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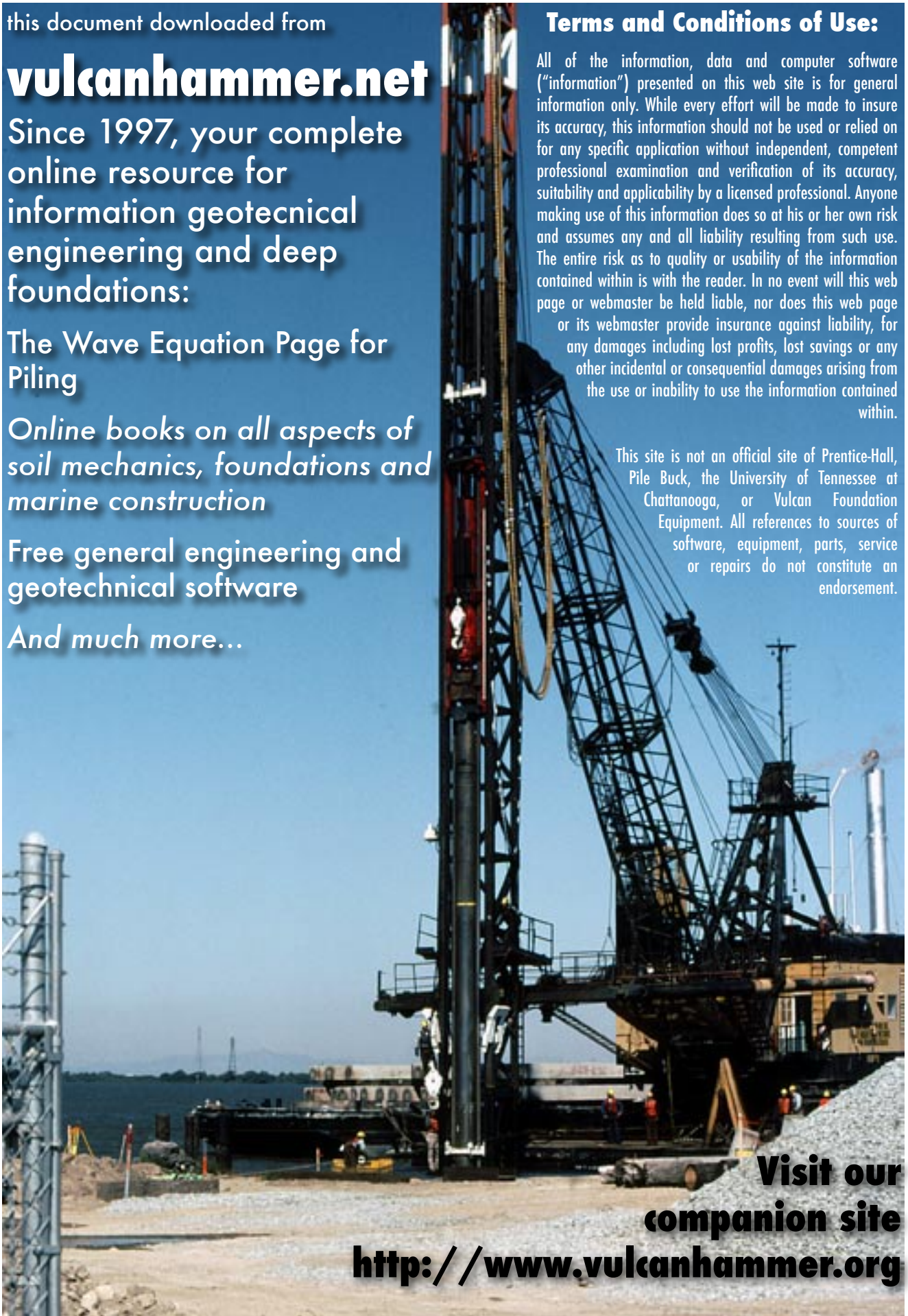
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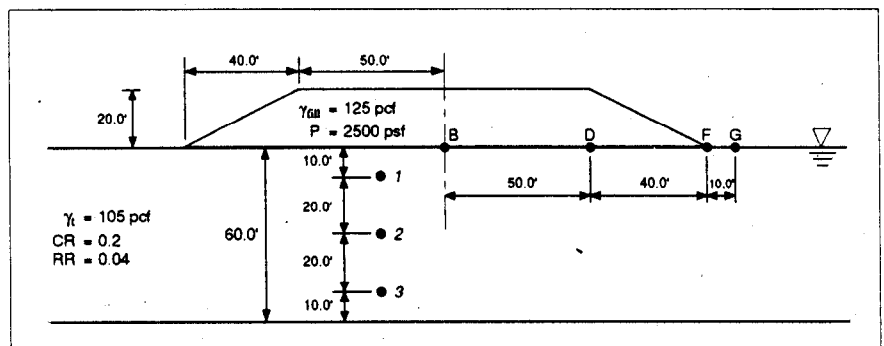
Publication No. FHWA-SA-92-045

May 1993

GEOTECHNOLOGY

EMBANK

A Microcomputer Program to Determine One-Dimensional Compression Settlement Due to Embankment Loads



User's Manual

Office of Engineering
Office of Technology Applications
400 Seventh Street, SW.
Washington, D.C. 20590



Innovation Through Partnerships

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1. Report No. FHWA-SA-92-045		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle EMBANK: A Microcomputer Program to Determine One-Dimensional Compression Settlement Due to Embankment Loads				5. Report Date	
				6. Performing Organization Code	
7. Author(s) Dr. Alfredo Urzua				8. Performing Organization Report No.	
9. Performing Organization Name and Address PROTOTYPE Engineering Inc. 57 Westland Avenue Winchester, MA 01890				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. DTFH61-91-P-01097	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Office of Technology Applications Washington, DC 20590				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes FHWA Contracting Officer's Technical Representative: Chien-Tan Chang (HRT-10) Technical Consultants: Richard Cheney, Jerry A. DiMaggio, Chris Dumas (HNG-31)					
16. Abstract The objective of this report is to introduce a microcomputer program for computing one-dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973), and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading, the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program internally superimposes a series of 10 rectangular loads to create the end-of-fill condition. The report presents the equations and analytical procedures utilized by the program and examples of the capabilities of the user-friendly data entry form. The computer program is coded in the Turbo Pascal 4.0 language and takes full advantage of the stand-alone, (single-user) characteristics of the IBM-PC through the use of "friendly" input menus and data-checking routines. The code implements copyrighted portions of the microcomputer programs SAF-I and STRESS developed by PROTOTYPE Engineering, Inc., Winchester, MA, and uses the screen editor Turbo Magic from Sophisticated Software.					
17. Key Words embankment, settlement, vertical stress, one-dimensional, compression, void ratio			18. Distribution Statement No restrictions. This document is available to the public through the MCTrans Support Center, University of Florida		
19. Security Classification (of this report) Unclassified		20. Security Classification (of this page) Unclassified		21. No. of Pages	
				22. Price	

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EMBANK

A Microcomputer Program to Determine One-Dimensional Compression Settlement Due to Embankment Loads

Introduction

An important part of the design of embankment foundations are analyses to predict settlements. When settlements or differential settlements exceed given tolerances, the overall safety and/or functionality of the structures may be endangered.

The objective of this report is to introduce a microcomputer program for computing one-dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973), and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading, the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program internally superimposes a series of 10 rectangular loads to create the end-of-fill condition.

The report presents the equations and analytical procedures utilized by the program and examples of the capabilities of the user-friendly data entry form. The computer program is coded in the Turbo Pascal 4.0 language and takes full advantage of the stand-alone (single-user) characteristics of the IBM-PC through the use of "friendly" input menus and data-checking routines.

The code implements copyrighted portions of the microcomputer programs SAF-I and STRESS developed by PROTOTYPE Engineering, Inc., Winchester, MA., and uses the screen editor Turbo Magic from Sophisticated Software.

One-Dimensional Compression

"One-dimensional compression" refers to situations where ground settlement occurs exclusively due to vertical straining of the soil mass, that is, when there are no lateral strains. Geologic processes of uniform loading and/or unloading of large areas of soil are good examples of one-dimensional compression conditions. While these conditions are rarely perfectly encountered, reasonable approximations occur when the foundations are large in relation to the soil thickness or when the points of interest for settlement computations are far from the edges of the loaded areas.

For the most general case of an elastic medium of finite thickness H , as depicted in figure 1, the vertical deformation of an element at a distance z under the surface is given by

$$\delta\rho = \varepsilon(z) \delta z \quad (1)$$

where $\varepsilon(z)$ describes the variation of vertical strain with depth.

The total deformation is given by:

$$\rho = \int_0^H \varepsilon(z) \delta z \quad (2)$$

When a discrete variation of vertical strain versus depth can be established and the compressible material can be divided in sublayers, within which the strain levels remain constant, equation [2] becomes

$$\rho = \sum_{i=1}^n \Delta H_i = \sum_{i=1}^n \epsilon_i H_i \quad (3)$$

in which:

ΔH_i = thickness change of sublayer i
 H_i = initial thickness of sublayer i
 ϵ_i = vertical strain in sublayer i
 n = number of sublayers

Equations (1) through (3) are valid for any kind of material where deformation is proportional to strain. In the particular case of soil, which is a multi-phase material, vertical strains under one-dimensional compression conditions are the result of changes in the void ratio (e), so that

$$\epsilon_i = \frac{\Delta H_i}{H_i} = \frac{\Delta e_i}{1 + e_{0i}} \quad (4)$$

in which:

Δe_i = change in void ratio for sublayer i = $e_{fi} - e_{0i}$
 e_{fi} = final void ratio for sublayer i
 e_{0i} = initial void ratio for sublayer i

Equation (3) then becomes:

$$\rho = \sum_{i=1}^n \Delta H_i = \sum_{i=1}^n H_i \frac{\Delta e_i}{1 + e_{0i}} \quad (5)$$

Soil Model

Equations (3) and (5) are valid for estimating one-dimensional compression settlements of any kind of soil, cohesive or cohesionless, provided a relationship between stress and strain or void ratio can be established. Such a relationship can be determined by running oedometer tests on representative undisturbed soil samples. Figure 2 (Ladd 1973) shows a typical compression curve from oedometer test results, where values of void ratio are plotted versus vertical effective stress on a semi-log scale. A bilinear model is regularly adopted to approximately represent the void ratio versus vertical effective stress relationship for a loading condition. The linear portions of the model are represented by:

C_c = compression index
 C_r = recompression index

For cases of one-dimensional unloading or reduction of vertical effective stresses, the relationship can be represented by a third parameter, C_s = Swelling Index. In most cases the values of C_r and C_s are very similar.

The maximum past pressure, $\bar{\sigma}_{vm}$, can be understood as a “yield stress,” which establishes the limit between the recompression and virgin regions. Overconsolidated (OC) soils are those where the in situ overburden effective stress, $\bar{\sigma}_{v0}$, is smaller than $\bar{\sigma}_{vm}$. The ratio

$$\bar{\sigma}_{vm}/\bar{\sigma}_{v0} = OCR$$

is called the Overconsolidation Ratio. For Normally Consolidated (NC) soils, $OCR = 1$.

Figure 3 (Ladd 1973) shows a compression curve from oedometer test results where values of vertical strain versus vertical effective consolidation stress are plotted on a semi-log scale. In this case the model is described by the Virgin Compression Ratio (CR), the Recompression Ratio (RR), and the Swelling Ratio (SR). The following relationships exist between these parameters and the Virgin Compression, Recompression, and Swelling indices, C_c , C_r , and C_s , respectively,

$$CR = \frac{C_c}{(1 + e_0)} \quad (6a)$$

$$RR = \frac{C_r}{(1 + e_0)} \quad (6b)$$

$$SR = \frac{C_s}{(1 + e_0)} \quad (6c)$$

where e_0 is the initial void ratio.

Determination of Changes in Void Ratio

The values of $\Delta e = e_{fi} - e_{0i}$ to input in equation (5) depend on the final stress level within each sublayer. If $\bar{\sigma}_{vf}$ does not exceed $\bar{\sigma}_{vm}$, the reduction in void ratio for the soil in sublayer i is:

$$\Delta e_i = e_{fi} - e_{0i} = C_r \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right) \quad (7)$$

If the final stress $\bar{\sigma}_{vf}$ is greater than $\bar{\sigma}_{vm}$, the value of Δe_i is:

$$\Delta e_i = e_{fi} - e_{0i} = C_r \log \left(\frac{\bar{\sigma}_{vm}}{\bar{\sigma}_{v0}} \right) + C_c \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{vm}} \right) \quad (8)$$

When unloading (reduction of effective stresses) occurs, the void ratio increases and the soil swells. The increment in void ratio is

$$\Delta e_i = e_{fi} - e_{0i} = -C_s \log \left(\frac{\bar{\sigma}_{v1}}{\bar{\sigma}_{v2}} \right) \quad (9)$$

where the difference $\bar{\sigma}_{v2} - \bar{\sigma}_{v1}$ represents the effective stress reduction.

Determination of Vertical Strains

Equation (3) can be used to evaluate the soil deformations. The expressions for vertical strains for a given sublayer can be obtained from equations (4), (6a), and (6b).

When $\bar{\sigma}_{vf}$ does not exceed $\bar{\sigma}_{vm}$, the vertical strain is:

$$\varepsilon_i = RR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right) \quad (10)$$

If the final stress $\bar{\sigma}_{vf}$ is greater than $\bar{\sigma}_{vm}$, the vertical strain is:

$$\varepsilon_i = RR \log \left(\frac{\bar{\sigma}_{vm}}{\bar{\sigma}_{v0}} \right) + CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{vm}} \right) \quad (11)$$

For unloading conditions the vertical strain is

$$\varepsilon_i = -CS \log \left(\frac{\bar{\sigma}_{v1}}{\bar{\sigma}_{v2}} \right) \quad (12)$$

where $\bar{\sigma}_{v2} - \bar{\sigma}_{v1}$ is the reduction in effective stress.

Determination of Vertical Stress

To use equations (6) through (12), the program must compute the increments of vertical stress as a function of depth for the following two types of loads.

Strip Symmetrical Embankment Loading

Poulos and Davis (1974) present an equation for the increment of vertical stresses due to a vertical "embankment" loading on the surface of a semi-infinite mass

$$\sigma_z = \frac{p}{\pi} \left(\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right) \quad (13)$$

where the parameters are defined in figure 4.

For symmetrical embankment loading, the load is divided into two equal vertical embankment components, and the contributions of both are added (see figure 5).

End of Embankment Loading

To compute the increment of vertical stresses due to an end-of-embankment condition, EMBANK superimposes a series of 10 flexible rectangular loads. Figure 6 shows the superposition scheme.

If the end of the embankment is modeled as shown in figure 7a, then the coordinates that determine the size of each of the rectangular loads are given by the expressions in figure 7b. The value $y_{\max} = y_1 + 10b_2$ is internally defined in the program.

The user must select the Strip Symmetrical Embankment loading option to compute increments of vertical stress for points beyond $y = y_1 + 5b_2$.

For a rectangular load the increment of vertical stress beneath the corner of the loaded area is (Poulos and Davis 1974)

$$\sigma_z = \frac{p}{2\pi} \left[\arctan \left(\frac{lb}{zR_3} \right) + \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right) \right] \quad (14)$$

where the parameters are defined in figure 8.

Figure 9 shows the application of the superposition principle for points inside and outside rectangular loaded areas. For the end-of-fill condition, a series of similar superposition schemes are applied for each one of the 10 rectangular loads.

Interactive Data Entry and Output Results

Input screens and menus are employed to enter the necessary data for the analysis. An input screen consists of a graphical display defining the data to be entered and an area to query the user for the data. Menus are used to select the entry of optional data and to control program operation. The output of the program is compact but complete. It includes an echo print of the input data (embankment geometry, soil parameters, etc.) and the computed total settlement. The output screens also include distributions of effective, increment, and maximum past pressure stresses and settlement with depth.

Appendix A contains a compilation of all the EMBANK computer screens. Appendix B contains four sample runs with hand computations, showing copies of the actual input screens, menus, and output result screens used by the program for each one of the four examples.

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Ladd, C.C. (1973), "Estimating Settlement of Structures on Cohesive Soils," Presentation prepared for the Foundations and Soil Mechanics Division of the ASCE, April 9-10, 1973.

Lambe, T.W. and Whitman, R.V. (1969), Soil Mechanics, John Wiley and Sons, New York.

Poulos, H.G. and Davis, E. H. (1978), Elastic Solutions for Soil and Rock Mechanics, John Wiley and Sons, New York.

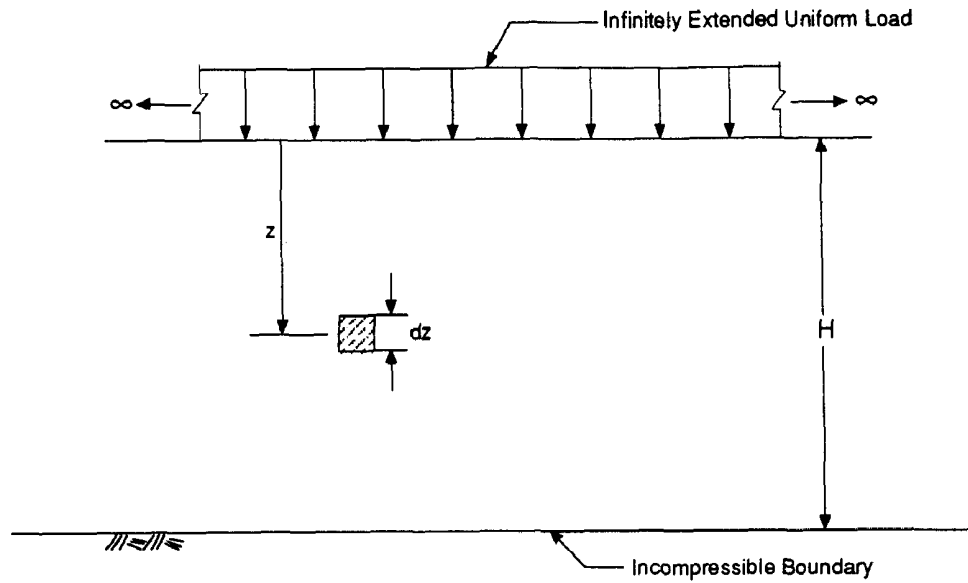


Figure 1. Elastic medium under one-dimensional compression

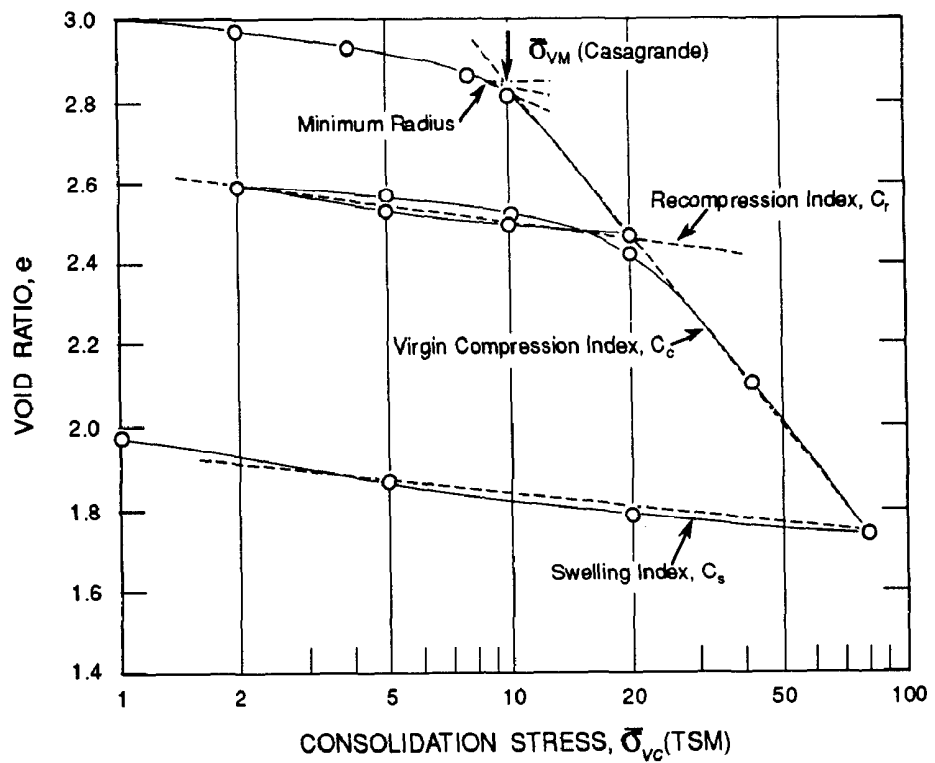


Figure 2. Compression curve and compressibility parameters void ratio vs. consolidation stress (Ladd 1973)

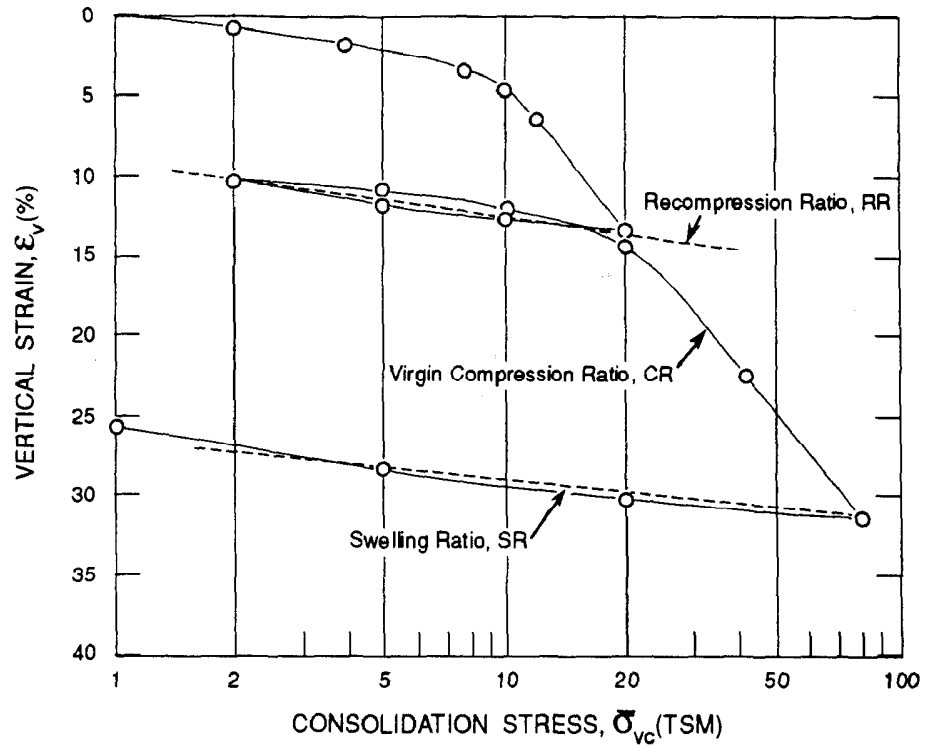


Figure 3. Compression curve and compressibility parameters
vertical strain vs. consolidation stress (Ladd 1973)

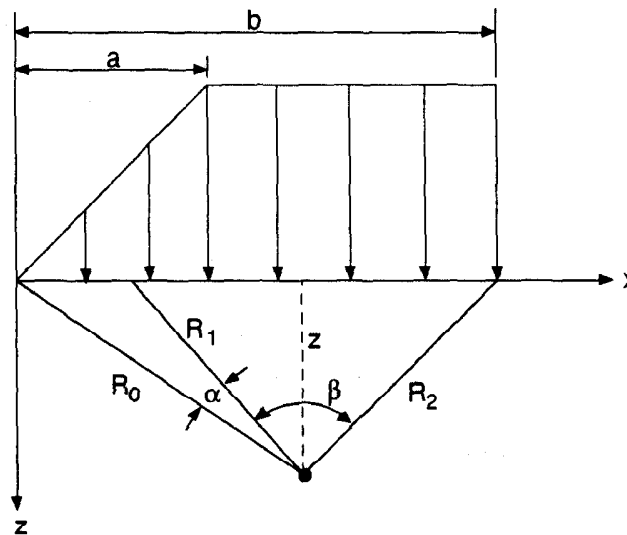


Figure 4. Embankment loading and parameters
(Poulos & Davis 1974)

