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GEOTECHNICAL BRANCH COMPUTER PROGRAMS: CON1D, CON1DP, AND CONPLOT

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Program CON1D analyzes standard one-dimensional consolidation or expansion test data. Data reduction analysis calculates axial strain as a function of dial reading changes. Specimen phase relationships, void ratio, moisture content, etc., are computed at the steady-state condition of every loading. Consolidation data can be further analyzed using automation of manual graphic techniques to determine pressure dependent settlement parameters; i.e., preconsolidation pressure and in situ compression index, and to determine time-dependent consolidation parameters, coefficient of consolidation, and permeability. Data input conforms to Bureau of Reclamation ADP sheets EL-548 and EL-550. Associated programs are CON1DP (a procedure file to execute CON1D) and CONPLOT (the plotting program).

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GEOTECHNICAL BRANCH COMPUTER PROGRAMS: CON1D, CON1DP AND CONPLOT

CONSOLIDATION, EXPANSION, OR UPLIFT TESTS FOR STANDARD ONE-DIMENSIONAL CONSOLIDATION TEST DATA

by

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Denver, Colorado

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June 1987

UNITED STATES DEPARTMENT OF THE INTERIOR ★ BUREAU OF RECLAMATION

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

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INTRODUCTION

The settlement of structures founded on compressible soil strata was a problem that baffled builders for centuries. It was not until the early 1920's when Karl Terzaghi proposed a theory relating pressure, volume change, and time to the water-soil structure interaction that the settlement process with its associated problems was clarified. When a load is applied to a saturated, compressible soil mass, the load is carried by the water in the pores because of the relative incompressibility of the water. This load then produces an "excess" pressure in the water. If the water is allowed to drain from the pores, this excess pore pressure dissipates. The applied load is then supported by the soil structure itself, and in theory, any soil volume change is equal to the volume of displaced water. This process has become known as consolidation.

In the geotechnical soils laboratory, a standard consolidation test consists of a soil specimen confined by a ring to prevent lateral displacement with drainage of pore water provided through top and bottom porous end plates. This testing apparatus approximates the conditions of a compressible stratum in nature because the lateral confinement on the specimen forces minor (x and y axes) planar conditions analagous to the field. The specimen is further confined with porous end plates that cause the outflow of pore water to occur in the vertical direction only. When a sample is wetted, movement can occur along the vertical axis only. These forced conditions give rise to the nomenclature of one-dimensional expansion and one-dimensional consolidation as defined in Terzaghi's original consolidation theory.

CON1D is the primary computer program in this report. The evolution of the program spans more than a decade. In the 1960's with the advent of computer technology, a program (named CON) was developed by Bureau personnel to reduce the data from standard consolidation testing apparatus. In the 1970's and early 1980's, this program was refined and expanded to provide advanced consolidation analyses. The name was changed, and expansion and uplift analyses were incorporated to give one program to analyze any data from one-dimensional testing apparatus. This report deals with CON1D and its associated programs principally in view of the consolidation analysis capabilities. The expansion, uplift, and compression analyses have the same format as the consolidation data reduction analysis. Compression and consolidation are differentiated for consistency with respect to one-dimensional consolidation theory, i.e., specimen moisture content and permeability.

CON1DP is a CDC computer procedure file that controls the execution of the one-dimensional analyses with the appropriate control statements to run a small user interactive program (CONGO) that writes the necessary input for the analysis program, CON1D (and possibly a submit file batch control stream). CON1DP working with CON1D is a powerful soil mechanics analysis tool because it provides users with flexibility in choosing available input and output options. Its execution is explained in the user's guide, appendix D.

CON1D is a unique soils laboratory analysis computer program because it reduces standard one-dimensional consolidation or expansion test data into percent axial strain as a function of axial dial changes and it computes

the soil constitutive phase relationships for the specimen condition at the end of each testing pressure. Dual input parameters that implicitly define the specimen's dry weight and initial and final moisture contents allow one to minimize testing errors and obtain a more consistent phase relationship analysis. With the input of consolidation test data, CON1D has the capability to perform a set of two deformation analyses that consist of the automation of manual graphic constructions. By defining polynomial equations through data points using least squares numeric fitting techniques, CON1D can analytically manipulate polynomial curves "drawn" through the reduced data plot. The void ratio versus the log of pressure plot (e-log p plot) is analyzed to evaluate the past stress history of the specimen (its preconsolidation pressure). In situ compressibility or compression index plots of percent axial strain (or percent consolidation for a true one-dimensional consolidation test) versus the consolidating time for each testing pressure are then evaluated to determine the soil parameters defining the time rate of consolidation, i.e., coefficient of consolidation and soil permeability within the incremental range of testing pressures.

For an engineer to have confidence in CON1D's output, one needs to visually check the graphic constructions from the analytical curve fittings. Therefore, CON1D outputs a file that serves as input to CONPLOT, a peripheral support "DISSPLA" plotting program that plots all of CON1D's data reduction and deformation analyses results. The output from CONPLOT is produced in direct correlation with the type of test analyzed and, in the case of consolidation testing, this plotted output refines the complete analysis into a powerful analytical engineering tool. As with any tool, its improper usage can cause more harm than good, so an understanding of the capabilities and limitations of CON1D will avoid frustrations and produce valid results.

The capabilities of CON1D are implicitly demonstrated by viewing its output. A maximization of the program's potential arises out of an understanding of the input and output options available when executing the procedure CON1DP, see the user's guide in appendix D. For a consolidation deformation analysis, the polynomial curve boundary input data parameters provide one with the capability to obtain graphic solutions through precise analytics. On the other hand, analytical expressions that define curves through data points have inherent limitations due to lack of human judgment when dealing with limited data, sometimes of an irregular nature. CON1D's consolidation deformation analyses were developed using classical one-dimensional consolidation theory and, as such, the time-dependent deformation analysis is only valid for saturated fine-grained soils of low permeability. The consolidation deformation analysis is valid for all soil types, provided the degree of specimen disturbance is small. Coarse- and medium-grained sands subject to void ratio collapse when wetted should be tested at the in situ moisture content when one is trying to determine the maximum past pressure.

Altogether, the engineering documentation in section 2.0 will provide enough understanding of the capabilities and limitations of CON1D to enable one to exercise engineering judgment and obtain a sound consolidation or expansion analysis.

1.0 Program Identification

1.1 Program Title: Consolidation, expansion, or uplift tests for standard one-dimensional compression test data.

1.2 Program Code Names

		CONVERT	CONGO	CON1D	CONPLOT
Sources:	CON1DP	CONVERT	CONGOS	CON1DS	CONPLS
Binary:			CONGOB	CON1DB	CONPLB
Password:	STA	STA	STA	STA	STA

1.3 Author

Written by: Stephen N. Gavlick

1.4 Organization

Geotechnical Branch, Division of Research and Laboratory Services, Bureau of Reclamation, Department of the Interior (address: Geotechnical Branch, D-1540, Bureau of Reclamation, PO Box 25007, Denver, Colorado 80225).

1.5 Date

May 1, 1983
CON1DP User's Guide, March 10, 1983

1.6 Update

March 21, 1983
Version: 0

1.7 Source Language

FORTRAN Extended 4.8 [1]*
Fortran Extended is designed to comply with American National Standards Institute FORTRAN.

1.8 Availability

A complete listing of all associated programs is included in appendix A. Source card decks or magnetic stranger tape ASCII listings are available from the Bureau of Reclamation, address provided in section 1.4.

1.9 Abstract

Program CON1D analyzes standard one-dimensional consolidation or expansion test data. Data reduction analysis calculates axial strain as a function of dial reading changes. Specimen phase relationships, void ratio,

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* Numbers in brackets refer to entries in the bibliography.

moisture content, etc., are computed at the steady-state condition of every loading. Consolidation data can be further analyzed using automation of manual graphic techniques to determine pressure dependent settlement parameters, i.e., preconsolidation pressure and in situ compression index, and to determine time-dependent consolidation parameters, coefficient of consolidation and permeability. Data input conforms to Bureau of Reclamation ADP sheets EL-548 and EL-550. Associated programs are CON1DP (a procedure file to execute CON1D) and CONPLOT (the plotting program).

2.0 Engineering Documentation

2.1 Narrative Description

CON1D is a computerized mathematical algorithm which analyzes standard one-dimensional consolidation or expansion test data. This analysis consists of two major sections. The first part computes the percent vertical strain from seating pressure conditions as a function of axial dial reading changes for every time-dial reading input and the soil phase relationship conditions at the end of each testing pressure. These include specimen height, void ratio, dry density, moisture content, and degree of saturation. This section of CON1D's analysis is the consolidation or expansion test data reduction algorithm that transforms the raw laboratory data into meaningful soil mechanics data. An advanced feature of this data reduction analysis is CON1D's ability to accept either of two possible sets of input data that are used to compute the testing specimen's initial moisture content and total dry weight. A printed table of a comparison of critical specimen phase relations enables one to choose and possibly refine the best set of dry weight input data, thereby eliminating some testing errors and obtaining the most consistent analysis possible. This dual input is further discussed in the following sections. Depending on the type of test being analyzed or the depth of analysis, CON1D can then begin the second major section of its analysis, a pressure-dependent and a time-dependent set of consolidation (or settlement) analysis. Determined are the past stress history and compressibility of the soil specimen and the soil parameters relating consolidation with the time rate of compression. As stated in the introduction, the theory of one-dimensional consolidation was developed for a specific soil type. This restricts the time rate of consolidation analysis to being valid only for saturated soils of low permeability. The remainder of this narrative identifies the theory behind the deformation analyses available in CON1D.

In 1936, Arthur Casagrande [2] developed an empirical graphical technique to determine the maximum past pressure or preconsolidation pressure from the semilogarithmic stress void ratio curve, the logarithm of effective pressure as the abscissa. This method has come to be known as the "Casagrande construction." Figure 1 illustrates its essential features.

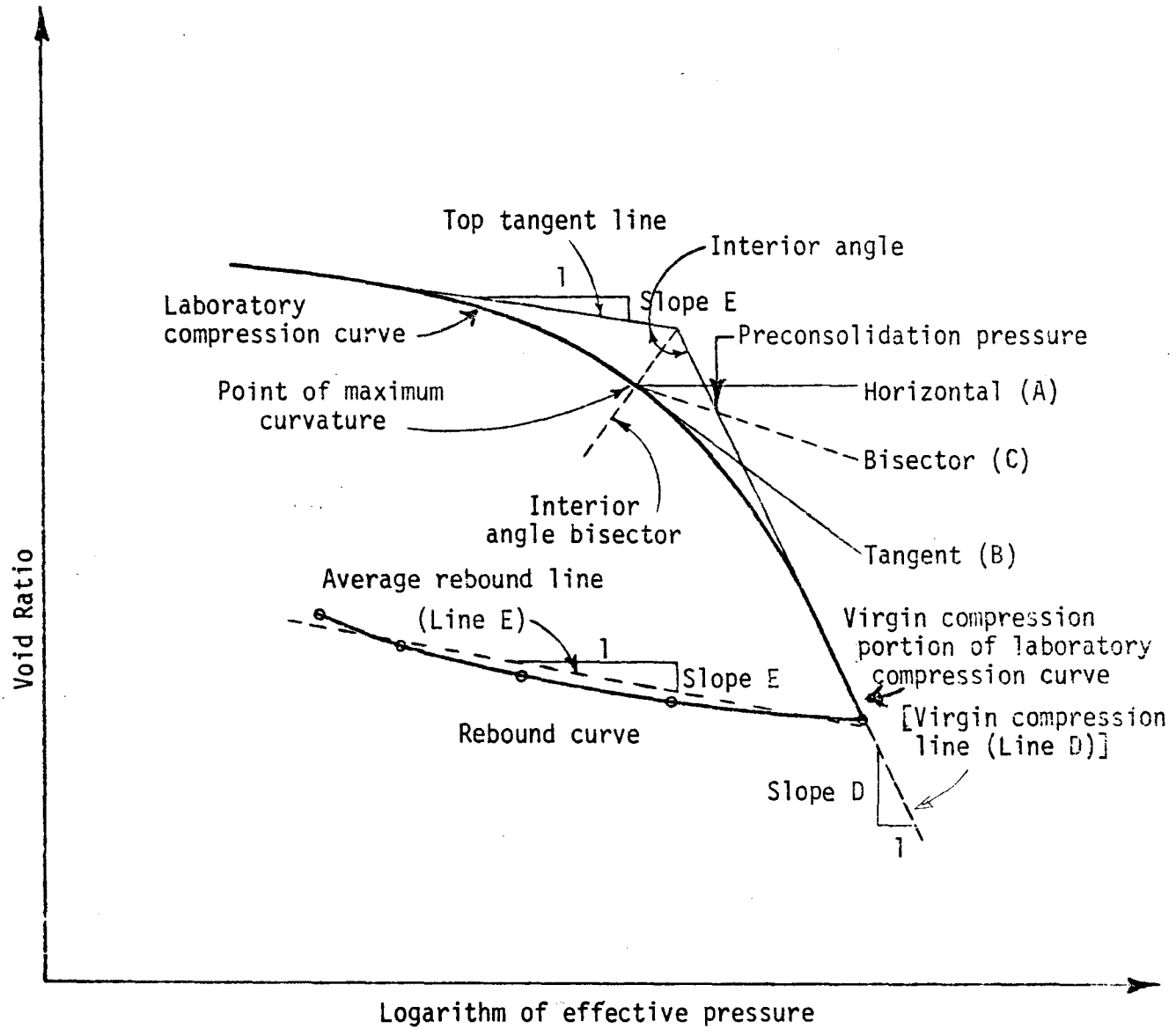


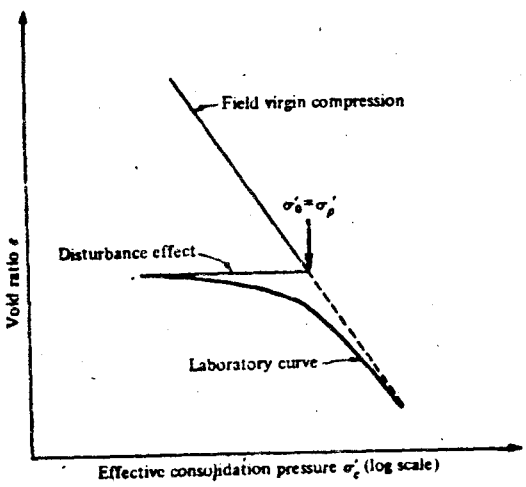
Figure 1. - Illustration of Casagrande's construction.

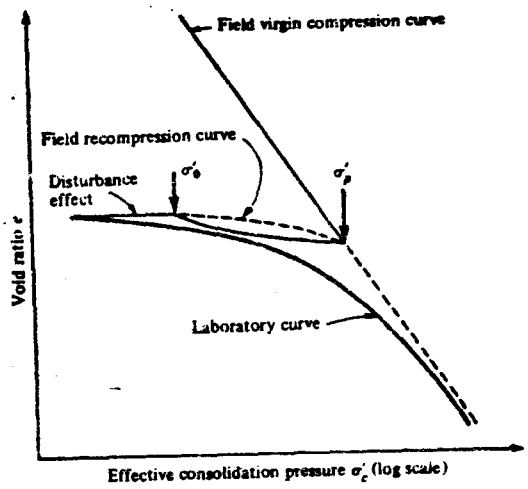
This figure demonstrates many of the graphical techniques used by CON1D in its pressure deformation analysis. The Casagrande construction is used to determine the most probable maximum past pressure at the ordinate where the virgin compression curve (line D) and the angle bisector line (line C) intersect. This line bisects the angle formed by a horizontal line (line A) and a line tangent to the laboratory compression curve (line B) with the tangency point or angle vertex of the point of maximum graphic curvature on the curve. The construction, laboratory virgin compression, and average rebound lines have been labeled as they are referred to in the program. The point of maximum curvature on the laboratory compression curve is located by the graphical method. The underlying idea behind this method is that a laboratory compression curve consists of two straight line segments which have a transitional curve between them. It is further

assumed that this transitional curve has its point of maximum curvature at the center of its variance from the straight line segments. Most laboratory compression curves will not follow the last assumption exactly, but the graphical method provides a rational analytically definable approach to defining the point of maximum curvature. As discussed later in section 2.2, this method also determines boundaries along the laboratory compression curve that serve to narrow the range for locating the point of maximum curvature by the analytical method (a more precise method but one that can lead to erroneous results usually in the initial portion of a curve with local irregularities).

The representation of the reduced laboratory data on the "e-log p" curve implies that steady-state consolidation conditions exist at the end of any pressure increment,that all hydrostatic stresses have dissipated, that the primary stage of settlement is complete, and that there is little appreciable change in the void ratio or axial dial readings with time. If the above conditions have not been reached, then all the consolidation deformation analyses of CON1D are of little use.

In order to predict settlements in the field, it is necessary to determine the relationship between the in situ void ratio and the effective vertical (overburden) stress. One of the effects of soil sampling is the reduction of effective overburden pressure. Along with other disturbance aspects, the observed laboratory compressibility is markedly altered from that in the field. Figures 2 and 3 illustrate the effect of sample disturbance on compressibility for a normal and overconsolidated clay [3]. One should be aware that within the normal pressure range of laboratory consolidation testing, the laboratory compression curve may not merge into the field compression curve.





The effect of sample disturbance on normally and overconsolidated clays

Figure 2. - Normally consolidated

Figure 3. - Overconsolidated

In 1955, Schmertmann [4] published an empirical graphic procedure which accounted for the effect of sample disturbance and which estimated the in situ compressibility or slope of the field virgin compression curve, the compression index C_c. He based his investigation on limited data restricted to saturated natural clays. This limitation in the scope of his empirical development warrants consideration with respect to CONID's output when dealing with soil conditions outside the range of Schmertmann's data.

Figure 4 illustrates the graphical constructions to determine the field virgin compression curve for a normally consolidated cohesive soil. The preconsolidation pressure is determined via the Casagrande construction. In this case, the in situ overburden pressure equals the preconsolidation pressure and the in situ void ratio is assumed to be the computed void ratio of the consolidation test at the seating pressure. Within the accuracy of the program, this assumption is valid unless the sample swells during storage. Schmertmann found that the field virgin compression curve intersected the laboratory compression curve (irrespective of the degree of sample disturbance) at a point on the curve where the void ratio equals 42 percent of the initial. Therefore, the field compression curve is drawn as a line on the semilog plot from the in situ void ratio and the preconsolidation pressure to the point on the laboratory curve at a void ratio of 42 percent of initial. The minimum possible preconsolidation pressure is located where the laboratory virgin compression curve intersects the in situ void ratio which remains unchanged by sampling disturbances.

The output from CONID's pressure deformation analysis consists of a range of values for the pressure-dependent settlement parameters. This range varies from the computed probable values to the minimum acceptable values still within the limits of the analysis. The minimum values of an acceptable preconsolidation pressure and preconsolidation void ratio are located at the abscissa pressure where the laboratory virgin compression curve intersects the in situ void ratio ordinate. Figure 4 illustrates the location of these minimum values for a normally consolidated specimen. Figure 5 illustrates the location of these minimum preconsolidation coordinates for an overconsolidated soil. The determination of the value of the minimum void ratio for an overconsolidated specimen is discussed below. The probable and mimimum values of the settlement parameter C_c (compression index) are the slopes of the field virgin compression curve and the laboratory virgin compression curve, respectively.

Figure 5 illustrates those steps necessary to graphically reconstruct the in situ compressibility of an overconsolidated material. The field virgin compression curve is again estimated as a line between a point on the virgin laboratory curve where the void ratio equals 42 percent of the initial void ratio and a point where the log of pressure abscissa equals the maximum past pressure and the void ratio ordinate equals its preconsolidation value. The difference in computations between a normally and an overconsolidated sample subsists in determining the value of the void ratio that the in situ soil exhibited in its preconsolidated state. Sometime in the soil's history, it underwent a stress unloading and its void ratio correspondingly rebounded. This in situ void rati~~o can be~~

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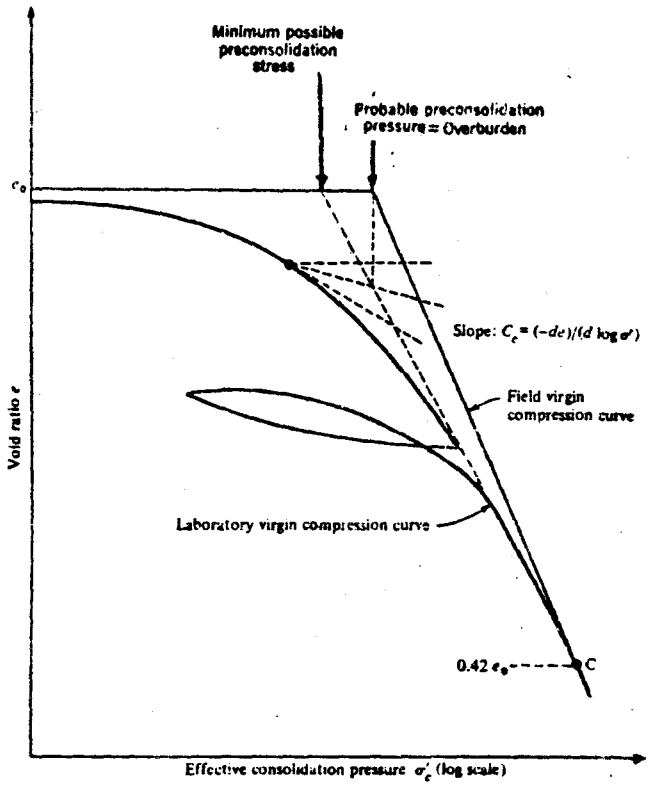

Figure 4. - Graphical constructions using Schmertmann's procedure for determining in situ compressibility of normally consolidated clays.

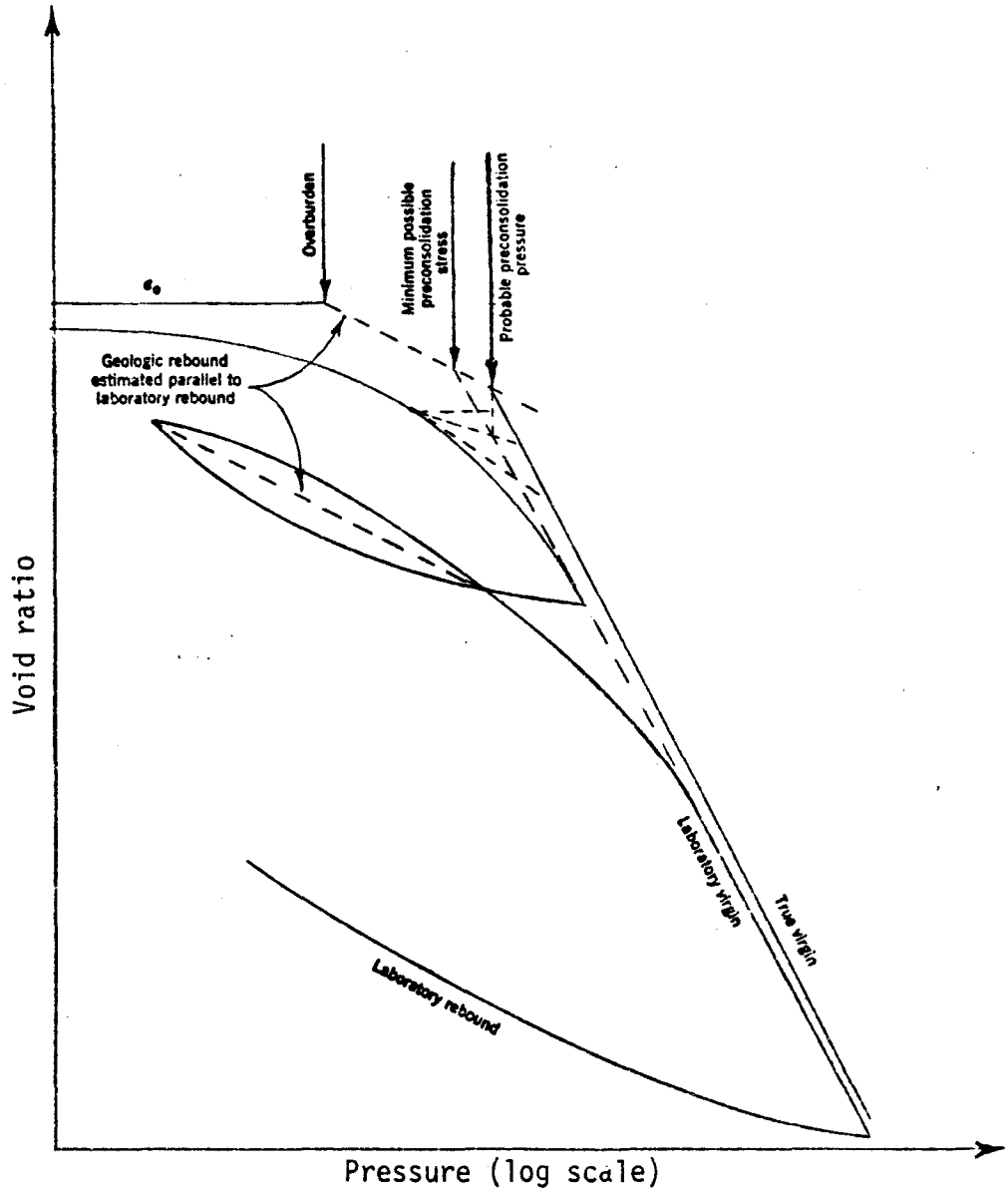

Figure 5. - Graphical constructions using Schmertmann's procedure for determining in situ compressibility of overconsolidated clays.

estimated if one assumes that the least squares slope of the rebound data or swell expansion index (C_s) equals the rebound-recompression average slope that exists in the field. Starting at the overburden pressure, rebounded in situ void ratio coordinates, it is possible to track along a line with a slope equal to C_s until the abscissa of the preconsolidated pressure is intersected. The void ratio ordinate at this intersection equals the preconsolidation void ratio.

It is important to note that for an accurate representation of the field rebound-recompression curve, C_s should be determined from a rebound-recompression cycle rather than from the rebound data points alone. Because the rebound and recompression curves on a semilog graph do not plot as a straight line, it is better to obtain an average slope using a linear best-fit on a full cycle of laboratory data points than on just the bottom half of the points. Another consideration when determining the expansion index for overconsolidated soils is to conduct the first unload-reload cycle at a pressure level at or just below the estimated maximum past pressure.

CON1D performs its pressure-deformation analysis on the testing pressure-percent strain data for all testing pressures up to and including those loads in the first unload-reload cycle. This cycle should not begin until the compressive curve merges into the virgin compression line, and judgment is required. If the soil sample is unloaded before the consolidation pressure reaches the preconsolidation pressure, then CON1D will not define the slope of the virgin compression line and, since this slope is paramount in determining the preconsolidation pressure, this part of the analysis would be inaccurate. On the other side, if the unload-reload cycle begins past the maximum past pressure, then the computed value of C_s (expansion index) will not be representative of the field rebound-recompression index. As the soil consolidates, the swell-expansion index becomes greater; the average slope becoming steeper.

The second part of CON1D's consolidation-deformation analysis considers the time-dependent consolidation test data to determine the coefficient of consolidation, C_v. Then, using the maximum compression index from the first of the deformation analyses and C_v, CON1D calculates the flow of water or permeability of the soil sample. The theory used to develop this stage of the deformation analysis can be found in any soil mechanics text, usually under the subchapter heading of "time rate of settlement." The specific methods used in the computer program are discussed in the next section.

2.2 Method of Solution

CON1D uses standard volume and phase relationships to calculate phase conditions during specimen loading. Since the specimen container diameter is constant, all computations involving phase volumes are computed in terms of compositional heights. Conversion constants used in the program include: the value of PI to 9 decimal places, 453.6 g/lb, and length conversion factors from metric to inch/pound units. The absolute density of water is assumed equal to 1.0 g/cm^3.

CON1D's first executable instruction is to read the output control parameter from input as defined by the user during the execution of CON1DP, the procedure file that interfaces a user with CON1D. If requested, CON1D writes a formatted copy of the data file (local to CON1D as TAPE5) CON1D then reads all remaining input and test data.

CON1D determines the type of test, packs a Hollerith array for specimen type, and sets a gage direction factor (referred to as CDIAL in the equations below) according to the number of the testing machine to account for ascending or descending dial readings. CON1D calculates the initial and final specimen phase conditions from the data on ADP data sheet EL-548 (12/82). Below are the equations used.

Note: Input data are denoted with an asterisk.

Given:

WWSP = Wet weight of specimen initially

Then:

WWSP = Weight of container cover plates and wet soil*
- weight of container and cover plates*

Using input for total dry weight from initial moisture;

Given:

WCI = Initial moisture content*
WCF = Final moisture content*

Then:

TDW = WWSP/(WCI/100.0 + 1.0)

where TDW is the total dry weight of the specimen

Using input for total dry weight from final measured weights;

Given:

TDW = Dry weight of specimen and container*
- weight of container*
+ dry weight of trim and container*
- weight of container for trim*

WCF = (Wet weight of specimen and container*
- dry weight of specimen and container*)/(Dry weight of specimen
and container* - weight of container*) x 100.0

Then:

$$WCI = WWSP/(TDW - 1.0) \times 100.0$$

Using the initial moisture content and the total dry weight from either set of input data;

$$HO = TDW/(AREA \times \gamma_W \times SPG^*)$$

where HO is the height of the soil solids

SPG = the specimen apparent specific gravity
AREA = PI x specimen diameter^2*/ 4.
γ_W = absolute density of water

HI = container height* +[CDIAL x
(dial reading with seating load on specimen*
- dial reading with seating load on gage block)]

where HI is the initial specimen height

$$VRI = (HI-HO)/HO$$

where VRI is the initial void ratio

$$HWI = TDW \times WCI/AREA/100.0$$

where HWI is the initial height of water

$$EHW = TDW \times WCF/AREA/100.0$$

where EHW is the final (extended) height of the water

The program assumes full specimen saturation at the final testing pressure. The last pressure is the final rebound pressure, and it is equal to the original seating pressure. The input or calculated final moisture content is assumed equal to the moisture content at the final pressure. The program then calculates the height of the entrapped air and assumes this height of air is constant once the specimen is wetted.

$$EHA = H - HO - EHW$$

where EHA is the extended height of the air
H = HI - CDIALX (difference in dial readings between dial reading with seating pressure on specimen and final dial reading)
H is the specimen height at the final dial reading

If the calculated extended height of air is less than zero, then CON1D sets the height to zero. CON1D also calculates and outputs the degree of saturation at the maximum pressure using the original calculated height of entrapped air.

The percent axial strain is calculated from the change in the axial readings over the initial specimen height times 100. All other specimen properties during compression are computed from the final laboratory readings for any one testing pressure. The dry density is computed from the soil total dry weight over the specimen volume. The moisture content for each pressure is calculated as follows:

WC = HWAT x AREA/TDW where

WC is the moisture content for any testing pressure, and

HWAT = H - HO - EHA

where HWAT is the height of the water for any testing pressure
H is the specimen height at the end of any one pressure
EHA is the height of the entrapped air

For pressures before wetting, the program tests to check for a positive difference between the height of the specimen and the sum of the height of the solids, the height of the water initially, and the height of the entrapped air. If the difference is positive, the remaining volume must be air and the moisture content for this pressure is set to the initial moisture content; for a negative difference, the moisture content is calculated as above. The degree of saturation, S, is calculated;

S = WC x SPG x 100/VR

where VR is the void ratio at the end of that pressure. The degree of saturation check is the height of the water over the height of the voids.

CON1D calculates the specimen rebound as,

$$REB = \frac{\epsilon_{max} - \epsilon_{reb}}{\epsilon_{max}} \times 100.0$$

where ϵ_{max} is the percent axial strain at the maximum pressure
ϵ_{reb} is the percent axial strain at the final testing pressure

After reducing all the laboratory consolidation or expansion data, CON1D outputs the results according to the type of test and the output control number selected. For uplift or expansion data, CON1D branches to its final block of Fortran code and tests to check that the pertinent input information of classification symbol and depth of sample are included in the input data file. Depending on this final check and if the user has requested plots, CON1D stops execution and the control stream language tests for a local computer file, TAPE15. If this file is local, then CON1D's test for missing input information was positive and any attempt to plot is aborted. If TAPE15 was not made local to the job by CON1D, then all the input information is present in the data file and the plotting program is loaded and executed.

For consolidation type data, CON1D tests for an expansive specimen by checking the second to the last compressive pressures of the first loading cycle. If the final value of axial strain at any pressure is less than the strain at the previous pressure or if the final value of strain at any pressure is less than strain value at the second data reading for this same pressure, then CON1D outputs a message and branches similar to that with expansion or uplift tests, i.e., exits. If requested, CON1D proceeds with its two-part consolidation deformation analysis. The first part of this analysis is a time-independent semilogarithmic pressure-void ratio analysis, that is to say that it is only concerned with the steady-state soil response to determine the past stress history of the soil as well as its compressibility. This part of CON1D automates the graphic procedures of Casagrande's and Schmertmann's constructions.

The algorithm is centered around fitting the consolidation data to least squares polynomial equation which has the form,

$$P(x) = c_1 + c_2x + c_3x^2 + \ldots + c_nx^{n-1}$$

where $P(x)$ is the given polynomial with constant coefficients c for the logarithmic abscissa values x in integer powers n.

The maximum value of n is limited to 12. The subroutine LSQFT fits this polynomial [5] to the semilogarithmic representation of the consolidation data for both parts of the consolidation deformation analysis. It is important to note that the above function is applied to the logarithms, base 10, of the abscissa values. For the "e-log p" curve this means that the logarithmic pressure values are reduced to their exponential powers, a very narrow range of arithmetic values.

An ordinary polynomial was chosen for the curve fitting function because of its flexibility in obtaining smooth functional shapes and because of the ease in manipulating the analytical expression to obtain accurate derivatives [6]. To simplify program coding, CON1D has three built-in arithmetic statement functions, POLY, D1, and D2 that evaluate the polynomial or determine its first and second derivative at any specified abscissa point, x.

The first step of the logarithmic consolidation deformation analysis is to fit a polynomial of a specified degree to the compression data of the first loading cycle to obtain the laboratory compression curve. A linear regression then fits a straight line to the rebound loop data points determining its slope or swell expansion index.

The laboratory virgin compression line is determined by iterating between boundaries 3 and 4 in steps of one one-hundredth to locate a slope tangent to the end of the compression curve. These boundaries are input parameters, and it is therefore possible to restrict the search to any desired portion of the curve. But, if omitted, CON1D defaults to searching between the third and last data points. The primary criterion to be passed in finding this slope is that the percent difference between any two successive first derivatives be less than 0.02 percent. The steepest slope satisfying this requirement with its point of tangency defines the line. If this criterion is unsatisfied, then the point of tangency is located where the slope is an absolute maximum. In either case, if the point of tangency lies between the ordinate void ratio values of the last two data points, and if the above slope is steeper than the slope of a line between these last two points, then the program defaults to a point of tangency at the last data point with a slope equal to a 3:1 average of these slopes, the weighted slope being the slope of the line between the last two points. This procedure is to ensure that the preconsolidation pressure (that will be determined) will be on the conservative side; it is necessary because the fitted polynomial curve has no constraints on either end and the slope at the last point may not be representative of the entire compression curve.

To locate the point of maximum curvature, CON1D uses two approaches, the graphical and the analytical methods. The graphical approach bisects the interior angle formed by the intersection of the virgin compression line and a line tangent to the top of the compression curve. Figure 1 illustrates the necessary construction. This line is located by iterating along the top of the curve between boundaries 1 and 2 searching for a tangency point with a slope equal to the rebound slope. If this tangency point cannot be located, the program selects a point at the abscissa of the first boundary with a slope equal to the rebound slope or the slope between the first two data points, whichever is less steep. This procedure is to ensure that the top tangent line lies over the compression curve, something that a highly compressible soil with a steep rebound slope might otherwise not do.

The point of maximum curvature by the graphical method is the intersection of the compression curve and a line that bisects the interior angle found above. This point is found by comparing ordinates of the compression curve polynomial and the angle bisector line with increasing abscissa values. When the ordinate value of the angle bisector line exceeds that value of the curve, the maximum curvature point is located.

In searching for the point of maximum curvature graphically, CON1D also generates intermediate boundaries to be used as the search boundaries in locating the point of maximum curvature by the analytical method. These

boundaries are at the intersection of the lines (through the vertex of the above interior angle with slopes equal to half and twice times the slopes of the top tangent and virgin compression lines, respectively) with the compression curve.

The analytical method finds the maximum curvature at the point where the radius of curvature, R, is a minimum. The radius of curvature is defined as:

$$R = (1+(dy/dx)^2)^{3/2} \ / \ (d^2y/dx^2)$$

In any arithmetic calculations automating graphical procedures, one must account for different scaling factors used to plot in the horizontal and vertical axes. CON1D calculates the scaling factor, F, as:

$$F = \Delta VR/\text{inch} \ / \Delta \log_{10} (P)/\text{inch}$$

where P is the effective consolidation pressure

The program scales the total change in void ratio to a 6-inch vertical span and a horizontal length of 2.64 inches per logarithmic cycle. The scale factor, F, adjusts all slopes and second derivatives needed to find the maximum curvature points on a e-log p plot.

If the difference between the two points of maximum curvature is less than 3 lb/in^2, CON1D averages the two and continues the analysis using one point.

Once this point or points are located with the mathematical representation of the compression curve, CON1D automates the manual graphic constructions of Casagrande and Schmertmann to estimate the probable preconsolidation pressure and to determine the compression index accounting for the effects of sampling disturbance. The various analytical procedures used mirror classical graphic techniques discussed above. In Schmertmann's construction, CON1D has two small changes that increase the program's flexibility yet do not affect the accuracy. In the classic Schmertmann construction, a constant value of 42 percent of the in situ void ratio is used to find the point of intersection of the line representation of the laboratory virgin compression tangent with the line representation of the in situ compression curve's tangent. CON1D sets the in situ void ratio equal to the specimen void ratio at seating load pressure, which introduces small error but of a magnitude less than the inherent errors of the analysis. Finally, CON1D treats remolded soils as normally consolidated by setting the effective overburden pressure equal to the preconsolidation pressure.

The second part of the deformation analysis, a time-dependent analysis, follows. A set of least squares polynomials is fit to the time-consolidation data of the compressive pressures of the first loading cycle. Cubic equations are fit to the first and last four time-pressure data points, and one polynomial equation is fit to the entire curve. The first cubic is necessary to determine the time-axial strain value of the corrected 0 percent primary consolidation ordinate. By the log method,

this value is determined by laying off above a point 6 seconds into the consolidation, a distance equal to the vertical distance between this point and one at a time of 24 seconds into the consolidation. The second cubic is to find a tangent to the end of the consolidation curve. The point of tangency is located three-quarters of the way between the logarithmic abscissa values of the last two data points, on the side of the last point. Its slope is the tangential slope or a slope between the last two points, whichever is the minimum positive slope. The fixed polynomial order of these cubic equations does impose limitations on the analysis when irregular data are encountered, see section 2.3. Using the polynomial representation of the entire time consolidation curve, CON1D iterates along its length between the third and next to the last data points seeking the curve's inflection point, the point at which the second derivative changes sign. A tangent at the inflection point is analytically defined, and the time value in seconds at the inflection point defines one time value necessary for calculating the coefficient of consolidation. The time for 50 percent consolidation is found at the abscissa value of the point on the curve that is halfway between the ordinate values of the corrected 0-percent consolidation point and the 100 percent consolidation point. This 100-percent consolidation point is located at the intersection of the line tangent to the inflection point and the line tangent to the end of the curve.

The coefficient of consolidation, C_V, is calculated:

$$C_V = (0.197 \times (HT50/2)^2)/TIME50$$

0.197 = time factor T for 50 percent consolidation

where HT50 is the specimen height at TIME50
TIME50 is the time in seconds for 50 percent consolidation

and

$$C_V = [0.405 \times (HTINF/2)^2] \times TIMINF \quad [7]$$

0.405 = time factor at the inflection point on a semilogarithmic consolidation curve

where HTINF is the specimen height at TIMINF
TIMINF is the time for consolidation to reach the curve's inflection point

Using the maximum compression index, C_C, calculated in the time-independent consolidation deformation analysis, and the coefficients of consolidation calculated above, CON1D computes permeability, PERM, as:

$$PERM = C_V \times A_V \times 94900/(1+VR)$$

where 94900 is the unit weight of water (62.4 lb/ft^3) times conversion factors. VR is the final void ratio

and $A_V = 0.435 \times C_C/P$ [8]

A_V = coefficient of compressibility

where P is the average pressure for the increment $(P_1+P_2)/2$

Methods of solution: for subroutine LSQFT [5] follows:

LSQFT is an algorithm that performs a multiple or polynomial regression on a given set of data to find a least squares polynomial fit.

The sum of the squares, S,

$$S = (y-a-b_1x-b_2x^2- \ldots -b_nx^n)^2$$

is minimized by setting $\delta S/\delta a = 0 = \delta S/\delta b_i$

Defining, with summations over the number of observations m,

$$C_{ij} = \Sigma x^i x^j - \frac{\Sigma x^i \Sigma x^j}{m}$$

$$C_{iy} = \Sigma x^i y - \frac{\Sigma x^i \Sigma y}{m}$$

leads to n simultaneous linear normal equations

where n is the degree of the polynomial

$$C_{11}b_1 + C_{12}b_2 + \ldots + C_{1n}b_n = C_{1y}$$
$$C_{21}b_1 + C_{22}b_2 + \ldots + C_{2n}b_n = C_{2y}$$
$$\vdots$$
$$C_{n1}b_1 + C_{n2}b_2 + \ldots + C_{nn}b_n = C_{ny}$$

and,

$$a = y - \sum_{i=1}^{n} b_i x^i$$

or a = mean y-intercept

LSQFDT solves the set of n simultaneous equations using a Gauss-Jordan reduction algorithm with the diagonal pivot strategy. The individual matrix elements, of dimension i rows x j columns, are double precision variables. Once the coefficient matrix is inverted, the desired polynomial coefficients are:

$b = a$
$b_i = \text{SING}\ (C_{i-1,y})$; $i = 2$ to $n + 1$.

2.3 Program Capabilities

CON1D can accommodate standard one-dimensional consolidation test data for all reasonable ranges of testing pressures. The data storage arrays in the program have limits of 50 testing pressures with 50 time-dial gage readings for each pressure. Any testing pressures or data readings greater than this amount are ignored. The number of pressure-void ratio coordinates for the first compressive loading cycle or for the first unload-reload cycle is limited to 20 points. The program is also limited to only two compressive loading cycles. The above two limitations apply to the advanced pressure and time-dependent settlement parameters analyses only, since these limitations are imposed by the automated graphics algorithms.

The testing procedures used for all one-dimensional consolidation, uplift, and expansion tests should conform to the methods described in the Earth Manual [9] designation E-15.

As discussed above (sec. 2.2) the program assumes full specimen saturation at the final rebounded pressure. The specimen should be wetted by the final compressive pressure and allowed to draw in water as it expands. However, the testing pressure at which the specimen should be wetted depends entirely on the type of test and the reason for the test. Consolidation tests on samples which were saturated under in situ conditions dictate wetting at the seating pressure. Coarse-grained and silty soils, where void ratio collapse or phase conditions (natural wet and dry densities) are of interest, should be wetted at an appropriate testing pressure. When the soil compression is being tested, the specimen need not be wetted at all.

The reduction of consolidation test data into computed specimen phase conditions that approach the in situ conditions of the soil depend heavily on the accuracy of the axial dial gage readings and on the wet and dry weights of the specimen. CON1D provides the means to calculate the specimen dry weight parameters by two different methods, thereby providing a way to minimize testing errors. This analysis option is discussed in detail in the program user's guide, see appendix D.

Once the one-dimensional consolidation data are reduced, CON1D can perform settlement parameters analyses. These analyses are restricted to consolidation test data of nonexpansive soils. As noted previously, these analyses are limited in the scope of their validity to particular soils, generally fine-grained soils in a saturated condition. The only reasonable exception to the above generality is for the determination of an apparent preconsolidation pressure of an undisturbed coarse-grained soil when tested at its in situ moisture content. The program will successfully execute an analysis on nonconforming soils as the program has many safeguards against abnormal termination, but the obtained results will be of questionable quality.

An assurance that the test specimen has soil characteristics applicable to performing the consolidation parameters analyses does not guarantee the quality of the results. The automation of manual graphic techniques using

a least squares polynomial regression technique is inherently limited by the quality of the data. The selection of an ordinary polynomial to represent the graphic curves necessary for these consolidation analyses are founded on the high statistical correlation achievable in fitting a curve to typical one-dimensional data on the ease of polynomial equation manipulation and particularly on the simplicity involved in changing the shape of the fitting curve, i.e., changing the polynomial order or degree [6].

It is usually possible for an engineer to achieve an acceptable graphic fit for the compression curve on the e-log p plot by varying the degree of the fitting polynomial, see appendix D. Unfortunately, the curve fitting techniques performed in the time-dependent consolidation parameters analysis algorithm can be limited in their effectiveness when dealing with either discontinuous data, as in specimen wetting with a void ratio collapse or with irregular data, particularly the last four time-dial gage readings for any one testing pressure. The problem with discontinuous data is that a high order polynomial equation has the same form as limited Taylor power series, and sometimes the fitting curve becomes sinusoidal in shape. This problem may be partially overcome by reducing the polynomial order (see sec. 2.5). The problem with irregular or odd shaped data, particularly the last four data points on a time-percent stain curve, arises from the algorithm to find a tangent to the end of this curve. A fixed third order polynomial is always fit to these points, and if the shape of this curve is not concave down, then the rest of this parameters analysis will usually not work. The only way to overcome this problem is to manipulate these data to smooth out the curve.

CON1D reads all of the consolidation test data for any one test before it begins any of the data reduction and graphic manipulation algorithms. After completing the analysis, the program reads from the data file and processes another set of data or exits if an EOF (end of file) is encountered. Therefore, the data from different one-dimensional tests can be stacked; but as execution time increases (especially significant in the plotting program), the job time limit might be exceeded (60 seconds).

2.4 Data Input

The data are input from a mass storage text data file in the format shown on forms EL-548 (12-82) - One-Dimensional Consolidation Test Data - ADP and either EL-549 (2-74) or EL-550 - One Dimensional Consolidation Test Data - (Variable) Time Data Sheet (see app. B). The data on form EL-548 (12-82) provide CON1D the information needed to determine the initial soil parameters and phase conditions. The measurement units for length should be in inches, for moisture content in percent, and for weight in grams. The alphanumeric data fields on the first data line, i.e., drill hole, depth of sample, and class symbol must not be empty or blank because CON1D checks for these data and if absent, the program establishes a file, TAPE15. The existence of this file flags the job control stream to inhibit the execution of the plotting program, CONPLOT. The data field labeled "LOADING UNIT NO." identifies the type of machine used in the test

by a predefined range of integer numbers. The range of acceptable numbers with their associated machines are:

0-99	consolidometer scales
100-499	conbels
500-599	anteus back pressure machines
600	soil test levermatics

Knowledge of the appropriate type of testing machine is significant to determine the direction of change of the dial gage readings.

The dual input data lines for total dry weight and the final line of data on form EL-548 (12-82) represent changes in the input data for the one-dimensional consolidation or compression testing analysis programs used within the Bureau since 1974. The meaning of these data is discussed in detail in the user's manual, appendix D. The significant point to note is that CON1DP, the consolidation procedure file, initiates its execution with an inquiry into the format of the data file cover sheet. Old formatted data files can be quickly updated into the proper format using the small interactive program, CONVERT, which is called by CON1DP. The user's manual also describes the necessary user input for the conversion process.

2.5 Program Options

Most of the options available to anyone wishing to analyze standard one-dimensional consolidation data are presented to the user during the execution of CON1DP, more specifically when CON1DP executes CONGO, the submit file, and input file setup program. This presentation takes the form of questions put to the user. The answers to questions pertaining to the method of analysis and the length of the printed output are passed into the analysis program through the INPUT file. A synopsis of the information passed follows, [see the user's guide for specific details (app. D)].

IOUT - The output control numbers, range 0-5
ITWD - Input data for calculating the specimen total dry weight
  1 from initial moisture
  2 from final measured weights
NPADJ - The number of pressure-strain curves that need the degree fitting polynomial adjusted. If the number is greater than zero then:
PADJ, NDGADJ - The testing pressure and degree adjustment are read from INPUT

Other analysis options available to the user deal with the pressure-dependent settlement analysis. The parameters affecting this analysis are on the sixth line of data or the last line on the data cover sheet, that is the polynomial degree and bound 1 through 4.

Any other program options deal with the output form, the type of plotting desired, and the mode of program execution. The first and second of the above two options are discussed in section 2.7. The mode of operation

primarily deals with the setting of job control registers to direct the procedure file run stream to execute one of the following actions:

1. Submit TAPE23, the submit file written by CONGO, for a full batch run with printed output
2. To submit TAPE23 to produce just plot files, no printed output
3. Run CON1D interactively without plots

Again, the user's guide in appendix D provides the specifics involved in implementing the available program options.

2.6 Printed Output

The printed output from the analysis of one-dimensional consolidation test data varies with the type of test and with the user selected output control option. The output from a consolidation, expansion, or uplift analysis in its most complete form is similar. This output consists of a formatted copy of the data file general information heading that displays the sample and specimen numbers, the specimen type, the dates of placement and removal, the specific gravity, and the specimen dimensions. Then the percent axial strain at the corresponding time readings and the dry density and void ratio at the final time reading for each testing pressure is listed. The final page output for these test types is a specimen phase relationship page that summarizes the specimen's height, void ratio, dry density, moisture content, degree of saturation, and percent axial strain at the end of each specimen loading. Included are two other tables, one that lists specimen phase conditions initially and at the maximum testing pressure and using another that displays selected specimen phase conditions as a comparison of values using the different input sets for computing the specimen total dry weight.

The output from the pressure and time-dependent settlement parameters analyses follows the above-described output with one page as output for each analysis. The first page, labeled "Semilogarithmic Stress Deformation Analysis," deals with the range of parameters obtainable by a graphic analysis of an e-log p plot. The top half of this printed sheet gives the input and analysis parameters [line six of input data form EL-548 (12-82)] followed by the intermediate boundary and the maximum curvature pressure abscissa values. The second half of this output sheet lists either one or two tables of ranges of consolidation parameters. One table is output if the difference in abscissa values for the points of maximum curvature determined by the analytic and graphic methods is less than 3.0 lb/in^2; otherwise, two tables are output, one table for each maximum curvature point. Each table lists a range of values, from a probable to a minimum value for the preconsolidation pressure, the in situ void ratio at the preconsolidation pressure, the overconsolidation ratio, the swell index, and the compression index and ratio.

The final page of printed output, labeled "Semilogarithmic Time Consolidation Analysis," is a table listing intermediate consolidation analysis parameters as well as the results of the analysis; that is, the coefficients of consolidation and the permeabilities of the specimen over the

range of testing pressures. Since two methods of analyses are employed to determine the results, the classical log method and the inflection point method, two sets of results are output. The intermediate output results are the degree of one-dimensional primary consolidation in percent axial strain at 0 percent and 100 percent, and the abscissa real time values at the 50-percent point of primary consolidation and at the curve's inflection point. The example program run in appendix B illustrates the output described above.

In addition to all of the possible printed output described above, CON1D will output several informative and warning messages as analysis conditions warrant. These messages and their meanings or significance are described below. Those messages that are informative in nature and self-explanatory are not listed.

On the bottom of the last page of any one-dimensional data reduction analysis, that is after the phase relationship tables, any one of the following might be printed:

THE HEIGHT OF ENTRAPPED AIR IN THE SPECIMEN WAS SET TO ZERO IN THE ABOVE ANALYSIS. THE DEGREE OF SATURATION AT THE MAXIMUM PRESSURE BEFORE ZEROING WAS ____ %.

The intent of this informative message is to provide the engineer with a method to quantify the extent of soil testing procedure error. The degree of saturation in percent printed on a real computer run output will always be greater than 100 percent.

*** EXPANSIVE SPECIMEN **** CLASSICAL DEFORMATION ANALYSIS INVALID

PROGRAM STOPS

CONSOLIDATION DATA REDUCTION COMPLETE

PROGRAM STOPS

The first of the these messages will be printed if the specimen swells during the one-dimensional consolidation test. Conditions defining this swelling are described in section 2.2. The second message is printed to denote the successful completion of the standard consolidation data reduction analysis, and it is printed if only a data consolidation reduction analysis was requested.

On the pressure deformation analysis output, two warning messages are of interest.

WARNING ANALYTICAL PROCEDURE WITH CASAGRANDE CONSTRUCTION FAILED

CHECK DATA.

PIVOT ELEMENT TO SMALL AND MATRIX MANIPULATION BREAKS DOWN

The above warning message is printed if the graphically determined value of the preconsolidation pressure is less than the real abscissa pressure coordinate value of the point of maximum curvature used in the analysis. The second message printed above is a fatal error in that the program cannot continue its execution and therefore stops. This error occurs in subroutine LSQFT, and its occurrence could happen anytime a polynomial regression is attempted. The problem identifed by this message arises in the solution of a system of linear equations by a pivotal matrix reduction method. The coefficient matrix is singular, i.e., two rows or equations are equal. The solution to this problem is to first check the data and make sure that the consolidation data (or reduced printout) is not duplicated for equal testing pressures. The only other solution is to reduce the degree of the fitting polynomial by at least one.

On the time dependent settlement parameters analysis output, the warning message:

WARNING ANALYSIS HAS FAILED

means that the graphic construction lines used to locate the coordinates of the point of 100 percent of primary consolidation did not intersect within a meaningful abscissa time range. Observe the time-percent strain curves plot in the CON1DP user's guide, appendix D, for a visual example of an erroneous graphic construction. Two possible solutions exist for this problem, each dealing independently with the two graphic lines. One solution might be to change the degree of the fitting polynomial using the option available through the input file setup; the second solution might be to slightly adjust the data of the last four points on the time-percent strain curves (see sec. 2.3).

The final message that might appear on any printed output is:

ANY CALLS TO PLOT HAVE BEEN TERMINATED.

MISSING INPUT DATA

The missing data are on the first line of a test data file; i.e., the specimen depth, drill hole number, and classification symbol.

2.7 Other Output

Other outputs produced by the analysis program, CON1D, consist of a sequential file, named TAPE2, that contains the complete analysis results. The data on this file are then read by the plotting program CONPLOT as its input. CONPLOT employs the FORTRAN callable plotting library DISSPLA, a software product of Issco, to produce a devise independent plotting file that may be interfaced with various plotting hardware. The consolidation procedure file provides the user with the option to attain plots on either a Xynetics flatbed plotter or a Comp80 microfilm plotter when submitting a batch run job. [An option is also provided to allow the user to save a plot file for hardware interfacing at a later time (see sec. 2.3)]. A description of the plotted output along with its engineering significance can be found in appendix D.

3.0 System Documentation

3.1 Computer Equipment

CON1D and all associated programs were developed on CDC (Control Data Corporation) machines, and they will execute on CYBER 6600, 74, and 170 series computers. These CDC computers use a 60-bit byte or 10 display code characters per word. All floating point arithmetic, with the exception of the calculations in the least squares fitting routine, are performed in single precision.

3.2 Peripheral Equipment

The peripheral equipment necessary to execute CONIDP includes a Telex-supported remote terminal, and a mass storage disk pack to store data files. Optional equipment, but necessary to achieve the full potential of the programs, include: Xerox copier and a plotting interface system such as a Xynetics flatbed plotter or a COMP 50 Microfilm plotter. For manufacturer and model numbers of the peripherals equipment used in the CON1D development, contact:

ADP User's Branch, Mail Code D-1130
Bureau of Reclamation
PO Box 25007
Denver CO 80225

3.3 Source Program and Subroutines

The Fortran IV source listings for all the related consolidation analysis programs are given in appendix A. A CYBER R=3 reference map and a statical load map are included with each program. A variable definition list is included for the program CON1D and its only subroutine LSQFT.

A Fortran callable system subroutine is employed by programs CONVERT and CONGO. This subroutine is a Bureau developed routine that links a permanent mass storage file to a program logical file unit. This routine is called GETIN.

3.4 Data Structure

All files used within the programs have a formatted sequencial structure. The one-dimensional consolidation test data file must be equated to TAPE5 for CON1D to execute properly. This program writes output to TAPE6 and the complete analysis results to TAPE1. CONPLOT reads TAPE1 and then processes the input data through DISSPLA Fortran callable routines to produce a CYBER direct mass storage access file named PLFILE.

3.5 Storage Requirements

The computer core memory storage requirements vary with the program executing a statical load map that gives the amount of core storage needed (in 60 bit CDC computer words) follows the source listing of each program. CON1D requires 66500_8 computer words. A complete analysis run with plots requires 150300_8 computer words.

3.6 Maintenance and Updates

CON1D was originally written in January 1981. Its output format was modified in January 1982 to include expansion and uplift pressure analyses. Changes to the input format in the procedural setup program were added to the overall analysis in March 1983. These changes included the user option of selecting which set of input parameters CON1D would use when calculating the specimen's total dry weight, as well as all the necessary branching and output statement changes. These data were the final update to bring the consolidation analysis up to its present form.

4.0 Operating Documentation

4.1 Operator Instructions

All the computer programs associated with CON1DP are stored on a CDC magnetic disk drive, and no special computer operator instructions exist. Peripheral equipment operations that the analysis procedure has the capability to invoke include disposing magnetic tapes from the print queue to the appropriate printer or plotter, as well as the operation of the equipment. These operations are dependent upon the system hardware and the CON1D procedure produces no special instructions.

4.2 Operating Messages

No operating messages are produced by the CON1DP procedure. Normal system messages are produced by the CYBER operating system.

4.3 Control Cards

CON1DP is executed from an interactive, time-share origin, terminal. User interaction with the CONGOS program creates a job environment for either interactive execution of CON1D at the terminal or batch job execution of CON1D and CONPLOT by submit file processing. A listing of the job card control stream copied from a submit file, with Xerox output and Xynetics plotting is in appendix C. The control stream for interactive execution of CON1D is very short (3 or 4 control cards) as no plotting is available. These job statements can be viewed in the CON1D source list in appendix A. The detailed description of control language and control statement formats and processing is explained in the NOS Version I Reference Manual [10].

4.4 Error Recovery

CON1DP must be rerun on error.

4.5 Run Time

The CPU execution time for the analysis program CON1D is a function of the length of the testing data, i.e., the number of testing pressures, and on the output control parameter selected by the user. The execution time for the example output in appendix D was 1.33 seconds. The data for this computer run was of a typical length and the output control parameter

selected, produced a full analysis with maximum output. The execution time for the plotting program CONPLOT varies in a similar manner to the factors affecting CON1D's execution time, i.e., the number of plots to produce. The run time needed to produce the file of plots for the consolidation analysis in appendix D was 23.4 seconds. The time needed to interface this plot file with the Xynetics plotting hardware was 23.3 seconds. A total of 46.7 CPU seconds was needed to produce five DISSPLA plots. The time necessary to convert the plot file to a physical plot is dependent on the plotting hardware.

