	DISH + WET SOIL (gms)	DISH + DRY SOIL (gms)	DISH WEIGHT (gms)	DISH + WET SOIL (gms)	DISH + DRY SOIL (gms)	DISH WEIGHT (gms)
5691.0	4761.88	211.04	.	.	.	467.23	390.45	211.71

DISH NO. Carton DISH NO. _____ DISH NO. Carton

1/ TUBE LENGTH = SAMPLE LENGTH FOR DENISON SAMPLE

REMARKS

BY E. H. B.C.	DATE	CHECKED P. K.	SHEET 1 OF 1

DATE 10-27-64 SAMPLE NO. 41L-45

IN-PLACE MOISTURE-DENSITY OF SOIL IN DENISON TUBE

SAMPLE LENGTH =	36.881 CM.	=	1.21CFT.
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.

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF STRIP	PROBLEM MA	JOB NO.
	DETAIL MECHANICAL ANALYSIS (GRADATION) TEST	#
COLORED CARDS	FEATURE China Meadows Damsite	RETURN TO
	PROJECT Lyman, Wyo.	ROOM BLDG. PHONE

SCREEN TEST YES = 1 NO = 0		SAMPLE NO.							
1		143G-1							
DATE	TOTAL WET WGT. BFR. SCREENING	5"	3"	1½"	3/4"	3/8"	NO. 4	-NO. 4	SCREEN SIZES
11-30-64	577.0	10.50	11.00	317.50	61.00	43.30	38.30	363.50	WGT. RET. ON EACH SCREEN
← MOISTURE OF +3/4" SOIL →			← MOISTURE OF -3/4", + NO. 4 SOIL →			← MOISTURE OF -NO. 4 SOIL →			
PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	PAN OR DISH WEIGHTS
						547.31	533.89	21.85	CTN
SIEVE TEST YES = 1 NO = 0	(FILL OUT ONLY IF NO SCREEN TEST) % PASSING NO. 4			TOTAL SAMPLE DISH + DRY SOIL	DISH WEIGHT	TO BE SIEVED DISH + DRY SOIL			DISH NO.
1				222.29	154.01	204.31			221
DATE	8	16	30	50	100	200	PAN		SIEVE NUMBERS
12-16-64	13.68	9.60	18.72	30.89	42.98	49.61	50.32		CUMULATIVE SOIL WEIGHTS
HYDROM. TEST YES = 1 NO = 0	(FILL OUT ONLY IF NO SCREEN OR SIEVE TESTS) % PASSING NO. 4			(FILL OUT ONLY IF NO SIEVE TEST) TOTAL SAMPLE DISH + DRY SOIL	DISH WEIGHT				DISH NO.
1									
DATE	STARTING TIME	HYDROMETER NO.	MI. USED	DISPERSING AGENT	TIME MIXED AND TYPE OF MIXER USED				
12-14-64	8:53	442	125	CALGON	5 MINUTE MALT MIXER				
1 MIN.	4 MIN.	19 MIN.	60 MIN.	7 HR. - 15 MIN.	25 HR. - 45 MIN.				
22.0	18.0	15.0	13.0						HYDROMETER READINGS
4.9	4.9	4.9	4.9						TEMPERATURE CORRECTION
23.0	23.0	23.0	23.0						TEMPERATURE °C
									TIME OF READING

REMARKS

BY E.H. B.C. J.S. DATE CHECKED P.K. SHEET 1 OF 1

MECHANICAL ANALYSIS (GRADATION) TEST SAMPLE NO 43G-1

DATE 11-30-64 *****SCREEN ANALYSIS*****

WET WGT-TOTAL SAMPLE (BEFORE SCREENING) = 261.723 KG = 577.00 LBS
WET WGT-TOTAL 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 RETAINED KG	DRY WEIGHT RETAINED LBS	DRY WEIGHT PASSING KG	DRY WEIGHT PASSING LBS	SCREEN SIZE IN	SCREEN SIZE MM	PERCENT OF TOTAL DRY WGT PASSING
4.763	10.50	247.351	545.32	5	127.0	98.1109
		242.362	534.32	3	76.2	96.1318
WET WEIGHT		225.352	496.82	1-1/2	38.1	89.3850
PASSING		197.683	435.82	3/4	19.1	78.4101
KG	LBS	178.042	392.52	3/8	9.52	70.6198
164.881	363.50	160.670	354.22	NO 4	4.76	63.7290

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

SIEVE NO	PARTICLE DIA (MM)	PERCENT OF TOTAL DRY WGT PASSING
8	2.380	60.2948
16	1.190	54.7702
30	0.590	46.2593
50	0.297	34.9021
100	0.149	23.6196
200	0.074	17.4324
PAN		

DRY WEIGHT RETAINED (GRAMS) 50.320

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 HYDROMETER NO 442

TIME ELAPSED	PARTICLE DIA (MM)	PERCENT OF TOTAL DRY WGT PASSING
1 MIN	0.037	15.9579
4 MIN	0.019	12.2251
19 MIN	0.009	9.4254
60 MIN	0.005	7.5590

GRAIN SIZE FRACTIONS IN PERCENT

OVERSIZE (LARGER THAN 5 INCHES)	1.8891
COBBLES (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

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF STRIP	PROBLEM MA	JOB NO.
	DETAIL MECHANICAL ANALYSIS (GRADATION) TEST	#
COLORED CARDS	FEATURE Lake Mead Sediment Survey	RETURN TO
	PROJECT	ROOM BLDG. PHONE

SCREEN TEST YES = 1 NO = 0		SAMPLE NO.							
0		412-131							
DATE	TOTAL WET WGT. BFR. SCREENING	5"	3"	1½"	3/4"	3/8"	NO. 4	-NO. 4	SCREEN SIZES
									WGT. RET. ON EACH SCREEN
← MOISTURE OF +3/4" SOIL →			← MOISTURE OF -3/4", + NO. 4 SOIL →			← MOISTURE OF -NO. 4 SOIL →			PAN OR DISH WEIGHTS
PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	PAN + WET SOIL	PAN + DRY SOIL	PAN WEIGHT	
SIEVE TEST YES = 1 NO = 0	(FILL OUT ONLY IF NO SCREEN TEST) % PASSING NO. 4			TOTAL SAMPLE DISH + DRY SOIL	DISH WEIGHT	TO BE SIEVED DISH + DRY SOIL			DISH NO.
0									
DATE	8	16	30	50	100	200	PAN		SIEVE NUMBERS
									CUMULATIVE SOIL WEIGHTS
HYDROM. TEST YES = 1 NO = 0	(FILL OUT ONLY IF NO SCREEN OR SIEVE TESTS) % PASSING NO. 4			(FILL OUT ONLY IF NO SIEVE TEST) TOTAL SAMPLE DISH + DRY SOIL	DISH WEIGHT				DISH NO.
1		100.0		220.41	170.41				98
DATE	STARTING TIME	HYDROMETER NO.	MI. USED	DISPERSING AGENT	TIME MIXED AND TYPE OF MIXER USED				
1-18-65	91:52	747	125	CALGON	10 MINUTE MALT MIXER				
1 MIN.	4 MIN.	19 MIN.	60 MIN.	7 HR. - 15 MIN.	25 HR. - 45 MIN.				
54.0	52.5	50.5	44.5	34.5	30.0				HYDROMETER READINGS
3.5	3.5	3.5	3.3	2.7	3.9				TEMPERATURE CORRECTION
25.0	25.0	25.0	25.5	27.5	24.0				TEMPERATURE °C
									TIME OF READING

REMARKS

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

TIME ELAPSED	PARTICLE DIA (MM)	PERCENT OF TOTAL DRY WGT PASSING
1 MIN	0.037	101.0000
4 MIN	0.019	98.0000
19 MIN	0.009	94.0000
60 MIN	0.005	82.4000
7 HR 15 MIN	0.002	63.6000
25 HR 45 MIN	0.001	52.2000

GRAIN SIZE FRACTIONS IN PERCENT
CLAY (SMALLER THAN 0.005 MM) 82.4000

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE ORANGE STRIP COLORED CARDS		
PROBLEM	SOIL CONSISTENCY TEST	JOB NO.
DETAIL	(ONE-POINT LIQUID LIMIT METHOD)	#
FEATURE	Panoche Creek Detention Dam	RETURN TO
PROJECT	Central Valley	ROOM BLDG. PHONE

SAMPLE NO.	DATE
43D-1X64	8-51-64

AIR-DRIED ☒
OVEN-DRIED ☐
NATURAL ☐

NO. OF MOISTURES TAKEN FOR LL: 1

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.	BLOWS USED
17.66	12.50	6.28	20

FIRST TRY BLOWS	DISH NO.
20	92

NO. OF MOISTURES TAKEN FOR PL: 2

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.
19.72	17.15	6.44
17.22	15.13	6.23

DISH NO.
157
147

NO. OF MOISTURES TAKEN FOR SL: 1

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.	VOL. SHRINK. DISH	VOL. DRY SOIL
32.57	22.39	11.23	14.85	5.75

BLOWS	DISH NO.
9	93

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

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE ORANGE STRIP COLORED CARDS	PROBLEM SOIL CONSISTENCY TEST	JOB NO.
	DETAIL (ONE-POINT LIQUID LIMIT METHOD)	#
	FEATURE Panoche Creek Detention Dam	RETURN TO
	PROJECT Central Valley	ROOM BLDG. PHONE

SAMPLE NO.	DATE
43D1-23	8-41-64

AIR-DRIED ☒
OVEN-DRIED ☐
NATURAL ☐

NO. OF MOISTURES TAKEN FOR LL: 1

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.	BLOWS USED
18.50	14.58	6.42	29

FIRST TRY BLOWS	DISH NO.
28	71

NO. OF MOISTURES TAKEN FOR PL: 2

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.
15.92	14.40	5.70
17.55	15.81	5.95

DISH NO.
116
113

NO. OF MOISTURES TAKEN FOR SL: 0

DISH + WET SOIL	DISH + DRY SOIL	DISH WGT.	VOL. SHRINK. DISH	VOL. DRY SOIL

BLOWS	DISH NO.