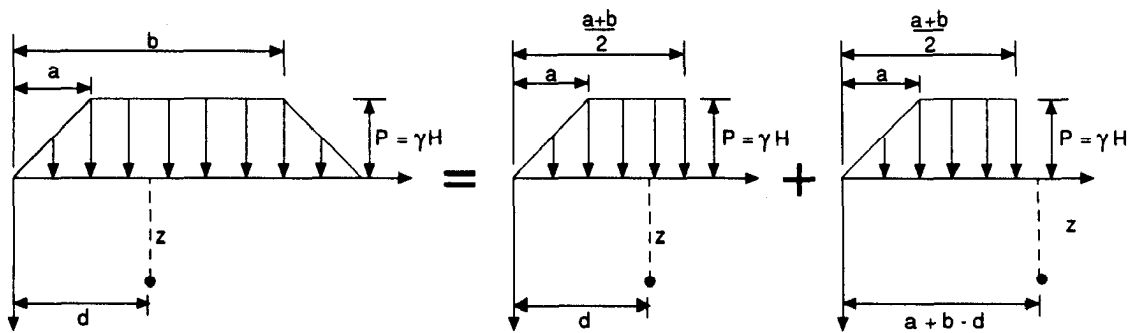


Figure 5. Superposition scheme for symmetrical embankment loading

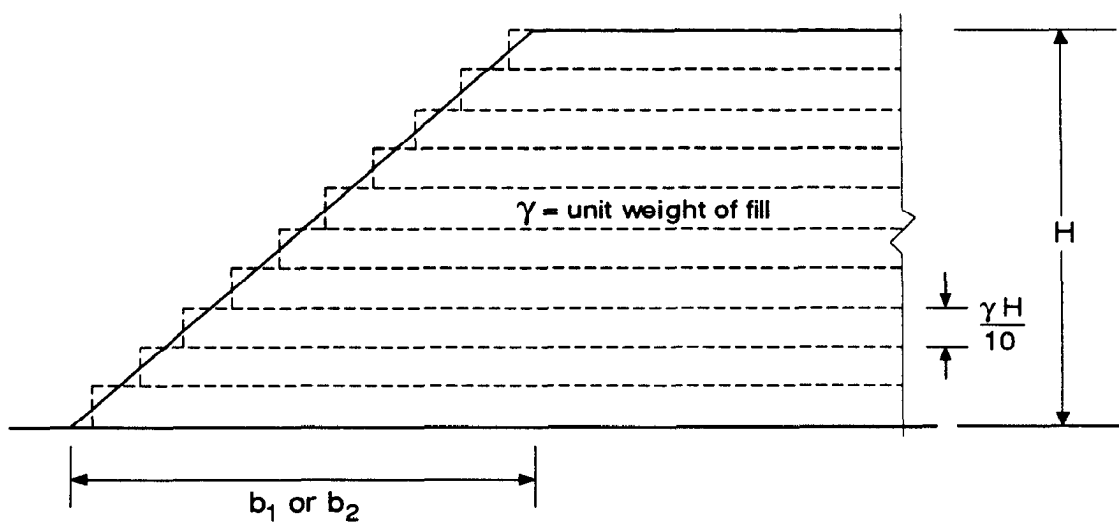


Figure 6. Superposition scheme to model end of embankment loading

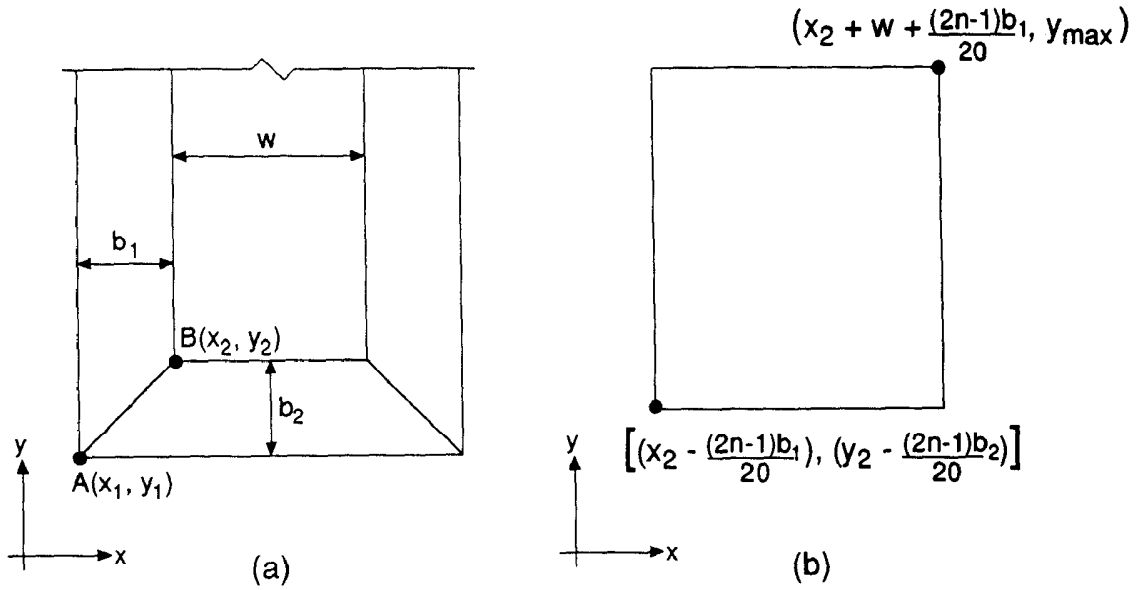


Figure 7. Transformation of end of embankment to equivalent rectangular loads

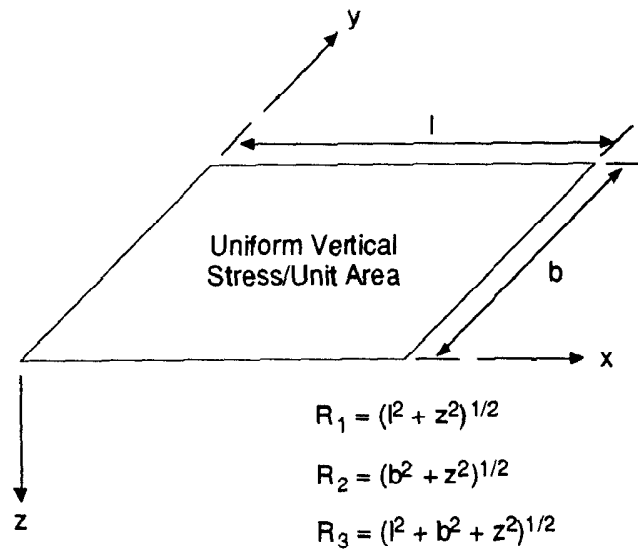
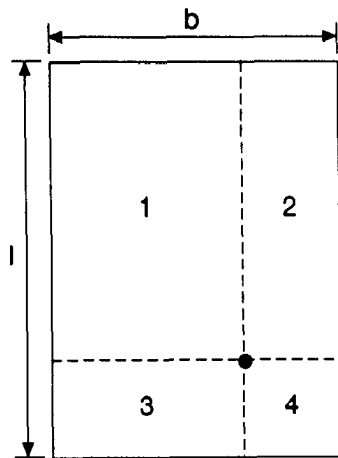
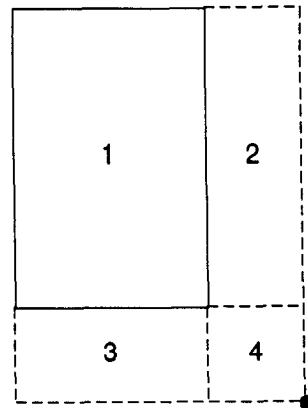


Figure 8. Parameters for the determination of increments of vertical stress under the corner of a rectangular load



$$\sigma = p (k_1 + k_2 + k_3 + k_4)$$

(a) Interior Point



$$\sigma = p (k_{1+2+3+4} - k_{2+4} - k_{3+4} + k_4)$$

(b) Exterior Point

Figure 9. Superposition scheme to determine increments of vertical stress at any point under a rectangular load

Appendix A

Appendix A contains a compilation of the EMBANK program screens.

To bring up EMBANK, first move to the directory or subdirectory where you have installed the program. Then type the following at the DOS prompt

EMBANK

and press the <Return/Enter> key.

EMBANK loads and returns the opening screen as shown below:

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
Version 2.00/October 1991	Hit <F10> to continue

From the opening screen, press the <F10> key to continue. EMBANK displays the Main Menu screen showing all the options available to the user:

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	
Enter letter only, or use arrows then <J> > Make selection.	

In general, the following rules apply:

1. To move between the options, use the up (↑) and down (↓) arrow keys or press the highlighted capital letter of your selection. EMBANK will select the option with that letter.
2. To make a selection, highlight the option of your choice and hit <Return/Enter>.
3. The bottom line of each EMBANK screen explains the operations you can perform and the keys required to perform those operations.
4. To exit a screen or to abort to the Main Menu, press the <ESC> key.

With the highlight on the "Project Definition" field, hit <Enter/Return>; EMBANK responds with the Project Definition screen:

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition
	PROJECT DEFINITION Client = Any client Project Name = Highway Embankment Project Manager = Mr. John Doe File Name = EXAMPLE1.EMB Date = 3/16/92 (MM/DD/YY) Computed by = AUM
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Hit <F10> to accept values ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

After the project is defined, press <F10> to accept the values. EMBANK returns to the Main Menu screen. (It is important to note that EMBANK functions even if the Project Definition values—Client, Project Name, etc.—are not entered.)

If the user selects "soil Profile and soil param.," EMBANK displays the following screen:

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. soil Profile and soil param. Void ratio per Δlog stress Strain per Δlog stress
	Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection. <Esc> $\rightarrow$ Main Menu

The compressibility of the soil can be expressed either as void ratio or strain per $\Delta \log$ stress. With the highlight on "Void ratio per $\Delta \log$ stress," press <Enter/Return>. EMBANK displays the soil profile input screen:

FEDERAL HIGHWAY ADMINISTRATION

Layer Number = 1

Sublayer 1

Sublayer n

Sublayer 1

Sublayer 2

Elev. of top of layer = 100.00

Number of sublayers = 1 (for this layer)

Unit weight of soil = 115.00

Type of layer = **Compressible**

Layer soil properties = **Compressible**

Compression Index Estl **Incompressible** curves

Recompression Index Estimated from e-logp curves

Swelling Index Estimated from e-logp curves

Is this the last layer of profile No

Hit <F10> to continue

←f1→-Move bar ↓-Select Esc-Exit

The elevation of the top of layer 1 can be between -999.00 and 9999.00 ft.; the compressible layers can be divided into 1 to 10 sublayers; and the value of the total unit weight of the soil ranges between 62.4 and 250.0 pcf.

EMBANK accepts two types of layers: compressible (it settles) and incompressible. If the user highlights "Incompressible" followed by <Enter/Return>, EMBANK returns the following screen:

FEDERAL HIGHWAY ADMINISTRATION

Layer Number = 1

Sublayer 1

Sublayer n

Sublayer 1

Sublayer 2

Elev. of top of layer = 100.00

Number of sublayers = 1 (for this layer)

Unit weight of soil = 115.00

Type of layer = Incompressible

Is this the last layer of profile **No**

Hit <F10> to continue

Space Bar-Next item Alt-M-Menu

For incompressible layers, the compressibility parameters are not required. The user selects the Compressible/Incompressible option by pressing the space bar key or the Alt-M key combination to display the menu options.

If the soil layer is compressible, the program prompts the user for the "Initial void ratio" or the "Initial water content."

The next screen shows the user options:

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 100.00
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 115.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 1	Compression Index Esti Initial void ratio
Sublayer 2	Recompression Index Esti Initial water content
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F10> to continue	
Press space bar to see menu options and then <Ret> to input values	

EMBANK uses the following equation between void ratio and water content: $G_w = S_e$.

When <Enter/Return> at the "Initial void ratio" highlight is pressed, the program responds:

FEDERAL HIGHWAY ADMINISTRATION	
Layer Soil Properties	
Initial Void Ratio = 1.00	f layer = 100.00
Hit <F10> to accept values	
:	ayers = 1 (for this layer)
Sublayer n	Unit weight of soil = 115.00
Sublayer 1	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 2	Compression Index Estimated from e-logp curves
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F10> to continue	

The program allows for void ratios between 0 and 5.0.

On the other hand, if the user selects "Initial water content," EMBANK displays the following screen:

Layer Soil Properties		ADMINISTRATION	
Initial Water Content	= 35.00%		
Specific Gravity of Solids	= 2.65	layer	= 100.00
Degree of Saturation	= 100.00%	yers	= 1 (for this layer)
Hit <F10> to accept values		soil	= 115.00
Sublayer n	1	Type of layer	= Compressible
Sublayer 1		Layer soil properties	= Initial water content
Sublayer 2	Layer 2	Compression Index	Estimated from e-logp curves
		Recompression Index	Estimated from e-logp curves
		Swelling Index	Estimated from e-logp curves
		Is this the last layer of profile No	
Hit <F10> to continue			

The values of initial water content can range between $w = 0\%$ to 900% .

During data entry, the user can exit to the Main Menu by pressing the <ESC> key. EMBANK responds with the following display:

Layer Soil Properties		ADMINISTRATION	
Initial Water Content	= 35.00%		
Specific Gravity of Solids	=	Verify	= 100.00
		Abort <Y/N>?	
Degree of Saturation	= 100.00%	yers	= 1 (for this layer)
Hit <F10> to accept values		soil	= 115.00
Sublayer n	1	Type of layer	= Compressible
Sublayer 1		Layer soil properties	= Initial water content
Sublayer 2	Layer 2	Compression Index	Computed using FHWA(1982)
		Recompression Index	Computed using FHWA(1982)
		Swelling Index	Same as recompression index
		Is this the last layer of profile No	
Hit <F10> to continue			

A "Y" answer will return the program to the Main Menu without saving the screen information. If the user selects "N," the program continues.

The next step is to define the compressibility indices. For the Compression Index, the user has the option of entering a value as obtained in an oedometer test or using an empirical relationship between C_c and the initial water content proposed by FHWA in the *Soils and Foundations Workshop Manual* (1982). The following screen displays the options:

Layer Soil Properties		ADMINISTRATION
Layer Number = 1	Elev. of top of layer = 100.00	
Sublayer 1	Number of sublayers = 1 (for this layer)	
:	Unit weight of soil = 115.00	
Sublayer n	Type of layer = Compressible	
Sublayer 1	Layer soil properties = Initial water content	
Sublayer 1	Compression Index	Estimated from e-logp curves
Sublayer 2	Recompression Index	Estimated from e-logp curves
	Swelling Index	Computed using FHWA(1982)
Is this the last layer of profile No		
Hit <F10> to continue		
Press space bar to see menu options and then <Ret> to input values		

These two options are available to the user only if the "Initial water content" option is selected. If "Initial void ratio" is highlighted, the compression indices can not be computed using the FHWA (1982) procedure.

If the user selects "Estimated from e-logp curves," EMBANK responds

		ATION
Input Value of Compression Index = .35		
Hit <F10> to accept value		100.00
Sublayer 1	Number of sublayers = 1 (for this layer)	
:	Unit weight of soil = 115.00	
Sublayer n	Type of layer = Compressible	
Sublayer 1	Layer soil properties = Initial water content	
Sublayer 1	Compression Index	Estimated from e-logp curves
Sublayer 2	Recompression Index	Estimated from e-logp curves
	Swelling Index	Estimated from e-logp curves
Is this the last layer of profile No		
Hit <F10> to continue		

where the values of the Compression Index can vary between 0 and 5.0.

If the FHWA (1982) empirical procedure is selected, EMBANK shows

Compression Index	
The Federal Highway Administration (FHWA) in the soil and Foundations Workshop Manual (1982) estimates the Compression Index by dividing the initial soil moisture content by 100. Comp. Index = Initial Water Content (in %) / Constant where constant = 100 Constant = 100 Hit <F10> to accept value	
----- Layer 2 Sublayer 2	Compression Index Computed using FHWA(1982) Recompression Index Estimated from e-logp curves Swelling Index Estimated from e-logp curves Is this the last layer of profile No Hit <F10> to continue

where the constant can vary between 0 and 200 with a default value of 100.

For the Recompression Index the user has the same two options as for the Compression Index:

Compression Index	
Layer Number = 1 Sublayer 1 ----- Sublayer n Sublayer 1 ----- Sublayer 2	Elev. of top of layer = 100.00 Number of sublayers = 1 (for this layer) Unit weight of soil = 115.00 Type of layer = Compressible Layer soil properties = Initial water content Compression Index Computed using FHWA(1982) Recompression Index Estimated from e-logp curves Swelling Index Estimated from e-logp curves Computed using FHWA(1982) Is this the last lay Hit <F10> to continue Press space bar to see menu options and then <Ret> to input values

If the "Estimated from e-logp curves" option is selected, the program displays

Input Value of Recompression Index = 0.035	
Hit <F10> to accept value 100.00	
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 115.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
-----	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F10> to continue	

where the Recompression Index can vary between 0.0 and 5.0.

If the FHWA (1982) method is selected, the program shows the following screen

Recompression Index	
The Federal Highway Administration (FHWA) in the soils and Foundations Workshop Manual (1982) estimates the Recompression Index by dividing the initial soil moisture content by 1000.	
Recomp. Index = Initial Water Content (in %) / Constant where Constant = 1000	
Constant = 1000	
Hit <F10> to accept values	
Sublayer 2	Layer 2
	Compression Index Computed using FHWA(1982)
	Recompression Index Computed using FHWA(1982)
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F10> to continue	

in which the constant can vary between 500 and 2000 with a default value of 1000.

For the Swelling Index, EMBANK has two options as displayed in the next screen:

Recompression Index	
Layer Number = 1	Elev. of top of layer = 100.00
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 115.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
:	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Computed using FHWA(1982)
	Swelling Index Estimated from e-logp curves
	Is this the last layer Estimated from e-logp curves Same as recompression index

Press space bar to see menu options and then <Ret> to input values

If the user selects "Estimated from e-logp curves" the program shows

Input Value of Swelling index = 0.035	
Hit <F10> to accept value 100.00	
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 115.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
:	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Computed using FHWA(1982)
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F10> to continue	

where the Swelling Index can vary between 0 and 2.0.

The other option is to select the Swelling Index as having the same value as the Recompression Index (common engineering practice).

The next step is to define the end of the soil profile. If layer i is not the last layer of the soil profile, the user responds "NO" to this entry. EMBANK displays the following screen:

Layer Number = 1		Elev. of top of layer = 100.00
Sublayer 1	Layer 1	Number of sublayers = 1 (for this layer)
:		Unit weight of soil = 115.00
Sublayer n	Layer 2	Type of layer = Compressible
Sublayer 1		Layer soil properties = Initial water content
Sublayer 2		Compression Index Computed using FHWA(1982)
		Recompression Index Computed using 982
		Swelling Index Same as recomp No Yes index
		Is this the last layer of profile N
Hit <F10> to continue		
←F1→-Move bar ←-Select Esc-Exit		

After<F10> is pressed to continue, EMBANK displays the following input screen for layer 2:

Layer Number = 2		Elev. of top of layer = 110.00
Sublayer 1	Layer 1	Number Too Large --> Upper Bound: 99.99
:		Unit weight of soil = 0.00
Sublayer n	Layer 2	Type of layer = Compressible
Sublayer 1		Layer soil properties = Initial void ratio
Sublayer 2		Compression Index Estimated from e-logp curves
		Recompression Index Estimated from e-logp curves
		Swelling Index Estimated from e-logp curves
		Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue		

For layer 2 the elevation of the top of the layer must be smaller than the elevation of the top of layer 1. If the user inputs an elevation for layer i+1 greater than that for layer i, EMBANK traps the error as shown above. The <F9> key permits the user to return to the previous layer.

The user inputs the information for layer 2 (layer 3, etc.) in the same manner as for the first layer. If layer i is the last layer of the profile, the user answers "Yes" to the last question as follows:

Layer Number = 2		Elev. of top of layer = 80.00
Sublayer 1		Number of sublayers = 5 (for this layer)
:	Layer 1	Unit weight of soil = 120.00
Sublayer n		Type of layer = Compressible
Sublayer 1	Layer 2	Layer soil properties = Initial void ratio
Sublayer 1		Compression Index Estimated from e-logp curves
Sublayer 2		Recompression Index Estimated from e-logp curves
		Swelling Index Estimated from e-logp curves
		Is this the last layer of profile Yes
Hit <F9> to Prev. Layer		Hit <F10> to continue
Space Bar-Next item		Alt-M-Menu

The last step is to define the elevation of the bottom of the last layer of the soil profile. EMBANK displays the following screen:

Layer Number = 2		Elev. of top of layer = 80.00
Sublayer 1		Number of sublayers = 5 (for this layer)
:	Layer 1	Elev. of bottom of last layer = 60.00
Sublayer n		Hit <F10> to accept value
Sublayer 1	Layer 2	Compression Index Estimated from e-logp curves
Sublayer 1		Recompression Index Estimated from e-logp curves
Sublayer 2		Swelling Index Estimated from e-logp curves
		Is this the last layer of profile Yes
Hit <F9> to Prev. Layer		Hit <F10> to continue

Press <F10> to continue and return EMBANK to the Main Menu screen.

If the user highlights "Strain per Δ log stress" in the soil Profile and soil param. menu, EMBANK displays the following soil profile input screen

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 100.00
Sublayer 1	Number of sublayers = 5 (for this layer)
-----	Unit weight of soil = 115.00
: Layer 1	Type of layer = Compressible
Sublayer n	Compression Ratio = 0.200
-----	Recompression Ratio = 0.040
Sublayer 1	Swelling Ratio = User defined
-----	Is this the last layer 0
Sublayer 2	User defined
	Same as Recomp. Ratio
H1	

←F1→Move bar ←Select Esc-Exit

in which the compressibility parameters are defined in terms of strain versus $\Delta \log$ stress. The input to this screen is similar to the one for void ratio versus $\Delta \log$ stress.

After the elevation of the bottom of the last layer is entered, EMBANK returns to the Main Menu the <F10> key is pressed.

If the user selects "Water table definition," EMBANK shows the water table definition input screen:

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for one-dimensional compression due to embankment load the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads. Main Menu - project Definition - soil Profile and soil param. Water table definition - Stress history - Vertical stress increment	
Water Table Definition Elev. of Water Table = -999.90 Hit <F10> to accept values	
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EMBANK defaults the elevation of the water table at -999.90 ft. After the water table is defined, press <F10> to accept the value and return to the Main Menu.

If the user selects "Stress history," EMBANK displays

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

Main Menu
 project Definition
 soil Profile and soil param.
 Water table definition
Stress history

Stress history
 Normally consolidated soil
 User defined stress history

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

The program defaults to a normally consolidated soil. If the soil is preconsolidated, the "User defined stress history" option must be selected. EMBANK displays the following screen:

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

User Defined

Stress history

Normally consolidated soil
User defined stress history

Main Menu
 project Definition
 soil Profile and soil param.
 Water table definition
Stress history

Stress history
 Normally consolidated soil
User defined stress history

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1 STRESS HISTORY
 Maximum Past Pressure with Elev.
WARNING : Maximum past pressure vs. Elevation
 must be defined for complete soil profile
 (Program interpolates linearly between points)

Elev.	Maximum Past Pressure	Last point
98.00	2000.00	No

Hit <F10> to accept values

Space Bar-Next item Alt-M-Menu

The user has up to 10 points to define the soil stress history for the complete soil profile. A minimum of two points are required, and the program interpolates linearly between points. The next screen shows a typical entry screen for the last point of the stress history.

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

User Defined

2 STRESS HISTORY

Maximum Past Pressure with Elev.

WARNING : Maximum past pressure vs. Elevation
must be defined for complete soil profile
(Program interpolates linearly between points)

Elev.	Maximum Past Pressure	Last point
80.00	1500.00	Yes

Hit <F9> to prev.point, <F10> to accept values

Main Menu

project Definition

soil Profile and soil param.

Water table definition

Stress history

Stress history

Normally consolidated soil

defined stress history

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Space Bar-Next item Alt-M-Menu

When the <F10> key is pressed, the program accepts the data and returns to the Main Menu.

If the user selects "Vertical stress increment" from EMBANK's main menu screen, the program shows the following screen:

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

A Microcomputer program for
dimensional compression ver
due to embankment loads. The program follows
the equations presented by Lambe&Whitman
(1969), Ladd (1973) and Poulos&Davis (1974).
For the case of a strip symmetrical vertical
embankment loading the program superimposes
two vertical embankment loads. For the
increment of vertical stresses at end of
fill, the program superimposes a series of
rectangular loads.

Main Menu

project Definition

soil Profile and soil param.

Water table definition

Stress history

Vertical stress increment

Vertical stress increment

strip Symmetrical vertical embankment loading

increment of stresses Beneath the end of a fill

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Enter letter only, or use arrows then ← → Make selection. <Esc> ► Main Menu

By pressing the <Enter/Return> key, the user selects the highlighted "strip Symmetrical vertical embankment loading" option. EMBANK displays the following screen:

SYMMETRICAL VERTICAL EMBANKMENT LOAD

VERTICAL EMBANKMENT FOOTING
 Embank. slope a = 20.00
 Embank. width b = 100.00
 Height of fill H = 15.00
 Unit weight of fill = 120.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Point
 x coordinate = X Point
X Direction

FOUNDATION ELEV.
 Z = 100.00

Hit <F10> to accept values

increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

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←↑↓→-Move bar ↵-Select Esc-Exit

The geometry, load, and coordinate(s) of the point(s) where settlement is calculated are entered into this screen. Note that the visual aid does not represent the actual geometry of the load; its objective is to guide the user in the data input process.

EMBANK can compute the settlement in a point or in the X-Direction.

If the user selects the computation of settlement in a point, EMBANK displays the following screen:

SYMMETRICAL VERTICAL EMBANKMENT LOAD

VERTICAL EMBANKMENT FOOTING
 Embank. slope a = 20.00
 Embank. width b = 100.00
 Height of fill H = 15.00
 Unit weight of fill = 120.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Point
 x coordinate = 60.00

FOUNDATION ELEV.
 Z = 100.00

Hit <F10> to accept values

increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

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For a given set of input parameters, press the space bar if settlement calculations are desired for more than one location. Delta x is the increment of distance between the x1 and x2 coordinates where EMBANK will calculate settlement. Example: x1 = 0.00', x2 = 60.00' and delta x = 10.00', EMBANK will calculate settlements at x = 0', 10', 20', 30', 40', 50', and 60'.

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 20.00 Embank. width b = 100.00 Height of fill H = 15.00 Unit weight of fill = 120.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = 0.00 x2 coordinate = 60.00 delta x = 10.00	
FOUNDATION ELEV. Z = 100.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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The last entry on this screen is the Foundation elevation. This option permits the placement of the load at an elevation smaller than the elevation of the top of the soil profile. EMBANK provides the alternative of computing the initial effective stress by considering the complete soil profile or correcting the applied load by discounting the effect of the excavated soil. A typical input screen is as follows:

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 20.00 Embank. width b = 100.00 Height of fill H = 15.00 Unit weight of fill = 120.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = 0.00 x2 coordinate = 60.00 delta x = 10.00	
FOUNDATION ELEV. Z = 98.00	
Compute excavation effect as gamma*Foundation Depth = No	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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←F1→ Move bar ←Select Esc-Exit

If the user exits to the Main Menu by hitting the <ESC> key, EMBANK will respond with the following screen:

SYMMETRICAL VERTICAL EMBANKMENT LOAD

VERTICAL EMBANKMENT FOOTING
 Embank. slope a = 20.00
 Embank. width b = 100.00
 Height of fill H = 15.00
 Unit weight of fill = 120.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Direction
 x1 coordinate = 0.00
 x2 coordinate = 60.00
 delta x = 10.00

FOUNDATION ELEU.
 Z = 98.00

Hit <F10> to accept values

increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

Compute excavation effect as gamma*Foundation Depth = No

Verify NC.
 Abort <Y/N>?

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Space Bar-Next item Alt-M-Menu

A “Y” answer will exit the program to the Main Menu without saving the information already entered. If the user selects “N,” the program continues. The <F10> key accepts (saves) the values and EMBANK returns to the Main Menu screen.

From the Main Menu, select “Vertical stress increment” followed by “increment of stresses Beneath the end of a fill.” EMBANK shows the following screen:

FEDERAL HIGHWAY ADMINISTRATION

A Microcomputer program for three-dimensional compression verification due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

Main Menu

- project Definition
- soil Profile and soil param.
- Water table definition
- Stress history
- Vertical stress increment**

Vertical stress increment

- strip Symmetrical vertical embankment loading
- increment of stresses Beneath the end of a fill**

Enter letter only, or use arrows then <←> Make selection. <Esc> > Main Menu

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Press <Enter/Return> to make the selection and EMBANK displays this screen:

END OF FILL CONDITION

CHARACTERISTICS OF FILL
 Height of fill = 15.00
 Width of top of fill u = 50.00
 Unit weight of fill = 120.00

COORDINATES
 Point A: x1 = 0.00 y1 = 0.00
 Point B: x2 = 30.00 y2 = 30.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Direction
 x1 coordinate = X Point
 x2 coordinate = X Direction
 delta x = X Direction
 y coordinate = X Direction

FOUNDATION ELEV.
 z = 100.00

Y
B() = (x2, y2)
A() = (x1, y1)
X

Y
H
Z

Hit <F10> to accept values

param.

ent

ading
a fill

INC.
= 90

rzua

←↑↓→ Move bar ← Select Esc-Exit

EMBANK has a XYZ coordinate system, where the X and Y axes are the horizontal components and Z is the vertical component. The XY diagram at the top of the screen is a plan view of the embankment. The ZY diagram beneath the plan view is an elevation view or cross section. The correct orientation of the elevation view is to picture it from the right side of the embankment, looking towards the XY origin, that is, towards the left. The Y direction is consistent in both the plan and elevation views. Point A in the plan view is at the bottom of the slope; it is normally the origin of the XY axis. Point B in the plan view is located at the top of the slope. Negative XY values are possible because EMBANK has the ability to compute settlements outside the embankment area.