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APPENDIX A

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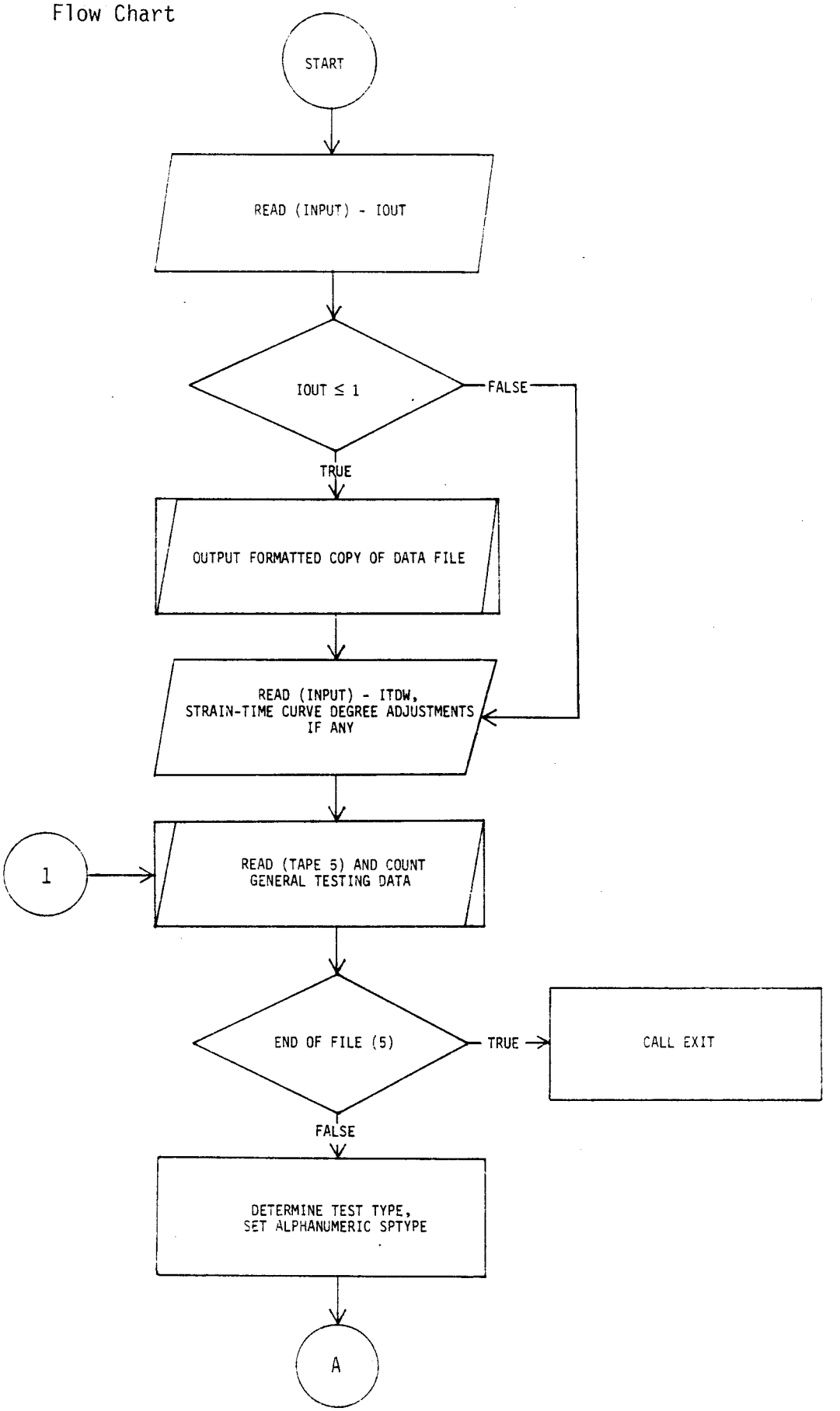
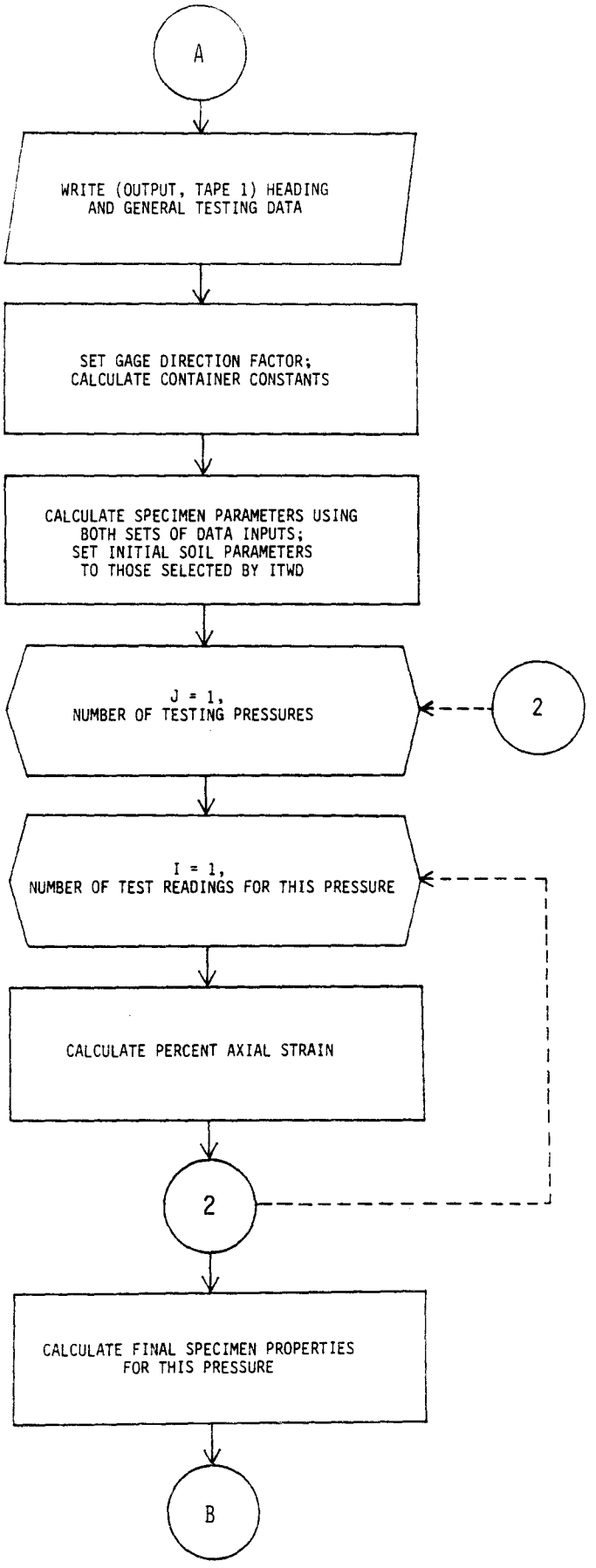
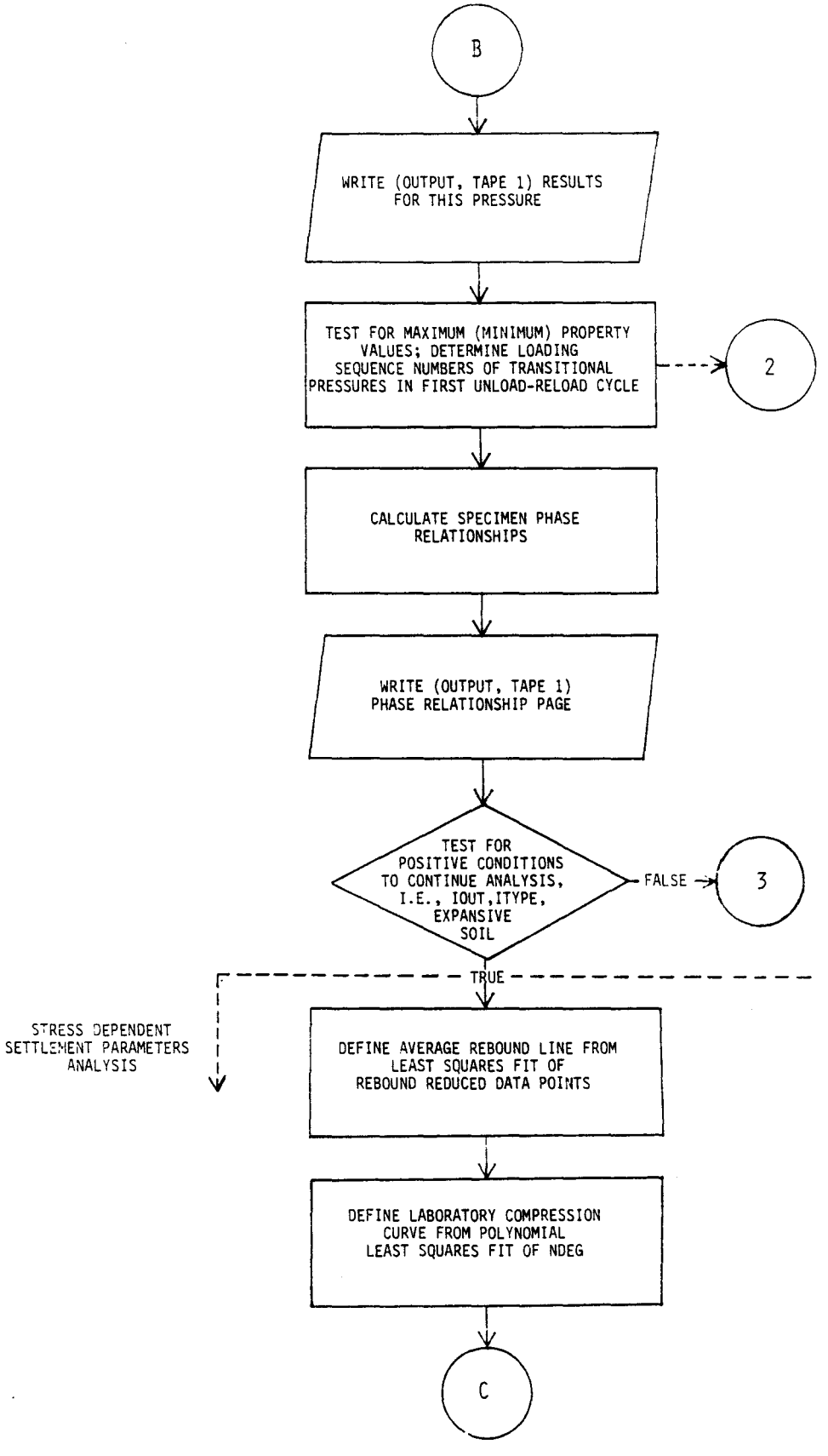
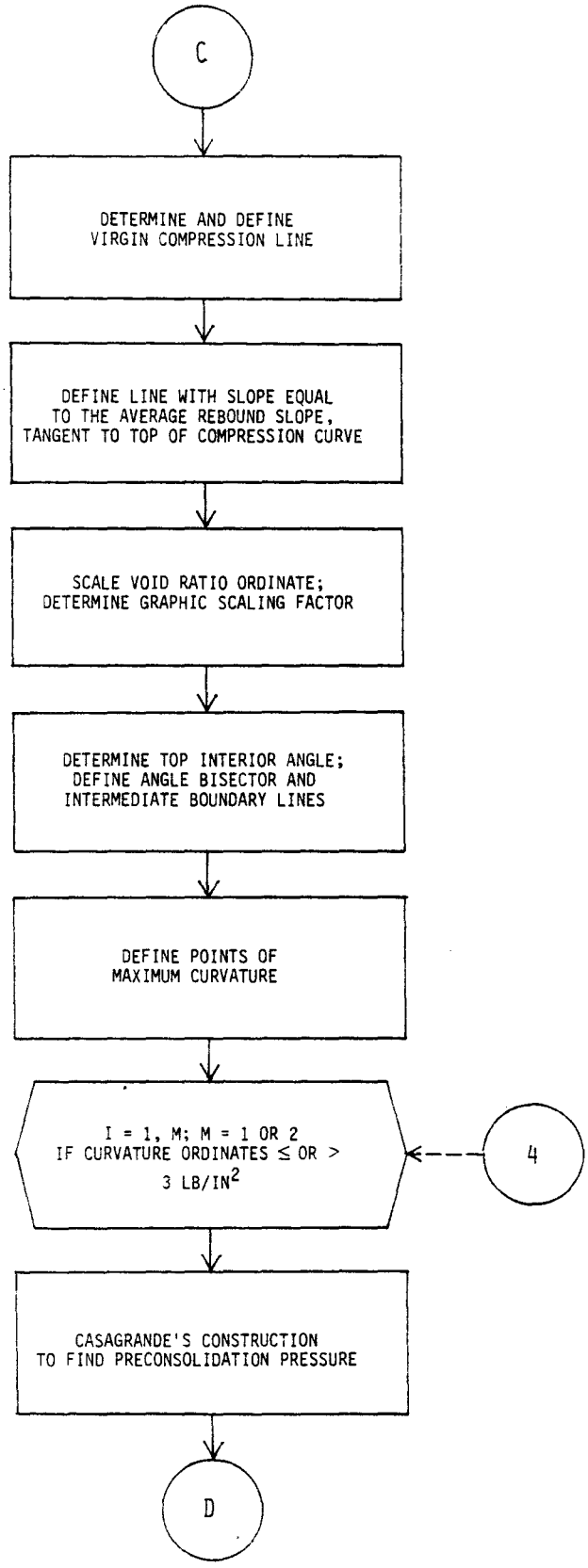
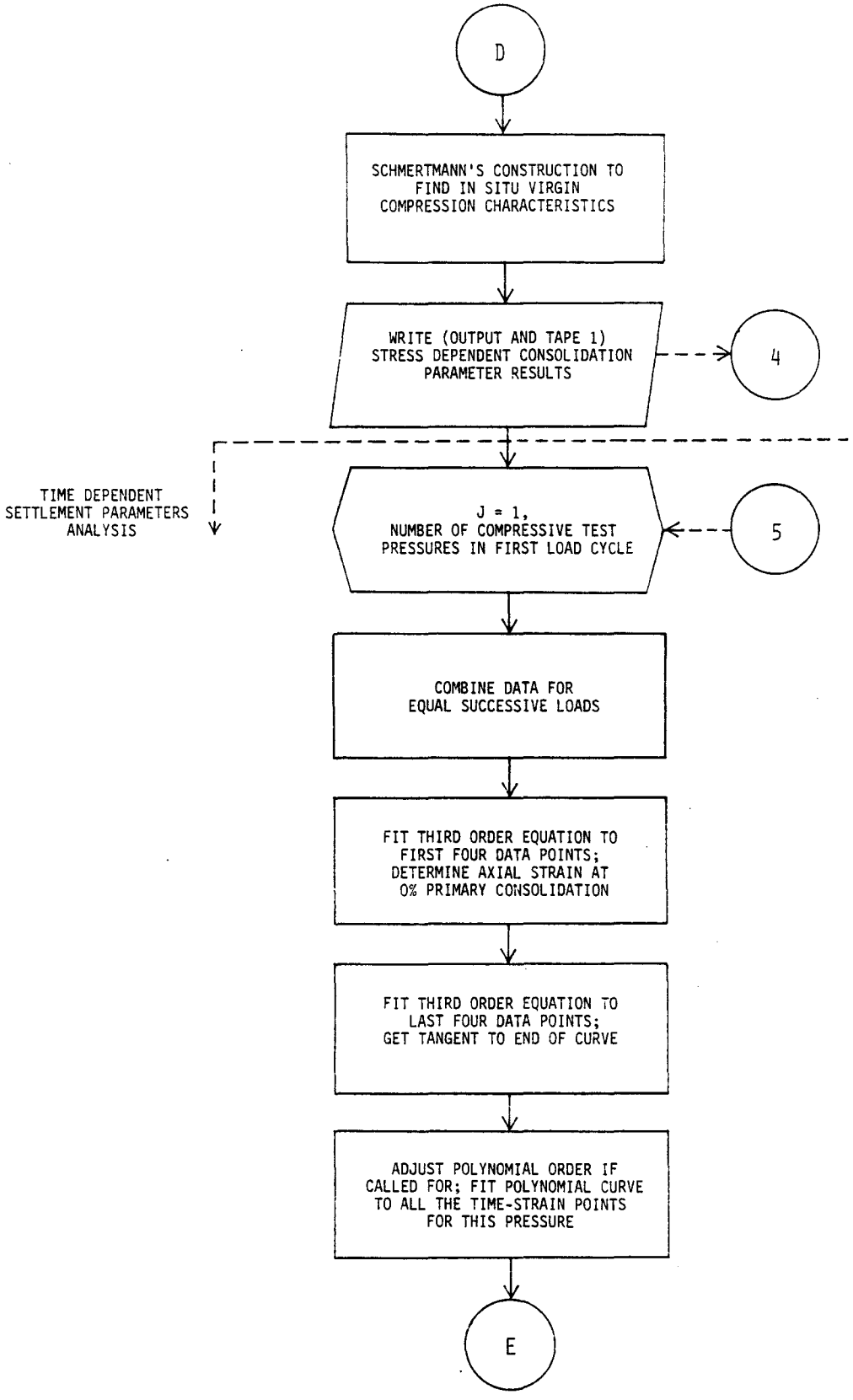
PROGRAM: CON1D
Consolidation, Expansion, or Uplift Test for
Standard One-Dimensional Consolidation Test Data
Flow Chart

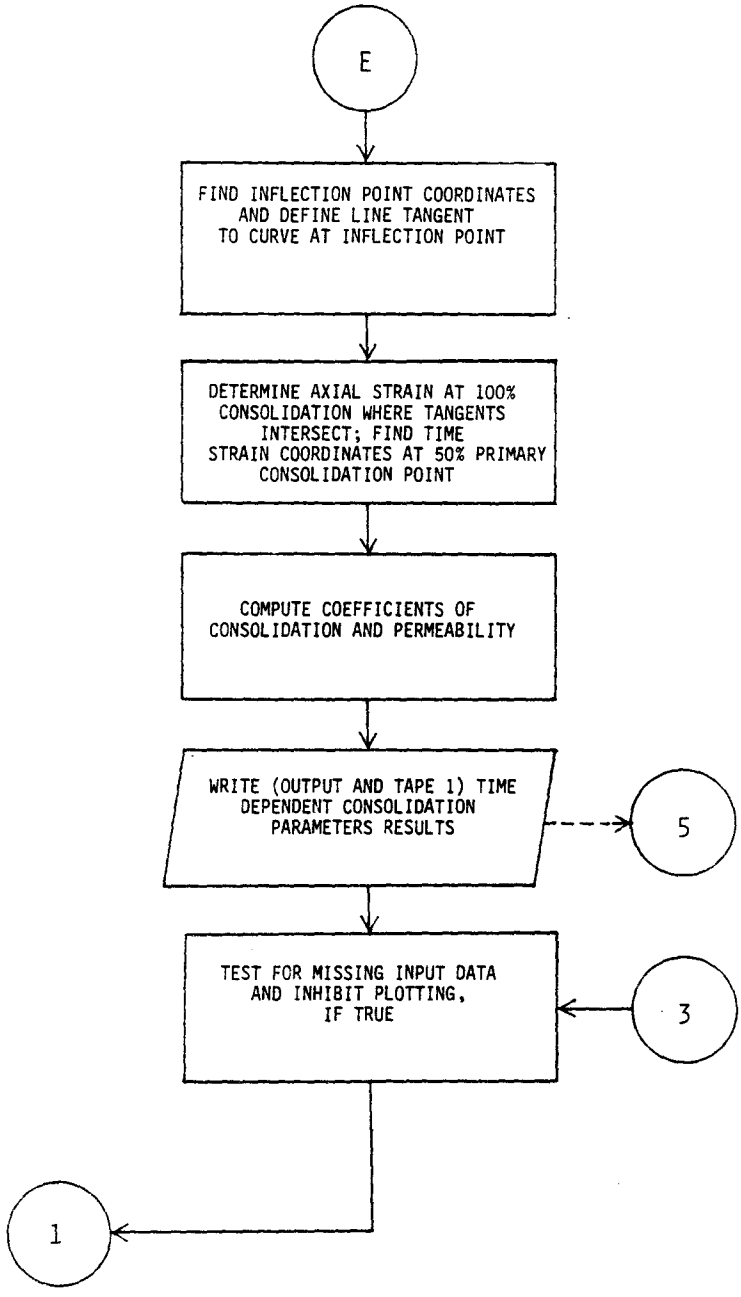



A
WRITE (OUTPUT, TAPE 1) HEADING
AND GENERAL TESTING DATA
SET GAGE DIRECTION FACTOR;
CALCULATE CONTAINER CONSTANTS
CALCULATE SPECIMEN PARAMETERS USING
BOTH SETS OF DATA INPUTS;
SET INITIAL SOIL PARAMETERS
TO THOSE SELECTED BY ITWD
J = 1,
NUMBER OF TESTING PRESSURES
2
I = 1,
NUMBER OF TEST READINGS FOR THIS PRESSURE
CALCULATE PERCENT AXIAL STRAIN
2
CALCULATE FINAL SPECIMEN PROPERTIES
FOR THIS PRESSURE
B


B
WRITE (OUTPUT, TAPE 1) RESULTS FOR THIS PRESSURE
TEST FOR MAXIMUM (MINIMUM) PROPERTY VALUES; DETERMINE LOADING SEQUENCE NUMBERS OF TRANSITIONAL PRESSURES IN FIRST UNLOAD-RELOAD CYCLE
2
CALCULATE SPECIMEN PHASE RELATIONSHIPS
WRITE (OUTPUT, TAPE 1) PHASE RELATIONSHIP PAGE
TEST FOR POSITIVE CONDITIONS TO CONTINUE ANALYSIS, I.E., IOUT,ITYPE, EXPANSIVE SOIL
FALSE
3
TRUE
STRESS DEPENDENT SETTLEMENT PARAMETERS ANALYSIS
DEFINE AVERAGE REBOUND LINE FROM LEAST SQUARES FIT OF REBOUND REDUCED DATA POINTS
DEFINE LABORATORY COMPRESSION CURVE FROM POLYNOMIAL LEAST SQUARES FIT OF NDEG
C


C
DETERMINE AND DEFINE
VIRGIN COMPRESSION LINE
DEFINE LINE WITH SLOPE EQUAL
TO THE AVERAGE REBOUND SLOPE,
TANGENT TO TOP OF COMPRESSION CURVE
SCALE VOID RATIO ORDINATE;
DETERMINE GRAPHIC SCALING FACTOR
DETERMINE TOP INTERIOR ANGLE;
DEFINE ANGLE BISECTOR AND
INTERMEDIATE BOUNDARY LINES
DEFINE POINTS OF
MAXIMUM CURVATURE
I = 1, M; M = 1 OR 2
IF CURVATURE ORDINATES ≤ OR >
3 LB/IN2
4
CASAGRANDE'S CONSTRUCTION
TO FIND PRECONSOLIDATION PRESSURE
D


D
SCHMERTMANN'S CONSTRUCTION TO FIND IN SITU VIRGIN COMPRESSION CHARACTERISTICS
WRITE (OUTPUT AND TAPE 1) STRESS DEPENDENT CONSOLIDATION PARAMETER RESULTS
4
TIME DEPENDENT SETTLEMENT PARAMETERS ANALYSIS
J = 1, NUMBER OF COMPRESSIVE TEST PRESSURES IN FIRST LOAD CYCLE
5
COMBINE DATA FOR EQUAL SUCCESSIVE LOADS
FIT THIRD ORDER EQUATION TO FIRST FOUR DATA POINTS; DETERMINE AXIAL STRAIN AT 0% PRIMARY CONSOLIDATION
FIT THIRD ORDER EQUATION TO LAST FOUR DATA POINTS; GET TANGENT TO END OF CURVE
ADJUST POLYNOMIAL ORDER IF CALLED FOR; FIT POLYNOMIAL CURVE TO ALL THE TIME-STRAIN POINTS FOR THIS PRESSURE
E


E
FIND INFLECTION POINT COORDINATES AND DEFINE LINE TANGENT TO CURVE AT INFLECTION POINT
DETERMINE AXIAL STRAIN AT 100% CONSOLIDATION WHERE TANGENTS INTERSECT; FIND TIME STRAIN COORDINATES AT 50% PRIMARY CONSOLIDATION POINT
COMPUTE COEFFICIENTS OF CONSOLIDATION AND PERMEABILITY
WRITE (OUTPUT AND TAPE 1) TIME DEPENDENT CONSOLIDATION PARAMETERS RESULTS
5
TEST FOR MISSING INPUT DATA AND INHIBIT PLOTTING, IF TRUE
3
1

```
 CCCCCCCC    OOOOOOOO   NN      NN      11      DDDDDDDDD   PPPPPPPPP
CCCCCCCCCC  OOOOOOOOOO  NNN     NN    1111      DDDDDDDDDD  PPPPPPPPPP
CC       C  OO      OO  NN N    NN    1 11      DD      DD  PP      PP
CC          OO      OO  NN NN   NN      11      DD      DD  PP      PP
CC          OO      OO  NN  NN  NN      11      DD      DD  PPPPPPPPPP
CC          OO      OO  NN  NN  NN      11      DD      DD  PPPPPPPPP
CC          OO      OO  NN   NN NN      11      DD      DD  PP
CC       C  OO      OO  NN    N NN      11      DD      DD  PP
CCCCCCCCCC  OOOOOOOOOO  NN     NNN  1111111111  DDDDDDDDDD  PP
 CCCCCCCC    OOOOOOOO   NN      NN  1111111111  DDDDDDDDD   PP
```

```
.PROC,GO.
.*
.*     A ONE-DIMENSIONAL CONSOLIDATION PROCEDURE
.*     U.S. BUREAU OF RECLAMATION,SOIL MECHANICS
.*     WRITTEN BY STEPHEN GAVLICK  FEBURARY 1983
.*
RETURN,*,CON1DP,ZZZZZC1,ZZZZZC2,GOWHERE.
SET,R1=0.
FTN,I=GOWHERE,L=0,GO.
IFE,R1.EQ.99,ONERUN.
SET,R2=0.
GET,CONVERT/UN=ER1540A,PW=STA.
FTN,I=CONVERT,L=0,REW,GO.
IFE,R2.EQ.1,NOGO.
REVERT,ABORT.
ENDIF,NOGO.
SET,R1=0.
RETURN,TAPE5,TAPE1,CONVERT,LGO.
ENDIF,ONERUN.
SET,R3=0.
GET,CONGOB/UN=ER1540A,PW=STA.
CONGOB.
IFE,R1.EQ.100,CONNOGO.
REVERT,ABORT. TRY AGAIN
ENDIF,CONNOGO.
IFE,R1.NE.99,BATCHRUN.
IFE,R3.EQ.99,PLOTS.
SUBMIT,TAPE23.
ELSE,PLOTS.
SUBMIT,TAPE23,B.
ENDIF,PLOTS.
RETURN,*,CON1DP,ZZZZZC1,ZZZZZC2.
NOTE,OUTPUT,NR./JOB SUBMITTED./
REVERT.
.* FOLLOWING CONTROL STREAM IS FOR CON1D INTERACTIVE USE
ENDIF,BATCHRUN.
GET,CON1DB/UN=ER1540A,PW=STA.
CON1DB,TAPE8,CONOUT.
PRIMARY,CONOUT.
NOTE,OUTPUT,NR./OUTPUT ON PRIMARY FILE(LNH TO VIEW)/
RETURN,*,CONOUT,CON1DP,ZZZZZC1,ZZZZZC2.
REVERT.
.DATA,GOWHERE
      PROGRAM GOWHERE(INPUT,OUTPUT)
C
C     A FORTRAN PROGRAM TO DIRECT THE CONSOLIDATION PROCEDURE
C     FOR USERS WITH DATA FILES FORMATTED FOR PREVIOUS CONSOLIDATION
C     PROGRAM(BEFORE FEBURARY  1983)
C
      PRINT*,"       1-DIMENSIONAL CONSOLIDATION"
      PRINT*," "
      PRINT*,"IS YOUR DATA FILE FORMATTED FOR THE UPDATED"
      PRINT*,"CONSOLIDATION TEST ANALYSIS PROGRAM(AFTER MARCH 1983)"
      READ 100,I
  100 FORMAT(A1)
      IF(I.NE.1HY)CALL SETREG(1,99)
      STOP
      END
```

```
 CCCCCCCC    OOOOOOOO   NN      NN   GGGGGGGG    OOOOOOOO    SSSSSSSS
CCCCCCCCCC  OOOOOOOOOO  NNN     NN  GGGGGGGGGG  OOOOOOOOOO  SSSSSSSSSS
CC        C OO      OO  NN N   NN  GG          OO      OO  SS       S
CC          OO      OO  NN NN  NN  GG          OO      OO  SS
CC          OO      OO  NN  NN NN  GG   GGGGG  OO      OO  SSSSSSSSS
CC          OO      OO  NN  NN NN  GG   GGGGG  OO      OO   SSSSSSSS
CC          OO      OO  NN   NN NN  GG      GG  OO      OO          SS
CC        C OO      OO  NN    N NN  GG      GG  OO      OO  S       SS
CCCCCCCCCC  OOOOOOOOOO  NN     NNN  GGGGGGGGGG  OOOOOOOOOO  SSSSSSSSSS
 CCCCCCCC    OOOOOOOO   NN      NN   GGGGGGGG    OOOOOOOO    SSSSSSSS
```

```
      PROGRAM CONGO(INPUT,OUTPUT,TAPE8,TAPE23)
C
C     A CONSOLIDATION PROCEDURE FILE PROGRAM TO DIRECT THE EXECUTION
C     OF THE PROCEDURE.  INPUT TO THE CONSOLIDATION PROGRAM ALSO OBTAINED.
C     TAPE8 STORES THE INPUT FILE COMMANDS
C     TAPE23 IS THE SUBMIT FILE BUILT BY CONGO.
C     CONGO COMMUNICATES WITH THE PROCEDURE THROUGH THE JOB CONTROL REGISTERS
C     CONTROL REGISTER 1 IS SET TO 99 FOR INTERACTIVE USE OF CON1D
C     CONTROL REGISTER 1 IS SET TO 100 IF DATA FILE IS NOT FOUND
C     CONTROL REGISTER 3 IS SET TO 99 FOR A SUBMIT JOB WITH NO
C     OUTPUT, ONLY DISSPLA PLOT FILES SAVED AS DIRECT ACCESS FILES.
C
      LOGICAL QSVPLT
      INTEGER PW,USENUM,NAM(29)
      REWIND 8
      REWIND 23
C     GET JOB STREAM INFO
      CALL USERNUM(NUSN)
      CALL GETCHRG(NCHRG)
C     GET DATA FILE NAME AND RECOVER
      PRINT*,"ENTER NAME OF CONSOLIDATION TEST DATA FILE;"
      PRINT*,"ALSO THE FILE'S USER NUMBER AND PASSWORD, IF"
      PRINT*,"THE FILE IS IN A CATALOG OTHER THAN YOUR USERS' NUMBER."
      PRINT*,"EX.  NAME/UN=USERNUM,PW=PASSWRD"
      READ 100,(NAM(I),I=1,29)
  100 FORMAT(29(A1))
  101 FORMAT(7A1)
      PW=USENUM=1H
      DO 1 I=1,8
    1 IF(NAM(I).EQ.1H/)GOTO 3
      I=8
    3 N=I-1
      ENCODE(7,101,NAME)(NAM(J),J=1,N)
      IF(I.EQ.8)GOTO 8
      J=I+4
      N=J+6
      ENCODE(7,101,USENUM)(NAM(L),L=J,N)
      N=N+5
      DO 5 I=N,29
    5 IF(NAM(I).EQ.55555555555555555555B)GOTO 7
      I=I-1
    7 ENCODE(7,101,PW)(NAM(L),L=N,I)
    8 NAB=2
C     GETTIN IS A FILE MANAGEMENT ROUTINE THAT MAKES THE DATA
C     FILE A LOCAL FILE WITH NAME TAPE5
      CALL GETIN(NAB,5HTAPE5,NAME,USENUM,PW)
C     FLAG PROCEDURE FILE AND EXIT PROGRAM IF FILE NOT FOUND
      IF(NAB.NE.-1)GOTO 9
      CALL SETREG(1,100)
      PRINT*,"THE DATA FILE, ",NAME," WAS NOT FOUND"
      STOP "DATA FILE NOT FOUND"
    9 PRINT*,"ENTER YOUR OUTPUT CONTROL NUMBER OR 9 FOR MORE INFO"
      READ 119,NUM1
      IF(NUM1.NE.9)GOTO 10
      PRINT*,"0 - FORMATTED COPY OF DATA FILE + CONSOLIDATION TEST",
     +" ANALYSIS"
      PRINT*,"1 - CONSOLIDATION TEST + CONSOLIDATION PARAMETERS ANALYSES
```

```
     +","    WITH A FORMATTED COPY OF THE DATA FILE"
      PRINT*,"2 - SAME AS 1 WITHOUT DATA FILE"
      PRINT*,"3 - CONSOLIDATION TEST ANALYSIS ONLY"
      PRINT*,"4 - ABRIDGED CONSOLIDATION TEST ANALYSIS(PHASE RELATIONS "
     +,"ONLY)"
      PRINT*,"5 - CONSOLIDATION PARAMETERS ANALYSIS ONLY"
      READ 119,NUM1
   10 WRITE(8,110)NUM1
      PRINT 102
  102 FORMAT(" ENTER A NUMBER TO DEFINE THE INPUT TO USE WHEN",
     +" CALCULATING SPEC. DRY WEIGHT")
   11 PRINT*,"    1) - INITIAL MOISTURE, OR 2) - MEASURED FINAL WEIGHTS"
      READ 119,NUM1
      IF(NUM1.NE.1.AND.NUM1.NE.2)GOTO 11
      WRITE(8,110)NUM1
      PRINT*,"ENTER A TWO DIGIT NUMBER TO DEFINE YOUR JOB'S EXECUTION"
   12 PRINT*,"ENTER 99 FOR MORE INFO"
      READ 119,NUM1,NUM2
  119 FORMAT(2I1)
      IF(NUM2.NE.9)GOTO 13
      PRINT*,"THE FIRST DIGIT ENTERED (THE TENS' DIGIT) IS THE NUMBER"
      PRINT*,"OF TIME CONSOLIDATION CURVES THAT YOU WANT TO ADJUST,"
      PRINT*,"THAT IS, CHANGE THE DEGREE OF THE POLYNOMIAL CURVE"
      PRINT*,"THAT FITS THE TIME-CONSOLIDATION DATA,AT ANY ONE PRESSURE"
      PRINT*,"IF YOU DO NOT WANT TO CHANGE ANY CURVE FITS, ENTER ZERO."
      PRINT*,"THE SECOND DIGIT ENTERED DEFINES THE MODE OF EXECUTION"
      PRINT*,"1 - FULL OUTPUT AND PLOTS, LINEPRINTER PAPER"
      PRINT*,"2 - FULL OUTPUT AND PLOTS, XEROX PAPER"
      PRINT*,"3 - NO OUTPUT, PLOTS SAVED AS A DIRECT ACCESS FILE"
      PRINT*,"4 - INTERACTIVE USE AT THIS TERMINAL, NO PLOTS"
      PRINT*,"AN EXAMPLE IS  "
      PRINT*,"?02"
      PRINT*," MEANING"
      PRINT*," NO CURVE ADJUSTMENTS, AND XEROX OUTPUT"
      READ 119,NUM1,NUM2
   13 IF(NUM2.EQ.0)GOTO 12
      WRITE(8,110)NUM1
  110 FORMAT(I2)
      IF(NUM1.EQ.0)GOTO 20
      PRINT*,"ENTER THE PRESSURE ON THE CURVE(S) TO BE ADJUSTED"
      PRINT*,"AND THE INTEGER NUMBER THAT THE POLYNOMIAL ORDER IS TO"
      PRINT*,"BE REDUCED BY.  EX. 400.0,4"
      DO 15 I=1,NUM1
      READ*,FORCE,IH1
   15 WRITE(8,113)FORCE,IH1
  113 FORMAT(F8.2,I2)
C     TEST FOR INTERACTIVE USE
   20 IF(NUM2.NE.4)GOTO 30
      CALL SETREG(1,99)
      REWIND 8
      STOP "INTERACTIVE USE"
C     TEST FOR NO OUTPUT WITH SAVED PLOT FILE
C     LOGICAL VARIABLE QSVPLT IS TRUE FOR BATCH JOB RUN,SAVING PLOT FILE
   30 QSVPLT=.FALSE.
      IF(NUM2.EQ.3)QSVPLT=.TRUE.
      IF(.NOT.QSVPLT)GOTO 40
      CALL SETREG(3,99)
```

```
      PRINT*,"ENTER A NAME FOR YOUR PLOT FILE"
      READ 115,IPLT
  115 FORMAT(A7)
      PRINT*,"IT IS YOUR RESPONSIBILITY TO INTERFACE THIS DISSPLA"
      PRINT*,"PLOT FILE ONCE CREATED(SEE A DISSPLA USER'S GUIDE)"
      GOTO 50
   40 PRINT*,"ENTER YOUR FIRST OUTPUT HEADING"
      READ 120,IH1
      PRINT*,"ENTER YOUR SECOND OUTPUT HEADING"
      READ 120,IH2
  120 FORMAT(A10)
   50 PRINT*,"ENTER YOUR JOB'S PRIORITY, P2, P3, P5"
      READ 125,IP
  125 FORMAT(A2)
      IF(QSVPLT)GOTO 60
      PRINT*,"ENTER 'COM' FOR MICROFILM (35MM) PLOTS"
      PRINT*,"ENTER 'XYN' FOR VELLUM FLATBED PLOTS"
      PRINT*,"OR ENTER 'NONE' FOR NO PLOTS"
      READ 115,IPLT
C
C     WRITE SUBMIT TAPE
C
   60 REWIND 23
      WRITE(23,200)IP,NUSN,NCHRG,NCHRG
  200 FORMAT("/JOB"/"SOILS,CM155000,",A2,"."/
     +"USER,",A7,",."/"CHARGE,",A6,",",R4,".")
      IF(QSVPLT)GOTO 70
      WRITE(23,210)IH1
      WRITE(23,210)IH2
  210 FORMAT("HEADING.  ",A10)
      IF(NUM2.EQ.2)WRITE(23,220)
  220 FORMAT("ROUTE,OUTPUT,DC=HR,FC=64,DEF.")
C     WRITE DATA FILE NAME INTO SUBMIT FILE, BRANCH DEPENDING ON ITS LOCATION
   70 IF(USENUM.EQ.1H )GOTO 80
      WRITE(23,230)NAME,USENUM,PW
  230 FORMAT("GET,TAPE5=",A7,"/UN=",A7,",PW=",A7,".")
      GOTO 82
   80 WRITE(23,240)NAME
  240 FORMAT("GET,TAPE5=",A7,".")
   82 IF(QSVPLT)WRITE(23,250)IPLT,IPLT
  250 FORMAT("PURGE,",A7,"/NA."/"DEFINE,PLFILE=",A7,"/M=W.")
      WRITE(23,260)
  260 FORMAT("GET,CON1DB/UN=ER1540A,PW=STA."/"CON1DB."/
     +"IFE,FILE(TAPE15,LO).EQ.0,NOPLOT."/"REWIND,TAPE1.")
      IF(IPLT.EQ.4HNONE)GOTO 85
      WRITE(23,265)
  265 FORMAT("GET,CONPLB/UN=ER1540A,PW=STA."/
     +"ATTACH,DISSPLA/UN=LIBRARY."/"LDSET,LIB=DISSPLA."/"CONPLB.")
      IF(QSVPLT)GOTO 85
      WRITE(23,270)IPLT,IPLT
  270 FORMAT("GET,",A3,"POP/UN=LIBRARY."/A3,"POP.")
   85 WRITE(23,280)
  280 FORMAT("SKIP,DONE."/"ENDIF,NOPLOT."/
     +"*COMMENT MISSING INPUT DATA, PLOTS ABORTED"/"SKIP,DONE."/
     +"EXIT."/"ENDIF,DONE."/"DAYFILE,CONDAY."/"REPLACE,CONDAY."/
     +"/EOR"/"/NOSEQ")
      IF(QSVPLT.OR.IPLT.EQ.4HNONE)GOTO 95
```

```
C     TEST FOR MODE OF PLOTTING AND WRITE NECESSARY INPUT TO TAPE8
      IF(IPLT.EQ.3HXYN)GOTO 90
      WRITE(8,290)IH1,IH2
  290 FORMAT("/EOR"/"ALTID=",A10,";",A10,";CON1D GRAPHICS$"/
     +"SWITCH=YES,SCALEFC=0.60"/
     +"CAMR=35MM,INT=5,END"//)
      GOTO 95
   90 WRITE(8,300)IH1,IH2
  300 FORMAT("/EOR"/"ALTID=",A10,";",A10,"$"/"DISP=YES,END"//)
C     COPY INPUT FILE TO BOTTOM OF SUBMIT FILE(TAPE23)
   95 REWIND 8
      ENDFILE 23
      CALL COPYEI(5HTAPE8,6HTAPE23)
      PRINT*,"YOU MAY LIST THE PERMANENT FILE 'CONDAY'"
      PRINT*,"TO CHECK YOUR JOB'S EXECUTION"
      STOP "NORMAL STOP"
      END
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES
10271	CONGO	1	

VARIABLES		SN	TYPE	RELOCATION								
11617	FORCE		REAL		REFS	102	DEFINED	101				
11607	I		INTEGER		REFS	25	30	32	34	35	40	41
					42	DEFINED	25	29	31	39	41	100
11620	IH1		INTEGER		REFS	102	142	174	179	DEFINED	101	122
11622	IH2		INTEGER		REFS	143	174	179	DEFINED	124		
11623	IP		INTEGER		REFS	138	DEFINED	127				
11621	IPLT		INTEGER		REFS	2*154	159	2*164	171	173		
					DEFINED	116	133					
11612	J		INTEGER		REFS	33	36	37	DEFINED	33	35	
11613	L		INTEGER		REFS	37	42	DEFINED	37	42		
11610	N		INTEGER		REFS	33	37	38	39	42		
					DEFINED	32	36	38				
11614	NAB		INTEGER		REFS	46	48	DEFINED	43			
11624	NAM		INTEGER	ARRAY	REFS	14	30	33	37	40	42	
					DEFINED	25						
11611	NAME		INTEGER		REFS	46	50	149	152	DEFINED	33	
11606	NCHRG		INTEGER		REFS	19	2*138					
11615	NUM1		INTEGER		REFS	54	65	2*71	72	94	96	100
					DEFINED	53	64	70	75	92		
11616	NUM2		INTEGER		REFS	77	93	105	112	145		
					DEFINED	75	92					
11605	NUSN		INTEGER		REFS	18	138					
11603	PW		INTEGER		REFS	14	46	149	DEFINED	28	42	
11602	QSVPLT		LOGICAL		REFS	13	113	129	141	154	163	171
					DEFINED	111	112					
11604	USENUM		INTEGER		REFS	14	46	148	149	DEFINED	28	37

FILE NAMES		MODE									
0	INPUT	MIXED	READS	25	53	64	70	75	92	101	116
			122	124	127	133					
2054	OUTPUT	MIXED	WRITES	21	22	23	24	50	52	55	57
			59	60	61	63	66	69	73	74	78
			79	80	81	82	83	84	85	86	87
			88	89	90	91	97	98	99	115	118
			119	121	123	126	130	131	132	185	186
6204	TAPE23	FMT	WRITES	138	142	143	145	149	152	154	156
			160	164	166	MOTION	16	137	183		
4130	TAPE8	FMT	WRITES	65	72	94	102	174	179		
			MOTION	15	107	182					

EXTERNALS	TYPE	ARGS	REFERENCES		
COPYEI		2	184		
GETCHRG		1	19		
GETIN		5	46		
SETREG		2	49	106	114
USERNUM		1	18		

STATEMENT LABELS			DEF LINE	REFERENCES				
0	1		30	29				
10325	3		32	30				
0	5		40	39				
10356	7		42	40				
10365	8		43	34				
10376	9		52	48				
10422	10		65	54				
10426	11		69	71				
10442	12		74	93				
10506	13		93	77				
0	15		102	100				
10530	20		105	96				
10537	30		111	105				
10557	40		121	113				
10567	50		126	120				
10604	60		137	129				
10621	70		148	141				
10626	80		152	148				
10630	82		154	151				
10644	85		166	159	163			
10656	90		179	173				
10660	95		182	171	178			
10744	100	FMT	26	25				
10746	101	FMT	27	33	37	42		
11045	102	FMT	67	66				
11175	110	FMT	95	65	72	94		
11222	113	FMT	103	102				
11235	115	FMT	117	116	133			
11107	119	FMT	76	53	64	70	75	92
11265	120	FMT	125	122	124			
11277	125	FMT	128	127				
11327	200	FMT	139	138				
11351	210	FMT	144	142	143			
11357	220	FMT	146	145				
11372	230	FMT	150	149				
11404	240	FMT	153	152				

```
STATEMENT LABELS                DEF LINE   REFERENCES
11415  250      FMT               155        154
11427  260      FMT               157        156
11446  265      FMT               161        160
11467  270      FMT               165        164
11500  280      FMT               167        166
11531  290      FMT               175        174
11552  300      FMT               180        179

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
10317  1         I            29 30        5B      INSTACK    EXITS
10350  5         I            39 40        5B      INSTACK    EXITS
10521  15        I           100 102       7B                EXT REFS

STATISTICS
  PROGRAM LENGTH                2257B     1199
  BUFFER LENGTH                10014B     4108
          60000B CM USED
```

```
FWA OF THE LOAD            111
LWA+1 OF THE LOAD        23725

TRANSFER ADDRESS -- CONGO          10402

PROGRAM ENTRY POINTS --       CONGO          10402


      .491 CP SECONDS              40700B CM STORAGE USED                    50 TABLE MOVES
```

```
 CCCCCCCC    OOOOOOOO   NN      NN  VV      VV  EEEEEEEEEE  RRRRRRRRR   TTTTTTTTTT
CCCCCCCCCC  OOOOOOOOOO  NNN     NN  VV      VV  EEEEEEEEEE  RRRRRRRRRR  TTTTTTTTTT
CC        C OO      OO  NN N   NN   VV    VV   EE          RR      RR      TT
CC          OO      OO  NN NN  NN   VV    VV   EE          RR      RR      TT
CC          OO      OO  NN  NN NN   VV    VV   EEEEE       RRRRRRRRRR      TT
CC          OO      OO  NN  NN NN   VV    VV   EEEEE       RRRRRRRRR       TT
CC          OO      OO  NN   NN NN    VV  VV    EE          RR   RR         TT
CC        C OO      OO  NN    N NN    VV  VV    EE          RR    RR        TT
CCCCCCCCCC  OOOOOOOOOO  NN     NNN     VVVV     EEEEEEEEEE  RR     RR       TT
 CCCCCCCC    OOOOOOOO   NN      NN      VV      EEEEEEEEEE  RR      RR      TT
```

```
      PROGRAM CONVERT(INPUT,OUTPUT,TAPE1,TAPE5)
C
C     A FORTRAN4 PROGRAM USED TO CONVERT CONSOLIDATION DATA FILES
C     FROM THE OLD FORMAT(BEFORE FEB. 1983)TO THE NEW FORMAT USED
C     BY THE CONSOLIDATION PROGRAM 'CON1D'. CONVERT IS CALLED BY
C     THE CONSOLIDATION PROCEDURE FILE 'CON1DP'.
C
      INTEGER WORDS(15),SPTYPE,NAME
      PRINT*,"ENTER THE NAME OF YOUR CONSOLIDATION DATA FILE"
      READ100,WORDS(1)
      NAB=2
      CALL GETIN(NAB,5HTAPE5,WORDS(1))
      IF(NAB.NE.-1)GOTO 1
      PRINT*,"THE DATA FILE ",WORDS(1),"WAS NOT FOUND"
      CALL SETREG(2,1)
      STOP "FILE NOT FOUND"
    1 READ(5,120)(WORDS(I),I=1,5),SPTYPE
      WRITE(1,120)(WORDS(I),I=1,5),SPTYPE
      READ(5,200)(WORDS(I),I=1,6)
      WRITE(1,200)(WORDS(I),I=1,6)
      READ(5,200)(WORDS(I),I=1,6)
      WRITE(1,200)(WORDS(I),I=1,6)
      PRINT*,"ENTER THE INITIAL AND FINAL WATER CONTENTS(%) OF THE"
      PRINT*,"SAMPLE.ENTER A ZERO FOR THE FINAL WATER CONTENT IF ITS"
      PRINT*,"VALUE IS TO BE CALCULATED FROM THE MEASURED FINAL WEIGHTS"
      PRINT*,"EX. 16.8,27.3  OR 16.8,0"
      READ*,A,B
      WRITE(1,160)A,B
      READ(5,200)(WORDS(I),I=1,5)
      A=0.0
      IF(SPTYPE.EQ.2)GOTO 5
      PRINT*,"ENTER THE EFFECTIVE OVERBURDEN PRESSURE"
      READ*,A
    5 WRITE(1,201)(WORDS(I),I=1,5),A
   10 READ(5,200)(WORDS(I),I=1,8)
      IF(EOF(5))20,15
   15 WRITE(1,200)(WORDS(I),I=1,8)
      GOTO 10
   20 REWIND 1
      PRINT*,"ENTER A NAME AND PASSWORD FOR THE NEW CONSOLIDATION"
      PRINT*,"DATA FILE.  EX. FNAME,SECRET"
      READ210,(WORDS(I),I=1,15)
      DO 25 I=1,8
   25 IF(WORDS(I).EQ.1H,)GOTO 30
      I=8
   30 N=I-1
      ENCODE(7,220,NAME)(WORDS(L),L=1,N)
      N=N+2
      I=N+6
      WORDS(1)=55555555555555555555B
      ENCODE(7,220,WORDS(1))(WORDS(L),L=N,I)
      CALL SAVE(5HTAPE1,NAME,WORDS(1),2HPU)
      PRINT230,NAME,WORDS(1)
      STOP "NORMAL STOP"
C
C
  100 FORMAT(A7)
```

```
                 120 FORMAT(5A10,4X,I2)
                 160 FORMAT(24X,2F8.2)
                 200 FORMAT(8A10)
                 201 FORMAT(8X,5A10/8X,F8.2)
                 210 FORMAT(15A1)
                 220 FORMAT(7A1)
                 230 FORMAT("THE NEW DATA FILE NAMED, ",A7/"WITH PASSWORD, ",A7,
                    +" HAS BEEN SAVED UNDER A PUBLIC STATUS"/
                    +"ENTER THIS NAME AT THE NEXT QUESTION")
                     END
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
10271  CONVERT        1

VARIABLES      SN  TYPE            RELOCATION
10701  A           REAL                          REFS        28        34    DEFINED       27        30        33
10702  B           REAL                          REFS        28    DEFINED       27
10700  I           INTEGER                       REFS        17        18        19        20        21        22        29
                                                   34        35        37        42        44        46        51
                                             DEFINED         17        18        19        20        21        22        29
                                                   34        35        37        42        43        45        49
10704  L           INTEGER                       REFS        47        51    DEFINED       47        51
10703  N           INTEGER                       REFS        47        48        49        51    DEFINED       46        48
10677  NAB         INTEGER                       REFS        12        13    DEFINED       11
10676  NAME        INTEGER                       REFS         8        52        53    DEFINED       47
10675  SPTYPE      INTEGER                       REFS         8        18        31    DEFINED       17
10705  WORDS       INTEGER     ARRAY             REFS         8        12        14        18        20        22        34
                                                   37        44        47        51        52        53
                                             DEFINED         10        17        19        21        29        35        42
                                                   50        51

FILE NAMES          MODE
    0  INPUT       MIXED                READS        10        27        33        42
 2054  OUTPUT      MIXED               WRITES         9        14        23        24        25        26        32        40
                                            41        53
 4130  TAPE1       FMT                 WRITES        18        20        22        28        34        37
                                       MOTION        39
 6204  TAPE5       FMT                  READS        17        19        21        29        35

EXTERNALS            TYPE    ARGS       REFERENCES
       EOF         REAL        1            36
       GETIN                   3            12
       SAVE                    4            52
       SETREG                  2            15

STATEMENT LABELS                DEF LINE    REFERENCES
10307  1                           17          13
10350  5                           34          31
10352  10                          35          38
    0  15            INACTIVE      37          36
10361  20                          39          36
```

```
STATEMENT LABELS              DEF LINE   REFERENCES
    0  25                        44         43
10400  30                        46         44
10630  100      FMT              57         10
10632  120      FMT              58         17         18
10635  160      FMT              59         28
10637  200      FMT              60         19         20         21         22         29         35         37
10641  201      FMT              61         34
10644  210      FMT              62         42
10646  220      FMT              63         47         51
10650  230      FMT              64         53

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
10372  25        I            43 44        5B       INSTACK     EXITS

STATISTICS
  PROGRAM LENGTH                 1011B      521
  BUFFER LENGTH                 10014B     4108
          60000B CM USED
```

```
 CCCCCCCC    OOOOOOOO   NN      NN      11      DDDDDDDDD    SSSSSSSS
CCCCCCCCCC  OOOOOOOOOO  NNN     NN    1111      DDDDDDDDDD  SSSSSSSSSS
CC        C OO      OO  NN N   NN    1 11      DD      DD  SS        S
CC          OO      OO  NN NN  NN      11      DD      DD  SS
CC          OO      OO  NN  NN NN      11      DD      DD  SSSSSSSS
CC          OO      OO  NN  NN NN      11      DD      DD   SSSSSSSS
CC          OO      OO  NN   NN NN     11      DD      DD          SS
CC        C OO      OO  NN    N NN     11      DD      DD  S       SS
CCCCCCCCCC  OOOOOOOOOO  NN     NNN  1111111111 DDDDDDDDDD  SSSSSSSSSS
 CCCCCCCC    OOOOOOOO   NN      NN  1111111111 DDDDDDDDD    SSSSSSSS
```

```
      PROGRAM CON1D(INPUT,OUTPUT,TAPE1,TAPE5,TAPE6=OUTPUT,TAPE15)
C
C     ALGORITHM FOR ANALYZING STANDARD 1-DIM. COMPRESSION TEST DATA
C
      DIMENSION P(51),DR1(50,51),PCON(50),CONM(50),
     +VR(50),DD(50),H(50),VOIDS(50),W(50),HWAT(50),SAT(50),
     +CONSOL(50,50),MM(50),ELAPSE(50,51),CORR(51),SPTYPE(2),
     +SLOPE1(101),X1(103),RAD(101),
     +RX(2),RY(2),PRECON(2),NDGADJ(20),PADJ(20),
     +TIMELG(50),VRPCON(2),CR(2),C(12),CC(2),DUMB(20)
C
C     DEFINE FUNCTIONS
C
      POLY(C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,X)=
     +C1+C2*X+C3*X*X+C4*X**3+C5*X**4+C6*X**5+C7*X**6+
     +C8*X**7+C9*X**8+C10*X**9+C11*X**10+C12*X**11
      D1(C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,X)=C2+C3*X+
     +C3*X+3*C4*X*X+4*C5*X**3+5*C6*X**4+6*C7*X**5+7*C8*X**6+
     +8*C9*X**7+9*C10*X**8+10*C11*X**9+11*C12*X**10
      D2(C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,X)=2*C3+6*C4*X+
     +12*C5*X*X+20*C6*X**3+30*C7*X**4+42*C8*X**5+56*C9*X**6+
     +72*C10*X**7+90*C11*X**8+110*C12*X**9
C
C     PROGRAM ANALYZES STANDARD 1-D COMPRESSION OR EXPANSION TEST DATA. DATA
C     REDUCTION ANALYSIS CALCULATES AXIAL STRAIN AS A FUNCTION OF DIAL READING
C     CHANGES. SPECIMEN PHASE RELATIONSHIPS,VOID RATIO,WATER CONTENT,ETC., ARE
C     COMPUTED AT THE STEADY-STATE CONDITIONS FOR EACH LOAD. CONSOLIDATION DATA
C     CAN BE FURTHER ANALYZED USING AUTOMATION OF MANUAL GRAPHIC TECHNIQUES TO
C     DETERNIME STRESS DEPENDENT SETTLEMENT PARAMETERS,I.E. PRECONSOLIDATION
C     PRESSURE AND IN SITU COMPRESSION INDEX, AND TO DETERMINE TIME DEPENDENT
C     CONSOLIDATION PARAMETERS, COEF. OF CONSOLIDATION AND PERMEABILITY. DATA
C     INPUT CONFORMS TO ADP SHEETS EL-548 AND EL-550. ASSOCIATED PROGRAMS ARE
C     CON1DP,A PROCEDURE FILE TO EXECUTE CON1D,AND CONPLOT, THE PLOTTING PROGRAM
C
C
C     CON1D WAS WRITTEN BY STEPHEN GAVLICK  JANURARY,1981
C     UPDATES - JANURARY,1982   MARCH,1983
C     VERSION  0
C
C
C     THE 6000 STATEMENTS WRITE A FORMATED COPY OF TAPE5 TO OUTPUT
C
C     READ OUTPUT CONTROL PARAMETER FROM INPUT;BRANCH ACCORDINGLY
C
      READ 5010,IOUT
      IF(IOUT.GT.1)GOTO 6005
C
C     WRITE FORMATTED COPY OF DATA FILE TO OUTPUT
C
      JJ=0
      J=0
      WRITE 1000
 6001 WRITE 6030,(I,I=1,7)
      WRITE 6040,((I,I=1,9),IJ=1,8)
 6002 J=J+1
      JJ=JJ+1
      READ(5,6010)(MM(I),I=1,8)
```