REMARKS

BY L.A.R. | DATE | CHECKED P.K. | SHEET 1 OF 2

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE			
PINK	PROBLEM	PRCOMP	JOB NO.
	DETAIL	PROCTOR COMPACTION TEST--ADP	#
COLORED CARDS	FEATURE	China Meadows Damsite	RETURN TO
	PROJECT	Lyman, Wyo.	ROOM BLDG. PHONE

	SAMPLE NO.	DATE	CYL. VOL.* (cu. ft.)	CYL. WGT. (lb.)				
	43G-2	12-17-64	20.0	5.58				
TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc.)		70	140	210	280	190		
WGT. CYL. +WET SOIL (lb.)		12.02	12.27	12.34	12.22	12.34		
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.		40	20	10	4	20		
AVERAGE READING (lb.)		9.2	6.4	1.9	2.9	2.0		
WATER CONTENT DETERMINATIONS								
DISH NO.		211	22	51	74	39		
WGT. DISH + WET SOIL		448.33	480.20	458.82	469.72	460.03		
WGT. DISH + DRY SOIL		423.38	445.98	420.97	426.24	425.00		
WGT. OF DISH		169.30	164.50	151.55	155.07	165.57		

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? 2 FIRM? 3 SOFT? 4
5. WAS BLEEDING NOTICED DURING TEST? No IF SO, WHAT TEST NOS.?
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? 5 slightly
7. OTHER COMMENTS

*For 1/20 cu. ft. mold, cyl. vol. = 20.0
For 1/30 cu. ft. mold, cyl. vol. = 30.0

BY E.H. DATE 12-17-64 CHECKED P.K. SHEET 2 OF 5

EARTH MATERIALS TESTING
PROCTOR COMPACTION TEST

SAMPLE NO 43G-2 DATE 12-17-64

TEST NO		1	2	3	4	5	6	7	8
WET DENSITY	PCF	0.	128.8	133.8	135.2	132.8	135.2	0.	0.
WET DENSITY	GM/CC	0.	2.063	2.143	2.166	2.127	2.166	0.	0.
PENET. RES.	PSI	0.	3680.	1280.	190.	116.	400.	0.	0.
PENET. RES.	KG/SQCM	0.	258.7	90.0	13.4	8.2	28.1	0.	0.
WATER CONTENT	PCT	0.	9.82	12.16	14.05	16.03	13.50	0.	0.
DRY DENSITY	PCF	0.	117.3	119.3	118.5	114.4	119.1	0.	0.
DRY DENSITY	GM/CC	0.	1.879	1.911	1.899	1.833	1.908	0.	0.

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE Blue Strip COLORED CARDS	PROBLEM	PERMCH	JOB NO.
	DETAIL	Permeability - Settlement Test ADP	#
	FEATURE	Starvation Dam	RETURN TO
	PROJECT	Central Utah	ROOM BLDG. PHONE

Sample No.	Date Placed	Date Removed	Head Tank No.	Calibration Factor	Cyl. No.	Total No. of Rdg's.	Placement Dry Density (pcf)	Sample Area (Sq. in.)	Initial Specimen Thickness (in.)
3.7Q-X68	1-7-65	1-25-65	414	216.64	48	31	119.1	50.3	3.0005

Date	Hour Observed	Hours Between Readings	Head (ft.)	Load (psi)	Dial A	Dial B	Head Tank Reading (in.)	Enter a 1 After Non-Test Values
1-7-65	9.00	0.0	10.0	10.0	0.1359	0.1421	10.0	1
	9.10	0.1	10.0	11.0	0.1362	0.1423	10.0	
	11.50	2.4	10.0	11.0	0.1362	0.1423	10.0	
	13.50	2.0	10.0	11.0	0.1362	0.1423	10.0	
	13.50	0.0	10.0	210.0	0.1366	0.1427	10.0	
	15.60	2.1	10.0	210.0	0.1367	0.1427	10.0	
1-11-65	7.05	817.45	10.27	210.0	0.1367	0.1427	18.20	
	15.63	8.58	10.27	210.0	0.1367	0.1427	18.35	
1-12-65	7.27	15.64	10.27	210.0	0.1367	0.1427	18.60	
	15.50	8.23	10.27	20.0	0.1367	0.1427	18.75	
1-13-65	7.46	15.96	10.27	20.0	0.1367	0.1427	19.00	
	15.55	8.09	10.27	20.0	0.1367	0.1427	19.15	
1-14-65	6.75	15.2	10.27	20.0	0.1367	0.1427	19.40	
	14.73	7.98	10.27	20.0	0.1367	0.1427	19.50	
1-15-65	7.55	16.82	10.27	20.0	0.1367	0.1427	19.80	

Remarks

BY J. B. DATE CHECKED P. K. SHEET 1 OF 2

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE COLORED CARDS: Buff

PROBLEM: PERMCH

DETAIL: Permeability - Settlement Test ADP

FEATURE:

PROJECT:

JOB NO.: #

RETURN TO:

ROOM: BLDG.: PHONE:

Date	Hour Observed	Hours Between Readings	Head (ft.)	Load (psi)	Dial A	Dial B	Head Tank Reading (in.)	Enter a 1 After Non-Test Values	
1-15-65	15.4	17.85	10.27	20.0	0.1367	0.1427	19.90		
1-18-65	6.18	62.78	10.27	20.0	0.1367	0.1428	10.80		
	14.41	8.23	10.27	20.0	0.1367	0.1428	10.95		
1-19-65	7.31	16.90	10.27	20.0	0.1367	0.1428	11.15		
	15.68	8.37	10.27	20.0	0.1367	0.1428	11.25		
1-20-65	7.02	15.34	0.27	20.0	0.1367	0.1428	11.50		
	15.46	8.44	0.75	20.0	0.1367	0.1428	11.75	1	Raise Head
1-21-65	7.26	15.80	10.75	20.0	0.1367	0.1428	12.35		
	15.39	8.13	10.75	20.0	0.1367	0.1428	12.65		
1-22-65	6.18	14.79	10.75	20.0	0.1367	0.1428	13.20		
	13.68	7.50	10.75	20.0	0.1367	0.1428	13.50		
	13.71	0.03	10.75	20.0	0.1367	0.1428	10.0	1	Fill Head Tank
1-25-65	7.19	65.48	10.75	20.0	0.1367	0.1430	12.4		
	9.47	2.28	10.75	20.0	0.1367	0.1430	12.5		Final Reading
	10.47	1.00	10.0	1.0	0.1362	0.1427	10.0	1	Release Load
	12.47	2.00	10.0	10.0	0.1359	0.1424	10.0	1	

Remarks: 37Q - X68

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

LOAD		CONSOLIDATED DRY DENSITY		SETTLEMENT	
PSI	KG/SQCM	PCF	GM/CC	PERCENT	
0.	0.				
1.00	0.07	119.26	1.9104	0.13	
1.00	0.07	119.26	1.9104	0.13	
1.00	0.07	119.26	1.9104	0.13	
20.00	1.41	119.50	1.9142	0.33	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.54	1.9148	0.37	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	*
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	
20.00	1.41	119.56	1.9151	0.38	*
20.00	1.41	119.60	1.9158	0.42	
20.00	1.41	119.60	1.9158	0.42	
1.00	0.07	119.34	1.9116	0.20	*
0.	0.	119.16	1.9088	0.05	*

37Q-X68 PERMEABILITY-SETTLEMENT TEST

HEAD FT	HYDRAULIC GRADIENT FT/FT	HOURS BETWEEN READINGS	TOTAL ELAPSED TIME IN HOURS	COEFFICIENT OF PERMEABILITY FT/YR	CM/SEC	
		0.	0.			
0.	0.	0.1	0.1	0.	0.	
0.	0.	2.4	2.5	0.	0.	
0.	0.	2.0	4.5	0.	0.	
0.	0.	0.	4.5	0.	0.	
0.	0.	2.1	6.6	0.	0.	
0.27	1.076	87.4	94.0	2.06	0.199E-05	
0.27	1.076	8.6	102.6	0.38	0.370E-06	
0.27	1.076	15.6	118.3	0.35	0.339E-06	
0.27	1.076	8.2	126.5	0.40	0.386E-06	
0.27	1.076	16.0	142.5	0.34	0.332E-06	
0.27	1.076	8.1	150.5	0.41	0.393E-06	
0.27	1.076	15.2	165.7	0.36	0.348E-06	
0.27	1.076	8.0	173.7	0.27	0.265E-06	
0.27	1.076	16.8	190.5	0.39	0.378E-06	
0.27	1.076	7.8	198.4	0.28	0.270E-06	
0.27	1.076	62.8	261.2	0.31	0.304E-06	
0.27	1.076	8.2	269.4	0.40	0.386E-06	
0.27	1.076	16.9	286.3	0.26	0.251E-06	
0.27	1.076	8.4	294.7	0.26	0.253E-06	
0.27	1.076	15.3	310.0	0.36	0.345E-06	
0.75	2.988	8.4	318.5	0.	0.	*
0.75	2.988	15.8	334.3	0.30	0.290E-06	
0.75	2.988	8.1	342.4	0.29	0.281E-06	
0.75	2.988	14.8	357.2	0.29	0.284E-06	
0.75	2.988	7.5	364.7	0.32	0.305E-06	
0.75	2.988	0.0	364.7	0.	0.	*
0.75	2.987	65.5	430.2	0.29	0.280E-06	
0.75	2.987	2.3	432.5	0.35	0.335E-06	
0.	0.	1.0	433.5	0.	0.	*
0.	0.	2.0	435.5	0.	0.	*
0.	0.	0.	435.5	0.	0.	

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
Yellow Strip	PROBLEM	JOB NO.
COLORED CARDS	DETAIL Falling Head Permeability Test	#
	FEATURE Cheney Dam	RETURN TO
	PROJECT Wichita, Kans.	ROOM BLDG. PHONE

Sample No.	Loading Spec. No.	Loading Unit No.	Date	Specimen Diameter (in)	Specimen Length (in)
25J-1X162	1	267	7-20-64	4.25	1.131

Initial Head (in)	Initial Tube Reading	Total No. of Tube Readings	Area of Standpipe (sq in)	Tube Constant
16.10	0.0	4	0.10075	0.5677

Elapsed Time (min)	Tube Readings
450	0.08
1440	0.15
2880	0.28
3870	0.34

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 FT/YR	PERMEABILITY CM/SEC	AVERAGE HYDRAULIC GRADIENT
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

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE GREEN STRIP COLORED CARDS	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 1	#
	FEATURE San Luis Dam Cutoff Trench	RETURN TO
	PROJECT Central Valley	ROOM BLDG. PHONE

NO. OF SPEC. FOR TAN Ø	DATE	PATH 1 OR 2 1/	TOTAL NO. OF SPEC. IN TEST	Punch Cards Required? Yes = 1 No = 0
4	10-14-64	2	4	0

SAMPLE NUMBER	SPEC. NO.	MACHINE NO.	TOTAL NO. OF READINGS ON SPEC.
36F-X673	10	3	24

INIT. WT. OF SPEC. + CONT. (GM)	INIT. WT. OF CONTAINER (GM)	INIT. WT. OF SPEC. + CONT. IN WATER (GM)	INIT. WT. LOSS OF CONTAINER (GM)
1265.10	746.25	897.7	111.18
FINAL WT. OF SPEC. + CONT. (GM)	**FINAL WT. OF CONTAINER (GM)**	**FINAL WT. OF SPEC. + CONT. IN WATER (GM)**	**FINAL WT. LOSS OF CONTAINER (GM)**
1265.02	746.34	901.10	111.30
WETTED WT. OF SPEC. + CONT. (GM)	**WETTED WT. OF CONTAINER (GM)**	**WETTED WT. OF SPEC. + CONT. IN WATER (GM)**	**WETTED WT. LOSS OF CONTAINER (GM)**
0.0	0.0	0.0	0.0

FINAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	DRY WT. OF TRIMMINGS (GM)
17.78	2.69	0.0

1/ PATH 1-LEAST SQUARES COMPUTATION ONLY
PATH 2-ENTIRE SHEAR TEST COMPUTATION

REMARKS

BY C.E.C.	DATE	CHECKED P.K.	SHEET 1 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
GREEN STRIP	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 2	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

STRAIN RATE (IN. PER MIN.)	INITIAL TEMP. (°F)	FINAL TEMP. (°F)	WEIGHING CAPSULE FACTOR	SPEC. LENGTH AT TOUCH	TIME OF READING
0.004	71.2	71.6	1.0	5.1016	10 10

APPLIED AIR BACK PRESSURE (PSI)	APPLIED WATER BACK PRESSURE (PSI)	BAROMETRIC PRESSURE (PSI)	1/ EFF. LATERAL PRESSURE	VOLUME TUBE READING AT TOUCH (DRAINED)	VOLUME TUBE NO. (LEFT, 1 RIGHT, 2)
0.0	0.0	12.2	-1.0	15.0	2

DEVIATOR CORRECTION DUE TO LATERAL PRESSURE	TEMP. CORR. COEFFICIENT	LOAD PISTON AREA FACTOR	DRAINAGE TUBE FACTOR	INITIAL VOLUME TUBE READING	SOIL 2/ VOLUME 1 OR 3
0.4456	0.0	0.0379	0.4394	0.0259	5.0	1

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)

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

REMARKS

BY	DATE	CHECKED	SHEET 2 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
0.0	0.0	0.0	5.00	.	.	-3.0	0.0	.
5.0	0.0	0.0	5.92	.	.	-3.7	1.4	.
10.0	0.0	0.0	6.44	.	.	-4.0	2.1	.
25.0	7.0	0.0	7.51	.	.	-3.5	4.9	.
25.0	8.0	0.0	7.58	.	.	-3.7	5.5	.
25.0	8.0	0.0	7.59	.	.	-3.9	5.3	.
-25.0	10.9	0.238	7.04	.	.	-4.0	5.2	.
25.0	29.0	0.25	15.00	.	.	-4.0	5.2	.
26.5	92.5	0.30	15.21	.	.	-3.9	7.7	.
28.8	132.0	0.35	15.41	.	.	-3.4	9.8	.
30.5	150.7	0.40	15.53	.	.	-0.9	11.3	.
31.6	176.0	0.45	15.59	.	.	+0.3	12.0	.
32.2	191.5	0.50	15.60	.	.	+0.7	12.6	.
32.5	209.5	0.55	15.56	.	.	0.8	12.7	.
32.5	212.0	0.60	15.49	.	.	0.9	12.7	.
32.4	220.0	0.65	15.40	.	.	1.0	12.5	.
32.0	227.0	0.70	15.30	.	.	0.8	12.1	.
31.6	234.0	0.75	15.21	.	.	0.8	11.6	.
31.0	240.0	0.80	15.11	.	.	0.7	11.0	.
30.4	243.5	0.85	14.98	.	.	0.5	10.3	.

REMARKS

BY	DATE	CHECKED	SHEET 3 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM TRIAXL	JOB NO.
COLORED CARDS	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
29.7	247.0	0.90	14.83			+0.2	9.5	
29.0	248.0	0.95	14.62			-0.3	8.8	
28.4	249.0	1.00	14.32			-0.5	8.4	
0.0	0.0	0.85	12.23			-4.2	0.1	

REMARKS

BY	DATE	CHECKED	SHEET 4 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
GREEN STRIP	PROBLEM	TRIAXL
	DETAIL	TRIAXIAL SHEAR TEST - ADP DATA SHEET 1
COLORED CARDS	FEATURE	San Luis Dam Cutoff Trench
	PROJECT	Central Valley

JOB NO. #

RETURN TO

ROOM BLDG. PHONE

NO. OF SPEC. FOR TAN Ø	DATE	PATH 1 OR 2 1/	TOTAL NO. OF SPEC. IN TEST	Punch Cards Required? Yes = 1 No = 0
4	10-15-64	2	4	0

SAMPLE NUMBER	SPEC. NO.	MACHINE NO.	TOTAL NO. OF READINGS ON SPEC.
36F-X673	20	3	15

INIT. WT. OF SPEC. + CONT. (GM)	INIT. WT. OF CONTAINER (GM)	INIT. WT. OF SPEC. + CONT. IN WATER (GM)	INIT. WT. LOSS OF CONTAINER (GM)
1263.40	746.17	896.90	111.10

FINAL WT. OF SPEC. + CONT. (GM)	FINAL WT. OF CONTAINER (GM)	FINAL WT. OF SPEC. + CONT. IN WATER (GM)	FINAL WT. LOSS OF CONTAINER (GM)
1263.40	746.15	900.02	111.18

WETTED WT. OF SPEC. + CONT. (GM)	WETTED WT. OF CONTAINER (GM)	WETTED WT. OF SPEC. + CONT. IN WATER (GM)	WETTED WT. LOSS OF CONTAINER (GM)
0.0	0.0	0.0	0.0

FINAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	DRY WT. OF TRIMMINGS (GM)
17.78	2.69	0.0

1/ PATH 1-LEAST SQUARES COMPUTATION ONLY
PATH 2-ENTIRE SHEAR TEST COMPUTATION

REMARKS

BY C.E.C. DATE CHECKED P.K. SHEET 1 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
GREEN STRIP	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 2	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

STRAIN RATE (IN. PER MIN.)	INITIAL TEMP. (°F)	FINAL TEMP. (°F)	WEIGHING CAPSULE FACTOR	SPEC. LENGTH AT TOUCH	TIME OF READING	
0.004	71.0	71.7	1.0	5.031	1100	
APPLIED AIR BACK PRESSURE (PSI)	**APPLIED WATER BACK PRESSURE (PSI)**	**BAROMETRIC PRESSURE (PSI)**	**1/ EFF. LATERAL PRESSURE**	**VOLUME TUBE READING AT TOUCH (DRAINED)**	**VOLUME TUBE NO. (LEFT, 1 RIGHT, 2)**	
0.0	0.0	12.2	-1.0	15.0	2	
DEVIATOR CORRECTION DUE TO LATERAL PRESSURE		**TEMP. CORR. COEFFICIENT**	**LOAD PISTON AREA FACTOR**	**DRAINAGE TUBE FACTOR**	**INITIAL VOLUME TUBE READING**	**SOIL 2/ VOLUME 1 OR 3**
0.4456	0.0	0.0379	0.4394	0.0259	5.0	1

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)

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

REMARKS

BY	DATE	CHECKED	SHEET 2 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE	PROBLEM TRIAXL	JOB NO.
BUFF	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
0.0	0.0	0.0	5.00			-5.0	0.0	
6.2	1.0	0.0	5.81			-4.5	1.4	
6.2	1.0	0.0	5.89			-4.8	1.2	
-6.2	2.1	0.223	5.40			-5.2	1.2	
6.2	38.0	0.25	15.03			-5.2	1.2	
6.4	80.0	0.30	15.09			-5.5	1.5	
6.6	106.0	0.35	15.09			-5.5	1.6	
6.8	125.0	0.40	15.05			-5.4	1.8	
6.9	140.0	0.45	14.96			-5.4	1.9	
6.9	149.0	0.50	14.84			-5.3	1.9	
6.8	157.0	0.55	14.71			-5.3	1.8	
6.7	162.0	0.60	14.54			-5.4	1.6	
6.4	162.0	0.65	14.32			-5.5	1.3	
6.1	162.0	0.70	14.09			-5.6	0.9	
0.0	0.0	0.60	14.52			-2.5	-0.1	

REMARKS

BY	DATE	CHECKED	SHEET 3 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE	PROBLEM TRIAXL	JOB NO.
GREEN STRIP	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 1	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

NO. OF SPEC. FOR TAN Ø	DATE	PATH 1 OR 2 1/	TOTAL NO. OF SPEC. IN TEST	Punch Cards Required? Yes = 1 No = 0
4	10-19-64	2	4	0

SAMPLE NUMBER	SPEC. NO.	MACHINE NO.	TOTAL NO. OF READINGS ON SPEC.
36F-X673	40	3	17

INIT. WT. OF SPEC. + CONT. (GM)	INIT. WT. OF CONTAINER (GM)	INIT. WT. OF SPEC. + CONT. IN WATER (GM)	INIT. WT. LOSS OF CONTAINER (GM)
1270.10	746.16	903.30	1111.09
FINAL WT. OF SPEC. + CONT. (GM)	**FINAL WT. OF CONTAINER (GM)**	**FINAL WT. OF SPEC. + CONT. IN WATER (GM)**	**FINAL WT. LOSS OF CONTAINER (GM)**
1270.30	746.17	906.30	1111.15
WETTED WT. OF SPEC. + CONT. (GM)	**WETTED WT. OF CONTAINER (GM)**	**WETTED WT. OF SPEC. + CONT. IN WATER (GM)**	**WETTED WT. LOSS OF CONTAINER (GM)**
0.0	0.0	0.0	0.0
FINAL MOISTURE CONTENT (%)	**SPECIFIC GRAVITY**	**DRY WT. OF TRIMMINGS (GM)**	
18.04	2.69	0.0	

1/ PATH 1-LEAST SQUARES COMPUTATION ONLY
PATH 2-ENTIRE SHEAR TEST COMPUTATION

REMARKS

BY C.E.C.	DATE	CHECKED P.K.	SHEET 1 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
GREEN STRIP	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 2	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

STRAIN RATE (IN. PER MIN.)	INITIAL TEMP. (°F)	FINAL TEMP. (°F)	WEIGHING CAPSULE FACTOR	SPEC. LENGTH AT TOUCH	TIME OF READING
0.1004	67.8	71.0	1.0	5.030	1010
APPLIED AIR BACK PRESSURE (PSI)	**APPLIED WATER BACK PRESSURE (PSI)**	**BAROMETRIC PRESSURE (PSI)**	**1/ EFF. LATERAL PRESSURE**	**VOLUME TUBE READING AT TOUCH (DRAINED)**	**VOLUME TUBE NO. (LEFT, 1 RIGHT, 2)**
0.0	0.0	12.2	-1.0	15.0	2
DEVIATOR CORRECTION DUE TO LATERAL PRESSURE		**TEMP. CORR. COEFFICIENT**	**LOAD PISTON AREA FACTOR**	**DRAINAGE TUBE FACTOR**	**INITIAL VOLUME TUBE READING**	**SOIL 2/ VOLUME 1 OR 3**
0.4456	0.0	0.0379	0.4394	0.0259	5.0	1

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)