The Z component is the foundation elevation and is the elevation of the soil profile where the embankment construction begins, that is, the bottom of the embankment. The magnitude of the Z component must be consistent with the elevation given in the "Soil Profile and Soil Parameters" screens. Example: Ground surface elevation value input for layer 1 in the "Soil Profile and Soil Parameter" screen is 100'. Layer 1 is a 5 foot thick layer of highly compressible organic material that will be removed prior to embankment construction. The foundation elevation "Z" in the case is 95'.

If the user selects the computation of settlement in a point, EMBANK displays the following screen:

END OF FILL CONDITION

CHARACTERISTICS OF FILL
 Height of fill = 15.00
 Width of top of fill u = 50.00
 Unit weight of fill = 120.00

COORDINATES
 Point A: x1 = 0.00 y1 = 0.00
 Point B: x2 = 30.00 y2 = 30.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Point
 x coordinate = 30.00
 y coordinate = 30.00

FOUNDATION ELEV.
 z = 100.00

Y
B() = (x2, y2)
A() = (x1, y1)
X

Y
H
Z

Hit <F10> to accept values

param.

ent

ading
a fill

INC.
= 90

rzua

If calculation of settlement in the X-direction is required, EMBANK prompts the user for the information displayed on the next screen:

END OF FILL CONDITION

CHARACTERISTICS OF FILL
 Height of fill = 15.00
 Width of top of fill u = 50.00
 Unit weight of fill = 120.00

COORDINATES
 Point A: x1 = 0.00 y1 = 0.00
 Point B: x2 = 30.00 y2 = 30.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Direction
 x1 coordinate = 0.00
 x2 coordinate = 80.00
 delta x = 10.00
 y coordinate = 30.00

FOUNDATION ELEV.
 z = 100.00

$B(\circ) = (x2, y2)$
 $A(\bullet) = (x1, y1)$

Hit <F10> to accept values

param.
ent
ading
a fill

INC.
e
90
rzua

The last entry on this screen is the Foundation elevation. This option permits the placement of the load at an elevation smaller than the elevation of the top of the soil profile. The program computes the initial effective vertical stress by considering the initial soil profile and allows the user to correct the applied load by discounting the effect of the excavated soil.

A typical input screen for this case is shown below:

END OF FILL CONDITION

CHARACTERISTICS OF FILL
 Height of fill = 15.00
 Width of top of fill u = 50.00
 Unit weight of fill = 120.00

COORDINATES
 Point A: x1 = 0.00 y1 = 0.00
 Point B: x2 = 30.00 y2 = 30.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Direction
 x1 coordinate = 0.00
 x2 coordinate = 80.00
 delta x = 10.00
 y coordinate = 30.00

FOUNDATION ELEV.
 z = 98.00

$B(\circ) = (x2, y2)$
 $A(\bullet) = (x1, y1)$

Hit <F10> to accept values

param.
ent
ading
a fill

INC.
e
90
rzua

Compute excavation effect
 as $\gamma \times \text{Foundation Depth} =$ No

No
Yes

←F1→-Move bar ←-Select Esc-Exit

Pressing the <F10> key accepts (saves) the values, and EMBANK returns to the Main Menu screen.

With the highlight on the "system of Units" field, hit <Enter/Return>. EMBANK responds with the Unit System screen. This is an informational screen that defines the system of units required by the program.

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer p dimensional compre due to embankment the equations pr (1969), Ladd (1973 For the case of a embankment loading two vertical emba increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Unit System Embank requires the information in : • Length : feet • Load : pounds • Stress (pressure) : psf • Unit weight : pcf • Unit weight of water defaults to : 62.4 pcf • Settlement : inches Hit <F10> to continue
	Main Menu - project Definition - soil Profile and soil param. - definition - ry - ess increment its - e ENGINEERING INC. land Avenue er, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <Left> > Make selection.

Hitting the <F10> key returns EMBANK to the Main Menu.

Move the arrows to highlight "Maintain file" and hit <Enter/Return>. EMBANK displays the Maintain file menu, which permits data file management inside the program.

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run - Exit PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
	Maintain file - Run - Maintain file Save file - Retrieve file - Clear entries

Enter letter only, or use arrows then <Left> > Make selection. <Esc> > Main Menu

By selecting "Save file," EMBANK displays

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run Maintain file - Exit Save file Destination File
A Microcomputer program for computing one dimensional compression vertical sett due to embankment loads. The program f the equations presented by Lambe&W (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **<J>** Make selection. **<Esc>** Main Menu

in which the program prompts the user for the destination file name for saving the input information. EMBANK defaults to filename extension .EMB. This filename extension can be changed by the user.

When **<Enter/Return>** is pressed, EMBANK shows the filename.EMB files that are in the current directory.

A typical screen will look similar to the following screen:

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. EXAMPLE1.EMB ent
A Microcomputer program for computing one dimensional compression vertical sett due to the eq (1969), For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **<J>** Make selection. **<Esc>** Main Menu

When the "Retrieve file" option is selected, EMBANK shows

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run Maintain file Exit Save file Retrieve file Input File
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program f the equations presented by Lambe&W (1969), Ladd (1973) and Poulos&Davis (For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	M.EMB PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> ► Main Menu

in which the program prompts the user for the filename.EMB to be retrieved. EMBANK defaults to the .EMBfilename extension of data files. This filename extension can be changed by the user.

If the user does not recall the name of the filename.EMB files in the current directory, a list of these can be displayed by pressing the <Enter/Return> key. EMBANK shows the following screen:

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run Maintain file Exit Save file Retrieve file Input File
A Microcomputer program for computing one dimensional compression vertical settlement due to the equations presented by Lambe&W (1969), Ladd (1973) and Poulos&Davis (For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	C:\EMBANK.2\M.EMB EX1.EMB EX2.EMB ent PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> ► Main Menu

The use of the arrow keys (←, ↑, ↓, →) allows the user to select a file. Press the <Enter/Return> key to retrieve the file into EMBANK. The program returns to the Main Menu screen.

Hitting <Enter/Return> at the "Clear entries" field initializes all EMBANK variables to their default values (equivalent to loading the program from scratch).

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Run Maintain file Exit Save file Retrieve file Clear entries
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ↵ ▶ Make selection. <Esc> ▶ Main Menu

EMBANK returns to the Main Menu.

Selecting the "Run program" option will run EMBANK. The user is referred to Appendix B for typical example runs and output screens.

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ↵ ▶ Make selection.

When "Exit to DOS" is selected the program displays the following screen:

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by LambesWhitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program Exit to DOS
	Exit to DOS Yes No
PROT NG INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then **<J>** Make selection. **<Esc>** Main Menu

A selection of "No" returns the program to the Main Menu. A "Yes" selection takes the user back to the disk operating system prompt.

Appendix B

Example 1

Example No. 1: Settlement of Normally Consolidated (NC) Soft Clay Layer Due to Symmetrical Embankment Load

This example is similar to the one presented in the U.S. Department of Transportation, FHWA, *Soils and Foundations Workshop Manual*, p. 161.

Figure EX-1 shows the problem geometry and soil parameters. The objective is to compute total settlement of the NC clay stratum beneath points A through E. The clay is divided into five sublayers.

Table EX-1 presents a summary of the computer-calculated and hand-computed settlements for points A through E.

Table 1. Summary of clay surface settlements

Point	Settlement (in)	
	Computer	Hand-Calculated
A	13.44	13.46
B	13.08	
C	12.01	12.02
D	10.34	
E	8.32	8.33

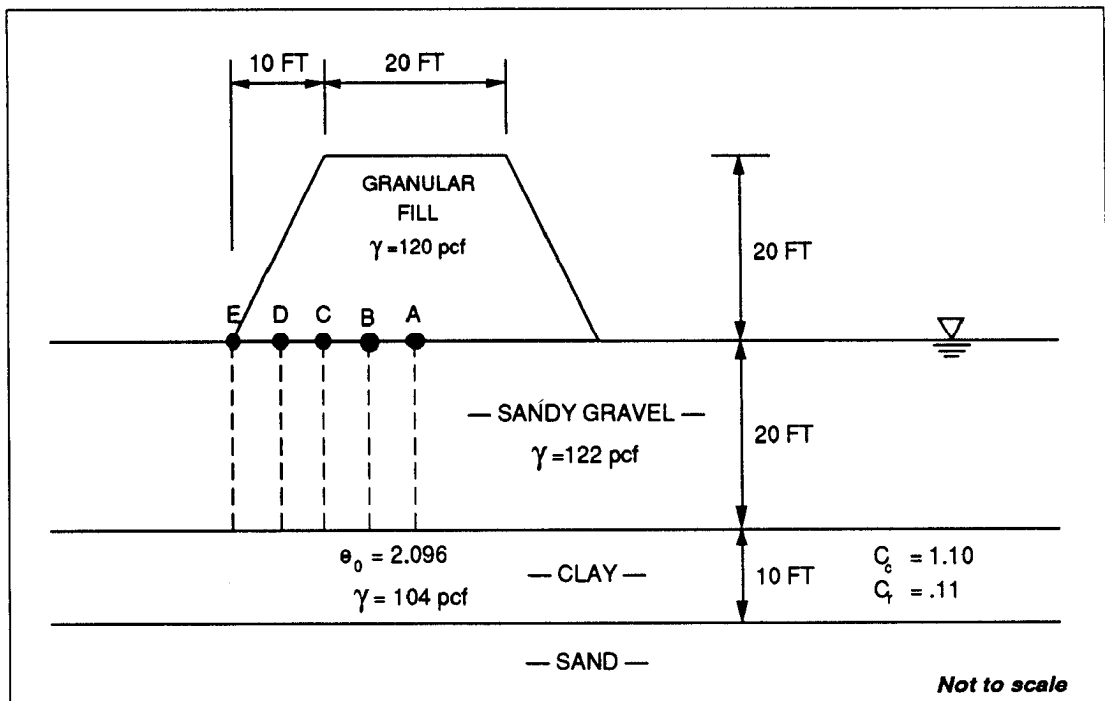
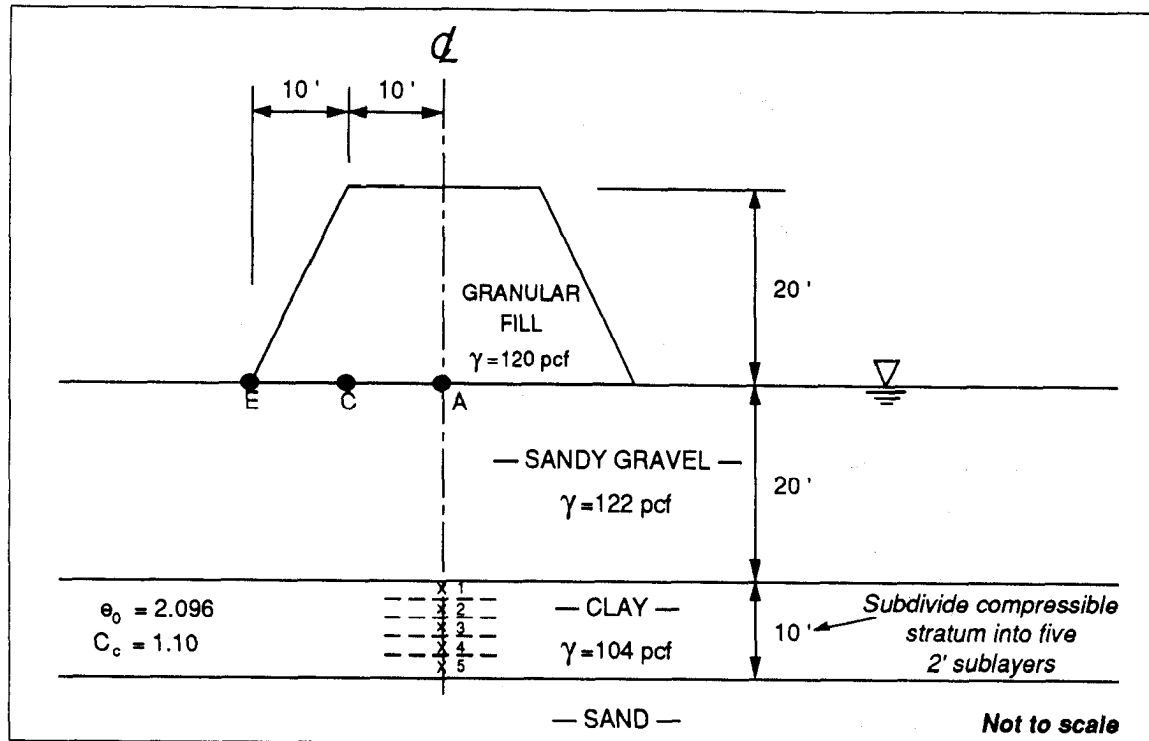


Figure 10. Example 1: Settlement of Symmetrical Embankment Load

Example No. 1: Symmetrical Embankment Load



Determine geostatic effective vertical stresses at points 1...5:

$$\bar{\sigma}_1 = 20 \times 122 + 1 \times 104 - 21 \times 62.4 = 1233.6 \text{ psf}$$

$$\bar{\sigma}_2 = 20 \times 122 + 3 \times 104 - 23 \times 62.4 = 1316.8$$

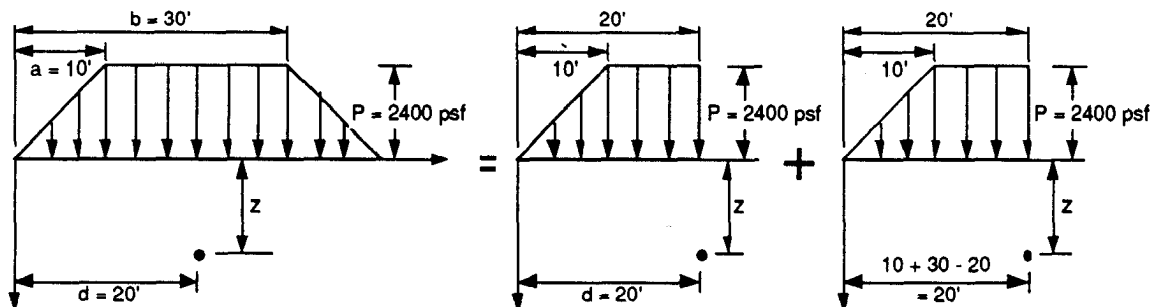
$$\bar{\sigma}_3 = 20 \times 122 + 5 \times 104 - 25 \times 62.4 = 1400.0$$

$$\bar{\sigma}_4 = 20 \times 122 + 7 \times 104 - 27 \times 62.4 = 1483.2$$

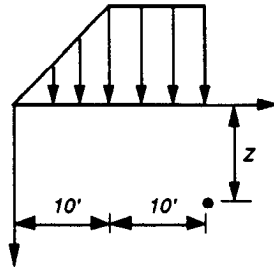
$$\bar{\sigma}_5 = 20 \times 122 + 9 \times 104 - 29 \times 62.4 = 1560.4$$

Determine increments of vertical stress under point A:

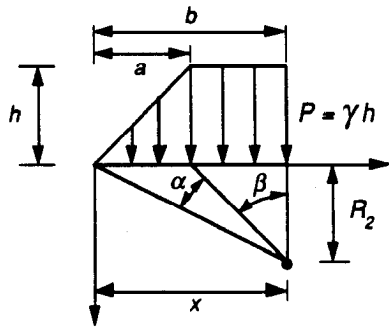
- Determine increments of vertical stress from figure 4 in text.
- Use superposition, as shown below:



Therefore, we compute increments of vertical stress as 2 times the vertical stress increment for:



For the general case shown below,
vertical stresses are given by:



$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

In this case:

$$b = 20'$$

$$a = 10'$$

$$R_2 = z$$

Therefore:

$$\tan \beta = \frac{10}{z} \Rightarrow \beta = \arctan \left(\frac{10}{z} \right)$$

$$\tan(\alpha + \beta) = \frac{20}{z} \Rightarrow \alpha = \arctan \left(\frac{20}{z} \right) - \beta$$

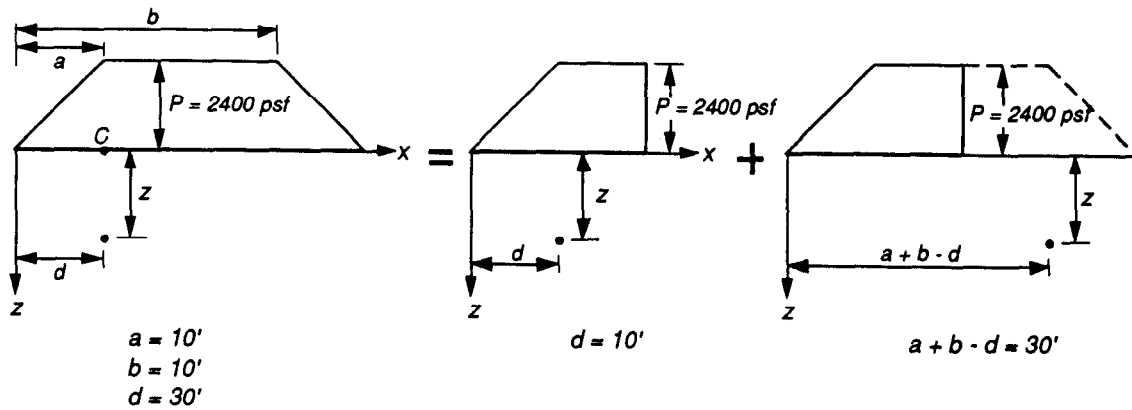
We compute the stress increments for $z = 21, 23, 25, 27$, and 29 ft:

z (ft)	$\beta = \arctan\left(\frac{10}{z}\right)$	$\alpha = \arctan\left(\frac{20}{z}\right) - \beta$	$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} \right]$	$2\sigma_z$
21	25.463345	18.139474	823.23057	1646.4611
23	23.498566	17.510521	780.26144	1560.5229
25	21.801410	16.858398	740.24275	1480.4855
27	20.323137	16.205718	703.12764	1406.2553
29	19.025606	15.566683	668.78629	1337.5726

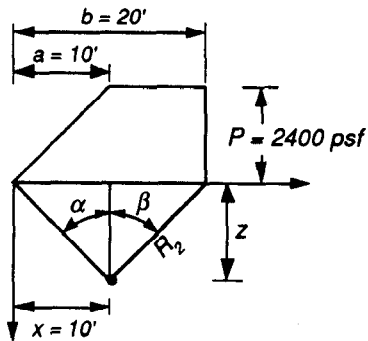
(σ_z in psf)

Determine increments of vertical stress under point C:

- Use superposition as shown below:



- For first superposition step, consider:



$$\begin{aligned}
 x &= 10' \\
 a &= 10' \\
 b &= 20' \\
 \frac{x}{a} &= 1; & x - b &= -10 \\
 R_2^2 &= z^2 + 10^2 \\
 \tan \beta &= \frac{10}{z}; & \tan \alpha &= \frac{10}{z}
 \end{aligned}$$

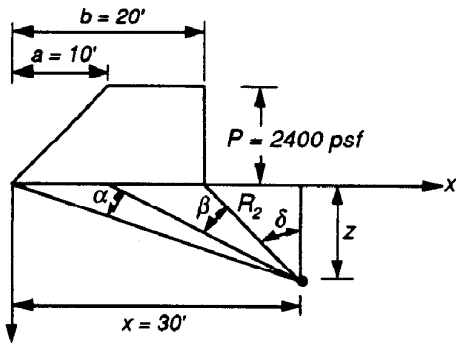
- Compute increment of stresses using:

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

- See results in table below:

$z \text{ (ft)}$	$\alpha = \beta$	$R_2^2 = z^2 + 10^2$	$\frac{z}{R_2^2} (x - b)$	$\sigma_z \text{ (psf)}$
21	25.463345	541	- 0.3881701	975.56265
23	23.498566	629	- 0.3656598	905.97194
25	21.801410	725	- 0.3448276	844.79982
27	20.323137	829	- 0.3256936	790.76190
29	19.025606	941	- 0.3081828	742.78381

- For second superposition step, consider:



$$\frac{x}{a} = \frac{30}{10} = 3$$

$$R_2^2 = z^2 + 10^2$$

$$x - b = 10$$

$$\beta = \arctg\left(\frac{20}{z}\right) - \delta$$

$$\alpha = \arctg\left(\frac{30}{z}\right) - (\beta + \delta)$$

$$\delta = \arctg\left(\frac{10}{z}\right)$$

- Compute increment of vertical stresses using:

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

- See results in the table below:

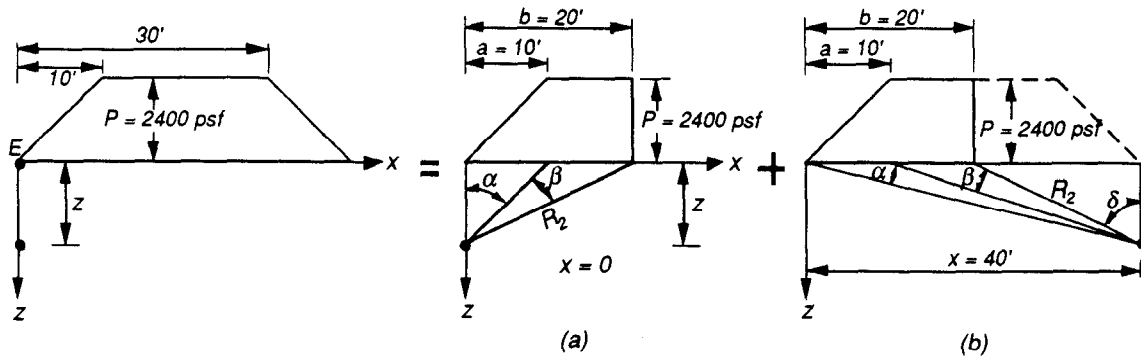
z (ft)	δ	β	α	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
21	25.463345	18.139474	11.405161	0.3881701	401.52598
23	23.498566	17.510521	11.514733	0.3656598	414.71942
25	21.801410	16.858398	11.534621	0.3448276	422.73460
27	20.323137	16.205718	11.483932	0.3256936	426.62194
29	19.025606	15.566683	11.378733	0.3081828	427.27078

- Add stress increments from both superposition steps:

z (ft)	σ_z (psf)
21	1377.0886
23	1320.6914
25	1267.5344
27	1217.3838
29	1170.0546

Determine increments of vertical stress under point E:

- Use superposition as shown below:



- From figure (a) above:

$$\alpha = \arctg\left(\frac{10}{z}\right)$$

$$\beta = \arctg\left(\frac{20}{z}\right) - \alpha$$

$$(x - b) = 0 - 20 = -20$$

$$R_2^2 = z^2 + (-20)^2$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

- Apply expressions above to compute increments of stress for case (a):

z (ft)	$\alpha = \arctg\left(\frac{10}{z}\right)$	$\beta = \arctg\left(\frac{20}{z}\right) - \alpha$	$R_2^2 = z^2 + (-20)^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
21	25.463345	18.139474	841	-0.4994055	623.37735
23	23.498566	17.510521	929	-0.4951561	611.74501
25	21.801410	16.858398	1025	-0.4878049	597.43413
27	20.323137	16.205718	1129	-0.4782994	581.47007
29	19.025606	15.566683	1241	-0.4673650	564.59633

- From Figure (b):

$$\delta = \arctg\left(\frac{20}{z}\right)$$

$$\beta = \arctg\left(\frac{30}{z}\right) - \delta$$

$$\alpha = \arctg\left(\frac{40}{z}\right) - (\beta + \delta)$$

$$(x - b) = 40 - 20 = 20$$

$$R_2^2 = z^2 + 20^2$$

$$\frac{x}{a} = \frac{40}{10} = 4$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

- Apply expressions above to compute increments of stress for case (b):

z (ft)	$\delta = \arctg\left(\frac{20}{z}\right)$	$\beta = \arctg\left(\frac{30}{z}\right) - \delta$	$\alpha = \arctg\left(\frac{40}{z}\right) - (\beta + \delta)$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
21	43.602819	11.405161	7.2925472	0.4994055	159.48697
23	41.009087	11.514733	7.5772781	0.4951561	179.37988
25	38.659808	11.534621	7.8001877	0.4878049	197.14946
27	36.528855	11.483932	7.9678630	0.4782994	212.67796
29	34.592289	11.378733	8.0868661	0.4673650	225.97541

- Add stress increments from cases (a) and (b). Obtain table below:

z (ft)	σ_z (psf)
21	782.86432
23	791.12489
25	794.58359
27	794.14803
29	790.57174

Compute settlements.

- Use following expression:

$$\rho = \sum_{i=1}^n H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$$

where:

n = number of substrata = 5

H_i = thickness of each substrata = 2 ft

$$\begin{aligned} CR = \text{Virgin Compression Ratio} &= \frac{C_c}{(1 + e_0)} \\ &= \frac{1.10}{(1 + 2.096)} \\ &= 0.3552972 \end{aligned}$$

$\bar{\sigma}_{vf}$ = Final vertical effective stress = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$

$\bar{\sigma}_{v0}$ = Initial vertical effective stress

- Apply expressions above for point A; get table below:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf}$ (psf) = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	$\rho_i = H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$
21	1233.6	1646.4611	2880.0611	0.2616603 ft
23	1316.8	1560.5229	2877.3229	0.2412246
25	1400.0	1480.4855	2880.4855	0.2226560
27	1483.2	1406.2553	2889.4553	0.2057997
29	1566.4	1337.5726	2903.9726	0.1905031
Total Settlement:				1.1218437 ft
				13.46 in

- Apply expressions above for point C; obtain table below:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf}$ (psf) = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	$\rho_i = H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$
21	1233.6	1377.0886	2610.6886	0.2313558 ft
23	1316.8	1320.6914	2637.4914	0.2143639
25	1400.0	1267.5344	2667.5344	0.1989536
27	1483.2	1217.3838	2700.5838	0.1849378
29	1566.4	1170.0546	2736.4546	0.1721668
Total Settlement:				1.0017799 ft 12.02 in

- Apply expressions above for point E; obtain table below:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf}$ (psf) = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	$\rho_i = H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$
21	1233.6	782.86432	2016.46432	0.1516523 ft
23	1316.8	791.12489	2107.92489	0.1451995
25	1400.0	794.58359	2194.58359	0.1387251
27	1483.2	794.14803	2277.34803	0.1323338
29	1566.4	790.57174	2356.97174	0.1260962
Total Settlement:				0.6940069 ft 8.33 in

Compilation of Computer Screens for Example 1

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
Version 2.00/October 1991	Hit <F10> to continue

OPENING SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then < > Make selection.

