U N I P H A S E

B A C K G R O U N D

A N D

M A N U A L

Version 2.0

for WINDOWS

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A Program for

Computing Phase Relations in Soil

written by

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1. Installation

UNIPHASE is a Microsoft Windows program and will not run outside Windows. To install UNIPHASE, place the original distribution disk in the 3.5-inch floppy drive—the A-drive or the B-drive—, go to Windows' File Manager, and run the program SETUP.EXE on the original distribution disk. The SETUP program will install, to a directory of your choice on the hard disk, UNIPHASE.EXE, the Help files, and the UNISOFT and UNIPHASE Icons.

During the installation process, the computer will request that the name of the program Licensee be entered. This name will be shown on every opening screen whenever the program is used. It will not show on the print-outs ordered through the program, though.

Installation can be speeded up by first copying over the files on the distribution disk to a directory on the hard drive and SETUP.EXE be run from this directory. For first time installation, however, the distribution (original) disk must be present in the floppy drive.

The default directory is C:\UNIPHASE, but the User can impose a different drive and directory name. The User also has the option to choose in which program group to install UNIPHASE. The group can be an existing group or a new. When no name for a program group is indicated, no UNIPHASE Icon will be placed in Windows' Program Manager (i.e., on the Task Menu). A click on the UNIPHASE Icon will start UNIPHASE. If the Icon is not installed, the User can start UNIPHASE from File Manager.

Notice, the files on the distribution disk are compressed and they can not simply be copied from the distribution disk to the UNIPHASE directory. The files must be expanded and installed by the SETUP program to work.

After completed installation, make a backup copy of the original disk and store the original distribution disk in a safe place. UNIPHASE includes no copy prevention. Therefore, a backup copy can be made using DOS commands or directly through Windows' File Manager. (**For information on license and copying rights, refer to the Preface**). Notice, to qualify for future upgrades of the program at discounted price, the distribution (original) disk must be returned for proof of right to the discount.

2. BACKGROUND

A soil mass consists of a heterogeneous collection of solid particles with voids in between. The solids are made up of grains of minerals or organic material. The voids contain water and gas. The water can be clean or include dissolved salts and gas. The gas is similar to ordinary air, sometimes mixed with gas generated from decaying organic matter. The solids, the water, and the gas are termed the three **phases** of the soil.

To aid a rational analysis of this mixture, the three phases are separated, as illustrated in Fig. 1. Soil analysis makes use of basic definitions and relations of volume, mass, density, water content, saturation, void ratio, etc., as indicated in the figure. The definitions are related and knowledge of a few will let the geotechnical engineer determine all the others.

The need for phase systems calculation arises, for example, when the engineer wants to establish the effective stress profile at a site and does not know the total density of the soil, only the water content. Or, when determining the dry density and the degree of saturation from the initial water content and total density in a Proctor test. Or when calculating the final void ratio from the measured final water content in an oedometer test.

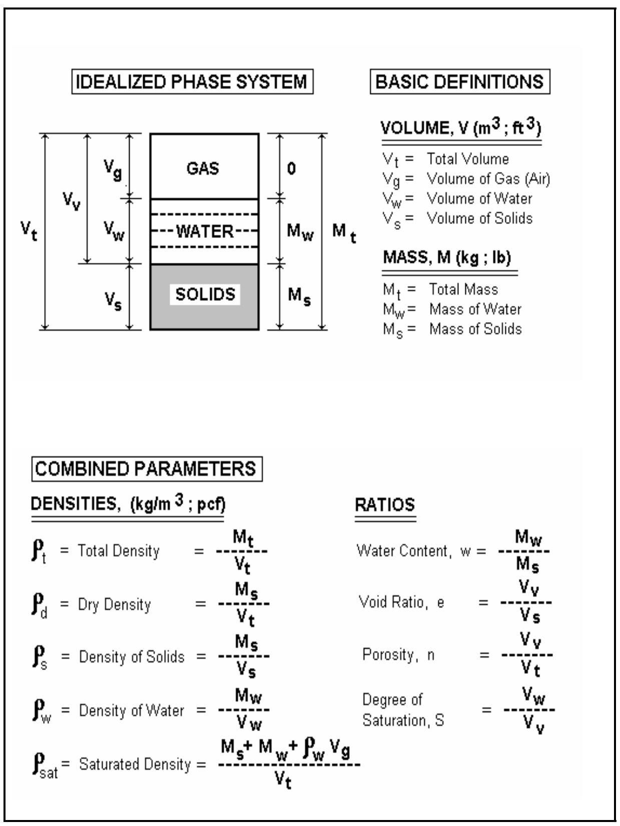

Fig. 1 The Soil Phase System

When performing phase calculations, the engineer normally knows or assumes the value of the density of the soil solids, and, often, the soil can be assumed to be fully saturated (although, most natural soils are not fully saturated even well below the groundwater table). Then, knowing one more parameter, such as the water content, all other relations can be calculated using formulae that can be found in many elementary textbooks, or be easily derived from the basic definitions and relations. However, the few textbooks that contain all the formulae required appears to have been be misplaced and that ol' crib sheet where they were written down last time they were derived seems to have disappeared. So, once again, the engineer must assign a little time to re-deriving the formulae. **UNIPHASE** is designed to eliminate all such frustrations by providing not only the formulae, but also the means to calculate all the necessary relations.