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

REMARKS

BY	DATE	CHECKED	SHEET 2 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE	PROBLEM TRIAXL	JOB NO.
BUFF	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
0.0	0.0	0.0	5.0			-4.2	0.0	
6.2	0.0	0.0	5.87			-4.2	1.6	
12.5	2.0	0.0	6.44			-4.2	2.6	
12.5	2.5	0.0	6.49			-4.8	2.2	
-12.5	4.8	0.226	5.97			-5.0	2.2	
12.5	34.5	0.25	15.00			-5.0	2.2	
13.4	81.0	0.30	15.11			-4.8	3.4	
14.1	113.5	0.35	15.15			-4.5	4.1	
14.5	137.0	0.40	15.10			-4.0	4.4	
14.7	156.0	0.45	15.00			-3.8	4.4	
14.7	171.0	0.50	14.89			-3.7	4.4	
14.6	182.0	0.55	14.77			-3.4	4.2	
14.2	189.0	0.60	14.60			-3.2	3.7	
13.7	193.0	0.65	14.41			-3.0	3.1	
13.1	195.0	0.70	14.20			-3.0	2.4	
12.4	196.0	0.75	13.96			-3.2	2.0	
0.0	0.0	0.65	13.36			-3.1	-0.4	

REMARKS

BY	DATE	CHECKED	SHEET 3 OF 3

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE GREEN STRIP COLORED CARDS		
PROBLEM	TRIAXL	JOB NO.
DETAIL	TRIAXIAL SHEAR TEST - ADP DATA SHEET 1	#
FEATURE		RETURN TO
PROJECT		ROOM BLDG. PHONE

NO. OF SPEC. FOR TAN Ø	DATE	PATH 1 OR 2 1/	TOTAL NO. OF SPEC. IN TEST	Punch Cards Required? Yes = 1 No = 0
4	10-21-64	2	4	0

SAMPLE NUMBER	SPEC. NO.	MACHINE NO.	TOTAL NO. OF READINGS ON SPEC.
36F-X673	50	3	26

INIT. WT. OF SPEC. + CONT. (GM)	INIT. WT. OF CONTAINER (GM)	INIT. WT. OF SPEC. + CONT. IN WATER (GM)	INIT. WT. LOSS OF CONTAINER (GM)
1269.90	746.14	902.50	111.07
FINAL WT. OF SPEC. + CONT. (GM)	FINAL WT. OF CONTAINER (GM)	FINAL WT. OF SPEC. + CONT. IN WATER (GM)	FINAL WT. LOSS OF CONTAINER (GM)
1270.20	746.25	905.30	111.18
WETTED WT. OF SPEC. + CONT. (GM)	WETTED WT. OF CONTAINER (GM)	WETTED WT. OF SPEC. + CONT. IN WATER (GM)	WETTED WT. LOSS OF CONTAINER (GM)
0.0	0.0	0.0	0.0
FINAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	DRY WT. OF TRIMMINGS (GM)	
17.90	2.69	0.0	

1/ PATH 1-LEAST SQUARES COMPUTATION ONLY
PATH 2-ENTIRE SHEAR TEST COMPUTATION

REMARKS

BY C.E.C.	DATE	CHECKED P.K.	SHEET 1 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
GREEN STRIP	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 2	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

STRAIN RATE (IN. PER MIN.)	INITIAL TEMP. (°F)	FINAL TEMP. (°F)	WEIGHING CAPSULE FACTOR	SPEC. LENGTH AT TOUCH	TIME OF READING
0.004	71.1	72.1	1.0	5.036	1030

APPLIED AIR BACK PRESSURE (PSI)	APPLIED WATER BACK PRESSURE (PSI)	BAROMETRIC PRESSURE (PSI)	1/ EFF. LATERAL PRESSURE	VOLUME TUBE READING AT TOUCH (DRAINED)	VOLUME TUBE NO. (LEFT, 1 RIGHT, 2)
10.0	10.0	12.2	-1.0	15.0	2

DEVIATOR CORRECTION DUE TO LATERAL PRESSURE		TEMP. CORR. COEFFICIENT	LOAD PISTON AREA FACTOR	DRAINAGE TUBE FACTOR	INITIAL VOLUME TUBE READING	SOIL 2/ VOLUME 1 OR 3
0.4456	10.0	0.0379	0.4394	0.0259	5.0	1

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)

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

REMARKS

BY	DATE	CHECKED	SHEET 2 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
0.0	0.0	0.0	5.0	.	.	-5.6	0.0	.
5.0	0.0	0.0	5.73	.	.	-5.3	1.3	.
10.0	0.0	0.0	6.21	.	.	-5.2	2.1	.
25.0	0.0	0.0	7.15	.	.	-4.7	4.5	.
40.0	0.0	0.0	7.92	.	.	-4.1	7.8	.
50.0	0.0	0.0	8.40	.	.	-3.6	10.0	.
50.0	0.0	0.0	8.49	.	.	-3.2	11.1	.
-50.0	22.7	0.218	8.00	.	.	-2.7	11.1	.
50.0	44.5	0.25	15.03	.	.	-2.7	11.1	.
51.2	87.5	0.30	15.16	.	.	-1.3	14.0	.
54.1	125.5	0.35	15.32	.	.	0.0	17.2	.
57.6	167.0	0.40	15.51	.	.	+5.7	21.3	.
62.1	201.5	0.45	15.69	.	.	13.0	26.4	.
66.7	232.0	0.50	15.83	.	.	17.0	31.1	.
71.1	257.0	0.55	15.92	.	.	18.8	35.2	.
75.0	280.0	0.60	15.98	.	.	21.6	38.8	.
78.7	297.0	0.65	15.98	.	.	24.6	40.7	.
81.7	311.0	0.70	15.99	.	.	28.0	44.4	.
83.9	322.0	0.75	15.95	.	.	31.4	46.2	.
85.4	330.0	0.80	15.91	.	.	33.8	47.4	.

REMARKS

BY	DATE	CHECKED	SHEET 3 OF 4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE	PROBLEM TRIAXL	JOB NO.
BUFF	DETAIL TRIAXIAL SHEAR TEST - ADP DATA SHEET 3	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

APP. LAT. PRES. READING (TOUCH VALUE MINUS)	DEVIATOR GAGE READING	AXIAL DIAL READING	VOLUME TUBE READING	DRAIN TUBE READING TUBE 1	DRAIN TUBE READING TUBE 2	TOP PLATE PORE PRESSURE READING	BOTTOM PLATE PORE PRESSURE READING	INSERT PORE PRESSURE READING
86.5	338.0	0.85	15.83			36.7	48.1	
87.1	345.0	0.90	15.75			38.2	48.4	
87.7	351.5	0.95	15.66			39.8	49.1	
88.0	354.5	1.00	15.57			40.3	48.9	
87.6	355.5	1.05	15.45			40.6	48.6	
0.0	0.0	0.95	11.38			-6.5	-0.7	

REMARKS

BY	DATE	CHECKED	SHEET 4 OF 4

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-14-64

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

PERCENT MOISTURE CONTENT INITIAL	PERCENT MOISTURE CONTENT FINAL	PERCENT AIR VOLUME INITIAL	SPECIFIC GRAVITY	VOID RATIO AT SATURATION	VA+H*VW PERCENT	PERCENT VOL CHANGE AT SATURATION
17.82	17.78	5.62	2.69	.4793	6.24	5.69

	SPECIMEN VOLUME CU.IN.	SPECIMEN VOLUME CC	DRY DENSITY PCF	DRY DENSITY GR/CC	VOID RATIO	DEGREE OF SATURATION
INITIAL	15.671	256.80	107.06	1.71	.5686	84.49
FINAL	15.451	253.19	108.59	1.74	.5466	87.70
WETTED	.000	.00	.00	.00	.0000	.00

PERCENT VOLUME CHANGE TOTAL	PERCENT VOLUME CHANGE DURING SHEAR	DEVIATOR STRESS PSI.	DEVIATOR STRESS KGSCM	PERCENT STRAIN	STRESS RATIO	PORE PRESSURE TOP PSI.	PORE PRESSURE TOP KGSCM	PORE PRESSURE BOTTOM PSI.	PORE PRESSURE BOTTOM KGSCM
.000	.000	.000	.000	.00	.000	-3.00	-.211	.00	.000
.981	.000	.000	.000	.00	.000	-3.70	-.260	1.40	.099
1.524	.000	.000	.000	.00	.000	-4.00	-.281	2.10	.148
2.555	.000	.000	.000	.00	.000	-3.50	-.246	4.90	.345
2.643	.000	.000	.000	.00	.000	-3.70	-.260	5.50	.387
2.659	.000	.000	.000	.00	.000	-3.90	-.274	5.30	.373
2.669	.000	.000	.000	.00	.000	-4.00	-.281	5.20	.366
2.706	.039	5.862	.412	.24	.296	-4.00	-.281	5.20	.366
3.078	.420	26.319	1.852	1.24	1.400	-3.90	-.274	7.70	.542
3.423	.775	38.613	2.717	2.23	2.032	-3.40	-.239	9.80	.690
3.682	1.041	44.092	3.102	3.23	2.296	-.90	-.063	11.30	.795
3.879	1.244	51.640	3.633	4.23	2.635	.30	.021	12.00	.844
4.025	1.394	55.995	3.940	5.22	2.857	.70	.049	12.60	.887
4.116	1.487	58.235	4.097	6.22	2.941	.80	.056	12.70	.894
4.176	1.549	61.216	4.307	7.22	3.092	.90	.063	12.70	.894
4.214	1.588	63.050	4.436	8.21	3.168	1.00	.070	12.50	.879
4.245	1.620	64.563	4.543	9.21	3.244	.80	.056	12.10	.851
4.288	1.664	66.039	4.646	10.21	3.302	.80	.056	11.60	.816
4.322	1.699	67.191	4.727	11.20	3.360	.70	.049	11.00	.774
4.321	1.697	67.542	4.752	12.20	3.360	.50	.035	10.30	.725
4.297	1.673	67.865	4.775	13.20	3.360	.20	.014	9.50	.668
4.201	1.574	67.395	4.742	14.19	3.336	-.30	-.021	8.80	.619
3.994	1.362	66.827	4.702	15.19	3.341	-.50	-.035	8.40	.591
1.601	-1.097	.000	.000	12.20	.000	-4.20	-.296	.10	.007