```
      IF(EOF(5))6004,6003
 6003 WRITE 6020,J,(MM(I),I=1,8),J
      IF(JJ.EQ.29)WRITE 6040,((I,I=1,9),IJ=1,8)
      IF(JJ.NE.56)GOTO 6002
      JJ=0
      WRITE 6040,((I,I=1,9),IJ=1,8)
      WRITE 1000
      GOTO 6001
 6004 WRITE 6040,((I,I=1,9),IJ=1,8)
 6005 REWIND 5
C
C     READ INPUT TYPE FOR CALCULATION OF TOTAL DRY WEIGHT
C
      READ 5010,ITDW
C
C     READ NUMBER OF PRESSURE ADJUSTMENTS FROM INPUT
C
      READ 5010,NPADJ
      IF(NPADJ.EQ.0)GO TO 1
C
C     ENTER CORRECTIONS FOR THE ORDER OF THE TIME CONSOLIDATION
C     POLYNOMIALS THRU INPUT FILE
C
      READ 5011,(PADJ(I),NDGADJ(I),I=1,NPADJ)
C
C     READ CONSOLIDATION DATA FROM TAPE5
C
    1 READ(5,1001)SAMP,NSP,DH,DEP,DEPTH,CLASS,SPG,ITYPE
      IF(EOF(5).NE.0)STOP "NORMAL EXIT"
      READ(5,1002)DATEP,LUN,CH,CD,PI,LL,SL
      READ(5,1003)WSR,WSRC,DR2,DR3,DATEO
      READ(5,1004)WI1,WF1,WWSPCF,DWSPCF,WCF,DWTCF,WCTF,LSAT
      READ(5,1005)NDEG,PINSTU,BOUND1,BOUND2,BOUND3,BOUND4
      OVERFLO=0.0
      NCYCLE=1
      N2CYC=1
      J=1
    2 READ(5,1006)P(J),CORR(J)
      I=1
    3 READ(5,1007)ELAPSE(I,J),DR1(I,J)
      IF(ELAPSE(I,J).EQ.99.)GO TO 4
      I=I+1
      GO TO 3
    4 MM(J)=I-1
      IF(DR1(I,J).GE.9.9999)GO TO 5
      J=J+1
C
C     CHECK FOR MORE THAN 50 LOADS
C
      IF(51-J)6,6,2
    6 OVERFLO=1.0
      J=51
      GO TO 2
    5 N=J
C
C     DETERMINE TYPE OF TEST; STORE IN VARIABLE ITYPE
C         0 - CONSOLIDATION
```

```
C          1 - UPLIFT
C          2 - EXPANSION
C      PACK ALPHANUMERIC OF SPECIMEN TYPE IN SPTYPE ARRAY
C
       DO 600 I=1,3
  600  IF(ITYPE.LT.10*I)GOTO 601
       STOP "ERROR IN TYPE OF TEST"
  601  I=I-1
       ISPTY=ITYPE-10*I
       ITYPE=I
       IF(ISPTY.NE.1)GOTO 7
       SPTYPE(1)=10HUNDISTURBE
       SPTYPE(2)=1HD
       GOTO 8
    7  SPTYPE(1)=10H REMOLDED
       SPTYPE(2)=1H
    8  IF(IOUT.GT.3)GO TO 9
C
C      WRITE HEADING AND TEST DATA INPUTS TO OUTPUT,ALSO TO TAPE1.
C
       WRITE(6,700)
       IF(ITYPE-1)610,615,620
  610  WRITE(6,710)
       GOTO 630
  615  WRITE(6,720)
       GOTO 630
  620  WRITE(6,730)
  630  WRITE(6,1008)SAMP,NSP,SPTYPE(1),SPTYPE(2),DATEP,DATEO,SPG,CD,CH
    9  WRITE(1,5003)SAMP,NSP,DH,DEP,DEPTH,CLASS,SPG,CH,CD,SPTYPE,
      +IOUT,ITYPE,LSAT,PI,LL,SL
C
C      SET CORRECTION FACTOR TO ACCOUNT FOR DIFFERENT DIAL
C      DIRECTION MOVEMENT.ALSO OUTPUT LOADING UNIT NUMBER.
C
       IF(LUN-100)10,11,12
   12  IF(LUN-500)11,13,14
   14  IF(LUN-600)13,15,15
   10  CDIAL=1.0
       IF(IOUT.GT.3)GO TO 20
       WRITE(6,1009)LUN
       GO TO 20
   11  CDIAL=-1.0
       IF(IOUT.GT.3)GO TO 20
       WRITE(6,1010)LUN
       GO TO 20
   13  CDIAL=1.0
       IF(IOUT.GT.3)GO TO 20
       WRITE(6,1011)LUN
       GO TO 20
   15  CDIAL=-1.0
       IF(IOUT.GT.3)GO TO 20
       WRITE(6,1012)LUN
C
C      CALCULATE SPECIMEN CONSTANTS AND SOIL PARAMETERS
C
   20  CAI=3.141592654/4.0*(CD*CD)
       CAC=CAI*6.4516
```

```
      CF=(453.6*CAI/144.0)/12.0
      WWS=WSR-WSRC
      HI=CH+(CDIAL*(DR3-DR2))
C
C     CALCULATE DRY WEIGHT AND WATER CONTENTS FROM DIFFERENT DATA INPUTS
C     THEN SET VARIABLES TO BE USED IN CONSOL. ANALYSIS FROM INPUT TYPE SELECTED
C
      TDW1=WWS/(WI1/100.0+1.0)
      TDW2=DWSPCF-WCF+DWTCF-WCTF
      WI2=(WWS/TDW2-1.0)*100.0
      WF2=(WWSPCF-DWSPCF)*100.0/(DWSPCF-WCF)
      HO1=TDW1/(CAC*SPG*2.54)
      VRI1=(HI-HO1)/HO1
      HO2=TDW2/(CAC*SPG*2.54)
      VRI2=(HI-HO2)/HO2
      IF(WF1.EQ.0.0)WF1=WF2
      IF(ITDW.EQ.2)GOTO 22
      TDW=TDW1
      WI=WI1
      WF=WF1
      HO=HO1
      VRI=VRI1
      GOTO 24
   22 TDW=TDW2
      WI=WI2
      WF=WF2
      HO=HO2
      VRI=VRI2
   24 DMAX=0.0
      AMAX=1.0E-50
      AMIN=1.0E99
      BMAX=0.0
      CMAX=0.0
      HMAX=0.0
      PMAX=0.0
      LINECT=0
      IF(N.LT.51)GO TO 25
      N=50
   25 WRITE(1,5004)N,(MM(I),I=1,N)
C
C     LOOP 40 CALCULATES AND OUTPUTS,VOID RATIO,DRY DENSITY AND MAX.
C     CONSOLIDATION FOR EACH LOAD.IT ALSO OUTPUTS PERCENT CONSOLIDATION
C     FOR EACH LOAD-TIME SEQUENCE INPUT.
C
      DO 40 J=1,N
      M=MM(J)
      IF(J.EQ.1)LINECT=16
C
C     LOOP 30 CALCULATES SPECIMEN CONSOLIDATION AS THE CHANGE IN
C     CORRECTED DIAL READINGS (SEATING LOAD READING - DIAL
C     READING CORRECTED FOR DEFLECTIONS) OVER THE INITIAL
C     HEIGHT, IN PERCENT. THE SIGN OF THE CONSOLIDATION IS ADJUSTED
C     TO ACCOUNT FOR DIFFERENT DIAL MOVEMENTS.
C     NOTE - FOR IMPROVEMENTS IN NOMENCLATURE ALL OUTPUT REFERENCES
C     TO PERCENT CONSOLIDATION HAVE BEEN CHANGED TO PERCENT AXIAL
C     STRAIN (JANUARY 1983)
C
```

```
      DO 30 I=1,M
      DRCORR=DR1(I,J)+CORR(J)*CDIAL
      PERCON=100.0*CDIAL*(DR3-DRCORR)/HI
      IF(PERCON.GT.AMAX)AMAX=PERCON
      IF(PERCON.LT.AMIN)AMIN=PERCON
   30 CONSOL(I,J)=PERCON
      CONM(J)=PERCON
      H(J)=HI-(DR3-DRCORR)*CDIAL
      VOIDS(J)=H(J)-HO
      VR(J)=VOIDS(J)/HO
      DD(J)=TDW/(CF*H(J))
      WRITE(1,10001)P(J),CONM(J),VR(J)
      IF(IOUT.GT.3)GO TO 32
      IF(60-LINECT.LT.6+M)WRITE(6,1000)
      IF(60-LINECT.LT.6+M)LINECT=0
      LINECT=LINECT+6+M
      WRITE(6,1013)P(J),CONM(J),DD(J),VR(J)
   32 DO 33 I=1,M
      WRITE(1,10002)ELAPSE(I,J),CONSOL(I,J)
      IF(IOUT.GT.3) GO TO 33
      WRITE(6,1014)ELAPSE(I,J),CONSOL(I,J)
   33 CONTINUE
C
C     STORE READING NUMBER OF MAX. EXTENDED LOAD FOR
C     UPLIFT AND EXPANSION PLOT
C
      IF(H(J).LT.HMAX)GOTO 35
      HMAX=H(J)
      NEXPT=J
C
C     STATEMENTS 35-40 COMPUTE MAXIMUM CONSOLIDATION PROPERTIES.ALSO
C     COMPUTED ARE THE NUMBER OF LOADING CYCLES(NCYCLE),THE NUMBER OF
C     COMPRESSIVE LOADS IN THE FIRST LOADING CYCLE(NN),THE TOTAL NUMBER
C     OF LOADS IN THE FIRST CYCLE(N1CYC),AND THE NUMBER OF LOADS IN THE
C     LOAD-UNLOAD-RELOAD CYCLE UP TO BUT NOT SURPASSING THE MAXIMUM LOAD
C     OF THE FIRST LOADING CYCLE(N2CYC).
C
   35 IF(PMAX-P(J))36,36,38
   36 IF(NCYCLE.EQ.2.AND.P(J-1).LE.P(NN))N2CYC=J-1
      PMAX=P(J)
      NCPTS=J
      BMAX=H(J)
      CMAX=VR(J)
      DMAX=VOIDS(J)
      GO TO 40
   38 IF(NCYCLE.EQ.1.AND.(P(J).GT.P(J-1).OR.P(J+1).GE.PMAX))GOTO 39
      IF(NCYCLE.GT.1)GO TO 40
      N1CYC=J
      GO TO 40
   39 NCYCLE=NCYCLE+1
      NN=NCPTS
      N1CYC=J-1
   40 CONTINUE
      IF(NCYCLE.EQ.1)NN=NCPTS
      IF(N2CYC.EQ.1)N2CYC=N1CYC
      REB=((AMAX-CONM(N))/AMAX)*100.0
C
```

```
C     CALCULATE PHASE CONDITIONS INITIALLY
C
      DDI=TDW/(CF*HI)
      HW=((TDW*WI)/(CAC*2.54))/100.0
      DSI=(HW*100.0)/(HI-HO)
      DSIP=SPG*WI/VR(1)
      EHW=((TDW*WF)/(CAC*2.54))/100.0
C
C     PROGRAM ASSUMES SATURATION AT THE LAST LOAD.IT CALCULATES FROM
C     FINAL CONDITIONS THE HEIGHT(I.E. VOLUMNE)OF THE ENTRAPPED AIR
C     AND ASSUMES THAT IT IS CONSTANT DURING ENTIRE TEST. IF THE
C     CALCULATED HEIGHT OF ENTRAPPED AIR IS NEGITIVE THEN PROGRAM
C     SETS A FLAG,CALCULATES THE DEGREE OF SATURATION AT MAX. LOAD
C     FOR AN ENGINEERS COMPARISON AND SETS ENTRAPPED AIR TO ZERO.
C
      EHA=H(N)-HO-EHW
      DUMB(1)=0.0
      IF(EHA.GT.0.0)GOTO 41
      DUMB(1)=1.0
      DUMB(2)=(BMAX-HO-EHA)/DMAX*100.0
      EHA=0.0
C
C     CALCULATE PHASE CONDITIONS AT MAX. LOAD
C
   41 DDML=TDW/(CF*BMAX)
      HWM=BMAX-HO-EHA
      CMLM=(HWM*CAC*254.0)/TDW
      DSML=(HWM*100.0)/DMAX
      DSML2=(SPG*CMLM)/CMAX
      VRML1=BMAX/HO1-1.0
      VRML2=BMAX/HO2-1.0
      DO 50 I=1,N
C
C     CALCULATE HEIGHT OF WATER,WATER CONTENT AND DEGREE OF SATURATION
C     AS A FUNCTION OF THE LOAD NUMBER WHERE SOIL WAS WETTED.
C
      IF(LSAT.EQ.0)GO TO 42
      IF(I-LSAT)42,44,44
   42 IF(H(I)-HO-HW-EHA)44,43,43
   43 W(I)=WI
      GO TO 45
   44 HWAT(I)=H(I)-HO-EHA
      W(I)=(HWAT(I)*CAC*254.0)/TDW
   45 SAT(I)=(SPG*W(I))/VR(I)
   50 CONTINUE
      IF(IOUT.GT.4)GO TO 60
C
C     OUTPUT RESULTS IN TABULAR FORM
C
      IF(60-LINECT.LT.N+36)WRITE(6,1000)
      IF(IOUT.EQ.4)WRITE(6,1015)SAMP,NSP
      WRITE(6,1016)
      DO 52 I=1,N
   52 WRITE(6,1017)P(I),H(I),VR(I),DD(I),W(I),SAT(I),CONM(I)
      WRITE(6,1018)DDI,DDML,WI,CMLM,DSI,DSML,DSIP,DSML2
      WRITE(6,1019)REB
      WRITE(6,1020)TDW1,TDW2,WI1,WI2,WF1,WF2,VRI1,VRI2,VRML1,VRML2
```

```
      IF(ITDW.EQ.2)GOTO 55
      WRITE(6,1021)
      GOTO 56
   55 WRITE(6,1022)
   56 IF(DUMB(1).EQ.1.0)WRITE(6,1032)DUMB(2)
      IF(ITYPE.EQ.1)WRITE(6,740)PMAX
      IF(ITYPE.EQ.2)WRITE(6,750)AMIN
   60 WRITE(1,5006)DDI,DDML,WI,CMLM,DSI,DSML,REB
     +,W(NEXPT),SAT(NEXPT),DD(NEXPT),VRI
C
C     TEST OUTPUT CONTROL AND TYPE OF TEST;BRANCH ACCORDINGLY
C
      CHSTOP=0.0
      IF(ITYPE.NE.0.OR.IOUT.EQ.4)GOTO 63
      IF(IOUT.NE.0.AND.IOUT.NE.3)GOTO 61
      WRITE(6,2055)
      GOTO 63
C
C     CHECK FOR EXPANSIVE SOIL; IF TRUE PRINT MESSAGE AND STOP
C
   61 DO 62 J=2,NN
      M=MM(J)
   62 IF(CONM(J).LT.CONM(J-1).OR.CONSOL(M,J).LT.CONSOL(2,J))CHSTOP=1.0
      IF(CHSTOP.EQ.1.0)WRITE(6,2060)
      GOTO 64
   63 CHSTOP=1.0
   64 WRITE(1,5005)NN,N1CYC,N2CYC,PMAX,CMAX,CHSTOP,AMIN
      IF(CHSTOP.EQ.1.0)GO TO 375
C
C     STRESS DEFORMATION ANALYSIS
C
C     CHECK AND SET DEFAULT BOUNDARIES IF NECESSARY
C
      IF(BOUND1.LT.0.1)BOUND1=4.5
      IF(BOUND2.LT.0.1)BOUND2=P(NN-1)-P(NN-2)/2
      IF(BOUND3.LT.0.1)BOUND3=P(3)
      IF(BOUND4.LT.0.1)BOUND4=P(NN)
      IF(NDEG.GT.NN-1.OR.NDEG.EQ.0)NDEG=NN-1
      IF(NDEG.GT.11)NDEG=11
C
C     WRITE HEADING TO OUTPUT.WRITE TO TAPE1.
C
      WRITE(6,2050)SAMP
      WRITE(6,1023)NDEG,BOUND1,BOUND2,BOUND3,BOUND4,PINSTU,VR(1)
      WRITE(1,10003)NDEG,BOUND1
C
C     ISOLATE EXPANSION AND RELOAD DATA POINTS
C
      J=0
      DO 70 I=NN,N2CYC
      J=J+1
      DUMB(J)=VR(I)
   70 PCON(J)=ALOG10(P(I))
      NEXPT=J
C
C     GET LINEAR LEAST SQUARES FIT OF THE REBOUND LOOP
C     AND DEFINE EXPANSION/REBOUND SLOPE
```

```
C
      CALL LSQFT(PCON,DUMB,NEXPT,1,CC)
      SLOPEE=CC(2)
C
C     FIND POLYNOMIAL FITS FOR THE ELOG P CURVE
C
      DO 85 I=1,NN
   85 PCON(I)=ALOG10(P(I))
C
C     CALL LEAST SQUARES FITTING ROUTINE TO GET A POLYNOMIAL FIT
C     OF THE COMMPRESSIVE DATA POINTS IN THE FIRST LOADING CYCLE
C
      CALL LSQFT(PCON,VR,NN,NDEG,C)
C
C     FIND VIRGIN COMPRESSION LINE
C
      CHECK=0.0
      XBIG=0.0
      BIG=0.0
      BOUND1=ALOG10(BOUND1)
      BOUND2=ALOG10(BOUND2)
      BOUND3=ALOG10(BOUND3)
      BOUND4=ALOG10(BOUND4)
C
C     ITERATE BETWEEN BOUNDS 3 AND 4 TO FIND THE STEEPEST SLOPE WITH A
C     PERCENT CHANGE OF .02% OR LESS FROM THE PREVIOUS ITERATION.
C     THIS IS THE PRIMARY CRITERIA FOR FINDING THE COMPRESSION LINE
C
      DELTA=(BOUND4-BOUND3)/100.0
      X1(1)=BOUND3
      DO 100 J=1,101
      SLOPE1(J)=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X1(J))
      IF(J.EQ.1)GO TO 95
      DIFF=ABS((SLOPE1(J)-SLOPE1(J-1))/SLOPE1(J))
      IF(DIFF.LE..00019)CHECK=1.0
      IF(DIFF.GT..00019)GO TO 95
      IF(ABS(SLOPE1(J)).LT.ABS(BIG))GO TO 95
      XBIG=X1(J)
      BIG=SLOPE1(J)
   95 X1(J+1)=X1(J)+DELTA
  100 CONTINUE
      IF(CHECK.GT.0.5)GO TO 120
C
C     IF THE PRIMARY CRITERIA HAS FAILED FIND THE STEEPEST
C     SLOPE WITH ITS CORRESPONDING POINT OF TANGENCY
C
      DO 110 I=1,101
      IF(ABS(SLOPE1(I)).LT.ABS(BIG))GO TO 110
      BIG=-ABS(SLOPE1(I))
      XBIG=X1(I)
  110 CONTINUE
  120 CONTINUE
C
C     CHECK TO SEE IF THE POINT OF TANGENCY LIES BETWEEN THE LAST TWO
C     COMPRESSIVE LOAD ORDINATES ;IF NOT USE THE ABOVE DETERMINED SLOPE
C     WITH ITS TANGENCY POINT TO DEFINE THE VIRGIN COMPRESSION LINE
```

```
C
      KSLOPE=0
      YBIG=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),XBIG)
      IF(YBIG.GE.VR(NN-1))GO TO 130
C
C     IF PT. OF TANGENCY IS BETWEEN LAST TWO LOAD POINTS,TEST FOR
C     SPECIMEN WETTING AT THE MAXIMUM COMPRESSIVE LOAD.IF TRUE CHOOSE THE
C     SECOND TO THE LAST LOAD-VOID RATIO COORDINATE WITH ITS CORRESPONDING
C     SLOPE TO REPRESENT THE VIRGIN COMPRESSION LINE.IF FALSE COMPARE THE
C     SLOPE BETWEEN THE LAST TWO COMPRESSION COORDINATES WITH THE ENTRY
C     SLOPE.IF THE SLOPE BETWEEN THE LAST TWO POINTS IS SHALLOWER THAN THE
C     ENTRY SLOPE THE PROGRAM DEFAULTS TO A POINT OF TANGENCY AT THE LAST
C     COMPRESSIVE LOAD COORDINATE WITH A SLOPE EQUAL TO A 3 TO 1 RATIO,
C     WEIGHTED TOWARDS THE SHALLOWER SLOPE.
C
      IF(PCON(NN).EQ.PCON(NN-1))GO TO 125
      SLOPE2=(VR(NN)-VR(NN-1))/(PCON(NN)-PCON(NN-1))
      IF(ABS(SLOPE2).GE.ABS(BIG))GO TO 130
      SLOPEM=SLOPE2-ABS(SLOPE2-BIG)/3.0
      KSLOPE=999
      YBIG=VR(NN)
      XBIG=PCON(NN)
      GO TO 130
  125 YBIG=VR(NN-1)
      XBIG=PCON(NN-1)
      BIG=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10),
     +C(11),C(12),XBIG)
  130 SLOPED=BIG
      IF(KSLOPE.EQ.999)SLOPED=SLOPEM
C
C     DEFINE VIRGIN COMPRESSION LINE
C
      CEPTD=YBIG-SLOPED*XBIG
C
C     FIND PT. OF MAX. CURVATURE USING GRAPHICAL METHOD
C
      BOUND5=BOUND2
      BOUND=BOUND1
C
C     DEFINE A LINE TANGENT TO THE TOP OF THE COMPRESSIVE CURVE WITH A SLOPE
C     EQUAL TO THE REBOUND SLOPE AND A POINT OF TANGENCY BETWEEN BOUNDS 1 AND 2
C
      J=0
  135 J=J+1
      DELTA=ABS(BOUND2-BOUND1)/100.0
      DO 140 I=1,101
      X1(1)=BOUND1
      SLOPE1(I)=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X1(I))
      IF(SLOPE1(I).LT.SLOPEE)GO TO 145
  140 X1(I+1)=X1(I)+DELTA
  145 IF(I.EQ.1)GO TO 147
      BOUND2=X1(I)
      BOUND1=X1(I-1)
      IF(J.LT.3)GO TO 135
      X=BOUND1
```

```
  147 IF(I.NE.1)GO TO 148
      X=BOUND
      IF(PCON(1).EQ.PCON(2))GO TO 148
C
C     IF A TANGENT TO THE COMPRESSIVE CURVE AT THE FIRST BOUNDARY IS STEEPER
C     THAN THE REBOUND SLOPE THE PROGRAMS DEFAULTS TO LOCATING THE TANGENT
C     LINE AT THIS BOUNDARY ABSCISSA WITH A SLOPE EQUAL TO THE REBOUND SLOPE
C     OR THE SLOPE BETTWEEN THE FIRST TWO DATA POINTS,WHICHEVER IS THE BEST FIT
C
      SLOPET=(VR(1)-VR(2))/(PCON(1)-PCON(2))
      IF(SLOPET.LT.SLOPEE.AND.SLOPET.GT.SLOPE1(1))SLOPEE=SLOPET
  148 BOUND2=BOUND5
      Y=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      CEPTAN=Y-SLOPEE*X
C
C     FIND INTERSECTION OF TANGENT LINE AND VIRGIN COMPRESSION LINE
C
      XI=(CEPTAN-CEPTD)/(SLOPED-SLOPEE)
      YI=CEPTAN+XI*SLOPEE
C
C     SET GRAPHIC SCALES TO GET SCALE FACTOR OF THE E LOG P PLOT
C
      ACC=3.141592654/180.0
      TVR=(VR(1)+.02)*100.0
      ITVR=TVR
      TVR=ITVR/100.0
      BVR=(AMIN1(VR(NN),VR(N2CYC)))*100.0
      IBVR=BVR
      BVR=IBVR/100.0
      VRCHG=(TVR-BVR)*100.0
      IVRCHG=VRCHG
      IODOEV=IVRCHG/2
      IODOEV=IODOEV*2
      IF(IVRCHG.GT.IODOEV)BVR=BVR-.01
      VRCHG=TVR-BVR
      LEXIT=0
C
C     SCALE VOID RATIO CHANGE,,TO A 6 INCH PLOTTING AXIS
C
      DO 151 I=1,8
      IF(LEXIT.EQ.1)GO TO 155
      IF(VRCHG.GT.5.4-(I*0.6))LEXIT=1
      IF(LEXIT.EQ.1)VRSCAL=1.0-(I*0.1)
  151 CONTINUE
      DO 153 I=1,9
      IF(LEXIT.EQ.1)GO TO 155
      IF(VRCHG.GT.0.6-(I*0.06))LEXIT=1
      IF(LEXIT.EQ.1)VRSCAL=0.11-(I*0.01)
  153 CONTINUE
      VRSCAL=0.01
C
C     THE SCALE FACTOR,F,EQUALS THE VOID RATIO CHANGE PER GRAPHIC INCH OVER
C     THE LOG OF PRESSURE CHANGE PER INCH(2.64 INCHES PER LOG CYCLE)
C
  155 F=VRSCAL/.378788
      ANGLE=(ATAN(ABS(SLOPEE/F))+ATAN(ABS(F/SLOPED))+90.0*ACC)
```

```
C
C     BISECT THE INTERIOR ANGLE FORMED AT THE INTERSECTION OF THE
C     VIRGIN COMPRESSION LINE AND THE TOP TANGENT LINE
C
      ANGBI=ANGLE/2.0
      PHI=ANGBI-ATAN(ABS(F/SLOPED))
      GAMMA=90.0*ACC-PHI
C
C     DEFINE SLOPE AND Y-INTERCEPT OF THE INTERMEDIATE BOUNDARY
C     AND THE ANGLE BISECTOR LINES
C
      SLBI=TAN(GAMMA)*F
      CEPTBI=YI-SLBI*XI
      SLBI1=SLOPEE*0.5
      CEPTB1=YI-SLBI1*XI
      SLBI2=2.0*SLOPED
      CEPTB2=YI-SLBI2*XI
C
C     GENERATE INTERMEDIATE BOUNDARIES POINTS AT INTERSECTION OF INTERMEDIATE
C     BOUNDARY LINES AND COMPRESSION CURVE BY COMPARING ORDINATES OF THE CURVE
C     AND THE LINES WITH INCREASING ABSICISSA VALUES.WHERE ORDINATES MATCH
C     (AS CLOSE AS POSSIBLE) DEFINE INTERSECTION POINT
C
      DO 170 I=1,2
      IF(I.EQ.1)GO TO 157
      SL=SLBI2
      YCEPT=CEPTB2
      GO TO 158
  157 SL=SLBI1
      YCEPT=CEPTB1
  158 DELTA=ABS(BOUND2-X)/200.0
      DO 165 IJ=1,201
      YCURVE=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      YLINE=YCEPT+SL*X
      IF(I.EQ.2)GO TO 164
      IF(YLINE.GE.YCURVE)GO TO 166
      GO TO 165
  164 IF(YLINE.LE.YCURVE)GO TO 166
  165 X=X+DELTA
  166 IF(I.EQ.1)GO TO 169
      XILBI2=X
      GO TO 170
  169 XILBI1=X
  170 CONTINUE
      XX1=10**XILBI1
      XX2=10**XILBI2
C
C     WRITE INTERMEDIATE ORDINATES TO OUTPUT
C
      WRITE(6,1024)XX1,XX2
C
C     GET PT. OF MAX. CURVATURE AT INTERSECTION OF COMPRESSION CURVE AND
C     ANGLE BISECTOR LINE
C
      DELTA=ABS(XILBI2-XILBI1)/200.0
      X=XILBI1
```

```
      DO 175 IJ=1,201
      YCURVE=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      YLINE=CEPTBI+SLBI*X
      IF(YLINE.GT.YCURVE)GO TO 180
  175 X=X+DELTA
C
C     DEFINE PT. OF MAX. CURVATURE FOUND GRAPHICALLY
C
  180 RADMXG=X
C
C     FIND PT. OF MAX. CURVATURE USING ANALYTICAL METHOD
C
C     SEARCH BETWEEN COMPUTER GENERATED BOUNDARIES AND PERFORM
C     ITERATIONS TWICE FOR HIGHER ACCURACY
C
      DO 195 I=1,2
      RADMIN=1.0E99
      DELTA=ABS(XILBI2-XILBI1)/100.0
      X=XILBI1
      DO 190 IJ=1,101
      SLOPE1(IJ)=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      SLOPE2=D2(C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10),
     +C(11),C(12),X)
C
C     USE MATHEMATICAL DEFINATION OF THE RADIUS OF CURVATURE TO FIND
C     MINIMUM RADIUS OF CURVATURE(I.E. MAXIMUM CURVATURE)
C
      RAD(IJ)=(1+(SLOPE1(IJ)/F)**2)**1.5/(SLOPE2/F)
      IF(ABS(RAD(IJ)).LT.ABS(RADMIN))RADMIN=RAD(IJ)
      IF(ABS(RAD(IJ)).LE.ABS(RADMIN))RADMXA=X
  190 X=X+DELTA
      IF(I.EQ.2)GO TO 200
      XILBI1=RADMXA-DELTA
  195 XILBI2=RADMXA+DELTA
  200 XMXCVA=10**RADMXA
      XMXCVG=10**RADMXG
C
C     WRITE TO OUTPUT MAX. CURVATURE ORDINATES FOUND USING BOTH METHODS
C
      WRITE(6,1025)XMXCVG,XMXCVA
      CHK=0.0
C
C     IF THE DIFFERENCE BETWEEN THE MAX. CURVATURE ORDINATES IS LESS THAN OR
C     EQUAL TO 3LB/IN**2,AVERAGE THEM,OUTPUT A MESSAGE,AND CONTINUE
C     ANALYSIS WITH ONLY ONE CURVATURE POINT
C
      IF(ABS(XMXCVG-XMXCVA).LE.3.0)WRITE(6,1026)
      IF(ABS(XMXCVG-XMXCVA).LE.3.0)CHK=1.0
      AVXMCV=ALOG10((XMXCVG+XMXCVA)/2)
      RX(1)=RADMXA
      RX(2)=RADMXG
      M=2
      IF(CHK.EQ.1.0)RX(1)=AVXMCV
      IF(CHK.EQ.1.0)M=1
      PCMINP=1.E99
```

```
      CMAX=0.0
      IMAX=1
      DO 250 I=1,M
      RY(I)=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),RX(I))
C
C     CASAGRAND"S CONSTRUCTION
C
C     DEFINE SLOPE OF TANGENT TO COMPRESSION CURVE AT POINT OF MAX. CURV.
C
      SLOPEB=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),RX(I))
C
C     DEFINE SLOPE AND Y-INTERCEPT OF A LINE THAT BISECTS THE ABOVE
C     TANGENT AND A HORIZONTAL LINE THRU THE POINT OF MAX. CURVATURE.
C     WHERE THIS BISECTOR LINE INTERSECTS THE VIRGIN COMPRESSION LINE
C     DEFINES THR PRECONSOLIDATION PRESSURE
C
      SLOPEC=SLOPEB/2.0
      CEPTC=RY(I)-SLOPEC*RX(I)
      PRECON(I)=(CEPTC-CEPTD)/(SLOPED-SLOPEC)
C
C     SCHMERTMANN"S CONSTRUCTION
C     (WITH APPROPIATE BRANCHES TO ACCOUNT FOR DIFFERENT SPECIMEN TYPES)
C     TREAT REMOLDED SOILS AS IF NORMALLY CONSOLIDATED
C
      SLOPEE=CC(2)
      IF(ISPTY.EQ.2)PINSTU=10**PRECON(I)
      APINST=ALOG10(PINSTU)
      IF(APINST.GE.PRECON(I))SLOPEE=0.0
C
C     DEFINE A LINE THRU THE INSITU OVERBURDEN PRESSURE AND THE INSITU VOID
C     RATIO WITH A SLOPE EQUAL TO THE REBOUND SLOPE
C
      CEPTF=VR(1)-SLOPEE*APINST
C
C     DEFINE THE PRECONSOLIDATION VOID RATIO AT THE ORDINATE VALUE WHERE
C     THE ABOVE LINE INTERSECTS THE PRECONSOLIDATION PRESSURE ABSCISSA
C
      VRPCON(I)=CEPTF+SLOPEE*PRECON(I)
C
C     NOW DEFINE A LINE THAT REPRESENTS THE TRUE INSITU VIRGIN
C     COMPRESSION LINE
C
      YVIRGI=0.42*VR(1)
      XVIRGI=(YVIRGI-CEPTD)/SLOPED
      SLOPEG=(YVIRGI-VRPCON(I))/(XVIRGI-PRECON(I))
      PRCONP=10.0**PRECON(I)
      OCR=PRCONP/PINSTU
      CR(I)=-SLOPEG
      CS=-CC(2)
      CRMIN=-SLOPED
      CRR=CR(I)/(1+VR(1))
      CRMINR=CRMIN/(1+VR(1))
      IF(ISPTY.EQ.2)GO TO 230
      PCMIN=(CEPTD-CEPTF)/(SLOPEE-SLOPED)
      VRMIN=SLOPEE*PCMIN+CEPTF
```

```
      IF(VRMIN.GT.VR(1))PCMIN=(CEPTD-VRPCON(I))/(-SLOPED)
      IF(VRMIN.GT.VR(1))VRMIN=VR(1)
      PCMIN=10.0**PCMIN
      OCRMIN=PCMIN/PINSTU
      GO TO 240
  230 PCMIN=0.0
      OCRMIN=1.0
      VRMIN=VR(1)
  240 CONTINUE
      WRITE(6,1027)
      IF(CHK.EQ.0.0.AND.I.EQ.1)WRITE(6,1028)
      IF(CHK.EQ.0.0.AND.I.EQ.2)WRITE(6,1029)
      WRITE(6,1030)PRCONP,PCMIN,VRPCON(I),VRMIN,OCR,OCRMIN,CR(I),CRMIN,
     +CRR,CRMINR,CS
C
C     DEFINE THE ABSOLUTE PRECONSOLIDATION PRESSURE MINIMUM FOR PLOTTING
C     DETERMINE AND SAVE MAXIMUMS FOR PLOTTING AND FOR PERMEABILITY CALCS.
C
      IF(PCMIN.LT.PCMINP)PCMINP=PCMIN
      IF(PINSTU.GT.CMAX)CMAX=PINSTU
      IF(I.EQ.1)GO TO 250
      IF(PRECON(2).GT.PRECON(1))IMAX=2
  250 CONTINUE
      IF(CHK.EQ.1.0.AND.AVXMCV.GT.PRECON(1))WRITE(6,1034)
      IF(CHK.EQ.1.0)GO TO 260
C
C     OUTPUT WARNING IF ANALYSIS HAS FAILED(PRECONSOLIDATION PRESSURE LESS
C     THAN THE ABSICCA OF THE POINT OF MAXIMIM CURVATURE)
C
      IF(RX(1).GT.PRECON(1).OR.RX(2).GT.PRECON(2))WRITE(6,1034)
  260 IF(OVERFLO.EQ.1.0)WRITE(6,1035)
      IF(NCYCLE.GT.1)WRITE(6,1036)
      WRITE(1,5007)XMXCVG,XMXCVA,CHK,PRECON,VRSCAL,BVR,PCMINP
      WRITE(1,1031)CC(1),CC(2),(C(I),I=1,12)
      WRITE(1,5012)SLOPED,CEPTD
      WRITE(1,5014)CR,VRPCON,CMAX,IMAX
C
C     PERFORM TIME DEFORMATION ANALYSIS ON THE SECOND THRU THE LAST
C      COMPRESSIVE LOADS OF THE FIRST LOADING CYCLE
C
      WRITE(6,1037)SAMP,P(1)
      DO 500 J=1,NN
      IF(J.EQ.1.AND.P(1).NE.P(2))GO TO 500
      M=MM(J)
C
C     IF ANY TWO SUCCESSIVE LOADS ARE EQUAL COMBINE TIME READINGS.
C     IF NUMBER OF REAINGS IS LESS THAN EIGHT SKIP ANALYSIS
C     FOR CORRESPONDING LOAD
C
      MCOUNT=0
      IF(J.EQ.1)GO TO 290
      IF(P(J).EQ.P(J-1))GO TO 500
      IF(P(J+1).NE.P(J))GO TO 299
  290 MCOUNT=MM(J+1)
      DO 295 I=1,MCOUNT
      ELAPSE(I+M,J)=ELAPSE(I,J+1)
  295 CONSOL(I+M,J)=CONSOL(I,J+1)
```

```
  299 M=M+MCOUNT
      IF(M.LT.8)GO TO 500
C
C     FIND CUBIC EQUATION TO FIT FIRST FOUR DATA PTS. AND GET
C     CORRECTED ZERO CONSOLIDATION POINT BY LOG METHOD
C
      DO 305 I=1,4
      TIMELG(I)=ALOG10(ELAPSE(I,J))
      PCON(I)=CONSOL(I,J)
  305 CONTINUE
      CALL LSQFT(TIMELG,PCON,4,3,C)
      WRITE(1,5001)P(J),(C(I),I=1,4),TIMELG(1),TIMELG(4)
      AX6S=POLY(C(1),C(2),C(3),C(4),0.0,0.0,0.0,0.0,0.0,0.0,
     +0.0,0.0,.778151)
      AX24S=POLY(C(1),C(2),C(3),C(4),0.0,0.0,0.0,0.0,0.0,0.0,
     +0.0,0.0,1.380211)
C     AXIAL STRAIN AT 0% CONSOLIDATION = AX6S - (AX24S-AXS6)
      AXOP=2*AX6S-AX24S
C
C     FIND CUBIC EQUATION TO FIT LAST FOUR DATA PTS. AND GET
C     TANGENT TO END OF LOG-TIME CONSOLIDATION CURVE
C
      DO 306 I=1,4
      TIMELG(I)=ALOG10(ELAPSE(M+I-4,J))
  306 PCON(I)=CONSOL(M+I-4,J)
      CALL LSQFT(TIMELG,PCON,4,3,C)
      WRITE(1,5001)P(J),(C(I),I=1,4),TIMELG(1),TIMELG(4)
C
C     COMPUTE TANGENT SLOPE AT POINT OF TANGENCY 3/4 OF THE DISTANCE BETWEEN
C     THE LAST TWO DATA POINTS.IF THIS TANGENT SLOPE IS LESS THAN ZERO OR IF A
C     SLOPE THRU THE LAST TWO DATA POINTS IS POSITIVE AND LESS THEN THE
C     TANGENT SLOPE,USE THE SLOPE THRU THE LAST TWO DATA POINTS AS THE TANGENT
C     SLOPE. MINIMUM SLOPE THRU LAST TWO DATA POINTS IS SET TO ZERO
C
      XEND=TIMELG(3)+.75*(TIMELG(4)-TIMELG(3))
      YEND=POLY(C(1),C(2),C(3),C(4),0.0,0.0,0.0,0.0,0.0,0.0,
     +0.0,0.0,XEND)
      SLOEND=D1(C(2),C(3),C(4),0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
     +0.0,XEND)
      SLOND1=(PCON(3)-PCON(4))/(TIMELG(3)-TIMELG(4))
      IF(SLOND1.LT.0.0)SLOND1=0.0
      IF(SLOEND.LT.0.0.OR.SLOND1.LT.SLOEND)SLOEND=SLOND1
      YCPTND=YEND-XEND*SLOEND
C
C     FIND POLYNOMIAL TO FIT ENTIRE CURVE AND GET INFLECTION
C     POINT WITH CORRESPONDING TANGENT TO MID-PORTION OF CURVE
C
      DO 308 I=1,M
      TIMELG(I)=ALOG10(ELAPSE(I,J))
  308 PCON(I)=CONSOL(I,J)
      NDEG=M-1
      IF(NDEG.GE.12)NDEG=11
C
C     ADJUST DEGREE OF POLYNOMIAL USING INPUT CORRECTIONS
C     OF CORRESPONDING LOADS
C
      IF(NPADJ.EQ.0)GO TO 311
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```
      DO 310 I=1,NPADJ
  310 IF(PADJ(I).EQ.P(J))NDEG=NDEG-NDGADJ(I)
      IF(NDEG.LT.3)NDEG=3
  311 CALL LSQFT(TIMELG,PCON,M,NDEG,C)
      N=NDEG+1
C
C     WRITE POLYNOMIAL EQUATION TO TAPE1 FOR PLOTTING
C
      WRITE(1,5002)N,(C(I),I=1,12),TIMELG(1),TIMELG(M)
C
C     ESTABLISH ITERATION BOUNDARIES FOR INFLECTION POINT SEARCH
C
      BDX1=TIMELG(3)
      BDX2=TIMELG(M-1)
C
C     PERFORM ITERATION WITH 3 CYCLES FOR HIGH ACCURRACY
C
      JJ=0
  313 JJ=JJ+1
      DELTA=ABS(BDX2-BDX1)/100.0
      DO 315 I=1,101
      X1(1)=BDX1
      RAD(I)=D2(C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10),
     +C(11),C(12),X1(I))
      IF(I.EQ.1)GO TO 315
      IF(RAD(I-1).LT.0.0)GO TO 315
C
C     THE INFLECTION POINT IS FOUND WHERE THE SECOND DERIVATIVE
C     CHANGES FROM POSITIVE TO NEGITIVE
C
      IF(RAD(I)*1.0E50.LT.RAD(I-1))GO TO 325
  315 X1(I+1)=X1(I)+DELTA
C
C     OUTPUT WARNING AND MOVE TO NEXT LOAD IF INFLECTION PT. NOT FOUND
C     USE H(50) AS A FLAG FOR PLOTTING PROGRAM
C
      WRITE(6,1040)P(J)
      H(50)=99.99
      WRITE(1,5013)H(50),H(50)
      GO TO 500
  325 BDX1=X1(I-1)
      BDX2=X1(I)
      IF(JJ.LT.3)GO TO 313
      X=ALOG10((10**BDX1+10**BDX2)/2.0)
C
C     CALCULATE TANGENT SLOPE AND THE PERCENT CONSOLIDATION AT THE
C     INFLECTION POINT
C
      SLOMID=D1(C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      Y=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      YCPTMD=Y-SLOMID*X
      TIMINF=10**X
      WRITE(1,5013)YCPTND,SLOEND,X,Y,YCPTMD,SLOMID,TIMINF
C
C     DEFINE THE SPECIMEN HEIGHT AT THE INFLECTION POINTS ORDINATE
```

```
C
      HTINF=HI-(Y/100.0*HI)
C
C     FIND INTERSECTION OF TWO TANGENTS TO GET U=100
C
      AX100P=(YCPTMD*SLOEND-YCPTND*SLOMID)/(SLOEND-SLOMID)
C
C     FIND U AT T=50
C
      AX50P=ABS(AX100P-AXOP)/2.0+AXOP
C
C     FIND THE TIME FOR 50 PERCENT CONSOLIDATION WHERE POLYNOMIAL CURVE
C     INTERSECTS THE 50 PERCENT ORDINATE, SEARCH BETWEEN ORDINATE VALUES
C     OF THE SECOND AND NEXT TO THE LAST DATA POINTS. ISOLATE 50 PERCENT
C     ORDINATE IN THREE CYCLES
C
      BDX1=TIMELG(2)
      BDX2=TIMELG(M-2)
      DO 370 JJ=1,4
      DELTA=ABS(BDX2-BDX1)/100.0
      X=BDX1
      DO 350 I=1,101
      YCURVE=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X)
      IF(YCURVE.GE.AX50P)GO TO 360
  350 X=X+DELTA
      IF(JJ-1)355,355,360
C
C     IF INTERSECTION IS OUTSIDE THE BOUNDARY RANGE OUTPUT WARNING
C     AND CONTINUE TO THE NEXT LOAD
C
  355 WRITE(6,1038)P(J)
      GO TO 500
  360 BDX1=X-DELTA
  370 BDX2=X
C     LOG OF TIME AT 50% AXIAL STRAIN IS BORDER TIME PLUS HALF DELTA
      TIME50=10**(BDX1+DELTA/2.0)
      HT50=HI-(AX50P/100.0*HI)
C
C     COMPUTE COEFFICIENTS OF CONSOLIDATION
C     COMPUTE PERMEABILITY USING LARGEST COMPRESSION INDEX
C
      CV=.197*(HT50/2.0)**2/TIME50
      CVINF=.405*(HTINF/2.0)**2/TIMINF
      ASUBV=.435*CR(IMAX)/((P(J)+P(J-1))/2)
      PERM1=CV*ASUBV*94900./(1+VR(J))
      PERM2=CVINF*PERM1/CV
C     OUTPUT RESULTS FOR THIS LOAD
      WRITE(6,1039)AXOP,AX100P,TIME50,TIMINF,CV,CVINF,PERM1,
     +PERM2,P(J)
  500 CONTINUE
C
C     CHECK FOR MISSING INPUT DATA NECESSARY FOR PLOTS.IF MISSING
C     MAKE TAPE15 LOCAL TO ACT AS FLAG TO INHIBIT PLOTTING
C
  375 J=1
      IF(DEP.EQ.10H          )J=2
```

```
      IF(DH.EQ.10H          )J=2
      IF(CLASS.EQ.5H     )J=2
      IF(OVERFLO.EQ.1.0)J=J+2
      GO TO (1,380,390,400),J
  380 WRITE(6,1041)
      WRITE(15,1000)
      GO TO 1
  390 WRITE(6,1042)
      WRITE(15,1000)
      GO TO 1
  400 WRITE(6,1043)
      WRITE(15,1000)
      GO TO 1
C
C     GO TO 1 FOR NEW DATA SET
C
C
C     FORMAT STATEMENTS
C
  700 FORMAT(1H1//54X*BUREAU OF RECLAMATION*/55X,*GEOTECHNICAL BRANCH*)
  710 FORMAT(48X,*ONE-DIMENIONAL CONSOLIDATION TEST*)
  720 FORMAT(47X,*ONE-DIMENSIONAL UPLIFT PRESSURE TEST*)
  730 FORMAT(50X,*ONE-DIMENSIONAL EXPANSION TEST*)
  740 FORMAT(/45X,*MAXIMUM UPLIFT PRESSURE =*,F6.2," LB/IN**2")
  750 FORMAT(//45X,*MAXIMUM VERTICAL EXPANSION =*,F7.4," %")
 1000 FORMAT(1H1)
 1001 FORMAT(A10,A4,A10,A5,1X,A6,A5,F7.3,I8)
 1002 FORMAT(A8,I8,8X,2F8.3,3X,A2,3X,A3,3X,A2)
 1003 FORMAT(2F8.2,2F8.4,A8)
 1004 FORMAT(24X,2F8.2/8X,5F8.2,6XI2)
 1005 FORMAT(I8,5F8.2)
 1006 FORMAT(F8.2,F6.4)
 1007 FORMAT(F8.0,F6.4)
 1008 FORMAT(//30X,10H SAMPLE NO ,
     +1X,A10,5X,12HSPECIMEN NO ,A4,5X,15HSPECIMEN TYPE  ,A10,A1//30X,
     +13H DATE PLACED ,A8,4X,13HDATE REMOVED ,A8,3X,
     +16HSPECIFIC GRAVITY,F5.2//32X,20H SPECIMEN DIAMETER =,F5.2,1X,
     +3HIN.,12X,17HSPECIMEN HEIGHT =,F5.2,4H IN.//)
 1009 FORMAT(52X,*TEST PERFORMED IN  SCALE NO.  *,I4)
 1010 FORMAT(50X,*TEST PERFORMED IN  CONBEL NO.  *,I4)
 1011 FORMAT(50X,*TEST PERFORMED IN  ANEUS NO.  *,I4)
 1012 FORMAT(48X,*TEST PERFORMED IN  LEVERMATIC NO.  *,I4)
 1013 FORMAT(//33X,*PRESSURE =*,F7.2,9H LB/IN**2,6X,*AXIAL STRAIN =*,
     +F7.3,* %*/30X,*DRY DENSITY =*,F7.1,9H LB/FT**3,8X,
     + *VOID RATIO =*,
     +F7.4,//40X,*TIME IN SEC.*,10X,*STRAIN IN (%)*)
 1014 FORMAT(42X,F10.0,15X,F8.3)
 1015 FORMAT(1H1/5X,"SAMPLE NO. ",A10/5X,"SPEC. NO.  ",A4)
 1016 FORMAT(///51X,4HVOID,8X,3HDRY,5X,5HWATER,4X,9HDEGREE OF,5X,
     +5HAXIAL/31X,8HPRESSURE,2X,6HHEIGHT,4X,5HRATIO,5X,7HDENSITY
     +,2X,7HCONTENT,3X,10HSATURATION,4X,6HSTRAIN/30X,10H(LB/IN**2)
     +,7H  (IN.),12X,10H(LB/FT**3),9H(PERCENT),3X,9H(PERCENT),2X
     +,9H(PERCENT))
 1017 FORMAT(29X,F9.2,F9.4,F10.4,F10.1,F9.1,F12.1,F11.2)
 1018 FORMAT(/68X,*INITIAL*,4X,*MAX PRESSURE*
     +//42X,*DRY DENSITY*,15X,F7.1,5X,F8.1,
     +//42X,*MOISTURE CONTENT*,10X,F7.1,5X,F8.1,
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     +//42X,*DEGREE OF SATURATION*,6X,F7.1,5X,F8.1,
     +//42X,*DEGREE OF SATURATION CK*,3X,F7.1,5X,F8.1)
1019 FORMAT(/57X,*REBOUND =*,F7.2,* %*)
1020 FORMAT(//35X,"COMPARISON OF PHASE RELATIONS CALCULATED FROM ",
     +"DIFFERENT INPUTS"/70X,"INITIAL      FINAL"/70X,
     +"MOISTURE     WEIGHTS"//40X,"TOTAL DRY WEIGHT(GMS)",1X,2F13.1
     +//40X,"INITIAL WATER CONTENT(%)",2X,F9.1,F13.1//40X,
     +"FINAL WATER CONTENT(%)",2F13.1//40X,"INITIAL VOID RATIO",
     +4X,2F13.4//40X,"MAX. PRES. VOID RATIO",1X,2F13.4)
1021 FORMAT(/16X,"***THE ABOVE ANALYSIS USES THE INPUT INITIAL MOISTU",
     +"RE IN THE PHASE RELATIONSHIP CALCULATIONS***")
1022 FORMAT(/19X,"***THE ABOVE ANALYSIS USES THE INPUT FINAL WEIGHTS",
     +" IN THE PHASE RELATIONSHIP CALCULATIONS***")
1023 FORMAT(/43X,*SEMI-LOGARITHMIC STRESS DEFORMATION ANALYSIS*////
     +54X,*DEGREE OF POLYNOMIAL = *,I2/25X,
     +*SEARCH BOUNDARIES FOR PT. OF MAX. CURVATURE *,10X,F5.1,9H LB/IN**
     +2,5XF7.1,9H LB/IN**2/25X,*SEARCH BOUNDARIES FOR VIRGIN COMPRESSION
     + LINE  *7X,F5.1,9H LB/IN**2,5X,F7.1,9H LB/IN**2/25X,*INSITU EFFECT
     +IVE OVERBURDEN PRESSURE =*,F7.1,9H LB/IN**2/25X*VOID RATIO*
     +* AT SEATING LOAD            =*,F7.3)
1024 FORMAT(/25X,*COMPUTER GENERATED BOUNDARIES FOR ANALYTICAL*
     +* METHOD *,F7.1,9H LB/IN**2,5XF7.1,9H LB/IN**2)
1025 FORMAT(/25X,*PT. OF MAX. CURVATURE USING GEOMETRICAL METHOD AT*,3X
     +,F5.1,9H LB/IN**2/25X,*PT. OF MAX. CURVATURE USING ANALYTICAL METH
     +OD AT*4X,F5.1,9H LB/IN**2)
1026 FORMAT(/25X,*ABSCISSA VALUE OF PT. OF MAX. CURVATURE USED FOR ANAL
     +YSIS IS THE AVERAGE VALUE*)
1027 FORMAT(//37X*RANGES OF PRESSURE - VOID RATIO CONSOLIDATION *,
     +*PARAMETERS*)
1028 FORMAT(38X,*WITH PT. OF MAX. CURVATURE FOUND BY ANALYTICAL METHOD*
     +)
1029 FORMAT(38X,*WITH PT. OF MAX. CURVATURE FOUND BY GEOMETRICAL METHOD
     +*)
1030 FORMAT(/81X,*PROBABLE   -   MINIMUM*//30X,"PRECONSOLIDATION PRESSU
     +RE .............(LB/IN**2)",3X,F6.1,*   -   *,F6.1//30X,
     +*VOID RATIO AT PRECONSOLIDATION PRESSURE ..........*,3X,F6.3,
     +*   -   *,F6.3//30X,*OVERCONSOLIDATION RATIO (OCR) ...............
     +.....*,3X,F6.3,*   -   *,F6.3//30X,*COMPRESSION INDEX (CC) .......
     +.....................*,3X,F6.3,*   -   *,F6.3//30X,
     +*PRIMARY COMPRESSION RATIO (CC/(1+V.R. AT SEATING))*,
     +3X,F6.3,*   -   *,F6.3//30X,*SWELL INDEX (CS)*
     +* ....................................*,3X,F6.3)
1031 FORMAT(7(2F40.20/))
1032 FORMAT(/23X,"THE HEIGHT OF THE ENTRAPPED AIR IN THE SPECIMEN ",
     +"WAS SET TO ZERO IN THE ABOVE ANALYSIS."/28X," THE DEGREE OF ",
     +"SATURATION AT THE MAX PRESSURE BEFORE ZEROING WAS",F6.1,2H %)
1034 FORMAT(//5X,"***WARNING***   ANALYTICAL PROCEDURE WITH CASA"
     +"GRANDE CONSTRUCTION HAS FAILED CHECK DATA")
1035 FORMAT(/5X,"NOTE   MORE THAN 50 LOADS. ALL LOADING CONDITIONS"
     +" AFTER THE 50TH IGNORED")
1036 FORMAT(/5X,*NOTE   DEFORMATION ANALYSIS PERFORMED *
     +*ON 1ST LOADING CYCLE ONLY*)
1037 FORMAT(1H1////5X*SAMPLE NO *,A10//43X,*SEMI-LOGARITHMIC TIME CON*
     +*SOLIDATION ANALYSIS*///21X,*DEGREE OF CONSOLIDATION (U)*,5X,
     +*TIME (SEC)*,5X*COEFFICIENT OF CONSOLIDATION*,5X,
     +*PERMEABILITY (FT/YR)*/
     +11X,"PRESSURE",5X,"(IN PERCENT AXIAL STRAIN)",4X,"AT  INFLECTION",
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                +12X"(IN**2/SEC)",13X*COMPUTED WITH MAX. CC*
                +/10X"(LB/IN**2)",4X*(U=0)*,6X,*(U=100)*,7X,
                +*(U=50)*,4X*PT.*,6X*LOG METHOD*,4X*INF.PT. METHOD*
                +*   LOG METHOD  INF.PT. METHOD*//10X,F7.2)
           1038 FORMAT(27X,"***WARNING*** ANALYSIS HAS FAILED"/10X,F7.2)
           1039 FORMAT(23XF6.2,5XF6.2,8XF7.0,1XF7.0,6XF9.7,5XF9.7,6XF9.2,3XF9.2,
                +/10X,F7.2)
           1040 FORMAT(27X"***INFLECTION PT. NOT FOUND***"
                +" CHECK DATA"/10X,F7.2)
           1041 FORMAT(//25X"***ANY CALLS TO PLOT HAVE BEEN TERMINATED.***"
                +/28X"MISSING INPUT DATA")
           1042 FORMAT(//25X"***ANY CALLS TO PLOT HAVE BEEN TERMINATED.***"
                +/28X"MORE THAN 50 LOADS")
           1043 FORMAT(//25X"***ANY CALLS TO PLOT HAVE BEEN TERMINATED.***"
                +/28X"MISSING INPUT DATA AND TO MANY LOADS")
           2050 FORMAT(1H1////5X,*SAMPLE NO *,A10)
           2055 FORMAT(////25X,"CONSOLIDATION DATA REDUCTION COMPLETE"/
                +30X,"PROGRAM STOPS")
           2060 FORMAT(//30X"****EXPANSIVE SPECIMEN**** CLASSICAL"
                +" DEFORMATION ANALYSIS INVALID."/57X"PROGRAM STOPS")
           5001 FORMAT(F7.2/2(2F40.20/),2F8.6)
           5002 FORMAT(I3/6(2F40.20/),2F8.6)
           5003 FORMAT(A10,A4,A10,A5,A6,A5,F7.3,2F8.3,A10,A1/3I3,3A3)
           5004 FORMAT(I3/30I3/21I3)
           5005 FORMAT(3I3,4F8.3)
           5006 FORMAT(6F8.3,E11.4/4F12.5)
           5007 FORMAT(2F10.2,F3.0/2F10.6,2F10.5,F10.2)
           5010 FORMAT(I2)
           5011 FORMAT(F8.2,I2)
           5013 FORMAT(F9.4/6E14.7)
           5012 FORMAT(2F12.5)
           5014 FORMAT(5F12.6,I2)
           6010 FORMAT(8A10)
           6020 FORMAT(1X,I4,5X,8A10,1X,I4)
           6030 FORMAT(19X,I1,6(9X,I1))
           6040 FORMAT(10X,8(9I1,1H0))
          10001 FORMAT(F8.2,2F11.4)
          10002 FORMAT(F8.0,F8.3)
          10003 FORMAT(I4,F8.2)
                END
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SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES
12347	CON1D	1	

VARIABLES		SN	TYPE	RELOCATION							
20407	ACC		REAL		REFS	570	577	DEFINED	537		
20326	AMAX		REAL		REFS	232	2*284	DEFINED	201	232	
20327	AMIN		REAL		REFS	233	349	369	DEFINED	202	233
20423	ANGBI		REAL		REFS	576	DEFINED	575			
20422	ANGLE		REAL		REFS	575	DEFINED	570			
20457	APINST		REAL		REFS	714	719	DEFINED	713		