The following phase system formulae are used by **UNIPHASE**. They are similar to and derived from the definitions shown in Fig. 1

(1) $$\mathbf{S} = \frac{w}{\rho_w} \; \frac{\rho_s \rho_d}{\rho_s - \rho_d}$$

(2) $$\mathbf{w} = S \rho_w \frac{\rho_s - \rho_d}{\rho_s \rho_d}$$

(3) $$\rho_d = \frac{S \rho_w}{w + S \rho_w/\rho_s}$$

(4) $$\rho_t = \rho_d (1 + w)$$

(5) $$\rho_{SAT} = \frac{\rho_d + \rho_w}{1 - \rho_d/\rho_s}$$

(6) $$\mathbf{e} = \rho_s/\rho_d - 1$$

(7) $$\mathbf{n} = 1 - \rho_d/\rho_s$$

Starting UNIPHASE.EXE will open the screen illustrated in Figs. 2a or 2b. The screen contains three boxed areas and values exist in the areas for soil. (The values are not necessarily the same as those shown in the figures).

The cursor can be moved with the mouse or with TAB key to any data position in the two upper boxes. The direction keys are used for editing of data within a data position. The values in the third box can not be changed directly; they are "passive" and will change when a value is changed in the upper two boxes.

The upper box accepts values for density of water and density of the soil solids. Changing or the other will affect the values of dry and total densities in the middle box and the values in the bottom box. A change to any value in the middle box will not affect the two values in the upper box.

Changing the degree of saturation, the first value in the middle box, will change the value for water content and total density and produce appropriate changes to the parameters in the bottom box. The dry density will not change, however. Notice that UNIPHASE will not accept input of a degree of saturation that is larger than 100 percent.

Changing the water content will change all values below this data box, but none above. Notice, UNIPHASE will not accept a water content input that is equal to zero percent.

Changing the dry density will change all values below this data box, but none above. Notice, UNIPHASE will not accept a value for dry density that is larger than that of the solid density.

Changing the total density will change the degree of saturation and the dry density, but the water content will not change. All values in the third box will change. Notice that a total density value may be input that makes UNIPHASE calculate a degree of saturation that is larger than 100 %. This is of course, not physically possible and UNIPHASE will alert the User to this occurrence. To correct, go to the input for degree of saturation and input a value of 100 % or smaller. The total density for this degree will be displayed.