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-14-64

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

LATERAL PRESSURE APPLIED PSI.	LATERAL PRESSURE APPLIED KGSCM	LATERAL PRESSURE EFFECTIVE PSI.	LATERAL PRESSURE EFFECTIVE KGSCM	SPECIMEN VOLUME AT ANY POINT CU.IN.	SPECIMEN VOLUME AT ANY POINT CC	ANGLE IN DEGREES	COMPUTE PORE PRESSURE PSI.	COMPUTE PORE PRESSURE KGSCM	DENSITY PCF.	DENSITY GR/CC	VOID RATIO
.00	.000	.00	.000	15.671	256.80	.000	.00	.000	107.06	1.715	.5686
5.00	.352	3.60	.253	15.517	254.28	.000	2.28	.160	108.12	1.732	.5532
10.00	.704	7.90	.556	15.432	252.89	.000	3.95	.278	108.72	1.742	.5447
25.00	1.759	20.10	1.414	15.271	250.24	.000	8.47	.596	109.87	1.760	.5285
25.00	1.759	19.50	1.372	15.257	250.01	.000	8.98	.632	109.97	1.762	.5271
25.00	1.759	19.70	1.386	15.254	249.97	.000	9.07	.638	109.99	1.762	.5269
25.00	1.759	19.80	1.393	15.253	249.95	.000	9.13	.642	110.00	1.762	.5267
25.00	1.759	19.80	1.393	15.247	249.85	87.663	9.36	.658	110.04	1.763	.5261
26.50	1.864	18.80	1.323	15.189	248.90	87.210	11.89	.836	110.46	1.769	.5203
28.80	2.026	19.00	1.337	15.135	248.01	85.365	14.84	1.044	110.86	1.776	.5149
30.50	2.146	19.20	1.351	15.094	247.35	79.689	17.59	1.237	111.15	1.781	.5108
31.60	2.223	19.60	1.379	15.063	246.84	82.477	20.08	1.413	111.38	1.784	.5078
32.20	2.266	19.60	1.379	15.040	246.46	77.108	22.22	1.563	111.55	1.787	.5055
32.50	2.287	19.80	1.393	15.026	246.23	66.004	23.69	1.667	111.66	1.789	.5040
32.50	2.287	19.80	1.393	15.016	246.08	71.512	24.74	1.741	111.73	1.790	.5031
32.40	2.280	19.90	1.400	15.011	245.98	61.470	25.43	1.789	111.77	1.790	.5025
32.00	2.251	19.90	1.400	15.006	245.90	56.638	26.02	1.830	111.81	1.791	.5020
31.60	2.223	20.00	1.407	14.999	245.79	55.956	26.86	1.890	111.86	1.792	.5013
31.00	2.181	20.00	1.407	14.994	245.70	49.136	27.56	1.939	111.90	1.792	.5008
30.40	2.139	20.10	1.414	14.994	245.70	19.405	27.53	1.937	111.90	1.792	.5008
29.70	2.090	20.20	1.421	14.998	245.77	17.959	27.04	1.902	111.87	1.792	.5012
29.00	2.040	20.20	1.421	15.013	246.01	-25.273	25.18	1.772	111.76	1.790	.5027
28.40	1.998	20.00	1.407	15.045	246.54	-29.665	21.74	1.530	111.52	1.786	.5059
.00	.000	-.10	-.007	15.420	252.69	87.438	4.21	.297	108.80	1.743	.5435

STRAIN RATE	TOTAL DRAINAGE
.004	.000

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-15-64

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	20	3

PERCENT MOISTURE CONTENT INITIAL	PERCENT MOISTURE CONTENT FINAL	PERCENT AIR VOLUME INITIAL	SPECIFIC GRAVITY	VOID RATIO AT SATURATION	VA+H*VW PERCENT	PERCENT VOL CHANGE AT SATURATION
17.78	17.78	5.66	2.69	.4782	6.27	5.72

	SPECIMEN VOLUME CU.IN.	SPECIMEN VOLUME CC	DRY DENSITY PCF	DRY DENSITY GR/CC	VOID RATIO	DEGREE OF SATURATION
INITIAL	15.621	255.98	107.11	1.72	.5679	84.39
FINAL	15.425	252.77	108.47	1.74	.5483	87.43
WETTED	.000	.00	.00	.00	.0000	.00

PERCENT VOLUME CHANGE TOTAL	PERCENT VOLUME CHANGE DURING SHEAR	DEVIATOR STRESS PSI.	DEVIATOR STRESS KGSCM	PERCENT STRAIN	STRESS RATIO	PORE PRESSURE TOP PSI.	PORE PRESSURE TOP KGSCM	PORE PRESSURE BOTTOM PSI.	PORE PRESSURE BOTTOM KGSCM
.000	.000	.000	.000	.00	.000	-5.00	-.352	.00	.000
.838	.000	.000	.000	.00	.000	-4.50	-.317	1.40	.099
.947	.000	.000	.000	.00	.000	-4.80	-.338	1.20	.084
.995	.000	.000	.000	.00	.000	-5.20	-.366	1.20	.084
1.119	.126	11.416	.803	.54	2.283	-5.20	-.366	1.20	.084
1.341	.350	24.799	1.745	1.53	5.061	-5.50	-.387	1.50	.106
1.490	.500	32.844	2.311	2.52	6.569	-5.50	-.387	1.60	.113
1.591	.602	38.514	2.710	3.52	7.703	-5.40	-.380	1.80	.127
1.633	.645	42.809	3.012	4.51	8.562	-5.40	-.380	1.90	.134
1.641	.653	45.152	3.177	5.51	9.030	-5.30	-.373	1.90	.134
1.639	.650	47.138	3.317	6.50	9.428	-5.30	-.373	1.80	.127
1.588	.599	48.141	3.387	7.49	9.439	-5.40	-.380	1.60	.113
1.480	.490	47.611	3.350	8.49	9.336	-5.50	-.387	1.30	.091
1.360	.369	47.077	3.312	9.48	9.053	-5.60	-.394	.90	.063
1.761	.774	.000	.000	7.49	.000	-2.50	-.176	-.10	-.007

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-15-64

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	20	3

LATERAL PRESSURE APPLIED PSI.	LATERAL PRESSURE APPLIED KGSCM	LATERAL PRESSURE EFFECTIVE PSI.	LATERAL PRESSURE EFFECTIVE KGSCM	SPECIMEN VOLUME AT ANY POINT CU.IN.	SPECIMEN VOLUME AT ANY POINT CC	ANGLE IN DEGREES	COMPUTE PORE PRESSURE PSI.	COMPUTE PORE PRESSURE KGSCM	DENSITY PCF.	DENSITY GR/CC	VOID RATIO
.00	.000	.00	.000	15.621	255.98	.000	.00	.000	107.11	1.716	.5679
6.20	.436	4.80	.338	15.490	253.83	.000	1.88	.133	108.01	1.730	.5548
6.20	.436	5.00	.352	15.473	253.55	.000	2.17	.153	108.13	1.732	.5531
6.20	.436	5.00	.352	15.465	253.43	.000	2.30	.162	108.19	1.733	.5523
6.20	.436	5.00	.352	15.446	253.11	87.308	2.65	.187	108.32	1.735	.5504
6.40	.450	4.90	.345	15.411	252.55	85.753	3.32	.234	108.56	1.739	.5469
6.60	.464	5.00	.352	15.388	252.16	82.957	3.81	.268	108.73	1.742	.5445
6.80	.478	5.00	.352	15.372	251.91	80.058	4.15	.292	108.84	1.743	.5430
6.90	.485	5.00	.352	15.366	251.80	76.973	4.30	.303	108.89	1.744	.5423
6.90	.485	5.00	.352	15.364	251.78	67.011	4.33	.305	108.90	1.744	.5422
6.80	.478	5.00	.352	15.365	251.78	63.425	4.32	.304	108.89	1.744	.5422
6.70	.471	5.10	.359	15.373	251.91	45.236	4.14	.291	108.84	1.743	.5430
6.40	.450	5.10	.359	15.390	252.19	-28.038	3.77	.265	108.72	1.742	.5447
6.10	.429	5.20	.366	15.408	252.50	-28.283	3.38	.238	108.59	1.739	.5466
.00	.000	.10	.007	15.346	251.47	87.582	4.77	.335	109.03	1.746	.5403

STRAIN RATE	TOTAL DRAINAGE
.004	.000

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-19-64

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

PERCENT MOISTURE CONTENT INITIAL	PERCENT MOISTURE CONTENT FINAL	PERCENT AIR VOLUME INITIAL	SPECIFIC GRAVITY	VOID RATIO AT SATURATION	VA+H*VW PERCENT	PERCENT VOL CHANGE AT SATURATION
18.00	18.04	4.34	2.69	.4841	4.97	4.41

	SPECIMEN VOLUME CU.IN.	SPECIMEN VOLUME CC	DRY DENSITY PCF	DRY DENSITY GR/CC	VOID RATIO	DEGREE OF SATURATION
INITIAL	15.640	256.29	108.16	1.73	.5526	87.80
FINAL	15.465	253.42	109.39	1.75	.5353	90.87
WETTED	.000	.00	.00	.00	.0000	.00

PERCENT VOLUME CHANGE TOTAL	PERCENT VOLUME CHANGE DURING SHEAR	DEVIATOR STRESS PSI.	DEVIATOR STRESS KGSCM	PERCENT STRAIN	STRESS RATIO	PORE PRESSURE TOP PSI.	PORE PRESSURE TOP KGSCM	PORE PRESSURE BOTTOM PSI.	PORE PRESSURE BOTTOM KGSCM
.000	.000	.000	.000	.00	.000	-4.20	-.296	.00	.000
.946	.000	.000	.000	.00	.000	-4.20	-.296	1.60	.113
1.572	.000	.000	.000	.00	.000	-4.20	-.296	2.60	.183
1.681	.000	.000	.000	.00	.000	-4.80	-.338	2.20	.155
1.737	.000	.000	.000	.00	.000	-5.00	-.352	2.20	.155
1.853	.118	9.435	.664	.48	.916	-5.00	-.352	2.20	.155
2.159	.429	24.300	1.710	1.47	2.430	-4.80	-.338	3.40	.239
2.384	.658	34.454	2.424	2.47	3.445	-4.50	-.317	4.10	.288
2.505	.782	41.573	2.925	3.46	4.116	-4.00	-.281	4.40	.310
2.570	.848	47.136	3.316	4.45	4.576	-3.80	-.267	4.40	.310
2.626	.905	51.357	3.613	5.45	4.986	-3.70	-.260	4.40	.310
2.672	.952	54.256	3.817	6.44	5.217	-3.40	-.239	4.20	.296
2.663	.942	55.870	3.931	7.44	5.321	-3.20	-.225	3.70	.260
2.631	.910	56.529	3.977	8.43	5.333	-3.00	-.211	3.10	.218
2.577	.855	56.563	3.980	9.42	5.286	-3.00	-.211	2.40	.169
2.489	.766	56.279	3.960	10.42	5.411	-3.20	-.225	2.00	.141
1.793	.057	.000	.000	8.43	.000	-3.10	-.218	-.40	-.028