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VARIABLES      SN  TYPE          RELOCATION
20522  ASUBV     REAL                          REFS      958    DEFINED     957
20451  AVXMCV    REAL                          REFS      682      765    DEFINED     678
20500  AXOP      REAL                          REFS    2*922      961    DEFINED     816
20514  AX100P    REAL                          REFS      922      961    DEFINED     918
20477  AX24S     REAL                          REFS      816    DEFINED     813
20515  AX50P     REAL                          REFS      937      950    DEFINED     922
20476  AX6S      REAL                          REFS      816    DEFINED     811
20506  BDX1      REAL                          REFS      875      877      899      932      933      949
                                              DEFINED     868      896      929      946
20507  BDX2      REAL                          REFS      875      899      932    DEFINED     869      897      930
                                                947
20366  BIG       REAL                          REFS      437      448      475      476      485
                                              DEFINED     418      439      449      483
20330  BMAX      REAL                          REFS      305      310      311      315      316
                                              DEFINED     203      270
20400  BOUND     REAL                          REFS      515    DEFINED     495
20271  BOUND1    REAL                          REFS      376      386      387      419      495      502      504
                                                513    DEFINED      90      376      419      511
20272  BOUND2    REAL                          REFS      377      386      420      494      502      601
                                              DEFINED      90      377      420      510      525
20273  BOUND3    REAL                          REFS      378      386      421      428      429
                                              DEFINED      90      378      421
20274  BOUND4    REAL                          REFS      379      386      422      428    DEFINED      90      379
                                                422
20377  BOUND5    REAL                          REFS      525    DEFINED     494
20412  BVR       REAL                          REFS      542      544      548      549      774
                                              DEFINED     541      543      548
41366  C         REAL        ARRAY             REFS        5      412    12*431   12*459   12*483   12*505   12*526
                                             12*603   12*629   12*649   10*651   12*688   12*695      775      809
                                                810    4*811    4*813      824      825    4*834    4*836      859
                                                864   10*878   12*904   12*906   12*935
20304  CAC       REAL                          REFS      183      185      289      292      312      328
                                              DEFINED     171
20303  CAI       REAL                          REFS      171      172    DEFINED     170
41402  CC        REAL        ARRAY             REFS        5      401      402      711      735    2*775
20246  CD        REAL                          REFS      142      143    2*170    DEFINED      87
20302  CDIAL     REAL                          REFS      174      230      231      236    DEFINED     152      156
                                                160      164
20404  CEPTAN    REAL                          REFS      532      533    DEFINED     528
20427  CEPTBI    REAL                          REFS      631    DEFINED     583
20431  CEPTB1    REAL                          REFS      600    DEFINED     585
20433  CEPTB2    REAL                          REFS      597    DEFINED     587
20456  CEPTC     REAL                          REFS      705    DEFINED     704
20376  CEPTD     REAL                          REFS      532      705      730      740      742      776
                                              DEFINED     490
20460  CEPTF     REAL                          REFS      724      740      741    DEFINED     719
20305  CF        REAL                          REFS      239      288      310    DEFINED     172
20245  CH        REAL                          REFS      142      143      174    DEFINED      87
20364  CHECK     REAL                          REFS      442    DEFINED     416      435
20450  CHK       REAL                          REFS      682      683      752      753      765      766      774
                                              DEFINED     670      677
20362  CHSTOP    REAL                          REFS      366      369      370    DEFINED     355      365      368
20240  CLASS     REAL                          REFS      143      971    DEFINED      85
20331  CMAX      REAL                          REFS      314      369      761      777    DEFINED     204      271
                                                685      761
20355  CMLM      REAL                          REFS      314      340      350    DEFINED     312
25660  CONM      REAL        ARRAY             REFS        5      240      245      284      339    2*365
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VARIABLES      SN  TYPE          RELOCATION
                                              DEFINED     235
26500  CONSOL      REAL      ARRAY             REFS        5       247       249      2*365      798       807       823
                                                848    DEFINED      234       798
40454  CORR        REAL      ARRAY             REFS        5       230    DEFINED       95
41364  CR          REAL      ARRAY             REFS        5       737       754       777       957
                                              DEFINED     734
20467  CRMIN       REAL                        REFS      738       754    DEFINED      736
20471  CRMINR      REAL                        REFS      754    DEFINED      738
20470  CRR         REAL                        REFS      754    DEFINED      737
20466  CS          REAL                        REFS      754    DEFINED      735
20520  CV          REAL                        REFS      958       959       961    DEFINED      955
20521  CVINF       REAL                        REFS      959       961    DEFINED      956
20256  DATEO       REAL                        REFS      142    DEFINED       88
20243  DATEP       REAL                        REFS      142    DEFINED       87
26024  DD          REAL      ARRAY             REFS        5       245       339       350    DEFINED      239
20345  DDI         REAL                        REFS      340       350    DEFINED      288
20353  DDML        REAL                        REFS      340       350    DEFINED      310
20367  DELTA       REAL                        REFS      440       508       610       633       660       662       663
                                                887       938       946       949    DEFINED      428       502       601
                                                626       646       875       932
20236  DEP         REAL                        REFS      143       969    DEFINED       85
20237  DEPTH       REAL                        REFS      143    DEFINED       85
20235  DH          REAL                        REFS      143       970    DEFINED       85
20370  DIFF        REAL                        REFS      435       436    DEFINED      434
20325  DMAX        REAL                        REFS      305       313    DEFINED      200       272
20336  DRCORR      REAL                        REFS      231       236    DEFINED      230
20610  DR1         REAL      ARRAY             REFS        5       102       230    DEFINED       97
20254  DR2         REAL                        REFS      174    DEFINED       88
20255  DR3         REAL                        REFS      174       231       236    DEFINED       88
20347  DSI         REAL                        REFS      340       350    DEFINED      290
20350  DSIP        REAL                        REFS      340    DEFINED      291
20356  DSML        REAL                        REFS      340       350    DEFINED      313
20357  DSML2       REAL                        REFS      340    DEFINED      314
41404  DUMB        REAL      ARRAY             REFS        5     2*347       401    DEFINED      302       304       305
                                                394
20262  DWSPCF      REAL                        REFS      180     2*182    DEFINED       89
20264  DWTCF       REAL                        REFS      180    DEFINED       89
20352  EHA         REAL                        REFS      303       305       311       324       327
                                              DEFINED     301       306
20351  EHW         REAL                        REFS      301    DEFINED      292
33466  ELAPSE      REAL      ARRAY             REFS        5        98       247       249       797       806       822
                                                847    DEFINED       97       797
20421  F           REAL                        REFS    2*570       576       582     2*657    DEFINED      569
20425  GAMMA       REAL                        REFS      582    DEFINED      577
26106  H           REAL      ARRAY             REFS        5       237       239       255       256       270       301
                                                324       327       339     2*894    DEFINED      236       893
20307  HI          REAL                        REFS      184       186       231       236       288       290     2*914
                                              2*950    DEFINED      174
20332  HMAX        REAL                        REFS      255    DEFINED      205       256
20323  HO          REAL                        REFS      237       238       290       301       305       311       324
                                                327    DEFINED      192       198
20314  HO1         REAL                        REFS    2*184       192       315    DEFINED      183
20316  HO2         REAL                        REFS    2*186       198       316    DEFINED      185
20513  HTINF       REAL                        REFS      956    DEFINED      914
20517  HT50        REAL                        REFS      955    DEFINED      950
20346  HW          REAL                        REFS      290       324    DEFINED      289
26334  HWAT        REAL      ARRAY             REFS        5       328    DEFINED      327
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VARIABLES	SN	TYPE	RELOCATION							
20354	HWM	REAL	REFS	312	313	DEFINED	311			
20227	I	INTEGER	REFS	53	54	57	59	60	63	66
			2*81	2*97	98	99	101	102	120	122
			123	124	210	230	234	2*247	2*249	323
			324	325	2*327	2*328	3*329	7*339	394	395
			2*407	448	449	450	13*505	507	2*508	509
			510	511	514	556	557	561	562	595
			606	611	661	13*688	12*695	2*704	705	712
			714	2*724	2*731	732	734	737	742	752
			753	2*754	762	775	2*797	2*798	2*806	2*807
			810	2*822	2*823	825	2*847	2*848	2*857	864
			11*878	880	881	2*886	2*887	896	897	
			DEFINED	53	54	57	59	60	63	66
			81	96	99	119	122	210	229	246
			317	338	392	406	447	503	554	559
			594	644	687	775	796	805	810	821
			825	846	856	864	876	934		
20413	IBVR	INTEGER	REFS	543	DEFINED	542				
20230	IJ	INTEGER	REFS	649	2*657	2*658	659	DEFINED	54	60
			63	66	602	628	648			
20453	IMAX	INTEGER	REFS	777	957	DEFINED	686	763		
20416	IODOEV	INTEGER	REFS	547	548	DEFINED	546	547		
20224	IOUT	INTEGER	REFS	46	131	143	153	157	161	165
			241	248	331	336	356	2*357		
			DEFINED	45						
20301	ISPTY	INTEGER	REFS	125	712	739	DEFINED	123		
20231	ITDW	INTEGER	REFS	188	343	DEFINED	71			
20411	ITVR	INTEGER	REFS	540	DEFINED	539				
20242	ITYPE	INTEGER	REFS	120	123	136	143	348	349	356
			DEFINED	85	124					
20415	IVRCHG	INTEGER	REFS	546	548	DEFINED	545			
20226	J	INTEGER	REFS	55	2*59	2*95	2*97	98	101	102
			103	107	111	217	218	2*230	234	235
			236	2*237	2*238	2*239	3*240	4*245	2*247	2*249
			255	256	257	266	2*267	268	269	270
			271	272	3*274	276	280	364	4*365	393
			394	395	396	13*431	433	3*434	437	438
			439	2*440	501	512	784	785	792	2*793
			2*794	795	2*797	2*798	806	807	810	822
			823	825	847	848	857	892	944	2*957
			958	961	972	973	DEFINED	51	55	94
			103	109	216	363	391	393	430	500
			501	783	968	969	970	971	972	
20225	JJ	INTEGER	REFS	56	60	61	874	898	939	
			DEFINED	50	56	62	873	874	931	
20371	KSLOPE	INTEGER	REFS	486	DEFINED	458	477			
20417	LEXIT	INTEGER	REFS	555	557	560	562	DEFINED	550	556
			561							
20334	LINECT	INTEGER	REFS	242	243	244	335	DEFINED	207	218
			243	244						
20250	LL	INTEGER	REFS	143	DEFINED	87				
20266	LSAT	INTEGER	REFS	143	322	323	DEFINED	89		
20244	LUN	INTEGER	REFS	149	150	151	154	158	162	166
			DEFINED	87						
20335	M	INTEGER	REFS	229	242	243	244	246	365	687
			797	798	799	800	822	823	846	849
			859	864	869	930	DEFINED	217	364	681

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VARIABLES      SN  TYPE            RELOCATION
                                                683       785       799
20475  MCOUNT      INTEGER                     REFS       796       799    DEFINED       791       795
33404  MM          INTEGER    ARRAY            REFS         5        59       210       217       364       785       795
                                             DEFINED        57       101
20300  N           INTEGER                     REFS       208     2*210       216       284       301       317       335
                                                338       864   DEFINED       111       209       860
20342  NCPTS       INTEGER                     REFS       279       282    DEFINED       269
20276  NCYCLE      INTEGER                     REFS       267       274       275       278       282       773
                                             DEFINED        92       278
20267  NDEG        INTEGER                     REFS     2*380       381       386       387       412       850       857
                                                858       859       860    DEFINED        90       380       381       849
                                                850       857       858
41230  NDGADJ      INTEGER    ARRAY            REFS         5       857    DEFINED        81
20340  NEXPT       INTEGER                     REFS     3*350       401    DEFINED       257       396
20341  NN          INTEGER                     REFS       267       363       369     2*377       379     2*380       392
                                                406       412       461     2*473     4*474       478       479       481
                                                482       541       783    DEFINED       279       282
20232  NPADJ       INTEGER                     REFS        76        81       855       856    DEFINED        75
20234  NSP         INTEGER                     REFS       142       143       336   DEFINED        85
20343  N1CYC       INTEGER                     REFS       283       369    DEFINED       276       280
20277  N2CYC       INTEGER                     REFS       283       369       392       541    DEFINED        93       267
                                                283
20465  OCR         REAL                        REFS       754   DEFINED       733
20474  OCRMIN      REAL                        REFS       754   DEFINED       745       748
20275  OVERFLO     REAL                        REFS       772       972    DEFINED        91       108
20525  P           REAL       ARRAY            REFS         5       240       245       266     2*267       268     3*274
                                                339     2*377       378       379       395       407       782     2*784
                                              2*793     2*794       810       825       857       892       944     2*957
                                                961   DEFINED        95
41254  PADJ        REAL       ARRAY            REFS         5       857    DEFINED        81
20472  PCMIN       REAL                        REFS       741       744       745       754     2*760
                                             DEFINED       740       742       744       747
20452  PCMINP      REAL                        REFS       760       774    DEFINED       684       760
25576  PCON        REAL       ARRAY            REFS         5       401       412     2*473     2*474       479       482
                                              2*516     2*523       809       824     2*838       859
                                             DEFINED       395       407       807       823       848
20337  PERCON      REAL                        REFS     2*232     2*233       234       235    DEFINED       231
20523  PERM1       REAL                        REFS       959       961    DEFINED       958
20524  PERM2       REAL                        REFS       961   DEFINED       959
20424  PHI         REAL                        REFS       577   DEFINED       576
20247  PI          REAL                        REFS       143   DEFINED        87
20270  PINSTU      REAL                        REFS       386       713       733       745     2*761
                                             DEFINED        90       712
20333  PMAX        REAL                        REFS       266       274       348       369    DEFINED       206       268
20464  PRCONP      REAL                        REFS       733       754    DEFINED       732
41226  PRECON      REAL       ARRAY            REFS         5       712       714       724       731       732     2*763
                                                765     2*771       774    DEFINED       705
41055  RAD         REAL       ARRAY            REFS         5     2*658       659       881     2*886
                                             DEFINED       657       878
20444  RADMIN      REAL                        REFS       658       659    DEFINED       645       658
20445  RADMXA      REAL                        REFS       662       663       664       679    DEFINED       659
20443  RADMXG      REAL                        REFS       665       680    DEFINED       637
20344  REB         REAL                        REFS       341       350    DEFINED       284
41222  RX          REAL       ARRAY            REFS         5    12*688    12*695       704     2*771
                                             DEFINED       679       680       682
41224  RY          REAL       ARRAY            REFS         5       704    DEFINED       688
20233  SAMP        REAL                        REFS       142       143       336       385       782
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VARIABLES	SN	TYPE	RELOCATION									
				DEFINED	85							
26416	SAT	REAL	ARRAY	REFS	5	339	350	DEFINED	329			
20251	SL	REAL		REFS	143	605	DEFINED	87	596	599		
20426	SLBI	REAL		REFS	583	631	DEFINED	582				
20430	SLBI1	REAL		REFS	585	599	DEFINED	584				
20432	SLBI2	REAL		REFS	587	596	DEFINED	586				
20503	SLOEND	REAL		REFS	2*840	841	910	2*918	DEFINED	836	840	
20510	SLOMID	REAL		REFS	908	910	2*918	DEFINED	904			
20504	SLOND1	REAL		REFS	839	2*840	DEFINED	838	839			
20454	SLOPEB	REAL		REFS	703	DEFINED	695					
20455	SLOPEC	REAL		REFS	704	705	DEFINED	703				
20375	SLOPED	REAL		REFS	490	532	570	576	586	705	730	
				736	740	742	776	DEFINED	485	486		
20363	SLOPEE	REAL		REFS	507	524	528	532	533	570	584	
				719	724	740	741	DEFINED	402	524	711	
				714								
20463	SLOPEG	REAL		REFS	734	DEFINED	731					
20374	SLOPEM	REAL		REFS	486	DEFINED	476					
20402	SLOPET	REAL		REFS	3*524	DEFINED	523					
40541	SLOPE1	REAL	ARRAY	REFS	5	3*434	437	439	448	449	507	
				524	657	DEFINED	431	505	649			
20373	SLOPE2	REAL		REFS	475	2*476	657	DEFINED	474	651		
20241	SPG	REAL		REFS	142	143	183	185	291	314	329	
				DEFINED	85							
40537	SPTYPE	REAL	ARRAY	REFS	5	2*142	143	DEFINED	126	127	129	
				130								
20320	TDW	REAL		REFS	239	288	289	292	310	312	328	
				DEFINED	189	195						
20310	TDW1	REAL		REFS	183	189	342	DEFINED	179			
20311	TDW2	REAL		REFS	181	185	195	342	DEFINED	180		
41300	TIMELG	REAL	ARRAY	REFS	5	809	2*810	824	2*825	3*833	2*838	
				859	2*864	868	869	929	930			
				DEFINED	806	822	847					
20516	TIME50	REAL		REFS	955	961	DEFINED	949				
20512	TIMINF	REAL		REFS	910	956	961	DEFINED	909			
20410	TVR	REAL		REFS	539	544	549	DEFINED	538	540		
26170	VOIDS	REAL	ARRAY	REFS	5	238	272	DEFINED	237			
25742	VR	REAL	ARRAY	REFS	5	240	245	271	291	329	339	
				386	394	412	461	2*474	478	481	2*523	
				538	2*541	719	729	737	738	742	2*743	
				749	958	DEFINED	238					
20414	VRCHG	REAL		REFS	545	556	561	DEFINED	544	549		
20324	VRI	REAL		REFS	350	DEFINED	193	199				
20315	VRI1	REAL		REFS	193	342	DEFINED	184				
20317	VRI2	REAL		REFS	199	342	DEFINED	186				
20473	VRMIN	REAL		REFS	742	743	754	DEFINED	741	743	749	
20360	VRML1	REAL		REFS	342	DEFINED	315					
20361	VRML2	REAL		REFS	342	DEFINED	316					
41362	VRPCON	REAL	ARRAY	REFS	5	731	742	754	777			
				DEFINED	724							
20420	VRSCAL	REAL		REFS	569	774	DEFINED	557	562	564		
26252	W	REAL	ARRAY	REFS	5	329	339	350	DEFINED	325	328	
20263	WCF	REAL		REFS	180	182	DEFINED	89				
20265	WCTF	REAL		REFS	180	DEFINED	89					
20322	WF	REAL		REFS	292	DEFINED	191	197				
20260	WF1	REAL		REFS	187	191	342	DEFINED	89	187		
20313	WF2	REAL		REFS	187	197	342	DEFINED	182			

VARIABLES	SN	TYPE	RELOCATION								
20321	WI	REAL		REFS	289	291	325	340	350		
				DEFINED	190	196					
20257	WI1	REAL		REFS	179	190	342	DEFINED	89		
20312	WI2	REAL		REFS	196	342	DEFINED	181			
20252	WSR	REAL		REFS	173	DEFINED	88				
20253	WSRC	REAL		REFS	173	DEFINED	88				
20306	WWS	REAL		REFS	179	181	DEFINED	173			
20261	WWSPCF	REAL		REFS	182	DEFINED	89				
20401	X	REAL		REFS	12*526	528	601	12*603	605	610	612
				614	12*629	631	633	637	12*649	10*651	659
				660	12*904	12*906	908	909	910	12*935	938
				946	947	DEFINED	513	515	610	627	633
				647	660	899	933	938			
20365	XBIG	REAL		REFS	12*459	12*483	490	DEFINED	417	438	450
				479	482						
20501	XEND	REAL		REFS	12*834	12*836	841	DEFINED	833		
20405	XI	REAL		REFS	533	583	585	587	DEFINED	532	
20440	XILBI1	REAL		REFS	616	626	627	646	647		
				DEFINED	614	662					
20437	XILBI2	REAL		REFS	617	626	646	DEFINED	612	663	
20446	XMXCVA	REAL		REFS	669	676	677	678	774		
				DEFINED	664						
20447	XMXCVG	REAL		REFS	669	676	677	678	774		
				DEFINED	665						
20462	XVIRGI	REAL		REFS	731	DEFINED	730				
20441	XX1	REAL		REFS	621	DEFINED	616				
20442	XX2	REAL		REFS	621	DEFINED	617				
40706	X1	REAL	ARRAY	REFS	5	12*431	438	440	450	12*505	508
				510	511	10*878	887	896	897		
				DEFINED	429	440	504	508	877	887	
20403	Y	REAL		REFS	528	908	910	914	DEFINED	526	906
20372	YBIG	REAL		REFS	461	490	DEFINED	459	478	481	
20434	YCEPT	REAL		REFS	605	DEFINED	597	600			
20511	YCPTMD	REAL		REFS	910	918	DEFINED	908			
20505	YCPTND	REAL		REFS	910	918	DEFINED	841			
20435	YCURVE	REAL		REFS	607	609	632	937	DEFINED	603	629
				935							
20502	YEND	REAL		REFS	841	DEFINED	834				
20406	YI	REAL		REFS	583	585	587	DEFINED	533		
20436	YLINE	REAL		REFS	607	609	632	DEFINED	605	631	
20461	YVIRGI	REAL		REFS	730	731	DEFINED	729			

FILE NAMES		MODE									
0	INPUT	FMT	READS	45	71	75	81				
2054	OUTPUT	FMT	WRITES	52	53	54	59	60	63	64	66
4130	TAPE1	FMT	WRITES	143	210	240	247	350	369	387	774
			775	776	777	810	825	864	894	910	
10260	TAPE15	FMT	WRITES	975	978	981					
6204	TAPE5	FMT	READS	57	85	87	88	89	90	95	97
			MOTION	67							
2054	TAPE6	FMT	WRITES	135	137	139	141	142	154	158	162
			166	242	245	249	335	336	337	339	340
			341	342	344	346	347	348	349	358	366
			385	386	621	669	676	751	752	753	754
			765	771	772	773	782	892	944	961	974
			977	980							

EXTERNALS	TYPE	ARGS	REFERENCES								
ALOG10	REAL	1	LIBRARY	395	407	419	420	421	422	678	713	806
				822	847	899						
ATAN	REAL	1	LIBRARY	2*570	576							
EOF	REAL	1		58	86							
LSQFT		5		401	412	809	824	859				
TAN	REAL	1	LIBRARY	582								

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES							
ABS	REAL	1	INTRIN		434	2*437	2*448	449	2*475	476	502	2*570
					576	601	626	646	2*658	2*659	676	677
					875	922	932					
AMIN1	REAL	0	INTRIN		541							
D1	REAL	12	SF	17	431	483	505	649	695	836	904	
D2	REAL	11	SF	20	651	878						
POLY	REAL	13	SF	14	459	526	603	629	688	811	813	834
					906	935						

STATEMENT LABELS			DEF LINE	REFERENCES					
12506	1		85	76	973	976	979	982	
12527	2		95	107	110				
12536	3		97	100					
12553	4		101	98					
12565	5		111	102					
0	6	INACTIVE	108	2*107					
12606	7		129	125					
12611	8		131	128					
12631	9		143	131					
12642	10		152	149					
12650	11		156	149	150				
0	12	INACTIVE	150	149					
12656	13		160	150	151				
0	14	INACTIVE	151	150					
12664	15		164	2*151					
12671	20		170	153	155	157	159	161	163	165
12743	22		195	188					
12752	24		200	194					
12763	25		210	208					
0	30		234	229					
13073	32		246	241					
13114	33		250	246	248				
13123	35		266	255					
0	36	INACTIVE	267	2*266					
13144	38		274	266					
13155	39		278	274					
13161	40		281	216	273	275	277		
13224	41		310	303					
13253	42		324	322	323				
0	43	INACTIVE	325	2*324					
13261	44		327	2*323	324				
13267	45		329	326					
0	50		330	317					
0	52		339	338					
13345	55		346	343					
13347	56		347	345					
13363	60		350	331					
13404	61		363	357					

STATEMENT LABELS			DEF LINE	REFERENCES				
0	62		365	363				
13427	63		368	356	359			
13431	64		369	367				
0	70		395	392				
0	85		407	406				
13627	95		440	433	436	437		
0	100		441	430				
13645	110		451	447	448			
13647	120		452	442				
13714	125		481	473				
13751	130		485	461	475	480		
13763	135		501	512				
0	140		508	503				
14033	145		509	507				
14042	147		514	509				
14055	148		525	514	516			
0	151		558	554				
0	153		563	559				
14202	155		569	555	560			
14246	157		599	595				
14251	158		601	598				
14310	164		609	606				
14312	165		610	602	608			
14316	166		611	607	609			
14322	169		614	611				
14324	170		615	594	613			
0	175		633	628				
14375	180		637	632				
0	190		660	648				
0	195		663	644				
14531	200		664	661				
14751	230		747	739				
14755	240		750	746				
15014	250		764	687	762			
15035	260		772	766				
15073	290		795	792				
0	295		798	796				
15110	299		799	794				
0	305		808	805				
0	306		823	821				
0	308		848	846				
0	310		857	856				
15255	311		859	855				
15271	313		874	898				
15335	315		887	876	880	881		
15352	325		896	886				
0	350		938	934				
0	355	INACTIVE	944	2*939				
15550	360		946	937	939			
0	370		947	931				
15613	375		968	370				
15642	380		974	973				
15647	390		977	973				
15654	400		980	973				
15610	500		963	783	784	793	800	895	945
0	600		120	119				
12576	601		122	120				

STATEMENT LABELS				DEF LINE	REFERENCES					
0	610		INACTIVE	137	136					
12622	615			139	136					
12625	620			141	136					
12627	630			142	138	140				
16717	700	FMT		989	135					
16727	710	FMT		990	137					
16735	720	FMT		991	139					
16743	730	FMT		992	141					
16750	740	FMT		993	348					
16757	750	FMT		994	349					
16765	1000	FMT		995	52	64	242	335	975	978	981
16767	1001	FMT		996	85					
16774	1002	FMT		997	87					
17000	1003	FMT		998	88					
17003	1004	FMT		999	89					
17007	1005	FMT		1000	90					
17011	1006	FMT		1001	95					
17014	1007	FMT		1002	97					
17017	1008	FMT		1003	142					
17046	1009	FMT		1008	154					
17054	1010	FMT		1009	158					
17062	1011	FMT		1010	162					
17070	1012	FMT		1011	166					
17076	1013	FMT		1012	245					
17120	1014	FMT		1016	249					
17123	1015	FMT		1017	336					
17131	1016	FMT		1018	337					
17160	1017	FMT		1023	339					
17166	1018	FMT		1024	340					
17213	1019	FMT		1029	341					
17217	1020	FMT		1030	342					
17261	1021	FMT		1036	344					
17275	1022	FMT		1038	346					
17311	1023	FMT		1040	386					
17361	1024	FMT		1047	621					
17374	1025	FMT		1049	669					
17415	1026	FMT		1052	676					
17427	1027	FMT		1054	751					
17440	1028	FMT		1056	752					
17450	1029	FMT		1058	753					
17460	1030	FMT		1060	754					
17544	1031	FMT		1069	775					
17547	1032	FMT		1070	347					
17573	1034	FMT		1073	765	771				
17607	1035	FMT		1075	772					
17621	1036	FMT		1077	773					
17632	1037	FMT		1079	782					
17711	1038	FMT		1088	944					
17717	1039	FMT		1089	961					
17727	1040	FMT		1091	892					
17737	1041	FMT		1093	974					
17751	1042	FMT		1095	977					
17763	1043	FMT		1097	980					
17776	2050	FMT		1099	385					
20002	2055	FMT		1100	358					
20013	2060	FMT		1102	366					
20027	5001	FMT		1104	810	825				

STATEMENT LABELS			DEF LINE	REFERENCES			
20033	5002	FMT	1105	864			
20037	5003	FMT	1106	143			
20045	5004	FMT	1107	210			
20050	5005	FMT	1108	369			
20053	5006	FMT	1109	350			
20056	5007	FMT	1110	774			
20063	5010	FMT	1111	45	71	75	
20065	5011	FMT	1112	81			
20072	5012	FMT	1114	776			
20067	5013	FMT	1113	894	910		
20074	5014	FMT	1115	777			
12357	6001		53	65			
12402	6002		55	61			
0	6003	INACTIVE	59	58			
12447	6004		66	58			
12462	6005		67	46			
20077	6010	FMT	1116	57			
20101	6020	FMT	1117	59			
20104	6030	FMT	1118	53			
20107	6040	FMT	1119	54	60	63	66
20112	10001	FMT	1120	240			
20115	10002	FMT	1121	247			
20120	10003	FMT	1122	387			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
12362		I	53 53	4B		EXT REFS		
12372		IJ	54 54	7B		EXT REFS	NOT INNER	
12373		I	54 54	4B		EXT REFS		
12417		IJ	60 60	7B		EXT REFS	NOT INNER	
12420		I	60 60	4B		EXT REFS		
12434		IJ	63 63	7B		EXT REFS	NOT INNER	
12435		I	63 63	4B		EXT REFS		
12452		IJ	66 66	7B		EXT REFS	NOT INNER	
12453		I	66 66	4B		EXT REFS		
12474		I	81 81	11B		EXT REFS		
12570	600	I	119 120	5B	INSTACK	EXITS		
12771	40	J	216 281	173B		EXT REFS	NOT INNER	
13006	30	I	229 234	15B	OPT			
13074	33	I	246 250	23B		EXT REFS		
13250	50	I	317 330	23B	OPT			
13312	52	I	338 339	21B		EXT REFS		
13410	62	J	363 365	12B	OPT			
13477	70	I	392 395	11B		EXT REFS		
13516	85	I	406 407	6B		EXT REFS		
13570	100	J	430 441	42B	OPT			
13640	110	I	447 451	6B	INSTACK			
13771	140	I	503 508	42B	OPT	EXITS		
14140	151	I	554 558	20B	OPT	EXITS		
14161	153	I	559 563	20B	OPT	EXITS		
14241	170	I	594 615	66B		NOT INNER		
14256	165	IJ	602 610	40B	OPT	EXITS		
14342	175	IJ	628 633	33B	OPT	EXITS		
14400	195	I	644 663	131B		EXT REFS	EXITS	NOT INNER
14407	190	IJ	648 660	113B		EXT REFS		
14574	250	I	687 764	223B		EXT REFS		
15060	500	J	783 963	533B		EXT REFS	NOT INNER	
15103	295	I	796 798	4B	INSTACK			

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LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
15114  305      I          805 808     11B              EXT REFS
15150  306      I          821 823     13B              EXT REFS
15221  308      I          846 848     11B              EXT REFS
15245  310      I          856 857      5B     INSTACK
15277  315      I          876 887     43B        OPT     EXITS
15501  370      JJ         931 947     54B              EXT REFS    EXITS   NOT INNER
15507  350      I          934 938     31B        OPT     EXITS

STATISTICS
  PROGRAM LENGTH              27471B   12089
  BUFFER LENGTH               11746B    5094
          60000B CM USED
```

Program: CON1D

Consolidation, Expansion, or Uplift Test for
Standard One-Dimensional Consolidation Test Data

Variable name	Definition
ACC	The number of radians in 1 degree
AMAX	The maximum value of axial strain for a 1-D test data (%)
AMIN	The minimum value of axial strain (%)
ANGBI	The bisector angle of the interior angle, ANGLE
ANGLE	The interior angle formed by the intersection of the virgin compression line and the line with a rebound slope tangent to the top of the compression curve
APINST	The $\log_{10}$ of the in situ overburden pressure
ASUBV	The coefficient of compressibility (in^2/lb)
AVXMCV	The $\log_{-10}$ of the average maximum curvature abscissa
AXØP	The value of axial strain at 0 percent primary consolidation (%)
AX100P	The value of axial strain at 100 percent primary consolidation (%)
AX24S	The axial strain value 24 seconds after the application of a testing pressure (%)
AX50P	The value of axial strain at 50 percent primary consolidation (%)
AX6S	The value of axial strain at 6 seconds after the application of a testing pressure
BDX1 BDX2	The $\log_{10}$ of abscissa time values that are the lower and upper iteration boundaries used to find the inflection point and the point of intersection of lines tangent to the time percent strain curves
BIG	The steepest slope tangent to the laboratory compression curve, used to locate the virgin compression line
BMAX	The minimum height of the specimen at the maximum testing pressure (in)
BOUND	The variable to store original value of BOUND1
BOUND1 BOUND2	The $\log_{10}$ pressure abscissa values that are the lower and upper iteration boundaries used to define a line with the rebound slope tangent to the top of the compresion curve

Variable name	Definition
BOUND3 BOUND4	The upper and lower ordinate boundaries that the program searches between to define the virgin compression line
BOUND5	The variable to store the original value of BOUND2
BVR	The bottom void ratio on the e-log p graph
C	An array containing the polynomial coefficients
CAC	The cross-sectional area of the specimen container (cm^2)
CAI	The cross-sectional area of the specimen container (in^2)
CC	An array containing the coefficients of the average rebound line
CD	The container diameter (in)
CDIAL	A constant (1 or -1) that indicates the direction of the consolidometer dial gage movement
CEPT**	Y-intercept of graphic construction lines - variables are defined as:
TAN	Top tangent line
TBI	Interior angle bisector line
TB1	Low abscissa value intermediate boundary line
TB2	The high abscissa value intermediate boundary line
TC	Line that bisects the angle formed by the tangent to the compression curve at a point of maximum curvature and a horizontal line
TD	Virgin compression line
TF	Line through the log of the effective overburden pressure abscissa and the seating pressure void ratio ordinate with a slope equal to the rebound slope
CF	A factor to convert the specimen's total dry weight over its height to its dry density (g ft^3 in lb)
CH	The height of the specimen container (in)
CHECK	A check variable used to flag passing the primary criteria when looking for the virgin compression line
CHK	A flag to indicate if the points of maximum curvature found by both methods are within 3 lb/in^2 of each other
CHSTOP	A flag to indicate an expansive soil
CLASS	A Unified Soil Classification symbol

Variable name	Definition
CMAX	The minimum void ratio at the maximum testing pressure
CMLM	The moisture content at the maximum testing pressure (%)
CONM	The value of axial strain at the end of each testing pressure (%)
CONSOL	The axial strain at every time reading for every testing pressure (%)
CORR	The load deflection correction factor (in)
CR	The maximum compression index, i.e., the slope of the in situ virgin compression line on the e-log p plot
CRMIN	The minimum compression index, i.e., the slope of the virgin compression line on the e-log p plot
CRMINR	The minimum compression ratio
CRR	The maximum compression ratio
CS	The swell expansion index, i.e., the slope of the average rebound line on the e-log p plot
CV	The coefficient of consolidation determined by the log method
CVINF	The coefficient of consolidation determined by the infletion point method
DATO	The date the specimen was removed
DATEP	The date that the specimen was placed
DDI	The initial dry density (lb/ft^3)
DDML	The dry density of the specimen at the maximum testing pressure (lb/ft3)
DELTA	A variable equal to incremental steps used when iterating
DEP DEPTH	The upper and lower in situ depth of the test specimen
DH	Drill hole

Variable name	Definition
DIFF	The difference between successive slopes at tangency points along the compression curve
DMAX	The specimen soil voids at the maximum testing pressure
DRCORR	The gage dial reading corrected for deflection
DR1	The gage dial readings during the test (in)
DR2	The gage dial reading with the gage ring in place (in)
DR3	The gage dial reading with the seating pressure on the specimen (in)
DSI	The initial degree of saturation in the specimen (%)
DSIP	The initial degree of saturation check in the specimen (%)
DSML	The degree of saturation in the specimen at the maximum testing pressure (%)
DSML2	The degree of saturation check in the specimen at the maximum testing pressure (%)
DUMB	A scratch array that acts as a flag if EHA (extended height of the air) is initially negative - also stores the specimen void ratios in the first unload-reload cycle
DWSPCF	The dry weight of the specimen and container finally (g)
EHA	The extended height of air in the rebounded specimen at the seating pressure (entrapped air) (in)
EHW	The height of water in the specimen at the end of testing (in)
ELAPSE	The elapsed time between a testing pressure application and the dial gage readings (sec)
F	Graphical scaling factor
GAMMA	An acute angle that defines the slope of the angle bisector line
H	The specimen height at the end of each testing pressure (in)
HI	The initial height of the specimen (in)
HMAX	The maximum height of the specimen (in)

Variable name	Definition
HO	The height of the specimen soil solid (in)
HO1	The height of the soil solids computed using the total dry weight as calculated from initial moisture conditions (in)
HO2	The height of the soil solids computed using the total dry weight as calculated from final specimen weight (in)
HTINF	The height of the specimen at the inflection point on a time-percent strain curve (in)
HT50	The height of the specimen at 50 percent of primary consolidation (in)
HW	The initial height of water in the test specimen (in)
HWAT	The height of water in the test specimen at the end of each testing pressure (in)
HWM	The height of water in the test specimen at the maximum testing pressure (in)
I	Integer count and scratch variable
IBVR	The integer value of the bottom void ratio on the e-log p graph x 100
IJ	An integer loop counter
IMAX	The subscript value of the maximum preconsolidation subscript, for plotting
IODEV	Integer odd or even
IOUT	The output control variable read from INPUT file, 0-5
ISPTY	The specimen type, 1 - undisturbed 2 - remolded
ITWD	A variable that flags CON1D on which set of INPUT data to use in the consolidation data reduction, 1 - initial moisure conditions 2 - final weights
ITVR	Integer value of the void ratio on the e-log p graph x 100

Variable name	Definition
ITYPE	Test type: 0 - consolidation 1 - uplift 2 - expansion
IVRCHG	The integer of the void ratio change on the e-log p graph x 100
J JJ	An integer loop counter and variable subscripts - also temporary integer scratch variables
KSLOPE	A flag set to 999 if the primary criterion is passed when searching for the virgin compression line
LEXIT	A loop exit flag used in the void ratio ordinate scaling
LINECT	A line count of printed output
LL	Liquid limit (%)
LSAT	Testing pressure count number that denotes the pressure at which water was added to the specimen
LUN	Loading unit number
M	The number of data readings for any one testing pressure - also, a count of the number of points of maximum curvature for the stress deformation analysis
MCOUNT	The number of data readings in the second testing pressure of equal successive pressures
MM	The number of data readings for each testing pressure
N	The total number of testing pressures applied to the specimens - also, the number of polynomial coefficients
NCPTS	The total number of compressive testing pressures
NCYCLE	The number of loading cycles
NDEG	The degree of the least squares fit polynomial that defines the laboratory compressive curve
NDGADJ	The amount the polynomial degree on the least squares fit of the time-percent strain data is reduced by
NEXPT	The testing pressure count number that defines the pressure of maximum specimen height - can also be the number of data points in the first unload-reload cycle

Variable name	Definition
NN	The number of compressive pressures in the first loading cycle
NPADJ	The number of time-percent strain curves that are to have the degree of the least squares fit polynomial adjusted
NSP	The specimen number
N1CYC	The number of testing pressures in the first load-unload cycle
N2CYC	The number of compressive testing pressures from the start of the second loading cycle to the testing pressure less than or equal to the maximum compressive pressure of the first loading cycle + N1CYC
OCR	The maximum overconsolidation ratio
OCRMIN	The minimum overconsolidation ratio
OVERFLO	A flag set if there are more than 50 testing pressures
P	The applied testing pressures
PADJ	The testing pressure on the time percent strain curve that is to have the degree of the fitting polynomial adjusted
PCMIN	The minimum preconsolidation pressure (lb/in^2)
PCMINP	The minimum preconsolidation pressure for plotting (lb/in^2)
PCON	A temporary storage array that holds testing pressures and percent axial strain values
PERCON	The percent axial strain as calculated from dial gage changes (%)
PERM1 PERM2	The specimen permeabilities calculated using the coefficient of consolidation determined by the log method and by the inflection method, respectively
PHI	An interior acute angle equal to 90° - GAMMA
PI	Plasticity index (%)
PINSTU	The in situ effective overburden pressure (lb/in^2)
PMAX	The maximum testing pressure (lb/in^2)

Variable name	Definition
PRECONP	The preconsolidation pressure that is output (lb/in^2)
PRECON	The $\log_{10}$ of preconsolidation pressures
RAD	The radius of curvature, and the second derivative at points on the time-percent strain curve used to find inflection points
RADMIN	The minimum radius of curvature
RADMXA RADMXG	The $\log_{10}$ of abscissa pressure values at the points of maximum curvature found by analytical and graphic methods, respectively
REB	The specimen rebound (%)
RX RY	Graphic coordinates of the points of maximum curvature
SAMP	Specimen sample number
SAT	The degree of specimen saturation at the end of each testing pressure (%)
SL	Shrinkage limit (%) - also, the slope of the intermediate boundary lines on the e log p plot
SLBI	The slope of the interior angle bisector line on the e-log p plot
SLBI1 SLBI2	The slope of the intermediate boundary lines on the e-log p plot
SLOEND	The slope of a line tangent to the end of a time-percent strain curve
SLOMID	The slope of a line tangent to a time-percent strain curve at the curve's inflection point
SLOMD1	The slope of a line through the last two data points on a time-percent strain curve
SLOPEB	The slope of a line tangent to the laboratory compression curve at the curve's point of maximum curvature
SLOPEC	The slope of a line that bisects the angle formed by a tangent to the compression curve at the point of maximum curvature and a horizontal line on the e-log p plot
SLOPED	The slope of the virgin compression line (CRMIN)

Variable name	Definition
SLOPEE	The slope of the expansion/average rebound line (CS)
SLOPEG	The slope of the in situ virgin compression line (CR)
SLOPEM	The slope formed by combining the slope of a line between the last two compressive testing data coordinates on the e-log p plot and the steepest tangent slope on the compressive curve between these same two coordinates in a weighted ratio of 3:1
SLOPET	The slope of a line between the first two data coordinates on the e-log p plot
SLOPE1	The first derivative of the polynomial expression that defines the laboratory compression curve
SLOPE2	The slope of a line between the last two compressive data coordinates on the e-log p plot - also, a scratch variable that stores values of the second derivative
SPG	Specific gravity
SPTYPE	The Hollerith of the specimen type
TDW	The specimen total dry weight used to reduce the consolidation data (g)
TDW1	The specimen total dry weight calculated from an initial moisture condition (g)
TDW2	The specimen total dry weight computed from the measured final weights (g)
TIMELG	The $\log_{10}$ of data time ordinate values on the time percent strain curves
TIME50	The time ordinate values at 50 percent of primary consolidation (SEC)
TIMINF	The time ordinate value at the inflection point coordinates on the time percent strain curves (SEC)
TVR	The top void ratio on the e-log p graph
VOIDS	The height of void in the specimen at the end of each testing pressure
VR	The void ratio in the specimen at the end of each testing pressure

Variable name	Definition
VRCHG	The change in the void ratio top and bottom abscissa values on the e-log p graph
VRI	The initial void ratio of the specimen
VRI1	The initial void ratio of the specimen computed using the specimen total dry weight as calculated from initial moisture conditions
VRI2	The initial void ratio of the specimen computed using the specimen total dry weight as calculated from final measured weights
VRMIN	The minimum void ratio in the specimen at the computed minimum preconsolidation pressure
VRML1 VRML2	The specimen's void ratio at the maximum testing pressure computed using a total dry weight calculated from the initial moisture condition input data and from the input final weights data, respectively
VRPCON	The probable in situ void ratio in the specimen at the computed probable preconsolidation pressure
VRSCAL	The graphic scale for the void ratio ordinates on the e-log p graph
W	The calculated moisture content in the specimen at the end of each testing pressure (%)
WCF	The weight of the container for the consolidated specimen (g)
WCTF	The weight of the container for the specimen trim of the final wash (g)
WF	The final moisture content in the specimen (%)
WF1	The final moisture content in the specimen, either input directly from the data file or set equal to WF2 (%)
WF2	The final moisture content in the specimen as computed using the input for the total dry weight from the final measured weights (%)
WI	The initial moisture content in the specimen (%)
WI1	The initial moisture content in the specimen input directly from the data file (%)

Variable name	Definition
WI2	The initial moisture content in the specimen computed using the total dry weight as calculated from the final measured weights (%)
WSR	The weight of the specimen ring, cover plates, and the wet specimen (g)
WSRC	The weight of the specimen ring and cover plates (g)
WWS	The computed wet weight of the specimen (g)
WWSPCS	The wet weight of the consolidated specimen and a container (g)
X	A scratch variable, usually to store an abscissa value (i.e., the abscissa at the point of tangency on the top of the compression curve)
XBIG	The abscissa value at the point of tangency on the compression curve where the virgin compression line is located
XEND	The abscissa value of a point of tangency on the end segment of a time-percent strain curve
XI	The pressure abscissa value at the point of intersection of the top tangent line and the virgin compression line on the e-log p plot
XILBI1 XILBI2	The abscissa $\log_{10}$ pressure values of the intermediate boundary points on the laboratory compression curve
XMXCVA XMXCVG	The pressure values at the points of maximum curvature found by the analytical and graphical methods, respectively (lb/in^2)
XVIRGI YVIRGI	The coordinates of a point that lie on the virgin compression line where the ordinate value equals 42 percent the initial specimen void ratio at the seating pressure
XX1 XX2	The real pressure values of XILBI1 and XILBI2 (lb/in^2)
X1	A scratch array to store abscissa values
Y	The scratch variable that stores ordinate values
YBIG	The ordinate value at the point of tangency on the compression curve where the virgin compression line is located

Variable name	Definition
YCEPT	A scratch variable to store values of the y intercept of the intermediate boundary lines
YCPTMD	The y-intercept of the line tangent to the midportion of a time-percent strain curve
YCPTND	The y-intercept of the line tangent to the end of a time-percent strain curve
YCURVE	A scratch variable to hold ordinate values of points along the polynomial curves
YEND	The ordinate values at the point of tangency at the end of a time-percent strain curve
YI	The void ratio ordinate value at the point of intersection of the top tangent line and the virgin compression line on the e-log p plot
YLINE	A scratch variable to store ordinate values of points along the intermediate boundary lines
YVIRGI	See XVIRGI

Variable list for variables
in subroutine LSQFT

Variable name	Definition
B	An array of vector containing the values of the polynomial coefficients
C	The matrix elements C_{ij} of the mean summarization equations listed in section 2.2
CYX	Vector in the (N+1)th colunm of matrix C
DUM	A dummy storage variable
I	An integer counter
IM1	I minus 1
IPJ	I plus J
K	Counter
KP1	K plus I
M	The number of data points
N	The order of the polynomial regression (NDEG)
NPI	N plus I
NP1	N plus I
NTWO	N times 2
SX	The sum of the products of the abscissa data values
SY	The sum of the product data values
SYX	The sum of the ordinate Y times the sum of the products of X
X	Data point
Y	Coordinates

```
      SUBROUTINE LSQFT(X,Y,M,N,B)
      DOUBLE C(12,12),CYX(11)
      DIMENSION SX(22),SYX(11),X(50),Y(50),B(13)
C
C     COMPUTING SUMS OF POWERS AND PRODUCTS
C
      NTWO=2*N
      NP1=N+1
      SY=0.0
      DO 1 I=1,N
      NPI=N+I
      SX(I)=0.0
      SX(NPI)=0.0
    1 SYX(I)=0.0
      DO 3 I=1,M
      SY=SY+Y(I)
      DUM=1.0
      DO 2 J=1,N
      DUM=DUM*X(I)
      SX(J)=SX(J)+DUM
    2 SYX(J)=SYX(J)+Y(I)*DUM
      DO 3 J=NP1,NTWO
      DUM=DUM*X(I)
    3 SX(J)=SX(J)+DUM
C
C     COMPUTE COEFFICIENTS C(I,J)
C
      DO 4 I=1,12
      DO 4 J=1,12
    4 C(I,J)=0.0
      DO 5 I=1,N
      CYX(I)=SYX(I)-SY*SX(I)/M
      C(I,NP1)=CYX(I)
      DO 5 J=1,N
      IPJ=I+J
    5 C(I,J)=SX(IPJ)-SX(I)*SX(J)/M
C
C     SOLVE SIMULTANIOUS EQUATIONS USING GAUSS-JORDAN REDUCTION
C
      DO 10 K=1,N
C
C     CHECK FOR PIVOT ELEMENT TO SMALL
C
      IF(DABS(C(K,K)).GT.1.0D-25)GO TO 7
      WRITE(6,100)
      STOP
C     NORMALIZE THE PIVOT ROW
    7 KP1=K+1
      DO 8 J=KP1,NP1
    8 C(K,J)=C(K,J)/C(K,K)
      C(K,K)=1.0
C     ELIMINATE K(TH) COLUMN ELEMENTS EXCEPT FOR PIVOT
      DO 10 I=1,N
      IF(I.EQ.K.OR.C(I,K).EQ.0.0)GO TO 10
      DO 9 J=KP1,NP1
    9 C(I,J)=C(I,J)-C(I,K)*C(K,J)
      C(I,K)=0.0
```

```
                 10 CONTINUE
                    DUM=SY
 60                 DO 11 I=1,N
                 11 DUM=DUM-C(I,NP1)*SX(I)
                    B(1)=DUM/M
                    DO 12 I=2,13
                    IM1=I-1
 65              12 B(I)=SNGL(C(IM1,NP1))
                    RETURN
                100 FORMAT(25X*PIVOT ELEMENT TO SMALL AND MATRIX MANIPULATION*
                   +* BREAKS DOWN*)
                    END
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES
3	LSQFT	1	66

VARIABLES		SN	TYPE		RELOCATION								
0	B		REAL	ARRAY	F.P.	REFS	3	DEFINED	1	62	65		
332	C		DOUBLE	ARRAY		REFS	2	44	2*50	54	3*56	61	65
						DEFINED	30	33	36	50	51	56	57
772	CYX		DOUBLE	ARRAY		REFS	2	33	DEFINED	32			
324	DUM		REAL			REFS	19	20	21	23	24	61	62
						DEFINED	17	19	23	59	61		
322	I		INTEGER			REFS	11	12	14	16	19	21	23
						30	3*32	2*33	35	2*36	2*54	3*56	57
						2*61	64	65	DEFINED	10	15	28	31
						53	60	63					
331	IM1		INTEGER			REFS	65	DEFINED	64				
326	IPJ		INTEGER			REFS	36	DEFINED	35				
325	J		INTEGER			REFS	2*20	2*21	2*24	30	35	2*36	2*50
						3*56	DEFINED	18	22	29	34	49	55
327	K		INTEGER			REFS	2*44	48	4*50	2*51	2*54	2*56	57
						DEFINED	40						
330	KP1		INTEGER			REFS	49	55	DEFINED	48			
0	M		INTEGER		F.P.	REFS	15	32	36	62	DEFINED	1	
0	N		INTEGER		F.P.	REFS	7	8	10	11	18	31	34
						40	53	60	DEFINED	1			
323	NPI		INTEGER			REFS	13	DEFINED	11				
320	NP1		INTEGER			REFS	22	33	49	55	61	65	
						DEFINED	8						
317	NTWO		INTEGER			REFS	22	DEFINED	7				
1020	SX		REAL	ARRAY		REFS	3	20	24	32	3*36	61	
						DEFINED	12	13	20	24			
321	SY		REAL			REFS	16	32	59	DEFINED	9	16	
1046	SYX		REAL	ARRAY		REFS	3	21	32	DEFINED	14	21	
0	X		REAL	ARRAY	F.P.	REFS	3	19	23	DEFINED	1		
0	Y		REAL	ARRAY	F.P.	REFS	3	16	21	DEFINED	1		