EMBANK MAIN MENU - SELECTION OF PROJECT DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
	PROJECT DEFINITION Client = Any client Project Name = Embankment load Project Manager = AUM File Name = EXAMPLE1.EMB Date = 3/13/92 (MM/DD/YY) Computed by = AUM
	Hit <F10> to accept values
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	INEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

PROJECT DEFINITION SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. soil Profile and soil param. Void ratio per $\Delta \log$ stress Strain per $\Delta \log$ stress Run program Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **<I>** > Make selection. **<Esc>** > Main Menu

SOIL PROFILE MENU - SELECTION OF VOID RATIO PER LOG STRESS

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1 Sublayer 1 : Sublayer n Sublayer 1 Sublayer 2	Elev. of top of layer = 100.00 Number of sublayers = 1 (for this layer) Unit weight of soil = 122.00 Type of layer = Incompressible } Layer 1 Layer 2 } Is this the last layer of profile No
Hit <F10> to continue Space Bar-Next item Alt-M-Menu	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #1

Layer Soil Properties		ADMINISTRATION	
Layer Number = 2		Elev. of top of layer = 88.00	
Sublayer 1		Number of sublayers = 5 (for this layer)	
:		Unit weight of soil = 104.00	
Sublayer n		Type of layer = Compressible	
Sublayer 1		Layer soil properties = Initial void ratio	
:		Compression Index Esti Initial void ratio	
Sublayer 2		Recompression Index Esti Initial water content	
		Swelling Index Estimated from e-logp curves	
Is this the last layer of profile No			
Hit <F9> to Prev. Layer Hit <F10> to continue			
Press space bar to see menu options and then <Ret> to input values			

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #2

Layer Soil Properties		FEDERAL HIGHWAY ADMINISTRATION	
Initial Void Ratio = 2.10		f layer = 88.00	
Hit <F10> to accept values		ayers = 5 (for this layer)	
:		Unit weight of soil = 104.00	
Sublayer n		Type of layer = Compressible	
Sublayer 1		Layer soil properties = Initial void ratio	
:		Compression Index Estimated from e-logp curves	
Sublayer 2		Recompression Index Estimated from e-logp curves	
		Swelling Index Estimated from e-logp curves	
Is this the last layer of profile No			
Hit <F9> to Prev. Layer Hit <F10> to continue			

INITIAL VOID RATIO - LAYER #2

ACTION		
Input Value of Compression Index = 1.1		
Hit <F10> to accept value 88.00		
Sublayer 1	Layer 1	Number of sublayers = 5 (for this layer)
:		Unit weight of soil = 104.00
Sublayer n	Layer 2	Type of layer = Compressible
Sublayer 1		Layer soil properties = Initial void ratio
Sublayer 2	Layer 2	Compression Index Estimated from e-logp curves
		Recompression Index Estimated from e-logp curves
		Swelling Index Estimated from e-logp curves
		Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue		

COMPRESSION INDEX - LAYER #2

ACTION		
Input Value of Recompression index = 1.1		
Hit <F10> to accept value 88.00		
Sublayer 1	Layer 1	Number of sublayers = 5 (for this layer)
:		Unit weight of soil = 104.00
Sublayer n	Layer 2	Type of layer = Compressible
Sublayer 1		Layer soil properties = Initial void ratio
Sublayer 2	Layer 2	Compression Index Estimated from e-logp curves
		Recompression Index Estimated from e-logp curves
		Swelling Index Estimated from e-logp curves
		Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue		

RECOMPRESSION INDEX - LAYER #2

ACTION	
Layer Number = 2	Elev. of top of layer = 80.00
Sublayer 1	Number of sublayers = 5 (for this layer)
:	Unit weight of soil = 104.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 2	Compression Index Estimated from e-logp curves
	Recompression Index Estimated from e-logp curves
	Swelling Index Same as recompression index
	Is this the last lay Estimated from e-logp curves
	Same as recompression index
Hit <F9> to Prev. Layer	
Press space bar to see menu options and then <Ret> to input values	
SWELLING INDEX - LAYER #2	

ACTION	
Layer Number = 2	Elev. of top of layer = 80.00
Sublayer 1	Number of sublayers = 5 (for this layer)
:	Unit weight of soil = 104.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 2	Compression Index Estimated from e-logp curves
	Recompression Index Estimated from e-logp curves
	Swelling Index Same as recompression index
	Is this the last layer of profile Yes
Hit <F9> to Prev. Layer Hit <F10> to continue	
Space Bar-Next item Alt-M-Menu	
DEFINING LAYER #2 AS LAST LAYER OF SOIL PROFILE	

ACTION	
Layer Number = 2	Elev. of top of layer = 80.00
Number of sublayers = 5 (for this layer)	
Sublayer 1	Elev. of bottom of last layer = 70.00 ible Hit <F10> to accept value id ratio
Sublayer n	
Sublayer 1	
Layer 2	
Sublayer 2	
Compression Index Estimated from e-logp curves Recompression Index Estimated from e-logp curves Swelling Index Same as recompression index Is this the last layer of profile Yes Hit <F9> to Prev. Layer Hit <F10> to continue	

DEFINING THICKNESS OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF WATER TABLE DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK Water Table Definition Elev. of Water Table = 100.00 Hit <F10> to accept values A Microcomputer pro dimensional compress due to embankment loa the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment Units ile M S PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

WATER TABLE AT ELEVATION = 100 FT.

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK Water Table Definition Elev. of Water Table = 100.00 Hit <F10> to accept values A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Stress history Normally consolidated soil User defined stress history E PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> ▶ Main Menu

COMPRESSIBLE LAYER IS DEFINED AS NORMALLY CONSOLIDATED (DEFAULT)

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↩** ▶ Make selection.

EMBank MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment Vertical stress increment strip Symmetrical vertical embankment loading - increment of stresses Beneath the end of a fill PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↩** ▶ Make selection. <Esc> ▶ Main Menu

VERTICAL STRESS INCREMENT MENU - STRIP SYMMETRICAL EMBANKMENT LOADING

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 10.00 Embank. width b = 30.00 Height of fill H = 20.00 Unit weight of fill = 120.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = x2 coordinate = X Point delta x = X Direction	
FOUNDATION ELEV. Z = 100.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	(617) 729-2363 Attn. Dr. Alfredo Urzua

←F10→-Move bar ←F10→-Select Esc-Exit

STRIP SYMM. EMBANKMENT LOADING GEOMETRY - SETTLEMENT IN X-DIRECTION

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 10.00 Embank. width b = 30.00 Height of fill H = 20.00 Unit weight of fill = 120.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = 0.00 x2 coordinate = 20.00 delta x = 5.00	
FOUNDATION ELEV. Z = 100.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	(617) 729-2363 Attn. Dr. Alfredo Urzua

←F10→-Move bar ←F10→-Select Esc-Exit

DEFINING POINTS FOR COMPUTATION OF SETTLEMENT

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <J> Make selection.

EMBANK MAIN MENU - SELECTION OF RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING																																									
Project Name :		Embankment load			Client :		Any Client																																		
Project Number :		91-1234			Project Manager :		AUM																																		
Date :		10/01/91			Computed by :		AUM																																		
Settlement for X-Direction																																									
Embankment slope a		=		10.00 (ft)		Height of fill H		= 20.00 (ft)																																	
Embankment top width		=		20.00 (ft)		Unit weight of fill		= 120.00 (pcf)																																	
Embankment bottom width		=		40.00 (ft)		p load/unit area		= 2400.00 (psf)																																	
Ground Surface Elev.		=		100.00 (ft)		Foundation Elev.		= 100.00 (ft)																																	
Water table Elev.		=		100.00 (ft)		Unit weight of Mat.		= 62.40 (pcf)																																	
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">No.</th> <th colspan="2">LAYER</th> <th rowspan="2">THICK. (ft)</th> <th colspan="3">COEFFICIENT</th> <th rowspan="2">UNIT WEIGHT (pcf)</th> <th rowspan="2">SPECIFIC GRAVITY</th> <th rowspan="2">VOID RATIO</th> </tr> <tr> <th>TYPE</th> <th>COMP.</th> <th>RECOMP.</th> <th>SWELL.</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>INCOMP.</td> <td>20.0</td> <td>-----</td> <td>-----</td> <td>-----</td> <td>122.00</td> <td>---</td> <td>---</td> </tr> <tr> <td>2</td> <td>COMP.</td> <td>10.0</td> <td>1.100</td> <td>0.110</td> <td>0.110</td> <td>104.00</td> <td>2.65</td> <td>2.10</td> </tr> </tbody> </table>										No.	LAYER		THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	TYPE	COMP.	RECOMP.	SWELL.	1	INCOMP.	20.0	-----	-----	-----	122.00	---	---	2	COMP.	10.0	1.100	0.110	0.110	104.00	2.65	2.10
No.	LAYER		THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO																																
	TYPE	COMP.		RECOMP.	SWELL.																																				
1	INCOMP.	20.0	-----	-----	-----	122.00	---	---																																	
2	COMP.	10.0	1.100	0.110	0.110	104.00	2.65	2.10																																	
Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu																																									

PROGRAM OUTPUT SCREEN

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Embankment load Client : Any Client
Project Number : 91-1234 Project Manager : AUM
Date : 10/01/91 Computed by : AUM

Settlement for X-Direction

Embankment slope a = 10.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 20.00 (ft) Unit weight of fill = 120.00 (pcf)
Embankment bottom width = 40.00 (ft) p load/unit area = 2400.00 (psf)
Ground Surface Elev. = 100.00 (ft) Foundation Elev. = 100.00 (ft)
Water table Elev. = 100.00 (ft)

Select
Send form to: ☐-Printer, ☐-Disk File.

LAYER Nº.	TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	20.0	-----	-----	-----	122.00	-----	-----
2	COMP.	10.0	1.100	0.110	0.110	104.00	2.65	2.10

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISK FILE PRINTED OUTPUT

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Embankment load Client : Any Client
Project Number : 91-1234 Project Manager : AUM
Date : 10/01/91 Computed by : AUM

Settlement for X-Direction

Embankment slope a = 10.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 20.00 (ft) Unit weight of fill = 120.00 (pcf)
Embankment bottom width = 40.00 (ft) p load/unit area = 2400.00 (psf)
Ground Surface Elev. = 100.00 (ft) Foundation Elev. = 100.00 (ft)
Water table Elev. = 100.00 (ft)

Destination File
EXAMPLE1.OUT

LAYER Nº.	TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	20.0	-----	-----	-----	122.00	-----	-----
2	COMP.	10.0	1.100	0.110	0.110	104.00	2.65	2.10

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DESTINATION FILE

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Embankment load Client : Any Client
File Name : Example1.EMB Project Manager : AUM
Date : 10/01/91 computed by : AUM

Settlement for X-Direction

Embankment slope a = 10.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 20.00 (ft) Unit weight of fill = 120.00 (pcf)
Embankment bottom width = 40.00 (ft) p load/unit area = 2400.00 (psf)
Ground Surface Elev. = 100.00 (ft) Foundation Elev. = 100.00 (ft)
Water table Elev. = 100.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER N°.	TYPE	THICK. (ft)	COEFFICIENT COMP.	RECOMP.	SWELL.	UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
1	INCOMP.	20.0	-----	-----	-----	122.00	-----	-----
2	COMP.	10.0	1.100	0.110	0.110	104.00	2.65	2.10

N°.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES	
			INITIAL (psf)	MAX. PAST PRESS. (psf)
1	INCOMP.			
2	2.00	79.00	1233.60	1233.60
3	2.00	77.00	1316.80	1316.80
4	2.00	75.00	1400.00	1400.00
5	2.00	73.00	1483.20	1483.20
6	2.00	71.00	1566.40	1566.40

Layer	X = 0.00		X = 5.00		X = 10.00		X = 15.00	
	Stress (psf)	Sett. (in.)	Stress (psf)	Sett. (in.)	Stress (psf)	Sett. (in.)	Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	782.86	1.82	1089.37	2.34	1377.09	2.77	1576.37	3.04
3	791.12	1.74	1065.97	2.19	1320.69	2.57	1497.77	2.81
4	794.58	1.66	1041.58	2.06	1267.53	2.38	1424.60	2.60
5	794.15	1.59	1016.53	1.93	1217.38	2.22	1356.64	2.40
6	790.57	1.51	991.15	1.81	1170.05	2.06	1293.57	2.23
		8.32		10.34		12.01		13.08

Layer	X = 20.00	
	Stress (psf)	Sett. (in.)
1	INCOMP.	
2	1646.46	3.14
3	1560.52	2.89
4	1480.49	2.67
5	1406.26	2.47
6	1337.57	2.28
		13.44

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↩** ▶ Make selection.

EMBANK MAIN MENU - SELECTION OF MAINTAIN FILE

FEDERAL HIGHWAY ADMINISTRATION									
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file								
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	<table border="1"> <tr> <td>Run</td> <td>Maintain file</td> </tr> <tr> <td>Exit</td> <td>Save file</td> </tr> <tr> <td></td> <td>Retrieve file</td> </tr> <tr> <td></td> <td>Clear entries</td> </tr> </table>	Run	Maintain file	Exit	Save file		Retrieve file		Clear entries
Run	Maintain file								
Exit	Save file								
	Retrieve file								
	Clear entries								
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua								

Enter letter only, or use arrows then **↩** ▶ Make selection. **<Esc>** ▶ Main Menu

MAINTAIN FILE MENU - SELECTION OF SAVE FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run Maintain file Exit Save file Destination File
	EXAMPLE1.EMB
A Microcomputer program for computing one dimensional compression vertical sett due to embankment loads. The program f the equations presented by Lambe&U (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

SAVING INPUT FILE AS EXAMPLE1.DAT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	

Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - EXIT TO DOS

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS Exit to DOS Yes No PROT NG INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↵** ▶ Make selection. **<Esc>** ▶ Main Menu

EXIT TO DOS MENU - SELECTION OF YES

Example 2

Example No. 2: Approach Embankment Settlement

This example is similar to the one presented in the U.S Department of Transportation, FHWA, *Soils and Foundations Workshop Manual*, p. 165.

Figure EX-2 shows the problem geometry and soil parameters. The purpose of the example is to compute the settlement of the clay stratum under points A through D. The clay stratum is divided into seven sublayers.

Table EX-2 presents a summary of the computer-calculated and hand-computed settlement for points A through D.

Table 2. Summary of surface settlements

Point	Surface Settlement (in)	
	Computer	Hand-Calculated
A	34.46	34.46
B	23.99	
C	7.51	
D	18.97	

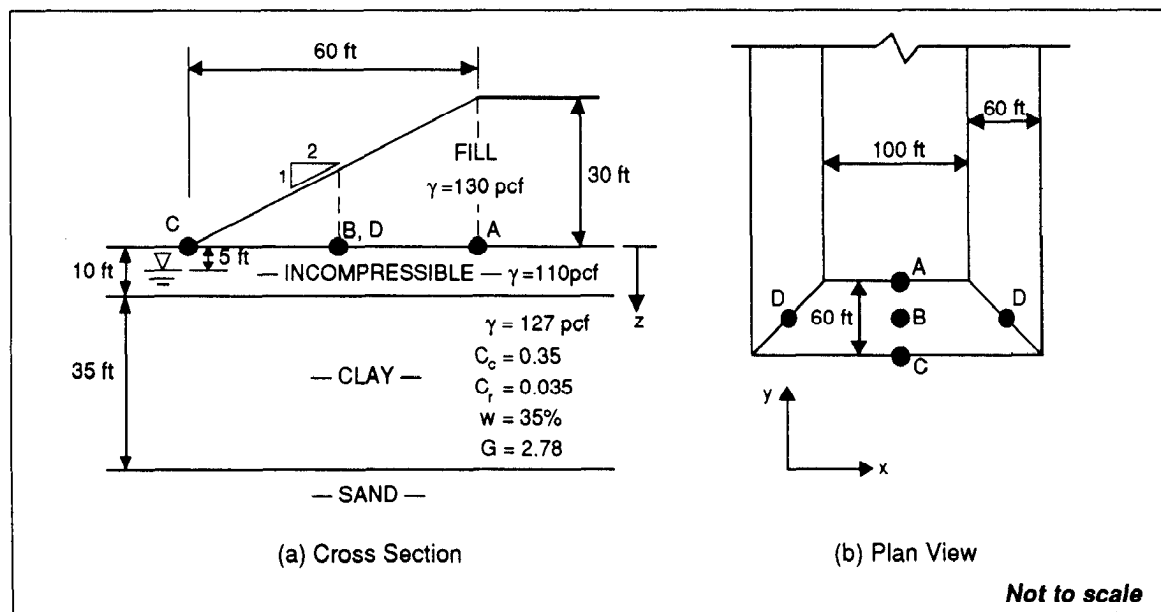


Figure 11. Approach embankment settlement

Example No. 2: Approach Embankment Settlement

Problem: Compute settlement at point A in figure 11.

— Geostatic Effective Vertical Stresses

- Divide compressible clay stratum into seven 5-ft substrata.
- Compute effective vertical stresses at midpoint for each substrata; obtain table below:

$$\begin{aligned}
 z = 12.5 \text{ ft: } \bar{\sigma}_1 &= 110 \times 10 + 127 \times 2.5 - 62.4 \times 7.5 = 949.5 \text{ psf} \\
 z = 17.5 \text{ ft: } \bar{\sigma}_2 &= 110 \times 10 + 127 \times 7.5 - 62.4 \times 12.5 = 1272.5 \text{ psf} \\
 z = 22.5 \text{ ft: } \bar{\sigma}_3 &= 110 \times 10 + 127 \times 12.5 - 62.4 \times 17.5 = 1595.5 \text{ psf} \\
 z = 27.5 \text{ ft: } \bar{\sigma}_4 &= 110 \times 10 + 127 \times 17.5 - 62.4 \times 22.5 = 1918.5 \text{ psf} \\
 z = 32.5 \text{ ft: } \bar{\sigma}_5 &= 110 \times 10 + 127 \times 22.5 - 62.4 \times 27.5 = 2241.5 \text{ psf} \\
 z = 37.5 \text{ ft: } \bar{\sigma}_6 &= 110 \times 10 + 127 \times 27.5 - 62.4 \times 32.5 = 2564.5 \text{ psf} \\
 z = 42.5 \text{ ft: } \bar{\sigma}_7 &= 110 \times 10 + 127 \times 32.5 - 62.4 \times 37.5 = 2887.5 \text{ psf}
 \end{aligned}$$

— Determine Increments of Effective Stress

- Program divides embankment load into 10 3-ft high rectangular sub-loads, as shown in figure 6 of the main text.
- Program extends loads to $y_{\max} = y_1 + 10b_2 = 0 + 10 \times 60 = 600 \text{ ft}$.
- Coordinates of lower left and upper right corners of each sub-load are as follows: (Refer to figure 7 of main text.)

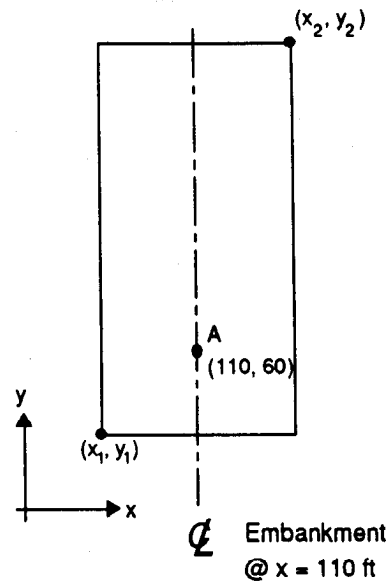
Sub-Load No.	x_1	y_1	x_2	y_2
1	57	57	163	600
2	51	51	169	600
3	45	45	175	600
4	39	39	181	600
5	33	33	187	600
6	27	27	193	600
7	21	21	199	600
8	15	15	205	600
9	9	9	211	600
10	3	3	217	600

- Note that "x" and "y" coordinates of point A are:

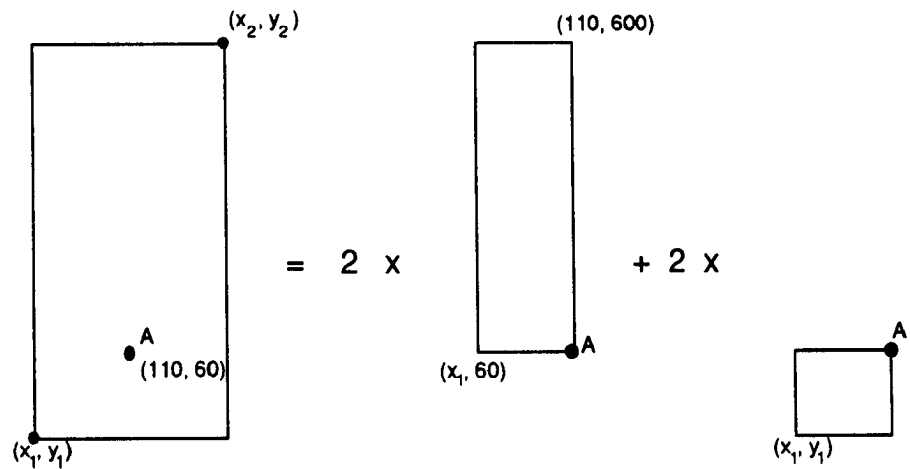
$$x_A = 110 \text{ ft}; y_A = 60 \text{ ft}$$

- The configuration of a typical sub-load and its relation to point A is shown below:

Note: Values of x_1 , x_2 , y_1 , and y_2 are as shown on table in previous page for each sub-load. In all cases, $y_2 = 600$ ft.



- For each sub-load, the increments of vertical stress at point A must be computed by superposition, as shown below:



$$(0) = 2 \times (a) + 2 \times (b)$$

$$(0) = 2 \times [(a) + (b)]$$

- Equation (14) in main text is applied to superposition steps (a) and (b) for each sub-load in order to compute the increments of stress.

$$\sigma_z = \frac{P}{2\pi} \left[\arctg\left(\frac{lb}{zR_3}\right) + \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right) \right] \quad (14)$$

Parameters R_1 , R_2 , and R_3 are defined in figure 8:

$$R_1 = (l^2 + z^2)^{\frac{1}{2}}$$

$$R_2 = (b^2 + z^2)^{\frac{1}{2}}$$

$$R_3 = (l^2 + b^2 + z^2)^{\frac{1}{2}}$$

- Tables 1 through 7 on the following pages summarize the computation for $z = 12.5$; 17.5 ; 22.5 ; 27.5 ; 32.5 ; 37.5 ; and 42.5 ft.

Parameters C_1 and C_2 in the tables are defined as follows:

$$C_1 = \arctg\left(\frac{lb}{zR_3}\right)$$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

so that: $\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$

Table 3. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 12.5 feet

								Increment	
		b	l	R ₁ ²	R ₂ ²	R ₃	C ₁	C ₂	σ _z
3	53			2965.25	165.25	54.54	0.23	0.23	28.67 57.35
53	540			291756.30	2965.25	542.74	1.34	0.22	96.99 193.98
9	59			3637.25	237.25	60.98	0.61	0.49	68.10 136.21
59	540			291756.30	3637.25	543.36	1.36	0.20	97.13 194.25
15	65			4381.25	381.25	67.87	0.85	0.51	84.83 169.67
65	540			291756.30	4381.25	544.04	1.38	0.19	97.22 194.44
21	71			5197.25	597.25	75.09	1.01	0.46	91.39 182.77
71	540			291756.30	5197.25	544.79	1.40	0.17	97.28 194.56
27	77			6085.25	885.25	82.55	1.11	0.41	94.19 188.38
77	540			291756.30	6085.25	545.61	1.41	0.16	97.33 194.66
33	83			7045.25	1245.25	90.19	1.18	0.36	95.53 191.06
83	540			291756.30	7045.25	546.48	1.42	0.15	97.36 194.72
39	89			8077.25	1677.25	97.97	1.23	0.32	96.24 192.48
89	540			291756.30	8077.25	547.43	1.43	0.14	97.39 194.78
45	95			9181.25	2181.25	105.86	1.27	0.29	96.65 193.29
95	540			291756.30	9181.25	548.44	1.44	0.13	97.41 194.82
51	101			10357.25	2757.25	113.83	1.30	0.26	96.89 193.79
101	540			291756.30	10357.25	549.51	1.45	0.12	97.42 194.85
57	107			11605.25	3405.25	121.88	1.33	0.24	97.05 194.11
107	540			291756.30	11605.25	550.64	1.45	0.12	97.43 194.87

Increment of Stress = 3645.02 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 4. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 17.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	3115.25	315.25	55.89	0.16	0.17	20.80	41.59
53	540	291906.30	3115.25	542.88	1.25	0.30	96.18	192.37
9	59	3787.25	387.25	62.20	0.45	0.43	54.57	109.14
59	540	291906.30	3787.25	543.50	1.28	0.27	96.52	193.05
15	65	4531.25	531.25	68.97	0.68	0.52	74.47	148.95
65	540	291906.30	4531.25	544.18	1.31	0.25	96.76	193.51
21	71	5347.25	747.25	76.08	0.84	0.52	84.72	169.45
71	540	291906.30	5347.25	544.93	1.33	0.23	96.92	193.85
27	77	6235.25	1035.25	83.45	0.96	0.49	89.97	179.94
77	540	291906.30	6235.25	545.74	1.35	0.22	97.04	194.09
33	83	7195.25	1395.25	91.02	1.04	0.45	92.78	185.55
83	540	291906.30	7195.25	546.62	1.36	0.20	97.13	194.26
39	89	8227.25	1827.25	98.73	1.11	0.41	94.37	188.74
89	540	291906.30	8227.25	547.56	1.37	0.19	97.20	194.40
45	95	9331.25	2331.25	106.57	1.16	0.38	95.33	190.66
95	540	291906.30	9331.25	548.57	1.39	0.18	97.25	194.50
51	101	10507.25	2907.25	114.49	1.20	0.35	95.93	191.87
101	540	291906.30	10507.25	549.64	1.40	0.17	97.29	194.58
57	107	11755.25	3555.25	122.49	1.23	0.32	96.33	192.67
107	540	291906.30	11755.25	550.78	1.41	0.16	97.32	194.65

Increment of Stress = 3537.82 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 5. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 22.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	3315.25	515.25	57.66	0.12	0.14	16.21	32.41
53	540	292106.30	3315.25	543.06	1.17	0.36	94.91	189.81
9	59	3987.25	587.25	63.78	0.35	0.37	44.71	89.42
59	540	292106.30	3987.25	543.68	1.20	0.34	95.55	191.10
15	65	4731.25	731.25	70.40	0.55	0.49	64.79	129.57
65	540	292106.30	4731.25	544.36	1.24	0.31	96.00	192.00
21	71	5547.25	947.25	77.38	0.71	0.54	77.21	154.43
71	540	292106.30	5547.25	545.11	1.26	0.29	96.33	192.65
27	77	6435.25	1235.25	84.64	0.83	0.53	84.57	169.14
77	540	292106.30	6435.25	545.93	1.28	0.27	96.56	193.13
33	83	7395.25	1595.25	92.11	0.92	0.51	88.94	177.89
83	540	292106.30	7395.25	546.80	1.30	0.26	96.74	193.49
39	89	8427.25	2027.25	99.74	1.00	0.48	91.62	183.23
89	540	292106.30	8427.25	547.75	1.32	0.24	96.88	193.76
45	95	9531.25	2531.25	107.50	1.06	0.45	93.31	186.62
95	540	292106.30	9531.25	548.75	1.33	0.23	96.98	193.97
51	101	10707.25	3107.25	115.36	1.10	0.42	94.42	188.84
101	540	292106.30	10707.25	549.82	1.35	0.22	97.07	194.14
57	107	11955.25	3755.25	123.31	1.14	0.39	95.17	190.35
107	540	292106.30	11955.25	550.96	1.36	0.21	97.13	194.27