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-19-64

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

LATERAL PRESSURE APPLIED PSI.	LATERAL PRESSURE APPLIED KGSCM	LATERAL PRESSURE EFFECTIVE PSI.	LATERAL PRESSURE EFFECTIVE KGSCM	SPECIMEN VOLUME AT ANY POINT CU.IN.	SPECIMEN VOLUME AT ANY POINT CC	ANGLE IN DEGREES	COMPUTE PORE PRESSURE PSI.	COMPUTE PORE PRESSURE KGSCM	DENSITY PCF.	DENSITY GR/CC	VOID RATIO
.00	.000	.00	.000	15.640	256.29	.000	.00	.000	108.16	1.733	.5526
6.20	.436	4.60	.324	15.492	253.86	.000	2.87	.202	109.20	1.749	.5379
12.50	.879	9.90	.697	15.394	252.26	.000	5.65	.398	109.89	1.760	.5282
12.50	.879	10.30	.725	15.377	251.98	.000	6.24	.439	110.01	1.762	.5265
12.50	.879	10.30	.725	15.368	251.84	.000	6.56	.462	110.08	1.763	.5257
12.50	.879	10.30	.725	15.350	251.54	87.105	7.26	.511	110.21	1.765	.5239
13.40	.943	10.00	.704	15.302	250.76	86.174	9.38	.660	110.55	1.771	.5191
14.10	.992	10.00	.704	15.267	250.18	84.409	11.26	.792	110.80	1.775	.5156
14.50	1.020	10.10	.711	15.248	249.87	82.051	12.42	.874	110.94	1.777	.5137
14.70	1.034	10.30	.725	15.238	249.70	79.870	13.08	.920	111.02	1.778	.5127
14.70	1.034	10.30	.725	15.229	249.56	76.748	13.69	.963	111.08	1.779	.5118
14.60	1.027	10.40	.732	15.222	249.44	71.071	14.21	1.000	111.13	1.780	.5111
14.20	.999	10.50	.739	15.223	249.46	58.371	14.10	.992	111.12	1.780	.5113
13.70	.964	10.60	.746	15.228	249.55	33.557	13.75	.967	111.09	1.779	.5118
13.10	.922	10.70	.753	15.237	249.68	1.923	13.16	.926	111.03	1.778	.5126
12.40	.872	10.40	.732	15.250	249.91	-15.935	12.26	.862	110.92	1.777	.5140
.00	.000	.40	.028	15.359	251.69	87.977	6.89	.485	110.14	1.764	.5248

STRAIN RATE	TOTAL DRAINAGE
.004	.000

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-21-64

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	50	3

PERCENT MOISTURE CONTENT INITIAL	PERCENT MOISTURE CONTENT FINAL	PERCENT AIR VOLUME INITIAL	SPECIFIC GRAVITY	VOID RATIO AT SATURATION	VA+H+VW PERCENT	PERCENT VOL CHANGE AT SATURATION
17.86	17.90	4.74	2.69	.4804	5.35	4.80

	SPECIMEN VOLUME CU.IN.	SPECIMEN VOLUME CC	DRY DENSITY PCF	DRY DENSITY GR/CC	VOID RATIO	DEGREE OF SATURATION
INITIAL	15.678	256.91	107.99	1.73	.5551	86.73
FINAL	15.518	254.30	109.10	1.75	.5392	89.50
WETTED	.000	.00	.00	.00	.0000	.00

PERCENT VOLUME CHANGE TOTAL	PERCENT VOLUME CHANGE DURING SHEAR	DEVIATOR STRESS PSI.	DEVIATOR STRESS KGSCM	PERCENT STRAIN	STRESS RATIO	PORE PRESSURE TOP PSI.	PORE PRESSURE TOP KGSCM	PORE PRESSURE BOTTOM PSI.	PORE PRESSURE BOTTOM KGSCM
.000	.000	.000	.000	.00	.000	-5.60	-.394	.00	.000
.758	.000	.000	.000	.00	.000	-5.30	-.373	1.30	.091
1.258	.000	.000	.000	.00	.000	-5.20	-.366	2.10	.148
2.137	.000	.000	.000	.00	.000	-4.70	-.331	4.50	.317
2.811	.000	.000	.000	.00	.000	-4.10	-.288	7.80	.549
3.224	.000	.000	.000	.00	.000	-3.60	-.253	10.00	.704
3.342	.000	.000	.000	.00	.000	-3.20	-.225	11.10	.781
3.372	.000	.000	.000	.00	.000	-2.70	-.190	11.10	.781
3.508	.140	7.350	.517	.64	.189	-2.70	-.190	11.10	.781
3.793	.435	21.246	1.495	1.63	.571	-1.30	-.091	14.00	.985
4.085	.737	33.067	2.327	2.62	.896	.00	.000	17.20	1.210
4.402	1.066	45.774	3.221	3.61	1.261	5.70	.401	21.30	1.499
4.690	1.364	55.886	3.932	4.61	1.565	13.00	.915	26.40	1.857
4.928	1.610	64.517	4.539	5.60	1.812	17.00	1.196	31.10	2.188
5.109	1.797	71.245	5.013	6.59	1.985	18.80	1.323	35.20	2.477
5.263	1.957	77.265	5.436	7.59	2.134	21.60	1.520	38.80	2.730
5.348	2.045	81.267	5.718	8.58	2.139	24.60	1.731	40.70	2.864
5.458	2.158	84.368	5.936	9.57	2.262	28.00	1.970	44.40	3.124
5.521	2.223	86.544	6.089	10.56	2.296	31.40	2.209	46.20	3.251
5.596	2.301	87.858	6.182	11.56	2.312	33.80	2.378	47.40	3.335
5.664	2.371	90.140	6.342	13.54	2.329	38.20	2.688	48.40	3.405
5.640	2.347	89.148	6.272	12.55	2.322	36.70	2.582	48.10	3.384
5.705	2.414	90.958	6.400	14.54	2.356	39.80	2.800	49.10	3.455
5.741	2.451	90.761	6.386	15.53	2.321	40.30	2.835	48.90	3.441
5.753	2.464	90.041	6.335	16.52	2.309	40.60	2.857	48.60	3.419
2.158	-1.257	.000	.000	14.54	.000	-6.50	-.457	-.70	-.049

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-21-64

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	50	3

LATERAL PRESSURE APPLIED PSI.	LATERAL PRESSURE APPLIED KGSCM	LATERAL PRESSURE EFFECTIVE PSI.	LATERAL PRESSURE EFFECTIVE KGSCM	SPECIMEN VOLUME AT ANY POINT CU.IN.	SPECIMEN VOLUME AT ANY POINT CC	ANGLE IN DEGREES	COMPUTE PORE PRESSURE PSI.	COMPUTE PORE PRESSURE KGSCM	DENSITY PCF.	DENSITY GR/CC	VOID RATIO
.00	.000	.00	.000	15.678	256.91	.000	.00	.000	107.99	1.730	.5551
5.00	.352	3.70	.260	15.559	254.96	.000	2.01	.141	108.82	1.743	.5433
10.00	.704	7.90	.556	15.480	253.68	.000	3.75	.264	109.37	1.752	.5355
25.00	1.759	20.50	1.442	15.343	251.42	.000	8.10	.570	110.35	1.768	.5218
40.00	2.814	32.20	2.266	15.237	249.69	.000	13.48	.949	111.12	1.780	.5114
50.00	3.518	40.00	2.814	15.172	248.63	.000	18.46	1.299	111.59	1.788	.5049
50.00	3.518	38.90	2.737	15.154	248.33	.000	20.26	1.425	111.73	1.790	.5031
50.00	3.518	38.90	2.737	15.149	248.25	.000	20.76	1.461	111.76	1.790	.5026
50.00	3.518	38.90	2.737	15.128	247.90	85.059	23.18	1.631	111.92	1.793	.5005
51.20	3.602	37.20	2.617	15.083	247.17	85.913	29.65	2.086	112.25	1.798	.4961
54.10	3.806	36.90	2.596	15.037	246.42	85.199	39.26	2.762	112.59	1.804	.4915
57.60	4.053	36.30	2.554	14.988	245.60	85.532	56.42	3.969	112.97	1.810	.4866
62.10	4.369	35.70	2.512	14.942	244.86	84.393	86.15	6.061	113.31	1.815	.4821
66.70	4.693	35.60	2.505	14.905	244.25	83.438	141.05	9.924	113.59	1.820	.4784
71.10	5.002	35.90	2.526	14.877	243.78	81.606	254.41	17.900	113.81	1.823	.4756
75.00	5.277	36.20	2.547	14.853	243.39	80.634	704.45	49.563	113.99	1.826	.4732
78.70	5.537	38.00	2.674	14.839	243.17	76.065	10859.05	764.022	114.09	1.828	.4719
81.70	5.748	37.30	2.624	14.822	242.89	72.247	-643.92	-45.305	114.23	1.830	.4702
83.90	5.903	37.70	2.653	14.812	242.73	65.477	-404.26	-28.443	114.30	1.831	.4692
85.40	6.009	38.00	2.674	14.800	242.53	52.926	-282.06	-19.845	114.39	1.832	.4680
87.10	6.128	38.70	2.723	14.790	242.36	48.971	-223.11	-15.698	114.48	1.834	.4670
86.50	6.086	38.40	2.702	14.793	242.42	44.977	-240.58	-16.927	114.45	1.833	.4674
87.70	6.170	38.60	2.716	14.783	242.26	42.348	-198.64	-13.976	114.53	1.835	.4664
88.00	6.192	39.10	2.751	14.778	242.16	-11.222	-181.16	-12.746	114.57	1.835	.4658
87.60	6.163	39.00	2.744	14.776	242.13	-35.940	-175.93	-12.378	114.59	1.835	.4656
.00	.000	.70	.049	15.339	251.37	88.737	8.24	.580	110.37	1.768	.5215

STRAIN RATE	TOTAL DRAINAGE
.004	.000

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-14-64
TEST

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

MAJOR PRINCIPAL EFFECTIVE STRESS BAR SIGMA 1		SHEAR STRESS ABSCISSA		NORMAL STRESS ORDINATE	
PSI	KGSQCM	PSI	KGSQCM	PSI	KGSQCM
.00	.000	.00	.000	.00	.000
3.60	.253	3.60	.253	.00	.000
7.90	.556	7.90	.556	.00	.000
20.10	1.414	20.10	1.414	.00	.000
19.50	1.372	19.50	1.372	.00	.000
19.70	1.386	19.70	1.386	.00	.000
19.80	1.393	19.80	1.393	.00	.000
25.66	1.806	19.80	1.393	.00	.000
45.12	3.174	21.07	1.483	3.40	.239
57.61	4.054	25.57	1.799	9.82	.691
63.29	4.453	29.43	2.070	15.28	1.075
71.24	5.012	33.76	2.375	21.16	1.489
75.60	5.319	36.88	2.595	25.83	1.817
78.03	5.490	39.75	2.797	29.82	2.098
81.02	5.700	41.83	2.943	32.93	2.317
82.95	5.836	43.80	3.081	35.71	2.513
84.46	5.943	45.03	3.169	37.56	2.643
86.04	6.054	46.09	3.243	38.99	2.744
87.19	6.135	46.77	3.290	40.00	2.814
87.64	6.166	47.27	3.326	40.61	2.857
88.07	6.196	48.08	3.383	41.66	2.931
87.59	6.163	47.77	3.361	41.20	2.899
86.83	6.109	48.13	3.386	42.04	2.958
-.10	-.007	27.97	1.968	41.95	2.951