FILE NAMES	MODE		
TAPE6	FMT	WRITES	45

```
INLINE FUNCTIONS   TYPE    ARGS        DEF LINE  REFERENCES
       DABS      DOUBLE     1  INTRIN                44
       SNGL      REAL       1  INTRIN                65

STATEMENT LABELS              DEF LINE   REFERENCES
    0  1                          14         10
    0  2                          21         18
    0  3                          24         15        22
    0  4                          30         28        29
    0  5                          36         31        34
  146  7                          48         44
    0  8                          50         49
    0  9                          56         55
  231  10                         58         40        53        54
    0  11                         61         60
    0  12                         65         63
  302  100      FMT               67         45

LOOPS  LABEL     INDEX      FROM-TO     LENGTH    PROPERTIES
   15  1         I            10 14        4B     INSTACK
   23  3         I            15 24       36B              NOT INNER
   36  2         J            18 21        6B     INSTACK
   52  3         J            22 24        4B     INSTACK
   62  4         I            28 30       14B              NOT INNER
   70  4         J            29 30        2B     INSTACK
   77  5         I            31 36       34B              NOT INNER
  121  5         J            34 36        6B     INSTACK
  134  10        K            40 58      102B               EXT REFS  NOT INNER
  157  8         J            49 50        7B     INSTACK
  173  10        I            53 58       41B              NOT INNER
  214  9         J            55 56       10B        OPT
  246  11        I            60 61        7B     INSTACK
  270  12        I            63 65        4B     INSTACK

STATISTICS
  PROGRAM LENGTH                1076B      574
          60000B CM USED
```

```
LOAD MAP - CON1D                                    CYBER LOADER 1.5-498       83/09/07. 10.10.28.      PAGE      1


FWA OF THE LOAD            111
LWA+1 OF THE LOAD        51641

TRANSFER ADDRESS -- CON1D          12460

PROGRAM ENTRY POINTS --       CON1D          12460


      .474 CP SECONDS              66500B CM STORAGE USED                    54 TABLE MOVES
```

```
 CCCCCCCC    OOOOOOOO   NN      NN  PPPPPPPPP   LL          SSSSSSSS
CCCCCCCCCC  OOOOOOOOOO  NNN     NN  PPPPPPPPPP  LL         SSSSSSSSSS
CC       C  OO      OO  NN N    NN  PP      PP  LL         SS       S
CC          OO      OO  NN NN   NN  PP      PP  LL         SS
CC          OO      OO  NN  NN  NN  PPPPPPPPPP  LL         SSSSSSSSS
CC          OO      OO  NN  NN  NN  PPPPPPPPP   LL          SSSSSSSS
CC          OO      OO  NN   NN NN  PP          LL                 SS
CC       C  OO      OO  NN    N NN  PP          LL         S       SS
CCCCCCCCCC  OOOOOOOOOO  NN     NNN  PP          LLLLLLLLLL SSSSSSSSSS
 CCCCCCCC    OOOOOOOO   NN      NN  PP          LLLLLLLLLL  SSSSSSSS
```

```
      PROGRAM CONPLOT(INPUT,OUTPUT,TAPE1)
C
C     A COMPUTER PROGRAM THAT PLOTS THE OUTPUT FROM THE CONSOLIDATION
C     ALGORITHM 'CON1D', USING THE 'DISSPLA' PLOTTING SOFTWARE.
C
      COMMON /AAA/SAMP,NSP,DH,DEP,DEPTH,CLASS,SPG,CH,CD,SPTYPE(2)
      COMMON/BBB/N,DDI,WI,DSI,DDEXP,WEXP,DSEXP,AMIN,PMAX,ITYPE,LSAT
      COMMON /BLK1/MM(50),P(50),CONM(50),VR(50),ELAPSE(50,50),
     +CONSOL(50,50),X(101),Y(101)
      COMMON /Z/IDEN(100),LEGLIN(100),IPAK(20),IXLB(5)
      DIMENSION C(12),CC(2),PRECON(2),PTEXX(2),CR(2),
     +PTEXY(2),PTDX(2),PTDY(2),VRPCON(2),PTMAXC(2),VRMAXC(2),VRMAX(2)
      LOGICAL QPCON
      POLY(C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,X)=C1+C2*X+
     +C3*X**2+C4*X**3+C5*X**4+C6*X**5+C7*X**6+C8*X**7+C9*X**8+
     +C10*X**9+C11*X**10+C12*X**11
      DATA (IXLB(I),I=1,5)/"EFFECTIVE ","PRESSURE -",
     +" ((LB/IN*E","H.5(2*EXHX",")))$"/
      REWIND 1
C     OPEN COMMUNICATION WITH DISSPLA
      CALL ID("ONE DIMENSIONAL CONSOLIDATION;GRAPHICS$",100)
      CALL COMPRS
C
C     ALL INPUT TO CONPLOT IS READ FROM TAPE1, A FILE PRODUCED BY CON1D.
C
    1 READ(1,1000)SAMP,NSP,DH,DEP,DEPTH,CLASS,SPG,CH,CD,SPTYPE,
     +IOUT,ITYPE,LSAT,PI,LL,SL
      IF(EOF(1))2,3
    2 CALL DONEPL
      CALL EXIT
 1000 FORMAT(A10,A4,A10,A5,A6,A5,F7.3,2F8.3,A10,A1/3I3,3A3)
    3 READ(1,1001)N,(MM(I),I=1,N)
 1001 FORMAT(I3/30I3/21I3)
      DO 10 J=1,N
      READ(1,1002)P(J),CONM(J),VR(J)
 1002 FORMAT(F8.2,2F11.4)
      M=MM(J)
      DO 5 I=1,M
    5 READ(1,1003)ELAPSE(I,J),CONSOL(I,J)
 1003 FORMAT(F8.0,F8.3)
   10 CONTINUE
      READ(1,1004)DDI,DDML,WI,CMLM,DSI,DSML,REB,WEXP,DSEXP,DDEXP
     +,VRI
 1004 FORMAT(6F8.3,E11.4/4F12.5)
      READ(1,1005)NN,N1CYC,N2CYC,PMAX,VRMIN,CHSTOP,AMIN
 1005 FORMAT(3I3,4F8.3)
      CALL BGNPL(0)
      CALL BASALF("STANDARD")
      CALL MIXALF("L/CSTD")
      CALL MX3ALF("INSTRU","*")
      CALL MX4ALF("SPECIAL","+")
      CALL YAXANG(0.0)
      CALL GRACE(0.0)
C
C     PACK ARRAY FOR SPECIMEN ID
C
      I=LINEST(IDEN,100,131)
```

```
      CALL HEIGHT(0.08)
      ENCODE(111,2000,IPAK)SAMP,NSP,CH,CD
 2000 FORMAT("SAMPLE N(0.) *P)",A10,"*U)  SPECIMEN N(0.) *P1)",A4,
     +"*U1)  SPECIMEN SIZE *P2)",F5.2,"(X)",F5.2,"*U2( IN.)$")
      CALL LINES(IPAK,IDEN,1)
      ENCODE(106,2010,IPAK)SPTYPE,CLASS,DEP,DEPTH,DH
 2010 FORMAT(A10,A2," CLASSIFICATION SYMBOL *P)",A5,"*U)  DEPTH *P1)",
     +A5,"-",A6,"*U1) HOLE N(0.) *P2)",A10,"*U2)$")
      CALL LINES(IPAK,IDEN,2)
      ENCODE(131,2020,IPAK)SL,LL,PI
 2020 FORMAT("                    SHRINKAGE LIMIT *P)",A2,
     +"*U) LIQUID LIMIT *P1)",A3,
     +"*U1) PLASTICITY INDEX *P2)",A2,"*U2)                    *H.8L.5(F
     +IGURE)$")
      CALL LINES(IPAK,IDEN,3)
      CALL RESET("HEIGHT")
      CALL RESET("LINESP")
C
C     TEST FOR EXPANSIVE SPECIMEN AND TYPE OF TEST
C     BRANCH ACCORDINGLY
C
      IF(ITYPE.EQ.0)GOTO 15
      CALL EXUPPT
      GOTO 1
C
C     RESET LOGICAL FLAG IF DEFORMATION ANALYSIS WAS NOT PERFORMED
C
   15 QPCON=.TRUE.
      IF(CHSTOP.EQ.1.0)QPCON=.FALSE.
      IF(.NOT.QPCON)GOTO 501
      READ(1,1006)NDEG,BD1
 1006 FORMAT(I4,F8.2)
      READ(1,1007)XMXCVG,XMXCVA,CHK,PRECON(1),PRECON(2),VRSCAL,BVR,PCMIN
 1007 FORMAT(2F10.2,F3.0/2F10.6,2F10.5,F10.2)
      READ(1,1008)CC(1),CC(2),(C(I),I=1,12)
 1008 FORMAT(7(2F40.20/))
      READ(1,1009)SLOPED,CEPTD
 1009 FORMAT(2F12.5)
      READ(1,1015)CR(1),CR(2),VRMAX(1),VRMAX(2),PINSTU,IMAX
 1015 FORMAT(5F12.6,I2)
C
C     ON 1ST PAGE PLOT E LOG P ANALYSIS WITH CONSTRUCTION POINTS OF
C     CASAGRANDE'S AND SCHMERTMANN'S GRAPHICS
C
C     SET UP ARRAY TO PLOT CURVE
C
      DELTA=((ALOG10(P(NN)))-(ALOG10(BD1)))/50
      X1=ALOG10(BD1)
      DO 20 I=1,51
      Y(I)=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10),
     +C(11),C(12),X1)
      X(I)=10**X1
   20 X1=X1+DELTA
C
C     FIND POINTS FOR DRAWING LINES
C
      PTEXX(1)=P(NN)
```

```
      PTEXX(2)=P(N1CYC)
      PTEXY(1)=CC(1)+CC(2)*ALOG10(P(NN))
      PTEXY(2)=CC(1)+CC(2)*ALOG10(P(N1CYC))
      PTDY(1)=(BVR+VR(NN))/2.0
      PTDX(1)=10**((PTDY(1)-CEPTD)/SLOPED)
      PTDY(2)=(VR(1)+VR(2))/2.
      PTDX(2)=10**((PTDY(2)-CEPTD)/SLOPED)
C
C     FIND COORDINATES OF MAX. CURV. PTS. AND PRECONSOLIDATIONS PTS.
C
      IF(CHK.EQ.1.0)GO TO 30
      DO 25 I=1,2
      VRPCON(I)=CEPTD+SLOPED*PRECON(I)
      PRECON(I)=10**PRECON(I)
      IF(I.EQ.2)GO TO 22
      PTMAXC(I)=XMXCVA
      GO TO 24
   22 PTMAXC(I)=XMXCVG
   24 XX=ALOG10(PTMAXC(I))
   25 VRMAXC(I)=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),XX)
      GO TO 40
   30 VRPCON(1)=CEPTD+SLOPED*PRECON(1)
      PRECON(1)=10**PRECON(1)
      PTMAXC(1)=(XMXCVG+XMXCVA)/2.0
      XX=ALOG10(PTMAXC(1))
      VRMAXC(1)=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),XX)
   40 CALL PAGE(11.0,8.5)
      CALL PHYSOR(0.7,1.15)
      CALL SCMPLX
      CALL TITLE(1H ,1,IXLB,100,
     +"VOID RATIO$",100,9.8,6.0)
      CALL HEADIN("E(LOG)P (PLOT)$",100,-4,2)
      CALL HEADIN("F(OR) A(NALYSIS) O(NLY)$",100,3,2)
C
C     PACK ARRAY FOR E LOG P LEGEND
C
      CALL RESET("SCMPLX")
      I=LINEST(LEGLIN,100,80)
      CALL HEIGHT(0.1)
      CALL LINES("LAB DATA POINTS$",LEGLIN,1)
      CALL LINES("POINT (OF) MAX. CURVATURE$",LEGLIN,2)
      CALL LINES("*H.89)PRECONSOLIDATION PRESSURE$",LEGLIN,3)
      CALL BLNK1(7.085,9.5,5.1214,5.9,2)
      CALL BLNK2(0.0,2.04,0.0,0.24,2)
      CALL SCMPLX
      CALL XLOG(0.4,2.64,BVR,VRSCAL)
      CALL FRAME
C
C     DETERMINE NUMBER OF DIVISIONS FOR Y AXIS GRID LINES
C
      IYGRID=1
      VRSCAL=VRSCAL*100.0
      IF(VRSCAL.LT.10.0)VRSCAL=VRSCAL*10.0
      IF(VRSCAL.GT.80.0)IYGRID=VRSCAL/30
      IF(VRSCAL.GT.50.0.AND.VRSCAL.LT.81.0)IYGRID=VRSCAL/20
```

```
      IF(VRSCAL.GT.20.0.AND.VRSCAL.LT.51.0)IYGRID=VRSCAL/10
      IF(VRSCAL.EQ.20.0)IYGRID=4
      IF(VRSCAL.EQ.10.0)IYGRID=5
      IF(VRSCAL.EQ.70.0)IYGRID=2
      CALL GRID(2,IYGRID)
C
C     PLOT 1ST GRAPH
C
      CALL MARKER(9)
C     PLOT LAB DATA POINTS
      CALL CURVE(P,VR,N2CYC,-1)
      CALL MARKER(3)
      NCVPTS=2
      IF(CHK.EQ.1.0)NCVPTS=1
C     PLOT MAXIMUM CURVATURE POINTS
      CALL CURVE(PTMAXC,VRMAXC,NCVPTS,-1)
      CALL MARKER(13)
      NPRCON=2
      IF(CHK.EQ.1.0)NPRCON=1
C     PLOT PRECONSOLIDATION POINTS
      CALL CURVE(PRECON,VRPCON,NPRCON,-1)
      CALL RESET("MARKER")
      CALL SPLINE
      CALL SCLPIC(0.1)
C     PLOT FITTED POLYNOMIAL CURVE
      CALL CURVE(X,Y,51,0)
      XXNN=XPOSN(PTEXX(1),PTEXY(1))
      YYNN=YPOSN(PTEXX(1),PTEXY(1))
      XEX=XPOSN(PTEXX(2),PTEXY(2))
      YEX=YPOSN(PTEXX(2),PTEXY(2))
C     PLOT REBOUND LINE
      CALL STRTPT(XXNN,YYNN)
      CALL CONNPT(XEX,YEX)
      XBOT=XPOSN(PTDX(1),PTDY(1))
      YBOT=YPOSN(PTDX(1),PTDY(1))
      XTOP=XPOSN(PTDX(2),PTDY(2))
      YTOP=YPOSN(PTDX(2),PTDY(2))
C     PLOT LABORATORY VIRGIN COMPRESSION LINE
      CALL STRTPT(XBOT,YBOT)
      CALL CONNPT(XTOP,YTOP)
      CALL DASH
      XTOP=XPOSN(PINSTU,VR(1))
      YTOP=YPOSN(0.2,VR(1))
C     PLOT INSITU VOID RATIO LINE
      CALL STRTPT(0.0,YTOP)
      CALL CONNPT(XTOP,YTOP)
      IF(ABS(PINSTU-PRECON(IMAX)).LT.0.005)GO TO 60
C
C     FOR OVERCONSOLIDATED SOILS PLOT FIELD RECOMPRESSION LINE
C
      XTOP=XPOSN(PRECON(IMAX),VRMAX(IMAX))
      YTOP=YPOSN(PRECON(IMAX),VRMAX(IMAX))
      CALL CONNPT(XTOP,YTOP)
   60 IF(BVR.GT.0.42*VR(1))GO TO 63
      YBOT=0.42*VR(1)
      XBOT=10**((YBOT-CEPTD)/SLOPED)
      GO TO 65
```

```
   63 YBOT=BVR
      XBOT=10**((YBOT-(VRMAX(IMAX)+CR(IMAX)*ALOG10(PRECON(IMAX))))/
     +(-CR(IMAX)))
   65 X1=XPOSN(XBOT,YBOT)
      Y1=YPOSN(XBOT,YBOT)
      CALL RESET("DASH")
C     PLOT INSITU COMPRESSION LINE
      CALL CONNPT(X1,Y1)
      Y1=(VR(NN)+VR(2))/2.0
      X1=10**((Y1-CEPTD)/SLOPED)
      XFROM=XPOSN(X1,Y1)-0.10
      YFROM=YPOSN(X1,Y1)
      CALL VECTOR(XFROM,YFROM,XFROM-.5,YFROM+.15,2101)
      CALL MESSAG("V(IRGIN) C(OMPRESSION) L(INE)$",100,
     +XFROM-2.9,YFROM+.20)
      X1=10**((Y1-(VRMAX(IMAX)+CR(IMAX)*ALOG10(PRECON(IMAX))))/
     +(-CR(IMAX)))
      XFROM=XPOSN(X1,Y1)+.05
      CALL VECTOR(XFROM,YFROM,XFROM+0.3,YFROM+0.5,2101)
      CALL MESSAG("I(NSITU) V(IRGIN) C(OMPRESSION) L(INE)$",100,
     +XFROM-0.25,YFROM+0.6)
C
C     WRITE IN LEGEND; ADD SPECIMEN ID TO BOTTOM OF PLOT
C
      CALL RESET("SCMPLX")
      CALL RESET("SCLPIC")
      CALL RESET("BLNK1")
      CALL LEGEND(LEGLIN,3,7.180,5.2214)
      CALL RESET("BLNK2")
      CALL MESSAG("(E*H.5L-.5(O*HXLX(=)$",100,0.1,0.07)
      CALL REALNO(VR(1),104,"ABUT","ABUT")
      CALL MESSAG("(, .42E*H.5L-.5(O*HXLX(=)$",100,"ABUT","ABUT")
      CALL REALNO(VR(1)*.42,104,"ABUT","ABUT")
      CALL STORY(IDEN,3,1.60,-0.95)
      CALL ENDGR(0)
C
C     ADD FRAMED BLOCK ON TOP OF PLOT
C
      CALL OREL(3.34,6.0)
      CALL AREA2D(3.12,0.26)
      CALL FRAME
      CALL RESET("HEIGHT")
      CALL MESSAG("DEGREE (OF) POLYNOMIAL = $",100,0.1,0.06)
      CALL INTNO(NDEG,"ABUT","ABUT")
      CALL ENDPL(0)
C
C     CALCULATE Y AXIS SCALES FOR LOG TIME CONSOLIDATION PLOT
C
      CALL AXSPLT(0.0,CONM(NN),9.0,YOR,YSTEP,YAXIS)
      CALL PAGE(8.5,11.0)
      CALL SPLINE
      CALL PHYSOR(1.25,1.0)
      CALL SCMPLX
C
C     SET UP PLOT AREA ON 2ND PAGE
C
      CALL TITLE("*P)TIME-PERCENT STRAIN CURVES*U)$",100,"TIME - ((SEC))
```

```
     +$",100,"AXIAL STRAIN - ((*M6)DC/C*MX))+X)$",100,6.0,9.0)
      CALL HEIGHT(0.1)
      CALL FRAME
      CALL XLOG(1.0,1.0,YSTEP*9.0,-YSTEP)
      CALL GRID(1,2)
      CALL MESSAG(8HPRESSURE,8,-0.1,9.25)
      CALL MESSAG("((LB/IN*EH.5(2*EXHX))$",100,.011,9.1)
      CALL MESSAG("ORDER (OF) POLYNOMIAL$",100,4.35,9.1)
      CALL RESET("SCMPLX")
      CORR=YINVRS(0,8.95)
      NOGO=0
C
C     NOGO AND LOOP 112 ARE TO INSURE COMPATABILITY OF TAPE1
C     (PRODUCED BY CON1D) WITH INPUT CALLS IN LOOP 500
C
      DO 500 J=1,NN
      IF(J.EQ.1.AND.ABS(P(1)-P(2)).GT.0.001)GO TO 500
      IF(J.EQ.1)GO TO 111
      IF(ABS(P(J)-P(J-1)).LT.0.001)GO TO 500
  111 M=MM(J)
      MCOUNT=0
      IF(ABS(P(J+1)-P(J)).GT.0.001)GO TO 115
      MCOUNT=MM(J+1)
      DO 112 I=1,MCOUNT
      ELAPSE(I+M,J)=ELAPSE(I,J+1)
  112 CONSOL(I+M,J)=CONSOL(I,J+1)
  115 M=M+MCOUNT
      IF(M.LT.8)GO TO 500
      CALL MARKER(9)
      DO 120 I=1,M
      X(I)=ELAPSE(I,J)
  120 Y(I)=CONSOL(I,J)
C     PLOT DATA POINTS
      CALL CURVE(X,Y,M,-1)
      LOOPCT=1
      IF(NOGO.NE.1)GO TO 125
      READ(1,1014)(C(I),I=1,4),TIMEST,TIMEND
 1014 FORMAT(2(2F40.20/),2F8.6)
      NOGO=0
      GO TO 126
  125 READ(1,1010)P(J),(C(I),I=1,4),TIMEST,TIMEND
 1010 FORMAT(F7.2/2(2F40.20/),2F8.6)
  126 DELTA=(TIMEND-TIMEST)/20
      X1=TIMEST
      DO 130 I=1,21
      Y(I)=POLY(C(1),C(2),C(3),C(4),0,0,0,0,0,0,0,0,X1)
      X(I)=10**X1
  130 X1=X1+DELTA
C
C     PLOT 3RD ORDER FITTED CURVES(THRU FIRST AND LAST FOUR DATA POINTS)
C
      CALL CURVE(X,Y,21,0)
      LOOPCT=LOOPCT+1
      IF(LOOPCT.LE.2)GO TO 125
      DO 135 I=1,12
  135 C(I)=0.0
      READ(1,1011)NC,(C(I),I=1,12),TIMEST,TIMEND
```

```
 1011 FORMAT(I3/6(2F40.20/),2F8.6)
      DELTA=(ALOG10(ELAPSE(M-3,J))-ALOG10(ELAPSE(4,J)))/40
      X1=ALOG10(ELAPSE(4,J))
      DO 140 I=1,41
      Y(I)=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),X1)
      X(I)=10**X1
  140 X1=X1+DELTA
C
C     PLOT POLYNOMIAL FIT OF ENTIRE CURVE, ONLY IN CENTER SECTION
C
      CALL CURVE(X,Y,41,0)
      READ(1,1012)YCPTND
 1012 FORMAT(F9.4)
      IF(ABS(YCPTND-P(J+1)).GT.0.001)GO TO 150
      NOGO=1
      GO TO 500
  150 READ(1,1013)SLOEND,X(101),YINF,YCPTMD,SLOMID,TIMINF
      IF(SLOEND.EQ.99.99)GOTO 500
 1013 FORMAT(6E14.7)
      CALL MARKER(8)
C
C     PLOT INFLECTION PT. AND TANGENT LINES
C
      CALL CURVE(TIMINF,YINF,1,1)
      XSTRT=10**TIMEND
      YSTRT=SLOEND*ALOG10(XSTRT)+YCPTND
      XFIN=TIMINF
      YFIN=SLOEND*ALOG10(XFIN)+YCPTND
      CALL RLVEC(XSTRT,YSTRT,XFIN,YFIN,0000)
      YSTART=POLY(C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),
     +C(10),C(11),C(12),TIMEST)
      XSTART=10**((YSTART-YCPTMD)/SLOMID)
      YFIN=YSTRT
      XFIN=10**((YFIN-YCPTMD)/SLOMID)
      IF(XFIN.GT.1E06)XFIN=1E06
      IF(XFIN.EQ.1E06)YFIN=6*SLOMID+YCPTMD
      CALL RLVEC(XSTART,YSTART,XFIN,YFIN,0000)
      YVAL=CONSOL(1,J)+CORR
      CALL RLREAL(P(J),104,1.025,YVAL)
      YVAL=CONSOL(M,J)+CORR
      CALL RLMESS(" DEG = $",100,ELAPSE(M,J)+100,YVAL)
      CALL INTNO(NC-1,"ABUT","ABUT")
  500 CONTINUE
C
C     ADD SPECIMEN ID TO PAGE BOTTOM
C
      CALL STORY(IDEN,3,-.3,-.76)
      CALL ENDPL(0)
      CALL RESET("SPLINE")
      IF(IOUT.EQ.5)GOTO 1
C
C     SCALE AND SET UP THIRD PLOT AREA, TIME VS. PERCENT STRAIN
C     PLOT OF LAB DATA POINTS.UP TO 4 PLOTS POSSIBLE,
C     UNLOAD - RELOAD FOR 2 CYCLES.
C
  501 YMAX=0.0
```

```
      DO 502 I=2,N
  502 IF(CONM(I).GT.YMAX)YMAX=CONM(I)
      CALL AXSPLT(0.0,YMAX,9.0,YOR,YSTEP,YAXIS)
      CALL MARKER(1)
      CALL SCLPIC(0.8)
      LOOPCT=1
      CORR=YSTEP*0.05
      ISTART=1
      ILAST=NN
C     PLOTTING LOOP STARTS HERE
  504 CALL SCMPLX
      CALL RESET("HEIGHT")
      CALL PHYSOR(1.25,1.0)
      CALL TITLE("*P)TIME-PERCENT STRAIN CURVES*U)$",100,"TIME - ((SEC))$
     +$",100,"AXIAL STRAIN - ((*M6)DC/C*MX))+X)$",100,6.0,9.0)
      CALL FRAME
      CALL HEIGHT(0.1)
      CALL XLOG(1.0,1.0,9.0*YSTEP,-YSTEP)
      CALL GRID(1,2)
      CALL RLMESS(8HPRESSURE,8,0.80,-0.25*YSTEP)
      CALL RLMESS("((LB/IN*EH.5(2*EXHX))$",100,1.025,-0.1*YSTEP)
      CALL RESET("SCMPLX")
C
      AMAX=0.0
      AMIN=1.E99
      DO 530 J=ISTART,ILAST
      MCOUNT=0
      M=MM(J)
C     BRANCH FOR LOADING VERSUS UNLOADING
      IF((LOOPCT/2)*2.EQ.LOOPCT)GOTO 512
C     COMPRESSIVE LOADING; PLOT ONLY INCREASING LOADS,SKIP SECOND LOAD
C     IF EQUAL TO PREVIOUS LOAD.STORE READING NUMBER OF MAXIMUM LOAD IN
C     VARIABLE NOGO TO SET READING START OF SECOND UNLOAD CYCLE.
      IF(P(J)-AMAX)525,507,508
  507 NOGO=J
      GOTO 525
  508 AMAX=P(J)
      NOGO=J
  509 IF(ABS(P(J+1)-P(J)).GT.0.001)GOTO 521
      GOTO 514
C     COMPRESSIVE UNLOADING
  512 IF(P(J).GE.AMIN)GOTO 525
      AMIN=P(J)
      IF(J.EQ.ILAST)GOTO 521
      GOTO 509
C
C     DO LOOP 519 COMBINES TIME-CONSOLIDATION READINGS FOR EQUAL
C     LOADS INTO ONE SET OF READINGS
C
  514 MCOUNT=MM(J+1)
      DO 519 I=1,MCOUNT
      ELAPSE(I+M,J)=ELAPSE(I,J+1)
  519 CONSOL(I+M,J)=CONSOL(I,J+1)
      M=M+MCOUNT
  521 DO 523 I=1,M
      X(I)=ELAPSE(I,J)
  523 Y(I)=CONSOL(I,J)
```

```
C     PLOT DATA POINTS CONNECTED BY STRAIGHT LINES
      CALL CURVE(X,Y,M,1)
      CALL RLREAL(P(J),104,1.025,Y(1)+CORR)
C     TEST FOR WETTING LOAD AND OUTPUT MESSAGE IF TRUE
  525 IF(LSAT.NE.J)GOTO 530
      X1=ELAPSE(1,J)
      Y1=CONSOL(1,J)
      XTO=XPOSN(X1,Y1)
      YTO=YPOSN(X1,Y1)
      XFROM=XTO+.125
      YFROM=YTO+.125
      CALL VECTOR(XFROM,YFROM,XTO,YTO,2101)
      CALL VECTOR(XFROM,YFROM,XFROM+.5,YFROM,0000)
      CALL MESSAG("WATER ADDED$",100,XFROM+.55,YTO+.075)
  530 CONTINUE
      CALL STORY(IDEN,3,-.3,-.76)
      CALL ENDPL(0)
      LOOPCT=LOOPCT+1
C     SET PLOTTING LOAD BOUNDARIES DEPENDENT ON NUMBER OF TIMES
C     THRU PLOTTING LOOP
      IF(LOOPCT.NE.2)GOTO 535
      ISTART=NN+1
      ILAST=N1CYC
      GOTO 504
C     EXIT PLOTTING LOOP IF ONLY ONE LOAD-UNLOAD CYCLE
  535 IF(N1CYC.EQ.N2CYC)GOTO 550
      IF(LOOPCT.NE.3)GOTO 540
      ISTART=N1CYC+1
      ILAST=N-1
      GOTO 504
  540 IF(LOOPCT.NE.4)GOTO 550
      ISTART=NOGO+1
      ILAST=N
      GOTO 504
C     BEGIN FINAL PAGE OF PLOTS(E LOG P AND AXIAL STRAIN VS. LOAD)
  550 CALL PHYSOR(1.90,1.0)
      CALL AXSPLT(VRMIN,VR(1),4.0,VRO,VRSTEP,X(101))
      CALL TITLE(0,0,IXLB,100,
     +"VOID RATIO$",100,5.0,4.0)
      CALL FRAME
      CALL HEIGHT(0.1)
      CALL SCMPLX
      CALL XLOG(0.3,1.32,VRO,VRSTEP)
      CALL MESSAG("REBOUND = $",100,.1,.45)
      CALL REALNO(REB,1,"ABUT","ABUT")
      CALL MESSAG("+X)$",100,"ABUT","ABUT")
      CALL BLNK1(0.,1.728,.4,.6,1)
      CALL GRID(1,2)
      CALL RESET("BLNK1")
      CALL MARKER(9)
      CALL CURVE(P,VR,N,1)
      CALL STORY(IDEN,3,-0.8,-.76)
      CALL ENDGR(0)
      CALL PHYSOR(1.90,5.4)
      CALL AXSPLT(0.0,YMAX,4.0,YOR,YSTEP,YAXIS)
      CALL AXSPLT(0.0,PMAX,5.0,X(100),XSTEP,X(101))
      CALL TITLE(0,0,IXLB,100,
```

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     +"AXIAL STRAIN - ((*M6)DC/C*MX))+X)$",100,5.0,4.0)
      CALL FRAME
      CALL HEIGHT(0.1)
      CALL GRAPH(0.0,XSTEP,YSTEP*YAXIS+YOR,-YSTEP)
      CALL GRID(2,2)
      CALL CURVE(P,CONM,N,1)
C
C     2ND PLOT ON FINAL PAGE IS FINISHED, ADD TITLE AND
C     TEST SUMMARY BLOCK ON TOP OF PAGE
C
      CALL HEIGHT(0.21)
      CALL MESSAG("*P)ONE - DIMENSIONAL CONSOLIDATION*U)$",100,-.7925,
     +5.2)
      CALL RESET("SCMPLX")
      CALL HEIGHT(0.12)
      CALL LINES("VOID RATIO$",IDEN,1)
      CALL LINESP(1.333)
      CALL LINES("DRY DENSITY - *F3H.5833E.2(LB/FT*E-.8H-.8(3)$",IDEN,2)
      CALL LINES("WATER CONTENT$",IDEN,3)
      CALL HEIGHT(0.10)
      CALL LINESP(1.4)
      CALL LINES("DEGREE (OF)$",IDEN,4)
      CALL LINESP(1.2)
      CALL LINES("SATURATION$",IDEN,5)
C     X1=XSTORY(IDEN,5)
      CALL HEIGHT(0.11)
      CALL LINES("PRESSURES$",LEGLIN,1)
      CALL HEIGHT(0.08)
      CALL LINESP(1.375)
      CALL LINES("INITIAL*A3.75)MAXIMUM$",LEGLIN,2)
C     X2=XSTORY(LEGLIN,2)
      X3=0.0
      IF(.NOT.QPCON)GOTO 560
      CALL HEIGHT(0.10)
      CALL LINESP(1.3)
      CALL LINES("PRECONSOLIDATION$",IPAK,1)
      CALL LINES("PRESSURES$",IPAK,2)
      CALL HEIGHT(0.12)
      CALL LINESP(1.25)
      CALL LINES("PROBABLE*A2.5)MINIMUM$",IPAK,3)
C     X3=XSTORY(IPAK,3)
      X3=1.8256
C     XLEN=X1+X2+X3+.9
  560 XLEN=3.6258+X3*1.16433
      XPOS=(5.0-XLEN)/2.0
      CALL STORY(IDEN,5,XPOS+0.15,4.12)
      CALL STORY(LEGLIN,2,XPOS+2.2273,4.85)
      IF(QPCON)CALL STORY(IPAK,3,XPOS+3.7758,4.7)
      CALL VECTOR(XPOS,4.1,XPOS+3.6258,4.1,0000)
      CALL VECTOR(XPOS,4.36,XPOS+3.6258,4.36,0000)
      CALL VECTOR(XPOS,4.52,XPOS+XLEN,4.52,0000)
      CALL VECTOR(XPOS,4.68,XPOS+XLEN,4.68,0000)
      CALL VECTOR(XPOS,4.84,XPOS+XLEN,4.84,0000)
      CALL VECTOR(XPOS,4.1,XPOS,4.84,0000)
      XPOS=XPOS+2.0773
      CALL VECTOR(XPOS,4.94,XPOS+1.5485,4.94,0000)
      CALL VECTOR(XPOS,5.1,XPOS+1.5485+X3*1.16433,5.1,0000)
```

```
                CALL VECTOR(XPOS,4.1,XPOS,5.1,0000)
                XPOS=XPOS+.77425
                CALL VECTOR(XPOS,4.1,XPOS,4.94,0000)
                XPOS=XPOS+0.77425
                CALL VECTOR(XPOS,4.1,XPOS,5.1,0000)
                IF(.NOT.QPCON)GOTO 570
                CALL VECTOR(XPOS+0.15+X3/2.0,4.52,XPOS+0.15+X3/2.0,4.84,0000)
                CALL VECTOR(XPOS+0.3+X3,4.52,XPOS+0.3+X3,5.1,0000)
            570 CALL HEIGHT(0.10)
                CALL REALNO(VRI,104,XPOS-1.4485,4.71)
                CALL REALNO(VRMIN,104,XPOS-.67425,4.71)
                CALL REALNO(DDI,104,XPOS-1.4485,4.55)
                CALL REALNO(DDML,104,XPOS-.67425,4.55)
                CALL REALNO(WI,103,XPOS-1.4485,4.39)
                CALL REALNO(CMLM,103,XPOS-0.67425,4.39)
                CALL REALNO(DSI,103,XPOS-1.4485,4.18)
                IF(DSML.GT.100.0)DSML=100.0
                CALL REALNO(DSML,103,XPOS-0.67425,4.18)
                IF(.NOT.QPCON)GOTO 590
                IF(CHK.EQ.1.0)GO TO 580
                IF(PRECON(2).GT.PRECON(1))PRECON(1)=PRECON(2)
            580 CALL REALNO(PRECON(1),1,XPOS+.15,4.55)
                CALL MESSAG("*F3H.583(LB/IN*EH.46(2$",100,"ABUT","ABUT")
                CALL REALNO(PCMIN,1,XPOS+.28+X3/2.0,4.55)
                CALL MESSAG("*F3H.583(LB/IN*EH.46(2$",100,"ABUT","ABUT")
            590 CALL SCMPLX
                CALL HEIGHT(0.07)
                XPER=XMESS("+X$",100)+.15
                CALL MESSAG("+X$",100,XPOS-XPER-.77425,4.4)
                CALL MESSAG("+X$",100,XPOS-XPER-.77425,4.19)
                CALL MESSAG("+X$",100,XPOS-XPER,4.19)
                CALL MESSAG("+X$",100,XPOS-XPER,4.4)
                CALL ENDPL(0)
                GO TO 1
                END
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
 6214  CONPLOT        1

VARIABLES      SN  TYPE          RELOCATION
12763  AMAX       REAL                          REFS      433    DEFINED     423      436
    7  AMIN       REAL               BBB        REFS        7      441    DEFINED      45      424      442
12675  BD1        REAL                          REFS      104      105    DEFINED      88
12702  BVR        REAL                          REFS      118      162      225      229    DEFINED       90
12775  C          REAL       ARRAY              REFS       11    12*107   12*134   12*141    4*331   12*347   12*373
                                               DEFINED      92      322      326      341      342
13011  CC         REAL       ARRAY              REFS       11     2*116    2*117   DEFINED    2*92
   10  CD         REAL               AAA        REFS        6       59    DEFINED      26
12705  CEPTD      REAL                          REFS      119      121      127      137      227      238
                                               DEFINED      94
    7  CH         REAL               AAA        REFS        6       59    DEFINED      26
```

VARIABLES	SN	TYPE	RELOCATION									
12700	CHK	REAL			REFS	125	185	190	590	DEFINED	90	
12673	CHSTOP	REAL			REFS	86	DEFINED	45				
5	CLASS	REAL		AAA	REFS	6	63	DEFINED	26			
12663	CMLM	REAL			REFS	585	DEFINED	42				
144	CONM	REAL	ARRAY	BLK1	REFS	8	277	2*401	519	DEFINED	35	
5214	CONSOL	REAL	ARRAY	BLK1	REFS	8	311	317	381	383	452	456
					463	DEFINED	39	311	452			
12734	CORR	REAL			REFS	381	383	459	DEFINED	295	406	
13017	CR	REAL	ARRAY		REFS	11	2*230	2*244	DEFINED	2*96		
4	DDEXP	REAL		BBB	REFS	7	DEFINED	42				
1	DDI	REAL		BBB	REFS	7	582	DEFINED	42			
12662	DDML	REAL			REFS	583	DEFINED	42				
12710	DELTA	REAL			REFS	110	333	350	DEFINED	104	328	344
3	DEP	REAL		AAA	REFS	6	63	DEFINED	26			
4	DEPTH	REAL		AAA	REFS	6	63	DEFINED	26			
2	DH	REAL		AAA	REFS	6	63	DEFINED	26			
6	DSEXP	REAL		BBB	REFS	7	DEFINED	42				
3	DSI	REAL		BBB	REFS	7	586	DEFINED	42			
12664	DSML	REAL			REFS	587	588	DEFINED	42	587		
310	ELAPSE	REAL	ARRAY	BLK1	REFS	8	310	316	2*344	345	384	451
					455	462	DEFINED	39	310	451		
12657	I	INTEGER			REFS	32	2*39	92	107	109	2*127	2*128
					129	130	132	133	134	2*310	2*311	2*316
					2*317	322	326	331	332	341	342	347
					349	2*401	2*451	2*452	2*455	2*456		
					DEFINED	32	38	57	92	106	126	154
					309	315	322	326	330	340	342	346
					400	450	454					
0	IDEN	INTEGER	ARRAY	Z	REFS	10	57	62	66	72	262	390
					472	508	529	531	532	535	537	559
12762	ILAST	INTEGER			REFS	425	443	DEFINED	408	479	485	489
12707	IMAX	INTEGER			REFS	218	2*222	2*223	4*230	4*244		
					DEFINED	96						
12653	IOUT	INTEGER			REFS	393	DEFINED	26				
310	IPAK	INTEGER	ARRAY	Z	REFS	10	62	66	72	549	550	553
					561	DEFINED	59	63	67			
12761	ISTART	INTEGER			REFS	425	DEFINED	407	478	484	488	
11	ITYPE	INTEGER		BBB	REFS	7	79	DEFINED	26			
334	IXLB	INTEGER	ARRAY	Z	REFS	10	146	494	513	DEFINED	17	
12713	IYGRID	INTEGER			REFS	176	DEFINED	167	170	171	172	173
					174	175						
12660	J	INTEGER			REFS	3*35	37	2*39	302	303	2*304	305
					2*307	308	2*310	2*311	316	317	326	2*344
					345	357	381	382	383	384	427	433
					434	436	437	2*438	441	442	443	449
					2*451	2*452	455	456	459	461	462	463
					DEFINED	34	301	425				
144	LEGLIN	INTEGER	ARRAY	Z	REFS	10	154	156	157	158	256	540
					543	560						
12655	LL	INTEGER			REFS	67	DEFINED	26				
12737	LOOPCT	INTEGER			REFS	338	339	2*429	474	477	483	487
					DEFINED	320	338	405	474			
12	LSAT	INTEGER		BBB	REFS	7	461	DEFINED	26			
12661	M	INTEGER			REFS	38	310	311	312	313	315	319
					344	383	384	451	452	453	454	458
					DEFINED	37	305	312	427	453		
12736	MCOUNT	INTEGER			REFS	309	312	450	453	DEFINED	306	308

```
VARIABLES      SN  TYPE            RELOCATION
                                                  426      449
    0  MM          INTEGER    ARRAY    BLK1       REFS       8       37      305      308      427      449
                                                DEFINED     32
    0  N           INTEGER             BBB       REFS       7       32       34      400      485      489      507
                                                  519   DEFINED       32
12742  NC          INTEGER                       REFS     385   DEFINED      342
12714  NCVPTS      INTEGER                       REFS     187   DEFINED      184      185
12674  NDEG        INTEGER                       REFS     272   DEFINED       88
12667  NN          INTEGER                       REFS     104      114      116      118      237      277      301
                                                  408      478   DEFINED       45
12735  NOGO        INTEGER                       REFS     321      488   DEFINED      296      324      358      434
                                                  437
12715  NPRCON      INTEGER                       REFS     192   DEFINED      189      190
    1  NSP         INTEGER             AAA       REFS       6       59   DEFINED       26
12670  N1CYC       INTEGER                       REFS     115      117      479      482      484
                                                DEFINED     45
12671  N2CYC       INTEGER                       REFS     182      482   DEFINED       45
   62  P           REAL       ARRAY    BLK1       REFS       8      104      114      115      116      117      182
                                                  2*302    2*304    2*307      357      382      433      436    2*438
                                                  441      442      459      507      519   DEFINED       35      326
12703  PCMIN       REAL                          REFS     594   DEFINED       90
12654  PI          REAL                          REFS      67   DEFINED       26
12706  PINSTU      REAL                          REFS     213      218   DEFINED       96
   10  PMAX        REAL                BBB       REFS       7      512   DEFINED       45
13013  PRECON      REAL       ARRAY              REFS      11      127      128      137      138      192      218
                                                  222      223      230      244    3*591      592
                                                DEFINED    2*90      128      138      591
13023  PTDX        REAL       ARRAY              REFS      11      205      206      207      208
                                                DEFINED    119      121
13025  PTDY        REAL       ARRAY              REFS      11      119      121      205      206      207      208
                                                DEFINED    118      120
13015  PTEXX       REAL       ARRAY              REFS      11      198      199      200      201
                                                DEFINED    114      115
13021  PTEXY       REAL       ARRAY              REFS      11      198      199      200      201
                                                DEFINED    116      117
13031  PTMAXC      REAL       ARRAY              REFS      11      133      140      187   DEFINED      130      132
                                                  139
12652  QPCON       LOGICAL                       REFS      13       87      546      561      576      589
                                                DEFINED     85       86
12665  REB         REAL                          REFS     501   DEFINED       42
    0  SAMP        REAL                AAA       REFS       6       59   DEFINED       26
12656  SL          REAL                          REFS      67   DEFINED       26
12744  SLOEND      REAL                          REFS     361      369      371   DEFINED      360
12747  SLOMID      REAL                          REFS     375      377      379   DEFINED      360
12704  SLOPED      REAL                          REFS     119      121      127      137      227      238
                                                DEFINED     94
    6  SPG         REAL                AAA       REFS       6   DEFINED       26
   11  SPTYPE      REAL       ARRAY    AAA       REFS       6       63   DEFINED       26
12741  TIMEND      REAL                          REFS     328      368   DEFINED      322      326      342
12740  TIMEST      REAL                          REFS     328      329    11*373   DEFINED      322      326      342
12750  TIMINF      REAL                          REFS     367      370   DEFINED      360
  226  VR          REAL       ARRAY    BLK1       REFS       8      118     2*120      182      213      214      225
                                                  226    2*237      259      261      493      507
                                                DEFINED     35
12666  VRI         REAL                          REFS     580   DEFINED       42
13035  VRMAX       REAL       ARRAY              REFS      11      222      223      230      244
                                                DEFINED    2*96
```

VARIABLES	SN	TYPE		RELOCATION								
13033	VRMAXC	REAL	ARRAY		REFS	11	187	DEFINED	134	141		
12672	VRMIN	REAL			REFS	493	581	DEFINED	45			
12766	VRO	REAL			REFS	493	499					
13027	VRPCON	REAL	ARRAY		REFS	11	192	DEFINED	127	137		
12701	VRSCAL	REAL			REFS	162	168	2*169	2*170	3*171	3*172	173
					174	175	DEFINED	90	168	169		
12767	VRSTEP	REAL			REFS	493	499					
5	WEXP	REAL		BBB	REFS	7	DEFINED	42				
2	WI	REAL		BBB	REFS	7	584	DEFINED	42			
12120	X	REAL	ARRAY	BLK1	REFS	8	197	319	337	354	458	493
					2*512	DEFINED	109	316	332	349	360	455
12722	XBOT	REAL			REFS	210	232	233	DEFINED	205	227	230
12720	XEX	REAL			REFS	204	DEFINED	200				
12753	XFIN	REAL			REFS	371	372	378	379	380		
					DEFINED	370	377	378				
12727	XFROM	REAL			REFS	2*241	242	2*247	248	468	2*469	470
					DEFINED	239	246	466				
12772	XLEN	REAL			REFS	558	564	565	566	DEFINED	557	
12677	XMXCVA	REAL			REFS	130	139	DEFINED	90			
12676	XMXCVG	REAL			REFS	132	139	DEFINED	90			
12774	XPER	REAL			REFS	599	600	601	602	DEFINED	598	
12773	XPOS	REAL			REFS	559	560	561	2*562	2*563	2*564	2*565
					2*566	2*567	568	2*569	2*570	2*571	572	2*573
					574	2*575	2*577	2*578	580	581	582	583
					584	585	586	588	592	594	599	600
					601	602	DEFINED	558	568	572	574	
12756	XSTART	REAL			REFS	380	DEFINED	375				
12770	XSTEP	REAL			REFS	512	517					
12751	XSTRT	REAL			REFS	369	372	DEFINED	368			
12764	XTO	REAL			REFS	466	468	DEFINED	464			
12724	XTOP	REAL			REFS	211	217	224	DEFINED	207	213	222
12712	XX	REAL			REFS	11*134	11*141	DEFINED	133	140		
12716	XXNN	REAL			REFS	203	DEFINED	198				
12711	X1	REAL			REFS	11*107	109	110	236	239	240	246
					11*331	332	333	11*347	349	350	464	465
					DEFINED	105	110	232	238	244	329	333
					345	350	462					
12771	X3	REAL			REFS	557	570	2*577	2*578	594		
					DEFINED	545	555					
12265	Y	REAL	ARRAY	BLK1	REFS	8	197	319	337	354	458	459
					DEFINED	107	317	331	347	456		
12733	YAXIS	REAL			REFS	277	402	511	517			
12723	YBOT	REAL			REFS	210	227	230	232	233		
					DEFINED	206	226	229				
12746	YCPTMD	REAL			REFS	375	377	379	DEFINED	360		
12743	YCPTND	REAL			REFS	357	369	371	DEFINED	355		
12721	YEX	REAL			REFS	204	DEFINED	201				
12754	YFIN	REAL			REFS	372	377	380	DEFINED	371	376	379
12730	YFROM	REAL			REFS	2*241	242	2*247	248	468	2*469	
					DEFINED	240	467					
12745	YINF	REAL			REFS	367	DEFINED	360				
12760	YMAX	REAL			REFS	401	402	511	DEFINED	399	401	
12731	YOR	REAL			REFS	277	402	511	517			
12755	YSTART	REAL			REFS	375	380	DEFINED	373			
12732	YSTEP	REAL			REFS	277	2*289	402	406	2*417	419	420
					511	2*517						
12752	YSTRT	REAL			REFS	372	376	DEFINED	369			

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VARIABLES       SN  TYPE          RELOCATION
12765  YTO          REAL                          REFS      467      468      470   DEFINED      465
12725  YTOP         REAL                          REFS      211      216      217      224   DEFINED      208      214
                                                   223
12757  YVAL         REAL                          REFS      382      384  DEFINED      381      383
12717  YYNN         REAL                          REFS      203  DEFINED      199
12726  Y1           REAL                          REFS      236      238      239      240      244      246      464
                                                   465  DEFINED      233      237      463

FILE NAMES          MODE
    0  INPUT
 2054  OUTPUT
 4130  TAPE1        FMT                   READS       26       32       35       39       42       45       88       90
                                              92       94       96      322      326      342      355      360
                                          MOTION       19

EXTERNALS             TYPE   ARGS       REFERENCES
       ALOG10         REAL      1 LIBRARY    2*104      105      116      117      133      140      230      244    2*344
                                             345      369      371
       AREA2D                  2             268
       AXSPLT                  6             277      402      493      511      512
       BASALF                  1              48
       BGNPL                   1              47
       BLNK1                   5             159      503
       BLNK2                   5             160
       COMPRS                  0              22
       CONNPT                  2             204      211      217      224      236
       CURVE                   4             182      187      192      197      319      337      354      367      458
                                             507      519
       DASH                    0             212
       DONEPL                  0              29
       ENDGR                   1             263      509
       ENDPL                   1             273      391      473      603
       EOF            REAL     1              28
       EXIT                    0              30
       EXUPPT                  0              80
       FRAME                   0             163      269      288      415      496      515
       GRACE                   1              53
       GRAPH                   4             517
       GRID                    2             176      290      418      504      518
       HEADIN                  4             148      149
       HEIGHT                  1              58      155      287      416      497      516      524      528      533
                                             539      541      547      551      579      597
       ID                      2              21
       INTNO                   3             272      385
       LEGEND                  4             256
       LINES                   3              62       66       72      156      157      158      529      531      532
                                             535      537      540      543      549      550      553
       LINESP                  1             530      534      536      542      548      552
       LINEST         INTEGER  3              57      154
       MARKER                  1             180      183      188      314      363      403      506
       MESSAG                  4             242      248      258      260      271      291      292      293      470
                                             500      502      525      593      595      599      600      601      602
       MIXALF                  1              49
       MX3ALF                  2              50
       MX4ALF                  2              51
       OREL                    2             267
       PAGE                    2             143      278
```

EXTERNALS	TYPE	ARGS	REFERENCES								
PHYSOR		2	144	280	412	492	510				
REALNO		4	259	261	501	580	581	582	583	584	585
			586	588	592	594					
RESET		1	73	74	153	193	234	253	254	255	257
			270	294	392	411	421	505	527		
RLMESS		4	384	419	420						
RLREAL		4	382	459							
RLVEC		5	372	380							
SCLPIC		1	195	404							
SCMPLX		0	145	161	281	410	498	596			
SPLINE		0	194	279							
STORY		4	262	390	472	508	559	560	561		
STRTPT		2	203	210	216						
TITLE		8	146	285	413	494	513				
VECTOR		5	241	247	468	469	562	563	564	565	566
			567	569	570	571	573	575	577	578	
XLOG		4	162	289	417	499					
XMESS	REAL	2	598								
XPOSN	REAL	2	198	200	205	207	213	222	232	239	246
			464								
YAXANG		1	52								
YINVRS	REAL	2	295								
YPOSN	REAL	2	199	201	206	208	214	223	233	240	465

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES					
ABS	REAL	1	INTRIN	218	302	304	307	357	438
POLY	REAL	13	SF 14	107	134	141	331	347	373

STATEMENT LABELS			DEF LINE	REFERENCES					
6222	1		26	81	393	604			
0	2	INACTIVE	29	28					
6231	3		32	28					
0	5		39	38					
0	10		41	34					
6340	15		85	79					
0	20		110	106					
6510	22		132	129					
6512	24		133	131					
0	25		134	126					
6562	30		137	125					
6635	40		143	136					
7053	60		225	218					
7063	63		229	225					
7074	65		232	228					
7302	111		305	303					
0	112		311	309					
7326	115		312	307					
0	120		317	315					
7355	125		326	321	339				
7362	126		328	325					
0	130		333	330					
0	135		341	340					
0	140		350	346					
7501	150		360	357					
7615	500		386	301	302	304	313	359	361
7627	501		399	87					
0	502		401	400					

```
STATEMENT LABELS                DEF LINE   REFERENCES
 7653  504                        410        480       486       490
    0  507          INACTIVE      434        433
 7722  508                        436        433
 7725  509                        438        444
 7732  512                        441        429
 7740  514                        449        439
    0  519                        452        450
 7756  521                        454        438       443
    0  523                        456        454
 7776  525                        461        433       435       441
10027  530                        471        425       461
10043  535                        482        477
10052  540                        487        483
10060  550                        492        482       487
10233  560                        557        546
10343  570                        579        576
10416  580                        592        590
10434  590                        596        589
12063  1000     FMT                31         26
12100  1001     FMT                33         32
12112  1002     FMT                36         35
12123  1003     FMT                40         39
12145  1004     FMT                44         42
12163  1005     FMT                46         45
12275  1006     FMT                89         88
12313  1007     FMT                91         90
12327  1008     FMT                93         92
12340  1009     FMT                95         94
12401  1010     FMT               327        326
12415  1011     FMT               343        342
12426  1012     FMT               356        355
12442  1013     FMT               362        360
12366  1014     FMT               323        322
12354  1015     FMT                97         96
12176  2000     FMT                60         59
12224  2010     FMT                64         63
12247  2020     FMT                68         67

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
 6241  10       J          34 41       26B              EXT REFS  NOT INNER
 6253  5        I          38 39       12B              EXT REFS
 6371  20       I         106 110      52B              EXT REFS
 6476  25       I         126 134      63B              EXT REFS
 7270  500      J         301 386     330B              EXT REFS  NOT INNER
 7321  112      I         309 311       4B     INSTACK
 7340  120      I         315 317       4B     INSTACK
 7367  130      I         330 333      15B              EXT REFS
 7412  135      I         340 341       2B     INSTACK
 7434  140      I         346 350      33B              EXT REFS
 7633  502      I         400 401       4B     INSTACK
 7711  530      J         425 471     121B              EXT REFS  NOT INNER
 7750  519      I         450 452       4B     INSTACK
 7763  523      I         454 456       4B     INSTACK

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       AAA          11              0 SAMP    (1)                1 NSP     (1)                2 DH      (1)
                                    3 DEP     (1)                4 DEPTH   (1)                5 CLASS   (1)
```

```
COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
                                   6 SPG     (1)          7 CH      (1)          8 CD      (1)
                                   9 SPTYPE  (2)
      BBB          11              0 N       (1)          1 DDI     (1)          2 WI      (1)
                                   3 DSI     (1)          4 DDEXP   (1)          5 WEXP    (1)
                                   6 DSEXP   (1)          7 AMIN    (1)          8 PMAX    (1)
                                   9 ITYPE   (1)         10 LSAT    (1)
      BLK1       5402              0 MM      (50)         50 P       (50)       100 CONM    (50)
                                 150 VR      (50)        200 ELAPSE (2500)      2700 CONSOL (2500)
                                5200 X       (101)      5301 Y      (101)
      Z           225              0 IDEN    (100)       100 LEGLIN (100)       200 IPAK    (20)
                                 220 IXLB    (5)

STATISTICS
  PROGRAM LENGTH                 5414B    2828
  BUFFER LENGTH                  6011B    3081
  CM LABELED COMMON LENGTH      13021B    5649
          60000B CM USED
```

```
      SUBROUTINE EXUPPT
C
C     SUBROUTINE TO PLOT EXPANSION-UPLIFT 1-D TESTS
C
      COMMON/BBB/N,DDI,WI,DSI,DDEXP,WEXP,DSEXP,AMIN,PMAX,ITYPE,LSAT
      COMMON /BLK1/MM(50),P(50),CONM(50),VR(50),ELAPSE(50,50),
     +CONSOL(50,50),X(101),Y(101)
      COMMON /Z/IDEN(100),LEGLIN(100),IPAK(20),IXLB(5)
C
      CALL SCMPLX
      CALL PHYSOR(1.90,1.2)
      CALL TITLE(0,0,"PRESSURE - ((LB/IN*EH.5(2*EXHX))$",100,
     +"AXIAL STRAIN - ((*M6)DC/C*MX))+X)$",100,5.0,7.0)
      CALL AXSPLT(0.0,PMAX,5.0,X(1),X(2),X(3))
      CALL AXSPLT(0.0,-AMIN,6.0,Y(1),Y(2),Y(3))
      CALL HEIGHT(0.10)
      CALL GRAPH(0.0,X(2),Y(1)+Y(2),-Y(2))
      CALL FRAME
      CALL GRID(2,2)
      CALL MARKER(9)
      CALL SCLPIC(0.8)
      CALL STORY(IDEN,3,-0.8,-0.95)
      CALL HEIGHT(0.21)
      IF(ITYPE.NE.2)GOTO 10
      CALL MESSAG("*P)ONE - DIMENSIONAL EXPANSION*U)$",100,-.4145,8.9)
      CALL CURVE(P,CONM,N,1)
      CALL RLVEC(P(1),0.0,P(1),AMIN/2.0,2211)
      GOTO 20
   10 CALL MESSAG("*P)ONE - DIMENSIONAL UPLIFT*U)$",100,-.05,9.1)
      CALL MESSAG("*P)PRESSURE TEST*U)$",100,1.12,8.75)
C     FOR UPLIFT, ELIMINATE DATA SCATTER DUE TO DIAL READING FLUCTUATIONS
C     WHEN LOADING TO FIND MAX. UPLIFT PRESSURE
      X(1)=P(1)
      Y(1)=0.0
      X(101)=0.0
      DO 15 I=2,N
      IF(X(101).EQ.0.0)GOTO 12
      J=J+1
      X(J)=P(I)
      Y(J)=CONM(I)
      GOTO 15
   12 IF(P(I).NE.PMAX)GOTO 15
      X(2)=PMAX
      Y(2)=0.0
      J=2
      X(101)=1.0
   15 CONTINUE
      CALL CURVE(X,Y,J,1)
      CALL RLVEC(P(1),0.0,PMAX/2.0,0.0,2211)
   20 CALL RESET("SCMPLX")
      CALL HEIGHT(0.12)
      CALL LINES("DRY DENSITY - *H.58E.3(LB/FT*E-.8H-.8(3)$",IDEN,1)
      CALL LINES("WATER CONTENT - *H.8F3+X*FX)$",IDEN,2)
      CALL HEIGHT(0.1)
      CALL LINES("DEGREE (OF)   $",IDEN,3)
      CALL LINESP(1.2)
      CALL LINES("SATURATION *E.92)- *F3H.95+X*FX)$",IDEN,4)
```

```
      CALL HEIGHT(0.12)
      CALL STORY(IDEN,4,.398,7.7)
      CALL MESSAG("INITIAL*A3.30)EXPANDED$",100,2.476,8.3885)
      CALL VECTOR(.2984,7.65,4.5016,7.65,0000)
      CALL VECTOR(.2984,7.9645,4.5016,7.9645,0000)
      CALL VECTOR(.2984,8.1445,4.5016,8.1445,0000)
      CALL VECTOR(.2984,8.3245,4.5016,8.3245,0000)
      CALL VECTOR(2.2764,8.6045,4.5016,8.6045,0000)
      CALL VECTOR(.2984,7.29,.2984,8.3245,0000)
      CALL VECTOR(2.2764,7.65,2.2764,8.6045,0000)
      CALL VECTOR(3.3792,7.65,3.3792,8.6045,0000)
      CALL VECTOR(4.5016,7.29,4.5016,8.6045,0000)
      CALL VECTOR(.2984,7.47,4.5016,7.47,0000)
      CALL VECTOR(.2984,7.29,4.5016,7.29,0000)
      CALL REALNO(DDI,1,2.4764,8.1695)
      CALL REALNO(DDEXP,1,3.6292,8.1695)
      CALL REALNO(WI,1,2.4764,7.9895)
      CALL REALNO(WEXP,1,3.6292,7.9895)
      CALL REALNO(DSI,103,2.4764,7.74)
      CALL REALNO(DSEXP,103,3.6292,7.74)
      IF(ITYPE.NE.2)GOTO 30
      CALL MESSAG("MAXIMUM VERTICAL EXPANSION = $",100,.4,7.5)
      CALL REALNO(AMIN,2,"ABUT","ABUT")
      CALL MESSAG("*H.8) %$",100,"ABUT","ABUT")
      CALL MESSAG("PRESSURE TO COMPRESS SPEC. = $",100,.4,7.32)
      CALL REALNO(PMAX,1,"ABUT","ABUT")
      CALL MESSAG(" *H.6(LB/IN*E-.7H-.8(2*EXHX)$",100,"ABUT",7.335)
      GOTO 40
   30 CALL MESSAG("EXPANSION WHEN PRESSURE RELEASED=$",100,
     +.4,7.5)
      CALL REALNO(CONM(N),2,"ABUT","ABUT")
      CALL MESSAG("*H.8) %$",100,"ABUT","ABUT")
      CALL MESSAG("MAXIMUM UPLIFT PRESSURE = $",100,.4,7.32)
      CALL REALNO(PMAX,1,"ABUT","ABUT")
      CALL MESSAG(" *H.6(LB/IN*E-.7H-.8(2*EXHX)$",100,"ABUT",7.335)
   40 CALL HEIGHT(0.1)
      X(10)=XPOSN(P(LSAT),CONM(LSAT))+0.03
      Y(10)=YPOSN(P(LSAT),CONM(LSAT))-0.03
      X(9)=X(10)+0.2
      Y(9)=Y(10)-0.2
      X(8)=X(9)+0.2
      CALL VECTOR(X(9),Y(9),X(10),Y(10),2101)
      CALL VECTOR(X(9),Y(9),X(8),Y(9),0000)
      CALL MESSAG("WATER ADDED",11,X(8)+.05,Y(9)-.05)
      CALL ENDPL(0)
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS	DEF LINE	REFERENCES
1 EXUPPT	1	103

VARIABLES	SN	TYPE		RELOCATION									
7	AMIN	REAL		BBB	REFS	5	15	27	80				
144	CONM	REAL	ARRAY	BLK1	REFS	6	26	40	88	94	95		
5214	CONSOL	REAL	ARRAY	BLK1	REFS	6							
4	DDEXP	REAL		BBB	REFS	5	73						
1	DDI	REAL		BBB	REFS	5	72						
6	DSEXP	REAL		BBB	REFS	5	77						
3	DSI	REAL		BBB	REFS	5	76						
310	ELAPSE	REAL	ARRAY	BLK1	REFS	6							
1030	I	INTEGER			REFS	39	40	42	DEFINED	36			
0	IDEN	INTEGER	ARRAY	Z	REFS	8	22	52	53	55	57	59	
310	IPAK	INTEGER	ARRAY	Z	REFS	8							
11	ITYPE	INTEGER		BBB	REFS	5	24	78					
334	IXLB	INTEGER	ARRAY	Z	REFS	8							
1031	J	INTEGER			REFS	38	39	40	48	DEFINED	38	45	
144	LEGLIN	INTEGER	ARRAY	Z	REFS	8							
12	LSAT	INTEGER		BBB	REFS	5	2*94	2*95					
0	MM	INTEGER	ARRAY	BLK1	REFS	6							
0	N	INTEGER		BBB	REFS	5	26	36	88				
62	P	REAL	ARRAY	BLK1	REFS	6	26	2*27	33	39	42	49	
					94	95							
10	PMAX	REAL		BBB	REFS	5	14	42	43	49	83	91	
226	VR	REAL	ARRAY	BLK1	REFS	6							
5	WEXP	REAL		BBB	REFS	5	75						
2	WI	REAL		BBB	REFS	5	74						
12120	X	REAL	ARRAY	BLK1	REFS	6	3*14	17	37	48	96	98	
					2*99	2*100	101	DEFINED	33	35	39	43	
					46	94	96	98					
12265	Y	REAL	ARRAY	BLK1	REFS	6	3*15	3*17	48	97	2*99	2*100	
					101	DEFINED	34	40	44	95	97		

EXTERNALS	TYPE	ARGS	REFERENCES								
AXSPLT		6	14	15							
CURVE		4	26	48							
ENDPL		1	102								
FRAME		0	18								
GRAPH		4	17								
GRID		2	19								
HEIGHT		1	16	23	51	54	58	93			
LINES		3	52	53	55	57					
LINESP		1	56								
MARKER		1	20								
MESSAG		4	25	29	30	60	79	81	82	84	86
			89	90	92	101					
PHYSOR		2	11								
REALNO		4	72	73	74	75	76	77	80	83	88
			91								
RESET		1	50								
RLVEC		5	27	49							
SCLPIC		1	21								
SCMPLX		0	10								
STORY		4	22	59							
TITLE		8	12								
VECTOR		5	61	62	63	64	65	66	67	68	69
			70	71	99	100					
XPOSN	REAL	2	94								
YPOSN	REAL	2	95								

```
STATEMENT LABELS              DEF LINE   REFERENCES
   51  10                        29         24
   70  12                        42         37
   76  15                        47         36        41        42
  105  20                        50         28
  214  30                        86         78
  231  40                        93         85

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   63  15       I           36 47       14B        OPT

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       BBB          11               0 N      (1)                1 DDI    (1)                2 WI     (1)
                                     3 DSI    (1)                4 DDEXP  (1)                5 WEXP   (1)
                                     6 DSEXP  (1)                7 AMIN   (1)                8 PMAX   (1)
                                     9 ITYPE  (1)               10 LSAT   (1)
       BLK1       5402               0 MM     (50)              50 P      (50)             100 CONM   (50)
                                   150 VR     (50)             200 ELAPSE (2500)          2700 CONSOL (2500)
                                  5200 X      (101)           5301 Y      (101)
       Z           225               0 IDEN   (100)            100 LEGLIN (100)            200 IPAK   (20)
                                   220 IXLB   (5)

STATISTICS
  PROGRAM LENGTH                 1205B     645
  CM LABELED COMMON LENGTH      13006B    5638
          60000B CM USED
```

```
      SUBROUTINE AXSPLT(MIN,MAX,AXLEN,ORIG,STEP,ALEN)
C
C     A SCALING ROUTINE TO REPLACE THE DISSPLA ROUTINE(AXSPLT). PARAMETERS
C     PASSED ARE IDENTICAL BUT THIS ROUTINE SCALES TO ENGINEER'S SCALE,
C     THAT IS MULTIPLES OF INTERGER 1 THRU 6 AND 8.
C
      REAL MIN,MAX,MINN
C     CALCULATE MINIMUM AXIS STEP SIZE ALLOWABLE. USE AS ENTRY STEP
      DIFF=MAX-MIN
      ES=DIFF/AXLEN
      IF(DIFF.LT.0.0.OR.ES.LT.0.0)STOP "ERROR IS AXSPLT PARAMETERS"
      IF(DIFF.NE.0.0)GOTO 1
      ALEN=AXLEN
      ORIG=MIN
      STEP=0.1
      RETURN
C     ROUND STEP SIZE
C     FIRST NORMALIZE ENTRY STEP TO UNITS (ONES) DIGIT.
    1 IF(ES.LT.1.0)GOTO 10
      IF(ES.GE.10.0)GOTO 100
      IEXP=0
      GOTO 1000
   10 DO 20 IEXP=1,100
      ES=ES*10.0
   20 IF(ES.GE.1.0)GOTO 999
C
  100 DO 200 IEXP=1,100
      ES=ES/10.0
  200 IF(ES.LT.10.0)GOTO 1000
C
  999 IEXP=-IEXP
 1000 REDUCE=1.0
C     IF NORMALIZED ENTRY STEP IS .GT. 6.0 THEN HALF
      IF(ES.LE.6.0)GOTO 1010
      ES=ES/2.0
      REDUCE=2.0
 1010 IES=INT(ES)
C     TEST FOR O.K. SCALE
      IF(ES-FLOAT(IES).EQ.0.0)GOTO 2000
C     IF NOT O.K. ROUND UP TO NEAREST INTEGER
      ES=FLOAT(IES)+1.0
C     UNNORMALIZE
 2000 STEP=ES*REDUCE*10.0**IEXP
C
C     DETERMINE ORIGIN.  AS WITH STEP ORIGIN IS MULTIPLE OF ENGINEER'S
C     SCALE BUT ORIGIN IS ROUNDED DOWN UNSTEAD OF UP,EXCEPT FOR
C     A NEGITIVE MINIMUM VALUE.
C
      IF(MIN.NE.0.0)GOTO 3000
C     IF MINIMUM ENTRY IS 0.0, ORIG =0.0
      ORIG=0.0
      GOTO 4000
 3000 SIGN=1.0
      NEG=0
      MINN=MIN
      IF(MINN.GT.0.0)GOTO 3100
      SIGN=-1.0
```

```
                 NEG=1
            C
            C    NORMALIZE MINN TO MANTISSA AND EXPONENT(BASE 10) WITH EXPONENT
            C    EQUAL TO EXPONENT OF STEP SIZE AND MANTISSA TO UNITS PLACE
            C
             3100 MINN=ABS(MINN)
                 MINN=MINN/10.0**IEXP
                 IMINN=INT(MINN)
                 IF(MINN-FLOAT(IMINN).EQ.0)GOTO 3500
                 MINN=FLOAT(IMINN+NEG)
             3500 ORIG=SIGN*MINN*10.0**IEXP
            C
            C    DETERMINE AXIS LENGTH TO ROUND INCH
            C
             4000 ALEN=(MAX-ORIG)/STEP
                 DIFF=AXLEN-ALEN
                 IEXP=INT(DIFF)
                 ALEN=AXLEN-FLOAT(IEXP)
                 RETURN
                 END
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES	
3	AXSPLT	1	16	76

VARIABLES	SN	TYPE	RELOCATION									
0	ALEN	REAL	F.P.	REFS	73	DEFINED	1	13	72	75		
0	AXLEN	REAL	F.P.	REFS	10	13	73	75	DEFINED	1		
135	DIFF	REAL		REFS	10	11	12	74	DEFINED	9	73	
136	ES	REAL		REFS	11	19	20	24	25	28	29	
				34	35	37	39	43	DEFINED	10	24	
				28	35	41						
141	IES	INTEGER		REFS	39	41	DEFINED	37				
137	IEXP	INTEGER		REFS	31	43	64	68	75			
				DEFINED	21	23	27	31	74			
144	IMINN	INTEGER		REFS	66	67	DEFINED	65				
0	MAX	REAL	F.P.	REFS	7	9	72	DEFINED	1			
0	MIN	REAL	F.P.	REFS	7	9	14	49	55			
				DEFINED	1							
134	MINN	REAL		REFS	7	56	63	64	65	66	68	
				DEFINED	55	63	64	67				
143	NEG	INTEGER		REFS	67	DEFINED	54	58				
0	ORIG	REAL	F.P.	REFS	72	DEFINED	1	14	51	68		
140	REDUCE	REAL		REFS	43	DEFINED	32	36				
142	SIGN	REAL		REFS	68	DEFINED	53	57				
0	STEP	REAL	F.P.	REFS	72	DEFINED	1	15	43			

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES				
ABS	REAL	1	INTRIN		63				
FLOAT	REAL	1	INTRIN		39	41	66	67	75
INT	INTEGER	1	INTRIN		37	65	74		

```
STATEMENT LABELS              DEF LINE   REFERENCES
   22  1                         19         12
   27  10                        23         19
    0  20                        25         23
   36  100                       27         20
    0  200                       29         27
   44  999                       31         25
   45  1000                      32         22        29
   53  1010                      37         34
   60  2000                      43         39
   67  3000                      53         49
   76  3100                      63         56
  107  3500                      68         66
  114  4000                      72         52

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   30  20        IEXP         23 25       6B       INSTACK    EXITS
   37  200       IEXP         27 29       5B       INSTACK    EXITS

STATISTICS
  PROGRAM LENGTH                 151B      105
          60000B CM USED
```

```
FWA OF THE LOAD            111
LWA+1 OF THE LOAD       125776

TRANSFER ADDRESS -- CONPLOT        21346

PROGRAM ENTRY POINTS --       CONPLOT        21346


     2.841 CP SECONDS             150300B CM STORAGE USED                    176 TABLE MOVES
```

APPENDIX B

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ONE-DIMENSIONAL CONSOLIDATION TEST DATA — ADP

F = Force
L = Length

EL-548 (12-82)
Bureau of Reclamation

FEATURE	PROJECT

SAMPLE NO.	SPEC. NO.	DRILL HOLE	DEPTH OF SAMPLE (L)	CLASS SYMBOL	SPECIFIC GRAVITY	SPECIMEN TYPE* 1 UNDISTURBED 2 REMOLDED
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

DATE PLACED	LOADING UNIT NO.	CONTAINER NO.	CONTAINER HEIGHT (L)	CONTAINER DIAMETER (L)	P.I. (%)	L.L. (%)	S.L. (%)
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

WT. OF SPEC. CONT., COVER PLATES AND WET SOIL (GMS.)	WT. OF SPEC. CONT. AND COVER PLATES (GMS.)	DIAL READING WITH SEATING LOAD ON GAGE BLOCK	DIAL READING WITH SEATING LOAD ON SPECIMEN	DATE REMOVED	CONTAINER NO. FOR WATER CONTENT OF CONSOL. SPEC.	CONTAINER NO. FOR WEIGHT OF TRIMMINGS OR WASHINGS
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

INPUT FOR TOTAL DRY WEIGHT

	FROM INITIAL MOISTURE	CONT. NO. FOR INITIAL WATER CONT.	INITIAL WATER CONTENT (%)	FINAL WATER CONTENT** (%)		
		17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32	33 34 35 36 37 38 39 40		
FROM FINAL MEASURED WEIGHTS	WET WT. OF CONSOL. SPEC. +CONTAINER (GMS.)	DRY WT. OF CONSOL. SPEC. +CONTAINER (GMS.)	WT. OF CONTAINER FOR CONSOL. SPEC. (GMS.)	DRY WT. OF TRIM. OR WASH. +CONTAINER (GMS.)	WT. OF CONTAINER FOR TRIM. OR WASH. (GMS.)	WATER ADDED AT LOAD NO.
	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
POLYNOMIAL DEGREE	EFFECTIVE OVERBURDEN*** (F.L-2)	BOUND 1 (F.L-2)	BOUND 2 (F.L-2)	BOUND 3 (F.L-2)	BOUND 4 (F.L-2)	
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	

SCALES TESTING LOADS

Equip. =
Soil =
Dry tare =

Dry tare =
Water =
Wet tare =

Spec. seat. load =
Water =
Wet load =

SCALES SEATING LOAD

(with gage block)
Equip. =
Block =
1 PSI =
Gage seat load =

(with specimen)
Dry tare =
1 PSI =
Spec. seat load =

FOOTNOTES
*For uplift test add 10; i.e. 11, 12
For expansion test add 20; i.e. 21, 22
**Optional: If blank then final water content calculated from final weights
***Not required if Remolded Specimen

BY	DATE	CHECKED	SHEET ___ OF ___

Sample No. _____
Specimen No. _____
Date _____

MOISTURE DETERMINATION
TRIMMINGS

Dish No. _____ gms
Dish+Wet Soil _____ gms
Dish+Dry Soil _____ gms
Dish _____ gms
Water _____ gms
Dry Soil _____ gms
Moisture _____ %

REMOLDING DATA

Max. Dry Den. _____ lb/ft^3
Placement % X _____ %
Placement Dry Den. _____ pcf
1.0+(% Moist./100) X _____
Placement Wet Den. _____ pcf
Remolding Factor X _____
Wet Soil Required _____ gms
÷3 = _____
Container (Can) + _____ gms
Wet Soil + Container _____ gms
Less Layer (1) Soil _____ gms
Less Layer (2) Soil _____ gms
Less Layer (3) Soil _____ gms

GPO 838-722

EL - 549 (2 - 74) Bureau of Reclamation

ONE-DIMENSIONAL CONSOLIDATION TEST DATA – VARIABLE TIME DATA SHEET

– USE BUFF CARDS –

BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14

NOTE: RECORD LOAD WITH DECIMAL IN COLUMN 6 AND DEFLECTION CORRECTION WITH DECIMAL IN COLUMN 10. TIME RECORDED IN FIRST 8 COLUMNS, RIGHT JUSTIFIED; DIAL READINGS WITH DECIMAL IN COLUMN 10. AFTER THE LAST READING OF EACH LOAD, PLACE 99 IN COLUMNS 7 & 8.