Increment of Stress = 3430.22 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 6. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth
z = 27.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	3565.25	765.25	59.79	0.10	0.12	13.19	26.38
53	540	292356.30	3565.25	543.29	1.09	0.41	93.17	186.33
9	59	4237.25	837.25	65.71	0.29	0.32	37.47	74.94
59	540	292356.30	4237.25	543.91	1.13	0.39	94.19	188.39
15	65	4981.25	981.25	72.15	0.46	0.45	56.49	112.97
65	540	292356.30	4981.25	544.59	1.17	0.36	94.93	189.86
21	71	5797.25	1197.25	78.98	0.60	0.52	69.81	139.63
71	540	292356.30	5797.25	545.34	1.20	0.34	95.47	190.93
27	77	6685.25	1485.25	86.11	0.72	0.55	78.64	157.27
77	540	292356.30	6685.25	546.15	1.22	0.32	95.87	191.74
33	83	7645.25	1845.25	93.46	0.82	0.54	84.38	168.76
83	540	292356.30	7645.25	547.03	1.25	0.30	96.17	192.34
39	89	8677.25	2277.25	100.99	0.90	0.52	88.14	176.28
89	540	292356.30	8677.25	547.98	1.27	0.29	96.41	192.81
45	95	9781.25	2781.25	108.66	0.96	0.50	90.65	181.30
95	540	292356.30	9781.25	548.98	1.28	0.27	96.59	193.18
51	101	10957.25	3357.25	116.44	1.01	0.47	92.36	184.72
101	540	292356.30	10957.25	550.05	1.30	0.26	96.73	193.46
57	107	12205.25	4005.25	124.32	1.06	0.45	93.56	187.12
107	540	292356.30	12205.25	551.19	1.31	0.25	96.85	193.70

Increment of Stress = 3322.09 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 7. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 32.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	3865.25	1065.25	62.24	0.08	0.10	11.04	22.08
53	540	292656.30	3865.25	543.57	1.02	0.45	91.02	182.03
9	59	4537.25	1137.25	67.96	0.24	0.28	31.98	63.96
59	540	292656.30	4537.25	544.18	1.06	0.43	92.48	184.96
15	65	5281.25	1281.25	74.20	0.38	0.41	49.55	99.11
65	540	292656.30	5281.25	544.87	1.10	0.40	93.55	187.10
21	71	6097.25	1497.25	80.86	0.52	0.50	62.98	125.96
71	540	292656.30	6097.25	545.62	1.14	0.38	94.34	188.69
27	77	6985.25	1785.25	87.83	0.63	0.54	72.66	145.31
77	540	292656.30	6985.25	546.43	1.17	0.36	94.95	189.89
33	83	7945.25	2145.25	95.05	0.73	0.55	79.44	158.88
83	540	292656.30	7945.25	547.31	1.19	0.34	95.41	190.81
39	89	8977.25	2577.25	102.46	0.81	0.55	84.17	168.33
89	540	292656.30	8977.25	548.25	1.22	0.33	95.77	191.53
45	95	10081.25	3081.25	110.03	0.87	0.54	87.47	174.95
95	540	292656.30	10081.25	549.26	1.24	0.31	96.05	192.10
51	101	11257.25	3657.25	117.72	0.93	0.52	89.82	179.65
101	540	292656.30	11257.25	550.32	1.25	0.30	96.27	192.55
57	107	12505.25	4305.25	125.52	0.98	0.49	91.52	183.03
107	540	292656.30	12505.25	551.46	1.27	0.28	96.46	192.91

Increment of Stress = 3213.81 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 8. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 37.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	4215.25	1415.25	64.99	0.07	0.09	9.42	18.84
53	540	293006.30	4215.25	543.89	0.95	0.47	88.54	177.09
9	59	4887.25	1487.25	70.49	0.20	0.25	27.68	55.37
59	540	293006.30	4887.25	544.51	1.00	0.46	90.46	180.91
15	65	5631.25	1631.25	76.53	0.33	0.38	43.78	87.55
65	540	293006.30	5631.25	545.19	1.04	0.44	91.89	183.77
21	71	6447.25	1847.25	83.00	0.45	0.47	56.85	113.71
71	540	293006.30	6447.25	545.94	1.08	0.42	92.97	185.94
27	77	7335.25	2135.25	89.80	0.55	0.52	66.91	133.83
77	540	293006.30	7335.25	546.75	1.11	0.40	93.80	187.60
33	83	8295.25	2495.25	96.87	0.65	0.55	74.41	148.82
83	540	293006.30	8295.25	547.63	1.14	0.38	94.45	188.89
39	89	9327.25	2927.25	104.15	0.73	0.56	79.91	159.82
89	540	293006.30	9327.25	548.57	1.17	0.36	94.96	189.91
45	95	10431.25	3431.25	111.61	0.80	0.56	83.94	167.88
95	540	293006.30	10431.25	549.57	1.19	0.35	95.36	190.72
51	101	11607.25	4007.25	119.20	0.86	0.54	86.90	173.81
101	540	293006.30	11607.25	550.64	1.21	0.33	95.68	191.37
57	107	12855.25	4655.25	126.90	0.91	0.53	89.11	178.21
107	540	293006.30	12855.25	551.77	1.23	0.32	95.95	191.90

Increment of Stress = 3105.92 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Table 9. Approach Embankment Settlement
Summary Calculations for Increment of Stresses at Depth

z = 42.5 feet

b	l	R_1^2	R_2^2	R_3	C_1	C_2	Increment σ_z	
3	53	4615.25	1815.25	68.00	0.05	0.08	8.15	15.29
53	540	293406.30	4615.25	544.26	0.89	0.49	85.84	171.68
9	59	5287.25	1887.25	73.27	0.17	0.22	24.23	48.26
59	540	293406.30	5287.25	544.87	0.94	0.48	88.19	176.37
15	65	6031.25	2031.25	79.10	0.28	0.34	38.92	77.84
65	540	293406.30	6031.25	545.56	0.99	0.46	89.98	179.97
21	71	6847.25	2247.25	85.37	0.39	0.44	51.43	102.86
71	540	293406.30	6847.25	546.30	1.03	0.45	91.37	182.74
27	77	7735.25	2535.25	92.00	0.49	0.50	61.55	123.11
77	540	293406.30	7735.25	547.12	1.06	0.43	92.45	184.90
33	83	8695.25	2895.25	98.92	0.58	0.54	69.47	138.95
83	540	293406.30	8695.25	547.99	1.09	0.41	93.30	186.61
39	89	9727.25	3327.25	106.06	0.66	0.56	75.55	151.11
89	540	293406.30	9727.25	548.93	1.12	0.40	93.98	187.96
45	95	10831.25	3831.25	113.39	0.73	0.57	80.19	160.37
95	540	293406.30	10831.25	549.94	1.14	0.38	94.52	189.05
51	101	12007.25	4407.25	120.86	0.79	0.56	83.71	167.42
101	540	293406.30	12007.25	551.01	1.17	0.36	94.96	189.93
57	107	13255.25	5055.25	128.47	0.84	0.55	86.40	172.80
107	540	293406.30	13255.25	552.14	1.19	0.35	95.32	190.64

Increment of Stress = 2999.06 (psf)

where: $C_1 = \arctg\left(\frac{lb}{zR_3}\right)$

$$C_2 = \frac{lbz}{R_3} \left(\frac{1}{R_1^2} + \frac{1}{R_2^2} \right)$$

$$\sigma_z = \frac{P}{2\pi} (C_1 + C_2)$$

Compute settlement.

- Use the following expression:

$$\rho = \sum_{i=1}^n \rho_i = \sum_{i=1}^n H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$$

where:

n = number of sublayers = 7

H_i = thickness of each sublayer = 5 ft

$$CR = \text{Virgin Compression Ratio} = \frac{C_c}{(1 + e_0)}$$

$\bar{\sigma}_{vf}$ = Final vertical effective stress = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$

$\bar{\sigma}_{v0}$ = Initial vertical effective stress

- Determine value of CR :

$$CR = \frac{C_c}{(1 + e_0)}$$

$$\text{Use: } G_w = Se \Rightarrow e = \frac{G_w}{S}$$

$$\text{Therefore: } e_0 = \frac{G_w}{S} = \frac{2.78 \times 0.35}{1} \quad \text{Note: Assumed } S = 100\%$$

$$e_0 = 0.973$$

$$\text{Thus: } CR = \frac{C_c}{(1 + e_0)} = \frac{0.35}{(1 + 0.973)} = 0.177$$

- Apply expressions above; obtain table below:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf}$ (psf) = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	$\rho_i = H_i CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{v0}} \right)$
12.5	949.5	3645.024	4594.524	0.6073516 ft
17.5	1272.5	3537.818	4810.318	0.5122418
22.5	1595.5	3430.215	5025.715	0.4419801
27.5	1918.5	3322.095	5240.595	0.3870922
32.5	2241.5	3213.811	5455.311	0.3426211
37.5	2564.5	3105.922	5670.422	0.3056625
42.5	2887.5	2999.06	5886.56	0.2743762
Total Settlement:				2.8713 ft
				34.46 in

Compilation of Computer Screens for Example 2

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
Version 2.00/October 1991	Hit <F10> to continue

OPENING SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then < > Make selection.

EMBANK MAIN MENU - SELECTION OF PROJECT DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROJECT DEFINITION Client = Any client Project Name = Approach Embankment Project Manager = AUM File Name = EXAMPLE2.EMB Date = 3/13/92 (MM/DD/YY) Computed by = aum Hit <F10> to accept values
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

PROJECT DEFINITION SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

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EMBANK MAIN MENU - SELECTION OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. soil Profile and soil param. Void ratio per Δlog stress Strain per Δlog stress Run program Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection. <Esc> $\rightarrow$ Main Menu

SOIL PROFILE MENU - SELECTION OF VOID RATIO PER LOG STRESS

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 100.00
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 110.00
Sublayer n	Type of layer = <u>Incompressible</u>
Sublayer 1	
Sublayer 2	
Is this the last layer of profile No	
Hit <F10> to continue	
Space Bar-Next item Alt-M-Menu	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #1

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 2	Elev. of top of layer = 98.00
Sublayer 1	Number of sublayers = 7 (for this layer)
:	Unit weight of soil = 127.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 2	Compression Index Esti Initial void ratio
	Recompression Index Esti Initial water content
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue	
Press space bar to see menu options and then <Ret> to input values	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #2

Layer Soil Properties		ADMINISTRATION	
Initial Water Content = 35.00%		layer = 98.00	
Specific Gravity of Solids = 2.78		yers = 7 (for this layer)	
Degree of Saturation = 100.00%		soil = 127.00	
Hit <F10> to accept values			
Sublayer n	1	Type of layer = Compressible	
Sublayer 1		Layer soil properties = Initial water content	
Sublayer 2	Layer 2	Compression Index Estimated from e-logp curves	
		Recompression Index Estimated from e-logp curves	
		Swelling Index Estimated from e-logp curves	
		Is this the last layer of profile No	
Hit <F9> to Prev. Layer Hit <F10> to continue			

INITIAL WATER CONTENT - LAYER #2

ACTION	
Layer Number = 2	Elev. of top of layer = 98.00
Sublayer 1	Number of sublayers = 7 (for this layer)
:	Unit weight of soil = 127.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
:	Compression Index Estimated from e-logp curves
Sublayer 2	Recompression Index Estimated from e-logp curves
	Swelling Index Computed using FHWA(1982)
Is this the last layer of profile No	
Hit <F9> to Prev. Layer Hit <F10> to continue	
Press space bar to see menu options and then <Ret> to input values	
COMPRESSION INDEX MENU - FHWA(1982)	

Compression Index	
The Federal Highway Administration (FHWA) in the soil and Foundations Workshop Manual (1982) estimates the Compression Index by dividing the initial soil moisture content by 100.	
Comp. Index = Initial Water Content (in %) / Constant where constant = 100	
Constant = 100	
Hit <F10> to accept value	
Sublayer 2	Layer 2
Compression Index	Computed using FHWA(1982)
Recompression Index	Estimated from e-logp curves
Swelling Index	Estimated from e-logp curves
Is this the last layer of profile No	
Hit <F9> to Prev. Layer Hit <F10> to continue	
FHWA(1982) PROCEDURE SCREEN	

Compression Index	
Layer Number = 2	Elev. of top of layer = 98.00
Sublayer 1	Number of sublayers = 7 (for this layer)
:	Unit weight of soil = 127.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
Sublayer 2	Compression Index Computed using FHWA(1982)
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves Computed using FHWA(1982)
	Is this the last lay

Hit <F9> to Prev. Layer Hit <F10> to continue
Press space bar to see menu options and then <Ret> to input values

RECOMPRESSION INDEX MENU - FHWA(1982)

Recompression Index	
The Federal Highway Administration (FHWA) in the soils and Foundations Workshop Manual (1982) estimates the Recompression Index by dividing the initial soil moisture content by 1000.	
Recomp. Index = Initial Water Content (in %) / Constant	
where Constant = 1000	
Hit <F10> to accept values	
Sublayer 2	Layer 2
	Compression Index Computed using FHWA(1982)
	Recompression Index Computed using FHWA(1982)
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue	

RECOMPRESSION INDEX - FHWA(1982) PROCEDURE SCREEN

Recompression Index	
Layer Number = 2	Elev. of top of layer = 98.00
Sublayer 1	Number of sublayers = 7 (for this layer)
:	Unit weight of soil = 127.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
:	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Computed using FHWA(1982)
	Swelling Index Estimated from e-logp curves
	Is this the last lay Estimated from e-logp curves
	Same as recompression index
Hit <F9> to Prev. Layer	
Press space bar to see menu options and then <Ret> to input values	
SWELLING INDEX - LAYER #2	

Recompression Index	
Layer Number = 2	Elev. of top of layer = 98.00
Sublayer 1	Number of sublayers = 7 (for this layer)
:	Unit weight of soil = 127.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
:	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Computed using FHWA(1982)
	Swelling Index Same as recompression index
	Is this the last layer of profile <u>Yes</u>
Hit <F9> to Prev. Layer Hit <F10> to continue	
Space Bar-Next item Alt-M-Menu	

DEFINING LAYER #2 AS LAST LAYER OF SOIL PROFILE

Recompression Index	
Layer Number = 2	Elev. of top of layer = 98.00
Number of sublayers = 7 (for this layer)	
Sublayer 1	Elev. of bottom of last layer = 55.00
Sublayer n	
Sublayer 1	Hit <F10> to accept value
Sublayer 2	Compression Index Computed using FHWA(1982)
	Recompression Index Computed using FHWA(1982)
	Swelling Index Same as recompression index
	Is this the last layer of profile Yes
Hit <F9> to Prev. Layer Hit <F10> to continue	

DEFINING THE THICKNESS OF THE SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - SELECTION OF WATER TABLE DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK Water Table Definition Elev. of Water Table = 95.00 Hit <F10> to accept values	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment Units ile m S PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
A Microcomputer pro dimensional compress due to embankment loa the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	

WATER TABLE AT ELEVATION 95 FT.

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK Water Table Definition Elev. of Water Table = 95.00 Hit <F10> to accept values	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Stress history Normally consolidated soil User defined stress history E PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	

Enter letter only, or use arrows then ← → Make selection. <Esc> Main Menu

COMPRESSIBLE LAYER IS DEFINED AS NORMALLY CONSOLIDATED

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Vertical stress increment strip Symmetrical vertical embankment loading - increment of stresses Beneath the end of a fill
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Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

VERTICAL STRESS INCREMENT MENU - SELECTION OF END OF FILL CONDITION

END OF FILL CONDITION

CHARACTERISTICS OF FILL Height of fill = 30.00 Width of top of fill w = 100.00 Unit weight of fill = 130.00		
COORDINATES Point A: x1 = 0.00 y1 = 0.00 Point B: x2 = 60.00 y2 = 60.00		
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = 110.00 y coordinate = 60.00		param. ent ading a fill
FOUNDATION ELEV. z = 100.00		INC. e 90 rzua

Hit <F10> to accept values

END OF FILL GEOMETRY - POINT A COORDINATES

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration								
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION								
No.	LAYER TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	10.0	-----	-----	-----	110.00	-----	-----
2	COMP.	35.0	0.350	0.035	0.035	127.00	2.78	0.97
Total Settlement =								34.46
SOIL STRESSES								
No.	SUBLAYER		INITIAL INCREMENT			MAX. PAST PRESS. (psf)	SETTLEMENT	
	THICK. (ft)	ELEV. (ft)	(psf)	(psf)	(psf)		(in.)	
1	INCOMP.							
2	5.00	87.50	949.50	3645.03	949.50		7.29	
3	5.00	82.50	1272.50	3537.82	1272.50		6.15	
4	5.00	77.50	1595.50	3430.22	1595.50		5.30	
5	5.00	72.50	1918.50	3322.11	1918.50		4.65	
6	5.00	67.50	2241.50	3213.84	2241.50		4.11	
7	5.00	62.50	2564.50	3105.97	2564.50		3.67	

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

PROGRAM OUTPUT - PARTIAL SCREEN

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration								
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION								
No.	LAYER TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	10.0	-----	-----	-----	110.00	-----	-----
2	COMP.	35.0	0.350	0.035	0.035	127.00	2.78	0.97
Total Settlement =								34.46
No.	SUBLAYER		INITIAL INCR			MAX. PAST PRESS. (psf)	SETTLEMENT	
	THICK. (ft)	ELEV. (ft)	(psf)	(p	(psf)		(in.)	
1	INCOMP.							
2	5.00	87.50	949.50	3645.03	949.50		7.29	
3	5.00	82.50	1272.50	3537.82	1272.50		6.15	
4	5.00	77.50	1595.50	3430.22	1595.50		5.30	
5	5.00	72.50	1918.50	3322.11	1918.50		4.65	
6	5.00	67.50	2241.50	3213.84	2241.50		4.11	
7	5.00	62.50	2564.50	3105.97	2564.50		3.67	

Select
Send form to: ☐-Printer, ☐-Disk File.

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISK FILE PRINTED OUTPUT

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

y direc. = 60.00 (ft) Unit weight of fill = 130.00 (pcf)
 Embankment top width = 100.00 (ft) p load/unit area = 3900.00 (psf)
 Embankment bottom width = 220.00 (ft) Foundation Elev. = 100.00 (ft)
 Ground Surface Elev. = 100.00 (ft)
 Water table Elev. = 95.00 (ft) Unit weight of Wat. = 62.40 (pcf)

No.	LAYER		COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)
	TYPE	THICK. (ft)	COMP.	RECOMP.	SWELL.				
1	INCOMP.	10.0							
2	COMP.	35.0	0.350	0.035	0.035				

Destination File EXAM2A.OUT

Total Settlement = 34.46

No.	SUBLAYER		SOIL STRESSES			SETTLEMENT (in.)
	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	INCREMENT (psf)	MAX. PAST PRESS. (psf)	
1	INCOMP.	10.0				
2	COMP.	35.0				

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

DISK FILE PRINTED OUTPUT - DESTINATION OUTPUT FILE NAME

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name : Approach Embankment Client : Any Client
 File Name : EXAM2A.EMB Project Manager : AUM
 Date : 10/02/91 Computed by : aum

Settlement for X = 110.00 (ft) Y = 60.00 (ft)

Embank. slope, x direc. = 60.00 (ft) Height of fill H = 30.00 (ft)
 y direc. = 60.00 (ft) Unit weight of fill = 130.00 (pcf)
 Embankment top width = 100.00 (ft) p load/unit area = 3900.00 (psf)
 Embankment bottom width = 220.00 (ft) Foundation Elev. = 100.00 (ft)
 Ground Surface Elev. = 100.00 (ft)
 Water table Elev. = 95.00 (ft) Unit weight of Wat. = 62.40 (pcf)

No.	LAYER		COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)
	TYPE	THICK. (ft)	COMP.	RECOMP.	SWELL.				
1	INCOMP.	10.0				110.00			
2	COMP.	35.0	0.350	0.035	0.035	127.00	2.78	0.97	34.46

Total Settlement = 34.46

No.	SUBLAYER		SOIL STRESSES			SETTLEMENT (in.)
	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	INCREMENT (psf)	MAX. PAST PRESS. (psf)	
1	INCOMP.					
2	5.00	87.50	949.50	3645.03	949.50	7.29
3	5.00	82.50	1272.50	3537.82	1272.50	6.15
4	5.00	77.50	1595.50	3430.22	1595.50	5.30
5	5.00	72.50	1918.50	3322.11	1918.50	4.65
6	5.00	67.50	2241.50	3213.84	2241.50	4.11
7	5.00	62.50	2564.50	3105.97	2564.50	3.67
8	5.00	57.50	2887.50	2999.13	2887.50	3.29

Total Settlement = 34.46 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION



Main Menu

- project Definition
- soil Profile and soil param.
- Water table definition
- Stress history
- Vertical stress increment**

Vertical stress increment

strip Symmetrical vertical embankment loading

increment of stresses Beneath the end of a fill

A Microcomputer program for dimensional compression ver due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

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 Winchester, MA 01890
 (617) 729-2363
 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection. $\langle$ Esc $\rangle$ $\rightarrow$ Main Menu

EMBAK MAIN MENU - VERTICAL STRESS INCREMENT MENU

END OF FILL CONDITION

CHARACTERISTICS OF FILL

Height of fill = 30.00

Width of top of fill u = 100.00

Unit weight of fill = 130.00

COORDINATES

Point A: x1 = 0.00 y1 = 0.00

Point B: x2 = 60.00 y2 = 60.00

POINTS FOR COMPUTATION OF SETTLEMENT

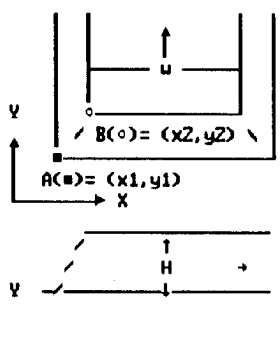
calculate in = X Point

x coordinate = 110.00

y coordinate = 0.00

FOUNDATION ELEV.

z = 100.00



Hit $\langle$ F10 $\rangle$ to accept values

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END OF FILL GEOMETRY - POINT C COORDINATES

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.
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Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration																																
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION																																
Project Name		: Approach Embankment		Client		: Any Client																										
Project Number		: 91-1235		Project Manager		: AUM																										
Date		: 10/02/91		Computed by		: aum																										
Settlement for X = 110.00(ft)				Y = 0.00 (ft)																												
Embank. slope, x direc.		= 60.00 (ft)		Height of fill H		= 30.00 (ft)																										
y direc.		= 60.00 (ft)		Unit weight of fill		= 130.00 (pcf)																										
Embankment top width		= 100.00 (ft)		p load/unit area		= 3900.00 (psf)																										
Embankment bottom width		= 220.00 (ft)		Foundation Elev.		= 100.00 (ft)																										
Ground Surface Elev.		= 100.00 (ft)		Destination File																												
Water table Elev.		= 95.00 (ft)		EXAM2C.OUT																												
<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th colspan="2">LAYER</th> <th colspan="3">COEFFICIENT</th> <th rowspan="2">UNIT WEIGHT (pcf)</th> <th rowspan="2">SPECIFIC GRAVITY</th> <th rowspan="2">VOID RATIO</th> <th rowspan="2">Settlement (in.)</th> </tr> <tr> <th>THICK. (ft)</th> <th></th> <th>COMP.</th> <th>RECOMP.</th> <th>SWELL.</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>INCOMP.</td> <td>10.0</td> <td>---</td> <td>---</td> <td>---</td> <td>110.00</td> <td>---</td> <td>---</td> <td></td> </tr> </tbody> </table>								No.	LAYER		COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)	THICK. (ft)		COMP.	RECOMP.	SWELL.	1	INCOMP.	10.0	---	---	---	110.00	---	---	
No.	LAYER		COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY		VOID RATIO	Settlement (in.)																						
	THICK. (ft)		COMP.	RECOMP.	SWELL.																											
1	INCOMP.	10.0	---	---	---	110.00	---	---																								
Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu																																

DISK FILE PRINTED OUTPUT - DESTINATION OUTPUT FILE

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name : Approach Embankment Client : Any Client
File Name : EXAMPLE2.EMB Project Manager : AUM
Date : 10/02/91 Computed by : aum

Settlement for X = 110.00 (ft) Y = 0.00 (ft)

Embank. slope, x direc. = 60.00 (ft) Height of fill H = 30.00 (ft)
y direc. = 60.00 (ft) Unit weight of fill = 130.00 (pcf)
Embankment top width = 100.00 (ft) p load/unit area = 3900.00 (psf)
Embankment bottom width = 220.00 (ft) Foundation Elev. = 100.00 (ft)
Ground Surface Elev. = 100.00 (ft)
Water table Elev. = 95.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER N#.	THICK. (ft)	COEFFICIENT COMP. RECOMP. SWELL.	UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)
1 INCOMP.	10.0	-----	110.00	-----	-----	
2 COMP.	35.0	0.350 0.035 0.035	127.00	2.78	0.97	7.51
Total Settlement =						7.51

SUBLAYER N#.	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	SOIL STRESSES INCREMENT (psf)	MAX. PAST PRESS. (psf)	SETTLEMENT (in.)
1 INCOMP.						
2	5.00	87.50	949.50	248.05	949.50	1.07
3	5.00	82.50	1272.50	343.85	1272.50	1.11
4	5.00	77.50	1595.50	432.56	1595.50	1.11
5	5.00	72.50	1918.50	513.52	1918.50	1.10
6	5.00	67.50	2241.50	586.22	2241.50	1.07
7	5.00	62.50	2564.50	650.45	2564.50	1.04
8	5.00	57.50	2887.50	706.28	2887.50	1.01
Total Settlement =						7.51 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history
Vertical stress increment

Vertical stress increment
strip Symmetrical vertical embankment loading
increment of stresses Beneath the end of a fill

A Microcomputer program for one dimensional compression versus time due to embankment loads. The program follows the equations presented by Lane & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

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Winchester, MA 01890
(617) 729-2363
Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <J> Make selection. <Esc> Main Menu

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT MENU

END OF FILL CONDITION

CHARACTERISTICS OF FILL
 Height of fill = 38.00
 Width of top of fill w = 100.00
 Unit weight of fill = 130.00

COORDINATES
 Point A: x1 = 0.00 y1 = 0.00
 Point B: x2 = 50.00 y2 = 50.00

POINTS FOR COMPUTATION OF SETTLEMENT
 calculate in = X Direction
 x1 coordinate = 38.00
 x2 coordinate = 198.00
 delta x = 80.00
 y coordinate = 38.00

FOUNDATION ELEV.
 z = 100.00

Hit <F10> to accept values

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END OF FILL GEOMETRY - SETTLEMENT IN X-DIRECTION

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

Main Menu

- project Definition
- soil Profile and soil param.
- Water table definition
- Stress history
- Vertical stress increment
- system of Units
- Maintain file
- Run program**
- Exit to DOS

PROTOTYPE ENGINEERING INC.
 57 Westland Avenue
 Winchester, MA 01890
 (617) 729-2363
 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then < > Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name : Approach Embankment Client : Any Client
Project Number : 91-1235 Project Manager : AUM
Date : 10/02/91 Computed by : aum

Settlement for X-Direction

Embank. slope, x direc. = 60.00 (ft) Height of fill H = 30.00 (ft)
y direc. = 60.00 (ft) Unit weight of fill = 130.00 (pcf)
Embankment top width = 100.00 (ft) Destination File
Embankment bottom width = 220.00 (ft) EXAMZD-D.OUT
Ground Surface Elev. = 100.00 (ft)
Water table Elev. = 95.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER NO.	TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	10.0	-----	-----	-----	110.00	----	----

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISK FILE PRINTED OUTPUT - DESTINATION FILE

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name : Approach Embankment Client : Any Client
File Name : EXAMPLE2.EMB Project Manager : AUM
Date : 10/02/91 Computed by : aum

Settlement for X-Direction

Embank. slope, x direc. = 60.00 (ft) Height of fill H = 30.00 (ft)
y direc. = 60.00 (ft) Unit weight of fill = 130.00 (pcf)
Embankment top width = 100.00 (ft) p load/unit area = 3900.00 (psf)
Embankment bottom width = 220.00 (ft) Foundation Elev. = 100.00 (ft)
Ground Surface Elev. = 100.00 (ft)
Water table Elev. = 95.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER NO.	TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
			COMP.	RECOMP.	SWELL.			
1	INCOMP.	10.0	-----	-----	-----	110.00	----	----
2	COMP.	35.0	0.350	0.035	0.035	127.00	2.78	0.97

LAYER NO.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES	
			INITIAL (psf)	MAX. PAST PRESS. (psf)
1	INCOMP.			
2	5.00	87.50	949.50	949.50
3	5.00	82.50	1272.50	1272.50
4	5.00	77.50	1595.50	1595.50
5	5.00	72.50	1918.50	1918.50
6	5.00	67.50	2241.50	2241.50
7	5.00	62.50	2564.50	2564.50
8	5.00	57.50	2887.50	2887.50

Layer	X = 30.00		X = 110.00		X = 190.00	
	Stress (psf)	Sett. (in.)	Stress (psf)	Sett. (in.)	Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.			
2	1607.73	4.58	1946.78	5.16	1607.73	4.58
3	1496.84	3.59	1941.44	4.28	1496.84	3.59
4	1404.36	2.92	1932.52	3.67	1404.36	2.92
5	1328.79	2.43	1919.59	3.21	1328.79	2.43
6	1267.55	2.07	1902.51	2.84	1267.55	2.07
7	1217.89	1.80	1881.37	2.54	1217.89	1.80
8	1177.30	1.58	1856.48	2.30	1177.30	1.58
		18.97		23.99		18.97

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - SELECTION OF MAINTAIN FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run Maintain file Exit Save file Retrive file Clear entries
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

MAINTAIN FILE MENU - SELECTION OF SAVE FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run Maintain file - Exit Save file - Destination File
A Microcomputer program for computing one dimensional compression vertical sett due to embankment loads. The program f the equations presented by Lambe&U (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	EXAMPLE2.EMB PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↩** ▶ Make selection. **(Esc)** ▶ Main Menu

SAVING INPUT FILE AS EXAMPLE2.EMB

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **↩** ▶ Make selection.