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-15-64
TEST

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	20	3

MAJOR PRINCIPAL EFFECTIVE STRESS BAR SIGMA 1		SHEAR STRESS ABSCISSA		NORMAL STRESS ORDINATE	
PSI	KGSQCM	PSI	KGSQCM	PSI	KGSQCM
.00	.000	.00	.000	.00	.000
4.80	.338	4.80	.338	.00	.000
5.00	.352	5.00	.352	.00	.000
5.00	.352	5.00	.352	.00	.000
16.42	1.155	5.00	.352	.00	.000
29.70	2.090	4.90	.345	.00	.000
37.84	2.663	5.00	.352	.00	.000
43.51	3.062	5.00	.352	.00	.000
47.81	3.364	7.27	.512	3.40	.239
50.15	3.529	11.57	.814	9.82	.691
52.14	3.668	15.23	1.071	15.28	1.075
53.24	3.746	19.26	1.355	21.16	1.489
52.71	3.709	22.38	1.575	25.83	1.817
52.28	3.678	25.15	1.770	29.82	2.098
.10	.007	22.13	1.557	32.93	2.317

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-19-64
TEST

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

MAJOR PRINCIPAL EFFECTIVE STRESS BAR SIGMA 1		SHEAR STRESS ABSCISSA		NORMAL STRESS ORDINATE	
PSI	KGSQCM	PSI	KGSQCM	PSI	KGSQCM
.00	.000	.00	.000	.00	.000
4.60	.324	4.60	.324	.00	.000
9.90	.697	9.90	.697	.00	.000
10.30	.725	10.30	.725	.00	.000
10.30	.725	10.30	.725	.00	.000
19.73	1.389	10.30	.725	.00	.000
34.30	2.413	10.00	.704	.00	.000
44.45	3.128	10.00	.704	.00	.000
51.67	3.636	12.37	.871	3.40	.239
57.44	4.041	16.87	1.187	9.82	.691
61.66	4.338	20.53	1.444	15.28	1.075
64.66	4.549	24.56	1.728	21.16	1.489
66.37	4.670	27.78	1.955	25.83	1.817
67.13	4.723	30.55	2.150	29.82	2.098
67.26	4.732	32.73	2.303	32.93	2.317
66.68	4.691	34.30	2.413	35.71	2.513
.40	.028	25.53	1.797	37.56	2.643

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
10-21-64
TEST

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
36F-X673	50	3

MAJOR PRINCIPAL EFFECTIVE STRESS BAR SIGMA 1		SHEAR STRESS ABSCISSA		NORMAL STRESS ORDINATE	
PSI	KGSQCM	PSI	KGSQCM	PSI	KGSQCM
.00	.000	.00	.000	.00	.000
3.70	.260	3.70	.260	.00	.000
7.90	.556	7.90	.556	.00	.000
20.50	1.442	20.50	1.442	.00	.000
32.20	2.266	32.20	2.266	.00	.000
40.00	2.814	40.00	2.814	.00	.000
38.90	2.737	38.90	2.737	.00	.000
38.90	2.737	38.90	2.737	.00	.000
46.25	3.254	41.17	2.897	3.40	.239
58.45	4.112	43.77	3.080	9.82	.691
69.97	4.923	47.13	3.316	15.28	1.075
82.07	5.775	50.46	3.550	21.16	1.489
91.59	6.444	52.98	3.728	25.83	1.817
100.12	7.044	55.55	3.909	29.82	2.098
107.15	7.539	57.93	4.076	32.93	2.317
113.47	7.983	60.10	4.228	35.71	2.513
119.27	8.391	63.13	4.442	37.56	2.643
121.67	8.560	63.39	4.460	38.99	2.744
124.24	8.742	64.47	4.536	40.00	2.814
125.86	8.855	65.17	4.585	40.61	2.857
128.84	9.065	66.58	4.684	41.66	2.931
127.55	8.974	65.97	4.642	41.20	2.899
129.56	9.115	66.73	4.695	42.04	2.958
129.86	9.137	67.17	4.726	41.95	2.951
129.04	9.079	66.85	4.703	41.62	2.928
.70	.049	.70	.049	.00	.000

COHESION		TANGENT	ANGLE PHI	
PSI.	KGSCM	PHI	DEG.	MIN.
14.26	1.006	.41263	22	25.4

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE YELLOW STRIP COLORED CARDS	PROBLEM TRIAXL	JOB NO.
	DETAIL TRIAXIAL SHEAR TEST - LEAST SQUARES METHOD	#
	FEATURE Glen Elder Dam	RETURN TO
	PROJECT Missouri River Basin	ROOM BLDG. PHONE

NO. OF SPEC. IN TEST	DATE	PATH 1--LEAST SQUARES 2--ENTIRE SHEAR TEST
3	4-15-64	1

SAMPLE NUMBER	MACHINE NO.
18C-X330	3

MAX. DEVIATOR STRESS ($\sigma_1 - \sigma_3$)	EFF. LAT. ($\bar{\sigma}_3$)
126.41	42.8
90.31	23.9
46.31	0.0

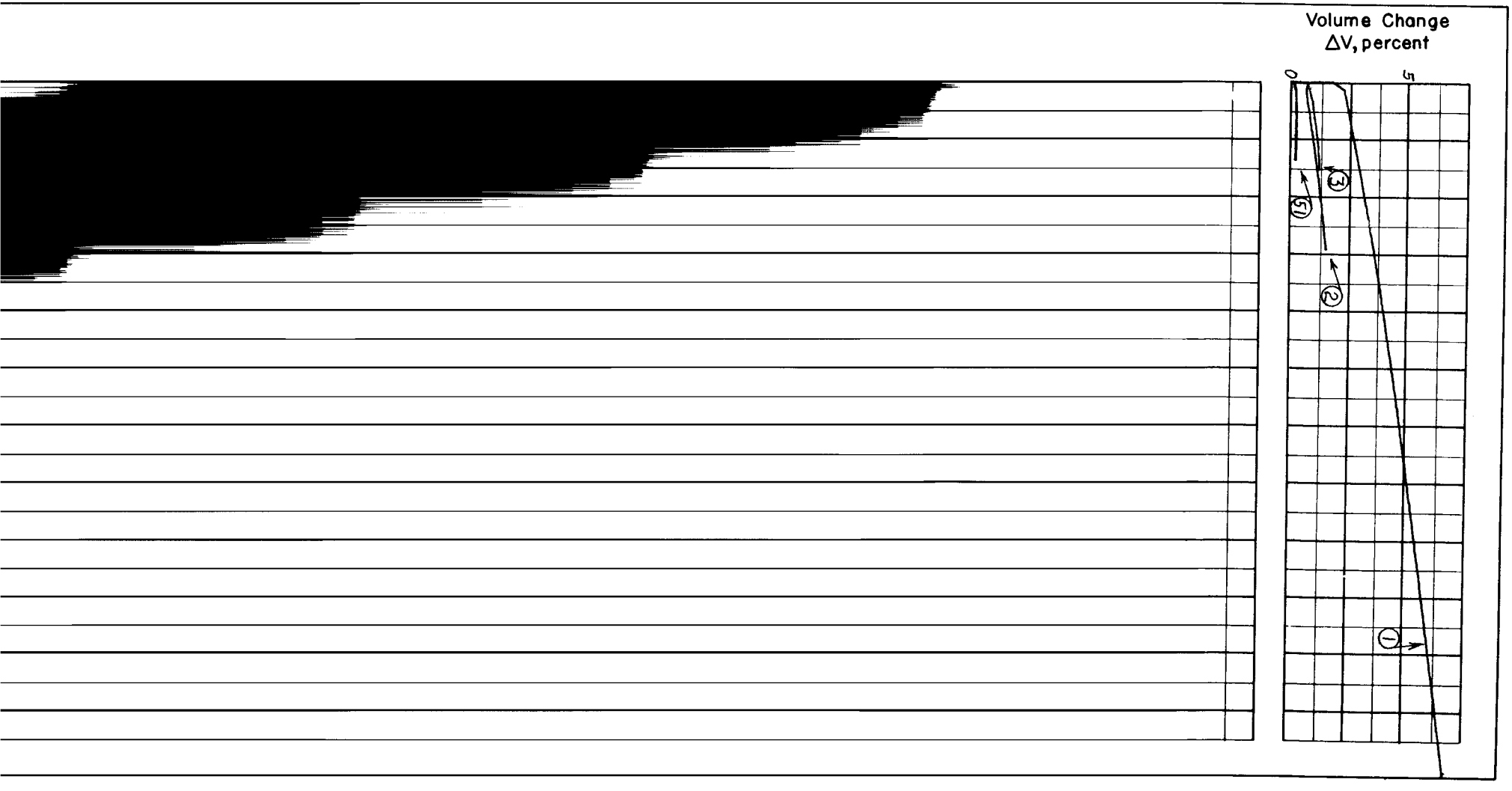
REMARKS

BY C.E.C.	DATE	CHECKED P.K.	SHEET 1 OF 1

SOILS ENGINEERING BRANCH
TRIAXIAL SHEAR TEST RESULTS
4-15-64
TEST

SAMPLE NUMBER	SPECIMEN NUMBER	MACHINE NUMBER
18C-X330	0	3

COHESION PSI.	COHESION KGSCM	TANGENT PHI	ANGLE PHI DEG.	ANGLE PHI MIN.
13.60	.960	.55196	28	53.8


Volume Change
ΔV, percent
0
5
1
2
3
5

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD

USE GREEN STRIP COLORED CARDS	
PROBLEM	CONONE
DETAIL	ONE-DIMENSIONAL CONSOLIDATION TEST DATA
FEATURE	Spangler Dam
PROJECT	Mann Creek
JOB NO.	#
RETURN TO	
ROOM	BLDG. PHONE

SAMPLE NO.	SPECIMEN NO.	SPECIMEN TYPE	CONTAINER NO.	LOADING UNIT NO.	DATE PLACED	CONTAINER HEIGHT (IN.)	CONTAINER DIAMETER (IN.)	SPECIFIC GRAVITY
5K-101	1	REMOLDED	346	346	10-30-64	1.25	14.25	12.65

WT. OF SPEC. RING, COVER PLATES AND WET SOIL (GM.)	WT. OF SPEC. RING AND COVER PLATES (GM.)	DIAL READING WITH GAGE RING IN PLACE	DIAL READING WITH SEATING LOAD ON SPEC.	DATE OUT	CONTAINER NO. W_e	CONTAINER NO. **
2021.80	1423.10	0.1865	0.1855	11-12-64	RP-2	CL-180

WET WT. OF SPEC. + CONT. W_e (GMS.)	DRY WT. OF SPEC. + CONT. W_e (GMS.)	WT. OF CONT W_e (GMS.)	WT. OF CONT. ** (GMS.)	DRY WT. OF SPEC. + CONT. ** (GMS.)
754.20	686.50	181.85	176.50	219.58

TOTAL NO. OF LOADS	LOAD NO. FOR EXPANDED CONDITIONS	NO. OF PERMEABILITY TESTS PERFORMED
10	10	1

REMARKS

BY A. B. | DATE | CHECKED P. K. | SHEET 1 OF

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

LOAD (PSI.)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
0.35	1	0.10

ELAPSED TIME IN SECONDS	DIAL READING
4	0.11855

SAMPLE NO.