SAMPLE NO. _____

SPEC. NO. _____

LOAD UNIT NO. _____

BY	DATE	CHECKED	SHEET OF

EL - 550 (2 - 74)
Bureau of Reclamation

ONE-DIMENSIONAL CONSOLIDATION TEST DATA — TIME DATA SHEET

- USE BUFF CARDS -

GAGE _____ BEAM _____		GAGE _____ BEAM _____		GAGE _____ BEAM _____		GAGE _____ BEAM _____	
1 2 3 4 5 6 7 8	9 10 11 12 13 14	1 2 3 4 5 6 7 8	9 10 11 12 13 14	1 2 3 4 5 6 7 8	9 10 11 12 13 14	1 2 3 4 5 6 7 8	9 10 11 12 13 14
LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION
	0.0		0.0		0.0		0.0
ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS
4		4		4		4	
10		10		10		10	
20		20		20		20	
40		40		40		40	
80		80		80		80	
200		200		200		200	
400		400		400		400	
800		800		800		800	
2000		2000		2000		2000	
4000		4000		4000		4000	
8000		8000		8000		8000	
20000		20000		20000		20000	
86400		86400		86400		86400	

SAMPLE NO. _____

SPEC. NO. _____

LOADING UNIT NO. _____

NOTE: AFTER THE LAST READING OF EACH LOAD, PLACE 99 IN COLUMNS 7 & 8

HRS.	MIN.	SEC.
	1	20
	3	20
	6	40
	13	20
	33	20
1	6	40
2	13	20
5	33	20
24	00	00

NOTES:

BY	DATE	CHECKED	SHEET OF

GPO 832 - 384

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890123456789
    58C-29   1     DH-1  36.0-38.2  CL-CH  2.76        1
 1-13-80     269     269   1.25    4.25
1728.05 1213.8   0.0679  0.1057  2-8-80
                         38.70    0.00
          648.3   550.0   179.7   164.8   164.3        7
        5   22.00    6.00
      1.0
        4 .1057
       99
     10.0
        4 .1182
       10 .1201
       20 .1212
       40 .1226
       80 .1252
      200 .1299
      400 .1356
      800 .1401
     2000 .1582
     4000 .1699
     8540 .1874
    20000 .1947
    86400 .1978
   172800 .1987
       99
     15.0
        4 .1997
       10 .2000
       20 .2003
1234567890123456789012345678901234567890123456789012345678901234567890123456789
       40 .2008
       80 .2014
      200 .2028
      400 .2045
      800 .2068
     2000 .2116
     4300 .2167
     8240 .2207
    20000 .2242
    86400 .2270
   170400 .2281
   254400 .2286
       99
     30.0
        4 .2313
       10 .2322
       20 .2334
       40 .2347
       80 .2365
      200 .2394
      400 .2429
      800 .2475
     2000 .2563
     4000 .2660
     8000 .2683
    20000 .2754
    82800 .2788
1234567890123456789012345678901234567890123456789012345678901234567890123456789
```

```
                1         2         3         4         5         6         7
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
 57      165600 .2795                                                                  57
 58      250500 .2802                                                                  58
 59          99                                                                        59
 60        60.0                                                                        60
 61           4 .2839                                                                  61
 62          10 .2851                                                                  62
 63          20 .2864                                                                  63
 64          40 .2878                                                                  64
 65          80 .2896                                                                  65
 66         200 .2931                                                                  66
 67         400 .2977                                                                  67
 68         800 .3023                                                                  68
 69        2000 .3127                                                                  69
 70        4000 .3215                                                                  70
 71        8000 .3275                                                                  71
 72       20000 .3320                                                                  72
 73       86400 .3347                                                                  73
 74      169200 .3356                                                                  74
 75      248400 .3359                                                                  75
 76          99                                                                        76
 77      120.0                                                                         77
 78           4 .3396                                                                  78
 79          10 .3408                                                                  79
 80          20 .3418                                                                  80
 81          40 .3431                                                                  81
 82          80 .3452                                                                  82
 83         200 .3487                                                                  83
 84         400 .3526                                                                  84
 85         800 .3580                                                                  85
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
 86        2000 .3681                                                                  86
 87        4000 .3760                                                                  87
 88        8000 .3813                                                                  88
 89       20000 .3856                                                                  89
 90      175200 .3889                                                                  90
 91      265200 .3894                                                                  91
 92      379200 .3896                                                                  92
 93          99                                                                        93
 94      120.0                                                                         94
 95      379204 .3897                                                                  95
 96      383200 .3897                                                                  96
 97      387200 .3899                                                                  97
 98      399200 .3899                                                                  98
 99      465600 .3899                                                                  99
100          99                                                                       100
101        60.0                                                                       101
102           4 .3885                                                                 102
103        4000 .3852                                                                 103
104        8000 .3848                                                                 104
105       20000 .3841                                                                 105
106       86400 .3845                                                                 106
107          99                                                                       107
108        15.0                                                                       108
109           4 .3832                                                                 109
110        4000 .3702                                                                 110
111        8000 .3682                                                                 111
112       20000 .3663                                                                 112
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

```
                1         2         3         4         5         6         7
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
113       .86400 .3645                                                                  113
114      252300 .3640                                                                   114
115          99                                                                         115
116        1.0                                                                          116
117           4 .3628                                                                   117
118        4000 .3476                                                                   118
119        8000 .3415                                                                   119
120       20000 .3333                                                                   120
121       86400 .3248                                                                   121
122      172800 .3202                                                                   122
123      259200 .3190                                                                   123
124      345600 .3186                                                                   124
125          999.9999                                                                   125
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

BUREAU OF RECLAMATION
GEOTECHNICAL BRANCH
ONE-DIMENIONAL CONSOLIDATION TEST

SAMPLE NO 58C-29 SPECIMEN NO 1 SPECIMEN TYPE UNDISTURBED

DATE PLACED 1-13-80 DATE REMOVED 2-8-80 SPECIFIC GRAVITY 2.76

SPECIMEN DIAMETER = 4.25 IN. SPECIMEN HEIGHT = 1.25 IN.

TEST PERFORMED IN CONBEL NO. 269

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 82.1 LB/FT**3 VOID RATIO = 1.0976

TIME IN SEC.	STRAIN IN (%)
4.	0.000

PRESSURE = 10.00 LB/IN**2 AXIAL STRAIN = 7.672 %
DRY DENSITY = 89.0 LB/FT**3 VOID RATIO = .9366

TIME IN SEC.	STRAIN IN (%)
4.	1.031
10.	1.188
20.	1.279
40.	1.394
80.	1.609
200.	1.996
400.	2.467
800.	2.838
2000.	4.331
4000.	5.296
8540.	6.740
20000.	7.342
86400.	7.598
172800.	7.672

PRESSURE = 15.00 LB/IN**2 AXIAL STRAIN = 10.139 %
DRY DENSITY = 91.4 LB/FT**3 VOID RATIO = .8849

TIME IN SEC.	STRAIN IN (%)
4.	7.754
10.	7.779
20.	7.804
40.	7.845
80.	7.895
200.	8.010
400.	8.150
800.	8.340
2000.	8.736
4300.	9.157
8240.	9.487
20000.	9.776
86400.	10.007
170400.	10.097
254400.	10.139

PRESSURE = 30.00 LB/IN**2 AXIAL STRAIN = 14.395 %
DRY DENSITY = 96.0 LB/FT**3 VOID RATIO = .7956

TIME IN SEC.	STRAIN IN (%)
4.	10.361
10.	10.436
20.	10.535
40.	10.642
80.	10.790
200.	11.030
400.	11.318
800.	11.698
2000.	12.424
4000.	13.224
8000.	13.414
20000.	13.999
82800.	14.280
165600.	14.338
250500.	14.395

PRESSURE = 60.00 LB/IN**2 AXIAL STRAIN = 18.990 %
DRY DENSITY = 101.4 LB/FT**3 VOID RATIO = .6992

TIME IN SEC.	STRAIN IN (%)
4.	14.701
10.	14.800
20.	14.907
40.	15.022
80.	15.171
200.	15.459
400.	15.839
800.	16.218
2000.	17.076
4000.	17.802
8000.	18.297
20000.	18.669
86400.	18.891
169200.	18.966
248400.	18.990

PRESSURE = 120.00 LB/IN**2 AXIAL STRAIN = 23.420 %
DRY DENSITY = 107.3 LB/FT**3 VOID RATIO = .6063

TIME IN SEC.	STRAIN IN (%)
4.	19.295
10.	19.394
20.	19.477
40.	19.584
80.	19.757
200.	20.046
400.	20.368
800.	20.813
2000.	21.647
4000.	22.298
8000.	22.736
20000.	23.090
175200.	23.362
265200.	23.404
379200.	23.420

PRESSURE = 120.00 LB/IN**2 AXIAL STRAIN = 23.445 %
DRY DENSITY = 107.3 LB/FT**3 VOID RATIO = .6058

TIME IN SEC.	STRAIN IN (%)
379204.	23.428
383200.	23.428
387200.	23.445
399200.	23.445
465600.	23.445

PRESSURE = 60.00 LB/IN**2 AXIAL STRAIN = 23.000 %
DRY DENSITY = 106.7 LB/FT**3 VOID RATIO = .6151

TIME IN SEC.	STRAIN IN (%)
4.	23.329
4000.	23.057
8000.	23.024
20000.	22.967
86400.	23.000

PRESSURE = 15.00 LB/IN**2 AXIAL STRAIN = 21.308 %
DRY DENSITY = 104.4 LB/FT**3 VOID RATIO = .6506

TIME IN SEC.	STRAIN IN (%)
4.	22.892
4000.	21.820
8000.	21.655
20000.	21.498
86400.	21.350
252300.	21.308

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 17.563 %
DRY DENSITY = 99.6 LB/FT**3 VOID RATIO = .7292

TIME IN SEC.	STRAIN IN (%)
4.	21.209
4000.	19.955
8000.	19.452
20000.	18.776
86400.	18.075
172800.	17.695
259200.	17.596
345600.	17.563

PRESSURE (LB/IN**2)	HEIGHT (IN.)	VOID RATIO	DRY DENSITY (LB/FT**3)	WATER CONTENT (PERCENT)	DEGREE OF SATURATION (PERCENT)	AXIAL STRAIN (PERCENT)
1.00	1.2122	1.0976	82.1	38.7	97.3	0.00
10.00	1.1192	.9366	89.0	33.9	100.0	7.67
15.00	1.0893	.8849	91.4	32.1	100.0	10.14
30.00	1.0377	.7956	96.0	28.8	100.0	14.40
60.00	.9820	.6992	101.4	25.3	100.0	18.99
120.00	.9283	.6063	107.3	22.0	100.0	23.42
120.00	.9280	.6058	107.3	21.9	100.0	23.44
60.00	.9334	.6151	106.7	22.3	100.0	23.00
15.00	.9539	.6506	104.4	23.6	100.0	21.31
1.00	.9993	.7292	99.6	26.4	100.0	17.56

	INITIAL	MAX PRESSURE
DRY DENSITY	82.1	107.3
MOISTURE CONTENT	38.7	21.9
DEGREE OF SATURATION	97.3	100.0
DEGREE OF SATURATION CK	97.3	100.0

REBOUND = 25.09 %

COMPARISON OF PHASE RELATIONS CALCULATED FROM DIFFERENT INPUTS

	INITIAL MOISTURE	FINAL WEIGHTS
TOTAL DRY WEIGHT(GMS)	370.8	370.8
INITIAL WATER CONTENT(%)	38.7	38.7
FINAL WATER CONTENT(%)	26.5	26.5
INITIAL VOID RATIO	1.0978	1.0976
MAX. PRES. VOID RATIO	.6059	.6058

THE ABOVE ANALYSIS USES THE INPUT FINAL WEIGHTS IN THE PHASE RELATIONSHIP CALCULATIONS

THE HEIGHT OF THE ENTRAPPED AIR IN THE SPECIMEN WAS SET TO ZERO IN THE ABOVE ANALYSIS.
THE DEGREE OF SATURATION AT THE MAX PRESSURE BEFORE ZEROING WAS 100.6 %

SAMPLE NO 58C-29

SEMI-LOGARITHMIC STRESS DEFORMATION ANALYSIS

DEGREE OF POLYNOMIAL = 5

SEARCH BOUNDARIES FOR PT. OF MAX. CURVATURE	6.0 LB/IN**2	90.0 LB/IN**2
SEARCH BOUNDARIES FOR VIRGIN COMPRESSION LINE	15.0 LB/IN**2	120.0 LB/IN**2

INSITU EFFECTIVE OVERBURDEN PRESSURE = 22.0 LB/IN**2
VOID RATIO AT SEATING LOAD = 1.098

COMPUTER GENERATED BOUNDARIES FOR ANALYTICAL METHOD	6.8 LB/IN**2	9.7 LB/IN**2

PT. OF MAX. CURVATURE USING GEOMETRICAL METHOD AT 7.7 LB/IN**2
PT. OF MAX. CURVATURE USING ANALYTICAL METHOD AT 9.3 LB/IN**2

ABSCISSA VALUE OF PT. OF MAX. CURVATURE USED FOR ANALYSIS IS THE AVERAGE VALUE

RANGES OF PRESSURE - VOID RATIO CONSOLIDATION PARAMETERS

	PROBABLE	-	MINIMUM
PRECONSOLIDATION PRESSURE .....(LB/IN**2)	11.1	-	3.7
VOID RATIO AT PRECONSOLIDATION PRESSURE	1.098	-	1.098
OVERCONSOLIDATION RATIO (OCR)	.506	-	.168
COMPRESSION INDEX (CC)	.438	-	.329
PRIMARY COMPRESSION RATIO (CC/(1+V.R. AT SEATING))	.209	-	.157
SWELL INDEX (CS)	.061		

SAMPLE NO 58C-29

SEMI-LOGARITHMIC TIME CONSOLIDATION ANALYSIS

PRESSURE (LB/IN**2)	DEGREE OF CONSOLIDATION (U) (IN PERCENT AXIAL STRAIN) (U=0)	(U=100)	TIME (SEC) AT (U=50)	INFLECTION PT.	COEFFICIENT OF CONSOLIDATION (IN**2/SEC) LOG METHOD	INF.PT. METHOD	PERMEABILITY (FT/YR) COMPUTED WITH MAX. CC LOG METHOD	INF.PT. METHOD
1.00								
	.92	7.37	1954.	3629.	.0000340	.0000368	.06	.06
10.00								
	7.72	9.87	2214.	3292.	.0000272	.0000374	.02	.03
15.00								
	10.20	17.73	20876.	38.	.0000026	.0031033	.00	1.39
30.00								
	14.54	18.82	1297.	2173.	.0000387	.0000470	.01	.01
60.00								
	19.18	23.45	1404.	1980.	.0000319	.0000462	.00	.01
120.00								

```
                    PLOTTING COMMENCING
                    ...................

..... DISSPLA VERSION 8.2 .....
NO. OF FIRST PLOT  O



END OF DISSPLA 8.2 --     27258 VECTORS GENERATED IN     5 PLOT FRAMES.
-ISSCO-  4186 SORRENTO VALLEY BLVD.,SAN DIEGO CALIF. 92121

DISSPLA IS A CONFIDENTIAL PROPRIETARY PRODUCT OF ISSCO AND ITS USE
   IS SUBJECT TO A NONDISSEMINATION AND NONDISCLOSURE AGREEMENT.


* * * * * * * * * *  XYNETICS POST-PROCESSOR  * * * * * * * * * *


        PLOT FILE GENERATED BY AGXQKSI     AT 10.44.53  ON 09/27/83
   POPOO1A    ENTER DISSPOP COMMANDS - CARRIAGE RETURN TO CONT.
```

```
            XYNETICS PLOT TAPE STATISTICS
DRAWING NO.   NO. OF RECORDS   LOCATION OF FIRST RECORD
      1              54                      1
      2              55                     55
      3              44                    110
      4              37                    154
      5              62                    191
      6               1                    253
      7               2                    254
      8               1                    256
      9               1                    257
   INF009I    PLOT FILE AUTOMATICALLY DISPOSED - ID = AGXQKSI  XYNPLT,DC=PL,ID,FC=40.

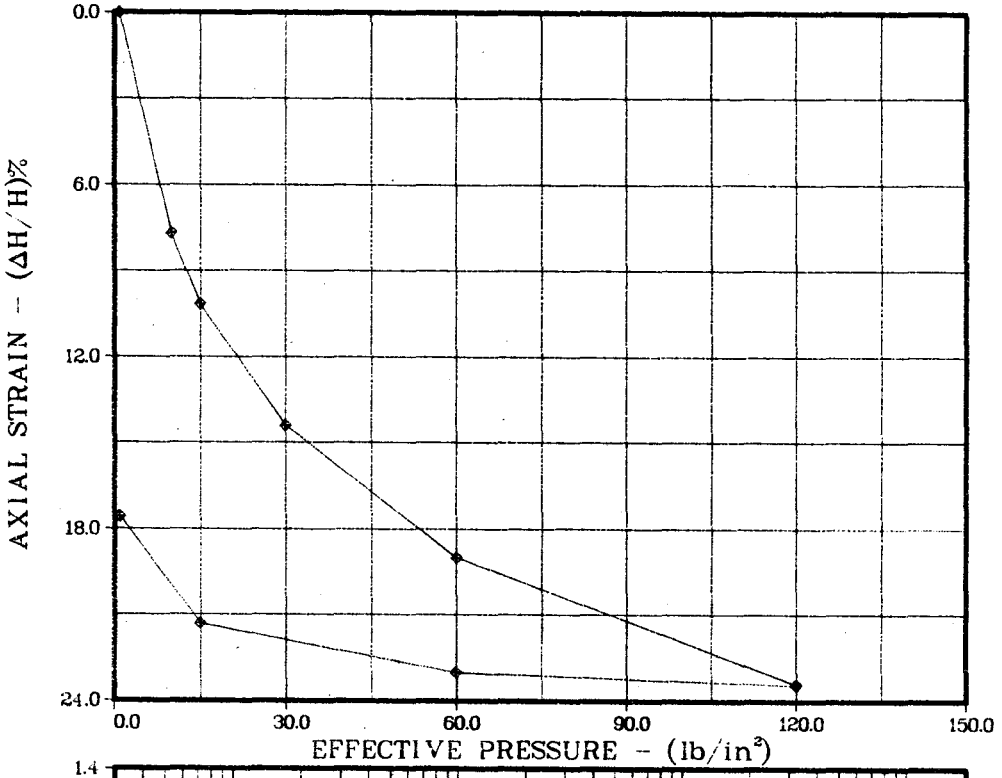

*** END OF DISSPLA PLOTTING ***
            6 PLOTS HAVE BEEN PROCESSED

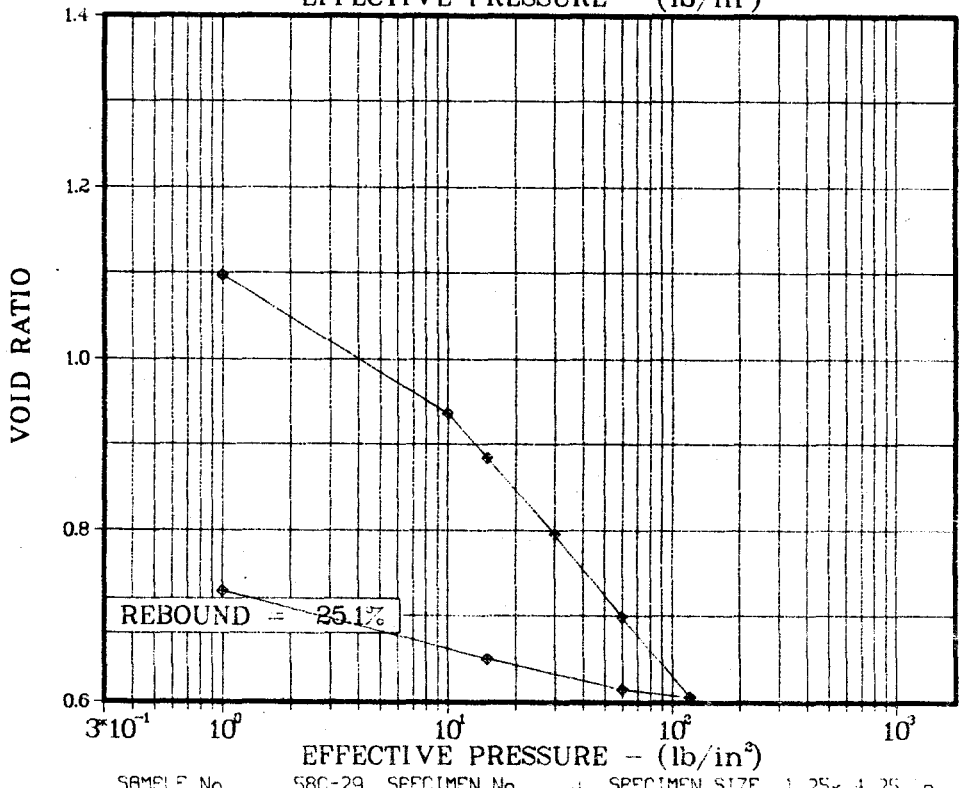
   POP002I    END OF POST-PROCESSOR EXECUTION.
```

```
10.44.30.SOILS,CM155000,P2.
10.44.30. PRIORITY= 2
10.44.30.USER,ER1540A,.
10.44.30.CHARGE,857040,9061.
10.44.32.HEADING.  Y-BIN
10.44.32.HEADING.  GAVLICK
10.44.32.ROUTE,OUTPUT,DC=HR,FC=64,DEF.
10.44.32. ROUTE COMPLETE.
10.44.32.GET,TAPE5=CONDATB.
10.44.32.GET,CON1DB/UN=ER1540A,PW=.
10.44.34.CON1DB.
10.44.36.  CM LWA+1 = 51641B, LOADER USED  66500B
10.44.40.    STOP  NORMAL EXIT
10.44.40.     1.046 CP SECONDS EXECUTION TIME
10.44.40.IFE,FILE(TAPE15,LO).EQ.0,NOPLOT.
10.44.41.REWIND,TAPE1.
10.44.41.GET,CONPLB/UN=ER1540A,PW=.
10.44.42.ATTACH,DISSPLA/UN=LIBRARY.
10.44.42.LDSET,LIB=DISSPLA.
10.44.42.CONPLB.
10.44.52.  CM LWA+1 =125776B, LOADER USED 150300B
10.44.53. DSMSSG NOT FOUND, AT 121615.
10.44.53. DISSPLA - REL-8.2
10.46.04.  EXIT
10.46.04.    21.908 CP SECONDS EXECUTION TIME
10.46.04.GET,XYNPOP/UN=LIBRARY.
10.46.07.XYNPOP.
10.46.09. DSMSSG NOT FOUND, AT 040550.
10.48.48. ROUTE COMPLETE -   XYNPLT
10.48.48.*** ROUTE - DISSPLA PLOT FILE.
10.48.48.XYNPLT,DC=PL,ID,FC=40.
10.48.48.*** ROUTE - JOB NAME= AGXQKSI
10.48.49.    STOP  .XYNPOP. NORMAL EXIT
10.48.49.    21.903 CP SECONDS EXECUTION TIME
10.48.49.SKIP,DONE.
10.48.49.ENDIF,DONE.
10.48.49.DAYFILE,CONDAY.
10.48.49. USER DAYFILE DUMPED.
10.48.49.REPLACE,CONDAY.
10.48.49.UEAD,      0.002KUNS.
10.48.49.UEPF,      0.233KUNS.
10.48.49.UEMS,     13.283KUNS.
10.48.49.UECP,     48.382SECS.
10.48.49.AESR,     73.738UNTS.
```

ONE – DIMENSIONAL CONSOLIDATION

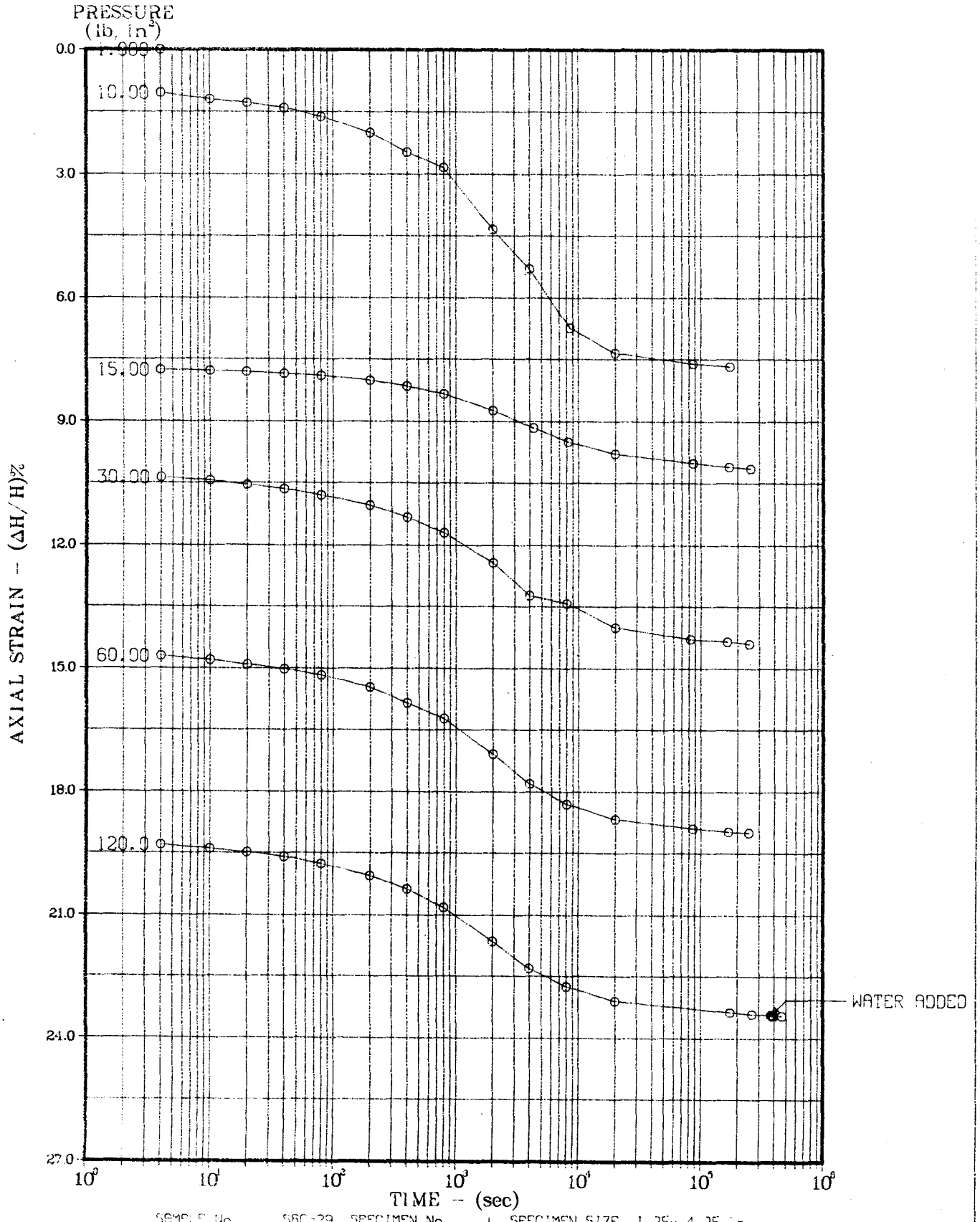
	PRESSURES		PRECONSOLIDATION PRESSURES	
	INITIAL	MAXIMUM	PROBABLE	MINIMUM
VOID RATIO	1.098	0.606		
DRY DENSITY – lb/ft³	82.14	107.3	11.1 lb/in²	3.7 lb/in²
WATER CONTENT	38.7%	21.9%		
DEGREE of SATURATION	97.3%	100.%		





SAMPLE No. 580-29 SPECIMEN No. 1 SPECIMEN SIZE 1.25x 1.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CL-CH DEPTH 36.0-36.2 HOLE No. SH-1
SHRINKAGE LIMIT ___ LIQUID LIMIT ___ PLASTICITY INDEX ___

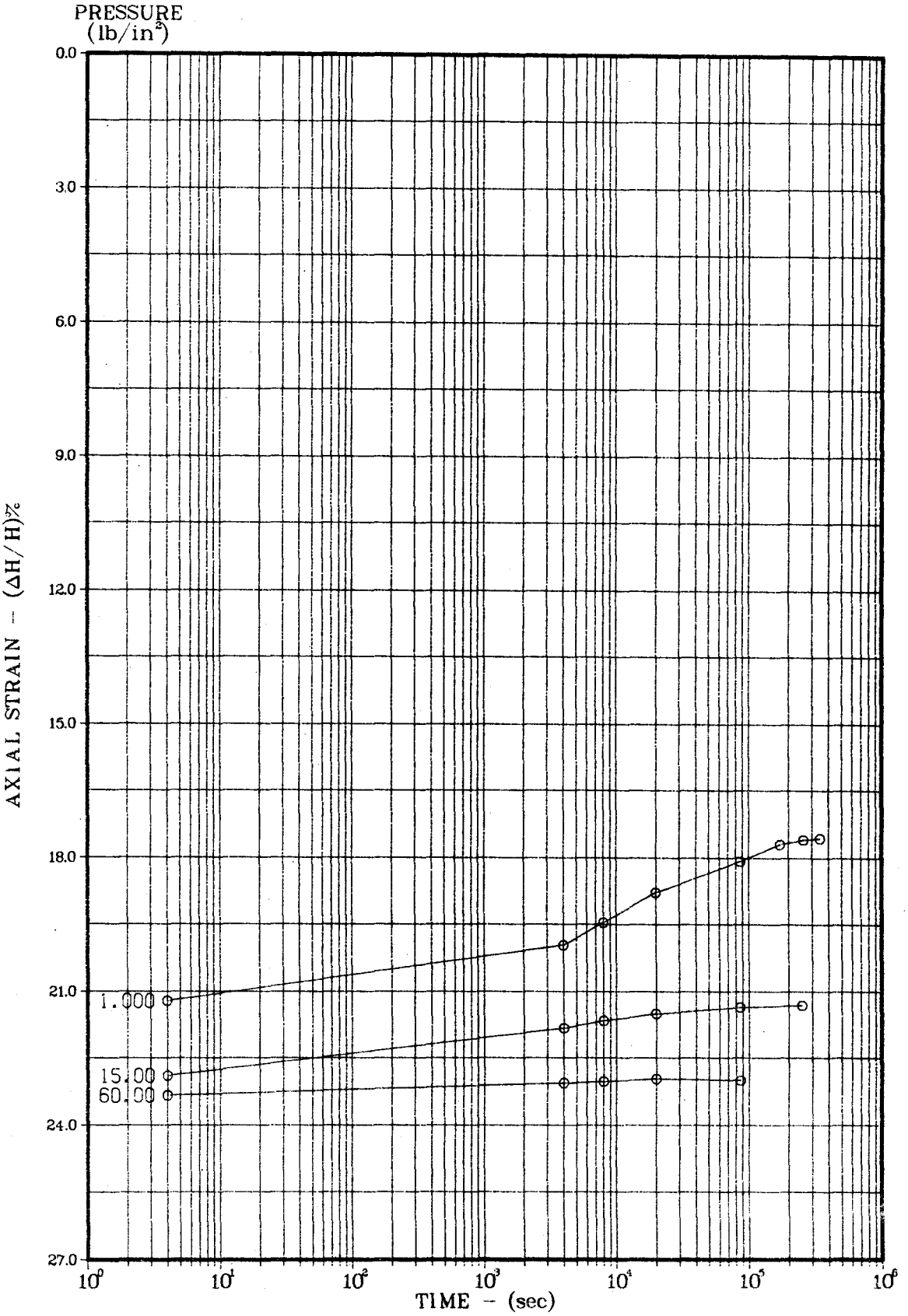
TIME–PERCENT STRAIN CURVES



SAMPLE No. 980-29 SPECIMEN No. 1 SPECIMEN SIZE 1.25x 4.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CL-CH DEPTH 36.0-38.2 HOLE No. DH-1
SHRINKAGE LIMIT ___ LIQUID LIMIT ___ PLASTICITY INDEX ___

Figure .

TIME–PERCENT STRAIN CURVES

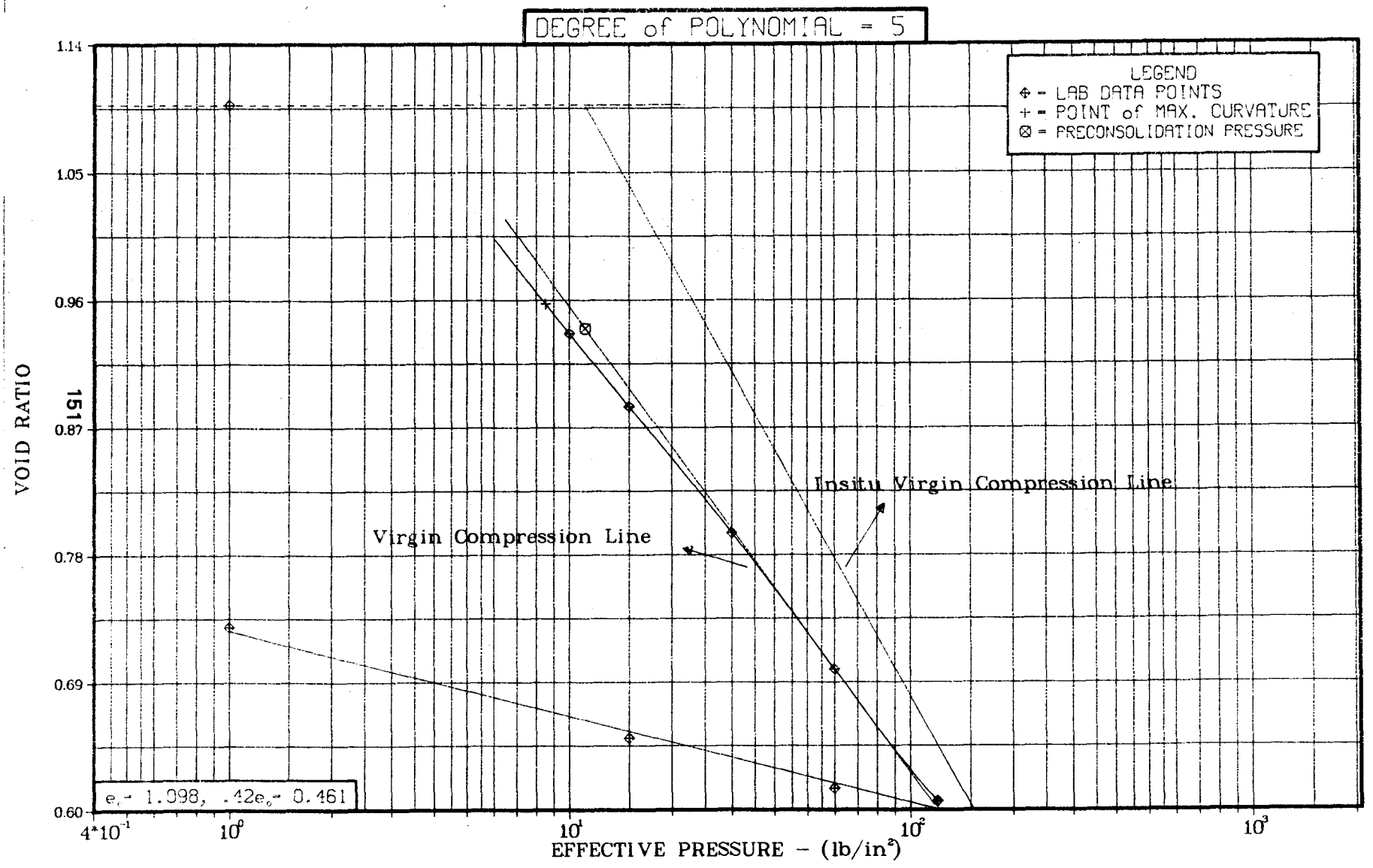


SAMPLE No. 58C-29 SPECIMEN No. 1 SPECIMEN SIZE 1.25x 4.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CL-CH DEPTH 36.0-38.2 HOLE No. DH-1
SHRINKAGE LIMIT __ LIQUID LIMIT __ PLASTICITY INDEX __

Figure

ElogP plot

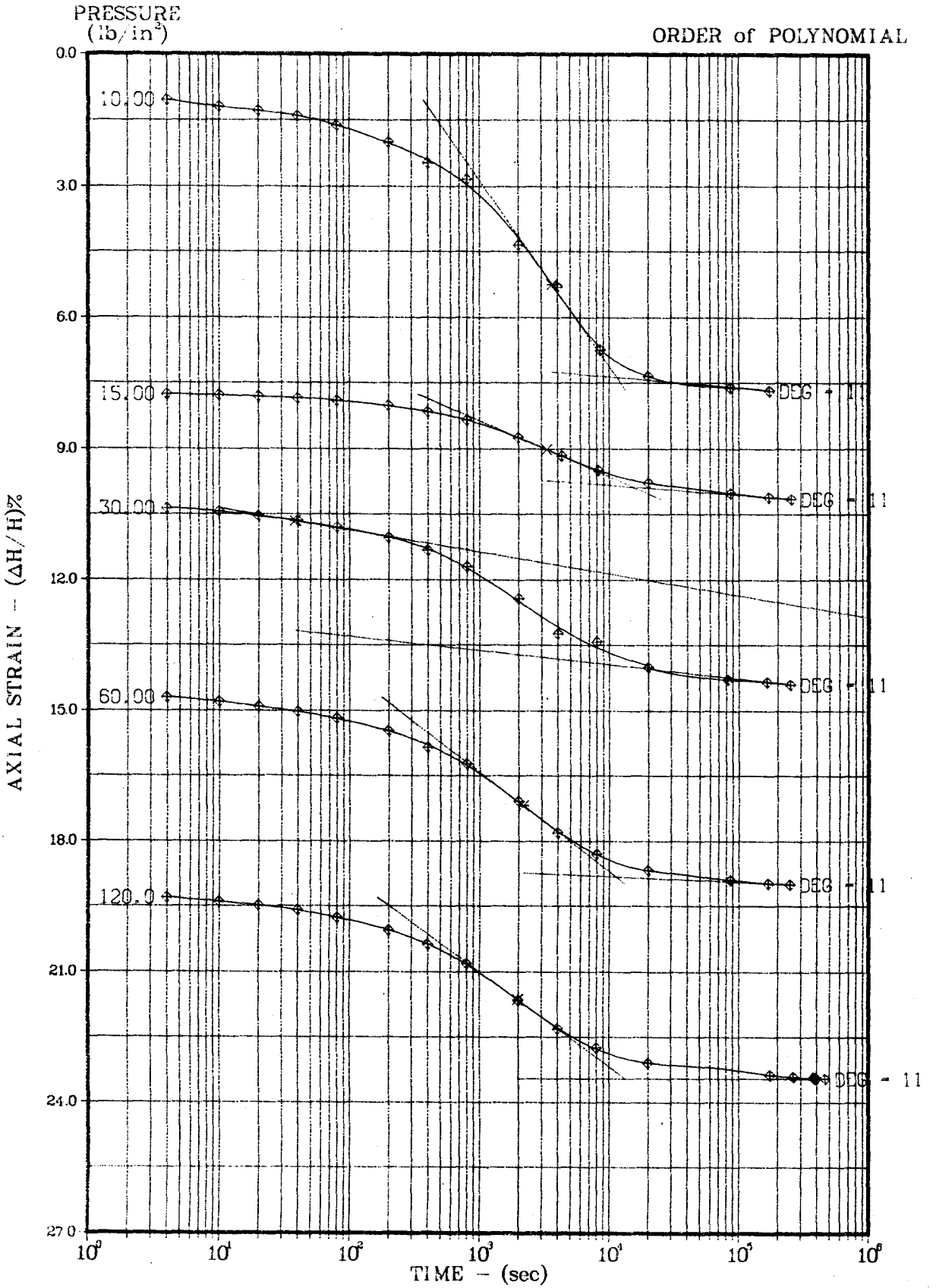
For Analysis Only



SAMPLE No. 58C-29 SPECIMEN No. 1 SPECIMEN SIZE 1.25x 4.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CL-CH DEPTH 36.0-38.2 HOLE No. DH-1
SHRINKAGE LIMIT __ LIQUID LIMIT __ PLASTICITY INDEX __

Figure

TIME-PERCENT STRAIN CURVES



SAMPLE No. 500-29 SPECIMEN No. 1 SPECIMEN SIZE 1.25x 4.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CL-CH DEPTH 36.0-38.2 HOLE No. DH-1
SHRINKAGE LIMIT __ LIQUID LIMIT __ PLASTICITY INDEX __

Figure

APPENDIX C
CONTROL CARDS

```
/JOB
SOILS,CM155000,P3.
USER,ER1540A,.
CHARGE,857040,9061.
HEADING.    EXAMPLE
HEADING.  JOB  CNTRL
ROUTE,OUTPUT,DC=HR,FC=64,DEF.
GET,TAPE5  CONDATA.
GET,CON1DB/UN=ER1540A,PW=STA.
CON1DB.
IFE,FILE (TAPE15,LO).EQ.0,NOPLOT.
REWIND,TAPE1.
GET,CONPLB/UN=ER1540A,PW=STA.
ATTACH,DISSPLA/UN=LIBRARY.
LDSET,LIB  DISSPLA.
CONPLB.
GET,XYNPOP/UN=LIBRARY.
XYNPOP.
SKIP,DONE.
ENDIF,NOPLOT.
*COMMENT MISSING INPUT DATA, PLOTS ABORTED
SKIP,DONE.
EXIT.
ENDIF,DONE.
DAYFILE,CONDAY.
REPLACE,CONDAY.
/EOR
/NOSEQ
 1
 1
 1
  160.00  5
/EOR
ALTID = EXAMPLE  ;  JOB  CNTRL $
DISP=YES,END
DRAW=1-END $
/EOF
```

APPENDIX D

CON1DP USER'S GUIDE

ONE-DIMENSIONAL CONSOLIDATION EXPANSION AND UPLIFT PRESSURE ANALYSES

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Output	2
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Input considerations	9
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A-39	One-dimensional uplift pressure test	A-39

INTRODUCTION

The computer procedure file CON1DP, which is used to analyze results of one-dimensional consolidation, expansion, and uplift tests, was developed for use by the Bureau of Reclamation at the Engineering and Research Center, Denver, Colorado. CON1DP is a procedure file that links the Bureau's central site CYBER engineering computer with a user, and coordinates the use of the one-dimensional consolidation test analysis and plotting programs through user interactive FORTRAN computer programs. CON1D, the main analysis program, was developed primarily to reduce standard laboratory consolidation test data, and secondly to provide users the capability to perform extended consolidation test parameters analyses that involve the automation of graphic techniques. CON1D was later modified to include the capability to analyze expansion and uplift test data. The laboratory data reduction techniques are identical for all three tests and the computer output was modified to include the expansion and uplift testing. This user's guide deals primarily with the consolidation test analyses available through CON1DP. The expansion and uplift tests analyses available are implicitly defined in the consolidation test data reduction analysis, and only the differences in input and output are noted in this manual.

CON1D computes the primary compression of the soil test specimen as the percent axial strain for each test pressure. The standard volume and weight relationships of the soil are also computed. Then, using Casagrande's and Schmertmann's graphical construction techniques, CON1D can determine the maximum preconsolidation pressure and generate the in situ compression curve of the soil. Finally, CON1D can graphically display the percent compression for each pressure increment on a log of time versus percent axial strain plot that defines the rate of consolidation. CON1D also computes the coefficient of consolidation and the corresponding value of permeability.

CONPLOT, the consolidation, expansion, and uplift test plotting program, plots the results of CON1D data reduction in report quality form and, if requested, plots the automated graphic construction used in the consolidation test parameters analyses.

This CON1DP user's guide consists of two sections. The first section is considered the "operational guide" to using CON1DP and the user can also consider this section as the main body of the user's guide since it attempts to identify and explain all the questions (with their various options) that the user could encounter when executing CON1DP. The second section describes how the various CON1DP options and input parameters on the laboratory data file affect the consolidation parameters analyses. The second section will be particularly helpful to users trying to achieve the best possible analysis of slightly irregular data. The appendix contains a full set of example output and a glossary.

CON1DP OPERATIONAL GUIDE

Input

The input required to execute CON1DP consists of a laboratory data file in the format of Consolidation Test Data Forms EL-548* and EL-549* or EL-550* (pls. 1, 2, or 3, respectively). This data file must be stored on the engineering CYBER computer mass storage system and is input into CON1D, the analysis program, as the local computer file, TAPE5. CON1D also reads input parameters from the local computer file, INPUT. This input file is created by CON1DP, and the content of the file is determined by the user's response to questions asked by the procedure. The questions asked by CON1DP cover a range of functions, from input parameters for CON1D to modes of execution for CON1DP. The section on "Execution of CON1DP" which follows, covers these questions and the meanings of their answers in detail (see below).

With the introduction of this upgraded one-dimensional consolidation test analysis program, the ADP form EL-548 was updated to include additional soil sample placement data and options for consolidation test parameters analysis. CON1DP has the capability to convert old consolidation test data files into the required new format. Unfortunately, CON1DP will not correctly convert old uplift or expansion test data files. Users will have to manually reconstruct the ADP data file for the old uplift and expansion tests to obtain the proper input to CON1D.

Output

The output from CON1DP consists of printed computer output produced by the consolidation analysis program CON1D and computer graphic output produced by CONPLOT in the form of plots or a plot file saved as a direct access mass storage file. The form in which the output appears, as well as the length and completeness of the output, is determined by the user's response to questions asked during CON1DP's execution. By studying these questions, the user will come to understand the output options available.

Execution of CON1DP

To execute CON1DP, follow these steps:

- Log on to the engineering CYBER system
- Type: get,con1dp/un=er1540a,pw=sta
- Type: -go,con1dp

Then answer all questions appropriately.

The questions that may be asked by CON1DP fall into three general categories. The first category of questions pertains to obtaining additional input data

---

* EL-548 (12-82)
EL-549 (2-74)
EL-550 (2-74)

from users with data files in the old consolidation test data file format (before February 1983). CON1DP has the capability to convert the old data file format into a data file of the new format. The second and third categories of questions deal with the consolidation test analysis (CON1D's input) and with the consolidation test parameters analysis execution, i.e., mode and type of output. This user's guide presents a complete set of CON1DP questions in the order and format that they are asked at the computer terminal.

```
-go,con1dp

   1-DIMENSIONAL CONSOLIDATION

IS YOUR DATA FILE FORMATTED FOR THE UPDATED
CONSOLIDATION TEST ANALYSIS PROGRAM(AFTER MARCH 1983)
? no
```

CON1DP initiates execution with the above question. This question seeks a simple "yes" or "no" response that will control the direction of CON1DP's execution. A "no" response implies that the user has a consolidation data file with a front cover sheet in the old ADP format and CON1DP calls the test data file conversion routine. A "yes" response to the above question causes CON1DP to skip the conversion routine and branch to the main body of the procedure. The questions asked by CON1DP's conversion program follow:

```
ENTER THE NAME OF YOUR OLD CONSOLIDATION TEST DATA FILE
? oldfile
ENTER THE INITIAL AND FINAL WATER CONTENTS(%) OF THE
SAMPLE.ENTER A ZERO FOR THE FINAL WATER CONTENT IF ITS
VALUE IS TO BE CALCULATED FROM THE MEASURED FINAL WEIGHTS
EX. 16.8,27.3 OR 16.8,0
? 8.5,13.4
ENTER THE EFFECTIVE OVERBURDEN PRESSURE
? 7.8
ENTER A NAME AND PASSWORD FOR THE NEW CONSOLIDATION TEST
DATA FILE.  EX. FNAME,SECRET
? newfile,secret
THE NEW DATA FILE NAMED, NEWFILE
WITH PASSWORD, SECRET HAS BEEN SAVED UNDER A PUBLIC STATUS
ENTER THIS NAME AT THE NEXT QUESTION
```

A user with an old consolidation test data file is required to input the initial water content (in percent) of the consolidation test specimen. In an attempt to provide an engineer with the analytical means to attain the most consistent or realistic consolidation test analysis possible, CON1DP gives the user the choice of defining the soil solid phase (a function of the total dry weight and specific gravity) of the specimen using either initial wet weights or final dry weights (see below for more details). CON1DP's request for a final specimen water content is optional with the default value being the final water content calculated from the final specimen wet and dry weights. The request for the specimen effective overburden pressure is relevant to users who want to perform a consolidation test parameters analysis with an undisturbed specimen to determine the in situ compressibility of the

soil. After receiving input to the above questions, CON1DP constructs a new data file and prompts the user for a file name and password. This new file is then saved as a public file on the permanent mass storage system in the user's user number catalog. After saving this file, CON1DP brings the user into the main body of the procedure.

```
ENTER NAME OF CONSOLIDATION TEST DATA FILE;
ALSO THE FILE'S USER NUMBER AND PASSWORD, IF
THE FILE IS IN A CATALOG OTHER THAN YOUR USERS' NUMBER.
EX.  NAME/UN=USERNUM,PW=PASSWRD
? newfile
```

This question seeks the name of the consolidation test data file to be analyzed by CON1D. If the data file is stored on the user's user number, then only the file name needs to be entered. If the data file is stored on an alternative user number under a public or semipublic status, then the user may access the file provided the user number and file password are entered. Once CON1DP has retrieved a copy of the data file, the procedure begins asking questions pertaining to CON1D's analysis.

```
ENTER YOUR OUTPUT CONTROL NUMBER OR 9 FOR MORE INFO
? 9

0 - FORMATTED COPY OF DATA FILE + CONSOLIDATION TEST ANALYSIS
1 - CONSOLIDATION TEST + CONSOLIDATION PARAMETERS ANALYSES
    WITH A FORMATTED COPY OF THE DATA FILE
2 - SAME AS 1 WITHOUT DATA FILE
3 - CONSOLIDATION TEST ANALYSIS ONLY
4 - ABRIDGED CONSOLIDATON TEST ANALYSIS(PHASE RELATIONS ONLY)
5 - CONSOLIDATION PARAMETERS ANALYSIS ONLY
? 5
```

The output control number input at this question controls the length and style of CON1D's analysis output. The output control number gives the user the ability to limit the output to just what is needed. The formatted data file gives the user a quick check on data placement, and once the data file is executable, copies of it can be omitted from further computer run outputs. Consolidation test parameters analyses are of limited value on some soil types so they need not be performed. Parameters analysis requests for expansion and uplift tests are ignored. Options 4 and 5 provide the user with the ability to limit the output to the particular area of interest. The output control number also implicitly controls the output from the plotting program. CONPLOT has the capability to produce two sets of plots. One set consists of at least three plots (more if there are two unload-reload cycles) that graphically show the range and path of the soil specimen compression in the testing apparatus, i.e., plots of the reduced consolidation data points. The other set of plots shows in graphic form, the plotting techniques that CON1D used in the pressure and time analyses. The plots a user will receive after executing CON1DP are in direct correlation with the analysis or analyses requested when defining the output control number.

Note: The summary block on the cover plot of the consolidation test data reduction analysis will appropriately depict (or omit) the results of the consolidation test parameters analysis, i.e., preconsolidation pressures (see example output in the appendix).