EMBANK MAIN MENU - EXIT TO DOS

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.
Enter letter only, or use arrows then ↓ > Make selection. <Esc> > Main Menu	

EXIT TO DOS MENU - YES SELECTION

Example 3

Example No. 3: Highway Embankment Settlement

This example is presented in Appendix C of the FHWA Report No. FHWA/RD-86/168, entitled "Prefabricated Vertical Drains, Vol. I: Engineering Guidelines."

Figure 12 depicts the problem geometry and soil parameters. The clay stratum is divided into three sublayers.

Table 10 presents a summary of the computer-calculated settlement for points A through G.

Table 10. Summary of Clay Surface Settlements

Point	Settlement (in)	
	Computer	Hand-Calculated
A	8.92	
B	63.07	63.09
C	62.17	
D	56.50	56.53
E	37.96	
F	14.44	14.46
G	8.92	8.95

Note that the symmetry of the problem is fully satisfied, as EMBANK predicts the same amount of settlement for points A and G.

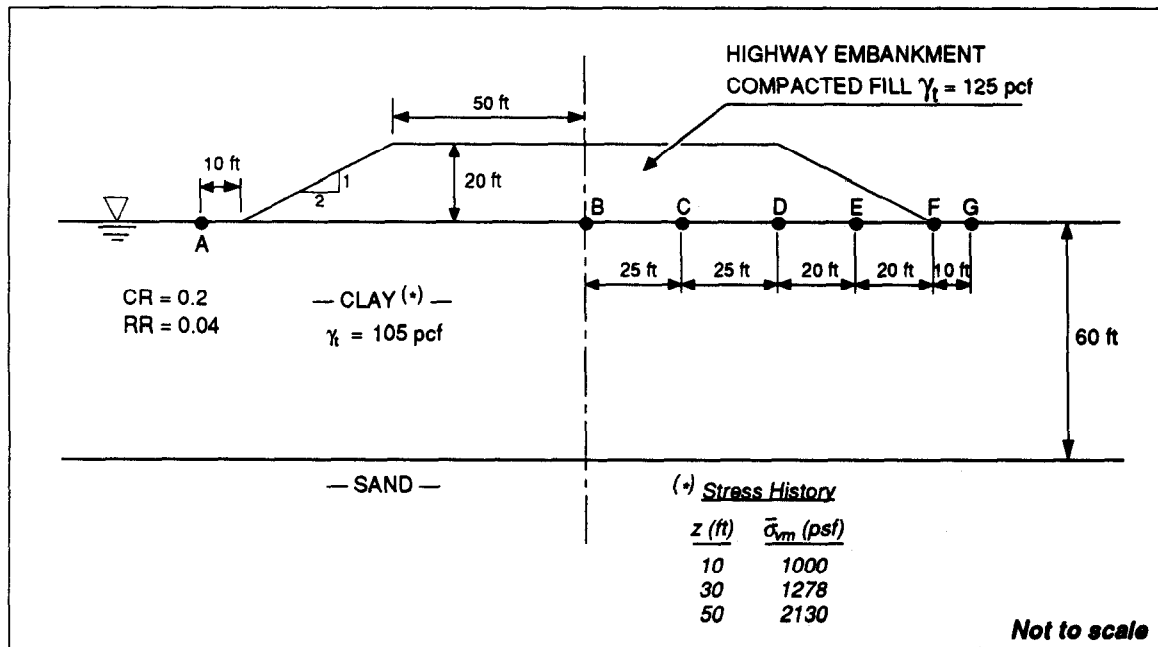
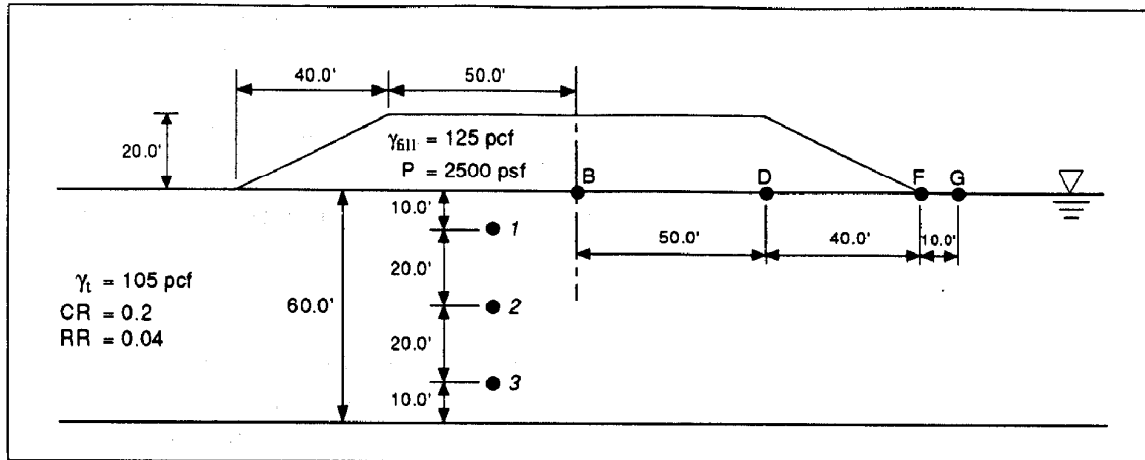


Figure 12. Example 3: Highway embankment settlement

Example No. 3: Highway Embankment Settlement



Clay is overconsolidated from 0 to 20 ft. A maximum past pressure of $\bar{\sigma}_{vm} = 1,000 \text{ psf}$ at $z = 10 \text{ ft}$ is used.

Settlement is computed at points B, D, F, and G and compared to program results.

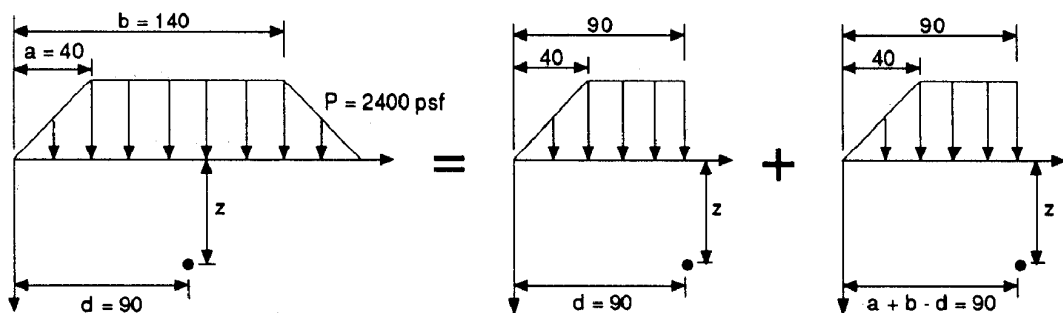
Determine geostatic effective vertical stresses at points 1, 2, and 3:

$$\bar{\sigma}_1 = 10 \times 105 - 10 \times 62.4 = 426 \text{ psf}$$

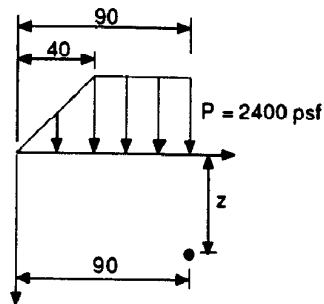
$$\bar{\sigma}_2 = 30 \times 105 - 30 \times 62.4 = 1278 \text{ psf}$$

$$\bar{\sigma}_3 = 50 \times 105 - 50 \times 62.4 = 2130 \text{ psf}$$

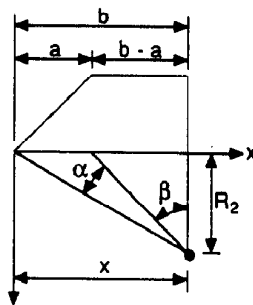
Determine increments of vertical stress under point B; use principle of superposition, as explained in figure 5 of main text:



Therefore, increments of vertical stresses are computed in this case as two times the vertical stress increment for:



For the general case shown below:



The vertical stresses are given by

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

In this case:

$$a = 40$$

$$b = 90$$

$$b - a = 50$$

$$x = 90$$

$$x - b = 0$$

$$\text{Therefore: } \sigma_z = \frac{P}{\pi} \left[\beta + \frac{90\alpha}{40} \right] = \frac{P}{\pi} [\beta + 2.25\alpha]$$

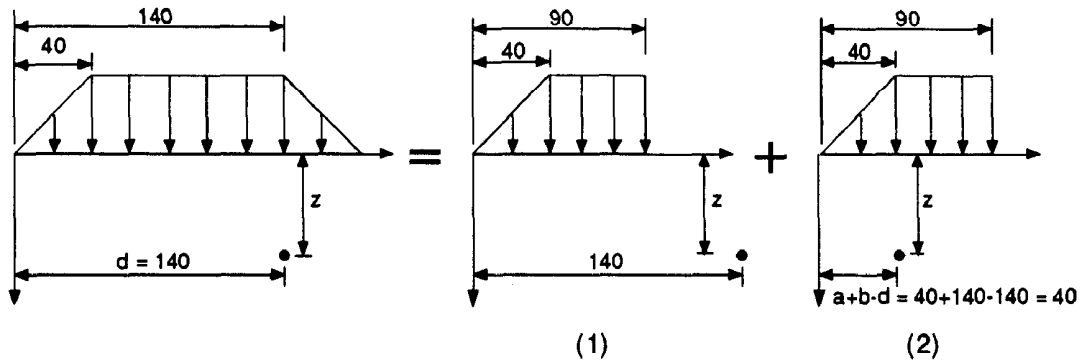
$$\tan \beta = \frac{(b-a)}{z} = \frac{50}{z} \Rightarrow \beta = \arctan\left(\frac{50}{z}\right)$$

$$\tan(\alpha + \beta) = \frac{b}{z} = \frac{90}{z} \Rightarrow \alpha = \arctan\left(\frac{90}{z}\right) - \beta$$

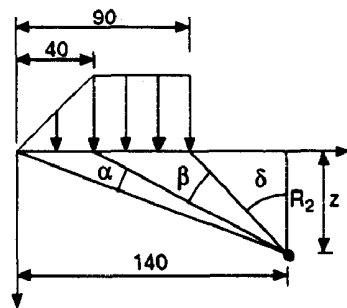
Compute stress increments for $z = 10, 30,$ and 50 ft:

z (ft)	$\beta = \arctan\left(\frac{50}{z}\right)$	$\alpha = \arctan\left(\frac{90}{z}\right) - \beta$	$\sigma_z = \frac{P}{\pi} [\beta + 2.25\alpha]$	$2\sigma_z$ psf
10	78.69006	4.969741	1,248.222	2,496.444
30	59.03625	12.52881	1,211.473	2,422.940
50	45.0	15.94539	1,123.294	2,246.5870

Determine increments of vertical stress under point D; use principle of superposition, as indicated below:



For (1) we have:



$$x = 140$$

$$a = 40$$

$$b = 90$$

$$(x - b) = 50$$

$$\frac{x}{a} = \frac{140}{40} = 90$$

$$R_2^2 = z^2 + (x - b)^2 \Rightarrow R_2^2 = z^2 + 50^2$$

$$\tan \delta = \frac{(x - b)}{z} = \frac{50}{z} \Rightarrow \delta = \arctan\left(\frac{50}{z}\right)$$

$$\tan(\beta + \delta) = \frac{100}{z} \Rightarrow \beta = \arctan\left(\frac{100}{z}\right) - \delta$$

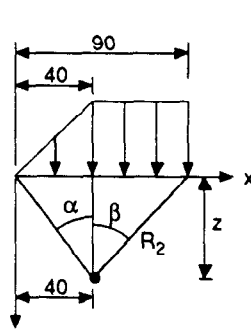
$$\tan(\delta + \beta + \alpha) = \frac{140}{z} \Rightarrow \alpha = \arctan\left(\frac{140}{z}\right) - \delta -$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right] = \frac{P}{\pi} \left[\beta + 3.5\alpha - \frac{50z}{R_2^2} \right]$$

The results for $z = 10, 30$, and 50 ft are:

z (ft)	δ	β	α	$R_2^2 = z^2 + 50^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	78.69006	5.599341	1.62497	2,600	0.1923077	3.726639
30	59.03625	14.26451	4.60449	3,400	0.4411765	70.87047
50	45.0	18.43495	6.911229	5,000	0.5	194.1161

For the second superposition step (2), we have:



$$x = 40$$

$$a = 40$$

$$b = 90$$

$$(x - b) = (40 - 90) = -50$$

$$\frac{x}{a} = \frac{40}{40} = 1$$

$$R_2^2 = z^2 + 50^2$$

$$\tan \beta = \frac{50}{z} \Rightarrow \beta = \arctan\left(\frac{50}{z}\right)$$

$$\tan \alpha = \frac{40}{z} \Rightarrow \alpha = \arctan\left(\frac{40}{z}\right)$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right] \Rightarrow \sigma_z = \frac{P}{\pi} \left[\beta + \alpha + \frac{50z}{R_2^2} \right]$$

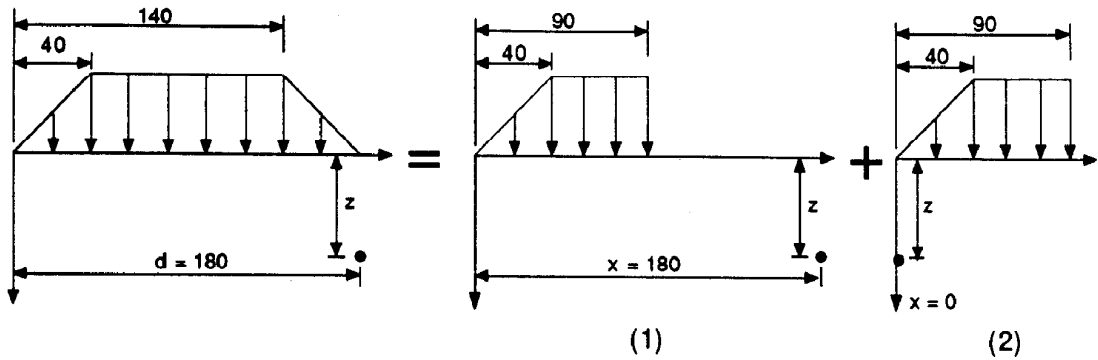
The results for $z = 10, 30$, and 50 ft are indicated in the table below:

z (ft)	α	β	$R_2^2 = z^2 + 50^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	75.96376	78.69006	2,600	0.1923077	2,301.003
30	53.13011	59.03625	3,400	0.4411765	1,908.943
50	38.65981	45.0	5,000	0.5	1,559.829

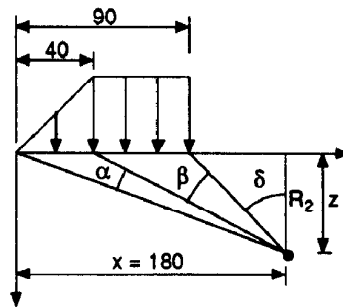
Add stress increments from steps (1) and (2) to obtain the stress increments. See table below:

z (ft)	σ_z (psf)	σ_z (psf)
10	2,301.003 + 3.726639	2,304.7296
30	1,908.943 + 70.87047	1,979.8135
50	1,559.829 + 194.1161	1,753.9451

Determine increments of vertical stress under point F; use principle of superposition as indicated below:



For superposition step (1) we have:



$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

$$x = 180$$

$$a = 40$$

$$b = 90$$

$$(x - b) = 90$$

$$\frac{x}{a} = \frac{180}{40} = 4.5$$

$$R_2^2 = z^2 + 90^2$$

$$\tan \delta = \frac{90}{z} \Rightarrow \delta = \arctan\left(\frac{90}{z}\right)$$

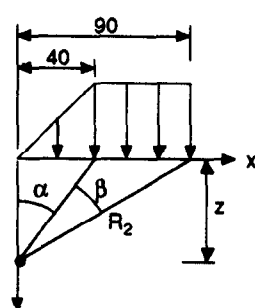
$$\tan(\beta + \delta) = \frac{140}{z} \Rightarrow \beta = \arctan\left(\frac{140}{z}\right) - \delta$$

$$\tan(\alpha + \beta + \delta) = \frac{180}{z} \Rightarrow \alpha = \arctan\left(\frac{180}{z}\right) - \delta - \beta$$

The results for $z = 10, 30$, and 50 ft are indicated in the table below:

z (ft)	δ	β	α	$R_2^2 = z^2 + 50^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	83.65981	2.25457	0.9057924	8,200	0.1097561	0.5843725
30	71.56505	6.340192	2.632437	9,000	0.3	13.85309
50	60.9454	9.400786	4.12971	10,600	0.4245283	50.84445

For the second superposition:



$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

$$x = 0$$

$$a = 40$$

$$b = 90$$

$$(x - b) = -90$$

$$\frac{x}{a} = 0$$

$$R_2^2 = z^2 + 90^2$$

$$\tan \alpha = \frac{40}{z} \Rightarrow \alpha = \arctan\left(\frac{40}{z}\right)$$

$$\tan(\alpha + \beta) = \frac{90}{z} \Rightarrow \beta = \arctan\left(\frac{90}{z}\right) - \alpha$$

Thus:
$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{90z}{R_2^2} \right]$$

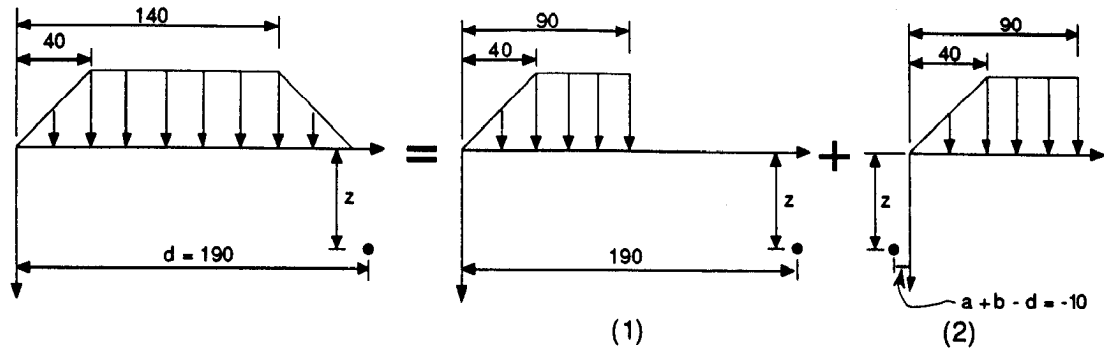
The results for $z = 10, 30$, and 50 ft are indicated in the table below:

z (ft)	α	β	$R_2^2 = z^2 + 90^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	75.96376	7.696052	8,200	0.1097561	194.2307
30	53.13011	18.43495	9,000	0.3	494.7734
50	38.65981	22.28558	10,600	0.4245283	647.3508

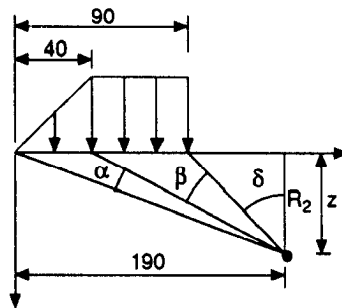
Determine actual increments of stress by adding the increments from superposition steps (1) and (2). Results are indicated in table below:

z (ft)	σ_z (psf)	σ_z (psf)
10	194.2307 + 0.5843725	194.81507
30	494.7734 + 13.85309	508.62649
50	647.3508 + 50.84445	698.19525

Determine increments of vertical stress under point G; use principle of superposition as indicated below:



For superposition step (1) we have:



$$x = 190$$

$$a = 40$$

$$b = 90$$

$$(x - b) = 100$$

$$\frac{x}{a} = \frac{190}{40} = 4.75$$

$$R_2^2 = z^2 + 100^2$$

$$\tan \delta = \frac{100}{z} \Rightarrow \delta = \arctan\left(\frac{100}{z}\right)$$

$$\tan(\beta + \delta) = \frac{150}{z} \Rightarrow \beta = \arctan\left(\frac{150}{z}\right) - \delta$$

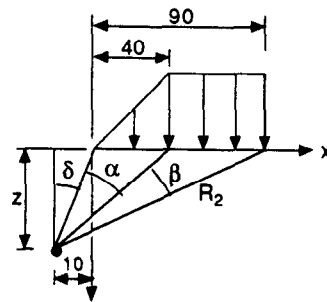
$$\tan(\alpha + \beta + \delta) = \frac{190}{z} \Rightarrow \alpha = \arctan\left(\frac{190}{z}\right) - \delta - \beta$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right] \Rightarrow \sigma_z = \frac{P}{\pi} \left[\beta + 4.75\alpha - \frac{100z}{R_2^2} \right]$$

The results for $z = 10, 30$, and 50 ft are indicated in the table below:

z (ft)	δ	β	α	$R_2^2 = z^2 + 100^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	84.28941	1.896518	0.8012836	10,100	0.0990099	0.4134162
30	73.30075	5.389313	2.337304	10,900	0.2752294	10.02816
50	63.43495	8.130105	3.691383	12,500	0.4	38.13693

For the second superposition step (2), we have:



$$x = -10$$

$$a = 40$$

$$b = 90$$

$$(x - b) = (-10 - 90) = -100$$

$$\frac{x}{a} = -0.25$$

$$R_2^2 = z^2 + 100^2$$

$$\tan \delta = \frac{10}{z} \Rightarrow \delta = \arctan\left(\frac{10}{z}\right)$$

$$\tan(\alpha + \delta) = \frac{50}{z} \Rightarrow \alpha = \arctan\left(\frac{50}{z}\right) - \delta$$

$$\tan(\alpha + \beta + \delta) = \frac{100}{z} \Rightarrow \beta = \arctan\left(\frac{100}{z}\right) - \delta - \alpha$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right] \Rightarrow \sigma_z = \frac{P}{\pi} \left[\beta - 0.25\alpha - \frac{100z}{R_2^2} \right]$$

The results for $z = 10, 30$, and 50 ft are indicated in the table below:

z (ft)	δ	β	α	$R_2^2 = z^2 + 100^2$	$\frac{z}{R_2^2} (x - b)$	σ_z (psf)
10	45.0	33.69006	5.599341	10,100	0.0990099	39.57881
30	18.43495	40.6013	14.26451	10,900	0.2752294	276.162
50	11.30993	33.69007	18.43495	12,500	0.4	457.3714

Determine actual increments of stress by adding the increments from superposition steps (1) and (2). Results are indicated in table below:

z (ft)	σ_z (psf)	σ_z (psf)
10	$39.57881 + 0.4134162$	39.992226
30	$276.162 + 10.02816$	286.19016
50	$457.3714 + 38.13693$	495.50833

Compute settlements; use expression indicated below:

$$\rho = \sum_{i=1}^3 H_i \left[RR \log \left(\frac{\bar{\sigma}_{vm}}{\bar{\sigma}_{v0}} \right) + CR \log \left(\frac{\bar{\sigma}_{vf}}{\bar{\sigma}_{vm}} \right) \right]$$

where:

H_i = thickness of each sublayer = 20 ft

$RR = 0.04$

$CR = 0.2$

$\bar{\sigma}_{vm}$ = Maximum past pressure = 1,000 psf at $z = 10$ ft

$\bar{\sigma}_{vf}$ = Final vertical effective stress = $\bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$

$\bar{\sigma}_{v0}$ = Initial vertical effective stress

• Apply expressions above for point B; obtain table below:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vm}$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	ρ_i (ft)
10	426	2496.444	1000	2922.444	2.1594571
30	1278	2422.946	1278	3700.946	1.8471276
50	2130	2246.587	2130	4376.587	1.2510239
Total Settlement:					5.2576085 ft
					63.09 in

• Similarly, at point D:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vm}$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	ρ_i (ft)
10	426	2304.7296	1000	2730.7296	2.0415871
30	1278	1979.8135	1278	3257.8135	1.6255815
50	2130	1753.9451	2130	3883.9451	1.0435739
Total Settlement:					4.7107425 ft
					56.53 in

• At point E:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vm}$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	ρ_i (ft)
10	426	194.81507	1000	620.81507	0.1308421
30	1278	508.62649	1278	1786.6265	0.5820117
50	2130	698.19525	2130	2828.1953	0.4925192
Total Settlement:					1.2053729 ft
					14.46 in

• At point G:

z (ft)	$\bar{\sigma}_{v0}$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vm}$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$	ρ_i (ft)
10	426	39.992226	1000	465.99923	0.0311753
30	1278	286.19016	1278	1564.1902	0.3510348
50	2130	495.50833	2130	2625.5083	0.3633352
Total Settlement:					0.7455453 ft
					8.95 in

Compilation of Computer Screens for Example 3

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
Version 2.00/October 1991	Hit <F10> to continue

OPENING SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then < > Make selection.