GAGE

BEAM

UNIT

REMARKS

BY	DATE	CHECKED	SHEET 2 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
1.0	2	0.10005

ELAPSED TIME IN SECONDS	DIAL READING
4	0.1862
716680	0.1863

SAMPLE NO.

GAGE

BEAM

UNIT

REMARKS

BY | DATE | CHECKED | SHEET 3 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS		
PROBLEM CONONE		JOB NO.
DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA		#
FEATURE		RETURN TO
PROJECT		ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
6.2	13	0.00034

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL RD'G.	HRS	MIN	SEC
4	0.1898			
10	0.1899			
20	0.1899			
40	0.1899			
80	0.1899		1	20
200	0.1899		3	20
400	0.1899		6	40
800	0.1900		13	20
2000	0.1900		33	20
4000	0.1900	1	6	40
8000	0.1900	2	13	20
20000	0.1900	5	33	20
~~86400~~	~~0.~~	24	00	00
172800	0.1901			

REMARKS

BY	DATE	CHECKED	SHEET 4 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
12.5	13	0.0057

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL RD'G.	HRS	MIN	SEC
4	0.1922			
10	0.1923			
20	0.1923			
40	0.1923			
80	0.1923		1	20
200	0.1924		3	20
400	0.1924		6	40
800	0.1924		13	20
2000	0.1924		33	20
4000	0.1924	1	6	40
8000	0.1924	2	13	20
20000	0.1924	5	33	20
86400	0.1925	24	00	00

REMARKS

BY	DATE	CHECKED	SHEET 5 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS		
PROBLEM	CONONE	JOB NO.
DETAIL	ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
FEATURE		RETURN TO
PROJECT		ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
25.0	13	0.0086

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL RD'G.	HRS	MIN	SEC
4	0.1942			
10	0.1943			
20	0.1944			
40	0.1944			
80	0.1944		1	20
200	0.1944		3	20
400	0.1944		6	40
800	0.1944		13	20
2000	0.1945		33	20
4000	0.1945	1	6	40
8000	0.1945	2	13	20
20000	0.1946	5	33	20
86400	0.1947	24	00	00

REMARKS

BY	DATE	CHECKED	SHEET 6 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS		
PROBLEM	CONONE	JOB NO.
DETAIL	ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
FEATURE		RETURN TO
PROJECT		ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
510.0	13	0.0106

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL RD'G.	HRS	MIN	SEC
4	0.1970			
10	0.1971			
20	0.1971			
40	0.1971			
80	0.1971		1	20
200	0.1972		3	20
400	0.1972		6	40
800	0.1972		13	20
2000	0.1973		33	20
4000	0.1973	1	6	40
8000	0.1973	2	13	20
20000	0.1973	5	33	20
86400	0.1974	24	00	00

REMARKS

BY | DATE | CHECKED | SHEET 7 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATIO': TEST DATA	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
100.0	13	0.0135

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL RD'G.	HRS	MIN	SEC
4	0.12007			
10	0.12008			
20	0.12009			
40	0.12009			
80	0.12010		1	20
200	0.12010		3	20
400	0.12010		6.	40
800	0.12011		13	20
2000	0.12011		33	20
4000	0.12012	1	6	40
8000	0.12012	2	13	20
20000	0.12012	5	33	20
86400	0.12014	24	00	00

REMARKS

BY	DATE	CHECKED	SHEET 8 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
100.0	3	0.0135

SAMPLE NO.

GAGE

BEAM

UNIT

ELAPSED TIME IN SECONDS	DIAL READING
86404	0.12014
172800	0.12015
315600	0.12016

REMARKS

BY | DATE | CHECKED | SHEET 9 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE		
BUFF	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
COLORED CARDS	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

LOAD (PSI)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
1.0	2	0.00400

ELAPSED TIME IN SECONDS	DIAL READING
4	0.11897
86400	0.11885

SAMPLE NO.

GAGE

BEAM

UNIT

REMARKS

BY | DATE | CHECKED | SHEET 10 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE BUFF COLORED CARDS	PROBLEM CONONE	JOB NO.
	DETAIL ONE-DIMENSIONAL CONSOLIDATION TEST DATA	#
	FEATURE	RETURN TO
	PROJECT	ROOM BLDG. PHONE

LOAD (PSI.)	NO. OF DIAL READINGS	CORRECTION DUE TO DEFLECTION
0.35	2	0.00025

ELAPSED TIME IN SECONDS	DIAL READING
4	0.1860
172800	0.1852

SAMPLE NO.

GAGE

BEAM

UNIT

REMARKS

BY | DATE | CHECKED | SHEET 11 OF 12

BUREAU OF RECLAMATION

LABORATORY PUNCH CARD DATA

USE	PROBLEM	JOB NO.
Yellow Strip	DETAIL Falling Head Permeability Test	#
COLORED CARDS	FEATURE Spangler Dam	RETURN TO
	PROJECT Mann Creek	ROOM BLDG. PHONE

Sample No.	Loading Spec. No.	Loading Unit No.	Date	Specimen Diameter (in)	Specimen Length (in)
5K-101	1	346	11-9-64	4.25	1.2349

Initial Head (in)	Initial Tube Reading	Total No. of Tube Readings	Area of Standpipe (sq in)	Tube Constant
17.55	0.0	4	0.10075	0.5677

Elapsed Time (min)	Tube Readings
0.5	5.00
1.0	9.25
1.5	12.70
2.0	15.50

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

5K-101
LOAD = 0.35 PSI CONSOLIDATION = -0. PERCENT
DRY DENSITY = 115.64 PCF VOID RATIO = 0.4305

TIME IN SEC.	PERCENT CONS.
4.	-0.

5K-101
LOAD = 1.00 PSI CONSOLIDATION = 0.0240 PERCENT
DRY DENSITY = 115.67 PCF VOID RATIO = 0.4302

TIME IN SEC.	PERCENT CONS.
4.	0.016
76680.	0.024

5K-101
LOAD = 6.20 PSI CONSOLIDATION = 0.0959 PERCENT
DRY DENSITY = 115.75 PCF VOID RATIO = 0.4292

TIME IN SEC.	PERCENT CONS.
4.	0.072
10.	0.080
20.	0.080
40.	0.080
80.	0.080
200.	0.080
400.	0.080
800.	0.088
2000.	0.088
4000.	0.088
8000.	0.088
20000.	0.088
172800.	0.096

5K-101
LOAD = 12.50 PSI CONSOLIDATION = 0.1039 PERCENT
DRY DENSITY = 115.76 PCF VOID RATIO = 0.4291

TIME IN SEC.	PERCENT CONS.
4.	0.080
10.	0.088
20.	0.088
40.	0.088
80.	0.088

200.	0.096
400.	0.096
800.	0.096
2000.	0.096
4000.	0.096
8000.	0.096
20000.	0.096
86400.	0.104

5K-101

LOAD = 25.00 PSI CONSOLIDATION = 0.0480 PERCENT

DRY DENSITY = 115.70 PCF VOID RATIO = 0.4299

TIME IN SEC.	PERCENT CONS.
4.	0.008
10.	0.016
20.	0.024
40.	0.024
80.	0.024
200.	0.024
400.	0.024
800.	0.024
2000.	0.032
4000.	0.032
8000.	0.032
20000.	0.040
86400.	0.048

5K-101

LOAD = 50.00 PSI CONSOLIDATION = 0.1039 PERCENT

DRY DENSITY = 115.76 PCF VOID RATIO = 0.4291

TIME IN SEC.	PERCENT CONS.
4.	0.072
10.	0.080
20.	0.080
40.	0.080
80.	0.080
200.	0.088
400.	0.088
800.	0.088
2000.	0.096
4000.	0.096
8000.	0.096
20000.	0.096
86400.	0.104

5K-101

LOAD = 100.00 PSI CONSOLIDATION = 0.1918 PERCENT

DRY DENSITY = 115.86 PCF VOID RATIO = 0.4278

TIME IN SEC.	PERCENT CONS.
4.	0.136
10.	0.144
20.	0.152

40.	0.152
80.	0.160
200.	0.160
400.	0.160
800.	0.168
2000.	0.168
4000.	0.176
8000.	0.176
20000.	0.176
86400.	0.192

5K-101
LOAD = 100.00 PSI CONSOLIDATION = 0.2078 PERCENT
DRY DENSITY = 115.88 PCF VOID RATIO = 0.4276

TIME IN SEC.	PERCENT CONS.
86404.	0.192
172800.	0.200
355600.	0.208

5K-101
LOAD = 1.00 PSI CONSOLIDATION = -0.0799 PERCENT
DRY DENSITY = 115.55 PCF VOID RATIO = 0.4317

TIME IN SEC.	PERCENT CONS.
4.	0.016
86400.	-0.080

5K-101
LOAD = 0.35 PSI CONSOLIDATION = -0.2238 PERCENT
DRY DENSITY = 115.38 PCF VOID RATIO = 0.4337

TIME IN SEC.	PERCENT CONS.
4.	-0.160
172800.	-0.224

LOAD		VOID RATIO	DRY DENSITY		CONSOLIDATION
PSI	KG/SQCM		PCF	GM/CC	PERCENT
0.35	0.025	0.43054	115.64	1.852	-0.
1.00	0.070	0.43020	115.67	1.853	0.02
6.20	0.436	0.42917	115.75	1.854	0.10
12.50	0.879	0.42906	115.76	1.854	0.10
25.00	1.758	0.42986	115.70	1.853	0.05
50.00	3.515	0.42906	115.76	1.854	0.10
100.00	7.031	0.42780	115.86	1.856	0.19
100.00	7.031	0.42757	115.88	1.856	0.21
1.00	0.070	0.43169	115.55	1.851	-0.08
0.35	0.025	0.43374	115.38	1.848	-0.22

REBOUND = 207.69 PERCENT

	INITIAL	MAX LOAD	EXPANDED
DRY DENSITY	115.642	115.883	115.384

MOISTURE CONTENT	11.132	13.182	13.415
DEGREE OF SATURATION	68.516	81.701	81.962
DEGREE OF SATURATION CK	68.516	81.701	81.962

FALLING HEAD PERMEABILITY TEST

SAMPLE NO. 5K-101 SPECIMEN NO. 1

DATE 11-09-64 LOADING UNIT NO. 346

PERMEABILITY		AVERAGE HYDRAULIC GRADIENT
FT/YR	CM/SEC	
144.6223	0.1403E-03	13.062
145.7312	0.1414E-03	12.086
144.5514	0.1402E-03	11.292
142.6197	0.1383E-03	10.649