```
ENTER A NUMBER TO DEFINE THE INPUT TO USE WHEN CALCULATING
SPEC. DRY WEIGHT
1) - INITIAL MOISTURE, OR 2) - MEASURED FINAL WEIGHTS
? 2
```

The consolidation test data sheet EL-548 (12-82) contains enough information to calculate the total dry weight of the specimen in two ways: (1) from initial wet weights with initial moisture conditions or (2) from final dry weights. The volume of the soil solids phase is a direct function of the soil dry weight. Since all the specimen phase relationships, particularly void ratio, water content, and degree of saturation, are a function of the soil solids phase, the user is given the option of varying the analysis to adjust the soil constitutive relations to their most consistent values, i.e., having measured and calculated values coincide.

A general rule for choosing which input to use on initial runs (minimizing testing errors) is: (1) to use initial moisture conditions for remolded specimens, and (2) to use final weights for undisturbed specimens.

The next question asked by CON1DP merges the questions about CON1D's analysis with the questions about the style and mode of analysis.

```
ENTER A TWO DIGIT NUMBER TO DEFINE YOUR JOB'S EXECUTION
ENTER 99 FOR MORE INFO
? 99
THE FIRST DIGIT ENTERED (THE TENS' DIGIT) IS THE NUMBER
OF TIME-STRAIN CURVES THAT YOU WANT TO ADJUST,
THAT IS, CHANGE THE DEGREE OF THE POLYNOMIAL CURVE
THAT FITS THE TIME-STRAIN DATA, FOR ANY ONE PRESSURE.
IF YOU DO NOT WANT TO CHANGE ANY CURVE FITS, ENTER ZERO.
THE SECOND DIGIT ENTERED DEFINES THE MODE OF EXECUTION
1 - FULL OUTPUT AND PLOTS, LINEPRINTER PAPER
2 - FULL OUTPUT AND PLOTS, XEROX PAPER
3 - NO OUTPUT, PLOTS SAVED AS A DIRECT ACCESS FILE
4 - INTERACTIVE USE AT THIS TERMINAL, NO PLOTS
AN EXAMPLE IS :
?02
MEANING
NO CURVE ADJUSTMENTS, AND XEROX OUTPUT
? 04

OUTPUT ON PRIMARY FILE(LNH TO VIEW)
READY.
```

The first digit entered to the above question defines for CON1D the change in the polynomial degree of the equation used to fit a curve to the reduced time-percent strain data. The default polynomial degree that CON1DP uses is the number of data points minus 1 or 11, whichever is less. Sometimes a high

(polynomial) order least squares curve fit by CON1D is too irregular or unsmooth for automated graphing; so in order to obtain a better analysis, a user can reduce the polynomial degree of the fitted curve on the time-percent strain curve for any particular pressure. In the above example, a zero was entered for the number of curves to be adjusted so no further questions were asked.

The second digit entered to the above question defines for CON1DP how to process the analysis. In this example, the user requested an interactive analysis and CON1DP called and executed CON1D, storing the output on the user's primary file.

A different response to the previous question is illustrated below:

```
ENTER A TWO DIGIT NUMBER TO DEFINE YOUR JOB'S EXECUTION
ENTER 99 FOR MORE INFO
? 22
ENTER THE PRESSURE ON THE CURVE(S) TO BE ADJUSTED
AND THE INTEGER NUMBER THAT THE POLYNOMIAL ORDER IS TO
BE REDUCED BY.  EX.  400.0,4
? 50.0,2
? 100.0,3
```

The first response to the above question indicates that the user wants to adjust two of the time-percent strain curves and that the user wants to submit a batch job with Xerox output. CON1DP then prompts the user for the pressure on the curves to be adjusted, along with the change in the polynomial degree of the fitting curve. Finally, after the above information has been entered, CON1DP asks the user the final set of batch job execution type questions necessary to initiate processing.

```
ENTER YOUR FIRST OUTPUT HEADING
? y-gave up
ENTER YOUR SECOND OUTPUT HEADING
? consol
ENTER YOUR JOB'S PRIORITY, P2, P3, P5
? p3
ENTER 'COM' FOR MICROFILM (35MM) PLOTS
ENTER 'XYN' FOR VELLUM FLATBED PLOTS
OR ENTER 'NONE' FOR NO PLOTS
? xyn
YOU MAY LIST THE PERMANENT FILE 'CONDAY'
TO CHECK YOUR JOB'S EXECUTION
15.21.12.AGXQVZO
JOB SUBMITTED.
READY.
```

The above questions control the final disposition of a submitted batch job. The output headings are the heading banners on the first page of the printed output. The first heading also serves as the user's identification to the peripheral plotting operator, so entering a surname will facilitate locating all output.

The job's priority instructs the computer when to process the job. P2 is immediate (as soon as possible) processing, P3 is processing after 5 p.m., and P5 is weekend processing. As the cost of computer processing is a function of the job's priority (the higher the priority number, the lower the cost), the user should choose the job's priority according to need, time of day, and day of the week. In the above example, the job was submitted at 3:21 p.m., with processing deferred until 5 p.m.

The question about plots requests the user to choose a method of plot file disposal or plot peripheral interfacing. A response of 'COM' causes the plot file to be interfaced with the COMp-80 microfilm plotter. A response of 'XYN' causes the plot file to be interfaced with the XYNETICS flatbed plotter.

Users who elect to submit a batch job through option 3 (no output, plots saved as a direct access file) terminate CON1DP execution with a slightly different set of questions.

```
ENTER A TWO DIGIT NUMBER TO DEFINE YOUR JOB'S EXECUTION
ENTER 99 FOR MORE INFO
? 03
ENTER A NAME FOR YOUR PLOT FILE
? conplot
IT IS YOUR RESPONSIBILITY TO INTERFACE THIS DISSPLA
PLOT FILE ONCE CREATED(SEE A DISSPLA USER'S GUIDE)
ENTER YOUR JOB'S PRIORITY, P2, P3, P5
? p2
YOU MAY LIST THE PERMANENT FILE 'CONDAY'
TO CHECK YOUR JOB'S EXECUTION
11.57.00.AGXQGCP
JOB SUBMITTED.
READY.
```

When the user chooses execution option 3, the plot file created by the consolidation plotting program is saved as a user-named direct access file on the user number catalog that was logged onto by the user. It is the user's responsibility to interface this file with a plotting device that can communicate with CYBER, e.g., Tektronix, HP 7200 plotters, or Houston Instruments.

CON1DP terminates all submit batch job runs with a reference to the indirect access permanent file named 'CONDAY'. This file will contain the dayfile of the computer's job stream once the computer has finished the job. A user may check the status of the job usually within 5 minutes after submitting it by listing this file.

CONSOLIDATION TEST AND CONSOLIDATION PARAMETERS ANALYSIS

Input Considerations

The phase relationships of the consolidation test or expansion test specimen, i.e., the relationship of the solid, liquid, and gas components of the specimen, are of secondary importance in a consolidation test data reduction analysis. The axial strain of the soil specimen is of primary importance. Since the axial strain is a direct function of the laboratory apparatus, little discretion is available in calculating the percent axial strain. But, since the phase relationships of the specimen are a function of the volume, weight, and water content, some flexibility is available in calculating the relationships of the specimen phases.

Recognizing the potential for compounding errors in phase calculations, CON1DP provides a user with the means to attain the most consistent phase calculations possible. The phase relationship calculations performed by CON1DP (output as void ratio, water content, and degree of saturation) are deduced from the input data on the front sheet, ADP form EL-548 (12-82), and from the laboratory dial readings recorded on EL-550 (2-74). The dial readings provide a direct measurement of the specimen volume, and the user is forced to accept these measurements as accurate.

The flexibility that CON1DP provides the user arises from the user's selection of the type of input data on the front cover sheet. The standard method of obtaining the specimen dry weight and initial and final water contents is to weigh the initial wet specimen, and after consolidating the specimen, to weigh the specimen wet and dry. As the total dry weight of the specimen is assumed constant, the initial and final water contents are computable. The alternate set of input data directly inputs the initial and final water contents, and then using the initial wet weight of the specimen, the total dry weight of the specimen is computable.

CON1D assumes that the consolidation test specimen is saturated at or before the maximum pressure and that the computed final water content is the water content at the final pressure. These assumptions are reasonable if the laboratory procedure is correct. Using the measured volume of the sample, the computed volume of soil solids (a function of dry weight and specific gravity), and the volume of water at the final pressure, CON1D calculates the volume of entrapped air in the specimen. This volume of air is assumed to be trapped within the specimen during the entire test. If the calculated volume of entrapped air is negative, CON1D sets this volume to zero. Using the computed and measured volumes, CON1D calculates water content and degree of saturation at the end of every pressure increment. (The program also assumes that all free air is expelled from the specimen before any water moves out of the specimen.)

A quick examination of the output phase relationships table gives the user an idea of the quality of the testing data. If the degree of saturation at the maximum pressure is exactly 100 percent, the calculated water content at the final pressure will be less than the input (from the front cover sheet) final water content. The calculated volume of entrapped air was negative and, consequently, set to zero. For an idea of the magnitude of combined testing

errors, the user can observe at the bottom of the printed phase relationship sheet that the degree of saturation at the maximum pressure calculated with the volume of entrapped air was not set to zero (see example output). It is difficult to ascertain exactly where the testing errors are the most significant; but because of CON1DP dual inputs for dry weight and water contents, the user can reduce the errors to only errors in the input initial wet weight of the specimen and/or the input total volume measurements. A comparison of phase relations calculated from different inputs is part of the printed output on the phase relationship page. An investigation into this comparison, particularly the specimen total dry weights and initial water contents, will aid the user in defining and/or choosing the input parameters that will give the most consistent consolidation test data reduction analysis. The total dry weight calculated from the measured final weights is the minimum weight to use in the analysis. But, if the initial water content calculated from final weights is significantly different from the water content measured and input with the initial moisture conditions, then either the measured dry weight is low or the input inital wet weight is in error. The user may reduce the magnitude of testing errors by rerunning the analysis using the input from initial moisture conditions. This adjusts the input initial and final water contents (by editing these values on the front cover sheet using a CYBER editing utility) until the volume of entrapped air is zero or greater and the initial water content and total dry weight of the specimen are within reasonable bounds. As a last resort, the user could adjust the wet weight of the specimen to bring the calculated dry weight into line with a known initial water content, i.e., when the total dry weight calculated from initial moisture conditions is less than the dry weight calculated from final weights.

The consolidation parameters analysis capabilities of CON1D should only be performed on undisturbed soil specimens and only when the soil stress history or consolidation characteristics are required. The analysis techniques used by CON1D in the consolidation parameters analyses involve the automation of manual graphic techniques proposed by various authors, i.e., techniques found in any reputable modern soil mechanics text. The heart of this graphic automation is a least squares polynomial curve fitting routine through the pertinent data points with a user selected degree of polynomial in the range of 2 to 11. The consolidation parameter analysis performed by CON1D fits a polynomial curve of degree N (obtained from the front cover sheet) to the final void ratio - log pressure data coordinates for all the pressures in the first loading cycle. The degree of the fitting polynomial is the single most important parameter affecting the analysis. The highest degree of polynomial allowed equals n - 1, where n is the number of data points, up to the maximum of 11. CON1D defaults to the highest degree allowable, thereby getting the best fit of the data points. Unfortunately, if the data are irregular to any extent, the fitted polynomial curve will undulate and lack the smoothness required for graphic techniques. Therefore, for computer runs where the shape of the e-log p curve is unknown, users should pick a polynomial degree equal to n - 2, where n is as above or less.

Generally, the smaller the polynomial degree, the smoother the fitted curve; but a user must use discretion in the analysis so as not to sacrifice the contour of the curve for the sake of smoothness. The fitted curve serves a dual function in the consolidation parameters analysis. Its purpose is to

analytically define the void ratio versus log pressure data so that the computer program can determine two tangent lines to the data, one off the top (low pressure portion) of the curve and one tangent to the lower end of the curve. Figure 1 illustrates the essential characteristics of the Casagrande construction to determine the maximum preconsolidation pressure of a soil specimen with the point of maximum curvature found by the geometrical method. The two tangent lines referred to above are listed as the "top tangent line" with a slope equal to the slope of the average rebound curve line and the "line D" tangent to the high pressure end of the virgin compression portion of the laboratory curve.

A user has some control over the location of the point of tangency of these tangent lines by altering boundary input parameters (BOUND1, BOUND2, BOUND3, and BOUND4) on the front cover sheet of the data file. These boundaries are the abscissa values on the e-log p plot between which CON1D iterates to find the points of tangency.

Input parameters BOUND1 and BOUND2 (default values are 4.5 lb/in^2 and the pressure at the next to last pressure of the first loading cycle, respectively) are the abscissa pressure values between which CON1D iterates to find a point on the laboratory compression curve that has a slope equal to the slope of the average rebound line (line E on fig. 1). If this point of tangency cannot be found, then CON1D defaults to drawing the top tangent line at the first boundary, BOUND1. By setting a value for parameter BOUND1, the user has some control over fixing the point of maximum curvature. (The point of maximum curvature by the geometrical method is located on the laboratory compression curve at its intersection with the interior angle bisector. Computer-generated boundaries, used for iterating to find the point of maximum curvature by the analytical method, are located at the intersection of the laboratory compression curve and the interior angle quadsectors.) Input parameters, BOUND1 and BOUND2, control the location of the intersection of the laboratory compression curve with the top tangent line. This intersection is not necessarily the point of tangency because the slope of the top tangent line is fixed to the slope of the average rebound curve. If CON1D cannot find a point of tangency, then the top line is drawn at the abscissa value of the first boundary, BOUND1.

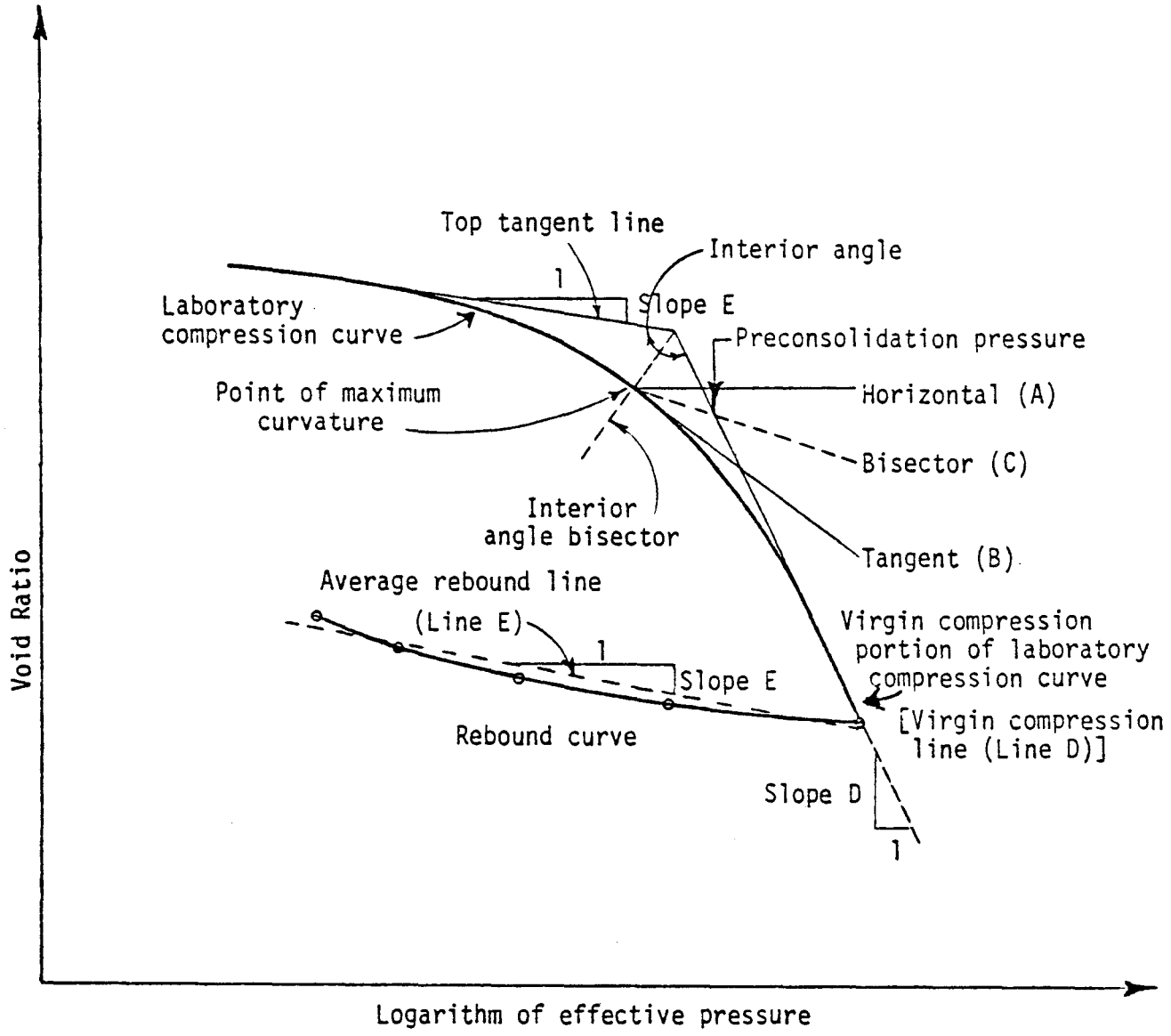


Figure 1. - Casagrande construction

The bottom tangent line (line D on fig. 1) is located at the point of tangency on the laboratory compression curve between input parameters BOUND3 and BOUND4. The techniques used by CON1D to locate the virgin compression portion of the compression curve are beyond the scope of this discussion. The options available to the user who is attempting to adjust the slope and/or point of tangency of the virgin compression line should be executed in this order, an order prioritized on the effectiveness of the available options. The most effective method of changing the fix of the virgin compression line is to change the shape of the laboratory compression curve. As discussed above, the input parameter NDEG determines the degree of the fitting polynomial curve and to some extent the shape of the curve. Having obtained the laboratory compression curve with the most favorable appearance,

the only other option is to change the fix of the virgin compression line by adjusting the range of pressures over which CON1D will iterate. Set the input parameter BOUND3 at the pressure abscissa value that intersects the laboratory compression curve at the point where the curve begins to straighten and merge with the virgin compression line. Finally, the input parameter BOUND4, which is the high-pressure limiting range value (default value is the maximum pressure of the first loading cycle), can be set. By adjusting the range over which CON1D can search for the tangency point on the laboratory compression curve, the user has tight control over the analysis. Working in the interactive mode, or with the submit batch run (save plot file) mode, the user should be able to produce an acceptable analysis in a cost-effective time frame.

Discussion of Example Output

The attached example output illustrates the use (or lack of use) of the various input options available to the user. The consolidation test data reduction analysis calculates the specimen total dry weight using the measured final weights for input data. The input used for the phase relationship calculations is defined on the bottom of the phase relationship page (fig. A-12). An examination of this page exemplifies the input considerations discussed above. The table of comparisons of phase relations from different inputs indicates that some of the input data are in error or inconsistent. This includes the fact that the calculated degree of saturation at the maximum pressure, before the volume of entrapped air was set to zero, was 117.9 percent. In this particular case, more accurate results will be produced by raising the input initial water content to 35 percent (assuming the input data used to calculate the initial wet weight of the specimen are correct) and rerunning the analysis using the initial moisture input for calculating the phase relationships. The plots that correspond to the consolidation test data reduction analysis are the first four plots (figs. A-18 through A-21) following the printed Xerox output. The first two plots (figs. A-18 and A-19) are the consolidation test analysis cover sheet plots. The only difference between these two plots is the summary block at the top of the page. One plot (fig. A-18) was produced in conjunction with a complete computer run of consolidation test and consolidation parameters analyses, and the other plot (fig. A-19) was produced by a consolidation analysis computer run only. The other two plots (figs. A-20 and A-21) included in the consolidation test data reduction set are plots of the reduced time percent axial strain laboratory data. One plot (fig. A-20) is produced for the loading portion of the test and one (fig. A-21) is produced showing the unloading portion. If two loading cycles are included in the consolidation test, then four time-percent strain curve plots would be produced.

The output from the consolidation parameters analyses also illustrates the use of the input options to enhance the analyses. A review of the void ratio-log pressure plot (e-log p plot) on the consolidation test analysis cover sheet plot (fig. A-18) reveals a normally consolidated soil specimen with a sharp "break" in the e-log p compression curve at the approximate in situ effective overburden pressure. The e-log p plot used in the consolidation parameters analysis (fig. A-22) (with the plot heading "For Analysis Only") indicates that the general distribution of the e-log p data points

coupled with the sharp break in the laboratory compression curve will make obtaining a good fitting polynomial curve difficult in this example. A relatively low order polynomial equation was chosen primarily to illustrate its effect on curve smoothing. Higher order polynomials allow CON1D to produce irregular curves, and the result of the laboratory compression curve fitting algorithm is less acceptable, i.e., this fourth order polynomial curve indirectly generates a good graphic fit of the all-important virgin compression line. The fit of the virgin compression line was improved by setting the lower search boundary, input parameter BOUND4, to an abscissa pressure value between the last and second to last pressures of the first loading cycle. This is a good practice to follow if the slope of the tangent to the compression curve at the lower boundary (which defaults to the last compressive testing pressure abscissa value) is too large, i.e., the virgin compression line is too steep or possibly unconservative. The example output from the time-dependent portion of the consolidation parameters analysis consists of a printed Xerox page (fig. A-14) and one plot of time-percent strain curves (fig. A-23) that shows the graphic construction techniques used by CON1D to determine the coefficient of consolidation (and with the compression index found from an analysis of the void ratio-log pressure plot, the corresponding permeability).

The complete printed output with plots from uplift and expansion tests are shown in figures A-24 through A-39.

ONE-DIMENSIONAL CONSOLIDATION TEST DATA — ADP

F = Force
L = Length

EL-548 (12-82)
Bureau of Reclamation

FEATURE	PROJECT

SAMPLE NO.	SPEC. NO.	DRILL HOLE	DEPTH OF SAMPLE (L)	CLASS SYMBOL	SPECIFIC GRAVITY	SPECIMEN TYPE* 1 UNDISTURBED 2 REMOLDED

DATE PLACED	LOADING UNIT NO.	CONTAINER NO.	CONTAINER HEIGHT (L)	CONTAINER DIAMETER (L)	P.I. (%)	L.L. (%)	S.L. (%)

WT. OF SPEC. CONT., COVER PLATES AND WET SOIL (GMS.)	WT. OF SPEC. CONT. AND COVER PLATES (GMS.)	DIAL READING WITH SEATING LOAD ON GAGE BLOCK	DIAL READING WITH SEATING LOAD ON SPECIMEN	DATE REMOVED	CONTAINER NO. FOR WATER CONTENT OF CONSOL. SPEC.	CONTAINER NO. FOR WEIGHT OF TRIMMINGS OR WASHINGS
		0	0			

INPUT FOR TOTAL DRY WEIGHT

	FROM INITIAL MOISTURE	CONT. NO. FOR INITIAL WATER CONT.	INITIAL WATER CONTENT (%)	FINAL WATER CONTENT** (%)		
FROM FINAL MEASURED WEIGHTS	WET WT. OF CONSOL. SPEC. +CONTAINER (GMS.)	DRY WT. OF CONSOL. SPEC. +CONTAINER (GMS.)	WT. OF CONTAINER FOR CONSOL. SPEC. (GMS.)	DRY WT. OF TRIM. OR WASH. +CONTAINER (GMS.)	WT. OF CONTAINER FOR TRIM. OR WASH. (GMS.)	WATER ADDED AT LOAD NO.

POLYNOMIAL DEGREE	EFFECTIVE OVERBURDEN*** (F.L-2)	BOUND 1 (F.L-2)	BOUND 2 (F.L-2)	BOUND 3 (F.L-2)	BOUND 4 (F.L-2)

SCALES TESTING LOADS

Equip. =
Soil =
Dry tare =

Dry tare =
Water =
Wet tare =

Spec. seat. load =
Water =
Wet load =

SCALES SEATING LOAD

(with gage block)
Equip. =
Block =
1 PSI =
Gage seat load =

(with specimen)
Dry tare =
1 PSI =
Spec. seat load =

FOOTNOTES
*For uplift test add 10; i.e. 11, 12
For expansion test add 20; i.e. 21, 22
**Optional: If blank then final water content calculated from final weights
***Not required if Remolded Specimen

BY	DATE	CHECKED	SHEET ___ OF ___

PLATE 1

ONE-DIMENSIONAL CONSOLIDATION TEST DATA – VARIABLE TIME DATA SHEET

– USE BUFF CARDS –

BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	BEAM OR GAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14

NOTE: RECORD LOAD WITH DECIMAL IN COLUMN 6 AND DEFLECTION CORRECTION WITH DECIMAL IN COLUMN 10. TIME RECORDED IN FIRST 8 COLUMNS, RIGHT JUSTIFIED; DIAL READINGS WITH DECIMAL IN COLUMN 10. AFTER THE LAST READING OF EACH LOAD, PLACE 99 IN COLUMNS 7 & 8.

SAMPLE NO. _____

SPEC. NO. _____

LOAD UNIT NO. _____

BY	DATE	CHECKED	SHEET OF

EL - 550 (2 - 74)
Bureau of Reclamation

ONE-DIMENSIONAL CONSOLIDATION TEST DATA — TIME DATA SHEET

– USE BUFF CARDS –

GAGE ____ BEAM ____		GAGE ____ BEAM ____		GAGE ____ BEAM ____		GAGE ____ BEAM ____	
LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION	LOAD (PSI)	DEFLECTION CORRECTION
	0.0		0.0		0.0		0.0
ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS	ELAPSED TIME IN SECONDS	DIAL READINGS
4		4		4		4	
10		10		10		10	
20		20		20		20	
40		40		40		40	
80		80		80		80	
200		200		200		200	
400		400		400		400	
800		800		800		800	
2000		2000		2000		2000	
4000		4000		4000		4000	
8000		8000		8000		8000	
20000		20000		20000		20000	
86400		86400		86400		86400	

SAMPLE NO. _____

SPEC. NO. _____

LOADING UNIT NO. _____

NOTE: AFTER THE LAST READING OF EACH LOAD, PLACE 99 IN COLUMNS 7 & 8

HRS.	MIN.	SEC.
	1	20
	3	20
	6	40
	13	20
	33	20
1	6	40
2	13	20
5	33	20
24	00	00

NOTES:

BY	DATE	CHECKED	SHEET OF

GPO 832 - 384

PLATE 3

APPENDIX

COMPUTER OUTPUT AND GLOSSARY

USER INTERACTIVE SESSION FOR CONSOLIDATION OUTPUT

```
-go,conldp

       1-DIMENSIONAL CONSOLIDATION

 IS YOUR DATA FILE FORMATTED FOR THE UPDATED
 CONSOLIDATION TEST ANALYSIS PROGRAM(AFTER MARCH 1983
? yes
 ENTER NAME OF CONSOLIDATION TEST DATA FILE:
 ALSO THE FILE'S USER NUMBER AND PASSWORD, IF
 THE FILE IS IN A CATALOG OTHER THAN YOUR USERS' NUMBER.
 EX. NAME/UN=USERNUM,PW=PASSWRD
?condata
 ENTER YOUR OUTPUT CONTOL NUMBER OR 9 FOR MORE INFO
? 9
 0 - FORMATTED COPY OF DATA FILE + CONSOLIDATION TEST ANALYSIS
 1 - CONSOLIDATION TEST + CONSOLIDATION PARAMETERS ANALYSES WITH DATA FILE
     WITH A FORMATTED COPY OF THE DATA FILE
 2 - SAME AS 1 WITHOUT DATA FILE
 3 - CONSOLIDATION TEST ANALYSIS ONLY
 4 - ABRIDGED CONSOLIDATION TEST ANALYSIS(PHASE RELATIONS ONLY)
 5 - CONSOLIDATION PARAMETERS ANALYSIS ONLY
? 1
 ENTER A NUMBER TO DEFINE THE INPUT TO USE WHEN CALCULATING SPEC. DRY WEIGHT
     1) - INITIAL MOISTURE, OR 2) - MEASURED FINAL WEIGHTS
? 2
 ENTER A TWO DIGIT NUMBER TO DEFINE YOUR JOB'S EXECUTION
 ENTER 99 FOR MORE INFO
? 12
 ENTER THE PRESSURE ON THE CURVE(S) TO BE ADJUSTED
 AND THE INTEGER NUMBER THAT THE POLYNOMINAL ORDER IS TO
 BE REDUCED BY.  EX. 400.0,4
? 160.0,3
 ENTER YOUR FIRST OUTPUT HEADING
? ygavlick
 ENTER YOUR SECOND OUTPUT HEADING
? consol
 ENTER YOUR JOB'S PRIORITY, P2, P3, P5
? p3
 ENTER 'COM' FOR MICROFILM (35MM) PLOTS
 ENTER 'XYN' FOR VELLUM FLATBED PLOTS
 OR ENTER 'NONE' FOR NO PLOTS
? xyn
 YOU MAY LIST THE PERMANENT FILE 'CONDAY'
 TO CHECK YOUR JOB'S EXECUTION
 14.02.83.AGXQCUN
JOB SUBMITTED.
READY.
```

LAST MOTD REVISION DATE - 2-14-83, 1610 HOURS.

READ ON FOR- SYSTEM AVAILABILITY (2-20/21-83);
EARTHWORK USERS (REVISED 2-10-83);
DUE DATE EXTENDED FOR DATA BASE UPDATE;
ATTENTION ADP MANUAL USERS.

***** THE EE SYSTEM WILL BE DOWN SUNDAY, 2-20-83, FROM 0900 TO 1500 HOURS, AND MONDAY, 2-21-83, FROM 0800 TO 1700 HOURS, FOR SOFTWARE MAINTENANCE. (1610/021483/SAL)

***** NOTICE TO USERS OF ERTHWRK/UN=ERBRECT - DUE TO THE REMOVAL OF'ECS' FROM THE "EE" SYSTEM, ALL REFERENCES TO "ECS' MUST BE REMOVED FROM YOUR SUBMIT FILES OR USERS MAY RECREATE THEIR SUBMIT FILES BY USING SWE58/UN=SW0981E. TO EXECUTE SWE58, ENTER -,SWE58. IF YOU HAVE ANY QUESTIONS CONTACT JIM TRIETSCH, FTS 735-5423. (1300/021083/SAL)

***** IN THE DATA BASE UPDATE MEMO, WHICH WILL BE RECEIVED BY ALL ADP MANUAL HOLDERS, THE DUE DATE, 2-14-83, HAS BEEN EXTENDED TO 2-22-83. (1230/020783/SAL)

***** IN ORDER TO UPDATE OUR MAIL DATA BASE, MANUAL UPDATING REQUESTS HAVE BEEN SENT TO ALL MANUAL HOLDERS. IF YOU ARE HAVING TROUBLE IDENTIFYING THE MANUAL I.D. NUMBER(S), A PUBLIC FILE CALLED "MANUAL" IS AVAILABLE FROM USER NUMBER ERBRECT WHICH LISTS A TITLE CORRESPONDING TO EACH I.D. NUMBER.

```
GET,MANUAL/UN=ERBRECT
LIST,FN=MANUAL
```

(1115/020283/SAL)

```
YY      YY   GGGGGGGG    AAAAAAAA   VV      VV  LL          IIIIIIIIII   CCCCCCCC   KK      KK
 YY    YY   GGGGGGGGGG  AAAAAAAAAA  VV      VV  LL          IIIIIIIIII  CCCCCCCCCC  KK     KK
  YY  YY    GG          AA      AA   VV    VV   LL              II      CC       C  KK   KK
   YYYY     GG          AA      AA   VV    VV   LL              II      CC          KK KK
    YY      GG   GGGGG  AA      AA   VV    VV   LL              II      CC          KKKKK
    YY      GG   GGGGG  AAAAAAAAAA   VV    VV   LL              II      CC          KK  KK
    YY      GG      GG  AAAAAAAAAA    VV  VV    LL              II      CC          KK   KK
    YY      GG      GG  AA      AA    VV  VV    LL              II      CC       C  KK    KK
    YY      GGGGGGGGGG  AA      AA     VVVV     LLLLLLLLLL  IIIIIIIIII  CCCCCCCCCC  KK     KK
    YY       GGGGGGGGG  AA      AA      VV      LLLLLLLLLL  IIIIIIIIII   CCCCCCCC   KK      KK

 CCCCCCCC    00000000   NN      NN   SSSSSSSS    00000000   LL
CCCCCCCCCC  0000000000  NNN     NN  SSSSSSSSSS  0000000000  LL
CC       C  00      00  NN N    NN  SS       S  00      00  LL
CC          00      00  NN NN   NN  SS          00      00  LL
CC          00      00  NN  NN  NN  SSSSSSSSS   00      00  LL
CC          00      00  NN  NN  NN   SSSSSSSSS  00      00  LL
CC          00      00  NN   NN NN          SS  00      00  LL
CC       C  00      00  NN    N NN  S       SS  00      00  LL
CCCCCCCCCC  0000000000  NN     NNN  SSSSSSSSSS  0000000000  LLLLLLLLLL
 CCCCCCCC    00000000   NN      NN   SSSSSSSS    00000000   LLLLLLLLLL
```

Consolidation

CON1D Xerox output

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
57I-446   51  DH-446    210.1-212.6  CH    2.67        1
 5-28-82     228      8    0.75    2.00    42    66
 1564.0  1493.1   0.2399  0.2415 6-21-82
                           34.50   24.40
            261.8   247.6   196.9   203.5   202.3        2
         4   80.00   11.0   150.00  160.00 350.0
      1.0
         4 .2415
        99
      1.0
         4 .2418
        10 .2420
        20 .2420
        40 .2420
        80 .2420
        99
      5.0
         4 .2444
        10 .2447
        20 .2449
        40 .2452
        80 .2453
       200 .2455
       400 .2455
       800 .2455
      2000 .2456
      4000 .2456
      8000 .2457
     20000 .2457
1234567890123456789012345678901234567890123456789012345678901234567890
    199500 .2465
    341820 .2480
        99
     10.0
         4 .2489
        10 .2490
        20 .2491
        40 .2493
        80 .2495
       200 .2497
       400 .2499
       800 .2501
      2000 .2502
      4000 .2504
      8000 .2505
     20000 .2506
     80700 .2511
    166200 .2518
        99
     20.0
         4 .2534
        10 .2537
        20 .2541
        40 .2545
        80 .2551
       200 .2560
       400 .2565
1234567890123456789012345678901234567890123456789012345678901234567890
```

```
                1         2         3         4         5         6         7
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
 57        800 .2568                                                                 57
 58       2000 .2570                                                                 58
 59       4000 .2572                                                                 59
 60       8000 .2573                                                                 60
 61      20000 .2573                                                                 61
 62      77160 .2578                                                                 62
 63         99                                                                       63
 64      40.0                                                                        64
 65          4 .2602                                                                 65
 66         10 .2609                                                                 66
 67         20 .2617                                                                 67
 68         40 .2625                                                                 68
 69         80 .2635                                                                 69
 70        200 .2649                                                                 70
 71        400 .2653                                                                 71
 72        800 .2658                                                                 72
 73       2000 .2661                                                                 73
 74       4000 .2662                                                                 74
 75       8000 .2665                                                                 75
 76      20000 .2667                                                                 76
 77     104460 .2669                                                                 77
 78     253500 .2674                                                                 78
 79         99                                                                       79
 80      80.0                                                                        80
 81          4 .2707                                                                 81
 82         10 .2716                                                                 82
 83         20 .2726                                                                 83
 84         40 .2737                                                                 84
 85         80 .2749                                                                 85
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
 86        200 .2762                                                                 86
 87        400 .2768                                                                 87
 88        800 .2771                                                                 88
 89       2000 .2775                                                                 89
 90       4000 .2780                                                                 90
 91       8000 .2783                                                                 91
 92      20000 .2787                                                                 92
 93      77580 .2793                                                                 93
 94         99                                                                       94
 95     160.0                                                                        95
 96          4 .2844                                                                 96
 97         10 .2862                                                                 97
 98         20 .2881                                                                 98
 99         40 .2908                                                                 99
100         80 .2935                                                                100
101        200 .2983                                                                101
102        400 .3021                                                                102
103        800 .3073                                                                103
104       2000 .3095                                                                104
105       4000 .3134                                                                105
106       8000 .3170                                                                106
107      20000 .3210                                                                107
108      82260 .3259                                                                108
109     169620 .3277                                                                109
110         99                                                                      110
111     320.0                                                                       111
112          4 .3328                                                                112
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

```
                1         2         3         4         5         6         7
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
113          10 .3349                                                                113
114          20 .3375                                                                114
115          40 .3410                                                                115
116          80 .3457                                                                116
117         200 .3539                                                                117
118         400 .3603                                                                118
119         800 .3661                                                                119
120        2000 .3711                                                                120
121        4000 .3738                                                                121
122        8000 .3758                                                                122
123       20000 .3779                                                                123
124       76500 .3807                                                                124
125          99                                                                      125
126       640.0                                                                      126
127           4 .3867                                                                127
128          10 .3890                                                                128
129          20 .3917                                                                129
130          40 .3954                                                                130
131          80 .3994                                                                131
132         200 .4061                                                                132
133         400 .4129                                                                133
134         800 .4164                                                                134
135        2000 .4201                                                                135
136        4000 .4221                                                                136
137        8000 .4239                                                                137
138       20000 .4254                                                                138
139       82200 .4279                                                                139
140      249840 .4294                                                                140
141          99                                                                      141
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
142       80.0                                                                       142
143           4 .4193                                                                143
144         400 .4162                                                                144
145        2000 .4120                                                                145
146        4000 .4110                                                                146
147        8000 .4106                                                                147
148       20000 .4104                                                                148
149       81480 .4101                                                                149
150          99                                                                      150
151       20.0                                                                       151
152           4 .4059                                                                152
153         200 .4031                                                                153
154        2000 .3958                                                                154
155        4000 .3939                                                                155
156        8000 .3925                                                                156
157       20000 .3915                                                                157
158       76080 .3910                                                                158
159          99                                                                      159
160        5.0                                                                       160
161           4 .3890                                                                161
162        2000 .3818                                                                162
163        4000 .3790                                                                163
164        8000 .3769                                                                164
165       20000 .3745                                                                165
166       78420 .3729                                                                166
167      165480 .3724                                                                167
168          99                                                                      168
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

```
                1         2         3         4         5         6         7
        1234567890123456789012345678901234567890123456789012345678901234567890123456789
169        1.0                                                                        169
170          4 .3714                                                                  170
171       2000 .3693                                                                  171
172       4000 .3685                                                                  172
173       8000 .3674                                                                  173
174      20000 .3660                                                                  174
175      90120 .3641                                                                  175
176     252900 .3628                                                                  176
177        999.9999                                                                   177
        1234567890123456789012345678901234567890123456789012345678901234567890123456789
```

BUREAU OF RECLAMATION
GEOTECHNICAL BRANCH
ONE-DIMENIONAL CONSOLIDATION TEST

SAMPLE NO 57I-446 SPECIMEN NO 51 SPECIMEN TYPE UNDISTURBED

DATE PLACED 5-28-82 DATE REMOVED 6-21-82 SPECIFIC GRAVITY 2.67

SPECIMEN DIAMETER = 2.00 IN. SPECIMEN HEIGHT = .75 IN.

TEST PERFORMED IN CONBEL NO. 228

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 84.1 LB/FT**3 VOID RATIO = .9821

TIME IN SEC.	STRAIN IN (%)
4.	0.000

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = .067 %
DRY DENSITY = 84.1 LB/FT**3 VOID RATIO = .9808

TIME IN SEC.	STRAIN IN (%)
4.	.040
10.	.067
20.	.067
40.	.067
80.	.067

PRESSURE = 5.00 LB/IN**2 AXIAL STRAIN = .869 %
DRY DENSITY = 84.8 LB/FT**3 VOID RATIO = .9649

TIME IN SEC.	STRAIN IN (%)
4.	.387
10.	.428
20.	.454
40.	.494
80.	.508
200.	.534
400.	.534
800.	.534
2000.	.548
4000.	.548
8000.	.561
20000.	.561
199500.	.668
341820.	.869

PRESSURE = 10.00 LB/IN**2 AXIAL STRAIN = 1.376 %
DRY DENSITY = 85.3 LB/FT**3 VOID RATIO = .9548

TIME IN SEC.	STRAIN IN (%)
4.	.989
10.	1.002
20.	1.015
40.	1.042
80.	1.069
200.	1.096
400.	1.122
800.	1.149
2000.	1.162
4000.	1.189
8000.	1.203
20000.	1.216
80700.	1.283
166200.	1.376

PRESSURE = 20.00 LB/IN**2 AXIAL STRAIN = 2.178 %
DRY DENSITY = 86.0 LB/FT**3 VOID RATIO = .9389

TIME IN SEC.	STRAIN IN (%)
4.	1.590
10.	1.630
20.	1.684
40.	1.737
80.	1.817
200.	1.937
400.	2.004
800.	2.044
2000.	2.071
4000.	2.098
8000.	2.111
20000.	2.111
77160.	2.178

PRESSURE = 40.00 LB/IN**2 AXIAL STRAIN = 3.461 %
DRY DENSITY = 87.1 LB/FT**3 VOID RATIO = .9135

TIME IN SEC.	STRAIN IN (%)
4.	2.499
10.	2.592
20.	2.699
40.	2.806
80.	2.940
200.	3.127
400.	3.180
800.	3.247
2000.	3.287
4000.	3.300
8000.	3.340
20000.	3.367
104460.	3.394
253500.	3.461

PRESSURE = 80.00 LB/IN**2 AXIAL STRAIN = 5.051 %
DRY DENSITY = 88.6 LB/FT**3 VOID RATIO = .8820

TIME IN SEC.	STRAIN IN (%)
4.	3.902
10.	4.022
20.	4.156
40.	4.303
80.	4.463
200.	4.637
400.	4.717
800.	4.757
2000.	4.810
4000.	4.877
8000.	4.917
20000.	4.971
77580.	5.051

PRESSURE = 160.00 LB/IN**2 AXIAL STRAIN = 11.518 %
DRY DENSITY = 95.0 LB/FT**3 VOID RATIO = .7538

TIME IN SEC.	STRAIN IN (%)
4.	5.732
10.	5.973
20.	6.227
40.	6.587
80.	6.948
200.	7.590
400.	8.097
800.	8.792
2000.	9.086
4000.	9.607
8000.	10.088
20000.	10.623
82260.	11.277
169620.	11.518

PRESSURE = 320.00 LB/IN**2 AXIAL STRAIN = 18.600 %
DRY DENSITY = 103.3 LB/FT**3 VOID RATIO = .6134

TIME IN SEC.	STRAIN IN (%)
4.	12.199
10.	12.480
20.	12.827
40.	13.295
80.	13.923
200.	15.019
400.	15.874
800.	16.649
2000.	17.317
4000.	17.678
8000.	17.945
20000.	18.226
76500.	18.600

PRESSURE = 640.00 LB/IN**2 AXIAL STRAIN = 25.107 %
DRY DENSITY = 112.3 LB/FT**3 VOID RATIO = .4845

TIME IN SEC.	STRAIN IN (%)
4.	19.401
10.	19.709
20.	20.069
40.	20.564
80.	21.098
200.	21.994
400.	22.902
800.	23.370
2000.	23.864
4000.	24.131
8000.	24.372
20000.	24.572
82200.	24.906
249840.	25.107

PRESSURE = 80.00 LB/IN**2 AXIAL STRAIN = 22.528 %
DRY DENSITY = 108.5 LB/FT**3 VOID RATIO = .5356

TIME IN SEC.	STRAIN IN (%)
4.	23.757
400.	23.343
2000.	22.782
4000.	22.648
8000.	22.595
20000.	22.568
81480.	22.528

PRESSURE = 20.00 LB/IN**2 AXIAL STRAIN = 19.976 %
DRY DENSITY = 105.1 LB/FT**3 VOID RATIO = .5862

TIME IN SEC.	STRAIN IN (%)
4.	21.967
200.	21.593
2000.	20.617
4000.	20.363
8000.	20.176
20000.	20.043
76080.	19.976

PRESSURE = 5.00 LB/IN**2 AXIAL STRAIN = 17.491 %
DRY DENSITY = 101.9 LB/FT**3 VOID RATIO = .6354

TIME IN SEC.	STRAIN IN (%)
4.	19.709
2000.	18.747
4000.	18.373
8000.	18.092
20000.	17.771
78420.	17.557
165480.	17.491

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 16.208 %
DRY DENSITY = 100.4 LB/FT**3 VOID RATIO = .6609

TIME IN SEC.	STRAIN IN (%)
4.	17.357
2000.	17.076
4000.	16.970
8000.	16.823
20000.	16.635
90120.	16.382
252900.	16.208

SAMPLE NO. 57I-446
SPEC. NO. 51

PRESSURE (LB/IN**2)	HEIGHT (IN.)	VOID RATIO	DRY DENSITY (LB/FT**3)	WATER CONTENT (PERCENT)	DEGREE OF SATURATION (PERCENT)	AXIAL STRAIN (PERCENT)
1.00	.7484	.9821	84.1	36.6	99.5	0.00
1.00	.7479	.9808	84.1	36.7	100.0	.07
5.00	.7419	.9649	84.8	36.1	100.0	.87
10.00	.7381	.9548	85.3	35.8	100.0	1.38
20.00	.7321	.9389	86.0	35.2	100.0	2.18
40.00	.7225	.9135	87.1	34.2	100.0	3.46
80.00	.7106	.8820	88.6	33.0	100.0	5.05
160.00	.6622	.7538	95.0	28.2	100.0	11.52
320.00	.6092	.6134	103.3	23.0	100.0	18.60
640.00	.5605	.4845	112.3	18.1	100.0	25.11
80.00	.5798	.5356	108.5	20.1	100.0	22.53
20.00	.5989	.5862	105.1	22.0	100.0	19.98
5.00	.6175	.6354	101.9	23.8	100.0	17.49
1.00	.6271	.6609	100.4	24.8	100.0	16.21

	INITIAL	MAX PRESSURE
DRY DENSITY	84.1	112.3
MOISTURE CONTENT	36.6	18.1
DEGREE OF SATURATION	99.5	100.0
DEGREE OF SATURATION CK	99.5	100.0

REBOUND = 35.44 %

COMPARISON OF PHASE RELATIONS CALCULATED FROM DIFFERENT INPUTS

	INITIAL MOISTURE	FINAL WEIGHTS
TOTAL DRY WEIGHT(GMS)	52.7	51.9
INITIAL WATER CONTENT(%)	34.5	36.6
FINAL WATER CONTENT(%)	24.4	28.0
INITIAL VOID RATIO	.9515	.9821
MAX. PRES. VOID RATIO	.4616	.4845

THE ABOVE ANALYSIS USES THE INPUT FINAL WEIGHTS IN THE PHASE RELATIONSHIP CALCULATIONS

THE HEIGHT OF THE ENTRAPPED AIR IN THE SPECIMEN WAS SET TO ZERO IN THE ABOVE ANALYSIS.
THE DEGREE OF SATURATION AT THE MAX PRESSURE BEFORE ZEROING WAS 117.9 %

SAMPLE NO 57I-446

SEMI-LOGARITHMIC STRESS DEFORMATION ANALYSIS

DEGREE OF POLYNOMIAL = 4

SEARCH BOUNDARIES FOR PT. OF MAX. CURVATURE	11.0 LB/IN**2	150.0 LB/IN**2
SEARCH BOUNDARIES FOR VIRGIN COMPRESSION LINE	160.0 LB/IN**2	350.0 LB/IN**2
INSITU EFFECTIVE OVERBURDEN PRESSURE =	80.0 LB/IN**2	
VOID RATIO AT SEATING LOAD =	.982	
COMPUTER GENERATED BOUNDARIES FOR ANALYTICAL METHOD	36.1 LB/IN**2	80.8 LB/IN**2
PT. OF MAX. CURVATURE USING GEOMETRICAL METHOD AT	56.5 LB/IN**2	
PT. OF MAX. CURVATURE USING ANALYTICAL METHOD AT	35.8 LB/IN**2	

RANGES OF PRESSURE - VOID RATIO CONSOLIDATION PARAMETERS WITH PT. OF MAX. CURVATURE FOUND BY ANALYTICAL METHOD

	PROBABLE	-	MINIMUM
PRECONSOLIDATION PRESSURE .....(LB/IN**2)	73.1	-	48.9
VOID RATIO AT PRECONSOLIDATION PRESSURE	.982	-	.982
OVERCONSOLIDATION RATIO (OCR)	.913	-	.611
COMPRESSION INDEX (CC)	.516	-	.445
PRIMARY COMPRESSION RATIO (CC/(1+V.R. AT SEATING))	.260	-	.225
SWELL INDEX (CS)	.066		

RANGES OF PRESSURE - VOID RATIO CONSOLIDATION PARAMETERS WITH PT. OF MAX. CURVATURE FOUND BY GEOMETRICAL METHOD

	PROBABLE	-	MINIMUM
PRECONSOLIDATION PRESSURE .....(LB/IN**2)	86.5	-	49.4
VOID RATIO AT PRECONSOLIDATION PRESSURE	.980	-	.982
OVERCONSOLIDATION RATIO (OCR)	1.082	-	.618
COMPRESSION INDEX (CC)	.551	-	.445
PRIMARY COMPRESSION RATIO (CC/(1+V.R. AT SEATING))	.278	-	.225
SWELL INDEX (CS)	.066		

SAMPLE NO 571-446

SEMI-LOGARITHMIC TIME CONSOLIDATION ANALYSIS

PRESSURE (LB/IN**2)	DEGREE OF CONSOLIDATION (U) (IN PERCENT AXIAL STRAIN) (U=0)	(U=100)	TIME (SEC) AT INFLECTION (U=50)	PT.	COEFFICIENT OF CONSOLIDATION (IN**2/SEC) LOG METHOD	INF.PT. METHOD	PERMEABILITY (FT/YR) COMPUTED WITH MAX. CC LOG METHOD	INF.PT. METHOD
1.00								
	WARNING ANALYSIS HAS FAILED							
5.00								
	.97	1.37	1958.	85.	.0000138	.0006563	.02	1.02
10.00								
	1.50	1.83	16.	112.	.0017166	.0004867	1.34	.38
20.00								
	2.33	2.78	9.	45.	.0028283	.0011931	1.12	.47
40.00								
	3.69	4.71	25.	59.	.0010149	.0008847	.20	.18
80.00								
	5.35	10.62	323.	249.	.0000724	.0001939	.01	.02
160.00								
	11.66	17.48	140.	225.	.0001441	.0001814	.01	.01
320.00								
	18.85	24.29	128.	191.	.0001328	.0001809	.00	.01
640.00								

```
                    PLOTTING COMMENCING
                    ...................

..... DISSPLA VERSION 8.2 .....
NO. OF FIRST PLOT  O


END OF DISSPLA 8.2 --     30280 VECTORS GENERATED IN      5 PLOT FRAMES.
-ISSCO-  4186 SORRENTO VALLEY BLVD.,SAN DIEGO CALIF. 92121

DISSPLA IS A CONFIDENTIAL PROPRIETARY PRODUCT OF ISSCO AND ITS USE
   IS SUBJECT TO A NONDISSEMINATION AND NONDISCLOSURE AGREEMENT.


* * * * * * * * * *  XYNETICS POST-PROCESSOR  * * * * * * * * * *


        PLOT FILE GENERATED BY AGXQCVN     AT 19.06.05  ON 02/14/83
   POPOO1A    ENTER DISSPOP COMMANDS - CARRIAGE RETURN TO CONT.
```

```
            XYNETICS PLOT TAPE STATISTICS
DRAWING NO.   NO. OF RECORDS   LOCATION OF FIRST RECORD
      1              57                        1
      2              65                       58
      3              50                      123
      4              39                      173
      5              68                      212
      6               1                      280
      7               2                      281
      8               1                      283
      9               1                      284
   INF009I    PLOT FILE AUTOMATICALLY DISPOSED - ID = AGXQCVN  XYNPLT,DC=PL,ID,FC=40.


*** END OF DISSPLA PLOTTING ***
            6 PLOTS HAVE BEEN PROCESSED

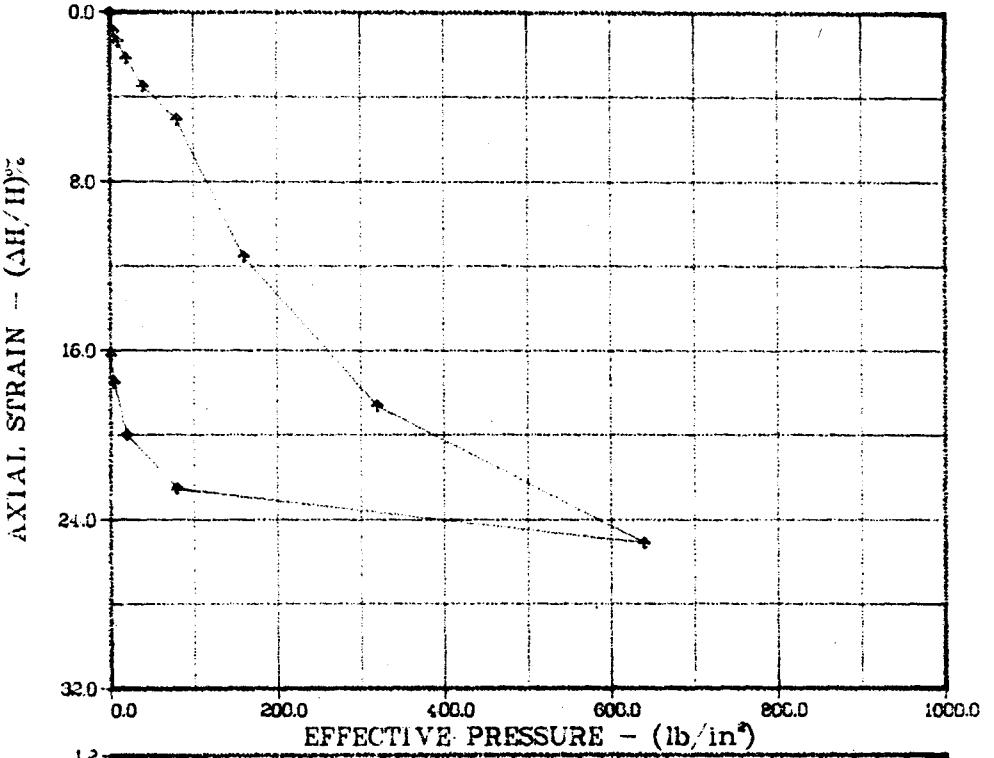
   POPC02I    END OF POST-PROCESSOR EXECUTION.
```

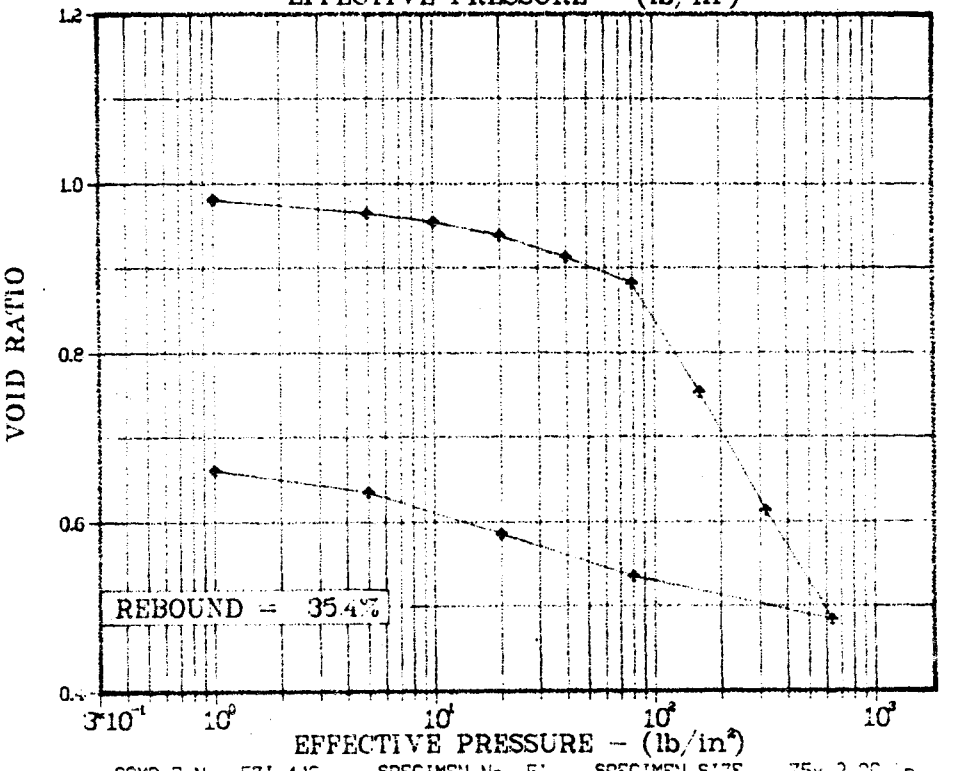
AGXQCVN. 83/02/14.CYBER 170/730EE PRODUCTION

```
17.01.59.SOILS,CM155000,P3.
17.01.59. PRIORITY= 3
17.01.59.USER,ER1540A,.
17.01.59.CHARGE,857040,9061.
17.02.29.HEADING.  YGAVLICK
17.02.30.HEADING.  CONSOL
17.02.30.ROUTE,OUTPUT,DC=HR,FC=64,DEF.
17.02.30. ROUTE COMPLETE.
17.02.30.GET,TAPE5=CONDATA.
17.02.30.GET,CON1DBG/UN=ER1540A,PW=.
17.02.31.CON1DBG.
17.20.47.  CM LWA+1 = 52417B, LOADER USED  67200B
17.39.14.    STOP  NORMAL EXIT
17.39.14.     1.334 CP SECONDS EXECUTION TIME
17.39.14.IFE,FILE(TAPE15,LO).EQ.0,NOPLOT.
17.39.14.REWIND,TAPE1.
17.39.14.GET,CONPLBG/UN=ER1540A,PW=.
17.39.16.ATTACH,DISSPLA/UN=LIBRARY.
17.39.34.LDSET,LIB=DISSPLA.
17.39.34.CONPLBG.
19.06.04.  CM LWA+1 =125522B, LOADER USED 150000B
19.06.05. DSMSSG NOT FOUND, AT 121314.
19.06.05. DISSPLA - REL-8.2
19.07.15.  EXIT
19.07.15.    23.391 CP SECONDS EXECUTION TIME
19.07.15.GET,XYNPOP/UN=LIBRARY.
19.08.07.XYNPOP.
19.08.07. DSMSSG NOT FOUND, AT 040550.
19.09.09. ROUTE COMPLETE -   XYNPLT
19.09.09.*** ROUTE - DISSPLA PLOT FILE.
19.09.09.XYNPLT,DC=PL,ID,FC=40.
19.09.09.*** ROUTE - JOB NAME= AGXQCVN
19.09.10.    STOP  .XYNPOP. NORMAL EXIT
19.09.10.    23.320 CP SECONDS EXECUTION TIME
19.09.10.SKIP,DONE.
19.09.10.ENDIF,DONE.
19.09.11.DAYFILE,CONDAY.
19.09.11. USER DAYFILE DUMPED.
19.09.11.REPLACE,CONDAY.
19.09.11.UEAD,       0.002KUNS.
19.09.11.UEPF,       0.227KUNS.
19.09.11.UEMS,      14.158KUNS.
19.09.11.UECP,      51.527SECS.
19.09.11.AESR,      78.238UNTS.
```