EMBANK MAIN MENU - SELECTION OF PROJECT DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
	PROJECT DEFINITION Client = Any client Project Name = Highway Embankment Project Manager = AUM File Name = EXAMPLE3.EMB Date = 3/13/92 (MM/DD/YY) Computed by = aum Hit <F10> to accept values
	Main Menu project Definition soil Profile and soil param. Water table definition y s increment s
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lamb & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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PROJECT DEFINITION SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lamb & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. soil Profile and soil param. Void ratio per olog stress Strain per olog stress Run program Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then **<↑>** Make selection. **<Esc>** Main Menu

SOIL PROFILE MENU - SELECTION OF STRAIN PER LOG STRESS

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1 Sublayer 1 : Sublayer n : Sublayer 1 : Sublayer 2	Elev. of top of layer = 0.00 Number of sublayers = 3 (for this layer) Unit weight of soil = 105.00 Type of layer = Compressible Compression Ratio = 0.200 Recompression Ratio = 0.040 Suelling Ratio = Same as Recomp. Ratio M. M. SSS Is this the last layer of profile No Hit <F10> to continue

Space Bar-Next item Alt-M-Menu

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #1

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 0.00
Sublayer 1	Number of sublayers = 3 (for this layer)
:	Unit weight of soil = 105.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Compression Ratio = 0.200
	Recompression Ratio = 0.040
Sublayer 2	Swelling Ratio = Same as Recomp. Ratio
Is this the last layer of profile Yes	
Hit <F10> to continue	

Space Bar-Next Item Alt-M-Menu

DEFINING LAYER #1 AS LAST LAYER OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 0.00
Sublayer 1	Number of sublayers = 3 (for this layer)
:	Elev. of bottom of last layer = -60.00 ible
Sublayer n	Hit <F10> to accept value
Sublayer 1	Recompression Ratio = 0.040
Sublayer 2	Swelling Ratio = Same as Recomp. Ratio
Is this the last layer of profile Yes	
Hit <F10> to continue	

DEFINING THICKNESS OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
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Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection.

EMBANK MAIN MENU - SELECTION OF WATER TABLE DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. Water table definition - Stress history - Vertical stress increment - Units - file - m - S
	Water Table Definition Elev. of Water Table = 0.00 Hit <F10> to accept values

WATER TABLE AT ELEVATION = 0.0 FT.

FEDERAL HIGHWAY ADMINISTRATION



A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history

Stress history
Normally consolidated soil
User defined stress history

E

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Winchester, MA 01890
(617) 729-2363
Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

SOIL IS OVERCONSOLIDATED - USER DEFINED STRESS HISTORY

FEDERAL HIGHWAY ADMINISTRATION



User Defined

1 STRESS HISTORY
Maximum Past Pressure with Elev.
WARNING : Maximum past pressure vs. Elevation
must be defined for complete soil profile
(Program interpolates linearly between points)

Elev.	Maximum Past Pressure	Last point
-10.00	1800.00	No

Hit <F10> to accept values

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history

Stress history
Normally consolidated soil
User defined stress history

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Dr. Alfredo Urzua

Space Bar-Next item Alt-M-Menu

STRESS HISTORY - POINT #1

FEDERAL HIGHWAY ADMINISTRATION

EMBAK

User Defined

2 STRESS HISTORY

Maximum Past Pressure with Elev.

WARNING : Maximum past pressure vs. Elevation
must be defined for complete soil profile
(Program interpolates linearly between points)

Elev.	Maximum Past Pressure	Last point
-38.00	1288.00	No

Hit <F9> to prev.point, <F18> to accept values

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history

Stress history
Normally consolidated soil
finned stress history

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Space Bar-Next item Alt-M-Menu

STRESS HISTORY - POINT #2

FEDERAL HIGHWAY ADMINISTRATION

EMBAK

User Defined

3 STRESS HISTORY

Maximum Past Pressure with Elev.

WARNING : Maximum past pressure vs. Elevation
must be defined for complete soil profile
(Program interpolates linearly between points)

Elev.	Maximum Past Pressure	Last point
-58.00	2138.00	Yes

Hit <F9> to prev.point, <F18> to accept values

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history

Stress history
Normally consolidated soil
finned stress history

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Space Bar-Next item Alt-M-Menu

STRESS HISTORY - POINT #3

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FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment
Vertical stress increment strip Symmetrical vertical embankment loading - increment of stresses Beneath the end of a fill	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

VERTICAL STRESS INCREMENT MENU - SELECTION OF STRIP SYMM. EMBANKMENT

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 40.00 Embank. width b = 140.00 Height of fill H = 20.00 Unit weight of fill = 125.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = X Point X Direction	
FOUNDATION ELEV. Z = 0.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	u n soil param. ition ncrement t nt loading nd of a fill ERING INC. Avenue A 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

←||→-Move bar ←-Select Esc-Exit

STRIP SYMM. VERTICAL EMBANKMENT LOAD - SELECTION OF X DIRECTION

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 40.00 Embank. width b = 140.00 Height of fill H = 20.00 Unit weight of fill = 125.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = -10.00 x2 coordinate = 190.00 delta x = 100.00	
FOUNDATION ELEV. Z = 0.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	u n soil param. ition ncrement t nt loading nd of a fill ERING INC. Avenue A 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

DEFINING A, B & G POINTS FOR COMPUTATION OF SETTLEMENT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration																			
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING																			
Project Name : Highway Embankment		Client : Any Client																	
Project Number : 91-1236		Project Manager : AUM																	
Date : 10/03/91		Computed by : aum																	
Settlement for X-Direction																			
Embankment slope a	=	40.00 (ft)	Height of fill H	=	20.00 (ft)														
Embankment top width	=	100.00 (ft)	Unit weight of fill	=	125.00 (pcf)														
Embankment bottom width	=	180.00 (ft)	p load/unit area	=	2500.00 (psf)														
Ground Surface Elev.	=	0.00 (ft)	Foundation Elev.	=	0.00 (ft)														
Water table Elev.	=	0.00 (ft)	Unit weight of Wat.	=	62.40 (pcf)														
<table border="1"> <thead> <tr> <th>№.</th> <th>LAYER TYPE</th> <th>THICK. (ft)</th> <th>COMP.</th> <th>RECOMP. RATIO</th> <th>SWELL.</th> <th>UNIT WEIGHT (pcf)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>COMP.</td> <td>60.0</td> <td>0.200</td> <td>0.040</td> <td>0.040</td> <td>105.00</td> </tr> </tbody> </table>						№.	LAYER TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)	1	COMP.	60.0	0.200	0.040	0.040	105.00
№.	LAYER TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)													
1	COMP.	60.0	0.200	0.040	0.040	105.00													

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

PROGRAM OUTPUT PARTIAL SCREEN

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Highway Embankment Client : Any Client
Project Number : 91-1236 Project Manager : ALM
Date : 10/03/91 Computed by : aum

Settlement for X-Direction

Embankment slope a = 40.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 100.00 (ft) Unit weight of fill = 125.00 (pcf)
Embankment bottom width = 100.00 (ft) Select
Ground Surface Elev. = 0.00 (ft) Send form to: ☐-Printer, ☒-Disk File.
Water table Elev. = 0.00 (ft)

NO.	LAYER TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)
1	COMP.	60.0	0.200	0.040	0.040	105.00

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISK FILE PRINTED OUTPUT

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Highway Embankment Client : Any Client
Project Number : 91-1236 Project Manager : ALM
Date : 10/03/91 Computed by : aum

Settlement for X-Direction

Embankment slope a = 40.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 100.00 (ft) Unit weight of fill = 125.00 (pcf)
Embankment bottom width = 100.00 (ft) Destination File
Ground Surface Elev. = 0.00 (ft) EXAM3ABG.OUT
Water table Elev. = 0.00 (ft)

NO.	LAYER TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)
1	COMP.	60.0	0.200	0.040	0.040	105.00

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF OUTPUT DESTINATION FILE NAME

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Project Name : Highway Embankment Client : Any Client
File Name : EXAMPLE3.EMB Project Manager : AUM
Date : 10/03/91 Computed by : aum

Settlement for X-Direction

Embankment slope a = 40.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 100.00 (ft) Unit weight of fill = 125.00 (pcf)
Embankment bottom width = 180.00 (ft) p load/unit area = 2500.00 (psf)
Ground Surface Elev. = 0.00 (ft) Foundation Elev. = 0.00 (ft)
Water table Elev. = 0.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER N°.	TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)
1	COMP.	60.0	0.200	0.040	0.040	105.00

N°.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES INITIAL (psf)	MAX. PAST PRESS. (psf)
1	20.00	-10.00	426.00	1000.00
2	20.00	-30.00	1278.00	1280.00
3	20.00	-50.00	2130.00	2130.00

Layer	X = -10.00 Stress (psf)	X = -10.00 Sett. (in.)	X = 90.00 Stress (psf)	X = 90.00 Sett. (in.)	X = 190.00 Stress (psf)	X = 190.00 Sett. (in.)
1	39.99	0.37	2496.44	25.91	39.99	0.37
2	286.19	4.19	2422.95	22.14	286.19	4.19
3	495.51	4.36	2246.59	15.01	495.51	4.36
		8.92		63.07		8.92

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION

EMBANK

Main Menu
project Definition
soil Profile and soil param.
Water table definition
Stress history
Vertical stress increment

Vertical stress increment
strip Symmetrical vertical embankment loading
increment of stresses Beneath the end of a fill

A Microcomputer program for
dimensional compression ver
due to embankment loads. The program follows
the equations presented by Lamb & Whitman
(1969), Ladd (1973) andoulos & Davis (1974).
For the case of a strip symmetrical vertical
embankment loading the program superimposes
two vertical embankment loads. For the
increment of vertical stresses at end of
fill, the program superimposes a series of
rectangular loads.

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(617) 729-2363
Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <F8> Make selection. <Esc> Main Menu

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT MENU

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 40.00 Embank. width b = 140.00 Height of fill H = 20.00 Unit weight of fill = 125.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Direction x1 coordinate = 140.00 x2 coordinate = 180.00 delta x = 20.00	
FOUNDATION ELEU. Z = 0.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	ERING INC. Avenue A 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

DEFINING D,E & F POINTS FOR COMPUTATION OF SETTLEMENT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <] > Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration					
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING					
No.	SUBLAYER		SOIL STRESSES		MAX. PAST PRESS.
	THICK.	ELEV.	INITIAL		
	(ft)	(ft)	(psf)		(psf)
1	20.00	-10.00	426.00		1000.00
2	20.00	-30.00	1278.00		1280.00
3	20.00	-50.00	2130.00		2130.00

Layer	X = 140.00		X = 160.00		Destination File	
	Stress	Sett.	Stress	Sett.	EXAM3DEF.OUT	
	(psf)	(in.)	(psf)	(in.)		
1	2304.73	24.50	1249.80	14.32	194.81	1.57
2	1979.81	19.48	1244.86	14.15	508.63	6.96
3	1753.95	12.52	1228.38	9.49	698.20	5.91
		56.50		37.96		14.44

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF OUTPUT DESTINATION FILE NAME

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration					
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING					
Project Name		: Highway Embankment		Client	
File Name		: EXAMPLE3.EMB		Project Manager	
Date		: 10/03/91		Computed by	
				: aum	

Settlement for X-Direction					
Embankment slope a	=	40.00 (ft)	Height of fill H	=	20.00 (ft)
Embankment top width	=	100.00 (ft)	Unit weight of fill	=	125.00 (pcf)
Embankment bottom width	=	180.00 (ft)	p load/unit area	=	2500.00 (psf)
Ground Surface Elev.	=	0.00 (ft)	Foundation Elev.	=	0.00 (ft)
Water table Elev.	=	0.00 (ft)	Unit weight of Wat.	=	62.40 (pcf)

No.	LAYER		COMP.	RECOMP.	SWELL.	UNIT WEIGHT
	TYPE	THICK.				
		(ft)		RATIO		(pcf)
1	COMP.	60.0	0.200	0.040	0.040	105.00

No.	SUBLAYER		SOIL STRESSES		MAX. PAST PRESS.
	THICK.	ELEV.	INITIAL		
	(ft)	(ft)	(psf)		(psf)
1	20.00	-10.00	426.00		1000.00
2	20.00	-30.00	1278.00		1280.00
3	20.00	-50.00	2130.00		2130.00

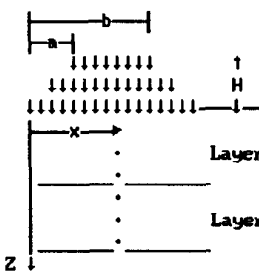
Layer	X = 140.00		X = 160.00		X = 180.00	
	Stress	Sett.	Stress	Sett.	Stress	Sett.
	(psf)	(in.)	(psf)	(in.)	(psf)	(in.)
1	2304.73	24.50	1249.80	14.32	194.81	1.57
2	1979.81	19.48	1244.86	14.15	508.63	6.96
3	1753.95	12.52	1228.38	9.49	698.20	5.91
		56.50		37.96		14.44

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for dimensional compression verification due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment Vertical stress increment strip Symmetrical vertical embankment loading increment of stresses Beneath the end of a fill PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection. $\langle$ Esc $\rangle$ $\rightarrow$ Main Menu

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT MENU

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 40.00 Embank. width b = 140.00 Height of fill H = 20.00 Unit weight of fill = 125.00 POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = 115.00 FOUNDATION ELEV. Z = 0.00	
Hit $\langle$F10$\rangle$ to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	u n soil param. ition ncrement t nt loading nd of a fill ERING INC. Avenue A 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

DEFINING POINT C COORDINATES

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration						
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING						
Water table Elev. = 0.00 (ft) Unit weight of Wat. = 62.40 (pcf)						
LAYER NO.	TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	Settlement (in.)
1	COMP.	60.0	0.200	0.040	0.040	62.17
Total Settlement =						62.17
Destination File						
EXAM3C.OUT						
SUBLAYER NO.	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	INCREMENT (psf)	MAX.PAST PRESS. (psf)	SETTLEMENT (in.)
1	20.00	-10.00	425.00	2491.19	1000.00	25.88
2	20.00	-30.00	1278.00	2360.48	1200.00	21.78
3	20.00	-50.00	2130.00	2141.78	2130.00	14.51
Total Settlement =						62.17 (in.)

Hit arrow keys to display next screen. (F8) Print. (F10) Main Menu

SELECTION OF OUTPUT DESTINATION FILE NAME

**ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING**

Project Name : Highway Embankment Client : Any Client
File Name : EXAMPLE3.EMB Project Manager : AUM
Date : 10/03/91 Computed by : aum

Settlement for X = 115.00 (ft)

Embankment slope a = 40.00 (ft) Height of fill H = 20.00 (ft)
Embankment top width = 100.00 (ft) Unit weight of fill = 125.00 (pcf)
Embankment bottom width = 180.00 (ft) p load/unit area = 2500.00 (psf)
Ground Surface Elev. = 0.00 (ft) Foundation Elev. = 0.00 (ft)
Water table Elev. = 0.00 (ft) Unit weight of Wat. = 62.40 (pcf)

LAYER N°.	TYPE	THICK. (ft)	COMP.	RECOMP. RATIO	SWELL.	UNIT WEIGHT (pcf)	Settlement (in.)
1	COMP.	60.0	0.200	0.040	0.040	105.00	62.17
Total Settlement =							62.17

N°.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES			SETTLEMENT (in.)
			INITIAL (psf)	INCREMENT (psf)	MAX.PAST PRESS. (psf)	
1	20.00	-10.00	426.00	2491.19	1000.00	25.88
2	20.00	-30.00	1278.00	2360.48	1280.00	21.78
3	20.00	-50.00	2130.00	2141.78	2130.00	14.51
Total Settlement =						62.17 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <J> Make selection.

EMBANK MAIN MENU - SELECTION OF MAINTAIN FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Run Maintain file Exit Save file Retrieve file Clear entries
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

MAINTAIN FILE MENU - SELECTION OF SAVE FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Run Maintain file Exit Save file Destination File EXAMPLE3.EMB
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. <Esc> → Main Menu

SAVING INPUT FILE AS EXAMPLE3.EMB

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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Enter letter only, or use arrows then **↵** Make selection.

EMBank MAIN MENU - EXIT TO DOS

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
PROT NG INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then **↵** Make selection. **<Esc>** Main Menu

EXIT TO DOS MENU - YES SELECTION

Example 4

Example No. 4: Embankment on Layered Soil

Figure 13 shows the problem geometry and soil parameters. The purpose of the example is to compare the settlement for the following cases:

1. The embankment bears on top of the organic soil.
2. The embankment bears on top of the sand stratum after the organic soil has been removed.

The clay layer is divided into four sublayers. The example shows the use of the foundation depth option included in EMBANK.

Table 11 presents a comparison of the computer-calculated and hand-computed settlements.

Table 11. Settlements at point A

	Settlement (in.)	
	Computer	Hand-Calculated
Embankment on top of organic soil	23.80	23.80
Embankment on top of sand stratum	10.51	10.51

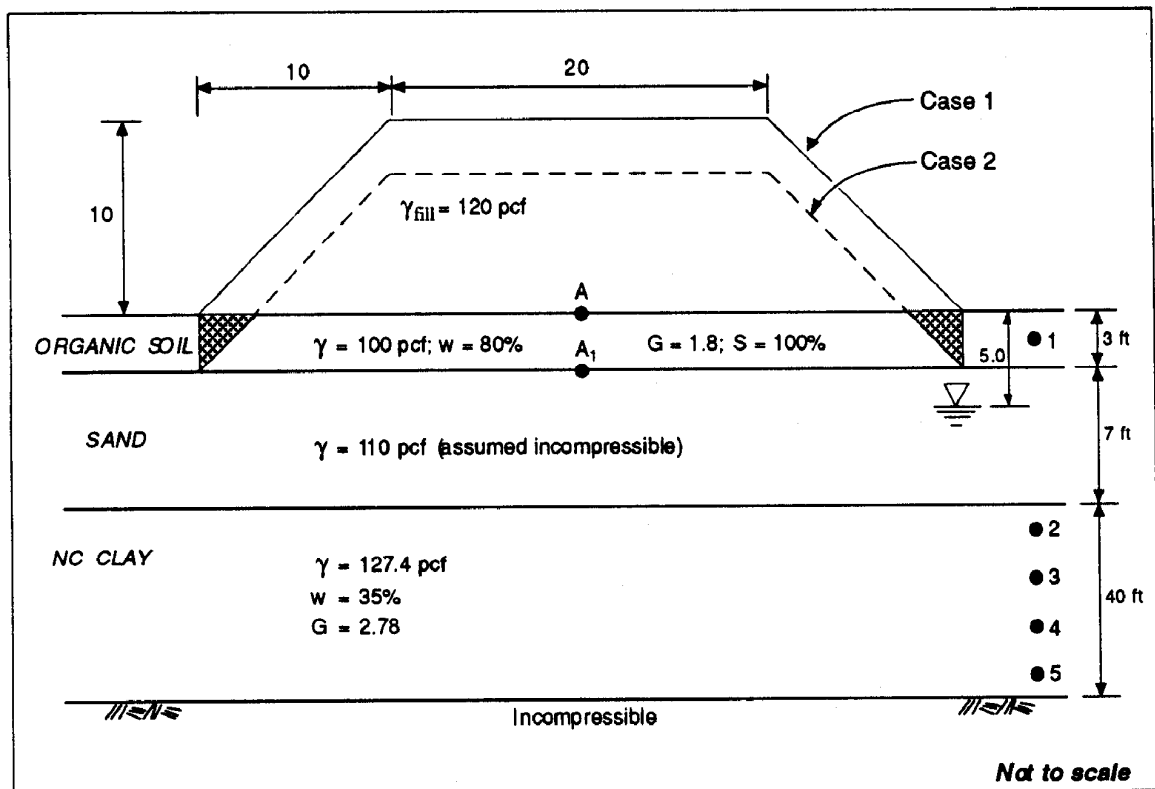


Figure 13. Example 4: Embankment on layered soil

Case 1: Embankment Bears on Top of Organic Soil

- Divide NC Clay stratum into four 10-ft thick sublayers.
- Determine geostatic vertical effective stresses at points 1 through 5:

$$\bar{\sigma}_1 = 1.5 \times 100 = 150 \text{ psf} < 200 \text{ psf, use } 200 \text{ psf}$$

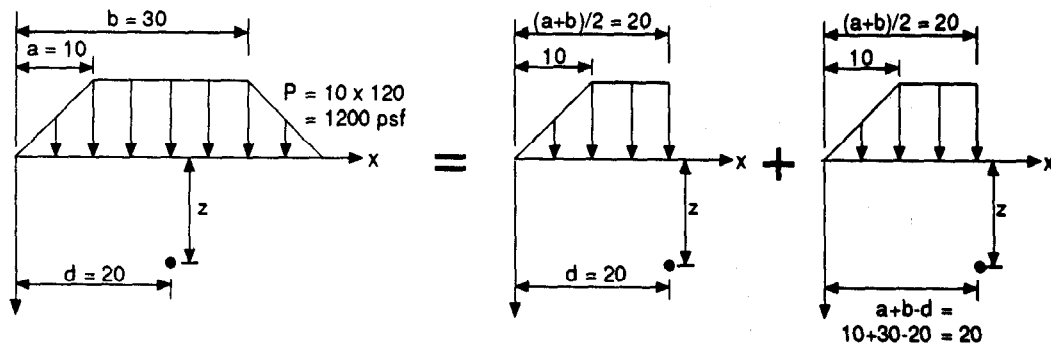
$$\bar{\sigma}_2 = 3 \times 100 + 2 \times 110 + 5(110 - 62.4) + 5(127.4 - 62.4) = 1083 \text{ psf}$$

$$\bar{\sigma}_3 = 3 \times 100 + 2 \times 110 + 5(110 - 62.4) + 15(127.4 - 62.4) = 1733 \text{ psf}$$

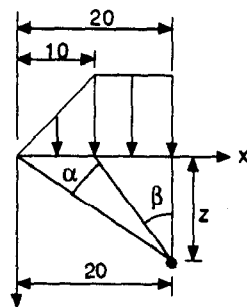
$$\bar{\sigma}_4 = 3 \times 100 + 2 \times 110 + 5(110 - 62.4) + 25(127.4 - 62.4) = 2383 \text{ psf}$$

$$\bar{\sigma}_5 = 3 \times 100 + 2 \times 110 + 5(110 - 62.4) + 35(127.4 - 62.4) = 3033 \text{ psf}$$

Determine increments of vertical stress under point A; use superposition principle as explained in Figure 5 of main text:



Therefore we compute the increments of vertical stress as two times the vertical stress increments:



The vertical stresses are given by

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{x\alpha}{a} - \frac{z}{R_2^2} (x - b) \right]$$

In this case:

$$a = 10$$

$$b = 20$$

$$x = 20$$

$$x - b = 0$$

$$\sigma_z = \frac{P}{\pi} \left[\beta + \frac{20\alpha}{10} \right] \Rightarrow \sigma_z = \frac{P}{\pi} [\beta + 2\alpha]$$

$$\tan \beta = \frac{(b-a)}{z} \Rightarrow \beta = \arctan\left(\frac{b-a}{z}\right) = \arctan\left(\frac{10}{z}\right)$$

$$\tan(\alpha + \beta) = \frac{b}{z} \Rightarrow \alpha = \arctan\left(\frac{20}{z}\right) - \beta$$

The results for $z = 1.5, 15, 25, 35$, and 45 are indicated below:

z (ft)	$\beta = \arctan\left(\frac{10}{z}\right)$	$\alpha = \arctan\left(\frac{20}{z}\right) - \beta$	$\Delta \sigma_z$ (psf)	$2\Delta \sigma_z$ [psf]
1.5	81.46924	4.241609	599.6831	1199.366
15	33.69007	19.44004	483.801	967.6019
25	21.80141	16.8584	370.1214	740.2428
35	15.9454	13.79948	290.2958	580.5915
45	12.52881	11.43368	235.9745	471.949

Settlement determination for point A:

- Use the following expression:

$$\rho = \sum_{i=1}^5 H_i \frac{C_c}{1 + e_0} \log \left(\frac{\bar{\sigma}_{v0} + \Delta \sigma_v}{\bar{\sigma}_{v0}} \right)$$

where:

H_i = thickness of each substrata

C_c = Use FHWA procedure

For organic soil layer: $C_c = \frac{w \%}{100} = 0.8$

For NC clay: $C_c = \frac{w \%}{100} = 0.35$

e_0 = Initial void ratio; use equation $Gw = Se$

where $S = 100\% = 1$. Therefore, $Gw = e$.