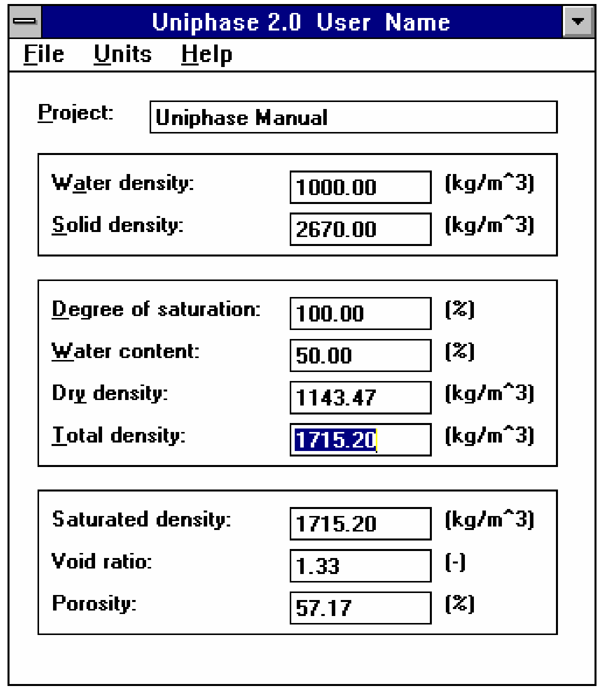

Fig. 2a. Example of UNIPHASE screen SI-units

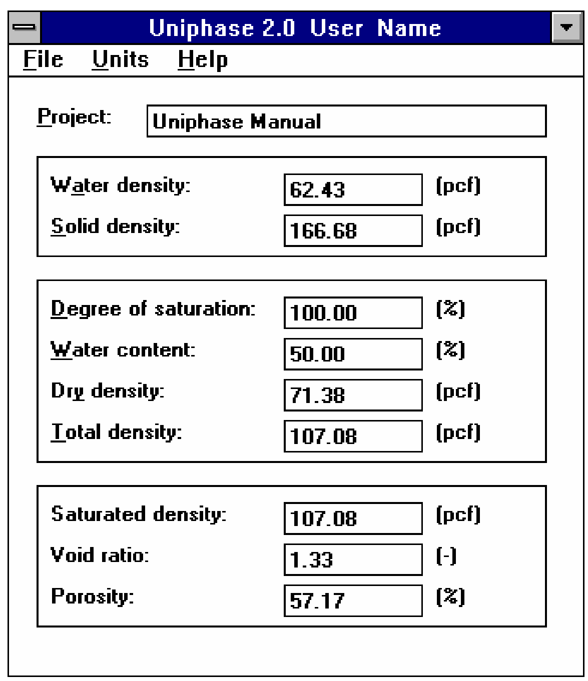

Fig. 2b. Example of UNIPHASE screen English units

CHANGING THE SYSTEM OF UNITS

The system of units can be toggled between English units and metric units (SI-units) by moving the cursor to the Command Line and clicking on "**Units**".

PRINTING

The **File/Print to Printer** command will print out the screen. The **File/Print to File** command will send the UNIPHASE screen as a text file (*.txt) to the User designated directory for later import to a word processing document.

SAVING

Data files are not saved (nor created) by UNIPHASE.

EXITING

To quit the program, engage the **File/Exit** command. Notice, because the screen data are not saved, exiting will result in immediate action with no second change.

HELP

Clicking on **Help/Contents**
will call up a contents sensitive help file similar to Windows help files.

USER TIPS

When a User working in a Windows program, say, UNIPILE, needs assistance from UNIPHASE to determine the total density input, UNIPHASE can be called to the front by CTRL+ESC, and a click on the UNIPHASE Icon. The UNIPHASE screen will superimpose on the first program (UNIPILE, in this case). When the calculation is completed, a click outside the UNIPHASE frame will return the computer to the first program.

When working in UNIPILE or some other geotechnical program where input is total density, the User normally knows the water content and has a good feel for the dry density. The total density value is then the result of the UNIPHASE calculation. When the User compiles the result of a oedometer test, the water content and the total density values are normally the input and UNIPHASE is used to determine the degree of saturation, and the void ratio. Notice that while most quarts clays can be assumed to made up of particles with a solid density of 2,650 kg/m^3 (165 pcf), other clay types can differ. For example, calcareous clays can have a solid density of 2,900 kg/m^3 (180 pcf).

The density of water is usually 1,000 kg/m^3. However, temperature and, especially, salt content can change this value by a few percentage points.

Organic materials may have a solid density that is much smaller than inorganic material. Therefore, when soils contain organics, the average solid density may have to be reduced.

Soil is made up of rock material and the solid density varies between what minerals that make up the rock. The following table lists some values of solid density for rocks of different mineral origins.

Mineral Type	Solid Density kg/m^3	Solid Density pcf
Amphibole	≅3,000+	190
Calcite	2,800	180
Quartz	2,670	165
Mica	2,800	175
Pyrite	5,000	310
Illite	2,700	170

(The need for listing the densities in both units could have been avoided by giving the densities relative the density of water, which is called "relative density" in modern international terminology and "specific gravity" in old, now abandoned terminology. However, the authors could not resolve the conflict of what of the two terms to use; either the correct term which many Users would misunderstand, or the incorrect term, which all understand, but showing ignorance. Shifting to a homemade term such as "specific density", which sometimes pops up in the literature, would not have made the choice more palatable.)

Depending on the soil void ratio and degree of saturation, the total density of soils can vary within wide boundaries. The following table lists some representative values of total saturated density for some typical soils.

Soil Type	Saturated Density Metric (SI) units kg/m^3
Sands; gravels	1,900 - 2,300
Silts	1,500 - 1,900
Soft clays	1,300 - 1,800
Firm clays	1,600 - 2,100
Glacial till	2,100 - 2,400
Peat	1,000 - 1,200
Organic silt	1,200 - 1,900
Granular fill	1,900 - 2,200

Soil Type	Saturated Density English units pcf
Sands; gravels	118 - 144
Silts	95 - 118
Soft clays	80 - 112
Firm clays	100 - 130
Glacial till	130 - 150
Peat	62 - 75
Organic silt	75 - 118
Granular fill	118 - 137