ONE – DIMENSIONAL CONSOLIDATION

	PRESSURES		PRECONSOLIDATION PRESSURES	
	INITIAL	MAXIMUM	PROBABLE	MINIMUM
VOID RATIO	0.982	0.484		
DRY DENSITY – lb/ft³	84.09	112.3	86.5 lb/in²	49.9 lb/in²
WATER CONTENT	36.6%	18.1%		
DEGREE OF SATURATION	99.5%	100.%		



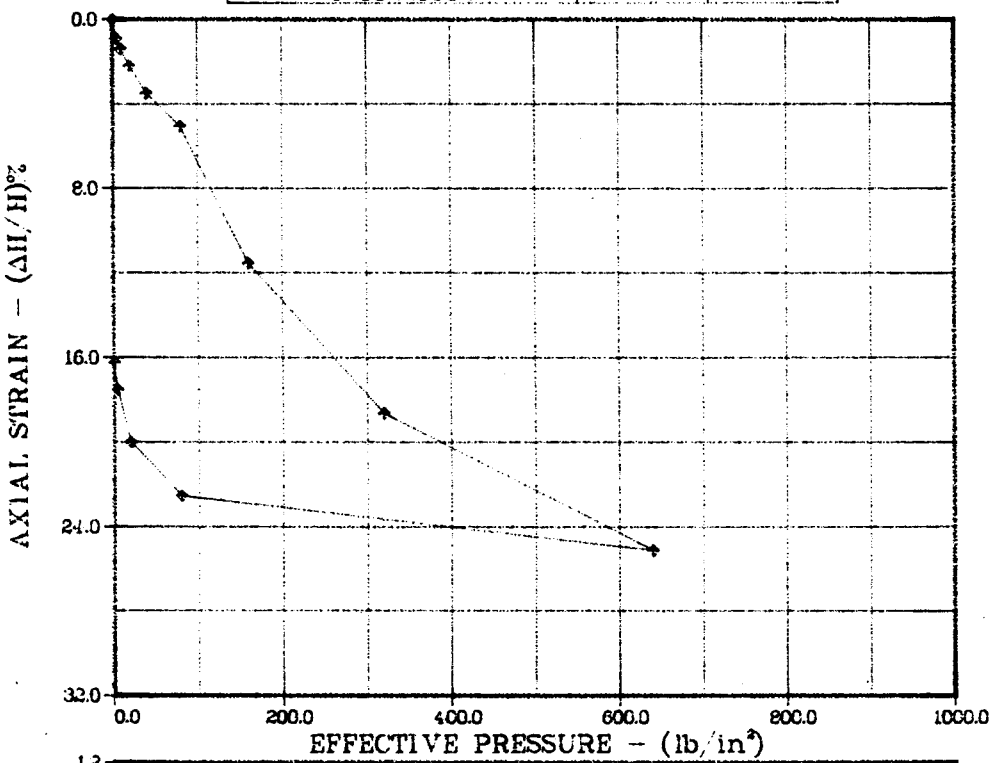


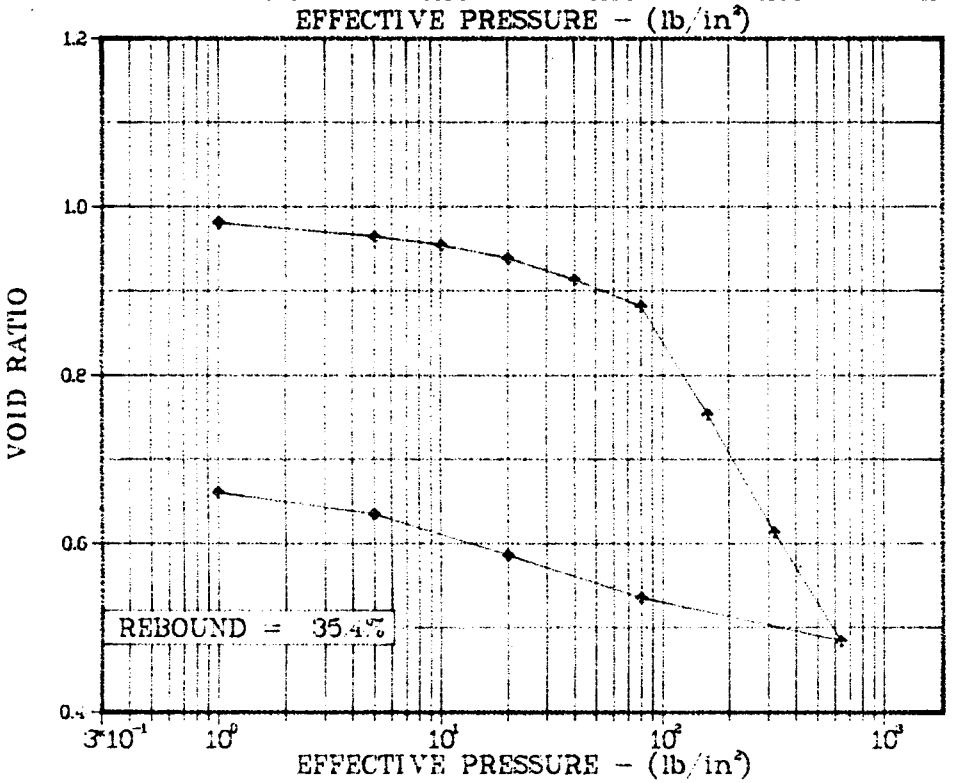
SAMPLE No. 571-416 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.1-212.3 HOLE No. [illegible]
SHRINKAGE LIMIT ___ LIQUID LIMIT 66 PLASTICITY INDEX 42

Figure A-18

ONE – DIMENSIONAL CONSOLIDATION

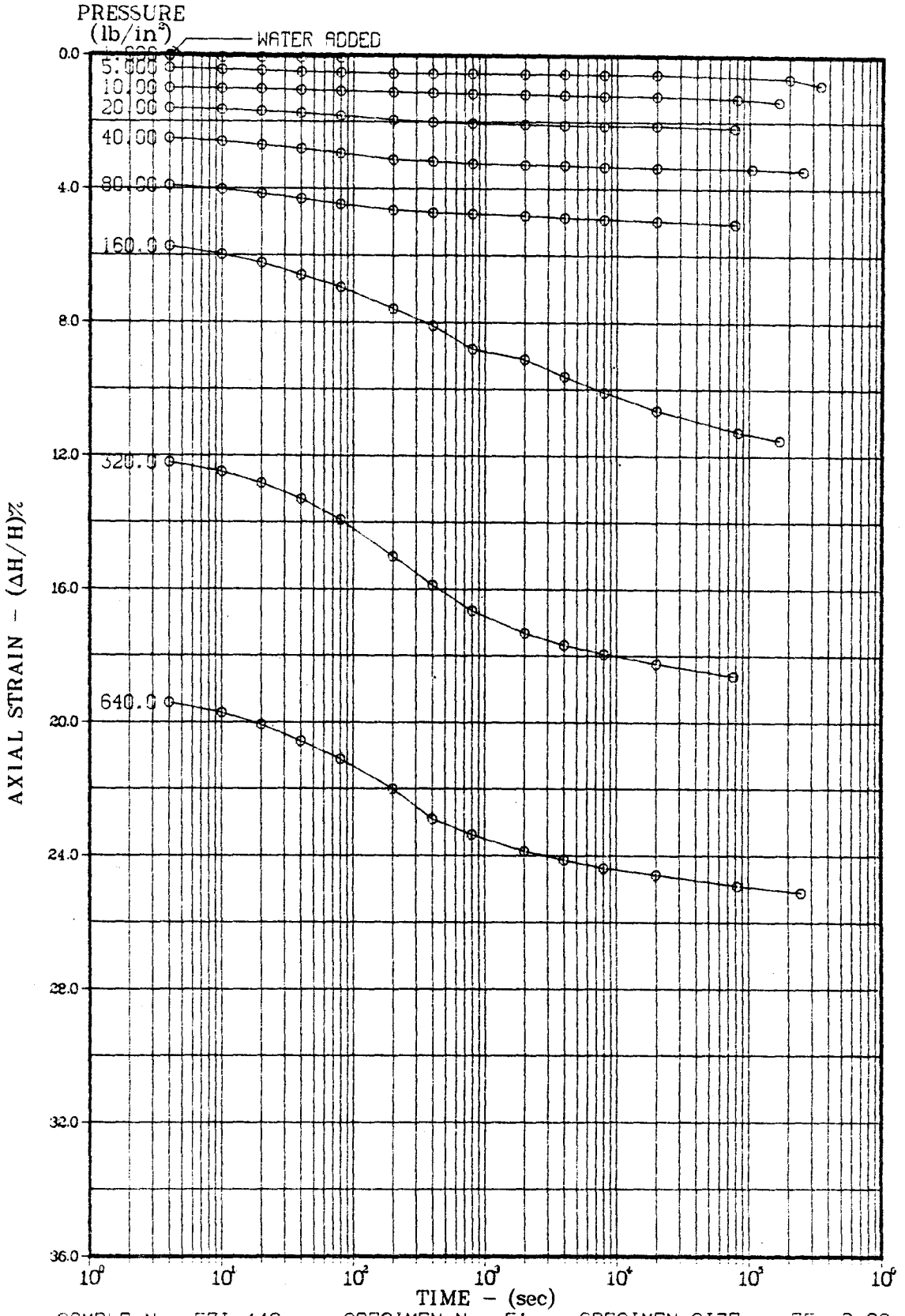
	PRESSURES	
	INITIAL	MAXIMUM
VOID RATIO	0.982	0.484
DRY DENSITY – lb/ft³	84.09	112.3
WATER CONTENT	36.6%	13.1%
DEGREE of SATURATION	99.5%	100.%





SAMPLE No. 571-416 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.0-212.5 HOLE No. DH-116
SHRINKAGE LIMIT __ LIQUID LIMIT 66 PLASTICITY INDEX 42

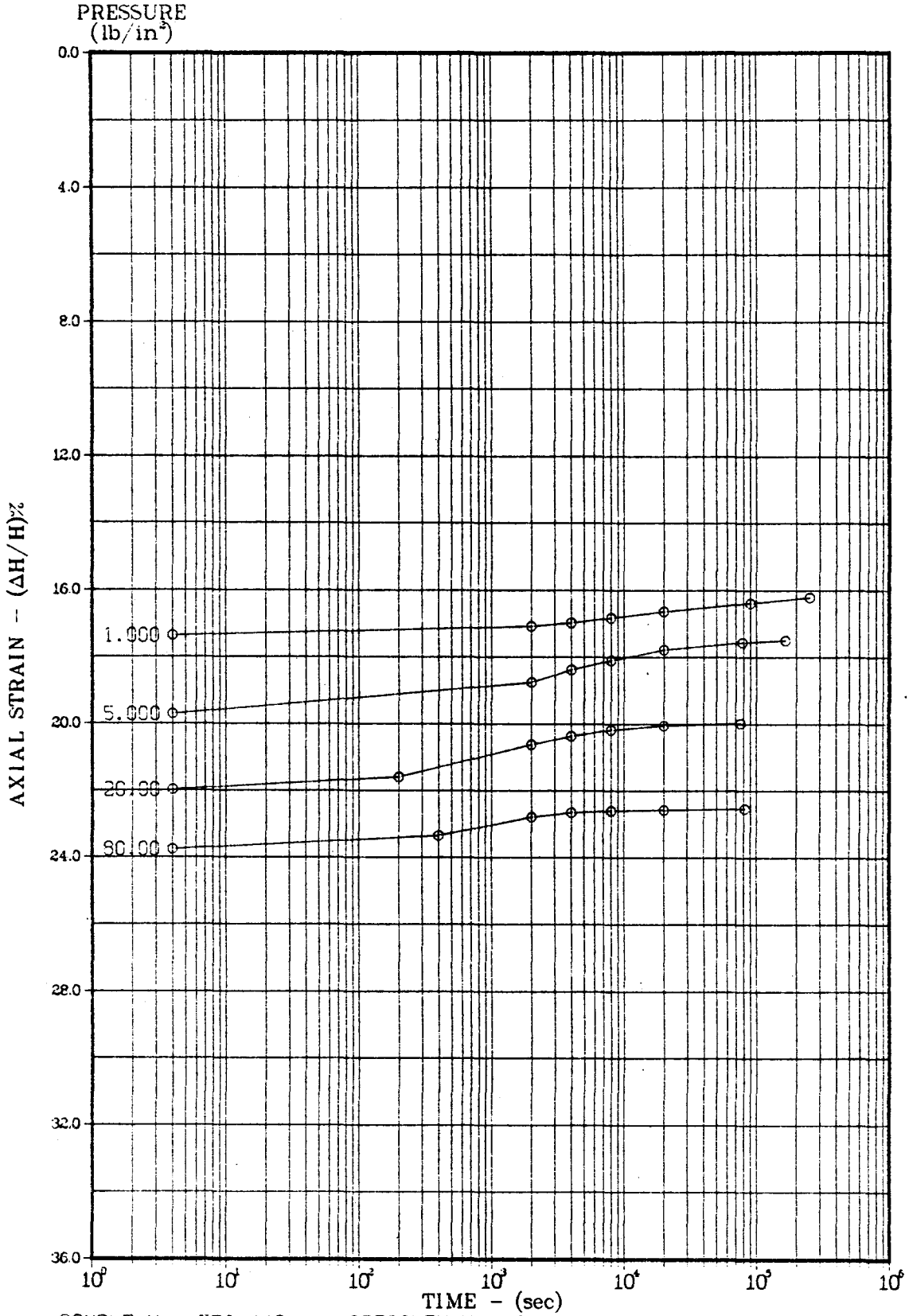
TIME–PERCENT STRAIN CURVES



SAMPLE No. 571-446 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.1-212.6 HOLE No. DH-446
SHRINKAGE LIMIT __ LIQUID LIMIT 86 PLASTICITY INDEX 42

Figure A-20

TIME–PERCENT STRAIN CURVES

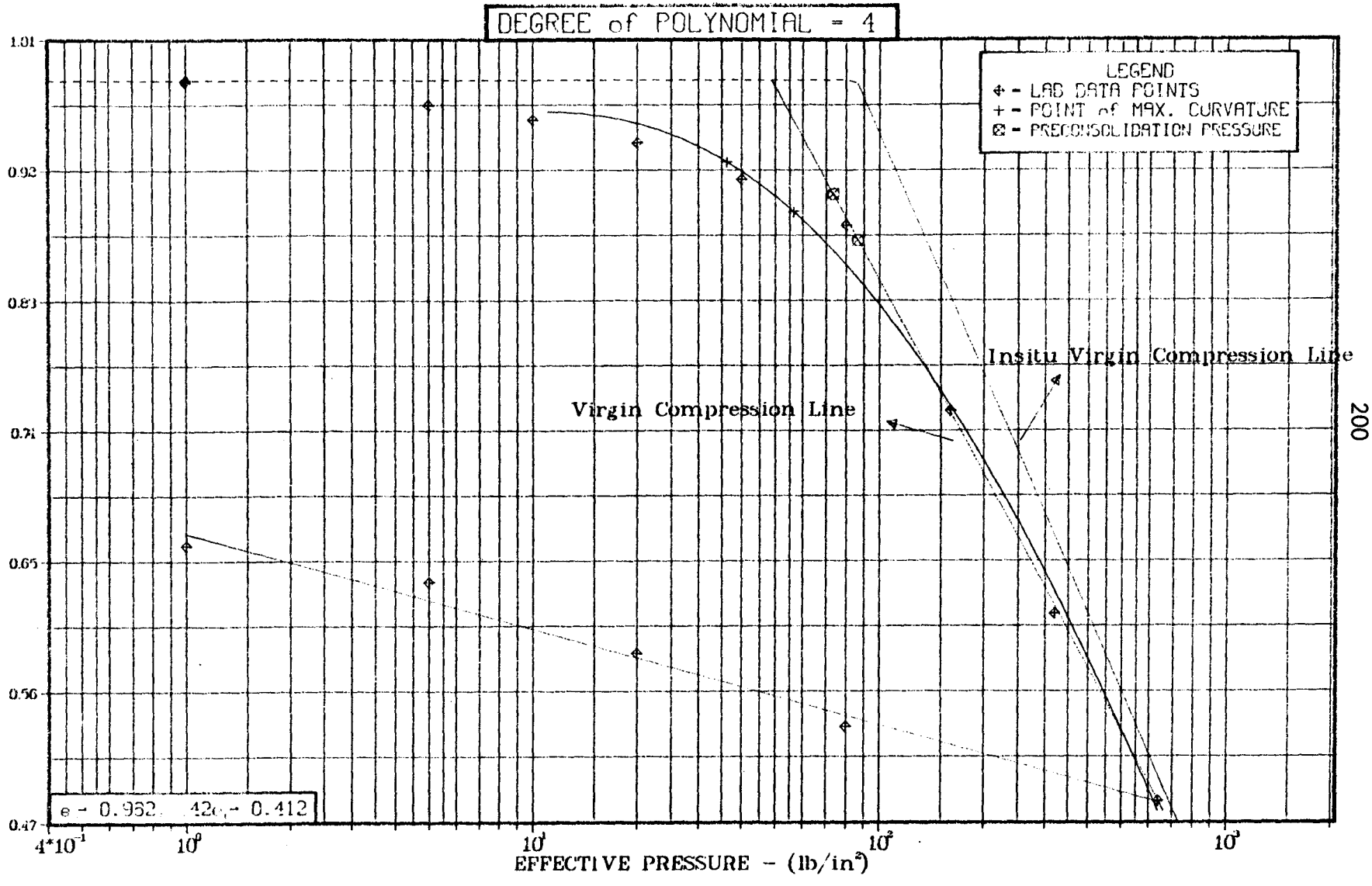


SAMPLE No. 571-446 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.1-212.6 HOLE No. DH-446
SHRINKAGE LIMIT __ LIQUID LIMIT 66 PLASTICITY INDEX 42

Figure A-21

Elogt plot

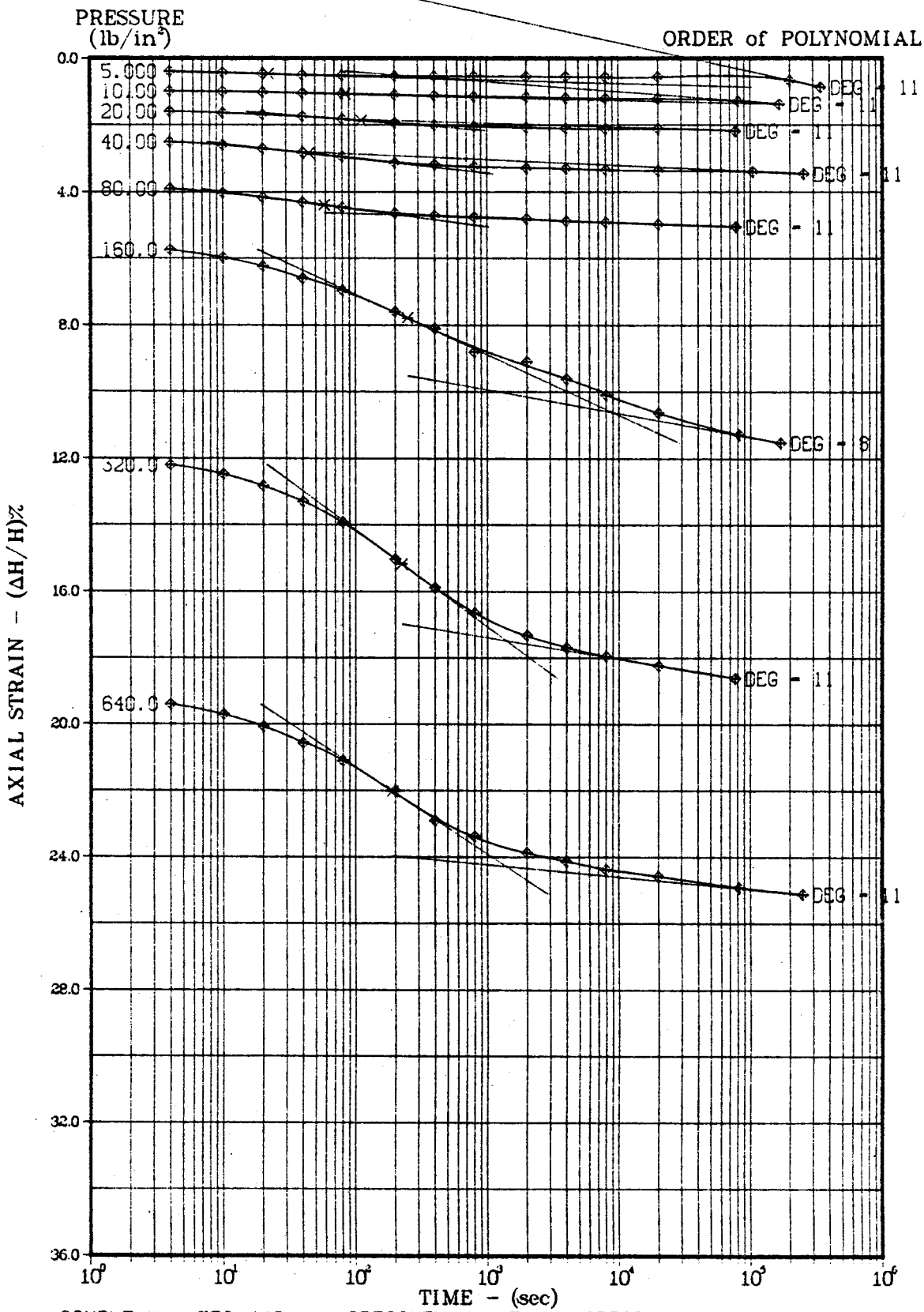
For Analysis Only



SAMPLE No. 521-416 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.1-212.6 HOLE No. CH-416
SHRINKAGE LIMIT __ LIQUID LIMIT 66 PLASTICITY INDEX 12

Figure A 22

TIME–PERCENT STRAIN CURVES



SAMPLE No. 571-446 SPECIMEN No. 51 SPECIMEN SIZE .75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 210.1-212.6 HOLE No. DH-446
SHRINKAGE LIMIT __ LIQUID LIMIT 66 PLASTICITY INDEX 42

Figure A-23

CON1D Xerox output

Expansion

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890123456789
 1  591-82     52  DN-107A   30.26-30.63  CH     2.75        21                  1
 2   8-06-82       5      267    1.25     4.25     38     65    10               2
 3   1812.8   1226.3    0.1913   0.2087 8-23-82                                  3
 4                             32.5                                              4
 5              786.3    624.1    186.0    209.6    209.0        1               5
 6          9    13.68                                                           6
 7        1.0                                                                   7
 8          4  .2087                                                            8
 9         99                                                                   9
10        1.0                                                                   10
11          4  .2089                                                            11
12         90  .2105                                                            12
13       1260  .2176                                                            13
14       2160  .2210                                                            14
15       2580  .2218                                                            15
16       5940  .2232                                                            16
17     151260  .2257                                                            17
18     230700  .2263                                                            18
19     316560  .2266                                                            19
20     403200  .2271                                                            20
21     497580  .2277                                                            21
22     575760  .2280                                                            22
23     763200  .2284                                                            23
24     835200  .2284                                                            24
25         99                                                                   25
26        2.0                                                                   26
27          4  .2277                                                            27
28      13440  .2273                                                            28
29      71520  .2273                                                            29
1234567890123456789012345678901234567890123456789012345678901234567890123456789
30         99                                                                   30
31        4.0                                                                   31
32          4  .2250                                                            32
33       5700  .2242                                                            33
34      28200  .2241                                                            34
35      93780  .2240                                                            35
36         99                                                                   36
37        8.0                                                                   37
38          4  .2192                                                            38
39      20580  .2182                                                            39
40      82200  .2180                                                            40
41     106920  .2179                                                            41
42         99                                                                   42
43       12.0                                                                   43
44          4  .2153                                                            44
45      56040  .2131                                                            45
46     235800  .2128                                                            46
47     315780  .2129                                                            47
48         99                                                                   48
49       16.0                                                                   49
50          4  .2095                                                            50
51        840  .2090                                                            51
52      17280  .2087                                                            52
53        999.9999                                                              53
1234567890123456789012345678901234567890123456789012345678901234567890123456789
```

BUREAU OF RECLAMATION
GEOTECHNICAL BRANCH
ONE-DIMENSIONAL EXPANSION TEST

SAMPLE NO 591-82 SPECIMEN NO 52 SPECIMEN TYPE UNDISTURBED

DATE PLACED 8-06-82 DATE REMOVED 8-23-82 SPECIFIC GRAVITY 2.75

SPECIMEN DIAMETER = 4.25 IN. SPECIMEN HEIGHT = 1.25 IN.

TEST PERFORMED IN SCALE NO. 5

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 93.0 LB/FT**3 VOID RATIO = .8469

TIME IN SEC.	STRAIN IN (%)
4.	0.000

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = -1.554 %
DRY DENSITY = 91.5 LB/FT**3 VOID RATIO = .8756

TIME IN SEC.	STRAIN IN (%)
4.	-.016
90.	-.142
1260.	-.702
2160.	-.970
2580.	-1.034
5940.	-1.144
151260.	-1.341
230700.	-1.389
316560.	-1.412
403200.	-1.452
497580.	-1.499
575760.	-1.523
763200.	-1.554
835200.	-1.554

PRESSURE = 2.00 LB/IN**2 AXIAL STRAIN = -1.468 %
DRY DENSITY = 91.6 LB/FT**3 VOID RATIO = .8740

TIME IN SEC.	STRAIN IN (%)
4.	-1.499
13440.	-1.468
71520.	-1.468

PRESSURE = 4.00 LB/IN**2 AXIAL STRAIN = -1.207 %
DRY DENSITY = 91.8 LB/FT**3 VOID RATIO = .8692

TIME IN SEC.	STRAIN IN (%)
4.	-1.286
5700.	-1.223
28200.	-1.215
93780.	-1.207

PRESSURE = 8.00 LB/IN**2 AXIAL STRAIN = -.726 %
DRY DENSITY = 92.3 LB/FT**3 VOID RATIO = .8603

TIME IN SEC.	STRAIN IN (%)
4.	-.828
20580.	-.750
82200.	-.734
106920.	-.726

PRESSURE = 12.00 LB/IN**2 AXIAL STRAIN = -.331 %
DRY DENSITY = 92.6 LB/FT**3 VOID RATIO = .8530

TIME IN SEC.	STRAIN IN (%)
4.	-.521
56040.	-.347
235800.	-.323
315780.	-.331

PRESSURE = 16.00 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 93.0 LB/FT**3 VOID RATIO = .8469

TIME IN SEC.	STRAIN IN (%)
4.	-.063
840.	-.024
17280.	0.000

PRESSURE (LB/IN**2)	HEIGHT (IN.)	VOID RATIO	DRY DENSITY (LB/FT**3)	WATER CONTENT (PERCENT)	DEGREE OF SATURATION (PERCENT)	AXIAL STRAIN (PERCENT)
1.00	1.2674	.8469	93.0	30.8	100.0	0.00
1.00	1.2871	.8756	91.5	31.8	100.0	-1.55
2.00	1.2860	.8740	91.6	31.8	100.0	-1.47
4.00	1.2827	.8692	91.8	31.6	100.0	-1.21
8.00	1.2766	.8603	92.3	31.3	100.0	-.73
12.00	1.2716	.8530	92.6	31.0	100.0	-.33
16.00	1.2674	.8469	93.0	30.8	100.0	0.00

	INITIAL	MAX PRESSURE
DRY DENSITY	93.0	93.0
MOISTURE CONTENT	33.7	30.8
DEGREE OF SATURATION	109.4	100.0
DEGREE OF SATURATION CK	109.4	100.0

REBOUND = 100.00 %

COMPARISON OF PHASE RELATIONS CALCULATED FROM DIFFERENT INPUTS

	INITIAL MOISTURE	FINAL WEIGHTS
TOTAL DRY WEIGHT(GMS)	442.6	438.7
INITIAL WATER CONTENT(%)	32.5	33.7
FINAL WATER CONTENT(%)	37.0	37.0
INITIAL VOID RATIO	.8305	.8469
MAX. PRES. VOID RATIO	.8305	.8469

THE ABOVE ANALYSIS USES THE INPUT FINAL WEIGHTS IN THE PHASE RELATIONSHIP CALCULATIONS

THE HEIGHT OF THE ENTRAPPED AIR IN THE SPECIMEN WAS SET TO ZERO IN THE ABOVE ANALYSIS.
THE DEGREE OF SATURATION AT THE MAX PRESSURE BEFORE ZEROING WAS 120.2 %

MAXIMUM VERTICAL EXPANSION =-1.5544 %

```
                    PLOTTING COMMENCING
                    ...................

..... DISSPLA VERSION 8.2 .....
NO. OF FIRST PLOT  0


END OF DISSPLA 8.2 --     4495 VECTORS GENERATED IN     1 PLOT FRAMES.
-ISSCO-  4186 SORRENTO VALLEY BLVD.,SAN DIEGO CALIF. 92121

DISSPLA IS A CONFIDENTIAL PROPRIETARY PRODUCT OF ISSCO AND ITS USE
   IS SUBJECT TO A NONDISSEMINATION AND NONDISCLOSURE AGREEMENT.


* * * * * * * * * *  XYNETICS POST-PROCESSOR  * * * * * * * * * *


        PLOT FILE GENERATED BY AGXQABL     AT 17.01.57  ON 03/09/83
   POPOO1A    ENTER DISSPOP COMMANDS - CARRIAGE RETURN TO CONT.
```

```
            XYNETICS PLOT TAPE STATISTICS
DRAWING NO.   NO. OF RECORDS   LOCATION OF FIRST RECORD
      1              45                      1
      2               1                     46
      3               2                     47
      4               1                     49
      5               1                     50
   INF009I    PLOT FILE AUTOMATICALLY DISPOSED - ID = AGXQABL  XYNPLT,DC=PL,ID,FC=40.



*** END OF DISSPLA PLOTTING ***
            2 PLOTS HAVE BEEN PROCESSED

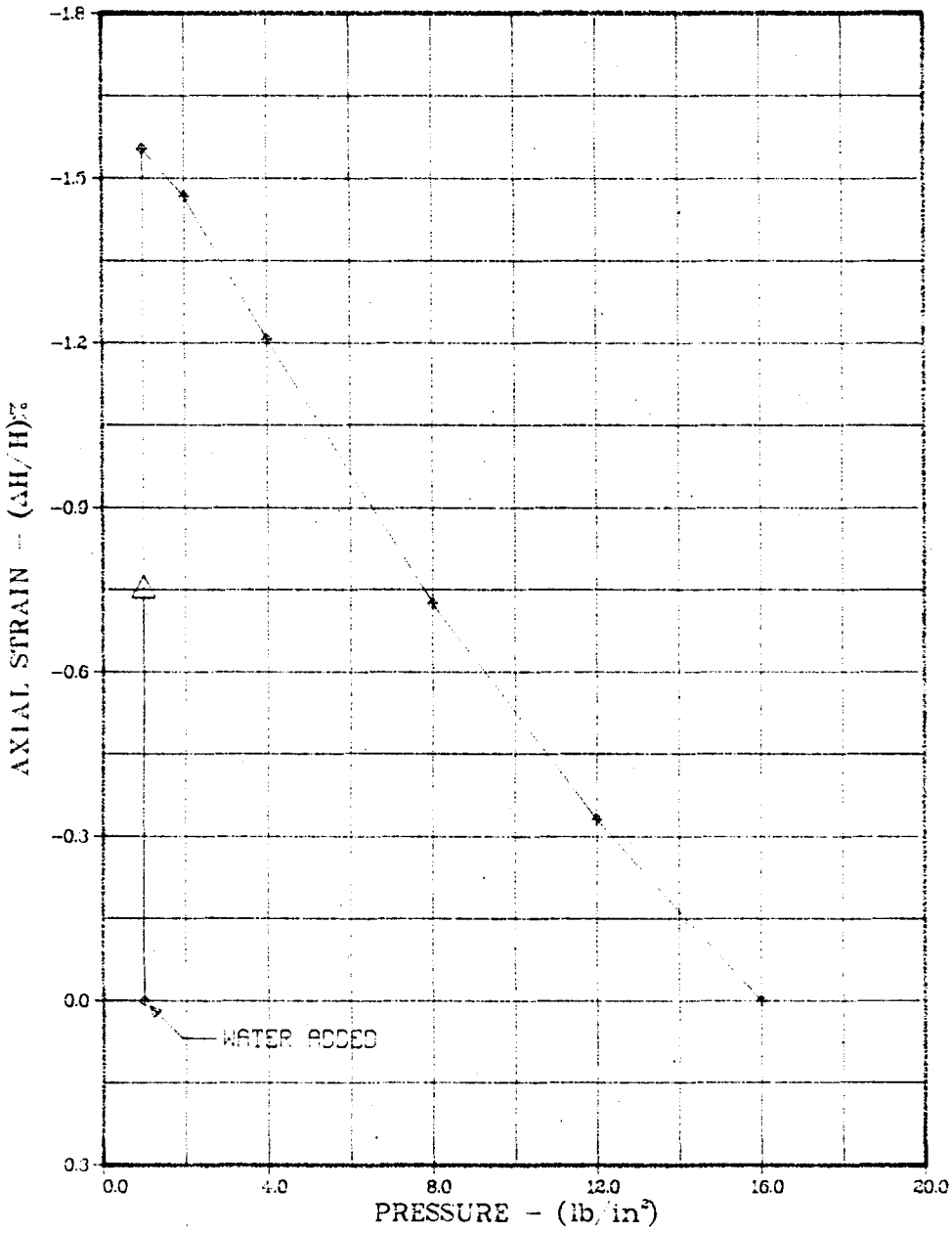
   POP002I    END OF POST-PROCESSOR EXECUTION.
```

AGXQABL. 83/03/09.CYBER 170/730EE PRODUCTION

```
17.00.37.SOILS,CM155000,P3.
17.00.37. PRIORITY= 3
17.00.37.USER,ER1540A,.
17.00.37.CHARGE,857040,9061.
17.00.45.HEADING.  YGAVLICK
17.00.45.HEADING.  EXPANSION
17.00.45.ROUTE,OUTPUT,DC=HR,FC=64,DEF.
17.00.45. ROUTE COMPLETE.
17.00.45.GET,TAPE5=CONEXP .
17.00.45.GET,CON1DBG/UN=ER1540A,PW=.
17.00.46.CON1DBG.
17.00.49.  CM LWA+1 = 52417B, LOADER USED  67200B
17.00.53.    STOP  NORMAL EXIT
17.00.53.      .348 CP SECONDS EXECUTION TIME
17.00.53.IFE,FILE(TAPE15,LO).EQ.0,NOPLOT.
17.00.53.REWIND,TAPE1.
17.00.53.GET,CONPLBG/UN=ER1540A,PW=.
17.00.55.ATTACH,DISSPLA/UN=LIBRARY.
17.00.58.LDSET,LIB=DISSPLA.
17.00.58.CONPLBG.
17.01.56.  CM LWA+1 =126124B, LOADER USED 150400B
17.01.57. DSMSSG NOT FOUND, AT 121743.
17.01.57. DISSPLA - REL-8.2
17.02.38.  EXIT
17.02.38.     3.402 CP SECONDS EXECUTION TIME
17.02.38.GET,XYNPOP/UN=LIBRARY.
17.02.39.XYNPOP.
17.02.40. DSMSSG NOT FOUND, AT 040550.
17.02.58. ROUTE COMPLETE -   XYNPLT
17.02.58.*** ROUTE - DISSPLA PLOT FILE.
17.02.58.XYNPLT,DC=PL,ID,FC=40.
17.02.58.*** ROUTE - JOB NAME= AGXQABL
17.02.58.    STOP  .XYNPOP. NORMAL EXIT
17.02.58.     3.915 CP SECONDS EXECUTION TIME
17.02.58.SKIP,DONE.
17.02.58.ENDIF,DONE.
17.02.58.DAYFILE,CONDAY.
17.02.58. USER DAYFILE DUMPED.
17.02.58.REPLACE,CONDAY.
17.02.59.UEAD,       0.002KUNS.
17.02.59.UEPF,       0.227KUNS.
17.02.59.UEMS,       7.121KUNS.
17.02.59.UECP,      11.403SECS.
17.02.59.AESR,      21.292UNTS.
```

ONE - DIMENSIONAL EXPANSION

	INITIAL	EXPANDED
DRY DENSITY - lb/ft³	93.0	91.5
WATER CONTENT - %	33.7	31.8
DEGREE of SATURATION - %	109.	100.
MAXIMUM VERTICAL EXPANSION = -1.55 %		
PRESSURE TO COMPRESS SPEC. = 16.0 lb/in²		



SAMPLE No. 591-SD SPECIMEN No. SD SPECIMEN SIZE 1.25x 1.25 in.
UNDISTURBED CLASSIFICATION SYMBOL CH DEPTH 30.26-30.63 HOLE No. 2N-1076
SHRINKAGE LIMIT 10 LIQUID LIMIT 65 PLASTICITY INDEX 35

Uplift

CONID Xerox output

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
55I-368   52  SP-52       20.5-22.5   CL     2.70        11
 8-10-82        2       12   0.75     2.00    31    61    12
 1827.0  1748.0   0.7031  0.7080 8-25-82
                          19.6
          259.6   244.9   179.2   239.7   239.3         1

     1.0
       4 .7080
      99
     1.0
       4 .7080
      60 .7082
      99
     2.5
       4 .7080
     420 .7084
      99
     5.9
       4 .7080
    3240 .7084
      99
     9.2
       4 .7080
   69240 .7081
      99
    10.4
       4 .7080
   93060 .7080
      99
1234567890123456789012345678901234567890123456789012345678901234567890
     8.7
       4 .7080
   78840 .7081
  266460 .7082
  266520 .7083
  338520 .7083
      99
     6.0
       4 .7080
   71160 .7086
      99
     3.0
       4 .7086
   22140 .7088
   88860 .7090
  108480 .7090
      99
     2.5
       4 .7089
   62340 .7093
      99
     1.0
       4 .7097
   23880 .7103
   83400 .7106
  263220 .7110
  340860 .7111
1234567890123456789012345678901234567890123456789012345678901234567890
```

```
                1         2         3         4         5         6         7
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
57        428640 .7111                                                                  57
58        519300 .7112                                                                  58
59            999.9999                                                                  59
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

BUREAU OF RECLAMATION
GEOTECHNICAL BRANCH
ONE-DIMENSIONAL UPLIFT PRESSURE TEST

SAMPLE NO 55I-368 SPECIMEN NO 52 SPECIMEN TYPE UNDISTURBED

DATE PLACED 8-10-82 DATE REMOVED 8-25-82 SPECIFIC GRAVITY 2.70

SPECIMEN DIAMETER = 2.00 IN. SPECIMEN HEIGHT = .75 IN.

TEST PERFORMED IN SCALE NO. 2

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 106.2 LB/FT**3 VOID RATIO = .5875

TIME IN SEC.	STRAIN IN (%)
4.	0.000

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = -.026 %
DRY DENSITY = 106.1 LB/FT**3 VOID RATIO = .5879

TIME IN SEC.	STRAIN IN (%)
4.	0.000
60.	-.026

PRESSURE = 2.50 LB/IN**2 AXIAL STRAIN = -.053 %
DRY DENSITY = 106.1 LB/FT**3 VOID RATIO = .5883

TIME IN SEC.	STRAIN IN (%)
4.	0.000
420.	-.053

PRESSURE = 5.90 LB/IN**2 AXIAL STRAIN = -.053 %
DRY DENSITY = 106.1 LB/FT**3 VOID RATIO = .5883

TIME IN SEC.	STRAIN IN (%)
4.	0.000
3240.	-.053

PRESSURE = 9.20 LB/IN**2 AXIAL STRAIN = -.013 %
DRY DENSITY = 106.2 LB/FT**3 VOID RATIO = .5877

TIME IN SEC.	STRAIN IN (%)
4.	0.000
69240.	-.013

PRESSURE = 10.40 LB/IN**2 AXIAL STRAIN = 0.000 %
DRY DENSITY = 106.2 LB/FT**3 VOID RATIO = .5875

TIME IN SEC.	STRAIN IN (%)
4.	0.000
93060.	0.000

PRESSURE = 8.70 LB/IN**2 AXIAL STRAIN = -.040 %
DRY DENSITY = 106.1 LB/FT**3 VOID RATIO = .5881

TIME IN SEC.	STRAIN IN (%)
4.	0.000
78840.	-.013
266460.	-.026
266520.	-.040
338520.	-.040

PRESSURE = 6.00 LB/IN**2 AXIAL STRAIN = -.079 %
DRY DENSITY = 106.1 LB/FT**3 VOID RATIO = .5887

TIME IN SEC.	STRAIN IN (%)
4.	0.000
71160.	-.079

PRESSURE = 3.00 LB/IN**2 AXIAL STRAIN = -.132 %
DRY DENSITY = 106.0 LB/FT**3 VOID RATIO = .5896

TIME IN SEC.	STRAIN IN (%)
4.	-.079
22140.	-.106
88860.	-.132
108480.	-.132

PRESSURE = 2.50 LB/IN**2 AXIAL STRAIN = -.172 %
DRY DENSITY = 106.0 LB/FT**3 VOID RATIO = .5902

TIME IN SEC.	STRAIN IN (%)
4.	-.119
62340.	-.172

PRESSURE = 1.00 LB/IN**2 AXIAL STRAIN = -.424 %
DRY DENSITY = 105.7 LB/FT**3 VOID RATIO = .5942

TIME IN SEC.	STRAIN IN (%)
4.	-.225
23880.	-.305
83400.	-.344
263220.	-.397
340860.	-.411
428640.	-.411
519300.	-.424

PRESSURE (LB/IN**2)	HEIGHT (IN.)	VOID RATIO	DRY DENSITY (LB/FT**3)	WATER CONTENT (PERCENT)	DEGREE OF SATURATION (PERCENT)	AXIAL STRAIN (PERCENT)
1.00	.7549	.5875	106.2	21.8	100.0	0.00
1.00	.7551	.5879	106.1	21.8	100.0	-.03
2.50	.7553	.5883	106.1	21.8	100.0	-.05
5.90	.7553	.5883	106.1	21.8	100.0	-.05
9.20	.7550	.5877	106.2	21.8	100.0	-.01
10.40	.7549	.5875	106.2	21.8	100.0	0.00
8.70	.7552	.5881	106.1	21.8	100.0	-.04
6.00	.7555	.5887	106.1	21.8	100.0	-.08
3.00	.7559	.5896	106.0	21.8	100.0	-.13
2.50	.7562	.5902	106.0	21.9	100.0	-.17
1.00	.7581	.5942	105.7	22.0	100.0	-.42

	INITIAL	MAX PRESSURE
DRY DENSITY	106.2	106.2
MOISTURE CONTENT	19.5	21.8
DEGREE OF SATURATION	89.7	100.0
DEGREE OF SATURATION CK	89.7	100.0

REBOUND =******* %

COMPARISON OF PHASE RELATIONS CALCULATED FROM DIFFERENT INPUTS

	INITIAL MOISTURE	FINAL WEIGHTS
TOTAL DRY WEIGHT(GMS)	66.1	66.1
INITIAL WATER CONTENT(%)	19.6	19.5
FINAL WATER CONTENT(%)	22.4	22.4
INITIAL VOID RATIO	.5886	.5875
MAX. PRES. VOID RATIO	.5886	.5875

THE ABOVE ANALYSIS USES THE INPUT FINAL WEIGHTS IN THE PHASE RELATIONSHIP CALCULATIONS

THE HEIGHT OF THE ENTRAPPED AIR IN THE SPECIMEN WAS SET TO ZERO IN THE ABOVE ANALYSIS.
THE DEGREE OF SATURATION AT THE MAX PRESSURE BEFORE ZEROING WAS 101.7 %

MAXIMUM UPLIFT PRESSURE = 10.40 LB/IN**2

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                    PLOTTING COMMENCING
                    ...................

..... DISSPLA VERSION 8.2 .....
NO. OF FIRST PLOT  O


END OF DISSPLA 8.2 --      4908 VECTORS GENERATED IN      1 PLOT FRAMES.
-ISSCO-  4186 SORRENTO VALLEY BLVD.,SAN DIEGO CALIF. 92121

DISSPLA IS A CONFIDENTIAL PROPRIETARY PRODUCT OF ISSCO AND ITS USE
   IS SUBJECT TO A NONDISSEMINATION AND NONDISCLOSURE AGREEMENT.


* * * * * * * * * *  XYNETICS POST-PROCESSOR  * * * * * * * * * *


        PLOT FILE GENERATED BY AGXQFTY     AT 17.44.41  ON 08/16/83
   POPOO1A    ENTER DISSPOP COMMANDS - CARRIAGE RETURN TO CONT.
```
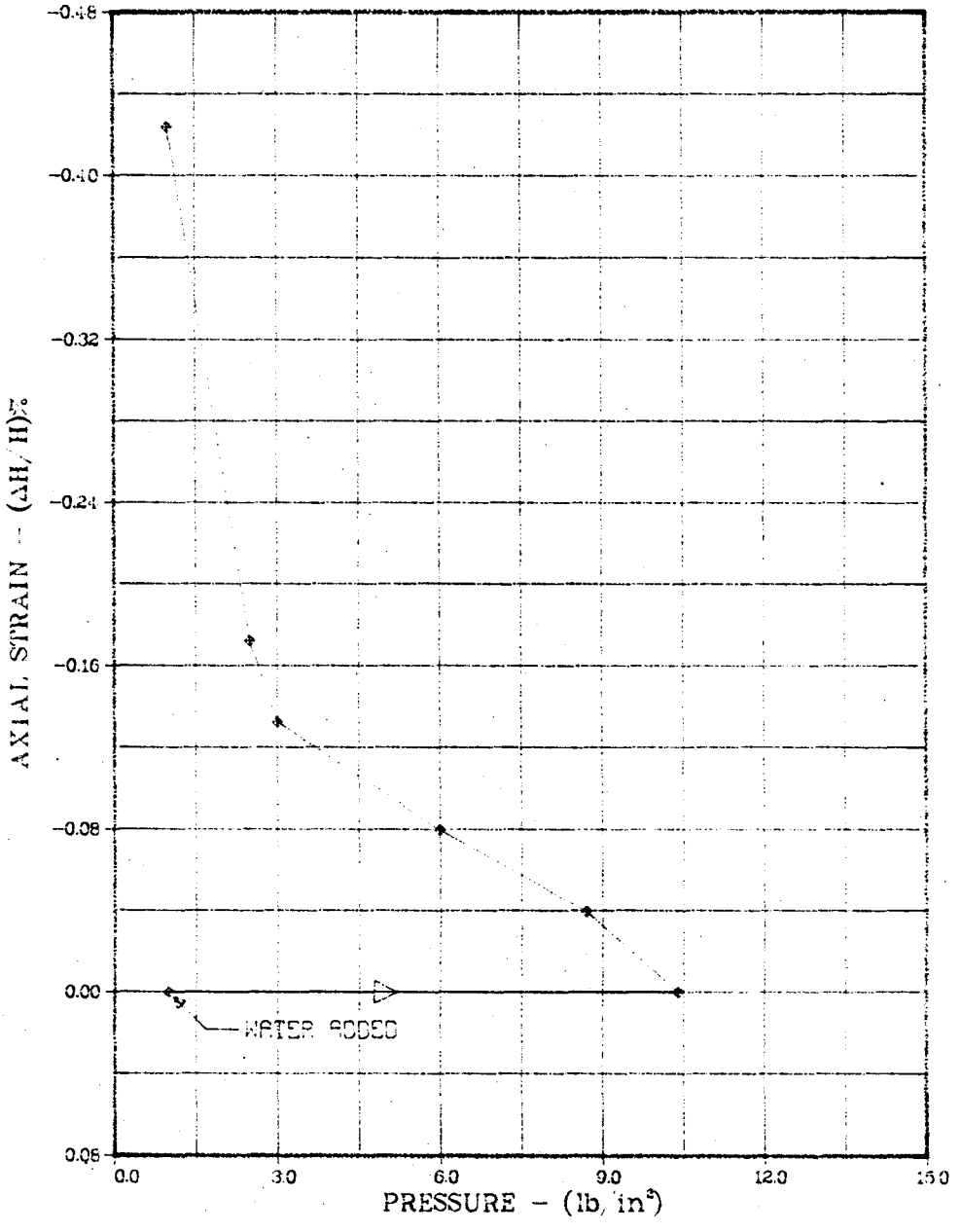

```
            XYNETICS PLOT TAPE STATISTICS
DRAWING NO.   NO. OF RECORDS   LOCATION OF FIRST RECORD
      1              48                        1
      2               1                       49
      3               2                       50
      4               1                       52
      5               1                       53
   INF009I    PLOT FILE AUTOMATICALLY DISPOSED - ID = AGXQFTY  XYNPLT,DC=PL,ID,FC=40.



*** END OF DISSPLA PLOTTING ***
            2 PLOTS HAVE BEEN PROCESSED

   POP002I    END OF POST-PROCESSOR EXECUTION.
```

ONE - DIMENSIONAL UPLIFT PRESSURE TEST

	INITIAL	EXPANDED
DRY DENSITY - lb/ft³	106.2	105.7
WATER CONTENT - %	19.5	22.0
DEGREE of SATURATION - %	89.7	100.
EXPANSION WHEN PRESSURE RELEASED--0.42 %		
MAXIMUM UPLIFT PRESSURE = 10.4 lb/in²		



SAMPLE No. 551-366 SPECIMEN No. 52 SPECIMEN SIZE 2.75x 2.00 in.
UNDISTURBED CLASSIFICATION SYMBOL CL DEPTH 20.5-22.5 HOLE No. TP 52
SHRINKAGE LIMIT 12 LIQUID LIMIT 61 PLASTICITY INDEX 31

ONE-DIMENSIONAL CONSOLIDATION TEST GLOSSARY

Units

F - Force, such as pound, ton, gram, kilogram
L - Length, such as inch, foot, meter
T - Time, such as second, minute
D - Dimensionless

Positive exponents designate multiples in the numerator.
Negative exponents designate multiples in the denominator.

Coefficient of compressibility (coefficient of compression), a_v (L^2F^{-1}) - The slope of the void ratio versus pressure curve when plotted to an arithmetic scale.

$$a_v = -\frac{\Delta e}{\Delta \sigma v} \text{ where:}$$

Δe = change in void ratio
$\Delta \sigma v$ = change in vertical pressure

Coefficient consolidation, c_v (L^2T^{-1}) - The coefficient which relates volume compressibility and permeability.

$c_v = k/\gamma w\ m_v$ where:
m_v = coefficient of volume compressibility, L^2F^{-1}

or

$C_v = k\ (1+e)/a_v : \gamma w$ where:

k = coefficient of permeability, LT^{-1}
e = void ratio, D
a_v = coefficient of compressibility, L^2F^{-1}
γw = unit weight of water, FL^{-3}

Coefficient of permeability (permeability), k (LT^{-1}) - The rate of discharge of water under laminar flow conditions through a unit cross-sectional area of porous medium under a unit hydraulic gradient and standard temperature conditions (usually 20 °C).

Coefficient of volume compressibility (modulus of volume change), m_v (L^2F^{-1}) - The compression of a soil layer per unit of original thickness due to a given unit increase in pressure. It is numerically equal to the coefficient of compressibility divided by 1 plus the void ratio, or $a_v/(1+e)$.

Compression index, C_c (D) - An indication of the compressibility of a homogeneous saturated soil. From a plot of the void ratio versus log pressure, a laboratory virgin compression line can be computed. The compression index is the slope of the laboratory virgin compression line.

Consolidation - The gradual decrease in volume of voids of a soil brought about under the action of a continuously acting static load over a period of time. In completely saturated soils, the process of consolidation is accompanied by the gradual expulsion of some of the water out of the soil voids with a consequent decrease in volume of the soil.

Consolidation parameters - Numerical values (parameters) obtained from the one-dimensional consolidation test that will assist in the determination of the rate of consolidation and magnitude of settlement are:

a_v - coefficient of compressibility
c_v - coefficient of consolidation
k - coefficient of permeability
m_v - coefficient of volume compressibility
C_c - compression index
OCR - overconsolidation ratio
P_c - preconsolidation pressure
r - primary compression ratio
C_s - swell index

Consolidometer - The one-dimensional consolidation test apparatus.

Deformation - The change in the original shape of a soil mass produced by a change in pressure. In one-dimensional consolidation, this is generally a plastic nonreversible movement of a soil and corresponds to the change in volume.

Percent consolidation (degree of consolidation), U (D) - The ratio, expressed as a percentage, of the amount of consolidation at a given time within a soil mass to the total amount of consolidation obtainable in that soil mass under a given pressure.

Degree of saturation, S (D) - The ratio, expressed as a percent, of the volume of water in the soil voids to the total volume of voids. At 100 percent saturation, the voids are totally filled with water.

Entrapped air - The volume of air within the soil mass which cannot normally be expelled with an increase in pressure.

Expansion - An increase in soil volume which may be caused by soil structure realinement, soil mineralogy, addition of water, or reduction in pressure.

Initial compression - During the initial application of the seating pressure, the specimen may exhibit compression or expansion. This could be caused by compression of entrapped air, distortion of structural bonds, or realinement of soil particles.

In situ virgin compression line - This straight line is determined using a graphical construction and may require at least one unload-reload cycle after the point of maximum curvature on the void ratio versus log pressure (e-log p) plot.

Laboratory compression curve - The portion of a void ratio versus log pressure curve at pressures higher than the preconsilidation pressure where the void ratio is decreasing.

Laboratory virgin compression line - The straight line portion of the void ratio versus log pressure curve (laboratory compression curve) defined at pressures that have exceeded the preconsolidation pressure.

Load, q (F) - The force applied to a test specimen.

Pressure increment - A pressure application for the period of time required for pore water pressure to reach equilibrium.

Normally consolidated - A soil mass that is at equilibrium under the existing effective overburden pressure and has not been loaded to pressures in excess of the existing effective overburden pressure.

Effective overburden pressure, P_0' (FL^{-2}) - The pressure at a point in a soil mass caused by the weight of soil and water above that point.

Overconsolidated - A soil at equilibrium under a pressure less than the preconsolidation pressure.

Overconsolidation ratio, OCR (D) - The ratio of the preconsolidation pressure to the present overburden pressure.

Phase relationships - Relationships between the three fundamental phases of a soil system: solid (mineral particles), gas (usually air), and liquid (usually water).

Preconsolidation pressure, P_c (FL^{-2}) - The maximum pressure to which a soil mass has been subjected at some time prior to performance of a consolidation test. This can be determined by analytical and/or graphical means from the void ratio versus log pressure plot.

Pressure, P (FL^{-2}) - Force per unit area. The load applied to a consolidation test specimen divided by the surface area of the specimen.

Primary compression - Compression that occurs while excess pore water pressure is dissipating. In a saturated soil, pore water is expelled due to the applied pressure and after some time the excess water has drained out. At this time, the soil reaches a state of equilibrium, and the applied pressure is carried by the soil skeleton.

Primary compression ratio, r (D) - The ratio of the void ratio change which takes place during primary compression to the total void ratio change which takes place during a specific pressure increment (primary plus secondary compression).

Rate of consolidation - The rate of consolidation under a pressure increment is represented by the coefficient of consolidation. Since the coefficient of consolidation is a function of permeability, void ratio, and compression index, it is a function of applied pressure.

Rebound - The ratio, expressed as a percentage, of the difference between the compressed height of the specimen at the maximum applied pressure and the height of the specimen when the pressure is released to the seating pressure to the difference between the compressed height of the specimen at the maximum applied pressure and the initial height of the specimen at the seating pressure. This is an indication of the elastic rebound of the soil.

Laboratory rebound curve - The portion of the void ratio versus log pressure curve from an applied compressive pressure to a pressure of less value, usually to the seating pressure.

Laboratory recompression curve - The portion of the void ratio versus log pressure curve from the seating pressure to the preconsolidation pressure. Also, during the consolidation test it may be required to perform one or more unload-reload cycles, any void ratio versus log pressure curve formed by the reapplication of pressures to a specimen is a recompression curve.

Reload cycle - The pressure increments that define recompression curves other than the initial recompression curve.

Seating pressure, (FL^{-2}) - The initial pressure on the specimen caused by a nominal load used to determine the initial height of the specimen.

Secondary compression - Plastic flow or gradual structural adjustment with time under an imposed pressure. After the excess pore water pressure generated by a pressure increment has dissipated (initial compression), compression of a specimen does not cease. Instead, it continues slowly at an ever-decreasing rate. This appears to be the result of plastic readjustment of the soil grains to the new pressure or progressive fracturing of the interparticle bonds and progressive fracturing of the particles themselves.

Settlement, ρ (L) - Downward movement of the surface of a soil strata due to consolidation of the strata.

Stress σ, P, (FL^{-2}) - Force per unit area.

Swell index, C_s (D) - The slope of the average line defining an unload-reload cycle on the e-log p plot.

Underconsolidated - Soils that have been recently deposited, either geologically or by man and that have not reached equilibrium under the existing overburden pressure, are said to be underconsolidated. The excess pore water pressure generated by the existing overburden pressure has not had time to dissipate.

Unload cycle - The pressure increments that define the rebound and recompression curves on the void ratio versus log pressure plot.

Uplift pressure - The pressure that is required to maintain a specimen at a constant volume when water is applied to the specimen.

GLOSSARY REFERENCES

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Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-822A, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.