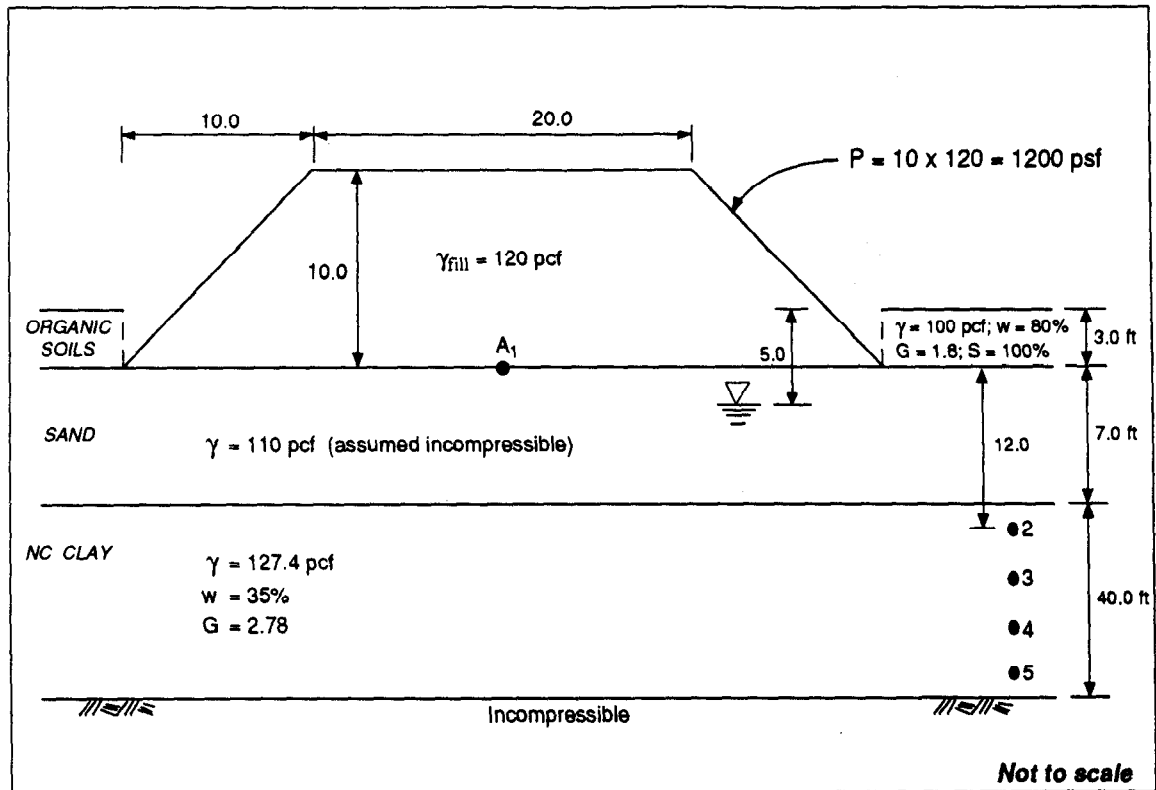
For organic soil layer: $e_0 = 1.8 \times 0.8 = 1.44$

For NC clay: $e_0 = 2.78 \times 0.35 = 0.973$

- Apply expressions above at point A, for $z = 1.5, 15, 25, 35$, and 45 ft. Results are indicated in table below:

z (ft)	H_i (ft)	$\Delta \bar{\sigma}_0$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$ (psf)	ρ_i (ft)
1.5	3.0	200	1199.366	1399.366	0.8310505
15	10.0	1083	967.6019	2050.6019	0.4918323
25	10.0	1733	740.2428	2473.2428	0.2740186
35	10.0	2383	580.5915	2963.5915	0.1679828
45	10.0	3033	471.949	3504.949	0.1114204
Total Settlement:					1.7689566 ft
					21.23 in

Case 2: Embankment Bears on Sand Stratum, After Organic Soil has Been Removed



- Determine geostatic vertical effective stresses at points 2, 3, 4, and 5. These geostatic stresses are before excavation of the organic soil layer (same values as in Case 1):

$$\bar{\sigma}_2 = 1083 \text{ psf}$$

$$\bar{\sigma}_3 = 1733 \text{ psf}$$

$$\bar{\sigma}_4 = 2383 \text{ psf}$$

$$\bar{\sigma}_5 = 3033 \text{ psf}$$

- Three feet of organic soil is excavated:

$$3 \times 100 \text{ pcf} = 300 \text{ psf}$$

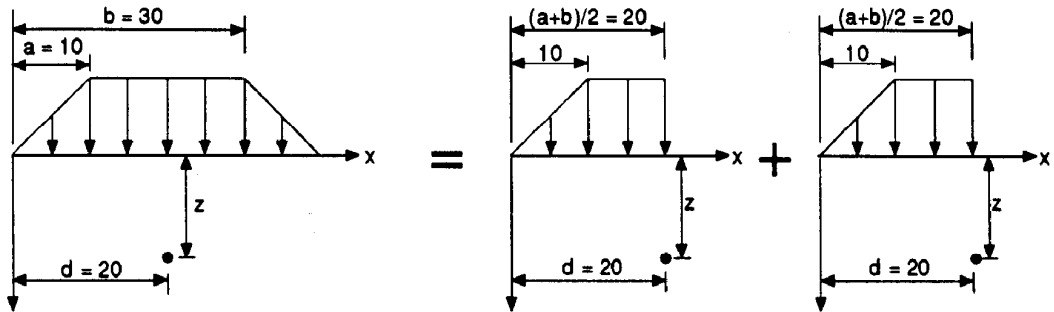
- Compute new embankment load as:

$$P' = P - 300 \text{ psf}$$

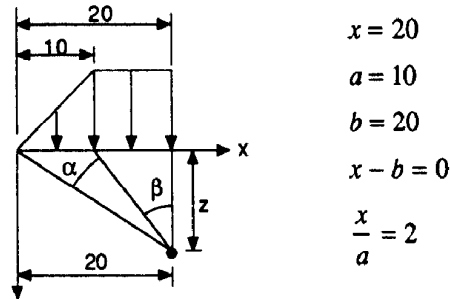
where $P = 10 \text{ ft} \times 120 \text{ pcf} = 1200 \text{ psf}$

Therefore $P' = 1200 - 300 = 900 \text{ psf}$ (considers excavation)

Determine increments of vertical stress under point A₁; use superposition principle as explained in figure 5 of main text:



Therefore we compute the increments of vertical stress as two times the vertical stress increments which result from:



Therefore:

$$\sigma_z = \frac{P}{\pi} [\beta + 2\alpha]$$

$$\tan \beta = \frac{(b-a)}{z} \Rightarrow \beta = \arctan\left(\frac{10}{z}\right)$$

$$\tan(\alpha + \beta) = \frac{b}{z} \Rightarrow \alpha = \arctan\left(\frac{20}{z}\right) - \beta$$

Compute stress increments for $z = 12, 22, 32$, and 42 ft. Results are indicated in the table below:

z (ft)	$\beta = \arctan\left(\frac{10}{z}\right)$	$\alpha = \arctan\left(\frac{20}{z}\right) - \beta$	$\Delta\sigma_z$ (psf)	$2\Delta\sigma_z$ [psf]
12	39.80557	19.23068	391.3346	782.6692
22	24.44395	17.82974	300.5171	601.0342
32	17.35403	14.65136	233.2837	466.5674
42	13.3925	12.07085	187.671	375.3419

Settlement determination for point A₁:

- Use the following expression:

$$\rho = \sum_{i=1}^4 H_i \frac{C_c}{1 + e_0} \log \left(\frac{\bar{\sigma}_{v0} + \Delta\sigma_v}{\bar{\sigma}_{v0}} \right)$$

where:

H_i = thickness of each sublayer = 10.0 ft

C_c = According to FHWA procedure = $\frac{w \%}{100}$

Therefore: $C_c = \frac{35 \%}{100} = 0.35$

e_0 = Initial void ratio = $\frac{Gw}{S} = \frac{2.78 \times 0.35}{1} = 0.973$

- Apply expressions above for $z = 12, 22, 32,$ and 42 ft. Results are indicated in table below:

z (ft)	H_i (ft)	$\Delta \bar{\sigma}_0$ (psf)	$\Delta \bar{\sigma}_v$ (psf)	$\bar{\sigma}_{vf} = \bar{\sigma}_{v0} + \Delta \bar{\sigma}_v$ (psf)	ρ_i (ft)
12	10	1083	782.6692	1865.6692	0.4190176
22	10	1733	601.0342	2334.0342	0.2293869
32	10	2383	466.5674	2849.5674	0.1377558
42	10	3033	375.3419	3408.3419	0.0898873
Total Settlement:					0.8760476 ft
					10.51 in

Compilation of Computer Screens for Example 4

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Version 2.00/October 1991

Hit <F10> to continue

OPENING SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
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Enter letter only, or use arrows then <↓> Make selection.

EMBANK MAIN MENU - SELECTION OF PROJECT DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition
	PROJECT DEFINITION Client = ANY CLIENT Project Name = EXCAVATION EXAMPLE Project Manager = Mr. John Doe File Name = EXAMPLE4.EMB Date = 3/13/92 (MM/DD/YY) Computed by = JUP
A Microcomputer dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Hit <F10> to accept values ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

PROJECT DEFINITION SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS
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Enter letter only, or use arrows then <→> Make selection.

EMBANK MAIN MENU - SELECTION OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu project Definition soil Profile and soil param. soil Profile and soil param. Void ratio per σ_{log} stress Strain per σ_{log} stress
	Run program Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
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Enter letter only, or use arrows then $\leftarrow$ Make selection. $\langle$ Esc $\rangle$ Main Menu

SOIL PROFILE MENU - SELECTION OF VOID RATIO PER LOG STRESS

FEDERAL HIGHWAY ADMINISTRATION	
Layer Number = 1	Elev. of top of layer = 0.00
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 100.00
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
Sublayer 2	Compression Index Estimated from e-logp curves
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit $\langle$ F10 $\rangle$ to continue	
Space Bar-Next item Alt-M-Menu	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #1

Layer Soil Properties		ADMINISTRATION	
Initial Water Content	= 80.00%	layer	= 0.00
Specific Gravity of Solids	= 1.80	yers	= 1 (for this layer)
Degree of Saturation	= 100.00%	soil	= 100.00
Hit <F10> to accept values			
Sublayer n	1	Type of layer	= Compressible
Sublayer 1		Layer soil properties	= Initial water content
		Compression Index	Estimated from e-logp curves
	Layer 2	Recompression Index	Estimated from e-logp curves
Sublayer 2		Swelling Index	Estimated from e-logp curves
Is this the last layer of profile No			
Hit <F10> to continue			

INITIAL WATER CONTENT - LAYER #1

Compression Index	
The Federal Highway Administration (FHWA) in the soil and Foundations Workshop Manual (1982) estimates the Compression Index by dividing the initial soil moisture content by 100.	
Comp. Index = Initial Water Content (in %) / Constant where constant = 100	
Constant = 100	
Hit <F10> to accept value	
Sublayer 2	Layer 2
	Compression Index Computed using FHWA(1982)
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
Is this the last layer of profile No	
Hit <F10> to continue	

COMPRESSION INDEX - FHWA PROCEDURE - LAYER #1

Compression Index	
Layer Number = 2	Elev. of top of layer = -3.00
Sublayer 1	Number of sublayers = 1 (for this layer)
:	Unit weight of soil = 110.00
Sublayer n	Type of layer = Incompressible
Sublayer 1	
:	
Sublayer 2	
Is this the last layer of profile No	
Hit <F9> to Prev. Layer Hit <F10> to continue	
Space Bar-Next item Alt-M-Menu	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #2

Compression Index	
Layer Number = 3	Elev. of top of layer = -10.00
Sublayer 1	Number of sublayers = 4 (for this layer)
:	Unit weight of soil = 127.40
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial void ratio
:	Compression Index Estimated from e-logp curves
Sublayer 2	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
Is this the last layer of profile No	
Hit <F9> to Prev. Layer Hit <F10> to continue	
Space Bar-Next item Alt-M-Menu	

SOIL DESCRIPTION AND PARAMETERS FOR LAYER #3

Layer Soil Properties	
Initial Water Content	= 35.00%
Specific Gravity of Solids	= 2.78
Degree of Saturation	= 100.00%
Hit <F10> to accept values	
layer	= -10.00
yers	= 4 (for this layer)
soil	= 127.40
Sublayer n	1 Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
Sublayer 2	Compression Index Estimated from e-logp curves
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue	

INITIAL WATER CONTENT - LAYER #3

Compression Index	
The Federal Highway Administration (FHWA) in the soil and Foundations Workshop Manual (1982) estimates the Compression Index by dividing the initial soil moisture content by 100.	
Comp. Index = Initial Water Content (in %) / Constant where constant = 100	
Constant = 100	
Hit <F10> to accept value	
Sublayer 2	Layer 2 Compression Index Computed using FHWA(1982)
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile No
Hit <F9> to Prev. Layer Hit <F10> to continue	

COMPRESSION INDEX - FHWA PROCEDURE - LAYER #3

Compression Index	
Layer Number = 3	Elev. of top of layer = -10.00
Sublayer 1	Number of sublayers = 4 (for this layer)
:	Unit weight of soil = 127.40
Sublayer n	Type of layer = Compressible
Sublayer 1	Layer soil properties = Initial water content
-----	Compression Index Computed using FHWA(1982)
Sublayer 2	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile ☒ Yes
Hit <F9> to Prev. Layer Hit <F10> to continue	
Space Bar--Next item Alt-M--Menu	

DEFINING LAYER #3 AS LAST LAYER OF SOIL PROFILE

Compression Index	
Layer Number = 3	Elev. of top of layer = -10.00
Sublayer 1	Number of sublayers = 4 (for this layer)
:	
Sublayer n	Elev. of bottom of last layer = -50.00
Sublayer 1	Hit <F10> to accept value
-----	ter content
Sublayer 2	Compression Index Computed using FHWA(1982)
	Recompression Index Estimated from e-logp curves
	Swelling Index Estimated from e-logp curves
	Is this the last layer of profile Yes
Hit <F9> to Prev. Layer Hit <F10> to continue	

DEFINING THICKNESS OF SOIL PROFILE

FEDERAL HIGHWAY ADMINISTRATION	
EMBank A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. Water Table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then $\leftarrow$ $\rightarrow$ Make selection.

EMBank MAIN MENU - SELECTION OF WATER TABLE DEFINITION

FEDERAL HIGHWAY ADMINISTRATION	
EMBank A Microcomputer pro dimensional compress due to embankment loa the equations presented by Lambe & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. Water table definition - Stress history - Vertical stress increment Water Table Definition Units Elev. of Water Table = -5.00 ille m S

WATER TABLE AT ELEVATION -5 FT

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - STRESS HISTORY

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition Stress history Stress history Normally consolidated soil - User defined stress history E
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. (Esc) → Main Menu

SOIL IS DEFINED AS NORMALLY CONSOLIDATED

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <J> Make selection.

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment
	Vertical stress increment strip Symmetrical vertical embankment loading increment of stresses Beneath the end of a fill
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then <J> Make selection. <Esc> Main Menu

VERTICAL STRESS INCREMENT - SELECTION OF STRIP SYMM. EMBANKMENT LOAD

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 10.00 Embank. width b = 30.00 Height of fill H = 10.00 Unit weight of fill = 120.00	
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = 20.00	
FOUNDATION ELEV. Z = 0.00	
Hit <F10> to accept values	
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
ERING INC. Avenue A 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

STRIP SYMM. VERTICAL EMB. LOADING GEOMETRY INPUT SCREEN

FEDERAL HIGHWAY ADMINISTRATION	
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lamb8Whitman (1969), Ladd (1973) and Poulos8Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	
Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment system of Units Maintain file Run program Exit to DOS	
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then < > Make selection.

EMBANK MAIN MENU - RUN PROGRAM OPTION

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Embankment slope a = 10.00 (ft) Height of fill H = 10.00 (ft)
Embankment top width = 20.00 (ft) Unit weight of fill = 120.00 (pcf)
Embankment bottom width = 40.00 (ft) p load/unit area = 1200.00 (psf)
Ground Surface Elev. = 0.00 (ft) Foundation Elev. = 0.00 (ft)
Water table Elev. = -5.00 (ft) Unit weight of Mat. = 62.40 (pcf)

No.	LAYER TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)
			COMP.	RECOMP.	SWELL.				
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	9.97
2	INCOMP.	7.0	-----	-----	-----	110.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	12.54
Total Settlement =									21.23

SUBLAYER SOIL STRESSES

No.	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	INCREMENT (psf)	MAX. PAST PRESS. (psf)	SETTLEMENT (in.)
1	3.00	-1.50	200.00	1199.37	200.00	9.97
2	10.00	-15.00	1083.00	967.60	1083.00	5.90
3	10.00	-25.00	1733.00	740.24	1733.00	3.23
4	10.00	-35.00	2383.00	580.59	2383.00	2.02
5	10.00	-45.00	3033.00	471.95	3033.00	1.34
Total Settlement =						21.23 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

PROGRAM OUTPUT - PARTIAL SCREEN

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

No.	THICK. (ft)	ELEV. (ft)	INITIAL (psf)	INCREMENT (psf)	MAX. PAST PRESS. (psf)	SETTLEMENT (in.)
1	3.0	-1.50	200.00	1199.37	200.00	9.97
2	10.00	-15.00	1083.00	967.60	1083.00	5.90
3	10.00	-25.00	1733.00	740.24	1733.00	3.23
4	10.00	-35.00	2383.00	580.59	2383.00	2.02
5	10.00	-45.00	3033.00	471.95	3033.00	1.34
Total Settlement =						21.23 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISC FILE PRINTED OUTPUT

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration									
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING									
		(ft)	(pcf)				(in.)		
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	9.97
2	INCOMP.	7.0	-----	-----	-----	110.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	12.54
Total Settlement =									21.23

SUBLAYER			SOIL STRESSES			Destination File	
Nº.	THICK.	ELEV.	INITIAL	INCRE			
	(ft)	(ft)	(psf)	(psf)			
1	3.00	-1.50	200.00	1199.37	200.00		9.97
2	INCOMP.						
3	10.00	-15.00	1083.00	967.60	1083.00		5.90
4	10.00	-25.00	1733.00	740.24	1733.00		3.29
5	10.00	-35.00	2383.00	580.59	2383.00		2.02
6	10.00	-45.00	3033.00	471.95	3033.00		1.34
Total Settlement =							21.23 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF OUTPUT DESTINATION FILE NAME

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration									
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING									
Project Name : EXCAVATION EXAMPLE Client : ANY CLIENT									
File Name : EXAMPLE4.EMB Project Manager : MR. JOHN DOE									
Date : 10/03/91 Computed by : aum									
Settlement for X = 20.00 (ft)									
Embankment slope a = 10.00 (ft) Height of fill H = 10.00 (ft)									
Embankment top width = 20.00 (ft) Unit weight of fill = 120.00 (pcf)									
Embankment bottom width = 40.00 (ft) p load/unit area = 1200.00 (psf)									
Ground Surface Elev. = 0.00 (ft) Foundation Elev. = 0.00 (ft)									
Water table Elev. = -5.00 (ft) Unit weight of Wat. = 62.40 (pcf)									

LAYER		COEFFICIENT				UNIT		SPECIFIC VOID	
Nº.	TYPE	THICK.	COMP.	RECOMP.	SWELL.	WEIGHT	GRAVITY	RATIO	Settlement
		(ft)				(pcf)			(in.)
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	9.97
2	INCOMP.	7.0	-----	-----	-----	110.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	12.54
Total Settlement =									21.23

SUBLAYER			SOIL STRESSES			SETTLEMENT	
Nº.	THICK.	ELEV.	INITIAL	INCREMENT	MAX. PAST PRESS.		
	(ft)	(ft)	(psf)	(psf)	(psf)		(in.)
1	3.00	-1.50	200.00	1199.37	200.00		9.97
2	INCOMP.						
3	10.00	-15.00	1083.00	967.60	1083.00		5.90
4	10.00	-25.00	1733.00	740.24	1733.00		3.29
5	10.00	-35.00	2383.00	580.59	2383.00		2.02
6	10.00	-45.00	3033.00	471.95	3033.00		1.34
Total Settlement =							21.23 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

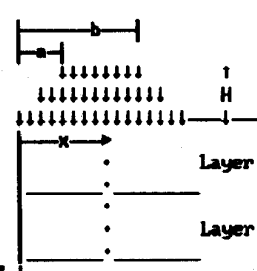
Enter letter only, or use arrows then ← → Make selection.

EMBANK MAIN MENU - SELECTION OF VERTICAL STRESS INCREMENT

FEDERAL HIGHWAY ADMINISTRATION	
EMBANK A Microcomputer program for dimensional compression over due to embankment loads. The program follows the equations presented by Lambeth & Whitman (1969), Ladd (1973) and Poulos & Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu project Definition soil Profile and soil param. Water table definition Stress history Vertical stress increment Vertical stress increment strip Symmetrical vertical embankment loading increment of stresses Beneath the end of a fill PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then <J> > Make selection. <Esc> > Main Menu

VERTICAL STRESS INCREMENT MENU - SELECTION OF STRIP SYMM. EMB. LOAD

SYMMETRICAL VERTICAL EMBANKMENT LOAD	
VERTICAL EMBANKMENT FOOTING Embank. slope a = 10.00 Embank. width b = 30.00 Height of fill H = 10.00 Unit weight of fill = 120.00 POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = 20.00 FOUNDATION ELEV. Z = 1	 Hit <F10> to accept values
increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	

LOAD GEOMETRY - FOUNDATION DEPTH AT ELEVATION -3 FT

SYMMETRICAL VERTICAL EMBANKMENT LOAD

VERTICAL EMBANKMENT FOOTING Embank. slope a = 10.00 Embank. width b = 30.00 Height of fill H = 10.00 Unit weight of fill = 120.00			u n soil param. ition
POINTS FOR COMPUTATION OF SETTLEMENT calculate in = X Point x coordinate = 20.00			ncrement t nt loading nd of a fill
FOUNDATION ELEV. Z = -3.00			ERING INC. Avenue A 81890 29-2363 Ifredo Urzua

Compute excavation effect as gamma*Foundation Depth = ☐ No ☒ Yes

Hit <F10> to accept values ☐ No ☒ Yes

Increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads. Attn

←F1→-Move bar ←-Select Esc-Exit

SELECTION OF EXCAVATION EFFECT

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ←J→ Make selection.

EMBANK MAIN MENU - RUN PROGRAM

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

Embankment slope a = 18.00 (ft) Height of fill H = 18.00 (ft)
Embankment top width = 28.00 (ft) Unit weight of fill = 128.00 (pcf)
Embankment bottom width = 48.00 (ft) p load/unit area = 1280.00 (psf)
Ground Surface Elev. = 8.00 (ft) Foundation Elev. = -3.00 (ft)
Water table Elev. = -5.00 (ft) Unit weight of Wat. = 62.40 (pcf)

No.	LAYER TYPE	THICK. (ft)	COEFFICIENT			UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO	Settlement (in.)
			COMP.	RECOMP.	SWELL.				
1	COMP.	3.0	0.800	0.800	0.000	100.00	1.80	1.44	0.00
2	INCOMP.	7.0	-----	-----	-----	118.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	10.51
Total Settlement =									10.51

SUBLAYER SOIL STRESSES
No. THICK. ELEV. INITIAL INCREMENT MAX.PAST PRESS. SETTLEMENT

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

PROGRAM OUTPUT - PARTIAL SCREEN

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING

		(ft)				(pcf)			(in.)
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	0.00
2	INCOMP.	7.0	-----	-----	-----	118.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	10.51
Total Settlement =									10.51

SUBLAYER SOIL STRESSES
No. THICK. ELEV. INITIAL INCR Select
(ft) (ft) (psf) (p) Send form to: ☐-Printer, ☐-Disk File.

1	Sublayer over Foundation Elev.									
2	INCOMP.									
3	10.00	-15.00	1883.00	782.67	1883.00		5.83			
4	10.00	-25.00	1733.00	601.03	1733.00		2.75			
5	10.00	-35.00	2383.00	466.57	2383.00		1.65			
6	10.00	-45.00	3033.00	375.34	3033.00		1.00			
Total Settlement =										10.51 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF DISC FILE PRINTED OUTPUT

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration									
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING									
		(ft)			(pcf)			(in.)	
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	0.00
2	INCOMP.	7.0	-----	-----	-----	110.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	10.51
Total Settlement =									10.51

SUBLAYER		SOIL STRESSES		Destination File	
NO.	THICK.	ELEV.	INITIAL	INCRE	
	(ft)	(ft)	(psf)	(ps)	
1	Sublayer over foundation Elev.				
2	INCOMP.				
3	10.00	-15.00	1083.00	782.67	1083.00 5.03
4	10.00	-25.00	1733.00	601.03	1733.00 2.75
5	10.00	-35.00	2383.00	466.57	2383.00 1.65
6	10.00	-45.00	3033.00	375.34	3033.00 1.08
Total Settlement =					10.51 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

SELECTION OF OUTPUT DESTINATION FILE NAME

ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration									
STRIP SYMMETRICAL VERTICAL EMBANKMENT LOADING									
Project Name		: EXCAVATION EXAMPLE		Client		: ANY CLIENT			
File Name		: EXAMPLE4.EMB		Project Manager		: MR. JOHN DOE			
Date		: 10/03/91		Computed by		: aum			

Settlement for X = 20.00 (ft)

Embankment slope a	=	10.00 (ft)	Height of fill H	=	10.00 (ft)
Embankment top width	=	20.00 (ft)	Unit weight of fill	=	120.00 (pcf)
Embankment bottom width	=	40.00 (ft)	p load/unit area	=	1200.00 (psf)
Ground Surface Elev.	=	0.00 (ft)	Foundation Elev.	=	-3.00 (ft)
Water table Elev.	=	-5.00 (ft)	Unit weight of Wat.	=	62.40 (pcf)

LAYER		COEFFICIENT		UNIT		SPECIFIC		VOID	
Na.	TYPE	THICK.	COMP.	RECOMP.	SWELL.	WEIGHT	GRAVITY	RATIO	Settlement
		(ft)				(pcf)			(in.)
1	COMP.	3.0	0.800	0.000	0.000	100.00	1.80	1.44	0.00
2	INCOMP.	7.0	-----	-----	-----	110.00	-----	-----	-----
3	COMP.	40.0	0.350	0.000	0.000	127.40	2.78	0.97	10.51
Total Settlement =									10.51

SUBLAYER		SOIL STRESSES		SETTLEMENT	
Na.	THICK.	ELEV.	INITIAL	INCREMENT	MAX.PAST PRESS.
	(ft)	(ft)	(psf)	(psf)	(psf)
1	Sublayer over foundation Elev.				
2	INCOMP.				
3	10.00	-15.00	1083.00	782.67	1083.00 5.03
4	10.00	-25.00	1733.00	601.03	1733.00 2.75
5	10.00	-35.00	2383.00	466.57	2383.00 1.65
6	10.00	-45.00	3033.00	375.34	3033.00 1.08
Total Settlement =					10.51 (in.)

Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run program - Exit to DOS PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection.

EMBAK MAIN MENU - MAINTAIN FILE OPTION

FEDERAL HIGHWAY ADMINISTRATION	
 A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units Maintain file - Run - Exit Maintain file Save file - Retrieve file - Clear entries PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

Enter letter only, or use arrows then ← → Make selection. (Esc) → Main Menu

MAINTAIN FILE MENU - SELECTION OF SAVE FILE

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run Maintain file - Exit Save File - Destination File
A Microcomputer program for computing one dimensional compression vertical sett due to embankment loads. The program f the equations presented by Lambe&W (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	EXAMPLE4.EMB
PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua	

Enter letter only, or use arrows then < > Make selection. <Esc> > Main Menu

SAVING INPUT FILE AS EXAMPLE4.EMB

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
A Microcomputer program for computing one dimensional compression vertical settlement due to embankment loads. The program follows the equations presented by Lambe&Whitman (1969), Ladd (1973) and Poulos&Davis (1974). For the case of a strip symmetrical vertical embankment loading the program superimposes two vertical embankment loads. For the increment of vertical stresses at end of fill, the program superimposes a series of rectangular loads.	PROTOTYPE ENGINEERING INC. 57 Westland Avenue Winchester, MA 01890 (617) 729-2363 Attn. Dr. Alfredo Urzua

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EMBANK MAIN MENU - EXIT TO DOS OPTION

FEDERAL HIGHWAY ADMINISTRATION	
	Main Menu - project Definition - soil Profile and soil param. - Water table definition - Stress history - Vertical stress increment - system of Units - Maintain file - Run program - Exit to DOS
	Exit to DOS Yes No
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EXIT TO DOS MENU - YES OPTION

